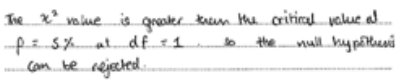
Mark scheme

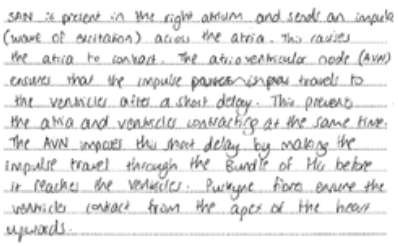
Question			Answer/Indicative content	Marks	Guidance
1	a	i	3:1 / higher, collagen:elastin ratio, leads to, an aneurysm forming / a larger aneurysm ✓	1	**IGNORE** as the aneurysm size increases the collagen:elastin ratio increases **Examiner's Comments** The question was well answered. Good answers separated the 2:1 ratio from the others, having appreciated the baseline relevance of patient A's data. Some answers referred to more collagen as a cause of the aneurysm without appreciating that it is relative to elastin and may not necessarily mean an increase in collagen in isolation.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE.** **If answer = 5.297 award 3 marks** 5.297 ✓✓✓ **If answer incorrect allow:** $(O-E)^2$ = 1156 (males and females) ✓ $(O-E)^2/E$ = 1.927 **and** 3.370 (males and females) ✓	3	**ALLOW** 2 marks for **correct answer** to incorrect significant figures **ALLOW** 1.927 **and** 3.370 to incorrect significant figures. *Calculation:* *= $(-34)^2/600 + (34)^2/343$* *= 1156/600 + 1156/343* *= 1.927 + 3.370 = 5.2968 = 5.297* **Examiner's Comments** A good differentiator with some candidates achieving maximum marks but many didn't attempt the question. The most common error was to use the female or male data instead of both. *Calculation:* $= (-34)^2/600 + (34)^2/343$ = 1156/600 + 1156/343

					= 1.927 + 3.370 = 5.2968 Rounding up to 4 sig figs = 5.297
		iii	**1** reject the null hypothesis / there is a difference between expected and observed (at the 5% level) ✓ **2** as (calculated) chi squared is higher than, the critical value of 3.841 ✓ **3** using 1, df / degree of freedom (at the 5% level) ✓	max 2	**ALLOW ECF** from 4(a)(ii) throughout **1 ALLOW ECF** from incorrect critical value used **2 ALLOW** 3.841 (only) circled in table for 'the critical value of 3.841'. **2 ALLOW** 5.297 >3.841 **3 ALLOW** 1 df circled in the table **Examiner's Comments** Only a few candidates could interpret their answer from question 4 (a) (ii) and provide an answer in this question. Although candidates were able to select the correct probability, there was often confusion with the degrees of freedom required for a chi squared test. The degrees of freedom for chi-squared test is calculated as: df = (r-1) (c-1) r = number of rows c = number of columns *Calculation for df*: df = (2-1) (2-1) = 1 **OCR support** The Mathematical skills handbook covers contexts in biology and the chi squared test. There is also additional support on statistics on 'Maths for Biology' resources, which include a tutorial and a quiz, as well as the 'Statistics for Biologists' resource.

					Exemplar 2  The χ^2 value is greater than the critical value at $p = 5\%$ at $df = 1$, so the null hypothesis can be rejected. This exemplar lays out the order in which to answer a conclusion from a statistical test, starting with a comparison of the calculated value with the critical value, referring to the degrees of freedom used and concluding with a correct rejection of the null hypothesis.
	b	i	**1** stops backflow of blood due to low pressure ✓ **2** allows (one way) flow back to the heart ✓	2	**2 ALLOW** stops backflow of blood so blood goes to the heart **<u>Examiner's Comments</u>** Most candidates realised that valves prevent the backflow of blood but did not explain this role, merely stating it. Some answers referred solely to the role of valves in the heart rather than veins.
		ii	**1** relaxation of smooth muscle (in arteriole) causes vasodilation (of the lumen) ✓ **2** (this) regulates / controls, blood flow to capillaries (in the organ) ✓ **3** pressure of blood in artery is high<u>er</u> ✓ **4** as blood flows from the artery to the arteriole, the pressure falls ✓ **5** (so) capillary (walls) will not rupture ✓	max 3	**IGNORE** ref to the, small size / number, of arterioles **IGNORE** ref to vasoconstriction **2 IGNORE** ref to diffusion **3 ALLOW** arterioles have a lower pressure **<u>Examiner's Comments</u>** Most candidates struggled to answer this question. Candidates rarely referred to arterioles branching into capillaries and thus the importance of controlling blood flow in the arterioles. Answers often referred to arterioles as increasing blood pressure so blood flow increases as it enters organs. **Assessment for learning** Arterioles should be regarded as

					the resistant vessels with the smooth muscle restricting blood flow to help lower the pressure as blood enters the capillaries. Analogies with physics and electrical current/resistance would be relevant to these concepts. **Misconception** A common misconception is vasoconstriction increasing blood flow and pressure.
	c		**Level 3 (5–6 marks)** A full and detailed description of how heart action is initiated by the SAN **AND** coordinated including the AVN, Bundle of His **AND** Purkyne fibres **AND** a detailed explanation of why the atria and ventricles don't contract at the same time. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** A detailed description of how heart action is initiated by the SAN **AND** coordinated to include the AVN and Bundle of His **OR** Purkyne fibres **AND** a simple explanation of why the atria and ventricles don't contract at the same time. *There is a line of reasoning presented with some structure. The information presented is relevant andsupported by some evidence.* **Level 1 (1–2 marks)** A brief description of how heart action is initiated by the SAN **AND** coordinated with the AVN **OR**	6	**Indicative points may include:** **SAN** • (starts the) wave of excitation • electrical activity causes **atria** to contract • non conducting tissue • ref to pace maker • myogenic / not requiring input from brain **AVN** • atrio-ventricular node (AVN) • picks up electrical activity from SAN **Contraction not at same time** • AVN causes a slight (0.1ms) delay • (AVN) delay ensures atria have stopped contracting before the ventricles contract • Ventricles only contract when (wave of excitation in) Purkyne fibres • Makes sure blood has, left the atria/ entered the ventricles. • Otherwise less blood will exit the heart **Bundle of His and Purkyne fibres**

			reference to the delay after the SAN. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 mark** *No response or no response worthy of credit.*		• AVN stimulates Bundle of His • Bundle of His in septum • Bundle of His conducts wave of excitation to apex (of heart) • Bundle of His / Purkyne, is specialised muscle fibres • Purkyne fibres in walls of ventricles • Purkyne fibres ensures ventricles contract at same time *Examples of when the communication statement would be met include:* Correct chronology of the electrical activity Focus on electrical activity associated with the cardiac cycle **Examiner's Comments** Good answers had a clear flow from the SAN and atrial systole through the Bundle of His to Purkyne fibres and ventricular systole. These answers concentrated on the electrical activity of the heart and did not become diverted by discussions centred around blood flow through the heart. Some answers did not state the consequences of SAN or AVN activation or mixed the chronology of events. A few candidates confused the AVN node with AV valves. **Assessment for learning** Words that can become mixed together for candidates should be discussed and highlighted to help detangle them. Etymology and discussions beyond the limitations of letter abbreviations for certain scientific words is beneficial.

					Exemplar 3  SAN is present in the right atrium and sends an impulse (wave of excitation) across the atria. This causes the atria to contract. The atrioventricular node (AVN) ensures that the impulse passes/stops travel to the ventricles after a short delay. This prevents the atria and ventricles contracting at the same time. The AVN imposes this short delay by making the impulse travel through the Bundle of His before it reaches the ventricles. Purkyne fibre ensure the ventricles contract from the apex of the heart upwards. This exemplar answer is clear and to the point, with an exact chronology of events and no deviation with blood flow which is irrelevant to the question asked. Reference to a delay is provided within the sequence of events to provide a flow of succinct facts.
			Total	**17**	
2		i	**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = −1.5 (kPa) award 2 marks** ✓✓ net hydrostatic pressure = 1.7 − 1.1 = 0.6 net oncotic pressure = −3.3 − (−1.2) = −2.1 net pressure = 0.6 + (−2.1) = −1.5 (kPa)	2	**Minus sign needed for two marks** **For one mark** 1.5 (without the minus) **OR** anywhere within calculation (net hydrostatic pressure) = 0.6 **OR** anywhere within calculation (net oncotic pressure) = −2.1 **<u>Examiner's Comments</u>** Good responses included clear working of net hydrostatic pressure and net oncotic pressure before adding these together. Many incorrect responses gave -1.6 or -1.7 responses and one mark for the working was rarely given. Common errors included: • calculation of total oncotic pressure values and subtracting these from the total hydrostatic pressure values • adding the hydrostatic or oncotic pressures of the blood and tissue fluid together instead of calculating the net pressure

					• errors in subtraction of the correct negative numbers *Calculation:* net hydrostatic pressure = 1.7 − 1.1 = 0.6 net oncotic pressure = −3.3 − (−1.2) = −2.1 net pressure = 0.6 + (−2.1) = −1.5 (kPa)
		ii	hydrostatic (pressure) at arteriole end is higher than oncotic (pressure) so fluid moves out (of blood / capillaries) **OR** net positive pressure at arteriole end so fluid moves out (of blood / capillaries) ✓ hydrostatic (pressure) at venule end is lower than oncotic (pressure) so fluid moves in (to blood / capillaries) **OR** net negative pressure at venule end so fluid moves in (to blood / capillaries) ✓	2	Must be comparative **ALLOW** arterial for arteriole and venous for venule **ALLOW** e.g. plasma / water for fluid **DO NOT ALLOW** blood **ALLOW** ora e.g. oncotic is lower at arteriole end than hydrostatic so fluid moves out **Examiner's Comments** Candidates that completed the calculation in **18(c)(i)** correctly were more likely to gain full marks here. Responses that did not gain credit were unclear about which end (of the capillary bed) they were describing (i.e. arteriole or venule) and some responses only included details about one end. Many responses referred only to hydrostatic pressure and did not include the idea of the *difference* between hydrostatic pressure and oncotic pressure. Some candidates had difficulty in naming the fluid itself, using terms like 'small molecules' or 'substances' and even 'blood' being stated as an example. **Assessment for learning** The number of incorrect responses suggest that the formation of tissue

					fluid is not understood well or that candidates were not able to effectively use the information given in the table. Candidates should be encouraged to learn and use appropriate terminology involved in the formation of tissue fluid and its return to capillaries. **Misconception** A common misconception is that movement of water is by osmosis rather than caused by pressure difference between hydrostatic and oncotic pressures (at arteriole or venule end). The pressure difference forces the water through and is not due to any difference in water potentials on either side of the capillary.
			Total	**4**	
3			A	1	**Examiner's Comments** Many candidates correctly chose option **A**. Option **C** was an incorrect option chosen by some candidates, possibly not realising that insulin and glucagon would need to enter tissue fluid to reach the receptors on the cells of the tissue.
			Total	**1**	
4			D	1	**Examiner's Comments** Most candidates chose the correct response, option **D**. The most common incorrect response was option **B**, perhaps as candidates could not recall the correct name for the valves between the atria and ventricles. Some candidates confused the left and right sides of

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td>the heart, choosing the incorrect option C.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>5</td><td></td><td>i</td><td>
<table>
<tr><th>Statement</th><th>Level of Protein Structure</th></tr>
<tr><td>Disulfide bonds are formed when two cysteine amino acids in an a-globin chain come together after the alpha helix folds</td><td>tertiary</td></tr>
<tr><td>Haemoglobin is made up of two α-globin chains and two β-globin chains</td><td>quaternary</td></tr>
<tr><td>Each α-globin and β-globin chain undergoes folding into a spherical shape</td><td>tertiary</td></tr>
<tr><td>β-globin is an amino acid sequence, 147 amino acids in length</td><td>primary</td></tr>
</table>
</td><td>3</td><td>4 correct answers = 3 marks ✓ ✓ ✓
3 correct answers = 2 marks ✓ ✓
2 or 1 correct answer(s) = 1 mark ✓

ALLOW phonetic spelling e.g. quarternary

<u>Examiner’s Comments</u>

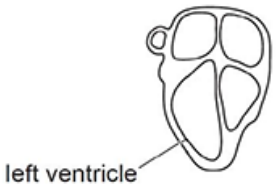
Most candidates were given 1 or 2 marks here. Some candidates lost all marks as they misunderstood the question and wrote ‘once’, ‘more than once’ or ‘not at all’ in the boxes, taking these from the question stem. Some thought that all the structures needed to be used, and so mistakenly identified secondary for one of the statements. Both of these points indicate that some candidates need more practice with this style of question and/or need to take more time to understand the task outlined and should be advised not to rush into this style of question.</td></tr>
<tr><td></td><td></td><td>ii</td><td>carbonic anhydrase ✓</td><td>1</td><td>ALLOW phonetic spelling
ALLOW ‘carbonate hydrolase’

<u>Examiner’s Comments</u>

When attempted, this was well answered and many candidates were given the mark. When attempted correctly, spelling was generally good with only a small number not spelling the enzyme correctly, although clear phonetic spelling was given the mark. Those who were not given the mark either gave other enzymes or did not give a response.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
<tr><td>6</td><td></td><td></td><td>B ✓</td><td>1</td><td><u>Examiner’s Comments</u>

Many candidates were able to identify the correct cells in the</td></tr>
</table>

					image provided and selected B as the correct response. Examination of microscope images/micrographs and drawing skill activities linked to the different types of leucocytes can reinforce the key features of the different types.
			Total	**1**	
7			C ✓	1	**Examiner's Comments** The was a well-answered question which showed that many candidates were able to carry out the needed calculation. They recognised that they needed to convert the dm^3 of the cardiac output into cm^3 to make it the same units as the stroke volume, before multiplying the value by 5 as answer is for five minutes to get C as the correct answer. *Calculation:* Rearrange equation: Cardiac output = stroke volume x heart rate Heart rate = cardiac output / stroke volume Convert dm^3 to cm^3 = 28 x 1000 = 28,000cm^3 Heart rate per min = 28,000 / 160 = 175 Heart rate for 5 mins = 175 x 5 = 875
			Total	**1**	
8			B ✓	1	**Examiner's Comments** Many candidates were able to identify an absence of erythrocytes in tissue fluid as the correct response(B). Some gave A as the correct response possibly because tissue fluid carries oxygen towards muscle cells, so some oxygen may be carried away this would not be a specific feature of tissue fluid but a side consequence of excess oxygen in the blood or possibly low

					metabolic activity of muscle cells. The most common incorrect responses were C and D, where the formation of tissue fluid was poorly understood.
			Total	**1**	
9	a		simple line drawing of the heart with continuous and non-overlapping lines ✓ no shading **and** covers at least half the box ✓ left ventricle labelled (left bottom chamber) ✓	3	**Place three annotations in vertical column to left hand side of the diagram in order of marks in mark scheme** **Note diagram should be at least half the vertical size of the space provided** **IGNORE** absence of the blood vessels shown in the photograph **DO NOT ALLOW** if label line is not ruled or has arrowhead e.g. 3 marks for this:  **<u>Examiner's Comments</u>** Many candidates achieved one mark. This was usually for the size of the diagram covering more than half the available space. The quality of the diagrams did not usually follow the guideline for biological drawings (i.e., lines were not drawn with sufficient care and most diagrams showed overlapping lines or incomplete lines). On the positive side very few diagrams had been shaded. Candidates did find the interpretation of the images to be demanding and many labelled the left ventricle on the right-hand side of their diagram as would be expected in the normal textbook view of a heart. Of those that did correctly identify the left ventricle some lost the mark because they

					did not use a ruler for their label line or added an arrowhead. **OCR support** Guidance on biological drawings is available in the drawing skills handbook at: Drawing skills handbook: Biology Learner checklist: Graphs, Tables and drawings
	b	i	double and closed ✓	1	**Examiner's Comments** Most candidates recognised this as a double or a closed circulatory system but only the more able candidates identified both aspects.
		ii	*idea of* high, metabolic demands / activity levels ✓ small(er) SA:V ratio / diffusion pathway too long ✓ for, transport / delivery / supply, of (named) substances ✓	2 max	**ALLOW ORA** if they talk about small(er) organisms throughout **ALLOW** birds fly and therefore use a lot of energy **IGNORE** high metabolic rate **ALLOW** diffusion, too slow / would take too long e.g. of named substances: oxygen, carbon dioxide, glucose, metabolic wastes **Examiner's Comments** The majority of candidates gained credit for the idea that a larger organism would have a smaller surface area to volume ratio, but few could develop the idea much further. Some candidates gained credit for understanding that oxygen has to be delivered to all the tissues. Less able candidates discussed the idea of gas exchange rather than transport. Only a few more able candidates linked in the idea of higher metabolic demand in larger organisms.
	c		*in bird ECG…* *idea of* (Q)R(S) (wave) moves	2 max	**assume answer refers to the bird ECG unless otherwise stated.**

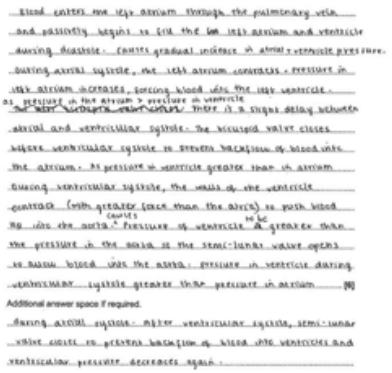
			down instead of moving up ✓ no gap between (QR)S and T ✓ higher T (wave) ✓ faster heart rate ✓		**ALLOW ORA** for human ECG statements **ALLOW** ventricular, wave / systole, moves down instead of up **ALLOW** (ventricular) diastole (wave) higher **IGNORE** beats faster **ALLOW** more beats per second / higher bpm **<u>Examiner's Comments</u>** The majority of candidates recognised that the heart rate was higher than in a human. However, very few candidates could describe the trace accurately referring to the letters P, Q, R, S and T. Many recognised that part of the trace (the R peak in humans) went down rather than up. Sometimes the attempted descriptions were too vague such as 'the peak is upside down' or 'the trace is upside down'. The least able candidates related the trace to breathing movements as if it were a spirometer trace.
			Total	**8**	
10	a	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 7010 / 7012.5 / 7013 cm^3 min^{-1} award 3 marks** correct values from graph for stroke volume **and** heart rate at 20 weeks ✓ correct use of cardiac output = heart rate x stroke volume i.e. 82.5 x 85 = 7012.5 ✓ correct units = **cm^3 min^{-1}** ✓	3 (AO2.2)	**ALLOW for 3 marks 7.01 / 7 / 7.0 dm^3 min^{-1}** **ALLOW** for numbers indicated on graphs or seen in response SV = 85 (cm^3) **and** HR = 82.5 (bpm) **ALLOW** max 2 ECF from incorrect values from graph **e.g. 83 x 85 = 7055 cm^3 min^{-1}** **ALLOW** 1 mark for correct unit i.e. **cm^3 min^{-1}** **Answer must match unit** e.g. 7.01 cm^3 min^{-1} = 2 marks as correct answer but incorrect unit **ALLOW** cm^3 / min for cm^3 min^{-1} **ALLOW** L min^{-1} or dm^3 / min L / min or for dm^3 min^{-1} **DO NOT ALLOW** m for mins

					Examiner's Comments Most candidates selected the correct figures from the graph in Fig. 16.1 to gain 1 mark. Candidates who could recall the correct equation for cardiac output achieved 2 marks for the calculation. However, some candidates divided one figure by the other instead of multiplying them. Some candidates also struggled with the units, often stating cm^3/bpm, suggesting they have applied the logic of combining the units for stroke volume and heart rate but not appreciating that the 'beats' would not be a unit that could be used for cardiac output.
		ii	to deliver more blood to , (maternal) cells / tissues / organs / placenta ✓ to deliver more , oxygen / glucose / amino acids , to , (fetal / maternal) cells / tissues / organs ✓ to meet the need for , higher / faster , metabolic rate (of mother / fetus) ✓	max 1 (AO2.1)	**IGNORE** baby / body **DO NOT ALLOW** delivers more blood to fetus **IGNORE** nutrients **ALLOW** higher / faster , respiration rate for metabolic rate **Examiner's Comments** Good responses suggested that increased cardiac output would help more blood to be delivered to the placenta or more oxygen to respiring fetal cells. However, many candidates found it challenging to use the correct terminology and suggested the advantage of increase in cardiac output is to deliver more blood around the body without mentioning specifically to the (fetal/maternal) cells, tissues, organs, or placenta.
		iii	1 *conclusion is valid because* during weeks 9 to 24 as cardiac output increases blood pressure decreases ✓ 2 *idea that* decreased vascular resistance could explain drop in blood pressure ✓	max 3 (AO3.2)	**MP1 ALLOW** any range in weeks between 9 to 24 stated that incorporates at least three bars e.g. from 13 to 24 weeks **MP1 ALLOW** conclusion is only, valid / true , up to , 20 / 24 , weeks

			3 *conclusion is not valid because* after 24 weeks / from 25 weeks , blood pressure increases ✓ 4 (changes in blood pressure) could be due to (named) factor (other than vascular resistance) ✓ 5 *general statements* – ***max 2 marks*** overlapping error bars suggest that any changes in blood pressure are not significant ✓ 6 no (named) statistical tests / would need to carry out appropriate statistical test ✓ 7 no mention of how many females were involved in the study ✓ 8 no data available at 0 weeks in , Fig.16.2 / bar chart ✓		**MP4 ALLOW** e.g. changes in blood volume e.g. changes in hormone levels **MP4 IGNORE** suggestions for lifestyle changes that would decrease blood pressure e.g. diet, exercise **MP6 IGNORE** correlation / chi-squared for named statistical tests **MP7 ALLOW** no sample size **<u>Examiner's Comments</u>** Good responses were able to link points from the data provided in Fig. 16.1 and 16.2 to the validity of the conclusion. Many responses referred to stroke volume and heart rate rather than the consequential cardiac output and did not provide a full description of the trends shown. Time references were often focused on the lowest or highest levels of blood pressure, or just referred to early or late stages of pregnancy without quoting the correct range of weeks from the data. Successful candidates provided a balanced argument and noted the lack of a statistical test, no stated sample size or no data being seen at 0 weeks in Fig. 16.2. Some candidates referred to the overlapping error bars but were unable to correctly describe what this implied. Several candidates mentioned that correlation did not mean causation but not all followed this with the idea that the blood pressure changes may be due to another factor.
	b		***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using a 'best-fit' approach based on the science content of the answer, first decide which of the*	6 (AO1.2)	**Loss of mark for communication statement for incorrect statements and more than 50% irrelevant points** e.g. describes flow of blood through <u>right</u> side of heart, incorrect sequence of blood flow, SL valves with AV function, low(er) pressure

			*level descriptors, **Level 1**, **Level 2** or **Level 3**, best describes the overall quality of the answer. Then, award the higher or lower mark within the level, according to the **Communication Statement** (shown in italics):* ○ *award the higher mark where the Communication Statement has been met.* ○ *award the lower mark where aspects of the Communication Statement have been missed.* • **The science content determines the level.** • **The Communication Statement determines the mark within a level.** **Level 3** (5–6 marks) A detailed account that correctly describes blood flow through the heart **and** includes statements about the role of valves **and** pressure differences. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2** (3–4 marks) An account that **partly** describes blood flow through the heart **and** includes **a** statement about the role of valves **and** pressure differences. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1** (1–2 marks) A basic outline that **partly** describes blood flow through the		for high(er) pressure, AV valve stays shut until atrium contracts **Indicative scientific content** ***Blood flow through left side of heart*** • return via pulmonary <u>vein</u> • (left) atrium → (left) ventricle → aorta **Role of valves** • to prevent back-flow • valves open or close due to pressure differences • atrio-ventricular / AV / bicuspid **and** semi-lunar / SL / aortic • AV between atrium and ventricle • SL between ventricle and aorta **Pressure differences** *diastole* • during diastole pressure is (relatively) low • pressure increases as (left) atrium fills with blood *atrial systole* • pressure increases due to atrial , contraction / systole • blood forced into (left) ventricle *ventricular systole* • further increases due to atrial , contraction / systole • increased pressure in (left) ventricle causes AV / bicuspid valve to close • higher pressure in ventricle forces blood into aorta • as pressure in ventricle drops, SL valve closes

			heart **OR** includes a statement about the role of valves **OR** includes a statement about pressure differences *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* 0 mark *No response or no response worthy of credit.*		• pressure in ventricle drops below that of the atrium so AV valves open **Examiner's Comments** This Level of Response question was generally answered well by candidates. Most responses were presented in a logical manner, effectively describing the flow of blood through the left side of the heart from the pulmonary vein onwards, demonstrating good knowledge of the pressure differences and the role of the valves. Some candidates did not state that the pulmonary vein was delivering blood to the left atrium or confused it with the vena cava or pulmonary artery. Responses achieving Level 1 did not make a clear link between contraction and pressure differences. Some candidates described pressure differences between the two sides of the heart rather than differences within the left side. Others included unnecessary information about the role of the SAN, AVN and Purkyne tissue. **Misconception** A common misconception was about the role of pressure differences in relation to the opening and closing of valves. Some candidates wrongly stated that the left atrioventricular valve opens as a result of atrial systole rather than as a result of increased pressure when the atrium fills during diastole. **OCR support** The delivery guide on Transport in animals offers an overview of key concepts and links to classroom

					activities. Exemplar 1  A good Level 3 response is shown by this exemplar. The candidate completes their response in the space available.
	c	i	sigmoid curve sketched to the left of the adult curve ✓	1 (AO2.2)	Curve must start and finish on same % as maternal and must not exceed 96% at any point **<u>Examiner's Comments</u>** Most candidates successfully drew the sigmoid curve to the left of the curve in Fig.16.3. A common error was seen in curves which either exceeded 96% before the plateau or would plateau at a higher percentage saturation than the maternal curve.
		ii	1 (at same pO_2) fetal haemoglobin has higher affinity (for oxygen) ✓ 2 <u>low</u> pO_2 in placenta ✓ 3 (so) oxygen dissociates from (maternal / adult) haemoglobin (in placenta) ✓ 4 (so) oxygen <u>diffuses</u> from maternal to fetal , blood / circulation ✓ 5 increased saturation of fetal haemoglobin at low(er) pO_2 ✓	max 3 (AO1.1)	**ALLOW** Hb for haemoglobin throughout **MP1 ALLOW** ORA i.e. maternal Hb has lower affinity **MP4 IGNORE** to / diffuses across , placenta **MP5 ALLOW** fetal Hb associates with / binds with oxygen at low(er) pO_2 e.g. **MP3** and **MP5** so oxygen dissociating from maternal Hb is uploaded by fetal Hb at low pO_2

Examiner's Comments

Most candidates correctly stated that fetal haemoglobin (Hb) has a higher affinity for oxygen. Candidates recognised that oxygen would dissociate from maternal Hb and would be uploaded by the fetal Hb but few specified that this was at low pO_2. Less successful candidates did not write about the low pO_2 in the placenta or didn't use the correct scientific terminology to describe how oxygen moves from maternal blood to fetal blood or didn't describe the association/dissociation of oxygen.

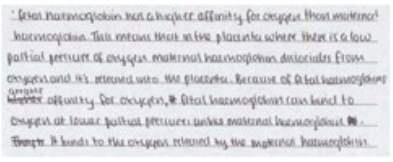
Assessment for learning

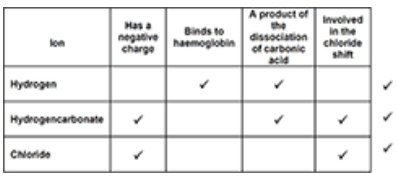
When comparing oxygen dissociation curves, it is beneficial to include details about partial pressures of oxygen understand what is occurring, e.g. it is the low pO_2 in the placenta that enables fetal Hb to associate with oxygen (from maternal) Hb and increase in saturation due to the higher affinity.

OCR support

OCR provides a Topic Exploration Pack on Oxygen Dissociation Curves to support teaching and offer advice on common misconceptions on Teach Cambridge

Exemplar 2



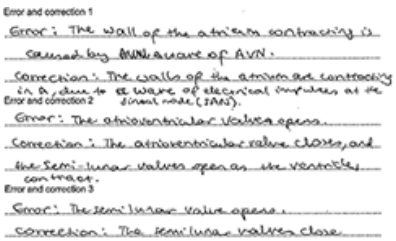
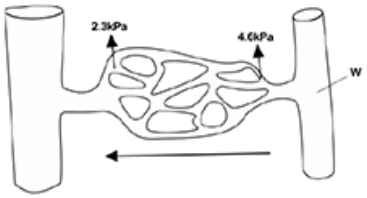
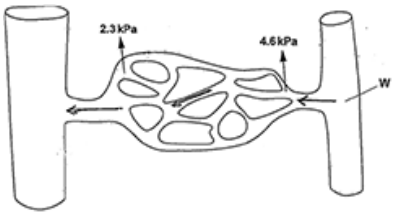
					A good response is shown by this exemplar. Good understanding of the dissociation curves and correct terminology used throughout.
			Total	**17**	
11			A ✓	1 (AO1.1)	
			Total	**1**	
12		i	large surface area to volume ratio ✓ *idea that* it can obtain all required substances (largely) through diffusion ✓ low metabolic rate ✓	1 max(AO2.1)	**IGNORE** small size e.g. 'diffusion pathway is short' / 'diffusion alone is sufficient' **Examiner's Comments** Most candidates could explain why the sponge did not need a circulatory system. Common correct answers referred to the large surface area to volume ratio of the sponge, its short diffusion pathway and the sponge's inactivity giving a low metabolic rate. Responses that did not gain marks focused on the filter-feeding system of water flowing through the ostia. A few hinted at low metabolic rate but weren't specific enough, e.g., it doesn't move much, with no reference to energy needed.
		ii	closed / described ✓ single / described ✓	2(AO2.1)	**Examiner's Comments** Most candidates correctly describe the circulatory system of the zebra shark as being single and closed.
			Total	**3**	
13			 	3(AO1.1)	**AWARD** one mark per correct row **Examiner's Comments** Candidates generally gained 2 or 3 marks. Not all candidates knew that hydrogen ions bind to haemoglobin but most identified the two properties/features of chloride ions

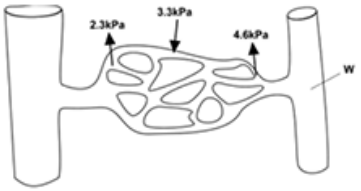
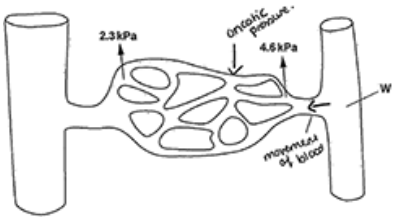
					correctly. Many candidates did not recognise that hydrogencarbonate ions are involved in the chloride shift. On the whole candidates were good at identifying the correct charges of the ions.
			Total	**3**	
14			*in the heart disease ECG* *idea of* QRS (complex) closer together ✓ *idea of* inconsistent gaps between, QRS / ventricular systoles ✓ *idea of* more / no clear, P waves / atrial systoles ✓ *idea of* no clear, T (peak) / diastole ✓	2 max(AO2.1)	**Assume answer refers to the heart disease ECG unless otherwise stated.** **Ora for *in the normal heart ECG*** e.g ventricular systoles closer together / more QRS waves / higher heart rate / more heart beats / tachycardia e.g. irregular heart beat / arrhythmia e.g. atria contract more often / atrial fibrillation / more / larger, P peaks / atrial systoles / no gap between P and Q **IGNORE** 'no P wave' e.g. no clear T section / T peaks are different sizes / no gap between, T and P / S and T **IGNORE** 'no T wave' / 'T wave more frequent' **<u>Examiner's Comments</u>** This was completed well in the majority of cases and 1 or 2 marks were often given. Candidates often used correct medical terminology like tachycardia, atrial fibrillation and arrhythmia. Candidates appeared to have a clear understanding of the normal ECG trace and could apply this to the trace with heart disease. Responses varied greatly in terms of referencing to the waves on the trace or relating it to the heart function. Those students whose responses were given no marks suffered from lack of detail, only referring to peaks or spikes, or incorrect use of terminology identifying fibrillation without 'atrial'.

			Total	2	
15	a	i	(X) (T or B) lymphocyte ✓ (Y) neutrophil ✓	2(AO2.3)	**ALLOW** T cell / B cell / T helper cell / T killer cell / T regulator cell **ALLOW** phagocyte **Examiner's Comments** Most candidates only got 1 mark for correctly naming Y as a neutrophil. The most common errors were incorrectly naming X as a macrophage or monocyte, with few candidates correctly identifying it as a lymphocyte.
		ii	flattened / biconcave (shape), to increase surface area (to volume ratio) ✓ no, nucleus / organelles, to give (more) space for haemoglobin ✓ flexible, to increase surface area in contact with capillary wall / to squeeze through capillaries ✓ small, for short diffusion pathway / to fit through capillaries ✓ transport proteins in plasma membrane, to allow chloride shift ✓ high concentrations of carbonic anhydrase (inside cells), to allow transport of carbon dioxide / described ✓	2 max(AO1.1)(AO2.1)	**IGNORE** concave **ALLOW** few organelles so more haemoglobin can be in the cell **IGNORE** to give (more) space for oxygen 'cells are small and flexible to fit through capillaries' = 2 marks **Examiner's Comments** This question was generally answered well by a wide range of candidates. Common errors included omitting 'bi' from 'biconcave' and describing the lack of a nucleus as giving more space for oxygen (rather than haemoglobin). Some candidates lost marks for linking an adaptation to the wrong benefit, especially biconcave with being able to fit through capillaries, rather than increasing surface area.
		iii	**FIRST CHECK ON ANSWER LINE** **If answer = 13 award 2 marks** 10 mm / 800 (= 0.0125mm) ✓ 0.0125mm × 1 000 (= 12.5μm) ✓	2(AO2.8)	**ALLOW** 12.5 for 2 marks **ALLOW** answer to more than 3 s.f. for 1 mark **ALLOW ECF** if incorrect measurement of cell W **with units** used but divided by 800 for 1 mark **or** measurement of cell W **with units** correctly converted to μm for 1 mark **ALLOW** 0.01m / 800 (= 0.0000125m)

					and 0.0000125m x 1 000 000 (= 12.5μm) **ALLOW** 1cm / 800 (= 0.00125cm) **and** 0.00125 × 10 000 = (12.5μm) **If candidate measures cell W as 9.5 mm** **ALLOW 12 /11.9 for 2 marks and 11.88/11.875 for 1 mark** **If candidate measures cell W as 10.5 mm** **ALLOW 13 /13.1 for 2 marks and 13.13 / 13.125 for 1 mark** **Examiner's Comments** About half of candidates gained the full 2 marks for this question. Marks were most often lost for measuring in cm then an incorrect conversion to micrometres – most multiplying by 1000 rather than 10,000. Candidates who showed working, including the measurement of the diameter with units divided by 800, could access 1 mark even if their final answer was incorrect.
	b	i	*L = artery because* *small*(er), diameter / lumen ✓ thick(er) layer of, (smooth) muscle / elastic tissue / elastin ✓ *idea of* lumen is more open ✓ tunica intima / endothelium, folded ✓	2 max(AO2.1)	**DO NOT ALLOW** mark points if L identified as vein or not identified at all **ALLOW** narrow(er) lumen **ALLOW** greater proportion of, muscle / elastic tissue /elastin (than veins) **ALLOW** thick(er) tunica media / thick(er) wall **ALLOW** 'less flattened' than veins **Examiner's Comments** Most candidates correctly identified the vessel as an artery and managed to gain 1 or 2 marks here. A noticeable error was the omission of the terms layer or wall and led to phrasing such as thick smooth muscle or thick elastic fibres, which gained no marks. Some candidates made reference to no valves in the

					artery, even though they were not visible in the image.
		ii	Collagen ✓	1(AO2.1)	**Examiner's Comments** Very few candidates could correctly label 'collagen' for N. Most common incorrect answers were tissue fluid, smooth muscle or elastic fibres.
			Total	**9**	
16		i	**1** CO_2 + water form carbonic acid ✓ **2** carbonic acid dissociates giving, H^+ / protons ✓ **3** H^+ / protons, bind to Hb ✓ **4** so CO_2 can be carried as HCO_3^- ✓	2 Max (AO2.5)	**Examiner's Comments** Many candidates appeared not to understand the term 'buffer'. Many referred to reactions that happen in the red blood cell but did not apply their knowledge to this question.
		ii	**1** more CO_2 during exercise so curve shifts to right ✓ **2** at same $_PO_2$ Hb has a lower % saturation of oxygen ✓ **3** so oxygen, dissociates / is released, from Hb more readily ✓ **4** more oxygen (provided / needed) for, muscles / aerobic respiration ✓	2 Max (AO1.2) (AO2.5)	**2 ALLOW** haemoglobin's affinity for oxygen is decreased **4 ALLOW** to help supply sufficient oxygen to muscles **Examiner's Comments** Candidates in general showed a limited understanding of the Bohr shift shown on the graph. Some candidates' responses misquoting or mis-applying the axis labels and incorrectly concluding that the affinity of haemoglobin for oxygen increases during exercise, when the graph shows the opposite.
			Total	**4**	
17			**1 (A)** it is not atrioventricular node (AVN), it is sino-atrial node (SAN) ✓ **2 (B)** atrioventricular valve doesn't open, it closes ✓ **3 (B)** the pressure in the aorta doesn't fall, it rises ✓ **4 (C)** semilunar valve doesn't open, it closes ✓	3 Max (AO3.4)	**ALLOW max 1 mark** for 2 errors identified without corrections **OR** for 2 corrections without errors **OR** for 1 error + 1 (different) correction **2 ALLOW in B** it is not the atrioventricular valve that opens it is the semi-lunar valve **4 ALLOW** it is not the semi-lunar valve that opens it is the, atrioventricular / bicuspid / mitral, valve **Examiner's Comments**

					The candidates were asked to identify three errors in the text and to write the correction for each error. It is imperative that answers clearly and succinctly identify the error as an error **and** suggest the correction. Too many answers quoted extensive pieces of the original 'student description' without saying which part they considered to be wrong. For some answers it was unclear whether the description referred to an error or a correction. A systematic approach is needed for this type of question, as shown in exemplar 3. Exemplar 3  Error and correction 1 Error: The wall of the atrium contracting is caused by AVN/awave of AVN. Correction: The walls of the atrium are contracted in A, due to a wave of electrical impulses at the Error and correction 2 sinual node (SAN). Error: The atrioventricular valves opens. Correction: The atrioventricular valve closes, and the semi-lunar valves open as the ventricle contract. Error and correction 3 Error: The semi lunar valve opens. Correction: The semi lunar valves close. This response clearly labels the error and the correction in each case and gains 3 marks. Some candidates save time by putting the error in quotation marks, which implies that this must be the error since it is lifted directly from the student description.
			Total	**3**	
18	a	i	arrow drawn from right to left ✓	1	 **ALLOW**  **Examiner's Comments** Most candidates were able to give the correct direction of flow but less

					able candidates did not realise that the blood would flow from the higher hydrostatic pressure toward the lower pressure or that the relative width of the main blood vessels revealed which was the arterial side and which was the venous side.
		ii	arrow pointing into capillary (anywhere) ✓ value (next to arrow) between 2.4kPa and 4.5kPa ✓	2	 Note: arrow must be touching or must enter capillary **Examiner's Comments** The most able candidates drew correct arrows and labelled each arrow to make it clear which arrow answered which question – as shown in the exemplar below. However, few candidates were able to gain any credit here. It seems that many candidates were not confident with the term oncotic pressure (this is reinforced by their responses to 23b seen below). Commonly an arrow going across the diagram in the opposite direction to blood flow was given. Where a correct arrow was shown it was rare that a suitable value for the pressure was stated. **Exemplar 2**  Exemplar 2 shows an example of correctly drawn arrows.
		iii	arteriole ✓	1	**Mark first answer only** **Examiner's Comments** A low proportion of candidates scored the mark here. It seems that candidates are not familiar with the

					term ‘arteriole’. Responses included ‘artery’, ‘vein’ and ‘blood vessel’.
	b		(named) plasma proteins ✓ (are) too large to, leave the capillary / fit between gaps in the endothelium ✓ (so) creates a low water potential (in the capillary) ✓ water potential is lower than in tissue fluid ✓ water moves, by osmosis / down the water potential gradient, into capillary (causing pressure) ✓	Max 3	**ALLOW** water potential is decreased **ALLOW** water potential in tissue fluid is higher than in blood **ALLOW** water moves from high WP to low WP into capillary **IGNORE** tissue fluid moves by osmosis into capillary **Examiner’s Comments** It was clear that very few candidates were confident with what oncotic pressure is. Most of the candidates either left this blank or explained it as being blood pressure or hydrostatic pressure. The majority of answers made no mention of ‘plasma proteins’ or ‘water potential’. It was not clear whether the term ‘oncotic pressure’ was unfamiliar to candidates or whether the detail of tissue fluid formation was simply unknown to them. Candidates did not understand the role of plasma proteins in creating a water potential gradient nor the implication of the reduced hydrostatic pressure at the venule end of the capillary bed. Even the most able candidates who had the idea of a water potential gradient being created often referred to tissue fluid or blood moving in and out of capillaries.
			Total	**7**	
19			**C** ✓	1	**Examiner’s Comments** Only a minority of candidates gave the correct response (C). The most

					common incorrect responses were B and D. Candidates need to practice at interpreting this sort of diagram and relating it to the action of the heart.
			Total	**1**	