Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		surface area / diffusion distance ✓	1	**ALLOW** thickness / width, of membrane/exchange surface **IGNORE** volume ratio **Examiner's Comments** Well answered with most candidates stating surface area. Some answers referred to humidity or pH suggesting a confusion with enzymes and transpiration. **Assessment for learning** A good technique for candidates to remember the main factors is discussion of Fick's Law and the adaptation of the lungs. Please note that Fick's Law is not a required knowledge for AS level Biology spec A (H020).
	b	i	stopwatch / timer ✓ thermometer / water bath ✓ measuring cylinder / pipette / syringe ✓ ruler ✓	max 2	**IGNORE** beaker **Examiner's Comments** The question was well answered with candidates recognising the relevance of the investigation title to complete the list of apparatus required. Some answers referred to cuvettes which, although required, is not contributing to a controlled investigation.
		ii	**1** add glucose (solution) to the, dialysis tubing / model cell ✓ **2** knot / secure dialysis tubing, before / after, addition of glucose ✓ **3** place (tubing) in a water bath and remove sample (around tubing) at, certain / specified / set, time interval(s) ✓ **4** add Benedict's (solution) to sample to test for glucose ✓	max 4	**ALLOW** Visking tubing for dialysis tubing throughout **1 ALLOW** tubing containing glucose (solution) **3 ALLOW** glucose solution for 'sample' **3 IGNORE** remove sample from inside the dialysis tubing **3 ALLOW** dialysis tubing added to, test tube/beaker, of water **4 IGNORE** adding Benedict's to the dialysis tubing **4 ALLOW** look at colour with Benedicts to see how much glucose is present **Examiner's Comments**

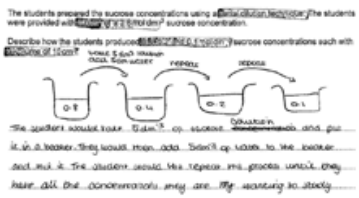
			5 use colorimeter to obtain, absorption / transmission, values ✓ **6** use calibration curve to estimate the concentration of glucose ✓ **7** repeat at / use, different temperatures ✓		This was a good discriminating question. Most candidates were able to recognise the need for different temperatures, often suggesting relevant temperatures to use. Some answers referred to the calibration and use of the colorimeter. Few candidates were familiar with the use of dialysis tubing to form a model cell. This restricted their ability to elaborate on their answer. Many incorrect answers referred to potato or beetroot cylinders as the model cell. Candidates often discussed the dialysis tubing in terms of a covering for the test tubes. **Assessment for learning** The Examiners' reports are an excellent source of information for candidates when refining their understanding of certain techniques and methodology. **OCR support** The practical activity groups provided by OCR are an excellent teaching tool even if the practical is not feasible or an alternative activity has been assessed from a practical perspective. Providing a copy of all the activities to the students will broaden their understanding and knowledge of the practical techniques discussed at A level. Also the practice PAG materials can be used to reinforce indirect assessment of practical skills.
	c		**1** as temperature increase the kinetic energy of the glucose molecules increases ✓ **2** (increased temperature causes) glucose molecules, move / diffuse (from dialysis tubing) at a faster rate ✓ **3** correct analysis of figures with units from table ✓ **4** greater rate between 10°C and 20°C ✓	max 3	**ALLOW** ORA for MP 1- 3 **IGNORE** ref to phospholipid bilayer **2 ALLOW** as temperature increases the rate of glucose diffusion increases **2 DO NOT ALLOW** increased rate of glucose diffusion in context of increased permeability of membrane. **3 e.g.** from 20°C-40°C increase in temp, the glucose concentration increases by 1.1 moldm^{-3} **Examiner's Comments**

					Many candidates were able to explain the data in terms of an increase in kinetic energy of particles and an increased rate of diffusion. However, confusion often arose with relating these details to a membrane and the effect of temperature on membrane permeability. Candidates should appreciate that theresults referred to a model cell investigation and should have been discussed in that context, not inthe setting of a living cell. Few candidates analysed the results, often quoting from the table but not extrapolating the data.
			Total	**10**	
2			A✓	1 (AO 2.8)	**Examiner's Comments** M The vast majority got this correct.
			Total	**1**	
3			D✓	1 (AO 2.8)	**Examiner's Comments** Most candidates were able to perform this calculation correctly.
			Total	**1**	
4		i	because they have many mitochondria ✓ catalase activity may be (too) low ✓ mutation in / less transcription of , catalase gene✓ (or) SOD activity may be (too) high ✓	max 2	**ALLOW** catalase may be inactive **ALLOW** low concentration of catalase **ALLOW** high concentration of SOD **Examiner's Comments** Many candidates understood that sperm cells would have many mitochondria to gain credit. However, only high achieving candidates gained further mark points by referring to the possibility of high concentrations of SOD or the presence of inactive catalase.
		ii	*Evidence to support* **1** as (H_2O_2) concentration increases motility (of treated sperm) decreases ✓ **2** as (H_2O_2) concentration increases cells with changes to (composition of) plasma membrane increase ✓	max 3	**MP1 ALLOW** e.g. negative correlation between hydrogen peroxide concentration and motility **MP1 DO NOT ALLOW** normal sperm cells **MP2 ALLOW** e.g. positive correlation between concentration of hydrogen peroxide and cells with changes to plasma membrane **MP3 ALLOW** there may have been another cause of low motility

			Evidence that does not support ***-max 2*** **3** correlation does not prove causation ✓ **4** sample size was (relatively) small / only 10 men ✓ **5** no statistical test has been performed ✓ **6** (sperm cell) samples , not representative / show bias ✓ **7** (some motility) error bars overlap ✓		**MP5 ALLOW** no correlation coefficient calculated / no Spearman's rank **MP6 ALLOW** samples from fertility clinic more likely to have abnormal sperm **MP6 ALLOW** *idea* of skewed results **Examiner's Comments** Candidates appear to be more familiar with the command word "evaluate" and there were many who structured their response with supporting points followed by points against the conclusion, along with comments on the methodology of the investigation. **Assessment for learning** Candidates should be encouraged to read graphs carefully noting the named variables on the x and y axes.
		iii	oxidises / reacts with / AW , fatty acids / phospholipids / cholesterol ✓ damages / denatures (named) , membrane proteins ✓ disrupts phospholipid bilayer ✓ causes membrane to be more permeable ✓	max 2	**ALLOW** changes the fluidity of the membrane **ALLOW** causes breaks / pores in membrane **Examiner's Comments** Most candidates achieved at least one mark for this question part. There were a number of alternative phrases allowed and candidates should be encouraged to refer to the phospholipid bilayer when answering questions on this topic, rather than the more general term 'membrane'.
			Total	**7**	
5	a		any **two** from: size / shape / surface area / dimensions , of (beetroot) pieces ✓ type / varieties , of beetroot ✓	max 2	**IGNORE** mass of beetroot / temperature / 25°C (these are given in the stem) **IGNORE** pH **ALLOW** same beetroot / same species **Examiner's Comments** Most candidates could identify at least one

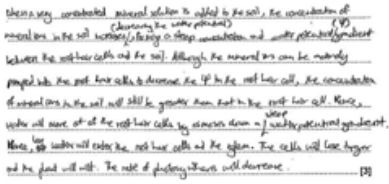
			same part of beetroot / no skin on beetroot ✓ age of beetroot ✓ time (beetroot) pieces are kept in ethanol (before measuring absorbance) ✓ volume of ethanol (solution) ✓		variable for this investigation. Although some restated e.g. temperature which was ignored as it had been mentioned in the stem of the question.
	b	i	(increased) ethanol (concentration) increases permeability of membranes / AW ✓ (curve) levels off as , no more / all , pigment is released ✓	2	**ALLOW** e.g. ethanol disrupts phospholipid bilayer so more pigment leaks out **IGNORE** positive correlation **ALLOW** until concentration of pigment inside and outside cell is the same **Examiner's Comments** Many candidates did not spot the command term in this question and went on to provide a description rather than an explanation. Good responses offered an explanation for both the rise of the curve and the plateau.
		ii	curve to the left of the student's curve ✓ reaches same max value ✓	2	**IGNORE** start point (increased temperature may cause release of pigment at 0% ethanol) **Max 1** if curve drops below student curve at any point (allow if touches points) or if goes above maximum shown by last two points **Examiner's Comments** Most candidates drew a graph to the left of the original for one mark, but many then extended their graphs beyond the maximum value of the original so were not given the second mark. There were a number of 'no responses' suggesting that some candidates missed this question at the end of the question paper.
			Total	**6**	
6			A	1	**Examiner's Comments** Many candidates chose the correct option **A**. The terms intrinsic and extrinsic could be emphasised when teaching the structure of the membrane, along with the idea of fluidity rather than rigidity.
			Total	**1**	

7			A	1	**Examiner's Comments** The diagram proved a useful aid for candidates in choosing a response and most candidates opted for **A**, the correct response. Option **B** was a common incorrect response, and candidates could be reminded that it is one of the fatty acids that is replaced, not glycerol, when phospholipids are formed.
			Total	**1**	
8	a		*mean gain in mass* (solution at) 0.0 (mol dm^{-3}) has a higher water potential than inside the (sweet potato) cells ✓ *mean loss in mass* (solution at) 0.8 (mol dm^{-3}) has a lower water potential than inside the (sweet potato) cells ✓ correct ref to water moving via osmosis ✓	2 max	**ALLOW** symbol for water potential throughout **IGNORE** solute potential **IGNORE** concentration of water **DO NOT ALLOW** greater for higher MP1 & MP2 **IGNORE** along water potential gradient MP1 & MP2 **ALLOW** ORA with correct direction of water movement MP1 & MP2 **ALLOW** down water potential gradient MP1 & MP2 **Examiner's Comments** Many candidates gave a correct reference to water moving inwards or outwards by osmosis for 1 mark. A few students were given 2 marks here and thesecandidates were able to provide a correct description of water potential and included specific details about locations such as 'the potato cell' rather than more general statements about 'cylinders'. Candidates who were given marks were able to identify the need to 'explain' the results rather than 'describe' them from the stem of the question and did not waste valuable exam time describing the data in the table.
	b		replicate 3 at 0.1 (mol dm^{-3}) / +10.3 ✓ reduces repeatability of data ✓ it increases the standard deviation / it increases the spread about the mean / it increases the range of data about the mean ✓	3	**ALLOW** +10.3 indicated in the table if no other numbers circled and no response written **IGNORE** ref to accuracy **Examiner's Comments** The anomaly was well identified so most candidates were able to achieve 1 mark, however only a few candidates were able to 'explain' its effect on precision to be awarded 2 or 3 marks. Most stated it made the results less precise because it lowered the mean value, or it increased the spread of results – without linking this to the mean. Some more successful responses correctly

					stated it increased the standard deviation. Very few candidates tried to link repeatability into their response. **OCR support** OCR has a resource available to support candidates with the practical investigation and 'Language of measurement'. Language of measurement in context - Biology
	c		add 5 cm^3 of 0.8 (mol dm^{-3}) sucrose (concentration) to 5 cm^3 of (distilled) water ✓ idea of take contents from previous tube and add to next tube with (distilled) water ✓ *ref* to shake(ing) / mix(ing) contents ✓	2 max	**ALLOW** annotated diagram **ALLOW** ml in place of cm^3 **ALLOW** 'half the 0.8 (mol dm^{-3}) and fill to 10cm^3 distilled water' **ALLOW** '(10cm^3) 0.8 (mol dm^{-3}) sucrose (concentration) plus 10cm^3 (distilled) water **IGNORE** 'repeat these steps' unqualified **ALLOW** 'and mix it' / stir(ring) **Examiner's Comments** Many candidates were given 2 marks for correctly suggesting taking 5 cm^3 of sucrose and adding it to 5 cm^3 of water and then giving the process of serial dilution. They described (or used an annotated diagram) that for each new solution the previous solution is diluted further, rather than simply stating that the process was 'repeated', which was not given in the mark scheme. Few got the idea of mixing or stirring the contents. Exemplar 1  The candidate uses a clear annotated diagram to support their written description of the procedure. They use correct volumes and include the need to mix the solution at each stage of the process. Their written description alone would not be enough for them to be given a mark. In their description, they just state repeat this process' for

					the mark point for the idea of 'taking contents from previous tube and add to the next', but their diagram shows us clearly that this is what they know should happen in a serial dilution so they could be given the mark. **OCR support** Practical skills are an important component of GCE Biology. Centres should appreciate that even at AS Level practical skills must be part of the teaching and will be tested in the written examination papers. Practical skills handbook / PAG practicals
	d		plot a graph of sucrose concentration against (percentage) change in mass **AND** draw a line of best fit (for both plant tissues) ✓ identify the sucrose concentration via where, the line crosses the x axis / the x intercept is / there is zero percentage change ✓ higher concentration of x intercept = higher sucrose concentration in cells ✓ reference to qualitative interpretation of data ✓	2 max	**ALLOW** answer in form of sketched and labelled graph **IGNORE** ref to isotonic point unless qualified for MP2 and MP3 e.g. estimate the sucrose concentration where percentage mass change is zero. e.g. see if higher mass increase was observed indicating more water had entered due to a higher concentration of sucrose being present **Examiner's Comments** A few candidates knew to plot a graph and use the x axis intercept to predict the sucrose concentration of the cells. Some suggested plotting a graph but were then unable to explain how to use it and/or did not mention drawing a line of best fit for both plant tissues. The most common mark given was for a correct reference to a qualitative interpretation of data, e.g. higher mass increase is due to a higher concentration of sucrose in the cells, so candidates were aware of the concept but unable to describe a qualitative method to achieve this.
			Total	**9**	
9	a		*idea of* barrier between cell (contents) and environment ✓ regulates which substances , enter / leave , the cell ✓	2 max	**ALLOW** (partially permeable to) control which substances move across the membrane **ALLOW** binding of, signalling molecules / hormones **Examiner's Comments**

			site of (chemical) reactions ✓ cell communication / cell signalling ✓		Almost all candidates scored at least one mark here – usually for the idea that the cell surface membrane controls what substances enter and leave the cell. Many candidates were able to provide a second correct response. Those that did not score well wrote vague statements such as 'allows substances in and out of the cell' or described functions of internal cell membranes such as compartmentalisation. Perhaps the most common misconception was that the cell surface membrane provides support/protection to the cell.
	b		*Idea that* the temperature would need to be known to conclude what effect cholesterol has ✓ (cholesterol) increases fluidity at low temperatures ✓ (cholesterol) decreases fluidity at , high temperatures / body temperature / 36-38°C ✓ one example of other factor that affects fluidity ✓	3 max	e.g.. the effect of cholesterol is dependent on temperature **IGNORE** temperature needs to be controlled temperature, concentration of saturated fatty acids, concentration of unsaturated fatty acids, relative proportions of saturated and unsaturated fatty acids, presence of solvent **Examiner's Comments** Most candidates appreciated that cholesterol is found in the cell membrane. However, many described the position of cholesterol between the phospholipid tails or discussed the disruption of the bilayer structure rather than relating their responses to the question. Very few candidates appreciated that the effect of cholesterol on the fluidity was dependent on temperature although they did realise that temperature itself can affect fluidity of the membrane.
			Total	**5**	
10		i	(increase in set point) will result in fever ✓ raised body temperatures help to , kill / prevent increase in number of , pathogens ✓ causes an increase in antibody production / faster immune response ✓ high body temperature can	max 2 (AO2.1)	**ALLOW** viruses / bacteria for pathogens **IGNORE** affects enzyme activity **Examiner's Comments** This question proved challenging. Some candidates identified that a fever would occur but other marking points were rarely included in responses. Most candidates mentioned enzyme

			result in organ , damage / failure ✓		activity and didn't make the link between increased temperature and the body's response to pathogens.
		ii	(membrane acts in) cell signalling ✓ (membrane) controls , entry / exit , to cell ✓	2 (AO1.2) (AO2.5)	**ALLOW** cell communication **ALLOW** is partially permeable / selectively permeable / acts as a barrier **Examiner's Comments** Good responses gained both marks for recognising that the functions illustrated in the question stem were those of cell signalling and control of substances into and out of the cell.
			Total	**4**	
11		i	the (fertiliser) solution would lower water potential (of soil) ✓ water moves out of (root) cells (into soil) by osmosis **OR** less water enters (root) cells (from soil) by osmosis ✓ plant loses more water than it gains / AW ✓ (in aerial parts of plant) turgor (pressure) is reduced ✓	max 3 (AO2.3)	**ALLOW** water potential of root cells would be higher than soil **ALLOW** down water potential gradient for osmosis **ALLOW** (leaf) cells are , flaccid / plasmolysed **Examiner's Comments** Good responses were those where candidates recognised that increased mineral ion content would lower the water potential of the soil so prevent uptake of water into root hair cells by osmosis. Weak responses often repeated the question stem about the plant wilting rather than describing that it is the loss of turgor pressure in the cells of the leaves which caused the plant to wilt. Exemplar 3  This exemplar shows a good response for this question. All 3 marking points clearly stated using appropriate scientific terminology.

		ii	*correct because* 1 ATP is required for active transport of mineral ions into , root (cells) / xylem ✓ 2 (so) no water potential gradient (into root / xylem) / AW ✓ *incorrect because* 3 cyanide (ions) may not have entered roots ✓ 4 plant cells may be tolerant to cyanide ions ✓ 5 concentration of cyanide ions may not be high enough (to inhibit ATP synthesis) ✓	max 2 (AO3.1)	**ALLOW** more mineral ions remain in soil **Examiner's Comments** Most candidates agreed with the teacher in the question stem for their responses so few alternative statements were seen. Some candidates were unable to link ATP to active transport of mineral ions into root hair cells, necessary to allow a water potential gradient to be established. Some responses included reference to generic situations where ATP would not be synthesised so the plants would not be able to carry out metabolic processes, growth, photosynthesis, sucrose loading etc. which were not credited.
		iii	(high light intensity) increases (rate of), light-dependent reaction / LDR / photosynthesis ✓ more stomata open to allow , gas exchange / entry of carbon dioxide ✓ (high light intensity) increases transpiration so more , evaporation / water vapour is lost ✓	max 2 (AO2.3)	**ALLOW** more photolysis **ALLOW** stomata widen to allow , gas exchange / entry of carbon dioxide **Examiner's Comments** Good responses showed understanding that high light intensity would increase the rate of photosynthesis and included good use of comparative descriptions. Weak responses often stated that no photosynthesis would occur in the shade. Some candidates correctly described the effect of light intensity would have on increased stomatal opening but did not link this to more gas exchange. Although some candidates did refer to increased transpiration it was not always linked to increased loss of water vapour. **Misconception** A common misconception is about transpiration. Loss of water is often identified but it is important that correct terms are used, and candidates are aware that it is water vapour that leaves through stomata. It would be acceptable to state loss of water by evaporation.
			Total	**7**	
12			B ✓	1 (AO2.8)	

			Total	1	
13	a		*any two **I** marks and matching **R** marks:* *If an I mark is just missed (e.g. for **I1** answer says weight instead of mass) can still give the matching reason mark **R1*** **I1** same, number / size / mass / volume (of pieces) ✓ **R1** to control / same, <u>surface area</u> ✓ **I2** pieces from same beetroot **OR** pieces from same, part / depth / variety, of beetroot ✓ **R2** to control / same, pigment concentration ✓ **I3** rinse / wash / wipe / dry, pieces ✓ **R3** to remove pigment released by, cutting / cell damage ✓ **I4** use, one / new, flask / tube, per, temperature / repeat ✓ **R4** to, test effect of / get absorbance for, one / single, temperature ✓	4 Max (AO3.3)	**ALLOW** cubes / discs / cylinders / strips / rectangles / chips / samples / beetroot, for 'pieces' throughout **ALLOW** betalain for 'pigment' throughout **I1 ALLOW** cork borer cylinders of same length **I1 IGNORE** weight for 'mass' **R1 ALLOW** same, surface area to volume ratio / SA:V **ALLOW I1** 'same <u>surface area</u>' **+ R1** '<u>surface area</u> affects rate of pigment loss' for 2 marks **I2 ALLOW** plant for 'beetroot' **I2 ALLOW** species for 'variety' **R2 ALLOW** *idea of* pigment concentration varies / AW **R3 ALLOW** to avoid artificially high absorbance reading **I4 ALLOW** add pieces when temperature reached **I4 ALLOW** different / new / fresh, pieces for each, temperature / repeat **R4 ALLOW** so pieces experience a single temperature / so pieces not affected by previous temperature **OR** as used / old, pieces damaged by high temperatures / AW **<u>Examiner's Comments</u>** This question used the context of an experiment investigating varying temperature and measuring pigment loss from beetroot cells to assess how candidates could refine experimental design. Successful responses must identify the independent variable, plot results, relate experimental results to the fluid-mosaic theory of membrane structure and suggest how freezing affects cell membrane permeability. In order to do well candidates needed to study the information given carefully. Less successful responses described general 'improvements' such as carrying out repeats and testing at smaller temperature intervals or over a greater range of temperatures. Strong responses focused on the faulty method described and picked up on generalities such as 'cut some pieces of beetroot' by asking questions about the size, shape and number of the pieces, so that they could suggest an improvement in line with the principles of experimental design (controlling extraneous variables) such as cutting the same number of pieces or same sized pieces. Similarly focusing on the error of heating the same pieces of beetroot through successive temperatures led to ideas for

					improvement such as having one flask and fresh beetroot pieces for each temperature tested. Candidates who suggested two sensible improvements to the method could not always explain the reasons why their suggestion was an improvement. Controlling the size and shape of the beetroot pieces was important in terms of the surface area over which betalain pigment could escape, and rinsing or drying the pieces was important in terms of removing excess pigment released by the cutting operation. **Misconception** Some candidates confused this experiment investigating the effect of temperature on membrane permeability with the osmosis practical that aims to find the water potential of plant material such as potato chips.
	b		temperature ✓	1 (AO3.3)	**DO NOT ALLOW** room temperature **Examiner's Comments** Most candidates named temperature as the independent variable.
	c		**1** percentage / absorbance / mean, higher ✓ **2** water / ice, expansion, breaks / damages, membrane **OR** ice crystals, puncture / damage, membrane ✓	2 (AO3.3)	**1 DO NOT ALLOW** absorption for 'absorbance' **1 ALLOW** ORA percentage / absorbance / mean, lower, for first experiment / in table **Examiner's Comments** The command word 'suggest' provides a challenge for candidates to think creatively using their existing knowledge. A minority of candidates realised that the absorbance would be higher as more pigment would escape from the cells that had been frozen. Many candidates argued that freezing would make the membrane rigid and impermeable, preventing pigment loss, as they did not notice that the frozen beetroot was defrosted. Many candidates did not comment on the results (measured as absorbance in the colorimeter) as asked, but instead just commented on membrane permeability. Few candidates had the idea that when water freezes it both expands in volume, putting pressure on the cell surface membrane, and forms sharp ice crystals which can pierce the membrane.
	d	i	**1** linear scales using half of grid or more **AND** *x* axis labelled temperature	3 (AO2.4)	**1 ALLOW** solidus before unit (instead of brackets) **2 ALLOW** to **±1** small square **2 IGNORE** figures plotted from trial 1, 2 or 3

			(°C) **AND** *y* axis labelled (mean) absorbance (%)✓ **2** points plotted correctly for mean absorbance ✓ **3** all points joined with curved line ✓		**2 DO NOT ALLOW** bars **3 DO NOT ALLOW** ruled lines between points **3 ALLOW** one data point outside of curved line of best fit **3 IGNORE** line extended beyond first or last point **3 ALLOW ECF** for data plot from trial 1, 2 or 3 **Examiner's Comments** Graph skills varied, with most using the space appropriately and plotting temperature on the *x* axis and absorbance on the *y* axis, giving units for each axis and choosing a linear scale for each axis, but a proportion did not do some or all of these things. Most plotted the mean absorbance only but some obscured the mean data by also plotting the results from each trial. Candidates should be adequately equipped in the exam with a pencil for plotting data and a rubber for erasing mistakes so that the final answer is not marred by scribbled out lines or double lines. **OCR support** OCR provides tutorials, student tests and teacher answers on creating and interpreting graphs for M3.1 at **https:/www.ocr.org.uk/subjects/science/maths-for-biology/graphs/** This checklist for graphs is taken from the OCR support document 'Learner Checklist: Graphs, Tables and Drawings'. A link to this document can be found here: https:/www.ocr.org.uk/qualifications/as-and-a-level/biology-a-h020-h420-from-2015/planning-and-teaching/

S	**S**ize of the graph: does the bit with actual plotted points in take up at least half the paper?	
P	**P**lotting: is every data point within half a little square of where it should be?	
L	**L**ine of best fit: if there's a trend in your data, is it indicated with a smooth curve or straight line?	
A	**A**xes right way round: the thing you changed (independent variable) along the bottom; the thing you measured (dependent variable) up the side.	
T	**T**itle: have you included a title that tells you what this graph shows?	

					A Axis labels: name of each variable with the right unit symbol.
		ii	***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 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)** Full and detailed description of how the phospholipids in the cell membrane are affected by temperature, causing the structure of the plasma membrane to become disrupted with reference to the results between 20°C and 70°C. *There is a well-developed line of reasoning which is clear and*	6 (AO1.2) (AO2.3) (AO3.1)	**Indicative points may include:** **Explanation of results** At 20°C, membrane intact / impermeable / least permeable At, low temperature / 30°C / 40°C / 50°C, pigment escapes Through gaps between (moving) phospholipids As temperature increases kinetic energy increases More, phospholipid movement / gaps Membrane becomes more permeable More, pigment loss / betalain release / colour in flask Higher absorbance figure Graph curves upwards At high temperature / 60°C / 70°C, membrane disrupted Phospholipid, arrangement / bilayer, breaks down / melts Membrane, leaky / very permeable Large increase in, pigment loss / betalain release / AW Large increase in absorbance figure Graph curves up more steeply **Structure of phospholipids** Phosphate (and glycerol) head (Two) fatty acid / hydrocarbon, tails **Properties of phospholipids** Heads, are hydrophilic / face out / face aqueous medium Tails, are hydrophobic / face inwards / in centre of bilayer Phospholipids form bilayer Form barrier to, water / water-soluble molecules **IGNORE** ref. proteins / cholesterol **<u>Examiner's Comments</u>** This was the first of two 6-mark levels of response questions on the paper. This style of question requires specific skills and candidates need guidance in how to assess what the question is asking for and how to structure their response. In this case a systematic approach to the data in the table was needed, covering the whole range of temperatures and dividing the range into sections with a common cause of permeability

			logically structured. The information presented is relevant and substantiated. **Level 2 (3–4 marks)** A detailed description of how the phospholipids in the cell membrane are affected by temperature, causing the structure of the plasma membrane to become disrupted with reference to the results between 20°C and 70°C. *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 description of some of the effects on phospholipids in the cell membrane of either high or low temperature with reference to the results between 20°C and 70°C. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*		characteristics. Here there was the lowest temperature with zero permeability, the middle range of temperatures where progressive heating gave progressively more kinetic energy, membrane fluidity and pigment loss, and the highest temperatures where a more dramatic disruption and increase in permeability occurred. This disruption is a result of the phospholipids moving so that the bilayer arrangement breaks, which can be referred to as the bilayer melting. However, it is not correct to say that the phospholipid molecules themselves change state (melt). The question also asked for explanation in terms of both the **structure** and the **properties** of phospholipids, so both these aspects needed to be referred to in a Level 3 answer. Exemplar 1  Between 20°C and 70°C, there is a major increase in the absorbance. This is because the increase in temperature caused the proteins in the phospholipid bilayer of the plasma membrane to denature. The ~~as~~ cytoskeleton below the ~~pl~~ plasma membrane will also denature. The higher the temperature the more proteins that will denature, ~~and so the permeability of the whole plasma membrane will increase. This allows~~ This will leave holes in the plasma membrane and so increase the permeability. This will allow beta lain to cross the membrane and diffuse into the ~~distilled~~ water. When the ~~colorimetry~~ colorimetry takes place, this red pigment will be absorbed by the blue filter, hence why the absorbance ~~as~~ increases as the temperature increases. Additional answer space if required. This response shows a clear understanding of how membrane permeability affects pigment movement which is measured by the colorimeter as light absorbance. The candidate seeks to explain a general increase in absorbance over the whole temperature range and does not distinguish between the different temperature spans with different rates of permeability increase. Their explanation is all in terms of the effects of temperature increase on proteins. As the question asks for an explanation in terms of phospholipids, the protein references are irrelevant. This is a Level 1 response.
			Total	**16**	
14		i	(position / arrangement, of) chromosomes visible ✓	1 (AO2.7)	**ALLOW** chromosomes, different colour to cytoplasm / contrast with rest of cell / show up / stand out, for 'visible' **ALLOW** to, identify / distinguish, chromosomes **ALLOW ORA** 'otherwise we could not see chromosomes' **ALLOW** chromatids / genetic material / DNA /

<table>
<tr>
<td></td><td></td><td></td><td></td><td></td>
<td>chromatin, for ‘chromosomes’

<u>Examiner’s Comments</u>

Most candidates realised that staining made the chromosomes visible.</td>
</tr>
<tr>
<td></td><td></td><td>ii</td><td>chromosomes lined up at, equator / metaphase plate ✓</td><td>1
(AO3.1)</td>
<td>ALLOW middle (of cell) for ‘equator’
ALLOW pairs of sister chromatids for ‘chromosomes’

<u>Examiner’s Comments</u>

Most candidates described the chromosomes lining up at the equator of the cell as showing metaphase.</td>
</tr>
<tr>
<td></td><td></td><td>iii</td><td>all columns with informative headings ✓

stages of mitosis in correct order ✓</td><td>2
(AO3.2)</td>
<td>IGNORE data in table.
<table>
<tr><th rowspan="2">Stage (of mitosis)</th><th colspan="3">Number of cells (counted)</th></tr>
<tr><th>Student 1</th><th>Student 2</th><th>Student 3</th></tr>
<tr><td>Prophase</td><td>3</td><td>5</td><td>2</td></tr>
<tr><td>Metaphase</td><td>1</td><td>0</td><td>5</td></tr>
<tr><td>Anaphase</td><td>3</td><td>4</td><td>0</td></tr>
<tr><td>Telophase</td><td>0</td><td>1</td><td>3</td></tr>
</table>
OR
<table>
<tr><th rowspan="2">Student</th><th colspan="4">Number of cells (at stage of mitosis)</th></tr>
<tr><th>Prophase</th><th>Metaphase</th><th>Anaphase</th><th>Telophase</th></tr>
<tr><td>1</td><td>3</td><td>1</td><td>3</td><td>0</td></tr>
<tr><td>2</td><td>5</td><td>0</td><td>4</td><td>1</td></tr>
<tr><td>3</td><td>2</td><td>5</td><td>0</td><td>3</td></tr>
</table>
ALLOW Trial / test, for ‘Student’
ALLOW Amount for ‘Number’
ALLOW Phase for ‘Stage’
ALLOW student 1, student 2, student 3 on left in 2nd table

<u>Examiner’s Comments</u>

Very few candidates were able to design an appropriate table. Too frequently candidates were not providing informative column headings, not giving all the required information within the table itself, not enclosing the table in a box (or the box provided) and not showing the stages of mitosis in the correct order. Candidates should be encouraged to draw tables for their results from class practical experiments rather than relying on pre-printed worksheets to fill in the data. The table on page 4 of the exam paper could have been taken as a model for the task; in this example the dependent variable column was subdivided to show three trials in the same way that ‘number of cells in each stage’ results from three students</td>
</tr>
</table>

needed to be plotted in Question 2 (b) (iii). The published mark scheme shows two ways of arranging the table, with the top version being a better match to the principle of putting the independent variable in the left-hand column. The principles of drawing a table are shown in the checklist below.

OCR support

This checklist for producing tables can be found in the 'Learner Checklist: Graphs, Tables and Drawings' here: https:/www.ocr.org.uk/qualifications/as-and-a-level/biology-a-h020-h420-from-2015/planning-and-teaching/

1	All raw data in a single table with ruled lines and border.	
2	Independent variable (IV) in the first column; dependent variable (DV) in columns to the right (for quantitative observations) OR descriptive comments in columns to the right (for qualitative observations).	
3	Processed data (e.g. means, rates, standard deviations) in columns to the far right.	
4	No calculations in the table, only calculated values.	
5	Each column headed with informative description (for qualitative data) or physical quantity **and** correct units (for quantitative data); units separated from physical quantity using either brackets or a solidus (slash).	
6	No units in the body of the table, only in the column headings.	
7	Raw data recorded to a number of decimal places appropriate to the resolution of the measuring equipment.	
8	All raw data of the same type recorded to the same number of decimal places.	
9	Processed data recorded to up to one significant figure more than the raw data.	

			Total	**4**	
15			D ✓	1(AO1.1)	

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td><u>Examiner's Comments</u>

Almost half of answers were correct. The most common incorrect response was B. It should be noted that, although most animals do not produce cellulases, enzymes that digest cellulase are common in microorganisms.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>16</td><td></td><td></td><td>inside cells / in cytoplasm / in the nucleus ✓

because steroids can cross the, cell surface / plasma, membrane ✓</td><td>2
(AO2.1)</td><td>ALLOW can cross phospholipid bilayer

<u>Examiner's Comments</u>

This question was generally well answered. Some candidates suggested that the receptor would be on the membrane despite also describing those steroid hormones could pass through. Other candidates incorrectly concluded that being lipid soluble meant they would not be able to pass through and stated the receptors would be on the surface of the plasma membrane. Some just referred to the 'cell membrane' or 'bilayer' instead of the plasma membrane, cell surface membrane or phospholipid bilayer.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
<tr><td>17</td><td></td><td></td><td>D</td><td>1
(AO2.1)</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr><td>18</td><td>a</td><td>i</td><td>
<table>
<tr><th>Final concentration of solution (mol dm^{-3})</th><th>Volume of 1 mol dm^{-3} sucrose solution (cm^3)</th><th>Volume of distilled water (cm^3)</th><th>Final Volume (cm^3)</th></tr>
<tr><td>1.0</td><td>30.0</td><td>0.0</td><td>30.0</td></tr>
<tr><td>0.8</td><td>24.0</td><td>6.0</td><td>30.0</td></tr>
<tr><td>0.6</td><td>18.0</td><td>12.0</td><td>30.0</td></tr>
<tr><td>0.4</td><td>12.0</td><td>18.0</td><td>30.0</td></tr>
<tr><td>0.2</td><td>6.0</td><td>24.0</td><td>30.0</td></tr>
<tr><td>0.0</td><td>0.0</td><td>30.0</td><td>30.0</td></tr>
</table>
both columns correct with values given to one d.p. ✓ ✓ ✓</td><td>3
(AO2.4)</td><td>ALL 12 values i.e. both columns must be correct and to 1 decimal place for 3 marks

ALLOW for 2 marks
All 12 values correct but incorrect number of decimal places

ALLOW for 1 mark
One column with correct values regardless of d.ps i.e. either volume of sucrose or volume of distilled water

<u>Examiner's Comments</u>

Many candidates had the appropriate mathematical skills to work out dilutions correctly. Candidates should be reminded to keep their data in the same mathematical format provided in the question, in this case recording their answers to 1 decimal place.</td></tr>
</table>

		ii	**FIRST CHECK ANSWER ON ANSWER LINE** **if answer = 0.06 (%) award 2 marks** total uncertainty = ±0.02 g ✓ Uncertainty = 0.02 ÷ 34.23 (× 100) = 0.06 (%) ✓	2 (AO2.4)	**ALLOW** for 1 mark calculator value not to 2d.p e.g. 0.058428 / 0.05843 / 0.0584 / 0.058 **ALLOW** for 1 mark 0.03 (%) (calculated with incorrect total uncertainty) **Examiner's Comments** The broad range of values seen by examiners demonstrated a lack of confidence in how to carry out this calculation, with few candidates stating the correct answer, 0.06, to the correct number of decimal places. Some candidates realised that they did need to double the uncertainty but could not correctly progress the calculation any further. Some responses seemed random with very large values and candidates should be encouraged to apply logic to such responses. **OCR support** The Maths skills handbook can be found on the qualification webpage to support candidates preparing for assessment.
	b	i	−1.5(0) / 3rd replicate / 3rd repeat, at 0.4 (mol dm^{-3}) **OR** −2.9% ✓	1 (AO2.8)	**If value not circled in the table, response must include 0.4 (mol dm^{-3})** **ALLOW** anomalous result circled in the table **ALLOW** any value in the 3rd replicate row for 0.4 **IGNORE** 0.7% **Examiner's Comments** Most candidates correctly identified the value, with many highlighting it in the table as well, which is good practice. Some candidates were not specific enough in regard to which replicate value they were referring to, e.g., stating '−1.50' or '49.5', which were repeated in several different concentrations in the table so could not be given.
		ii	**Any two marks** for **one** variable **and one** explanation **V1 temperature** ✓ **E1** (because temperature) affects the rate of, diffusion / osmosis ✓	2 (AO3.3)	**variable (V) and explanation (E) must match** **DO NOT ALLOW** two variables or two explanations **DO NOT ALLOW** shape as the question stem says 'cylinders' **E1 ALLOW** temperature affects kinetic energy (of molecules) **E1 ALLOW** (temperature) changes **or** affects

			OR **V2** type / variety / species / age, of potato ✓ **E2** (because potatoes have) different, density / water potential / AW ✓ **OR** **V3** ensure enough solution to fully immerse potato cylinders / AW ✓ **E3** so osmosis occurs across the whole surface of the cylinder ✓		permeability of membranes **V2 ALLOW** use peeled potato **V2 ALLOW** same potato **Examiner's Comments** Many candidates correctly stated that temperature should be controlled and were able to give a suitable explanation in terms of increased kinetic energy, increased rate of osmosis or effect on membrane permeability. Some candidates noted that the age or species of potato should be controlled but were less sure as to why that was, with only the more able candidates mentioning that different potatoes could have a difference in water potential. Candidates should be reminded that it is important not to give a variable which had already been controlled. Several candidates stated length or surface area of potato cylinders as variables that should have been controlled, despite the procedure for preparing the cylinders being described in the question and percentage change in length being shown in the table of data.
			Total	**8**	
19			(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	**3**	
20	a	i	sucrose, diffuses / moves down a concentration gradient, into the, Visking tubing bag / delivery tube ✓	1	**DO NOT ALLOW** sucrose solution diffuses **Examiner's Comments** Only the most able candidates scored well here. The uncertainty about the role of osmosis continued into this question. It was clear that many candidates were not confident with the nature of an aqueous solution, osmosis or diffusion. Most candidates did not understand that sucrose molecules diffused from the flask into the Visking tubing. Many suggested that the sucrose solution moved or even diffused into the Visking tubing.
		ii	water potential inside the Visking tubing is reduced ✓ (water potential inside the Visking tubing) is lower than the water potential in the beaker ✓ (so) water moves, by osmosis / down water potential gradient, into the Visking tubing ✓ pushing water into the capillary ✓	Max 2	**ALLOW** pushing / moving, coloured water up **Examiner's Comments** Only a few candidates gave excellent answers with correct references to water potential and the relative differences or gradients. Some candidates realised that the sucrose lowered the water potential in the tubing but did not link that to movement of water by osmosis or did not make it clear that the water moved into the Visking tubing. Most responses, however, simply talked about the sucrose solution moving through the apparatus or capillary action moving fluid up the capillary tube. Quite a few candidates referred to active transport or facilitated diffusion being responsible for the observed changes showing a misunderstanding of the question.

		iii	phloem / sieve tube (element) ✓ xylem ✓ companion cell ✓	3	**Mark first answer only** **ALLOW** named surrounding tissue eg. Parenchyma **Examiner's Comments** Many candidates were able to identify the capillary as representing the phloem or the sieve tube, but few were able to identify the other tissues represented. Indeed, many candidates identified plant organs (the leaf, the root) or abiotic factors, such as soil, rather than plant cells or tissues as asked in the question. It was clear that few candidates were able to correctly match the model to sucrose movement in a plant. This suggests that few have had access to similar models or used apparatus to demonstrate sucrose transport.
	b		0.05 ✓ ✓	2	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.05 (mm^3s^{-1}) award 2 marks** **ALLOW** correct answer anywhere in answer space **ALLOW** 0.052(4) for two marks **ALLOW** additional significant figures for one mark e.g. 0.0523667 If correct answer not given then, **ALLOW** one mark for: 6.28 / 6.3 (mm^3) Note: allow additional figures after the decimal point × / 120 (i.e. a mark for knowing that the volume must be divided by the time) **Examiner's Comments** Most candidates gained at least one mark here with many getting full credit. The most common errors were mistakes with substitution into the given formula (using diameter rather than radius) or for dividing by 2 (mins) rather than 120 (secs). Where candidates gained only one mark it was usually because they did not divide by time to calculate the rate. **OCR support**

					Math for Biology website has a range of tutorials to support with mathematical skills: https:/www.ocr.org.uk/subjects/science/maths-for-biology/geometry-and-trigonometry/
			Total	**8**	
21			**A** ✓	1	**Examiner's Comments** Most candidates gave the correct response (A). The most common incorrect response appeared to be C showing that candidates had thought about the correct proportion (20%) but did not understand the significance of the effect of increasing the thickness. Alternatively, candidates may have misread the question as 'what is the % change in thickness of the alveolus wall'.
			Total	**1**	
22			**C** ✓	1	**Examiner's Comments** Most candidates correctly identified C as the required value. The most common incorrect response appeared to be B. **Assessment for learning** Candidates should read the axes of graphs carefully and read all the possible responses before committing to an answer.
			Total	**1**	