AS
LEVEL

BIOLOGY EXAM PRACTICE

FOR CCEA AS LEVEL

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MARK SCHEME

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Unit AS 1: Molecules and Cells: Answers

Chapter 1 – Molecules

1 **(a)** Conjugated; cellulose; hydrolysis; [3]

(b) Fructose; [1] **[4]**

2 **(a)** Disaccharides; two; [2]

(b)

Molecule	Type of bond involved in forming polymers	Branched	Monomer or polymer
amylopectin;	α-1,4 and α-1,6 glycosidic bonds	yes	polymer
glucose;	α-1,4 and α-1,6 glycosidic bonds	no	monomer
amylose;	α-1,4 glycosidic bonds	no	polymer

(All correct = 2, 1 or 2 correct = 1) [2] **[4]**

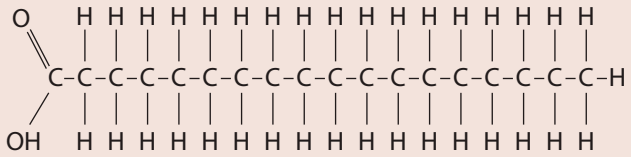
3 **(a)** (i) Glycerol; [1]

(ii) Y on fatty acid chains (allow at periphery of fatty acid chains only); [1]

(iii) Ester; [1]

(b) Triglyceride has three fatty acids (linked to glycerol);
but no phosphate;
(or converse) [2] **[5]**

4 **(a)** (i)



One mark for completing the CH_2 backbone and one mark for the CH_3 group at the end. [2]

(ii) No double bonds within body of molecule/maximum number of H atoms present; [1]

(b) Required for formation of membranes in cells/energy store/thermal insulation/protect organs; [2] **[5]**

5 **(a)** (i) 4; [1]

(ii) NH_2 group circled; [1]

(iii) Peptide; [1]

(b) Hydrogen; [1]

(c) Any **two** from:

- ionic bonds
- disulfide bonds
- hydrophobic interactions

[2] **[6]**

6 **(a)** (i) The presence of the nitrogen (in NH_2)/presence of disulfide bonds; [1]

(ii) Spherical/compact/irregular shape; [1]

(iii) Only one NH_2/COOH end; [1]

(b) Disulfide bonds (unlike some other types of bonds) are able to withstand very high temperatures;
preventing denaturation of proteins/enzymes;

[2] **[5]**

7 (a) (i) P correctly labelled; [1]

(ii) Nucleotide correctly circled; [1]

(iii) Adenine; [1]

(b) The two DNA strands are running in opposite directions; [1] **[4]**

8 (a)

- (DNA polymerase) joins the nucleotides on each strand together (using covalent bonds);
- (DNA helicase) 'unzips' the two DNA strands during DNA replication by breaking hydrogen bonds; [2]

(b) Semi-conservative replication describes how each of the (existing) DNA strands (following their separation) acts as a template;
allowing bases to join by complementary base pairing/for the formation of (two) new DNA molecules; [2]

(c) (i) Band added in a position in the middle tube that is in the same position as the lower band in the right tube; [1]

(ii) In the first generation in ^{14}N (middle) tube, each DNA molecule contains one ^{14}N strand and one ^{15}N strand;
during replication to form the second generation each of these strands will combine with a ^{14}N strand;
forming (50% of) strands with ^{14}N only and (50% of) strands with combination of ^{14}N and ^{15}N;
the lower band represents DNA that contains a mixture of ^{14}N and ^{15}N and the upper band represents the DNA that is ^{14}N only; [4]

(iii) The (nitrogenous) base; [1] **[10]**

Chapter 2 – Enzymes

1 (a) A non-protein substance that a protein requires in order to function; [1]

(b) (i) The amount of substrate decreased over time;
the rate of decrease was fastest at the start /slower at the end; [2]

(ii) Any **two** from:

- the rate of substrate remaining decreases as the enzyme converts the substrate to product
- (the rate was fastest) initially as there were more substrate molecules available allowing all/most enzyme active sites to react
- (the rate was slowest) at the end as there were many fewer substrate molecules meaning that relatively few enzymes could react (due to a shortage of substrate molecules) [2]

(c) The substrates for each enzyme will be produced close to where needed/increases likelihood of enzyme coming in contact with substrate/shorter distances for substrates to diffuse to enzyme;
this will facilitate faster reactions/enzyme action; [2] **[7]**

2 (a) In competitive inhibition, the inhibitor competes with the normal substrate for the enzyme active site;
in non-competitive inhibition, the inhibitor attaches to the enzyme at a position other than the active site; [2]

(b) (i) Enzyme activity (rate of reaction) initially increases at a rapid rate but then levels off as substrate concentration increases;
the (initial) increase in rate is due to more substrate molecules being available allowing more enzymes to react;
(at a certain substrate concentration) all the enzymes/active sites are reacting and the addition of more substrate will not increase the reaction rate (as it is the number of enzymes that is now limiting); [3]

Notes: In this type of graph (unless advised differently) assume that other variables such as number of enzymes and amount of inhibitor are constant.
Part 2 (b) (i) is testing the same concept as tested in 1(b) in this section. Although these two questions would not appear together on the same examination paper, this should remind you that the same knowledge and understanding can be tested in many different ways.

(ii) (With the inhibitor present) the enzyme activity increases as substrate concentration increases as more enzymes will be able to form enzyme-substrate complexes;
the rate will still be lower than that without the inhibitor as some enzymes will not be able to function as they will have the inhibitor in their active sites; [2]

(iii) At very high substrate concentrations there are so many substrate molecules relative to inhibitor molecules that the inhibitors have no effect/the chance of an inhibitor molecule attaching to an enzyme is so low; [1]

(c) (i) $5 \div 8 \times 100\%$;
$= 62.5\%$; [2]

(ii) (With the non-competitive inhibitor present) enzymes that are inhibited will not be able to react irrespective of the substrate concentration;
the initial increase is due to those enzymes not inhibited contributing to faster enzyme activity as the rate increases due to more substrate molecules being available; [2]

(iii) Initial increase and levelling off above the level of original inhibitor line;
plateau approximately double the height of the original inhibitor line; [2] **[14]**

3 **(a)** (i) Destroys harmful pathogens (in food/drink); [1]

(ii) (The enzyme activity is reduced) due to ionic bonds being broken;
resulting in changes to the shape of the active site; [2]

(iii) Oesophagus doesn't have a protective lining of mucus; [1]

(iv) Active site; [1]

(v) Digestion of food will be reduced/slower;
too little acid will be produced;
the enzymes will not have an optimum pH; [3]

(b) (i) Advantage – the enzyme concentration rises immediately symptoms start/early in process;
Disadvantage – enzyme level may have fallen by the time the patient is admitted to hospital; [2]

(ii) Glucose blood level monitors/pregnancy kits/other appropriate response; [1] **[11]**

4 **(a)** Advantage – inexpensive/substrate or products do not have to diffuse through enclosing membrane/barrier/or gel (as with entrapment and encapsulation);
Disadvantage – enzymes can fail to adhere to the supporting material/some active sites may be inaccessible; [2]

(b) Enzymes can be retained and reused/the end product does not have to be separated from the enzymes/facilitates continuous flow set-ups/enzymes more thermostable/more resistant to changes in pH; [1] **[3]**

Chapter 3 – Cells and Viruses

1 **(a)** F; B; D; E; [4]

(b) Hydrophilic ends at edge of membrane/hydrophobic ends inside;
hydrophilic ends in contact with aqueous cytoplasm/hydrophobic ends in centre away from aqueous cytoplasm/beside other hydrophobic molecules; [2]

Note: You will be aware that 'describe and explain' questions are relatively common in AS papers – remember that 'describe' is the *what* and 'explain' is the *why*.

(c) The presence of cholesterol in the membrane; [1] **[7]**

2 **(a)** A – ribosomes;
B – Golgi apparatus/body;
C – vesicles;
D – mitochondrial double membrane;
E – cristae; [5]

(b) (i) Endoplasmic reticulum labelled; [1]

(ii) Membrane-bound organelles are discrete structures with clear boundary/membrane systems have no clear boundary; [1]

(c) (i) Nucleus/cell-surface membrane/endoplasmic reticulum/mitochondria/ribosomes/vesicles; [1]

(ii) Cell wall/(large) vacuole; [1] **[9]**

3 **(a)** Eukaryotic cells are usually larger/ have membrane-bound organelles (or by example)/ have larger ribosomes/have microtubules/no plasmids present/cell walls (if present) are not made of peptidoglycan (or converse)/DNA in chromosomes; [1]

(b)

Feature/ Cell type	Cell wall present	May be multinucleate	Centrioles present	Possess rough endoplasmic reticulum	Possess plasmodesmata	
Animal	×	×	✓	✓	×	;
Plant	✓	×	×	✓	✓	;
Fungi	✓	✓	×	✓	×	;

[3] **[4]**

Note: Some fungal species (and a small number of plant species) have centrioles but normally they are absent in these groups.

4 (a) (i) Nucleolus;
makes rRNA/ribosomes; [2]

(ii) Presence of ribosomes (on outer edge of outer membrane); [1]

(ii) Made from extensions from nuclear envelope/in contact with nuclear envelope;
shorter distance for mRNA to travel from nucleus reduces risk of mRNA being damaged in the cytoplasm; [2]

(b) Nucleus width = 5 μm = 5×10^{-6} m;
envelope is $5\times10^{-9} \div 5\times10^{-6} \times 100 = 0.1\%$;
envelope on both sides of the nucleus, so $0.1 \times 2 = 0.2\%$; [3]

Note: Calculations are usually marked with a mark given to each correct process. In this example, the 3 marks available are awarded for the stages shown. It is important to show your working as an error in the calculation of one stage will not necessarily prevent the other marks being awarded.

(c) (i) Transmission electron microscope; [1]

(ii) Magnification is the degree to which something has been enlarged;
resolution is the ability to see two adjacent points as separate entities; [2] **[11]**

5 (a) (i) Protein; [1]

(ii) DNA; [1]

(iii) Bacteria; [1]

(iv) To insert/inject the DNA into the host cell (bacteria); [1]

(b) Any **three** from:

- HIV is spherical and phages have tail fibres attached to a base plate
- HIV has a phospholipid bilayer
- glycoproteins present in HIV but not in phages
- phages normally contain DNA while HIV contains RNA
- HIV contains reverse transcriptase [3] **[7]**

Chapter 4 – Cell Physiology

1 **(a)** The water potential of a solution is its ability to take in water by osmosis from pure water across a selectively permeable membrane; [1]

(b) (i) –750 kPa; [1]

(ii) Arrows from B to both A and C; [1]

(c) Any **five** from:

- the volume of sucrose in the well has increased
- as the water potential of the 10% sucrose is more negative/less than the water potential of the potato cells
- causing water to enter the well
- the level of water in the beaker outside the potato has decreased
- as water has entered the potato
- as the potato's water potential is more negative than the water in the beaker [5] **[8]**

Note: In 'describe and explain' questions it is essential you both 'describe (the what)' and 'explain (the why)' the results are as they are. In this example, the first and fourth bullet points are descriptions with the rest the explanation. Normally, as here, it is impossible to gain full marks unless you include both in your answer.

2 **(a)** (Incipient plasmolysis) is the point at which the cell-surface membrane just begins to lose contact with the cell wall; [1]

(b) *solute potential* – at full turgor the maximum volume of water is in the cell, (therefore the solute potential will be at its least negative value);
at incipient plasmolysis, the volume of water is reduced making the cell more concentrated (so the solute potential is more negative);

pressure potential – at full turgor there is maximum force exerted on the cell wall by the cell-surface membrane (contributing to the high pressure potential);
at incipient plasmolysis the cell-surface membrane and cell wall are at the point of separating therefore the force of the membrane on the wall is zero; [4]

(c) The cell will always have some solutes present/it will never contain pure water only; [1]

(d) 0;
there is no contact at all between the cell-surface membrane and the cell wall; [2] **[8]**

3

Statement Mechanism of transport	channel or carrier proteins are involved	carrier but not channel proteins are involved	transport is only down the concentration gradient	requires energy	
osmosis	×	×	✓	×	
facilitated diffusion	✓	×	✓	×	;
active transport	✓	✓	×	✓	;
(simple) diffusion	×	×	✓	×	;

[3] **[3]**

4 **(a)** Once the respiratory inhibitor was applied there was no further uptake of K^+;
the respiratory inhibitor prevented energy/ATP being released;
preventing active transport from taking place; [3]

Note: The levelling off of the graph at 3 hours assumes that there is no concentration gradient at this stage between the seedling cells and the external environment, i.e. only active transport and not diffusion was involved.

(b) The uptake of K^+ increased (steadily) throughout the first hour then levelled off;
for the first hour, K^+ had been entering the seedlings by diffusion (until there was no concentration gradient between the substrate and the seedling);
after one hour, there was little further increase as the temperature was too low for active transport to take place; [3] **[6]**

5 **(a)** (i) Helps protect against herbivore attack/wind damage/high transpirational loss of water/other appropriate response; [1]

Note: This is a typical example of a 'suggest' type question; it is very unlikely that any student will have come across this particular question during his/her 'A' level Biology course and, therefore, they will not be able to recall an answer. Any acceptable answer that could be deduced from the information provided and based on background biological knowledge is likely to be acceptable.

(ii) Reduced leaf area so less photosynthesis can take place; [1]

(b) The K^+ ions cause the surrounding cells to develop a more negative water potential;
water is drawn from the 'hinge' cell to the surrounding cells;
leading to a reduction in turgor in the 'hinge' cells causing the folding effect; [3] **[5]**

Chapter 5 – Continuity of Cells

1 Centrioles;
S phase;
G_2 checkpoint;
cytokinesis; [4] **[4]**

2 **(a)** micrometres/µm/microns; [1]

(b) The chromatids remain attached until 6 minutes then separate at a steady rate;
before speed of separation decreases until no further separation takes place;
separation (from 6 minutes) is a consequence of anaphase;
(after a period of time) little/no further separation takes place as anaphase is complete; [4]

(c) Increase in graph line starts at same time (6 minutes);
but rise of line is approximately half of line already present (before levelling off around same time); [2] **[7]**

3 **(a)** Vincristine binds to the microtubules/spindle fibres and prevents them from contracting;
this prevents anaphase from taking place (therefore preventing cancer cells from replicating); [2]

(b) Cancer cells divide more rapidly/in an uncontrolled way (compared to non-cancer cells);
therefore do not get a chance to grow to full size/mature/differentiate fully; [2] **[4]**

4 **(a)**

Name of stage	Description of stage
Metaphase II;	23 chromosomes, each containing two chromatids, align on the equator and attach to spindle fibres
Metaphase I	23 homologous pairs of chromosomes, each containing two chromatids, align on the equator and attach to spindle fibres;

[2]

(b) (i) Centromere; [1]

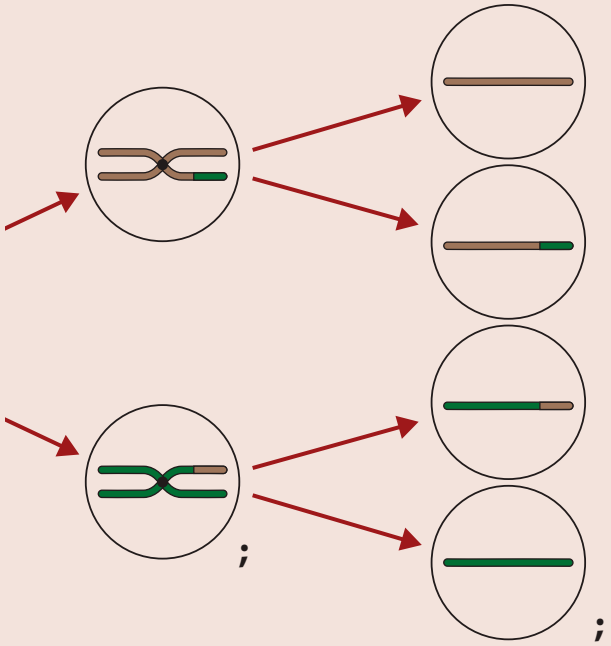
(ii) Anaphase I;
anaphase as (homologous pairs of) chromosomes are being separated;
stage I as chromosomes each contain two chromatids/homologous pairs of chromosomes are being separated; [3] **[6]**

5 Independent assortment;
either chromosome in a (homologous) pair can combine with either chromosome from another (homologous) pair (in a gamete) leading to different chromosome combinations;
crossing over;

exchange of genetic information between non-sister chromatids/leads to different/non-parental sequences in chromosomes/new allelic combinations; [4] **[4]**

6 **(a)** Crossing over has taken place during stage A/crossing over is complete by time metaphase starts; [1]

(b)



; ; [2]

Note: The semicolons indicate where marks are awarded.

(c) Each cell contains one chromosome from each (homologous) pair;
each formed of two chromatids; [2] **[5]**

7 **(a)** (i) $8 \div 52 \times 100\%$;
15.4%; [2]

(ii) Reduces the number of cells undergoing mitosis;
by preventing spindle fibres contracting (thus preventing anaphase taking place); [2]

Note: Based on the evidence in the table, the metabolic poison used did not stop mitosis completely – it reduced the rate at which it takes place.

(b) (i) 67.1 (µm); [1]

(ii) *Supports hypothesis* – mean length of treated plants is longer;
Does not support hypothesis – two largest cell lengths are in control plants;
[2] **[7]**

Chapter 6 – Tissues and Organs

1 (a)

Tissue layer	Function
muscularis externa	causes peristalsis in intestine/churns and moves food;
muscularis mucosa	move the villi thus increasing contact between villi and food (in lumen of gut);
serosa	outer protective/supporting layer;

[3]

(b) Sub-mucosa; [1] **[4]**

2 (a) (i) X – microvilli;
Y – capillary; [2]

(ii) Possess microvilli to increase surface area;
only one layer of cells/very short distance between lumen of gut and capillary; [2]

Note: Many students lose marks in AS papers by not answering the question exactly as asked. In this question you are asked to describe how the villi are adapted using *only* the information in the diagram, therefore reference to the gut having many villi, or the villi having many mitochondria, would not be awarded.

(b) Produces mucus; [1]

(c) Crypts of Lieberkuhn;
have antimicrobial function (protecting the actively dividing cells); [2] **[7]**

3 (a) The spongy mesophyll lies between the palisade mesophyll and the lower epidermis;
it consists of (rounded/unspecialised) cells and air spaces; [2]

(b) Guard cells control the opening of the stomatal pore;
during day/when light intensity high will keep pore open allowing carbon dioxide to diffuse in for photosynthesis;
during night/darkness/when plant is under water stress will close pore to reduce loss of water by transpiration; [3] **[5]**

4 **(a)** A – upper epidermis;
B – palisade (mesophyll) layer; [2]

(b) Waterproof;
so reducing transpirational water loss from the upper epidermis/top of leaf;
transparent;
so allowing light to enter the leaf for photosynthesis; [4]

(c) No/very little light absorbed in A;
but high levels of light absorbed in B;
layer A (epidermis) has no chloroplasts (to absorb light);
layer B has many chloroplasts to absorb light;
small dip absorption in centre of layer B due to presence of vacuole allowing fewer chloroplasts in this zone; [5]

(d) Any **three** from:

- palisade layer closer to surface of leaf so receives more light
- fewer chloroplasts in cells of spongy mesophyll
- air spaces in spongy mesophyll restrict number of cells
- more regular arrangement of palisade cells allows more photosynthesising tissue to be present per unit volume of tissue

[3] **[14]**

5 Indicative content:

1. leaves contain epidermal (including guard cells), palisade mesophyll, spongy mesophyll, xylem and phloem cells
2. epidermal cells are elongated/unspecialised and contain no chloroplasts (except guard cells)
3. form an outer protective/covering layer
4. they produce a waxy cuticle
5. important in restricting water loss (and transmitting light)
6. guard cells (mainly in the lower epidermis) contain chloroplasts
7. and control stomatal opening
8. palisade cells (are found immediately below the upper epidermis and) are rich in chloroplasts
9. are perpendicular/end on to the epidermis
10. and tightly/regularly packed (with no air spaces)
11. are the main sites of photosynthesis in the leaf
12. spongy mesophyll cells are more rounded (and are located immediately below the palisade cells)
13. and more loosely arranged thus creating air spaces
14. their membranes provide the effective gas exchange surface in leaves
15. (the presence of air spaces between spongy mesophyll cells) facilitates gas exchange between the palisade cells and the stomata/atmosphere
16. spongy mesophyll cells contain chloroplasts so carry out some photosynthesis
17. vascular tissue (xylem/phloem) occurs in the leaf midrib/veins
18. xylem cells/vessels transport water (and inorganic ions) to the leaf
19. phloem cells/sieve tubes transport organic content/sucrose/the products of photosynthesis away from the leaf

Band	Response	Mark
3	Candidates use the most appropriate specialist terms to clearly compare and contrast the structure and function of cells in the different tissues in a mesophyll leaf using a minimum of **twelve points** of indicative content. Spelling, punctuation and grammar are excellent and the form and style are of a high standard.	[11] – [15]
2	Candidates use appropriate specialist terms to clearly compare and contrast the structure and function of cells in the different tissues in a mesophyll leaf using a minimum of **six points** of indicative content. Spelling, punctuation and grammar are excellent and the form and style are of a high standard.	[6] – [10]
1	Candidates partially compare and/or contrast the structure and function of cells in the different tissues in a mesophyll leaf using a minimum of **one point** of indicative content.	[1] – [5]
0	Response not worthy of credit.	[0]

Unit AS 2: Organisms and Biodiversity: Answers

Chapter 7 – The Principles of Exchange and Transport

1 **(a)** The rate of diffusion is proportional to the surface area multiplied by the concentration difference divided by the thickness of the membrane (length of diffusion path); [1]

(b) Any **three** from:

- (by having the air spaces only in the spongy mesophyll) this allows the maximum number of palisade cells to be in the palisade layer
- closer to the light/near the top of the leaf
- (most) stomata are on the lower surface, thus close/adjacent to air spaces in the spongy mesophyll
- continuous pathway between the stomata/atmosphere and main photosynthesising cells

[3] **[4]**

2 **(a)** Any **three** from:

- high concentration gradient achieved by breathing/ventilation
- and the capillaries removing oxygen-rich air from lungs/bringing carbon dioxide-rich air to the lungs
- large surface area due to rounded shape of alveoli
- short diffusion distance due to shape of squamous epithelial cells/only two layers of cells to diffuse through
- the very thin capillaries ensures that the red blood cells are close to the squamous epithelial wall further decreasing the diffusion distance [3]

Note: If asked to 'use the diagram only', you must answer only from the information provided in the diagram (i.e. an answer such as there are many alveoli would not be credited in this question). Additionally, to answer a question like this it is useful to think in terms of Fick's law factors.

(b) There are many alveoli increasing surface area;
alveolar surface is moist, necessary for gaseous diffusion; [2]

(c) Any **three** from:

- this prevents/reduces pressure changes between the thorax and the atmosphere
- that normally occur due to the chest wall/diaphragm changing position during breathing
- less oxygen/carbon dioxide can be exchanged in each breath
- leading to a faster breathing rate to compensate [3] **[8]**

3 **(a)** Inflammation/increased mucus production;
causes narrowing of the bronchial tubes/airways thus allowing less air to pass through;
[2]

(b) (i) *Similarity* – in both men and women the average peak flow decreases with age;
Difference – in men the peak flow is higher than that for women; [2]

(ii) Peak flow would decrease;
as less air can pass through bronchi/airways thus producing less of a force when breathing; [2] **[6]**

4 **(a)** 16 breaths per minute; [1]

(b) 500 ml; [1]

(c) (i) A very large intake of breath/breathing in very deeply; [1]

(ii) Any **two** from:

- breathing is deeper
- more irregular
- slower

[2] **[5]**

Transport in Plants and Transpiration

1 **(a)** Provides strength (to support xylem vessels);
(is waterproof) so prevents loss of water through the xylem walls; [2]

(b) Protoxylem is formed first/early in development/contains annular or spiral thickening/has thinner lumens than metaxylem;

metaxylem is formed later/in more mature sections of the plant/contains reticulate or pitted thickening/contains a more complete covering of lignin/has a wider lumen than protoxylem;

[2]

Note: In this type of question it is important to give two differences that are clearly distinct. For example, an answer of protoxylem is formed first and metaxylem is formed later would only gain one mark but an answer of protoxylem is formed first and metaxylem has reticulate or pitted thickening would gain two marks.

(c) (i) Has an extensive covering of lignin/thickening with pits; [1]

(ii) Allows (lateral) transport between xylem vessels; [1] **[6]**

2 **(a)**

Pathway	Part of cell involved	Movement of water mainly under osmotic control
	cell walls;	
		yes;

[2]

(b) Contains a waterproof Casparian strip;
which prevents movement of water through the cell walls/by the apoplast pathway;
water deflected into the protoplast/cytoplasm/symplast pathway (where it is under metabolic control); [3] **[5]**

3 (a) *Cohesion* – the force that causes water molecules to stick together; helps pull the water as a column up xylem vessels;

Adhesion – the force between water and its surrounding medium, e.g. xylem walls; helps support water column as it moves up the xylem vessel (meaning that overall force required to pull water up xylem is reduced); [4]

(b) (i) 22 µm; [1]

(ii) *Lower* – if lower, friction between walls and water column would increase;
Higher – if higher, would lower value of adhesive forces/water column would be at risk of breaking; [2]

(iii) Different degrees of thickening with lignin/(in water transport) thickness of wall less critical than thickness of lumen; [1]

(iv) Cells/lumens measured at widest (or identified, e.g. mid-point) position/other appropriate response; [1] **[9]**

4 (a) (i) Sieve plate; [1]

(ii) Sieve tube cell; [1]

(iii) Any **two** from:

- sieve pores in end walls (sieve plates)
- reduced cytoplasm/absence of nucleus
- presence of microtubules extending through and between cells (involved in transporting organic molecules)
- other appropriate response [2]

Note: Although phloem tissue is adapted by having companion cells supporting sieve tube cells (through carrying out many metabolic processes to compensate for the reduced cytoplasm) reference to companion cells would not gain credit in this question – they are not an adaptation of sieve tube cells.

(b) (i) Following the removal of bark the sucrose content in phloem immediately above the point of removal increases;
and decreases in phloem immediately below the point of removal;
(immediately above the point of removal) sucrose accumulates as can no longer move further down the tree;
(immediately below the point of removal) sucrose is translocated down (into roots/other growing points) but is not replaced; [4]

(ii) The lower parts of the tree are starved of sucrose/carbohydrate/products of photosynthesis;
no longer able to carry out respiration; [2] **[10]**

5

Adaptation	Explanation of adaptation
thickened cuticle;	
	stores large quantities of water in cells;
sunken stomata;	
	traps a layer of humid air/restricts air flow over leaf surface;

[4] **[4]**

6 **(a)** (i) Transpiration can be defined as the evaporation of water from the (spongy) mesophyll surface and the subsequent diffusion of water vapour through the stomata and into the atmosphere; [1]

(ii) Any **two** from:
- transports water to the leaves for photosynthesis
- transports minerals up the plant
- provides water for turgor in leaf cells
- as water evaporates from leaves it has a cooling effect [2]

(b) During daylight the stomata open/close at night;
when photosynthesis can occur, stomata are open allowing gas exchange to take place/carbon dioxide to enter leaves and oxygen to leave;
at night/when too dark to photosynthesise, the stomata close reducing water loss; [3]

(c) Leaf surface area/stomatal density/other appropriate response; [1]

Note: While leaf surface area and stomatal density are the only internal factors (apart from cuticle thickness) listed in the specification, there are other factors that affect transpiration rate and one of these could be given credit as an 'other appropriate response'. A suitable OAR would be surface area of mesophyll cells in contact with sub-stomatal air spaces.

(d) (i) 3.79 µm; [1]

(ii) (3.79 – 0.84 = 2.95)
2.95 ÷ 3.79 × 100%;
= 77.9%; [2]

Note: As you have been asked to give your answer to three significant figures, a 'correct' answer given to the incorrect number of significant figures would only be credited with one mark.

(iii) Any **four** from:

- thinner cuticles allow more light through
- therefore more photosynthesis can occur
- important in low light intensity habitats
- evaporation/temperatures will be lower in low light intensity habitats
- therefore a thick cuticle is not necessary to reduce (cuticular) transpiration [4]

(iv) Any **two** from:

- cuticle thickness measured from same position on each leaf
- size/position/feature of leaf on plant consistent, e.g. largest/leaf from highest position on stem
- cuticles measured when leaves at same age/state of growth/maximum size
- other appropriate response [2] **[16]**

Chapter 9 – Circulatory Systems in Mammals

1 **(a)** A double circulatory system means that the blood goes through the heart twice for each complete circuit of the body/there are two distinct circuits, the pulmonary and the systemic (body); [1]

(b) Any **four** from:

- there is a very extensive capillary network
- ensuring that no tissue/cell is far from a capillary/providing a large surface area for the diffusion of materials
- capillaries have very thin/one cell thick walls
- making them permeable
- and providing a short diffusion distance [4] **[5]**

Note: In this question you were asked to explain how each of the capillary system (the network) and capillaries (the vessels) are adapted. Therefore, you should not expect to obtain full marks unless you address both aspects.

2 **(a)** X – liver;

Y – hepatic portal vein; [2]

(b) Any **two** from:

- will contain less oxygen
- more carbon dioxide
- lower blood pressure
- other appropriate response [2]

Note: In this question you were asked to suggest two ways in which the blood would be different therefore 'will have a lower blood pressure' would be acceptable. If the question had asked for differences in the blood composition a pressure-related answer would not be credited.

(c) Vena cava; [1] **[5]**

3 Any **five** from:

- in the aorta (the velocity changes very little as) the blood pressure remains high due to being close to the heart/there is very little increase in total cross-sectional area
- in the arterioles the blood pressure falls (causing the decrease in blood velocity)
- due to the large increase in total cross-sectional area
- (low velocity) in capillaries due to further (small) increase in cross-sectional area/resistance to blood flow due to capillaries being very narrow
- (low velocity) allows exchange of material between capillaries and tissue/protects delicate tissues
- (velocity increases) in veins due to increase in lumen size thus reducing friction with walls

[5] **[5]**

4 **(a)** (i) The elastic tissue allows artery walls to stretch as blood pulses through them;
as it recoils it helps push blood along/maintain blood pressure; [2]

(ii) As distance from the heart increases the proportion of artery that is elastic tissue decreases;
due to reduced pulse effect with distance; [2]

(b) (i) Contraction of smooth muscle in the artery;
causes the lumen to reduce;
reducing blood flow to skin capillaries;
reducing heat loss by radiation through the skin surface; [4]

(ii) Vasoconstriction can only reduce heat loss/cannot increase heat gain; [1] **[9]**

5 **(a)** (i) Reference to aortic pressure/if on right side would be pressure on pulmonary artery; [1]

(ii) Ventricular systole; [1]

(iii) Pressure increases as ventricle walls contract (reducing volume in the ventricles);
pressure (peaks and) decreases as the ventricles empty of blood; [2]

(iv) The increased pressure of the contracting ventricle causes a back pressure on the atrium/AV valve;
the subsequent fall in pressure is caused by the relaxation (and increase in volume) of the atria;
gradual increase in pressure (after the fall) is caused by the atria filling with blood; [3]

(v) At Y, the aortic/semi-lunar valves open;
at Z, the semi-lunar valves close; [2]

(b) (i) The heart is beating faster; [1]

(ii) The heart doesn't get an opportunity to fill with blood/its beat is less efficient; therefore less blood is getting around the body/to the brain (causing the dizziness and risk of fainting);

[2] **[12]**

Note: Many students will be able to deduce that a heart beat that is much faster than normal will be inefficient and/or that there may not be enough time for the heart chambers to fully fill. However, some students who don't work this out may be able to work backwards by understanding that fainting or dizziness will be caused by a lack of oxygen in the blood or a lack of blood getting to the brain (or around the body). Therefore, the heart trace shown must show a condition in which the heart is beating less efficiently.

6 (a) (i) Both have a nucleus;

Any **two** from:

- polymorphs have a granular cytoplasm/monocytes are agranular
- monocytes have a bean shaped nucleus/polymorphs have a multi-lobed nucleus
- monocytes are larger than polymorphs [3]

Note: Remember that in a 'compare and contrast' question you have to both compare and contrast. While often there will be the same number of marks for comparing and contrasting, this is not always the situation (as in this question). The 1 – 2 split is because students would be expected to come up with more differences than similarities in this question.

(ii) (B-lymphocytes) produce antibodies; [1]

(b) The reduced number of red blood cells will result in less oxygen being transported around the body;
(the heart and breathing rates increase) to bring more oxygen into the body/or to pump more blood per unit time to compensate; [2] **[6]**

7 (a) (i) Any **two** from:

- biconcave shape to give large surface area/volume ratio
- no nucleus/organelles so can contain more haemoglobin
- small so can be close to capillary wall thus shortening the diffusion distance [2]

(ii) Any **three** from:

- contains haem/iron which can bind to oxygen
- picks up oxygen at high partial pressures and releases oxygen at low partial pressures
- further explanation of significance of sigmoidal dissociation curve
- co-operative loading or by explanation [3]

(b) (i) Increased rates of respiration (caused by increased activity); [1]

(ii) 76 – 40% saturation in graph;
24 and 60% dissociation;
36 ÷ 24 × 100% = 150%; [3]

(iii) Any **three** from:

- the haemoglobin has a reduced affinity for oxygen
- more oxygen is released
- for more respiration
- at a time of high respiratory need [3]

(c) (i) Myoglobin has only one polypeptide and haemoglobin has four/myoglobin is found in (red) muscle whereas haemoglobin is transported around the body in the blood; [1]

(ii) Myoglobin has a greater affinity for oxygen (than haemoglobin);
therefore will only release oxygen at very low partial pressures of oxygen;
such as at times of higher respiratory need/when haemoglobin oxygen reserves are depleted;
[3] **[16]**

8 **(a)** (i) The partial pressure of oxygen is the pressure contributed by oxygen only; [1]

(ii) Decreases; [1]

(b) The (atmospheric) partial pressure of oxygen is low;
therefore by saturating at lower (than normal) partial pressures, full saturation can still be achieved; [2]

(c) Their number of red blood cells will increase;
enabling them to transport more oxygen around the body;
for higher rates of respiration; [3] **[7]**

The adaptation of organisms

1 (a) A morphological adaptation is a physical adaptation involving the structure of an organism;
a physiological adaptation is a biochemical (metabolic) adaptation; [2]

(b) (i) Aerenchyma/large/prominent air spaces within the leaves;
that enables the leaves to float on the water surface;

or

stomata on the upper leaf surface (rather than the lower surface);
as on the lower surface would fill with water/upper surface only is in contact with the atmosphere; [2]

Note: It is important to state *large/prominent* air spaces (if not using the term aerenchyma) as all leaves will have air spaces!

(ii) **Any pair:**
The canal is disused;
therefore, the water lilies will not be damaged;

or

the canal is not too deep;
therefore, the stalk attaching the lilies to the substratum is not too long (reducing the risk of the stalks being broken/damaged);

or

the water in canals will be slow moving;
therefore, the stalks attaching the lilies to the substratum are less likely to be damaged; [2] **[6]**

2 (a) Presence of sharp spines; [1]

(b) (i) Do not require food (in winter);
at a time food is likely to be in short supply;

or

their body temperature drops to a lower level;
therefore, they require less food/energy to maintain their body temperature;

or

they are not active;
therefore, they require less food/energy; [2]

(ii) Hibernation involves a change of behaviour/or by example, e.g. no longer active;
but also reduced heart rate/metabolic rate/respiration rate which are physiological changes;

[2]

(c) (i) When badger numbers are (relatively) high, hedgehog numbers are (relatively) low (or converse);
suggesting that high levels of predation in some areas leads to reduced numbers of hedgehogs in these areas (or converse); [2]

(ii) A scatter diagram provides more visual impact/it is clearer to identify if there is a relationship between two variables/variability of data can be easily seen/ anomalous results can be easily identified;

[1] **[8]**

Note: This is an example of a question where some students could be expected to misinterpret the question through not being careful enough in working out exactly what is required. You are asked to suggest why a scatter graph is normally used for this type of data, *not* what a scatter graph is.

3 **(a)** (As it is a plant that grows close to the ground) it will be out-competed by other plants/grasses; [1]

(b) Dry soils/soils with low mineral content/'salty' soils/other appropriate response; [1]

(c) (i) An organism's role within an ecosystem/within the environment; [1]

(ii) The habitat is not common (e.g. sea cliffs/unfertilised grasslands close to the sea/areas subjected to sea spray)/other appropriate response; [1] **[4]**

Chapter 11 – Biodiversity

1 (a) (i) A group of individuals of common ancestry that closely resemble each other, and are normally capable of interbreeding to produce fertile offspring; [1]

(ii) The genetic variability within a species; [1]

(b) (i) $\frac{(9 \times 8) + (31 \times 30) + (3 \times 2) + (22 \times 21) + (4 \times 3)}{69 \times 68}$;

$= \frac{1483}{4692}$;

$= 0.32$; [3]

Note: The Simpson's index value for the upper shore was given to 2 decimal places so it is appropriate that the lower shore is the same – traditionally Simpson's index values are given to two decimal places. In this question the third mark would not be awarded if the answer was just given as 0.3.

(ii) The snail biodiversity of the upper and lower shores are approximately the same/ the upper shore has a *slightly higher* biodiversity than the lower shore.

[1] **[6]**

Note: In this question it is important to appreciate that the difference in Simpson's index values for the two shores is very small and that therefore an answer such as 'the upper shore has a higher biodiversity' does not fully explain what the data shows and therefore may not be awarded the mark.

2 (a) Systematics/taxonomy; [1]

(b) Order; [1] **[2]**

3

Kingdom	All are unicellular	All have a heterotrophic mode of nutrition	All have cells with cell walls
animalia	…	…	…
fungi	×	✓	✓;
protoctista	×	×	×;
plantae	×	×	✓;
prokaryotae	✓	×	✓;

[4] **[4]**

4 (a) Prokaryotae, protoctista, plantae and animalia; [1]

(b) (i) An organism that (heterotrophically) feeds on dead organic matter/an organism that decomposes dead organic matter; [1]

(ii) They secrete enzymes into the soil (by exocytosis);
these enzymes break down organic matter/organic matter is broken down by extracellular digestion;
the products of digestion are absorbed into the fungi; [3]

(iii) There is more dead/decomposable organic matter close to the tree stump; [1] **[6]**

5 (a) (i) E; [1]

(ii) D/E;
the number of base differences from the ancestral species are very different to the others/other appropriate response; [2]

Note: As with many 'suggest' questions there is more than one possible answer. In this question both D and E are very different to the remaining values (with the other values all having between 20 – 29 differences). However, based on the information provided it is impossible to know which of D or E belong to the same genus as the others – therefore, the marks would be awarded for an answer of either D or E with a suitable explanation.

(b) RNA/protein/other appropriate response; [1] **[4]**

Chapter 12 – Human Impact on biodiversity

1 (a) (i) Appropriate best fit line (needs to have a steeper incline); [1]

(ii) For both hedges with ditches and hedges without ditches, the number of bird species increases with hedgerow width;
(for any particular width) the number of species in hedges with ditches is greater; [2]

(iii) The hedgerows with ditches have a wider range of habitats (leading to a greater number of species)/other appropriate response; [1]

Note: In this question as with many other similar types of questions, the converse answer would be given credit, e.g. hedgerows without ditches have fewer habitats.

(iv) Any **two** from:
- use the same procedure for counting bird species, e.g. do a bird count at same times/for the same length of time
- use the same procedure for measuring hedge width, e.g. measure to widest point
- sample hedges of the same approximate height
- sample hedges in the same geographical area
- other appropriate response [2]

Note: When choosing variables in an unfamiliar investigation, you should choose variables that are quite different if possible. In the mark scheme above, doing the bird count at the same times and for the same length of time are grouped together as they both are variations of the procedure for counting birds – therefore, if you just use these answers you will only get one mark.

(b) (i) Predator strips increase biodiversity/pesticide use decreases biodiversity;
predator strips increase the range of habitats;
pesticides decrease the number of invertebrates/insects/animals that feed on the pest/crop; [3]

(ii) (Predator strips) reduce the area of land available for crops/may not be as effective as pesticides/may provide habitats for other pests; [1] **[10]**

2 (a) Biological oxygen demand is an indication of how rapidly oxygen is used up in water; [1]

(b) Any **two** from:
- eutrophication has a longer time scale
- it involves increased growth of algae and water plants
- other appropriate response [2]

(c) Farmers test soils before application of fertiliser/only enough fertiliser is used to meet crop needs/fertiliser not applied in wet/closed periods/close to water ways/other appropriate response; [1] **[4]**

3 **(a)** (i) A species native to that area/a species historically from that area; [1]

(ii) (Increase in) temperature; [1]

Note: The term 'directly' was used in this question as it is increased temperature (or the consequences of temperature) that directly affects species ranges. The increase in carbon dioxide is what causes the increase in temperature, but the increased atmospheric carbon dioxide does not directly affect (most) species.

(iii) Dragonflies and damselflies can fly (therefore able to move much greater distances); [1]

(b) Reduced biodiversity;
as a consequence of the reduced number of animals/named animals; [2] **[5]**

4 Indicative content:

1. polyculture/the growing of a range of crops at the one time
2. provides a greater range of food sources/habitats
3. creating more complex food webs/encouraging the establishment of a greater variety of animal species
4. hedgerow conservation/maintenance
5. provides a greater range of food sources/habitats (if 2 not given above)
6. (cutting at appropriate time) allows bird species to nest (and produce offspring)
7. and provides berries/food over winter
8. integrated pest management/biological control
9. narrow spectrum pesticides only target pests and not other animal species
10. crop rotation prevents the build up of pests thus reduces the need for pesticide use
11. (effective) biological control will not harm other non-pest species
12. predator strips provide a greater range of food sources/habitats (if 2 not given above)
13. encouraging the establishment of beetles/ladybirds/other invertebrates
14. increased use of organic fertiliser/more controlled (reduced) use of artificial fertiliser
15. example of how controlled, e.g. test mineral content of soil before the application of fertiliser
16. reduces eutrophication/enrichment of waterways
17. prevents algal blooms/increased decomposition/saprobiotic activity
18. and reduced oxygen content/increased BOD avoiding the loss of invertebrates/fish
19. other (Government) initiatives
20. e.g. ASSIs
21. brief description of initiative
22. other appropriate response

Band	Response	Mark
3	Candidates use the most appropriate specialist terms to clearly describe and explain agricultural practices that promote biodiversity using a minimum of **twelve points** of indicative content. Spelling, punctuation and grammar are excellent and the form and style are of a high standard.	[11] – [15]
2	Candidates use appropriate specialist terms to clearly describe and explain agricultural practices that promote biodiversity using a minimum of **six points** of indicative content. Spelling, punctuation and grammar are excellent and the form and style are of a high standard.	[6] – [10]
1	Candidates partially describe and/or explain agricultural practices that promote biodiversity using a minimum of **one point** of indicative content.	[1] – [5]
0	Response not worthy of credit.	[0]

Unit AS 3: Practical skills in AS Biology: Answers

1 (a) Brick-red precipitate; [1]

(b) To control other variables (such as length of heating and amount of heating; to ensure valid results; [2]

(c) Recording of the end point is subjective; [1] **[4]**

Note: Obviously the answer for (c) – and for many other questions – will not require the answer to exactly match the wording in the mark scheme as the correct understanding can be written in so many different ways.

2 (a) (i) Use a micropipette/capillary tube/other appropriate response; to place a number of spots (on the origin) and allow each spot to dry between each application; [2]

(ii) The tank is saturated to prevent the solute/solvent drying out; as if dry, the solute will not travel as far/give an accurate R_f value; [2]

(b) (i) 0.64; [1]

(ii) 0.67; [1]

(iii) Difficulty in determining the leading edge/centre of spot; [1]

Note: The variation within each class is relatively small (i.e. < 0.1) so unlikely to be due to differences in technique, e.g. some students measuring to the leading edge and others to the middle of the spot.

(iv) Comparison – both sets of data extend over a range of R_f values;
Contrast – the (mean) value(s) in Graph B are (overall) higher than graph A; the students in class B may have used the leading edge of the spot when calculating the R_f value, whereas the students in class A may have used the centre of the spot; [3] **[10]**

Note: In this type of question other alternatives would normally be allowed for the third mark – some students could suggest that the vessels/tanks in class A were slightly less saturated than in B – a reasonable suggestion to account for lower R_f values – but is this realistically going to be a difference across the entire class?

3 **(a)** Independent variable – (experiment carried out at) a range of pH values;
dependent – time taken for glucose to be detected; [2]

(b) Any **two** from:
- temperature
- volume/concentration of sucrose
- volume/concentration of sucrase [2]

(c) Use buffers to set up a range of experimental pH values;
remove a sample every 30 seconds (or other appropriate time) from the tube containing sucrose-sucrase (following mixing);
test with Clinistix/other glucose-specific reagent; [3]

(d) Table with two columns and appropriate number and range of experimental pH values (5 or 6 experimental pH values that includes 7 (e.g. 5-6-7-8-9);
appropriate headings in the top row (or left column) e.g. - pH and Time for glucose to appear;
appropriate units for time, e.g. seconds/S (units in heading row only); [3] **[10]**

4 **(a)** (i) 2 ÷ 6;
= 0.33; [2]

(ii) The rate of gas production decreases over time;
eventually/after 120 seconds no further gas is produced;
initially there is enough substrate/hydrogen peroxide to allow all the catalase enzymes to react;
as concentration of substrate/hydrogen peroxide decreases some enzymes (do not have substrates therefore) do not react (leading to the reduction in rate of reaction);
over time/after 120 seconds the hydrogen peroxide has all reacted/no more substrate available; [5]

(b) (i) Use water baths to set up a range of experimental temperatures (and carry out the investigations at each of these temperatures);
bring each of the hydrogen peroxide and catalase to the appropriate temperature before mixing;
record the volume of oxygen produced in the gas syringe every 15 seconds (after the hydrogen peroxide and catalase are mixed); [3]

(ii) Any **two** from:
- pH
- volume/concentration of hydrogen peroxide
- volume/concentration of catalyse [2] **[12]**

5 **(a)** Drawing representative of electron micrograph image, i.e. overall a general 'bean' shape that takes up same proportion of space and extends (almost) from side to side; drawing at a slight angle similar to as in image;
mitochondrial envelope of double membrane;
cristae present with some extending across the width of the mitochondrion; [4]

(b) Ribosomes; [1]

(c) Length = 100 mm;
= 100 000 µm;
(100 000 ÷ 62 800) = 1.59 µm; [3] **[8]**

6 **(a)** 100 SEUs (eyepiece units) = 24 stage micrometer units;
100 SEUs = 0.24 mm = 240 µm;
1 SEU = 240 ÷ 100 = 2.4; [3]

Note: Obviously you could use another position where the eyepiece graticule and stage micrometer grid lines match up but, in this example, the 100-24 overlap is the most obvious and allows easier calculations.

(b) (i) Larger field of view seen/all the stage micrometer will be visible; [1]

(ii) A slight error in lining up grid lines represents a smaller value/as the stage micrometer grid lines are magnified to a greater degree, this will enable grid lines on the two scales to be more accurately matched up; [1]

(c) Measure to a fixed point in the cell, then move slide to measure the length of the rest of the cell/measure to the midpoint and multiply by two; [1] **[6]**

7 **(a)** As some cells/cell membranes would be already damaged (when cutting the section); therefore there would already be pigment in the water affecting the colorimeter reading (before the heating effect); [2]

(b) 94 – 10;
84 ÷ 94 × 100 = 89.4; [2]

Note: In calculations where you are asked to give an answer to a particular number of significant figures or a particular number of decimal places, you will usually lose one mark if you do not do this.

(c) The percentage transmission falls off with increasing temperature;
relatively small decrease between 20 – 40 °C/largest fall between 40 – 50 °C;
most membrane damage occurs at 50 °C/between 40 °C and 50/60 °C causing more betalain to leak into the water producing the large fall in transmission;
between 20 – 40 ° C, the temperatures are not high enough to cause (much) damage to the membranes/at highest temperature (70 °C) the membranes are already damaged to the extent that further heating causes little additional damage; [4]

(d) There would be increased percentage transmission at each temperature; as there would be less membrane damage (at each temperature); [2] **[10]**

8 (a) (Opposing) centrifuge tubes must be balanced/other appropriate response; [1]

(b) (i)

Sediment (A, B or C)	Main organ in sediment
B	mitochondria
A	nuclei
C	ribosomes

[All correct = 1 mark] [1]

(ii) Remove the sediment an additional time between A and B; [1]

(c) Length of time centrifuge is spinning/other appropriate response; [1] **[4]**

9 (a) 0.3 mol dm^{-3}; [1]

(b) The water potential of the potato and sucrose are the same; therefore there is no net movement of water into or out of the potato; [2]

(c) 8.5 = 0.78;
8.5 ÷ 0.78 = 10.9 g; [2]

(d) The cells are fully plasmolysed (at each of these concentrations)/can lose no more water; [1] **[6]**

10 Add sections of onion epidermal tissue to pure water (to ensure all cells are turgid); place sections in each of water and a range of sucrose solutions of different solute potentials for 30 minutes/an appropriate period of time;
(remove the onion epidermal sections and add to microscope slides) then count the number of plasmolysed and the number of turgid/not plasmolysed cells in a sample of the tissue in each concentration;
draw a graph of the percentage plasmolysis against solute potential of the immersing solution;
using the graph, identify the point at which 50% of the cells are plasmolysed (at this point the solute potential of the immersing solution is the same as the average solute potential of the onion cells);

[5] **[5]**

Note: The different sucrose concentrations may be labelled as concentrations rather than solute concentration. If so, before drawing the graph the concentration can be converted to solute potential using a suitable table.

11 (a) Allows stain to permeate the cells/softens the tissue (making the 'squash' easier); [1]

(b) (i) Tap/(apply vertical pressure to) the cover slip (with e.g. the blunt end of a pencil); [1]

Note: It is possible to use your thumb to form a squash – normally you would not press directly on the coverslip but press through a folded tissue or equivalent – however, it is very important that the angle of pressing is perpendicular to the slide.

(ii) Do not over squash/squash at an angle;
as this will break up the rows of cells (meaning that a distinct zone of division may not be present)/dividing cells will not all be in same region (making it more difficult to find cells in mitosis); [2]

(c) (i) Prophase; [1]

(ii) More difficult to identify if cells are in prophase (than anaphase or any other stage); [1] **[6]**

12 (a) Cuticle; [1]

(b) (i) Palisade cells;
Any **two** from:
- elongated shape
- immediately under the upper epidermis
- perpendicular to the epidermal layer [3]

(ii) Gaps between cells/not in clear rows; [1]

(c) Scanning electron microscope; [1] **[6]**

13 (a) Absorbs carbon dioxide;
so that only changes in oxygen used (by insect larvae) contributes to the movement of the coloured liquid; [2]

(b) (b) 24 mm^3 in 35 minutes = 0.69 per minute;
= 0.69 ÷ 10 = 0.069 $mm^3\ min^{-1}\ g^{-1}$; [2]

(c) Replace the KOH with water;
(apart from that) use same apparatus and living material in same temperature/environmental conditions;
record the distance the coloured liquid moves over time;
volume of carbon dioxide produced can be calculated by using the volume of oxygen produced plus or minus the volume of carbon dioxide produced; [4] **[8]**

14 (a) (i) The estimated number of plantain plants in the grassland is variable when estimated using a small number (up to 20) of quadrats;
but the estimated number is approximately 150/remains stable when using 25 or more/a large number of quadrats; [2]

(ii) 25;
it is the minimum number that can be used to produce stable/reliable results; [2]

(b) (i) The violet plants are small;
less likely that some plants will be missed in a smaller quadrat (or converse); [2]

(ii) Each quadrat = 0.0625 m^2;
mean number of violets = 1 ÷ 0.0625 (16) × 8 = 128 m^2;
(grassland = 40 m × 25 m = 1000 m^2) so = 128 000; [3] **[9]**

15 (a) The percentage of all quadrats/sampling points in which a species occurs; [1]

(b) Select an appropriate number of leaves from each tree (e.g. 20);
use an appropriate method to standardise position from which to select leaves from the *two trees* (e.g. only use leaves facing south/only leaves on lowest branches);
use an appropriate method to avoid bias when *sampling in each tree*, (e.g. use only largest leaf from each (minor) branch);
count the number of tar spots on each leaf sampled;
further detail re standardising sample, (e.g. description of how to record spots that coalesce with each other/very small spots or idea of sampling only leaves of a particular size); [5] **[6]**

16 (a) (i) Deciduous trees lose their leaf cover in winter/coniferous trees keep their leaves the entire year; [1]

(ii) Any **two** from:
- (take all) readings at the same time of day
- (take all) readings in the same weather conditions, e.g. when no cloud present
- (take all readings) at the same height, e.g. 1 metre above ground level
- take reading(s) at the same position(s) in the woodlands, e.g. at centre or 20 m in from wood edge
- other appropriate response [2]

Note: This is another typical 'suggest' question – students would not be expected to know possible answers, but they should be able to deduce factors that would affect light levels and appreciate what variables would need to be kept constant to produce valid results. An 'other appropriate response' is a valid answer that was not previously considered by the examining team or added to the mark scheme.

(b) Any **two** from:
- soil moisture
- soil humus levels/organic content
- soil pH
- soil depth (above underlying rock)
- other appropriate response [2] **[5]**