

A-Level Edexcel

BIOLOGY

UNIT 4(IAL)
2020 — 2025

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1 - ((WBI11)/4(IAL)_Summer_2020_Q1) - Energy, Environment, Microbiology And Immunity

Chloroplasts are involved in both the light-dependent reactions and light-independent reactions of photosynthesis.

- (a) Which row of the table shows where the light-dependent reactions and light-independent reactions take place?

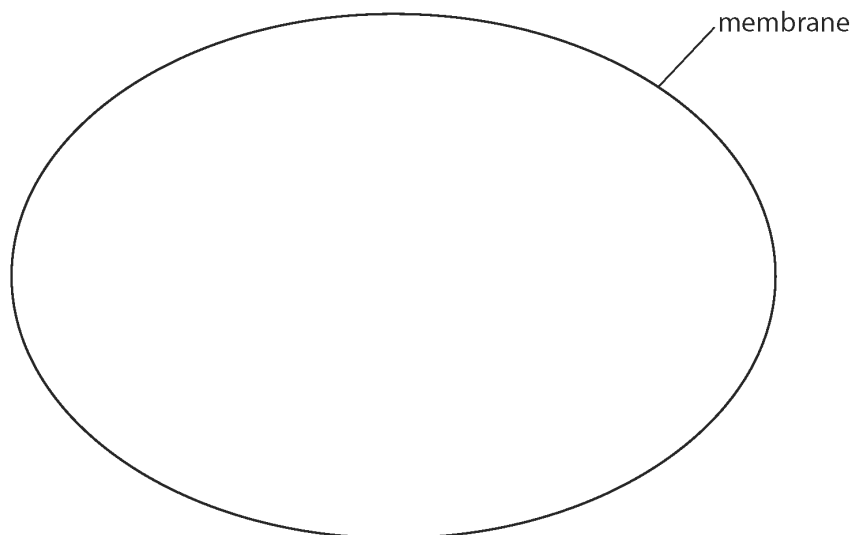
(1)

	Light-dependent reactions	Light-independent reactions
☐ A	stroma	stroma
☐ B	stroma	thylakoid membranes
☐ C	thylakoid membranes	stroma
☐ D	thylakoid membranes	thylakoid membranes

- (b) The diagram shows the outline of a chloroplast.

Draw **three** labelled features on this diagram that are found in a chloroplast, other than the stroma and the thylakoid membranes.

(3)



- (c) An absorption spectrum shows how much light is absorbed by chloroplasts at different wavelengths of light.

The table shows the colour of light at four wavelengths.

Wavelength of light / nm	460	520	600	680
Colour of light	blue	green	yellow	red

Which wavelength of light is absorbed the **least** by chloroplasts?

(1)

- ☒ **A** 460 nm
- ☒ **B** 520 nm
- ☒ **C** 600 nm
- ☒ **D** 680 nm

- (d) State what is meant by the term **action spectrum**.

(1)

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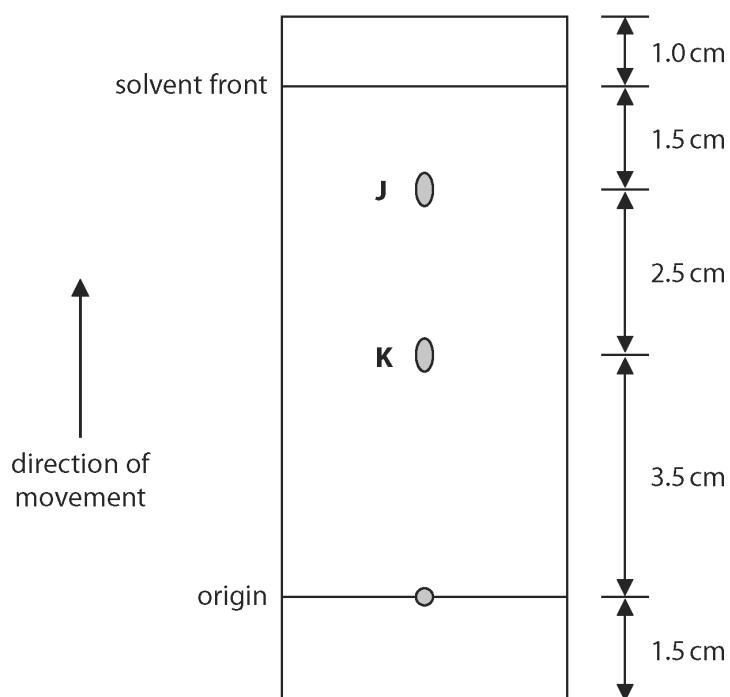
- (e) Chloroplast pigments can be separated and then identified by their R_f values.

- (i) Which process can be used to separate chloroplast pigments?

(1)

- ☒ **A** chromatography
- ☒ **B** dendrochronology
- ☒ **C** osmosis
- ☒ **D** PCR

(ii) The diagram shows separated chloroplast pigments, **J** and **K**.



What is the R_f value for chloroplast pigment **J**?

(1)

- ☐ **A** 0.625
- ☐ **B** 0.800
- ☒ **C** 0.830
- ☐ **D** 1.714

2 - ((WBI11)/4(IAL)_Summer_2020_Q2) - Energy, Environment, Microbiology And Immunity

Body temperature and the degree of muscle contraction can be used to determine the time since death of a person.

The table shows how body temperature and body stiffness, due to muscle contraction, change with time since death.

Time since death / hours	Body temperature	Body stiffness
< 3	warm	not stiff
3 to 8	warm	stiff
8 to 36	cold	stiff
> 36	cold	not stiff

(a) State how the temperature of a dead body should be measured.

(1)

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(b) (i) Body temperature can be used to estimate the time since death using the following information:

- loss of 0.78°C per hour for the first 12 hours after death
- after 12 hours, loss of 0.4°C per hour.

Estimate the time since death of a person whose body temperature had fallen 11.5°C .

Give your answer to the nearest hour.

(2)

Answer hours

- (ii) Explain why this estimate would be different if the body had been left in a colder place.

(2)

- (c) Explain why using body stiffness only, as shown in the table, is insufficient to estimate the time since death accurately.

(3)

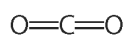
3 - ((WBI11)/4(IAL)_Summer_2020_Q3) - Energy, Environment, Microbiology And Immunity

The following equation summarises photosynthesis.

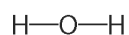


The diagrams show the bonds in carbon dioxide, water and oxygen.

carbon dioxide



water



oxygen



Energy is needed to break chemical bonds, and to form new chemical bonds. This is called the bond energy.

The table shows some bond energies for the bonds in carbon dioxide, water, glucose and oxygen.

Type of bond	Bond energy / kJ per bond
C=O	785
O—H	462
O=O	487

(a) (i) In photolysis, one of the bonds in each water molecule is broken.

Using the equation for photosynthesis, calculate how much energy is released by photolysis in order for one molecule of glucose to be made.

(1)

Answer kJ

(ii) Explain how light energy is converted into chemical energy in the form of ATP.

(4)

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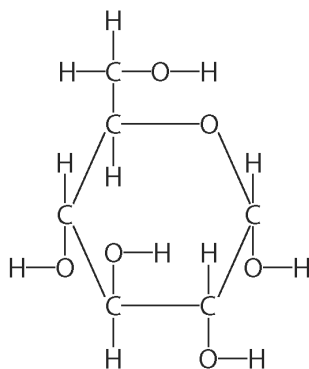
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(b) The diagram shows the structure of glucose.



The energy needed to form the bonds in one molecule of glucose is 9164 kJ.

(i) State what other information is needed in the table of bond energies for this value to be calculated.

(1)

(ii) Where in the chloroplasts are these bonds formed?

(1)

- ☐ A cytoplasm
- ☐ B matrix
- ☐ C stroma
- ☐ D thylakoid membrane

(c) Glucose is used by plants in the production of amino acids.

(i) Which row of the table describes how two amino acids join together?

(1)

	Bond formed between	Type of reaction
☐ A	carbon and nitrogen	condensation
☐ B	carbon and nitrogen	hydrolysis
☐ C	oxygen and nitrogen	condensation
☐ D	oxygen and nitrogen	hydrolysis

(ii) Explain why amino acids cannot be produced from glucose alone.

(2)

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4 - ((WBI11)/4(IAL)_Summer_2020_Q4) - Energy, Environment, Microbiology And Immunity

Rheumatoid arthritis is an inflammatory condition caused by the overactivity of the immune system.

- (a) The photographs show the hand of a person with rheumatoid arthritis and the hand of a person without rheumatoid arthritis.



(Source: © Mediscan/Alamy Stock Photo)

Hand with rheumatoid arthritis

Magnification $\times 0.2$



Hand without rheumatoid arthritis

Magnification $\times 0.2$

- (i) Give **one** piece of evidence, shown in the photographs, that rheumatoid arthritis is an inflammatory condition.

(1)

- (ii) Give **two other** signs of inflammation that are experienced in the hand of a person with rheumatoid arthritis.

(1)

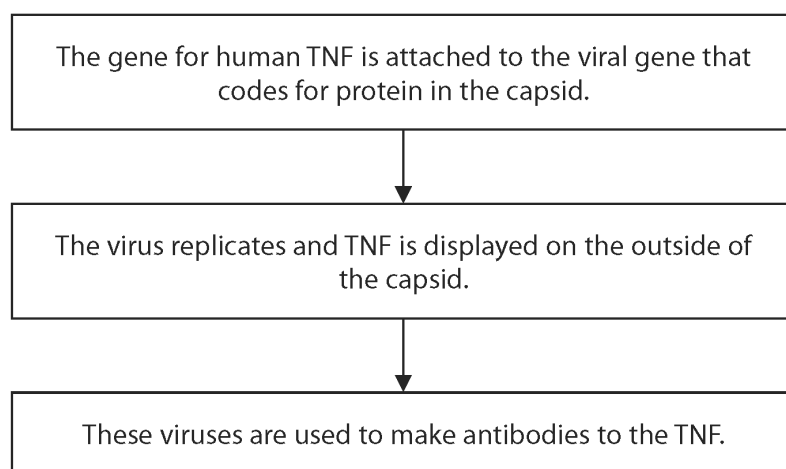
- (b) Tumour necrosis factor (TNF) is a protein that can be released by several types of cell. It plays an important part in the immune response.

This protein binds to specific receptors on the surface of cell membranes stimulating chemical reactions inside the cell. As a result, a number of responses may occur that include inflammation and the stimulation of phagocytosis by macrophages.

Antibodies to TNF are used to treat rheumatoid arthritis.

Scientists have used a virus that infects bacteria to produce antibodies to human TNF.

The diagram summarises this process.



- (i) Explain how attaching the gene for TNF to the viral gene results in TNF being displayed on the outside of the capsid.

(2)

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(ii) Explain why antibodies to TNF are used in the treatment of rheumatoid arthritis.

(2)

(iii) Patients being treated with antibodies to TNF are more susceptible to tuberculosis (TB), which can be fatal.

Explain why patients being treated with antibodies to TNF can die from TB.

(4)

5 - ((WBI11)/4(IAL)_Summer_2020_Q5) - *Energy, Environment, Microbiology And Immunity*

Viruses can infect bacteria.

(a) Which virus can infect bacteria?

(1)

- ☐ **A** Ebola virus
- ☐ **B** human immunodeficiency virus (HIV)
- ☐ **C** lambda phage (λ phage)
- ☐ **D** tobacco mosaic virus (TMV)

(b) Some viruses that infect bacteria cause the production of molecules called holins.

Holins form protein channels in the cell membranes of bacteria. This allows polar molecules called lysins to reach the cell wall by facilitated diffusion.

The DNA of these viruses codes for lysins.

(i) Describe the role of channel proteins in the facilitated diffusion of lysins.

(2)

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- (ii) Explain how the primary structure and the tertiary structure of holins determine the properties of these channel proteins.

(3)

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- (iii) Lysins break down the cell wall of bacteria.

Explain the role of lysins in the lytic cycle.

(2)

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6 - ((WBI11)/4(IAL)_Summer_2020_Q6) - *Energy, Environment, Microbiology And Immunity*

The photograph shows a ground squirrel.



(Source: Caroline Wilcox)

magnification $\times 0.5$

Ground squirrels feed on a variety of foods including nuts.

Ground squirrels have evolved food pouches.

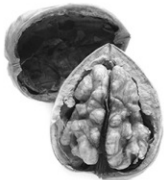
The photograph shows the food pouches of a ground squirrel.

food pouch —



(Source: © All Canada Photos/Alamy Stock Photo)

The table shows some information about three types of nut: acorns, hazelnuts and walnuts.

Type of nut	Photograph	Description	Energy content / kJ per 100 g
acorn		1.0 to 3.0 cm long 0.8 to 2.0 cm wide	1619
hazelnut		1.5 to 2.5 cm long 1.0 to 1.5 cm wide hard covering	2788
walnut		3.0 to 5.0 cm long 2.0 to 4.0 cm wide hard shell	2822

(Source: © Science photo library, Source: © Jon Stokes/Science photo library,
Source: © Science photo library)

- (a) The volume of the smallest walnut is approximately 50 cm^3 .

Calculate the approximate volume of the largest hazelnut, using the formula

$$\text{volume} = \frac{4}{3} \pi l w^2$$

where $\pi = 3$, l = length of the hazelnut and w = width of the hazelnut.

(1)

Answer cm^3

(b) A student investigated the feeding preferences of ground squirrels.

- (i) Design a laboratory investigation to find out which of these three types of nut ground squirrels prefer to eat.

(3)

- (ii) Predict the results of this investigation, giving reasons.

Use the information in the table to support your answer.

(3)

(c) Suggest how ground squirrels evolved pouches.

(3)

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ANSWERS

1 - ((WBI11)/4(IAL)_Summer_2020_Q1) - Energy, Environment, Microbiology And Immunity

Question number	Answer	Mark		
(a)	C <table><tr><td>thylakoid membranes</td><td>stroma</td></tr></table> The only correct answer is C. A is incorrect because the light-dependent reactions take place in the thylakoid membranes B is incorrect because the light-dependent reactions take place in the thylakoid membranes and the light-independent reactions take place in the stroma D is incorrect because the light-independent reactions take place in the stroma	thylakoid membranes	stroma	(1)
thylakoid membranes	stroma			

Question number	Answer	Additional guidance	Mark
(b)	An answer that includes three of the following points: - DNA (loop) drawn and labelled (1) - starch grain drawn and labelled (1) {envelope / inner membrane / outer membrane} drawn and labelled (1) - grana / grana stack / granum / (inter granal) lamellae (1) - ribosomes drawn and labelled (1)	IGNORE lipid droplets, stroma, thylakoid membranes ACCEPT plasmid / plasmid-like DNA ACCEPT starch granules ACCEPT / double membrane IGNORE size references	(3)

Question number	Answer	Mark
(c)	The only correct answer is B. A is incorrect because green wavelengths are reflected C is incorrect because green wavelengths are reflected D is incorrect because green wavelengths are reflected	(1)

Question number	Answer	Additional guidance	Mark
(d)	rate of photosynthesis at different wavelengths of light		(1)

Question number	Answer	Mark
(e)(i)	The only correct answer is A B is incorrect because dendrochronology is the study of tree growth rings C is incorrect because osmosis is the movement of free water molecules from a high solute potential to a lower solute potential D is incorrect because PCR amplifies the number of DNA molecules	(1)

Question number	Answer	Mark
(e)(ii)	The only correct answer is B. A is incorrect because the <i>R_f</i> value of J is distance moved by J divided by distance moved by solvent front = $6 \div 7.5 = 0.800$ C is incorrect because the <i>R_f</i> value of J is distance moved by J divided by distance moved by solvent front = $6 \div 7.5 = 0.800$ D is incorrect because the <i>R_f</i> value of J is distance moved by J divided by distance moved by solvent front = $6 \div 7.5 = 0.800$	(1)

2 - ((WBI11)/4(IAL)_Summer_2020_Q2) - Energy, Environment, Microbiology And Immunity

(a)	using a {thermometer / (temperature) probe} to take the temperature of the {liver / rectum}	ACCEPT into the core / deep into the body / up the anus IGNORE other parts of body	(1)
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Question number	Answer	Additional guidance	Mark
(b)(i)	- drop in body temperature in first 12 hours calculated and subtracted from 11.5°C (1) - this value divided by 0.4, added to 12 hours and answer rounded to nearest hour (1)	$11.5 - (0.78 \times 12) / 11.5 - 9.36 / 2.14$ 17 (hours) $17.35 = 1$ mark Correct answer with no working gains 2 marks	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes the following points: (this) estimate would be {shorter / an under-estimate} (1) - because a body loses <u>heat</u> faster (in cooler conditions) (1)	ACCEPT converse	(2)

Question number	Answer	Additional guidance	Mark
(c)	An explanation that includes three of the following points: - because temperature affects {rigor / body stiffness} (1) - because deciding when a body is stiff or not stiff is subjective (1) - because if the body is stiff, the time since death can only be estimated as being between 3 and 36 hours (1) - because if the body is not stiff, there is no way of telling if it has been dead for less than 3 hours or more than 36 hours (1)	ACCEPT exercise / body shape / body fat / ATP levels ACCEPT gives a wide range of (time) values ACCEPT if not stiff cannot tell how many hours after 36 hours time of death was	(3)

3 - ((WBI11)/4(IAL)_Summer_2020_Q3) - Energy, Environment, Microbiology And Immunity

Question number	Answer	Additional guidance	Mark
(a)(i)	2772	IGNORE any other units given	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes four of the following points: - light is absorbed by {photosystems / chlorophyll} (1) - which {excites electrons / releases high-energy electrons / releases electrons to higher energy levels} (1) - these electrons are passed along a series of (electron) carriers (1) - therefore releasing <u>energy</u> to phosphorylate ADP into ATP (cyclic)(1) - phosphorylation of ADP via the proton gradient to form ATP (non-cyclic) (1)	ACCEPT description e.g. hydrogen ions pass through ATP synthase releasing energy for phosphorylation of ADP NB reference to ATP being synthesised from ADP only needed once to award both 4th and 5th marking point	(4)

Question number	Answer	Additional guidance	Mark
(b)(i)	two from: C - H, C - O and C - C	IGNORE O - H ACCEPT bond between carbon and hydrogen bond between carbon and oxygen bond between carbon and carbon	(1)

Question number	Answer	Mark
(b)(ii)	The only correct answer is C. A is incorrect because there is no cytoplasm inside chloroplasts B is incorrect because the matrix is not found in chloroplasts D is incorrect because glucose is synthesized in the stroma of chloroplasts	(1)

Question number	Answer	Mark		
(c)(i)	<table><tr><td>carbon and nitrogen</td><td>condensation</td></tr></table> The only correct answer is A. B is incorrect because bonds form by condensation reactions not hydrolysis C is incorrect because the peptide bond joins the C of one amino acid to the N of the other D is incorrect because the peptide bond joins the C of one amino acid to the N of the other and bonds form by condensation reactions not hydrolysis	carbon and nitrogen	condensation	(1)
carbon and nitrogen	condensation			

Question number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that includes two of the following points: - because amino acids contain nitrogen (1) - because some {amino acids / R groups} contain sulfur (1) - nitrogen obtained from nitrates / sulfur obtained from sulfates (1)	ACCEPT glucose does not contain nitrogen IGNORE nitrates ACCEPT glucose does not contain sulfur IGNORE sulfates ACCEPT nitrates / sulfates needed	(2)

4 - ((WBI11)/4(IAL)_Summer_2020_Q4) - Energy, Environment, Microbiology And Immunity

Question number	Answer	Additional guidance	Mark
(a)(i)	swollen / enlarged (hands)	ACCEPT oedema IGNORE other symptoms	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	Any two from: pain / hurts / tender / aches redness / red warmth / heat / increased temperature / hot	IGNORE swelling IGNORE immobility / itching IGNORE fever	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes two of the following points: - because when the virus replicates the {DNA / gene} will be transcribed (1) - and when the RNA is translated the {protein / TNF} will be synthesized (1) - TNF incorporated into capsid when virus is assembled (1)	ACCEPT RNA / mRNA will be made ACCEPT description ACCEPT when new particles are made NB The {gene / DNA} is transcribed and translated = 1 mark if no other mark awarded	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes two of the following points: - antibody {binds to / neutralises / agglutinates} TNF (1) - therefore will prevent the TNF from binding to the cells (1) - and therefore inflammatory responses will not be triggered (1)	DO NOT ACCEPT antibody binds to cells / antibody destroys TNF IGNORE opsonisation DO NOT ACCEPT antibody binds to receptors (on the cells) ACCEPT inflammation will {not occur / be reduced}	(2)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that includes four of the following points: - because (as a result of the TNF antibodies binding to TNF) phagocytosis (by macrophages) will {not happen / be reduced} (1) - therefore {fewer bacteria will be destroyed / bacteria will increase in number} (if less phagocytosis) (1) - credit details of what will not take place if <u>macrophages</u> are impaired (1) - therefore tubercles (more likely to) form (1) - credit example of how TB can cause death (1)	e.g. antigen presentation / activation of T helper cells / humoral immune response e.g. destruction of lung tissue / organ failure / opportunistic infection / pneumonia / HIV / lung damage	(4)

5 - ((WB111)/4(IAL)_Summer_2020_Q5) - Energy, Environment, Microbiology And Immunity

Question number	Answer	Mark
(a)	The only correct answer is C lambda phage (λ phage) A is incorrect because Ebola virus infects humans B is incorrect because the HIV infects humans D is incorrect because TMV infects plants	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	A description that includes two of the following points: - provide a {polar / hydrophilic} channel (1) - so that lysins can pass through the {non-polar / hydrophobic} {membrane / phospholipids / fatty acid tails} (out of cell) (1) - down their concentration gradient (1)	IGNORE direction of movement with respect to the cell	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes three of the following points: - primary structure is the sequence of amino acids that will determine the (tertiary) structure of {holin / protein} (1) - as this will determine the {bonds / position of bonds} (1) (amino acids with) polar R groups will face into the channel (1) (amino acids with) non-polar R groups will face outwards to the {fatty acids / phospholipids / membrane} (1)	PIECE TOGETHER DO NOT ACCEPT bases ACCEPT correctly named bond	(3)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that includes the following points: - lysins break bonds between the {peptidoglycan / murein} molecules (1) - therefore the virus particles {leave the bacterial cells / get (out) through the cell wall} (once formed) (1)	ACCEPT are enzymes that breakdown {peptidoglycan / murein} ACCEPT causing {bacterial cells to burst / pores in the cell wall}	(2)

6 - ((WBI11)/4(IAL)_Summer_2020_Q6) - Energy, Environment, Microbiology And Immunity

(a)	22.5 (cm ³)	ACCEPT 23.3 / 23.6 IGNORE any other units given	(1)
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Question number	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following points: - give squirrel access to all three types of nut (1) - a range of sizes used (1) - determine the {number / order} that the nuts are eaten (by the squirrel) (1)	. ACCEPT record which size they prefer / comparing measurements made before and after	(3)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: - a reason based on size (1) - a reason based on shell (1) - a reason based on energy content (1)	e.g. more hazelnuts eaten (in the investigation) because they are smaller walnuts are too big to fit in the pouch e.g hazelnuts are easier to eat than walnuts because they have a hard covering and not a hard shell walnuts have a hard shell but squirrels have sharp teeth e.g. walnuts provide a lot of energy so squirrels get enough energy for hibernation more acorns have to be eaten as they store less energy NB if a comparison is made between the nuts using the three sets of information, award 1 mark if no other marks awarded	(3)

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