

A LEVEL Cambridge Topical Past Papers

BIOLOGY

2020 — 2025

P4

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1 - (9700/42_Winter_2020_Q1)



Fig. 1.1 shows a transmission electron micrograph of a chloroplast.

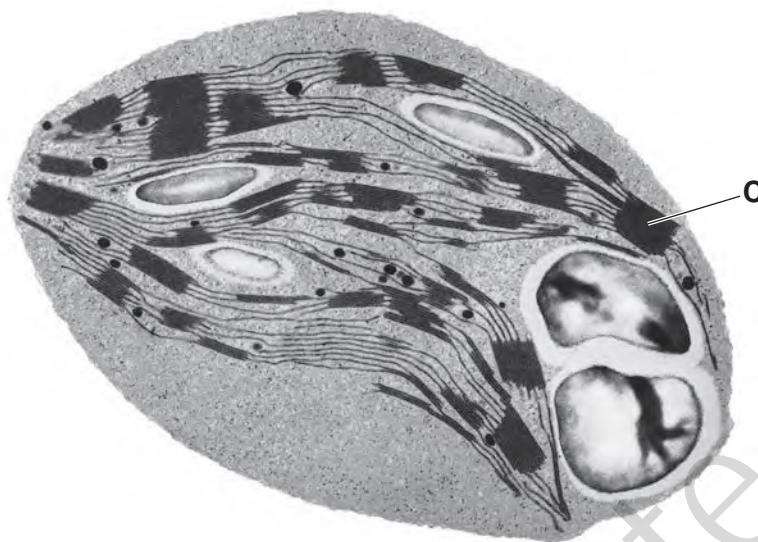


Fig. 1.1

(a) On Fig. 1.1, use label lines and letters to label:

A – the storage site of the carbohydrate product of photosynthesis

B – the site of the light independent stage.

[2]

(b) (i) Name the structure labelled **C** in Fig. 1.1.

C [1]

(ii) Explain how the structure of **C** is linked to its function.

..... [4]

(c) (i) The anatomy of C4 plants is adapted to allow the rate of photosynthesis to remain high at high temperatures.

C3 plants do not have these adaptations and an additional reaction occurs at high temperatures that reduces the rate of photosynthesis.

Explain why the reaction that takes place at high temperatures in **C3** plants reduces the rate of photosynthesis.

..... [2]

- (ii) C4 plants have higher rates of photosynthesis than C3 plants when the ratio of atmospheric oxygen to atmospheric carbon dioxide is high.

Fig. 1.2 shows the atmospheric carbon dioxide concentration in the last 50 million years.

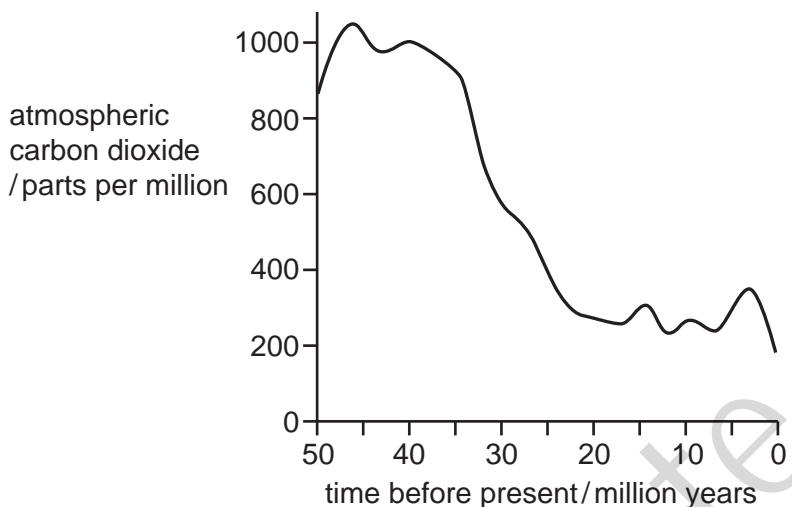


Fig. 1.2

There is evidence that C4 plants first appeared 30 million years ago.

With reference to Fig. 1.2, suggest why C4 plants first appeared 30 million years ago.

..... [3]

[Total: 12]

2 - (9700/42_Summer_2021_O9)



- (a) Describe how the structure of a mitochondrion is related to its function. [9]

- (b) Explain how rice is adapted to grow with its roots submerged in water. [6]

[Total: 15]

3 - (9700/41_Winter_2024_Q1)



Different species of animal have neurones with different characteristics.

(a) Fig. 1.1 is a diagram of a motor neurone of a rat and a motor neurone of a snail.

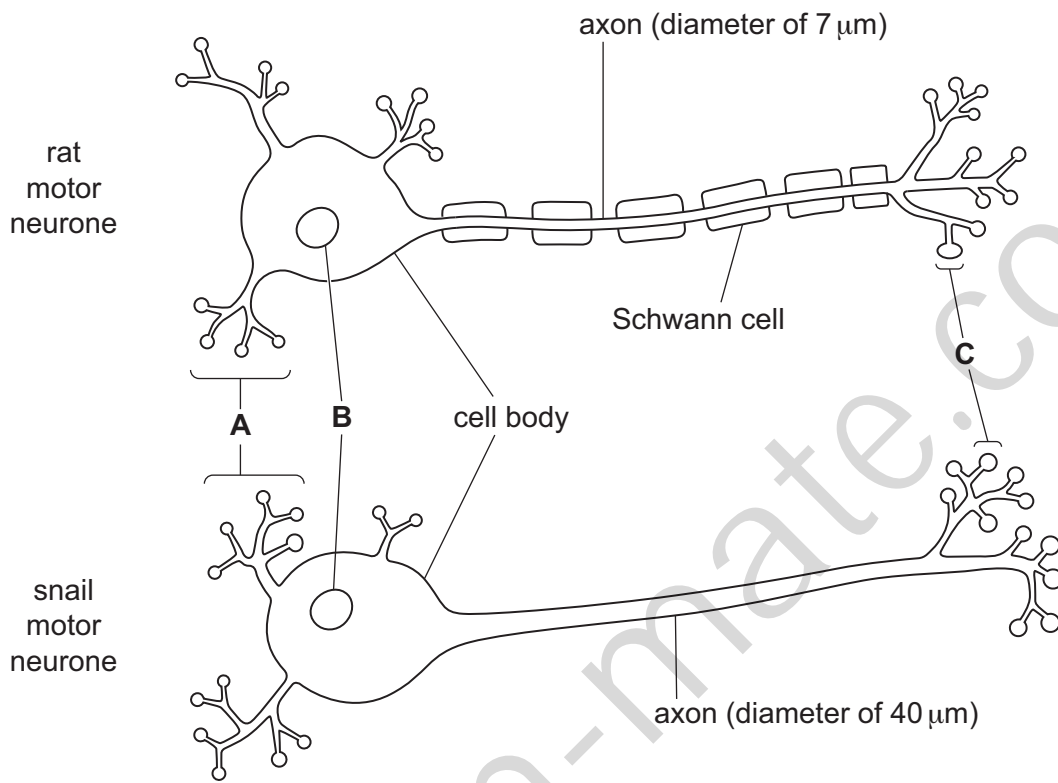


Fig. 1.1

(i) Name the structures labelled **A**, **B** and **C** on Fig. 1.1.

A

B

C

[3]

(ii) The rat motor neurone has an impulse transmission speed of 50 ms^{-1} . The snail motor neurone has an impulse transmission speed of 8 ms^{-1} .

Explain why the rat motor neurone has a faster impulse transmission speed than the snail motor neurone.

..... [2]

(b) Fig. 1.2 shows an action potential in a rat neurone and Fig. 1.3 shows an action potential in a snail neurone.

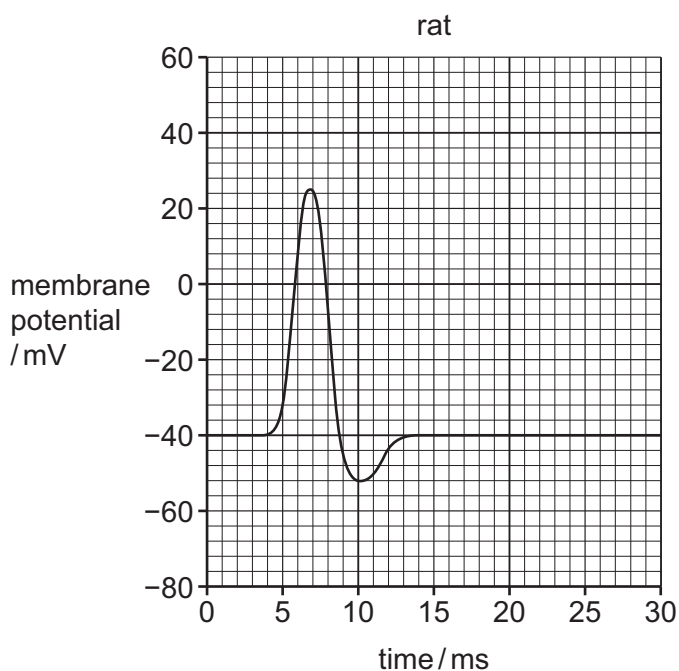


Fig. 1.2

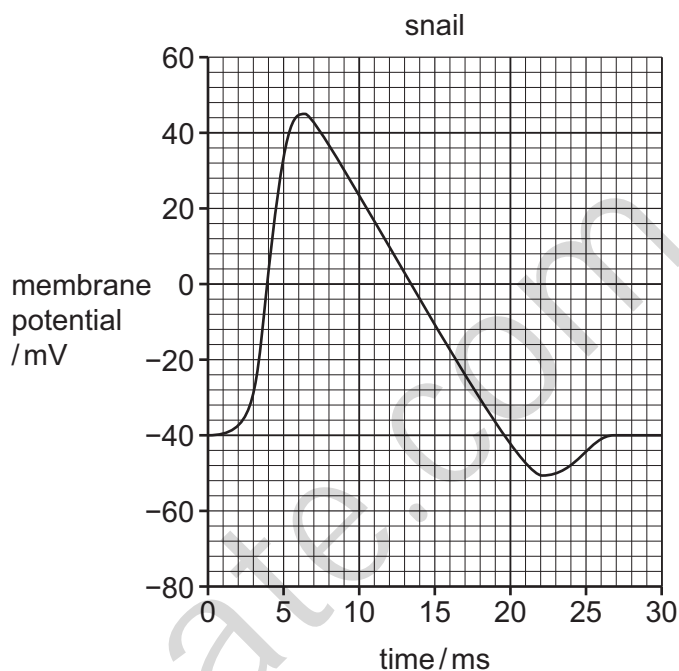


Fig. 1.3

Contrast the two action potentials shown in Fig. 1.2 and Fig. 1.3.

..... [3]

[Total: 8]

4 - (9700/41_Summer_2025_Q4)

ANSWER

Scientists have invented a way of producing food by artificial photosynthesis.

- Solar panels convert sunlight energy into electricity.
- The electricity powers an electrolysis reaction between carbon dioxide gas and water to form the organic product acetate.
- The single-celled alga *Chlamydomonas*, a protocist, can use acetate to grow and reproduce in the dark, instead of photosynthesising in the light.
- The algae can be processed to make a food product.

Fig. 4.1 shows an outline of the artificial photosynthesis process.

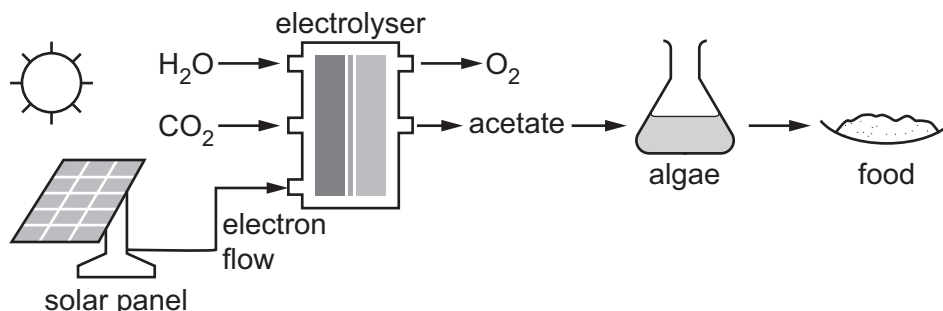


Fig. 4.1

- (a) Identify **three** similarities between the artificial photosynthesis process shown in Fig. 4.1 and the normal process of photosynthesis.

..... [3]

- (b) Fig. 4.2 shows the single-celled alga *Chlamydomonas*. It contains a large, cup-shaped chloroplast for photosynthesis.



Fig. 4.2

Structures **A** and **B** in Fig. 4.2 are found within the chloroplast.

Name structures **A** and **B**.

A

B

[2]

- (c) Thylakoid membranes are the site of the light-dependent stage of photosynthesis.

- (i) Name the products of the light-dependent stage of photosynthesis.

..... [1]

- (ii) Some of the protein components of the thylakoid membrane have a role in the light-dependent stage of photosynthesis.

Explain the roles of the different proteins that function in the light-dependent stage of photosynthesis.

..... [4]

- (d) The products of the light-dependent stage of photosynthesis are used in the Calvin cycle. Calvin cycle intermediates are used to produce amino acids, carbohydrates and lipids.

Name the Calvin cycle intermediate that can be used to produce starch.

..... [1]

- (e) Scientists claim that the artificial photosynthesis process shown in Fig. 4.1 is more efficient at converting light energy into food than normal photosynthesis by crop plants.

Give reasons why this claim may or may **not** be true.

[3]

[Total: 14]

5 - (9700/43_Summer_2025_Q7)



- (a) A chloroplast is composed of many structures, each with a different function. Several chloroplast structures are listed.

stroma	lamellae	thylakoid membrane	ribosome
thylakoid space	starch grain	DNA	outer membrane

From the list:

- (i) identify the structures involved in the production of rubisco

.....

[2]

- (ii) identify the structure that contains a high concentration of protons in daylight.

.....

[1]

- (b) Paper chromatography is a technique that can be used to separate a mixture of four common chloroplast pigments. The pigments can be identified by calculating their R_f values.

A student carried out paper chromatography on a solution containing a mixture of chloroplast pigments.

The results are shown in Table 7.1.

Table 7.1

pigment	distance travelled by pigment from baseline / cm	distance travelled by solvent from baseline / cm	R _f
.....	6.5	8.9	0.73
chlorophyll a	4.6	8.9	0.52
chlorophyll b	8.9	0.38
carotene	8.2	8.9

Complete Table 7.1.

[3]

(c) Fig. 7.1 shows the absorption spectrum for carotene and for chlorophyll a.

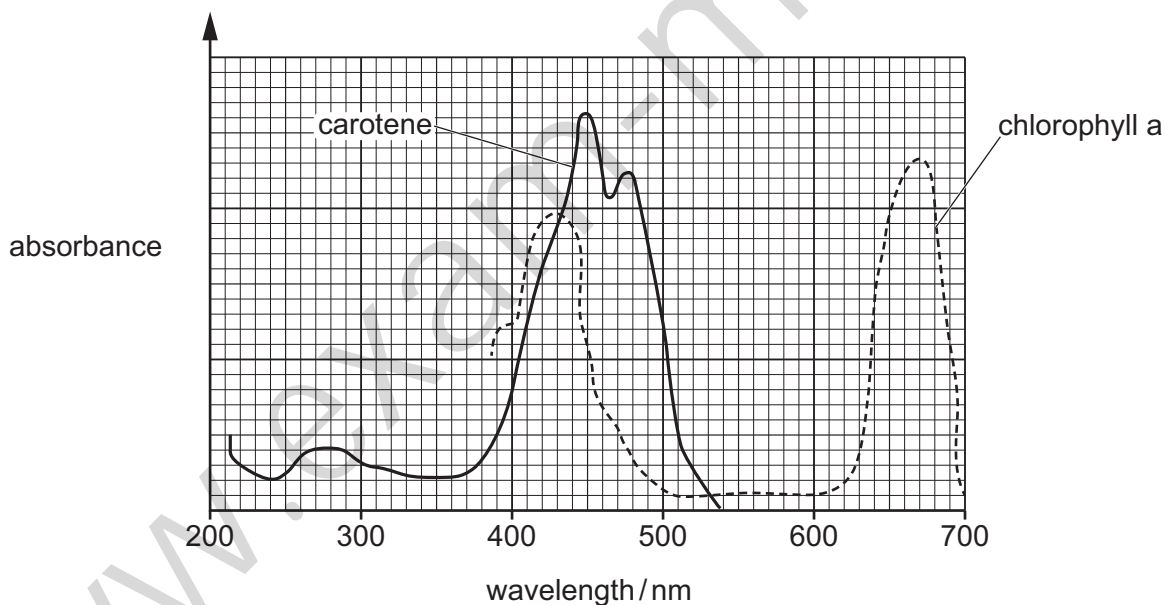


Fig. 7.1

With reference to Fig. 7.1, describe **and** explain the role of carotene in photosynthesis.

..... [4]

[Total: 10]

6 - (9700/43_Summer_2025_Q9)



(a) Most carnivorous mammals need to move to hunt their prey.

Outline why a carnivorous mammal makes more use of its nervous system, rather than its endocrine system, when it hunts.

..... [4]

(b) Fig. 9.1 is a diagram of a motor neurone.

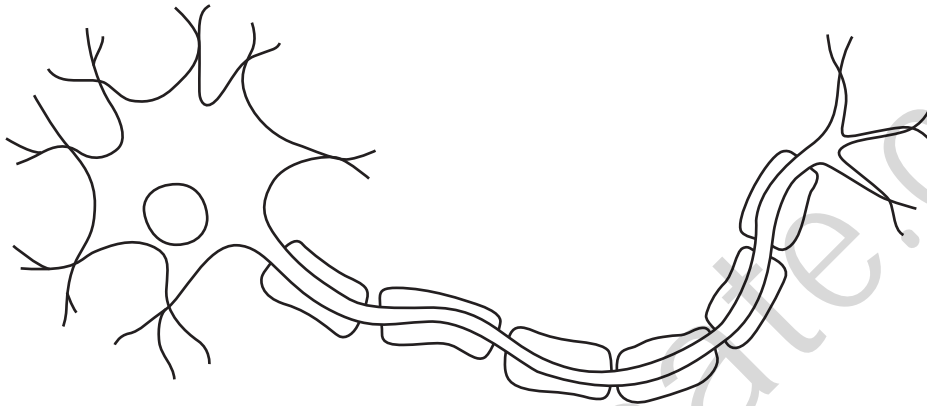


Fig. 9.1

On Fig. 9.1, add label lines and the letters **R**, **S** and **T** to label a part of the neurone that:

- can become depolarised – use the letter **R**
- contains many mitochondria – use the letter **S**
- acts as an insulator – use the letter **T**.

[3]

(c) Fig. 9.2 summarises changes that occur during the contraction of a sarcomere.

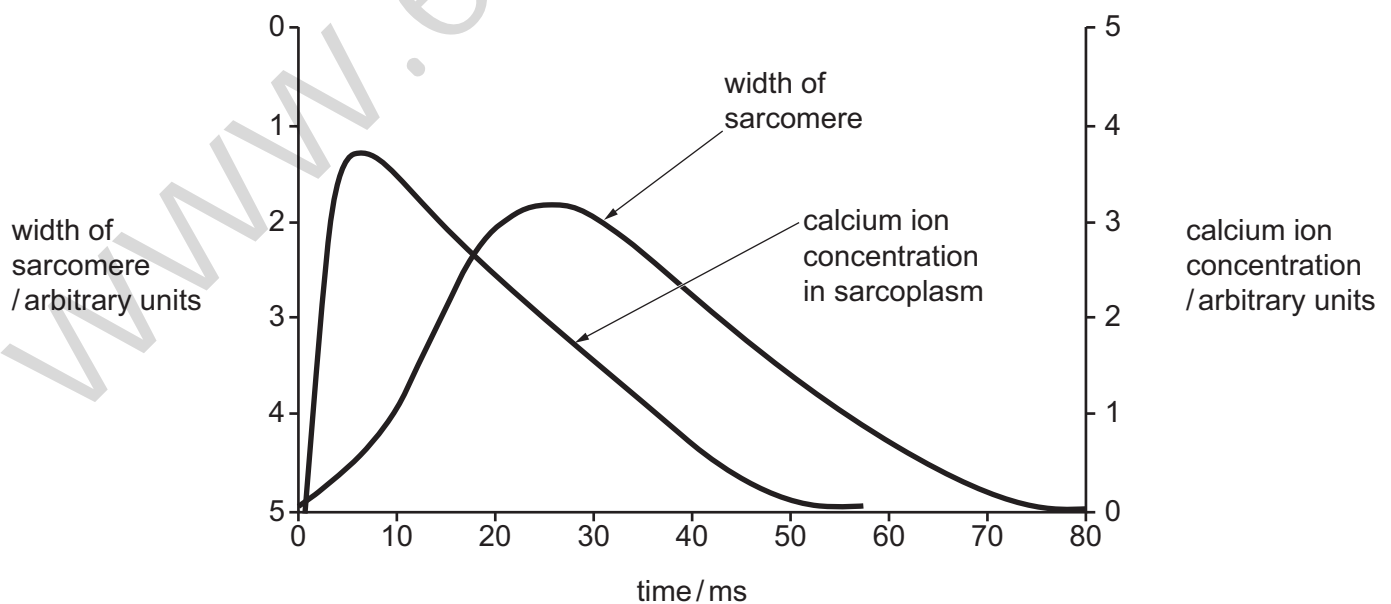


Fig. 9.2

(i) Suggest an explanation for the shape of the curve that shows changes in the width of the sarcomere.

..... [3]

(ii) Suggest an explanation for the curve that shows changes in calcium ion concentration.

..... [3]

[Total: 13]

7 - (9700/44_Summer_2025_Q8)



(a) Fig. 8.1 is a transmission electron micrograph of striated muscle.

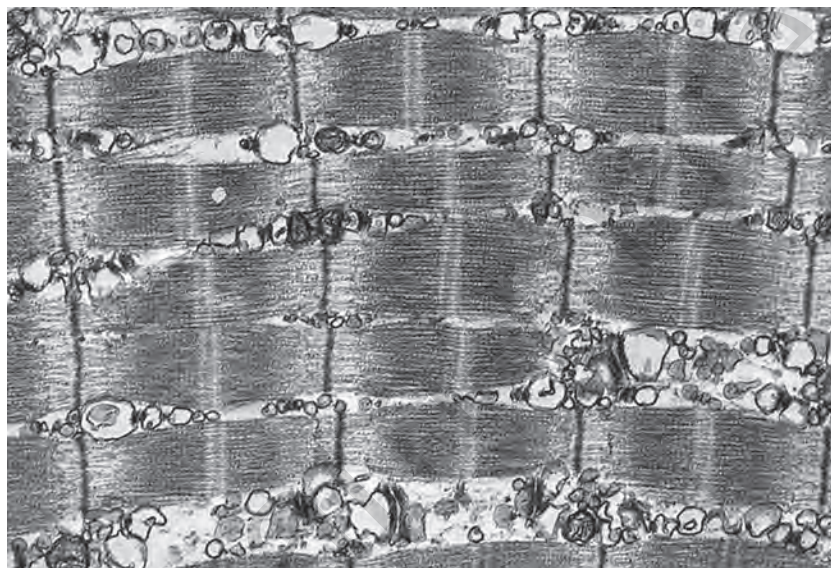


Fig. 8.1

On Fig. 8.1:

- use the letter **P** with a label line to show a region containing only actin
- use the letter **Q** with a label line to show a region containing only myosin
- use the letter **R** with a label line to show a region containing both actin and myosin.

[3]

(b) Striated muscle contraction is explained by the sliding filament model.

Outline the role of the proteins troponin and tropomyosin in the sliding filament model.

..... [4]

(c) Striated muscles can sometimes become less efficient at contracting if they have been active for a long time. This is called muscle fatigue.

Suggest why muscles may become fatigued.

..... [2]

[Total: 9]

1 - (9700/42_Winter_2020_Q1)



(a)	<p>A – label line pointing to starch grain ;</p> <p>B – label line pointing to stroma ;</p>	2
(b)(i)	granum / grana ; A stack of thylakoids I thylakoid	1
(b)(ii)	<p><i>any four from:</i></p> <p>1 (stack of) <u>thylakoids</u> ;</p> <p>2 (membranes / thylakoids / C) form large / increase, surface area ;</p> <p>3 for, (named) pigments / photosystems / light-harvesting clusters ;</p> <p>4 for absorption of light <u>energy</u> ;</p> <p>5 so, large number of / many, enzymes / ETC / ATP synthase / stalked particles ;</p> <p>6 for, light dependent stage / photophosphorylation ;</p>	4
(c)(i)	<p>1 oxygen, combines / reacts, with, rubisco / RuBP ;</p> <p>2 less / no, carbon dioxide, combines / reacts, with, rubisco / RuBP ; A less or no carbon fixation</p> <p>3 <i>ref. to photorespiration ;</i></p> <p><i>ignore refs to denaturation</i></p>	2

(c)(ii)	<p>any three from:</p> <ol style="list-style-type: none">1 photosynthesis (by C3 plants) is occurring ;2 decrease in (atmospheric) carbon dioxide or increase in (atmospheric) oxygen or increase in / high, oxygen to carbon dioxide ratio ;3 rubisco favours reaction with oxygen / AW ;4 C4 plants have a selective advantage / description ;5 oxygen acts as a selection pressure ;6 AVP ; e.g. <i>ref. to</i> mutation in C3 plants	3
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2 - (9700/42_Summer_2021_O9)



(a)	<p>any nine from:</p> <p>1 (function is) to make ATP ;</p> <p>2 ref. to double membrane / outer and inner membrane / envelope ;</p> <p><i>inner membrane</i></p> <p>3 folded / cristae, to increase / for large, surface area ;</p> <p>4 has, ATP synthase / stalked particles ;</p> <p>5 has, ETC / carrier (proteins) / cytochromes ;</p> <p>6 (site of) oxidative phosphorylation / chemiosmosis ;</p> <p>7 impermeable to protons ;</p> <p><i>intermembrane space</i></p> <p>8 has low pH / high concentration of protons ;</p> <p>9 protons pumped into intermembrane space ;</p> <p>10 proton gradient between intermembrane space and matrix or protons diffuse from intermembrane space to matrix ;</p> <p><i>matrix</i></p> <p>11 contains (co)enzymes for, link reaction / the Krebs cycle ;</p> <p><i>outer membrane</i></p> <p>12 permeable to, pyruvate / reduced NAD / oxygen ;</p> <p>13 AVP ; e.g. ribosomes / DNA, involved in protein synthesis</p>	9
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(b)	<p>any six from:</p> <ol style="list-style-type: none">1 <u>aerenchyma</u> ;2 in stem and roots ;3 help <u>oxygen</u> to, move / diffuse, to, roots / submerged parts ;4 shallow roots ;5 air (film) trapped on underwater leaves / described ;6 greater internode growth or leaves or flowers grow above water level ;7 (growth regulated by) gibberellin / ethene ;8 anaerobic respiration, in roots / underwater / when submerged ; A alcoholic fermentation9 tolerant to high <u>ethanol</u> (concentration) ;10 <i>ref. to</i> ethanol / alcohol, dehydrogenase ;	6
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3 - (9700/41_Winter_2024_Q1)



(a)(i)	A = dendrite(s) ; B = nuclei ; C = synaptic knob(s) ;	3
(a)(ii)	1 rat has, myelin sheath / Schwann cell / myelinated axon / myelinated neurone ; 2 (rat has) saltatory conduction OR (rat) impulse / action potential, jumps / leaps / AW, from (one) <u>node of Ranvier</u> to, the next / another ;	2
(b)	<i>any three from:</i> snail / Fig. 1.3 1 greater depolarisation OR (membrane potential) gets more positive / has higher increase / has higher peak ; 2 action potential, slower / takes longer / takes more time OR longer time to return to resting potential ; 3 longer (absolute / relative) <u>refractory period</u> ; 4 longer hyperpolarisation ; 5 AVP ;	3

4 - (9700/41_Summer_2025_Q4)



(a)	<p>any three from: (both processes)</p> <p>1 use / require, carbon dioxide / CO₂ ; 2 use / require, water / H₂O ; 3 use / require, (sun) light energy / source of energy is light ; 4 make an organic, molecule / product ; 5 produce / release, oxygen / O₂ ; 6 involve <u>transduction</u> of energy (from one form to another) ; 7 involve electron flow ;</p>	3
(b)	<p>A starch, grain / granule ; B thylakoid (membrane) / lamella / granum ;</p>	2
(c)(i)	ATP <u>and</u> reduced NADP (and oxygen) ;	1
(c)(ii)	<p>any four from:</p> <p>1 electron carriers / electron transport chain / to carry electrons ; 2 to release energy to, move / pump, protons (into, thylakoid space / lumen) or to release energy to generate proton gradient ; 3 oxygen-evolving, complex / enzyme ; 4 (to catalyse) splitting / photolysis, of water ; 5 LHC / antenna complex / photosystem, <u>proteins</u> hold pigments ; 6 ATP synth(et)ase to make ATP ;</p>	4
(d)	triose phosphate ;	1

(e)	<p><i>any two plus one opposing arguments based on correct ref. to:</i></p> <p>1 percentage / amount, of sunlight, absorbed / used ;</p> <p>2 absorption / action, spectrum or wavelengths / colours of light, used ;</p> <p>3 respiration of organism ;</p> <p>4, 5 stage/transition, where, energy lost ; ;</p> <p>6, 7 (named) limiting factor(s) ; ;</p> <p>8 energy storage capability or night / dark, process ;</p> <p>9 quality / nutrition in / palatability, of food product ;</p> <p>10 proportion edible ;</p> <p>11,12 additional energy inputs ; ;</p> <p>13, 14 additional resources needed ; ;</p> <p>15 labour / maintenance, needed ;</p> <p>16 amount of space needed ;</p> <p>17 plant, hormones / coordination ;</p> <p>18 evolutionary adaptation ;</p>	3
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5 - (9700/43_Summer_2025_Q7)



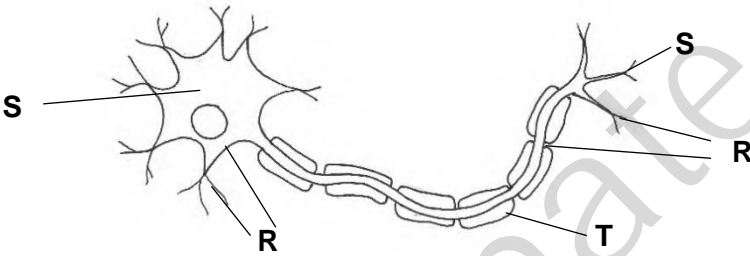
(a)(i)	<p>DNA ;</p> <p>ribosome ;</p>	2
(a)(ii)	thylakoid space ;	1

(b)	xanthophyll ; 3.4 ; 0.92 ;	3
(c)	<p>any four from:</p> <ol style="list-style-type: none"> 1 absorbs light between 400 and 500 nm / peak at 450 nm ; 2 accessory pigment ; 3 absorbs light wavelengths <u>not</u> absorbed by, reaction centre / primary pigment / chlorophyll a ; A harvest 4 so extends the range of wavelengths absorbed ; 5 pass <u>energy</u> to, reaction centre / primary pigment / chlorophyll a ; 6 <i>idea</i> improves efficiency of light-dependent stage ; 	4

6 - (9700/43_Summer_2025_Q9)



(a)	<p>any four from:</p> <ol style="list-style-type: none"> 1 use (named) sense organs to detect prey ; 2 <u>faster</u> transmission of, impulses / signals ; 3 (so) <u>faster</u> reaction to stimuli ; 4 <i>ref. to</i> control centre / brain / CNS (decision making) ; 5 <u>faster</u> response or ref. reflexes ; 6 (by) muscles ; 	4
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<p>(b)</p>	<p>(if a letter is used more than once, all must be correct) correct position of label and letter for: R ; S ; T ;</p>  <p>The diagram shows a sarcomere with thick filaments (myosin) and thin filaments (actin). Label 'S' points to the Z-discs. Label 'R' points to the thin filaments. Label 'T' points to the thick filaments.</p>	<p>3</p>
<p>(c)(i)</p>	<p>any three from:</p> <p><i>increase in curve</i></p> <ol style="list-style-type: none"> 1 cross bridges form / myosin heads bind to actin ; 2 power stroke / actin filaments slide over myosin filaments ; 3 bands get, smaller / shorter or decrease in width of sarcomere ; <p><i>decrease in curve</i></p> <ol style="list-style-type: none"> 4 breaking of cross bridges / detachment of myosin heads from actin ; 5 bands get, bigger / longer or increases width of sarcomere ; 	<p>3</p>

(c)(ii)	<p><i>increase</i></p> <p>1 calcium ions / Ca^{2+}, released by sarcoplasmic reticulum ;</p> <p>2 calcium ions / Ca^{2+}, bound to troponin ;</p> <p><i>decrease</i></p> <p>3 calcium ions / Ca^{2+}, pumped back into sarcoplasmic reticulum ;</p>	3
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7 - (9700/44_Summer_2025_Q8)



(a)	<p>P to light area ; A on Z line</p> <p>Q to medium area ; A on M line</p> <p>R to darker area ;</p> <div style="text-align: center;"> </div>	3
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<p>(b)</p>	<p>any four from:</p> <ol style="list-style-type: none">1 (at rest) tropomyosin, covers / AW, the binding sites on actin ; R active sites2 Ca^{2+} binds to troponin ;3 troponin changes shape ;4 (causing) tropomyosin to move ;5 (so) exposes binding site ;6 (so) myosin <u>head</u>, binds (to binding sites) / forms crossbridge ;	<p>4</p>
<p>(c)</p>	<p>any two from:</p> <ol style="list-style-type: none">1 no / less, Ca^{2+} ;2 no / less, ATP ;3 no / less, glucose / glycogen ;4 no / less, oxygen ;5 build-up / presence of, lactate / lactic acid ;6 AVP ; e.g. no / less, creatine phosphate	<p>2</p>