5.1 Energy transfers in and between organisms (A-Level Only) Photosynthesis 1 Mark schemes

Q1.

(a) 1. Osmosis does not occur;
2. Chloroplast / organelle does not burst / lyse / shrivel / shrink;

1. Accept: osmosis would occur if water potentials were not the same.

*1 and 2, Accept: correct reference to osmotic lysis for **2 marks**.*

2. Accept: chloroplast would burst / lyse / shrivel / shrink if water potentials were not the same.

2. Reject: 'cell bursts/shrivels'

2. Ignore: damage to chloroplasts on its own is not enough for a mark.

3. Reject: becomes turgid / flaccid.

2

(b) 1. To show light does not affect DCPIP;
2. To show chloroplasts are required;

Ignore: comparison with other tubes.

2

(c) 1. Reduction of DCPIP by electrons;
2. (From) chlorophyll / light dependent reaction;

1. Accept: hydrogen / H for electrons but not protons / hydrogen ions / H on their own.*

2. Accept: from chloroplasts / photosystems / water.

2

(d) Provides a standard / reference point
OR
Can compare different chemicals/weed-killers
OR
Can compare different concentrations of chemicals / weed-killers;

*Accept: decolourises quicker than 100% **or** saves time waiting for complete decolourisation.*

Note: comparisons must be qualified.

*Accept: find the most effective weed-killer **or** the most effective concentration.*

Accept: answers relating to cost effectiveness.

1

(e) 1. Less / no ATP produced;
2. Less / no reduced NADP produced;
3. Less / no GP reduced / converted to TP;

2, Accept: less / no NADPH / $NADPH_2$ / NADPH + H

2 max

[9]

Q2.

(a) 7.7(%);

1

(b) 1. No error bars / SD;

2. To show if overlap occurs so difference (in means) is not significant / due to chance
OR
To show if no overlap occurs so difference (in means) is significant / is not due to chance.

Do not accept 'no statistical test performed' as Chi squared / Spearman's rank would be inappropriate.

Ignore references to sample size as it can be assumed that scientists completed the study using appropriate methodology.

2

(c) 1. Reduced transfer of protons across thylakoid membrane
OR
Reduced chemiosomotic gradient / proton gradient across thylakoid membrane;

2. (So) less ATP produced;

3. (So) less reduced NADP produced;

Accept NADPH / $NADPH_2$ / $NADPH^+$

Reject reduced NAD

4. (So) light-independent reaction slows / stops;
OR
Less reduction of GP to triose phosphate.

4

(d) Idea that energy is released from high energy / excited electron/s (that were lost from chlorophyll)

1

[8]

Q3.

(a) 1. Oxygen produced in light-dependent reaction;
2. The faster (oxygen) is produced, the faster the light-dependent reaction.

2

(b) 35–36 µmol Oxygen per mg chlorophyll.

Correct difference at 500 µmol photons m^{-2} s^{-1} or incorrect difference but division by 4 shown = 1 mark.

2

(c) At all light intensities, chloroplasts from mutant plants:
1. Have faster production of ATP and reduced NADP;
2. (So) have faster / more light-independent reaction;
3. (So) produce more sugars that can be used in respiration;
4. (So) have more energy for growth;
5. Have faster / more synthesis of new organic materials.

Accept converse points if clear answer relates to non-mutant plants

4 max

[8]

Q4.

(a) Stroma (of chloroplasts);

Reject: stoma.

Reject: stroma of chlorophyll or any reference to chlorophyll.

Accept: stroma of chloroplasts.

1

(b) (i) (Less) RuBP combines with carbon dioxide;

Accept: binds/joins.

1

(ii) 1. Temperature is a limiting factor/below optimum;
2. Light is a limiting factor/below optimum;

Accept: limited by reduced NADP or ATP.

3. Limited by RuBP (available/produced);

Accept: RuBP will always give 2 GP (at high CO_2).

4. Limited by enzyme;

Accept: limited by Rubisco.

2 max

(c) 1. (Provides) hydrogen / protons/H^+ **and** electrons/e^-;

Ignore: if water is used as source of hydrogen.

2. For reduction;

Reject: reduction of NAD.

Reject: reduction by H^+ or protons on their own.

3. Source of electrons for chlorophyll/electron transfer chain;

Accept: electrons for photophosphorylation.

Ignore: photosystems.

1, 2 and 3. Reject: reference to respiration/mitochondria.

2 max

[6]

Q5.

(a) 1. (No grease)

means stomata are open
OR
allows normal CO_2 uptake;

Allow 'gas exchange' for CO_2 uptake.

'As a control' is insufficient on its own.

2. (Grease on lower surface)
seals stomata
OR
stops CO_2 uptake through
stomata
OR
to find CO_2 uptake through
stomata
OR
shows CO_2 uptake through cuticle / upper surface;

3. (Grease on both surfaces) shows sealing is effective
OR
stops all CO_2 uptake.

3

(b) (i) 1. (Mean rate of) carbon dioxide uptake was constant *and* fell after the light turned off;

Ignore absence of arbitrary units in both marking points.

Both ideas needed for mark.

Accept 'stayed at 4.5' as equivalent to 'was constant'.

2. Uptake fell from 4.5 to 0 / uptake started to fall at 60 minutes and reached lowest at 80 minutes / uptake fell over period of 20 minutes;

One correct use of figures required.

Accept fell to nothing / no uptake for 0.

2

(ii) 1. (Because) water is lost through stomata;
2. (Closure) prevents / reduces water loss;
3. Maintain water content of cells.

This marking point rewards an understanding of reducing water loss e.g. reduce wilting, maintain turgor, and is not related to photosynthesis.

2 max

(c) (i) (Carbon dioxide uptake) through the upper surface of the leaf / through cuticle.

1

(ii) 1. No use of carbon dioxide in photosynthesis (in the dark);
2. No diffusion gradient (maintained) for carbon dioxide into leaf / there is now a diffusion gradient for carbon dioxide out of leaf (due to respiration).

2

[10]

Q6.

(a) Oxygen production / concentration and time.

Accept: oxygen volume / concentration

Reject: oxygen uptake

Neutral: reference to carbon dioxide uptake

1

(b) 1. Intensity of light;

Accept: distance from light

2. Amount / number / mass / species of algae / photosynthesising cells;
3. Carbon dioxide (concentration / partial pressure);
4. Time.

2 max

(c) 1. (pH) increases;

Neutral: becomes more alkaline / less acidic

2. As (more) carbon dioxide removed (for photosynthesis).

2

(d) 1. Less absorption / (more) reflection (of these wavelengths of light);

Reject: no absorption or cannot absorb unless in context of green light.

Note: no green light absorbed or green light reflected = 2 marks.

2. (Light required) for light dependent (reaction) / photolysis

Accept: for excitation / removal of electrons (from chlorophyll)

3. (Represents) green light / colour of chlorophyll.

2 max

[7]

Q7.

(a) 1. Excites electrons / electrons removed (from chlorophyll);

Accept: higher energy level as 'excites'.

2. Electrons move along carriers/electron transfer chain releasing energy;

Accept: movement of H^+/protons across membrane releases energy.

Reject: 'produces energy' for either mark but not for both.

3. Energy used to join ADP and Pi to form ATP;

Reject: 'produces energy' for either mark but not for

both.

Accept: energy used for phosphorylation of ADP to ATP

Do not accept P as Pi but accept phosphate.

4. Photolysis of water produces protons, electrons and oxygen;
5. NADP reduced by electrons / electrons and protons / hydrogen;

Accept: NADP to NADPH (or equivalent) by addition of electrons/hydrogen.

Do not accept NADP reduced by protons on its own.

5

(b) 1. Protein/amino acids/DNA into ammonium compounds / ammonia;

Accept: any named nitrogen containing compound e.g. urea.

2. By saprobionts;

Accept: saprophytes.

3. Ammonium/ammonia into nitrite;
4. Nitrite into nitrate;
5. By nitrifying bacteria/microorganisms;

Reject: nitrifying bacteria in root nodules.

1, 3 and 4. Accept: marks for conversion even if incorrect type of bacteria named as being involved.

2 and 5. Reject: marks for type of bacteria if linked to incorrect process e.g. nitrite converted to nitrate by saprobionts.

3 and 4. Accept: for one mark ammonia/ammonium into nitrate if neither mark point 3 or 4 awarded.

Note: there are no marks for the role of nitrogen-fixing bacteria as the question refers to producing a source of nitrates from the remains of crops.

5

[10]

Q8.

(a) 1. <u>Geographic(al)</u> isolation;

2. Separate gene pools / no interbreeding / gene flow (between populations);

Accept: reproductive isolation

This mark should only be awarded in context of during the process of speciation. Do not credit if context is after speciation has occurred.

3. Variation due to mutation;
4. Different selection pressures / different abiotic / biotic conditions / environments / habitats;

Neutral: different conditions / climates if not

qualified

Accept: named abiotic / biotic conditions

5. Different(ial) reproductive success / selected organisms (survive and) reproduce;

Accept: pass on alleles / genes to next generation as equivalent to reproduce

6. Leads to change / increase in allele frequency.

Accept: increase in proportion / percentage as equivalent to frequency

6

(b) 1. Capture / collect sample, mark and release;
2. Method of marking does not harm lizard / make it more visible to predators;
3. Leave sufficient time for lizards to (randomly) distribute (on island) before collecting a second sample;
4. (Population =) number in first sample × number in second sample divided by number of marked lizards in second sample / number recaptured.

4

(c) 1. High concentration of / increase in carbon dioxide linked with respiration at night / in darkness;
2. No photosynthesis in dark / night / photosynthesis only in light / day;

Neutral: less photosynthesis

3. In light net uptake of carbon dioxide / use more carbon dioxide than produced / (rate of) photosynthesis greater than rate of respiration;
4. Decrease in carbon dioxide concentration with height;

More carbon dioxide absorbed higher up

Accept: less carbon dioxide higher up / more carbon dioxide lower down

5. (At ground level)
less photosynthesis / less photosynthesising tissue / more respiration / more micro-organisms / micro-organisms produce carbon dioxide.

Neutral: less leaves unqualified or reference to animals

5

[15]

Q9.

1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. Produces two glycerate (3-)phosphate / GP;

Accept: any answer which indicates that 2 x as much GP produced from one RuBP.

3. GP reduced to triose phosphate / TP;

Must have idea of reduction. This may be conveyed by stating m.p. 4.

4. Using reduced NADP;

***Reject**: Any reference to reduced NAD for m.p.4 but allow reference to reduction for m.p. 3.*

5. Using <u>energy</u> from ATP;

Must be in context of GP to TP.

6. Triose phosphate converted to glucose / hexose / RuBP / ribulose bisphosphate / named organic substance;

[6]

Q10.

(a)

Part of ecosystem	**Mean rate of carbon dioxide production / $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	**<u>39.8</u>**
Non-photosynthetic soil organisms	0.045	**<u>35.2</u>**

2 correct = 2 marks;;

Adding rates to get 0.128 = 1;

If rounded to 40 and 35 in table;

- *but working shows decimal points, then award 2 marks*
- *but no working shown, then 1 max*

2 max

(b) 1. Data only include (heterotrophic) soil organisms;

2. Doesn't include animals (above ground) / other (non-soil) organisms;

3. Doesn't take into account anaerobic respiration;

Award points in any combination

Accept for 1 mark idea that CO_2 for leaves doesn't take into account photosynthesis – not told in dark until part (d)

2 max

(c) **All three** of following = 2 marks;;

Two of them = 1 mark;

Volume of carbon dioxide given off

(From known) area / per m^2 / m^{-2}

In a known / set time

Ignore 'amount' / concentration of CO_2

Accept per second / per unit time

2

(d) 1. (In the light) photosynthesis / in the dark no photosynthesis;

2. (In light,) carbon dioxide (from respiration) being used / taken up (by photosynthesis);

2

(e) (i) (Rate of respiration)

Assume "it" means soil under trees

1. In soil under trees (always) higher;

Accept converse for soil not under trees

Accept 'in the shade' means under the trees

2. In soil under trees does not rise between 06.00 and 12.00 / in the middle of the day / peaks at 20:00-21.00 / in the evening;

3. In soil **not** under trees, peaks at about 14:00-15:00 / in middle of day;

2. and 3. No mm grid, so accept 'between 18.00 and 24.00' or 'between 12.00 and 18.00'

2 max

(ii) <u>(Between 06.00 and 12.00</u>, (No Mark))

Respiration higher in soil under tree, (No mark)

Do not mix and match mark points

No list rule

1. Tree roots carry out (a lot of) respiration;

2. More / there are roots under tree;

Accept converse for soil not under trees

OR

3. More food under trees;

4. So more active / greater mass of / more organisms

(carrying out respiration);
Accept converse for soil not under trees

OR

Soil not under trees respiration increases (No mark)

5. Soil in sunlight gets warmer;

6. Enzymes (of respiration) work faster;
Accept converse for soil under trees

2 max

(f) (i) 1. Photosynthesis produces sugars;

2. Sugars moved to roots;
Do not penalise named sugars other than sucrose

3. (Sugars) are used / required for respiration;

2 max

(ii) Takes time to move sugars to roots;
Look for movement idea in (i) – can carry forward to (ii)

1

[15]

Q11.

(a) 1. Protein synthesis **and** cell wall synthesis **and** cell expansion stop at −0.7 / at a *higher* water potential than other two;
If all 3 are correctly identified in marking point 1, accept 'the others / the other two' in marking point 2, and vice versa

2. Photosynthesis **and** stomatal opening stop at -1.5 / at a *lower* water potential than other three;
Correct processes must be named in at least one of marking point 1 or marking point 2
Where reference to water potential differences are made, they must be comparative, eg 'higher'

2

(b) 1. Stomata allow uptake of carbon dioxide;

2. Carbon dioxide used in / required for photosynthesis;

2

(c) 1. Growth involves cell division / cell expansion / increase in mass;
Marking point 1 is for the principle

2. Protein synthesis stops **so** no enzymes / no membrane proteins / no <u>named</u> protein (for growth / division);

Marking points 2, 3 and 4 require appreciation of 'why' before credit can be awarded

'named' protein must relate to proteins involved in growth or cell division

3. Cell wall synthesis stops **so** no new cells can be made;

Full credit is possible without a statement of the principle
(marking point 1)

4. No cell expansion / increase in mass **because** (cells) stop taking up water;

3 max

[7]

Q12.

(a) (i) So it / CO_2 is not a limiting factor (on growth / photosynthesis);

Accept: CO_2 is a limiting factor

1

(ii) So any difference is due to iron (deficiency);

Accept: iron is the variable

1

(iii) Amount of triose phosphate / TP will be similar / same / low (at start);

Accept: to allow triose phosphate to stabilise / become constant

Reject: so all triose phosphate is used up

Reject: so no triose phosphate

1

(b) 1. (Less) ATP produced;

Accept: alternatives for reduced NADP ie NADP with hydrogen / s attached

2. (Less) reduced NADP produced;

3. ATP / reduced NADP produced during light-dependent reaction;

4. (Less) GP to triose phosphate / TP;

4

(c) 1. Less triose phosphate converted to RuBP;

Accept: less triose phosphate so less RuBP

2. CO_2 combines with RuBP;

2

[9]

Q13.

(a) 1. Peaks at 420-430 and 660-670;

2. No absorption of light between approximately 500 and 600;

3. Highest peak at 420-430;

2 max

(b) 1. Less (light) energy passes through leaves / reaches ground;

2. Smaller range of wavelengths passes through leaves;
Accept reference to only green (and yellow) light pass through

3. Little light for chlorophyll to absorb;
Accept carotenoids can absorb this light

4. So insufficient photosynthesis (for growth);
Sufficient photosynthesis for plants with carotenoids

5. Photosynthesis unlikely to exceed respiration;

3 max

(c) 1. Light not limiting / lots of light (as no shading);

2. Light-dependent reaction not limiting / fast;

OR

3. Temperature not limiting / Warm (as no shading);

4. Fast reactions of enzymes in light-independent reaction;

OR

5. High use of CO_2;

6. Light-independent reaction is limiting;
Mark as a pair

2

[7]

Q14.

(a) 1. Bar chart;

2. Error bars to represent standard deviation (of mean);

3. Photosynthetic pigment on *x* axis and mass of pigment on *y* axis;
Accept suitable sketch

2 max

(b) 1. Number leaves on the branch;

2. Use random number table / calculator / pick numbers from bag

to determine which leaf to pick;

Accept use of random number generator

OR

3. Collect large number of leaves;

4. Pick out of bag with some idea of randomness;

2

(c) No (no mark)

1. No stats test carried out;

2. Standard error / 95% confidence interval calculation identified;

If awarded, student scores 2 marks – for points 1 and 2

Yes (no mark)

3. No overlap shown by the standard deviations;

4. Ranges around mean stated;

88.6-92.8 and 111.0-111.2 (1 × SD) or 86.5-94.9 and 110.9-111.3 (2 × SD)

2 max

(d) In shade leaves:

1. Greater amount of enzyme / enzyme activity (for production of chlorophyll b);

2. Greater gene expression / transcription of the gene / more mRNA produced / gene switched on;

3. Greater translation;

4. Enzyme / substrate is light sensitive – faster rate of reaction with lower light;

2 max

[8]

Q15.

(a) 1. (Some of the) light that passes through is absorbed by chlorophyll b;

2. This is light of around 500 and / or around 640;

Accept any value or range between 460 and 540 and / or 600 and 670

2

(b) (i) Supports hypothesis 2 (no mark)

1. Greater carotenoid found in sun leaves than shade leaves of beech tree;

2. Sun leaves exposed to much brighter light than shade leaves;

OR

It supports hypothesis 2 because it does not support hypothesis 1 (no mark)

3. Although carotenoids absorb wavelengths of light that pass through leaves;

4. There are not more carotenoids in shade leaves;

2

(ii) 1. Mass of pigments / carotenoids in sun and shade leaves of other trees;

2. Position of carotenoids in leaf cells;

3. Effect of bright light on (isolated) chlorophyll;

4. Whether without carotenoids chlorophyll is damaged (supporting hypothesis 2) / photosynthesis is reduced (supporting hypothesis 1);

1 max

[5]

Q16.

(a) (i) Stroma (of chloroplasts);

Reject: stoma

1

(ii) 2;

1

(b) 1. As oxygen (concentration) increases less Rubisco / RuBP reacts / binds with carbon dioxide;

1. Accept - as oxygen (concentration) increases more Rubisco / RuBP reacts / binds with oxygen

1. Accept – less GP / more phosphoglycolate formed as oxygen (concentration) increases

2. Competitive inhibition / competition between oxygen and carbon dioxide for rubisco / enzyme / active site (therefore) less RuBP formed / regenerated (to join with carbon dioxide);

2. Accept oxygen and carbon dioxide are complementary to active site

2

(c) 1. Less glycerate 3-phosphate / GP produced;

1. Accept one GP formed rather than two GP

2. (Less) triose phosphate to form sugars / protein / organic (product) / any named photosynthetic product;

3. Less RuBP formed / regenerated;

3. Accept RuBP takes longer to form

3

[7]

Q17.

(a) 1. Chlorophyll absorbs light energy;

Accept light energy 'hits' chlorophyll

Accept photon for light energy

2. Excites electrons / electrons removed (from chlorophyll);

Accept higher energy level as 'excites'

3. Electrons move along carriers / electron transport chain releasing energy;

Accept movement of H^+ / protons across membrane releases energy

4. Energy used to join ADP and Pi to form ATP;

Negate 'produces energy' for either mark but not for both

Accept energy used for phosphorylation of ADP to ATP

Do not accept P as Pi

5. Photolysis of water produces protons, electrons and oxygen;

3. and 4.

6. NADP reduced by electrons / electrons and protons / hydrogen;

Accept NADP to NADPH (or equivalent) by addition of electrons / hydrogen

Do not accept NADP reduced by protons on their own

5 max

(b) 1. Variation / variety;

2. Mutation;

Do not accept answers which suggest the mutation is caused by copper

3. Some plants have allele to survive / grow / live in high concentration of copper / polluted soils;

Reference to immunity disqualifies this mark

Do not disqualify mark for references to allele providing resistance to copper

4. (Differential) reproductive success / adapted organisms

reproduce;

5. Increase in frequency of allele;

6. No interbreeding (with other populations) / separate gene pool / gene pool differs (from other populations);

Accept reproductive isolation

5 max

[10]

Q18.

(a) Ribulose bisphosphate / RuBP;

Accept Ribulose biphosphate or Ribulose diphosphate

Accept phonetic spellings

Accept any variation in upper or lower case for RuBP

1

(b) ATP and reduced NADP are produced in grana / thylakoids / present in A / both tubes;

Must be reduced NADP but accept any alternative which show hydrogen attached to NADP

Must be reduced NADP not reduced NAD

1

(c) 1. 4 000;

Accept 'same as in (tube) C', but not 'same' on its own

2. Light-dependent reaction does not occur / ATP and reduced NADP are not produced;

Accept converse for mark point 2

2

(d) 1. (Less) GP converted to TP;

GP = glycerate 3-phosphate

TP = triose phosphate but abbreviations are sufficient

2. (Less) TP converted to RuBP;

Accept GALP as TP

2

(e) 1. No / less ATP / ATP produced (during electron transport);

Must be reduced NADP but accept any alternative which shows hydrogen attached to NADP

2. No / less reduced NADP / reduced NADP produced (during electron transport)

2

[8]

Q19.

(a) 530 to 630;

1

(b) 1. Reduced NADP;

Accept NADPH or rNADP

2. ATP;

Reduced NAD is incorrect

2

(c) (i) 1. Unit of volume and unit of time;

Accept any reasonable unit of volume

E.g. cm^3 or ml

Accept any reasonable unit of time

E.g. s, min or h

2. Unit of area / mass;

Accept any reasonable unit of area or mass

E.g. cm^2 or g

Symbols should be correct. Do not accept m for minutes.

2

(ii) 1. (Light intensity) limiting factor;

2. Fewer electrons (released) from chlorophyll;

3. Less photolysis therefore (less) oxygen from water;

3

(d) Will not affect (no mark):

1. Photolysis / splitting of water does not use enzymes;

Will affect (no mark):

2. May increase respiration;

3. Respiration uses oxygen;

3

(e) (i) 1. Overlap in standard deviations;

2. Unlikely that any difference is significant;

2

(ii) 1. **P** / visible light has more wavelengths;

2. **Q** has only light of wavelength 460 nm;

3. Wavelengths over 460 nm can also be used for photosynthesis / wavelengths over 460 nm can also be absorbed;

3

[16]

Q20.

(a) (i) Non-living / physical / chemical factor / non biological;

Do not accept named factor unless general answer given.

1

(ii) Accept an abiotic factor that may limit photosynthesis / growth;

Reject altitude / height

Water

Named soil factor

Not "soil" / "weather"

Light

Carbon dioxide

Accept Oxygen

Incline / aspect

Wind / wind speed

1

(b) 1. Correct explanation for differences between day and night e.g. photosynthesises only during the daytime / no photosynthesis / only respiration at night;

2. Net carbon dioxide uptake during the day / in light

OR

No carbon dioxide taken up at night / in dark / carbon dioxide released at night / in dark;

3. At ground level more respiration / in leaves more photosynthesis;

4. Carbon dioxide produced at ground level / carbon dioxide taken up in leaves;

Principles

Comparing day and night / light and dark

1. Explanation in terms of photosynthesis / respiration

2. Effect on carbon dioxide production / uptake

Comparing leaves with ground level

3. Explanation in terms of photosynthesis / respiration

4. Effect on carbon dioxide production / uptake

2 and 4 must relate to why the change occurs

4

(c) 1. Variation in original colonisers / mutations took place;

2. Some better (adapted for) survival (in mountains);

2. Allow "advantage so able to survive"

3. Greater reproductive success;

4. Allele frequencies change;
   4. Reject gene / genotype

3 max

[9]

Q21.

(a) 1. Releases energy in small / manageable amounts;
   1. Accept less than glucose

2. (Broken down) in a one step / single bond broken immediate energy compound / makes energy available rapidly;
   2. Accept easily broken down

3. Phosphorylates / adds phosphate makes (phosphorylated substances) more reactive / lowers activation energy;
   3. Do not accept phosphorus or P on its own

4. Reformed / made again;
   4. Must relate to regeneration

4

(b) 1. Substrate level phosphorylation / ATP produced in Krebs cycle;
   Accept alternatives for reduced NAD

2. Krebs cycle / link reaction produces reduced coenzyme / reduced NAD / reduced FAD;
   2. Accept description of either Krebs cycle or link reaction

3. Electrons released from reduced / coenzymes / NAD / FAD;

4. (Electrons) pass along carriers / through electron transport chain / through series of redox reactions;

5. Energy released;
   5. Allow this mark in context of electron transport or chemiosmosis

6. ADP / ADP + Pi;
   6. Accept H^+ or hydrogen ions and cristae

7. Protons move into intermembrane space;
   7. Allow description of movement through membrane

8. ATP synthase;
   8. Accept ATPase. Reject stalked particles

6 max

(c) 1. In the dark no ATP production in photosynthesis;

1. In context of in photosynthetic tissue / leaves

2. Some tissues unable to photosynthesise / produce ATP;

3. ATP cannot be moved from cell to cell / stored;

4. Plant uses more ATP than produced in photosynthesis;

5. ATP for active transport / synthesis (of named substance);

5

[15]

Q22.

(a) 1. Saprobionts / saprophytes;

2. Digest / break down proteins / DNA / nitrogen-containing substances;

3. Extracellular digestion / release of enzymes;

4. Ammonia / ammonium produced;

5. Ammonia converted to nitrite to nitrate / ammonia to nitrate;

6. Nitrifying (bacteria) / nitrification;

7. Oxidation;

Ignore all references to other parts of the nitrogen cycle

1. Accept saprotrophs. Allow this mark if saprobionts linked to fungi.

2. Ignore"nitrogen in plants"

Ignore enzymes excreted

6. Accept Nitrosomonas / Nitrobacter

5 max

(b) 1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. Produces two molecules of glycerate (3-)phosphate / GP;

3. Reduced to triose phosphate / TP;

4. Using reduced NADP;

5. Using energy from ATP;

6. Triose phosphate converted to other organic substances / named organic substances / ribulose bisphosphate;

7. In light independent reaction / Calvin cycle;

3. Accept add hydrogen for reduced

4. Accept alternatives such as NADPH for reduced

NADP / GALP for TP / ribulose biphosphate

6 max

[11]

Q23.

(a) (i) Temperature and light;

1

(ii) Increase in temperature causes increase in rate of photosynthesis / uptake of carbon dioxide;

Increase in light / more / medium / high light (intensity) causes increase in rate of photosynthesis / uptake of carbon dioxide;

2

(b) 2.75 – 2.81 (mg g^{-1} hr^{-1})

Accept answers in range 2.75 – 2.81

1

(c) 1. Growth will decrease (at higher temperature);

2. Rate of respiration will increase at higher temperature;

3. Photosynthesis decreases as limited by light / as there is less light;

Ignore references to effect of temperature on rate of photosynthesis

3

[7]

Q24.

(a) 1. High concentration of carbon dioxide linked with night / darkness;

Accept: converse of low in day

2. No photosynthesis in dark / night / light required for photosynthesis / light-dependent reaction;

Ignore references to rate of photosynthesis in day / night
Accept day = light

3. (In dark) <u>plants</u> (and other organisms) respire;

Must be a reference to plants or <u>all</u> organisms

4. In light net uptake of carbon dioxide by plants / plants use more carbon dioxide than they produce / rate of photosynthesis greater
than rate of respiration;

Do not allow converse for this point
Accept description of compensation point

5. Decrease in carbon dioxide concentration with height;

Accept: converse of increase closer to ground

6. At ground level fewer leaves / less photosynthesising tissue / more animals / less light;

5 max

(b) 1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. To produce two molecules of glycerate 3-phosphate / GP;

3. Reduced to triose phosphate / TP;

4. Requires reduced NADP;

5. Energy from ATP;

This mark scheme is based on specification content. Accept alternate names such as NADPH

Credit relevant diagrams

Accept: description of 'reduced'

5

[10]

Q25.

(a) Excitation of chlorophyll molecule / electrons / energy of (pairs of) electrons raised to higher energy level;

Electron(s) emitted from chlorophyll molecule;

Electron(s) to electron transport chain;

Loss of energy by electron(s) along electron transport chain;

Energy lost by electron(s) is used to synthesise ATP;

From ADP + Pi;

"By electrons" need not be stated in each marking point if it can be reasonably inferred that the candidate is referring to electrons

max 5

(b) Little green light reaches bottom as absorbed by surface dwellers / water;
Red and blue not absorbed and so penetrate;
Variation in pigments of sediment dwellers;
Bacteria with chlorophyll at an advantage as chlorophyll absorbs red and blue;
(Survive to) reproduce in greater numbers and pass on advantageous alleles / genes in greater numbers / increase in frequency of advantageous alleles in subsequent generations;
Increase in frequency / numbers of bacteria with chlorophyll;

6

[11]

Q26.

(a) (i) Yield increases by 0.6 kg m^{-2} (when extra carbon dioxide present);

1

(ii) Temperature / light intensity so could be lower in these weeks (as temperature / light insensity not fully controlled / monitored) (over period 1998 – 2000);

1

(b) Two marks for correct answer of 50.6%;;
One mark for incorrect answer in which candidate has shown clearly that calculation based on an increase / 0.42 and original mass / 0.83

2

(c) Cost of supplying carbon dioxide;
Price of (very early) tomatoes;

2

(d) Lowest price paid for tomatoes;
Some carbon dioxide lost as windows open in summer;
Little / no mean increase in yield in summer;

2 max

(e) Grow with extra carbon dioxide in one glasshouse and without carbon dioxidein other glasshouse at same time;
So all environmental conditions / light and temperature same for experiment and control;

2

[10]

Q27.

1. Light (energy) excites / raises energy level of electrons in chlorophyll;

2. Electrons pass down electron transfer chain;

   Q *Accept any reasonable alternative for electron transfer chain.*

3. (Electrons) reduce carriers / passage involves redox reactions;

4. Electron transfer chain / role of chain associated with chloroplast membranes / in thylakoids / grana;

   Example such as chemiosmosis;

5. Energy released / carriers at decreasing energy levels;

6. ATP generated from ADP and phosphate / P_i / phosphorylation of ATP;

[5]

Q28.

(a) 1 5C / RuBP combines with CO_2;

2 to form 3C compound / TP / GP;

3 using ATP;

4 and reduced NADP / eq;

5 2 molecules of 3C compound / TP / GP form hexose;

6 all RuBP is regenerated;

7 10 molecules of 3C / TP / GP form 6 molecules of 5C / RuBP;

6 max

(b) 1 electron transport chain accepts excited electrons;

2 from chlorophyll / photosystem;

3 electrons lose energy along chain;

4 ATP produced;

5 from ADP and Pi;

6 reduced NADP formed;

7 when electrons (from transport chain) and H^+ combine with NADP;

8 H^+ from photolysis;

6 max

(c) 1 some hexose / biomass / eq. used in respiration;
growth cancels this point

2 CO_2 produced (is lost to air);

3 some parts of the plant are eaten / some parts lost to decomposers / in leaf fall;

3

[15]

Q29.

(a) Temperature affects photosynthesis; Affects enzyme activity;
So that any change in photosynthesis rate is result of carbon dioxide / light intensity;

max 2

(b) Carbon dioxide increases rate of photosynthesis;
Up to max;
Something else / correct suggestion is a limiting factor;

3

[5]

Q30.

(a) On diagram, correctly labelled:

Light-dependent: granum / thylakoid membranes – labelled 'X'
AND
Light-independent: stroma – labelled 'Y';

1

(b) Any two from:

(Water) forms H^+ / hydrogen ions and electrons / e^- ;

O_2 / oxygen formed; [*NOT* 'O', *NOT* 'O^-']

(Light) excites electrons / raises energy level of electrons / electrons to chlorophyll / to photosystem;

max 2

(c) (ATP) Provides energy for GP → TP / provides P for RuP / TP → RuBP;

(Reduced NADP) Provides H / electrons for GP → TP / reduces GP to TP;

2

[5]

Q31.

(a) (i) temperature also affects photosynthesis / rate of reaction; need to ensure the effect of only one variable is being observed;

1

(ii) CO_2 used / O_2 produced / sugar produced / increase in mass; per unit of time;

accept any volume or mass unit; per time unit;)

(allow one mark for indicator of photosynthesis – second mark is for time element)

2

(b) (i) as carbon dioxide increases, rate of photosynthesis increases;

1

(ii) carbon dioxide not limiting photosynthesis / another factor / named
factor limiting;
explanation for named factor;

2

[6]

Q32.

(a) Grana / thylakoids / lamellae;

1

(b) **A** = oxygen / O_2
B = ADP and phosphate / P_i / phosphoric acid / correct formula;
C = reduced NADP; ALLOW NADPH / $NADPH_2$ / NADPH + H^+

3

(c) (i) Absorbs light / energy;

Loses electrons / becomes positively charged / is oxidised;
Accepts electrons from water / from OH^- which causes more water
to dissociate / pulls equilibrium to the right;

3

(ii) Electrons raised to higher energy level / electrons excited;
Use of electron carriers / cytochromes / acceptors;
For production of ACT

[REJECT 'energy production']

3

(d) (i) GP formed from RuBP + CO_2;
GP → TP / sugar-phosphate / sugar / to RuBP;
GP formed at same rate as it is used;

3

(ii) No CO_2 to combine with / not enough CO_2 to combine with RuBP
RuBP not changed into GP / TP RuBP reformed from GP / TP;

2

[15]