A-Level Biology

Photosynthesis

Mark Scheme

Time available: 71 minutes
Marks available: 50 marks

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1.

(a) ☑ NADP, ADP, Pi and water;

1

(b) 1. Chlorophyll absorbs light
OR
Light excites/moves electrons in chlorophyll;
Ignore photosystems.

2. Electron/s are lost
OR
(Chlorophyll) becomes positively charged;
Ignore site/molecule from where electrons are lost.
Accept electrons go to electron transport/carrier chain for 'electrons lost'.

2

(c) Ink and (leaf) pigments would mix
OR
(With ink) origin/line in different position
OR
(With pencil) origin/line in same position
OR
(With pencil) origin/line still visible;

1

(d) 1. Level of solvent below origin/line;
Reject water or any named aqueous solution.
Accept named organic solvent.

2. Remove/stop before (solvent) reaches top/end;

2

(e) Accept any answer in range of 0.58 to 0.62;
Accept 0.58 or 0.62.
Ignore any numbers which follow numbers in range.

1

(f) (Absorb) different/more wavelengths (of light) for photosynthesis;
Accept wider/larger range of wavelengths.
Accept frequency for wavelength.
Accept light-dependent reaction /photophosphorylation /photoionisation for photosynthesis.

1

[8]

2.

(a) 1. (Less/no) ATP;

2. (Less/no) reduced NADP;
Accept NADPH, NADPH + H, $NADPH_2$ NADPH + H^+
Reject reduced NAD, NADH etc,

2

(b) 1. (Less/no) carbon dioxide (reacts) with RuBP;

2. (Less/no) GP;

2

(c) 1. Stroma (of/in chloroplast);

Reject: stoma

Reject stroma of cytoplasm/chlorophyll

Reject stroma of mitochondrion

Ignore references to Calvin cycle or the light-independent reaction

1

(d) 1. Rubisco activity increases with temperature
OR
Rubisco optimum temperature is above (**rubisco activase**);

2. (Rubisco) **activase** activity decreases at high temperatures (allow any temperature above 25 ºC.)
OR
(Rubisco) **activase** optimum (allow in range) 25 to 30 ºC.;

Accept denatures at high temperature (allow any temperature above 25 ºC)

3. (Results/graphs suggest) **activase** cannot/does not affect activity of rubisco;

4. (Results are) only for cotton;

Accept may not be the same in other species/types of plant

Ignore: only one study

5. (Results are) for isolated enzymes;

6. No stats test;

4 max

[9]

3. (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]

4. (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]

5.

(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]

6.

(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 named 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]