

Markscheme

November 2021

Biology

Higher level

Paper 2

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Section B

Extended response questions – quality mark

- Extended response questions for HLP2 each carry a mark total of **[16]**. Of these marks, **[15]** are awarded for content and **[1]** for the quality of the answer.
- **[1]** for quality is awarded when:
 - the candidate's answers are clear enough to be understood without re-reading.
 - the candidate has answered the question succinctly with little or no repetition or irrelevant material.

Candidates that score very highly on the content marks need not necessarily automatically gain **[1]** for quality (and *vice versa*).

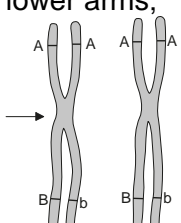
Section A

| Question | | Answers | Notes | Total |
|----------|---|---|-------|-------|
| 1. | a | a negative correlation/decrease (in biomass) as temperature rises in added-nutrients (mesocosms); b little/no (significant) change in biomass as temperature increases in control (mesocosms); | | 2 max |
| | b | a autotroph biomass decreases <u>and</u> heterotroph biomass increases with higher temperatures; b decrease in autotrophs is greater/larger/more than increase in heterotrophs OR little difference in biomass (between auto and heterotrophs) at highest temperature/27°C; c autotrophs show smaller and smaller gains in biomass from initial as temperature rises/WTTE; d heterotrophs no gain in biomass at 21°C then larger and larger gains as temperature rises; | | 2 max |
| | c | <i>rate of photosynthesis increases as temperature rises because:</i> a temperature is the limiting factor for photosynthesis; b higher temperatures increase enzyme activity; c faster molecular motion/more molecular kinetic energy/more frequent enzyme-substrate collisions; d Calvin cycle/light independent reactions (of photosynthesis) speed up; | | 2 max |
| | d | <i>biomass of autotrophs decreases as temperature rises because of:</i> a more herbivory/grazing/feeding by (zooplankton/heterotrophs); b higher populations/numbers/biomass of zooplankton/heterotrophs; c more mortality/more decomposition/decay of autotrophs/phytoplankton; d <u>respiration</u> (rate higher than photosynthesis rate in autotrophs/phytoplankton); | | 2 max |

(continued...)

(Question 1 continued)

| Question | | Answers | Notes | Total |
|----------|---|--|---|-------|
| 1. | e | a increased temperature raises biomass; b increased nitrate raises biomass more than increased temperature; c increased nitrate and temperature raises biomass by same amount as nitrate alone; | | 3 max |
| | f | a water availability/rainfall/humidity; b light/sunlight (intensity) / daylength; c salinity of <u>soil</u> / high/low <u>soil</u> pH; d chemical pollution/herbicides/allelopathy/parasitic weeds; | Mark the first two answers only. Do not accept carbon dioxide or weather conditions. | 2 max |
| | g | <p><i>advantages of mesocosms/converse problems with studies in natural environments</i></p> a easier to manipulate/control variables/conditions / less susceptible to outside influences OR easier to replicate OR take up less space; | Allow only one mark for an advantage and one mark for a disadvantage as this is a discuss question. | 2 max |
| | | <p><i>disadvantages of mesocosms/converse opportunities with studies in natural environments</i></p> b some trophic levels missing/incomplete food chains in mesocosms OR large animals cannot be included / ethical concerns about enclosing animals in mesocosms OR some variables lacking in mesocosms / doesn't show what happens in natural ecosystems; | | |

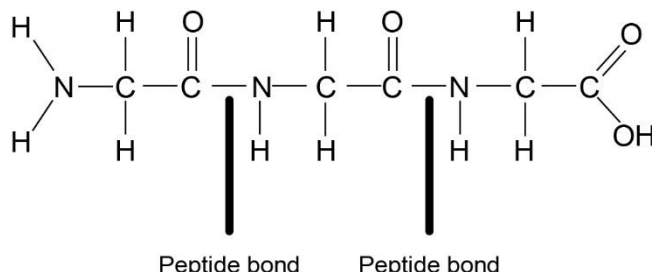
| Question | | | Answers | Notes | Total | | | | | | | | | |
|----------|-----------|---------|--|--|--------------|-----|-------|-----------|---------|-------|-----------|---------|--|----------|
| 2. | a | i | <p>a parental alleles shown as X^H and X^h (female) and X^H and Y (male);</p> <p>b Punnett square with genotypes of offspring shown as $X^H X^H$ and $X^H Y$ and $X^H X^h$ and $X^h Y$;</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>X^H</td> <td>Y</td> </tr> <tr> <td>X^H</td> <td>$X^H X^H$</td> <td>$X^H Y$</td> </tr> <tr> <td>X^h</td> <td>$X^H X^h$</td> <td>$X^h Y$</td> </tr> </table> | | X^H | Y | X^H | $X^H X^H$ | $X^H Y$ | X^h | $X^H X^h$ | $X^h Y$ | | 2 |
| | X^H | Y | | | | | | | | | | | | |
| X^H | $X^H X^H$ | $X^H Y$ | | | | | | | | | | | | |
| X^h | $X^H X^h$ | $X^h Y$ | | | | | | | | | | | | |
| | a | ii | $X^H X^h$; | | 1 | | | | | | | | | |
| 2. | b | i | <p>all four upper arms with one A and both chromosomes with one B and one b on the lower arms;</p>  | <i>The chromatids can be shown as single lines rather than the wider versions in the question.</i> | 1 | | | | | | | | | |
| | b | ii | prophase I; | | 1 | | | | | | | | | |
| | c | | <p>a located on the same chromosome;</p> <p>b genes/gene loci close together (on the same chromosome);</p> <p>c do not follow (the law of) independent assortment;</p> <p>d more chance of recombination if genes are further apart;</p> <p>e inherited together unless crossing over/recombination occurs;</p> <p>f ratios of offspring in dihybrid crosses are different from expected/non-Mendelian</p> <p style="text-align: center;">OR</p> <p>more offspring with parental phenotype combinations than expected;</p> | | 2 max | | | | | | | | | |

(continued...)

(Question 2 continued)

| Question | | Answers | Notes | Total |
|----------|----------|---|-------|--------------|
| | d | a cortical reaction (after first sperm nucleus enters the egg); b vesicles/cortical granules release their contents/enzymes (from the egg/zygote); c zona pellucida/glycoprotein coat/outer coat hardened / fertilization membrane formed; d <u>enzymes</u> of sperm/acrosome cannot digest (hardened coat) OR glycoproteins/ZP3 (in zona pellucida) altered so sperm cannot bind; | | 2 max |

| Question | | Answers | Notes | Total |
|-----------|----------|---|--|--------------|
| 3. | a | cells absorb water by <u>osmosis</u> and swell/increase in volume OR cells burst/lyse; | | 1 |
| | b | leukemia/other diseases of the hematopoietic system / skin burns; | | 1 max |
| | c | a depolarization of part of axon/membrane triggers/causes depolarization of next part; b local currents; c diffusion of sodium ions between depolarized part and next/polarized part (of axon); d resting potential reduced/polarization of membrane becomes less /change from -70 to -50mV; e sodium channels open when -50mV/threshold potential reached; f entry of sodium ions causes depolarization; g saltatory conduction in myelinated neurons/axons; | <i>Allow answers in an annotated diagram</i> | 3 max |

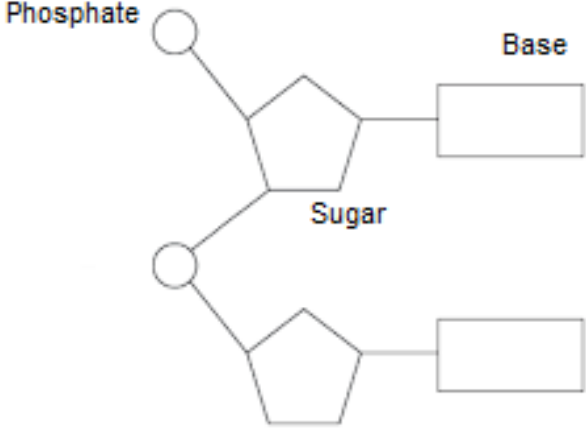
| | | | |
|---|---|--|--|
| Question 4a and 4c: are common with SLP2 Q2a and 2c | | | |
| 4. | a | <p>circle/bracket around peptide bond / arrow pointing to peptide bond / peptide bond labelled;</p>  <p style="text-align: center;">Peptide bond Peptide bond</p> | <p><i>Allow either peptide bond</i></p> <p><i>Allow if adjacent C=O and NH groups are included in the circle/bracket, but do not allow if other parts of the molecule are included.</i></p> <p style="text-align: right;">1</p> |
| | b | <p>a polypeptide wound into a helical structure / alpha/α helix OR polypeptide folded back on itself forming a pleated sheet / beta/β pleated sheet;</p> <p>b stabilized/held in shape by/due to hydrogen bonds (between C=O and N-H groups);</p> <p>c secondary structures are regular/unvarying (within polypeptides/proteins);</p> | <p><i>Allow annotated diagrams</i></p> <p style="text-align: right;">2 max</p> |
| | c | contracts/flattens/becomes less domed/increases volume of thorax; | 1 |

| Question 5a: is common with SLP2 Q3a | | | | | | |
|--------------------------------------|---|---|--|--|--|---|
| Question | | Answers | | Notes | Total | |
| 5. | a | | Detritivores | Saprotrophs | Accept not autotrophic/not photosynthetic instead of heterotrophic. Do not accept that both groups are decomposers or consumers for the similarity. | 2 |
| | | Similarity | heterotrophic OR feed on/obtain nutrients from dead organic matter/dead organisms; | | | |
| | | Difference | internal digestion/digestion in gut OR enzymes secreted into gut OR food ingested before digestion | external digestion OR enzymes secreted into surroundings OR food digested before being absorbed; | | |
| | b | a genes for flowering are activated/gene activation/changes to gene expression; b shoot apex changes from producing leaves/stem to producing flowers; c daylength/duration of the day/night length/photoperiod measured/detected/responded to; d short day plants flower when they have a long night/period of darkness OR long day plants only flower when they have a short night/period of darkness; e so short day plants/SDPs flower in late summer/fall/autumn/winter OR so long day plants/LDPs flower in spring/(early) summer; | | | 3 max | |
| | c | a apical meristem (of shoot/stem) produces cells/elongates the stem OR cell division/mitosis in tip/apex of shoot/stem; b auxin stimulates cell/stem growth/extension/enlargement; c elongation of cells causes stem to grow (in length); | | | 2 max | |

Section B

Clarity of communication: [1]

The candidate's answers are clear enough to be understood without re-reading. The candidate has answered the question succinctly with little or no repetition or irrelevant material.

| Question | | Answers | Notes | Total |
|----------|---|--|-------|-------|
| 6. | a | <p>a ribose drawn as pentagon and labelled sugar/ribose; b base drawn with correct link to (C₁ of) ribose and labelled base/nitrogenous base; c phosphate drawn with correct link to (C₅ of) ribose and labelled P/phosphate; d two (or more) ribonucleotides drawn with correct link (C₃ to C₅)</p>  | | 4 max |

(continued...)

(Question 6 continued)

| Question | | Answers | Notes | Total |
|----------|---|--|--|--------------|
| 6. | b | a synthesis of RNA/mRNA / transcription of DNA to RNA; b RNA nucleotides linked together to form a strand/chain; c RNA strand assembled on DNA template/antisense strand / copy made of sense strand; d <u>RNA polymerase</u> carries out transcription/links RNA nucleotides; e uncoiling/separation of DNA strands; f 3' end of nucleotides linked to 5' end of (growing RNA) strand; g <u>complementary base pairing</u> (is the basis of copying the base sequence); h <u>uracil</u> instead of <u>thymine</u> in RNA; i starts at/RNA polymerase binds to a promoter; j regulated by transcription factors/DNA binding proteins/nucleosomes; | <i>Annotated diagrams can be used.</i> | 7 max |

(continued...)

(Question 6 continued)

| Question | | Answers | | Notes | Total |
|--|---|---|--|-------|-------|
| 6. | c | | | | 4 max |
| | | <i>continuous variation</i> | <i>discrete variation</i> | | |
| | | a no distinct categories / intermediates / many possible phenotypes | distinct categories / non-overlapping classes / few possible phenotypes; | | |
| | | b multiple genes/polygenic | one/few influencing genes; | | |
| | | c environmental influences | not influenced by environment; | | |
| d height/weight/skin colour/intelligence/other example | blood groups/number of eggs/ other example; | | | | |

| Question | | Answers | | Notes | Total | | | | | | | | | | | | | | | | | | |
|--|--|---|--|--|---------------|---------------------------------|--|------------------------|-----------------------------------|-----------------------------------|---|--|--|---|--|-----------------|---------------|--|------------------------------------|---------------|----------------|--|--------------|
| 7. | a | a polarity of water; b hydrogen bonds between water molecules; c cohesion between water molecules/water molecules stick together; d cohesion allows tensions/low pressures/transpiration pull/movement upward/against gravity; e adhesion to cellulose/cell walls generates tensions/pull (in xylem) OR adhesion to xylem walls/vessel walls causes capillary rise/upward movement; f solvent for many substances / many substances dissolve; g liquid at most temperatures experienced by plants / liquid so can flow; | | <i>Polarity of water and/or hydrogen bonding can be shown in an annotated diagram.</i> | 4 max | | | | | | | | | | | | | | | | | | |
| | b | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%; text-align: center;"><i>Xylem</i></th> <th style="width: 50%; text-align: center;"><i>Phloem</i></th> </tr> </thead> <tbody> <tr> <td>a transports water/mineral ions</td> <td>sucrose/sugars/amino acids/organic/carbon compounds/products of photosynthesis/food;</td> </tr> <tr> <td>b from roots to leaves</td> <td>from source/leaves to sink/roots;</td> </tr> <tr> <td>c dead/no membranes/no organelles</td> <td>living/membranes present/some organelles;</td> </tr> <tr> <td>d no cross/end walls/hollow/continuous tubes</td> <td>sieve plates/perforated walls/separate elements;</td> </tr> <tr> <td>e flow due to low pressures/tension/suction</td> <td>flow due to high pressure/pressure gradient;</td> </tr> <tr> <td>f thicker walls</td> <td>thinner walls</td> </tr> <tr> <td>g lignified walls / gives support / forms wood</td> <td>does not provide support/strength;</td> </tr> <tr> <td>h wider lumen</td> <td>narrower lumen</td> </tr> </tbody> </table> | | <i>Xylem</i> | <i>Phloem</i> | a transports water/mineral ions | sucrose/sugars/amino acids/organic/carbon compounds/products of photosynthesis/food; | b from roots to leaves | from source/leaves to sink/roots; | c dead/no membranes/no organelles | living/membranes present/some organelles; | d no cross/end walls/hollow/continuous tubes | sieve plates/perforated walls/separate elements; | e flow due to low pressures/tension/suction | flow due to high pressure/pressure gradient; | f thicker walls | thinner walls | g lignified walls / gives support / forms wood | does not provide support/strength; | h wider lumen | narrower lumen | | 4 max |
| <i>Xylem</i> | <i>Phloem</i> | | | | | | | | | | | | | | | | | | | | | | |
| a transports water/mineral ions | sucrose/sugars/amino acids/organic/carbon compounds/products of photosynthesis/food; | | | | | | | | | | | | | | | | | | | | | | |
| b from roots to leaves | from source/leaves to sink/roots; | | | | | | | | | | | | | | | | | | | | | | |
| c dead/no membranes/no organelles | living/membranes present/some organelles; | | | | | | | | | | | | | | | | | | | | | | |
| d no cross/end walls/hollow/continuous tubes | sieve plates/perforated walls/separate elements; | | | | | | | | | | | | | | | | | | | | | | |
| e flow due to low pressures/tension/suction | flow due to high pressure/pressure gradient; | | | | | | | | | | | | | | | | | | | | | | |
| f thicker walls | thinner walls | | | | | | | | | | | | | | | | | | | | | | |
| g lignified walls / gives support / forms wood | does not provide support/strength; | | | | | | | | | | | | | | | | | | | | | | |
| h wider lumen | narrower lumen | | | | | | | | | | | | | | | | | | | | | | |

(continued...)

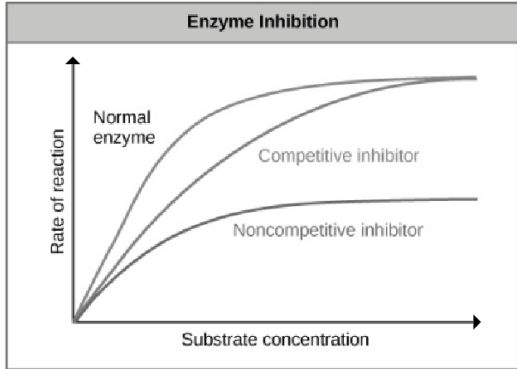
(Question 7 continued)

| Question | | Answers | Notes | Total |
|----------|---|--|-------|-------|
| 7. | c | a light-dependent reactions produce ATP/reduced NADP; b ATP generated by chemiosmosis/by photophosphorylation/by ATP synthase; c reduced NADP produced by/using electrons from Photosystem I; d RuBP + CO ₂ to glycerate 3-phosphate (in light independent reactions); e glycerate 3-phosphate reduced to triose phosphate (in light independent reactions); f ATP/reduced NADP used in the light-independent reactions; g reduced NADP provides electrons/hydrogen / to reduce (glycerate 3-phosphate) OR reduced NADP used to convert glycerate 3-phosphate to triose phosphate; h ATP provides energy (for reduction of glycerate 3-phosphate); i ATP needed to regenerate RuBP j ATP/reduced NADP run out in darkness k <u>Calvin cycle</u> only possible with light/in the day/is indirectly dependent on light; | | 7 max |

| Question | | Answers | Notes | Total |
|----------|---|---|---|-------|
| 8. | a | a change to conformation/shape/tertiary structure/3-D shape; b bonds within the protein/intramolecular bonds broken/changed; c pH and temperature (outside tolerated ranges) can cause denaturation; d vibrations/heat at high temperatures breaks bonds; e high pH/low pH/extreme pH alters ionization/charges (of amino acids and breaks ionic bonds); f protein cannot carry out its function OR active site of enzymes cannot bind substrates/catalyze reaction/no enzyme-substrate complex; g permanent/irreversible change (usually) OR soluble proteins become insoluble/precipitate; | Allow any mark points if made clearly on an annotated graph or diagram. | 4 max |
| | b | a antigens stimulate antibody production; b antibodies produced by lymphocytes; c macrophages/phagocytes ingest/engulf pathogens and display antigens from them; d T-cells activated by binding antigen/by macrophage displaying antigen; e activated T-cells cause activation of B-cells; f mitosis/division of (activated) B-cells (to produce a clone of cells) g plasma cells formed from divided/activated/growing/differentiating B-cells; h plasma cells/plasma B-cells secrete antibodies; i clonal selection / plasma cells make same type of antibody/antibody specific to same antigen; j some activated B-cells become memory cells; | | 7 max |

(continued...)

(Question 8 continued)

| Question | | Answers | | Notes | Total | | | | | | | | | | | | |
|------------------------------------|-----------------------------------|--|--|-------------|-----------------|--------------------------------------|---|--|-------------------------------------|---|--|--|---|------------------------------------|-----------------------------------|---|-------|
| 8. | c | <table border="1"> <thead> <tr> <th>competitive</th> <th>non-competitive</th> </tr> </thead> <tbody> <tr> <td>a binds to/blocks <u>active site</u></td> <td>binding away from active site/to allosteric site;</td> </tr> <tr> <td>b inhibitor and substrate are (chemically) similar</td> <td>inhibitor different from substrate;</td> </tr> <tr> <td>c binding of <u>substrate</u> prevented (because active site is occupied)</td> <td>active site changed (by inhibitor binding elsewhere) preventing substrate binding;</td> </tr> <tr> <td>d inhibition reduced by increasing substrate concentration</td> <td>inhibition not affected by increased substrate concentration;</td> </tr> <tr> <td>e useful as pharmaceuticals/toxins</td> <td>useful as end-product inhibitors;</td> </tr> </tbody> </table> | | competitive | non-competitive | a binds to/blocks <u>active site</u> | binding away from active site/to allosteric site; | b inhibitor and substrate are (chemically) similar | inhibitor different from substrate; | c binding of <u>substrate</u> prevented (because active site is occupied) | active site changed (by inhibitor binding elsewhere) preventing substrate binding; | d inhibition reduced by increasing substrate concentration | inhibition not affected by increased substrate concentration; | e useful as pharmaceuticals/toxins | useful as end-product inhibitors; | <p>Accept <i>mpd</i> in a graph.</p> <p>Accept <i>mpa</i>, <i>mpb</i> or <i>mpc</i> on an annotated diagram.</p>  <p>[Source: Enzyme inhibition curves, ImranKhan1992, Available at: https://commons.wikimedia.org/wiki/File:Enzyme_kinetics_curve#/media/File:Enzyme_kinetics_curve.png CC0 1.0 Universal (CC0 1.0) Public Domain Dedication https://creativecommons.org/publicdomain/zero/1.0/deed.en Source adapted.]</p> | 4 max |
| | | competitive | non-competitive | | | | | | | | | | | | | | |
| | | a binds to/blocks <u>active site</u> | binding away from active site/to allosteric site; | | | | | | | | | | | | | | |
| | | b inhibitor and substrate are (chemically) similar | inhibitor different from substrate; | | | | | | | | | | | | | | |
| | | c binding of <u>substrate</u> prevented (because active site is occupied) | active site changed (by inhibitor binding elsewhere) preventing substrate binding; | | | | | | | | | | | | | | |
| | | d inhibition reduced by increasing substrate concentration | inhibition not affected by increased substrate concentration; | | | | | | | | | | | | | | |
| e useful as pharmaceuticals/toxins | useful as end-product inhibitors; | | | | | | | | | | | | | | | | |

References:

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