Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2022

Biology

Higher level

Paper 2

18 pages

Subject Details: Biology HL Paper 2 Markscheme

Candidates are required to answer **all** questions in Section A and **two** out of **three** questions in Section B. Maximum total = **72 marks**.

1. Each row in the "Question" column relates to the smallest subpart of the question.

2. The maximum mark for each question subpart is indicated in the "Total" column.

3. Each marking point in the "Answers" column is shown by means of a semicolon (;) at the end of the marking point.

4. A question subpart may have more marking points than the total allows. This will be indicated by "**max**" written after the mark in the "Total" column. The related rubric, if necessary, will be outlined in the "Notes" column.

5. An alternative word is indicated in the "Answers" column by a slash (*/*). Either word can be accepted.

6. An alternative answer is indicated in the "Answers" column by "***OR***". Either answer can be accepted.

7. An alternative markscheme is indicated in the "Answers" column under heading **ALTERNATIVE 1** *etc*. Either alternative can be accepted.

8. Words inside brackets ( ) in the "Answers" column are not necessary to gain the mark.

9. Words that are <u>underlined</u> are essential for the mark.

10. The order of marking points does not have to be as in the "Answers" column, unless stated otherwise in the "Notes" column.

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 to be 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.

Section A

Question			Answers	Notes	Total
1.	a		loss of water/evaporation through the stomata/leaves;		1
1.	b	i	a. in both groups drought/lack of water causes (significant) increase in water stress index; b. in both groups, with water, water stress index close to values for the control/not significantly different; c. both groups have no changes between weeks 14 and 15 / values remain constant in weeks 14 and 15;	*Only accept similarities;*	2
1.	b	ii	a. (the hypothesis is supported as) more immediate response to drought in post-flowering plants than pre-flowering; b. at week 5 of pre-flowering drought the stress index has only reached 0.15 whereas after two weeks of post-flowering drought it is 0.5 and/or after five weeks it is nearly 0.8 ***OR*** larger/higher/greater level response to drought in post-flowering plants than pre-flowering; c. stress index reaches a maximum of 0.56 pre-flowering but 0.78 post-flowering / much higher at week 15/end of study; d. stress index remains high for post flowering;	*OWTTE* *Accept OWTTE for valid contrasts*	2 max
1.	c		Gram-positive more common in pre-flowering drought while Gram-negative more common in control; Gram-negative e and f never present in (pre-flowering) drought;	*OWTTE*	1

(continued…)

(Question 1 continued)

1.	**d**	**i**	*Similarities*: ***[2 max]*** a. both groups have an increase from week 1 to week 2; b. there is an (overall) decrease (in the relative abundance of Gram-negative) in both after week 2 / lower abundance from weeks 3 to 8; c. both increase (greatly) after week 8/starting from week 9/flowering/end of drought period/with water onwards; d. both have similar abundance after week 8/from week 9/end of drought period onwards; e. both plateau in the last weeks; f. other correct similarity e.g., the overall pattern is similar for both roots and soil over the entire study / overall similar trend; *Difference*: g. the soil has more Gram-negative than the root in the drought period/up to week 8/until flowering / OWTTE;	*For **[3 max]** answer must include a difference (mp g)*	**3 max**
1.	**d**	**ii**	a. Gram-positive are more resistant/better adapted to drought conditions ***OR*** Gram-negative are more resistant/better adapted to conditions with water; b. Gram-positive outcompete the Gram-negative in drought conditions ***OR*** Gram-negative outcompete Gram-positive in conditions with water; c. water allows for greater metabolism/reproduction of Gram-negative;	*Accept vice versa*	**1 max**
1.	**e**	**i**	drought causes a (very large) drop in the fresh mass (compared to controls) / decrease in range of fresh mass;		**1**

(continued…)

(Question 1 continued)

1.	**e**	**ii**	a. in drought condition root, both inoculations have a higher mean of root fresh mass compared to no inoculation; b. in control conditions root, a (slightly) lower mean (of the root mass) in both inoculations compared to no inoculation; c. II/Z has a (slightly) higher mean than I/Y in the drought root; d. Inoculation increases the range of fresh mass values (in both cases) / more in control conditions;	*Award **[2 max]** if **only** similarities or only differences*	**3**
1.	**e**	**iii**	a. Gram-positive bacteria may have a symbiotic/positive relationship with the sorghum; b. Gram-positive bacteria may provide plants with oxygen/more nutrients/change pH; c. Gram-positive bacteria may help to retain/absorb more water;		**1 max**
1.	**e**	**iv**	faster/cheaper to develop to resistance to drought / known way to increase yield during drought;	*OWTTE*	**1**

Question			Answers	Notes	Total
2.	a	i	a. anaphase; b. the (replicated) chromosomes/chromatids are separating/moving to opposite poles of the cell;	*OWTTE*	**2**
2.	a	ii	50 µm = 27/28/29 mm, Y = 8/9/10 mm ***OR*** 50 x 9 /27 ***OR*** 16.7 µm (accept answers in the range of 14.8 µm to 17.2 µm)	*Award **[1]** for correct ratios not precise measurements in the work **or [1]** for correct answer with correct unit*	**1 max**
2.	a	iii	a. (group of regulatory proteins that) control/regulate the cell cycle; b. activate cyclin-dependent kinases (which control cell cycle processes);		**1 max**
2.	b	i	a. prokaryotes (usually) have one chromosome while eukaryotes have numerous chromosomes; b. prokaryotes have a circular chromosome while eukaryotes have linear ones; c. eukaryotes' chromosomes are associated with histones/proteins but prokaryotes/Eubacteria have naked DNA vs eukaryote DNA associated to proteins/histones;	*Accept only differences.* *Differentiating terms expected;*	**2 max**
2.	b	ii	a. Cairns grew prokaryotes/*E. coli* in radioactive thymidine/thymine/thymine containing tritium; b. contents of cell put on photographic film/surface (for several weeks) / used autoradiography and electron microscopes; c. measured the length of the DNA molecule and photographed it / produced image of DNA; d. could show the new strands were all labelled with thymidine/thymine;		**2 max**

Question			Answers	Notes	Total
3.	**a**		there is a positive / negative association between the two species; they tend to grow together / they tend to grow apart;	*OWTTE*	**1**
3.	**b**		a. $\frac{70 \times 55}{150}$; b. 25.7;	*Award **[1]** for proper values chosen/equation **or [1]** for answer*	**1 max**
3.	**c**		1 (df) ***OR*** (r-1) (c-1);		**1**
3.	**d**		a. (when the calculated value is smaller than the critical value) there is no significant association between the two species / H_0/null hypothesis accepted; b. it is random chance if both species are either present or absent in most quadrats;		**1 max**

4.	**a**		pineal gland;	*"Brain" not sufficient*	**1**
4.	**b**		lower in night workers ***OR*** later increase/phase difference/shift in night workers;	*Vice versa*	**1**
4.	**c**		*Time of day:* around 18:00 (locally); ***OR*** time that is in the range of local standard bed time; *Reason:* need to re-establish the increase that occurs after 18:00 hours / reestablish circadian rhythm / OWTTE;	*OWTTE*	**1**

Question			Answers	Notes	Total
5.	**a**	**i**	a unit of DNA wound/coiled around 8 histone proteins / octamer;		**1**
5.	**a**	**ii**	a. hydrogen bonding <u>between</u> nucleotides / bases; b. complementary base pairs; c. adenine-thymine and cytosine-guanine form base pairs (between the two strands with H-bonding); d. 2 bonds between A and T, while 3 bonds between C and G;	*OWTTE* *Full names required for c and d though use ecf*	**2**
5.	**a**	**iii**	a. tandem repeats (at one locus) vary in number of times sequence repeats / represent different alleles for one locus; b. DNA sample cut by restriction enzymes into fragments; c. samples of DNA are amplified at specific genetic sites with PCR; d. the fragments are separated by their size/number of repeats with gel electrophoresis; e. fluorescent/radioactive label attached to different tandem repeats; f. data from several loci at one time uniquely identify individuals / like a fingerprint, combinations of alleles are specific to an individual; g. <u>comparisons/similarities</u> between fragment patterns to determine paternity/evidence match to a suspect's profile / other example of comparison/similarity;	*OWTTE*	**3 max**
5.	**b**	**i**	a. insulin is necessary to control/regulate blood glucose concentrations ***OR*** insulin is necessary for the cells to take up glucose (for energy); b. insufficient insulin is made by the pancreas ***OR*** <u>autoimmune response</u>/<u>antibodies</u> destroy the (β) cells of the pancreas that make insulin; c. reduced uptake of glucose from the blood / glucose accumulates in the blood / elevated blood glucose levels;	*"sugar" is NOT accepted in place of glucose however this should only be penalized once; I.e., utiltize ECF;*	**2 max**
5.	**b**	**ii**	a. inject insulin / monitoring blood glucose / devices that release insulin; b. decrease consumption of sugars/CHO / diet modification; c. increase exercise; d. keep weight in healthy range;		**1 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**		a. (overall) process is translocation / bidirectional / movement from source to sink; b. sugars/sucrose/organic compounds produced in leaves; c. (loaded by) active transport / passage by apoplast route; d. loaded into companion cells / transported in phloem / sieve tubes; e. high concentrations of solutes at the source cause uptake of water (by osmosis); f. water provides hydrostatic pressure for transport (from source to sink); g. unloaded / stored / used at sink; h. lowers pressure at sink / creates pressure differential / water re-entry to xylem;		**4 max**

(continued…)

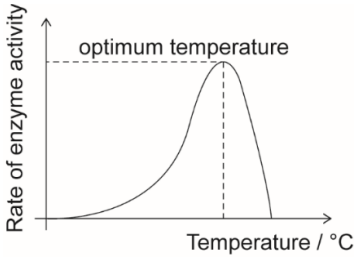
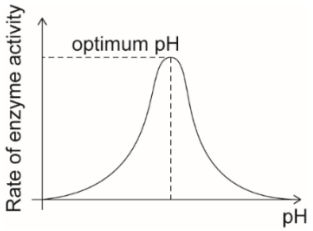
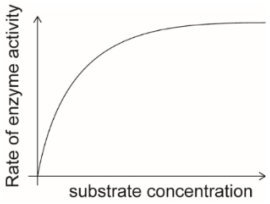
(Question 6 continued)

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>6.</td><td>b</td><td></td><td>
<table>
<tr><th></th><th>Photosynthesis</th><th>Respiration</th></tr>
<tr><td></td><td colspan="2">Similarities</td></tr>
<tr><td>a.</td><td colspan="2">both have membrane-bound organelles adapted to their functions;</td></tr>
<tr><td>b.</td><td colspan="2">both use (excited) electrons transferred between carriers on membranes / both have an ETC;</td></tr>
<tr><td>c.</td><td colspan="2">both generate proton gradients on the membranes by transfer of electrons / both involve chemiosmosis / both use ATP synthase;</td></tr>
<tr><td>d.</td><td colspan="2">(both) generate ATP;</td></tr>
<tr><td></td><td colspan="2">Differences</td></tr>
<tr><td>e.</td><td>solar energy converted to chemical energy</td><td>organic/chemical energy converted to usable energy/ATP;</td></tr>
<tr><td>f.</td><td>occurs in chloroplast / stroma site of light-independent reaction</td><td>occurs in mitochondrion / matrix site of glycolysis;</td></tr>
<tr><td>g.</td><td>(excited electrons) reduce NADP</td><td>(excited electrons) reduce NAD / FAD;</td></tr>
<tr><td>h.</td><td><u>fix</u> CO_2 / product is carbohydrates / carboxylation</td><td>produce/release CO_2 / break down of carbohydrates/pyruvate / carbohydrate is a reactant / decarboxylation;</td></tr>
<tr><td>i.</td><td>O_2 is produced/released / photolysis of water</td><td>O_2 is used / final electron acceptor in ETC;</td></tr>
</table>
</td><td></td><td>7 max</td></tr>
</table>

(continued…)

(Question 6 continued)

6.	**c**		a. salivary amylase breaks down starch in the mouth ***OR*** pancreatic amylase breaks down starch in small intestine; b. product is disaccharides / maltose; c. <u>maltase</u> digest disaccharides into monosaccharides / glucose / simple sugars; d. <u>monosaccharides</u>/<u>glucose</u> absorbed in the small intestine; e. villi increase the surface area of the intestinal epithelium for greater absorption; f. (monosaccharides are) absorbed by co-transport/active transport (into intestinal cell) / absorbed by facilitated diffusion into blood (from intestinal cell);	*Do not accept glucose or sugars for mpb*	**4 max**

Question			Answers	Notes	Total
7.	a		a. enzymes have active sites that bind specific substrates; b. act as catalysts to speed up reactions ***OR*** lower activation energy; c. rate/activity increases with temperature; d. up to an optimum temperature; e. sharp decline in activity above (optimum temperature); (*Graph has to be clearly asymmetrical for mpe*) (*Graph shown would earn mpc, mpd and mpe*)  ; f. rate/activity declines at a pH above and below the optimum pH (*Graph shown would earn mpf*)  ; g. rate/activity increases sharply as substrate concentration goes up; h. above a certain concentration, the rate reaches a maximum/plateau; (*Graph shown would earn mpg and mph*)  ; i. competitive inhibitor present, as substrate concentration increases, enzyme requires higher concentration to achieve maximum rate / graph showing this with and without inhibitor; j. non-competitive inhibitor present, as substrate concentration rises, enzyme activity is lower at all substrate concentrations / graph showing shape with and without inhibitor;	*Award **[3 max]** if there are no graphs.* *For each graph, axes must be correctly labelled, the shape must be correctly drawn* *Marks can be awarded to a correctly annotated graph*	**5 max**

(continued…)

(Question 7 continued)

Question			Answers	Notes	Total
7.	**b**		a. Helicase separates/unwinds DNA from double helix; b. (DNA) gyrase / topoisomerase releases tension/strain (caused by super coiling); c. (DNA) primase builds/forms/adds an RNA primer; d. DNA polymerase I is a (5' → 3') exonuclease/removes RNA primers/replacement of RNA by DNA; e. DNA polymerase III synthesizes DNA (5' → 3') on leading/lagging strands/forms bonds between DNA nucleotides; f. (DNA) ligase connects/seals nick between Okazaki fragments to make continuous DNA strand;	*Only mark the first three answers in sequence* *DNA polymerase I required for mpd and DNA polymerase III required for mpe (i.e., the numbers are required).*	**3 max**

(continued…)

(Question 7 continued)

7.	**c**		a. Species is a group of organisms that interbreeds (normally in the wild) and produce fertile offspring; b. within an interbreeding population there is variety / variation exists; c. some adaptations favour survival to reproductive age /survival of the fittest / natural selection; d. alleles for these adaptations become more frequent/are inherited in the population /change with time; e. speciation is the formation of new species; f. (speciation) occurs because populations have become reproductively isolated / no longer able to interbreed / exposed to different selection pressures; g. behavioural isolation involves differences in courtship or mating behaviours; h. temporal isolation involves differences in the timing of courtship or mating behaviours; i. geographical isolation / allopatric refers to the physical barriers that exist that keep two populations from mating; j. polyploidy can lead to reproductive isolation; k. stabilizing selection is when the two extremes of a trait have lower reproductive fitness (OWTTE) / favours average phenotype; l. directional selection is when one extreme of the trait has lower reproductive fitness (OWTTE); m. disruptive/diversifying selection favours both extreme phenotypes / intermediate phenotype has lower fitness;	*OWTTE*	**7 max**

Question			Answers	Notes	Total
8.	a		a. simple/passive diffusion down a concentration gradient / from high concentration to low concentration (without the use of channels/proteins); (*e.g., CO_2 / O_2 / H_2O / steroid hormones*) b. osmosis is the diffusion of water from an area of high water potential / low solute concentration to low water potential / high solute concentration; c. facilitated diffusion is passive transport/diffusion through a protein channel; (*e.g.*, *glucose*) d. active transport requires energy/ATP to move the molecules through a protein channel (*e.g., Na-K pump / sodium potassium pump*) against a concentration gradient/from low solute concentration to high concentration; e. endocytosis is the infolding of membranes to form a vesicle and take in a large molecule; (*e.g., macrophages engulfing pathogens*) f. exocytosis is the fusion of vesicles with membranes to release a large molecule; (*e.g. neurotransmitters*)		**4 max**
8.	b		a. humans are osmoregulators/maintain the internal concentrations of the blood/osmolarity within specific/ limited range / OWTTE; b. glomerulus / Bowman's capsule **(**in the nephron**)** carry out ultrafiltration; c. proximal convoluted tubule selectively reabsorbs glucose/solute/salts/amino acids; d. loop of Henle maintains hypertonic conditions in the medulla/absorbs salts (by active transport); e. loop of Henle reabsorbs water (by osmosis); f. (osmoreceptors in the hypothalamus) cause production of ADH if the blood is too concentrated / person is dehydrated / OWTTE; g. ADH causes more uptake of water/increases permeability in the collecting duct; h. resulting in a more concentrated urine / lower volume of urine; I. excess amino acids are broken down producing nitrogenous waste / ammonia / urea as a result; j. ammonia is toxic and is converted into non-toxic urea; k. urea is eliminated in the urine;	*Marks can be awarded to clearly annotated diagrams.*	**7 max**

(continued…)

(Question 8 continued)

Question			Answers	Notes	Total
8.	**c**		a. behavioural adaptations to avoid over-heating / hiding in burrows/out of sun during hot period of day / active at cooler times of the day/nocturnal animals / panting; b. adaptations for heat exchange such as large ears; c. may have longer loop of Henle (to reabsorb more water); d. may produce more ADH (according to osmotic concentrations of the blood) / produce concentrated urine / lower volume of urine; e. camel humps that store fat that releases (metabolic) water when broken down; f. reduced sweat; g. any other valid adaptation; (e.g., light coloured coats)		**4 max**