

Markscheme

November 2024

Biology

Higher level

Paper 2

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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 = **80 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 underlined 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.
11. If the candidate’s answer has the same “meaning” or can be clearly interpreted as being of equivalent significance, detail and validity as that in the “Answers” column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by **OWTTE** (or words to that effect) in the “Notes” column.
12. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
13. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script.
14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to 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.
- It is important to judge this on the overall answer, taking into account the answers to all parts of the question. Although, the part with the largest number of marks is likely to provide the most evidence.
- ◆ 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	65/66/67(%) and OP-367;		1
1.	b	a. higher survival of poplar than pine/willow / less effect (of contaminants) on poplar; b. similar survival/mortality in pine and willow; c. poplar 15-29 has highest survival (in 2012); d. results for 2010 and 2012 are similar (though poplar clone 49-177 differs more between 2010 and 2012);	<i>Accept lower mortality instead of higher survival and higher mortality instead of lower survival.</i>	2 max
1.	c	negative correlation / as fuel concentration increases rate of transpiration decreases;		1
1.	d	a. both have low/reduced transpiration at 500 µl or higher (at 48/72 hours) OR both have lowest transpiration/greatest decrease at 1000 µl (at 48/72 hours); b. with 200 µl willow transpiration is increased/maximal but poplar is decreased OR at 24 hours/initially willow transpiration is increased but poplar decreased (at all concentrations) OR transpiration always lower than control in poplar but sometimes higher in willow;	<i>mpa is for a similarity and mpb is for a difference.</i>	2 max
1.	e	a. (roots need oxygen) for <u>aerobic</u> respiration/for energy supply/for ATP production; b. less anaerobic respiration / less production of (toxic) ethanol/alcohol; c. increase in bacteria/decomposers that can metabolize contaminants;		1 max
1.	f	-99.6% / -99.56%;		1

(continued...)

(Question 1 continued)

Question		Answers	Notes	Total
1.	g	<p>TPH because the (absolute) decrease (in mass) is greater (than BTEX)</p> <p>OR</p> <p>TPH because it decreases by 5170 (µg) whereas BTEX decreases by 402 (µg)</p> <p>OR</p> <p>BTEX because the <u>percentage decrease</u> (in mass) is greater (than TPH)</p> <p>OR</p> <p>BTEX because % decrease (in mass) is 87.6% whereas with TPH it is 27.6%;</p>		1
1.	h	<p>to show dioxane did not reduce/was not broken down spontaneously</p> <p>OR</p> <p>to show that plants/roots absorb dioxane;</p>		1
1.	i	<p>a. roots of immersed cuttings absorbed dioxane;</p> <p>b. dioxane evaporated/volatilized/lost from leaves/stomata of immersed cuttings;</p> <p>c. no/less transpiration by cuttings without leaves;</p> <p>d. less water absorbed by cuttings without leaves;</p> <p>e. less xylem flow/water transport up the stem/transpiration stream/transpiration pull without leaves;</p> <p>f. without leaves there is no/less photosynthesis/less energy for dioxane uptake/life processes;</p>		2 max

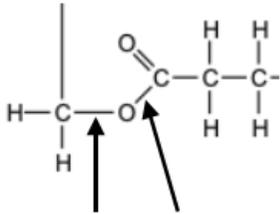
(continued...)

(Question 1 continued)

Question		Answers	Notes	Total
1.	j	<p>a. (1st study shows) some trees/pines/willows are killed by contaminants/are not useful for phytoremediation;</p> <p>b. (2nd study shows) transpiration (can be) affected/increased/decreased by petroleum fuel/contaminants;</p> <p>c. (3rd study shows) trees removed TPH/BTEX/hydrocarbons/petrochemicals/petroleum/petroleum fuel (from contaminated soil);</p> <p>d. (4th study shows) roots (of poplars) absorb dioxane;</p> <p>e. (4th study shows) leaves/transpiration needed for dioxane uptake;</p> <p>f. (4th study shows) leaves (can) release dioxane/petrochemicals into the air (polluting it);</p>		3 max

Question		Answers	Notes	Total
2.	a	50 000 OR answers between 40 000 and 60 000 with correct working;		1
2.	b	vesicle / secretory granule / zymogen granule / lysosome;		1
2.	c	rough endoplasmic reticulum / rER / RER / ribosomes (attached to ER);		1
2.	d	exocytosis;		1
2.	e	insulin from the beta/ β -cells OR glucagon from the alpha/ α -cells;		1

Question			Answers	Notes	Total															
3.	a	i	<p>a. non-disjunction</p> <p>OR</p> <p>failure to separate of chromosome 18 / <u>homologous</u> chromosomes / bivalents;</p> <p>b. both chromosomes move to the same pole/same cell in anaphase 1 of meiosis;</p> <p>c. failure of sister <u>chromatids</u> to separate in <u>meiosis 2/anaphase 2</u>;</p> <p>d. extra chromosome in/error in meiosis (during production of) <u>egg/sperm/gamete</u>;</p> <p>e. spindle fibres attach incorrectly to chromosomes;</p>		2 max															
3.	a	ii	<p>(gamete/embryo/foetus) dies/cannot survive/is non-viable due to overexpression of a gene/too many alleles for a trait/overproduction of a protein</p> <p>OR</p> <p>chromosomes 1/2/3 contain <u>many</u> genes/<u>more</u> genes (than smaller chromosomes);</p>		1															
3.	b	i	<p>1 mark for gametes shown in the Punnett grid below;</p> <p>1 mark for genotypes based on the gametes shown in the answer even if incorrect;</p> <table border="1" data-bbox="315 935 974 1201"> <tr> <td></td> <td>Ad</td> <td>ad</td> </tr> <tr> <td>AD</td> <td>AADd</td> <td>AaDd</td> </tr> </table>		Ad	ad	AD	AADd	AaDd	<p><i>Allow a 4x4 grid with the gametes from the Aadd parent repeated.</i></p>	2									
	Ad	ad																		
AD	AADd	AaDd																		
Ad	AAdd	Aadd																		
aD	AaDd	aaDd																		
ad	Aadd	aadd																		
3.	b	ii	<p>phenotypes are green, blue, yellow and white;</p> <p>ratio is 3 : 3 : 1 : 1</p> <p>OR</p> <p>ratio is 6 : 6 : 2 : 2;</p>		2															

Question		Answers	Notes	Total
4.	a	glycerol and fatty acids;	<i>Both required.</i>	1
4.	b	any of the 3 O-C bonds or C-O bonds; 		1
4.	c	Krebs cycle / TCA cycle / tricarboxylic acid cycle / citric acid cycle;		1
4.	d	a. energy released by oxidation reactions; b. more carbon/hydrogen (per gram) in triglycerides (than glucose) OR more C-C/C-H bonds (per gram) in triglycerides (than glucose); c. triglycerides in less oxidized/more reduced state / have less oxygen (per gram than glucose); d. more acetyl CoA formed (per gram) from triglycerides (than glucose) OR more NADH ₂ /reduced NAD (per gram) from triglycerides (than glucose);	<i>Allow vice versa in mpb to mpd.</i>	2 max
4.	e	a. saturated fatty acids / saturated fat / saturated triglyceride; b. CHD/(coronary) heart disease / heart attacks / cardiovascular disease / arteriosclerosis/atherosclerosis/hardening of the arteries/atheroma/plaque in the arteries /hypertension/high blood pressure; c. (high levels of saturated fat) in the diet associated with high blood cholesterol/LDL;		2 max

Question			Answers	Notes	Total
5.	a		X: triose phosphate / glyceraldehyde 3-phosphate / phosphoglyceraldehyde; Y: ribulose bisphosphate / RuBP;		2
5.	b	i	sucrose;		1
5.	b	ii	a. transport/translocation in <u>phloem sieve tubes</u> ; b. (sucrose) loaded using <u>active transport</u> / proton gradient / co-transport; c. companion cells provide ATP/energy; d. high solute concentration/low water potential causes water uptake (by osmosis); e. raised (hydrostatic) pressure causes flow (from leaves/to roots);		3 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	<table border="1"> <thead> <tr> <th>competitive</th> <th>non-competitive</th> </tr> </thead> <tbody> <tr> <td>a. binds at active site</td> <td>binds at another/allosteric site</td> </tr> <tr> <td>b. shape/(chemical) structure similar to substrate</td> <td>shape/(chemical) structure dissimilar</td> </tr> <tr> <td>c. active site blocked for substrate</td> <td>active site changed so substrate cannot bind</td> </tr> <tr> <td>d. high/increase in substrate concentration reduces/overcomes inhibition/maximum rate reached /does not alter V_{max}</td> <td>high/increase in substrate concentration does not affect inhibition/maximum rate not reached / reduces V_{max}</td> </tr> <tr> <td>e. (does not control metabolic pathways/act as end-product inhibitor)</td> <td>can control metabolic pathways/act as end-product inhibitor</td> </tr> </tbody> </table>	competitive	non-competitive	a. binds at active site	binds at another/allosteric site	b. shape/(chemical) structure similar to substrate	shape/(chemical) structure dissimilar	c. active site blocked for substrate	active site changed so substrate cannot bind	d. high/increase in substrate concentration reduces/overcomes inhibition/maximum rate reached /does not alter V_{max}	high/increase in substrate concentration does not affect inhibition/maximum rate not reached / reduces V_{max}	e. (does not control metabolic pathways/act as end-product inhibitor)	can control metabolic pathways/act as end-product inhibitor	<p><i>Each of the mark points can be awarded as long as the features of both competitive and non-competitive inhibition are included somewhere in the answer – they do not have to be in the same sentence or paragraph.</i></p> <p><i>Accept answers shown using annotated diagram or a graph (for the effect of substrate concentration).</i></p>	4 max
competitive	non-competitive															
a. binds at active site	binds at another/allosteric site															
b. shape/(chemical) structure similar to substrate	shape/(chemical) structure dissimilar															
c. active site blocked for substrate	active site changed so substrate cannot bind															
d. high/increase in substrate concentration reduces/overcomes inhibition/maximum rate reached /does not alter V_{max}	high/increase in substrate concentration does not affect inhibition/maximum rate not reached / reduces V_{max}															
e. (does not control metabolic pathways/act as end-product inhibitor)	can control metabolic pathways/act as end-product inhibitor															

(continued...)

(Question 6 continued)

Question		Answers	Notes	Total
6.	b	<p><i>Process [3 max]:</i></p> <p>a. undifferentiated tissue / meristematic tissue / tissue from the shoot apex/tip;</p> <p>b. use of aseptic techniques/grow on <u>sterile</u> (nutrient) agar/sterilization of plant tissue;</p> <p>c. hormones/auxin/cytokinin added to stimulate growth/differentiation;</p> <p><i>Benefits [3 max]:</i></p> <p>d. faster method of asexual reproduction/cloning/producing genetically identical plants (than traditional methods) / uses less space / bulk production;</p> <p>e. (generates) virus free strains (of existing varieties);</p> <p>f. propagation of (large numbers of) (endangered) orchids/rare species/(high yielding) oil palms;</p>		4 max

(continued...)

(Question 6 continued)

Question		Answers	Notes	Total
6.	c	<ul style="list-style-type: none"> a. increase caused (mostly) by <u>human activities/anthropogenic</u>; b. carbon dioxide increasing in atmosphere due to fossil fuel combustion/deforestation /other verifiable human factors/actions; c. carbon dioxide in the atmosphere absorbs reflected infrared/long wave rays from the earth / enhanced greenhouse effect; d. raises global temperatures / global warming; e. oceans absorb heat / ocean temperature increases; f. sea levels rise / polar ice melts reducing habitat / warming causes coral bleaching; g. changes in ocean currents / changes in climate/weather patterns; h. carbon dioxide dissolves in ocean / diffuses from atmosphere/air into oceans; i. (dissolved) carbon dioxide is a (weak) acid / pH of ocean decreases / acidity increases; j. carbonate ions in water decrease / (calcium) carbonate becomes less available; k. corals/shellfish cannot build skeletons; l. other species become invasive / biodiversity/ecosystems/populations (of fish/algae) may be reduced/increased/changed / food chains/webs may be altered / species could die/become extinct/be displaced from their habitat / habitats of species are changed / other verifiable effects on marine organisms; 		7 max

Question		Answers	Notes	Total
7.	a	<p>a. mRNA attaches to a ribosome OR translation is initiated by assembly of ribosome, mRNA and tRNA;</p> <p>b. translation happens by a repeated cycle of events OR ribosome moves along mRNA;</p> <p>c. <u>tRNA</u> carrying an amino acid binds to ribosome / to A/P site (of ribosome);</p> <p>d. <u>anticodon</u> on tRNA binds <u>codon</u> on mRNA;</p> <p>e. <u>complementary base pairing</u> links anticodon to codon/ensures the amino acid corresponds to the codon OR base sequence determines amino acid sequence due to <u>complementary base pairing</u>;</p> <p>f. <u>peptide bond</u> links amino acid (on tRNA) to the peptide chain already assembled OR <u>peptide bond</u> links amino acids (attached to tRNAs) on the P and A sites;</p> <p>g. polypeptide released from ribosome when stop codon is reached;</p>		4 max
7.	b	<p>a. amino acid sequence of the protein from each organism is compared;</p> <p>b. changes in (base/amino acid) sequence accumulate over time;</p> <p>c. due to mutation;</p> <p>d. positive correlation between number of (base/amino acid) differences between (two) species and time they diverged from a common ancestor OR fewer the (base/amino acid) differences, the less time since diverged from a common ancestor / more closely related;</p> <p>e. cladograms illustrate probable sequence of divergence/evolutionary origins;</p> <p>f. accumulation of mutations can be used as a molecular clock/allows time since evolutionary divergence to be estimated;</p>		4 max

(continued...)

(Question 7 continued)

Question		Answers	Notes	Total
7.	c	<p>a. <u>actin</u> and <u>myosin</u> are <u>protein filaments</u>;</p> <p>b. actin/myosin/protein (filaments) form sarcomeres (in muscle myofibrils);</p> <p>c. actin (filaments) are thin and myosin (filaments) are thick;</p> <p>d. actin attached to Z lines / diagram showing overlapping actin and myosin in a sarcomere;</p> <p>e. actin has myosin binding sites;</p> <p>f. (protein) tropomyosin blocks myosin binding sites on actin (in relaxed muscle);</p> <p>g. calcium released (from sarcoplasmic reticulum) when depolarisation/action potential arrives;</p> <p>h. calcium (ions) bind to (protein) troponin;</p> <p>i. troponin causes removal of (protein) tropomyosin from binding sites;</p> <p>j. myosin heads attach to/form cross-bridges with (next binding site on) actin;</p> <p>k. ATP activates/cocks/changes angle of/provides energy for detaching <u>myosin heads</u>;</p> <p>l. heads tilt to move actin towards centre of sarcomere / filaments slide over each other;</p> <p>m. (muscle) contraction due to shortening of sarcomere/more overlapping of actin and myosin;</p>	<p><i>Allow points made using annotated diagrams.</i></p>	<p>7 max</p>

Question		Answers	Notes	Total
8.	a	<p>a. phototropism is a growth response to direction of light/differences in light intensity OR (positive) phototropism is growth towards the light (source);</p> <p>b. auxin is produced in the shoot (apical) meristem OR auxin promotes cell/stem growth/elongation;</p> <p>c. auxin (efflux) pumps set up a concentration gradient;</p> <p>d. auxin is transported to the shaded side (of the stem)/side with lower light intensity;</p> <p>e. (auxin) changes transcription/gene expression (in stem cells);</p> <p>f. (auxin) causes more growth/elongation on the shaded part of the stem/shoot tip/meristem;</p> <p>g. stem/shoot (tip)/coleoptile/plant bends towards the light;</p>	<p><i>Allow points made using annotated diagrams.</i></p>	4 max
8.	b	<p>a. FSH promotes estrogen secretion (by the follicle) OR FSH promotes follicle development and follicles secrete estrogen;</p> <p>b. (high levels of) estrogen inhibits FSH secretion (by the pituitary gland);</p> <p>c. (high levels at ovulation of) estrogen promotes LH secretion (by pituitary gland);</p> <p>d. LH promotes progesterone secretion (by the corpus luteum) OR LH induces corpus luteum development and the corpus luteum secretes progesterone;</p> <p>e. (high levels of) progesterone inhibits LH/FSH secretion (by the pituitary gland);</p> <p>f. progesterone secretion decreases due to reduced LH/FSH (concentration);</p> <p>g. FSH secretion increases due to reduced progesterone (concentration) OR decrease in progesterone restarts the cycle;</p>		4 max

(Question 8 continued)

8.	c	<p>a. loop of Henle creates high solute concentration/hypertonic conditions <u>in medulla</u>;</p> <p>b. active transport/pumping of Na⁺/sodium ions (from filtrate) in ascending limb;</p> <p>c. descending limb permeable to water but not Na⁺/ sodium/salt/mineral (ions)</p> <p>OR</p> <p>water passes from filtrate to medulla in descending limb;</p> <p>d. filtrate entering distal convoluted tubule is hypotonic (to blood);</p> <p>e. raised osmolarity/blood solute concentration detected by hypothalamus;</p> <p>f. pituitary secretes ADH (in response to hypertonic blood);</p> <p>g. (ADH) transported in blood to (DCT and) collecting ducts;</p> <p>h. (ADH) causes collecting duct walls to become more permeable to water</p> <p>OR</p> <p>(ADH) causes more water reabsorption from filtrate in collecting duct;</p> <p>i. more aquaporins in (plasma membranes of cells in the) collecting duct (wall);</p> <p>j. reabsorption by <u>osmosis</u> due to the hypertonic medulla;</p> <p>k. small volume of/concentrated urine produced;</p> <p>l. less/no ADH produced with low blood concentration so water retained/dilute urine produced;</p>		7 max
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