

Markscheme

May 2025

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. A markscheme often has more marking points than the total allows. This is intentional.
2. Each marking point has a separate line and the end is shown by means of a semicolon (;).
3. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.
4. An alternative answer is indicated by “**OR**”. Either answer can be accepted.
5. An alternative markscheme is indicated under heading **ALTERNATIVE 1** etc. Either alternative can be accepted.
6. Words in brackets () in the markscheme are not necessary to gain the mark.
7. Words that are underlined are essential for the mark.
8. The order of marking points does not have to be as in the markscheme, unless stated otherwise.
9. 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 markscheme 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).
10. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
11. 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.
12. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

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	235 / 235.0 / 235.00 (g);		1
1.	b	i	negative correlation / inverse relationship / higher expression (of WIF1) with lower wool production / higher wool production with lower expression (of WIF1);	1
1.	b	ii	<p>a. there could be a causal relationship because there is a (negative) correlation / OWTTE;</p> <p>b. correlation does not prove/show causation;</p> <p>c. no mechanism shown for/no explanation of (how expression of WIF1 affects hair growth);</p> <p>d. wool growth may be affected by other factors/(expression of) other genes;</p> <p>e. data is only for two levels of wool production/intermediate values not shown;</p> <p>f. not an experiment/variables not manipulated experimentally/OWTTE (so causal relationship not shown);</p>	<p><i>Do not award marks for answers that state unequivocally that there is a causal relationship.</i></p> <p>2 max</p>
1.	c	pcDNA / (control is the) plasmid/DNA without the WIF1 gene;		1
1.	d	<p>a. no significant effect on EGF expression OR (small) increase in (mean) EGF expression but error bars overlap/difference is not statistically significant/is not within 0.01 confidence/99% confidence;</p> <p>b. SFR2 (expression) is increased/promoted (by pcDNA-WIF1);</p> <p>c. CCND1 (expression) is decreased/inhibited (by pcDNA-WIF1);</p>		3

Question		Answers	Notes	Total
1.	e	<p>a. apoptosis is increased by pcDNA-WIF1 / by WIF1;</p> <p>b. proliferation is decreased by pcDNA-WIF1 / by WIF1;</p> <p>c. increased apoptosis/decreased proliferation of (dermal papilla) cells decreases wool/hair growth;</p> <p>d. protein produced by expressing WIF1 affects/promotes/inhibits expression of other genes;</p> <p>e. (increased) expression of SFRP2 could cause apoptosis/prevent proliferation;</p> <p>f. expression of CCND1 could prevent apoptosis/cause proliferation</p> <p>OR</p> <p>reduced expression of CCND1 (caused by WIF1) could allow apoptosis/reduce proliferation;</p>	<p><i>Accept the converse in a. and b. (effects on apoptosis or cell proliferation of absence of WIF1)</i></p> <p><i>Accept the converse in e. and f. (effects on apoptosis or cell proliferation of non-expression of SFRP2 and CCND1)</i></p>	4 max

Question			Answers	Notes	Total
2.	a	i	a. sweating/sweat secretion; b. vasodilation / skin arterioles widen / increased blood flow to skin; c. shunt vessels in the skin close;	<i>b. Do not accept 'blood vessels widen' unless the answer indicates that more blood will flow to the skin.</i>	1 max
2.	a	ii	a. negative (feedback) because temperature/body heat is reduced (followed the increase); b. negative (feedback) because body temperature returns (to normal/to the original level); c. negative (feedback) because sweating/response stops (after enough cooling); d. negative (feedback) because every change is followed by the opposite change;		1 max
2.	b		a. CO ₂ is released/is a greenhouse gas; b. long wave radiation/heat/infrared (emitted by the Earth) trapped/absorbed by CO ₂ ; c. (so) heat retained in atmosphere;	<i>Do not award a mark for 'Earth's temperature is increased' as this is in the question.</i> <i>b. Do not accept 'reflected back' instead of trapped or absorbed and do not accept absorption of any type of radiation from the sun.</i> <i>The word 'heat' can be used for both marking points b. and c. but in b. the idea is heat retained by CO₂ the whereas the idea in c. is heat retention in the atmosphere.</i>	2 max
2.	c		a. positive feedback because warming causes melting of polar ice; b. positive feedback because less ice means less sunlight is reflected (lower albedo); c. positive feedback because more heat is absorbed by the Earth's surface which becomes warmer;		1 max

Question		Answers	Notes	Total
3.	a	DNA / deoxyribonucleic acid / deoxyribo(nucleic acid) /deoxyribose (nucleic acid);		1
3.	b	replication because the base shown (on the new strand) is T/thymine / is not U/uracil;		1
3.	c	cytosine / C;		1
3.	d	5' (terminal);		1
3.	e	i	covalent/phosphodiester;	1
3	e	ii	a. (DNA) <u>polymerase</u> adds nucleotides (to the template strand) / makes a new strand (of nucleotides) OR <u>DNA polymerase III</u> (adds nucleotides) with complementary bases/ makes base pairs; b. DNA polymerase I removes the RNA primer replacing it with DNA; c. (DNA) ligase joins Okazaki/DNA fragments / seals gaps between fragments;	2 max

Question		Answers	Notes	Total
4.	a	increases/higher (volume of air inhaled/exhaled per minute);		1
4.	b	by chemoreceptors OR in the brainstem / medulla (oblongata) / carotid artery / aorta;		1
4.	c	a. changes/increases/decreases in carbon dioxide concentration/level; b. (increases in) carbon dioxide reduce pH/converse; c. carbon dioxide produced by (aerobic cell) respiration; d. removal of carbon dioxide from the blood in the lungs / by ventilation / by exhalation/expiration; e. dissociation of carbonic acid / hydrogen ions from carbonic acid / H_2CO_3 to $HCO_3^- + H^+$; f. lactic acid produced by anaerobic respiration / lactic acid reduces blood pH;		2 max
4.	d	diaphragm; <u>external</u> intercostal muscles;		2

Question			Answers	Notes	Total
5.	a		population;		1
5.	b		a. competition for/taking/blocking/limiting access to light/sun; b. competition for/taking/limiting supplies of water/nutrients (from the soil); c. allelopathy/release of toxins;		2 max
5.	c	i	mutualism;		1
5.	c	ii	herbivory / heterotrophic nutrition / (primary) consumer;		1

Question		Answers	Notes	Total
6.	a	<p><i>Upper epidermis:</i> allows light to pass through / (has waxy cuticle which) prevents water loss / protects;</p> <p><i>Palisade mesophyll:</i> photosynthesis / synthesis of carbon compounds / absorption of light;</p>		2
6.	b	<p>a. spongy mesophyll provides a large/moist/permeable surface area (for gas exchange);</p> <p>b. guard cells form pores/stomata (through the epidermis) / open and close stomata OR stomata are pores (through the epidermis that) allow CO₂/O₂/gases to enter/exit the leaf/to pass through the epidermis;</p> <p>c. (air) spaces for diffusion/movement/transfer of gases (to/from spongy mesophyll cells and stomata);</p>		2 max
6.	c	<p><i>Xylem:</i> transports water (to the leaf);</p> <p><i>Phloem:</i> transports sugars/sucrose/products of photosynthesis out of the leaf/to sinks/to where it is needed;</p>		2

Question		Answers	Notes	Total
7.	a	<p>a. root is the (last/initial) common ancestor of all the organisms / earliest ancestor (in the cladogram);</p> <p>b. node represents the most recent common ancestor (of two species/two clades)</p> <p>OR</p> <p>node is a branching point indicating that a group of organisms are related</p> <p>OR</p> <p>node is a point where species/clades branch off;</p>	<p><i>a. It must be clear that all of the organisms/clades in the cladogram came / evolved /descended from the root.</i></p>	2
7.	b	<p>a. mutations change base sequence of DNA;</p> <p>b. changes to DNA/base sequence cause changes to amino acid sequence;</p> <p>c. sequence differences accumulate (gradually/slowly) over time;</p> <p>d. species with more differences in amino acid sequences diverged longer ago / fewer differences means more recent divergence from a common ancestor;</p> <p>e. more objective than using morphology/physical traits / <i>OWTTE</i>;</p> <p>f. species with similar amino acid sequences are more closely related;</p>		3 max
7.	c	<p>a. base sequence of genes / DNA (base) sequences</p> <p>OR</p> <p>base sequence of rRNA</p> <p>OR</p> <p>comparing karyotypes;</p> <p>b. morphological/physical/anatomical/homologous traits/characteristics / specific example of morphology/homology that could be used;</p>		1 max

Question		Answers	Notes	Total
7.	d	a. choose the simplest explanation for observations; b. choose the cladogram that requires the smallest number of sequence/genetic/ trait changes/fewest mutations;		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
8.	a	<p>a. meiosis halves the chromosome number / allows production of haploid gametes/cells;</p> <p>b. fusion of gametes/fertilization doubles (the chromosome number) / $n + n = 2$;</p> <p>c. meiosis prevents chromosome number doubling/conserves the chromosome number (between generations);</p> <p>d. fusion of gametes brings together genes/alleles/chromosomes from two parents;</p> <p>e. meiosis breaks up combinations of alleles/genes / segregation of alleles</p> <p>OR</p> <p>meiosis generates variation by independent assortment/crossing over;</p> <p>f. fusion of gametes/fertilization/meiosis produces variation needed for natural selection/evolution/resilience/survivability/<i>OWTTE</i>;</p>		4 max

Question		Answers	Notes	Total
8.	b	<p>a. DNA replication / DNA is duplicated/copied; b. during S-phase of interphase OR DNA polymerase replicates/makes new DNA strands; c. each chromosome with two identical/sister chromatids/DNA molecules after replication/at start of mitosis; d. cell cycle controlled by cyclins / checkpoints with control by cyclins; e. chromosomes/chromatids/DNA condenses/coils/supercoils (at the start of mitosis/in prophase); f. microtubules/spindle attaches to the kinetochores/centromeres (in metaphase) OR in metaphase chromosomes are lined up/aligned on equator; g. kinetochores shorten/remove tubulin from (spindle) microtubules; h. cohesin molecules (binding sister chromatids together) break OR centromeres divide; i. (sister) chromatids/chromosomes) pulled to (opposite) poles/ends/sides (in anaphase); j. nuclear membranes reform (in telophase); k. cytokinesis (at the end of mitosis); l. (mitosis/cell division/cytokinesis) produces two (daughter) cells with the same chromosome number as the original cell/maintains diploid chromosome number;</p>		7 max

Question		Answers	Notes	Total
9.	a	<p>a. (membranes divide the cell into) <u>organelles</u>;</p> <p>b. nucleus/chloroplast/mitochondrion is double membraned/has inner and outer membrane;</p> <p>c. enzymes/substrates can be concentrated (in the small volume);</p> <p>d. different/incompatible functions/processes in different organelles (so harm prevented);</p> <p>e. hydrolytic/digestive enzymes held inside lysosomes/phagocytic vacuoles;</p> <p>f. pH/conditions can be for optimized for (each) function/process;</p> <p>g. small spaces/volumes for proton gradient/concentration gradient (to develop quickly);</p> <p>h. (post- transcriptional) modification of mRNA in nucleus (before it reaches the ribosome);</p> <p>i. vesicles for transport/transfers;</p> <p>j. nuclear membrane/envelope protects DNA/chromosomes (from the cytoplasm);</p>	<p><i>Do not award marks describing the functions of the plasma membrane.</i></p>	<p>4 max</p>
9.	b	<p>a. diffusion/facilitated diffusion is passive movement/does not require ATP;</p> <p>b. diffusion/facilitated diffusion is movement from a higher to lower concentration;</p> <p>c. <u>simple diffusion</u> does not require channels/(membrane) proteins / is movement between phospholipid molecules;</p> <p>d. small/hydrophobic substances/oxygen/CO₂ pass across the membrane by simple diffusion;</p> <p>e. <u>facilitated diffusion</u> is movement through/assisted by channel proteins;</p> <p>f. (facilitated) diffusion/diffusion through channel proteins for polar molecules/ions/charged particles;</p> <p>g. <u>voltage-gating</u> allows channels to open and close / <u>voltage-gated</u> Na⁺/K⁺ channels;</p> <p>h. <u>aquaporins</u> for osmosis/water movement/diffusion of water across the membrane;</p> <p>i. <u>active transport</u> is movement across the membrane using ATP/energy;</p> <p>j. active transport by protein pumps (in the membrane) / active transport by Na⁺/K⁺ pump;</p> <p>k. active transport is (usually) movement (from lower) to higher concentration;</p> <p>l. endocytosis/phagocytosis takes materials in and exocytosis removes materials from the cell;</p> <p>m. formation of vesicles/vacuoles to take materials into the cell (by endocytosis);</p> <p>n. fusion of vesicles/vacuoles with plasma membrane to release materials (by exocytosis);</p>		<p>7 max</p>

Question		Answers	Notes	Total
9.	c	a. depolarization is due to movement/diffusion of sodium <u>ions</u> into the axon; b. by facilitated diffusion/through sodium channels (that have opened); c. repolarization is due to movement/diffusion of potassium (ions) out of axon; d. by facilitated diffusion/through potassium channels (that have opened); e. sodium/potassium channels are voltage-gated; f. <u>sodium-potassium pumps</u> generate concentration gradients/resting potential/higher sodium outside and higher potassium inside; g. <u>phospholipid bilayer</u> is impermeable to ions/allows concentration gradients of ions to be established;		4 max

Question		Answers	Notes	Total
10	a	a. used as a source/(temporary) store of energy / is the energy currency of the cell; b. releases energy when converted to ADP/when a phosphate is removed; c. amount of energy released can be used/sufficient for (many metabolic) tasks; d. active transport/another valid example; e. ATP to ADP conversion is reversible / ATP can be regenerated from ADP; f. can be produced in different ways/using energy from different sources/by aerobic or anaerobic respiration; g. stable within cell so does not release energy prematurely/before needed; h. small molecule/soluble so can move easily/quickly (through the cell); i. cannot diffuse through membranes so is not lost from cell/to the environment;	h. <i>The idea of ATP being small/soluble must be there along with its moveability.</i>	3 max

Question		Answers	Notes	Total
10.	b	<p>a. ATP produced by photosynthesis/in chloroplasts OR photosynthesis occurs in the chloroplast / photosynthesis produces glucose;</p> <p>b. ATP synthase/electron carriers/proton pumps/photosystems/pigments in the thylakoid membrane OR ATP synthase/electron carriers/proton pumps the inner mitochondrial membrane/cristae;</p> <p>c. chlorophyll/pigments absorb light;</p> <p>d. in photosystems/Photosystem I/Photosystem II/antenna complexes;</p> <p>e. electrons (in chlorophyll/pigments) raised to higher energy levels/become excited;</p> <p>f. (excited) electrons passed between carriers/along the electron transport chain;</p> <p>g. energy from electrons used (by carriers) to pump protons/H⁺ ions;</p> <p>h. from the stroma to the thylakoid space;</p> <p>i. proton gradient generated/high concentration of protons generated in the thylakoid space/lumen;</p> <p>j. protons flow back (to stroma) through ATP synthase;</p> <p>k. ADP phosphorylated / ADP and phosphate converted to ATP / ATP made by phosphorylating ADP;</p> <p>l. cyclic (photophosphorylation) only uses PS1 but non-cyclic uses both/PS1 and PS2;</p> <p>m. water is split (by photolysis) to replace electrons lost (by photosystem);</p>		7 max

Question		Answers	Notes	Total
10.	c	<p><i>Similarities</i></p> <p>a. (all heterotrophs) use foods/carbon compounds/other organisms as their energy source/to use for ATP production;</p> <p>b. (all heterotrophs) get energy/carbon compounds/organic compounds/glucose/carbohydrate/lipids/fats from other organisms;</p> <p><i>Differences</i></p> <p>c. saprotrophs/decomposers feed on dead organic matter;</p> <p>d. saprotrophs/decomposers secrete digestive enzymes into the food source / digest externally;</p> <p>e. consumers feed on living organisms/other organisms;</p> <p>f. primary consumers feed on plants/other example of feeding relationships in a food chain;</p> <p>g. detritivores ingest detritus/<i>OWTTE</i>;</p> <p>h. digestion of food so compounds can be absorbed;</p> <p>i. internal digestion in holozoic animals/detritivores;</p> <p>j. energy from carbon compounds used to produce ATP by cell respiration;</p>		<p>5 max</p>