Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2025

Biology

Higher level

Paper 2

23 pages

The following are the annotations available to use when marking responses.

Annotation	Explanation	Shortcut
	Correct point (automatically awards 1 mark when stamped)	
	These are annotations which can be used to show which marking point was used to award a mark. It is easier to use these than to pick up the tick stamp and then the text box (they each automatically award 1 mark when stamped)	
	Quality marks awarded for clarity and structure (these each automatically award 1 mark when stamped)	
	Pointer (use when you want to delete an annotation or change colour)	
	Benefit of the doubt	
	Error carried forward	
	Irrelevant, a significant amount of material that does not answer the question	
	Contradiction	
	Omission/incomplete	
	Too vague	
	No working shown	
	Unclear	

Annotation	Explanation	Shortcut
	This is a dynamic annotation; it can be used to surround work	
	This is a dynamic, vertical wavy line that can be expanded (for instance, to highlight a section of irrelevant work)	
	This is a dynamic, horizontal wavy line that can be expanded (for instance, to highlight a section of irrelevant work)	
	Valid part (to be used when more than one element is required to gain the mark eg: drawings)	
	Same as	
	Or words to that effect	
	Advantage / pro (to identify elements in an unclear discussion when pairs are required)	
	Disadvantage / con (to identify elements in an unclear discussion when pairs are required)	
	Difference (to identify elements in an unclear comparison)	
	Similarity (to identify elements in an unclear comparison)	
	Highlight, stamp and drag out to highlight an area of the script	
	Text box used for additional marking comments. It can be linked to a specific tick if that is appropriate	
	Seen; to be stamped on parts of a question or option which have been left blank	
0	Zero; to be used when a question part is not worthy of credit. Awards zero for the question part	

You **must** make sure you have looked at all pages. Please put the  annotation on any blank page, to indicate that you have seen it.

General Marking Instructions

Assistant Examiners (AEs) will be contacted by their team leader (TL) through RM™ Assessor, by e-mail or telephone – if through RM™ Assessor or by e-mail, please reply to confirm that you have downloaded the markscheme from IBIS. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the markscheme and its interpretation. AEs should contact their team leader through RM™ Assessor or by e-mail at any time if they have any problems/queries regarding marking. For any queries regarding the use of RM™ Assessor, please contact emarking@ibo.org.

1. Follow the markscheme provided, award only whole marks and mark only in **RED**.

2. Make sure that the question you are about to mark is highlighted in the mark panel on the right-hand side of the screen.

3. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded**. Please use lettered ticks (e.g. ✓a) where appropriate to indicate which marking point is awarded.

4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases, use RM™ Assessor annotations to support your decision. You are encouraged to write comments where it helps clarity, especially for re-marking purposes. Use a text box for these additional comments. It should be remembered that the script may be returned to the candidate.

5. Personal codes/notations are unacceptable.

6. Where an answer to a part question is worth no marks but the candidate has attempted the part question, use the “ZERO” annotation to award zero marks. Where a candidate has not attempted the part question, use the “SEEN” annotation to show you have looked at the question. RM™ Assessor will apply “NR” once you click complete.

7. If a candidate has attempted more than the required number of questions within a paper or section of a paper, mark all the answers. RM™ Assessor will only award the highest mark or marks in line with the rubric.

8. Ensure that you have viewed **every** page including any additional sheets. Please ensure that you stamp “SEEN” on any additional pages that are blank or where the candidate has crossed out his/her work.

9. Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have got wrong. However, a mark should not be awarded where there is contradiction within an answer. Make a comment to this effect using a text box or the “CON” stamp.

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 WIFI);	*Do not award a mark for 'negative relationship' or 'inversely proportional' unless the answer also states that wool production increases as WIFI expression decreases.* *Answers stating higher expression with lower wool production can be accepted but do not award a mark for answers stating that lower wool production causes/results in/leads to higher WIFI expression, even if the answer includes 'negative correlation' or 'inverse relationship'.*	**1**
1.	**b**	**ii**	a. there could be a causal relationship because there is a (negative) correlation / *OWTTE*; b. correlation does not prove/show causation; c. no mechanism shown for/no explanation of (how expression of WIF1 affects hair growth); d. wool growth may be affected by other factors/(expression of) other genes; e. data is only for two levels of wool production/intermediate values not shown; f. not an experiment/variables not manipulated experimentally/*OWTTE* (so causal relationship not shown);	*Do not award marks for answers that state unequivocally that there is a causal relationship.* *a. Allow converse answers such as 'Though there is a negative correlation there may not be a causal relationship.'*	**2 max**
1.	**c**		pcDNA / (control is the) plasmid/DNA without the WIFI gene;		**1**
1.	**d**		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; b. SFR2 (expression) is increased/promoted (by pcDNA-WIF1); c. CCND1 (expression) is decreased/inhibited (by pcDNA-WIF1);		**3**

Question			Answers	Notes	Total
1.	**e**		a. apoptosis is increased by pcDNA-WIF1 / by WIF1; b. proliferation is decreased by pcDNA-WIF1 / by WIF1; c. increased apoptosis/decreased proliferation of (dermal papilla) cells decreases wool/hair growth; d. protein produced by expressing WIF1 affects/promotes/inhibits expression of other genes; e. (increased) expression of SFRP2 could cause apoptosis/prevent proliferation; f. expression of CCND1 could prevent apoptosis/cause proliferation ***OR*** reduced expression of CCND1 (caused by WIFI) could allow apoptosis/reduce proliferation;	*Accept the converse in a. and b. (effects on apoptosis or cell proliferation of absence of WIFI)* *Accept the converse in e. and f. (effects on apoptosis or cell proliferation of non-expression of SFRP2 and CCND1)*	**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;	*b. Do not accept 'blood vessels widen' unless the answer indicates that more blood will flow to the skin.*	**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;	*Do not award a mark for 'Earth's temperature is increased' as this is in the question.* *b. Do not accept 'reflected back' instead of trapped or absorbed and do not accept absorption of any type of radiation from the sun.* *The word 'heat' can be used for both marking points b. and c., but in b. the idea is heat retention by CO_2 whereas the idea in c. is heat retention in the atmosphere.*	**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);	*Accept misspellings such as deoxyribosenucleic as long as the answer is unambiguously referring to DNA.*	**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);	*Do not award a mark for phosphate terminal.*	**1**
3.	**e**	**i**	covalent/phosphodiester;	*Do not accept sugar-phosphate bond.*	**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;	*Accept 'RNA polymerase adds nucleotides/makes a new strand for mpa'.* *Do not award a mark for helicase or other enzymes not included in the mark scheme.*	**2 max**

Question			Answers	Notes	Total
4.	a		increases/higher (volume of air inhaled/exhaled per minute);	*Do not accept 'negative correlation'*	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;	*c. Do not award if the answer refers to anaerobic respiration.*	2 max
4.	d		diaphragm; <u>external</u> intercostal muscles;	*Mark only the first two muscles in responses where more than two muscles are given. Follow this rule even if both internal intercostal and external intercostal muscles are among the answers given.* *Accept misspellings of diaphragm, for example diaphram, if they are unambiguous.*	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;	*Do not award a mark for competition for space.*	**2 max**
5.	**c**	**i**	mutualism / mutualistic / mutually beneficial;	*Do not award a mark for answers that state only 'symbiosis' or 'symbiotic'*	**1**
5.	**c**	**ii**	herbivory / heterotrophic nutrition / (primary) consumer;	*Do not allow predation or parasitism or feeding.*	**1**

Question			Answers	Notes	Total
6.	a		*Upper epidermis:* allows light to pass through / (has waxy cuticle which) prevents water loss / protects; *Palisade mesophyll:* photosynthesis / synthesis of carbon compounds / absorption of light;	*The response must make it clear which function is being assigned to which tissue and not assign functions to both tissues.*	**2**
6.	b		a. spongy mesophyll provides a large/moist/permeable surface area (for gas exchange); b. guard cells form pores/stomata (through the epidermis) / open and close stomata ***OR*** stomata are pores (through the epidermis that) allow CO_2/O_2/gases to enter/exit the leaf/to pass through the epidermis; c. (air) spaces for diffusion/movement/transfer of gases (to/from spongy mesophyll cells and stomata);	*Remember that the term gas exchange is in the question, so for marking point b. 'stomata/guard cells for gas exchange' is not sufficient.* *Do not award marks for statements about transpiration/water movement as this is not gas exchange.*	**2 max**
6.	c		*Xylem:* transports water (to the leaf); *Phloem:* transports sugars/sucrose/products of photosynthesis out of the leaf/to sinks/to where it is needed;	*Do not award the mark for phloem transport if the term 'nutrients' is used instead of* sug*ars/sucrose/products of photosynthesis, or if there is no indication of destination or indication of 'out of leaf'.*	**2**

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

Question			Answers	Notes	Total
8.	**a**		a. meiosis halves the chromosome number / allows production of haploid gametes/cells; b. fusion of gametes/fertilization doubles (the chromosome number) / n + n = 2; c. meiosis prevents chromosome number doubling/conserves the chromosome number (between generations); d. fusion of gametes brings together genes/alleles/chromosomes from two parents; e. meiosis breaks up combinations of alleles/genes / segregation of alleles ***OR*** meiosis generates variation by independent assortment/crossing over; f. fusion of gametes/fertilization/meiosis produces variation needed for natural selection/evolution/resilience/survivability/*OWTTE*;		**4 max**

Question			Answers	Notes	Total
8.	**b**		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;		**7 max**

Question			Answers	Notes	Total
8.	**c**		a. courtship/sexual behaviour prevents interbreeding/hybridization ***OR*** species do not usually mate with other species; b. temporal isolation (in reproduction)/mating season differences prevent interbreeding/hybridization; c. geographical/physical isolation/separation may prevent interbreeding/hybridization; d. differences in reproductive anatomy can prevent interbreeding/hybridization / example of this; e. (interspecific) hybrids are (usually) sterile/infertile/cannot produce (viable) offspring; f. meiosis fails (in interspecific hybrids); g. differences in chromosome number/structure; h. so chromosomes cannot pair/are not homologous/bivalents not formed; i. polyploidy is doubling of chromosome number/having more sets of chromosomes (than normal); j. sterile interspecific hybrids can become fertile if the chromosome number is doubled/by polyploidy; k. tetraploids produce diploid gametes; l. new species can be formed by polyploidy in interspecific hybrids;	*a. For the second alternative, do not accept interbreeding instead of mating.* *i. Do not award for answers describing aneuploidy or non-disjunction of individual bivalents.*	**4 max**

Question			Answers	Notes	Total
9.	a		a. (membranes divide the cell into) <u>organelles</u>; b. nucleus/chloroplast/mitochondrion is double membraned/has inner and outer membrane; c. enzymes/substrates can be concentrated (in the small volume); d. different/incompatible functions/processes in different organelles (so harm prevented); e. hydrolytic/digestive enzymes held inside lysosomes/phagocytic vacuoles; f. pH/conditions can be for optimized for (each) function/process; g. small spaces/volumes for proton gradient/concentration gradient (to develop quickly); h. (post- transcriptional) modification of mRNA in nucleus (before it reaches the ribosome); i. vesicles for transport/transfers; j. nuclear membrane/envelope protects DNA/chromosomes (from the cytoplasm);	*Do not award marks describing the functions of the plasma membrane.*	**4 max**
9.	b		a. diffusion/facilitated diffusion is passive movement/does not require ATP; b. diffusion/facilitated diffusion is movement from a higher to lower concentration; c. <u>simple diffusion</u> does not require channels/(membrane) proteins / is movement between phospholipid molecules; d. small/hydrophobic substances/oxygen/CO_2 pass across the membrane by simple diffusion; e. f<u>acilitated diffusion</u> is movement through/assisted by channel proteins; f. (facilitated) diffusion/diffusion through channel proteins for polar molecules/ions/charged particles; g. <u>voltage-gating</u> allows channels to open and close / <u>voltage-gated</u> Na^+/K^+ channels; h. <u>aquaporins</u> for osmosis/water movement/diffusion of water across the membrane; i. <u>active transport</u> is movement across the membrane using ATP/energy; j. active transport by protein pumps (in the membrane) / active transport by Na^+/K^+ pump; k. active transport is (usually) movement (from lower) to higher concentration; l. endocytosis/phagocytosis takes materials in and exocytosis removes materials from the cell; m. formation of vesicles/vacuoles to take materials into the cell (by endocytosis); n. fusion of vesicles/vacuoles with plasma membrane to release materials (by exocytosis);	*h. is the only mark relating to osmosis.* *k. Do not accept 'across the concentration gradient' or 'along the concentration gradient' instead of up/against the concentration gradient or from low to high concentration.*	**7 max**

Question			Answers	Notes	Total
9.	c		a. depolarization is due to movement/diffusion of sodium ions 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. sodium-potassium pumps generate concentration gradients/resting potential/higher sodium outside and higher potassium inside; g. phospholipid bilayer is impermeable to ions/allows concentration gradients of ions to be established;	*With marking point a. and c. penalise once only if:* ** the terms depolarization and repolarization are used the wrong way round* ** if the direction of diffusion of sodium and potassium ions is reversed* ** if the ions are the wrong way round (sodium movement for repolarization and potassium for depolarization* ** if the answer states that the ions are pumped (rather than diffusing)* *But if two of these errors are made, do not award marking point a. or c.*	**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;	*Do not allow 'used to distribute energy in cells' for marking point a. as this is part of the question.* *h. The idea of ATP being small/soluble must be there along with its moveability.*	**3 max**

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

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