8825 – 6021M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2025

Biology

Higher level

Paper 2

28 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 = **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 of construction

- 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**		2016;		**1**
1.	**b**		*Similarities* a. the numbers fluctuate/vary for each species from year to year; b. both ended with a higher number of nests compared to the initial value/first year of survey; *Differences* **2 max** c. every year there are more loggerhead nests than green turtle nests; d. the (overall) trend for green turtles is an increase and for loggerhead turtles (a relatively) constant number of nests (with a dip in the middle years)/ small fluctuations/changes over the years ***OR*** green turtles had a greater increase (in number of nests) during the survey than loggerhead turtles; e. green turtles tend to come ashore (roughly) every other year to nest but no trend for loggerhead turtles ***OR*** in some years / named years there were no nests at all for green turtles only;	*Comparative terms are expected. Do not award points for just stating values.*	**3 max**

Question			Answers	Notes	Total
1.	c		a. (may be inaccurate as) it does not include male turtles; b. (young or old) turtles which are not nesting are not counted / not all turtles are at reproductive age; c. no information is provided about how often they nest / criteria for selecting beaches; d. not all nests are counted/found/identified; e. unknown number of eggs / neonatal mortality / not all newborn turtles survive / make it to the ocean;	*Do not award a marking point for vague statements such as turtles at sea not being counted.*	**2 max**
1.	d		*Chelonia mydas*/Green;		**1**
1.	e		a. occupy different habitats / live in different areas / different migration patterns ***OR*** swim/forage at different depths; b. some samples are small, so not representative ***OR*** the larger the population may lead to more chances of VSI;		**1 max**
1.	f.		as (mean annual) number of vessels increase (the proportion of stranded sea turtles with a) VSI increase / positive correlation;	*Do not accept "directly proportional" or "positive relationship"*	**1**

Question			Answers	Notes	Total
1.	**g**		a. too many turtles with VSI for (low) number of vessels; b. too few vessels for the (high) number of turtles with VSI;	*Do not accept outlier on its own or just values. Clear indication to relationship between vessels and turtles with VSI required.*	**1 max**
1.	**h**		a. (evidence shows that) increased number of vessels increases turtle injuries; b. no evidence that VSI results in death / vessel injuries (VSI) may not result in death; c. no information is given about other reasons turtles die (in Florida) / causes of death; d. no information provided on total number / percentage of deaths; e. evidence from the table shows that vessel injury accounts for damage to less than half/50% of (stranded) turtles ***OR*** evidence from the table shows that vessel injury accounts for maximum 34.4% (of stranded turtles);	*For c. do not accept that other factors ARE the main cause of death (no evidence for this). Stranded includes dead, sick or injured.* *For e. (first strand) allow any value between 50% and 34.4%.*	**3 max**

Question			Answers	Notes	Total
2.	**a**		a. skin; b. mucous membranes; c. acidic/low pH of gastric juice/stomach/ lysozymes / mucus / cilia in respiratory tract;	*Accept first two answers only.*	**2 max**
2.	**b**		a. rapid rate of mutation; b. in RNA viruses / retroviruses enzymes (RNA replicase/polymerases/reverse transcriptase) do not proofread or correct errors (unlike DNA polymerase); c. exchange of genetic material with each other (in the same generation)/ recombination and horizontal gene transfer; d. viruses have short generation times / high reproduction rates / reproduce/replicate fast; e. transmission of viruses between species can lead to new strains;		**2 max**

Question			Answers	Notes	Total
3.	**a**		a. saltatory conduction / nerve/electric impulse/action potential “jumps” from node (of Ranvier) to node (of Ranvier); b. myelin is an insulating material / does not allow ion exchange ***OR*** ion exchange / action potential only occurs at the nodes of Ranvier ***OR*** ion pumps/channels/Na^+ and K^+ channels clustered/more abundant/higher in numbers at nodes of Ranvier;		**2**
3.	**b**		a. both involve transport of particles down/along a concentration gradient ***OR*** both are passive / do not require energy/ATP; b. facilitated diffusion requires membrane proteins/channel proteins whereas simple diffusion does not ***OR*** facilitated diffusion moves hydrophilic/polar particles/ions/large molecules, whereas simple diffusion moves hydrophobic/non-polar particles/small molecules;	*OWTTE* *For b. allow correct reference to gated ion channels.*	**2**

Question			Answers	*Notes*	Total
3.	**c**		a. prevent synaptic transmission; b. neonicotinoids act like / have similar structure to acetylcholine; c. neonicotinoids bind to acetylcholine receptors (in the post-synaptic membrane / in cholinergic synapses / between motor neuron and muscles); d. neonicotinoids are not broken down by acetylcholinesterase/enzymes; e. binding is irreversible ***OR*** receptors are blocked; f. the receptors are overstimulated ***OR*** acetylcholine cannot bind; g. paralyses/kills the insect;	*For c. accept ACh abbreviation.*	**3 max**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>4.</td><td>a</td><td></td><td>a. (when cell is placed in a hypotonic solution) surrounding/outside (of the root hair cell) is more dilute / has higher water potential
OR
water will enter the root hair cell
OR
water moves from high water potential to low water potential;
b. (positive) pressure potential will increase / become more positive;
c. (negative) solute/osmotic potential will increase / become less negative;
d. water potential inside the cell will increase / become less negative;
e. $\Psi_w = \Psi_s + \Psi_p$;
f. when cell’s water potential equals that of the solution, (net) water movement stops;</td><td>For e. allow word equation:
Ψ_w = water potential
Ψ_s = solute potential
Ψ_p = pressure potential</td><td>3 max</td></tr>
<tr><td>4.</td><td>b</td><td>i</td><td>a. uptake of mineral ions into root;
b. root cells transport mineral ions into the xylem;
c. requires active transport/ATP;
d. water enters the xylem by osmosis (due to hypertonic/higher solute concentration in xylem sap);
e. creates a pressure which pushes water up (the xylem / the stem / against gravity);</td><td>Do not accept “capillary action” or answers referring to “transpiration”</td><td>2 max</td></tr>
<tr><td>4.</td><td>b</td><td>ii</td><td><table><tr><th>Hormone</th><th>Site of production</th></tr><tr><td>Auxin</td><td>Shoot (tip)</td></tr><tr><td>Cytokinin</td><td>Root (tip)</td></tr></table></td><td>Award 1 mark per row.
If 0 marks awarded, allow 1 mark if both hormones are named.</td><td>2</td></tr>
</table>

Question			Answers	Notes	Total
5.	**a**		a. diaphragm flattens ***OR*** volume inside the thorax/chest increases; b. pressure inside the thorax/chest/lungs decreases (below atmospheric pressure); c. air enters lungs to equalise the pressure ***OR*** air enters lungs moving from high to low pressure;	*For c. do not accept just "air enters the lungs" without an explanation.*	**2 max**
5.	**b**		(external) intercostal (muscles);	*Do not accept "internal" intercostal muscles. If the answer refers to both "internal and external" intercostal muscles (without any clarification on the role of each), then it is considered a contradiction, award no marking point.*	**1**

Question			Answers	Notes	Total
5.	**c**		a. moistens the inside wall/surface of the alveoli (for gas exchange); b. reduces surface tension (inside alveoli); c. prevents (alveoli) walls/surfaces sticking together ***OR*** helps to prevent collapse of the lungs; d. enhances (alveolar) expansion of lungs ***OR*** allows the inflation of lungs after birth;	*For c. (second strand) accept alveoli.*	**2 max**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>6.</td><td>a</td><td></td><td>a. correct genotypes of parents shown = BbGg and bbgg;
b. correct gametes and genotypes of offspring (BbGg + Bbgg + bbGg + bbgg);

<table><tr><td></td><td>BG</td><td>Bg</td><td>bG</td><td>bg</td></tr><tr><td>bg</td><td>BbGg</td><td>Bbgg</td><td>bbGg</td><td>bbgg</td></tr></table>
c. correct phenotypes - broad, green (leaves): broad, yellow (leaves): narrow, green (leaves): narrow, yellow (leaves);</td><td>For a. and b. do not accept other letters to represent alleles. Allow use of other letters as ECF for c. only.

Accept other types of diagrams.

For c. phenotype must match genotype of the offspring.</td><td>3</td></tr>
<tr><td>6.</td><td>b</td><td></td><td>a. genes for leaf symmetry and colour are linked / on same chromosome / on chromosome 4;
b. alleles of these genes fail to assort independently / L and G / l and g inherited together;
c. low probability of recombinants being formed;
d. recombinants can only occur through <u>crossing over;</u></td><td>For b. OWTTE.</td><td>2 max</td></tr>
</table>

Question			Answers	Notes	Total
7.	**a**		a. X is more closely related to *M. luminyensis;* b. smaller number of nodes/closer node between two clades/ species ***OR*** more recent common ancestor (with *M. luminyensis*) / common ancestor between X and *E. faecalis* is more distant (than with *M. luminyensis)* ***OR*** X and *E. faecalis* belong to different clades / X and *M. luminyensis* belong to the same clade;	*For b. OWTTE.* *For b. accept 'branching point' for node.*	**2**
7.	**b**	**i**	a. has a disproportionate/large effect (on the community); b. they maintain/regulate populations of other species ***OR*** they maintain species diversity/biodiversity ***OR*** the removal of the keystone species decreases species diversity/biodiversity of the ecosystem; c. the removal of the keystone species can lead to collapse of the ecosystem;	*Do not accept examples.*	**2 max**

Question			Answers	Notes	Total
7.	**b**	**ii**	a. climax community occurs after succession has ended / the gut community has all its characteristics/stabilized / a stable/persistent ecosystem has been reached; b. antibiotics stop division/kill some <u>species</u> of gut bacteria ***OR*** antibiotics can kill beneficial as well as harmful bacteria ***OR*** antibiotics reduce bacterial population sizes; c. antibiotics decrease biodiversity/species richness; d. competition occurs to establish a new climax community; e. variation in antibiotic resistance among (gut) bacteria / some species may develop tolerance/resistance to the antibiotic;	*For b. do not award points for simple statements of antibiotics killing bacteria.* *For e. do not accept "immunity".*	**2 max**
7.	**c**		bacteria reproduce asexually/by binary fission ***OR*** (different species of) bacteria can exchange genetic material by horizontal gene transfer ***OR*** genes can be transferred from one species to another;	*Accept bacteria do not reproduce sexually or do not interbreed.*	**1**

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**		a. monosaccharides/disaccharides/sugars are soluble (in water/blood/plasma/sap) ***OR*** monosaccaharides/disaccharides/sugars can be transported (in blood/plasma/sap); b. glucose is used for (aerobic) respiration ***OR*** glucose releases/yields energy during respiration/when oxidized; c. can be polymerized / form polymers/macromolecules/long chains by <u>condensation</u>; d. starch/glycogen is a polymer containing/is made of many (alpha) glucose (molecules); e. starch consists of amylose and amylopectin ***OR*** amylose is unbranched / amylopectin is branched / glycogen is (more) branched; f. glycogen/starch (is branched so) can be hydrolyzed to release (alpha) glucose quickly/easily/when needed; g. starch/glycogen are used as energy stores; **Marking point for 8a continued on next page…**	*For a. accept named sugars* *For b. accept other sugars.* *For d. accept α.* *For g. energy is required.*	**7 max**

8a continued..

8.	**a**		h. (coiling of starch) makes it compact so that lots of (alpha) glucose can be stored in a small volume; i. starch/glycogen are insoluble (due to large molecular size) so do not affect the water/solute/pressure potential inside a cell ***OR*** glucose would cause osmotic problems if stored in cells; j. cellulose is a (beta) glucose polymer / is made of many (beta) glucose (molecules); k. cellulose consists of alternating orientation of (beta) glucose monomers / the glucose subunits in the chain face alternately upwards and downwards; l. (different) cellulose chains are crosslinked (by hydrogen bonds) to form bundles; m. cellulose has a structural role / supports / forms the cell wall (in plants); n. cellulose is insoluble / has high tensile strength / prevents plant cells from bursting (when water enters by osmosis);	*For h. accept references to 'area,' 'space' or 'density'.* *For j. accept β.* *For k. accept drawings.* *For l. accept 'microfibrils'.*	

Question			Answers	Notes	Total
8.	**b**		a. movement of cells/chromosomes **and** example of movement; b. movement of flagellum/cilium; c. endocytosis/exocytosis; d. detachment of myosin heads from actin filaments / myosin heads change their angle/become cocked; e. active transport **and** example of use of active transport; f. anabolic reactions / polymerization example / example of synthesizing macromolecules; g. generation of heat **and** to provide optimum temperature for enzyme activity / in homeostasis / to maintain body temperature; h. phosphorylation of substrates in glycolysis; i. phosphorylation of substrates in photosynthesis light-independent reaction/Calvin cycle;	*For a. accept descriptions of cells (e.g. amoeboid phagocyte moving to site of infection) or chromosomes (e.g. anaphase, chromosomes moving to opposite poles).* *For d. ignore 'muscle contraction'.* *For e. E.g. sodium-potassium pump (in neurons) / maintaining resting potential in neurons / generation of root pressure / villus epithelial cells / selective reabsorption in kidney.* *For e. do not accept transport of large molecules as example.* *For f. accept examples such as DNA replication / transcription / translation / and other examples of formation of macromolecules.* *For h. accept phosphorylation of glucose (to glucose-6-phosphate) or phosphorylation of fructose–6-phosphate (to fructose 1,6-biphosphate).* *For i. accept formation of triose phosphate and formation of ribulose bisphosphate (regeneration of RuBP).*	**5 max**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>8.</td><td>c</td><td></td><td>
<table>
<tr><th></th><th>Reduced hydrogen carriers in AEROBIC RESPIRATION</th><th>Reduced hydrogen carriers in PHOTOSYNTHESIS</th></tr>
<tr><td>a.</td><td>found in cytoplasm/mitochondria</td><td>found in chloroplasts;</td></tr>
<tr><td>b.</td><td>reduced NAD/NADH involved</td><td>reduced NADP/NADPH involved;</td></tr>
<tr><td>c.</td><td>made in glycolysis/ link reaction/Krebs cycle</td><td>made in light dependent reactions/ (non-cyclic) photophosphorylation;</td></tr>
<tr><td>d.</td><td>required for oxidative phosphorylation</td><td>required for light-independent reactions/Calvin cycle;</td></tr>
</table>
</td><td>Accept NAD⁺ and NADP⁺
For c. accept PSI / PSII / ETC / chemiosmosis for photophosphorylation in photosynthesis.
For d. accept ETC / chemiosmosis or oxidative phosphorylation in aerobic respiration
For d. accept named stages of the Calvin cycle
A table is not required. Accept separate paragraphs about respiration and photosynthesis as long as both parts of the marking point are stated.</td><td>3 max</td></tr>
</table>

Question			Answers	Notes	Total
9.	**a**		a. signalling chemicals/ligands bind to receptors; b. reference to specificity / the shape (and chemical properties) of the ligand-binding site match those of the ligand; c. receptors can be in (either) the plasma membrane / intracellular / in the cytoplasm / or nucleus ***OR*** ligand can bind to transmembrane receptors/receptors in the plasma membrane or intracellular receptors; d. only cells with a receptor to a signalling chemical will respond; e. reference to signal transduction (initiated by signalling chemical-receptor binding); f. example of signalling chemical;	*Do not accept the role of glycoproteins in cell-cell recognition or ABO glycoproteins.* *For b: do not accept "complementary" as this is part of the stem question.* *For e. OWTTE* *For e. the reference may include the pathway followed by a given example of a signalling chemical.* *Appropriate example for (f):* • *Neurotransmitters/named neurotransmitter* • *any named hormone* • *Cytokine* • *Calcium ions*	**4 max**

Question			Answers	Notes	Total
9.	b		a. enzymes are globular proteins with an active site (for catalysis); b. substrates must bind to the active site to be catalysed; c. description of induced fit mechanism / substrate can cause active site to change shape; d. conformational changes/changes in tertiary structure do not allow substrate to bind to active site / enzyme is denatured; e. denaturation decreases enzyme activity / enzymes no longer work; f. high temperatures/temperatures above the optimum break bonds in the enzymes / cause conformational changes to active site / denature enzymes; g. below the optimum temperature enzymes may be inhibited ***OR*** increased temperature increases kinetic energy, increasing enzyme activity (because of more collisions) up to optimum temperature; h. (changes in) pH cause changes in charges /alteration of (ionic/ H) bonds (between amino acids) / affect shape of active site / the enzyme becomes denatured (at higher or lower pH values than the optimum) i. <u>non-competitive inhibitors</u> bind to an allosteric site; j. (non-competitive inhibitors) cause disruption of hydrogen/ionic/disulfide/hydrophobic interactions; **Marking point for 9b continued on next page…**	*Ignore references to substrate concentration* *Ignore references to competitive inhibitors* *For h. do not accept that the enzyme is inhibited because of pH different from optimum.*	**7 max**

9b continued…

9.	**b**		k. (non-competitive inhibitors) cause conformational change of the enzyme / changes in the active site of the enzyme; l. (non-competitive inhibitors) decrease rate of enzyme-substrate complex formation / substrate can no longer bind to the active site / decrease enzyme activity;		

Question			Answers	Notes	Total
9.	**c**		a. haemoglobin transports oxygen by binding to it in the lungs and releasing it in tissues that require oxygen ***OR*** association/loading of oxygen to haemoglobin happens in the lungs ***OR*** dissociation/unloading of oxygen from haemoglobin occurs at cells that require oxygen/respiring tissues; b. each haemoglobin molecule can carry four oxygen molecules ***OR*** reference to cooperative binding / the binding of one oxygen molecule to a haemoglobin (subunit) increases the affinity of the other subunits for oxygen/makes it easier for the other oxygen molecules to bind; c. at low partial pressures of oxygen/when oxygen concentration is low, hemoglobin has a low affinity for oxygen ***OR*** at high partial pressures of oxygen/when oxygen concentration is high, oxygen has a high affinity for haemoglobin / (readily) binds to haemoglobin; d. (at low partial pressures of oxygen/ when oxygen concentration is low) this enables oxygen to dissociate/diffuse more readily at/into respiring tissues; e. provides more oxygen for aerobic respiration in the tissues; **Marking point for 9c continued on next page…**	*For a. accept OWTTE.* *For c. and g. Can be answered using a dissociation curve graph with labelled axes and annotations referring to the marking points c. and g.* *Ignore references to foetal haemoglobin (question requires adult only)*	**4 max**

9c continued…

9.	**c**		f. carbon dioxide from respiring tissues binds to haemoglobin; g. low pH / high concentration of carbon dioxide/carbonic acid causes Bohr shift / shift of curve to the right ***OR*** low pH / high concentration of carbon dioxide/carbonic acid promotes the release of oxygen from haemoglobin (to tissues); h. Bohr shift reduces the affinity of haemoglobin for oxygen ***OR*** Bohr shift results in oxygen unloading/diffusing easier to respiring tissues;		

Question			Answers	Notes	Total
10.	**a**		*Structure* a. RNA is single-stranded; b. polymer/chain of (RNA) nucleotides; c. (ribonucleotides) contain <u>ribose</u> **and** phosphate **and** base/named bases; d. sugar phosphate bonds / phosphodiester bonds (between sugar/ribose and phosphate) ***OR*** backbone made of alternating phosphate and ribose/sugar; *Evidence* e. (RNA) can be replicated; f. (RNA) has some catalytic activity (so it may have acted initially as both the genetic material and the enzymes of the earliest cells); g. ribozymes/rRNA in the ribosome (are still used to) catalyse peptide bond formation / involved in protein synthesis ***OR*** ribosomes contain rRNA/ribozymes with catalytic/enzymatic function h. some viruses contain RNA (supports the idea that RNA could have been used before genes made of DNA evolved);	*Allow a labelled drawing for the structure marking points (base must be attached to C1 and phosphate to C5).* *For c. do not allow "sugar" instead or ribose.*	**5 max**

Question			Answers	Notes	Total
10.	**b**		a. DNA can be amplified (for analysis) by PCR; b. to select endangered/evolutionary distinct species for conservation/EDGE of Existence programme; c. use of barcodes/environmental DNA allows to investigate/monitor biodiversity of habitats rapidly / to identify species; d. genetic profiling of species for identification; e. example of identification purpose / importance of identification: tracking populations / rewilding of native species / captive breeding / detecting invasive species / combating illegal wildlife trade/poaching / assess richness of a habitat / identify new species / track endangered species / cloning; f. seed / tissue banks for long term storage of living material / maintain viability of seeds for long periods / propagation in the future / reintroducing species / preserve genetic material of endangered species / study effects of climate change;		**3 max**

Question			Answers	Notes	Total
10.	**c**		a. a mutation is a change in the base sequence; b. types of mutation include substitutions/insertions/deletions/frameshifts/single-nucleotide polymorphisms (SNPs); c. mutation caused by (named) mutagens / errors in DNA replication/DNA repair; d. some mutations cause changes in amino acid sequence/(primary) structure of proteins; e. most changes to the amino acid sequence/(primary) structure of a protein are harmful or neutral to an individual ***OR*** some mutations are harmful or neutral; f. some changes to the amino acid sequence / (primary) structure of a protein confer (novel) advantageous effects/characteristics on the organism ***OR*** some mutations may be beneficial; g. new alleles produced by (random) mutation; h. advantageous alleles passed down to offspring; i. advantageous alleles increase in frequency in a population / enlarge the gene pool / increase genetic variation in a population; j. due to natural selection; k. enable evolution to occur ***OR*** enable the formation of new species / speciation;	*Ignore reference to meiosis and sexual reproduction.* *For a. accept that change in the base sequence of DNA is due to mutations.* *For j and k the answer must be related to mutations / changes in the base sequence / new alleles*	**7 max**