8825 – 6009M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2025

Biology

Higher level

Paper 2

21 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.

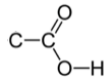
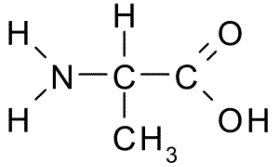
- Candidates that score very highly on the content marks need not necessarily automatically gain **[1]** for quality (and *vice versa*).

Section A

Question			Answers	Notes	Total
1.	**a**	**i**	6.1 °C;		**1**
1.	**a**	**ii**	600 / 600.2 / 600.18;	*Accept answers within the range 600 to 600.2.*	**1**
1.	**b**	**i**	in each season/in winter spring and summer there is a lower ratio in mature dolphins / higher ratio in young dolphins;	*Allow 'always' or equivalent wording instead of 'in each season'.* *Do not accept 'generally' instead of 'always' unless seasons are mentioned.*	**1**
1.	**b**	**ii**	a. young dolphins are smaller/have lower mass ***OR*** young dolphins have a higher surface area to body ratio; b. young dolphins lose more heat/need more heat insulation; c. blubber increases buoyancy/streamlining; d. young dolphins (may still be) feeding on milk;	*Accept converse answers for mature dolphins.* *Do not accept answers relating to blubber as a source of energy, or greater energy needs in either mature or young dolphins.*	**2 max**

Question			Answers	Notes	Total
1.	c		a. both rise and then reach a maximum/plateau; b. larger percentage increase/relative increase in mass (than length) ***OR*** x3.4 for mass but only x1.67 for length / OWTTE ***OR*** maximum length reached before maximum mass/20 versus 25 years;	*Reject length higher than mass.* *Reject smaller increase in length than mass for the first mark point b alternative – the answers must specify relative or percentage increase.*	**2**
1.	d		a. (higher body mass in winter due to) more/thicker <u>blubber</u> in winter; b. colder in winter / more need for (heat) insulation/thermoregulation in winter; c. dolphins more active/metabolism higher in the summer;	*Accept vice versa for summer/winter in all mark points.*	**2 max**
1.	e	i	positive correlation/ higher BMR with higher body mass;	*Do not award a mark for proportional, directly proportional, directly correlated, positive relationship, positive linear relationship, increasing linearly or directly related.*	**1**
1.	e	ii	more energy used/more energy needed/more respiration/more metabolism to maintain more cells/larger quantity of tissue/bigger organism/larger body*;*	*Accept converse.* *Do not award a mark for a restatement of the correlation.* *Do not accept 'energy needed for respiration'.*	**1**

Question			Answers	Notes	Total
1.	**f**		a. more/faster heat loss in polar mammals with lower temperatures/colder climate; b. polar mammals must generate more heat/need more energy to maintain body temperature/to stay warm; c. heat generated by <u>respiration</u>;	*b. Do not accept 'heat needed for insulation'.*	**2 max**
1.	**g**		a. surface area to volume ratio is low in large mammals/above 10kg; b. less heat/energy loss in larger mammals;		**2**

Question			Answers	Notes	Total
2.	**a**		a. essential amino acids cannot be synthesized (by human cells) ***OR*** essential amino acids are required to be obtained by diet / OWTTE; b. non-essential amino acids can be made (from other amino acids);		**2**
2.	**b**		a.  / NH_2 / amine group shown as N with two single bonds to H / as NH_2 and bonded to C; b.  / carboxyl group shown as C with single bond to OH and double bond to O / as COOH and bonded to C; c.  / H and R linked by single bonds to the same C as carboxyl and amine groups;	*Allow a specific amino acid R-group in marking point c, such as CH_3 (in alanine).* 	**3 max**
2.	**c**		hydrogen bonds; ionic bonds; <u>disulfide</u> bridges/<u>disulfide</u> (covalent) bonds; hydrophobic interactions;	*Mark the first two answers only.* *Do not allow 'interactions' instead of 'bonds'* *Do not allow 'bonds' instead of 'interactions'* *Do not allow van der Waals forces.*	**2 max**

Question			Answers	Notes	Total
3.	**a**		a. providing energy/ATP ***OR*** for <u>aerobic respiration</u>; b. for muscle contraction ***OR*** to break cross-bridges (between myosin heads and actin);	*b. can be awarded even if the answer states 'contraction and relaxation/lengthening'.*	**2**
3.	**b**		a. actin and myosin (filaments) slide over each other to shorten/contract the sarcomere/muscle ***OR*** sliding filament theory of muscle contraction; b. myosin in centre and actin at ends of sarcomere; c. myosin heads bind to actin/form cross-bridges/cross-linkages; d. myosin heads tilt/swivel ***OR*** myosin heads move/detach using (energy from) ATP; e. actin filaments moved towards the center of the sarcomere ***OR*** actin and myosin filaments overlap more;		**3 max**

Question			Answers	Notes	Total
3.	**c**		a. attaches myosin to the Z-line / keeps myosin centred in the sarcomere; b. stores potential energy/elastic energy; c. helps sarcomeres recoil / enhances next muscle contraction/relaxation/lengthening; d. prevents overstretching/straining of the sarcomere/muscle;		**2 max**

Question			Answers	Notes	Total
4.	**a**		photosynthesis;	*Allow Calvin cycle*	**1**
4.	**b**		a. biomass/trees/timber/forests; b. coal; c. limestone; d. natural gas/methane (reserves); e. oil; f. peat/peatland/peat bogs/swamps; g. permafrost; h. soil;	*Accept first two answers only.* *Answers that are not accepted:* *plants/phytoplankton (as they may be small/short-lived).* *fossils/fossil fuels unless a specific fossil fuel is named.* *air in the atmosphere or bubbles in ice.* *decomposers/saprotrophs.*	**2 max**
4.	**c**		a. combustion of fossil fuels/named fuel; b. less uptake of carbon dioxide / less photosynthesis / loss of carbon sink due to deforestation ***OR*** forest fires / combustion of forests; c. release of carbon (dioxide) from increased decomposition/increased activity of saprotrophs/bacteria/fungi (due to anthropogenic global warming) ***OR*** release of carbon (dioxide) due to drainage of wetlands (and decomposition of peat) ***OR*** release of carbon (dioxide) from melting permafrost (due to anthropogenic global warming);	*Do not award mark point b for just 'deforestation'.*	**2 max**

Question			Answers	Notes	Total
5.	**a**		a. measure rate of replacement/reproduction ***OR*** monitor (size of) fish population (to assess the effect of harvesting); b. rate of harvest should be lower than the rate of replacement;		**2**
5.	**b**		a. (phyto)plankton/autotrophs/producers take in/absorb arsenic from the water; b. feeding/ingestion passes arsenic from organism to organism/along the food chain; c. not excreted/not metabolized/not detoxified/not broken down ***OR*** accumulates/bioaccumulation in adipose/fat (storage) tissue; d. biomagnification ***OR*** higher concentration in each (successive) trophic level / highest in top trophic levels;		**2 max**
5.	**c**		a. cause mutations/act as mutagens; b. in genes that control the cell cycle/cell division; c. convert proto-oncogenes to oncogenes; e. mutations in tumour suppressor genes;		**2 max**
5.	**d**		eukaryotes / eukarya / eukaryota; family;		**2**

Question			Answers	Notes	Total
6.	**a**		a. groups/types of ecosystems / ecosystems with similar communities; b. with similar/characteristic abiotic/climatic conditions/rainfall/temperatures; c. convergent evolution (produces similarities between ecosystems in a biome);		**2 max**
6.	**b**		a. extensive roots (to collect water from a wide area/to collect water after rainfall); b. deep roots to collect water from underground sources; c. (thick) waxy cuticle to reduce transpiration/water loss/evaporation; d. water storage tissue/thick stems/thick leaves/succulent (to survive droughts); e. no leaves/narrow leaves/rolled leaves/spines instead of leaves to reduce the surface area for transpiration/evaporation; f. fewer stomata/sunken/pitted stomata to reduce transpiration/water loss; g. vertical stems to reduce exposure to sun at midday/heating when the sun is overhead/hottest ***OR*** pleated stems to allow shrinkage and reswelling/to store water; h. stomata open at night/CAM metabolism;	*Mark first three adaptations only.*	**3 max**
6.	**c**		spines/thorns/stings/spikes ***OR*** production of toxins/unpalatable substances ***OR*** mimicry/camouflage (to resemble rocks) ***OR*** mutualism with an ant/animal which defends the acacia/plant against herbivores;		**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
7.	**a**		a. four bases in DNA / bases in DNA are adenine cytosine guanine and thymine ***OR*** four bases in RNA / bases in RNA are adenine cytosine guanine and uracil; b. purines and pyrimidines ***OR*** uracil instead of thymine in RNA; c. bases/nucleotides can be arranged in any sequence; d. many/4^n possible permutations/combinations/sequences (of the four bases) ***OR*** 64 possible triplets of bases/codons; e. nucleic acids/RNA/DNA can have any number of nucleotides / unlimited in length; f. mutations can change base sequence/increase diversity; g. many different proteins/proteins so many sequences needed to code for them; h. three/triplet of bases needed to code for each amino acid ***OR*** degeneracy of genetic code/more than one codon per amino acid;	*Award mark point a and mark point b if the answer includes the four bases in both DNA and RNA.* *Do not accept letters instead of base names in mark point a.* *Mark points d and g are different: mark point d is for the idea that the four bases in any sequence gives many possible base sequences; mark point g is for the idea that the many different proteins necessitate many different base sequences in the genome.*	**4 max**

Question			Answers	Notes	Total
7.	b		a. variation in size/shape ***OR*** helical versus spherical / spikes versus no spikes / other contrasting shapes; b. head and tail in bacteriophage (lambda) and polyhedral/spherical in HIV/COVID-19; c. DNA or RNA as genetic material; d. retroviruses/HIV has reverse transcriptase (but other viruses do not); e. DNA in bacteriophage lambda and RNA in HIV/COVID-19; f. single-stranded or double stranded DNA/RNA/nucleic acid; g. bacteriophage lambda with double stranded and HIV/COVID-19 with single stranded; h. circular or linear DNA / linear DNA in bacteriophage lambda; i. variation in number of DNA/RNA/nucleic acid molecules ***OR*** HIV/other virus example with more than one molecule (of DNA/RNA); j. some viruses are enveloped (in plasma membrane from the host cell); k. bacteriophage lambda is a naked virus and HIV/COVID-19 is enveloped; l. rapid evolution due to short generation time/rapid mutation rate/no proofreading/intense natural selection; m. changes in influenza coat proteins/coronavirus spike proteins;	*Accept other verified and valid examples in marking points b, e, g, i, k and m.* *Accept coronavirus instead of COVID-19.* *Accept diagrams to show examples of structural differences for marking points b, e, g, i, k and m.* *Reject statements that some viruses have plasma membranes.*	**7 max**

Question			Answers	Notes	Total
7.	**c**		a. fusion of chromosomes (decreases chromosome number); b. chromosomes 12 and 13 in chimpanzees equivalent to human chromosome 2 ***OR*** fewer chromosomes in humans than chimpanzees / 46 in humans and 48 in chimpanzees; c. fission/breaks in/splitting of chromosomes increases chromosome number; d. doubling of chromosome number by polyploidy/in tetraploids; e. non-disjunction of all bivalents/chromosomes in meiosis ***OR*** DNA replication without cytokinesis; f. example of polyploidy in knotweeds/smartweeds/*Persicaria*/*Allium*/other verified example; g. changes in chromosome number/polyploidy can cause speciation ***OR*** chromosome number can change following speciation;	*d. do not allow types of polyploidy that result in infertility such as triploidy.* *e. Do not allow aneuploidy/trisomy.*	**4 max**

Question			Answers	Notes	Total
8.	**a**		a. binds to the active site / inhibitor is complementary to the active site; b. prevent binding of substrate (so reducing enzyme activity/rate of reaction) ***OR*** fewer enzyme-substrate complexes form; c. inhibitor chemically similar/similar in shape/similar in structure to substrate d. statins are competitive inhibitors of HMG-CoA reductase/enzyme needed to make cholesterol; e. statins prevent conversion of HMG-CoA to mevalonate;	*Accept other examples for mark point d and mark point e such as:* *Oxygen binds to rubisco (d.) and preventing production of glycerate 3-phosphate (e.)* *Malonate binds to succinic dehydrogenase (d.), preventing production of fumarate (e.).* *Allow penicillin as a competitive inhibitor of transpeptidase/for bacterial cell wall production for mark point d, but not mark point e.*	**4 max**

Question			Answers	Notes	Total
8.	**b**		a. depolarization/action potential in pre-synaptic membrane/pre-synaptic neuron causes release of neurotransmitter; b. by exocytosis/by fusion of vesicle with pre-synaptic membrane; c. neurotransmitter diffuses/travels across the synaptic cleft; d. neurotransmitter binds to receptors in postsynaptic membrane; e. (binding causes) ion/sodium/ligand-gated channels to open; f. post-synaptic membrane reaches threshold potential/depolarizes/action potential generated; g. neurotransmitter broken down / reabsorbed by presynaptic neuron **OR** exogenous chemicals/example of exogenous chemical not released from receptor/not broken down; h. exogenous chemicals can block/increase synaptic transmission; i. neonicotinoids bind to acetylcholine/neurotransmitter/post-synaptic <u>receptors</u>; j. excessive of Na^+ enters post-synaptic neuron / Na^+ channels remain open; k. cocaine binds to (dopamine) reuptake transporters; l. <u>dopamine</u> in the synaptic cleft continues to stimulate (post-synaptic neuron);	*Allow 'acetylcholine' instead of neurotransmitter in mark points a, c and d.* *Accept 'cause constant depolarization' instead of 'increase synaptic transmission' in mark point h.* *Mark point h. can be awarded for a specific example of blocking/increasing synaptic transmission.*	**7 max**

Question			Answers	Notes	Total
8.	**c**		a. HIV can be passed on/spread (by someone who is HIV positive); b. HIV invades/infects/destroys helper T-lymphocytes / CD4 cells; c. all (helper/CD4) T-lymphocytes gradually/eventually destroyed; d. B-lymphocytes not (sufficiently) activated without T-lymphocytes; e. antibodies not produced (in sufficient quantity); f. immunity to new infections/pathogens cannot develop / antibodies not produced in response to new pathogens/antigens g. opportunistic infections cannot be controlled/eliminated / valid example of an opportunistic infection; h. AIDS/acquired immune deficiency syndrome (develops); i. rapid mutation rate in HIV so evades immune system/resists (anti-retroviral) drugs;	*Allow T-cells instead of T-lymphocytes and B-cells instead of B-lymphocytes.* *Mark point a is awarded for spread of HIV from an infected person, not for spread to an uninfected person, because the question asks about the consequences of infection.* *Do not award mark point f or mark point g for understatements such as 'reduced immunity'.*	**4 max**

Question			Answers	Notes	Total
9.	**a**		a. <u>complementary base pairing</u> (between DNA nucleotides); b. adenine pairs with thymine and cytosine pairs with guanine; c. new strands with same/correct sequence/copy produced by <u>semiconservative replication</u> ***OR*** <u>semiconservative replication</u> is using a template strand (to make a new strand); d. DNA polymerase (III) adds <u>nucleotides</u> to the growing chain/to the template strand; e. <u>proofreading</u> is correction of errors/mutations (during DNA replication) f. <u>proofreading</u> by <u>DNA polymerase III</u> ***OR*** error in replication/nucleotide with mismatched base detected by <u>DNA polymerase III</u> g. <u>DNA polymerase III</u> has 3’ to 5’ exonuclease activity ***OR*** <u>DNA polymerase III</u> reverses and excises nucleotide ***OR*** (mismatched) <u>nucleotide</u> removed and replaced (by DNA polymerase III);		**4 max**

Question			Answers	Notes	Total
9.	**b.**		a. pancreas cells monitor blood glucose concentrations; b. glucagon secreted by alpha cells **and** insulin by beta cells; c. glucagon/insulin/hormones secreted into/transported by bloodstream; d. insulin secreted when glucose concentration rises/is high; e. insulin stimulates uptake of glucose by liver/muscle/body cells; f. insulin stimulates conversion of glucose to glycogen (in liver/muscle cells); g. insulin stimulates body cells to use glucose instead of fat in cell respiration; h. glucagon secreted when glucose concentration falls/is low; i. glucagon stimulates breakdown of glycogen to glucose (by liver/muscle cells); j. negative feedback (is used to regulate blood glucose concentration);		**7 max**
9.	**c**		a. isotonic is same water potential/solute potential/osmotic potential/solute concentration; b. (isotonic conditions) prevent (net) movement of water by <u>osmosis</u>; c. hypotonic plasma/tissue fluid causes water entry to blood/body cells; d. swelling/bursting of cells in (hypotonic plasma/tissue fluid); e. hypertonic plasma/tissue fluid causes water to exit cells; f. shrinkage/crenation/loss of volume/OWTTE; g. blood cells bathed in plasma; h. tissue fluid released by capillaries and then reabsorbed/flows between cells in tissues;	*In mark point c and mark point e accept 'higher/less negative water potential' instead of hypotonic and accept 'lower/more negative water potential' instead of hypertonic.*	**4 max**