2225 – 6009M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2025

Biology

Higher level

Paper 2

19 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 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

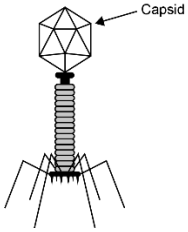
Question			Answers	Notes	Total
1.	**a**		250 mg L^{-1};	*Units required* *Accept values from 240 to 260 mg L^{-1}*	**1**
1.	**b**		when mussels are absent cyanobacteria increases over time and when they are present, they decrease;	*Or vice versa.*	**1**
1.	**c**		increasing in number as the cyanobacteria/phytoplankton were reproducing/ growing;		**1**
1.	**d**		*Similarity* a. both cause a reduction in the amount of chlorophyll in the water ***OR*** after 12/24/value between 12 and 24 there is no/little removal of chlorophyll/similar chlorophyll concentration; *Difference* b. rate of removal increases more/ faster at 0.5 mgL^{-1} between 4 and 8 hours /overall rate of removal in the first 8 hours is faster for 0.5 mgL^{-1}; ***OR*** rate of removal levels off earlier at 0.5 mgL^{-1} / mussel filtration more effective in the first 8 hours at 0.5 mgL^{-1} than filtration at 0.9 mgL^{-1};	*or vice versa*	**2**

Question			Answers	Notes	Total
1.	**e**		33(%);	*Accept 30 to 36*	**1**
1.	**f.**		*a.* 1964 as *A. anatine* is in similar percentages; *b.* 1964 as *P. complanate* are present; c. other valid reason*;*		**1 max**
1	**g**		a. the data does not provide population numbers / percentage does not represent population; b. the % has increased; c. the overall population may have decreased / even though the percentage is higher, there may have been a decrease in population;		**2 max**
1.	**h**		50(%);		**1**
1.	**i**		*Similarities* a. both showed a decrease in density (at all depths) from 1964 to 2020 ***OR*** both have the greatest decrease/change between 0-1m; *Differences* b. at all depths the decrease in *U. pictorum* density was greater than *U.tumidus* ***OR*** *U.tumidus* only shows major decrease at 0-1m depth /shows only small decreases at 1-4m while *U. pictorum* shows great change/almost 0 at all depths ***OR*** *U.tumidus* shows greater variation/possible overlap of values/range of error than *U. pictorum;*	*Award 1 mark for a similarity, another for a difference.*	**2**

Question			Answers	Notes	Total
1.	**j**		a. (the first piece of data shows) that mussels improved water quality because they filtered / quality goes down when mussels are absent and cannot filter; b. (the second piece of data) shows changes in the distribution of mussels over time so water quality may be changing ***OR*** the distribution changes indicate that the water quality became more suitable for some mussels and less suitable for others; c. (the third piece of data shows) shows a decrease in the number/density over time and that might indicate lower survival rates due to poor water quality ***OR*** decrease in the number/density of mussels over time indicates cleaner water/less food (because there is no need for filtering); d. other factors/legislation may lead to changes in water quality ***OR*** not only the quantity of mussels determines water quality;		**2 max**

Question			Answers	Notes	Total
2.	**a**		dipeptide **and** water;		**1**
2.	**b**		a. properties/structure of the R groups vary; b. may be hydrophobic or hydrophilic / polar or non-polar / acidic or basic; c. cause different types of interactions/bonds between R-groups; d. affect how protein folds/solubility;		**2 max**
2.	**c**	**i**	a. beta/β-pleated sheets; b. (structure held in place by) hydrogen bonds between N-H and C=O on different amino acids ***OR*** hydrogen bonds between sections of polypeptide running parallel or antiparallel ***OR*** sections of polypeptide form a pleat (when they run in opposite directions) because of the tetrahedral bond angles;		**2**
2.	**c**	**ii**	a. titin has elastic properties that allow potential energy storage; b. it returns the sarcomere to original length after contraction ***OR*** it prevents overstretching of the sarcomere; c. it contributes to the stability of (sarcomeres);		**2 max**

Question			Answers	Notes	Total
3.	**a**	**i**	mutualism;		**1**
3.	**a**	**ii**	a. (fungi provide) nutrients/water/C resources/P/N; b. (fungi required for) seed germination as orchid seeds lack stored resources;		**1**
3.	**b**		a. allelopathy uses secondary metabolites/chemicals/allelopathic agents to impact other (nearby) plants; b. named plant with action; c. prevents germination/growth/reproduction of other plants / is toxic to other plants / other verified result; d. increases the resources (soil/water/sunlight/etc.) available for growth/survival/reproduction; e. may impact plant community structure / become invasive;	*Question asks for a named example. Maximum of 2 marks if an example is not given.*	**3 max**

Question			Answers	Notes	Total
4.	**a**		capsid labelled;  [Source: ALI DAMOUH/SCIENCE PHOTO LIBRARY, 2024. *Bacteriophage, illustration*. [image online] Available at: https://www.gettyimages.co.uk/detail/illustration/bacteriophage-illustration-royalty-free-illustration/2080360644?ad ppopup=true [Accessed 29 July 2024]. Source adapted.]		**1**
4.	**b**		a. (viruses) do not have a metabolism of their own (rely on a host cell for chemical processes) / cannot carry out transcription/protein synthesis / cannot perform ATP synthesis; b. they are not made of cells (but consist only of a nucleic acid core and protein coat/capsid); c. they do not carry out all reproduction but only multiply inside other living cells;		**1 max**
4.	**c**		a. the virus attaches to maltoporin/protein in the host/bacterium membrane; b. the viral DNA/genome is integrated into a host/bacterium; c. when the host DNA replicates/does mitosis, viral DNA is also replicated; d. all daughter cells contain viral DNA/genetic material; e. the inserted DNA is known as a prophage; f. bacteriophage/prophage remains in dormant state in host/bacterium ***OR*** later prophage may exit to initiate <u>lytic</u> cycle;		**3 max**

Question			Answers	Notes	Total
5.	**a**		epinephrine /adrenaline;		**1**
5.	**b**		a. epinephrine is a ligand / binds to (GPCR) receptors in cell membrane; b. triggers G-protein activation / triggers G protein phosphorylation; c. initiates a cascade of events producing cAMP / adenylyl cyclase enzymes stimulates cAMP synthesis; d. (cAMP) acts as a second messenger; e. signals/influences/mediates specific cellular responses;	*Accept cyclic AMP for cAMP.*	**3 max**
5.	**c**		a. the heart beats faster for more blood flow / blood pressure increases pushing more blood to the muscles / vasodilation allows more blood to reach muscles; b. breathing rate increases providing the muscles with more oxygen; c. bronchi/bronchioles dilate to allow more air/oxygen into the lungs (for muscle contraction); d. triggers the release of blood sugar/glucose supplying energy/ATP/cellular respiration (for contraction) ***OR*** triggers the conversion of glycogen to glucose in the liver for energy;		**2 max**

Question			Answers	Notes	Total
6.	**a**	**i**	between glucose and fructose 1,6 – bisphosphate;		**1**
6.	**a**	**ii**	between triose phosphate and pyruvate;		**1**
6.	**b**		cytoplasm;		**1**
6.	**c**		a. NADH transfers electrons to pyruvate ***OR*** pyruvate acts as electron acceptor / pyruvate is reduced; b. (pyruvate) converted to lactate; c. NADH oxidized/converted to NAD ***OR*** NAD available to be reduced/converted to NADH again (in glycolysis);		**2 max**

Question			Answers	Notes	Total
7	**a**		<u>allopatric;</u>		**1**
7	**b**		a. geographic isolation/geographic barrier/separation of populations (of the common ancestor) by the river; b. (isolated populations) subjected to different/<u>selection</u>/environmental pressures; c. their allele frequencies changed/ genetic drift/genetic differences/different mutations/adaptations accumulated over time/passed on to offspring; d. until they could not interbreed anymore/reproductive isolation / populations became separate species; e. divergence due to differential selection;		**3 max**
7.	**c**		a. loss of habitat/breeding grounds leads to less reproductive success/lower survival/valid example; b. loss of food sources/resources leads to increased hunger/starvation/lower energy/valid example; c. loss of shelter leads to increased predation/lower protection/valid example;		**2 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**		a. cohesion is caused by the polarity of water ***OR*** water molecules have a negative and positive end; b. water molecules are attracted to each other ***OR*** water molecules are linked by hydrogen bonds; c. (cohesion) enables transport of water along stems/xylem ***OR*** enables a continuous column of water in transpiration/transpiration pull; d. surface tension provides a habitat for some organisms ***OR*** some insects can walk on water surface because surface tension/other verified example ***OR*** cohesion is related to buoyancy allowing organisms (like ringed seal) to float; e. helps animals regulate body temperature (through evaporative cooling); f. (cohesion causes high specific heat) so maintains a stable temperature in aquatic environments ***OR*** water is liquid at a wide range of temperatures supporting many aquatic habitats;		**4 max**

Question			Answers	Notes	Total
8	b		*Melting of ice:* a. can cause loss of habitat; b. can cause loss of breeding grounds /loss of food sources; c. polar bears/walruses/arctic foxes/ snowy owls/reindeer/other example of species affected; *Changes in ocean current:* d. may prevent nutrient upwelling / stop nutrients rising to the surface; e. lowers the growth of phytoplankton / ocean primary production; f. disrupts energy flow/food chains/migration patterns of aquatic species;		**4 max**
8	c		a. negative feedback loops maintain homeostasis/return variables to an original set point if levels are increased or decreased; b. osmoreceptors in the hypothalamus detect if body/blood is dehydrated/hypertonic/solute concentration is too high; c. ADH is secreted if body/blood is dehydrated/hypertonic; d. (ADH is released) from the pituitary; e. (ADH) increases/stimulates more aquaporins / aquaporins open in the collecting duct; f. collecting duct more permeable to water/reabsorbs more water (from filtrate/urine); g. more water is reabsorbed into the blood / blood solute concentration reduced; h. less water lost in urine / smaller volume of (more concentrated) urine; i. increases the concentration of water/ water potential in blood/decreases the concentration of blood/plasma; j. negative feedback / less/no ADH secreted when blood solute concentration returns to normal;		**7 max**

Question			Answers	Notes	Total
9	a		a. (substitution mutation) caused by mutagen/errors in DNA replication/chemicals/radiation; b. occurs randomly when one nucleotide/base is replaced by another ***OR*** a single codon in a gene is altered; c. no consequences if (mutation) occurs to a non-coding portion of DNA /results in a same-sense or silent mutation /new codon codes for the same amino acid (degeneracy/redundancy); d. (consequences may occur if) one amino acid in the polypeptide is replaced by another; e. resulting in the protein/polypeptide being wrongly coded/not functioning/shortened/3 dimensional protein structure changed; f. mutations in germ cells or gametes may pass on to offspring ***OR*** mutations in somatic cells may lead to cancer; g. valid example;		**4 max**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>9</td><td>b</td><td></td><td>
<table>
<tr><th></th><th>Mitosis</th><th>Meiosis</th><th></th></tr>
<tr><td>a.</td><td>maintains chromosome number/diploid;</td><td>halves chromosome number/haploid</td><td>;</td></tr>
<tr><td>b.</td><td>for growth/repair</td><td>for gamete production</td><td>;</td></tr>
<tr><td>c.</td><td>in somatic cells</td><td>in reproductive/sex/gamete cells</td><td>;</td></tr>
<tr><td>d.</td><td><u>one division</u></td><td><u>two divisions</u></td><td>;</td></tr>
<tr><td>e.</td><td>no exchange of genetic material between chromosomes/crossing over;</td><td>exchange of genetic material between chromosomes/crossing over</td><td>;</td></tr>
<tr><td>f.</td><td>results in two cells</td><td>results in 4 cells</td><td>;</td></tr>
<tr><td>g.</td><td>only divides chromatids/ chromatids separate during anaphase</td><td>also divides <u>homologous chromosomes</u>/ <u>homologous chromosomes</u> separate during anaphase 1 and (sister) chromatids separate during anaphase 2</td><td>;</td></tr>
<tr><td>h.</td><td>genetically identical</td><td>genetically different</td><td>;</td></tr>
</table>
</td><td></td><td>4 max</td></tr>
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Question			Answers	Notes	Total
9	c		a. transcription factors bind to DNA and can be activators or repressors ***OR*** transcription factors promote or block transcription; b. protein/transcription factor/TF binds to promoter to activate transcription ***OR*** promoter indicates where RNA polymerase binds to begin transcription; c. transcription factor/activator/protein binds to enhancer to increase the rate of transcription ***OR*** transcription factor/repressor/protein binds to silencer to decrease the rate of transcription; d. epigenic tags can alter gene expression / methylation can alter gene expression; e. methylation of cytosine in the DNA of a promoter represses transcription; f. methylation of amino acids/protein in histones can cause transcription to be repressed or activated; g. thereby regulating the production of proteins from the gene ***OR*** proteins from gene expression display/create phenotypic traits; h. gene expression may be altered by (steroid) hormones/biochemicals that act as chemical signals to activate receptors that promote transcription; i. alteration of methyl tags on DNA in response to air pollution or in response to the environment; j. valid example of gene regulation;		**7 max**

Question			Answers	Notes	Total
10	a		a. organelles perform specialized functions that integrate/work together ***OR*** organelles are adapted to perform isolated tasks that coordinate; b. nucleus makes the messenger RNA which codes for the protein; c. ribosome reads the messenger RNA (mRNA) sequence / uses the mRNA to synthesize the protein / performs translation using mRNA; d. (ribosomes embedded) <u>rough</u> Endoplasmic Reticulum/<u>R</u>ER synthesizes proteins for secretion out of the cell; e. RER transports proteins within the cell in vesicles/ forms vesicles around proteins for transport to golgi; f. Golgi apparatus where proteins are processed/modified/packaged for secretion; g. vesicles secrete proteins from the cell/fuse with membrane, release by exocytosis;		**4 max**
10	b		a. the <u>external</u> intercostal muscles contract and the <u>internal</u> intercostal muscles relax; b. this causes the ribs to move upwards/outwards; c. diaphragm contracts / moves downwards/flattens; d. abdominal muscled relax; e. the chest cavity / thorax expands/ volume of thorax increases; f. reducing pressure in the thorax/chest cavity/lung (allowing air to enter);		**4 max**

Question			Answers	Notes	Total
10	**c**		a. adaptive immunity is the response to a specific antigen/pathogen; b. macrophage/phagocyte/phagocytic white blood cell ingests/engulfs antigen and displays in/on plasma membrane; c. helper T-cells bind to antigen / activated by antigens presented (on macrophage); d. helper T-cells activate specific B-cells/B lymphocytes that can produce an effective antibody; e. B-cells to divide by mitosis to make clones for more/large numbers plasma cells; f. B-lymphocytes/plasma cells make antibodies /antibodies are specific to an antigen; g. antibodies fight disease-causing organisms/viruses/bacteria (by lysis, agglutination,neutralization, tagging, other verified action.); h. some plasma cells become (inactive) memory cells (that are retained in the body); i. memory cells can be activated/quickly respond to produce antibodies in the case of reinfection;		**7 max**