Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2023

Biology

Higher level

Paper 2

23 pages

Subject Details: Biology HL Paper 2 Markscheme

Candidates are required to answer **all** questions in Section A and **one** out of **two** questions in Section B. Maximum total = **72 marks**.

1. Each row in the "Question" column relates to the smallest subpart of the question.

2. The maximum mark for each question subpart is indicated in the "Total" column.

3. Each marking point in the "Answers" column is shown by means of a semicolon (;) at the end of the marking point.

4. A question subpart may have more marking points than the total allows. This will be indicated by "**max**" written after the mark in the "Total" column. The related rubric, if necessary, will be outlined in the "Notes" column.

5. An alternative word is indicated in the "Answers" column by a slash (/). Either word can be accepted.

6. An alternative answer is indicated in the "Answers" column by "***OR***". Either answer can be accepted.

7. An alternative markscheme is indicated in the "Answers" column under heading ***ALTERNATIVE 1*** *etc*. Either alternative can be accepted.

8. Words inside brackets ( ) in the "Answers" column are not necessary to gain the mark.

9. Words that are <u>underlined</u> are essential for the mark.

10. The order of marking points does not have to be as in the "Answers" column, unless stated otherwise in the "Notes" column.

Section B

Extended response questions - quality of construction

- Extended response questions for HLP2 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.

Section A

Question			Answers	Notes	Total
1.	**a**		736 500;	*No calculation required.* *Note accept 0.7365 million (4 significant figures needed) or other mathematics notations.*	**1**
1.	**b**		a. difficult to know what infection causes death in children with HIV; b. HIV lowers immunity/fewer T cells/reduces antibody production/more likely to catch infectious disease; c. deaths of HIV-infected children should be attributed to HIV;		**1 max**
1.	**c**	**i**	89%;	*Allow 88 to 91%.*	**1**
1.	**c**	**ii**	13 <u>years</u>;	*Allow any value between 13 and 14 years inclusive.*	**1**

(continued…)

(Question 1 continued)

Question			Answer	Notes	Total
1.	**d**		a. number of deaths (due to *S. pneumoniae)* and percentage of children not vaccinated (with PCV) both fall (along the years) ***OR*** number of deaths (due to *S. pneumoniae)* decreases while percentage of vaccinated children (with PCV) increases (along the years); b. positive correlation between number of deaths and percentage of children not vaccinated / ***OR*** negative correlation between number of deaths and percentage of children vaccinated / vaccination reduces the number of deaths; c. increased reduction in the number of deaths from 2010 onwards; d. still large number of deaths/large number of children unvaccinated in 2015;	*Comparative terms expected (do not award mp for just stating values).* *Mpb: do not allow "directly or inversely proportional".* *Mpb: Do not just accept "positive correlation" or "negative correlation" without a clear indication of the variables being correlated*	**2 max**

(continued…)

(Question 1 continued)

Question			Answers	Notes	Marks
1.	e		a. Hib vaccination program started earlier/PCV vaccination program started later ***OR*** Hib vaccine developed before PCV vaccine; b. deaths due to *H. influenzae* drop earlier than deaths due to *S. pneumoniae* because of earlier vaccination; c. more deaths due to *S. pneumoniae* than *H. influenzae* (in any year) as lower % of children vaccinated against *S. pneumoniae (*compared *H. influenzae)*;	*Mp a to c: accept vice versa.* *Comparative terms expected (do not award mp for just stating values).* *Mpa and mpb: there must be a clear reference to time.* *Mpc: there must be clear indication to vaccination.* *Allow no points for bacterial virulence / disease severity, etc., as bacterial pathogenicity is not addressed on graphs.*	**2 max**

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	**f**		a. 2 – 5 <u>years</u>; b. higher number/value/percentage/attributable fraction for 2 -5 years (than 0 – 5 years);		**2**
1.	**g**		a. highest attributed fraction (in both age groups) is in cases where antibiotic used; b. ARI cases due to *S. pneumoniae* can be severe so antibiotics are often prescribed; c. all cases include other causes / viral ARI which may not require antibiotics; d. antibiotics administered without prescription or physician consultation/to reduce symptoms;	*Mpa: Comparative terms expected (do not award mp for just stating values).*	**2 max**

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	**h**		a. higher population in lower-middle income countries/subgroup (compared to the other 2 subgroups); b. low income population may not have/have less access to medicine/antibiotics/vaccination (compared to lower-middle income population)/ low-income populations may not report data ***OR*** upper-middle population may have better living conditions/more adequate medical diagnoses (compared to lower-middle income population);	*Lower-middle income subgroup is not the same as LMIC (includes all 3 subgroups).* ***LMIC should not be used as equivalent.*** *Mpb: accept vice versa.*	**1 max**

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	**i**		(worldwide) drastic/huge/important/significant decrease/decrease of 42 million ARI cases (treated with antibiotics);	*There must be an indication of magnitude of decrease in the answer for the mark to be awarded.* *Accept 30 to 50 million for the decrease.*	**1 max**
1.	**j**		a. less use of antibiotics; b. less antibiotic resistance (in pathogens) / antibiotics more successful at treating infectious/bacterial diseases; c. decrease in health care costs / less money spent on antibiotics; d. decreased mortality / protection of immune-deficient patients/non-vaccinated population/ achieve herd immunity;	*Since the question already states "other than reducing the incidence of ARI", this reason should not be accepted.*	**2 max**

Question			Answers	Notes	Total
2.	**a**		amino acids;		**1**
2.	**b**		a. initial molecule/substrate/intermediates are regenerated; b. products become substrates/reactants;	*Accept clearly annotated diagrams.*	**1 max**
2.	**c**		reduced/lowered (activation energy);		**1**
2.	**d**		a. urea is toxic/ a (excretory) waste product removed from the body/ blood (plasma) by the kidneys/in the urine (to be excreted in the urine); b. urea filtered out from blood in glomerulus/Bowman's capsule; c. water reabsorbed from filtrate (by osmosis); d. in proximal convoluted tubule/descending loop of Henle/collecting duct; e. loop of Henle maintains hypertonic conditions in the medulla; f. little/no urea reabsorbed from filtrate;		**3 max**

Question			Answers	Notes	Total
3.	**a**		a. I is the stigma which receives the pollen/where pollen lands/is captured (during pollination); b. II is the anther and produces/contains/releases pollen;	*Both name and function must be included in each marking point.* *The role in pollination should be stated. Do not accept "pollination" on its own.*	**2**
3.	**b**		a. female gamete/ovule is produced/meiosis to produce ovules/ovule develops; b. Fertilisation occurs ***OR*** fusion/union of male and female gametes/nuclei; c. development of seed (from fertilised ovule); d. development of fruit (from the whole ovary);	*Mpb: Do not accept union of pollen and ovule (Too vague).* *Do not accept carpel/pistil as equivalent of ovary*	**2 max**
3.	**c**		a. attracts an insect/animal/which pollinates the flower; b. attracts a pollinator;	*Mpa: Both parts of the sentence are needed to award the point.*	**1 max**

Question			Answers	Notes	Total
4.	**a**	**i**	heterotrophic because it feeds on/eats food/other organisms /eats ants/termites/ doesn't photosynthesise/does not produce its own food;	*Do not accept "it is not autotrophic" as it is part of the stem question.*	**1**
4.	**a**	**ii**	a. what (prey) it eats/feeds on/ stomach content; b. the trophic level of what (prey) it eats/feeds on/the trophic level of ants/termites; c. trophic level is the position an organism occupies in the food chain/web;	*Do not award points for indicating that predator information is needed.*	**2 max**
4.	**b**		a. hair; b. mammary glands/milk secretion; c. alveoli in lungs; d. lower mandible/jaw consisting of just one bone; e. giving birth to live young/are placental (apart from duck-billed platypus/echidna); f. external ears/ pinna; g. warm-blooded/endothermic/constant body temperature;	*Mpa: pangolin underside may be covered with sparse fur.* *Do not accept double circulation. Mpe: accept "do not lay eggs" as WTTE* *Do not accept internal fertilization.*	**2 max**
4.	**c**	**i**	20;		**1**
4.	**c**	**ii**	38 ***OR*** 19 <u>pairs</u>;		**1**

Question			Answers	Notes	Total
5.	**a**		a. water forms hydrogen bonds but methane does not/hydrogen bonds form between water molecules, but are absent in methane; b. energy needed to break hydrogen bonds/intermolecular attractions; c. hydrogen bonds raise the freezing point/boiling point/heat capacity/heat of vaporization;	*Mpa: A clear difference between the 2 substances is expected.* *Mpc: Do not accept "water has a high boiling point", etc. if no reference is made to hydrogen bonds.*	**2 max**
5.	**b**		a. boiling point of methane is -160°C ***OR*** methane is in gaseous state when temperatures are above/higher than -160ºC; b. temperatures on Earth are always above -160°C;	*Mpb: accept reference to Earth average temperature being warmer / higher than methane boiling point.*	**2**
5.	**c**		a. heat of vaporization is low/heat of vaporization is only 760 J g^{-1} ***OR*** methane has a lower heat of vaporization compared to water; b. no hydrogen bonds that need to be broken; c. not enough heat removed when methane evaporates; d. methane boils at -160 °C so would already be a gas (in/on the human body);	*Mpa: the second statement aims at the idea of a comparison* *Mpa: accept vice versa.* *If methane is not referred to directly in the answer, then award **[1 max]***	**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
6.	**a**		a. cell cycle is (repeated) sequence of cytokinesis/cell division, (then) interphase (then) mitosis / cell cycle includes the sequence of interphase, mitosis and cytokinesis/cell division (to form new cells which repeat the cycle); b. <u>cyclins</u> control/regulate this cycle / ensure the cell moves on to the next stage of the cycle when it is appropriate; c. extra cells produced when they are needed; d. tumour formation is the result of uncontrolled cell division/ cells growing and dividing endlessly; e. repeated mitoses/high mitotic index; f. due to mutations in <u>oncogenes</u> / <u>oncogenes</u> may become active and contribute to the development of a cancer cell; g. carcinogens/radiation/mutagenic chemicals/mutagens/smoking cause mutations/tumours;		**4 max**

(continued…)

(Question 6 continued)

6.	**b**		a. right atrium collects (deoxygenated) blood from the body; b. blood drains into atrium through/from the vena cava; c. deoxygenated blood present in vena cava/right atrium/right ventricle; d. right atrium pumps blood into the right ventricle; e. during atrial systole/ventricular diastole/at the start of the cardiac cycle; f. sinoatrial node is in the right atrium/sinoatrial node acts as the (natural) pacemaker / sinoatrial node initiates the heartbeat; g. SA node sends out electrical signal to stimulate contraction in the (walls of the) atria/then propagated to the AV node / (walls of the) ventricles;		**4 max**

(continued…)

(Question 6 continued)

Question			Answers	Notes	Total
6.	**c**		a. photosynthesis uses carbon dioxide / reduces carbon dioxide concentration of the atmosphere; b. autotrophs/plants/cyanobacteria convert/fix carbon dioxide into carbon/organic compounds; c. cell respiration produces/releases carbon dioxide; d. glucose/carbon/organic compounds oxidised/broken down to produce/release carbon dioxide; e. carbon dioxide released from aerobic (cell) respiration AND anaerobic respiration in yeast/plants (but not animals); f. carbon dioxide released from saprotrophs/detritivores/decomposers from dead organic matter / during decay/decomposition/respiration; g. (partially) decomposed organic matter can lead to the formation of peat / fossilized organic matter (coal/oil/natural gas) h. carbon dioxide released when carbon/organic compounds burn / during combustion (of biomass/fossil fuels) / forest fires; i. carbon dioxide dissolves in aquatic ecosystems / can form carbonic acid/hydrogen carbonate ions; j. reef-building corals/molluscs use calcium carbonate to make/build shells/exoskeletons or other body parts; k. hard parts/shells/exoskeletons / precipitation of calcium carbonate to form limestone/tufa;	*Clear annotated diagrams with correct direction of arrows are accepted.*	**7 max**

[Plus one mark for quality]

Question			Answers	Notes	Total
7.	a		a. composed of one or more polypeptides / some are single polypeptides others made of 2 or more polypeptide chains / all proteins consist of, at least, one polypeptide chain; b. a polypeptide/protein is a chain of amino acids; c. (chains of) amino acids linked by peptide bonds; d. twenty different amino acids/ amino acids have different R groups/ R groups can be hydrophilic/polar or hydrophobic/non-polar; e. primary structure is the <u>sequence/order</u> (and number) of amino acids in the polypeptide; f. any sequence/order of amino acids could be linked together hence many possible polypeptides/proteins; g. secondary structure is the formation of alpha/ α helices and beta/ β pleated sheets; h. secondary structure stabilized by hydrogen bonding; i. tertiary structure is the further folding of the polypeptide / tertiary structure is the three-dimensional (3-D) conformation/structure/shape of a protein; j. tertiary structure stabilized by interactions / ionic bonds/hydrogen bonds/disulfide bridges between R groups; k. <u>fibrous or globular</u> are the two main classes of conformation/three-dimensional/ 3-D structure/shape; l. conformation/three-dimensional (3-D) structure determined by amino acid sequence; m. quaternary structure if two or more polypeptides are linked to form a (single) protein ***OR*** quaternary structure if a prosthetic group is linked (to form a conjugated protein);	*Accept clearly annotated diagrams.* *Mpc: accept a clearly annotated diagram of the bond between 2 drawn amino acids.*	**7 max**

(continued…)

(Question 7 continued)

Question			Answers	Notes	Total
7.	**b**		a. pump proteins for <u>active transport</u>; b. movement of particles against the concentration gradient /from lower to higher concentration; c. requires ATP/energy (from ATP); d. channel proteins for <u>facilitated diffusion</u>; e. particles diffuse along the concentration gradient /from a higher to a lower concentration; f. channel proteins allow ions/charged/hydrophilic/polar particles to diffuse across (which would otherwise not be able to move across the hydrophobic regions of the membrane); g. aquaporins for movement of water (by osmosis); h. greater membrane permeability to water with more aquaporins; i. proteins that move substances across membranes are integral/intrinsic/transmembrane/ embedded in the phospholipid bilayer;	*Do not award points for roles of proteins not involved in the movement of substances across membranes.* *Accept clearly annotated diagrams.*	**5 max**

(continued…)

(Question 7 continued)

7.	**c**		a. gel electrophoresis involves separating molecules according to their size and charge; b. proteins differ in size (due to differing amino acids) / may be positively or negatively charged; c. place protein sample in a well in a sheet/film/block of gel; d. place the gel in an electrical field/between positive and negative electrodes / an electric current is run through the gel; e. proteins move through the gel; f. separated according to size/small proteins move faster/farther than large proteins; g. size markers/ladder used;	*Accept clearly annotated diagrams.*	**3 max**

[Plus one mark for quality]

Question			Answers	Notes	Total
8.	**a**		a. fossils show the types of organisms that lived in the past; b. fossils can provide direct (bones/teeth/shells/leaves) or indirect (footprints/tooth marks/burrows) evidence left in layers of rocks; c. fossils can be dated by radioisotope dating of the rocks that hold them / the study of the different strata/sediment layers can help determine the relative age of fossils; d. the sequence in which fossils appear matches the sequence in which species evolved; e. (sequences of) fossils show (progressive) change over time / fossils show the sequence in which characteristics appear; f. increase in complexity of structures over time/simplest organisms longest ago; g. example of fossil sequence / example of increase in complexity over time; h. dinosaurs/trilobites/other extinct group in the fossil record suggest that organisms change over time / fossils are evidence of species that no longer exist / transition species; i. evidence of similar features/structures / evolution of homologous structures link existing organisms with their likely ancestors / fossils can show common ancestry / evolution of homologous structures;	*Mpf: e.g. only bacteria (and no other organisms) in the oldest rocks* *Mpg: e.g. sequences showing stages in development of bird wings /* whales evolving from land-dwelling mammals.	**4 max**

(continued…)

(Question 8 continued)

8.	**b**		a. cross males/fruit flies of one strain/with a certain trait/characteristic/phenotype with females/fruit flies of another / fruit flies with different characteristics crossed; b. study/analyse the progeny/offspring of the cross; c. dihybrid crosses/the inheritance of two genes/genetic traits is investigated together/at the same time; d. (Morgan) discovered sex linkage/can be used to study sex-linkage; e. ratios are different for males and females/males XY and females XX; f. (Morgan's) discovery of non-Mendelian ratios; g. autosomal linkage/groups of genes that are on the same chromosome/ genes arranged in a linear sequence along the chromosome / gene mapping; h. *Drosophila*/fruit flies useful in inheritance experiments due to short life cycle/ many generations can be studied in a short span / can be easily grown in the lab/ large number of offspring produced;	*Mpe: Do not accept males XO*	**4 max**

(continued…)

(Question 8 continued)

Question			Answers	Notes	Total
8.	**c**		a. find/study/compare the DNA/base sequence of the same gene/genes in different organisms/species; b. find/study/compare the amino acid sequence of the same protein in different organisms/species; c. deduce which organisms/species are part of a clade / a clade is a group of organisms that have evolved from a common ancestor; d. use similarities/differences in sequence to construct a cladogram; e. cladogram shows the (most probable) sequence of divergence of a clade/group of clades / allow for visualization of how species emerged from common ancestors / deduce which organisms / species evolved from a common ancestor; f. deduce phylogeny/evolutionary origins; g. numbers of base/amino acid differences help deduce time since species diverged/reference to evolutionary/molecular clock / correlation between number of differences between two species and the time since they diverged from a common ancestor / node; h. deduce closeness of relationships / how closely related species are (according to similarities in base/amino acid sequence); i. used to help classify/reclassify groups of organisms/species; j. shows how closely humans are related to other primates; k. has caused changes to classification of the figwort family/other example of reclassification; l. distinguishing between homologous and analogous structures led to mistakes in classification / homologous structures relate to ancestry/ analogous structures relate to function/ similar due to convergent evolution	*Mpe: A diagram of a cladogram can be accepted. Minimum 3 branches. Allow species to be named A, B, C, D, etc.*	**7 max**

[Plus one mark for quality]