Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2024

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 **two** out of **three** questions in Section B. Maximum total = **72 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**	**i**	less/reduced/fewer producers/prey/organisms lower down in the food chain/energy passed on /resources;	*OWTTE.*	**1**
1.	**a**	**ii**	a. (climate change causes) increase of sea water temperature/ocean acidification affects number of/decreases prey/food chain; b. (climate change causes)/(increased temperatures cause) melting of ice cover/ less landing sites/breeding sites/sites for rest while foraging / loss of habitat;	*Do not accept vague answers related to Albatross not adapting.*	**1 max**
1	**b**		(all three have) decreasing/declining numbers/breeding pairs (over the 22 years)/ negative growth rate;	*OWTTE.* *Comparative terms and trends expected (do not award marking point for just stating values).*	**1**

Continued…

Question 1 continued

Question			Answers	Notes	Total
1	**c**	**i**	*Comparison: (**max. 2**)* a. both have an overall negative annual survival / (mean) annual survival below the level 100% (of a stable population); b. both have fluctuations/variations/some positive/negative periods; c. both (approximately) recover their original survival in 2012/at the end / survival for each species is similar in 1981 and 2012; *Contrast: (**max. 2**)* d. the grey-headed had the sharpest decrease/lowest value (in 2000); e. the grey-headed has the overall higher mean (annual) survival/ vice versa;	*Comparative terms and trends expected (do not award marking point for just stating values).*	**3 max**
1.	**c**	**ii**	a. different food sources/prey/food availability could cause variations/drops/peaks in survival; b. climate changes could have a different effect on each species; c. one species could be more susceptible to be caught in fishing nets/to be eaten by predator / one species better at camouflaging from predators; d. breeding sites/niche of one species affected (over time);	*Note: The answer must be clear that it refers to differences in survival **between the two species.*** *Mpb. OWTTE.* *Mpc. OWTTE.* *Do not award mp for stating differences in initial population size.*	**1 max**

Continued…

Question 1 continued

Question			Answers	Notes	Total
1.	**d**	**i**	1992;		**1**
1.	**d**	**ii**	a. (overall) fishing efforts (by 2012) have decreased while adult survival has returned to the original value (of 1982); b. decrease in fishing effort followed by/resulted in increase in adult survival (such as in 1985) ***OR*** increase in fishing level followed by/resulted in decrease in adult survival (such as in late 1990s/2000); c. lag period between changes in fishing efforts and adult survival; d. exception to general pattern when both fishing and survival dropped / when both fishing and survival increased (almost simultaneously) (such as between 1994 and 1997);	*Comparative terms and trends expected (do not award marking point for just stating values).* *Do not accept correlation.*	**2 max**
1	**e**	**i**	300%;	*Calculation not needed.*	**1**

Continued…

Question 1 continued

Question			Answers	Notes	Total
1.	**e**	**ii**	a. yes, because from 1999 to 2002 when krill density increased survival increased ***OR*** yes, because from 1996 to 1999/2002 to 2005 when krill density decreased survival decreased; b. no, because from 2005 to 2008 when krill density decreased the albatross survival increased ***OR*** no, because from 2008 to 2011 / 1996 to 2011 krill density increased and survival decreased; c. not enough data given of intermediate years / data is irregular / there is no clear relationship/correlation (between krill density and adult survival) over the years / not enough evidence from the graph (to draw valid conclusions);	*Accept any other valid examples and time periods.* *Reference to <u>changes</u> in krill density over specific periods of time are needed (as stated in the question) for mpa and mpb.*	**2 max**

Continued…

Question 1 continued

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>1.</td><td>f</td><td></td><td>
<table>
<tr><th>Variable</th><th>Possible reasons</th></tr>
<tr><td>Wind

2 Max</td><td>a. number of eggs laid not affected by wind because food is sufficient for adults / to produce eggs / because wind does not interfere with the natural process of breeding/reproduction;
b. reduced chick survival if wind not optimum, adults may have trouble finding (more) food for the young ones/foraging / parents may need to travel longer distances/flying more frequently to get more food for the chicks;
c. reduced chick survival if parents killed in fishing lines or nets;
d. reduced chick survival as changes in wind could bring predators of chicks to the breeding sites;
e. reduced chick survival as strong winds may affect/destroy nests/ chicks unprotected from strong winds / difficult to maintain body temperature;</td></tr>
<tr><td>No. of breeding pairs

2 Max</td><td>f. increased/larger total number of eggs laid (per population) as direct result of more breeding pairs reproducing/interbreeding / higher chances of fertilization;
g. percent chick survival not affected as the eggs that are laid seem to be healthy / a certain percentage of chicks always dies;
h. percent chick survival not affected (as parents supply) sufficient food / little or no competition for food;
i. percent chick survival not affected as no problem of over-population/ little or no competition for space;
j. percent chick survival not affected as lack of/few predators of eggs;</td></tr>
</table>
</td><td>2 Max for wind.

2 Max for breeding pairs.

The possible reasons given must mention the aspect of the life cycle analysed.

“offspring” or “young ones” can be OWTTE for chicks but not for eggs.

Mpf. requires an explanation. Do not award the mp if the answer just repeats the information on the table that increased number of breeding pairs results in increased number of eggs laid.</td><td>4 max</td></tr>
</table>

Question			Answers	Notes	Total
2.	a		a. plants convert radioactive CO_2/$^{14}CO_2$ into (radioactive) sugars (in photosynthesis); b. aphids feed from phloem containing (radioactive/ ^{14}C) sugars; c. using stylets (which are put into the phloem and due to the pressure, they fill with the sap); d. they can measure the amounts/concentration/quantity of radioactive sugars/sugars with ^{14}C present; e. over time/ at different times ***OR*** at different distances;	*Mpa. OWTTE.* *Mpc. OWTTE.* *Allow for named sugars. Do not allow "starch".*	**2 max**
2.	b		a. active transport loads the sugars into the phloem (at the source); b. high concentrations of sugars in the phloem causes water uptake (by osmosis); c. raised (hydrostatic) pressure moves contents of the phloem/the sap (towards the sink) ***OR*** low pressure at sink/pressure gradient makes sap flow from source to sink; d. transport in phloem is (known as) translocation;	*Mpa. Accept co-transport.* *Allow for named sugars. Do not allow "starch".* *Mpc. must refer to pressure (do not award marking point c if student repeats stem question "sugars are transported from sources to sinks").*	**2 max**

Question			Answers	Notes	Total
3.	**a**		lipids/fats/triglycerides;	*Accept first answer only.*	**1**
3.	**b**	**i**	BMI: 27 +/- 1;	*Units not required.* *Accept any values between 26 and 28.*	**1**

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Question 3 continued

Question			Answers	Notes	Total
3.	**b**	**ii**	a. they (are overweight and) should limit their intake of calories/lipids/fats/sugars in order to decrease their energy intake/ lose weight/ decrease BMI to prevent (coronary) heart disease (CHD)/type 2 diabetes; b. they (are overweight and) should increase their exercise in order to burn off calories/decrease weight/body mass/BMI/stored fat / to prevent (coronary) heart disease (CHD)/type 2 diabetes;	*The recommendation must include an explanation.* *The answer/explanation must imply that diet is for people with overweight.* *Mpa. Accept examples of foods with high energy contents as OWTTE.* *Mpb. Accept examples of named physical activities as OWTTE.* *Do not accept vague answers related to being healthier.* *ECF if BMI is wrong but suggestion corresponds correctly to the BMI category given.*	**1 max**

Question			Answers	Notes	Total
4.	**a**	**i**	mammoth;	*Accept Mammuthus.*	**1**
4.	**a**	**ii**	(gradual) divergence / divergent;	*Accept "Adaptive radiation".* *Do not accept "speciation".*	**1**
4.	**b**	**i**	a. occurs due to natural selection / adaptive radiation / different selection pressures; b. variation exists (among members of the same species) due to mutations/meiosis/sexual reproduction; c. different sized/shaped beaks/variation allow different foods to be eaten/ different beaks adapted for different diets; d. the best adapted/those with best adapted beaks to get more food survive/have higher chances of survival; e. (the best adapted) reach reproductive age/reproduce; f. pass on (advantageous) characteristics/genes/alleles/ (for beak shape) to offspring; g. (overtime) increased frequency of the best adapted beaks;	*Mpb. A reason for variation is expected.* *Award **max 2** points if no reference to beaks and feeding.*	**3 max**
4.	**b**	**ii**	a. (new body cells produced) by mitosis/mitosis occurs/growth is due to mitosis/mitosis maintains the diploid number of chromosomes; b. first DNA/ chromosomes replicate/DNA replication takes place; c. replicated chromosomes consist of two identical sister chromatids / DNA replication results in two identical sister chromatids; d. sister chromatids (separate and) move to opposite ends/poles (of the cell); e. two new identical nuclei are formed/ nuclear membrane reforms at each pole; f. cytoplasm divides into two/ cytokinesis occurs; g. to produce two genetically identical cells;	*Name of phases of mitosis not required.* *Accept clear annotated diagrams.* *Award no points for explanation of meiosis/fertilization as the question refers to a growing organism.*	**3 max**

Question			Answers	Notes	Total
5.	a		a. in the observed ratio, the brown long and black short are more numerous than expected ***OR*** in the observed ratio, the most numerous offspring show the parental phenotypes; b. the expected ratio is (a Mendelian ratio) based on unlinked genes/ genes on different chromosomes ***OR*** the expected ratio is due to independent assortment; c. the observed ratio is (non-mendelian) due to linked genes/genes on the same chromosome ***OR*** the observed ratio shows that the 2 genes don't segregate independently/are inherited together; d. crossing over occurs between linked genes / is the exchange of DNA material between non-sister chromatids; e. crossing over produces recombinants / new combination of alleles;	*Do not accept sex-linkage.* *Mpd. and mpe. should refer to crossing over.*	**3 max**
5.	b		*a.* to control variables (such as light/temperature/substrate/food) ***OR*** to determine optimal conditions (such as light/temperature/substrate/food); b. to control size of starting population / allows starting population to be fixed; c. prevent entry of other organisms (that could compete for resources/act as predators); d. reproducible / to make repeated trials / easy to replicate;		**2 max**

Continued…

Question 5 continued

Question			Answers	Notes	Total
5.	**c**		a. they labelled the protein coat of some phages/ bacteriophages/viruses with radioactive sulfur (^{35}S); b. they labelled the nucleic acid/DNA (of other) phages/bacteriophages/viruses with radioactive phosphorus (^{32}P); c. proteins contain S but no P while nucleic acids/DNA contain P but no S; d. (one group of/ some) bacteria were infected with the (radioactive) S-labelled viruses and (some/others) with the (radioactive) P-labelled ones; e. the bacteria infected by the viruses contained radioactive P/^{32}P (in their cytoplasm) / radioactive P/^{32}P found in pellet; f. radioactive S/^{35}S was not found inside bacteria/ radioactive S/^{35}S remained in supernatant; g. the viruses injected DNA with radioactive P/^{32}P (and not protein) ***OR*** the presence of radioactive P/ ^{32}P (but not radioactive S/^{35}S) determined the genetic material to be DNA (not protein);	*Do not award mpg. for general statements about viruses injecting genetic material or repeating the stem question "DNA is the genetic material" if no reference to the experiment is made.*	**3 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 respiration is controlled release of energy (from organic compounds/sugars/glucose) as ATP; b. anaerobic respiration does not require oxygen/O_2; c. anaerobic respiration/glycolysis occurs in cytoplasm / not in mitochondrion; d. glucose converted to pyruvate; e. (anaerobic respiration) produces small amounts/yield of ATP from glucose/ 2 ATP per glucose molecule; f. (anaerobic respiration) can produce ethanol <u>and</u> CO_2 (in baking/fermentation) ***OR*** can produce lactate (as in muscles);	*Allow marking points in annotated diagram.*	**4 max**

Continued…

Question 6 continued

Question			Answers	Notes	Total
6.	**b**		a. alveoli provide a large surface area (for easy diffusion of gases); b. thin walls/ 1-cell thick walls /type 1 pneumocytes/cells lining the alveoli are (extremely) thin (to facilitate gas exchange); c. a moist surface on the cells (to dissolve the gases/oxygen and carbon dioxide); d. type II pneumocytes secrete surfactant to reduce surface tension/prevent sides of alveolus sticking together; e. blood capillaries have thin walls/1-cell thick walls (for short path/easy diffusion of gases); f. good supply of blood / blood flow through capillaries around alveoli to maintain the concentration gradients of gases/ higher oxygen concentration in alveoli than in blood capillaries/ higher CO_2 concentration in blood capillaries that in alveoli; g. ventilation/breathing maintains concentration gradients of gases (between air in alveoli and blood capillaries) (to facilitate diffusion);	*Mpb. Refers to thin walls, not membranes.* *Mpd. Requires function of surfactant.*	**3 marks**

Continued…

Question 6 continued

Question			Answers	Notes	Total
6.	**c**		a. Calvin's experiment used algae/*Chlorella* in a round/thin/flat apparatus/"lollipop"; b. labelled carbon dioxide with radioactive carbon/ C14 / ^{14}C (supplied to algae); c. exposed the algae to light to promote photosynthesis; d. every 5/few seconds/at short time intervals, samples of algae were taken; e. carbon compounds separated using chromatography; f. radioactive carbon compounds/molecules with radioactive carbon/C14/^{14}C identified with x-rays (autoradiography) / molecules containing radioactive carbon/C14/^{14}C traced / glycerate 3-phosphate was the first compound detected/identified; g. Calvin cycle/carbon fixation is the light-independent phase (of photosynthesis); h. it takes place in the stroma (of the chloroplast); i. ribulose bisphosphate/RuBP carboxylated to glycerate 3-phosphate/G3P; j. catalysed by rubisco / (ribulose bisphosphate) carboxylase; k. glycerate 3-phosphate/G3P is reduced to triose phosphate (using reduced NADP/NADPH and ATP); l. triose phosphate is used to produce glucose; m. triose phosphate is used to regenerate RuBP;	*Allow clear annotated diagrams for marking points mpi to mpm.*	**8 max**

Question			Answers	Notes	Total
7.	a		a. (transcription) is the synthesis of mRNA (copied from the DNA/DNA base sequences / using DNA as a template); b. by complementary base pairing (to the antisense strand); c. the bases of mRNA are A, U, C, G; d. using the enzyme RNA polymerase; e. to form (covalent/phosphodiester) bonds between RNA nucleotides; f. occurs in the 5' to the 3' direction; g. nucleosomes / histones help regulate the process in eukaryotes; h. eukaryotes can modify mRNA after transcription / removal of introns/splicing of exons after transcription; i. splicing of mRNA increases the number of different proteins that an organism can make / by including or not a particular exon in the final mRNA different proteins may be coded;	*Accept clear annotated diagrams.* *Mpc. All 4 RNA bases needed.*	**4 max**
7.	b		a. Down's syndrome is due to an extra chromosome (21) / trisomy 21; b. occurs in meiosis; c. during anaphase (I or II); d. homologous chromosomes (21) fail to separate (in anaphase I) ***OR*** chromatids (21) fail to separate (in anaphase II); e. leads to a gamete/zygote with one extra chromosome (21); f. (mainly) occurs in ovaries; g. in the formation of egg cells/ova/gametes; h. probability of nondisjunction increases with paternal/maternal age;	*Mpe. Requires reference to gamete or zygote.*	**4 max**

Continued…

Question 7 continued

Question			Answers	Notes	Total
7.	**c**		a. testosterone causes (pre-natal) development of male genitalia; b. testosterone controls the development of male secondary sexual characteristics (during puberty/adolescence); c. testosterone controls sperm production; d. estrogen and progesterone cause (pre-natal) development of female reproductive organs; e. estrogen (and progesterone) controls the development of female secondary sexual characteristics (during puberty/adolescence); f. follicle stimulating hormone/FSH stimulates the growth of follicle in ovaries / FSH stimulates production of sperm (in men); g. FSH stimulates estrogen secretion (from developing follicles); h. luteinizing hormone/LH causes ovulation/formation of corpus luteum; i. thus LH stimulates estrogen/progesterone secretion (from corpus luteum) / LH stimulates testosterone (in men); j. estrogen builds/thickens/repairs uterine lining/endometrium; k. estrogen inhibits FSH (by negative feedback) **OR** estrogen stimulates LH (release) (by positive feedback); l. progesterone inhibits FSH and LH; m. progesterone thickens/maintains thick uterine lining/endometrium; n. hCG/human chorionic gonadotrophin stimulates the production of progesterone during pregnancy;	***Max 2** per hormone.* *Must include testosterone for full marks.*	**7 max**

Question			Answers	Notes	Total
8.	a		a. capsule; b. cell wall; c. plasma membrane; d. cytoplasm; e. 70s ribosomes; f. nucleoid area/naked DNA; g. plasmids; h. pilli/flagella;	*Drawing should be clearly drawn and labelled.* *Mpb. Cell wall must be thicker than cell membrane.* *Mph. Pilli shorter than flagellum.* ***Max 2** if an eukaryote cell is drawn (presence of **labelled** nucleus/mitochondria/ chloroplasts/lysosomes), or if drawing does not clearly show a bacterium, but 2 unique prokaryotic features are correctly labelled (capsule, 70s ribosomes, nucleoid/naked DNA, plasmids, pilli/flagella).*	**4 max**

Continued…

Question 8 continued

Question			Answers	Notes	Total
8.	**b**		a. skin acts as a physical barrier to the entrance of bacteria / acidic/low pH of skin inhibits growth of bacteria/pathogens; b. mucous membranes produce mucus that trap bacteria; c. acid in the stomach can kill bacteria; d. lysozymes in tears/saliva can kill bacteria; e. cuts in the skin use clots as a barrier; f. clotting factors are released from platelets (in the blood); g. prothrombin (in the blood) is converted to thrombin / thrombin becomes activated ***OR*** thrombin promotes the conversion of fibrinogen to fibrin ***OR*** fibrin helps to form the clot / insoluble fibrin forms a net trapping cells to form the clot;	*Mpa. OWTTE.*	**3 max**

Continued…

Question 8 continued

Question			Answers	Notes	Total
8.	**c**		a. antigens found on (outer) surface of pathogens/bacteria; b. macrophages/phagocytes/phagocytic white blood cells engulf pathogens and display their antigens; c. T-lymphocytes/T-cells (specific to the antigen) become activated (by the macrophage); d. (activated)T-lymphocytes/T cells activate B-lymphocytes/cells; e. (activated) B-lymphocytes/B cells multiply/divide by mitosis; f. to form (clones) of plasma cells; g. and memory cells; h. plasma cells secrete (large quantity of) antibodies; i. antibodies are <u>specific</u> to the antigen; j. antibodies help/aid destroy the pathogens (in different ways); k. memory cells persist and allow rapid future response ***OR*** memory cells give long-term immunity; l. memory cells (rapidly) produce the same antibodies when pathogen encountered in the future; m. vaccines contain (specific) antigens of (specific) pathogens/ weakened/inactivated pathogens; n. these antigens trigger immunity in the same way but without causing the disease;	*Mpe. Accept clonal selection as alternative to mitosis.* *Mpl. OWTTE.*	**8 max**