Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2023

Biology

Higher level

Paper 2

17 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. 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.

11. 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 "Answers" column 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) in the "Notes" column.

12. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

13. 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.

14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

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.

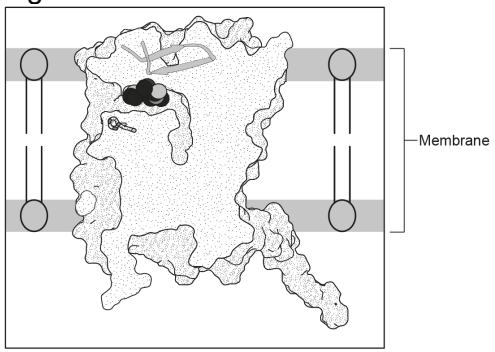
- Candidates that score very highly on the content marks need not necessarily automatically gain **[1]** for quality (and *vice versa*).

Section A

Question			Answers	Notes	Total
1.	a		*Similarity* both rise to peak/maximum/are highest in summer/warmest months/June/July/August ***OR*** both lowest in winter/December/January ***OR*** both rise then fall; *Difference* temperate always higher/higher overall/higher throughout year ***OR*** temperate peak is higher/is one month later/is in August versus July in arctic;	*For the difference, accept answers given as the converse of the mark point.* *For the difference, do not accept answers stating just that arctic LAI is lower or that the arctic has lower LAI on average.*	**[2]**
	b		a. climate/temperature/light consistent throughout year in equatorial but seasonal variation in boreal; b. conditions suitable for photosynthesis throughout the year in equatorial but not in boreal; c. temperatures higher/growing season longer in equatorial versus lower/shorter in boreal; d. water frozen/unavailable in boreal during winter whereas always available in equatorial; e. shorter daylengths in winter in boreal (than those months in equatorial so lower LAI); f. boreal LAI higher (than equatorial) in July due to longer daylengths; g. equatorial trees/plants are evergreen / boreal trees/plants are deciduous/have less/no leaves in winter; h. variation in angle of light rays (between different latitudes);		**[3 max]**

Question			Answers	Notes	Total
1.	**c**		a. decreases in LAI during El Niño **OR** increases in LAI between El Niño events; b. 1983-4/other example of a decrease during El Niño **OR** 1984-6/other example of increase between El Niño events; **OR** 94-95/2009 anomalous as LAI rises during El Niño event; **OR** 99-2000 anomalous as LAI decreases between El Niño events; c. larger decrease (in LAI) with more intense/longer El Niño events **OR** no/less decrease during less intense/briefer El Niño events;	*Mpa refers to changes in LAI, not whether levels were high or low.* *The example given for mpb must correspond with the trend given in mpa. The graph does not show the years clearly so we must show some lenience in mpb – award this mark if it is clear which period the candidate was referring to.* *For mpa, do not accept answers implying that decreases in LAI cause El Niño or increases in LAI prevent El Niño.*	**[2 max]**
	d	**i**	Increase/increasing/upwards/rising (trend);	*Reject 'positive', 'positive trend' and 'positive correlation'* *Accept linear increase.*	**[1]**
		ii	a. more <u>photosynthesis</u> (with higher carbon dioxide concentration); b. more plant growth/more (plant) biomass/more leaves/more plants;	*If the answer focuses on greenhouse effect or global warming, do not award mpa, but mpb can be awarded if one of the alternatives is included in the answer.*	**[2]**
	e		increases it/higher (maximum annual net primary production);	*The answer must be referring implicitly or explicitly to NPP.*	**[1]**

Question			Answers	Notes	Total
1.	f		check whether trend is confirmed/replicated/not specific to some forests **OR** investigate worldwide effects (of rising carbon dioxide) **OR** (check whether results are affected by) differences in tree species/types of tree/soil types/rainfall/temperature/climate/latitudes/conditions/biome/ecosystem;	*Reject general answers about reliability or anomalies.*	**[1]**
	g		a. more carbon stored/allocated (by the tree as a whole) with elevated carbon dioxide; b. evidence (from the bar chart) is strong (for the trend/hypothesis); c. all elevated plots have more carbon stored than all ambient plots in all sites/no overlap; d. more/most carbon allocated to <u>wood</u> (in stems and roots) with elevated carbon dioxide; e. more carbon allocated to narrow roots/leaves with elevated carbon dioxide; f. narrow roots increase most in Oak Ridge; g. most increase in wood (in stems and roots) in Rhinelander and Duke; h. much/more variation between plots at Oak Ridge (than at Rhinelander and Duke); i. no error bars so significance of differences is uncertain;	*Accept mpd and mpe if the answer refers only to Rhinelander and Duke.* *Allow mph if the answer describes an anomaly at Oak Ridge that does not follow the trend seen in Rhinelander and Duke.*	**[3 max]**

Question			Answers	Notes	Total
2.	**a**		phospholipid shown with circular head and 2 tails; e.g.  [Source: Material from: Stauch, B., Johansson, L.C., McCorvy, J.D., et al., Structural basis of ligand recognition at the human MT1 melatonin receptor, published 2019, *Nature*, reproduced with permission of SNCSC.] phospholipid shown in either the upper or lower half of the membrane only with its head at the margin of the membrane and tails towards centre;	*Accept answers with two or more phospholipids shown, as long as all are correct.*	**[2]**
	b		beta pleated sheet/beta-loop/beta strands;	*Reject 'beta helix'*	**[1]**
	c		polar/hydrophilic where exposed to the cytoplasm/to fluid outside cell/to polar phospholipid heads; non-polar/hydrophobic where exposed to the (core of the) membrane/hydrophobic tails (of phospholipids);		**[2]**
	d		a. control/maintain/regulate circadian rhythms; b. secreted/released late evening/end of day/in dark/night time/dim light/absence of blue light; c. helps to induce sleep/sleepiness/influences timing of sleeping/waking/control sleep cycle;	*Do not award mpb unless the answer is referring to secretion, not just correlations.*	**[2 max]**

Question			Answers	Notes	Total
3.	**a**		a. if antibiotic is in the environment/soil there is selection (pressure); b. bacteria without resistance (gene) die / converse; c. bacteria with resistance (gene) reproduce **OR** bacteria exchange/obtain resistance genes using plasmids/by conjugation; d. offspring inherit (the gene for) resistance/resistance passed on (to offspring);	*Do not award marks for general statements about natural selection – answers must refer to antibiotic resistance.*	**[3 max]**
	b	**i**	a. viruses lack metabolism/plasma membranes/cell walls / viruses are not living organisms; b. antibiotics kill/target bacteria/prokaryotes but not viruses; c. viral pathogens of animals use animal metabolism (which is not affected by antibiotics);		**[1 max]**
		ii	a. antibiotics (only) affect/kill/block processes in bacteria/prokaryotes / do not affect eukaryotes; b. metabolism/protein synthesis/ribosomes/cell walls not targeted in insects/animals/eukaryotes; c. no cell walls in animals (so antibiotics cannot attack cell walls); d. antibiotics are secreted (by microbes/fungi) to prevent competition (with other microbes);		**[2 max]**

Question			Answers	Notes	Total
4.	**a**	**i**	10;		**[1]**
		ii	hydrogen bonds/H bonds;		**[1]**
	b	**i**	a. heat increases molecular motion/vibration; b. (hydrogen) bonds break; c. evaporation is separation of water molecules / water changes from liquid to gas/vapour; d. heat removed from skin surface/body;		**[2 max]**
		ii	a. cooling/removing heat/lowering body temperature; b. to prevent overheating ***OR*** to help maintain body temperature/for temperature homeostasis/for thermoregulation ***OR*** to keep temperature at 37 °C;		**[2]**

Question			Answers	Notes	Total
5.	**a**		a. allele/trait/gene for banded is dominant / for unbanded is recessive; b. because there is a ratio of 3 banded:1 unbanded **OR** because two banded spiders produced some unbanded offspring; c. both parents are heterozygous;	*Accept answers given in the form of Punnet squares.*	**[2 max]**
	b		a. (1:1 ratio) in cross 2 as banded parent is heterozygous/has one copy of each allele; b. (no unbanded offspring) in cross 3 as banded parent is homozygous/has two alleles for banded; c. (in crosses 2 and 3) banded parental phenotypes are the same but their genotypes are different;		**[2 max]**
	c		0 | 79 | 0.000;	*All three parts of the answer must be correct for the mark to be awarded.*	**[1]**
	d		arthropods (as spider has) segmentation/exoskeleton/jointed limbs/jointed appendages/bilateral symmetry;		**[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
6.	**a**		a. ADH (secreted by pituitary) if body/blood is dehydrated/hypertonic/has high solute concentration; b. more aquaporins / aquaporins open (in collecting duct); c. collecting duct more permeable to water/reabsorbs more water (from filtrate/urine); d. water reabsorbed by osmosis/water reabsorbed because medulla is hypertonic; e. (reabsorbed) water passes (from filtrate) to blood / blood solute concentration reduced; f. less water lost in urine / smaller volume of (more concentrated) urine; g. negative feedback / less/no ADH secreted when blood solute concentration returns to normal;	*Do not accept answers suggesting that ADH has a different effect when body fluids are hypotonic.*	**[4 max]**
	b		a. final product in pathway acts as an inhibitor/blocks (reaction)/slows (reaction); b. first/early/earlier enzyme (in pathway is inhibited); c. non-competitive / binds at allosteric site / causes active site to change; d. production of end-product reduced/paused when there is an excess; e. isoleucine inhibits enzyme using threonine as substrate at start of pathway to isoleucine; f. negative feedback / production restarts when end-product used up/concentration drops;	*For mpe accept other examples of end-product inhibition if verified. Please add a note in such cases.*	**[4 max]**

Question			Answers	Notes	Total
6.	**c**		*Preparing the woman's body for pregnancy* a. FSH stimulates estrogen secretion (by the developing follicle); b. estrogen increases FSH receptors so boosting estrogen production/so causing positive feedback; c. estrogen stimulates repair/thickening of the endometrium/uterus lining; d. high levels of estrogen stimulate LH production/inhibit FSH secretion (negative feedback); e. LH (surge/peak) stimulates ovulation; *Sustaining pregnancy* f. LH stimulates the development of corpus luteum / corpus luteum secretes progesterone; g. progesterone inhibits FSH/LH secretion (negative feedback); h. progesterone maintains lining of uterus/endometrium (for pregnancy/implant of embryo); i. progesterone inhibits uterine contractions; j. HCG (secreted by embryo) stimulates maintenance of corpus luteum; *Childbirth* k. oxytocin stimulates uterine/myometrial contractions which stimulate oxytocin secretion; l. positive feedback (mechanism used to stimulate childbirth);		**[7 max]**

Question			Answers	Notes	Total
7.	**a**		a. pairing/synapsis of homologous chromosomes / homologous chromosomes form bivalents; b. crossing over / chromatid breaks then rejoins to non-sister chromatid; c. exchange of DNA/alleles/genetic information between chromatids/chromosomes; d. recombination / new combinations of alleles/genes generated; e. condensation/shortening/thickening/supercoiling of chromatids/chromosomes; f. formation of a chiasma where crossing over occurred;		**[4 max]**
	b		*replication* a. helicase unwinds the double helix/DNA; b. helicase breaks hydrogen bonds between/separates/unzips DNA strands; c. (DNA) gyrase/topoisomerase releases tensions in DNA as it unwinds; d. (DNA) primase adds RNA primers (where DNA polymerase can bind); e. DNA polymerase (III) replicates DNA/adds nucleotides (to make new strand); f. DNA polymerase I replaces RNA (primers) with DNA; g. DNA ligase seals nicks/joins sugar-phosphate backbones/joins (Okazaki) fragments; *transcription* h. RNA polymerase used for transcription; i. RNA polymerase unwinds / separates DNA strands / binds to the promoter; j. RNA polymerase copies DNA base sequence of a gene/makes mRNA; k. restriction enzymes/endonucleases cut DNA at specific base sequences; l. telomerase adds nucleotides to the ends of chromosomes/makes telomeres;		**[7 max]**

Question			Answers	Notes	Total
7.	**c**		*Mutation* a. (environment can cause) <u>mutation</u>; b. mutations are base sequence changes; c. radiation/UV/gamma rays can cause mutations/changes to base sequences; d. mutagenic/carcinogenic chemicals can cause mutations / mustard gas/another example; *Epigenetics* e. (environment) can cause changes to <u>gene expression</u>; f. methylation (patterns) in DNA changed (in response to environmental factors); g. methylation inhibits (gene transcription) / acetylation promotes (gene transcription); h. body temperature/stress/diet (can affect gene expression);	*For mpd do not allow 'mutagen' instead of 'mutagenic chemical' as it includes forms of radiation as well as chemicals.* *Allow smoking and asbestos as examples of mutagens /carcinogens in mpd.*	**[4 max]**

Question			Answers	Notes	Total
8.	**a**		a. fluidity of membranes allows vesicles to bud off membranes/fuse with membranes; b. materials taken into cells by endocytosis/vesicle formation; c. *Paramecium* takes in food / phagocytes engulf pathogens / another example; d. materials released from cells by exocytosis/by vesicle fusing with plasma membrane; e. neurotransmitter released at synapses / protein secretion / secretion from gland cell / another example; f. movement/transport of materials (inside vesicles) within cells/through the cytoplasm/between organelles/from an organelle to the (plasma) membrane/from the (plasma) membrane to an organelle; g. movement of proteins from the rough ER to the Golgi / another example;		**[5 max]**
	b		a. transport/translocation in (phloem) sieve tubes; b. flow of sap through pores in end walls/sieve plates; c. sugar/amino acids are transported dissolved in water/sap; d. loaded into phloem (companion cells/sieve tubes) by active transport; e. protons pumped out and sucrose then enters by cotransport; f. high solute concentration created in phloem/sieve tube; g. water enters (sieve tube) by osmosis; h. hydrostatic pressure in sieve tube increases; i. unloading from sieve tubes in sink/in roots; j. water leaves by osmosis lowering the hydrostatic pressure; k. sap movement (in phloem) from higher to lower pressure; l. movement from source/leaves to sink/roots;		**[7 max]**

Question			Answers	Notes	Total
8.	**c**		a. by muscles (contracting); b. peristalsis/waves of muscle contraction followed by relaxation; c. longitudinal muscle pushes food along the intestine when it contracts; d. circular muscle constricts the intestine to ensure movement only onwards/not back to stomach; e. movement (from stomach to large intestine) via the small intestine/duodenum/ileum;		**[3 max]**