Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2023

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 = **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**		allows comparisons (between mice/with other animals of different body mass) ***OR*** compensates/OWTTE for the different body masses (of individual mice);	*No mark for vague and general answers such as fair test, more accurate, more precise, helps to interpret the data, easier to analyze.*	**1**
1.	**b**		lactate; glutamine;		**2**
1.	**c**		palmitic acid because it has the lowest F_{circ} in relation to its blood concentration;		**1**
1.	**d**		a. (circulatory turnover flux/F_{circ}) increases/higher for feeding than fasting / lower for fasting than feeding (for each metabolite); b. largest/large/most significant increase with glucose; c. smallest <u>percentage</u> increase with lactate; d. small/smallest (absolute) increase with glutamine;	*Do not award a mark for comments about changes in the spread of the data.*	**2 max**

(Continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	**e**		a. rise in blood glucose / glucose produced by digestion / glucose absorbed from food / absorbed in small intestine / absorbed into blood (in feeding mice); b. insulin secreted in feeding mice/in response to increased blood glucose concentration; c. insulin causes more uptake/metabolism/storage (as glycogen) of glucose (by cells/liver/muscle); d. both consumption/metabolization/uptake into cells and production/absorption into blood increase/OWTTE; e. F_{circ}/flux increases because glucose metabolized faster/at a higher rate;	*Accept the converse of any of the mark points for fasting mice, for example glucose not absorbed into the blood in fasting mice for mpa.*	**3 max**
1.	**f**		kidney;		**1**
1.	**g**		a. brain uses highest/higher (proportion of)/more glucose; b. brain uses more/higher/highest total proportion of these (three) metabolites than other organs; c. brain uses less glutamine than other organs (except the heart);	*Do not award marks for statements that refer only to the brain and do not distinguish, explicitly or by clear implication between brain and other organs.* *Do not award marks for stating values without comparative terms.*	**2 max**

(Continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	**h**		a. (hypothesis) not supported except in the brain /(hypothesis) only supported for brain; b. highest turnover/F_{circ} of lactate/higher turnover/F_{circ} of lactate than glucose; c. <u>in both fasting and feeding</u> mice turnover/ F_{circ} of lactate is higher than glucose; d. glucose is the main metabolite (only) in the brain (and heart of feeding mice); e. more/most glutamine/lactate used (than glucose in organs of fasting mice) apart from <u>brain</u>; f. more/most glutamine/lactate used in organs <u>of feeding mice</u> apart from the <u>brain and heart</u>;	*Do not award mpa if the candidate states that the hypothesis is both supported and not supported, but other mark points can still be awarded.* *If mpb has been awarded, mpc should also be awarded if the answer makes it clear that lactate is higher than glucose in both feeding and fasting mice.*	**3 max**

Question			Answers	*Notes*	Total
2.	**a**		anticodon ***OR*** to bind/attach to the codon ***OR*** to bind/attach to GAC/CAG on the mRNA ***OR*** for complementary base pairing to mRNA;		**1**
2.	**b**		a. enzymes ensures that a specific amino acid/aspartic acid binds to tRNA; b. tRNA activating enzyme; c. enzyme only binds to this tRNA/recognizes the shape of this tRNA; d. different activating enzymes for different tRNAs; e. attached amino acid/aspartic acid corresponds to anticodon/CUG/GUC;		**2 max**
2.	**c**		a. binding sites are <u>on the ribosome</u>; b. A site for attachment/arrival/binding of an <u>tRNA</u> (carrying an amino acid); c. P site where a peptide bond is made/where amino acid linked to polypeptide ***OR*** where tRNA is holding the growing polypeptide ***OR*** where the polypeptide is elongated ***OR*** where tRNA carrying methionine/MET/tRNA with the start codon binds during initiation; d. E site for exit/detachment of (free) tRNA from ribosome;		**3 max**

Question			Answers	Notes	Total
3.	**a**		DNA/deoxyribonucleic acid;	*Do not accept nucleic acid or RNA*	**1**
3.	**b**		a. identical/the same; b. (because of) asexual reproduction/vegetative propagation/mitosis/DNA replication; c. clones/produced by cloning; d. any differences would be due to mutation;		**2 max**
3.	**c**		a. nucleus removed from egg cell/ovum ***OR*** unfertilized egg taken from sheep/animal and nucleus removed; b. body/somatic cells removed from donor/another animal/sheep; c. enucleated egg and body cell/donor cell fused ***OR*** egg cell nucleus replaced by somatic/body cell nucleus; d. (resulting) embryo/cell implanted in surrogate/mother/another individual;		**3 max**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>4.</td><td>a</td><td></td><td>CcRr / RrCc;</td><td>Do not accept ‘double heterozygote’</td><td>1</td></tr>
<tr><td>4.</td><td>b</td><td></td><td>EITHER
a. purple if at least one dominant allele of <u>both</u> genes / C_R_;
b. white if either gene is homozygous recessive / with either cc_ _ or _ _rr;
c. 1 (of 16) is white with ccrr;
d. 3 are white with cc_ _ and 3 are white with _ _rr;
e. ratio is 9:3:3:1 but 3 + 3 + 1 have the same phenotype/are all white;

OR
f. all gametes (of F1 parents) shown correctly (on Punnett grid);
g. all genotypes of F2 offspring shown correctly (on Punnett grid);
h. all phenotypes shown correctly (on Punnett grid)
OR
answer indicates that C_R_ gives purple flowers and other genotypes give white;

<table><tr><td></td><td>CR</td><td>Cr</td><td>cR</td><td>cr</td></tr><tr><td>CR</td><td>CCRR
purple</td><td>CCrR
purple</td><td>cCRR
purple</td><td>cCrR
purple</td></tr><tr><td>Cr</td><td>CCRr
purple</td><td>CCrr
white</td><td>cCRr
purple</td><td>cCrr
white</td></tr><tr><td>cR</td><td>CcRR
purple</td><td>CcrR
purple</td><td>ccRR
white</td><td>ccrR
white</td></tr><tr><td>cr</td><td>CcRr
purple</td><td>Ccrr
white</td><td>ccRr
white</td><td>ccrr
white</td></tr></table></td><td>Allow either mpa to mpe OR mpf to mpg, not a combination of marks from the two approaches to answering the question.

For mpf, mpg and mph a Punnett grid can be drawn, but answers can also be accepted without a Punnett grid if the four types of gametes and all the types of genotypes and resulting phenotypes are clearly indicated.</td><td>3 max</td></tr>
</table>

(continued…)

(Question 4 continued)

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>4.</td><td>c</td><td></td><td>CcRr, Ccrr, ccRr and ccrr
OR
1 purple : 3 white
OR
<table><tr><td></td><td>Cr</td><td>cr</td></tr><tr><td>cR</td><td>CcRr /purple</td><td>ccRr /white</td></tr><tr><td>cr</td><td>Ccrr /white</td><td>ccrr /white</td></tr></table></td><td>Accept percentages instead of ratios in the second alternative and accept 4 purple : 12 white.

A Punnett square can be used for the answer showing gametes plus genotypes and/or phenotypes.</td><td>1</td></tr>
</table>

Question			Answers	Notes	Total
5.	**a**		a. beta/β glucose (subunits/monomers in cellulose) / diagram showing position of OH groups in beta glucose molecule; b. C1 to C4 bonds / glycosidic bonds (between glucose molecules); c. unbranched/linear (polymer/molecule/chain); d. straight/not helical (polymer/molecule/chain); e. glucose subunits orientated alternately upwards and downwards/OWTTE; f. hydrogen bonding between adjacent cellulose molecules/polymers;	*Marks can be awarded for annotated diagrams that make any of mpb to mpe clear.*	**3 max**
5.	**b**	**i**	a. entry of water by osmosis; b. because solute concentration is higher inside (the cell) / because solute/water potential is more negative inside / because the bathing medium is hypotonic; c. because cell wall does not expand / cell wall prevents the cell from increasing in volume / cell wall allows high pressure/turgor pressure to build up (without the cell bursting);	*Reject statements that the cell wall can prevent water leaving the cell.*	**2 max**
5.	**b**	**ii**	prevents bursting;	*Do not accept 'prevents collapsing'*	**1**

(continued…)

(Question 5 continued)

Question			Answers	Notes	Total
5.	**c**		a. auxin causes (specific) genes to be transcribed/expressed; b. stimulates proton pumps/causes movement of hydrogen ions into cell wall/through plasma membrane; c. hydrogen ions/low pH/acidity loosens connections between cellulose (microfibrils/fibers) ***OR*** hydrogen ions/acidity activates expansin / expansin breaks/reforms connections between cellulose; d. loosened cellulose can move apart/separate so wall becomes weaker/can expand;		**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. carbon dioxide excreted by alveoli; b. network of capillaries surrounds the alveolus wall; c. diffusion of carbon dioxide; d. carbon dioxide from the blood to air/alveolus/lungs; e. single layers of cells/thin cells/thin (alveolus/capillary) walls / short distance for diffusion; f. high concentration of carbon dioxide in blood (in pulmonary artery/capillaries) / lower concentration of carbon dioxide in (alveolar) air than in blood; g. (some) air from alveolus/lungs passes out of body; h. (air forced out) by ventilation/exhalation/expiration; i. due to lungs/thorax increasing in pressure/decreasing in volume; j. air flow from high/higher to low/lower pressure; k. when the diaphragm/external intercostals relax / when elastic fibres (around alveoli) recoil; l. contraction of muscles in the abdomen wall/internal intercostal muscles; m. (air containing CO_2) flows out through the bronchioles/bronchi/trachea;	*Reject oxygenated /deoxygenated in place of low/high carbon dioxide concentrations.*	**7 max**

(continued…)

(Question 6 continued)

Question			Answers	Notes	Total
6.	**b**		a. ultrafiltration/urea filtered out (of blood plasma); b. in the Bowman's capsule/from the glomerulus; c. water reabsorbed from filtrate; d. in the proximal convoluted tubule/PCT/collecting duct/nephron; e. (reabsorption of water) because medulla is hypertonic / because solute concentration in filtrate is lower than in nephron wall (cells); f. due to solutes/ions being reabsorbed by active transport; g. loop of Henle generates/maintains hypertonic conditions in the medulla; h. no urea/less urea reabsorbed (from filtrate); i. ADH causes more water reabsorption by aquaporins;	*Accept 'higher solute concentration' instead of hypertonic.*	**5 max**
6.	**c**		*Similarities:* a. both expel CO_2/toxins/nitrogenous waste/waste products of metabolism; *Differences:* b. Paramecium does not have special organs for excretion ***OR*** humans do have (special) organs/kidneys/lungs/skin/liver for excretion; c. unicells/Paramecium excrete through their plasma membrane; d. (entirely) passive/by diffusion in unicells/Paramecium but humans use energy/active transport (to move blood/air/solutes); e. humans excrete urea whereas Paramecium excretes ammonia;	*Reject answers stating that Paramecium excretes waste products by exocytosis.*	**3 max**

Question			Answers	Notes	Total
7.	**a**		a. <u>autotrophs</u>/<u>producers</u>/<u>plants</u> provide energy for consumers/heterotrophs/the community; b. autotrophs convert light to chemical energy / photosynthesis; c. energy flows along food chains/through food webs; d. example of food chain with at least three named organisms and arrows to show energy flow; e. <u>heterotrophs</u> rely on carbon compounds/food from other organisms (for their energy); f. <u>consumers</u> ingest food/digest food internally; g. <u>primary consumers</u>/<u>herbivores</u> feed on/rely on producers/plants/autotrophs; h. <u>secondary consumers</u> feed on primary consumers/predators feed on prey; i. <u>detritivores</u> ingest/eat dead organic matter/digest dead organic matter internally; j. <u>saprotrophs</u>/<u>decomposers</u> feed on dead organic matter (produced by other organisms); k. <u>saprotrophs</u> digest externally / secrete/release digestive enzymes; l. energy not recycled/energy lost as heat/lost due to respiration/energy lost between trophic levels;	*Mpg and mph can be awarded for a food chain in which the trophic levels are specified, and the answer makes it clear that arrows indicate feeding relationships.*	**7 max**

(continued…)

(Question 7 continued)

Question			Answers	Notes	Total
7.	**b**		a. larger cell /host cell/cell with nucleus/eukaryotic cell engulfed/took in bacteria/prokaryotes; b. taken in by endocytosis/phagocytosis / taken into a vesicle/vacuole; c. not digested; d. mutualistic relationship / both host cell and ingested cell benefitted from the relationship / example of benefits; e. aerobically respiring bacterium engulfed/taken in/incorporated/absorbed/endocytosed; f. evolved into mitochondria / mitochondria were once independent cells/prokaryotes; g. cyanobacterium/photosynthetic bacterium engulfed/taken in/incorporated/absorbed/endocytosed; h. evolved into chloroplasts / chloroplasts were once independent cells/prokaryotes; i. chloroplasts/mitochondria have double membrane due to endocytosis/chloroplasts/mitochondria have (circular) DNA/70S ribosomes due to endosymbiosis;		**5 max**
7.	**c**		a. mutualistic relationship; b. pollinator transfers pollen from anther/stamen to stigma/from plant to plant; c. transfer of pollen between plants/cross-pollination increases diversity; d. pollinator obtains/gains pollen/nectar; e. plant gains higher chance of pollination/transfer of pollen to stigma (than if blown by wind); f. pollination/transfer of pollen needed for fertilization/reproduction/seed production in (flowering) plants;	*Do not accept symbiotic instead of mutualistic in mpa.*	**3 max**

Question			Answers	Notes	Total
8.	**a**		a. mutations generate variation/generate new traits; b. mutations are changes to <u>base</u>/<u>nucleotide</u> sequence (of DNA/genes); c. new alleles are formed by mutation; d. meiosis/sexual reproduction generates new combinations of genes/alleles; e. <u>natural selection</u>; f. better adapted (individuals) have higher chance of survival; g. better adapted (individuals) (tend to) produce more offspring/more likely to reach reproductive age; h. heritability / traits/genes passed on (to offspring) / offspring inherit genes/alleles of their parents; i. directional selection causes change in traits; j. environmental change/environmental pressure causes selection of advantageous mutations/new traits; k. antibiotic resistance/melanism in moths/other evidence-based example of development of new traits; l. development of new traits over time is evolution;	*Reject examples of speciation for mpk.*	**7 max**

(continued…)

(Question 8 continued)

8.	**b**		a. polyploidy is having more than two sets of (homologous) chromosomes; b. triploids have three sets of chromosomes/tetraploids have four sets of chromosomes; c. polyploid/tetraploid cells generated from diploid cells by DNA replication without cytokinesis/non-disjunction (of all bivalents) during meiosis; d. tetraploids produce diploid/2n gametes; e. fusion of diploid and haploid gametes results in triploids; f. triploids are sterile/no gametes produced because pairing of homologous chromosomes/meiosis fails; g. diploids and tetraploids are reproductively isolated / tetraploids cannot interbreed with the diploid parent species / diploids and tetraploids only produce infertile offspring when they cross; h. polyploids/tetraploids are therefore a different/new species (according to the biological species definition);	*Reject polyspermy as the origin of polyploid cells*	**5 max**
8.	**c**		a. binomial system ***OR*** (first name is) genus name and (second name is) species name; b. internationally agreed system/same system used by all scientists/used throughout the world/universal; c. (genus name) indicates which the most closely related species are/OWTTE; d. avoids confusion caused by use of common/local names; e. binomial name is unique to the species ***OR*** easier to name newly discovered species;		**3 max**