Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2021

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 tick (✓) 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

			Answers	Notes	Total
1.	**a**	**i**	240 ✓	*Reject 'about 240' and any answer other than 240*	**1**
1.	**a**	**ii**	reduces it ✓		**1**
1.	**b**		*similarities* a. both extracts reduce the mitotic index/percentage of cells undergoing mitosis OR mitotic index decreases as concentration of both extracts increases / negative correlations ✓ *differences* b. avocado (extract) more effective/reduces MI more (at higher concentrations) OR lower MI with avocado (than jasmine) above 2500/at 5000 to 20000/at 20000 ✓ c. at lower concentrations jasmine (extract) more effective/reduces MI more OR lower MI with jasmine (than avocado) below 5000/at 100 to 2500 ✓	*Accept MI for mitotic index* *and accept crepe or jasmine for T. divaricata.* *For similarities in mpa the answer must refer to the different extracts together, not in separate parts of the answer.* *For mpb or mpc the differences can be expressed in the reverse, for example jasmine less effective at higher concentrations for mpb.* *Do not award marks for quoting figures without a statement of the similarity or difference.* *For the first alternatives of mpb and mpc, do not accept 'greater rate' instead of 'more'.*	**3 max**
1.	**c**		a. % in prophase increased (at higher extract concentrations) ✓ b. % in metaphase decreased (slightly) ✓ c. % in anaphase with telophase decreased ✓	*Do not award mpa for 'prophase percentage is highest'* *The initial rise of metaphase % is unlikely to be significant so this and other fluctuations are not included in the mark scheme.*	**2 max**

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	d		a. yes / extracts (do contain chemicals that) block mitosis (in broad bean root tips) ✓ *evidence from table of mitotic indices* b. lower MI shows (both) extracts prevent cells from undergoing/entering/starting mitosis ✓ *evidence from bar charts* c. avocado increases prophase % indicating progression to metaphase/through mitosis slowed/blocked **OR** avocado decreases metaphase and anaphase-telophase % indicating progression from prophase/through mitosis slowed/blocked ✓ d. jasmine increases metaphase % so progression to anaphase/through mitosis slowed/blocked **OR** jasmine reduces prophase % so (entry to/start of) mitosis slowed/blocked ✓	*Do not award mpa if no attempt at deduction is presented in the answer.* *This is a deduce question so mpb to mpd not awarded for only describing of the data.*	**3 max**
1.	e		*evaluation of evidence in graph on left* a. increase in (percentage of) cells in mitosis (as vinblastine concentration rises) ✓ b. supports hypothesis that cells get stuck in/cannot complete mitosis ✓ *evaluation of evidence in graph on right* c. drop in anaphase-metaphase ratio due to fewer cells in anaphase/more cells in metaphase ✓ d. cells not progressing from metaphase to anaphase/get stuck in metaphase ✓	*Do not allow mpa if the candidate is arguing that the hypothesis is not supported.*	**3 max**

(continued…)

(Question 1 continued)

Question			Answers	Notes	Total
1.	f		a. causes microtubules/spindle fibres to break up / tubulin molecules to depolymerize ✓ b. prevents contraction of spindle microtubules/fibres ✓ c. disrupts/damages kinetochores/centromeres/microtubule motors/centrioles/centrosomes ✓ d. prevents separation/pulling apart of (sister) chromatids/chromosomes/centromeres ✓ e. prevents microtubules/spindle binding to chromatids/chromosomes/centromeres/DNA ✓	***Mark the first suggestion only in the answer.*** *Do not allow answers about DNA replication or other processes that precede mitosis.*	**1 max**
1.	g		*advantage*: avoids risks for humans/harm to humans / more ethical (than with human patients/volunteers) ✓ *disadvantage*: differences between plant and human cells so humans may not respond in same way OR plants have cell wall/no centrioles/other relevant difference between plant and human cells ✓	*Not enough for mpa to say 'not using humans'* *For mpb there must be either a statement that differences between cells may cause a different response, or a specific example of a cell difference.*	**2**

Question			Answers	Notes	Total
2.	a		e. (a loop of) DNA ✓ f. <u>70S</u> ribosomes ✓ g. <u>double</u> membrane ✓ h. electron transport chains/enzyme complexes in (internal) membranes ✓ i. enzymes in a region of fluid/in stroma and matrix ✓ large area of (internal) membrane/cristae and thylakoids ✓	***Only two answers should be marked – the first on each line.*** *Do not award marks for functions rather than structures, for example ATP production.* *Allow spaces inside cristae and thylakoids for mpf.*	**2 max**
2.	b		a. ATP produced by both / ADP used by both ✓ b. oxygen produced by chloroplasts and used by mitochondria ✓ c. carbon dioxide produced by mitochondria and used by chloroplasts ✓ d. carbon/organic compounds built up in chloroplasts/anabolism and broken down in mitochondria/catabolism ✓	*Do not award mpd for statements about carbohydrates or glucose (because the pyruvate used by mitochondria is not a carbohydrate)*	**2 max**
2.	c		a. in phloem ✓ b. loading into sieve tubes/by active transport/by cotransport/by companion cells ✓ c. entry of water (to phloem) by osmosis/because of high solute concentration ✓ d. causes high/hydrostatic pressure ✓ e. flow from high pressure to lower pressure down pressure gradient ✓ from source to sink ✓	*Do not award mpa if xylem included with phloem.* *Do not award a mark solely for mentioning the term 'translocation'.*	**3 max**

Question			Answers	Notes	Total
3.	a		a. carbon dioxide dissolves in oceans/seawater ✓ b. carbonic acid formed/equation/lowers pH/makes water acidic ✓ c. prevents deposition of calcium carbonate/causes calcium carbonate to dissolve ✓ d. skeleton of (hard) corals degraded ✓ e. carbon dioxide is a greenhouse gas/causes warming/increases temperatures ✓ f. warmer oceans cause corals to expel zooxanthellae ✓ g. bleaching due to death/expulsion of mutualistic organisms/algae ✓	*Allow zooxanthellae instead of algae in mpf* *Reject reacts and diffuses instead of dissolves in mpa*	**2 max**
3.	b	i	primary consumer/first consumer/heterotroph ✓	*Second trophic level is not enough to get the mark*	**1**
3.	b	ii	a. detritus feeders/named example of detritus feeder get more food/increase (in number) ✓ b. animals/named example of animal feeding on detritus feeders get more food/increase ✓ c. herbivores feed more on detritus so macroalgae/turf algae increase OR coral cryptic fauna feed more on detritus so turf algae increase OR more herbivores so macroalgae/turf algae decrease OR more coral cryptic fauna so turf algae decrease ✓ d. blocks light for/reduces growth of producers/macroalgae/turf algae OR blocks light penetration to algae inside (hard) corals ✓ e. feeding problems for corals/ filter-feeders OR degrades habitat of benthic piscivores/bottom dwellers ✓	***Mark the first two answers only.*** *For named example of detritus feeder in mpa accept* detritivores, coral cryptic fauna and herbivores only. *For named example of animals feeding on a detritus feeder please check arrows including arrowheads on the food web to verify.* *Answers must relate in some way to organisms in the food web – do not reward general answers such as 'decreases biodiversity' unless expanded with more specific references* *Allow zooxanthellae instead of algae in mpd.*	**2 max**

Question			Answers	Notes	Total
4.	a		a. macrophages/phagocytes recognize/engulf pathogen and display antigens ✓ b. antigen binds to T cell/helper T cell / antigen causes activation of T cell ✓ c. antigen binds to antibodies in membrane of B cells ✓ d. (activated) T cells activate B cells (that have the antigen bound to them) ✓ e. activated B cells divide to produce a clone of cells ✓ f. active plasma cells develop from the clone of cells/from activated B cells ✓	*Accept B-lymphocyte and T-lymphocyte instead of B cell and T cell throughout the answer.*	**3 max**
4.	b		a. endless cell divisions/unregulated mitosis (in hybridoma cells) ✓ b. large clone/population of identical cells produced ✓ c. all cells (in clone) produce same type of antibody ✓ d. large amount of (chosen) antibody can be produced ✓	*For mpa it must be clear that it is the hybridoma cells not tumour cells that divide endlessly and that division is more than just rapid.*	**2 max**
4.	c		a. pregnancy testing kits/detection of hCG (to diagnose pregnancy) ✓ b. produce antibodies for treating arthritis/*C.difficile*/anthrax/psoriasis/ulcerative colitis/asthma/ankylosing spondylitis/Crohn's disease/multiple sclerosis/HIV/other named disease if verified / targeting tumor cells in treatment of cancer **OR** gives artificial/passive <u>immunity</u> (if injected) ✓ c. blood typing/testing urine for drugs/other verified specific use of monoclonal antibodies ✓	***Mark only the first answer.*** *Check verified use with team leader if there is doubt.*	**1 max**

Question			Answers	Notes	Total
5.	**a**		a. increase the surface area for absorption ✓ b. absorption of digested foods/nutrients ✓ c. absorption of mineral ions/vitamins ✓		**2 max**
5.	**b**		a. (celiac disease/gluten causes) much smaller villi/flattened villi/smaller surface area (of villi) / no villi ✓ b. (smaller villi leads to) less efficient/less/slower/poor absorption OR nutrients/energy lost / fatigue/malnutrition may result ✓ c. (celiac sufferers) must eat a gluten-free diet / WTTE ✓	*Note that this question requires an explain not an outline*	**2 max**
5.	**c**		a. enzymes/protease required ✓ b. (protease/peptidase) breaks peptide bonds/bonds between amino acids ✓ c. hydrolysis adds water molecules/breaks peptide bonds between amino acids ✓ d. protein/macromolecule converted to monomer/amino acids ✓ e. endopeptidase/enzymes/protease/trypsin secreted by the pancreas ✓	*mpc can be awarded for an appropriate equation.* *Peptidase/endopeptidase can be accepted instead of protease for mpa.*	**2 max**

Section B

Question			Answers	Notes	Total
6.	a		a. male if (X and) Y chromosomes present ✓ b. gene on Y chromosome/SRY promotes development of testes (from embryonic gonads) ✓ c. testes secrete testosterone ✓ d. testosterone stimulates sperm production/spermatogenesis ✓ e. testosterone stimulates development (in fetus) of male genitals/primary sexual characteristics ✓ f. testosterone stimulates development of male <u>secondary</u> sexual characteristics OR testosterone causes changes to become adult male during puberty ✓	*Allow first alternative for mpf if two secondary sexual characteristics are named instead of the general term 'secondary sexual characteristics'*	**3 max**

(continued…)

(Question 6 continued)

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>6.</td><td>b</td><td></td><td>a. grows/bends towards (brightest) light/sun ✓
b. auxin moved from lighter to shadier side (of shoot/stem tip/apex) ✓
c. moved by auxin efflux pumps ✓
d. auxin promotes cell elongation/cell growth / auxin causes cell wall acidification/loosening ✓
e. more growth on shady side of stem (due to auxin concentration gradient) ✓
f. binds to auxin receptors (in target cells) ✓
auxin/auxin receptors promote expression of genes (for growth)/for H^+ secretion into wall ✓</td><td></td><td>5 max</td></tr>
<tr><td>6.</td><td>c</td><td></td><td>Similarities
a. both used for communication between cells/tissues/organs/parts of the body / WTTE ✓
b. both cause a response/change in specific/target cells
OR
both use chemicals that bind to receptors / hormones and neurotransmitters are both chemicals ✓
c. both can stimulate or inhibit (processes in target cells) / WTTE ✓
d. both can work over long distances/between widely separated parts of the body / WTTE ✓
e. both under (overall) control of the brain/CNS / brain (has role in) sending hormones and nerve impulses ✓
f. both use feedback mechanisms/negative feedback / both used in homeostasis ✓
Differences
<table>
<tr><th></th><th>Hormones</th><th>Nerves</th><th></th></tr>
<tr><td>g.</td><td>chemical (messenger)</td><td>nerve impulse/electrical (signal)</td><td>✓</td></tr>
<tr><td>h.</td><td>transported in blood</td><td>transported by neurons</td><td>✓</td></tr>
<tr><td>i.</td><td>slower</td><td>faster</td><td>✓</td></tr>
<tr><td>j.</td><td>carried throughout body</td><td>carried to single/specific cell/muscle fiber</td><td>✓</td></tr>
<tr><td>k.</td><td>all/wide range of tissues/organs affected</td><td>only muscles/glands receive signals</td><td>✓</td></tr>
<tr><td>l</td><td>(usually) long term (persistence/response)</td><td>short duration/short-lived (responses)</td><td>✓</td></tr>
</table>
m. example of use of hormonal and use of nervous communication ✓</td><td></td><td>7 max</td></tr>
</table>

Question			Answers	Notes	Total
7.	**a**		a. i and I^A and I^B are <u>alleles</u> (of the blood group gene) ✓ b. I^A is dominant and i is recessive / I^B is dominant and i is recessive ✓ c. Group O (only) with ii <u>and</u> Group A with I^Ai or I^AI^A / Group B with I^Bi or I^BI^B d. I^A and I^B are <u>co-dominant</u> so Group AB with I^AI^B ✓ e. one allele/copy of the gene inherited from each parent/Punnett square showing this ✓	*Disallow mpa if allele notation is incorrect (such as using different letters for different alleles) but allow other mps.* *The notation I^i can be accepted instead of i* *Reject blood groups or types being dominant/recessive – it should be alleles.*	**4 max**
7.	**b**		a. <u>mutation</u> (in genes/DNA generates variation) b. base substitution / change to base sequence of gene / makes single nucleotide polymorphisms /SNPs ✓ c. new <u>alleles</u> formed / different <u>alleles</u> of gene / multiple <u>alleles</u> ✓ d. radiation/mutagenic chemicals/mutagens cause/increase the chance of mutation ✓ e. <u>meiosis</u> (generates variation) ✓ f. recombination/new combinations of genes/alleles produced by <u>crossing over</u> ✓ g. independent assortment/random orientation of (pairs of homologous) chromosomes/bivalents ✓ h. gametes/chromosomes/DNA/genes from two parents combined (in sexual reproduction) i. random fertilization (increases genetic variation) ✓ j. in reproductively/geographically isolated populations natural selection may differ ✓ k. in small/isolated populations gene pools change/evolution occurs due to natural selection/genetic drift ✓ l. disruptive selection can cause different varieties/variants/types/phenotypes to diverge ✓ transfer of genes (between bacteria) in plasmids ✓	*For mpf it is not enough just to state 'crossing over'.* *Do not accept types of mutation other than substitution for mpb.*	**7 max**

(continued…)

(Question 7 continued)

Question			Answers	Notes	Total
7.	**c**		*analogous* a. different evolutionary origin/do not share (recent) common ancestor (despite similarities of function) ✓ b. arise by convergent evolution ✓ c. classification based on analogous traits brings together dissimilar species/is artificial ✓ *homologous* d. similar (internal) structures/pentadactyl limb/other example of homologous structures due to common ancestry ✓ e. different uses/functions ✓ f. arise by adaptive radiation/divergent evolution ✓ g. (natural) classification is based on homologous traits (not analogous) ✓ h. classification based on homologous traits has predictive values/matches evolutionary history ✓		**4 max**

Question			Answers	Notes	Total
8.	**a**		a. sample of DNA obtained from person/hair/blood/mouth/crime scene ✓ b. PCR used to amplify/make copies of DNA (in sample) ✓ c. using *Taq* DNA polymerase / using DNA polymerase from thermophilic bacteria ✓ d. tandem repeats amplified/used ✓ e. gel electrophoresis used to separate DNA (into bands) ✓ f. separation according to length of fragments/number of repeats OR fragments of same length/number of repeats travel same distance ✓ g. pattern of bands/numbers of repeats is the profile/is unique to the individual ✓ h. example of application/forensics/crime investigation/paternity ✓	*Do not accept 'determine ancestry' for mph. Other genes/chromosomes are more often used for that. Accept STR for (short) tandem repeat in mpd.*	**4 max**

(continued…)

(Question 8 continued)

Question			Answers	Notes	Total
8.	**b**		a. binds to template strand adjacent to a primer/at the primer ✓ b. adds nucleotides to template strand/to single stranded DNA ✓ c. using complementary base pairing ✓ d. links nucleotides with sugar-phosphate/phosphodiester bonds ✓ e. adds nucleotides/builds new strand in 5′ → 3′ direction ✓ f. lagging strand is built in short segments/Okazaki fragments/synthesis is discontinuous ✓	*Accept A to T and G to C instead of 'complementary' in mpc.* *For mpb it must be clear that nucleotides, not bases, are added to an existing strand of DNA. Do not accept 'to replication fork' for this.*	**4 max**
8.	**c**		a. temperature increases rate up to optimum and higher temperatures decrease rate / graph ✓ b. faster molecular movement as temperature rises (so more substrate-active site collisions) ✓ c. high temperature/heat causes denaturation/irreversible change to active site (so rate reduces) ✓ d. rate decreased if pH is above and below optimum/if pH is too high or low / graph ✓ e. pH affects shape/structure of enzyme/active site /affects ionization (of amino acids) ✓ f. increases in substrate concentration cause rate to rise towards a plateau/WTTE / graph ✓ g. greater chance of substrate-active site collisions with higher substrate concentration OR active sites saturated/all full at high substrate concentrations ✓ h. higher enzyme concentration increases rate (as there are more active sites) ✓ i. enzyme inhibitors/competitive inhibitors/non-competitive inhibitors reduce the rate ✓ j. end-product inhibitors switch off metabolic pathway / act on enzyme at start of pathway rate ✓ OR allosteric site used to control enzyme activity by binding of (non-competitive) inhibitor	*Graphs can be used for mpa, mpd mpf and mph but x-axis must have the variable indicated.* *For mpa there must be exponential rise to optimum then faster drop.* *For mpd there must be a bell-shaped curve but it need not be exactly symmetrical.* *For mpf and mph there must be decreasing increases in rate towards a plateau.*	**7 max**