

Markscheme

May 2021

Biology

Higher level

Paper 2

16 pages

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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 underlined 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	lean have less triglycerides and cholesterol / lipids (than obese) ✓	<i>Vice versa</i>	1	
1.	b	i	0.9 (ng ml ⁻¹) ✓	<i>Calculation not needed. Ignore any uncertainty figures that are included.</i>	1
1.	b	ii	a. leptin (is a hormone that) inhibits appetite / hunger ✓ b. (obese have more leptin) so should have less appetite / feed less ✓ c. obese dogs may have become resistant to leptin OR appetite not reduced even if more leptin is produced ✓	<i>Do not accept 'controls/regulates appetite' as equivalent to inhibits appetite.</i>	2 max
1.	c	77 (%) ✓	<i>Allow answers between 76 and 78%. Calculation not needed.</i>	1	
1.	d	lean dogs' microbiota dominated by <i>Firmicutes</i> while obese microbiota dominated by <i>Proteobacteria</i> OR more <i>Proteobacter</i> in obese dogs OR more <i>Actinobacter</i> in lean dogs OR more <i>Firmicutes</i> in lean dogs ✓	<i>Accept any correct difference.</i>	1	
1.	e	a. (most) obese microbiota belong to the same group / (most) lean microbiota belong to the same group ✓ b. some obese dogs' microbiota belong to the same group as lean dogs / obese 1/obese 2 belong to same group as lean / obese 1 and lean 4 belong to same group ✓	<i>Allow answers referring to similar microbiota instead of mentioning clade.</i>	2 max	

(continued...)

(Question 1 continued)

Question		Answers	Notes	Total
1.	f	more <i>Bacteroidetes</i> <u>and</u> less <i>Firmicutes</i> in low BMI than in high BMI ✓	Allow vice versa. Accept reference to lean and obese.	1
1.	g	<p>a. not a good model as (62%) more percentage contribution of <i>Firmicutes</i> in obese humans than in obese dogs / <i>Firmicutes</i> pattern is reversed as higher in obese humans and lower in obese dogs ✓</p> <p>b. not a good model as <i>Firmicutes</i> difference is much higher in two types of dogs compared to the two types of humans ✓</p> <p>c. <i>Proteobacteria</i> is most abundant in obese dogs but not common in humans ✓</p> <p>d. not a good model as obese and lean dogs have the same level of <i>Bacteroidetes</i> whereas they are higher in low BMI humans and decreases in high BMI ✓</p> <p>e. a good model because the <i>Firmicutes</i> is always higher compared to <i>Bacteroidetes</i> in humans and dogs ✓</p>	<p><i>Mp a intent refers to reversed pattern with Firmicutes.</i></p> <p><i>Mp b intents refers to big difference in dogs Firmicutes but lower difference in humans.</i></p>	2 max
1.	h	<p>a. as BMI increases the ratio <i>Bacteroidetes</i> to <i>Firmicutes</i> decreases ✓</p> <p>b. negative relationship ✓</p>	<i>Mp b: there is no expectation for the student to indicate whether the negative correlation is strong or weak.</i>	1 max
1.	i	<p>a. there is a difference in the microbiota composition between lean and obese dogs and humans (so there could be a causal relationship) ✓</p> <p>b. (this data) does not show whether gut microbiota induce the development of obesity <u>or</u> whether obesity causes the change in microbiota / no evidence whether the relationship is of causation ✓</p> <p>c. study only shows humans and dogs, and may not be applicable to all mammals / sample size is small ✓</p> <p>d. change in microbiota could affect leptin production/resistance (causing obesity) ✓</p>		2 max

Question			Answers	Notes	Total
2.	a	i	hydrophilic end of phospholipid shown ✓	<i>For 2 a, i,ii and iii, accept letters written on the structure even if a line is not drawn. Award the mark if the full word is used to label the structure. labels must be unambiguous.</i>	1
2.	a	ii	an exocytic vesicle shown ✓	<i>Accept any of the three intact circles or the exocytosis shown within the box.</i>	1
2.	a	iii	any receptor protein on post synaptic membrane marked ✓	<i>Must unambiguously be pointed to a receptor on the synapse side. Accept labels of acetylcholinesterase.</i>	1
2.	b		a. (local depolarization) causes ion / sodium / voltage gated channels to open ✓ b. altering membrane permeability to sodium ions/Na ⁺ /positive ions / Na ⁺ diffuses into the cytoplasm ✓ c. membrane potential (of the axon) changes from negative to positive ✓ d. a threshold potential is reached <u>and</u> an action potential is generated ✓	<i>Do not accept sodium pumps. Mp b requires evidence that the student recognizes sodium is an ion. Numerical values indicating change from -70 to +30/+40/+55 can be accepted.</i>	2 max
2.	c		a. acetylcholine binds to the receptor protein ✓ b. (causing a) change in <u>tertiary</u> structure / conformation of protein ✓ c. diffusion/entry of ions / Na ⁺ through the receptor/channel protein allowed ✓		2 max
2.	d	i	breaks down acetylcholine (to acetyl and choline) ✓		1
2.	d	ii	a. change in pH can cause a change in the tertiary structure of the enzyme OR enzyme denatured ✓ b. causing a change in the active site / substrate not able to bind ✓ c. the enzyme will not work as efficiently / decreased rate of reaction ✓ d. (may no longer be) the <u>optimum/optimal</u> pH for enzyme activity ✓	<i>Allow answer in the form of a graph.</i>	3 max

Question		Answers	Notes	Total
4.	a	a. (aerobic/cellular) respiration ✓ b. gas exchange / diffusion ✓	<i>Do not accept photosynthesis. Do not accept breathing.</i>	1 max
4.	b	a. photosynthesis ✓ b. absorption of (dissolved) carbon dioxide / (hydrogen)carbonate directly from the oceans ✓		1 max
4.	c	a. light energy is converted to chemical energy (in carbon compounds/sugars) by <u>photosynthesis</u> ✓ b. (chemical) energy (in carbon compounds) flows by means of feeding/through food chains/webs ✓ c. only (approximately) 10% of energy is passed to the next trophic level ✓ d. energy released as <u>heat</u> (by respiration) ✓ e. energy is not recycled ✓ f. after death, energy may remain trapped as undigested detritus/fossils/fossil fuels ✓	<i>WTTE</i>	3 max

(continued...)

(Question 4 continued)

Question			Answers	Notes	Total
4.	d	i	crustacean as they have more carbon per unit volume OR crustacean as jellyfish has little carbon per total body size ✓	<i>The conclusion must be supported from the information given.</i> Accept WTTE.	1
4.	d	ii	a. advantage of large size is ability to eat /catch large prey ✓ b. (advantage as) lower rates of predation of large jellyfish ✓ c. (advantage as) can produce more reproductive cells ✓ d. (disadvantage as) can move slower to escape from predators/capture prey ✓ e. (disadvantage as) needs more energy/nutrients to maintain structure/move/grow ✓ f. (disadvantage as) low surface area to volume ratio and thus possibly difficulty with materials/gas/nutrient exchange ✓ g. (disadvantage as) more prone to mechanical damage during storms ✓		1 max

Section B

Question		Answers	Notes	Total
5.	a	<p>a. unlinked genes are on different chromosomes / vice versa ✓</p> <p>b. unlinked alleles migrate/segregate/are inherited independently (during meiosis) / vice versa ✓</p> <p>c. (In unlinked inheritance) there is an equal chance for all 4 options to occur / AB, Ab, aB, ab / vice versa ✓</p> <p>d. (dihybrid crosses involving) linked genes do not produce Mendelian ratios ✓</p> <p>e. (excluding recombinants) there is a 1:1 chance of inheriting the different options/AB or ab ✓</p> <p>f. in linked characteristics alleles might not migrate together if there is crossing over/ recombinants are formed ✓</p> <p>g. crossing over occurs in prophase I of meiosis ✓</p> <p>h. when the sister chromatids migrate in meiosis II the characteristics forming gametes are different/Ab, aB ✓</p> <p>i. formation of recombinants causes changes in ratio/probability of inheritance/genetic variation ✓</p> <p>j. correct named example of inheritance of linked/unlinked characteristics ✓</p> <p>k. Punnett/paired diagrams of both unlinked and linked characteristics ✓</p> <p>l. genes which are linked but are far apart on the chromosome can display independent assortment ✓</p>	<p><i>Mp a could be awarded from an annotated diagram</i></p> <p><i>Allow annotated diagram of inheritance / could be shown in a Punnett square.</i></p> <p><i>Allow annotated diagram of linked inheritance for mp f.</i></p> <p><i>For mp K, accept sex linked examples involving two genes.</i></p> <p><i>If the student interprets the question as sex-linked and autosomal inheritance, look for WTTE marks from the scheme.</i></p>	7 max

(continued...)

(Question 5 continued)

Question		Answers	Notes	Total
5.	b	a. germinal epithelium divide endlessly (by mitosis giving rise to spermatagonia) b. spermatogonia are diploid/2n ✓ c. spermatogonia divide by mitosis / provide a continuous supply throughout adult life ✓ d. (some) spermatogonia enlarge forming primary spermatocytes ✓ e. primary spermatocytes undergo the first division of meiosis/meiosis I ✓ f. secondary spermatocytes produced are haploid/n ✓ g. secondary spermatocytes undergo the second division of meiosis (to produce spermatids) ✓ h. spermatids develop tails OR spermatids differentiate into spermatozoa / spermatids associate with Sertoli cells ✓	<i>Marks can be awarded to an annotated diagram. Do not accept sperm or spermatozoa as equivalent to spermatogonia or spermatocytes.</i>	4 max
5.	c	a. nucleus/nuclear membrane ✓ b. membrane bound organelles ✓ c. mitochondria ✓ d. rough ER/smooth ER/golgi apparatus ✓ e. lysosomes / centrioles ✓ f. large/80S ribosomes / ribosomes attached to a membrane ✓ g. linear chromosomes / histones ✓		4 max

Question		Answers	Notes	Total
6.	a	<p>a. hydrogen ions (and oxygen) are obtained from <u>photolysis</u> of water ✓</p> <p>b. (excited) electrons (from Photosystem II) contribute to generate a hydrogen ion/proton gradient</p> <p>OR</p> <p>protons build up in the thylakoid space/inside the thylakoid ✓</p> <p>c. ATP synthase generates ATP by chemiosmosis/using the proton gradient/by movement of protons from the thylakoid space to the stroma ✓</p> <p>d. (two) high energy/excited electrons (from Photosystem II) are passed through an electron transport chain ✓</p> <p>e. NADP accepts H⁺ (from the stroma) / electrons to produce NADPH⁺/reduced NADP ✓</p> <p>f. ATP/reduced NADP/NADPH⁺ are used by light-independent reactions/Calvin cycle in the stroma ✓</p> <p>g. (in Calvin cycle) carbon fixation to ribulose biphosphate/RuBP produces G3P ✓</p> <p>h. ATP is used to transform G3P to TP ✓</p> <p>i. reduced NADP/NADPH⁺ is used to transform G3P to TP ✓</p>	<p><i>Accept answers in an annotated diagram.</i></p> <p><i>Accept NADPH₂/NADPH/NADPH + H⁺ in place of NADPH⁺</i></p>	7 max
6.	b	<p>a. thylakoids have a small internal volume to maximize hydrogen gradient / quickly increase concentration gradient ✓</p> <p>b. many grana / thylakoids give large surface area ✓</p> <p>c. (grana) contain (photosynthetic) pigments/electron carriers/ATP synthase enzymes ✓</p> <p>d. (photosynthetic) pigments/chlorophyll arranged into photosystems allowing maximum absorption of light energy ✓</p> <p>e. stroma has suitable pH/ enzymes of Calvin/light independent cycle ✓</p> <p>f. lamellae connect/separate grana maximizing photosynthetic efficiency ✓</p>	<p><i>Accept diagram showing the disposition in space.</i></p>	4 max

(continued...)

(Question 6 continued)

Question		Answers	Notes	Total
6.	c	a. insulin receptors start the cellular signalling pathway/other receptor b. leptin is a hormone / other protein hormone ✓ c. immunoglobulins/antibodies defend body from disease ✓ d. rhodopsin/photosystems convert light energy to electrical impulses ✓ e. keratin/collagen/other example is a structural protein ✓ f. tubulin/microtubules part of cytoskeleton/ involved in cell division g. ATP synthase is an enzyme that catalyzes the formation of ATP / other enzyme and function ✓ h. fibrin/fibrinogen is a protein involved in clotting ✓ i. hemoglobin/sodium potassium pump/other example is a transport protein ✓ j. actin/myosin/other example is involved in muscle contraction ✓ k. any other named example and function ✓ l. a second other named example and function ✓ m. spider silk is used to form spider webs/capture prey ✓	<p><i>Accept only one example of each protein type for example only one enzyme or only one hormone etc.</i></p> <p><i>Mp k can be awarded only once.</i> <i>Mp l can be awarded only once.</i></p>	4 max

Question		Answers	Notes	Total
7.	a	<p>a. two stranded/double <u>helix</u> ✓</p> <p>b. antiparallel / strands running in opposite directions</p> <p>OR</p> <p>one strand organized 5' to 3' and the other 3' to 5' ✓</p> <p>c. sugar-phosphate backbone ✓</p> <p>d. each strand formed by chains of nucleotides ✓</p> <p>e. each nucleotide is formed by a phosphate, a deoxyribose and a base / annotated diagram of a nucleotide clearly indicated as a nucleotide ✓</p> <p>f. the bases are adenine, guanine, cytosine and thymine ✓</p> <p>g. strands held together by hydrogen bonds (between complementary base pairs)</p> <p>OR</p> <p>A pairs with T and C pairs with G ✓</p>	<p><i>Both helix and two strands needed for mp a. Double helix is sufficient for the mark</i></p> <p><i>Points can be awarded to annotated diagrams.</i></p> <p><i>For mp c, the explicit label sugar phosphate backbone is required</i></p> <p><i>To award mp d from a diagram, at least three pairs of nucleotides should be shown.</i></p> <p><i>For mp e, the diagram would need to be labelled as a nucleotide.</i></p> <p><i>For mp e, expect deoxyribose not just sugar.</i></p> <p><i>The written names of the bases are required for mp f. Do not penalize twice for mp f and g for using letters.</i></p> <p><i>If they only ever use the symbols A, T, C and G they are ineligible for mp f. If however, they say A pairs with T and C pairs with G, then they would get mp g. If they wrote adenine pairs with thymine and cytosine pairs with guanine, then they would obtain both mp f and mp g.</i></p>	5 max

(continued...)

(Question 7 continued)

Question		Answers	Notes	Total
7.	b	a. helicase to separate/unwind DNA strands ✓ b. gyrase / topoisomerase to relax the tension as bacterial DNA is being uncoiled / prevent supercoiling ✓ c. primase to synthesise primers ✓ d. polymerase (I) removes primers and replaces with nucleotide ✓ e. polymerase (III) adds nucleotides (in a 5' to 3' direction) ✓ f. ligase joins (Okazaki) fragments together ✓	Accept the enzyme name without 'DNA' included; e.g. 'DNA ligase' or 'ligase' can both be accepted.	3 max
7.	c	a. insulin production is determined by a gene ✓ b. gene for insulin (is found in all cells), but only activated in (β cells of) pancreas ✓ c. stem cells differentiate into specialized cells/(into pancreatic β) ✓ d. during differentiation some genes are turned on and others off ✓ e. insulin is a hormone that regulates the amount of glucose/sugar in blood ✓ f. pancreatic β cells have sensors that detect glucose level in blood ✓ g. an increase in glucose will increase transcription of mRNA of insulin ✓ h. the site of transcription of insulin is in the pancreatic β cells ✓ i. gene transcription is regulated by proteins that bind to specific base sequence in DNA/ enhancers/silencers/promoter proximal elements ✓ j. regulatory sequences/proteins are specific to the gene they regulate / insulin regulator proteins are only found in in the pancreatic β cells ✓ k. (DNA) methylation (usually) inhibits gene expression / (histone) acetylation promotes gene expression / tightness of coiling of DNA around histones affects gene expression ✓	Accept sugar as equivalent to glucose;	7max