

Markscheme

November 2020

Biology

Higher level

Paper 2

No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without written permission from the IB.

Additionally, the license tied with this product prohibits commercial use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, is not permitted and is subject to the IB's prior written consent via a license. More information on how to request a license can be obtained from <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite de l'IB.

De plus, la licence associée à ce produit interdit toute utilisation commerciale de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, n'est pas autorisée et est soumise au consentement écrit préalable de l'IB par l'intermédiaire d'une licence. Pour plus d'informations sur la procédure à suivre pour demander une licence, rendez-vous à l'adresse suivante : <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin que medie la autorización escrita del IB.

Además, la licencia vinculada a este producto prohíbe el uso con fines comerciales de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales— no está permitido y estará sujeto al otorgamiento previo de una licencia escrita por parte del IB. En este enlace encontrará más información sobre cómo solicitar una licencia: <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

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

Section A

Question			Answer	Notes	Total
1					
	a	i	32 (km);	<i>Accept answers in the range of 31 to 33 (km)</i>	1
	a	ii	<u>positive correlation</u> / (proportion with) HCN increases as distance increases;		1
	b		a <u>Toronto</u> <u>NYC</u> and <u>Boston</u> show same pattern/all show positive correlation/relationship/WTTE; b <u>Montreal</u> shows negative correlation/negative relationship/WTTE so is different;		2 max
	c		a (hypothesis) not supported; b large overlap/little difference between cyanogenic and non-cyanogenic (in herbivory); c smaller difference between cyanogenic and non-cyanogenic in rural areas; d both show negative correlation between herbivory and distance from city center/same trend; e some support/hypothesis partly supported by lower herbivory in cyanogenic (at all distances);	<i>Do not accept 'No' unqualified as an answer. Do not award mpe if the answer states that the hypothesis is supported without doubt/fully</i>	2 max

(continued...)

(Question 1 continued)

	d	i	Montreal because it has the lowest number of days below 0°C without snow cover;	<i>Do not award the mark for Montreal if the reason is not given</i>	1
	d	ii	<p><i>a</i> cities with more days without snow cover have positive correlation between distance from city center and HCN / vice versa for Montreal;</p> <p><i>b</i> fewer plants with HCN within cities that have more days without snow cover/have more exposure to freezing temperatures / converse for <u>Montreal</u> which has fewer days without snow cover;</p> <p><i>c</i> HCN is 0.2 (or less) HCN in cities that have more days without snow cover proportion whereas city with fewer days/Montreal it is 0.5/more than 0.4;</p> <p><i>d</i> in Toronto cyanogenic and non-cyanogenic plants show little difference in herbivory;</p> <p><i>e</i> support for hypothesis/exposure to freezing temperatures as reason;</p>	<i>Do not accept 'Yes' unqualified as an answer, but accept it if supported by reasoning</i>	2 max
	e	i	hours of daylight/light intensity/ <u>soil pH</u> /soil nutrients/mineral nutrients/watering regime/humidity/ /population plants came from/location plants were adapted to/duration of cold period/ /size of plant pot/size of plant/wind speed/ <u>carbon dioxide concentration</u> ;	<i>Mark the first answer given only. Reject nutrition and sunlight unqualified. Reject number of plants.</i>	1
	e	ii	<p><i>Lowest:</i> <u>non-cyanogenic</u> and <u>produces A</u>;</p> <p><i>Highest:</i> <u>non-cyanogenic</u> and <u>produces neither</u> (chemical);</p>	<i>Do not accept genotypes</i>	2

(continued...)

(Question 1 continued)

	e	iii	<p><i>Comparing the first and second bar with the third and fourth:</i> <i>a</i> higher survival with aa than Aa / allele/gene A lowers survival; <i>b</i> higher survival if substrate/chemical A not produced / substrate/chemical A lowers survival;</p> <p><i>Comparing the first bar with the second:</i> <i>c</i> no significant difference between A_L_ and A_II / if A is present L/l doesn't affect survival; <i>d</i> conversion of substrate/chemical A to cyanide does not affect survival;</p> <p><i>Comparing the fourth bar with the third:</i> <i>e</i> higher survival with aall than aaL_ / if A is not present L reduces survival; <i>f</i> lowers survival if chemical L/enzyme produced even if substrate/chemical A not produced;</p> <p><i>Comparing the fourth bar with the other three:</i> <i>g</i> highest survival with aall/homozygous recessive <i>h</i> chemicals A and L/substrate and enzyme both lower survival;</p>	<p><i>Do not accept L decreases survival unqualified as it does not for plants with allele A.</i> <i>Do not accept lower survival in A_II than A_LI as the difference is unlikely to be significant.</i> <i>Do not accept ranking the four genotypes in order of survival probability without more analysis.</i> <i>Accept any of these points if given as the converse, for example for mph 'highest survival without either chemical.'</i> <i>Accept 'withstand freezing' in place of 'survival' in any mark point.</i></p>	3 max
--	----------	------------	--	---	--------------

2	a	i	<p>a part hydrophobic/not attracted to water/non-polar AND part hydrophilic/attracted to water/polar; b <u>bilayer</u> formed (formed naturally by phospholipids in water); c <u>hydrophilic</u> heads/parts face outwards and <u>hydrophobic</u> tails/parts face inwards;</p>	<p><i>Do not allow water loving/hating in mpa or mpc</i></p>	2 max
		ii	<p>a controls/regulates/reduces fluidity of membrane / prevents crystallization of phospholipids; b reduces permeability to some substances;</p>	<p><i>Do not accept 'stabilizes membrane'</i></p>	1 max
	b		<p>a nuclear membrane breaks down/disappears (in prophase/at start of mitosis); b nuclear membrane reforms around two new nuclei (in telophase/at end of mitosis); c plasma membrane pulled inwards at equator / cleavage furrow formed; d membrane pinches apart to form two cells / cytoplasm divided / cytokinesis;</p>		2 max
	c	i	<p>synapse/synaptic</p>	<p><i>Allow any answer including either of these terms unless out of context</i></p>	1 max
		ii	<p>a depolarization of pre-synaptic membrane / action potential/nerve impulse arrives; b uptake of calcium / calcium ions diffuse in / calcium channels open; c structures containing neurotransmitter/vesicles move to/fuse with membrane; d <u>neurotransmitter/acetylcholine</u> released by <u>exocytosis</u> into cleft/binds to postsynaptic membrane/receptors;</p>	<p><i>Must see exocytosis</i></p>	3 max

3	a	<p>X: large/increased SA area for ATP production/electron transport/oxidative phosphorylation/proton pumping OR X: small/narrow intermembrane space for generating proton gradient (rapidly/steeply); Y: contains enzymes for Krebs cycle/link reaction;</p>		2
	b	<p>a protons pumped across inner membrane of mitochondria/into intermembrane space; b using energy released by flow of electrons/by electron transport/by electron carriers; c proton gradient established/maintained / proton motive force generated; d protons pass/diffuse back through inner membrane/membrane of cristae/to matrix; e through <u>ATP synthase</u>; f ATP production coupled to flow of protons / ATP from ADP and Pi using energy from protons;</p>	<p><i>Marks can be awarded in an annotated diagram</i></p>	4 max

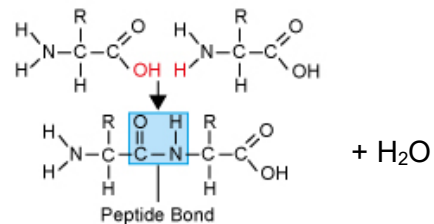
4	a	energy is lost (between trophic levels) / not all passed on / not reused / must be supplied; nutrients are recycled/reused;		2
	b	<p>a methane produced from organic matter; b in anaerobic conditions; c methane diffuses into atmosphere/accumulates in ground/soil; d oxidized/converted to carbon dioxide (in atmosphere);</p>		2 max
	c	<p>a light absorbed by (photosynthetic) pigments; b chlorophyll absorbs blue and red / drawing of absorption spectrum for chlorophyll; c photosystems are groups of pigment molecules/are light harvesting complexes; d photosystems are located in thylakoid membranes; e electrons excited/raised to higher energy level;</p>		3 max

5	a	WwKk					1																						
	b	WK Wk wK and wk for male gamete genotypes and wk for female; wwKk shown in Punnett square and identified as smooth;					2 max																						
		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2" data-bbox="286 1042 680 1082"></td> <td colspan="4" data-bbox="680 1042 1655 1082" style="text-align: center;">male gametes</td> </tr> <tr> <td colspan="2" data-bbox="286 1082 680 1114"></td> <td data-bbox="680 1082 927 1114" style="text-align: center;">WK</td> <td data-bbox="927 1082 1173 1114" style="text-align: center;">Wk</td> <td data-bbox="1173 1082 1420 1114" style="text-align: center;">wK</td> <td data-bbox="1420 1082 1655 1114" style="text-align: center;">wk</td> </tr> <tr> <td data-bbox="286 1114 568 1153" style="text-align: center;">female gametes</td> <td data-bbox="568 1114 680 1153" style="text-align: center;">wk</td> <td data-bbox="680 1114 927 1153" style="text-align: center;">WwKk</td> <td data-bbox="927 1114 1173 1153" style="text-align: center;">Wwkk</td> <td data-bbox="1173 1114 1420 1153" style="text-align: center;">wwKk</td> <td data-bbox="1420 1114 1655 1153" style="text-align: center;">wwkk</td> </tr> <tr> <td colspan="2" data-bbox="286 1153 680 1185" style="text-align: center;">phenotypes</td> <td data-bbox="680 1153 927 1185" style="text-align: center;">wire haired</td> <td data-bbox="927 1153 1173 1185" style="text-align: center;">wire haired</td> <td data-bbox="1173 1153 1420 1185" style="text-align: center;">smooth haired</td> <td data-bbox="1420 1153 1655 1185" style="text-align: center;">long haired</td> </tr> </table>						male gametes						WK	Wk	wK	wk	female gametes	wk	WwKk	Wwkk	wwKk	wwkk	phenotypes		wire haired	wire haired	smooth haired	long haired
		male gametes																											
		WK	Wk	wK	wk																								
female gametes	wk	WwKk	Wwkk	wwKk	wwkk																								
phenotypes		wire haired	wire haired	smooth haired	long haired																								

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	<p>a <u>two</u> amino acids correctly drawn;</p> <p>b removal/production of H₂O molecule shown;</p> <p>c peptide bond labelled between C of C=O and N of N-H;</p>	 <p><i>Accept specific examples of amino acids correctly drawn for example glycine with H instead of R mpc can be awarded if the peptide bond is shown as in the dipeptide diagram but there are errors elsewhere</i></p>	3
6	b	<p>a digested by peptidases/proteases;</p> <p>b pepsin/pepsinogen/<u>endopeptidase</u> secreted by stomach (lining)/digests proteins in stomach;</p> <p>c pancreas secretes/pancreatic juice contains endopeptidase/trypsin/peptidase;</p> <p>d <u>endopeptidase</u> digest proteins/polypeptides to shorter chains of amino acids/shorter peptides;</p> <p>e amino acids absorbed by active uptake/transport;</p> <p>f in small intestine/ileum;</p> <p>g villi increase the surface area for absorption;</p> <p>h absorbed into bloodstream/into capillaries;</p>	<p><i>Peptidase can be accepted instead of endopeptidase in mpc, but not in mpb or mpd</i></p>	4 max

(continued...)

(Question 6 continued)

<p>6</p>	<p>c</p>	<p>a mRNA is translated; b mRNA binds with ribosome/with small subunit of ribosome; c tRNA-activating enzymes/aminoacyl tRNA synthetases attach specific amino acid to tRNA; d <u>anticodon</u> of 3 bases/nucleotides on tRNA; e start codon/AUG on mRNA; f tRNA carrying first amino acid/methionine binds to P/peptidyl site (when large subunit binds); g anticodon (on tRNA) binds to codon (on mRNA); h <u>complementary base pairing</u> (between codon and anticodon); i tRNA for next codon binds to A site/amino acyl site; j peptide bond forms between amino acids (on tRNAs) at P and A sites; k ribosome moves along mRNA to next codon/by three bases/in 5' to 3' direction; l tRNA released from E/exit site; m process/cycle repeats to elongate the polypeptide/until stop codon is reached; n release of polypeptide and mRNA/disassembly of ribosome complex at <u>stop codon</u>;</p>	<p><i>Marks can be awarded in an annotated diagram</i></p> <p><i>Accept UAA, UAG or UGA instead of stop codon in mpn or mpn but do not accept terminator sequence. Do not award mpk for the ribosome moving to the start codon in a 5' to 3' direction.</i></p>	<p>8 max</p>
-----------------	-----------------	---	---	---------------------

7	a	<p>a water (molecules) are polar/dipolar/have partially positive and negative poles/have δ^+ and δ^-;</p> <p>b attraction/bonding between positive and negative (poles);</p> <p>c hydrogen bond formed between hydrogen and oxygen; <i>Reject if H and O in same molecule</i></p> <p>d bond/attraction between different water molecules/intermolecular;</p>	<p><i>Marks can be awarded in an annotated diagram</i></p> <p><i>Reject answers stating or implying that there are whole positive or negative charges for mpa</i></p>	3 max
7	b	<p>a water moved/transported in <u>xylem vessels</u>;</p> <p>b transported under tension/suction/pulled up (in xylem vessels);</p> <p>c transpiration/loss of water (vapour) generates pulling forces/low pressure/tension;</p> <p>d tension/pull generated when water evaporates from cell walls (in mesophyll);</p> <p>e transpiration is loss of water <u>vapour</u> from leaf (surface)/stomata;</p> <p>f <u>cohesivity/cohesion</u> in water due to hydrogen bonding/attractions between water molecules;</p> <p>g cohesion/WTTE so chain/column of water (molecules) doesn't break/remains continuous;</p> <p>h transpiration stream is a column of/flow of water in xylem from roots to leaves;</p>	<p><i>Do not award marks for absorption of water by roots</i></p>	4 max
7	c	<p>a osmoregulation is regulation of water and solute/salt balance/solute concentrations;</p> <p>b <u>nephron</u> (is the functional unit of the kidney/osmoregulates);</p> <p>c ultrafiltration in glomerulus / glomerular filtrate collected by Bowman's capsule;</p> <p>d loop of Henle establishes/maintains hypertonic conditions in medulla;</p> <p>e osmosis/reabsorption of water (from filtrate) in the collecting duct;</p> <p>f brain/hypothalamus monitors blood solute concentration / pituitary secretes ADH;</p> <p>g ADH secreted when solute concentration of blood is too high/hypertonic/when dehydrated;</p> <p>h ADH increases permeability of collecting duct to water;</p> <p>i ADH causes more aquaporins (in membranes of collecting duct wall cells);</p> <p>j more water reabsorbed resulting in more concentrated/hypertonic urine/less volume of urine;</p> <p>k less/no ADH secreted when solute concentration (of blood) is too low/hypotonic;</p> <p>l less water reabsorbed resulting in dilute/hypotonic urine/large volume of urine;</p>	<p><i>Reject 'water balance' and 'water concentration' for mpa</i></p>	8 max

8	a	<p><i>a</i> organisms can potentially interbreed; <i>b</i> to produce fertile offspring; <i>c</i> same sequence of genes (on chromosomes) / same types of chromosomes; <i>d</i> similar traits/phenotype/WTTE; <i>e</i> same chromosome number/karyotype;</p>		3 max
8	b	<p><i>a</i> gene pool is all genes/alleles in an (interbreeding) <u>population</u>; <i>b</i> gene pool splits/divides/separated during speciation; <i>c</i> due to reproductive isolation (of groups within a species); <i>d</i> temporal/behavioral/geographic isolation (can cause reproductive isolation); <i>e</i> divergence of gene pools; <i>f</i> allele frequencies change; <i>g</i> natural selection different (in the isolated groups so there is divergence); <i>h</i> different (random) mutations occur (in the isolated populations so there is divergence); <i>i</i> speciation has occurred when differences between populations prevent interbreeding;</p>	<p><i>Do not award both mpc and mpi for the same idea (reproductive isolation separating populations vs speciation due to interbreeding not being possible)</i></p>	5 max
8	c	<p><i>Process:</i> <i>a</i> genetic modification by gene transfer between species; <i>b</i> gene/Bt gene/DNA segment transferred from bacterium to plant/crop; <i>c</i> gene/DNA codes for/responsible for desired protein/gene product; <i>d</i> bacteria have/produce plasmids / gene/DNA inserted into plasmid; <i>e</i> using restriction enzymes/endonucleases to cut DNA; <i>f</i> using DNA ligase to join DNA; <i>g</i> bacterium transfers (modified) plasmid to plant cell; <i>Benefits:</i> <i>h</i> increase crop yields / more food produced / less land needed to grow food; <i>i</i> increase pest/disease resistance / use less pesticides/insecticides/fungicides; <i>j</i> improves crops to be more nutritious/increased vitamin content; <i>k</i> increased tolerance to saline soils/drought/high temperatures/low temperatures; <i>Risks:</i> <i>l</i> GM organisms could spread to sites (where they will cause harm); <i>m</i> transferred gene could spread to other species / spread of herbicide resistance to weeds; <i>n</i> GM crops that produce pesticide could kill non-pest insects/monarch butterflies / insect pests could develop resistance to pesticides/insecticides/Bt toxin;</p>		7 max