

# Markscheme

November 2019

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 <http://www.ibo.org/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-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 <http://www.ibo.org/fr/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-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: <http://www.ibo.org/es/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-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		Marking point	Answers	Notes	Total
1.	a		eukaryote ✓	<i>Accept eukaryotes.</i>	1
	b		antibiotics / named antibiotics ✓		1
	c		«2000» August <b>AND</b> «2080» July ✓	<i>Both required.</i>	1
	d	a	adults present through autumn and winter «according to the life cycle diagram» <b>OR</b> some adults «must» survive winter «despite graph suggesting zero» ✓	<i>Each mark point, requires month or season. Jan - Mar = winter Apr - Jun = spring Jul - Sep = summer Oct - Dec = autumn = fall</i>  <i>Do not accept that there are the lowest number or no adults in winter.</i>	2 max
		b	adults peak in October «& November»/in autumn/between September and December ✓		
		c	adults die after laying eggs in winter/beginning of spring ✓		
		d	smaller peak/10% versus 55% peak/smaller numbers of adults in April/spring ✓		
		e	adults absent from June to September/summer ✓		
	e	a	<u>nymphs</u> present through most of year/longer period/from March to November/through spring and summer «so more risk of infection» ✓		3 max
		b	more <u>adults</u> in winter/in January/February so more risk of infection then ✓		
		c	infection will be possible through more/most months of/throughout the year ✓		
		d	Lyme disease likely to/will increase ✓		

(continued...)

(Question 1 continued)

	<b>f</b>	<b>i</b>		because nymphs are present/numbers of nymphs rise «in these months» <b>OR</b> build up immunity/antibodies in mice before nymphs «peak» ✓	<i>Ignore references to larvae.</i>	<b>1</b>
		<b>ii</b>	<b>a</b>	low antibody level initially as mice not previously exposed to antigen/bacteria ✓	<i>Ignore any references to non-vaccinated/control mice – this means that no marks are awarded for them because the question is about vaccinated mice, but there is no penalty for including this information in an answer.</i>	<b>3 max</b>
			<b>b</b>	vaccination causes antibody production/development of immunity ✓		
			<b>c</b>	increased proportion of mice have been vaccinated in each successive month ✓		
			<b>d</b>	second vaccination/booster shot increases antibody level/speeds up antibody production ✓		
			<b>e</b>	<u>memory cells</u> produced so greater/faster antibody production ✓		
			<b>f</b>	many/rising numbers of nymphs which may spread the bacteria/antigens to mice ✓		
	<b>g</b>		<b>a</b>	at Site 1 there is little/no significant difference in the proportion of infected nymphs/numbers of infected and uninfected nymphs collected from both control and vaccinated mice ✓		<b>2 max</b>

(continued...)

(Question 1 continued)

			<p><b>b</b></p> <p>at Site 2 the proportion of infected nymphs is lower in those collected from vaccinated than control mice  <b>OR</b>                      at Site 2 «significantly» more nymphs are not infected from vaccinated than control mice ✓</p>	<p><i>Accept “ticks” instead of “tick nymphs” or “nymphs”</i>  <i>Do not accept quoting of untransformed numerical data.</i>  <i>Percentages are required for the second alternative of mpd.</i>  <i>For mpb and mpd, accept converse answers that give the proportions/percentages of uninfected nymphs rather than infected.</i></p>	
		<p><b>c</b></p> <p>at both sites there are fewer infected than uninfected nymphs in those collected from both vaccinated and control mice ✓</p>			
		<p><b>d</b></p> <p>proportion of infected nymphs is lower at Site 1 than Site 2 in nymphs collected from both control and vaccinated mice  <b>OR</b>                      22% of control mice and 23% of vaccinated mice with infected nymphs at Site 1 <b>AND</b> 39% of control mice and 29% of vaccinated mice with infected nymphs at Site 2 ✓</p>			
	<b>h</b>	<p><b>a</b></p> <p><u>Site 2</u> suggests that vaccination could reduce «nymph» infection rate «so method might be effective» ✓</p>		<b>3 max</b>	
		<p><b>b</b></p> <p><u>Site 1</u> suggests that vaccination does not reduce «nymph» infection rate «so method probably not effective» ✓</p>			
		<p><b>c</b></p> <p>effective «to some extent» as vaccination increases antibodies/immunity in mice ✓</p>			

			<b>d</b> high antibody levels needed/ many mice need to be vaccinated «for the method to be effective» ✓		
			<b>e</b> some nymphs are still infected / «absolute» numbers «rather than proportions» of infected nymphs are similar in those collected from control and vaccinated mice ✓		
			<b>f</b> there are other hosts/mammals/birds ✓		
			<b>g</b> difficult/expensive «to vaccinate many small mammals/mice» <b>OR</b> cheaper to use protective clothing/tick repellent/avoid wooded areas/other method ✓		

2.	a		«gene/autosomal» linkage ✓	<i>Reject sex linkage</i>	1
	b		grey vestigial and black normal ✓	<i>Accept Ggvv and ggVv or alternative acceptable upper/lower case genotypes.</i>	1
	c		<p>a yes/observed ratio did differ significantly «from the expected Mendelian ratio» OR expected ratio is 1:1:1:1 / 575 of each type / 25 % of each type ✓</p> <p>b 3 degrees of freedom ✓</p> <p>c critical value is 7.815 «at the 5% level / 11.345 «at the 1% level» ✓</p> <p>d chi-squared value «of 1002.6» exceeds the critical value ✓</p>	<p>Correct ratio not needed in first alternative of mpa <i>Accept mpc if candidates indicate the critical value of chi squared by circling it.</i> <i>Allow other levels of significance as long as the critical value is correctly stated for the chosen level.</i></p>	2 max
3.	a		<p>a similarities/differences between organisms/species/clades ✓</p> <p>b «probable» evolutionary relationships/closeness/common ancestry/phylogeny ✓</p> <p>c divergence/splits/speciation/branches/nodes ✓</p> <p>d relative similarity/differences between base sequence/amino acid sequence ✓</p>	<p><i>mpa and mpd concern actual characteristics, not evolutionary relationships.</i> <i>mpb concerns such relationships</i> <i>mpc concerns the structure branching of the cladogram</i></p>	2 max

(continued...)

(Question 3 continued)

<b>b</b>	<b>a</b>	survival of the better adapted/fittest ✓		<b>3 max</b>
	<b>b</b>	more reproduction of better adapted/fittest/individuals with favorable variations ✓		
	<b>c</b>	genes for favorable variations/adaptations passed on to offspring ✓	<i>Accept answers in the converse.</i>	
	<b>d</b>	competition for resources/more offspring produced than the environment can support/a struggle for existence ✓	<i>Accept answers in the converse.</i>	

4.	a	i	have both a hydrophilic and a hydrophobic region <b>OR</b> have both a polar and a non-polar region ✓		1										
		ii	they have a double bond between <u>carbon/C</u> «atoms» <b>OR</b> they could hold more <u>hydrogen</u> ✓	Accept clearly annotated diagrams to that effect. Do not accept double bonds between C and any other atom.	1										
	b	i	photolysis / light-dependent «reactions/stages» / photophosphorylation ✓		1										
		ii	<table border="1"> <tr> <td data-bbox="293 651 432 726"><b>a</b></td> <td data-bbox="432 651 1435 726">water is split/broken «up»/lysed/undergoes photolysis ✓</td> </tr> <tr> <td data-bbox="293 726 432 801"><b>b</b></td> <td data-bbox="432 726 1435 801">producing/providing electrons ✓</td> </tr> <tr> <td data-bbox="293 801 432 876"><b>c</b></td> <td data-bbox="432 801 1435 876">replaces electrons lost by Photosystem II / PSII / P680 / chlorophyll a ✓</td> </tr> <tr> <td data-bbox="293 876 432 951"><b>d</b></td> <td data-bbox="432 876 1435 951">allows electrons «to continue» to pass along the electron transport chain ✓</td> </tr> <tr> <td data-bbox="293 951 432 1161"><b>e</b></td> <td data-bbox="432 951 1435 1161">provides protons/H<sup>+</sup> «inside thylakoid» to help generate a «proton» gradient/maintain high concentration inside thylakoid ✓</td> </tr> </table>	<b>a</b>	water is split/broken «up»/lysed/undergoes photolysis ✓	<b>b</b>	producing/providing electrons ✓	<b>c</b>	replaces electrons lost by Photosystem II / PSII / P680 / chlorophyll a ✓	<b>d</b>	allows electrons «to continue» to pass along the electron transport chain ✓	<b>e</b>	provides protons/H <sup>+</sup> «inside thylakoid» to help generate a «proton» gradient/maintain high concentration inside thylakoid ✓	For mpa, reject “water is cut in half”. For mpa, accept photolysis only if the context shows that water is being split. For mpc, do not accept just chlorophyll. For mpe, reject pumping of protons into the thylakoid as photolysis produces them inside the thylakoid.	3 max
<b>a</b>	water is split/broken «up»/lysed/undergoes photolysis ✓														
<b>b</b>	producing/providing electrons ✓														
<b>c</b>	replaces electrons lost by Photosystem II / PSII / P680 / chlorophyll a ✓														
<b>d</b>	allows electrons «to continue» to pass along the electron transport chain ✓														
<b>e</b>	provides protons/H <sup>+</sup> «inside thylakoid» to help generate a «proton» gradient/maintain high concentration inside thylakoid ✓														

5.	a	i		nucleus ✓		1
		ii		myosin ✓		1
		iii		muscle fibre/muscle cell ✓	<i>Reject myofibril because it would be much narrower – diameter 1 to 2 μm.</i>	1
	b		a	«muscle fibres are» multinucleate/contain many nuclei «whereas cells are expected to have only one/so muscle fibers are an exception to the cell theory» ✓		2 max
			b	one cell membrane/sarcolemma enclosing a whole muscle fibre «as expected for cells» ✓		
			c	very large/much larger/longer/than most cells ✓		
			d	muscle fibres formed by fusion of cells/are syncytia ✓		
	c		a	action potential/nerve impulse causes release of calcium ✓		3 max
			b	from sarcoplasmic reticulum/specialized endoplasmic reticulum ✓		
			c	binds to troponin ✓		
			d	causes tropomyosin to move/be removed «from binding sites» ✓		
			e	exposes myosin-binding sites on actin/allows myosin «heads» to bind to actin ✓		

**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		Marking point	Answers	Notes	Total
6.	a	a	sugar, phosphate and base linked correctly to form at least one nucleotide ✓	<p><i>For mpa, ignore labelling of the subunits of the nucleotide. Carbon atoms in deoxyribose do not have to be numbered but the phosphate should be linked to C5 and the base to C1. Shapes other than circles and rectangles could be used for the phosphate and base.</i></p> <p><i>For mpc, full names of all four bases are required, but not relative sizes of the purine and pyrimidine bases.</i></p> <p><i>For mpd, a bond should connect the C3 of deoxyribose on one nucleotide to the phosphate on the adjacent nucleotide. Two nucleotides in each strand is sufficient.</i></p>	4 max
		b	<u>deoxyribose</u> , <u>phosphate</u> and base/named base labelled at least once ✓		
		c	<u>adenine</u> paired with <u>thymine</u> and <u>cytosine</u> paired with <u>guanine</u> ✓		
		d	two antiparallel chains of nucleotides linked by <u>hydrogen bonds</u> with all sugar-phosphate bonds in correct position ✓		

(continued...)

(Question 6 continued)

<b>b</b>	<b>a</b>	linear/not circular DNA molecule OR one chromosome is one molecule of DNA/one chromosome is two DNA molecules «after replication» ✓	<p><i>Do not accept 'sequence of bases' for mpe.</i></p> <p><i>Do not allow mph if the response states that chromosomes are always condensed.</i></p>	<b>4 max</b>
	<b>b</b>	associated with histone proteins/nucleosomes ✓		
	<b>c</b>	centromere joins sister chromatids «after DNA replication» ✓		
	<b>d</b>	telomeres at the end «of the chromosome/chromatid» ✓		
	<b>e</b>	carries a sequence of genes / each gene occupies a specific locus ✓		
	<b>f</b>	alternative alleles of genes / homologous chromosomes carry same sequence of genes ✓		
	<b>g</b>	chromosomes in pairs / two «homologous chromosomes» of each type «in a diploid cell» ✓		
	<b>h</b>	non-coding sequences/example of a non-coding sequence ✓		
	<b>i</b>	supercoiled/condensed «during mitosis/meiosis» ✓		

(continued...)

(Question 6 continued)

<b>c</b>	<b>a</b>	<u>translation</u> occurs on ribosomes ✓	<p><i>Accept these points in an annotated diagram.</i></p> <p><i>Do not award any marks for events in transcription</i></p>	<b>7 max</b>
	<b>b</b>	tRNA-activating enzymes attach amino acids to tRNAs ✓		
	<b>c</b>	small and large <u>ribosome</u> units assemble on mRNA OR translation/polypeptide synthesis starts at a start codon ✓		
	<b>d</b>	each tRNA arriving at the ribosome binds to the A site ✓		
	<b>e</b>	anticodon «on tRNA» binds to codon «on mRNA» ✓		
	<b>f</b>	according to complementary base pairing/A with U and G with C ✓		
	<b>g</b>	ribosome moves along the mRNA / mRNA moves over ribosome ✓		
	<b>h</b>	t-RNA shifts from the A site to P site/from the P to the E site ✓		
	<b>i</b>	peptide bond between amino acids «on tRNAs at A and P sites» ✓		
	<b>j</b>	tRNA released from ribosome at E site ✓		
	<b>k</b>	cycle repeats with other tRNAs / polypeptide grows as tRNAs bring more amino acids ✓		
	<b>l</b>	until stop codon on mRNA is reached ✓		
	<b>m</b>	components are disassembled / polypeptide leaves the ribosome ✓		

7.	a	a	urea/waste products lower in vein due to excretion «in urine»/ultrafiltration but not reabsorption ✓	<p><i>Accept any point given as the converse.</i></p> <p><i>Each mark point includes a difference and reason for it.</i></p>	4 max
		b	oxygen lower in vein due to use in cell respiration/in kidney tissue ✓		
		c	carbon dioxide higher in vein due to production by cell respiration/excretion by kidney cells ✓		
		d	glucose lower in vein due to use in cell respiration «by kidney tissue» ✓		
		e	sodium/chloride/ion concentrations changed due to production of hypertonic/hypotonic urine OR sodium/chloride/ion concentrations lower due to removal of excess ✓		
		f	ion/solute concentrations lower in vein than artery if ADH has been secreted OR ion/solute concentrations in vein vary depending on amount of water reabsorbed in the collecting duct ✓		
		g	drug/toxin concentrations lower in vein due to excretion in urine ✓		
	b	a	$I^A, i$ for one set of gametes/parental genotype ✓	<p><i>Answers can be given in a Punnett grid or in prose.</i></p> <p><i>Accept the four possible blood groups of the offspring anywhere in the answer.</i></p>	4 max
		b	$I^B, i$ for the other set of gametes/parental genotype ✓		
		c	«genotypes of offspring are» $I^A I^B, I^A i, I^B i, ii$ ✓		
		d	«phenotypes of offspring are» AB, A, B, O ✓		

(Question 7 continued)

<b>c</b>	<b>a</b>	<u>sinoatrial node/SAN</u> is a specialized group of muscle cells OR <u>sinoatrial node/SAN</u> is located in the right atrium ✓	<b>7 max</b>
	<b>b</b>	acts as a pacemaker/controls the heart rate OR initiates/generates the heart beat/starts the cardiac cycle ✓	
	<b>c</b>	sends out electrical signal/impulses/depolarisations ✓	
	<b>d</b>	electrical signal stimulates contraction «of heart muscle» ✓	
	<b>e</b>	signal passes through walls of atria/passes to AV node ✓	
	<b>f</b>	then through walls of the ventricles ✓	

(continued...)

(Question 7 continued)

			<b>g</b>	medulla «oblongata of brain» can change/increase/decrease the rate ✓		
			<b>h</b>	through nerves/named example of nerve/autonomic/sympathetic/ parasympathetic nervous system ✓	<i>In mph, only accept vagus nerve for slowing heart rate and sympathetic nerve for accelerating it.</i>	
			<b>i</b>	one nerve increases the rate and the other decreases it ✓		
			<b>j</b>	epinephrine/adrenaline increases heart rate/force of contraction ✓		
			<b>k</b>	epinephrine/adrenaline prepares the body for vigorous activity/is part of fight or flight response ✓		

8.	a		<b>a</b>	<u>sepals</u> as outermost part of flower ✓	<p><i>As the question does not specify a labelled half-view, allow some marks for unlabeled structures: award one mark for any two of the six structures in the mark scheme (mpa to mpf). It must be clear what each unlabeled part is. The maximum mark is therefore 3 for an unlabeled half-view.</i></p>	<p><b>4 max</b></p>
			<b>b</b>	<u>petals</u> as largest part of flower ✓		
			<b>c</b>	<u>stamen</u> drawn with recognizable anther and filament OR <u>anther</u> and <u>filament</u> shown as parts of the stamen ✓		
			<b>d</b>	<u>carpel/pistil</u> drawn with recognizable stigma, style and ovary OR <u>stigma</u> , <u>style</u> and <u>ovary</u> shown as parts of the carpel ✓		
			<b>e</b>	<u>nectary</u> at base of the ovary ✓		
			<b>f</b>	<u>ovule</u> inside the ovary ✓		

(continued...)

(Question 8 continued)

<b>b</b>	<b>a</b>	growth in shoots is indeterminate/unlimited ✓		<b>4 max</b>
	<b>b</b>	produces stem and leaves ✓	<i>For mpb, both stem and leaves are needed and buds or branches should not be accepted as alternatives.</i>	
	<b>c</b>	growth/cell growth/cell elongation controlled/affected by hormones/auxin/IAA ✓		
	<b>d</b>	new/extra cells produced by mitosis/cell division / apex is a meristem ✓		
	<b>e</b>	tropism/phototropism / grows towards the sun/light ✓		
	<b>f</b>	auxin moved away from sunny side/to shady side of shoot «apex» OR auxin efflux pumps set up concentration gradients ✓		
<b>c</b>	<b>a</b>	autotrophs/producers/plants obtain inorganic nutrients from the «abiotic» environment ✓	<i>Award [5 max] if only energy is mentioned.</i>	<b>7 max</b>
	<b>b</b>	energy is provided «mainly» by sunlight ✓		
	<b>c</b>	light energy is converted «to chemical energy» through photosynthesis ✓		
	<b>d</b>	photosynthesis/producers/autotrophs convert inorganic carbon/carbon dioxide and water into carbon/organic compounds ✓		

(continued...)

(Question 8 continued)

			<b>e</b>	carbon compounds/foods contain/are a source of «usable» energy «for life» ✓		
			<b>f</b>	carbon compounds/energy are transferred along food chains when eaten by consumers/heterotrophs ✓		
			<b>g</b>	respiration returns carbon «dioxide» to the environment ✓		
			<b>h</b>	respiration releases stored/chemical energy as heat/ATP ✓		
			<b>i</b>	energy/ATP is used to carry out life functions/synthesis/growth/movement ✓		
			<b>j</b>	energy is lost/is not recycled ✓		<i>Both related by “or” required.</i>
			<b>k</b>	nutrients are recycled / example of recycled nutrient e.g. carbon ✓		
			<b>l</b>	decomposers recycle minerals/inorganic nutrients ✓		

---