

Markscheme

November 2020

Biology

Higher level

Paper 3

20 pages

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/>.

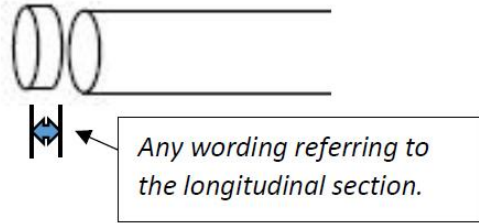
Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite de l'IB.

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 A

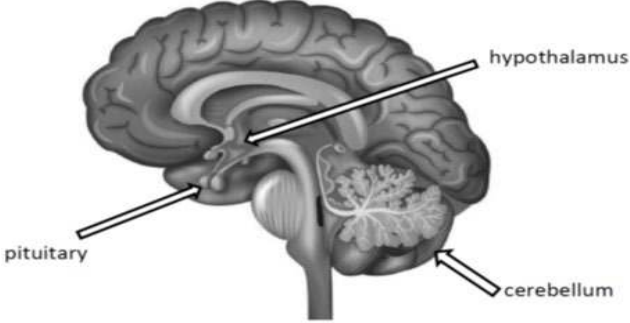
Question		Answers	Notes	Total
1.	a	<i>Calculation:</i> size of bar \div 15 μm (1.5 cm \div 15 μm or 15 000 μm \div 15 μm); <i>Answer:</i> 1000 x;	<i>First marking point is for division by 15 μm;</i> <i>Second marking point is for the correct answer; accept 930 and 1070 x.</i>	2
	b	(upper surface/epidermis usually has) fewer stomata/lower stomatal density/no stomata/OWTTE	<i>Do not accept a numerical value only.</i>	1
2.	a	<i>Independent:</i> mass; <i>Dependent:</i> (vertical) diameter;	<i>Do not accept elasticity.</i>	2
	b	a. width/depth of section/slice (of the ring); b. same animal/age/freshness/temperature;	<i>Do not accept thickness or diameter.</i>  <i>Any wording referring to the longitudinal section.</i>	1 max
	c	a. veins have thinner walls (than arteries); b. veins sustain lower (blood) pressure (than arteries); c. when stretched, veins become longer (than arteries); d. veins have less muscle/elastic (fibre in their) walls (than arteries); e. veins have lower elasticity/recover less/remain more stretched (than arteries after weights removed);	<i>Accept inverse for arteries in all cases.</i> <i>Do not accept a listing of numerical values without explanation.</i>	3 max

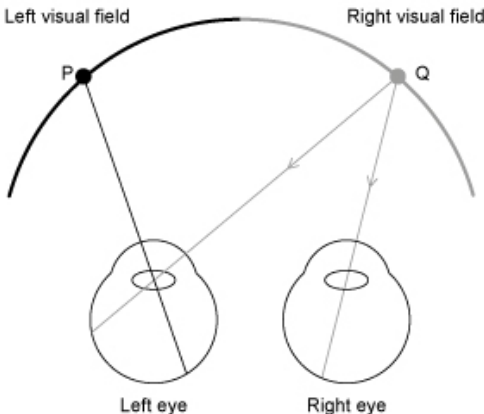
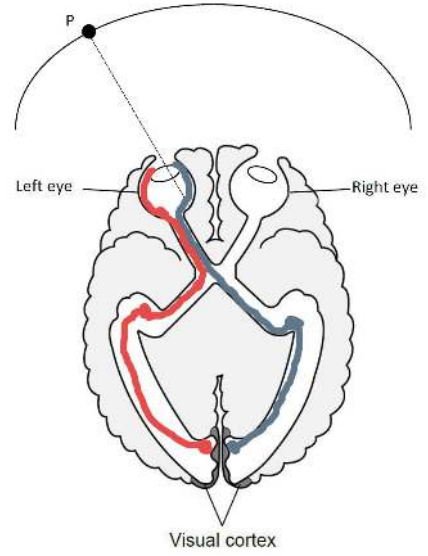
3.	a		photosynthesis/light independent reaction (of photosynthesis)		1
	b	i	the jars closer to the light had more purple colours OR the jar the furthest from the light was yellow OR purple to yellow	<i>Allow for answers indicating colours for each jar within this range.</i>	1
		ii	a. high light (intensity) increases photosynthesis; b. photosynthesis consumes CO ₂ ; c. (more photosynthesis/less CO ₂) increases pH/decreases acidity; d. less light means more respiration (than photosynthesis); e. respiration produces CO ₂ AND lowers pH/increases acidity;	<i>Allow inverse for all answers.</i> <i>Do not accept reference to colour only instead of pH.</i>	3 max
	c		temperature/volume of indicator/identical jars/number of beads/size of beads / density of <i>Chlorella</i> / other reasonable answer	<i>Do not accept light/pH/humidity.</i>	1

Section B

Option A — Neurobiology and behaviour

Question		Answers	Notes	Total
4.	a	a. branches (of dendrites/axons) formed OR new/more dendrites formed; b. dendrites/axons grow/get longer;		2
	b	a. neural tube differentiation/formation; b. neuron (may) migrate to other parts; c. axon (may) extend beyond the neural tube/myelinates; d. synapses develop; e. neural pruning;	<i>Do not accept “connection” instead of “synapse”.</i>	2
	c	a. neural pruning; b. neurons are destroyed / apoptosis		1 max

Question			Answers	Notes	Total
5.	a	i	label to cerebellum	<p><i>Diagram is for 5(a)(i), (b), (c)</i></p> 	1
		ii	controls/coordinates (motor) movements/balance		1
	b		label to pituitary OR label to hypothalamus;	<i>See 5ai for diagram.</i>	1
	c		<p><i>Alternative 1:</i> a. fMRI; b. scan detects changes in blood flow/oxygen in blood OR more active parts of brain receive more blood flow;</p> <p><i>Alternative 2:</i> c. lesions/autopsy; d. part of the brain damaged OR loss of function detected;</p> <p><i>Alternative 3:</i> e. stimulation during open brain surgery; f. reaction observed;</p>	<p><i>The "f" must be written for fMRI.</i> <i>Description must relate to method named.</i></p>	2 max

Question		Answers	Notes	Total	
6.	a	 <p>any straight line from P passing through the lens to the retina of left eye</p>		1	
	b	i	visual cortex/occipital lobe	1	
		ii	right	See note in a.	1
	c		ganglion (cell)	1	

Q	Answers	Notes	Total
7.	<p>a</p> <p>a. (the pattern/unit is) a low frequency followed by higher frequency; b. the same pattern/unit is repeated; c. range limited to specific frequencies;</p>		2 max
	<p>b</p> <p>a. early birdsong pattern is genetically determined/innate; b. later birdsong pattern is modified based on learning from adults/other birds;</p>	<i>OWTTE</i>	2
8.	<p>a</p> <p><i>Strengths:</i> a. (slight) increase in mate choice at higher male brightness index; <i>Weaknesses:</i> b. dots are scattered without a trend/no clear correlation OR most females choose mates around normal (brightness); c. insufficient data/information provided;</p>	<i>Allow any other data-based statement.</i>	2
	<p>b</p> <p>a. natural selection favours specific types of mate selection/behaviour; b. (behaviour/mate selection) increases the chances of survival/reproduction; c. chosen organisms/males will leave more offspring; d. pass on gene(s) for behavior to offspring; e. (behaviour/allele) will become more prevalent/frequent in a population;</p>		3 max
	<p>c</p> <p><u>vampire</u> bats share blood to ensure survival;</p>	<i>Other verified, outlined example.</i>	1
9.	<p>a. psychoactive drugs act upon the central nervous system/alter brain function; b. psychoactive drugs are addictive; <i>Stimulants:</i> c. increase postsynaptic transmission; d. mimic the stimulation provided by the sympathetic nervous system OR mimic action of natural stimulating neurotransmitters e.g. acetylcholine; e. example: e.g. nicotine/cocaine/amphetamine; <i>Sedatives:</i> f. decrease postsynaptic transmission; g. mimic inhibition (of the parasympathetic nervous system) OR mimic action of natural inhibiting neurotransmitters e.g. dopamine; h. example: e.g. benzodiazepines/alcohol/tetrahydrocannabinol (THC);</p>		6 max

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
10.	a	i	2		1
		ii	a. pH decreased by citric acid; b. (pH lowered by) production of CO ₂ produced (by the fungus) in respiration; c. (pH lowered by) production of carbonic acid by CO ₂ dissolving in water;		2 max
	b		batch fermentation because the citric acid is collected at the end of the fermentation OR batch fermentation because the process was carried out over 6 days then re-set up OR diagram does not show constant supply of nutrients so it must be a batch;		1
	c		preservative/flavour	<i>Accept other verified use, e.g. buffering.</i>	1
11.	a		2006		1
	b		a. glyphosate use increased and other herbicides use decreased; b. during this period there was no increase/decrease in the EIQ OR the data shows that there was not much change in environmental impact; c. data insufficient to reach conclusion;	<i>Both must be mentioned for the mark.</i>	2

(Continued...)

(Question 11 continued)

Question		Answers	Notes	Total
	c	a. the bacterium inserts a plasmid into plant cells; b. the Ti plasmid induces tumours in plants; c. (Ti plasmid) modified to include a gene coding for glyphosate resistance; d. (Ti plasmid) integrates its DNA into the plant genome OR plasmid is used as a vector to introduce glyphosate resistance gene; e. tumour/gall tissue is cultured to form plants with the gene for glyphosate resistance;		3 max
12.	a	a. biofilm bacteria are all together while free bacteria do not interact with others; b. biofilm bacteria present emergent properties not present in free bacteria; c. <u>quorum sensing</u> only found in biofilm; d. EPS matrix only in biofilm; e. biofilm bacteria are more resistant to antibiotics/disinfectants;		3 max
	b	<i>Monochloramine not a good choice [1 max]</i> a. high concentrations/amounts are needed; b. health risks need to be assessed; <i>Monochloramine a good choice [1 max]</i> c. monochloramine is more stable; d. monochloramine range for biofilm is very extensive OR some biofilm bacteria must be highly resistant;		2 max
	c	viruses/(bacterio)phages that are specific to the bacterium are used to kill it;		1

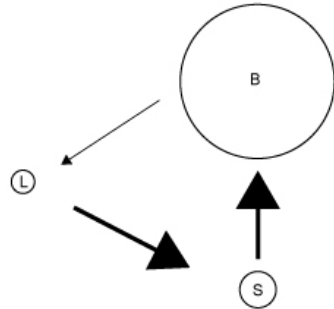
Question		Answers	Notes	Total
13.	a	a. fusion between genes of (viral) capsid and hepatitis B antigen/HBsAg; b. (transformed) virus infects tobacco plant; c. tobacco plant expresses antigen/HBsAg; d. HBsAg producing plants fed to animals; e. animals produce anti-HBsAg antibodies;		3 max
	b	as time passes, the soybean produces less antigen / stabilizes to a lower level (after 6 months)		1
	c	DNA/nucleotide sequence with a start codon and stop codon coding for a polypeptide chain;		1
	d	a. gene databank; (e.g. GenBank/NCBI); b. BLASTn to search similar DNA sequences; c. ORF finder to search for the start codon; <i>Alternative:</i> d. protein database search for antigen (sequence); e. example of database; (e.g. NCBI/SwissPro/Uniprot/PDB/other checked database); f. BLASTp to search similar protein sequences;		2 max

Question	Answers	Notes	Total
14.	<p><i>Presence of genetic material (PCR and/or microarray): [Allow 4 max]</i></p> <p><i>PCR:</i></p> <p>a. presence of the genetic material can be amplified by PCR; b. if the genetic material is RNA, a reverse transcription PCR must be performed</p> <p>OR</p> <p>using reverse transcriptase, the enzyme must first transform RNA into DNA; c. PCR primers stick to DNA; d. amplify DNA;</p> <p><i>Microarray:</i></p> <p>e. genetic material can be detected in microarray; f. probes of the DNA of the pathogen are placed on the chip; g. if the pathogen DNA is complementary, there is fluorescence;</p> <p><i>Presence of proteins: [Allow 4 max]</i></p> <p>h. presence of the proteins can be detected by ELISA; i. the test detects the antigens which are proteins of the pathogens; j. it uses antibodies stuck to a plate (which capture the pathogen antigen)</p> <p>OR</p> <p>it detects antibodies against pathogen; k. antibodies with an enzyme/fluorescence are used to reveal binding; l. metabolites of the disease detected in blood/urine;</p>		6 max

Option C — Ecology and conservation

Question		Answers	Notes	Total
15.	a	a. with <u>quadrats</u> (of 0.5 m side / 0.25m ²); b. (quadrats) position determined at fixed distance by transects OR (quadrats) position determined at random; c. random sampling / capture-recapture; d. average number calculated;		2 max
	b	a. sea otters (feeding on sea urchins) limit sea urchin population; b. the largest sea urchins are eaten; c. shown by low biomass/small size (of sea urchins); d. fewer/smaller sea urchins allow for increase in algae population; e. sea otters have a top down effect;	<i>Allow converse reasoning.</i>	3 max
	c	the sea urchins' limiting factors in their original habitat are missing OR lack of (natural) predators for sea urchins		1

Question			Answers	Notes	Total
16.	a	i	2		1
		ii	a. birds are unable to fly/swim for food; b. unable to escape predators; c. birds drown; d. birds suffocate/are strangled;		1 max
	b	i	(group) C / albatrosses, petrels and shearwaters		1
		ii	a. fill up the stomachs (of young birds) so they feel full / starve to death; b. damage the digestive system / cut the gut/stomach/oesophagus/intestines (leading to internal bleeding); c. block passage of food (causing starvation); d. cause choking (so cannot breathe); e. contain/decompose to microplastics/toxic chemicals (poisoning birds) OR toxins/microplastics in seawater build up/biomagnify (and poison wildlife);		2 max

Question		Answers	Notes	Total
17.	a	<p>a. richness refers to the number of (different) species in the environment/community/ecosystem;</p> <p>b. evenness refers to the number of individuals within each species;</p> <p>c. richness and evenness are components of biodiversity;</p> <p>d. biodiversity measured by (Simpson's) diversity index;</p>	<p><i>Accept converse.</i></p> <p><i>Do not accept "species" to mean "individuals of a species".</i></p>	2 max
	b	<p>temperature;</p> <p>precipitation;</p> <p>pH/e.g. acid rain;</p> <p>tides;</p> <p>sunlight;</p> <p>substrate;</p> <p>minerals/nutrients;</p> <p>pollutants;</p>	<p><i>Only mark the first two factors if more than two are stated.</i></p> <p><i>Allow any other verified factor.</i></p>	2 max
	c	<p>a. breeding/migration changes the number of individuals of some species;</p> <p>b. variation in some abiotic factors;</p> <p>c. food availability;</p>	<p><i>Accept any reasonable suggestion-that could cause a variation of number of individuals of some species reducing evenness.</i></p>	1 max
	d	<p><i>Gersmehl diagram showing the following:</i></p> <p>a. thick arrow from soil to biomass;</p> <p>b. thick arrow from litter to soil;</p> <p>c. thin arrow from biomass to litter;</p>		3

Question		Answers	Notes	Total
18.	a	<p>a. between 1930 and 1968 the numbers were reduced; b. after 1968/in the 1970s the numbers increased; c. in 1990s/1995 the numbers decreased again; d. lowest in 1968 and highest in 1990;</p>		3 max
	b	<p>a. relative rates of natality; b. disease/lack of food; c. competition for the same resources; d. immigration/emigration/migration;</p>		2 max
19.		<p>a. excess rains/floods/irrigation can wash away nutrients/N/P by leaching; b. excess rains/floods/irrigation can lead to waterlogged soils; c. waterlogging leads to denitrification due to anaerobic conditions; d. nutrients are added to the cycles by application of fertilizer; e. nutrients are removed by the harvesting of agricultural crops;</p> <p><i>Nitrogen:</i> f. lightning increases N in soil; g. planting legumes increases N in soil;</p> <p><i>Phosphate:</i> h. mining of P speeds up the P cycle/depletes P reserves; i. phosphorus is added to waters in detergents; j. phosphorus is mined/taken from rocks for making detergents/fertilizers;</p>		6 max

Option D — Human physiology

Question		Answers	Notes	Total
20.	a			1
	b	cannot be synthesized by the body		1
	c	250 (mL)		1

Question		Answers	Notes	Total
21.	a	a. produces acid to break down molecules; b. churns food for mechanical digestion; c. produces proteases to digest proteins/peptides;	<i>Allow pepsin. Do not allow "acid kills bacteria".</i>	2 max
	b	production of <u>hydrochloric acid/HCl</u>		1
	c	i <i>Helicobacter pylori/H. pylori</i>		1
		ii a. acidity is achieved by a proton pump/H ⁺ , K ⁺ -ATPase; b. exchange of H ⁺ from the cytoplasm for K ⁺ ions in the lumen; c. PPIs bind irreversibly to the (proton) pump; d. lowering amount of acid produced/H ⁺ ;		3 max
22.	a	a. systolic pressure increases with salt in diet during treatment; b. diastolic pressure is slightly higher/no change with salt during treatment OR diastolic pressure only changes towards the end of the period; c. (blood) pressure goes back to normal after treatment OR salt causes increased (blood) pressure; d. standard deviation values overlap therefore not statistically significant;		2 max
	b	sphygmomanometer/blood pressure <u>monitor</u> ;		1
	c	a. sinoatrial node/SAN initiates contraction of atria; b. SAN sends messages to the atrioventricular/AV node; c. AV node initiates ventricular contraction; d. through conducting fibres;		2 max

Question		Answers	Notes	Total
23.	a	a. respiring tissues produce CO ₂ ; b. CO ₂ leads to an increase in H ⁺ /decrease in blood pH; c. increased acidity/decreased pH shifts the oxygen dissociation curve to the right; d. affinity of the hemoglobin for oxygen is reduced; e. greater release of oxygen from hemoglobin (at the same partial pressure of oxygen) in tissues;		3 max
	b	a. dissolved/carried in plasma; b. forms carbonic acid/H ₂ CO ₃ (in plasma) OR as hydrogencarbonate (HCO ₃ ⁻) ions (in plasma); c. binds to hemoglobin in red blood cells;		2 max
	c	increased carbon dioxide in blood increases the rate of ventilation OR positive correlation/relationship;		1
	d	a. hemoglobin (from broken red blood cells) taken up by Kupffer cells (in the liver); b. hemoglobin broken down into heme and globin; c. globin hydrolyzed/broken down to amino acids; d. iron removed from heme group OR heme broken down to form bilirubin/bile pigment;	Do not accept red blood cells broken down into heme and globin.	3 max

Question	Answers	Notes	Total
24.	<p>a. endocrine glands secrete hormones directly into the bloodstream;</p> <p><i>Steroid hormones:</i></p> <p>b. pass through the <u>plasma</u> membrane (of target cells);</p> <p>c. bind to receptor proteins in the cytoplasm</p> <p>OR</p> <p>form a receptor–hormone complex;</p> <p>d. (receptor–hormone complex) enters the nucleus;</p> <p>e. promotes the transcription of specific genes;</p> <p><i>Peptide hormones:</i></p> <p>f. bind to receptors in the <u>plasma</u> membrane (of the target cell);</p> <p>g. (binding of hormones to membrane receptors) activates a cascade of reactions;</p> <p>h. (cascade of reactions) mediated by a second messenger (inside the cell);</p> <p>i. (cascade results in) activation of enzymes;</p>		6 max