

Markscheme

May 2024

Biology

Standard level

Paper 3

© International Baccalaureate Organization 2024

All rights reserved. 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 the prior written permission from the IB. Additionally, the license tied with this product prohibits 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, whether fee-covered or not, is prohibited and is a criminal offense.

More information on how to request written permission in the form of a license can be obtained from <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organisation du Baccalauréat International 2024

Tous droits réservés. 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 préalable de l'IB. De plus, la licence associée à ce produit interdit toute utilisation 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, moyennant paiement ou non, est interdite et constitue une infraction pénale.

Pour plus d'informations sur la procédure à suivre pour obtenir une autorisation écrite sous la forme d'une licence, rendez-vous à l'adresse <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organización del Bachillerato Internacional, 2024

Todos los derechos reservados. 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 la previa autorización por escrito del IB. Además, la licencia vinculada a este producto prohíbe el uso 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—, ya sea incluido en tasas o no, está prohibido y constituye un delito.

En este enlace encontrará más información sobre cómo solicitar una autorización por escrito en forma de licencia: <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

Subject Details; Biology SL Paper 3 Markscheme

Candidates are required to answer **all** questions in Section A and **all** of the questions from **one** option in Section B. Maximum total = **35 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 semicolon (;) 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 A

Question			Answers	Notes	Total
1.	a	i	measure of solute concentration / total number of solute/salt particles per litre;	<i>Do not accept sugar.</i>	1
1.	a	ii	7 (% salt solution);	<i>Accept range from 6.2 to 7.2 inclusive.</i>	1
1.	b		a. loses mass as water leaves/moves out (the tissue); b. loses mass by <u>osmosis</u> ; c. loses mass as water moves from a higher concentration to a lower concentration of water OR loses mass as water moves from hypotonic to hypertonic solution OR loses mass as water moves from low solute to high solute concentration;	<i>Both loss of mass and reason required.</i>	1 max
1.	c		a. (each piece should be approximately) the same surface area/size/shape/mass; b. leave the pieces of tissues in the solutions for the same period of time; c. all done at the same temperature; d. same volume / type of salt used in solution; e. use the same method to dry pieces before weighing; f. same fruit/age of fruit/type of tissue;	<i>Mark the first two only</i>	2 max

Question		Answers	Notes	Total
2.	a	<p>a. the standard deviation / range of values / standard error / (95%) confidence limits / spread of data / uncertainties / variation;</p> <p>b. if the bars overlap, it signifies little significant difference between the sets of data;</p>	<p><i>Do not accept outliers or systematic error.</i></p> <p><i>b. Accept vice versa.</i></p>	1 max
2.	b	<p>a. at all CO₂ concentrations, <i>Skeletonema</i> has a greater growth rate;</p> <p>b. <i>Nitzschia</i> is not as affected (significantly) by the changes of CO₂;</p> <p>c. only <i>Skeletonema</i> growth rate increased (significantly) at 780ppm</p> <p>OR</p> <p><i>Skeletonema</i> population decreased and increased/fluctuated while <i>Nitzschia</i> only decreased;</p>		2 max
2.	c	<p>a. <i>Skeletonema</i> may outcompete <i>Nitzschia</i></p> <p>OR</p> <p><i>Skeletonema</i> may cause decrease/extinction of <i>Nitzschia</i>;</p> <p>b. change in food chains/webs/food supply / increase in populations at higher trophic levels;</p> <p>c. more dissolved oxygen / more photosynthesis;</p> <p>d. decreased pH of ocean / damage to exoskeletons;</p> <p>e. decreased light penetration;</p>	<p><i>Do not accept that <i>Skeletonema</i> increases and <i>Nitzschia</i> decreases without a link.</i></p>	2 max

Question		Answers	Notes	Total
3.	a	<p>a. both positive/direct relationship;</p> <p>b. as exercise increases, (both) O₂ consumption and the total volume of air inhaled increase;</p>	<p><i>a. References to both are required for the mark.</i></p> <p><i>b. "O₂ consumption and the total volume of air inhaled increases" alone is insufficient without reference to an increase in exercise. Accept vice versa.</i></p>	1 max
3.	b	<p>a. exercise requires (more) ATP/energy/(cellular) respiration;</p> <p>b. requires more oxygen;</p> <p>c. increased ventilation moves more O₂ / oxygen / air into the lungs/alveoli/blood/body;</p> <p>d. ventilation maintains the concentration gradients of O₂ between alveoli air and blood in capillaries;</p>		2 max
3.	c	<p>a. the person will have shortness of breath/difficulty to breath well/difficulty to carry out exercise/cough more;</p> <p>b. emphysema causes changes/damage to the alveoli in the lungs/decreases surface area/elasticity of lungs for gas exchange;</p> <p>c. gaseous exchange (of O₂ and CO₂) is inefficient/slowed</p> <p>OR</p> <p>there is not enough O₂ to supply energy / oxygen consumption decreases (for the muscles during exercise);</p>	<p><i>b. Changes may include thicker alveolar walls/bigger alveoli/ fewer alveoli.</i></p>	2 max

Section B

Option A — Neurobiology and behaviour

Question			Answers	Notes	Total
4.	a	i	a. increase in synaptic density / more connections between neurones / more neural pathways; b. development of more neurons / neurogenesis;		2
4.	a	ii	neural pruning / unused neurons/synapses are eliminated;		1
4.	b	i	<i>Name:</i> cerebellum; <i>Function:</i> coordinate unconscious/involuntary (motor) functions/posture/balance/movement;		2
4.	b	ii	glucose/ATP/(cell) respiration;		1
4.	b	iii	speech/language processing/talking;		1

Question		Answers	Notes	Total
5.	a	a. able to react to (specific gaseous/volatile) chemicals in the air; b. (most) have mucous/moisture in which to dissolve the substance; c. they have cilia; d. have <u>protein</u> receptors in the membrane OR have receptors in the <u>membrane</u> ; e. are nerve cells/part of sensory neurons OR (cause an impulse) to be transmitted to the brain;		2 max
5.	b	a. mating; b. reproduction; c. scavenging/food search; d. social recognition; e. emotional responses; f. escaping from predators; g. any other valid behavioural change;	<i>Accept only the first two answers.</i>	2 max
5.	c	a. primates depend more on the sense of sight/hearing/other senses; b. smell is less important for survival/reproduction; c. natural selection favoured other senses;		2 max

Question		Answers	Notes	Total
6.	a	<ul style="list-style-type: none"> a. photoreceptors/cones/rods detect (reflected) light/stimulus; b. cones and rods found in the retina; c. rods active in low-intensity/dim light; d. cones active in high-intensity/bright light; e. rods give black and white vision; f. cones detect colours; 		3 max
6.	b	<ul style="list-style-type: none"> a. thermoreceptors/heat receptors sense temperature change; b. mechanoreceptors/touch receptors provide information on the texture/density; c. chemoreceptors/taste buds on the tongue detect chemicals/taste; d. several types of chemoreceptors/taste buds; e. mechanoreceptors/touch receptors prevent choking/promote swallowing; f. stimulus causes nerve impulses to be sent to central nervous system/CNS/brain; g. central nervous system/CNS/brain perceives taste / coordinates an appropriate response; 		4 max

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
7.	a		a. they are very small / less space needed for growth; b. have a fast population growth rate/reproduction rate; c. are metabolically diverse (so can be used for many different purposes); d. cheap;		1 max
7.	b	i	<i>Aspergillus niger/Aspergillus/A. niger;</i>		1
7.	b	ii	a. correct levels of pH/temperature/air/oxygen; b. there is a continuous provision of nutrients/medium; c. there is a continuous removal of products/wastes;	<i>Accept only the first answer.</i>	1 max
7.	c		a. uses knowledge of metabolic pathways; b. uses genetic engineering to optimise regulatory conditions (in microorganism); c. to change conditions/add extra substrates/remove byproducts that slow rate of reaction;		2 max

Question			Answers	Notes	Total
8.	a	i	production of paper/adhesives/starch/thickener for foods;		1
8.	a	ii	a. normal potatoes have amylose while GMO potatoes have no amylose; b. GMO potatoes contain only amylopectin;	<i>Accept vice versa.</i>	1 max
8.	a	iii	a. (genetic engineering used to) block translation of mRNA of a specific enzyme; b. in Amflora, enzyme necessary for producing amylose is not produced; c. gene expression is suppressed by antisense technology; d. antisense technology involves inserting a version of the gene that is inverted;	<i>b. OWWTE.</i> <i>Do not accept other methods.</i>	2 max
8.	b	i	<i>Agrobacterium tumefaciens /A. tumefaciens/Agrobacterium;</i>		1
8.	b	ii	a. the weeds compete with the soybean crops (reducing crop yield); b. farmers may overuse (other) herbicides (causing environmental problems); c. (increased use of herbicides causes) contamination of soils/water; d. uncontrolled spread of the trans-gene/formation of superweeds;		2 max

Question			Answers	Notes	Total
9.	a		a cooperative aggregate/colony of microorganisms/bacteria (that fix on surfaces) and produce extracellular matrix/ EPS/ communicate by quorum sensing/ show emergent properties;	<i>OWTTE.</i> <i>Do not accept resistance to antibiotics alone, as it is not a unique feature of biofilms.</i>	1
9.	b	i	a. could effectively control a biofilm formation as there is a decrease in the number of cells (that could form a biofilm); b. could not effectively control biofilm formation as there are still a considerable number of cells present (so biofilm could form again); c. effect of acid on other organisms not known (so could cause environmental problems);		2 max
9.	b	ii	a. the change in pH could cause denaturation of proteins/enzymes in the bacteria/biofilm; b. zosteric acid may interfere in quorum sensing; c. could stop the biofilm from developing emergent properties/ production of EPS;		1 max

Question	Answers	Notes	Total
10.	<p>Electroporation:</p> <ul style="list-style-type: none"> a. physical method / electric field applied (to cells); b. (electric field) make cell membranes permeable / causes the formation of temporary pores; c. DNA added with a plasmid; d. electric pulses allow DNA to enter the cell (and incorporate into plastids); <p>Calcium chloride:</p> <ul style="list-style-type: none"> e. chemical method; f. cells incubated in calcium chloride solution at cold temperature; g. makes the cell membranes permeable / causes the formation of temporary pores; h. heat shock/abrupt change in temperature induces DNA uptake; 	<p><i>Award [3 max] if only one technique described.</i></p> <p><i>b. and g. are similar marking points but apply to different situations, so mark both independently.</i></p>	4 max

Option C — Ecology and conservation

Question		Answers	Notes	Total
11.	a	<p><i>Both species grown together:</i> realized;</p> <p><i>Each species grown separately:</i> fundamental;</p>		2
11.	b	<p>a. <i>T. angustifolia</i> grows in deeper water. / <i>T. latifolia</i> does not grow in such deep water;</p> <p>b. <i>T. angustifolia</i> has a wider range of distribution / <i>T. latifolia</i> has a narrower range of distribution;</p> <p>c. <i>T. angustifolia</i> only grows out of water when grown separately / <i>T. latifolia</i> grows out of water when sperate and together;</p> <p>d. <i>T. angustifolia</i> has a lower peak of production/ <i>T. latifolia</i> has a higher peak of production;</p>		2 max
11.	c	<p>a. nutrients/minerals in soil/water for plant growth;</p> <p>b. compaction of soil for the growth of roots;</p> <p>c. temperatures for plant growth/photosynthesis/respiration/enzyme reactions;</p> <p>d. conditions of pH for plant growth/nutrient uptake/enzyme reactions;</p> <p>e. salinity for water uptake;</p> <p>f. light/carbon dioxide for photosynthesis;</p>	<p><i>Do not accept an environmental factor without a reason.</i></p>	2 max

Question			Answers	Notes	Total
12.	a	i	heat lost / respiration OR some energy egested as feces OR not all is absorbed OR some substances not digested;		1
12.	a	ii	a. the lower the ratio, the more efficient the production of protein; b. cows have a much higher conversion ratio (of 20) than fish (of 1.5); c. cow makes much less edible mass/protein per kilo of feed than the fish OR cow requires much more/(about) 13 times the amount of feed than fish for 1kg edible mass/protein; d. cows have higher/different metabolic rates than fish OR cows have a greater/different energy expenditure than fish;	a. <i>OWTTE</i> Accept valid statements using numbers for b. and c. Accept vice versa.	2 max
12.	a	iii	a. they have a low/a 1.25 conversion ratio; b. produce higher quantity of edible mass with same mass of food (as other animals); c. most parts are edible/ little is wasted; d. they reproduce very quickly/large amounts easily grown;		1 max
12.	b		tundra;		1

Question		Answers	Notes	Total
13.	a	<p>a. has no natural predators so increase in number; b. out-compete other predators of reef/occupies the niche of other species/competitive exclusion; c. disrupt food chains (of the reefs); d. decrease in native population OR could cause extinction of other/native species OR changes biodiversity of an ecosystem; e. affect local commercial fishing industry by decreasing the desired species; f. can use resources other species cannot;</p>		3 max
13.	b	<p>a. remains in the environment/not biodegradable; b. (taken in by organisms and) stored in fat tissues/bioaccumulates/not excreted; c. biomagnification /concentration increases up the food chain; d. may cause cancer/liver damage/infertility/weaken birds' eggshells/kills insects/other verified effect;</p>		2 max

Question		Answers	Notes	Total
14.		<ul style="list-style-type: none">a. use transects/quadrats;b. count number of species/individuals;c. measure <u>richness</u> and <u>evenness</u>;d. use Simpson (reciprocal) index;e. indicator species/biotic index to reflect a specific environmental condition;f. changes in Simpson index/richness/evenness/indicator species indicate changes in the community biodiversity;		4 max

Option D — Human physiology

Question			Answers	Notes	Total
15.	a	i	as body mass increases, vitamin D deficiency increases / positive correlation;	<i>Accept vice versa.</i>	1
15.	a	ii	bone demineralization/rickets/osteomalacia/soft bones/bone fractures/osteoporosis/ less calcium absorbed/any other valid answer;		1
15.	a	iii	a. risk factor in CHD/heart attack/stroke/diabetes type II; b. damages lining/walls of arteries OR rupture of blood vessels; c. promotes plaque production/atherosclerosis;	<i>a. Do not accept high blood pressure.</i>	2 max
15.	b		lack of vitamin C/ascorbic acid;	<i>Do not accept a source of vitamin C, such as citric fruits, without the specific mention of vitamin C.</i>	1

Question		Answers	Notes	Total
16.	a	dehydration/diarrhea/vomiting;	<i>Mark only the first answer written.</i>	1
16.	b	a. young people more likely to be in a situation where they contract cholera/bacteria/OWTTE; b. more young people in population/OWTTE; c. older people less likely to go to hospital; d. older people with more resistance/immunity to cholera/bacterium; e. other valid reason;	<i>Accept vice versa.</i>	1 max
16.	c	a. water/salt absorbed; b. materials not absorbed are egested/eliminated OR formation of feces; c. peristalsis occurs OR fiber aids transit through the large intestine;	<i>b. Do not accept excreted.</i>	2 max

Question		Answers	Notes	Total
17.	a	a. capillaries have smaller pores/gaps; b. capillaries have smaller lumen / are narrower; c. Kupffer cells are not present in capillaries; d. sinusoids do not have continuous wall, capillaries do;	Accept vice versa. b. Do not accept smaller capillaries/ bigger sinusoids.	1 max
17.	b	a. hemoglobin is broken down in the liver; b. (liver abnormalities) cause an accumulation of bilirubin/ bilirubin in blood; c. (bilirubin) causes a yellow colour / is a yellow pigment;		2 max

Question		Answers	Notes	Total
18.	a	death rate is higher in men;	<i>Accept vice versa.</i>	1
18.	b	due to differences in hormones/ intensity of physical work/ stress levels/ quality of diet/ alcohol consumption/ smoking /genetics/obesity/BMI;		1 max
18.	c	a. to identify whether different ethnic groups have different death rates due to CHD; b. different lifestyle/cultural/genetic/dietary factors may affect CHD death rates; c. (if the rates are different) to look for different factors that affect CHD; d. health measures can be adapted for factors identified in specific ethnic groups; e. differences in access to health care/socioeconomic levels/environmental factors;		2 max

Question	Answers	Notes	Total
19.	<p>a. cardiac muscle/SAN is myogenic/produces its own/innate rhythm / is the pacemaker; b. SA node/SAN transmits the signal throughout the atria; c. (causing) atria to contract/systole; d. signals from the SAN pass to the atrio-ventricular node (AVN); e. delay between the arrival and passing of a stimulus at atrio-ventricular node (AVN); f. conducting/Purkinje fibres branch out to each ventricle OR (signals from the AVN/Purkinje fibres cause) the ventricles to contract/systole; g. SAN has connections from the autonomic nervous system/ANS that influence the rate OR cardiac cells can respond to epinephrine/hormones / signals from the medulla oblongata;</p>		4 max