Markscheme

May 2023

Biology

Standard level

Paper 3

18 pages

© International Baccalaureate Organization 2023

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 2023

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, 2023

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 semi colon (;) 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 <u>underlined</u> 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	Marks
1	a		to check there is no carbon dioxide (left in the air)/show any carbon dioxide present;	*Do not accept absorb carbon dioxide*	1
1	b		soil releases CO_2 from microorganisms/decomposers/bacteria/fungi ***OR*** respiration by microorganisms may affect the result;		1
1	c		using the same apparatus without a plant ***OR*** cover the whole plant with a plastic bag;	*Do not accept a controlled variable*	1
1	d		no change/limewater stays clear ***OR*** because plant takes in carbon dioxide by photosynthesis;	*Do not accept references to oxygen produced by photosynthesis*	1

2	**a**		freeze fracture/etching ***OR*** involves freezing and fracturing cells;		**1**
2	**b**		140000 to 150 000 (X);		**1**
2	**c**		protein/named membrane protein;	*Accept first answer only*	**1**
2	**d**		the phospholipid bilayer was not coated by/sandwiched between two protein layers ***OR*** (transmembrane/integral) proteins are found within the phospholipid bilayer;	*OWTTE*	**1**
2	**e**		a. to prevent osmosis; b. cells placed in the in the incorrect osmolarity might swell/burst/shrink; c. hypotonic solution would cause water to enter cells/tissues; d. hypertonic solutions would cause water to leave cells/tissues; e. water loss would hinder (metabolic) reactions in cell cytoplasm ***OR*** distort appearance of the cells (for the investigation);	*Mp c and d must indicate direction of water movement* *Accept wtte for hypo- and hyper-tonic*	**3 max**

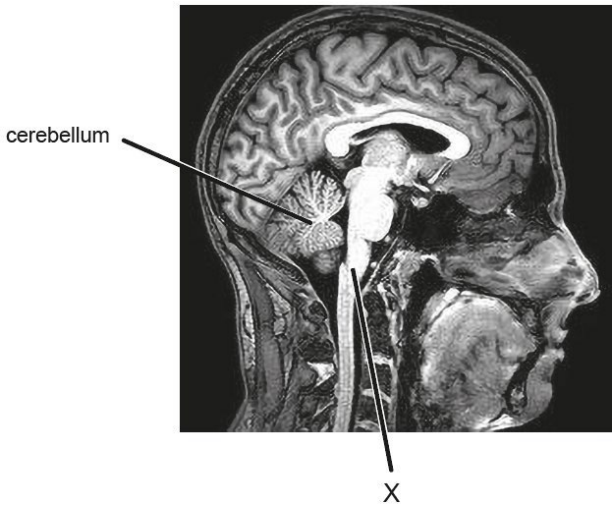
Question			Answers	Notes	Marks
3	**a**	**i**	from blood sample/hair/cheek/saliva/semen;	*Do not accept red blood cells*	**1**
3	**a**	**ii**	PCR/polymerase chain reaction ***OR*** using Taq polymerase;		**1**
3	**b**		a. male 2; b. each band in the child's DNA must be the same as a band in either the mother or the father ***OR*** any band in the child's profile that is not present in the mother's profile must be present in the father's;	*Must mention both the mother and father*	**2**

Section B

Option A — Neurobiology and behaviour

Question			Answers	Notes	Marks
4	**a**		reduced (neurological damage);		**1**
4	**b**		some recovery due to neurons replacing the function of damaged areas ***OR*** neural plasticity;	*Do not accept formation of new neurons*	**1**
4	**c**		some brain structures/disorders/functions in animals are similar to humans ***OR*** (more) unethical/risk to use humans **OR** nervous system develops more rapidly in other animals (than in humans);		**1**
4	**d**		a. (fMRI) shows active parts of the brain when stimulated; b. subject can be conscious; c. active parts of brain have increased blood flow/oxygenated haemoglobin; d. blood flow made visible by injecting a dye;		**2 max**

Question			Answers	Notes	Marks
5	a		there are no photoreceptors/cones/rods ***OR*** it is the blind spot;		**1**
5	b		a. mouse has greater photoreceptor density (than human); b. the graph does not distinguish between types of photoreceptor; c. cones detect colours ***OR*** rods provide monochromatic/night vision; d. there is no data about colour vision in mice;		**2 max**
5	c		a. bipolar cells interconnect/link photoreceptors to ganglion cells ***OR*** bipolar cells pass impulses from photoreceptors to ganglion cells; b. one bipolar cell receives signals from/synapses with one cone cell; c. one bipolar cell receives signals from/synapses with several rod cells;		**2**
5	d		a. chemoreceptors stimulated by chemicals but mechanoreceptors are stimulated by movement/forces/pressure; b. valid example of each;	*Chemoreceptors: taste buds, carotid/aortic bodies, pH, oxygen* *Mechanoreceptors: hair cells, stretch, touch, pressure* *Accept other verified examples*	**2**

Question			Answers	Notes	Marks
6	a		 [Source: DrOONeil, 2014. FMRI Brain Scan. [image online] Available at: https://commons.wikimedia.org/wiki/File:FMRI_Brain_ Scan.jpg [Accessed 26 January 2022]. Public domain.]		**1**
6	b		a. breathing centre in medulla (oblongata)/brain stem; b. operates via autonomic nervous system; c. blood pH reduced/more acidic (with increased carbon dioxide); d. (Medulla) causes deeper/faster breathing; e. expels more carbon dioxide from lungs/blood; f. raises pH of blood;	*Accept inverse responses for decreased carbon dioxide (for mp c to f)* *For mp d accept a valid mechanism*	**3 max**

7			a. axon develops from (immature) neuron; b. chemical stimuli cause (direction of) growth; c. some neurons/axons migrate/extend to other areas; d. dendrites develop; e. (multiple) synapses form between neurons; f. synapses are strengthened with use; g. neural pruning causes unused synapses to be eliminated; h. neural plasticity allows new connections/synapses;		**4 max**

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Marks
8	**a**		a. increase in methane; b. produced by methanogens/archaeans; c. in anaerobic conditions/absence of oxygen; d. decrease in carbon dioxide which is converted into methane; e. some methane and carbon dioxide produced by breakdown of organic acids/alcohol/organic compounds;	*Ignore any data from 0 to 40 days* *Ignore any comments on hydrogen – it is 0 from 40 days* *Accept correct formulae*	**3 max**
8	**b**		manure/animal dung/household waste/sewage/farm waste/bagasse;		**1**
8	**c**		(slurry) can be used as fertilizer;	*Accept other verified examples*	**1**

9	**a**		the enzyme/PPO was absent/deactivated/inhibited/replaced;		**1**
9	**b**		they allow scientists to know that the (trans)gene has been added (correctly/successfully);	*OWTTE*	**1**
9	**c**		a. cell wall removed/protoplast used; b. electric field applied; c. makes pores in cell membrane to allow genes to enter cells;		**2 max**
9	**d**		gene flow/cross pollination/hybridisation;		**1**

Question			Answers	Notes	Marks
10	**a**		SBP+PCHS as more bacteria removed/killed ***OR*** SBP+PCHS as the effect lasts longer/more than 3 days;	*OWTTE*	**1**
10	**b**		a. bacteriophages (are viruses that) infect bacteria; b. they can spread through entire biofilm to kill bacteria; ***OR*** chemicals only kill bacteria near the surface of biofilm c. polysaccharide matrix/EPS/biopolymers act as a (physical) barrier to chemicals; d. bacteriophages are specific/can be added to destroy a specific pathogen; e. chemicals can contaminate water ***OR*** can lead to bacteria resistant to the chemical;		**2 max**
10	**c**		a. bioremediation; b. *Pseudomonas putida* used; c. methyl mercury converted/decomposed to (methane and) mercury ions; d. mercury ions turned into mercury (by other bacteria); e. insoluble mercury can be separated from waste water;		**3 max**
11			a. carbon dioxide from respiration lowers the pH; b. affecting enzyme activity of microorganisms; c. low oxygen availability will stop aerobic respiration; d. heat generation (by metabolism) raises the temperature, which may denature enzymes; e. gas production may build up pressure and affect rates of reaction; f. nutrient level /mixing needed for production; g. build-up of waste product/toxins may harm microorganisms; h. contaminant microorganisms may outcompete useful microbial population;		**4 max**

Option C — Ecology and conservation

Question			Answers	Notes	Marks
12	**a**		(FCRs) decrease;	*Accept vice versa for high to low density*	**1**
12	**b**		*Pros:* a. less water is wasted (as it is purified and re-used); b. less impure water is released to the environment; *Cons:* c. (FCR with recirculation tanks) has higher feed conversion ratio; d. more food/energy needs to be supplied (to the fish) ***OR*** recirculation may cost more;	*Accept vice versa for water flow* *Pro or con need not be stated*	**3 max**

Question			Answers	Notes	Marks
13	a		lichen species increase as distance from the city centre increases/positive correlation/trend;		1
13	b		a. indicator species live in specific environmental conditions; b. absence (of lichens) is an indicator or (air) pollution; c. relative numbers of indicator species could be used to calculate biotic index; d. biotic index can be used to monitor pollution levels over time; e. can help evaluate antipollution actions/measures;		3 max
13	c		a. lay a line/belt transect line away from the road; b. quadrat sampling can be used; c. record the number of different species; d. count the number of plants in each species; e. calculate diversity using the (reciprocal) Simpson's diversity index;	*OWTTE* *Accept quadrant* *Accept formula for mpe* $D = \frac{N(N-1)}{\sum n(n-1)}$	3 max

Question			Answers	Notes	Marks
14	**a**	**i**	secondary consumer / third trophic level/ trophic level 3 / 3;		**1**
14	**a**	**ii**	predation/predator-prey;	*Do not accept whale eats otter*	**1**
14	**b**		a. protecting species outside their natural habitats in zoos/aquariums/botanical gardens; b. essential requirements can be managed/monitored; c. allows breeding programmes; d. useful when there is a serious decline/destruction of natural habitats ***OR*** when there is a threat to individuals in the wild;		**2 max**
14	**c**		do not show seasonal variations in energy transfers ***OR*** difficult to assign species to a specific trophic level ***OR*** do not show energy transfer to decomposers;	*Do not accept does not show food web*	**1**

15			a. animals may get entangled in plastic and cannot breathe/swim; b. macroplastics/plastics can be ingested as food ***OR*** used to feed chicks; c. which may block their gut/cause death; d. macroplastics broken down to microplastics ***OR*** (micro)plastics may release toxic chemicals; e. DDT/pesticides/heavy metals; f. microplastics/toxic chemicals may accumulate in tissues/bioaccumulate; g. microplastics/toxic chemicals build up along food chain/in higher trophic levels/biomagnification; h. plastics persist for a long time in the environment;		**4 max**

Option D — Human physiology

Question			Answers	Notes	Marks
16	**a**		high protein/HP diet decreases appetite;	*Accept vice versa but not negative correlation*	**1**
16	**b**		a. control is located in hypothalamus; b. reduces or increases desire to eat when stimulated by hormones; c. leptin secreted by adipose tissue; d. leptin depresses appetite; e. other example;	*For mpe accept verified examples of other hormones e.g. insulin, glucagon, ghrelin, CCK, PYY3-36*	**2 max**
16	**c**		a. HP diet will suppress appetite for obese adults; b. protein-rich diet may contain (higher levels of) <u>phenylalanine;</u> c. people with PKU cannot convert phenylalanine to tyrosine; d. (people with PKU) lack phenylalanine hydroxylase; e. high levels of phenylalanine build up in blood/body ***OR*** high levels of phenylalanine are harmful to sufferers of PKU;		**3 max**
17	**a**		as UV light intensity increases, blood serum bilirubin decreases / negative correlation;		**1**
17	**b**		neurological/brain damage;	*Do not accept death*	**1**
17	**c**		a. glucose stored as/released from glycogen; b. iron/copper/vitamin A/vitamin D stored/released; c. excess cholesterol/lipids broken down; d. excess protein/amino acids broken down;		**2 max**
17	**d**		a. sinusoids larger diameter than capillaries; b. sinusoids have gaps in the walls but capillaries do not; c. Kupffer cells only in sinusoids;		**1 max**

Question			Answers	Notes	Marks
18	a		ATP needed for absorption/active transport (of nutrients);	*Reason required*	1
18	b		microvilli/tight junctions/vesicles;		1
18	c		a. (the bacterium) produces a toxin; b. toxin enters/binds to (intestinal/epithelial) cells; c. causes ions (Cl^- and HCO_3^-) to move into lumen of intestine; d. water leaves the cells by osmosis; e. causing watery faeces;	*Accept choleragen*	3 max
19			a. impulses initiate in SAN/pacemaker; b. impulses transmitted to AV node; c. AV node transmits impulses to ventricles; d. delay before ventricles contract; e. ventricular contraction/systole begins from the base/apex; f. ensures ventricles are completely emptied; g. fibres ensure both ventricles contract together; h. AV valves close during ventricular systole/contraction ***OR*** AV valves close to prevent backflow of blood to atria;	*In mpg, accept Purkinje fibres or bundle of His*	4 max