Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2023

Biology

Standard level

Paper 3

23 pages

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 <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.

Section A

Question			Answers	Notes	Total
1.	**a**		measure of solute concentration / total number of solute particles per litre;	*Do not accept number of miliosmoles per litre / mOsmL^{-1} of solution as that is given on the graph.*	**1**
	b	**i**	negative relationship/correlation / as osmolarity increases, motility decreases / inversely proportional;		**1**
		ii	water would move from blood plasma to the semen as it follows the concentration gradient / from low osmolarity to higher;	*Must include reason/explanation.*	**1**
	c		2.4 um / 0.0024 mm / 0.00024cm / 2.2 x 10-4 cm / 2400 nm;	*Accept values from 2.2 um/0.0022 mm/0.00022cm to 2.6 um/0.0026 mm/0.00026cm.* *Units required.*	**1**
	d		a. water will enter (by osmosis) causing sperm to swell/enlarge/burst; b. water will enter (by osmosis) causing sperm to become more mobile as osmolarity decreases;	*Do not accept turgidity.* *Must show movement of water.*	**1**

Question			Answers	Notes	Total
2.	**a**		slows down/inactivates the enzyme;		**1**
	b		a. *Independent variable:* pH / sex; b. *Dependent variable:* enzyme/protease activity;		**2**
	c		a. change in acidity/pH changes the charges/shape/denatures/structure of the enzyme; b. changes may alter the ability of the enzyme to bind / binding of substrate; c. greatest/peak/maximum activity is at optimal pH/pH10;		**2 max**

Question			Answers	Notes	Total
3.	**a**		a. volume/source/composition of water; b. initial numbers/type of organisms of each species; c. size/volume/material of tanks; d. type of nutrients;	*"same" tanks is too vague.* *Do not accept amount of nutrients.* *Do not accept same temperature/amount of light as all are in the same open space.*	**1 max**
	b		a. prevent entering/leaving of organisms/leaves/organic matter; b. allow gases/air to circulate/enter; c. prevent animals from eating organisms/drinking water/damaging mesocosm; d. allow light to penetrate;	*Do not accept microorganisms.*	**1 max**
	c		a. more reliable results; b. detects experimental errors / more precise; c. allows to eliminate outliers/anomalous results / more accurate; d. adequate data for statistical tests / calculation of standard deviation;		**1 max**
	d		a. ability to control/measure variables/nutrients/physical factors (to determine their effects); b. isolation of populations / can compare with and without mosquitofish (to determine specific effects); c. not affect/impact/contaminate the natural ecosystem; d. avoid unpredictable effects that could occur in the natural ecosystem; e. possible to have exact replicates;		**2 max**

Section B

Option A — Neurobiology and behaviour

Question			Answers	Notes	Total
4.	**a**		a. X: neural fold/groove; b. Y: notochord;		**2**
	b		a. development/growth of dendrites; b. development/growth of axon; c. migration to other parts of the embryo/to final location;		**1 max**

Question			Answers	Notes	Total
5.	**a**	**i**	*Nucleus accumbens:* pleasure/laughter/regulation of sleep/motivation/reward centre/desire/feeding/addictive behaviours;		**1**
		ii	*Medulla:* breathing/cardiac function/respiration/digestion/vasodilation/swallowing/ sneezing/vomiting;		**1**
	b		a. through regeneration of neurons; b. (neuro)plasticity / makes new synapses / new neural pathways; c. reorganization of function, where another area of the brain takes over the function;		**2 max**

Question			Answers	Notes	Total
6.	a		*This statement seems justified as:* a. data shows there are more synapses at an early age ***OR*** synapses decrease with age; b. more synapses allow for greater learning/cognitive activity; c. information from the sensory neurons (auditory and visual) used to perform higher order functions (such as learning); d. huge variability at very early age in the number of synapses might mean different children might have differences in learning; e. insufficient information / no standard deviation;	*Do not accept "connection" instead of "synapse".*	**2 max**
	b		a. <u>neural/synaptic pruning</u>; b. (neural/synaptic pruning) involves the loss of neurons/dendrites/synapses; c. synapses that are not used do not persist;	*Do not accept "connection" instead of "synapse".*	**2 max**
	c		a. animal experiments / lesions / fMRI;	*"f" must be written in fMRI.*	**1**

Question			Answers	Notes	Total
7.			a. people with normal trichromatic vision can distinguish between red and green colours / are sensitive to red and green wavelengths; b. people with red-green colour blindness cannot distinguish between red and green colours / have low sensitivity to red and green wavelengths;	*Accept an annotated diagram of the wavelengths showing the overlap of red and green.* *Both answers may be given in one statement e.g., people with normal trichromatic vision can distinguish between red and green colours and those with red-green colour blindness cannot.*	**2**

Question			Answers	Notes	Total
8.	**a**	**i**	semicircular canals;		**1**
		ii	mechanoreceptor;		**1**
	b		a. (sound waves) cause movement of fluid (in the inner ear); b. (movement of the fluid) causes movement of hair/sensory cells (in the cochlea); c. different frequencies/wavelengths cause vibrations of different hair cells; d. the size/amplitude of the vibration determines the intensity/loudness of the sound; e. hair cells change movement to electric impulses/signals; f. send impulse to the auditory nerve (to be interpreted by brain);		**4 max**

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
9.	**a**	**i**	*Aspergillus niger/A.niger;*		**1**
		ii	used as a preservative/flavouring;		**1**
	b		a. the bacteria are spread over the surface of the agar of the petri dishes; b. a disc is soaked in the substance to be tested and then placed on the agar; c. the plates are incubated for a certain time (for bacterial growth); d. the greater the diameter/radius of the clear area, the greater the inhibiting effect of the substance; e. must have a control with no inhibitor ***OR*** the experiment should be replicated;		**3 max**

Question			Answers	Notes	Total
10.	**a**		successful as the bands in lanes 4 and 5 are the same size as in lane 2/positive control / same size as the gene;		**1**
	b		a. kanamycin resistance is used as a marker (gene); b. kanamycin kills non-transformed cells; c. cells are grown in a plate/medium containing kanamycin; d. growth indicates successful uptake (of gene) ***OR*** no growth means no uptake of gene/Ti plasmid;		**3 max**

Question			Answers	Notes	Total
11.	**a**		a. use less herbicide; b. higher crop yields; c. prevents soil erosion/no-till farming; d. due to genetic modifications of the soybeans, glyphosate kills weeds/is a herbicide but does not affect the soybeans/ ***OWTTE***;		**1 max**
	b		a. as use of glyphosate increases, the number of glyphosate-resistant weeds increases; b. the gene for resistance must have passed from the soybean to the weeds ***OR*** the weeds have developed resistance by natural selection; c. the effect of the herbicide/glyphosate is reduced if there are increased numbers of resistant weeds; d. the number of resistant weeds may continue to increase; e. increased use of glyphosate related to increased cancer/malformations ***OR*** impact on other organisms/disrupts the gut bacteria in animals;		**3 max**

Question			Answers	Notes	Total
12.	**a**		clogging/erosion of pipes/ transfer of microorganisms in ballast water / contamination of surfaces in food production / any other valid problem;		**1**
	b	**i**	a. release of (untreated) sewage in the town; b. increased fecal discharge from the town;		**1 max**
		ii	a. biofilms are made by (cooperative) aggregates of bacteria; b. bacteria need a surface/rocks for aggregation/attachment; c. more suitable habitats for biofilm formation in the town; d. lower current flow favours biofilm formation;		**1 max**
	c		a. biofilms produce extracellular polymeric substances/EPS; b. bacteria in the biofilm are densely populated; c. quorum sensing regulates the behavior of the entire bacterial population (with signal molecules/expression of certain genes) ***OR*** quorum sensing can regulate antibiotic resistance; d. biofilms can increase the survival rate/decrease the growth/metabolic rate of bacteria; e. (extreme) outer environment/stress can promote greater resistance ***OR*** (extreme) outer environment/stress reduce growth efficiency; f. higher chances of resistant plasmid being transferred;		**4 max**

Option C — Ecology and conservation

Question			Answers	Notes	Total
13.	**a**		a. symbiotic/mutually beneficial; b. the coral benefits from the algae/zoothanthellae by receiving nutrients/glucose/oxygen/products of photosynthesis; c. the algae benefit from the coral by receiving CO_2 ***OR*** the algae benefit from the coral by gaining a habitat;		**3**
	b	**i**	(heat stress begins) in photosynthesis/oxygen production at a (slightly) lower temperature than in respiration/oxygen consumption;	*Accept correct numerical distinction.*	**1**
		ii	a. the photosynthesis (of zooxanthellae) has decreased at 33°C ***OR*** less oxygen is provided (for the coral); b. the symbiotic relationship starts to break down as photosynthesis decreases/***OWTTE***; c. the coral expel the zooxanthellae;		**2 max**

Question			Answers	Notes	Total
14.	**a**		colonization of areas that were barren/not previously inhabited/not occupied by organisms;		**1**
	b		a. light limits photosynthesis ***OR*** daylength limits growth season; b. (low) temperature limits growth/slows metabolism **OR** (low) temperature slows activity of decomposers; c. (lack of) water due to frozen water/permafrost ***OR*** (lack of) water/rain limits photosynthesis/productivity; d. nutrients (in permafrost)/quality/depth of soil limit production of organic molecules/**OWTTE** ***OR*** insufficient soil / permafrost for tree growth;	*Award marks only for factors accompanied by a description.*	**2 marks**
	c		a. weathering of rock accumulates matter (allowing pioneer species to grow); b. death/decomposition of organisms increase organic matter/detritus/litter; c. increased soil allows larger/more plants to grow / roots preventing erosion; d. as more plants are decomposed, soil depth/amount of soil available increases;		**2 max**

Question			Answers	Notes	Total
15.	**a**		equal as there are the same number of species;		**1**
	b		a. Field 1 has the greater biodiversity (as it has the higher value); b. (likely) a more stable ecosystem (than Field 2) ***OR*** more ecological niches (than Field 2) ***OR*** more complex food webs (than Field 2) ***OR*** more evenness (than Field 2);		**2**

Question			Answers	Notes	Total
16.	**a**	**i**	a. they can belong to more than one trophic level; b. they eat both algae and zooplankton; c. they feed on organisms in level 2 (so are level 3) but are eaten by organisms in level 3 (so are level 2);		**1 max**
		ii	a. prey of the polar bears could increase in population (as the predator has disappeared); b. increase in prey/lower level predators could cause a drop in population of organisms at lower trophic levels;	*Accept relevant examples.*	**1 max**
	b		a. as producers/algae take in nutrients, they also collect/absorb PCBs; b. consumers can take in PCBs directly from the water; c. PCBs are not digested/metabolized; d. PCBs build up in cells/tissues / bioaccumulate; e. PCBs pass on to higher level consumers (when they feed) ***OR*** organisms in the higher trophic levels accumulate more; f. At each trophic level there is <u>biomagnification</u>;	*Accept examples from the diagram.*	**4 max**

Option D — Human physiology

Question			Answers	Notes	Total
17.	**a**	**i**	microvilli / brush border;	*Do not accept villi.*	**1**
		ii	a. (the many finger-like) projections increase the absorption by increased surface area/***OWTTE***;		**1**
		iii	a. goblet/exocrine/secretory cell as its products can be seen to be released into the intestine/***OWTTE***;		**1**
	b		a. caused by the *Helicobacter pylori*/*H.pylori*; b. secretes a protease; c. cause breakdown of the inner protective/mucous lining; d. the acid/gastric juices can get through to the stomach wall; e. cause inflammation/open sore;		**3 max**

Question			Answers	Notes	Total
18.			a. blood from the (hepatic) portal vein (from the intestine); b. blood (from portal vein) flows through the sinusoids; c. blood enters from hepatic artery (from heart/aorta); d. blood flows through capillaries; e. blood leaves through the hepatic vein;		**3 max**

Question			Answers	Notes	Total
19.	**a**		a. in both sexes the mortality rate has decreased over the years; b. women (in both countries) have a lower mortality rate (each year) than men/vice versa ***OR*** in both countries the mortality rates of men decline faster than those of women;	*Candidates must give **one** similarity and **one** distinction for 2 marks.*	**2**
	b		a. better medication/treatments over the years (in both countries); b. healthier diet; c. more exercise/better lifestyle; d. less smoking; e. increased awareness;		**1 max**

Question			Answers	Notes	Total
20.	**a**	**i**	(relatively) low risk as few/5% have vit C below RDA;		**1**
		ii	high risk, as many/90% have low intake of iron;		**1**
	b		a. constipation ***OR*** slow intestinal transport/transit; b. increased chances of diabetes/cancer/hemorrhoids/appendicitis/obesity; c. higher blood glycemic index;		**1 max**
	c		a. <u>essential</u> fatty acids missing; b. not enough energy/calories (for organs); c. not enough phospholipids (for cell membrane production); d. not enough myelin for neurons; e. not enough steroid/named steroid hormone produced; f. low levels/absorption of fat-soluble vitamins; g. insufficient HDL/LDL/cholesterol;	*Accept the definition or an example of essential fatty acid instead.* *Reject insulation.* *No mark if the named hormone is not a steroid.*	**1 max**
	d		a. the mass of food and temperature of the water are recorded; b. food is burned/heated/combusted to release energy/heat; c. the energy/heat is used to heat up water; d. the rise/change in temperature of the water allows the energy in the food to be calculated; e. energy from the food can be calculated from the specific heat capacity of water; f. a calorimeter/calorimetry is used / drawing of calorimeter;	*Both required.* *Accept annotated diagram.* *If a diagram is given, first read the answer then add any additional marks from the diagram.*	**4 max**