Markscheme

November 2024

Biology

Standard level

Paper 3

24 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 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	Total
1.	a		mass of sucrose ***OR*** grams of sucrose;	*Do not accept amount, quantity or sucrose alone.*	**1**
1.	b		a. to ensure time for yeast respiration/fermentation/metabolism/enzyme/reaction to start; b. to allow sucrose to mix/dissolve; c. temperature to stabilise; d. to allow sucrose uptake by yeast; e. to displace air with carbon dioxide;	*Do not allow 'to use up the oxygen'* .	**1 max**
1.	c		a. (yeast) enzymes require an optimum/suitable temperature to work ***OR*** *named enzyme* requires an optimum/suitable temperature to work require an optimum/suitable temperature to work; b. it must be a controlled variable ***OR*** the change in carbon dioxide volume is only due to mass of sucrose ***OR*** so the change in carbon dioxide is not affected by temperature change; c. if temperature is too high, enzymes would denature;	*b. OWTTE* *c. OWTTE*	**1 max**
1.	d		a. higher masses of sucrose prevent respiration/fermentation; b. higher mass (of sucrose), less volume (of CO_2) produced; c. negative relationship between sucrose mass and respiration;	*OWTTE*	**1 max**

Question 1 continued

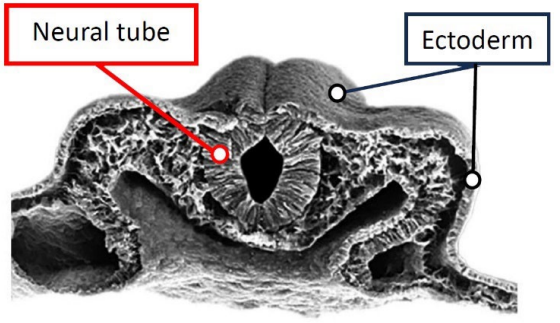
Question			Answers	Notes	Total
1.	**e**		*Candidate gives modification for 1 mark and 1 mark for reason. The reason must match the modification.* a. include a control of 0g/without sucrose; b. to compare other results; ***OR*** c. use more masses of sucrose; d. to get intermediate values; ***OR*** e. more trials/samples/replicates; f. to increase reliability / take mean/average / identify outliers/anomalies / enable statistical analysis / *example of statistical analysis;* ***OR*** g. use a different method to measure carbon dioxide; h. to avoid errors in measuring gas volume (with balloons);	*g and h. may be with an example such as. collect gas under water using measuring cylinder, use a gas pressure sensor;* *syringe. airlock, respirometer or by measuring the pH*.	**2 max**

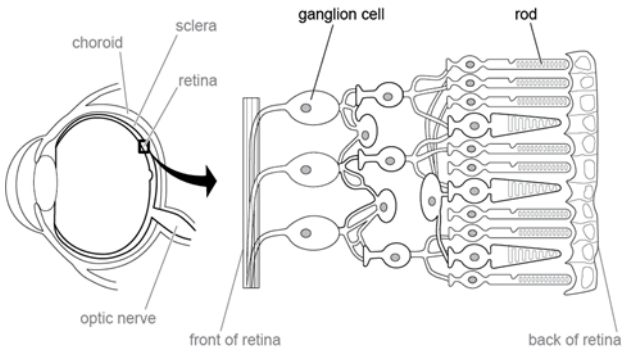
Question			Answers	Notes	Total
2.	**a**		number of (bacterial) colonies/ CFU/ colony forming units;	*Do not accept number/growth of bacteria*.	**1**
2.	**b**		a. to calculate mean/average/SD ***OR*** to carry out statistical testing/to assess the significance of results; b. to obtain more reliable/accurate/precise results; c. to identify experimental errors/anomalies/outliers;		**2 max**
2.	**c**		a. bacteria resistant to ampicillin; b. plasmid carrying resistance;		**1 max**

Question			Answers	Notes	Total
3.	**a**		(β-) carotene;		**1**
3.	**b**		a. crush/blend algae with organic solvent/alcohol/other valid solvent; b. place drop of extracted algal pigments/ obtained liquid on thin layer ***OR*** mark the origin; c. place slide (with pigments) in solvent ensuring the pigment spot does not touch the solvent ***OR*** ***s***olvent moves up carrying pigments ***OR*** different pigments move at different rates/distances (so can be distinguished);	*Thin layer could be (chromotography) paper, slide, column etc.*	**3 max**
3.	**c**		(Rf =) <u>distance pigment moved (from origin)</u> distance solvent moved (from origin) **OR** (Rf =) distance pigment moved (from origin) divided by distance of solvent moved (from origin);		**1**

Section B

Option A — Neurobiology and behaviour

Question			Answers	Notes	Total
4.	**a**	**i**	label the neural tube (accept label extending into the black canal);	 [Source: Reproduced with the permission of UPV/EHU Press from Schoenwolf, G. (2018). Contributions of the chick embryo and experimental embryology to understanding the cellular mechanisms of neurulation. *Int. J. Dev. Biol.* 62, pp. 49–55. doi: 10.1387/ijdb.170288gs.]	**1**
4.	**a**	**ii**	label the ectoderm (on the surface or the outer layer of the cross section);		**1**
4.	**b**		a. (proliferation/mitosis of) cells of neural tube; b. differentiation/specialisation (leading to neurons) ***OR*** axons/dendrites develop from an immature neuron (in response to chemical stimuli); c. a developing neuron forms multiple synapses; d. immature neurons migrate to a final location;		**2 max**
4.	**c**		a. formation of new connections/synapses between neurons; b. pruning/elimination of synapses/ dendrites/ branches of axons / neurons; c. occurs after injury/stroke; d. other areas take over function of damaged areas/lesions;		**2 max**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>5.</td><td>a</td><td>i</td><td>label a rod cell;</td><td rowspan="2"> 

[Source: Reprinted from Journal of Theoretical Biology, 267, Erika T. Camacho, Miguel A. Colón Vélez, Daniel J. Hernández, Ubaldo Rodríguez Bernier, Jon Van Laarhoven, Stephen Wirkus, A mathematical model for photoreceptor interactions, pp. 638–646, Copyright 2010, with permission from Elsevier.]</td><td>1</td></tr>
<tr><td>5.</td><td>a</td><td>ii</td><td>label a ganglion cell;</td><td>1</td></tr>
<tr><td>5.</td><td>b</td><td></td><td>
<table>
<tr><th></th><th>RODS</th><th>CONES</th><th></th></tr>
<tr><td>a</td><td>detect shapes / monochromatic images / black and white vision</td><td>detect colour</td><td>.</td></tr>
<tr><td>b</td><td>responsible for vision at low light levels</td><td>responsible for vision at higher light level</td><td>;</td></tr>
<tr><td>c</td><td>distributed throughout the retina</td><td>mainly found in the fovea / centre of retina</td><td>;</td></tr>
</table>
</td><td></td><td>2 max</td></tr>
</table>

Question			Answers	Notes	Total
6.	**a**		(*not true as*) a. primates/owl monkeys have larger numbers of neurons in the brain than rodents / agouti of a similar mass; b. primates have larger numbers of neurons in the brain than rodents of a larger brain mass (capybara); c. ratio of number of neurons to mass is 3 to 4 times more in primates; d. brain with largest number of neurons does not have the largest mass **OR** brain with smallest mass does not have the lowest number of neurons; (true as) e. within a group rodents/primates greater mass means more neurons;		**2 max**
6.	**b**		a. extensive folding (to fit in cranium); b. large surface area (to hold more neurons);		**2**
6.	**c**	**i**	speech/talking;		**1**
6.	**c**	**ii**	(coordinates/regulates) swallowing / breathing / heart rate / *other valid example;*		**1**

Question			Answers	Notes	Total
7.			a. semi-circular canals located in inner ear; b. (sensory) <u>hair cells</u> (in semicircular canals); c. three semi-circular canals are at right angles to each other ***OR*** (semi-circular canals) can detect movement of the head in any direction; d. (hair cells) detect movement of fluid; e. (hair cells) send impulses/signals to the brain;		**4 max**

Option B — Biotechnology and bioinformatics

Question			Answers	Notes	Total
8.	**a**		(*data supports as*) a. as pH increased (from 5.3-7.3) the rate of hydrolysis increased; b. greatest hydrolysis was achieved at higher pH values (6.8 and 7.3) **OR** same hydrolysis at end of investigation using pH 6.8 and 7.3 **OR** pH 6.8 reaches end of reaction at 50 hours / faster than 7.3 **OR** pH 7.3 takes longer / 96 hours to reach end compared to pH 6.8; c. no/ hardly any cellulose hydrolysis was observed at pH 5.3;	*Answers must refer to hydrolysis.* *Do not accept references to concentration of cellulose.*	**2 max**
8.	**b**		a. are small; b. fast growth rate; c. allow large-scale production of metabolites; d. microorganisms produce cellulase; e. can easily control the optimal conditions necessary; f. can be easily genetically modified;		**1 max**
8.	**c**		a. batch is a closed system, continuous is an open system; b. batch has nothing added during the process, continuous has nutrients continuously added; c. batch has products removed at end of the process, continuous has products continuously removed;	*Allow a statement such as 'only batch has….' provided contrasting words have been used.*	**1 max**

Question			Answers	Notes	Total
9.	**a**		a. *(A.tumefaciens*) contain Ti plasmid; b. Ti plasmid induces production of tumors / calluses; c. (plasmid) carries gene that does not belong to plant originally ***OR*** carries resistance gene to bialaphos / herbicide; d. antibiotic resistance gene is used for selection;		**2 max**
9.	**b**		50%;		**1**
9.	**c**		glyphosate resistance in soybean crops;	*Other valid example*	**1**

Question			Answers	Notes	Total
10.	**a**		methane;		**1**
10.	**b**		(*P.putida is effective for methyl mercury bioremediation as)* a. methyl mercury decreases with time / after 4 hrs incubation; b. *P.putida*/ cells keep growing /grows only a bit less in presence of methyl mercury ***OR*** *P.putida* is resistant to methyl mercury;		**2 max**

Question			Answers	Notes	Total
11.	**a**		cooperative aggregate/colonies of microorganisms/bacteria (that fix on surface);	*OWTTE*	**1**
11.	**b**		a. clogging/corrosion of pipes; b. transfer of microorganisms in ballast water; c. contamination of surfaces in food production; d. diseases such as cystic fibrosis/pneumonia; e. presence in catheters; f. plaque on teeth; g. other valid example;		**2 max**
11.	**c**		a. antibiotic cannot penetrate biofilm ***OR*** EPS/extracellular polymeric substance does not allow antibiotic to enter; b. high activity under the EPS could show that antibiotics have no effect/cannot penetrate ***OR*** high metabolic activity of cells/bacteria could represent the breakdown of the antibiotics ***OR*** low activity or dormant means low or no cell division ***OR*** low activity or dormant means antibiotic has no effect; c. quorum sensing allows synchronized gene expression (of resistance);		**2 max**

Question			Answers	Notes	Total
12.			a. gene (for high amylopectin starch) searched in data bank ***OR*** named data bank (e.g. NIH) **OR** bioinformatics/ORF programme may be used; b. (search for) start codon; c. read sequence in codons/base triplets; d. up to stop codon;	*a. Accept named bioinformatic program.* *b. and d. Accept named start codon/stop codon.*	**4 max**

Option C — Ecology and conservation

Question			Answers	Notes	Total
13.			a. bleaching is zooxanthellae expulsion from coral; b. high temperature/30°C/32°C resulted in loss/death of zooxanthellae (causing bleaching) ***OR*** negative correlation between temperature and zooxanthellae density ***OR*** positive correlation between temperature and bleaching; c. photosynthesis in zooxanthellae disrupted which leads to expulsion of zooxanthellae ***OR*** production of toxic substances which leads to expulsion of zooxanthellae;		**2 max**

Question			Answers	Notes	Total
14.	**a**		*Stigeoclonium farctum / S. farctum;*		**1**
14.	**b**		a. take samples at a given distance / in different areas/points; b. using a transect; c. count algae under a microscope/on a glass slide/per mm^2;		**2 max**
14	**c**	**i**	a. relative number/frequency of indicator species used; b. number of individuals of each indicator species multiplied by a pollution/tolerance factor; c. number of individuals of each indicator species indicate the level of pollution;		**1 max**
14.	**c**	**ii**	a. *Cocconeis placentula;* b. as was present before the sewage discharge but absent after **OR** as do not tolerate anoxia **OR** as sensitive to pollution;	*OWTTE*	**2**

Question			Answers	Notes	Total
15.	**a**	**i**	a. –4 to 32; b. 36;	*a. Allow answers in a range of ± 2 for each of the lower and upper measurements* *b. Allow answers in a range of ± 4*	**1 max**
15.	**a**	**ii**	a. 240-440; b. 200;	*a. Allow answers in the range of ± 10 for each of the lower and upper measurements* *b. Allow answers in the range of ± 20*	**1 max**
15.	**b**		a. soil as it is the main store in deserts (and there is little in tropical rainforests); b. soil as it has a low flow in desert; c. soil as high flow leaving store in tropical rainforests;		**1 max**

Question			Answers	Notes	Total
16.	**a**		a. richness is the number of different species present (contributes to biodiversity); b. the higher the sand quality the higher the richness / number of different species ***OR*** the lower the level of pollution, the higher the richness / number of different species; c. in highly polluted areas there are no species/ no biodiversity;	b. accept vice versa.	**2 max**
16.	**b**		a. aquatic plants absorb chemicals/crude oil ***OR*** smaller organisms take up chemicals/crude oil through food intake; b. (chemicals/crude oil) moves up through food chain/trophic levels ***OR*** concentration increases at each trophic level; c. accumulates in organs/tissues / bioaccumulation (in marine organisms); d. levels of chemical become toxic higher up the food chain;		**3 max**

Question			Answers	Notes	Total
17.			*(risks)* a. introduced alien species can escape into local ecosystems/become invasive; b. alien species has no competitors/predators / competitive exclusion ***OR*** cane toads/alien species reproduce quickly; c. can affect non-target species/native species ***OR*** can disrupt food webs/chains / reduce biodiversity; *(benefits)* d. decreased use of insecticides/pesticides/chemicals/DDT; e. can help maintain low levels / eradicate pest;		**4 max**

Option D — Human physiology

Question			Answers	Notes	Total
18.	**a**		a. altrono-(lactone); b. once injected the amount of vitamin C remains the same / does not increase /decreases (slightly) ***OR*** no peak after injection;		**2**
18.	**b**		a. humans have lost GULO gene (over the course of evolution); b. humans do not synthesize ascorbic acid / vitamin C ***OR*** it is an essential nutrient; c. prevents scurvy; d. synthesis of collagen **OR** antioxidant/cofactor ***OR*** contributes to immune system;		**2 max**

Question			Answers	Notes	Total
19.	**a**		a. phagocytosis of red blood cells ***OR*** by Kupffer cells; b. the hemoglobin molecule is split into globin chains and haem group; c. globin chains are broken down to amino acids ***OR*** haem group is broken down into iron and bilirubin;		**2 max**
19.	**b**		a. to produce hemoglobin ***OR*** iron is added to haem group; b. to produce new red blood cells; c. to carry oxygen;		**2 max**
19.	**c**	**i**	a. glycogen; b. vitamin A / B_{12} / D / E / K;		**1 max**
19.	**c**	**ii**	(surplus) cholesterol is converted to bile salts;		**1**

Question			Answers	Notes	Total
20.	**a**	**i**	P wave identified as contraction of atria/atrial systole;	*Accept the letters (i) and (ii) as labels*	**1**
20.	**a**	**ii**	QRS wave identified as contraction of ventricles / ventricular systole;		**1**
20.	**b**		repolarization/relaxation of ventricles / ventricular diastole;		**1**
20.	**c**		a. cells are branched/ Y shaped / joined end to end; b. intercalated disc/gap junctions/channels/connected cytoplasm between the cells; c. allows a wave/impulse/signal/depolarization to pass between cells; d. (allows) synchronization / coordination of muscle contraction; e. many mitochondria to provide energy;		**3 max**

Question			Answers	Notes	Total
21.			*Advantage of acid conditions:* a. needed for digestion/hydrolysis reactions; b. activates/provides optimal conditions for enzymes/proteases/pepsin; c. destroys harmful pathogens in food; *How excess acidity prevented*: d. proton pump inhibitors/PPI used; e. PPIs bind irreversibly to a pump **OR** PPI do not allow exchange of ions/protons; f. antiacids/ named antiacid are alkaline substances that neutralize acidity **OR** diets low in acids;		**4 max**