bio letters

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May 2025 Mock Examination

Markscheme

Biology

Higher level

Paper 1B

Preamble

- This paper is challenging. It is highly encouraged that you study well before attempting to solve it in order to get the most out of this mock exam.

- Simulate exam conditions as much as possible by timing yourself and not using aids like notes, search engines, etc.

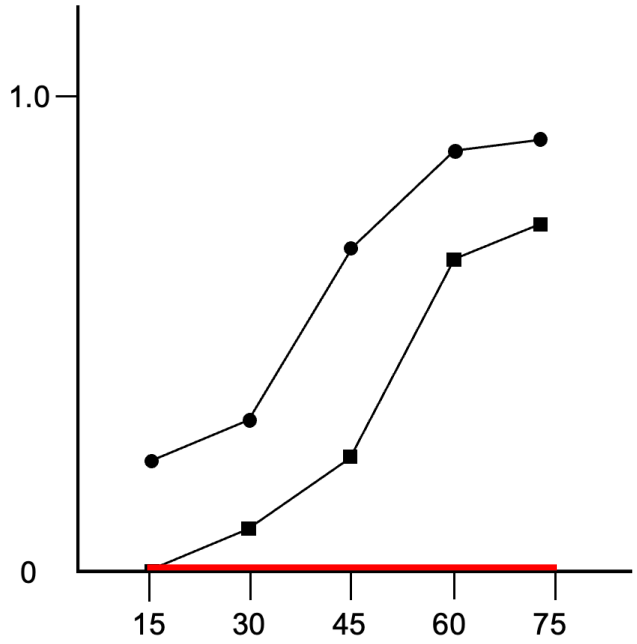
- None of the questions here are from past papers, they are all original.

- Each question addresses a different theme (A – D) and level of organization as per the new syllabus assessment guidelines, but some sub questions may be linked to other themes.

Question			Answers	Total
1.	**a**		Independent variable: presence or absence of cycloheximide **AND** Dependent variable: count of flagellated *Chlamydomonas* under a light microscope out of all counted *Chlamydomonas* [1]	**1**
	b		a. de-flagellating ensures that any flagellar regeneration is a result of new, not previous, protein synthesis [1] b. post-incubator plating of cultures onto cycloheximide-free media enables researchers to observe, in real-time, flagellar regeneration of cycloheximide treatment [1]	**2**
	c		a. both curves have a similar overall shape (sigmoidal) indicating that the same biological process (protein synthesis) is responsible for producing the observed data [1] b. both curves are increasing / have positive slopes, indicating flagellar regeneration [1] c. cycloheximide-present curve is lower than the cycloheximide-absent curve because the culture containing no cycloheximide had more time to regenerate its flagella compared to the cycloheximide-treated culture, which only began flagellar regeneration after cycloheximide was removed [1]	**3**
	d	**i**	a. since actinomycin D inhibits tubulin mRNA transcription, tubulin mRNA concentrations in the cytoplasm will decrease with time [1] b. when actinomycin D and cycloheximide are removed after incubation, the cells begin protein synthesis and flagellar regeneration c. the only possible way by which the rate of flagellar regeneration is unaffected is if tubulin mRNA is very stable and persists in the cytoplasm for a long time (in this case, at least 2 hours) such that any decrease in its concentration is negligible and does not affect rates of protein synthesis [1]	**2**
		ii	Long 3’ poly-A tail	**1**

(*continued…)*

(Question 1 continued)

Question			Answers	Total
1.	**e**		 Accept curves that are slightly above the x-axis. **Explanation**: if inhibition of protein synthesis is irreversible, the cell will not be able to regenerate its flagella.	**1**

Question			Answers	Total
2.	**a**		The fundamental niche is the entire set of conditions that allow a species to grow and reproduce, whereas the realized niche is the actual set of conditions used by a given species after biotic interactions (i.e. competition, predation, etc.) have been considered.	**1**
	b		a. controlled greenhouse enables scientists to control phenotypic variation arising from plasticity due to different conditions during growth [1] b. only using the F1 generation from a few wild plants reduces genetic differences between the plants which enhances the validity (do not accept reliability) of the results [1]	**2**
	c		Dispersal may be a limiting factor. Since the plants were 'forced' into quadrats, this reveals that some niches predicted by the model to be unsuitable are actually suitable but that *C. sparsiflora* is unable to disperse to these habitats. [1] **Explanation**: it makes sense for the model to predict unsuitability of habitats the plant is not able to disperse to because the ecological niche model is based on data collected from sites that already have *C. sparsiflora* present in them (it is not possible to collect a species' niche data from places the species itself does not exist in). The sites that the plant was unable to disperse to did not have their environmental conditions measured and thus were not considered in the model's predictions.	**1**
	d		zero	**1**
	e		a. the ecological niche model accurately predicts the fundamental niche of *C. sparsiflora* as the gathered data line has a positive slope / is increasing and is close in steepness to the 1:1 line [1] b. (suggests that) the fundamental and realized niche are different but not to a great extent as the gathered data curve is close to the 1:1 line [1] c. (suggests that) other factors, beyond the abiotic and biotic conditions measured by the researchers and fed into the model, affect the niche of *C. sparsiflora* [1]	**3**

Question			Answers	Total
3.	**a**		Days 3 and 6: $\frac{28.2 - 25.7}{25.7} \times 100 = 9.73\%$ [1] Days 9 and 12: $\frac{29.4 - 29.1}{29.1} \times 100 = 1.03\%$ [1]	**2**
	b		a. complement activation: the complement system is a large number of proteins that work to fight off disease by opsonization and cell lysis – it 'complements' the work of antibodies [1] b. opsonization: the antibody binds to the pathogen's antigens to promote phagocytosis and make it easier for phagocytes to identify and engulf the pathogen [1] c. the antibody prevents the pathogen from adhering to host cells, reducing its ability to cause damage **OR** d. neutralizes pathogenic toxins by binding to them to prevent host cell damage [1]	**3**
	c		a. immediately before vaccination at day 0, SPR angle is 25, so this is its value when T and B lymphocyte concentrations in the blood are normal b. since only B lymphocytes produce antibodies, the SPR angle is a function of B lymphocyte (<u>not T lymphocyte</u>) amount in the blood c. at day 3, T lymphocyte concentrations are high and B lymphocyte concentrations, while elevated, are still relatively low; clonal expansion has not yet fully taken place as indicated by the minor change in SPR angle (25.7 – 25.0 = 0.7) d. day 6 shows a 9.73% increase in SPR angle from day 3; clonal expansion has taken place and both T and B lymphocyte concentrations in the blood are high e. day 9 shows an SPR angle shift of 0.9 from day 6 so clonal expansion is slowing down, <u>but T and B lymphocyte concentrations are still high as the SPR angle is still significantly shifted from the original 25</u> f. days 12-18 show a plateau in SPR angle shift as the body has reached maximal response, <u>but T and B lymphocyte concentrations are still high as the SPR angle is still significantly shifted from the original 25</u> **Note**: cannot earn full [4] marks if point (b) is not mentioned. Each mark must be supported by SPR angle data to be earned.	**4**

Question			Answers	Total
4.	**a**		a. introduction of a sequence by CRISPR-Cas9 that disrupts *ADE2* functioning through either prime editing or a double-stranded break [1] b. introduction of indels by CRISPR-Cas9 in *ADE2* that render it functionless [1]	**2**
	b		a. a target gene is identified (i.e. *ADE2*) and a gRNA complementary to the target gene is created [1] b. Cas9 protein is guided by gRNA to *ADE2* and binds to the DNA [1] c. Cas9 cleaves DNA and introduces a double-stranded break [1] d. cell repair mechanisms attempt to repair the double-stranded break but errors lead to indels, which disrupt gene functioning [1] **Note**: answers describing prime editing are not accepted because the question specified a double-stranded break.	**4**
	c		a. gRNA 2 is the most efficient [1] b. gRNA 1 had a lower proportion of red-colored yeast compared to gRNA 2 **AND** c. gRNA 3 resulted in the death of yeast despite all colonies being red [1]	**2**