



# bio letters

## May 2025 Mock Examination Markscheme

**Biology**

**Higher level**

**Paper 1A**

## 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, with some questions taken from open access sources that have been cited at the end.
- Multiple questions in this paper include syllabus content statements from different topics. The connections of topics to each other may be direct or indirect.
- The questions are ordered from A1 to D1, A2 to D2, A3 to D3, and A4 to D4. This is how they are presented in the Syllabus Guide and Specimen Paper. Most of the questions also focus on the new additions in the syllabus that are AHL. The syllabus content statement(s) each question is addressing is indicated.
- The questions were designed following Bloom's Taxonomy; questions test recall (generally least difficult), comprehension, application, analysis, and evaluation (generally most difficult) skills. The type of question is indicated next to the syllabus content statement.

**1. B**

Syllabus content statements: A1.1.2, B1.2.5 (Application)

Urea contains four N–H bonds that collectively form 4 hydrogen bonds and an oxygen atom that forms 2 hydrogen bonds, for a total of 6 hydrogen bonds (compared to 4 hydrogen bonds in water). (A) is incorrect because urea does not form less hydrogen bonds. (C) and (D) are incorrect because they are irrelevant.

**2. C**

Syllabus content statement: A1.2.15 (Application)

On one strand and in a repeat (sequence of 10 bases),

$$A + T + G + C = 10$$

$$A = 3C$$

Since there is only 1 C in the repeat,  $A = 3(1) = 3$ , so  $A + C = 3 + 1 = 4$

$$4 + T + G = 10$$

Since  $G = T$ ,

$4 + 2T = 10$  ( $4 + 2G = 10$  is also valid); solving for T (or G),

$$T = G = 3$$

So, there are 3 G bases in 1 repeat. Across a hundred bases, aka 10 repeats, there are  $3 \times 10 = 30$  G on **one** strand.

The number of G bases on the other complementary strand depends on the number of C on the strand we just carried out our calculations on. Since there is 1 C every 10 bases,

$$1 \times 10 = 10 \text{ G bases in 100 bases of the complementary strand}$$

Therefore, the total amount of G in 100 bases of satellite double-stranded DNA is,

$$10 + 30 = 40$$

**3. B**

Syllabus content statements: B.1.1.4, D3.3.8 (Comprehension)

(B) is correct because glucose is an important energy source for cells, so using it to establish a gradient wastes nutritional reserves. (A) is incorrect because glucose is transported actively in the proximal convoluted tubule. (C) is incorrect because sodium ions do not diffuse through the plasma membrane alone, they require channels. (D) is incorrect because sodium ion channels mediate the movement of sodium ions out of the Loop of Henle, not sodium potassium pumps.

**4. C**

Syllabus content statement: B1.2.6 (Comprehension)

Side chains (R-groups) determine the structure and hence function of two different regions within hemoglobin because they give amino acids their unique properties.

**5. C**

Syllabus content statement: C1.1.17 (Recall)

(A) is incorrect because penicillin binds to transpeptidase, not the cell wall. (B) is incorrect because penicillin does not misfold a protein, it just acts as a mechanism-based inhibitor by irreversibly binding to the enzyme's active site. (D) is incorrect because penicillin forms a covalent bond with transpeptidase.

**6. C**

Syllabus content statement: C1.2.15 (Recall)

(A) is incorrect because the  $F_0$ , not  $F_1$ , rotates. (B) is incorrect because the half-channels are not aligned. (D) is incorrect because the half-channels transport protons passively (driven by a proton gradient) not actively.

**7. D**

Syllabus content statements: C1.3.6, C1.3.10 (Comprehension)

(A) is incorrect because chlorophyl a absorbs higher energy wavelengths than chlorophyl a. (B) is incorrect because the reaction center contains special chlorophyll, not diverse pigments. (C) is incorrect because proximity of pigments in the antenna complex (not reaction center) is what facilitates efficient transfer of energy.

**8. B**

Syllabus content statement: D1.1.8 (Application)

DNA primase adds an RNA primer starting from the 3' end of the parent strand and synthesizes the primer 5' to 3' relative to the new strand. Thus, the primer will be added on the 5'–...TGCCCTT–3' portion of the target DNA, *starting* from the 3' end to produce a complementary antiparallel primer:

5'–...TGCCCTT–3' (DNA)

3'–...ACGGGAA–5' (Primer)

## 9. C

### Syllabus content statement: D1.2.7 (Comprehension)

Since the genetic code is read in sets of three (codons), there are three possible reading frames:

- **Frame 1:** starting from the first nucleotide (e.g., **CAG-XXX-XXX...**)
- **Frame 2:** starting from the second nucleotide (e.g., **AG-XXX-XXX...**)
- **Frame 3:** starting from the third nucleotide (e.g., **G-XXX-XXX...**)

The correct reading frame is determined by the start codon AUG.

## 10. A

### Syllabus content statements: D1.3.2, D4.1.9 (Comprehension)

A nonsynonymous mutation changes the primary structure of a polypeptide chain (so it may be harmful, beneficial, or neutral), whereas a synonymous mutation maintains the original amino acid sequence (thus it is neutral). Since the frequency of the nonsynonymous mutation is increasing in the gene pool, it suggests that natural selection is favoring it, so it is beneficial.

## 11. A

### Syllabus content statement: A2.1.4 (Recall)

(A) is correct because the first step of the experiment is boiling water, which simulates oceans heating up and releasing water into the atmosphere. (B) is incorrect because carbon dioxide, methane, and other atmospheric gases are added to the apparatus using a different method. (C) is incorrect because the water collecting the organic matter is not heated up. (D) is incorrect because water vapor heated by electricity has already boiled (it cannot boil further).

## 12. B

### Syllabus content statement: A2.2.3 (Recall)

Since cryogenic microscopy and freeze-fracture electron microscopy both involve freezing the sample (hence killing it), they cannot be used to investigate protein interactions in a live cell.

**13. C**

Syllabus content statement: A2.3.3 (Recall)

(A) is incorrect because active transport is exclusive to living organisms; viruses are not considered living. (B) is incorrect because the capsid aids in the recognition and binding of the virus, not in replication. (D) is incorrect because viral mRNA works inside the cell, not outside.

**14. B**

Syllabus content statements: B2.1.1, B2.1.3 (Application)

(B) is correct because the phospholipid bilayer is fluid and allows movement of membrane proteins through it, causing the intermixing of the proteins from Cells A and B. (A) is incorrect the movement of proteins within the membrane is an intrinsic property and not a result an active process. (C) is incorrect because under the fluid mosaic model, proteins are not fixed in place. (D) is incorrect because the fluidity of the membrane is responsible for the protein intermixing, not the cytoskeleton.

**15. C**

Syllabus content statement: B2.2.8 (Analysis)

In the cisternal maturation model, the cisternae move towards the trans side as they mature, so the dye will be localized to that cisterna only and will appear closer to the trans side with time as the cisterna matures and moves closer to the trans side. In the vesicular transport model, vesicles transport proteins and lipids under modification from one cisterna to another, so the dye will spread to other cisternae.

**16. D**

Syllabus content statement: B2.3.9 (Recall)

Intercalated discs **include** gap junctions and other structures, so the **best** answer is (D). (A) is incorrect because tight junctions are watertight seals that hold adjacent cells tightly to each other but do not connect them.

17. C

Syllabus content statement: C2.1.11 (Recall)

(C) is correct because autophosphorylation is followed by the downstream cellular response. (A) is incorrect because signal molecule binding and dimerization occurs before autophosphorylation. (B) is incorrect because dimerization occurs before autophosphorylation. (D) is incorrect because dimerization occurs before autophosphorylation and phosphatase activity is irrelevant.

18. A

Syllabus content statement: C2.2.8 (Recall)

(A) is correct because the alpha subunit is the channel pore, so saxitoxin blocking it involves occluding its opening, which prevents the sodium entry required for depolarization. The remaining answer choices are incorrect because the activation, deactivation, and inactivation gates are not actual gates, they are just states of the gate.

19. A

Syllabus content statements: D2.1.6, D2.1.9, D2.1.10, D2.1.11, A4.1.11 (Comprehension)

(I) is correct because mutations in tubulin-coding genes would increase the chances of microtubule malfunctioning, which in turn increases the probability of non-disjunction. (II) is incorrect because meiosis does not create new alleles, it just changes their location to result in new allele **combinations**. (III) is incorrect because non-disjunction leads to both types of polyploidy.

20. C

Syllabus content statements: D2.2.2, D2.3.5, D3.3.5, D3.3.6 (Analysis)

(C) is correct because metabolic activity generates more heat, which is **not** a thermoregulatory response when temperatures are high so it is not a valid conclusion. The other options are valid conclusions.

21. A

Syllabus content statements: D2.3.2, D2.3.3, D2.3.5 (Analysis)

Percentage haemolysis is higher at  $0.084 \text{ mol dm}^{-3}$  (72%) than at  $0.12 \text{ mol dm}^{-3}$  (2%), so it increases. The difference between the two concentrations is  $72 - 2 = 70\%$ .

**22. D**

Syllabus content statement: A4.1.8 (Evaluation)

(D) is correct because examining continuous variation in both subpopulations across environmental gradients does not provide any useful information about the type of possible speciation. (A) is incorrect because historical records can help determine whether physical isolation has occurred leading to speciation, which is useful. (B) is incorrect because tracking changes in traits that dictate sexual characteristics can help determine whether behavioral sympatric speciation has occurred or will occur. (C) is incorrect because this helps in determining whether or not temporal and behavioral sympatric speciation occurred or will occur.

**23. B**

Syllabus content statements: A3.2.5, A3.2.6, A3.2.7 (Analysis)

(B) is correct because a shorter branch indicates a relatively small genetic difference between the ancestor and progeny that both live in the same habitats. (A) is incorrect because modern non-extremophiles are more genetically distant to ancient extremophiles than modern extremophiles are to ancient extremophiles. (C) and (D) are incorrect because there is not enough information to conclude either of them.

**24. C**

Syllabus content statement: B3.1.12 (Application)

(C) is correct because respiration rate increases when blood pH is low in order to expel carbon dioxide and hence reduce acidity. (A) and (B) are incorrect because respiration rate will not decrease. (D) is incorrect because mechanical respiration  $\neq$  cell respiration.

**25. B**

Syllabus content statements: B3.2.16, C3.1.14 (Application)

Sympathetic stimulation increases heart rate and stroke volume; it accelerates the filling of blood. (I) is correct because shorter systolic and diastolic durations allow for more beats per minute. (II) is correct because both ventral and atrial diastoles represent a greater proportion of the cardiac cycle compared to systole (the heart chambers spend more time relaxed than contracting). So, if both systole and diastole decreased by 5% to accelerate heart rate, 5% of 0.05 seconds of contraction is a lower value numerically than 5% of 0.5 seconds of relaxation. (III) is incorrect because stroke volume increases (not decreases) with sympathetic stimulation.

**26. C**

Syllabus content statement: B3.3.2 (Recall)

During one crossbridge cycle, an ATP molecule binds to myosin. ATP hydrolysis causes the myosin head to move backwards, and then attach to actin. The power stroke occurs after this where ADP and Pi detach and myosin releases its stored energy to slide actin towards the H-zone.

**27. D**

Syllabus content statement: C3.1.10 (Application)

(D) is correct because the cerebellum is responsible for muscle balance and coordination. The other options contain brain structures that are not involved in this function.

**28. C**

Syllabus content statement: C3.2.4 (Comprehension)

(C) is correct because the innate immune system provides a rapid and immediate response to infection. (A) is incorrect because although phagocytosis is part of the innate immune response, the main purpose of the system is immediate response, which is achieved through several ways, including phagocytosis. (B) is incorrect because the innate immune system does not provide prolonged immunity against future infections. (D) is incorrect because it is vague; it does not specify what is prevented from entry, which are pathogens in the context of immunity.

**29. D**

Syllabus content statement: D3.1.8 (Evaluation)

(D) is correct because the pollen tube is necessary in order to deliver the male gametes to the female gametes within the same plant. If the tube does not develop, the gametes will not be able to meet and self-fertilization will not occur. (A) is incorrect because there will be no offspring to begin with if the pollen tube does not develop. (B) is incorrect because the question states that the pollen tube is prevented from developing, not that it will be shortened. (C) is incorrect because the pollen grain does not possess such a property.

**30. A**

Syllabus content statement: D3.2.5, D3.2.10 (Application)

Since individuals can be carriers, the disease must be autosomal recessive.

31. D

Syllabus content statements: D3.3.8, D2.3.3 (Comprehension)

(D) is correct because as solutes are reabsorbed, water moves through osmosis out of the nephron in order to compensate for the increased osmolarity outside of the nephron; it is a natural consequence of solute reabsorption. (A) is not correct because osmoregulation in the nephron is carried out in the collecting duct. (B) is factually correct because it states the purpose of water reabsorption but it does not explain the reason behind the mechanism of water reabsorption that the question is specifically addressing so it is not the correct answer choice. (C) is incorrect because this is an unfounded statement, and sodium ions are not the only solutes in the filtrate.

32. D

Syllabus content statements: A4.1.1, A4.1.6 (Comprehension)

(D) is correct because evolution is **not** deterministic, even though some of the mechanisms causing it (i.e. natural selection) are deterministic.

33. D

Syllabus content statements: A4.2.6, A4.2.7 (Application)

(D) is correct because managing natural reserves of grasslands is an approach to conserving biodiversity. (A), (B), and (C) are all causes of the biodiversity crisis so they would cause further decline in the endangered butterfly's population.

34. C

Syllabus content statements: B4.1.3, B4.1.4 (Analysis)

(C) is correct because the 2010 curves for both bumble bee species shifted to the right towards higher altitudes so that they could remain within their ranges of tolerance. (A) and (B) are incorrect because both species responded similarly. (D) is incorrect because there is not enough information to arrive at this conclusion.

**35. D**

Syllabus content statements: B4.2.13, C4.1.5, C4.1.8, C4.1.16 (Evaluation)

(D) is correct because predation reduces the population size of a species below its carrying capacity. If just one out of the two competitors are predated on, this reduces contact between them and thus reduces competitive exclusion. (A) and (B) are incorrect because predation does not ‘eliminate’ an entire species, that is unsustainable. (C) is incorrect because this means that predation has no effect on population size, which is false.

**36. B**

Syllabus content statement: C4.1.17 (Application)

(B) is correct because once predators were removed, the deer population size increased. (A) is incorrect because anthropogenic factors reduced predation, which increased the deer population size. (C) is incorrect because resources are abundant enough that once predators were removed, the deer population size increased exponentially. (D) is incorrect because carrying capacity is a concept in a mathematical model; it has no real physical manifestations that directly interact with a species.

**37. C**

Syllabus content statements: C4.2.19, C4.2.20 (Recall)

(C) is correct because a decline carbon fixation rates, aka photosynthesis rates, does not provide conclusive evidence of the causal link between CO<sub>2</sub> and the rising annual temperatures. The remainder of the options provide conclusive evidence.

**38. A**

Syllabus content statements: D4.1.12, D4.1.13 (Comprehension)

Stabilizing selection favors the intermediate phenotype, so in a trait with two alleles only this would be the heterozygous genotype, 2pq. The heterozygous genotype frequency is the highest only when the frequencies of the two alleles are 0.35 < p < 0.65 and 0.35 < q < 0.65; this is when the 2pq curve is above both the p<sup>2</sup> and q<sup>2</sup> curves.

**39. B**

Syllabus content statement: D4.2.8 (Analysis)

(B) is correct because phosphorus being the **only** limiting factor **cannot** be concluded **solely** from the data discussed in the question. The other options are valid conclusions.

**40. A**

Syllabus content statements: D4.3.12, D3.2.6, D3.2.8, D3.2.13 (Evaluation)

(I) is correct because alleles can differ by single nucleotide polymorphisms (SNPs). So, the existence of many SNPs for many loci indicates a lot of alleles and hence genetic variation that is available to respond to climate change. (II) is incorrect because phenotypic plasticity is not heritable and thus does not play a role in evolutionary change. (III) is incorrect because a high proportion of genetically close individuals indicates that inbreeding is widespread in the population. Thus, genetic diversity is low, so an evolutionary response to climate change is less likely due to reduced variation.

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