



bio letters

May 2026 Mock Examination

Markscheme

Biology

Higher level

Paper 2

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 except for one question which I have edited from a referenced source.

| Question | | Answers | Total |
|----------|---|--|-------|
| 1. | a | <p>a. curve for ABS population is oscillating about ~120 breeders ✓</p> <p>b. ABS population is stabilized at <u>carrying capacity</u> <i>K</i> and experiencing minor fluctuations ✓</p> <p>c. curve for PLE population is <u>decreasing</u> with time due to suburban development/human impacts ✓</p> | 2 |
| 1. | b | <p>a. ABS population has higher heterozygosity than PLE ✓</p> <p>b. Both curves seem to increase slightly with time ✓</p> <p>Note: accept calculations that attempt to estimate differences (e.g. in heterozygosity) or similarities (e.g. both curves increasing).</p> | 2 |
| 1. | c | <p>a. relatedness of parents in ABS subpopulation is increasing with time ✓</p> <p>b. since the populations are within migratory distance from each other, inbred individuals from PLE are entering the ABS subpopulation ✓</p> <p>c. the increase in inbred individuals increases the relatedness of individuals in the ABS population</p> <p>Note: both the trend and the reason must be stated for the full mark.</p> | 1 |
| 1. | d | <p>$87.5 - 57.5 = 30\%$ ✓</p> <p>Accept values between 28.5 and 31.5.</p> | 1 |
| 1. | e | <p>a. parents who are more related to each other are more inbred ✓</p> <p>b. inbreeding increases the probability of accumulating recessive homozygous genotypes ✓</p> <p>c. many diseases are recessive</p> <p>d. offspring from parents who are moderately or highly related are more likely to have inherited harmful genotypes from their parents which reduces their fitness and cumulative survival ✓</p> | 2 |
| 1. | f | <p>$\frac{0.25 - 0.135}{0.25} \times 100 = 46\%$ (more in PLE than ABS) ✓</p> | 1 |
| 1. | g | <p>a. high ROH indicates parents are more closely related to each other</p> <p>b. proportion of ROH decreased in ABS from 2000 to 2008 due to the decline in PLE populations (and thus a reduction in migration / gene flow) ✓</p> <p>c. proportion of ROH increased in PLE from 2000 to 2008 due to more inbreeding and reduced genetic diversity ✓</p> <p>d. PLE show higher proportions of ROH than ABS in both 2000 and 2008 due to reduced genetic diversity driven by <u>inbreeding</u> and a <u>small population size</u> ✓</p> | 2 |

(continued...)

(Question 1 continued)

| Question | | Answers | Total |
|----------|---|--|-------|
| 1. | h | <p>a. small/declining populations (demographic) experience a higher likelihood of inbreeding (genetic) ✓</p> <p>b. inbreeding reduces genetic diversity (evidence from SNPs/ROH and parent relatedness) which decreases the fitness of the population ✓</p> <p>c. reduced fitness (evidence from hatching success and cumulative survival) leads to further declines in population size ✓</p> <p>d. a positive feedback loop is established between demographic and genetic factors that pushes populations to extinction (evidence from number of breeding individuals) ✓</p> <p>Note: do not award marks for answers that do not directly reference evidence from the question.</p> | 3 |
| 1. | i | <p><u>yes</u>, it is worthwhile to fund conservation efforts for the PLE population in order to preserve the integrity of the ecosystem it exists in ✓</p> <p>OR</p> <p>yes, in order to prevent more costly, species-wide interventions later on ✓</p> | 1 |

| Question | | Answers | Total | | | | | | | | | | |
|--|---------------------------------------|---|---------|---------|---------------------------------------|---------------------------------------|---------------------|-------------------------------|--|--|---|--|---|
| 2. | a | <p>Stomatal density =</p> $\frac{\text{number of stomata}}{\text{area of field view in mm}^2} = \frac{13}{0.15} = 86.7 \text{ (87) stomata per mm}^2$ | 1 | | | | | | | | | | |
| 2. | b | <p>a. closed stomata prevent transpiration pull</p> <p>b. plants overcome this by generating root pressure in xylem</p> <p>c. root cells adjacent to xylem vessels <u>pump</u> mineral ions into xylem by active transport ✓</p> <p>d. mineral ions cause movement of water by osmosis into xylem ✓</p> <p>e. this creates a <u>positive pressure potential</u> in roots that makes xylem sap move upwards against gravity ✓</p> | 2 | | | | | | | | | | |
| 2. | c | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Alveoli</th> <th style="width: 50%;">Stomata</th> </tr> </thead> <tbody> <tr> <td>gases diffuse through cells not pores</td> <td>gases diffuse through pores (stomata)</td> </tr> <tr> <td>alveoli always open</td> <td>stomatal opening is regulated</td> </tr> <tr> <td colspan="2" style="text-align: center;">both depend on diffusion of gases down their concentration gradients</td> </tr> <tr> <td colspan="2" style="text-align: center;">both are connected to transport systems</td> </tr> </tbody> </table> | Alveoli | Stomata | gases diffuse through cells not pores | gases diffuse through pores (stomata) | alveoli always open | stomatal opening is regulated | both depend on diffusion of gases down their concentration gradients | | both are connected to transport systems | | 2 |
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| both are connected to transport systems | | | | | | | | | | | | | |
| 2. | d | <p>a. actively respiring muscle tissue consumes O₂ and releases CO₂</p> <p>b. CO₂ binds to free hemoglobin and reduces oxygen affinity ✓</p> <p>c. high concentration of CO₂ in respiring muscle tissue reduces pH ✓</p> <p>d. low pH causes a <u>rightward Bohr shift</u> ✓</p> <p>e. Bohr shift promotes release of O₂ by hemoglobin where it is most needed (in respiring muscle tissue) ✓</p> | 2 | | | | | | | | | | |

| Question | | Answers | Total | | | | | | | | | | |
|--|---|---|--------------|-------------|-------------------------------------|---------------------------------------|--|--|------------------------------------|---|-----------------------------|--|---|
| 3. | a | a. bone marrow ✓ b. skin ✓ c. liver ✓ d. skeletal (striated) muscle ✓ | 1 | | | | | | | | | | |
| 3. | b | a. <u>morphogens</u> are signalling molecules that control cell differentiation ✓ b. different morphogen concentrations lead to differential <u>gene expression</u> in early embryo cells, causing them to differentiate into unique cell types ✓ c. other signalling molecules control differentiation as the embryo develops | 2 | | | | | | | | | | |
| 3. | c | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%; text-align: center;">Human uterus</th> <th style="width: 50%; text-align: center;">Plant ovary</th> </tr> </thead> <tbody> <tr> <td>uterus supplies nutrients to embryo</td> <td>embryo possesses nutritional reserves</td> </tr> <tr> <td>embryo embeds into endometrial lining (implantation)</td> <td>zygote develops within ovary (no implantation)</td> </tr> <tr> <td>able to support future pregnancies</td> <td>flower is shed after fertilization and unable to support future embryos; new flowers emerge</td> </tr> <tr> <td colspan="2" style="text-align: center;">provide physical protection</td> </tr> </tbody> </table> | Human uterus | Plant ovary | uterus supplies nutrients to embryo | embryo possesses nutritional reserves | embryo embeds into endometrial lining (implantation) | zygote develops within ovary (no implantation) | able to support future pregnancies | flower is shed after fertilization and unable to support future embryos; new flowers emerge | provide physical protection | | 2 |
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| provide physical protection | | | | | | | | | | | | | |
| 3. | d | a. GnRH is a peptide hormone secreted by the hypothalamus b. GnRH stimulates FSH and LH secretion from anterior pituitary gland ✓ c. FSH and LH stimulate synthesis of steroid hormones (i.e. testosterone, estrogens, progesterone) ✓ d. high levels of FSH and LH (due to negative feedback with steroid hormones) cause the gradual development of <u>primary and secondary characteristics</u> in males and females ✓ | 3 | | | | | | | | | | |

| Question | | Answers | Total |
|----------|---|--|-------|
| 4. | a | small signaling proteins that mediate <u>immune cell communication / inflammation</u> ✓ | 1 |
| 4. | b | a. insulin binds to <u>receptor tyrosine kinases (RTKs)</u> ✓ b. RTK dimerization causes <u>autophosphorylation</u> ✓ c. phosphorylation triggers a cellular response d. insulin cellular response increases fusion of vesicles containing glucose transporters in the plasma membrane ✓ e. insulin increases uptake of glucose by insertion of <u>glucose transporters</u> ✓ | 2 |
| 4. | c | a. G-proteins are coupled to receptors (GPCRs) b. G-proteins contain 3 subunits (α , β , γ) c. in the inactive form the $G\alpha$ subunit is attached to GDP ✓ d. binding of ligand causes <u>exchange of GDP to GTP</u> ✓ e. GTP causes the dissociation of the $\beta\gamma$ subunits from the $G\alpha$ subunit f. GTP-bound $G\alpha$ subunit activates effector molecules that stimulate second messenger synthesis and downstream cellular responses ✓ g. <u>GTP hydrolysis</u> to GDP deactivates $G\alpha$ subunit and the $\beta\gamma$ subunits reattach ✓ | 3 |

| Question | | Answers | Total |
|----------|---|--|-------|
| 5. | a | $\Psi = 300\text{kPa} - 450\text{ kPa} = -150\text{kPa} \checkmark$ | 1 |
| 5. | b | water will move <u>out</u> of the cell and into the solution \checkmark AND $-450\text{kPa} < -400\text{ kPa} / \Psi_{s1} < \Psi_{s2} / \text{OWTTE} \checkmark$ | 1 |
| 5. | c | a. as the potato dries and becomes less hydrated, solute concentration will increase \checkmark b. solute potential will decrease so water potential will decrease \checkmark | 2 |

| Question | | Answers | Total |
|----------|---|--|-------|
| 6. | a | Any two of small, fixed size; nucleic acid (DNA or RNA) as genetic material; a capsid made of protein; no cytoplasm; few or no enzymes | 1 |
| 6. | b | a. ascending loop of Henle <u>actively transports NaCl</u> into the medulla b. death of ascending loop of Henle cells prevents/greatly reduces active transport of NaCl \checkmark c. prevents/reduces hypertonic conditions in the medulla d. reduces effectiveness of water reabsorption / osmoregulation in collecting duct \checkmark | 2 |
| 6. | c | recruitment of white blood cells to the urinary tract (site of infection), facilitated through <u>ameboid movement</u> of leukocytes, can lead to pyuria \checkmark | 1 |

| Question | | Answers | Total |
|----------|---|---|-------|
| 7. | a | <p>a. primary succession occurs when newly exposed or newly formed rock is colonized by living things for the first time ✓</p> <p>AND</p> <p>b. secondary succession occurs when an area previously occupied by living things is disrupted and then recolonized after disturbance ✓</p> | 1 |
| 7. | b | <p>a. spring growth of Arctic mouse-ear chickweed is influenced by warmer temperatures ✓</p> <p>b. since climate change causes earlier warming in spring, the chickweed may begin growing and flowering earlier than before ✓</p> <p>c. migrating reindeer may use photoperiod as an important cue for migration</p> <p>d. photoperiod does not change with climate change so reindeer arrive at the same time each year</p> <p>e. earlier flowering causes plants to reach peak growth before reindeer arrival ✓</p> <p>f. this reduces nutrition available for reindeer, which affects their survival, reproduction, and population sizes ✓</p> | 2 |
| 7. | c | <p>a. phenological shifts are changes in the timing of life cycle events, like flowering in plants ✓</p> <p>b. climate change is causing global phenological shifts</p> <p>c. phenological shifts disrupt interspecific interactions (i.e. mutualisms, competition), creating open niches for colonizers ✓</p> <p>d. colonizers can take opportunity of disturbed communities, leading to a secondary succession ✓</p> | 2 |
| 7. | d | <p>a. assumption: large population size; since pioneer species have low population sizes during early succession ✓</p> <p>b. assumption: random mating; since pioneer species have low population sizes during early succession which might result in non-random mating (i.e. preference based on proximity) ✓</p> <p>c. assumption: no natural selection; since the ecosystem will be changing, certain traits will become more favorable than others ✓</p> | 1 |

| Question | | Answers | Total | | | | | | | | | | | | | | |
|---|--|--|-------|-------|------------------------|---------------------------|---|---|-----------------------------|---|--|--|--|---|---|--|---|
| 8. | a | <p>a. <u>photolysis</u> is the source of electrons in photosynthesis ✓</p> <p>b. photolysis is the splitting of water into electrons, hydrogen ions, oxygen</p> <p>c. electrons from photolysis are used to replenish the electrons lost from special chlorophyll at the reaction center of photosystem II</p> <p>d. <u>glucose</u> is the source of electrons in respiration ✓</p> <p>e. electrons in light-dependent reactions move from photosystem II to photosystem I then to <u>electron carriers/NADP</u> ✓</p> <p>f. electrons move to NADP through <u>cyclic</u> or <u>non-cyclic photophosphorylation</u> via the <u>electron transport chain</u> ✓</p> <p>g. electrons in light-independent reactions move through the Calvin Cycle to produce glucose ✓</p> <p>h. electrons in aerobic respiration move through glycolysis, link reaction, and Krebs cycle to oxidize glucose by reduction of electron carriers/NAD/FAD ✓</p> <p>i. <u>electron carriers/NADH/FADH₂</u> transfer electrons to the <u>electron transport chain</u> ✓</p> <p>j. <u>oxygen</u> is the last electron acceptor in the transport chain ✓</p> <p>k. electrons in photosynthesis move from reactants (water) to important products (glucose)</p> <p>l. electrons in respiration move from reactants (glucose) to byproducts (water)</p> <p>m. electrons in both photosynthesis and respiration are used in the transport chain to <u>pump protons to thylakoid space/intermembrane space</u> ✓</p> <p>n. protons move down their concentration gradients by <u>chemiosmosis</u> through <u>ATP synthase</u> to generate ATP ✓</p> | 7 | | | | | | | | | | | | | | |
| 8. | b | <table border="1"> <thead> <tr> <th>Human</th> <th>Plant</th> </tr> </thead> <tbody> <tr> <td>mobile gametes (sperm)</td> <td>immobile gametes (pollen)</td> </tr> <tr> <td>gametes are transported through a fluid (ejaculate) the male produces</td> <td>gametes are transported through a structure (pollen tube)</td> </tr> <tr> <td>testes are permanent organs</td> <td>anthers and stamen are temporary organs (lost with every flower shed)</td> </tr> <tr> <td>testes linked to other organ systems (neural, muscular, endocrine)</td> <td>anthers and stamen are isolated from / minimally connected with other organs</td> </tr> <tr> <td>testes enclosed within human body for protection</td> <td>pollen exposed to environment to maximize dispersal</td> </tr> <tr> <td colspan="2">internal fertilization (inside fallopian tubes in humans / ovary in plants)</td> </tr> </tbody> </table> | Human | Plant | mobile gametes (sperm) | immobile gametes (pollen) | gametes are transported through a fluid (ejaculate) the male produces | gametes are transported through a structure (pollen tube) | testes are permanent organs | anthers and stamen are temporary organs (lost with every flower shed) | testes linked to other organ systems (neural, muscular, endocrine) | anthers and stamen are isolated from / minimally connected with other organs | testes enclosed within human body for protection | pollen exposed to environment to maximize dispersal | internal fertilization (inside fallopian tubes in humans / ovary in plants) | | 4 |
| Human | Plant | | | | | | | | | | | | | | | | |
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(continued...)

(Question 8 continued)

| Question | | Answers | Total |
|----------|---|--|-------|
| 8. | c | <p>a. adaptive radiation (divergent evolution) occurs when a single ancestral species diverges into multiple species (with different niches) ✓</p> <p>b. emergence of new species increases <u>species diversity</u> in ecosystems ✓</p> <p>c. radiation into multiple species results in distinct gene pools that are each altered by many selective pressures, increasing <u>genetic diversity</u> ✓</p> <p>d. since ecosystems are all the biotic and abiotic interactions, new species increase <u>ecosystem diversity</u> by increasing the types of interactions between the living and non-living ✓</p> | 4 |

| Question | | Answers | Total |
|----------|---|--|-------|
| 9. | a | <p>a. muscles are adapted for contraction because they contain sarcomeres</p> <p>b. <u>actin</u> and <u>myosin filament</u> sliding leads to sarcomere shortening during contraction ✓</p> <p>c. <u>titin</u> stores potential energy useful during recoil after contraction ✓</p> <p>d. <u>tropomyosin</u> allows sarcomere contraction to be controlled ✓</p> <p>e. alveoli contain type II pneumocytes that secrete pulmonary surfactant</p> <p>f. <u>pulmonary surfactant</u> contains phospholipids and proteins that reduce surface tension to prevent alveolar collapse ✓</p> <p>g. sperm contain <u>flagella</u> which are composed of proteins ✓</p> <p>h. flagella allow for sperm motility ✓</p> <p>i. sperm <u>acrosomes</u> contain digestive enzymes to digest zona pellucida during fertilization ✓</p> <p>j. eggs contain <u>cortical granules</u> that prevent polyspermy by releasing proteins that break down sperm receptors ✓</p> | 7 |
| 9. | b | <p>a. auxin (indole-3-acetic acid, IAA) is produced in shoot tips and promotes meristematic differentiation but inhibits lateral growth ✓</p> <p>b. cytokinin is produced in root tips and promotes growth/cell division but inhibits leaf development ✓</p> <p>c. auxin and cytokinin interact in an <u>antagonistic</u> and <u>cooperative manner</u> depending on their concentrations ✓</p> <p>d. high auxin and low cytokinin levels induce root formation ✓</p> <p>e. low auxin and high cytokinin levels induce shoot formation ✓</p> <p>f. intermediate levels of auxin and cytokinin induce callus formation</p> | 4 |

(continued...)

(Question 9 continued)

| Question | | Answers | Total |
|----------|---|---|-------|
| 9. | c | <p>a. John Endler studied male guppies with different amounts of bright coloration ✓</p> <p>b. brightly colored males are more attractive to females, so sexual selection favors colorful males due to greater mating success ✓</p> <p>c. bright colors makes males more visible to predators, so in areas with many predators, natural selection favors duller males due to greater survival ✓</p> <p>d. males evolved brighter colors when predation was low and duller when predation was high ✓</p> <p>e. opposing pressures of sexual and natural selection drive evolution towards the strongest pressure ✓</p> | 4 |

| Question | | Answers | Total |
|----------|---|--|-------|
| 10. | a | <p>a. <u>frameshift/indel mutations</u> are more harmful than missense mutations because they affect all subsequent codons but missense mutations only affect one codon ✓</p> <p>b. mutations in <u>exons</u> are more harmful than in introns ✓</p> <p>c. mutations in <u>coding genes</u> are more harmful than in “junk DNA” ✓</p> <p>d. gain of function mutations in <u>proto-oncogenes</u> are more harmful than other types of genes ✓</p> <p>e. proto-oncogenes can become mutated to oncogenes and increase cell growth which promotes <u>cancer</u> ✓</p> <p>f. loss of function mutations in <u>tumor suppressor genes</u> are more harmful than in other types of genes because they promote cancer growth ✓</p> | 4 |
| 10. | b | <p>a. cladograms group taxa according to shared derived characteristics ✓</p> <p>b. <u>convergent evolution</u> is the process by which species from different ancestors develop similar traits (i.e. bird and insect wings) ✓</p> <p>c. convergent evolution could mislead scientists by grouping unrelated lineages with similar traits together ✓</p> <p>d. as new <u>genomic and fossil evidence</u> emerges, classification is revised accordingly ✓</p> <p>e. since cladograms make explicit predictions/hypotheses about the relatedness of taxa, they can be falsified as new evidence is discovered ✓</p> | 4 |

(continued...)

(Question 10 continued)

| Question | | Answers | Total |
|----------|---|--|-------|
| 10. | c | <p>a. photosynthesis converts sunlight energy to chemical energy in primary producers through light-dependent and light-independent reactions ✓</p> <p>b. nitrogen-fixing bacteria convert inert nitrogen into ammonia to be used up by primary producers for making proteins ✓</p> <p>c. stored biomolecules in primary producers are ingested and digested by herbivores / primary consumers ✓</p> <p>d. physical and chemical digestion of ingested material by enzymes ✓</p> <p>e. passive and active transport of simple molecules out of the digestive compartment and into the body (absorption) ✓</p> <p>f. incorporation of simple molecules into the organism's metabolism (assimilation) ✓</p> <p>g. ingestion and digestion of primary consumers by secondary consumers, then tertiary consumers, and finally quaternary consumers ✓</p> <p>h. cell respiration uses biomolecules to produce ATP and releases heat, contributing to sub-100% energy transfer efficiency across trophic levels ✓</p> <p>i. other functions of life (i.e. homeostasis, movement, reproduction) require cell respiration so energy is also lost through them ✓</p> <p>j. decomposers breakdown dead organisms into biomolecules that can be used by other organisms (i.e. plants) ✓</p> | 7 |
