bio letters

Biology
Higher level
Paper 1A

12 May 2025

Zone A afternoon | **Zone B** morning | **Zone C** afternoon

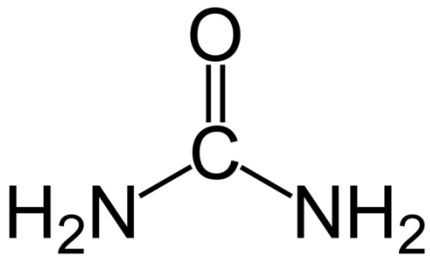
2 hours [Paper 1A and Paper 1B]

Instructions to candidates

- Do not open this mock examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A calculator is required for this paper.
- The maximum mark for paper 1A is **[40 marks]**.
- The maximum mark for paper 1A and paper 1B is **[75 marks]**.

1205–2025

1. The chemical structure of urea, a molecule that disrupts hydrogen bonding in water, is shown. Why might high concentrations of urea cause a protein to unfold, but not pure water?



A. Urea forms less hydrogen bonds than water

B. Urea forms more hydrogen bonds than water

C. Urea contains 2 amino groups but an amino acid only has 1 amino group

D. Urea is a toxic metabolic waste but water is not

2. Within a 10 base sequence of satellite DNA that repeats every 10 bases, A occurs three times more than C. Given that G and T are present in equal amounts within the sequence, and that only 1 cytosine is present in each repeat, how many G will be present in 100 bases of double-stranded DNA?

A. 20

B. 30

C. 40

D. 50

3. Even though glucose is a solute in blood, sodium ions are instead used to establish hypertonic conditions in the kidney's medulla. Which of the following statements explain this?

A. Glucose channels for facilitated diffusion are larger and thus more metabolically expensive to translate compared to sodium ion channels

B. Glucose is an organic molecule that is used in respiration, so it would be a waste to use it to establish a concentration gradient

C. Due to their small size, sodium ions readily diffuse through the plasma membrane, unlike glucose which requires special transporters

D. The sodium potassium pump ensures constant loss of sodium ions by cells

4. Hemoglobin's structure enables it to not only bind to oxygen, but also regulate blood pH. What portions of the amino acids in hemoglobin likely mediate the differences in the binding and non-binding regions of hemoglobin?

A. Amino group

B. Carboxyl group

C. Side chain

D. Peptide bond

5. What will be observed when gram-positive bacteria are treated with penicillin?

A. Binding of penicillin to bacterial cell wall, causing it to weaken and burst

B. Misfolded transpeptidase proteins

C. Unlinked carbohydrates

D. Noncovalent binding of penicillin to transpeptidase

6. How does ATP synthase couple energy from proton movement with ADP phosphorylation?

A. F_1 and stalk rotate in a clockwise direction when protons enter the channels

B. Induced conformational changes in F_1 due to alignment of the two half-channels leads to ATP generation

C. Clockwise rotation of rotor subunit induces conformational changes in the F_1 complex which leads to ADP phosphorylation

D. Half channels pump protons into the matrix which activates the catalytic unit of ATP synthase

7. What is an advantage of having a diverse set of pigments for photosynthesis?

A. Chlorophyl b absorbs higher energy than chlorophyl a to maintain thermal stability

B. The antenna complex absorbs a broad range of wavelengths to transfer to different types of pigments in the reaction center

C. The proximity of pigments in the reaction center facilitates efficient transfer of energy

D. Dissipation of heat to prevent thermal stress at higher temperatures

8. What is a suitable primer for amplifying the target DNA sequence shown?

5’ – GGATTCAAA…TGCCCTT – 3’

A. 5’ – CCUAAGUUU – 3’

B. 5’ – AAGGGCA – 3’

C. 5’ – UUUGACC – 3’

D. 5’ – ACGGGAA – 3’

9. What is the number of possible reading frames during translation?

A. 1

B. 2

C. 3

D. 4

10. A nonsynonymous mutation on a particular locus is spreading at a faster rate than a synonymous mutation on the same gene in a particular gene pool. What does this indicate about the mutations?

A. The nonsynonymous mutation is beneficial

B. The synonymous mutation is beneficial

C. The nonsynonymous mutation is harmful

D. The synonymous mutation is harmful

11. Miller and Urey's experiment aimed to simulate conditions on primitive Earth. What does the boiling water flask represent?

A. Oceans heating up and releasing water vapor

B. Oceans heating up and releasing carbon dioxide and methane

C. Water bodies that collected the organic matter after condensation and precipitation

D. Water vapor in the clouds heated by lightning

12. Which of the following microscopic techniques can be used to investigate whether or not two specific proteins are interacting with each other in a live cell?

I. Cryogenic microscopy

II. Fluorescence microscopy

III. Freeze-fracture electron microscopy

A. I only

B. II only

C. I and II only

D. I, II, and III

13. Which statement about viral replication is **true**?

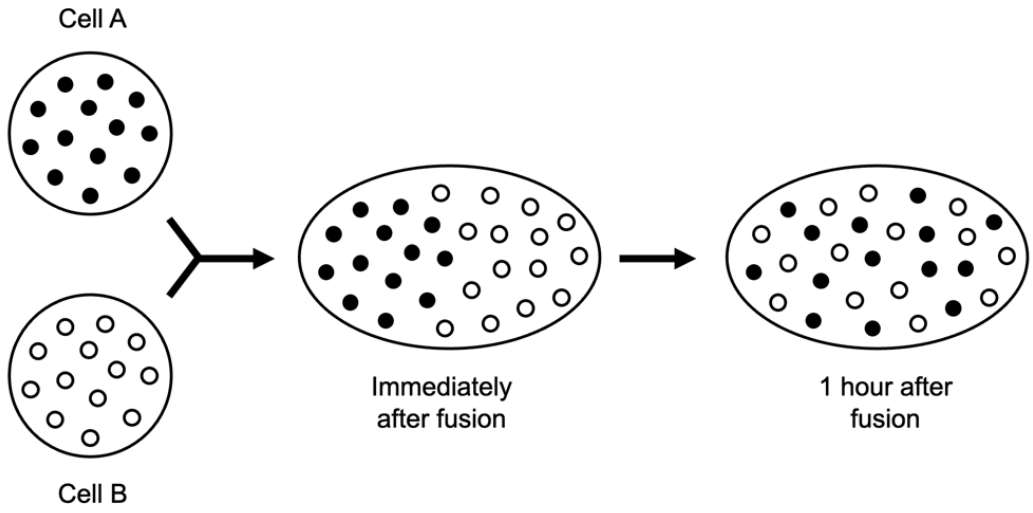
A. During lysis, the virus actively transports protons to the host membrane to create holes

B. The viral capsid helps the host cell produce more copies of the viral genome

C. During attachment, the virus attaches at specific sites on the cell surface

D. mRNA works outside of the host cell to produce enzymes and proteins

14. Transmembrane proteins of Cell A were tagged with dye A and Cell B's with dye B. The cells were then fused together in a lab, and the results after an hour are shown in the image below. Which of the following statements are **true**?



A. The cell actively moved the transmembrane proteins to where they are needed most

B. The transmembrane proteins diffused throughout the fluid phospholipid bilayer

C. The proteins remained in the same place and the dyes attached to other proteins

D. The cytoskeleton actively rearranged the cell structure after fusion

15. In an experiment aimed to understand the structure of the Golgi apparatus, a dye was injected into the lumen of a cisterna in a live cell and observed under a microscope. With time, what observations would the scientists find according to the two major models?

	Cisternal Maturation Model	**Vesicular Transport Model**
A.	Dye moves closer to cis side	Dye fixed to site of injection
B.	Dye fixed to site of injection	Dye moves closer to cis side
C.	Dye moves closer to trans side	Dye spreads to other cisternae
D.	Dye spreads to other cisternae	Dye moves closer to trans side

16. What ensures connectivity of cardiomyocytes?

A. Tight junctions

B. Gap junctions

C. Sarcoplasm

D. Intercalated discs

17. HER2 is a receptor tyrosine kinase which becomes permanently activated in some types of human breast cancer. Lapatinib, a drug used to treat breast cancer, inhibits autophosphorylation in the HER2 receptor, which reduces tumor growth. Besides autophosphorylation, what other steps would be inhibited by Lapatinib?

A. Signaling molecule binding, dimerization, and the downstream cellular response

B. Dimerization and the downstream cellular response

C. The downstream cellular response

D. Phosphatase activity, dimerization, and the downstream cellular response

18. Saxitoxin is a human toxin that binds to sodium ion channels and blocks the alpha subunit. Which of the following correctly describes the effects of saxitoxin on neural signalling?

A. It occludes the pore channel and blocks sodium ion entry

B. It blocks the inactivation gate of the alpha subunit, causing constant depolarization

C. It blocks the activation gate of the alpha subunit, preventing depolarization

D. It blocks the deactivation gate of the alpha subunit, increasing membrane potential

19. Which of the following statement(s) is/are **correct** about meiosis?

I. Mutations in tubulin-coding genes increase the chances of non-disjunction in meiosis I

II. Meiosis adds new alleles to gene pools

III. Non-disjunction leads to allopolyploidy whereas disjunction leads to autopolyploidy

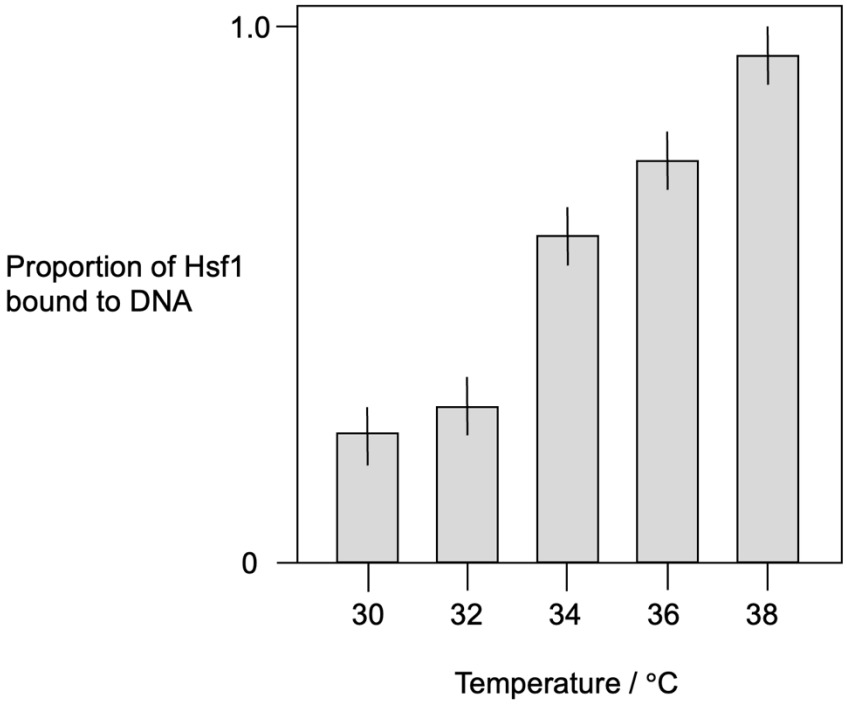
A. I only

B. I and II only

C. I and III only

D. I, II, and III

20. Hsf1 is a transcription factor that binds to DNA in response to thermal stress in human cells. In an experiment, scientists investigated the effect of temperature on the activity of Hsf1. The graph shows the proportion of Hsf1 bound to DNA at a given time and temperature. Which of the following conclusions are **false**?



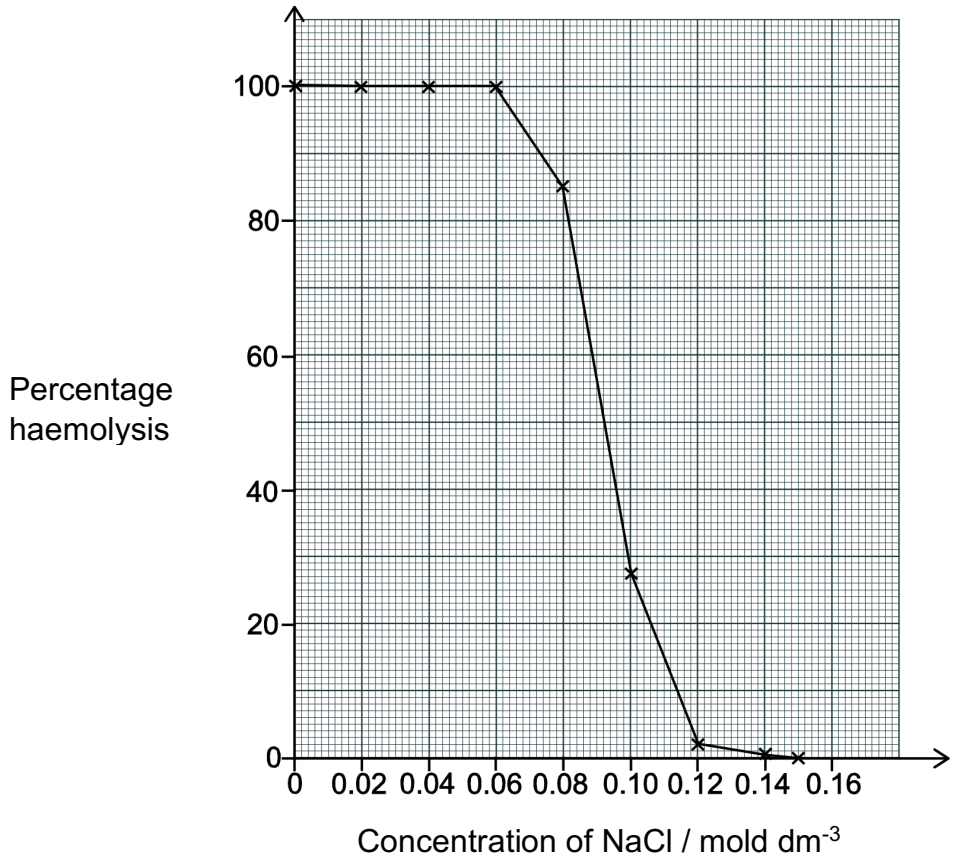
A. Hsf1 must have a stable tertiary structure to withstand relatively high temperatures

B. Hsf1 is involved in the pathway that responds to high temperatures in human cells

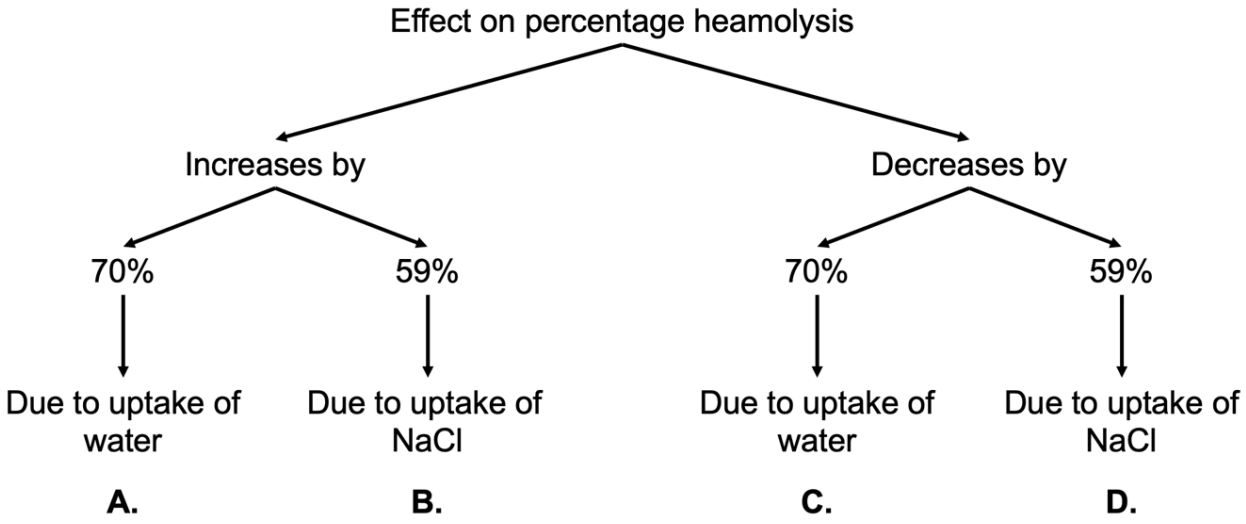
C. Hsf1 increases cellular metabolic activity by increasing gene expression

D. Hsf1 becomes more saturated at higher temperatures

21. The graph below shows the effect of different concentrations of sodium chloride (NaCl) solution on the percentage haemolysis of human red blood cells. Haemolysis occurs when the cells swell and then burst open.



What correctly describes the effect of changing the concentration of NaCl from 0.12 mol dm^{-3} to 0.084 mol dm^{-3} on percentage haemolysis?



22. A population of fish living in a lake have been monitored by scientists for the past 50 years. Across time, scientists observed changes in the behavior of the fish that seem to split the population into two distinct subpopulations. Under the biological species concept, which of the following lines of evidence is **least** useful in confirming whether allopatric or sympatric speciation has occurred or will occur?

A. Correlations between genetic divergence of the two populations with historical changes in habitat geography

B. Tracking genetic changes in traits that determine sexual characteristics

C. Observing mating behavior and timing

D. Comparing polygenic traits across environmental gradients in the two subpopulations

23. Many archaeans are extremophiles that live in extreme environments, which are habitats thought to now be less common on modern Earth. Modern extremophiles only survive in places that their extremophilic ancestors became adapted to long ago. Given that the branch length of a phylogenetic tree is proportional to the amount of genetic change, which of the following is **correct**?

A. Non-extremophilic archaeans have shorter branches than extremophilic ones

B. Non-extremophilic archaeans have longer branches than extremophilic ones

C. Eukaryotes descendant from extremophilic archaeans have longer branches than those descendant from non-extremophilic archaeans

D. Eukaryotes descendant from extremophilic archaeans have shorter branches than those descendant from non-extremophilic archaeans

24. Patients with diabetes mellitus who neglect insulin therapy metabolize lipids quickly, leading to the accumulation of acidic byproducts in the blood. How would this affect respiration rate?

A. Respiration rate decreases only if oxygen is reduced

B. Respiration rate decreases

C. Respiration rate increases

D. Respiration rate increases as pH conditions are not optimal for enzymes in the Krebs cycle

25. How does the cardiac cycle change during sympathetic stimulation?

I. Both systolic and diastolic durations decrease

II. Diastolic durations decrease disproportionately more than systolic durations

III. Oxygen delivery decreases as the ventricles receive less blood from the shortened diastolic durations

A. I only

B. I and II only

C. I and III only

D. I, II, and III

26. Within **one** crossbridge cycle, in which chronological order do the following occur **before** the power stroke?

I. ATP hydrolysis moves the myosin head backwards

II. Myosin binds to the actin filament

III. An ATP molecule binds to myosin

A. I then II only

B. II then I only

C. III then I then II

D. III then II then I

27. A police officer asks a driver to perform a sobriety test, which involves walking in a straight line. Difficulty in maintaining balance and coordinating movements during this test is most likely due to impairment in which part of the brain?

A. Hypothalamus

B. Medulla oblongata

C. Cerebrum

D. Cerebellum

28. What is the significance of having the innate immune system activate before the adaptive one?

A. It allows phagocytosis to occur

B. It allows the organism to adapt faster to current and future infections

C. It provides an immediate rapid response to infection

D. It provides a physical barrier to entry

29. If a mutation prevents the pollen tube cells from developing, which of the following outcomes is most likely to occur during fertilization in angiosperms?

A. Only one male gamete will be produced and the fitness of the offspring decreases

B. The mutation may result in a shorter than normal tube cell which delays self-fertilization and increases the chances of cross-fertilization to increase diversity

C. The pollen grain bypasses the need for a tube by releasing the generative cell directly into the ovary to ensure fertilization

D. Generative cells are unable to reach the ovaries and self-fertilization fails

30. A newly identified genetic disease is observed in multiple unrelated families. Gel electrophoresis results show that some individuals carry the allele for the illness but do not show symptoms. What is the pattern of inheritance?

A. Autosomal recessive with complete dominance

B. Autosomal recessive with incomplete dominance

C. Autosomal dominant with codominance

D. Autosomal dominant with incomplete dominance

31. Why is water reabsorption in the proximal convoluted tubule proportional to solute reabsorption?

A. Helps to regulate the osmolarity of the blood

B. Maintains isotonicity between filtrate and blood

C. There are equal numbers of aquaporins and sodium ion channels

D. Water reabsorption is a natural consequence of solute reabsorption

32. What is the purpose of evolution?

A. To preserve and increase biodiversity

B. To make species more adapted to their environments

C. To cause the development of more complex organisms

D. Evolution has no purpose

33. *Hesperia dacotae*, commonly known as the Dakota Skipper, is an endangered butterfly native to grasslands in central North America. Which of the following is **least** likely to cause further declines in its populations?

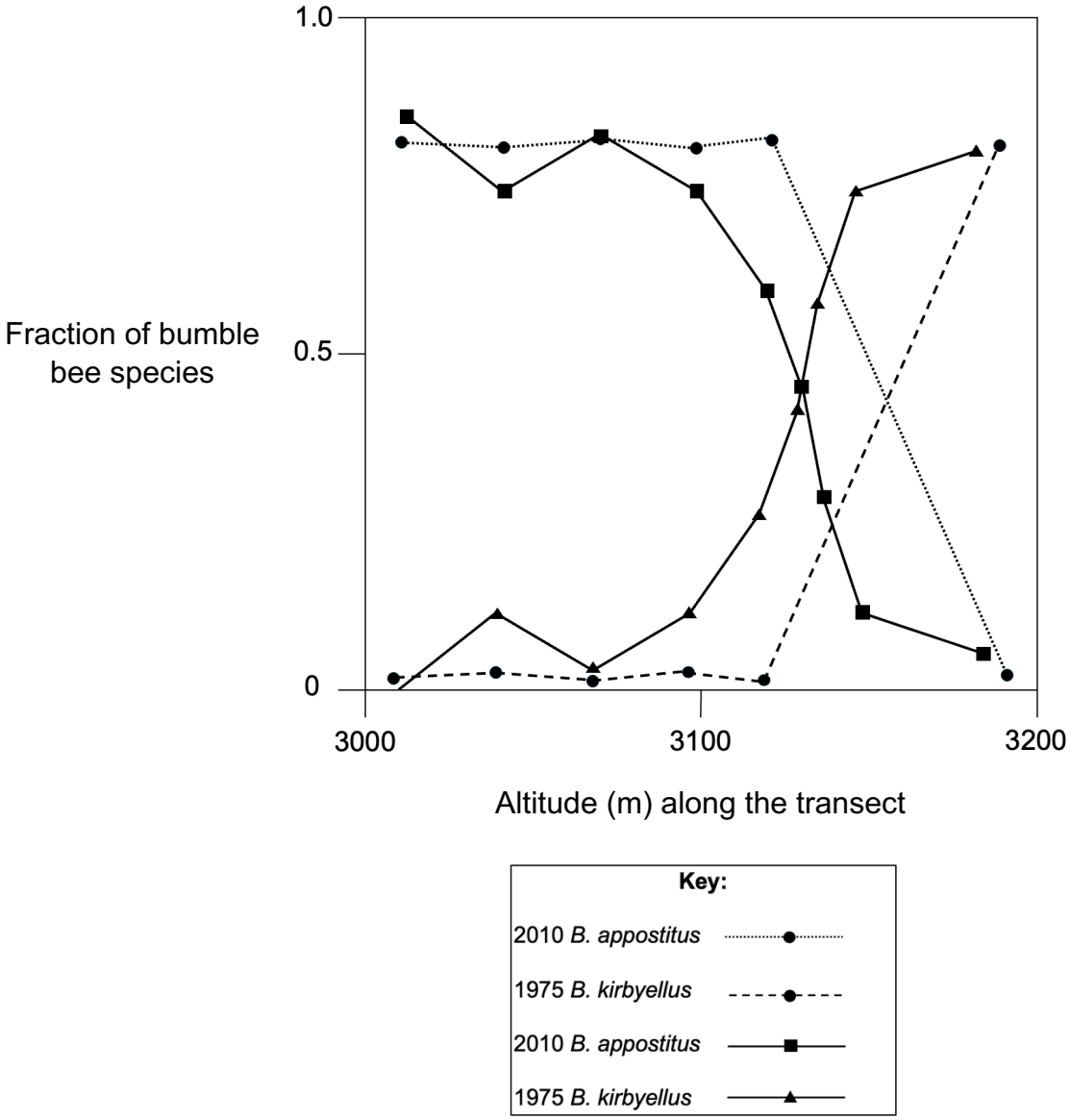
A. Conversion of grasslands to agricultural land

B. Spread of invasive grass species

C. Increasing levels of ammonia and phosphorus in the soil

D. Controlled burning to manage natural reserves of grasslands

34. A study was done to investigate the effects of climate change on the geographic range distribution of two species of bumble bee, *B. appostitus* and *B. kirbyellus*. The scientists set up transects that tracked the bumble bees across various altitudes with time, and the results are shown in the graph. Which of the following statements explain the trends in the data?



A. The two species responded differently because they each have unique ranges of tolerance

B. *B. appostitus* shifted towards lower elevation whereas *B. kirbyellus* shifted towards higher elevation to synchronize with earlier flowering times in plants they pollinate

C. Both species shifted towards higher elevation to remain within their tolerance ranges

D. Both species shifted towards higher elevation due to a rapid evolutionary response to rising annual temperatures

35. How can predation affect competitive exclusion between 2 species?

A. Reduce competitive exclusion by eliminating inferior competitors

B. Reduce competitive exclusion by eliminating superior competitors

C. Reduce competitive exclusion by keeping populations at their carrying capacity *K*

D. Reduce competitive exclusion by keeping populations below their carrying capacity *K*

36. Between 1907 and 1923, cattle grazing in the Kaibab National Forest in Arizona was greatly reduced. Deer hunting was eliminated, and predators were killed. Over 600 cougars and 3,000 coyotes were trapped or shot. In response, the deer herd began to increase. By 1915, the deer were estimated at 25,000; by 1920 at 50,000; and by 1923 at approximately 100,000. What initially limited the deer population?

A. Anthropogenic factors

B. Top-down control

C. Bottom-up control

D. Carrying capacity *K*

37. Which of the following is **not** conclusive evidence that anthropogenic CO_2 emissions have altered the carbon cycle?

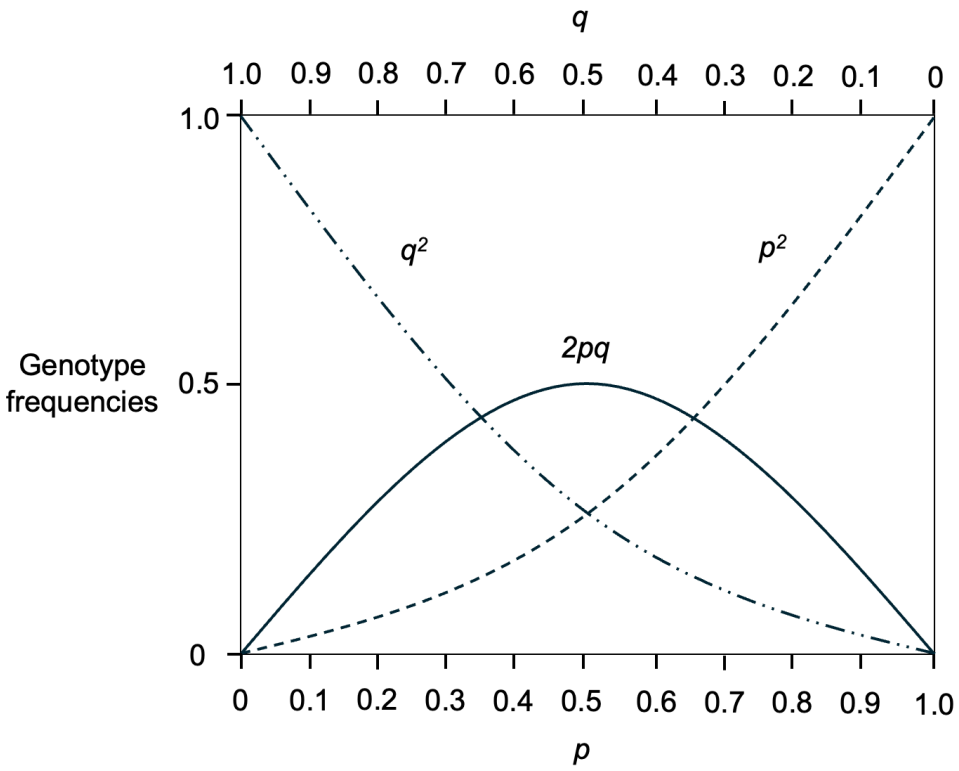
A. A sustained rise in atmospheric CO_2 with time

B. Isotopic carbon in CO_2 indicating a fossil fuel source

C. A decline in global carbon fixation rates

D. Strong correlations between industrialization and CO_2 levels

38. The graph shows the relationship between the different genotypes in the Hardy Weinberg equation for a trait with two alleles. Which allele frequencies would represent stabilizing selection acting on a population?



A. $0.35 < p < 0.65, 0.35 < q < 0.65$

B. $0.30 < p < 0.60, 0.30 < q < 0.60$

C. $0.30 < p^2 < 0.60, 0.30 < q^2 < 0.60$

D. $0.35 < p^2 < 0.65, 0.35 < q^2 < 0.65$

39. In a mesocosm study, scientists added double the natural amount of phosphorus to several tanks containing algae, which doubled chlorophyl a concentrations compared to the control. Which of the following **cannot** be concluded from this observation?

A. Algae respond positively to additional phosphorus

B. Phosphorus is the only limiting factor in the mesocosms

C. Phosphorus-induced eutrophication is most probably occurring in the mesocosms

D. Chlorophyl a concentrations can be used a direct measure of algal population size

40. Which of the following characteristics of a species would increase its likelihood of adapting to climate change through evolutionary change?

I. Most loci have multiple single-nucleotide polymorphisms

II. Individuals can adapt their phenotypes to their environments

III. High proportion of genetically close individuals in a population

A. I only

B. I and II only

C. II and III only

D. I, II, and III

References:

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