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HIGHER

B7H Ecology: Higher Tier Practice

AQA 8461 · Calculator allowed · about 100 minutes

Total Marks

Name: ______________________________ Date: ____ / ____ / ______

Answer ALL questions. Show all your working.

1 Define the term 'ecosystem'.

(a) Define the term 'ecosystem'. **(2)**

(Total for Question 1 is 2 marks)

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2 Priya studies two plant species on a coastal sand dune. One species has long roots and waxy leaves; the other has shallow fibrous roots and large thin leaves.

(a) Explain how long roots and waxy leaves help the first plant survive the sand dune environment. **(3)**

(Total for Question 2 is 3 marks)

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3 A pond food chain measured by biomass is: algae 500 g m^{-2} -> small invertebrates 120 g m^{-2} -> small fish 24 g m^{-2}. Calculate the percentage efficiency of biomass transfer from algae to small invertebrates, and from small invertebrates to small fish.

(a) Calculate percentage efficiency of biomass transfer from algae to small invertebrates. Show substitution. **(2)**

....

(b) Calculate percentage efficiency of biomass transfer from small invertebrates to small fish. Show substitution. **(1)**

....

(Total for Question 3 is 3 marks)

4 A small population of rabbits on an enclosed meadow increases from 30 to 42 individuals in one year. Use the population growth rate formula: growth rate (%) = ((final - initial) / initial) x 100. Calculate the annual percentage growth rate. State whether this represents exponential growth or not and justify your answer in one sentence.

(a) Calculate the annual percentage growth rate. Show substitution. **(2)**

....

(b) State whether this is exponential growth and justify your answer in one sentence. **(2)**

(Total for Question 4 is 4 marks)

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5 Oliwia samples a meadow using a 1 m x 1 m quadrat at 10 random locations. She records the number of clover plants in each quadrat: 5, 8, 3, 6, 7, 4, 9, 2, 6, 5. Calculate the mean number of clover plants per m^2 and the estimated population of clover on a 1 hectare meadow (1 hectare = 10000 m^2).

(a) Calculate the mean number of clover plants per m^2. Show substitution. **(1)**

....

(b) Estimate the population of clover on a 1 hectare (10000 m^2) meadow. Show substitution. **(2)**

....

(Total for Question 5 is 3 marks)

6 A mark-release-recapture study estimates the population of beetles in a wood. In the first visit 120 beetles are caught, marked and released. On a second visit, 150 beetles are caught, of which 30 are marked. Use the Lincoln index estimate: population = (number marked first x number caught second) / number recaptured.

(a) Calculate the estimated total population of beetles. Show substitution and give final answer as an integer. **(3)**

....

(b) State one assumption of the Lincoln index that, if violated, would make the estimate unreliable. **(1)**

(Total for Question 6 is 4 marks)

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7 Describe the roles of nitrifying bacteria and denitrifying bacteria in the nitrogen cycle. Your answer should include the chemical forms they produce or use.

(a) Describe the role of nitrifying bacteria. **(2)**

(b) Describe the role of denitrifying bacteria. **(1)**

(Total for Question 7 is 3 marks)

8 A farmer measures radiant energy entering a crop as 2.0×10^{8} J m^{-2} $year^{-1}$. Only 1.6×10^{6} J m^{-2} $year^{-1}$ is captured as plant biomass. Calculate the overall efficiency of the crop at converting radiant energy to biomass. Express your answer in percent to two significant figures.

(a) Calculate the efficiency using efficiency = (useful energy / total energy) x 100. Show substitution. **(2)**

....

(b) Suggest one agricultural practice that could increase the proportion of energy captured as crop biomass and briefly explain how. **(1)**

(Total for Question 8 is 3 marks)

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9 Ecological succession can change species composition over time. Describe primary succession on a bare rock surface and explain two processes that make the environment suitable for later species.

(a) Describe primary succession on bare rock and explain two processes that improve conditions for later species. **(4)**

(Total for Question 9 is 4 marks)

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10 The graph shows the relationship between dissolved oxygen concentration and the number of aquatic invertebrate species found at sampling sites. Data: DO (mg L^{-1}): 2, 4, 6, 8, 10. Species count: 2, 5, 9, 12, 13. Use the data to calculate the approximate gradient between DO 2 and DO 8, and interpret what this gradient means biologically.

(a) Calculate the gradient (change in species count per mg L^{-1} DO) between DO = 2 mg L^{-1} and DO = 8 mg L^{-1}. Show subtraction and division. **(2)**

....

(b) Interpret this gradient in biological terms. **(2)**

(Total for Question 10 is 4 marks)

11 Two areas of woodland, A and B, were surveyed. The counts of species observed were: Area A: species counts per quadrat averaged 12 with variance 9. Area B: species counts per quadrat averaged 8 with variance 16. Using only these summary statistics, state which area likely has higher species evenness and explain your reasoning.

(a) State which area likely has higher evenness and explain why, using the mean and variance information. **(4)**

(Total for Question 11 is 4 marks)

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12 Kwame proposes reintroducing a locally extinct predator to control an overabundant herbivore species. Outline two ecological benefits and two risks of this reintroduction.

(a) Give two ecological benefits. **(2)**

(b) Give two ecological risks. **(1)**

(Total for Question 12 is 3 marks)

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13 Explain how deforestation in tropical regions can lead to increased atmospheric CO2 concentrations. Include two distinct mechanisms in your answer.

(a) Explain two mechanisms by which deforestation increases atmospheric CO2. **(3)**

(Total for Question 13 is 3 marks)

14 In a closed aquatic microcosm experiment to measure respiration, Erin measures dissolved oxygen at the start and after 24 hours in the dark. Initial DO = 9.2 mg L^{-1}, final DO = 6.8 mg L^{-1}. The volume of water is 2.0 L. Calculate the rate of oxygen consumption in mg per L per hour, and the total oxygen used in the whole microcosm per hour (in mg h^{-1}). Show substitutions.

(a) Calculate the rate of oxygen consumption in mg per L per hour. Show substitution. **(2)**

....

(b) Calculate the total oxygen used in the whole 2.0 L microcosm per hour (mg h^{-1}). Show substitution. **(2)**

....

(Total for Question 14 is 4 marks)

15 A non-native plant species has recently spread along riverbanks in a region, outcompeting several native plants. As a conservation manager you must decide whether to attempt eradication. Evaluate the ecological and practical factors you would consider and reach a justified conclusion about whether to attempt eradication.

Write a balanced evaluation considering ecological impacts, feasibility, economic cost, potential unintended consequences, and monitoring. Conclude with a justified recommendation.

(Total for Question 15 is 6 marks)

16 In a river fish population the allele for fast swimming (F) is dominant and slow swimming (f) is recessive. A sample of 500 fish shows 64 individuals with the recessive phenotype (slow). Assume the population is in Hardy-Weinberg equilibrium. Calculate: (a) the frequency of the recessive allele f; (b) the frequency of the dominant allele F; (c) the expected number of heterozygotes in the population. Show the Hardy-Weinberg equations and substitutions used.

(a) Calculate frequency of recessive allele f. Show substitution using q^2 = frequency of recessive phenotype. **(2)**

....

(b) Calculate frequency of dominant allele F using p + q = 1. Show substitution. **(1)**

....

(c) Calculate expected number of heterozygotes (2pq x total population). Show substitution and give final integer answer. **(4)**

....

(Total for Question 16 is 7 marks)

Mark scheme · B7H Ecology: Higher Tier Practice

Question 1

- (a) **B1** a community of different organisms living together in a particular place, oe
- (a) **B1** and the non-living (abiotic) factors of that environment, oe
- **(a) Answer: A community of different organisms living together in a particular place and the non-living factors of that environment.**

Question 2

- (a) **M1** identifies water shortage or unstable sand as an abiotic stress and links long roots to accessing deeper water or stabilising the plant, oe
- (a) **A1** states that waxy leaves reduce water loss by transpiration, reducing evaporation from the leaf surface, cao
- (a) **A1** links these adaptations to increased survival in the dry, sandy environment, oe
- **(a) Answer: Long roots reach deeper water and help stabilise the plant in shifting sand; waxy leaves reduce water loss by transpiration, so the plant conserves water in the dry, exposed dune environment.**

Question 3

- (a) **M1** substitutes: efficiency = (120 / 500) x 100
- (a) **A1** 24% cao
- **(a) Answer: 24%**
- (b) **B1** 20% (24 / 120 x 100)
- **(b) Answer: 20%**

Question 4

- (a) **M1** substitutes: ((42 - 30) / 30) x 100
- (a) **A1** 40% cao
- **(a) Answer: 40%**
- (b) **M1** states that exponential growth would show growth rate remaining constant as a percentage and population increasing multiplicatively
- (b) **A1** concludes that a single year increase does not prove exponential growth; more data over time is needed, oe
- **(b) Answer: This result alone does not prove exponential growth; exponential growth requires a sustained constant percentage increase over several time intervals, so more years of data are needed.**

Question 5

- (a) **B1** mean = 55 / 10 = 5.5
- **(a) Answer: 5.5 per m^2**
- (b) **M1** substitutes: estimated population = 5.5 x 10000
- (b) **A1** 55000 clover plants cao
- **(b) Answer: 55000**

Question 6

- (a) **M1** substitutes: N = (120 x 150) / 30
- (a) **M1** carries out division to give N = 18000 / 30
- (a) **A1** 600 cao
- **(a) Answer: 600**
- (b) **B1** assumption such as marked beetles mix randomly back into the population, or no births/deaths/immigration/emigration between samples, or marking does not affect survival or recapture chance
- **(b) Answer: That marked beetles mix fully back into the population and that there are no births, deaths, immigration or emigration between the two samplings.**

Question 7

- (a) **M1** oxidise ammonium (NH_4^+) to nitrite (NO_2^-), or nitrite to nitrate (NO_3^-), oe
- (a) **A1** states that nitrification produces nitrate which plants can absorb, cao
- **(a) Answer: Nitrifying bacteria oxidise ammonium to nitrite and nitrite to nitrate, producing nitrate which plants can absorb.**
- (b) **B1** convert nitrate to nitrogen gas (N_2), returning nitrogen to the atmosphere, oe
- **(b) Answer: Denitrifying bacteria convert nitrate into nitrogen gas, returning nitrogen to the atmosphere.**

Question 8

- (a) **M1** substitutes: $(1.6 \times 10^6 / 2.0 \times 10^8) \times 100$
- (a) **A1** 0.80% cao
- **(a) Answer: 0.80%**
- (b) **B1** a practice such as selective breeding or using fertilisers or greenhouse cultivation, with brief explanation that it increases photosynthesis or reduces losses, oe
- **(b) Answer: Using a greenhouse to increase temperature and light or using fertilisers to reduce nutrient limitation, both increasing photosynthesis and therefore biomass production.**

Question 9

- (a) **M1** describes early colonisers such as lichens and mosses colonising bare rock and starting soil formation, oe
- (a) **A1** explains that weathering and acid produced by lichens break down rock to form small particles, producing initial soil, oe
- (a) **A1** explains that accumulation of dead organic matter from colonisers increases soil depth and nutrients, allowing larger plants to establish, oe
- (a) **A1** states that these changes in soil and moisture lead to succession towards more complex plant communities, oe
- **(a) Answer: Primary succession begins with pioneer species like lichens and mosses that colonise bare rock. They produce acids and trap particles that weather the rock into small soil particles, and their dead organic matter accumulates to increase soil depth and nutrients, allowing grasses and then shrubs and trees to establish.**

Question 10

- (a) **M1** substitutes: gradient = (species at 8 - species at 2) / (8 - 2) = (12 - 2) / 6
- (a) **A1** 1.67 species per mg L^{-1} (to 3 s.f.) cao
- **(a) Answer: 1.67 species per mg L^{-1}**
- (b) **M1** states that species richness increases as dissolved oxygen increases
- (b) **A1** explains that higher DO supports more invertebrate species because oxygen is needed for respiration, so low DO limits diversity, oe
- **(b) Answer: Species richness increases by about 1.67 species for each 1 mg L^{-1} increase in dissolved oxygen between 2 and 8 mg L^{-1}; biologically, higher DO supports more species because oxygen availability for respiration limits species survival at low DO.**

Question 11

- (a) **M1** states Area A likely has higher evenness
- (a) **A1** uses variance to justify: Area A has lower variance (9) than Area B (16), so counts are more consistent between quadrats, indicating more even distribution, oe
- (a) **A1** links evenness to ecological interpretation: less variance suggests species abundances are more similar rather than dominated by a few species, oe
- (a) **A1** qualifies that mean differences mean absolute richness differs but evenness is about distribution, oe
- **(a) Answer: Area A likely has higher evenness because it has a lower variance (9) compared with Area B (16), indicating species counts are more consistent between quadrats so abundances are more evenly distributed rather than dominated by a few species.**

Question 12

- (a) **B1** reduces herbivore numbers restoring vegetation and plant community balance, oe
- (a) **B1** increases trophic complexity and can increase biodiversity through top-down control, oe
- **(a) Answer: Reduces herbivore numbers to allow vegetation recovery, and increases trophic complexity which can boost biodiversity.**
- (b) **B1** risk of unintended effects such as predation on non-target species or spread of disease, oe
- **(b) Answer: Possible predation on non-target species or disruption of existing food webs, and risk of introducing diseases.**

Question 13

- (a) **M1** states that cutting or burning trees releases CO2 from biomass into the atmosphere, oe
- (a) **A1** states that removing trees reduces photosynthetic uptake of CO2 so less carbon is fixed, oe
- (a) **A1** optional further explanation that soil disturbance can release stored carbon as CO2, oe
- **(a) Answer: Trees release CO2 when burned or decomposed, increasing atmospheric CO2, and removal of trees reduces photosynthetic uptake so less CO2 is removed from the atmosphere; soil disturbance during deforestation can also release stored carbon.**

Question 14

- (a) **M1** substitutes: rate per L per hour = (9.2 - 6.8) / 24
- (a) **A1** 0.10 mg L^{-1} h^{-1} cao
- **(a) Answer: 0.10 mg L^{-1} h^{-1}**
- (b) **M1** multiplies rate per L by volume: 0.10 x 2.0
- (b) **A1** 0.20 mg h^{-1} cao
- **(b) Answer: 0.20 mg h^{-1}**

Question 15

- **Level 3** (5-6): Detailed evaluation with several relevant ecological and practical factors, clear consideration of trade-offs, and a justified, supported conclusion.
- **Level 2** (3-4): Some evaluation with relevant factors and a reasoned conclusion, but limited depth or justification of trade-offs.
- **Level 1** (0-2): Simple statements or one-sided argument with little or no justification or conclusion.
- **Indicative content:**
  - ecological impacts: loss of native species, reduced biodiversity, altered food webs, changes to soil and hydrology
  - feasibility: extent of invasion, reproductive biology of the invasive species, effectiveness of removal methods (mechanical, chemical, biological)
  - practical and economic factors: cost of eradication, availability of labour and equipment, long-term monitoring costs
  - unintended consequences: non-target damage from herbicides, soil erosion after vegetation removal, opportunity for other invasives
  - ethical and legal considerations: protected species present, landowner permissions
  - monitoring and follow-up: need for repeated treatments and restoration planting to prevent re-colonisation
  - balanced judgement: eradication recommended if invasion is small, removal feasible with acceptable cost and low non-target impact; control or containment may be better if widespread or removal risks large ecosystem damage

Question 16

- (a) **M1** uses $q^2 = 64 / 500 = 0.128$
- (a) **A1** $q = \sqrt{0.128} = 0.358$ cao (to 3 s.f.)
- **(a) Answer: 0.358**
- (b) **B1** p = 1 - 0.358 = 0.642
- **(b) Answer: 0.642**
- (c) **M1** calculates 2pq = 2 x 0.642 x 0.358
- (c) **M1** finds 2pq = 0.4599 (or equivalent)
- (c) **M1** multiplies by total population: 0.4599 x 500
- (c) **A1** 230 heterozygotes (to nearest whole number) cao