

Ecosystems (Interaction and interdependence) practice questions

16 questions • 56 marks • mark scheme at the back

For IB Diploma Biology, Standard Level and Higher Level (first assessment 2025). **HL only** is additional higher level content, for HL students only.

Name

Total / 56

Populations and communities **Spec C4.1**

1 PAPER 1A STYLE [1 mark]

In a capture-mark-release-recapture study, 40 snails were caught, marked and released. In a second sample of 50 snails, 10 were marked. What is the estimated population size?

- A. ☐ 100
- B. ☐ 200
- C. ☐ 500
- D. ☐ 2000

2 PAPER 1A STYLE [1 mark]

Which of the following is an example of allelopathy?

- A. ☐ A fungus secreting a chemical that kills bacteria around it
- B. ☐ A tree releasing a chemical from its roots that inhibits the growth of other plants nearby
- C. ☐ Bacteria in root nodules fixing nitrogen for a legume
- D. ☐ A plant producing toxins in its leaves that deter herbivores

3 PAPER 1A STYLE [1 mark]

What do hard corals obtain from the zooxanthellae living in their cells?

- A. ☐ Carbon dioxide and ammonia
- B. ☐ Fixed nitrogen from the atmosphere
- C. ☐ Sugars and other products of photosynthesis
- D. ☐ Protection from predators

Students estimated the population of dandelion plants on a school field of area 600 m². They placed ten 1 m² quadrats at random coordinates and counted the dandelions in each. (a) Calculate the mean number of dandelions per quadrat. [1] (b) Estimate the population size on the field. [1] (c) The standard deviation of the counts is 2.6. State what this indicates about the distribution of the dandelions. [1] (d) Explain why the quadrats were placed at random coordinates. [2]

Number of dandelion plants per 1 m ² quadrat										
Quadrat	1	2	3	4	5	6	7	8	9	10
Dandelions	4	7	2	0	5	8	3	6	1	4

Answer =

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5 PAPER 1B STYLE

[6 marks]

An ecologist recorded the presence or absence of two moss species, X and Y, in 60 random quadrats on a woodland floor. (a) State a null hypothesis for a chi-squared test on these data. [1] (b) Calculate the expected number of quadrats with both species present. [1] (c) The chi-squared value for the data is 10.0. The critical value at $p = 0.05$ with 1 degree of freedom is 3.84. Deduce what the result shows about the two species. [2] (d) Suggest why this result does not prove that the two species compete, and outline one way to test the hypothesis of competition. [2]

Presence and absence of moss species X and Y in 60 quadrats			
	Y present	Y absent	Total
X present	6	24	30
X absent	18	12	30
Total	24	36	60

Answer =

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6 PAPER 2A STYLE

[3 marks]

Outline how both partners benefit in the mutualistic relationship between plants of the family Fabaceae and the bacteria in their root nodules.

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7 PAPER 2A STYLE

[4 marks]

Duckweed plants were grown in a beaker of pond water and the number of fronds counted every three days. The numbers rose slowly, then very rapidly, then levelled off.

- (a) Explain the reasons for the rapid increase in the early part of the experiment. [2] (b) Suggest two factors that caused the numbers to level off. [2]

8 PAPER 2B STYLE

[7 marks]

Explain how density-dependent factors control the size of animal populations, using a predator-prey relationship as an example.

Transfers of energy and matter Spec C4.2

9 PAPER 1A STYLE

[1 mark]

What is the source of energy that iron-oxidising bacteria use to fix carbon dioxide?

- A. ☐ Light absorbed by chlorophyll
- B. ☐ Oxidation of iron(II) ions to iron(III) ions
- C. ☐ Reduction of iron(III) ions to iron(II) ions
- D. ☐ Carbon compounds absorbed from dead organic matter

10 PAPER 1A STYLE

[1 mark]

Which statement describes a closed system?

- A. ☐ Energy and matter can both enter and exit
- B. ☐ Matter can enter and exit but energy cannot
- C. ☐ Energy can enter and exit but matter cannot
- D. ☐ Neither energy nor matter can enter or exit

11 PAPER 1A STYLE

[1 mark]

Which statement about production in an ecosystem is correct?

- A. ☐ Secondary production is usually greater than primary production
- B. ☐ Primary production is measured in kJ per individual
- C. ☐ Secondary production is lower than primary production because carbon compounds are lost as CO₂ and water in respiration
- D. ☐ Primary production is the total biomass of the producers at one moment

12 PAPER 1B STYLE

[6 marks]

The table shows sample data for the energy flowing through each trophic level of a food chain in a grassland. (a) Calculate the percentage of energy transferred from producers to primary consumers. [1] (b) Calculate the percentage transferred from secondary to tertiary consumers. [1] (c) Explain two reasons why less than 100% of the energy is transferred between trophic levels. [2] (d) Using the data, suggest why this food chain has no quaternary consumer. [2]

Energy flow through a grassland food chain / kJ m ⁻² yr ⁻¹	
Trophic level	Energy / kJ m ⁻² yr ⁻¹
Producers	24 000
Primary consumers	2 160
Secondary consumers	194
Tertiary consumers	15

Answer =

The table shows illustrative monthly mean CO₂ concentrations at Mauna Loa in two consecutive years, following the pattern of the Keeling Curve. (a) Calculate the difference between the May and September concentrations in Year 1. [1] (b) Explain why CO₂ concentration falls between May and September. [2] (c) Calculate the rate of increase in mean CO₂ concentration between the January values, giving units. [1] (d) State the main cause of the long-term increase. [1]

Illustrative monthly mean CO ₂ concentration / ppm			
Year	January	May	September
Year 1	416.5	420.0	413.5
Year 2	419.0	422.5	416.0

Answer =

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Distinguish between the ways in which autotrophs and heterotrophs obtain the carbon compounds they require, and state one process they have in common.

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PAPER 2B STYLE

Explain how carbon is recycled in ecosystems, and how ecosystems and human activity can change the amount of carbon dioxide in the atmosphere.

[illegible]

PAPER 2A STYLE

Explain why chemical elements can be recycled in ecosystems but energy cannot.

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Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B [1]: $(40 \times 50) \div 10 = 200$

2. [1]

B B [1]. A is antibiotic secretion; C is mutualism; D is a defence against herbivory, not against competing plants.

3. [1]

C C [1]. A is what the zooxanthellae receive from the coral.

4. [5]

- (a) $40 \div 10 = 4.0$ (dandelions per quadrat / per m^2) [1]
- (b) $4.0 \times 600 = 2400$ dandelions [1] ECF from (a)
- (c) the counts vary widely around the mean / the dandelions are unevenly spread / clumped OWTTE [1]
- (d) to avoid (sampler) bias / so every part of the field has an equal chance of being sampled [1]
- (d) so the sample is representative / the estimate is closer to the true population size / reduces sampling error [1]

5. [6]

- (a) there is no association between the distributions of species X and Y / the two species are distributed independently [1]
- (b) $30 \times 24 \div 60 = 12$ [1]
- (c) $10.0 > 3.84$, so the null hypothesis is rejected / the association is significant [1]
- (c) negative association: the species occur together less often than expected (6 observed, 12 expected) [1]
- (d) association/correlation does not show cause / the species may need different conditions (e.g. light, moisture, soil pH) OWTTE [1]
- (d) remove one species from some plots and compare growth/abundance of the other with control plots / grow them alone and together in the laboratory [1]

6. [3]

- bacteria / *Rhizobium* fix nitrogen (gas) / convert N_2 to ammonia/ammonium [1]
- plant uses fixed nitrogen to make amino acids/proteins/nucleic acids / can grow in nitrogen-poor soil [1]
- bacteria receive sugars/carbon compounds/products of photosynthesis from the plant [1]
- bacteria gain a protected / low-oxygen environment in the nodule [1]
- max 3

7. [4]

- (a) resources (light, mineral ions, space) are plentiful / little competition [1]
- (a) birth/reproduction rate greatly exceeds death rate [1]
- (a) no/few pathogens/pests/consumers in the beaker [1]
- (b) competition for light as the surface becomes covered / shading [1]
- (b) mineral ions (e.g. nitrate/phosphate) in the water used up [1]
- (b) carrying capacity of the beaker reached / space on the water surface limited [1]
- max 4

8. [7]

- density-dependent factors have a greater effect as population density increases [1]
- they act by negative feedback / push the population back towards the carrying capacity [1]
- competition for limited resources (food, space) increases in dense populations [1]
- pathogens / pests / parasites are transferred more easily in dense populations [1]
- dense prey populations are easier for predators to find/catch [1]
- named real example, e.g. Canada lynx and snowshoe hare [1]
- more prey → more predators survive and breed → predator numbers rise [1]
- increased predation reduces prey numbers [1]
- fewer prey → predators starve / breed less → predator numbers fall [1]
- prey numbers then recover / cycles repeat with predator peaks lagging behind prey peaks [1]
- this is top-down control; bottom-up control by food supply may also act [1]
- density-independent factors (e.g. weather) cause fluctuations but do not regulate [1]
- max 7

9. [1]

B B [1]. Oxidation reactions release energy; these bacteria are chemoautotrophs.

10. [1]

C C [1]. A describes an open system such as a natural ecosystem.

11. [1]

C C [1]. B: units are $\text{g m}^{-2} \text{ yr}^{-1}$; D describes biomass, not production (a rate).

12. [6]

- (a) $2\,160 \div 24\,000 \times 100 = 9.0\%$ [1]
- (b) $15 \div 194 \times 100 = 7.7\%$ [1] accept 7.73%
- (c) energy converted to heat in cell respiration (lost to environment) [1]
- (c) not all of the organisms / parts eaten (e.g. roots, bones) [1]
- (c) not all food digested/absorbed; lost in faeces [1]
- (d) only $15 \text{ kJ m}^{-2} \text{ yr}^{-1}$ reaches tertiary consumers / about 8% of that would pass on, about $1 \text{ kJ m}^{-2} \text{ yr}^{-1}$ [1]
- (d) too little energy to sustain a population of a further trophic level [1]
- max 6

13. [5]

- (a) $420.0 - 413.5 = 6.5 \text{ ppm}$ [1]
- (b) northern hemisphere spring/summer: photosynthesis exceeds respiration [1]
- (b) net uptake of CO_2 by (the large area of) land plants in the northern hemisphere [1]
- (c) $419.0 - 416.5 = 2.5 \text{ ppm yr}^{-1}$ / ppm per year [1] units required
- (d) combustion of fossil fuels (coal, oil, natural gas) / accept deforestation by burning [1]

14. [4]

- autotrophs synthesise carbon compounds from simple inorganic substances / CO_2 [1]
- autotrophs use an external energy source (light or oxidation reactions) [1]
- heterotrophs obtain carbon compounds from other organisms [1]
- heterotrophs digest complex compounds (internally or externally) and assimilate the products to build their own compounds [1]
- both release energy by (oxidising carbon compounds in) cell respiration [1]
- max 4

15. [7]

- autotrophs/producers fix CO_2 by photosynthesis into carbon compounds [1]
- carbon compounds pass to consumers by feeding [1]
- dead organisms / faeces / dead parts are broken down by decomposers [1]
- producers, consumers and decomposers release CO_2 by (cell) respiration [1]
- if photosynthesis exceeds respiration, there is net uptake / ecosystem is a carbon sink [1]
- if respiration exceeds photosynthesis, there is net release / ecosystem is a carbon source [1]
- named sink/source, e.g. growing forest / peat bog as sink; drained peatland as source [1]
- combustion of biomass / peat / coal / oil / natural gas releases CO_2 [1]
- fossil fuels / peat are carbon stores formed over long periods (thousands to millions of years) [1]
- natural combustion after lightning strikes occurs, but human activity has greatly increased combustion rates [1]
- decomposers also recycle other elements, not just carbon [1]
- max 7

16. [3]

- elements/atoms are not destroyed / the supply of each element is finite [1]
- decomposers break down dead organic matter, releasing elements in inorganic forms that producers can reuse [1]
- energy is converted to heat in cell respiration / when ATP is made and used [1]
- heat is lost to the environment and cannot be converted back to chemical energy by organisms [1]
- so energy must be continually supplied by sunlight [1]
- max 3