



Energy Flow, Ecosystems and the Environment practice questions

38 questions · 142 marks · mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 142

Photosynthesis

Spec 5.1–5.8

A Level only

1 UNIT 4 STYLE [1 mark]

Which statement correctly describes where the light-dependent and light-independent reactions of photosynthesis take place in a chloroplast?

- A. ☐ Light-dependent: stroma. Light-independent: thylakoid membranes.
- B. ☐ Light-dependent: thylakoid membranes. Light-independent: stroma.
- C. ☐ Light-dependent: chloroplast envelope. Light-independent: thylakoid space.
- D. ☐ Light-dependent: thylakoid membranes. Light-independent: thylakoid membranes.

2 UNIT 4 STYLE [3 marks]

Describe the overall reaction of photosynthesis in terms of the fate of the hydrogen from water.

3 UNIT 4 STYLE [3 marks]

Explain why ATP is described as an immediate source of energy and why the formation of ATP in photosynthesis needs light energy.

4

[4 marks]

Compare and contrast cyclic and non-cyclic photophosphorylation.

[illegible]

5

[4 marks]

A student grew algae in a flask in the light, then in the dark. The concentrations of two compounds in the Calvin cycle were measured. Explain the changes in the concentrations of GP and RuBP after the light was turned off.

Relative concentrations of two compounds in the Calvin cycle (arbitrary units)		
Condition	GP	RuBP
Light	100	50
Dark (2 minutes after light turned off)	180	10

[illegible]

6

[5 marks]

Describe how carbon dioxide is converted into sugars and into other biological molecules in the light-independent reactions.

[illegible]

7 UNIT 4 STYLE

[4 marks]

Explain how the structure of a chloroplast is adapted for photosynthesis.

8 UNIT 4 STYLE

[4 marks]

The table shows the percentage of light absorbed by a leaf extract and the relative rate of photosynthesis at four wavelengths of light. Compare the absorption of light with the rate of photosynthesis at these wavelengths, and explain what the comparison shows.

Light absorption and rate of photosynthesis		
Wavelength / nm	Light absorbed / %	Relative rate of photosynthesis
450	90	85
550	20	25
650	80	75
700	30	20

9 UNIT 6 STYLE

[3 marks]

A student separated the pigments in a leaf extract by paper chromatography. The solvent front moved 8.0 cm from the origin. One pigment moved 6.2 cm and a second pigment moved 2.4 cm. Calculate the R_f value of each pigment and suggest which is more soluble in the solvent.

Answer = ...

10

[6 marks]

=====

11

[4 marks]

Oxygen released at different lamp distances	
Distance from lamp / cm	Volume of oxygen released in 10 minutes / cm ³
10	4.0
20	1.0
40	0.25

[illegible]

Productivity and ecosystems

Spec 5.9-5.15

A Level only

12

UNIT 4 STYLE

[1 mark]

A crop has a gross primary productivity of $15\,000\text{ kJ m}^{-2}\text{ year}^{-1}$ and loses $6\,000\text{ kJ m}^{-2}\text{ year}^{-1}$ in respiration. What is its net primary productivity?

- A. ☐ $6\,000\text{ kJ m}^{-2}\text{ year}^{-1}$
- B. ☐ $9\,000\text{ kJ m}^{-2}\text{ year}^{-1}$
- C. ☐ $15\,000\text{ kJ m}^{-2}\text{ year}^{-1}$
- D. ☐ $21\,000\text{ kJ m}^{-2}\text{ year}^{-1}$

13

UNIT 4 STYLE

[4 marks]

The table shows the energy flow through part of a grassland ecosystem. Calculate the net primary productivity of the grass, and the percentage efficiency of energy transfer from the energy available in the grass (its NPP) to the grasshoppers.

Energy flow in a grassland ($\text{kJ m}^{-2}\text{ year}^{-1}$)	
Quantity	Energy / $\text{kJ m}^{-2}\text{ year}^{-1}$
Gross primary productivity of grass	9 800
Energy lost by grass in respiration	2 600
Energy in grasshoppers (primary consumers)	720

Answer = ...

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14

UNIT 4 STYLE

[4 marks]

Explain why the efficiency of energy transfer from a primary consumer to a secondary consumer is less than 100%.

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15

UNIT 4 STYLE

[3 marks]

State what is meant by the terms population, community and ecosystem, using a named habitat as an example.

[illegible]

16

UNIT 4 STYLE

[4 marks]

A student studied the distribution of a species of limpet on a rocky shore and found it mostly on the lower shore. Suggest how one abiotic factor and one biotic factor could explain this distribution.

[illegible]

17

UNIT 4 STYLE

[4 marks]

Two species of tit feed on insects in the same woodland. One feeds mostly in the canopy, and the other feeds mostly near the ground. Use the concept of niche to explain how both species can live in the same woodland.

[illegible]

18 UNIT 6 STYLE

[6 marks]

Describe how you would investigate the distribution of a species of plant along a transect from a path into a woodland, and how you would find out whether its distribution is linked to light intensity.

[illegible]

19 UNIT 6 STYLE

[3 marks]

A student placed twelve 0.25 m^2 quadrats at random in a meadow of area $4\,800 \text{ m}^2$ and counted 54 buttercup plants in total. Estimate the number of buttercup plants in the meadow.

Answer = ...

[illegible]

20 UNIT 4 STYLE

[5 marks]

Describe and explain the changes that occur in a community during primary succession on bare rock, from pioneer species to a climax community.

[illegible]

21

UNIT 4 STYLE

[1 mark]

Which of the following is a limitation of using tree rings (dendrochronology) as evidence of past climate?

- A. ☐ Tree rings cannot be dated accurately.
- B. ☐ Tree growth is also affected by factors other than climate, such as disease and competition.
- C. ☐ Tree rings are formed only in the tropics.
- D. ☐ Tree rings show only changes in carbon dioxide concentration.

22

UNIT 4 STYLE

[4 marks]

Describe how pollen in peat bogs can be used to provide evidence of past climate change.

23

UNIT 4 STYLE

[3 marks]

The table shows a positive correlation between mean atmospheric carbon dioxide concentration and mean global temperature from 1900 to 2000. A student concluded that increased carbon dioxide has caused the temperature rise. Evaluate this conclusion.

Atmospheric CO ₂ and mean global temperature change (selected years)		
Year	CO ₂ / ppm	Temperature change from 1900 / °C
1900	296	0.0
1950	311	0.2
2000	369	0.9

24

UNIT 4 STYLE

[4 marks]

Explain how the greenhouse effect keeps the surface of Earth warm, and how human activities have enhanced it.

25

UNIT 4 STYLE

[4 marks]

Using your knowledge of the carbon cycle, explain how two different methods could reduce the concentration of carbon dioxide in the atmosphere.

26

UNIT 4 STYLE

[3 marks]

Scientists use models to predict future changes in mean global temperature. Explain two limitations of these models.

27

UNIT 4 STYLE

[4 marks]

A species of butterfly has been found at increasingly northerly latitudes in Europe over the last 50 years and now emerges from pupae earlier in spring. Explain how climate change could have caused these two changes.

28

UNIT 4 STYLE

[4 marks]

A report published by an oil company claims that human activity is not the main cause of recent climate change. Suggest why scientists might treat this report with caution, and how they could decide whether the conclusion is valid.

29

UNIT 4 STYLE

[5 marks]

A country plans to grow sugar cane to produce ethanol as a biofuel on land that is currently tropical forest. Evaluate this plan in terms of reducing atmospheric carbon dioxide and conserving biodiversity.

Temperature, evolution and speciation

Spec 5.21–5.24

A Level only

30

UNIT 4 STYLE

[1 mark]

The rate of an enzyme-controlled reaction in a plant is 6 units at 20 °C and 15 units at 30 °C. What is the Q_{10} for this reaction?

- A. ☐ 0.4
- B. ☐ 2.5
- C. ☐ 9.0
- D. ☐ 0.9

Explain the effect of increasing temperature on the rate of an enzyme-controlled reaction in a bacterium, from 10 °C to 60 °C.

The table shows the rate of oxygen consumption of a species of beetle at three temperatures. Calculate Q_{10} for the beetle between 10 °C and 20 °C, and between 20 °C and 30 °C.

Oxygen consumption of a beetle at different temperatures	
Temperature / °C	Oxygen consumption / mm ³ g ⁻¹ h ⁻¹
10	20
20	50
30	90

Answer = ...

Using the data in the previous question, suggest what the change in Q_{10} shows about the beetle, and explain the possible impact of a rise in mean temperature on the beetle population.

34 UNIT 6 STYLE

[6 marks]

Describe how you would investigate the effect of temperature on the hatching of brine shrimp eggs. Include the variables you would control and how you would take account of the ethical use of the organisms.

35 UNIT 6 STYLE

[4 marks]

A student measured the hatching of brine shrimp eggs. At 20 °C, 36 of 120 eggs hatched. At 30 °C, 84 of 120 eggs hatched. At 40 °C, 12 of 120 eggs hatched. Calculate the percentage hatching at each temperature and suggest why the percentage is lower at 40 °C.

Answer = ...

36 UNIT 4 STYLE

[5 marks]

Explain how a population of insects that was susceptible to an insecticide can become resistant to it.

Two populations of a species of lizard became isolated on two islands when a land bridge was submerged. Explain how this could lead to the formation of two new species.

Describe how sympatric speciation differs from allopatric speciation, and give one way in which reproductive isolation could arise in sympatric speciation.

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: the light-dependent reactions occur on the thylakoid membranes and the Calvin cycle occurs in the stroma.

2. [3]

- light energy used to split / photolysis of water (1)
- hydrogen (from the water) combined with carbon dioxide (1)
- to form glucose / a fuel (that stores the hydrogen) (1)
- oxygen is released (into the atmosphere) (1)
- Max 3

3. [3]

- hydrolysis of ATP to ADP and Pi releases energy in one step / quickly (1)
- in small usable amounts / only where it is needed (1)
- photophosphorylation is the addition of phosphate to ADP (1)
- which needs energy / is an endergonic reaction, supplied by light (1)
- Max 3

4. [4]

- similarity: both make ATP / both involve excited electrons passing along an electron transport chain / both use chemiosmosis (1)
- non-cyclic uses photosystems I and II but cyclic uses photosystem I only (1)
- non-cyclic: electrons come from water, cyclic: electrons return to the same chlorophyll (1)
- non-cyclic produces reduced NADP but cyclic does not (1)
- non-cyclic produces oxygen (by photolysis) but cyclic does not (1)
- Max 4. At least one similarity and one difference are needed.

5. [4]

- GP increases and RuBP decreases in the dark (accept figures: GP 100 to 180, RuBP 50 to 10) (1)
- no ATP / reduced NADP is made in the dark (since the light-dependent reactions stop) (1)
- so GP cannot be reduced to GALP, so GP accumulates (1)
- carbon dioxide is still fixed by rubisco for a short time, so RuBP is still used up / GP is still made (1)
- RuBP is not regenerated (from GALP, which also needs ATP) (1)
- Max 4

6. [5]

- carbon dioxide combines with RuBP (1)
- catalysed by rubisco (1)
- to form two molecules of GP (1)
- GP reduced to GALP using ATP and reduced NADP (1)
- GALP used to make glucose / hexose sugars / regenerate RuBP (1)
- (carbon skeletons from) GP / GALP used for amino acids, lipids (accept glycerol / fatty acids) (1)
- sugars used to make polysaccharides / nucleic acids (accept starch, cellulose) (1)
- Max 5

7. [4]

- thylakoids stacked into grana give a large surface area for pigments / photosystems / electron carriers / ATP synthase (1)
- pigments in photosystems absorb a range of wavelengths of light (1)
- stroma contains enzymes / rubisco for the Calvin cycle (1)
- stroma surrounds the grana so ATP / reduced NADP made on thylakoids are used close by (1)
- small thylakoid space allows a proton gradient to be built up quickly (1)
- envelope controls what enters and leaves (1)
- chloroplast has own DNA / ribosomes to make some proteins (1)
- Max 4

8. [4]

- absorption spectrum shows the amount of light absorbed at each wavelength; the action spectrum shows the rate of photosynthesis (1)
- most light absorbed at 450 and 650 nm / least at 550 nm (1)
- rate of photosynthesis is highest where absorption is highest / the two vary together (1)
- so the light absorbed (by pigments) is used in photosynthesis / pigments such as chlorophyll absorb in the blue and red regions (1)
- rate slightly lower than the absorption at 650 nm / not all absorbed light is used in photosynthesis (accept any one comparison with figures) (1)
- Max 4

9. [3]

- $R_f = \text{distance moved by pigment} \div \text{distance moved by solvent front}$ (1)
- $6.2 \div 8.0 = 0.78$ (accept 0.775) (1)
- $2.4 \div 8.0 = 0.30$ (1)
- the pigment with R_f 0.78 is more soluble (in the solvent) (1)
- Max 3 (calculation marks: correct working with the wrong answer is credited once)

10. [6]

- named plant (for example Cabomba / Elodea) cut under water, placed in a boiling tube with the cut end upwards (1)
- water bath at a range of temperatures (for example 10 to 40 °C) with a thermometer / set temperature each time (1)
- let the plant equilibrate / adjust to each new temperature (1)
- measure rate as number of bubbles / volume of oxygen per minute (accept volume of gas collected in a capillary / gas syringe) (1)
- light intensity controlled by keeping lamp at a fixed distance and a heat shield / LED lamp used (1)
- carbon dioxide supply controlled (for example same concentration of sodium hydrogencarbonate solution) (1)
- same plant / same length / mass of plant used each time (1)
- repeat at each temperature and calculate a mean (1)
- Max 6

11. [4]

- rate at 10 cm = $4.0 \div 10 = 0.40 \text{ cm}^3 \text{ min}^{-1}$ (1)
- rate at 20 cm = $0.10 \text{ cm}^3 \text{ min}^{-1}$ and at 40 cm = $0.025 \text{ cm}^3 \text{ min}^{-1}$ (accept 0.025 or 0.03) (1)
- light intensity is proportional to $1 \div \text{distance}^2$, so doubling the distance reduces intensity to one quarter (1)
- the rate is proportional to light intensity here, so light is the limiting factor (accept rate falls to a quarter each time the distance doubles) (1)

12. [1]

B B: $\text{NPP} = \text{GPP} - \text{R} = 15\,000 - 6\,000 = 9\,000 \text{ kJ m}^{-2} \text{ year}^{-1}$.

13. [4]

- $\text{NPP} = \text{GPP} - \text{R} = 9\,800 - 2\,600$ (1)
- $= 7\,200 \text{ kJ m}^{-2} \text{ year}^{-1}$ (1)
- $\text{efficiency} = 720 \div 7\,200 \times 100$ (1) (accept error carried forward from NPP)
- $= 10 \%$ (1)

14. [4]

- some of the primary consumer is not eaten (for example bones, fur, teeth) (1)
- some of what is eaten is not digested and is lost as faeces (egestion) (1)
- some energy is lost in excretory products such as urea (1)
- energy is lost as heat from respiration, which is used for movement / maintaining body temperature / active transport (1)
- some primary consumers die of other causes and pass to decomposers (1)
- Max 4

15. [3]

- population: all the organisms of one species in the habitat at the same time (1)
- community: all the populations of different species living (and interacting) in the habitat (1)
- ecosystem: the community together with the abiotic (non-living) environment (1)
- suitable named example (for example a pond / woodland) used correctly (1)
- Max 3

16. [4]

- abiotic: the lower shore is covered by sea water for longer, so the limpets are less likely to dry out / less desiccation (1)
- abiotic: temperature / salinity is more stable (less extreme) on the lower shore (1)
- biotic: more algae / food on the lower shore (accept limpets are submerged for longer so have more time to graze) (1)
- biotic: less time exposed to predators that feed at low tide, such as birds (1)
- a clear link between each factor and the survival / reproduction / numbers of the limpets (1)
- Max 4 (max 2 for abiotic and max 2 for biotic)

17. [4]

- niche is the role of a species in its habitat / how it interacts with its environment (1)
- the two species have different niches / different feeding positions (1)
- so less interspecific competition for food (1)
- if niches were the same, one species would outcompete the other / be excluded (1)
- each population is controlled by the food available in its part of the habitat (accept intraspecific competition) (1)
- Max 4

18. [6]

- tape measure laid out at right angles to the path / along the line from the path into the wood (1)
- quadrats placed at regular intervals (for example every 2 m) along the line (interrupted belt transect) (1)
- in each quadrat record the abundance of the species / percentage cover / number of plants (1)
- use of the same size quadrat each time (accept 0.25 m²) (1)
- measure light intensity at each quadrat using a light meter, held at the same height and orientation (1)
- repeat the transect / use several transects and calculate means (1)
- plot a graph of abundance against distance and light intensity / carry out a correlation test (1)
- link: correlation does not prove causation (accept other factors such as soil moisture could vary) (1)
- Max 6

19. [3]

- area sampled = $12 \times 0.25 = 3 \text{ m}^2$, so mean = $54 \div 3 = 18 \text{ per m}^2$ (1)
- population = $18 \times 4\,800$ (1)
- = 86 400 (1) (no mark for the unit; accept 86 400 plants)

20. [5]

- pioneer species (for example lichens / mosses) colonise the bare rock (1)
- they tolerate harsh conditions / lack soil / photosynthesise (1)
- when they die and decompose they add organic matter, which forms soil / increases nutrients and water retention (1)
- the abiotic conditions become less hostile, so other species (grasses, shrubs) can colonise and outcompete the pioneers (1)
- diversity and biomass increase / food webs become more complex (1)
- eventually a stable climax community forms, with no further net change in species, in balance with the climate (1)
- Max 5

21. [1]

B B: ring width depends on other factors as well as temperature and rainfall.

22. [4]

- peat is acidic / anaerobic / waterlogged so pollen is preserved (and does not decay) (1)
- cores are taken and layers (of different depths) are dated, for example by radiocarbon dating (1)
- pollen grains are identified and counted in each layer (1)
- different plant species need different conditions, so the species present show the climate at that time (accept cold-adapted vs warm-adapted species) (1)
- change in the pollen types with depth shows change in climate over time (1)
- Max 4

23. [3]

- both rise together / positive correlation (1)
- a correlation does not prove cause; another factor could affect both (1)
- the greenhouse effect gives a mechanism (CO₂ absorbs infra-red radiation) so a causal link is plausible (accept data from several independent sources / ice cores) (1)
- only three data points / limited data / temperature rose by more between 1950 and 2000 than before (1)
- Max 3

24. [4]

- short-wavelength radiation from the Sun passes through the atmosphere and warms Earth's surface (1)
- Earth emits longer-wavelength infra-red radiation (1)
- greenhouse gases absorb the infra-red radiation and re-radiate it back to Earth's surface (1)
- burning fossil fuels / deforestation increases carbon dioxide (accept methane from cattle / rice paddies) (1)
- so more infra-red is trapped (enhanced greenhouse effect) (1)
- Max 4

25. [4]

- planting trees / afforestation increases photosynthesis (1)
- so more carbon dioxide is removed from the atmosphere and carbon is stored in wood (1)
- burning fewer fossil fuels / using renewable energy reduces combustion (1)
- so less carbon is released from the fossil fuel store (1)
- other valid methods, for example protecting peat bogs / forests, using biofuels with explanation (up to 2)
- Max 4

26. [3]

- climate is a complex system with many variables / interacting factors (1)
- so not all can be included accurately / small errors in data are amplified (1)
- feedback loops are difficult to predict, for example melting ice reduces reflection of heat (1)
- predictions depend on assumptions about future emissions / extrapolation assumes the trend continues (1)
- data are incomplete / not available for all areas (1)
- Max 3

27. [4]

- mean temperatures have increased, so the area with suitable abiotic conditions has moved north (1)
- the butterfly (and its food plants) can now survive / reproduce further north (1)
- higher temperatures speed up enzyme-controlled reactions in development (1)
- so pupae develop faster and adults emerge earlier (accept earlier spring) (1)
- if food plants do not respond in the same way, there may be a mismatch in timing (1)
- Max 4

28. [4]

- the company may have a vested interest / financial interest in fossil fuels (1)
- the report may use selected data / not include all the evidence (1)
- check whether it has been peer reviewed / published in a scientific journal (1)
- compare with data from independent sources / other scientists' research (1)
- check the authors' expertise / who funded the research (1)
- Max 4

29. [5]

- biofuels may be close to carbon neutral, because the CO₂ released was absorbed by the crop in photosynthesis (1)
- they replace fossil fuels, so less carbon is released from the fossil store (1)
- clearing forest releases stored carbon as CO₂ (by burning and decay) (1)
- forests are removed so fewer trees to remove CO₂ / loss of carbon sink (1)
- loss of habitats and biodiversity / monoculture supports fewer species (1)
- fertiliser, machinery and processing use energy / release greenhouse gases (1)
- valid judgement, for example better to use waste material or poor land / reforestation (1)
- Max 5

30. [1]

B B: $Q_{10} = 15 \div 6 = 2.5$. A divides the lower rate by the higher rate; C is the difference in rate (15 – 6); D is the difference divided by the 10 °C interval.

31. [4]

- as temperature increases, molecules have more kinetic energy (1)
- so more frequent / more energetic collisions between enzyme and substrate, so more enzyme-substrate complexes (1)
- rate increases up to the optimum (1)
- above the optimum, bonds (hydrogen) break and the tertiary structure / active site changes shape (1)
- enzyme denatures, so substrate no longer fits and rate falls (1)
- Max 4

32. [3]

- $Q_{10} = \text{rate at higher temperature} \div \text{rate at lower temperature}$ (1)
- 10 to 20 °C: $50 \div 20 = 2.5$ (1)
- 20 to 30 °C: $90 \div 50 = 1.8$ (1)
- correct answers with no working gain full marks; Q_{10} has no unit (ignore units given)

33. [4]

- Q_{10} falls as temperature increases / rate does not double between 20 and 30 °C (1)
- the rate of increase is falling because enzymes are approaching their optimum / some enzymes begin to denature (1)
- beetle is an ectotherm, so its metabolic rate follows the environment temperature (1)
- warming may increase growth and development until the optimum, but above this enzymes denature and survival falls (1)
- Max 4

34. [6]

- set up water baths / incubators at several temperatures, for example 15 to 35 °C, checked with a thermometer (1)
- same volume and concentration of salt solution in each container (1)
- same number / mass of eggs from the same batch in each (1)
- same light, time and aeration in each (1)
- count the number hatched (or percentage hatching) after a fixed time (for example 24 h) (1)
- repeat at each temperature and calculate a mean (1)
- ethical: use minimum number of eggs / organisms (1)
- ethical: avoid extreme temperatures / treat humanely and dispose of the organisms humanely (1)
- Max 6

35. [4]

- 20 °C: $36 \div 120 \times 100 = 30 \%$ (1)
- 30 °C: $84 \div 120 \times 100 = 70 \%$ (1)
- 40 °C: $12 \div 120 \times 100 = 10 \%$ (1)
- enzymes (involved in development / hatching) denature at high temperatures / 40 °C is above the optimum, so development is disrupted (accept embryos killed / membranes damaged) (1)

36. [5]

- a mutation in a gene produced an allele giving resistance (1)
- mutation occurs at random / was present before the insecticide was used (1)
- insecticide is a selection pressure (1)
- resistant individuals survive and reproduce (1)
- they pass the allele to offspring (1)
- the frequency of the allele increases in the population (over generations) (1)
- Max 5

37. [5]

- geographical isolation prevents interbreeding / there is no gene flow between the populations (1)
- mutations occur independently in each population (1)
- different selection pressures on each island (1)
- allele frequencies diverge over generations (1)
- populations become unable to interbreed to produce fertile offspring (reproductive isolation) (1)
- this is allopatric speciation (1)
- Max 5

38. [3]

- sympatric occurs in the same area / allopatric requires a geographical barrier (1)
- in sympatric speciation, reproductive isolation arises without a physical barrier (1)
- valid example: different breeding seasons / different habitats within the same area / behavioural changes / polyploidy (1)