Nutrient Cycles: AQA A Level Biology Exam Questions by Topic

18 questions · 47 marks · about 61 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Paper 3 · June 2019 · Q02.1 · 2 marks

0 2 . 1 Describe the role of saprobionts in the nitrogen cycle.

[2 marks]

Question 2 · information from earlier in the question

1 0 Read the following passage.

Tropical rainforests are among the most biologically diverse ecosystems in the world. Their varied plant communities support a high biodiversity of animal species. Tropical rainforests form in parts of the world with high annual rainfall and high mean temperatures providing moist, warm conditions. Nutrient recycling occurs rapidly on the ground of these rainforests. The recycling of nitrogen-containing compounds from dead organic matter sustains the growth of plants.

Each year, large areas of rainforests are lost due to fires. Natural regeneration of rainforests occurs slowly by secondary succession. Secondary succession is similar to primary succession but occurs in areas previously inhabited. There is conflict between the needs of humans and conservation of rainforests. Deforestation by humans is removing large areas of rainforests. Farming practices have prevented the natural regeneration of rainforests by secondary succession.

Use the information in the passage and your own knowledge to answer the following questions.

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Question 2 · A level Paper 2 · June 2025 · Q10.2 · 2 marks

1 0 . 2 Nutrient recycling occurs rapidly on the ground of tropical rainforests (lines 4–5).

Explain how **two** abiotic factors in these rainforests enable the rapid rate of recycling.

[2 marks]

1 _____

2 _____

Question 3 · A level Paper 2 · June 2025 · Q10.3 · 4 marks

1 0 . 3 The recycling of nitrogen-containing compounds from dead organic matter sustains the growth of plants (lines 5–7).

Describe the roles of bacteria in this recycling.

[4 marks]

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Question 4 · A level Paper 3 · November 2021 · Q04.2 · 2 marks

0 4 . 2 Freshwater marsh soils are normally waterlogged. This creates anaerobic conditions.

Use your knowledge of the nitrogen cycle to suggest why these soils contain relatively high concentrations of ammonium compounds and low concentrations of nitrite ions and nitrate ions.

[2 marks]

Question 5 · information from earlier in the question

0 9 The sundew is a small flowering plant, growing in wet habitats such as bogs and marshes. The soil in bogs and marshes is acidic and has very low concentrations of some nutrients. The sundew can trap and digest insects.

Question 5 · A level Paper 2 · June 2019 · Q09.2 · 2 marks

0 9 . 2 Suggest and explain how digesting insects helps the sundew to grow in soil with very low concentrations of some nutrients.

[2 marks]

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0 6 Ammonia in soil is oxidised to nitrites and nitrates by species of nitrifying bacteria.

Scientists investigated whether two soils with a different pH contained different communities of nitrifying bacteria. These communities consist of all the nitrifying bacteria of different species in each soil. They took samples of soil from two sites, **A** and **B**.

They measured the pH of the samples and found that

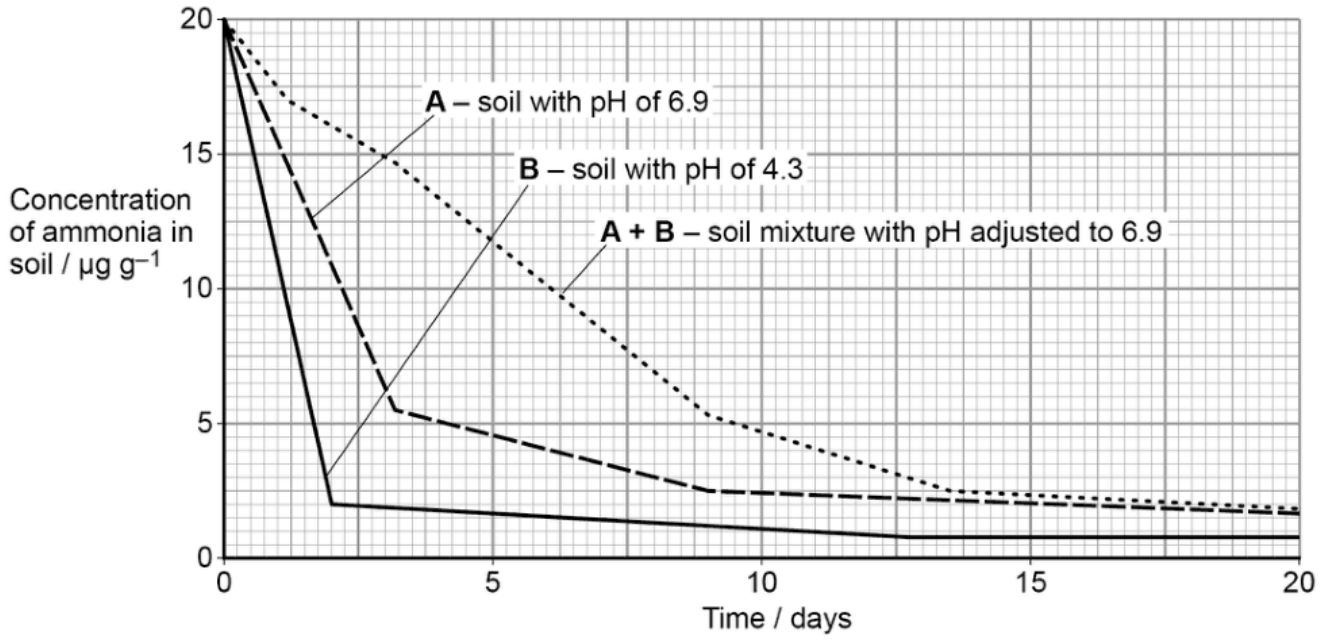
- the soil from site **A** had a pH of 6.9
- the soil from site **B** had a pH of 4.3

The scientists measured the concentration of ammonia in soil samples over 20 days. Each sample contained the same concentration of ammonia at the start and had the same mass. They recorded the concentration of ammonia in

- soil **A** with a pH of 6.9
- soil **B** with a pH of 4.3
- a mixture of equal masses of soils **A** and **B** with its pH adjusted to 6.9

Their results are shown in **Figure 6**.

Figure 6



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Question 6 · A level Paper 3 · June 2018 · Q06.3 · 3 marks

0 6 . 3 The scientists concluded that the soil mixture experiment showed there were different communities of bacteria in soils **A** and **B**.

What evidence from **Figure 6** supports their conclusions? Give reasons for your answer. **[3 marks]**

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Question 7 · information from earlier in the question

0 3 Nitrogen-fixing bacteria such as *Azotobacter chroococcum* use the enzyme nitrogenase to produce ammonia from nitrogen gas in the air. *A. chroococcum* can use ammonium chloride as a direct source of ammonia. When a source of ammonia is not available this bacterium uses nitrogen fixation.

A scientist investigated the effect of an increase in the concentration of ammonium chloride on the activity of nitrogenase in this bacterium. He prepared several liquid medium cultures of the bacterium. Each liquid culture had the same volume. He grew each culture in a different concentration of ammonium chloride.

In each culture:

- he recorded the nitrogenase activity in arbitrary units
- he removed the bacteria and then recorded the concentration of ammonium chloride remaining in each liquid medium.

Table 2 shows the scientist's results.

Table 2

Concentration of ammonium chloride / μg cm^{-3}	Nitrogenase activity / arbitrary units	Concentration of ammonium chloride remaining in liquid medium / μg cm^{-3}
0	45	0
20	30	0
40	17	0
60	7	0
80	0	6
100	0	14
120	0	20

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Question 7 · A level Paper 2 · June 2022 · Q03.2 · 3 marks

0 3 . 2 A student concluded that this investigation showed that ammonia inhibits nitrogenase activity in nitrogen-fixing bacteria. Use all the information to evaluate the student's conclusion.

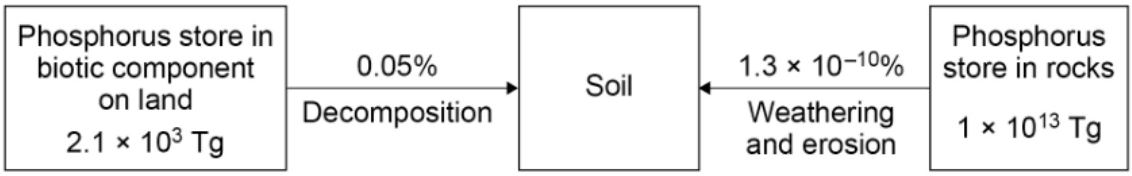
[3 marks]

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Question 8 · A level Paper 2 · June 2023 · Q03.1 · 2 marks

0 3 **Figure 1** shows part of a phosphorus cycle, including the mass of phosphorus in two stores.

Figure 1



One teragram (Tg) is 1×10^{12} grams.

The supply of phosphorus to the soil is shown as a percentage of the total phosphorus mass of each store.

0 3 . 1 Calculate in teragrams the difference in the supply of phosphorus to the soil from the two stores shown in **Figure 1**.

Show your working.

[2 marks]

Answer _____ Tg

Question 9 · A level Paper 2 · June 2017 · Q05.1 · 1 mark

0 5 Arbuscular mycorrhiza fungi (AMF) are fungi which grow on, and into, the roots of plants. AMF can increase the uptake of inorganic ions such as phosphate.

0 5 . 1 Suggest **one** way in which an increase in the uptake of phosphate could increase plant growth.

[1 mark]

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Question 10 · A level Paper 2 · June 2017 · Q05.2 · 1 mark

0 5 . 2 Suggest **one** way in which AMF may benefit from their association with plants.

[1 mark]

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Water shortage can inhibit crop production. Scientists investigated the effect of the mycorrhizal species *Glomus intraradices* on the growth of tomato plants under conditions of water shortage and **no** water shortage.

- The scientists planted tomato seeds into a large number of pots containing sterilised soil.
- They added a culture of *G. intraradices* to 50% of the pots and 50% were left untreated.
- After the seeds had developed into seedlings (young plants), the seedlings from the untreated and treated pots were planted into four separate large greenhouses (glasshouses).
- A very limited supply of water (water shortage) was provided to two of the greenhouses. A sufficient supply of water (**no** water shortage) was provided to the other two greenhouses.
- After 60 days, the scientists determined the mean mass of tomatoes (kg m^{-2}) from each greenhouse.

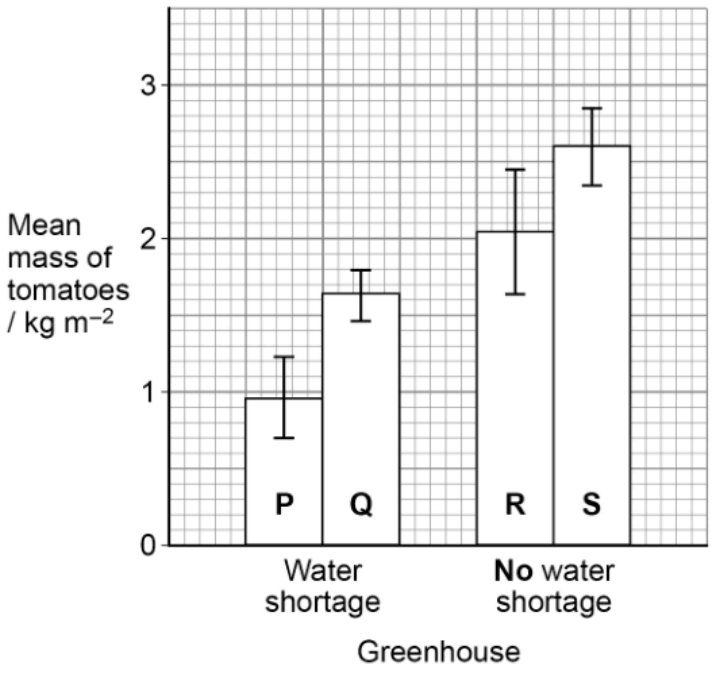
Greenhouse **P** – untreated seedlings with water shortage
Greenhouse **Q** – treated seedlings with water shortage
Greenhouse **R** – untreated seedlings with **no** water shortage
Greenhouse **S** – treated seedlings with **no** water shortage

Treated seedlings are plants grown with *G. intraradices*.

Figure 2 shows the scientists' results.

The error bars represent ± 2 standard deviations from the mean, which includes over 95% of the data.

Figure 2



0 3 . 2 Using all the information, evaluate the effectiveness of using mycorrhizae to increase crop production under conditions of water shortage and **no** water shortage.

[5 marks]

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Question 12 · A level Paper 2 · June 2023 · Q03.3 · 2 marks

0 3 . 3 The tomato seeds were planted into sterilised soil.

Suggest **two** reasons why the soil was sterilised.

[2 marks]

1 _____

_____

2 _____

_____

Question 13 · A level Paper 3 · June 2017 · Q03.1 · 2 marks

0 3 Farmers use artificial fertilisers to maintain or increase yield from grain-producing crop plants such as wheat.

0 3 . 1 Artificial fertiliser is used to replace mineral ions removed from the land when crops are harvested. One of the mineral ions is nitrate.

Give **two** examples of biological molecules containing nitrogen that would be removed when a crop is harvested.

[2 marks]

1 _____

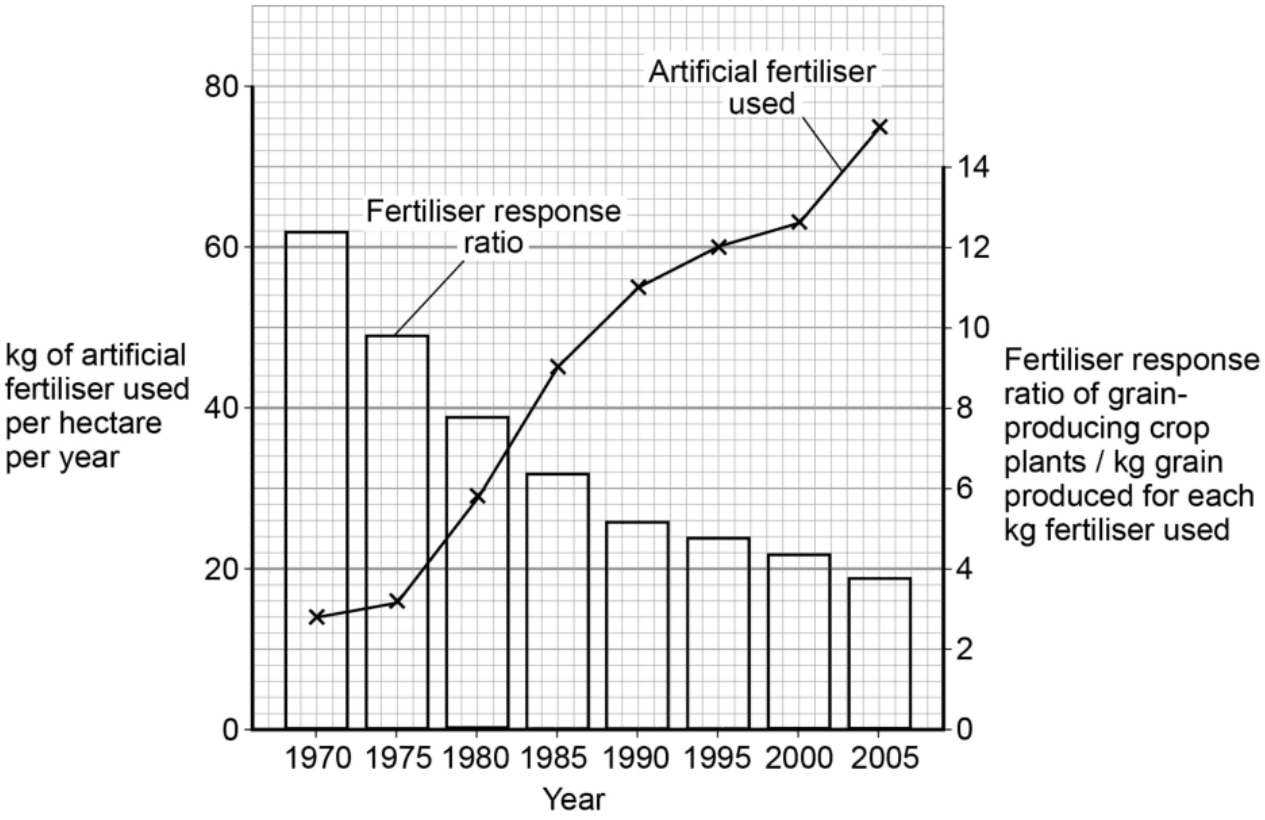
2 _____

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0 3 . 2 Scientists investigated changes in the use of artificial fertiliser in India between 1970 and 2005. They also investigated changes in the **fertiliser response ratio**. This ratio shows how many kg of grain are produced for each kg of fertiliser used.

Figure 4 shows their results in the form the scientists presented them.
(A hectare is a unit of area commonly used in agriculture)

Figure 4



Use these data to calculate the difference in the mass of grain produced per hectare in 1970 compared with 2005.

Show your working.

[2 marks]

Difference _____ kg hectare^{-1}

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Question 15 · A level Paper 3 · June 2017 · Q03.3 · 2 marks

0 3 . 3 Use the data in **Figure 4** to evaluate the use of artificial fertilisers on grain-producing crops in India.

[2 marks]

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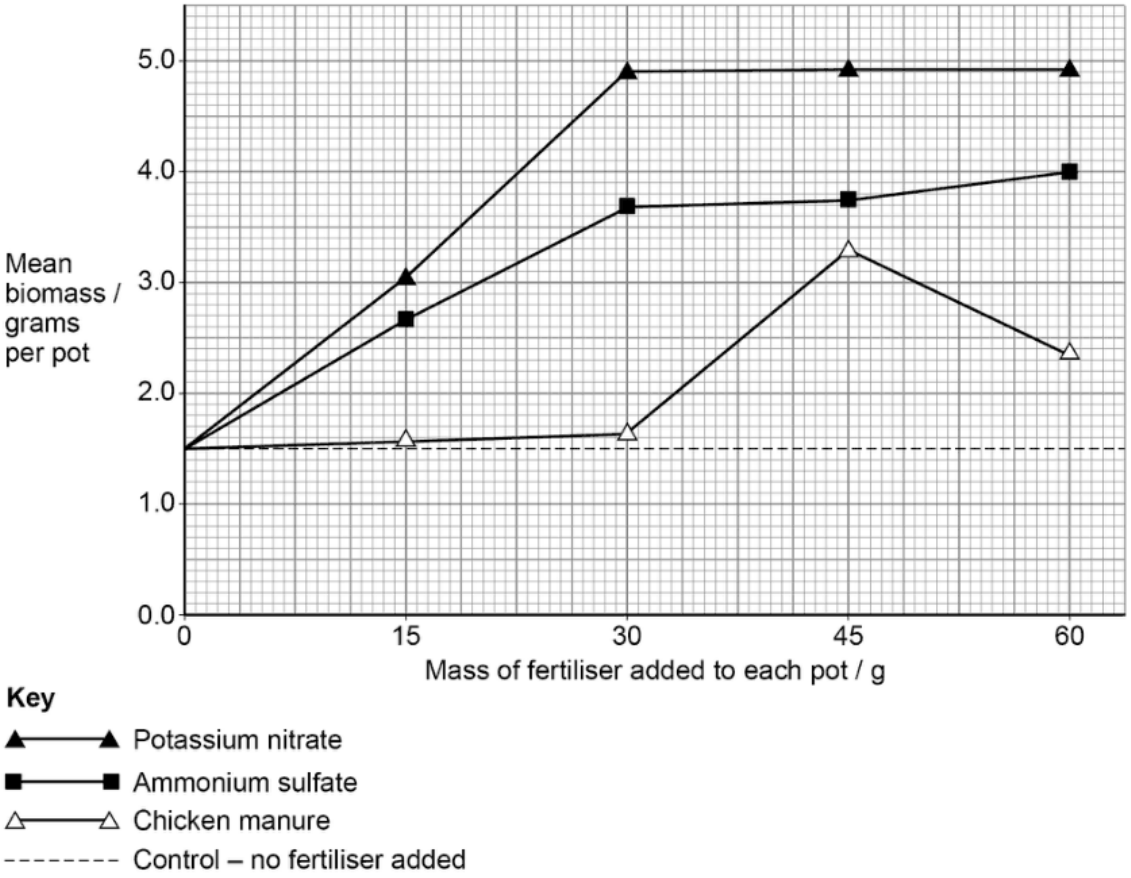
Question 16 · information from earlier in the question

0 7 A scientist investigated the effects of different fertilisers on the growth of spinach plants. The scientist:

- set up a large sample of identical pots of soil
- added different masses of different fertilisers to selected pots
- did not add fertiliser to the control pots
- planted the same number of young spinach plants in each pot
- after 20 days, determined the biomass of spinach plants in each pot.

The results the scientist obtained after 20 days are shown in **Figure 4**.

Figure 4



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Question 16 · A level Paper 2 · November 2020 · Q07.2 · 5 marks

0 7 . 2 Using all the information, evaluate the effect on plant growth of adding the different fertilisers to the soil.

[5 marks]

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Question 17 · information from earlier in the question

1 0 Read the following passage.

Lake Malawi in East Africa has more species of fish than any other lake in the world. Many of these species have evolved from a common ancestor. Lake Malawi is one of the largest lakes in the world and was formed several million years ago. Since then, the water level has fluctuated greatly. As a result, what is now a large lake was at one time many smaller, separate lakes.

The country of Malawi has a total area of 118 000 km^2. The actual land area is only 94 080 km^2, because approximately one-fifth of the country is Lake Malawi.

In December 1990, forests covered 41.4% of the actual land area of Malawi. In December 2016, forests covered 26.4% of the actual land area of Malawi.

Deforestation and farming along the shores of Lake Malawi have caused increased soil erosion and loss of nutrients into the lake. This has resulted in a decrease in some fish populations. The mark-release-recapture method can be used to estimate the size of a fish population. However, this method can produce unreliable results in very large lakes.

Use the information in the passage and your own knowledge to answer the following questions.

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Question 17 · A level Paper 2 · November 2021 · Q10.3 · 4 marks

1 0 . 3 Loss of nutrients **into** Lake Malawi has resulted in a decrease in some fish populations (lines 12–13).

Explain why.

[4 marks]

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Question 18 · A level Paper 3 · June 2019 · Q02.2 · 3 marks

0 2 . 2 One environmental issue arising from the use of fertilisers is eutrophication. Eutrophication can cause water to become cloudy.

You are given samples of water from three different rivers.

Describe how you would obtain a quantitative measurement of their cloudiness.

[3 marks]

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Mark schemes

Question 1 · A level Paper 3 · June 2019 · Q02.1 · 2 marks

02.1	1. (They use enzymes to) decompose proteins/DNA/RNA/urea; 2. Producing/releasing ammonia/ammonium compounds/ammonium ions;	2

1. Accept any named molecule containing nitrogen eg enzymes, NAD, ATP, amino acids

1. Accept digest/breakdown/hydrolyse for decompose

1. Ignore 'nitrogen -containing compounds' unqualified

2. Accept (they) perform ammonification

2. Accept named ammonium compound

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Question 2 · A level Paper 2 · June 2025 · Q10.2 · 2 marks

10.2	1. (High/optimum) temperature for enzymes /respiration/nitrification/ammonification; 2. Water/moisture for metabolic/enzyme reactions **OR** Water for hydrolysis; 3. (Optimum) pH for enzymes/respiration /nitrification/ammonification; 4. (High) oxygen (concentration) for respiration /nitrification /nitrifying bacteria/ saprobionts;	2 max (2 x AO2)	2. Reject 'water for photosynthesis' 4. Accept: saprophytes or saprotrophs for saprobionts

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10.3	1. Protein/amino acids/DNA into ammonium /ammonia; 2. (By) saprobionts; 3. Ammonium/ammonia into nitrite and (then) into nitrate; 4. (By) nitrifying bacteria/microorganisms;	4 (4 x AO1)

1. Accept any named nitrogen containing compound e.g. urea

2. Accept saprophytes or saprotrophs

1 and 3. Accept marks for conversion even if incorrect type of bacteria named as being involved

2 and 4. Reject marks for type of bacteria if linked to incorrect process e.g. nitrite converted to nitrate by saprobionts

2 and 4. Accept correctly named species

Ignore nitrogen fixation and denitrification and bacteria involved.

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Question 4 · A level Paper 3 · November 2021 · Q04.2 · 2 marks

04.2	1. Less nitrification **OR** Fewer/less active nitrifying bacteria; **OR** Nitrification/nitrifying bacteria require oxygen/aerobic conditions; 2. (Less) oxidation/conversion of ammonium (ions) to nitrite (ions) and to nitrate (ions); 3. More denitrification **OR** More/more active denitrifying bacteria **OR** Denitrification/denitrifying bacteria do not require oxygen **OR** Denitrification/denitrifying bacteria require anaerobic conditions; 4. (So more) nitrate (ions) reduced/converted to nitrogen (gas);

	2. Order must be nitrite then nitrate 2. Accept ammonia for ammonium ions 2. Accept correct chemical formulae for ions, eg there will be little oxidation/conversion

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Question 5 · A level Paper 2 · June 2019 · Q09.2 · 2 marks

09.2	1. Digestion/breakdown of proteins; 2. Provides amino acids **OR** (Sundew can) produce a **named** (organic) nitrogen-containing compound e.g. proteins, amino acids, DNA, ATP; 3. Digestion/breakdown of **named (**organic) phosphate-containing compound e.g. DNA, RNA; 4. Provides **named** (organic) phosphate-containing product e.g. nucleotides
	OR (Sundew can) produce a **named** phosphate-containing compound e.g. ATP, DNA;

2 max	**Mark in pairs** 1 and 2, or 3 and 4. Ignore carbohydrates, lipids or named carbohydrate/ lipid. 2. Ignore if nitrate or ammonium ions given as products. 4. Accept phosphate as a named product.

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06.3	1. pH 4.3 / B has fastest rate of breakdown (of ammonia); 2. A + B / mixture at pH 6.9 slowest / slower (than A or B); 3. Suggests (community / bacteria at) pH 4.3 / B doesn't work (well) at pH 6.9 / pH of mixture;	3	2. Not just ref. to A and then B on their own 3. Accept converse that only (community / bacteria at) pH 6.9 / A is working in the mixture

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Question 7 · A level Paper 2 · June 2022 · Q03.2 · 3 marks

03.2	(For) 1. Nitrogenase activity decreases with increase in ammonium chloride (concentration); 2. Nitrogenase activity zero with high (concentration of) ammonium chloride **OR** Ammonium chloride remains (in medium) when nitrogenase activity zero; (Against) 3. Only used one species; 4. (Inhibition/results) may be due to chloride (ions) **OR** (Investigation) uses ammonium chloride not ammonia;	3 max (3 x AO3)

1 and 2. Accept ammonia for ammonium chloride.

1. Accept negative correlation between nitrogenase activity and ammonium chloride (concentration).

2. Accept nitrogenase activity zero at 80/100/120/above 60 (µg cm^3 of ammonium chloride).

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Question 8 · A level Paper 2 · June 2023 · Q03.1 · 2 marks

03.1	Correct answer of 12 = **2 marks** **OR** Correct answer of 11.95 = **2 marks**;; Incorrect answer but shows 1195 (ignoring orders of magnitude) = **1 mark** **OR** Incorrect answer but shows 1.05 (Tg) or 13 (Tg) = **1 mark**;	2 (2 x AO2)

Accept any numerical representation of the correct answer for **two** marks. Do not allow 1.05 or 13 to the incorrect order of magnitude e.g. x 10^1.

Question 9 · A level Paper 2 · June 2017 · Q05.1 · 1 mark

05.1	Used to produce named phosphate compound in cells; e.g. ATP/ADP/phospholipids/DNA/ RNA/RuBP/TP /GP etc.	1

Question 10 · A level Paper 2 · June 2017 · Q05.2 · 1 mark

05.2	Example of a carbon-containing biological compound e.g. carbohydrate/ amino acid/vitamin;	1	Accept: sugars/organic (compounds). Ignore: products of photosynthesis. Ignore: starch.

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03.2	1. No significant difference (in production between untreated and treated) with **no** water shortage **OR** No significant difference (in production) between **R** and **S**; 2. Significantly greater/different (production in treated than untreated) with water shortage **OR** Significantly greater/different (production) in **Q** than **P**; 3. Significant decrease/difference (in production) of treated with water shortage **OR** Significant increase/difference (in production) of treated with **no** water shortage **OR** Significantly greater/different (production) in **S** than **Q**; 4. Overlap in SDs indicate no significant difference **OR** No overlap in SDs indicate a significant difference; 5. Only one (mycorrhizae) species studied; 6. Only shows (results for) tomato(es); 7. Large sample size increases validity/reliability; 8. (Investigation) done in sterile soil; 9. (Investigation) done in green/glasshouse **OR** Not done in field;	5 max (5 x AO3)

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03.3	1. Kill/remove/no (other) mycorrhizae/fungi; 2. Kill/remove/no nitrogen-fixing /nitrifying/denitrifying/saprobiotic bacteria; 3. Kill/remove/no pathogens; 4. Kill/remove/no pests; 5. Kill/remove/no competitors; 6. Kill/remove/no seeds/spores; 7. Is a (controlled) variable;	2 max (2 x AO2)	1 to 6. Accept in context of organisms being present if soil not sterilised. 2. Accept saprophytes and saprobionts. 3. Accept removes disease-causing bacteria/viruses /microorganisms. 3. Removes 'harmful bacteria' is not enough. 4. Accept named pests. 6. Accept weeds or (other) plants.

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03.1	Two suitable examples;; Examples 1. amino acid/protein/ polypeptide/peptide; 2. nucleic acid/nucleotide/base; 3. DNA; 4. RNA; 5. ATP/ADP; 6. NAD/NADP (reduced or not); 7. Cyclic AMP/cAMP; 8. Chlorophyll;	2 max

List rule applies

Reject for either point nitrates/nitrites/ammonia/ammonium/urea

4. Accept pre-mRNA/mRNA/rRNA/tRNA

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Question 14 · A level Paper 3 · June 2017 · Q03.2 · 2 marks

03.2	Correct answer in the range 90 to 133.2 scores 2 marks;; 1 mark for answers where yield calculated correctly for 1970 **OR** 2005; (1970 in range) 170.8 to 176.4 **OR** (2005 in range) 266.4 to 304.0;	2	Accept positive or negative values

Question 15 · A level Paper 3 · June 2017 · Q03.3 · 2 marks

03.3	1. Using more but getting less response over time; 2. The graph shows correlation but doesn't prove changes in yield due to fertiliser/but there could be other factors; 3. Becomes less cost effective with time;	2 max

Idea of over time is important

1. accept fertiliser becomes less effective over time

1. Accept use of figures from graph

1. Accept the idea of less grain/crop over time

2.Ignore whether correlation is positive or negative

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Question 16 · A level Paper 2 · November 2020 · Q07.2 · 5 marks

07.2	1. Potassium nitrate most effective **and** chicken manure least effective; 2. All fertilisers more effective than control; 3. No increase (in growth) with potassium nitrate above 30g; 4. Ammonium sulfate (shows) small/gradual increase after 30g; 5. Chicken manure effectiveness decreases after 45g **OR** Chicken manure effectiveness decreases at 60g; 6 Fertiliser/s provide nitrogen source for protein; 7. No statistical test (to determine if differences are significant); 8. Only shows (results for) spinach;	5 max

1. Accept greatest/highest growth/mass for most effective, and lowest growth/mass for least effective.

7. Accept 'no SDs' (to determine if differences are significant).

7. Accept no (named) stats test, no error bars and no confidence limits.

8. Accept only shows 'one species' or one type of plant.

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Question 17 · A level Paper 2 · November 2021 · Q10.3 · 4 marks

10.3	1. (Growth/increase of) algae/surface plants/algal bloom blocks light; 2. Reduced/no photosynthesis so (submerged) plants die; 3. Saprobiotic (microorganisms) aerobically respire **OR** Saprobiotic (microorganisms) use oxygen in respiration; 4. Less oxygen for fish to respire;	4	3. Accept: Saprobiont/saprophyte/ saprotroph 3. Neutral: decomposer

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02.2	Accept **any** valid method, for example 1. Use of colorimeter; 2. Measure the absorbance/transmission (of light); 3. Example of how method can be standardised eg same volume of water, zeroing colorimeter, same wavelength of light, shaking the sample;

3	Principle is 1. Named apparatus 2. What is measured 3. Standardisation of method 1. Reject calorimeter 2. Reject if samples are filtered unless filtering to remove debris 2. Accept descriptions 3. Ignore references to calibration curves

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