Helicate

HELICATE · A-LEVEL BIOLOGY · TOPIC BANK

3.5.4 Nutrient cycles

Topic question bank

Version 2 · 15 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
7	59	No time limit	/ 59

Contents

Subtopic	Questions	Marks
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The phosphorus cycle and mycorrhizae Specification 3.5.4	04–05	18
Fertilisers, leaching and eutrophication Specification 3.5.4	06–07	19
Total		**59**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

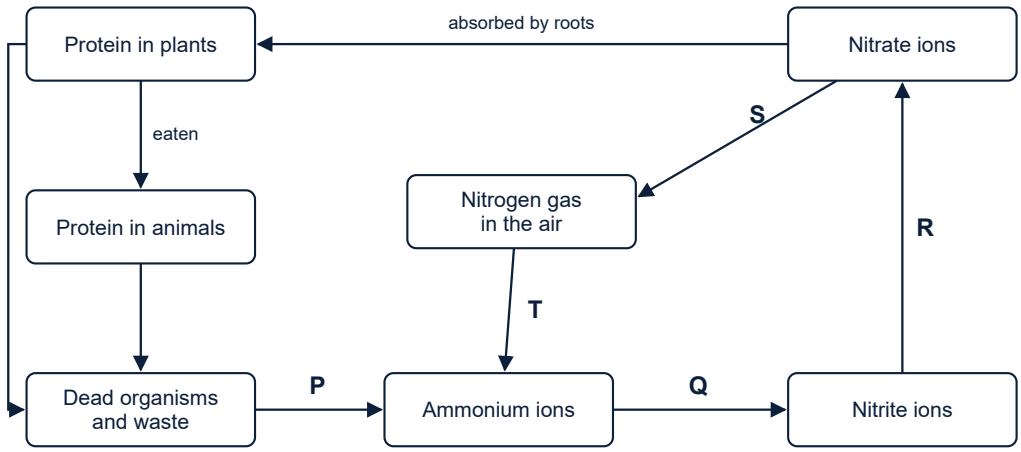
Original questions by Helicate for AQA A-level Biology (7402), specification section 3.5.4. Not affiliated with or endorsed by AQA.

Do not write outside the box

Microorganisms and the nitrogen cycle 3.5.4

Figure 1 shows part of the nitrogen cycle. The letters **P** to **T** show processes carried out by microorganisms.

Figure 1



0 1 . 1 Which statement describes the processes shown by arrows **Q** and **R**?
Tick (✓) one box.

[1 mark]

- Ammonium ions are reduced to nitrite ions and then to nitrate ions by nitrifying bacteria. ☐
- Ammonium ions are oxidised to nitrite ions and then to nitrate ions by nitrifying bacteria. ☐
- Ammonium ions are oxidised to nitrite ions and then to nitrate ions by nitrogen-fixing bacteria. ☐
- Ammonium ions are oxidised to nitrite ions and then to nitrate ions by saprobionts. ☐

0 1 . 2 Name the processes shown by arrows **P** and **S**.

[2 marks]

P .....

S .....

Question 1 continues on the next page

Do not write outside the box

0 1 . 3 Leaves that fall from the plants contain protein.
Describe how saprobionts obtain nutrients from the dead leaves, and how this produces ammonium ions.

[3 marks]

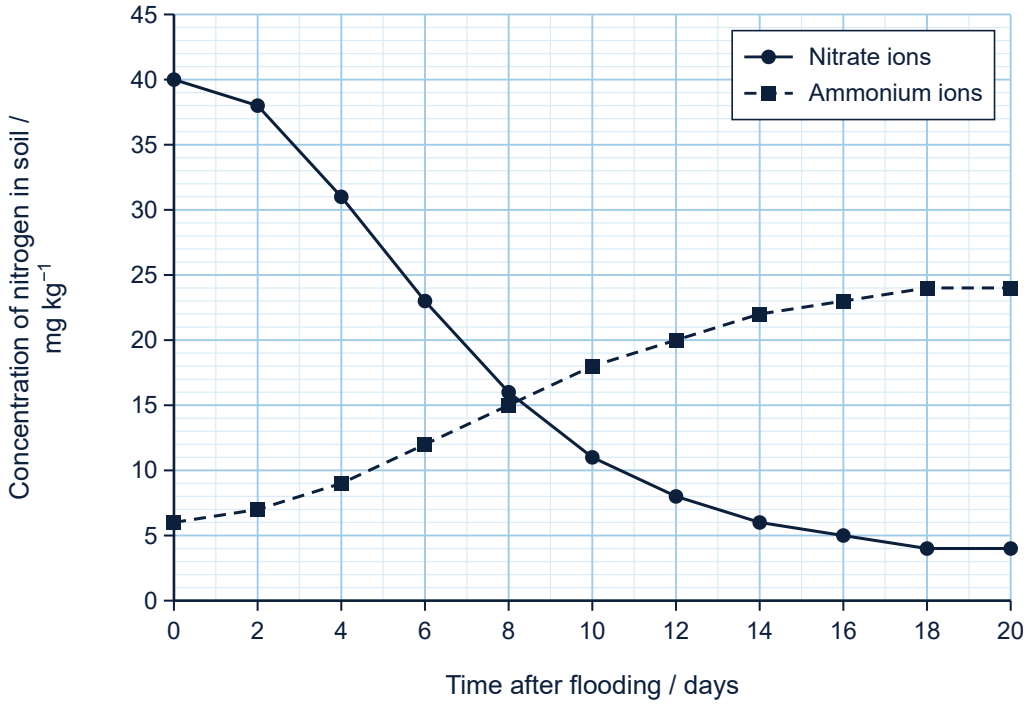
6

Turn over for the next question

Do not write outside the box

After very heavy rain, a field of grass was flooded and the soil became waterlogged. Scientists measured the concentrations of nitrate ions and ammonium ions in the soil for 20 days after the field flooded. Both concentrations are given as the mass of nitrogen in the ions per kg of soil. Figure 2 shows their results.

Figure 2



0 2 . 1 Calculate the percentage decrease in the concentration of nitrate ions in the soil in the first 10 days after the field flooded.

[2 marks]

Answer ..... **%**

Question 2 continues on the next page

Do not write outside the box

0 2 . 2 A student suggested that, after the flooding, the nitrate ions in the soil were being changed into ammonium ions.
Use Figure 2 to explain why this cannot account for all of the fall in nitrate. Use your knowledge of the nitrogen cycle to explain what happened to the rest of the nitrogen in the nitrate, and how ammonium ions were produced in the soil.

[4 marks]

0 2 . 3 After the field had drained, the farmer ploughed the soil. Ploughing turns the soil over and lets air into it.
Suggest how ploughing would increase the concentration of nitrate ions in the soil.

[2 marks]

8

Turn over for the next question

Do not write outside the box

Clover is a plant that forms root nodules containing nitrogen-fixing bacteria.

Scientists grew clover plants in pots of sterilised sand. They watered every pot with a solution containing all the mineral ions the plants need, except nitrate and ammonium ions. They gave the pots four treatments, with 8 plants in each treatment:

- some pots had nitrogen-fixing bacteria added to the sand
- some pots had nitrate added to the solution.

After 8 weeks, the scientists measured the dry mass of each plant. Table 1 shows their results.

Table 1

Treatment	Nitrogen-fixing bacteria added	Nitrate added to solution	Mean dry mass of plant ± standard deviation / g
A	No	No	0.42 ± 0.08
B	Yes	No	1.86 ± 0.21
C	No	Yes	2.04 ± 0.25
D	Yes	Yes	2.10 ± 0.27

0 3 . 1 Explain how the nitrogen-fixing bacteria increased the growth of the clover plants in treatment **B**.

[2 marks]

Question 3 continues on the next page

Do not write outside the box

0 3 . 2 How many times greater was the mean dry mass of plants in treatment **B** than in treatment **A**?

[1 mark]

Answer .....

0 3 . 3 A student concluded that, for clover, adding nitrogen-fixing bacteria is as effective as adding nitrate.
Evaluate this conclusion.

[3 marks]

0 3 . 4 The mean dry mass of plants in treatment **D** was similar to that of plants in treatment **C**.
Suggest **two** reasons why adding nitrogen-fixing bacteria as well as nitrate did not increase growth further.

[2 marks]

1 .....

2 .....

8

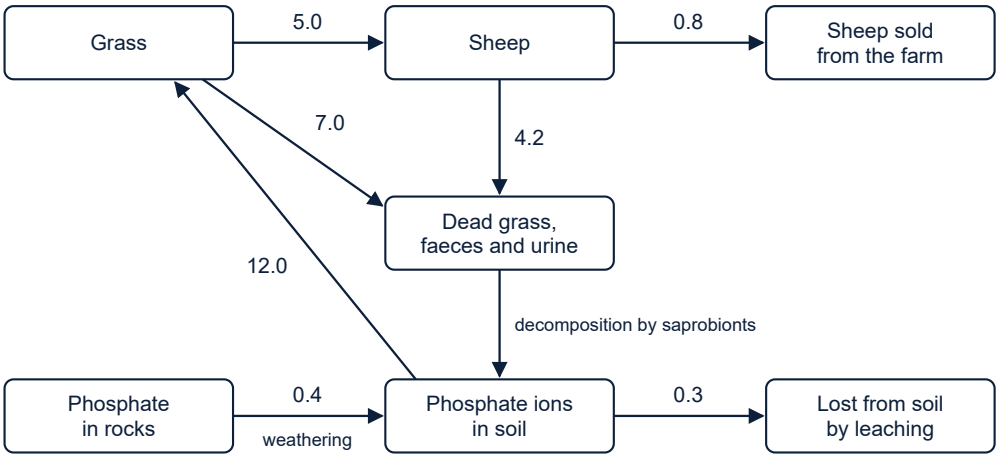
Turn over for the next question

Do not write outside the box

The phosphorus cycle and mycorrhizae 3.5.4

Figure 3 shows the movement of phosphorus in a field of grass grazed by sheep. The values are in kg of phosphorus per hectare per year.

Figure 3



The mass of phosphorus in the dead grass, faeces and urine does not change from year to year.

0 4 . 1 Calculate the percentage of the phosphorus absorbed by the grass that is returned to the soil by saprobionts.

[2 marks]

.....

.....

.....

.....

Answer ..... **%**

Question 4 continues on the next page

Do not write outside the box

0 4 . 2 The mass of phosphate in the soil of this field falls each year.
Use Figure 3 to explain why.

[2 marks]

0 4 . 3 The field has an area of 25 hectares.
Calculate the mass of phosphorus the farmer should add to the field in fertiliser each year to keep the mass of phosphorus in the soil constant.

[2 marks]

Answer _____ **kg**

0 4 . 4 If the soil is short of phosphate, the grass grows more slowly.
Give **two** molecules containing phosphorus that the grass needs to make.

[2 marks]

1

2

8

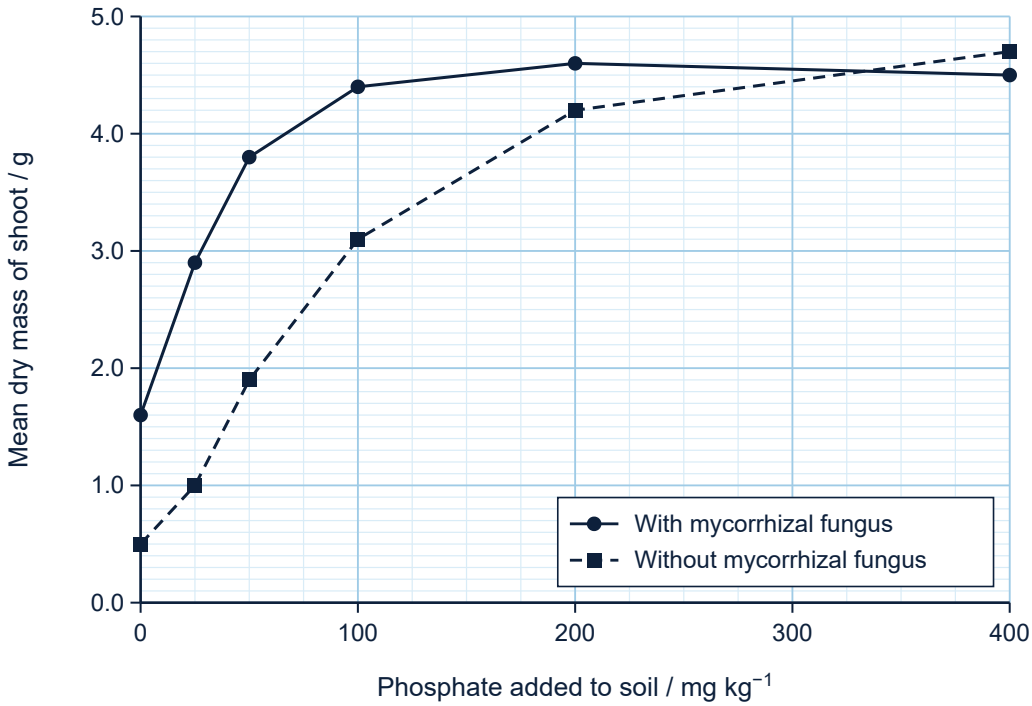
Turn over for the next question

Do not write outside the box

Scientists grew leek seedlings in pots of sterilised soil that contained very little phosphate. They added spores of a mycorrhizal fungus to half the pots. They added different masses of phosphate fertiliser to the soil in the pots. After 10 weeks, they measured the dry mass of the shoot of each plant.

Figure 4 shows their results. Each point is the mean for 12 plants.

Figure 4



0 5 . 1 Explain how the mycorrhizal fungus increased the growth of leeks when no phosphate was added.

[2 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 2 When no phosphate was added, how many times greater was the mean dry mass of shoots with the mycorrhizal fungus than without it?

[1 mark]

Answer .....

0 5 . 3 A company sells spores of this mycorrhizal fungus to farmers. It claims that adding the spores to fields allows farmers to use less phosphate fertiliser without reducing the growth of their crops.
Use Figure 4 and the information given to evaluate this claim.

[5 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 4 At 400 mg kg^{-1} of phosphate, the mean dry mass of shoots with the mycorrhizal fungus was lower than without it.
Suggest **two** explanations for this.

[2 marks]

1 .....

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2 .....

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10

Turn over for the next question

Do not write outside the box

Fertilisers, leaching and eutrophication 3.5.4

0 6 . 1 In natural ecosystems, nitrates and phosphates are recycled without fertilisers being added.
Explain why farmers need to add fertilisers to fields where wheat is grown and harvested every year.

[2 marks]

0 6 . 2 Which statement about natural and artificial fertilisers is correct?
Tick (✓) one box.

[1 mark]

- Much of the nitrogen in natural fertilisers is in organic compounds that saprobionts must break down before plants can absorb it. ☐
- Artificial fertilisers contain organic compounds that release nitrate ions slowly as they decompose. ☐
- Natural fertilisers contain only inorganic ions, such as nitrate ions and phosphate ions. ☐
- The nitrate in artificial fertilisers must be converted to ammonium ions by nitrogen-fixing bacteria before plants can use it. ☐

Question 6 continues on the next page

Do not write outside the box

Scientists compared two fertilisers on plots of wheat. Each fertiliser supplied 170 kg of nitrogen per hectare. Ammonium nitrate is an artificial fertiliser. Cattle manure is a natural fertiliser. The scientists measured the yield of grain and the mass of nitrogen lost as nitrate in the water draining out of the soil of each plot over one year. Table 2 shows their results.

Table 2

Treatment	Mean yield of grain / tonnes ha^{-1}	Nitrogen lost as nitrate in drainage water / kg ha^{-1} $year^{-1}$
No fertiliser	3.1	12
Cattle manure	6.4	21
Ammonium nitrate	8.2	46

0 6 . 3 Some nitrate is lost from soil even when no fertiliser is added.
Use Table 2 to calculate the percentage of the nitrogen added in ammonium nitrate that was lost as nitrate in the drainage water.

[2 marks]

Answer ..... **%**

Question 6 continues on the next page

Do not write outside the box

0 6 . 4 Use Table 2 and your knowledge of leaching to explain why more nitrate was lost from plots given ammonium nitrate than from plots given cattle manure.

[3 marks]

0 6 . 5 A farmer read these results and decided to use cattle manure instead of ammonium nitrate on all her wheat fields.
Evaluate her decision.

[3 marks]

11

Turn over for the next question

Do not write outside the box

A stream flows from farmland into a lake. Farmers spread nitrate fertiliser on the fields in March and April. Scientists took measurements each month from March to August. The concentration of chlorophyll in the surface water is a measure of the number of algae. Table 3 shows their results.

Table 3

Month	Nitrate in stream / mg dm^{-3}	Chlorophyll in surface water / µg dm^{-3}	Dissolved oxygen near the lake bed / mg dm^{-3}
March	2.1	4	10.8
April	6.8	6	10.5
May	9.4	31	9.7
June	7.2	78	7.1
July	4.5	96	3.2
August	3.0	64	1.1

0 7 . 1 Many dead fish were found in the lake in August.
Use Table 3 to explain how the use of nitrate fertiliser on the farmland could have caused the deaths of fish in the lake.

[6 marks]

Question 7 continues on the next page

Do not write outside the box

0 7 . 2 The farmers were advised to leave a strip of unfertilised grass, 10 m wide, between their fields and the stream.
Suggest how this would reduce eutrophication of the lake.

[2 marks]

8

END OF QUESTIONS

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