5.1 Energy transfers in and between organisms (A-Level Only) – Nutrient Cycles – Questions

Q1.

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

(a) 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.

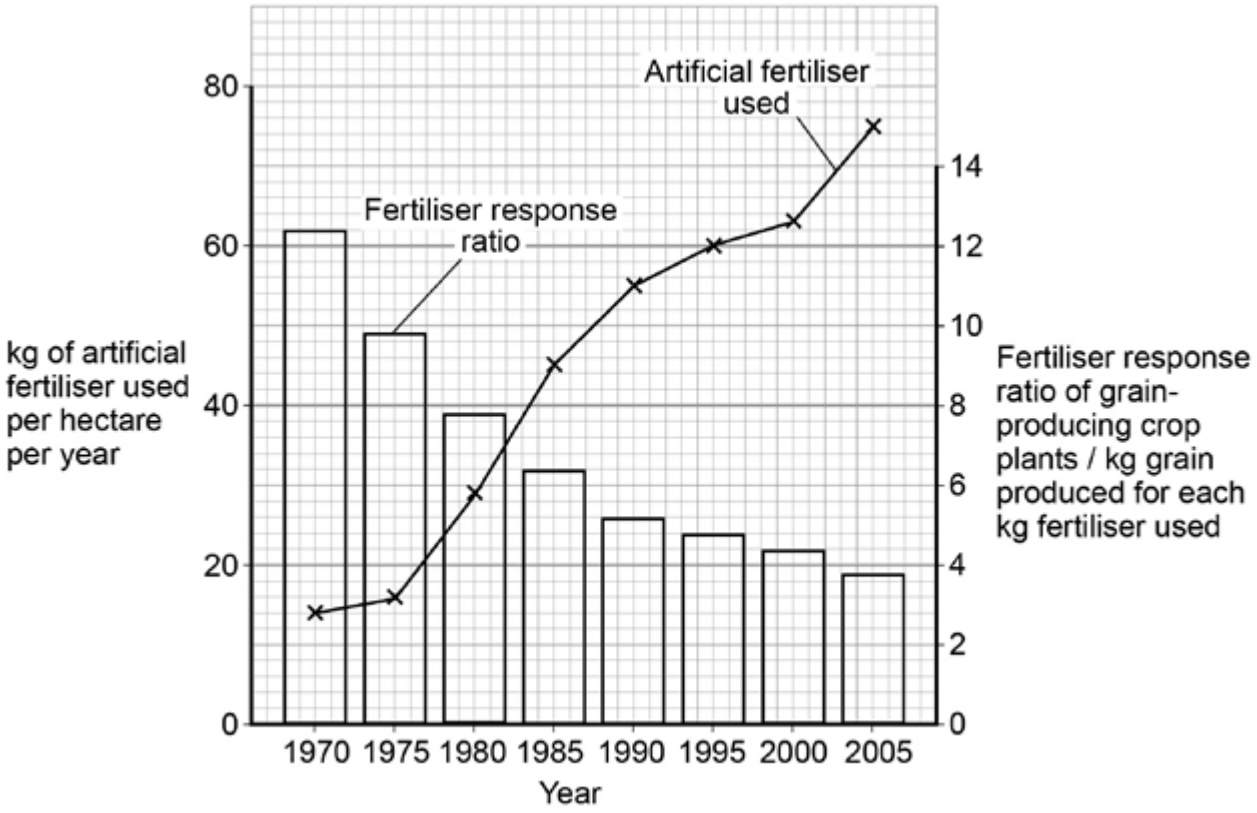
1. _____

2. _____

(2)

(b) 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.

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



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

Show your working.

Difference _____ kg hectare^{-1}

(2)

(c) Use the data in the graph above to evaluate the use of artificial fertilisers on grain-producing crops in India.

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(2)

(Total 6 marks)

Q2.

Read the following passage.

Plants require phosphate ions that they get from soil. These ions are often in poor supply and this results in poor growth of the plants. Most plants have mycorrhizae that help the plants to obtain nitrates. Mycorrhizal networks can connect the roots of plants growing next to each other. The use of fertilisers containing phosphate and nitrates in farming inhibits the growth of mycorrhizae. As a result, intensively farmed crop plants do not have mycorrhizae.

Plants can defend themselves by producing defensive enzymes that destroy pathogens such as bacteria. Some plants express the genes for defensive enzymes in response to signal proteins secreted by other plants that are being attacked by a pathogen. These signal proteins can be released into the air.

Scientists have discovered that tomato plants increase production of defensive enzymes if plants next to them become infected with a pathogen. These tomato plants were connected by a mycorrhizal network that can carry signal proteins between them. The largest increase in defensive enzyme secretion that the scientists found in a tomato plant in response to the signal protein was by 122.6 per cent.

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

(a) Suggest and explain **two** reasons why a poor supply of phosphate ions results in poor growth of plants (lines 1–2).

1. _____

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2. _____

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(2)

(b) Suggest how defensive enzymes produced by plants destroy bacteria (lines 8–9).

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(2)

(c) The signal proteins secreted into the air by a plant being attacked by a pathogen act as stimuli leading to the expression of genes for defensive enzymes in other plants (lines 9–12).

Suggest how they lead to the expression of these genes.

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(3)

(d) Suggest and explain **the** advantage to tomato plants of transmitting signal proteins through mycorrhizal networks, rather than releasing them into the air (line 11–12 and lines 14–16).

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(2)

(e) The largest increase in defensive enzyme secretion that the scientists found in a tomato plant in response to the signal protein was by 122.6 percent (lines 16–18).

The rate of secretion of the defensive enzymes before the signal protein was produced was 450 μmol dm^{-3} g^{-1} $hour^{-1}$.

Calculate the rate of secretion **per second** after the response to the signal protein.

Answer = _____ μmol dm^{-3} g^{-1} $second^{-1}$

(2)

(f) A student who read this passage concluded that farmers should **not** use fertilisers to increase yields when growing tomato plants.

Evaluate his conclusion.

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(4)

(Total 15 marks)

Q3.

Scientists investigated the effect of a mycorrhizal fungus on the growth of pea plants with a nitrate fertiliser or an ammonium fertiliser. The fertilisers were identical, except for nitrate or ammonium.

The scientists took pea seeds and sterilised their surfaces. They planted the seeds in soil that had been heated to 85 °C for 2 days before use. The soil was sand that contained no mineral ions useful to the plants.

(a) Explain why the scientists sterilised the surfaces of the seeds and grew them in soil that had been heated to 85 °C for 2 days.

(2)

(b) Explain why it was important that the soil contained no mineral ions useful to the plants.

(1)

The pea plants were divided into four groups, **A**, **B**, **C** and **D**.

- **Group A** – heat-treated mycorrhizal fungus added, nitrate fertiliser
- **Group B** – mycorrhizal fungus added, nitrate fertiliser
- **Group C** – heat-treated mycorrhizal fungus added, ammonium fertiliser
- **Group D** – mycorrhizal fungus added, ammonium fertiliser

The heat-treated fungus had been heated to 120 °C for 1 hour.

(c) Explain how groups **A** and **C** act as controls.

(2)

After 6 weeks, the scientists removed the plants from the soil and cut the roots from the shoots. They dried the plant material in an oven at 90 °C for 3 days. They then determined the mean dry masses of the roots and shoots of each group of pea plants.

(d) Suggest what the scientists should have done during the drying process to be sure that all of the water had been removed from the plant samples.

(2)

The scientists' results are shown in the table below.

Treatment	Mean dry mass / g per plant (standard deviation)	
	Root	**Shoot**
A – heat-treated fungus and nitrate fertiliser	0.40 (±0.05)	1.01 (±0.12)
B – fungus and nitrate fertiliser	1.61 (±0.28)	9.81 (±0.33)
C – heat-treated fungus and ammonium fertiliser	0.34 (±0.03)	0.96 (±0.26)
D – fungus and ammonium fertiliser	0.96 (±0.18)	4.01 (±0.47)

(e) What conclusions can be drawn from the data in the table about the following?

The effects of the fungus on growth of the pea plants.

The effects of nitrate fertiliser and ammonium fertiliser on growth of the pea plants.

(4)

The scientists determined the dry mass of the roots and shoots separately. The reason for this was they were interested in the ratio of shoot to root growth of pea plants. It is the shoot of the pea plant that is harvested for commercial purposes.

(f) Explain why determination of dry mass was an appropriate method to use in this investigation.

(2)

(g) Which treatment gave the best result in commercial terms? Justify your answer.

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(2)

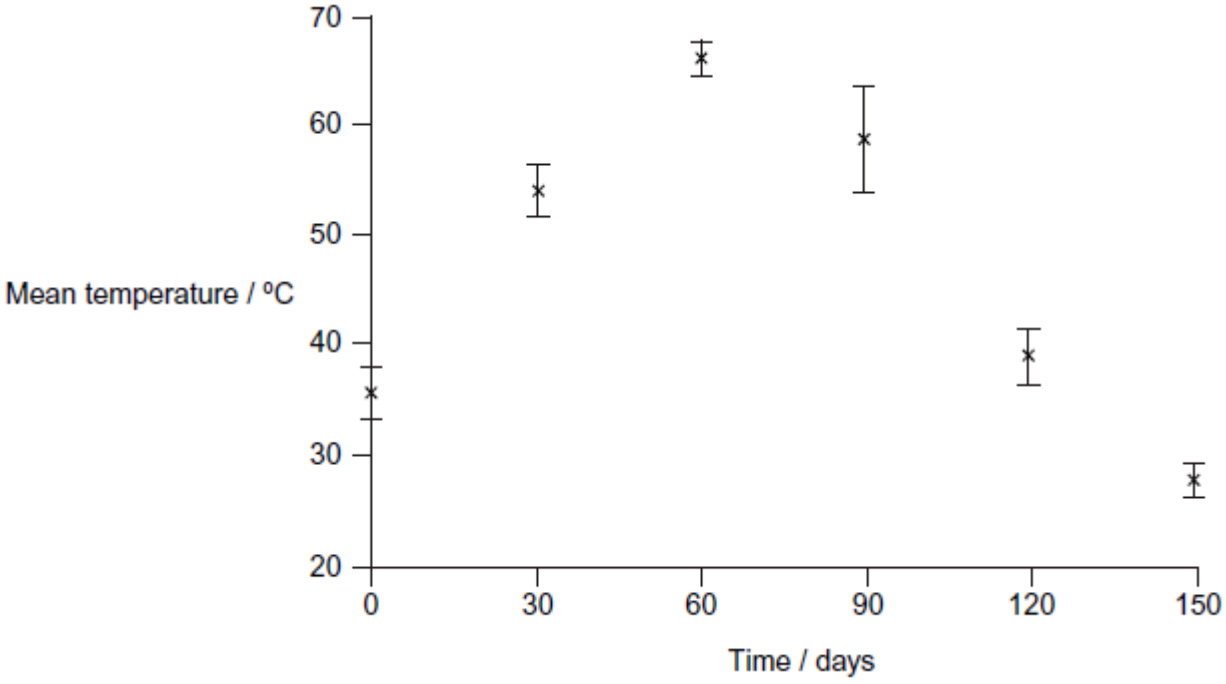
(Total 15 marks)

Q4.

The organic material in household waste can be used to make compost for use as a fertiliser. Scientists investigated changes during one process used to make this compost. The method involved placing the waste in large containers for 150 days. At regular intervals the containers were rotated. The scientists measured the temperature of samples of waste during the investigation.

Figure 1 shows the results they obtained. The vertical bars show standard deviations.

Figure 1



(a) Explain how microorganisms contributed to the increase in temperature during processing of organic waste.

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(2)

(b) Explain the advantage of showing the data using standard deviations rather than ranges.

_____

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_____

(2)

(c) Suggest **two** advantages of rotating the containers during the process.

1. _____

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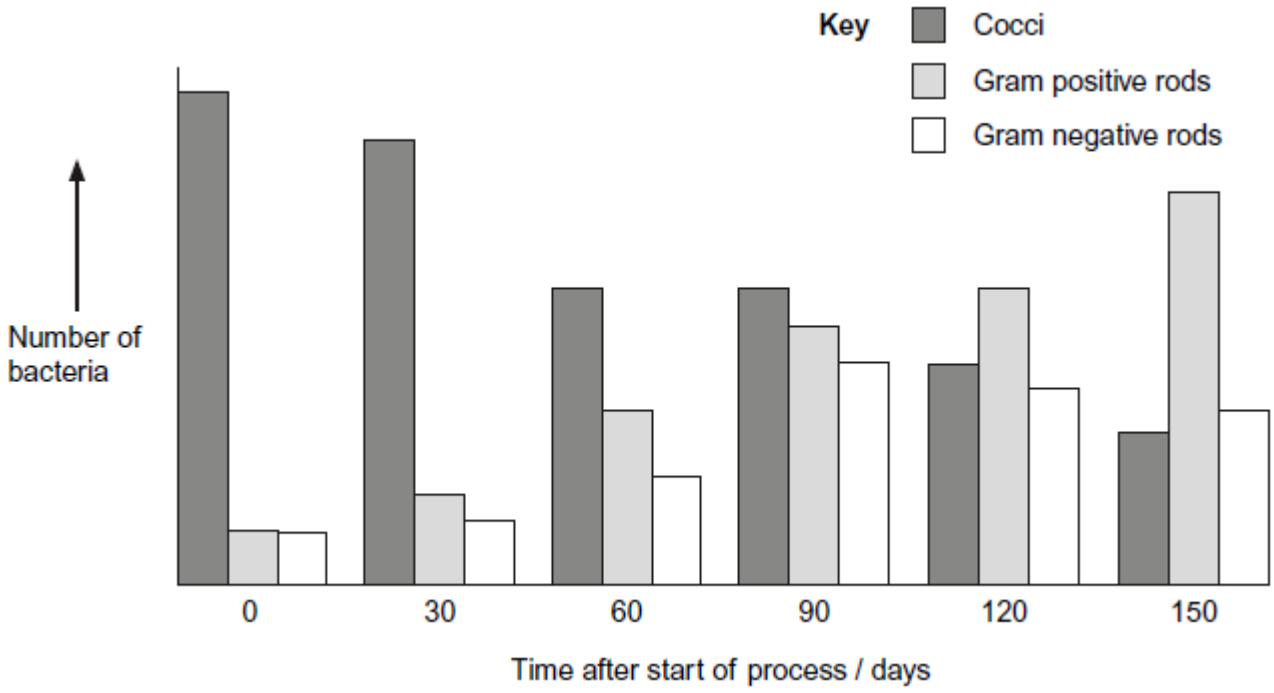
2. _____

_____

(2)

(d) The scientists took a sample of the waste at the start of the process. They then took samples every 30 days. In each sample, they determined the numbers of particular types of bacteria.
Figure 2 shows the changes in the number of three types of bacteria during the process.

Figure 2



The scientists concluded that the results in **Figure 1** and **Figure 2** are evidence for a form of succession during the process.

Use the information to suggest how they reached this conclusion.

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(3)

(Total 9 marks)

Q5.

(a) Crops use light energy to produce photosynthetic products.
Describe how crop plants use light energy during the light-dependent reaction.

(5)

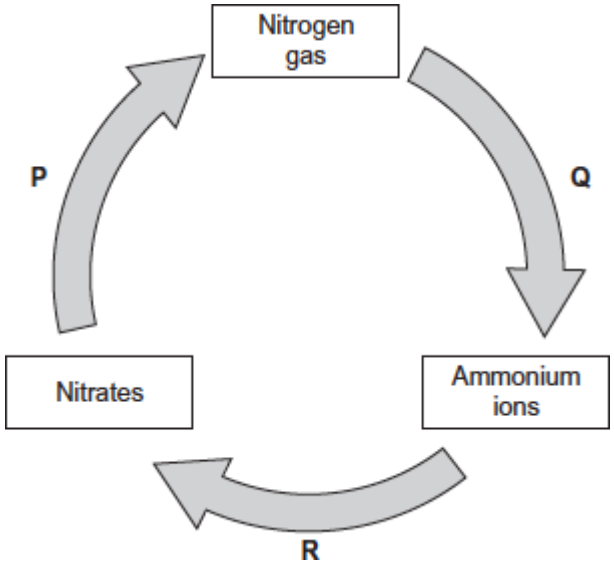
(b) After harvesting, the remains of crop plants are often ploughed into the soil.
Explain how microorganisms in the soil produce a source of nitrates from these remains.

(5)

(Total 10 marks)

Q6.

The diagram shows part of the nitrogen cycle.



(a) Which **one** of the processes **P**, **Q** or **R** involves nitrification?

(1)

(b) The diagram above includes one process in which microorganisms add ammonium ions to soil.

Describe another process carried out by microorganisms which adds ammonium ions to soil.

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(2)

(c) Denitrification requires anaerobic conditions. Ploughing aerates the soil.
Explain how ploughing would affect the fertility of the soil.

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(2)

(d) One farming practice used to maintain high crop yields is crop rotation. This involves growing a different crop each year in the same field.

Suggest **two** ways in which crop rotation may lead to high crop yields.

1. _____

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2. _____

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(2)

(Total 7 marks)

Q7.

Upwelling is a process where water moves from deeper parts of the sea to the surface. This water contains a lot of nutrients from the remains of dead organisms.

(a) (i) Nitrates and phosphates are two of these nutrients. They provide a source of nitrogen and phosphorus for cells.

Give a biological molecule that contains:

1. nitrogen_____

2. phosphorus_____

(2)

(ii) Describe the role of microorganisms in producing nitrates from the remains of dead organisms.

_____

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(Extra space) _____

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(3)

(b) Upwelling often results in high primary productivity in coastal waters.
Explain why some of the most productive fishing areas are found in coastal waters.

_____

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(2)

(Total 7 marks)

Q8.

During the light-independent reaction of photosynthesis, carbon dioxide is converted into organic substances. Describe how.

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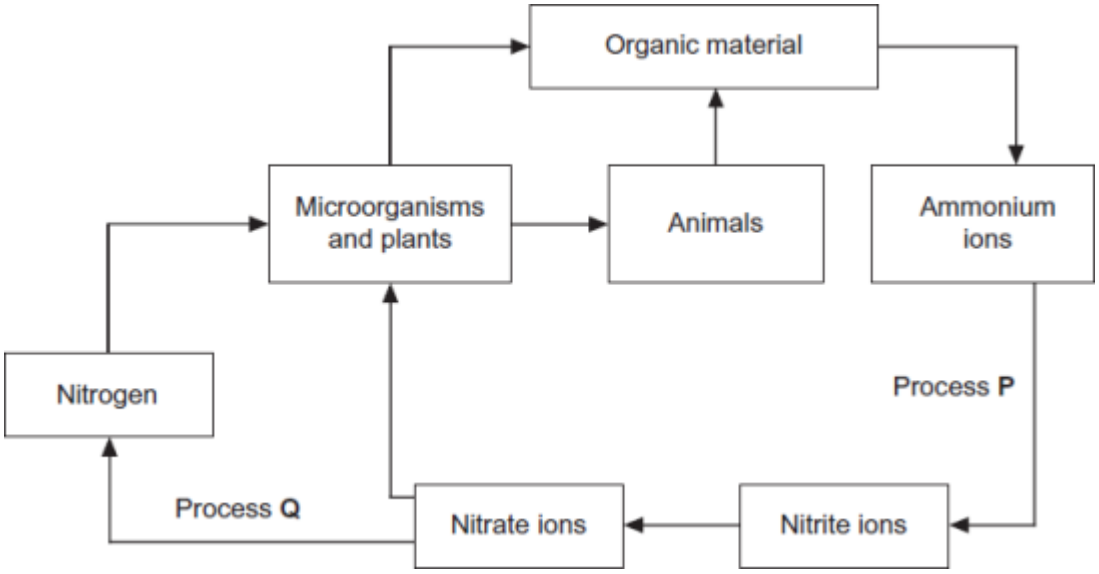
(Extra space) _____

(Total 6 marks)

Q9.

The diagram shows the nitrogen cycle.



(a) (i) Name process **P**.

_____

(1)

(ii) Name process **Q**.

_____

(1)

(b) Leguminous crop plants have nitrogen-fixing bacteria in nodules on their roots. On soils with a low concentration of nitrate ions, leguminous crops often grow better than other types of crop. Explain why.

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(2)

(c) Applying very high concentrations of fertiliser to the soil can reduce plant growth. Use your knowledge of water potential to explain why.

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(2)

(Total 6 marks)

Q10.

(a) Explain how farming practices increase the productivity of agricultural crops.

(Extra space)

(5)

(b) Describe how the action of microorganisms in the soil produces a source of nitrates for crop plants.

(Extra space)

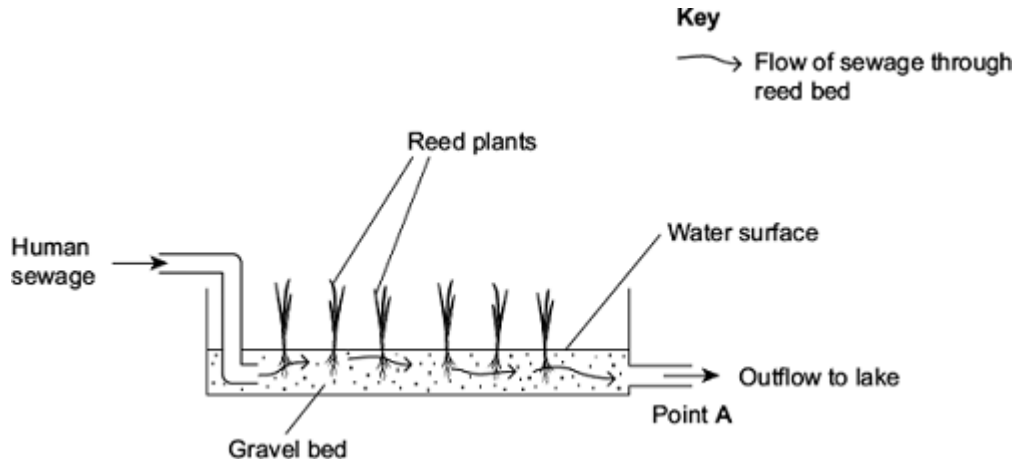
(5)
(Total 10 marks)

Q11.

(a) Name the process by which some bacteria oxidise ammonia to nitrate.

(1)

Reeds are plants that grow with their roots under water. A reed bed contains a large number of growing reeds. Reed beds may be used to absorb nitrates produced when bacteria break down human sewage. The diagram shows a reed bed.



(b) Reeds have hollow, air-filled tissue in their stems which supplies oxygen to their roots.
Explain how this enables the roots to take up nitrogen-containing substances.

(2)

(c) (i) There is an optimum rate at which human sewage should flow through the reed bed. If the flow of human sewage is too fast, the nitrate concentration at point **A** falls.
Explain why.

(2)

(ii) An increase in nitrate concentration in the water entering the lake could affect algae and fish in the lake. Explain how.

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*(Extra space)*_____

_____

_____

(3)

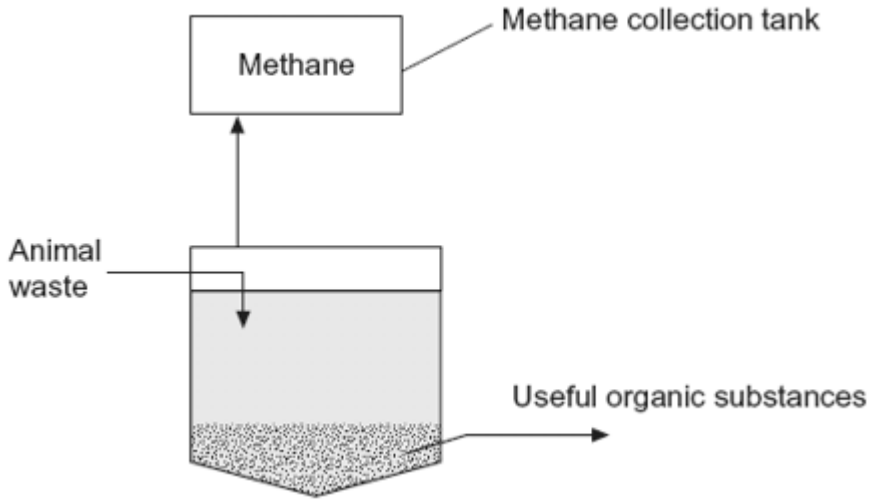
(Total 8 marks)

Q12.

Intensive rearing of livestock produces large quantities of waste. Some farmers use an anaerobic digester to get rid of the waste.

In an anaerobic digester, microorganisms break down the large, organic molecules in the waste. This produces methane, which is a useful fuel. It also produces organic substances that can be used as a natural fertiliser.

The diagram shows an anaerobic digester.



(a) (i) Suggest **two** advantages of processing waste in anaerobic digesters rather than in open ponds.

1. _____

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2. _____

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(2)

(ii) The anaerobic digester has a cooling system, which is not shown in the diagram.

Without this cooling system the digester would soon stop working. Explain why.

_____

(2)

(b) (i) The over-application of fertiliser increases the rate of leaching. Explain the consequences of leaching of fertiliser into ponds and lakes.

(*Extra Space)*

(3)

(ii) Give **one** advantage of using natural fertiliser produced in the digester rather than an artificial fertiliser.

(1)

(Total 8 marks)

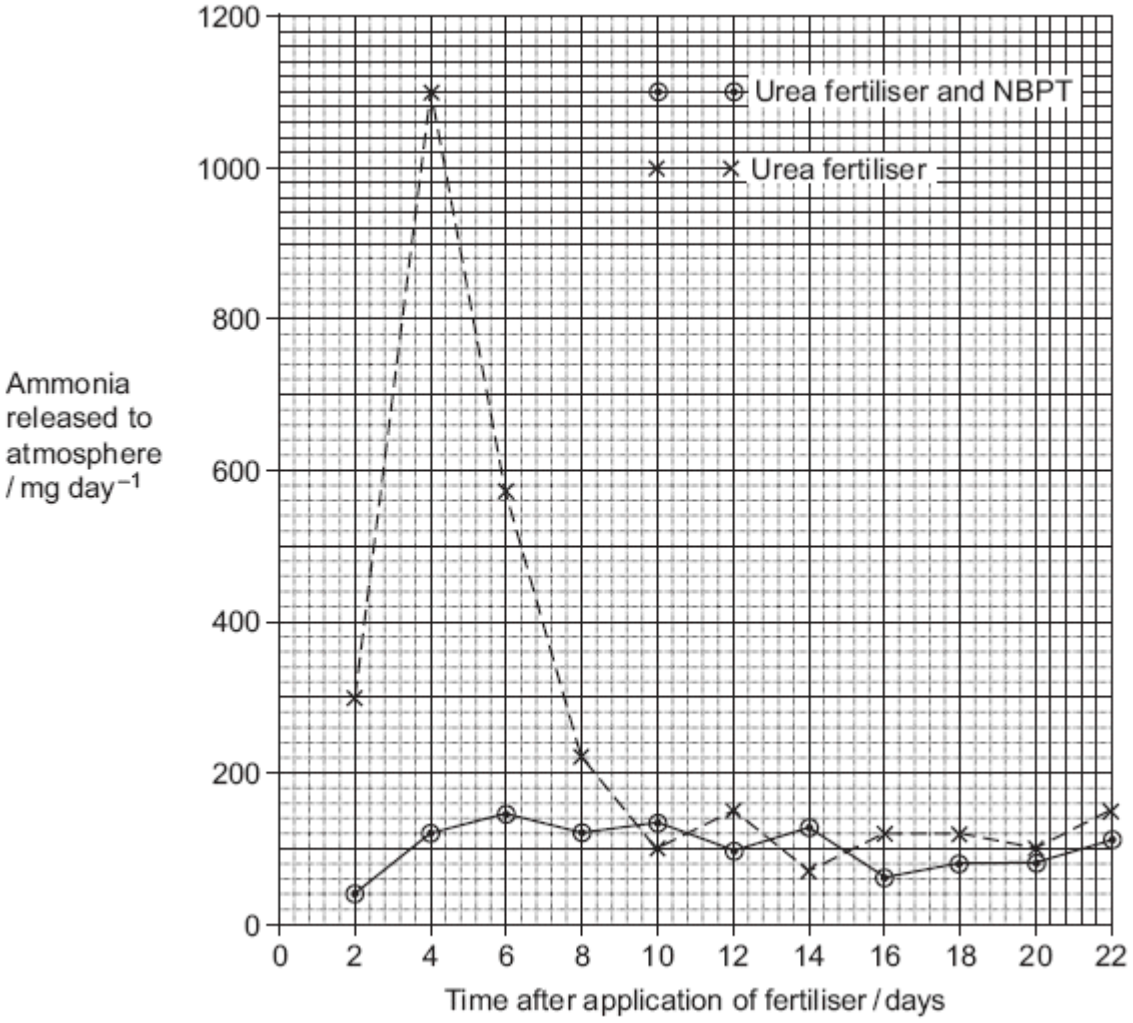
Q13.

Urea from animal waste can be used as a fertiliser. Some bacteria in the soil secrete the enzyme urease which hydrolyses urea into ammonia. Some of this ammonia is released into the atmosphere. NBPT is an inhibitor of urease and can be added to urea fertiliser to reduce the loss of ammonia to the atmosphere.

(a) A molecule of NBPT has a similar structure to a molecule of urea. Use this information to suggest how NBPT inhibits the enzyme urease.

(2)

Scientists investigated the effect of NBPT on the release of ammonia from urea fertiliser added to the soil. A control experiment was carried out. This involved adding urea fertiliser only. The graph shows their results.



(b) (i) Describe how NBPT affected the loss of ammonia from urea fertiliser.

(1)

(ii) Suggest an explanation for the increase in mass of ammonia released over the first four days in the control experiment.

_____

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(2)

(c) Suggest how the addition of NBPT to urea fertiliser could result in increased growth of crop plants.

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(3)

(Total 8 marks)

Q14.

Nitrogenase catalyses the reduction of nitrogen during nitrogen fixation. The reaction requires 16 molecules of ATP for each molecule of nitrogen that is reduced.

(a) Nitrogen gas is the usual substrate for this enzyme. Name the product.

_____

(1)

(b) Nitrogenase also catalyses reactions involving other substances. Explain what this suggests about the shapes of the molecules of these other substances.

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(2)

(c) (i) *Azotobacter* is a nitrogen-fixing bacterium. It produces the enzyme nitrogenase. The enzyme only works in the absence of oxygen.

Azotobacter has a very high rate of aerobic respiration compared with bacteria that do not fix nitrogen. Suggest **two** advantages of the very high rate of aerobic respiration.

(2)

(ii) If scientists could transfer the gene that codes for nitrogenase to cereal plants, these cereal plants would be able to fix nitrogen. However, the scientists would expect these genetically engineered cereal plants to grow more slowly than cereal plants that get their nitrogen from fertiliser. Explain why they would grow more slowly.

(2)

(Total 7 marks)

Q15.

Much of Indonesia is covered with forest. Large areas of forest have been cleared and planted with oil-palm trees to be used in the production of fuel.

(a) In these forests, nitrogen in dead leaves is made available to growing plants by the action of bacteria. Describe the role of bacteria in making the nitrogen in dead leaves available to growing plants.

(Extra space)

(5)

(b) During photosynthesis, oil-palm trees convert carbon dioxide into organic substances. Describe how.

(Extra space)

(6)

(Total 11 marks)

Q16.

(a) The concentrations of carbon dioxide in the air at different heights above ground in a forest changes over a period of 24 hours. Use your knowledge of photosynthesis to describe these changes and explain why they occur.

(5)

(b) In the light-independent reaction of photosynthesis, the carbon in carbon dioxide becomes carbon in triose phosphate. Describe how.

(5)

(Total 10 marks)

Q17.

When fertilisers are applied to fields next to a lake, nitrogen-containing substances from the fertilisers get into the lake.

(a) (i) Describe how the nitrogen-containing substances get into the lake.

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(1)

(ii) It takes longer for the nitrogen-containing substances to get into the lake when an organic fertiliser is used than when an inorganic fertiliser is used. Explain why it takes longer when an organic fertiliser is used.

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(2)

(b) Describe how the presence of nitrates in a lake may eventually lead to the death of fish.

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(4)

(Total 7 marks)

Q18.

In the activated sludge method of sewage treatment, organic matter in untreated sewage supplies nutrients to bacteria in the treatment tank. These bacteria include decomposers and nitrifying bacteria. The bacteria are eaten by ciliated protoctistans, which are, in turn, eaten by carnivorous protoctistans.

(a) (i) Explain the roles of the decomposers and the nitrifying bacteria in converting nitrogen in organic compounds in the sewage into a soluble, inorganic form.

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(3)

(ii) Nitrifying bacteria are one kind of bacteria that are important in the nitrogen cycle; nitrogen-fixing bacteria are another kind. Describe the part played by nitrogen-fixing bacteria in the nitrogen cycle.

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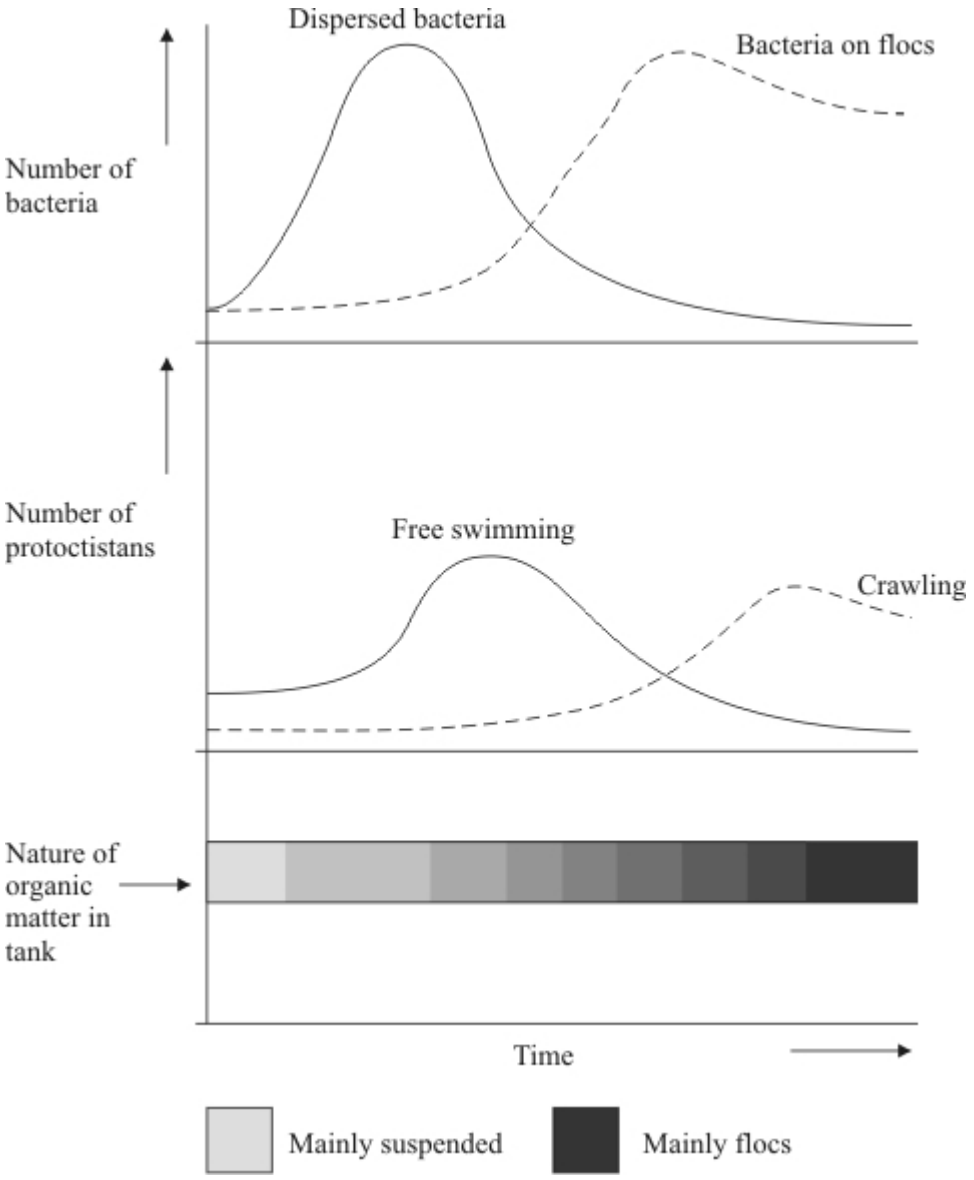
(2)

(b) The organic matter in untreated sewage consists of small particles, which are suspended in water. Activated sludge consists of solid lumps (flocs) of organic matter and bacteria. When the two are mixed in the treatment tank, bacteria from the flocs become dispersed in the water and feed on the suspended organic matter, converting it to flocs. Different types of ciliated protoctistans feed on the bacteria.

- Free-swimming protoctistans are able to move throughout the tank.
- Crawling protoctistans can only move over the surface of the flocs.

The diagram shows the change in the nature of the organic matter in the treatment tank and the changes in the numbers of the different types of organisms present.



(i) Explain the changes in the numbers of dispersed bacteria and the numbers of free-swimming protoctistans.

(3)

(ii) Explain how the changes that occur in the treatment tank illustrate the process of succession.

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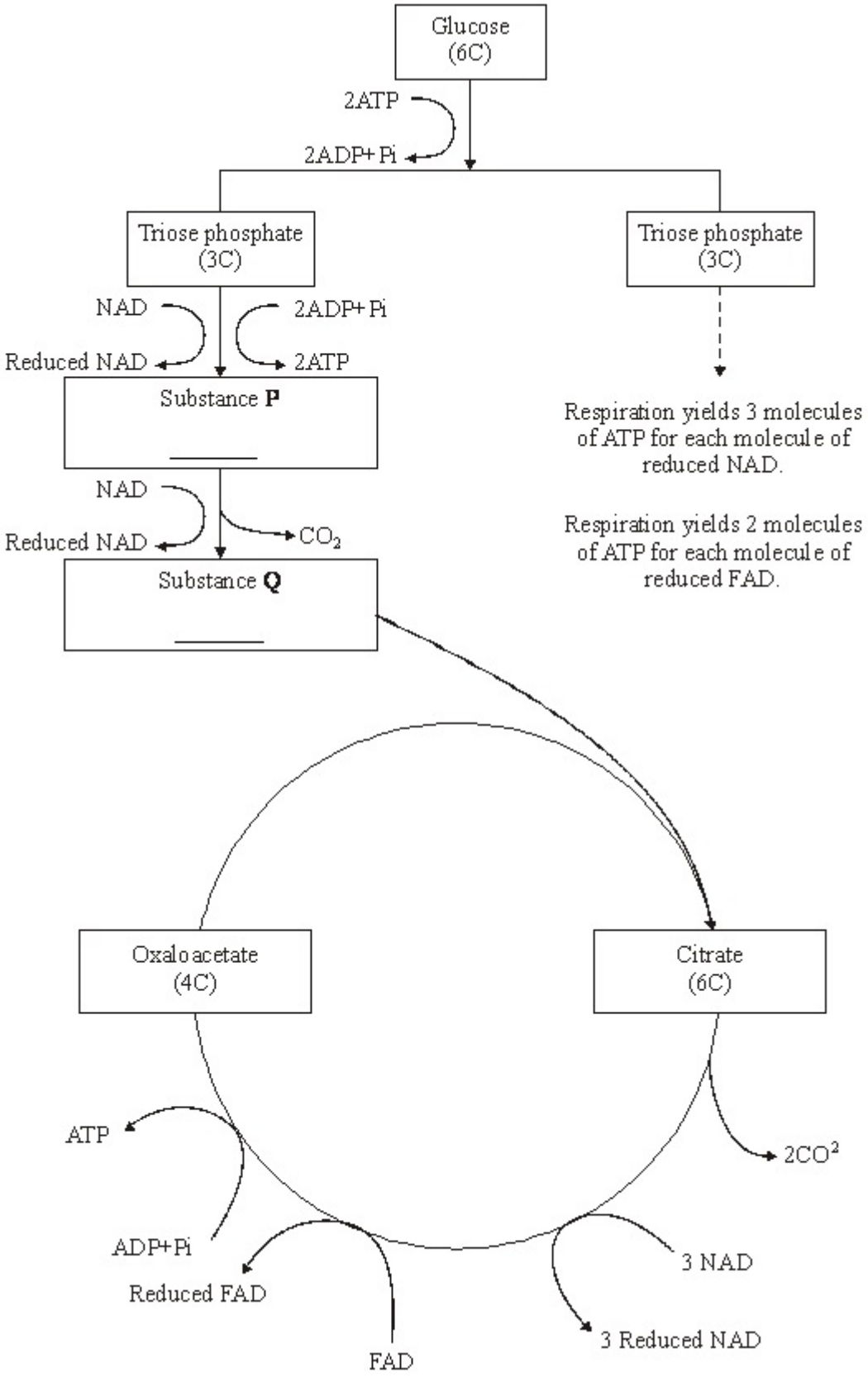
(4)

(Total 12 marks)

Q19.

(a) The flow chart shows the main stages in aerobic respiration.



(i) Complete the flow chart by writing, in the appropriate boxes, the number of carbon atoms in substance **P** and the name of substance **Q**.

(2)

(ii) Some ATP is formed in the cytoplasm and some in the mitochondria. Use the information given to calculate the number of molecules of ATP formed in a

mitochondrion from one molecule of glucose in aerobic respiration. Show how you arrived at your answer.

Answer_____

(2)

(iii) In the presence of oxygen, respiration yields more ATP per molecule of glucose than it does in the absence of oxygen. Explain why.

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_____

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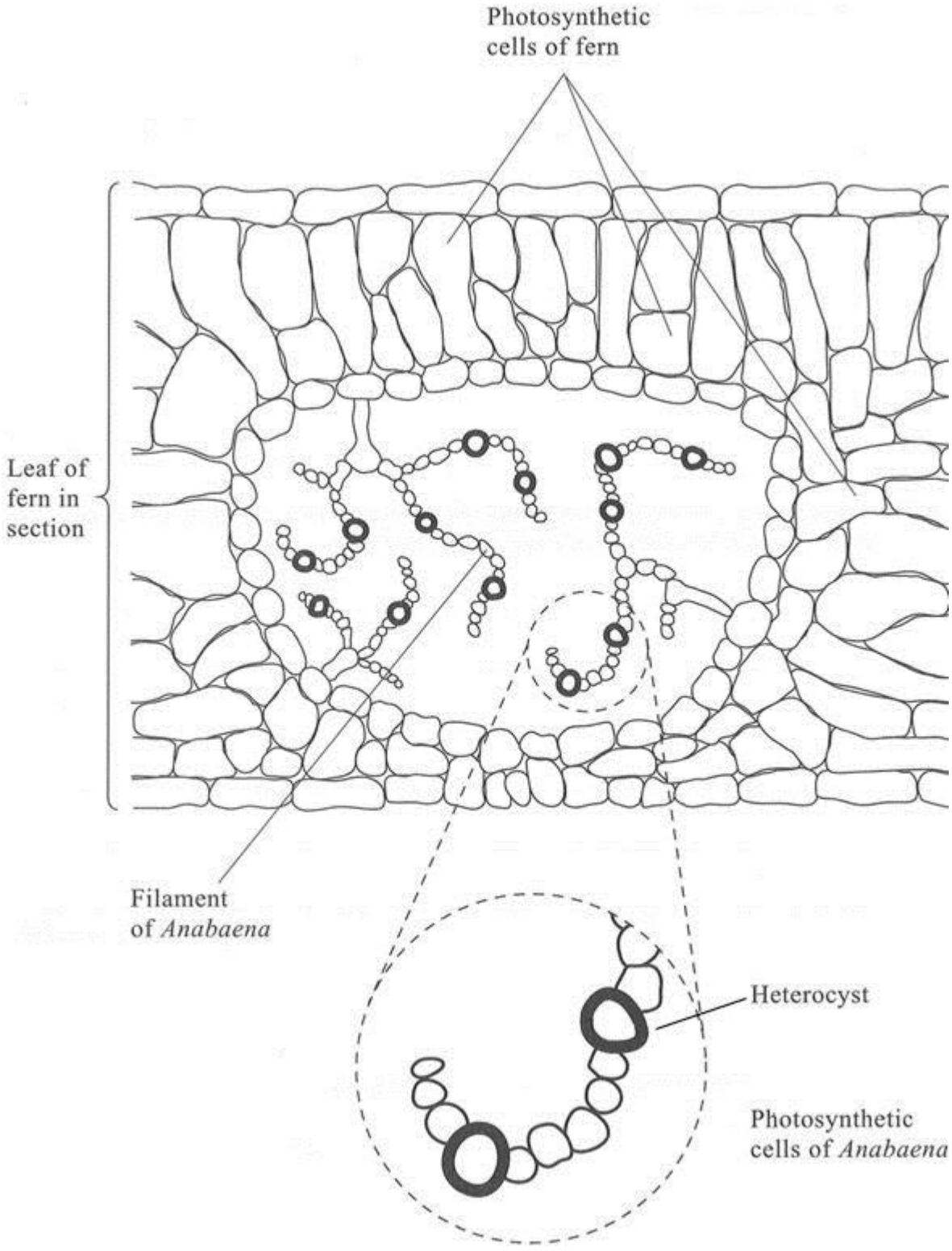
(3)

(b) Anabaena is a prokaryote found inside the leaves of a small fern. Anabaena can produce ammonia from nitrogen (nitrogen fixation). This reaction only takes place in the anaerobic conditions found in cells called heterocysts. Heterocysts are thick-walled cells that do not contain chlorophyll. The drawing shows the relationship between *Anabaena* and the fern.



(i) Suggest how the features of the heterocysts improve the efficiency of the process of nitrogen fixation.

(3)

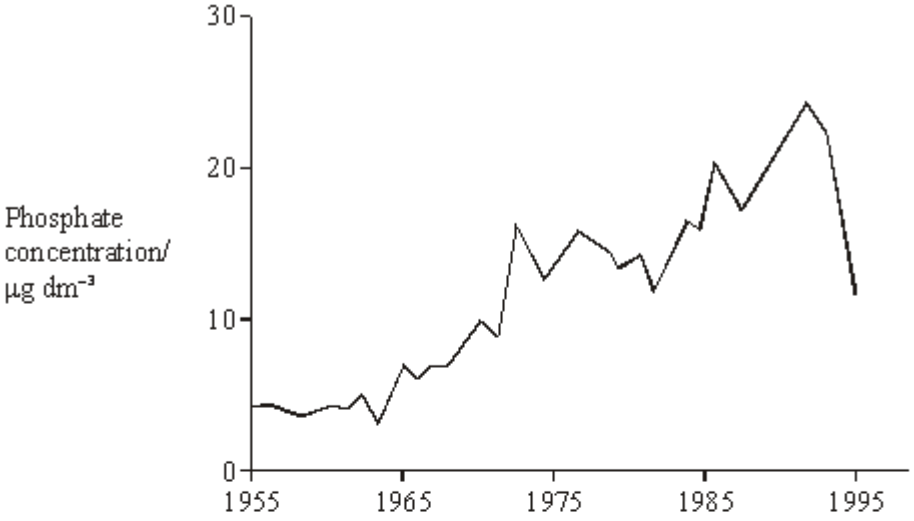
(ii) In China, the fern is cultivated and ploughed into fields to act as an organic fertiliser. Explain how ploughing the fern plants into the soil results in an improvement in the growth of the rice crop grown in these fields.

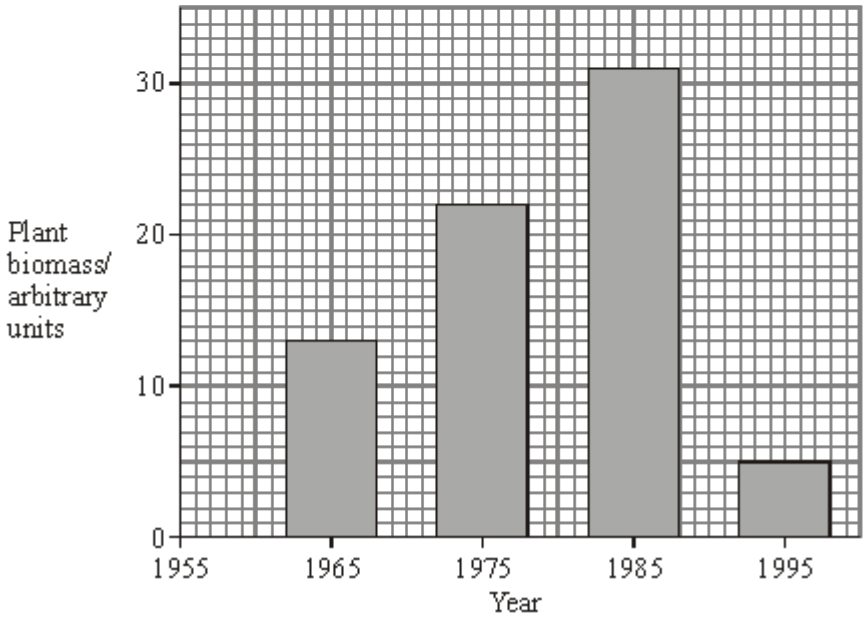
(5)

(Total 15 marks)

Q20.

Since 1965 there has been a steady rise in the phosphate concentration in the water of Lake Windermere. Scientists have monitored the phosphate concentration and plant biomass over a period of time. The results are shown in the graphs.





(a) Suggest **one** source of the phosphate in the lake.

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_____

(1)

(b) Calculate the percentage decrease in plant biomass between 1985 and 1995. Show your working.

Answer _____

(2)

(c) From these graphs, a student concluded that changes in phosphate concentration caused changes in plant biomass. Explain why this conclusion may not be valid.

(2)

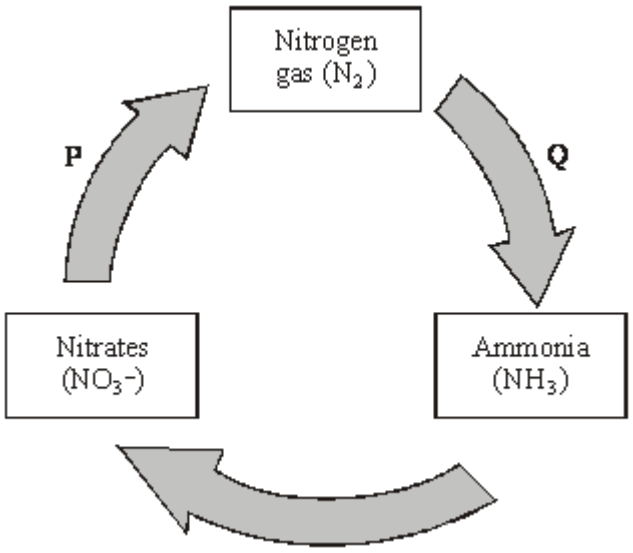
(d) Between 1982 and 1992 the number of fish in the lake decreased. Explain how the change in phosphate concentration may have resulted in this decrease in the fish population.

(6)

(Total 11 marks)

Q21.

The diagram shows part of the nitrogen cycle.



(a) Name processes **P** and **Q**.

P _____

Q _____

(2)

(b) It is estimated that, each year, a total of 3×10^9 tonnes of ammonia are converted to nitrate. Only 2×10^8 tonnes of ammonia are produced from nitrogen gas. Explain the difference in these figures.

_____

_____

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_____

(2)

(c) The conversion of ammonia to nitrate involves oxidation. What evidence in the diagram supports this?

_____

_____

(1)

(Total 5 marks)

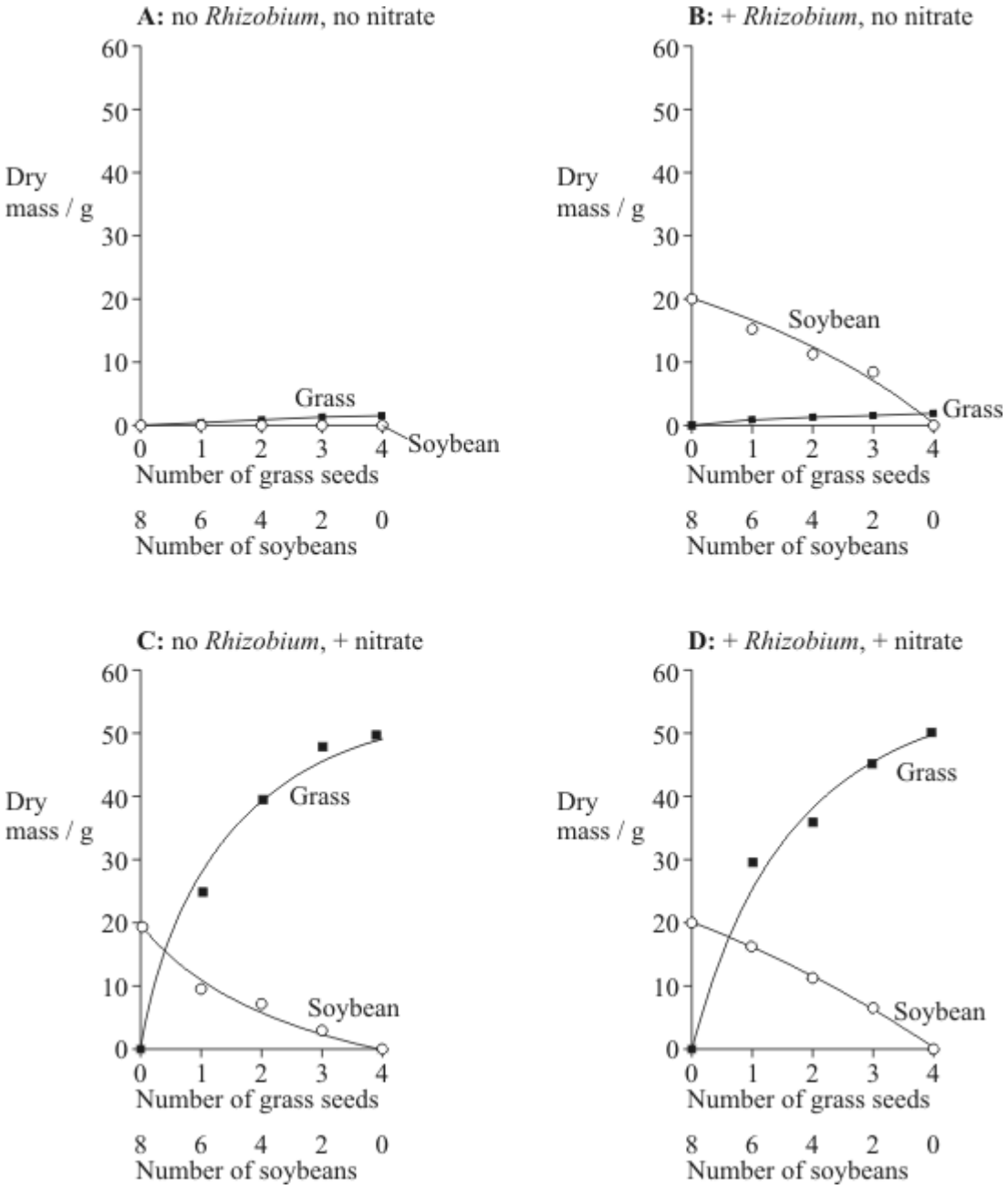
Q22.

The soybean is a leguminous plant. The effect of nitrate fertiliser and of the nitrogen-fixing bacterium, *Rhizobium*, on the growth of soybeans and on the growth of one species of grass was investigated. The soybeans and grass seeds were sown together in pots of soil in five different proportions. They were then treated with different combinations of nitrate fertiliser and *Rhizobium* bacteria, as follows:

Batch **A**: no *Rhizobium*, no nitrate fertiliser
Batch **B**: *Rhizobium* added, no nitrate fertiliser

Batch **C**: no *Rhizobium*, nitrate fertiliser added
Batch **D**: *Rhizobium* added, nitrate fertiliser added

The dry masses of the soybean plants and of the grass were determined after 6 months of growth. The results are shown in the graphs.



(a) Did *Rhizobium* bacteria have any effect on the growth of the grass? Give evidence from graphs **C** and **D** for your answer.

_____

_____

(1)

(b) Can the soybean make use of nitrogen supplied in the form of nitrate fertiliser? Give evidence from the graphs for your answer.

_____

_____

_____

_____

(2)

(c) Describe and explain the effect of *Rhizobium* bacteria on the growth of soybeans.

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_____

(3)

(Total 6 marks)

Q23.

(a) Name the type of bacteria which convert

(i) nitrogen in the air into ammonium compounds;

_____

(ii) nitrites into nitrates.

_____

(2)

(b) (i) Other than spreading fertilisers, describe and explain how **one** farming practice results in addition of nitrogen-containing compounds to a field.

_____

_____

_____

_____

(2)

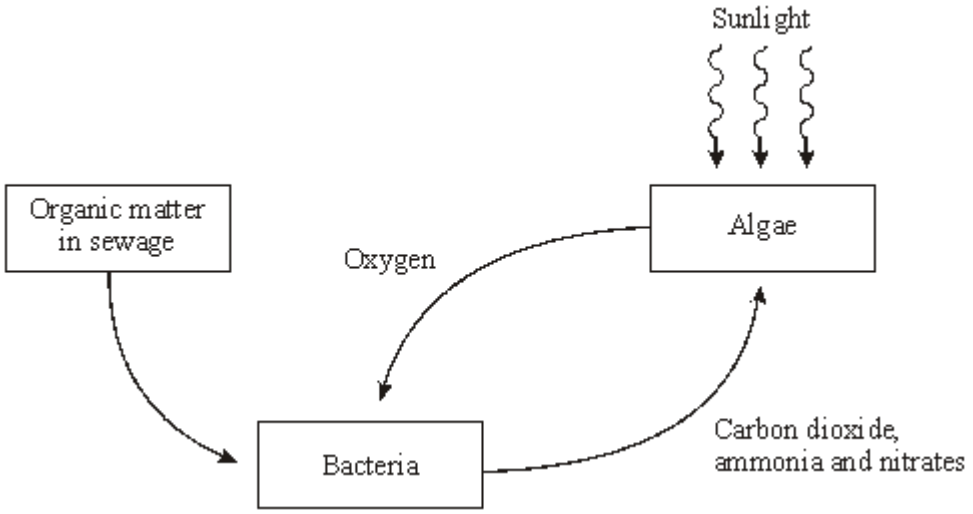
(ii) Describe and explain how **one** farming practice results in the removal of nitrogen-containing compounds from a field.

_____

(2)
(Total 6 marks)

Q24.

Purification ponds can be used in warm climates to break down sewage. The ponds are about 1m deep and contain bacteria and green algae. The diagram summarises the processes involved in the breakdown of sewage in a purification pond.



(a) Explain the advantage of having both algae and bacteria in a purification pond.

(4)

(b) Purification ponds only work efficiently when they are shallow and warm. Explain why.

_____

_____

_____

_____

_____

(4)

(Total 8 marks)

Q25.

The flow chart shows how high nitrate concentration can affect a river.

High nitrate concentration

↓

Increased growth of algae

↓

Death and decay of submerged plants rooted in the mud

↓

Reduced oxygen concentration and increased nitrate production

(a) Explain how a high nitrate concentration increases the growth of algae.

_____

_____

_____

(2)

(b) Suggest how increased growth of algae could lead to the death of the submerged plants.

_____

_____

_____

_____

(2)

(c) Explain how the decay of dead plants results in reduced oxygen concentration and increased nitrate production.

_____

_____

(6)

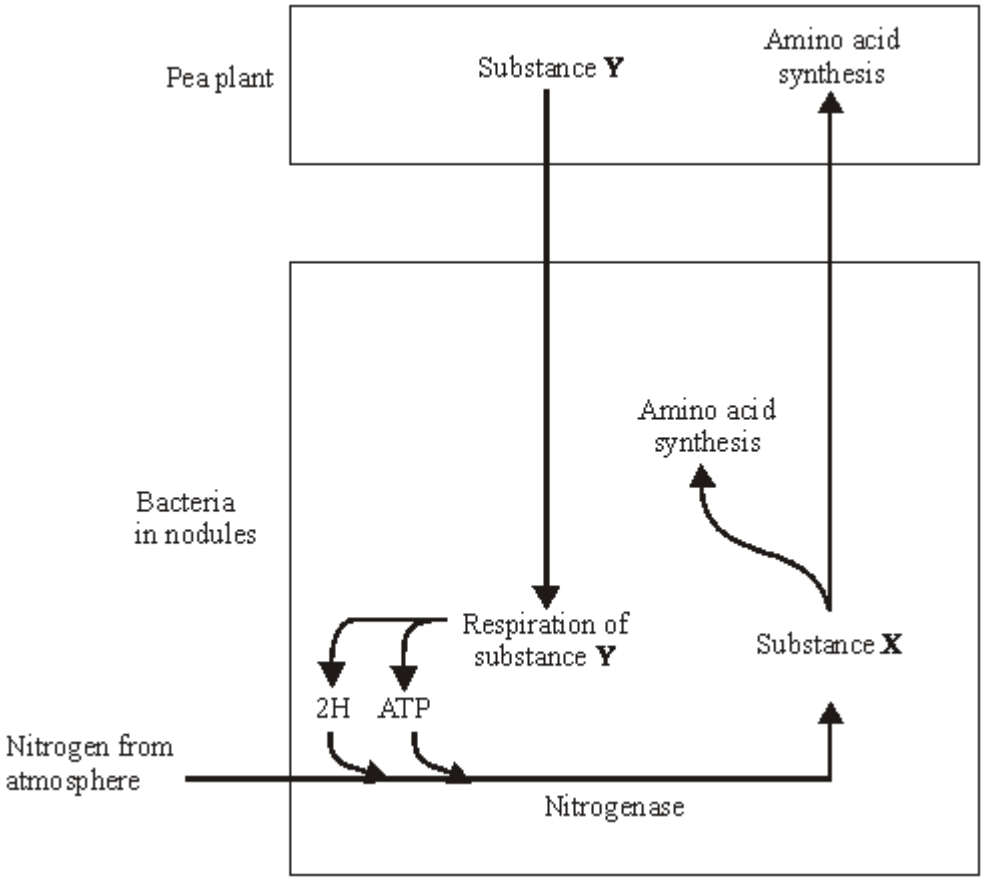
(d) Describe how the reduced oxygen concentration of the water will change the composition of the communities in the river.

(2)

(Total 12 marks)

Q26.

Pea plants are leguminous and have nodules on their roots which contain bacteria that are able to fix nitrogen. The diagram shows some of the processes involved in nitrogen fixation by these bacteria.



(a) Name

(i) substance **X**;

_____

(1)

(ii) substance **Y**.

_____

(1)

(b) Pea plants respire aerobically, producing ATP which can be used for amino acid synthesis. Describe the role of oxygen in aerobic respiration.

_____

_____

_____

_____

(2)

(c) The bacteria respire anaerobically. This produces hydrogen and ATP used in nitrogen fixation. The hydrogen comes from reduced NAD. Explain how the regeneration of NAD in this way allows ATP production to continue.

_____

(2)

(d) The enzyme nitrogenase is specific to the reaction shown. Explain how **one** feature of the enzyme would contribute to this specificity.

Feature

Explanation

(2)

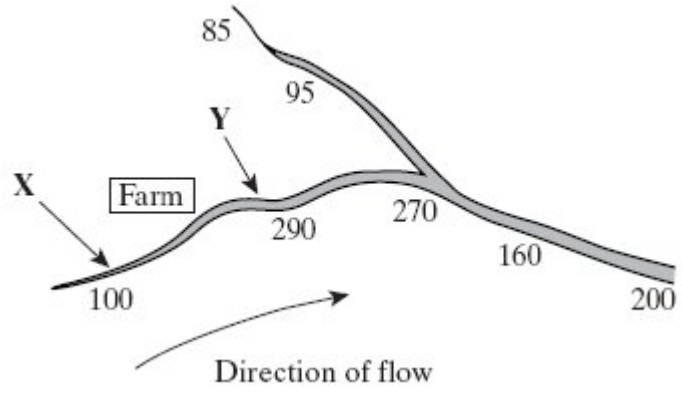
(e) Sodium ions act as a non-competitive inhibitor of the enzyme nitrogenase. Explain how the presence of a non-competitive inhibitor can alter the rate of the reaction catalysed by nitrogenase.

(3)

(Total 11 marks)

Q27.

The diagram shows a river system in an area of farmland. The numbers show the nitrate concentration in parts per million (ppm) in water samples taken at various locations along the river. Concentrations above 250 ppm encourage eutrophication in the river.



(i) Explain how farming practices might be responsible for the change in nitrate concentration in the water between point **X** and point **Y**.

(2)

(ii) Describe the effect the nitrate concentration may have in the river at point **Y**.

(5)

(Total 7 marks)

Q28.

The mesquite tree grows in dry areas which have soils with low concentrations of ions. Its roots grow down to 25 metres and contain nitrogen-fixing bacteria. It is considered a pest in areas where farm animals graze because it out-competes grass. In some areas, young mesquite trees are cut down and then ploughed into the ground. This is expensive but makes the soil slightly more fertile for a few years.

(a) Using the information given, explain **one** way in which mesquite trees are adapted for survival.

_____

_____

(1)

(b) Name the type of competition occurring between mesquite and grass.

_____

(1)

(c) Explain how ploughing the mesquite into the soil makes it more fertile.

_____

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

Q29.

Answers should be written in continuous prose, where appropriate.

A large lake is surrounded by fields. These fields are separated from each other by hedges. One hundred years ago the lake was a habitat for many plants, invertebrates and fish. Today the lake has no fish and few plants or invertebrates.

Explain how increased use of inorganic fertilisers on the fields may have led to these changes.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(Total 5 marks)

Q30.

In autumn when there is no crop, farm land may be used to grow mustard. The mustard absorbs nitrates which otherwise can leach out of the soil at this time of the year. The mustard is ploughed back into the soil just before sowing of the main crop in the spring.

(a) Nitrogen compounds in the mustard plants are made available for the main crop after ploughing in spring. Describe the role of microorganisms in this process.

(5)

(b) Explain why it is important for the farmer to reduce the leaching of nitrates.

(2)

(c) Plants absorb a number of other nutrients from the soil including phosphates. Describe why phosphates are needed by a growing plant.

(4)

(Total 11 marks)

Q31.

(a) Explain how including leguminous plants in a crop rotation reduces the need to use artificial fertilisers.

_____

_____

_____

_____

(2)

(b) Application of very high concentrations of fertiliser to the soil causes plants to wilt. Explain why.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q32.

Two fields, **A** and **B**, were used to grow the same crop. The fields were divided into plots. Different masses of fertiliser containing sodium nitrate were applied to these plots. After six weeks, samples of crop plants from each plot were collected and their mass determined. The results are shown in the table.

Mass of fertiliser added/kg ha^{-1}	**Mass of crop/kg m^{-2}**	
	Field **A** - used for grazing cattle in previous year	Field **B** - used for same crop in previous year
0	14.5	6.4
10	16.7	9.8
20	17.4	12.9
30	17.5	16.2
40	17.5	17.1
50	17.5	17.1
60	17.5	17.1

(a) (i) Describe the pattern shown by the data for field **B**.

_____

_____

(1)

(ii) Explain the change in the mass of crop produced from field **B** when the mass of fertiliser added increases from 0 to 20 kg ha^{-1}.

_____

_____

_____

_____

(2)

(iii) Explain why the mass of crop produced stays the same in both fields when more than 40 kg of fertiliser is added.

_____

_____

_____

_____

(2)

(b) In the previous year, field **A** had been used for grazing cattle. Field **B** had been used to grow the same crop as this year. When no fertiliser was added, the mass of crop from field **A** was higher than from field **B**. Explain this difference.

_____

_____

_____

_____

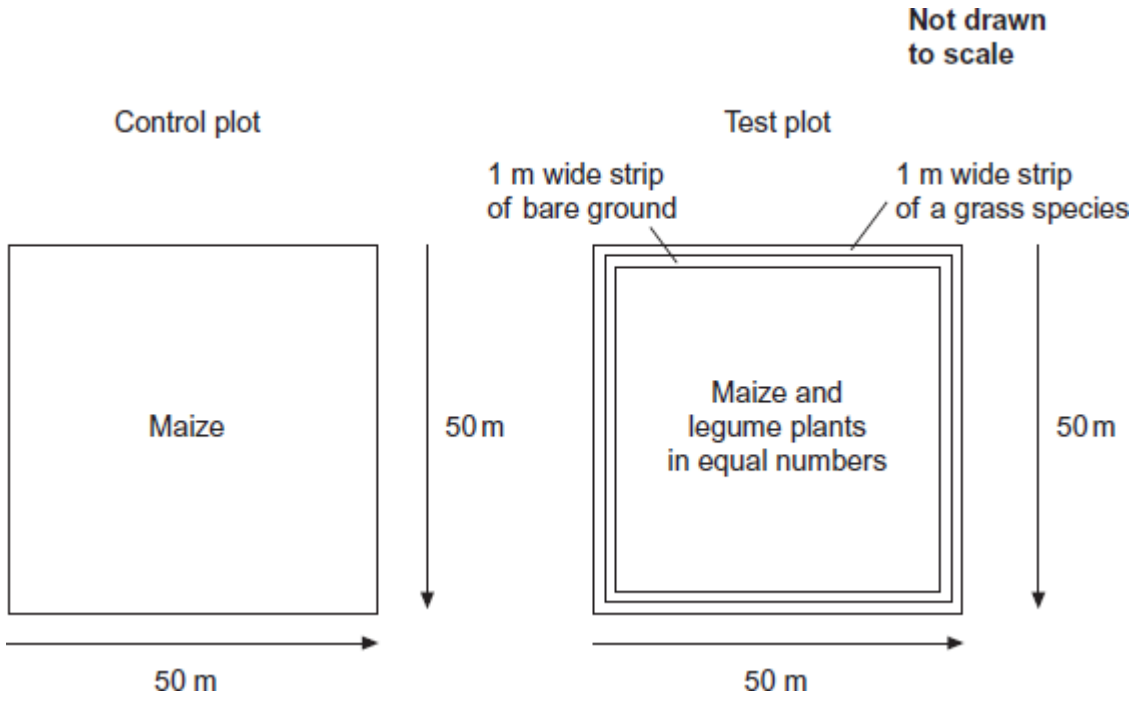
(2)

(Total 7 marks)

Q33.

Stemborers are insect pests that feed on maize plants. Scientists investigated the effect of **push-pull** stimuli on the control of these pests.

For this investigation, the scientists divided a large field into plots measuring 50 m × 50 m. They then designated each plot as a control plot or a test plot. The following figure shows what they planted in each type of plot.



The legumes planted with the maize drive stemborers away.
The grass species attracts stemborers.

The table below shows the scientists' results.

Plots	**Mean percentage damage to maize plants**	**Mean maize grain yield / tonnes per hectare (± standard deviation)**	**Mean production costs per farmer / $ per hectare (± standard deviation)**	**Mean total income for farmer / $ per hectare (± standard deviation)**
Control	29.6	1.5 (±0.2)	250 (±0.7)	329 (±5.9)
Test	6.7	3.7 (±0.3)	278 (±1.1)	679 (±10.2)

(a) In the test plot of land, identify the push stimulus and the pull stimulus.

Push stimulus _____

Pull stimulus _____

(1)

(b) When measuring the mean percentage damage to maize plants, 60 plants from each test plot were selected at random and examined.
Describe how the maize plants could be selected at random.

_____

_____

_____

(Extra space) _____

(3)

(c) In the test plot, bare ground was left between the maize and the grass species.
Suggest an explanation why.

(2)

(d) The legume plants have nodules containing nitrogen-fixing bacteria on their roots.
Explain how nitrogen-fixing bacteria could increase the growth of the maize.

(2)

(e) A year after this investigation, the government of one country decided that their farmers should use these **push-pull** stimuli.
How do these data support this decision?

(Extra space) _____

_____

_____

(3)

(Total 11 marks)

Q34.

Nitrate from fertiliser applied to crops may enter ponds and lakes. Explain how nitrate may cause the death of fish in fresh water.

(Total 5 marks)