EXAM PAPERS PRACTICE

Nutrient Cycles

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

Exam Board: AQA A Level 7402

Topic: Nutrient Cycles

1 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.

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(2)

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

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(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.

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(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.

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(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.

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

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(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.

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

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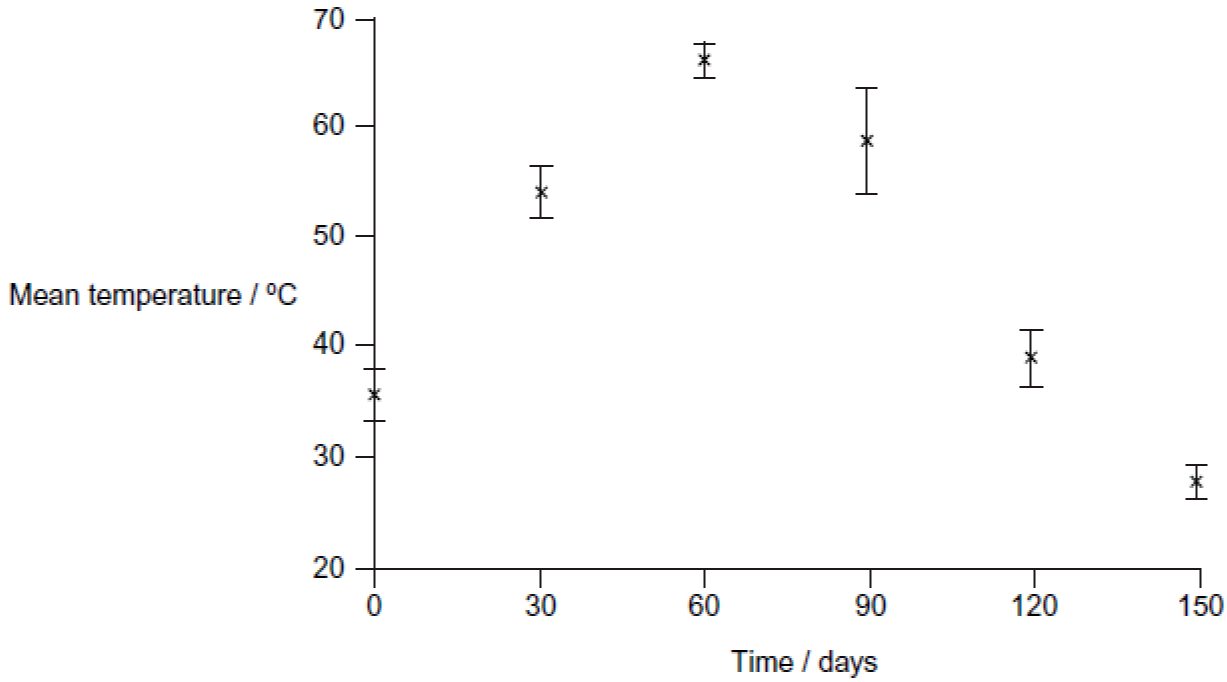
(2)

(Total 15 marks)

2 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.

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2. ____

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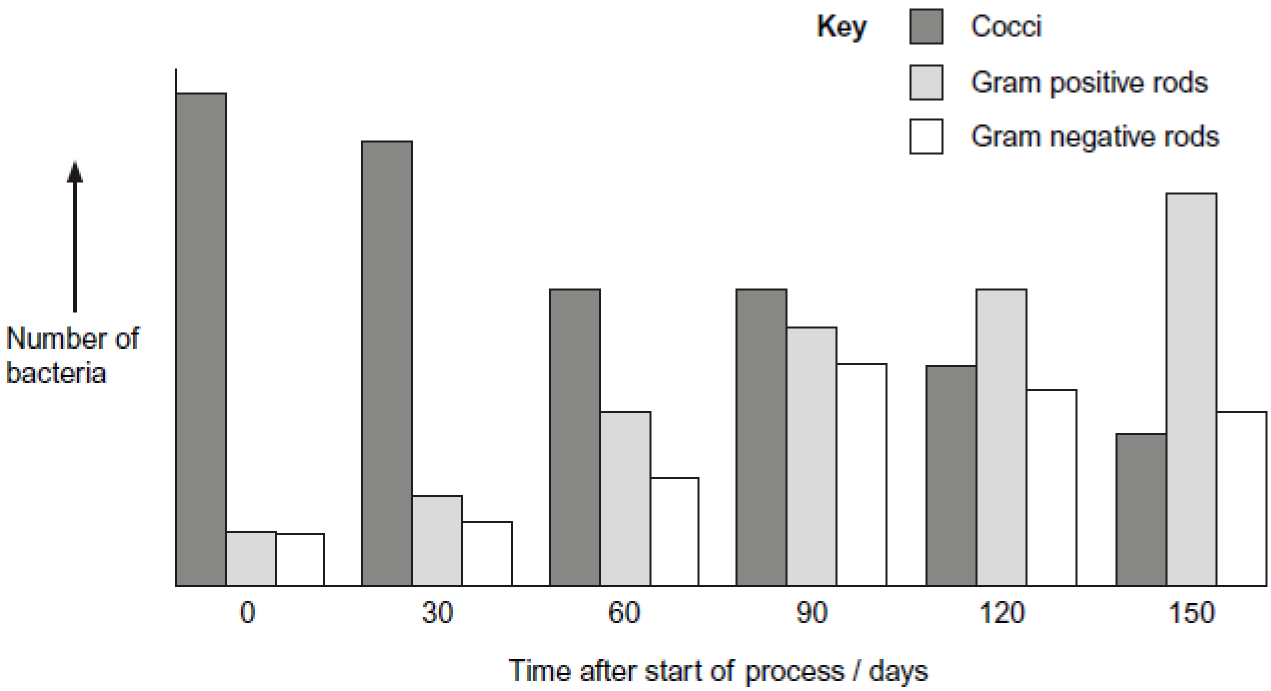
(2)

(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)

3 (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)

4 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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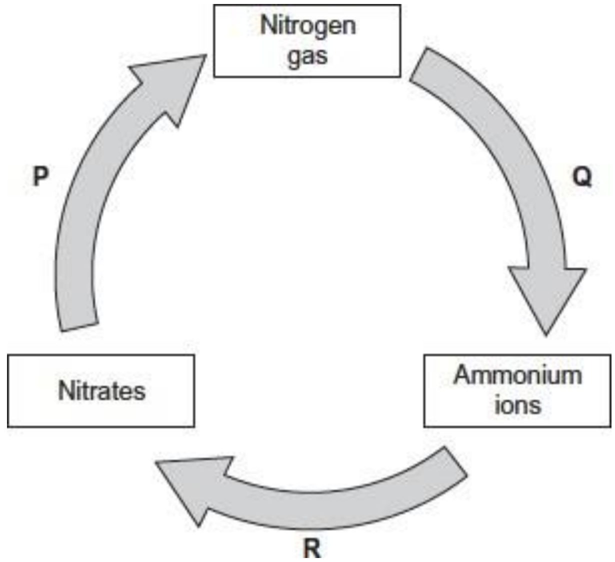
(2)
(Total 7 marks)

5 The diagram shows part of the nitrogen cycle.



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

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(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)

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

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(Extra space) ___

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(Total 6 marks)

7 Scientists measured the rate of respiration in **three** parts of an ecosystem.

They did this by measuring carbon dioxide released into the air by:

- leaves of plants
- stems and roots of plants
- non-photosynthetic soil organisms.

The table below shows the scientists' results for these three parts of the ecosystem.

Part of ecosystem	**Mean rate of carbon dioxide production / $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	
Non-photosynthetic soil organisms	0.045	

(a) Complete the table to show the percentage of total carbon dioxide production by each part of the ecosystem.

Show your working.

(2)

(b) A student who looked at the data in the table concluded that plants carry out more respiration than non-photosynthetic organisms in the ecosystem.

Use the information provided to suggest why these data may **not** support the student's conclusion.

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(2)

(c) What measurements would the scientists have made in order to calculate the rate of carbon dioxide production?

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(2)

(d) The scientists calculated the mean rate of carbon dioxide production of the leaves using measurements of carbon dioxide release in the dark.

Explain why they did **not** use measurements taken in the light.

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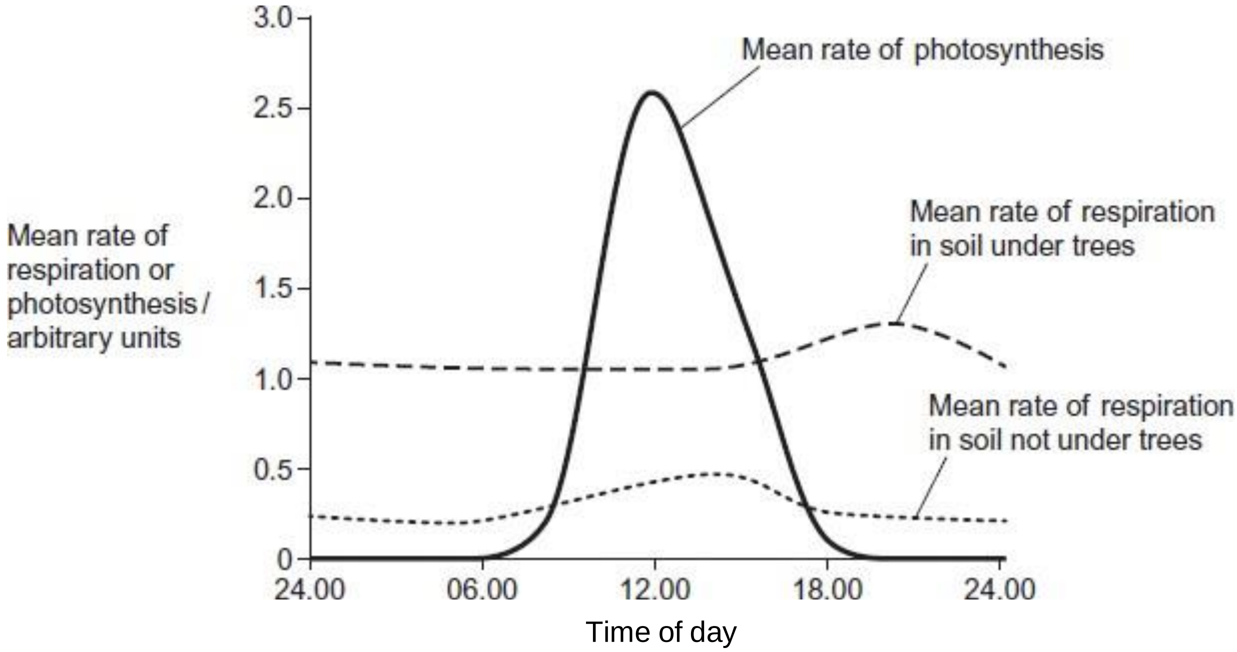
(2)

Another group of scientists measured the mean rate of respiration in soil under trees and soil not under trees in the same wood. They also measured the mean rate of photosynthesis in the trees.

They took measurements at different times of day during the summer.

The figure below shows the scientists' results.



(e) (i) Describe **two** ways in which the mean rate of respiration in soil under trees is different from soil not under trees.

1. ____

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2. ____

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(2)

(ii) Suggest **one** explanation for the differences in the mean rate of respiration in soil under trees and soil not under trees between 06.00 and 12.00.

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(2)

(f) The scientists suggested that the rise in the mean rate of photosynthesis was the cause of the rise in the mean rate of respiration in soil under trees.

(i) Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

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(2)

(ii) Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

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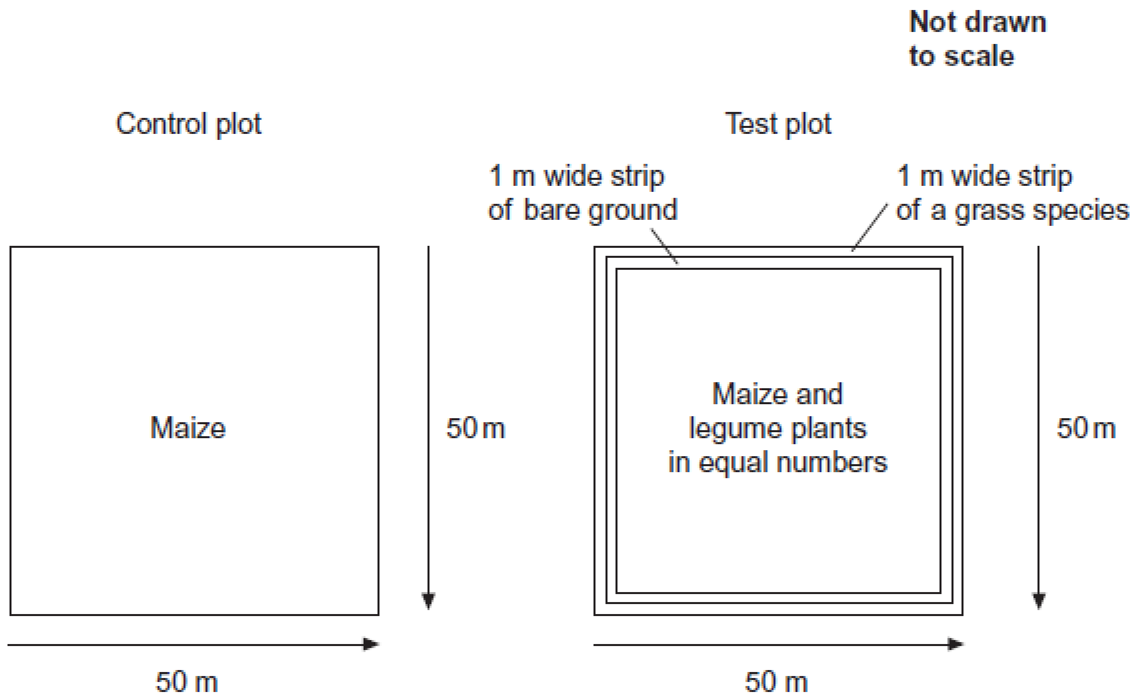
(1)

(Total 15 marks)

8 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.

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(Extra space) ___

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(3)

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

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(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.

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(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?

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(Extra space) ____

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(3)
(Total 11 marks)

9 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)

10 **Essay**

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

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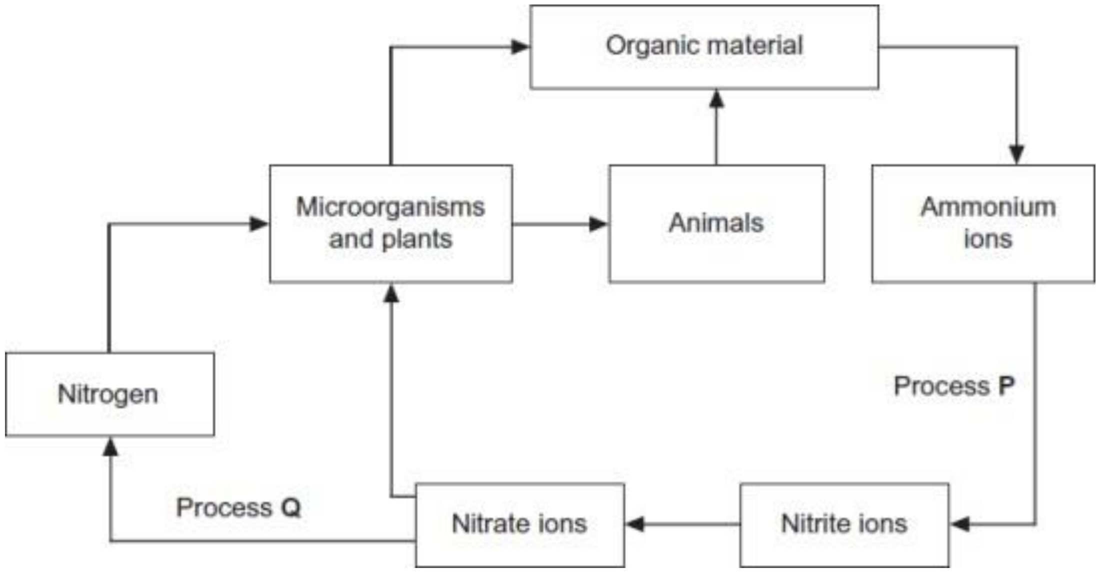
Write an essay on the following topic:

There are many different types of relationships and interactions between organisms.

(Total 25 marks)

11 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)

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

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*(Extra space)*____

(5)

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

(Extra space)

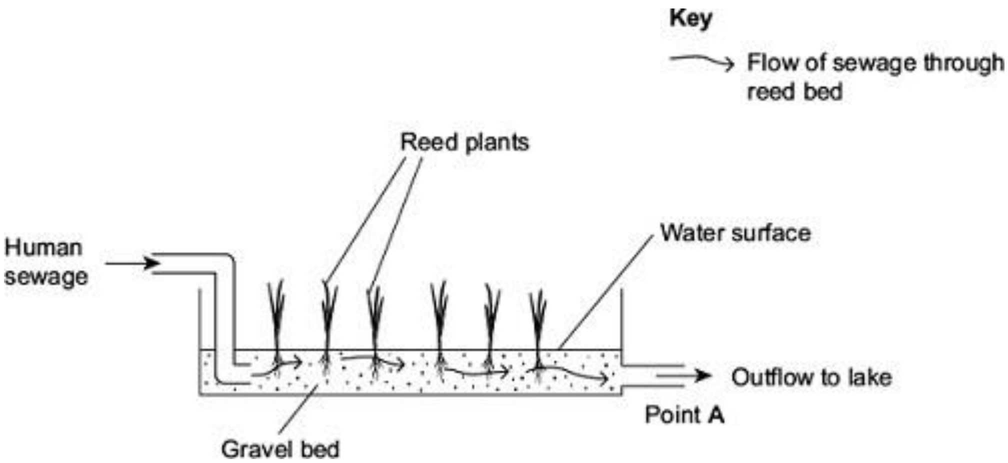
(5)

(Total 10 marks)

13 (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.

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(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.

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(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)*____

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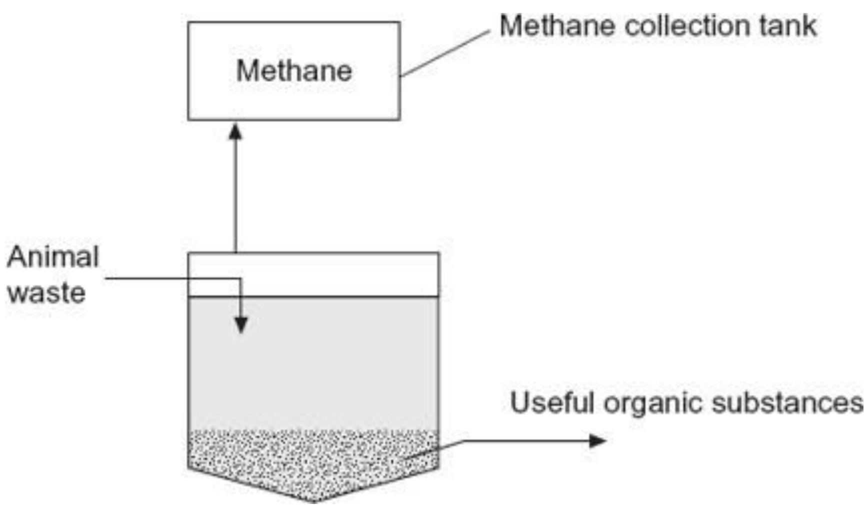
(3)

(Total 8 marks)

14 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.

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(2)

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

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(*Extra Space*)____

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(3)

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

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(1)
(Total 8 marks)

15 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.

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(Extra space) ___

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(5)

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

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(Extra space) ___

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(6)

(Total 11 marks)

16 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.

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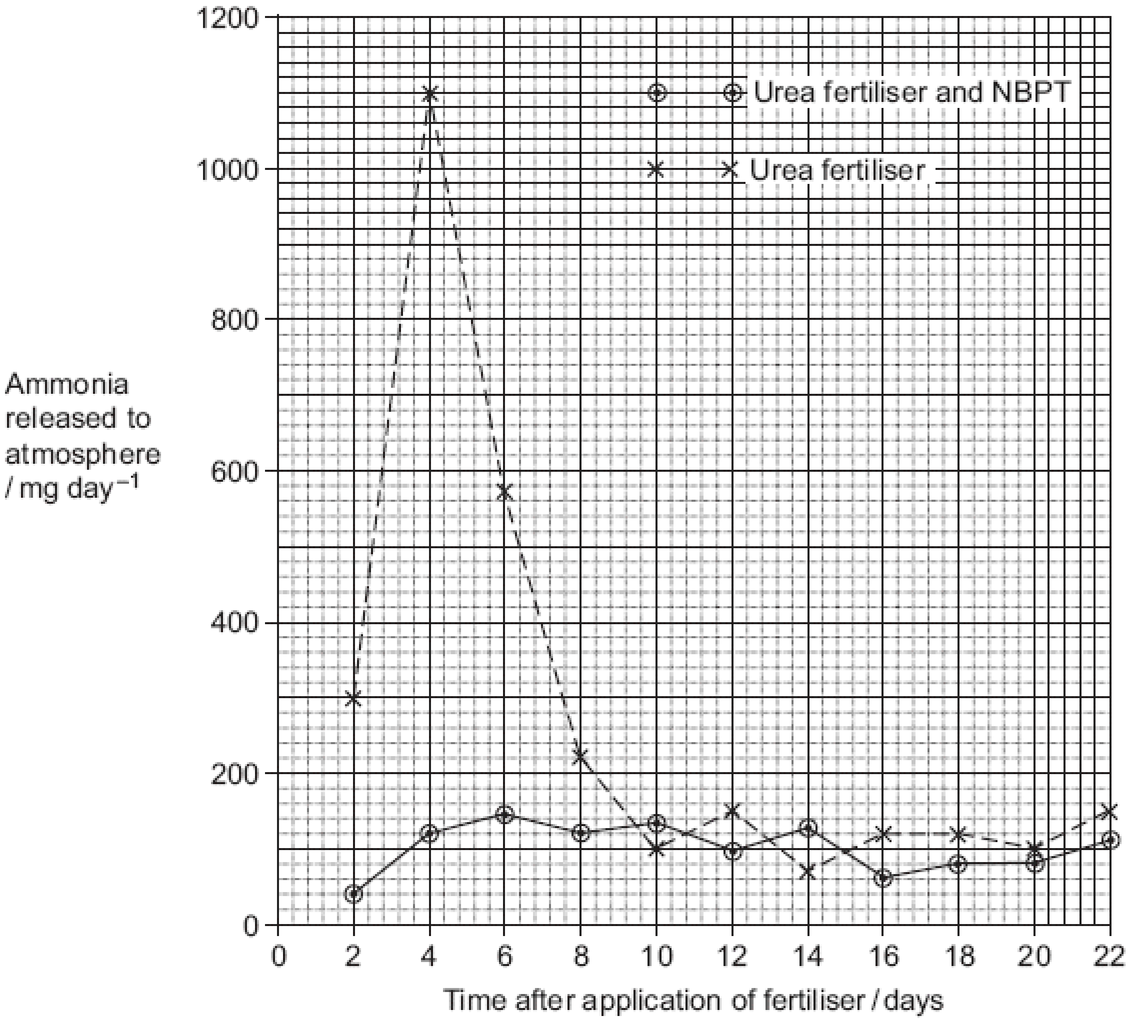
(2)

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.

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(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)

17 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.

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(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.

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(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.

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(2)

(Total 7 marks)

18 (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.

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(5)

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

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(5)

(Total 10 marks)

19 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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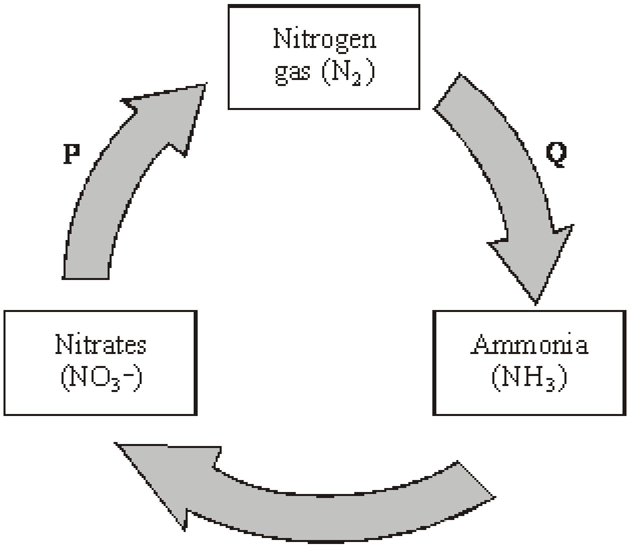
(4)

(Total 7 marks)

20 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?

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(1)

(Total 5 marks)

21 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**.

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(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}.

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(2)

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

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(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.

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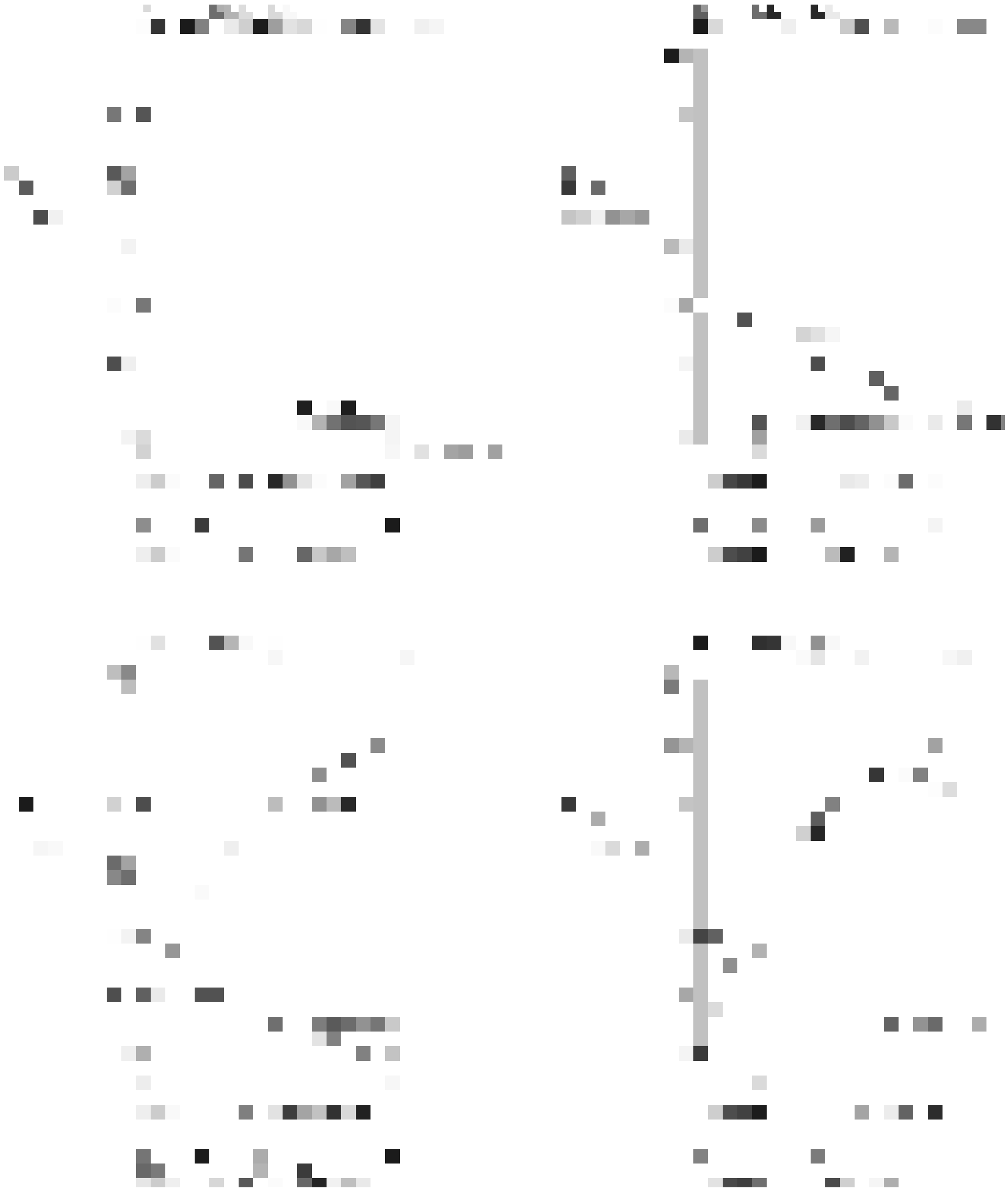
(2)

(Total 7 marks)

22 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.

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(1)

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

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(2)

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

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(3)

(Total 6 marks)

23 (a) Name the type of bacteria which convert

(i) nitrogen in the air into ammonium compounds;

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(ii) nitrites into nitrates.

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(2)

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

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(2)

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

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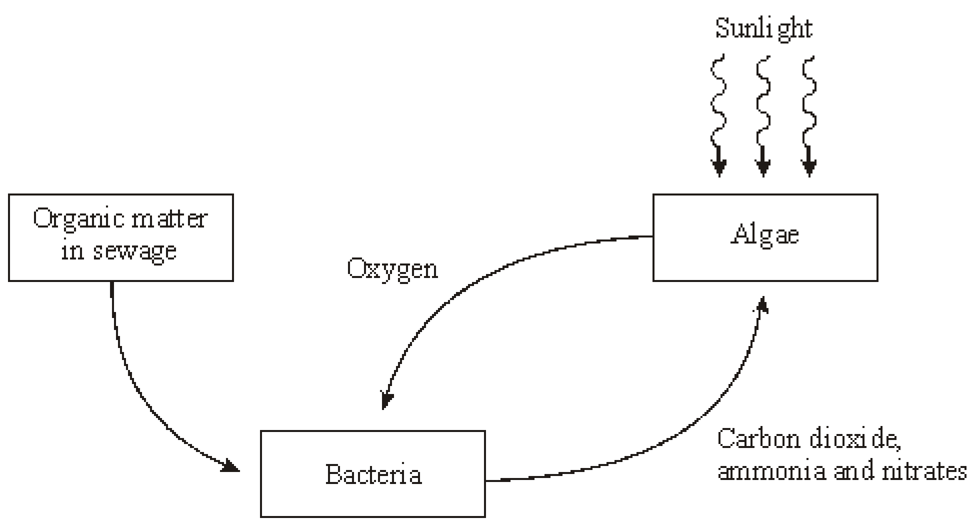
(2)
(Total 6 marks)

24 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.

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(4)

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

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(4)

(Total 8 marks)

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

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(2)

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

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(2)

(Total 4 marks)

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

High nitrate concentration

↓

Increased growth of algae

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Death and decay of submerged plants rooted in the mud

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Reduced oxygen concentration and increased nitrate production

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

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(2)

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

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(2)

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

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(1)

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

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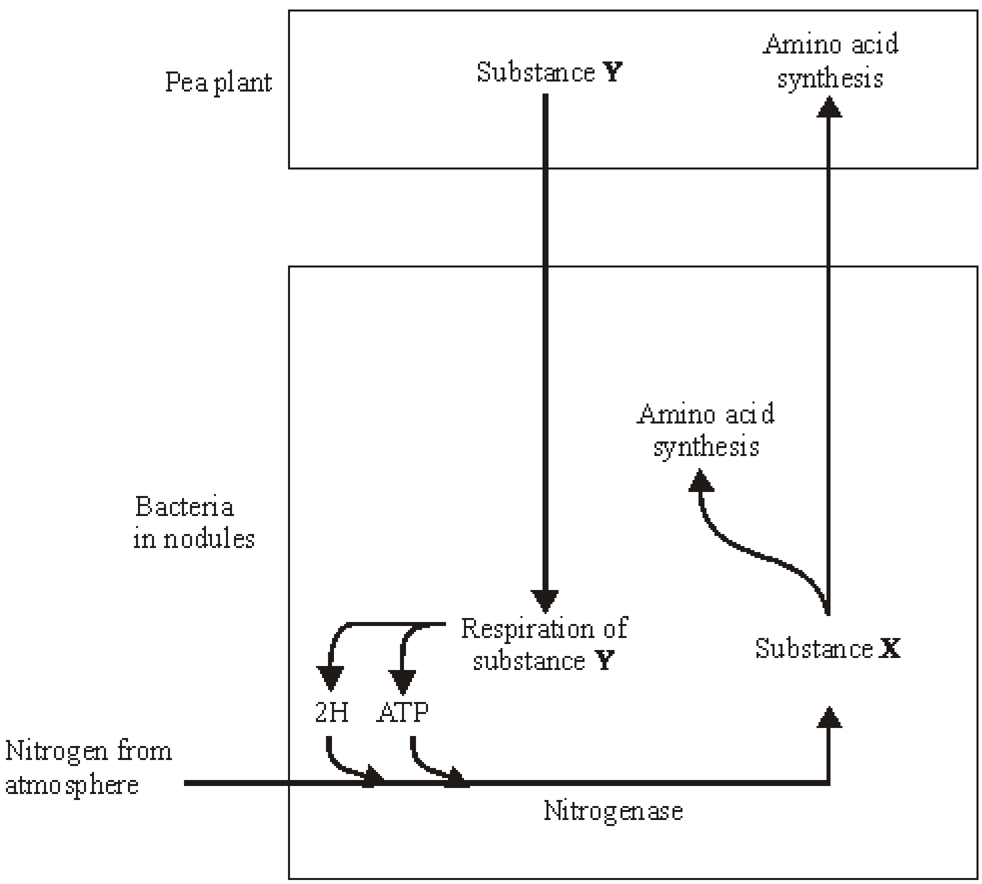
(2)
(Total 12 marks)

27 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)

(1)

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

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(2)

S (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.

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(2)

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

Feature

___

Explanation

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(2)

S (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.

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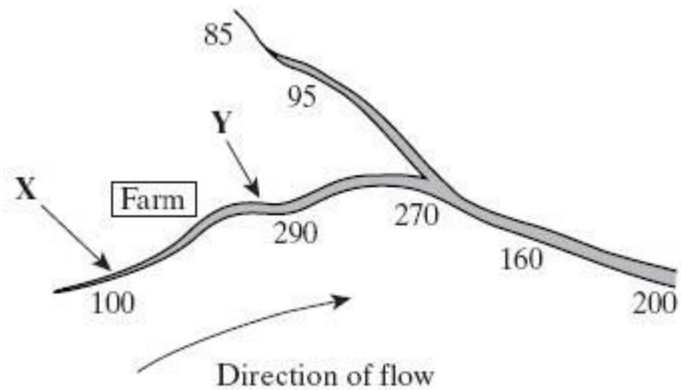
(3)

(Total 11 marks)

28 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**.

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____

(2)

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

(5)
(Total 7 marks)

29 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)

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

(1)

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

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(3)

(Total 5 marks)

30 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.

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(5)

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

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(2)

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

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(4)

(Total 11 marks)

31 (a) Farmers who grow wheat sometimes leave a field fallow for a year by not growing a crop in it. The concentration of nitrate ions in the soil decreases when a field is left fallow.

(i) When grass is grown in the field, fewer nitrate ions are lost than when the field is left with bare soil. Explain why.

____

____

(1)

(ii) A crop of leguminous plants such as clover may be grown in the field and then ploughed in. Explain why less fertiliser would be needed for the wheat crop in the following year.

____

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(2)

(b) The table gives information about the yield and profitability of a wheat crop grown using different amounts of fertiliser.

Nitrogen fertiliser applied / kg ha^{-1}	Grain yield / tonnes ha^{-1}	Grain protein / %	Value added by using fertiliser / £ha^{-1}	Cost of using fertiliser / £ha^{-1}	Benefit : cost ratio
0	2.4	11.7	–	–	–
25	2.5	12.5	19	11	1.7 : 1.0
50	2.5	12.9	25	22	1.1 : 1.0
75	2.5	13.3	31	33	0.9 : 1.0
100	2.5	13.5	37		

(i) Describe the effects of increasing fertiliser application on the yield and protein content of the grain produced.

____

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____

____

(2)

(ii) Use the data in the table to estimate the benefit: cost ratio for a fertiliser application of 100 kg ha^{-1}. Write your answer in the table.

(1)

(Total 6 marks)

32 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.

____

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____

____

____

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____

____

(Total 5 marks)

Mark schemes

1 (a) 1. To kill any fungus / bacteria on surface of seeds or in soil;
2. So only the added fungus has any effect.

2

(b) So that only nitrate or ammonia / type of fertiliser affects growth.

1

(c) 1. So that effects of nitrate or ammonium alone could be seen;
2. So that effects of fungus can be seen.

2

(d) 1. Weigh samples at intervals during drying;
2. To see if weighings became constant (by 3 days).

2

(e) With live fungus – showing effects of the fungus:
1. Fungus increases growth of roots and shoots in both;
2. Produces greater growth with nitrate.

With heat-treated fungus – showing effects of fertiliser:

3. Similar dry masses for roots and shoots;
4. (Probably) no significant difference because SDs overlap.

4

(f) 1. Dry mass measures / determines increase in biological / organic material;
2. Water content varies.

2

(g) 1. Fungus with nitrate-containing fertiliser gave largest shoot: root ratio;
2. And largest dry mass of shoot;
3. 6.09:1 compared with ammonium-containing fertiliser 4.18:1

2 max

[15]

2 (a) 1. Respiration/metabolism/ammonification;
2. (Releases/produces) heat;

Reject: 'produces energy'.

2

(b) 1. SD is spread of data around the mean;

Accept: variation around the mean.

Accept: range is difference between highest and lowest values/extremes ***or*** *range includes anomalies/outliers.*

2. (SD) reduces effect of anomalies/ outliers;

Reject: (SD) removes anomalies/outliers.

3. (SD) can be used to determine if (difference in results is) significant/not significant/due to chance /not due to chance;

Ignore: reliability/accuracy/validity.

2 max

(c) 1. Distributes heat / prevents 'hot' spots;
2. Distributes microorganisms;
3. More enzyme-substrate complexes;
4. Increases rate of decomposition;

Accept: increases nitrification/ammonification or 'breaks down waste faster'.

5. Aeration/provides oxygen;

2 max

(d) 1. Microorganisms change the abiotic conditions/temperature /organic waste /provide nutrients;

Must refer to microorganisms or bacteria/named bacteria causing the change.

Ignore: change the environment.

2. Less <u>hostile</u> conditions;
3. Decline in Cocci **and** increase in rods;

Accept: 'decrease in cocci, others are going up'.

Accept: decrease in cocci and increase in either rod type or increase in both types.

4. Gram positive outcompete / better competitors;

Accept: rods outcompete (cocci) / better competitors.

3 max

[9]

3 (a) 1. Excites electrons / electrons removed (from chlorophyll);

Accept: higher energy level as 'excites'.

2. Electrons move along carriers/electron transfer chain releasing energy;

Accept: movement of H^+/protons across membrane releases energy.

Reject: 'produces energy' for either mark but not for both.

3. Energy used to join ADP and Pi to form ATP;

Reject: 'produces energy' for either mark but not for both.

Accept: energy used for phosphorylation of ADP to ATP

Do not accept P as Pi but accept phosphate.

4. Photolysis of water produces protons, electrons and oxygen;
5. NADP reduced by electrons / electrons and protons / hydrogen;

Accept: NADP to NADPH (or equivalent) by addition of electrons/hydrogen.

Do not accept NADP reduced by protons on its own.

5

(b) 1. Protein/amino acids/DNA into ammonium compounds / ammonia;

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

2. By saprobionts;

Accept: saprophytes.

3. Ammonium/ammonia into nitrite;
4. Nitrite into nitrate;
5. By nitrifying bacteria/microorganisms;

Reject: nitrifying bacteria in root nodules.

1, 3 and 4. Accept: marks for conversion even if incorrect type of bacteria named as being involved.

2 and 5. Reject: marks for type of bacteria if linked to incorrect process e.g. nitrite converted to nitrate by saprobionts.

3 and 4. Accept: for one mark ammonia/ammonium into nitrate if neither mark point 3 or 4 awarded.

Note: there are no marks for the role of nitrogen-fixing bacteria as the question refers to producing a source of nitrates from the remains of crops.

5

[10]

4 (a) (i) 1. Amino acid / protein / enzyme / urea / nucleic acid / chlorophyll / DNA / RNA / / ATP / ADP / AMP / NAD / NADP;

2. DNA / RNA / nucleic acid / ATP / ADP / AMP / NADP / TP / GP / RuBP / phospholipids;

1. and 2. Accept any named equivalent examples e.g. nucleotides.

Neutral: ammonia / nitrite / nitrate / phosphate.

2

(ii) 1. Saprobiotic (microorganisms / bacteria) break down remains / dead material / protein / DNA into ammonia / ammonium;

Accept: saprobionts / saprophytes / saprotrophs

Neutral: decomposer

2. Ammonia / ammonium ions into nitrite and then into nitrate;

Allow correct chemical symbols.

Accept: correct answers which use incorrect bacteria e.g. nitrogen-fixing but then reject m.p. 3.

3. (By) Nitrifying bacteria / nitrification;

3

(b) 1. Nitrate / phosphate / named ion / nutrients for growth of / absorbed / used by plants / algae / producers;

2. More producers / consumers / food **so** more fish / fish reproduce more / fish grow more / fish move to area;

Must have idea of more plants related to some increase in fish.

2

[7]

5 (a) R.

1

(b) 1. Protein / amino acids broken down (to ammonium ions / ammonia);

Accept: nucleic acids / RNA / DNA / urea / any named nitrogen containing compound as an alternative to protein / amino acids

Accept: saprophytes / saprotrophs

2. By saprobionts / saprobiotic (microorganisms).

Neutral: decomposers

Reject: answers where incorrect type of bacteria given as saprobionts e.g. Nitrogen fixing bacteria

2

(c) 1. (Fertility increased as) more nitrate formed / less nitrate removed / broken down;

Accept: Nitrate remains

2. Less / no denitrification / process P is decreased / fewer denitrifying bacteria.

Accept: more nitrification / more nitrifying bacteria / process R is increased

2

(d) 1. Grow crops / plants with nitrogen-fixing (bacteria);

Accept: grow legumes / named example e.g. peas, beans, clover

Accept: fallow year

Accept: use different amounts of ions / nutrients

2. (Different crops use) different minerals / salts / nutrients / ions (from the soil);
3. (Different crops have) different pests / pathogens / diseases.

2 max

[7]

6

1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. Produces two glycerate (3-)phosphate / GP;

   Accept: any answer which indicates that 2 x as much GP produced from one RuBP.

3. GP reduced to triose phosphate / TP;

   Must have idea of reduction. This may be conveyed by stating m.p. 4.

4. Using reduced NADP;

   ***Reject**: Any reference to reduced NAD for m.p.4 but allow reference to reduction for m.p. 3.*

5. Using energy from ATP;

   Must be in context of GP to TP.

6. Triose phosphate converted to glucose / hexose / RuBP / ribulose bisphosphate / named organic substance;

[6]

7 (a)

Part of ecosystem	**Mean rate of carbon dioxide production / $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	**39.8**
Non-photosynthetic soil organisms	0.045	**35.2**

2 correct = 2 marks;;

Adding rates to get 0.128 = 1;

If rounded to 40 and 35 in table;

- *but working shows decimal points, then award 2 marks*
- *but no working shown, then 1 max*

2 max

(b) 1. Data only include (heterotrophic) soil organisms;

2. Doesn't include animals (above ground) / other (non-soil) organisms;

3. Doesn't take into account anaerobic respiration;

Award points in any combination

Accept for 1 mark idea that CO_2 for leaves doesn't take into account photosynthesis – not told in dark until part (d)

2 max

(c) **All three** of following = 2 marks;;

Two of them = 1 mark;

Volume of carbon dioxide given off

(From known) area / per m^2 / m^{-2}

In a known / set time

Ignore 'amount' / concentration of CO_2

Accept per second / per unit time

2

(d) 1. (In the light) photosynthesis / in the dark no photosynthesis;

2. (In light,) carbon dioxide (from respiration) being used / taken up (by photosynthesis);

2

(e) (i) (Rate of respiration)

Assume "it" means soil under trees

1. In soil under trees (always) higher;
   Accept converse for soil not under trees
   Accept 'in the shade' means under the trees

2. In soil under trees does not rise between 06.00 and 12.00 / in the middle of the day / peaks at 20:00-21.00 / in the evening;

3. In soil **not** under trees, peaks at about 14:00-15:00 / in middle of day;
   2. and 3. No mm grid, so accept 'between 18.00 and 24.00' or 'between 12.00 and 18.00'

2 max

(ii) <u>(Between 06.00 and 12.00</u>, (No Mark))

Respiration higher in soil under tree, (No mark)

Do not mix and match mark points

No list rule

1. Tree roots carry out (a lot of) respiration;

2. More / there are roots under tree;
   Accept converse for soil not under trees

OR

3. More food under trees;

4. So more active / greater mass of / more organisms (carrying out respiration);
   Accept converse for soil not under trees

OR

Soil not under trees respiration increases (No mark)

5. Soil in sunlight gets warmer;

6. Enzymes (of respiration) work faster;
   Accept converse for soil under trees

2 max

(f) (i)

1. Photosynthesis produces sugars;

2. Sugars moved to roots;
   Do not penalise named sugars other than sucrose

3. (Sugars) are used / required for respiration;

2 max

(ii) Takes time to move sugars to roots;

Look for movement idea in (i) – can carry forward to (ii)

1

[15]

8 (a) Push – legume

Pull – grass;

Both needed for mark

1

(b) 1. Set up tape measures on two sides of the plot / make grid of plot;

Allow 'Number each plant'. With this approach mp3 cannot be awarded.

2. Use random number table / calculator / generator;

Allow 'Select from a hat' idea.

3. To generate coordinates;

3

(c) 1. To prevent competition between the maize and the grass;

2. For light / nutrients / water;

OR

3. Idea of limits movement of pest (between grass and maize);

4. Only eating / damaging grass;

2 max

(d) 1. Nitrogen-fixing bacteria convert nitrogen (in the air) into ammonium compounds (in the soil) which are converted into nitrates / nitrification occurs;

Accept 'ammonia' for 'ammonium compounds'.

2. Maize uses nitrates (in soil) for amino acid / protein / ATP / nucleotide production;

2. Must be in the context of maize.
Ignore ionic formulae unless only these are given.

2

(e) 1. Reduced % damage to maize plants / increased maize grain yield;

2. Calculation to justify mp 1;

3. Standard deviation shows no overlap but need stats to show significance of this difference;

4. More profit / net income / greater income than additional cost (with push-pull);

5. $322 extra / 408% more / $401 v $79 profit;

Accept '$350 extra income compared to $28 extra spend'.

Mp5 gains credit for both mp4 and 5

3 max

[11]

9

1. Growth of algae / surface plants / algal bloom blocks light;

2. Reduced / no photosynthesis so (submerged) plants die;

3. <u>Saprobiotic</u> (microorganisms / bacteria);

3. Accept: Saprobiont / saprophyte / saprotroph

3. Neutral: decomposer

4. Aerobically respire / use oxygen in respiration;

5. Less oxygen for fish to respire / aerobic organisms die;

[5]

10 **1.P** Pathogens and effects on host

2.T Taxonomy

2.C Classification and evolution.

2.I Inheritance and evolution

2.Gc Genetic code, universal

2.B Behaviour

2.Ev Populations and evolution, variation between individuals within a species

3.BP Relationships within ecosystems − eg predator / prey

3.E Energy transfer in ecosystems

3.N Nutrient cycles, the organisms involved

3.S Succession, biodiversity, species and individuals in a community

4.H Human impacts on the environment and its effect on relationships between organisms − including farming

4.Gt Gene technology and GMO and selective breeding

4.Ar Antibiotic resistance

Examiners are free to select other letters if they wish

The emphasis in answers should be on the <u>relationships and interactions between organisms</u> not just the topics themselves

Breadth, one mark for use of an example from each of the following approaches − <u>3 max:</u>

1. Pathogen and host

2. Evolution (related topics)

3. Ecological

4. Human intervention in relationships

[25]

11 (a) (i) Nitrification / oxidation;

Accept 'nitrifying'

1

(ii) Denitrification;

Accept 'denitrifying'

1

(b) 1. (Nitrogen) to ammonia / NH_3 / ammonium;

1. Do not disqualify mark for any references to ammonia being converted to nitrite, nitrate etc

2. Produce protein / amino acids / named protein / DNA / RNA;

2. Do not disqualify mark for any references to protein being formed from nitrogen, nitrite or nitrate

2

(c) 1. Soil has low(er) water potential / plant / roots have higher water potential;

1. Reference to water potential gradient is sufficient if correct direction of gradient or water movement is outlined

1. Accept WP or Ψ for water potential

2. Osmosis from plant / diffusion of water from plant;

2. Accept plant takes up less / not enough water by osmosis

2. Reference to movement of minerals by osmosis negates mark

2

[6]

12 (a) 1. Fertilisers / minerals / named ion (added to soil);

Accept any named examples of natural fertilisers for mark point 1 e.g. manure, bone meal etc. Ignore named elements

2. Role of named nutrient or element e.g. nitrate / nitrogen for proteins / phosphate / phosphorus for ATP / DNA;

Accept fertilisers / minerals / named nutrient / element removes limiting factor for mark point 2

3. Selective breeding / genetic modification (of crops);

Accept idea of choosing particular variety of crop for mark point 5

4. Ploughing / aeration allows nitrification / decreases denitrification;

5. Benefit of crop rotation in terms of soil nutrients / fertility / pest reduction;

5

(b) 1. Protein / amino acids / DNA into ammonium compounds / ammonia;

Accept any named nitrogen containing compound e.g. urea for mark point 1

2. By saprobionts;

Accept saprophytes for mark point 2

3. Ammonium / ammonia into nitrite;

Accept marks for conversion i.e. mark points 1, 3, 4 and 6 even if incorrect type of bacteria named as being involved

4. Nitrite into nitrate;

However, reject marks for type of bacteria i.e. mark points 2, 5 and 7 if linked to incorrect process e.g. nitrite converted to nitrate by saprobionts

5. By nitrifying bacteria / microorganisms;

6. Nitrogen to ammonia / ammonium;

Award one mark for ammonia / ammonium into nitrate if neither mark point 3 or 4 awarded

7. By nitrogen-fixing bacteria / microorganisms in soil;

Ignore reference to nitrogen-fixing bacteria in root nodules. If not specified, assume nitrogen-fixing bacteria are in the soil

5 max

[10]

13 (a) Nitrification;

Accept nitrifying.

Do not accept nitrogen fixing.

1

(b) 1. Uptake (by roots) involves active transport;

Reject all references to bacteria

2. Requires ATP / aerobic respiration;

2

(c) (i) 1. Not enough time / fast flow washes bacteria away;

"Not enough time for bacteria to convert all the ammonia to nitrate" gains 2 marks

2. (Not all / less) ammonia converted to nitrate / less nitrification;

2

(ii) 1. Algal bloom / increase in algae blocks light / plants / algae die;

2. Decomposers / saprobionts / bacteria break down dead plant materials;

3. Bacteria / decomposers / saprobionts use up oxygen in respiration / increase BOD causing fish to die;

3. Accept alternatives such as microbes / saprophytes.

3

[8]

14 (a) (i) 1. Gases / correct named gas not released;

2. Conditions (in digester) can be controlled;

3. Products / named product can be collected;

4. Open ponds associated with health risk / environmental damage / eutrophication;

Correct named gases include: methane, carbon dioxide, hydrogen sulphide, nitrogen oxides

1. Allow substance = product

4. Accept 'pond' in any context

2 max

(ii) 1. <u>Respiration</u> causes temperature increase / release of heat;

2. Enzymes would be denatured / microorganisms killed;

2

(b) (i) 1. Increase algae / algal bloom causes light to be blocked out;

2. Plants can't photosynthesise / plants and / or algae die;

3. Bacteria / saprobionts / EW feed off / breakdown dead organisms using up oxygen / bacteria respire / BOD rises;

3

(ii) 1. Acts as soil conditioner / improves drainage / aerates soil / increases organic content of soil;

2. Contains other elements / named element / wider range of elements;

3. Production of artificial fertiliser energy-consuming;

4. Less leaching / slow release (of nutrient);

Unspecified answers relate to natural fertiliser. Ignore references to cost / eutrophication

2. i.e. elements other than nitrogen, phosphorus and potassium

1 max

[8]

15 (a) 1. Saprobionts / saprophytes;

2. Digest / break down proteins / DNA / nitrogen-containing substances;

3. Extracellular digestion / release of enzymes;

4. Ammonia / ammonium produced;

5. Ammonia converted to nitrite to nitrate / ammonia to nitrate;

6. Nitrifying (bacteria) / nitrification;

7. Oxidation;

Ignore all references to other parts of the nitrogen cycle

1. Accept saprotrophs. Allow this mark if saprobionts linked to fungi.

2. Ignore"nitrogen in plants"

Ignore enzymes excreted

6. Accept Nitrosomonas / Nitrobacter

5 max

(b) 1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. Produces two molecules of glycerate (3-)phosphate / GP;

3. Reduced to triose phosphate / TP;

4. Using reduced NADP;

5. Using energy from ATP;

6. Triose phosphate converted to other organic substances / named organic substances / ribulose bisphosphate;

7. In light independent reaction / Calvin cycle;

3. Accept add hydrogen for reduced

4. Accept alternatives such as NADPH for reduced NADP / GALP for TP / ribulose biphosphate

6 max

[11]

16 (a) Complementary to / fits / binds to <u>active site</u>;

Competitive / competes / ‘prevents’ enzyme-substrate complexes / ‘prevents’ urea attaching;

Max one mark if candidate suggests that active site / enzyme is damaged destroyed or useless.

Allow inhibitor ‘prevents’ or ‘stops’ urea / substrate attaching unless candidate clearly indicates this is permanent.

Ignore reference to inhibitor forming an enzyme / substrate complex.

2

(b) (i) Reduces loss of ammonia up to day8 / 9;

1

(ii) Increase in urease / temperature;

More enzyme-substrate complexes;

More bacteria;

2 max

(c) Less urea / ammonia lost (from soil) / less urea broken down;

Urea / ammonia converted to nitrite / nitrate;

Used to produce protein / amino acids / DNA / bases / nucleotides;

Reference to incorrect bacteria (e.g. denitrifying) producing nitrite / nitrate negates second marking point.

3

[8]

17 (a) Ammonia / ammonium / NH_3 / NH_4^+;

1

(b) Will have similar shape / tertiary structure (as substrate) / complementary shape (to active site);

Neutral: same shape as substrate

Fit / bind with active site / forms enzyme-substrate complex;

Reject: same shape as active site

2

(c) (i) Provides ATP for the reaction / nitrogen fixation / reduction of nitrogen / formation of ammonia;

Accept: ATP or energy

Enzyme / nitrogenase produced quicker / more enzyme produced;

Ignore references to temperature

Uses / removes oxygen (so nitrogenase works);

Use of oxygen must be in the correct context

2 max

(ii) ATP used for / needed for nitrogen fixation / reduction of nitrogen / formation of ammonia / production of enzyme / nitrogenase;

Accept: ATP or energy

(So less ATP) available for growth / protein synthesis / production of new cells / production of biomass;

Accept: converse for those without fertiliser

2

[7]

18 (a) 1. High concentration of carbon dioxide linked with night / darkness;

Accept: converse of low in day

2. No photosynthesis in dark / night / light required for photosynthesis / light-dependent reaction;

Ignore references to rate of photosynthesis in day / night
Accept day = light

3. (In dark) plants (and other organisms) respire;

Must be a reference to plants or all organisms

4. In light net uptake of carbon dioxide by plants / plants use more carbon dioxide than they produce / rate of photosynthesis greater than rate of respiration;

Do not allow converse for this point
Accept description of compensation point

5. Decrease in carbon dioxide concentration with height;

Accept: converse of increase closer to ground

6. At ground level fewer leaves / less photosynthesising tissue / more animals / less light;

5 max

(b) 1. Carbon dioxide combines with ribulose bisphosphate / RuBP;

2. To produce two molecules of glycerate 3-phosphate / GP;

3. Reduced to triose phosphate / TP;

4. Requires reduced NADP;

5. Energy from ATP;

This mark scheme is based on specification content. Accept alternate names such as NADPH

Credit relevant diagrams

Accept: description of 'reduced'

5

[10]

19 *(a)* (i) dissolve (in soil water) / run-off / leaching; *reject nitrogen dissolving.*

1

(ii) insoluble / less soluble;
(molecules) require breaking down / slow release;

2

(b) increased growth / algal bloom;
blocks light; less photosynthesis;
plants die;
increase in decomposers / bacteria; *ignore growth of bacteria*
bacteria respire;
less oxygen;

20 (a) **P** – denitrification;
Q – Nitrogen fixation;

(b) Ammonia formed by decay / decomposition / putrefying / ammonifying / by action of decomposers / saprobionts;
On nitrogenous waste / urea *or* nitrogenous compounds (e.g. proteins, amino acids, DNA, ATP);

(c) Oxygen added / hydrogen removed;
Ignore references to electron loss

21 (a) (i) mass produced increases then levels off at 17.1 kg m^{-2} / concentrations above 40 kg ha^{-1};

(ii) replaces nutrients removed;
fertiliser provides nitrate needed for protein / amino acid production; as more fertiliser added, there is more growth / protein / amino acid / yield;

(iii) plants already have enough nitrate / nitrate no longer limiting;
another named factor / element is limiting growth;

(b) because cattle excreted / produced faeces / droppings / cowpats / manure; in field B crop used elements / minerals / nitrates / nutrients last year;

22 *(a)* No - very little increase / no increase in yield of grass when *Rhizobium* added / no difference between C and D;

(b) Yes: increased yield with nitrates;

Correct reference to result in graph **C** c.f. graph **A /** use of correct numbers (from C + A)
e.g. greater yield of soyabean in C than in A /

greater yield of soyabean with nitrate than without if

2

4 max

[7]

2

2

1

[5]

1

2

2

2

[7]

1

(c) Forms mutualistic / symbiotic union with soyabean / forms root nodules / mutual benefits (/ described);
makes ammonia / ammonium; (Nitrates – CANCEL)
Helps produce organic-N / amino acids / protein;

max 3

[6]

23

(a) (i) nitrogen-fixing;

(ii) nitrifying;

(names neutral, name only no mark)

2

(b) (i) growing legumes / named legume;
ploughed in / allowed to decompose / nitrogen-fixing (bacteria in nodules);

OR

allow cattle / named species / (farm) animals (to graze);
add dung / urine;

OR

spread / add manure / slurry;
decomposed to release nitrates / ammonia / nitrites;

2

(ii) bare soil / fallow in winter / hedge removal; leaching (of nitrates) / soil erosion;

OR

uptake of nitrates / ammonium compounds by crop;
harvesting crop / named crop which would be harvested;

OR

(farm) animals eat plants (in field); (then) animals removed;

2

[6]

24

(a) breakdown of organic matter / sewage by enzymes from bacteria;
nitrates / ammonia used by algae to make amino acids / proteins;
algae photosynthesise;
bacterial respiration uses O_2 / produces CO_2 for algae;
(respiration) allows for reproduction / growth of bacteria;

4

(b) sufficient light penetration for photosynthesis (of algae);
warm leads to faster enzyme activity;
faster bacterial respiration / decomposition;
faster photosynthesis;
increased growth / reproduction of bacteria / algae;

4

[8]

25

(a) contain nitrogen-fixing bacteria in roots / nodules (so don't need fertiliser);
nitrogen containing compounds added to the soil
when plant dies / after harvest of crop;

2

(b) low(er) / more negative water potential in soil (than in the plant);
prevents roots from taking up water (from the soil) / plants still lose water by transpiration; plants lose water to soil by osmosis;

2

26

(a) more proteins / amino acids / more DNA / nucleotides / nucleotide derivative;
increased cell division / number of cells formed;

2

(b) reduced light / shading;
less photosynthesis;

2

(c)
1 bacteria / fungi feed on dead matter saprobiotically;
2 respiration uses up oxygen;
3 converts proteins to amino acids;
4 then to ammonium compounds;
5 nitrifying bacteria convert ammonium compounds;
6 via nitrates;

6

(d) lower species diversity / number of species;
species tolerant to low oxygen thrive / species requiring high oxygen die out;

2

[12]

27

(a) (i) ammonia / ammonium ions / compound;

1

(ii) glucose;

1

(b) final acceptor for hydrogen:
to form water;

2

(c) glycolysis can continue;
NAD can accept more hydrogen;

2

(d) secondary / tertiary structure;
produces particular shape of active site;
or
(shape of) active site;
complementary to shape of substrate;

2

(e) sodium ions / non-competitive inhibitor binds to enzyme
at a site other than active site;
resulting in change of shape of active site / no longer complementary;
substrate can no longer bind with the enzyme / enzyme-substrate complexes no longer formed;

3

[11]

28 (i) excessive use of fertilisers;
run-off / leaching;

2 max

(ii) 1. growth of algae / plants stimulated / increased;
2. death of algae / plants;
3. <u>more</u> bacteria / decomposers / decomposition;
4. respiration;
5. decomposers / bacteria remove oxygen;
6. animals die (because of lack of oxygen);

5 max

[7]

29 (a) very long / deep roots, to reach water deep in the soil / nitrogen-fixing bacteria, to provide a source of nitrogen for growth in poor soil;

1

interspecific;

1

(b) (mesquite) proteins / amino acids (ploughed) into soil / nodules ploughed in and (decomposers) bacteria / fungi feed on these;
excrete ammonia;
nitrifying bacteria convert these to nitrites / nitrates;
absorbed by roots of grasses and increase their growth;
accept increases recycling of other ions / phosphate / potassium;

3

(c) control organism a parasite / predator;
specific to pest;
population varies with population of pest;
controls size of pest population but does not kill all;
keeps pest population low enough to prevent significant (economic) damage;

3 max

[8]

30 (a) proteins / amino acids broken down;
deamination / ammonification / release of ammonium compounds;
conversion to nitrates;
by nitrifying bacteria / named bacterium;
nitrates absorbed into roots; **5**

(b) fewer nitrates in the soil for the next crop / plants grow less well because of lack of nitrates;
requiring application of more fertiliser / economic reason for using less fertiliser / valid environmental reason explained e.g. nitrates leaching into water / eutrophication / explanation / health related e.g drinking water; **2**

(c) production of phospholipids;
in cell membranes;
synthesis of ATP;
production of DNA;
production of RNA;
production of NADP; **4 max**

31 (a) (i) presence of grass causes less nutrients / minerals / nitrates / ammonium ions to be leached;
(do not allow references to less nitrogen) **1**

(ii) clover contains nitrogen-fixing bacteria;
(do not allow references to nitrifying bacteria)

decomposition (of ploughed clover) introduces nitrates / ammonium ions into soil; **2**

(b) (i) minimal effect / no significant effect on yield / small increase up to 25 kg ha^{-1};
increase in protein content of grain with all fertiliser applications; **2**

(ii) (37 ÷ 44 =) 0.84 : 1.0
(allow 0.8 : 1); **1**

32 run off / leaching of nutrients / nitrates;
leads to increased growth of algae / plants;
competition for light / effect of competition;
death of algae / plants;
increases food supply / increases microorganisms / decomposers;
respiration (of microorganisms) uses up oxygen / increases BOD;
fish / animals die due to lack of oxygen;

[5]

[11]

[6]