1. Dieldrin is an organochlorine pesticide. It was used to treat wheat grain before planting. An investigation was carried out to find the effect of treated wheat grain on the dieldrin concentration in the tissues of mice living in wheat fields. Mice were trapped before and after the treated wheat was planted. One line of traps was in the grass border of the field. Another was in the area planted with wheat.

Period	Location of traps	Number of mice caught	Number of mice analysed	Mean dieldrin content of mice / ppm
Before sowing	In grass border	11	9	0.15
Before sowing	In planted area	15	4	0.23
After sowing	In grass border	18	2	6.49
After sowing	In planted area	18	7	10.96

(a) (i) Calculate the percentage change in mean dieldrin concentration in the tissues of mice from each of the two areas. Show your working.

Percentage change in grass border . . . . . %

Percentage change in planted area . . . . . %

(2)

(ii) Suggest **one** explanation for the different dieldrin content of mice trapped in the two areas after sowing.

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(1)

(b) Suggest **one** reason why the results of the investigation might be unreliable.

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(1)

(c) Suggest an explanation for the fact that the use of dieldrin is now banned in this country.

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(2)
(Total 6 marks)

2. Read the following passage.

Nitrogen-fixing bacteria provide the first vital steps in making atmospheric nitrogen available to other living organisms. It has been estimated that every year a hundred million tonnes of nitrogen are fixed by these simple prokaryotic organisms.

The most effective nitrogen-fixing organisms are bacteria of the genus *Rhizobium* which form mutualistic relationships with leguminous plants such as beans and clover. These bacteria live freely in the soil and are attracted to the roots of young leguminous plants by secretions produced by these roots. They penetrate the root cells and multiply rapidly. The root cells around the point of infection also multiply rapidly and a root nodule is formed. A mature root nodule consists of a central region containing nitrogen-fixing bacteria and a surrounding region which contains xylem and phloem, the tissues of the plant's transport system.

The biochemical pathway by which the bacteria fix nitrogen is not fully understood, but it can be summarised by the equation:

$$15ATP + 6H^+ + 6e^- + N_2 \rightarrow 2NH_3 + 15ADP + 15P_i \text{ (inorganic phosphate)}$$

This reaction is catalysed by the enzyme nitrogenase and makes heavy demands on the photosynthetic product of the host plant. The ammonia (NH_3) is converted to organic products which are transported to the cells of the plant by the xylem.

(a) (i) Using information in the passage, explain why the relationship between nitrogen-fixing bacteria and leguminous plants is described as mutualistic.

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(3)

(ii) Explain why the fixation of nitrogen "makes heavy demands on the photosynthetic product of the host plant."

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(2)

(b) Nitrogen-fixing bacteria are described as providing "the first vital steps in making atmospheric nitrogen available to other living organisms". Describe the role of microorganisms in making nitrogen in organic compounds in dead material from leguminous plants available to other plants.

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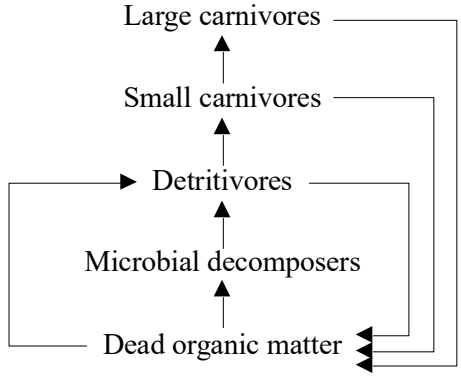
(5)
(Total 10 marks)

3. The diagram shows a simplified food web.



(a) What is the difference between the ways in which microbial decomposers and detritivores obtain their nutrients?

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(2)

(b) Explain **two** ways in which the presence of detritivores may increase the activity of microbial decomposers.

1. .....

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2. .....

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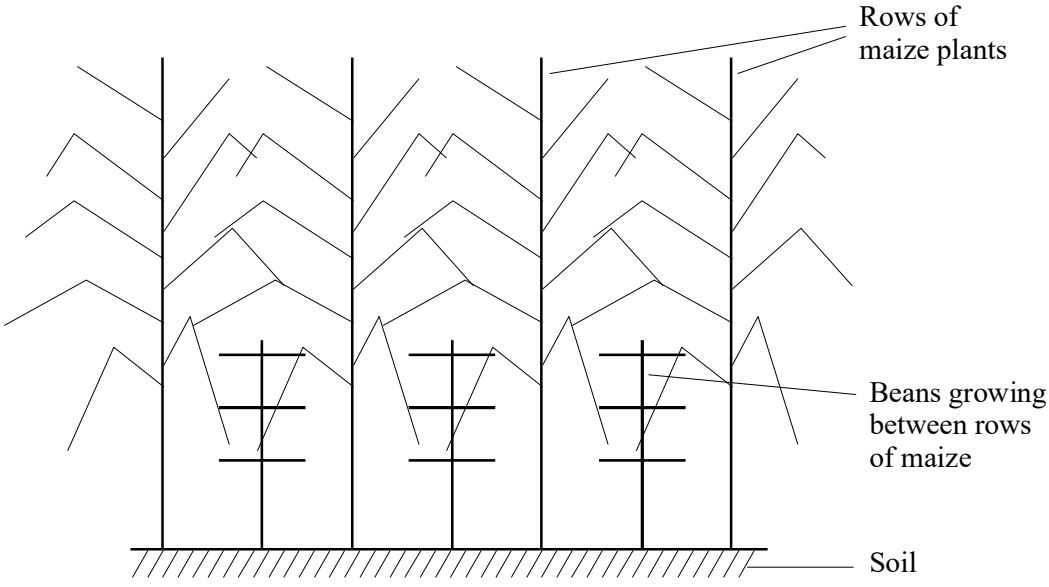
(4)
(Total 6 marks)

4. Intercropping involves growing two or more different species of plants together. Maize and beans are intercropped in many tropical regions.



Diagrammatic cross-section through a mixed crop of maize and beans

(a) Identify **one** abiotic factor which would affect the growth of maize plants. Describe how you could measure variation in this factor over a 24-hour period.

Abiotic factor

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Method of measurement

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(2)

(b) Describe **two** ways in which maize plants affect the abiotic environment of the bean plants.

1. .....

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2. .....

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(2)

(c) The maximum yield which could be gained from a plot in which maize and beans are intercropped would be higher than that which could be gained if either maize or beans were grown alone. Explain why.

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(2)

(Total 6 marks)

5. Read the following passage.

Reef-building corals are small marine animals that form immense colonies. Each animal (called a polyp) has a small sac-like body surrounded by a ring of tentacles. The beating action of these tentacles sets up a current which brings in a continuous supply of the tiny planktonic organisms which form their food.

The Gulf of Aqaba at the top of the Red Sea is home to the world's northernmost coral reefs. It is also becoming an increasingly popular tourist spot and an upsurge of tourism in this area could cause permanent damage to this ecosystem.

Development is often accompanied by pollution. With no rivers entering it and a relatively narrow connection with the rest of the Red Sea, the Gulf is so clear that it has been called a "blue desert". These are the conditions in which corals thrive. Pollution that enriches the water can lead to an increase in the amount of seaweed attached to the surface of the reef and to the amounts of planktonic algae suspended in the water.

Corals need sunlight because they also depend for their survival on tiny green algae that live in their tissues. These algae provide the coral polyps with additional carbon and benefit in turn from nitrates and phosphates produced as waste by the corals.

(a) Explain why the waters of the Gulf of Aqaba have been called a "blue desert" (lines 9 - 10).

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(2)

(b) (i) What name is given to the relationship between the coral polyps and the algae living in their tissues?

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(1)

(ii) Explain how the coral polyps gain carbon from the algae living in their tissues (line 14).

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(3)

(c) Explain the link between pollution, planktonic algae and a decrease in corals.

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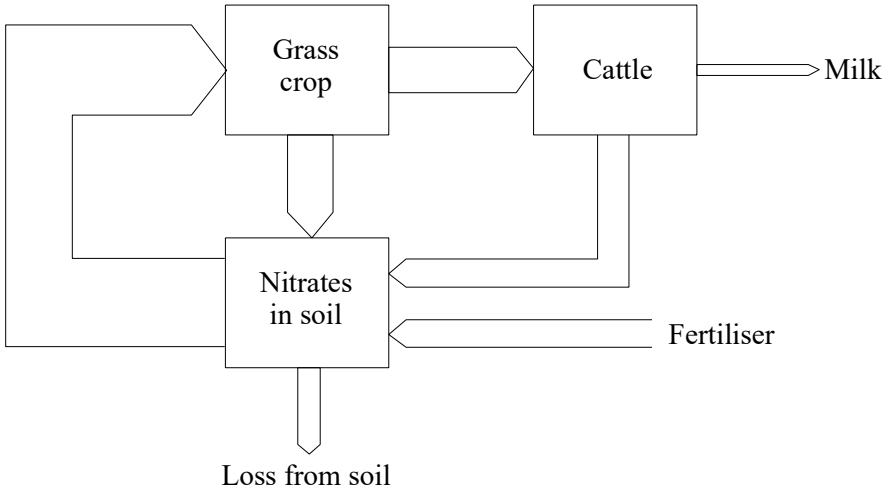
(6)

(Total 12 marks)

6. The diagram represents the cycling of nitrogen on a dairy farm. The width of the arrows represents the relative amount of nitrogen.



(a) Not all of the nitrate is taken up by the grass crop. Some is lost from the soil.
Give **two** ways in which nitrate may be lost from the soil.

1.....

2.....

(1)

(b) Use information from the diagram to explain why it is necessary for a farmer to add fertiliser in order to maintain production of milk.

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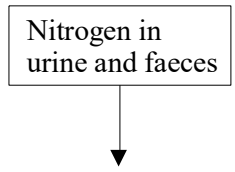
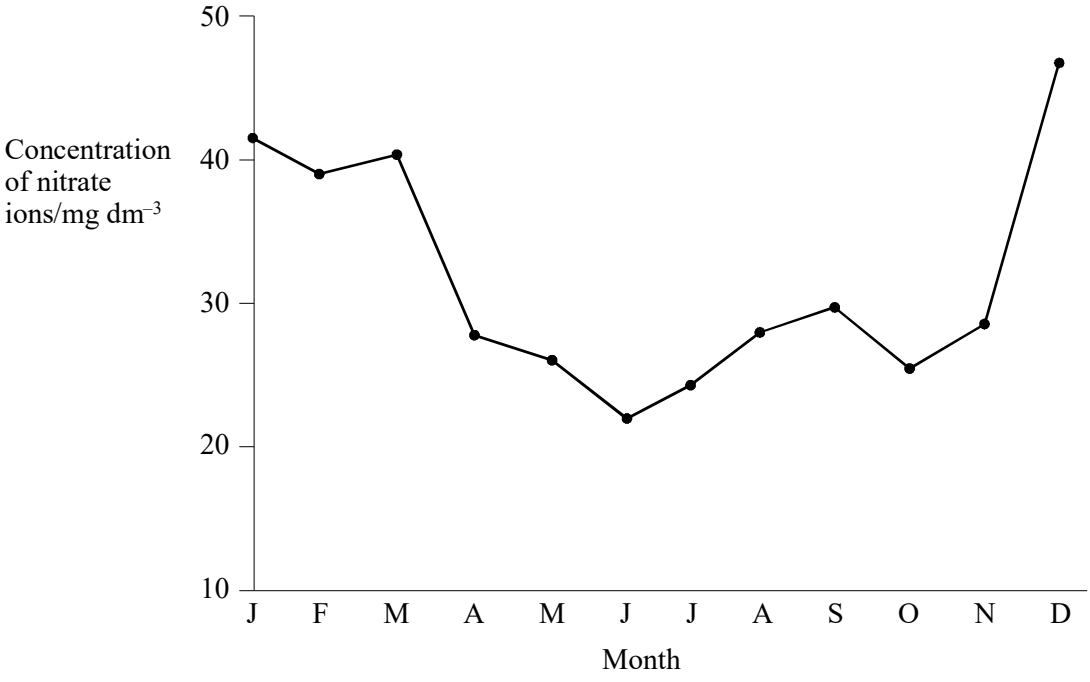
(2)

(c) Complete the flow chart below to show the pathway by which nitrogen in the urine and faeces of cattle is converted into a form suitable for uptake by the grass crop.
Indicate on your flow chart the type of bacterium responsible for each step.



(2)
(Total 5 marks)

7. The graph shows the nitrate concentration in a river over a period of one calendar year.



(a) (i) Describe the variation in nitrate concentration shown in the graph.

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(1)

(ii) Suggest **two** possible explanations for a rise in nitrate concentration in the river.

1. .....

2. .....

(2)

(b) Explain how each of the following could account for falling nitrate concentration.

(i) algal growth

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(2)

(ii) biological denitrification

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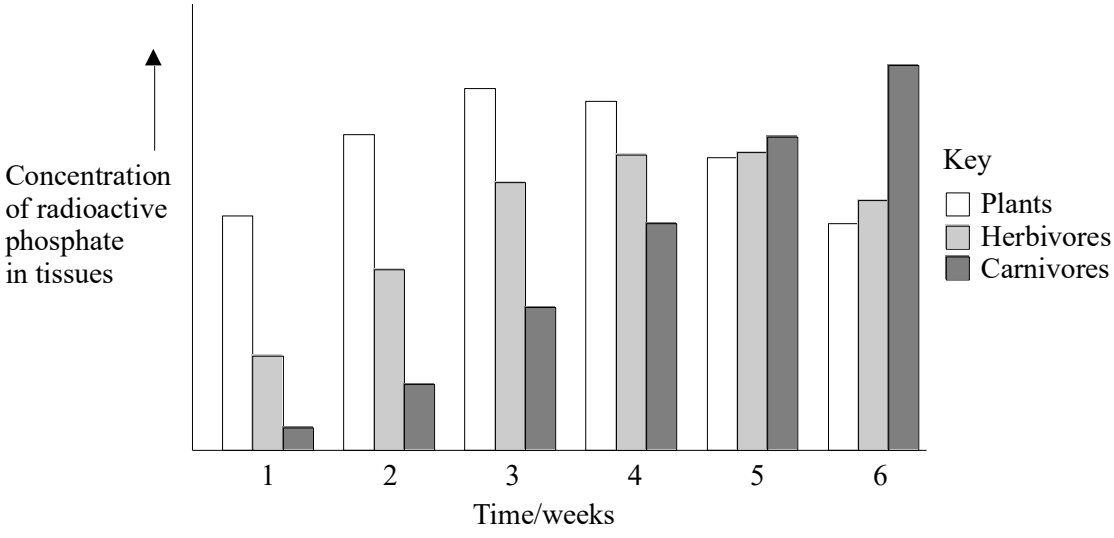
(2)
(Total 7 marks)

8. In an investigation of food chains in an area of grassland, an experimental plot was treated with a solution containing radioactive phosphate. The phosphate was taken up by the plants and their tissues became radioactive.

The bar chart shows the concentrations of radioactive phosphate in the tissues of the plants, the herbivores and the carnivores in the plot over the next six weeks.



(a) The radioactive phosphate was absorbed by the plant and incorporated into organic compounds. Name **two** phosphorus-containing organic compounds and describe their importance in plants.

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(4)

(b) (i) Describe and explain the changes in the concentrations of radioactive phosphate in the tissues of the plants and the herbivores over the six–week period.

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(4)

(ii) Suggest **one** way in which microorganisms are involved in recycling phosphorus contained in the tissues of dead carnivores.

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(1)

(c) If radioactive carbon had been used for this investigation, a much lower proportion would be passed on to the organisms in the next trophic level. Suggest why.

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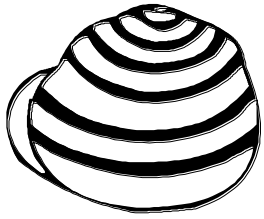
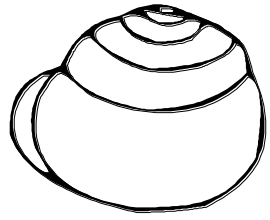
(3)

(Total 12 marks)

9. *Cepaea nemoralis* is a species of snail that lives in woods and fields. The snails are preyed on by birds such as thrushes. There are several different colour variations, such as yellow with dark bands and brown with no bands. The drawings show these two forms of the snail.



Yellow, banded



Brown, unbanded

In an investigation, samples of the snail were collected from two sites, one in a beech wood and the other under a hedge. The results are shown in the table.

Collection site	Number of snails collected		
	Yellow, banded	Brown, unbanded	Total
Beech wood	32	88	120
Hedge	49	26	75

(a) (i) Calculate the percentage of brown, unbanded snails at each collection site.

Beech wood .....% Hedge .....%

(1)

(ii) A chi-squared test was carried out on the results. Explain the purpose of this test.

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(2)

(b) Give **one** assumption that needs to be made about the method used to collect the snails.

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(1)

(c) Suggest a hypothesis to explain the different proportions of brown, unbanded snails found at the two sites.

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(1)

(d) Describe how the carbohydrates in the dead leaves in the beech wood would be recycled by the activity of detritivores and microorganisms.

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(7)
(Total 12 marks)

10. (a) (i) Describe **one** way in which mineral ions are released from rocks into soil.

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(1)

(ii) Describe how detritivores are involved in the recycling of nutrients.

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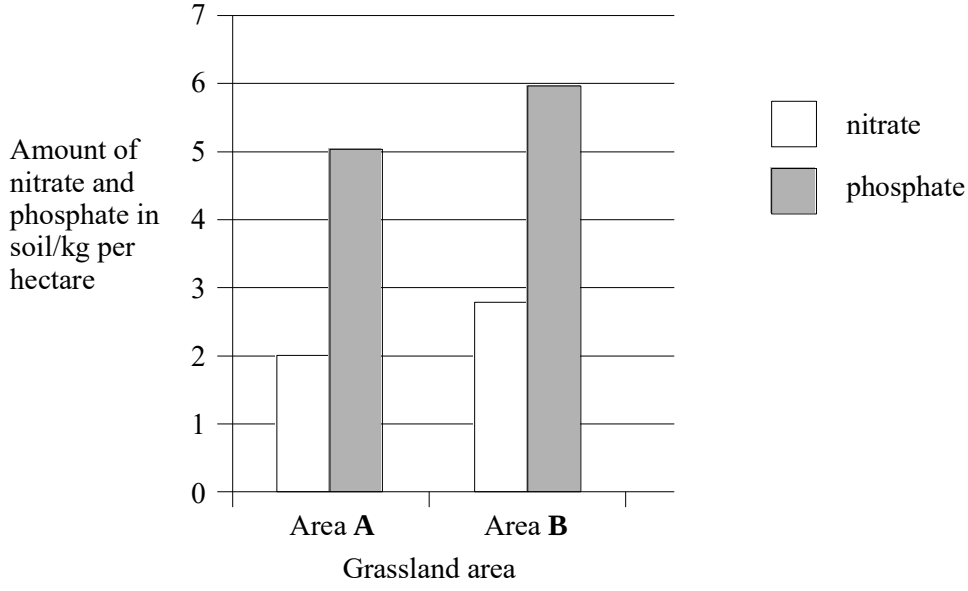
(3)

(b) The bar chart shows the amounts of nitrate and phosphate in soil from two different areas of grassland, **A** and **B**. Both areas are used for grazing.

Area A	**Area B**
No fertiliser or manure added. Contains: 2 species of grass 10 other species of flowering plant	Sprayed yearly with liquid manure. Contains: 3 species of grass 1 other species of flowering plant



(i) Explain the effect of nitrate and phosphate supply on the diversity of plants.

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(2)

(ii) Area **B** is going to become part of a nature reserve. A proposed change in land management is to stop spraying with liquid manure. Explain the likely effect of this change on the diversity of plants.

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(1)
(Total 7 marks)

11. (a) Explain what is meant by

(i) nitrification;

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(ii) denitrification.

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(2)

(b) Explain how the leaching of nitrates from farmland into rivers may lead to a large increase in biochemical oxygen demand (BOD).

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(5)
(Total 7 marks)

12. (a) Wet moorland soils often contain low concentrations of nitrogen compounds, as a result of denitrification. Sundew is a plant which lives in wet moorlands. Its leaves have sticky hairs which can trap small insects that are then digested.

(i) Describe the process of denitrification.

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(2)

S (ii) Explain how digestion of insects helps the sundew to obtain additional nitrogen compounds.

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(2)

S (b) Samples of plant and animal tissue were analysed to determine the proportions of the elements, carbon and nitrogen. In the plant tissue the ratio of carbon to nitrogen was 40:1. In the animal tissue the ratio was 8:1.

Explain why the ratio is much higher in the plant tissue than in the animal tissue.

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(2)

(c) Describe how nitrogen in compounds in a dead plant is made available for use by other plants.

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(6)
(Total 12 marks)

13. This questions should be answered in continuous prose, where appropriate.

The table shows the percentage of certain substances remaining in fallen oak leaves as they decompose.

Time after falling from tree/weeks	Percentage of each substance remaining		
	Starch	**Cellulose**	**Lignin**
4	63	98	99
8	50	94	98
12	41	90	96
16	37	64	94
20	30	52	92
24	18	38	90

S (a) Explain how the activities of saprophytic fungi account for the figures in the table.

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(3)

S (b) Microorganisms which feed only on sugars are common in the leaves 12 to 16 weeks after they have fallen. Suggest an explanation for the abundance of these microorganisms.

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(2)

S (c) Describe how carbon dioxide released by the decomposition of leaves may become incorporated into storage carbohydrate in the roots of green plants.

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(4)

S (d) Plants which live in peat bogs are decomposed very slowly after their death. This is because the peat contains tannic acid in which only a small number of species of microorganisms can survive. Explain how natural selection could result in microorganisms that can survive in peat bogs.

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(3)
(Total 12 marks)

14. This questions should be answered in continuous prose, where appropriate.
Quality of Written Communication will be assessed in these answers.

S (a) The availability of nitrogen-containing compounds in the soil is often a limiting factor for plant growth. Explain **two** ways in which a shortage of nitrogen-containing compounds could limit plant growth.

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(4)

(b) Farmers apply nitrate fertilisers to improve crop growth.

S (i) Explain why plants may fail to grow if high concentrations of nitrate are applied to the soil.

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(2)

(ii) Streams and rivers running through farmland can also be adversely affected by application of high concentrations of nitrate fertiliser. Fish cannot survive when the oxygen levels of water are reduced. Explain how high concentrations of nitrate applied to farmland may result in the reduction of the numbers of fish present in aquatic ecosystems.

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(5)

S (c) Malonate is a substance that inhibits the enzymes of the Krebs cycle. In an investigation, plant roots were placed in a solution containing nitrate and malonate. The solution had air bubbled through it. Explain why these plant roots took up nitrate more slowly than those in a control solution which contained nitrate but no malonate.

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(3)

(Total 14 marks)

15. 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.

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

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(5)

(b) Explain how the removal of hedges near the lake would increase the impact of fertilisers on the aquatic ecosystem.

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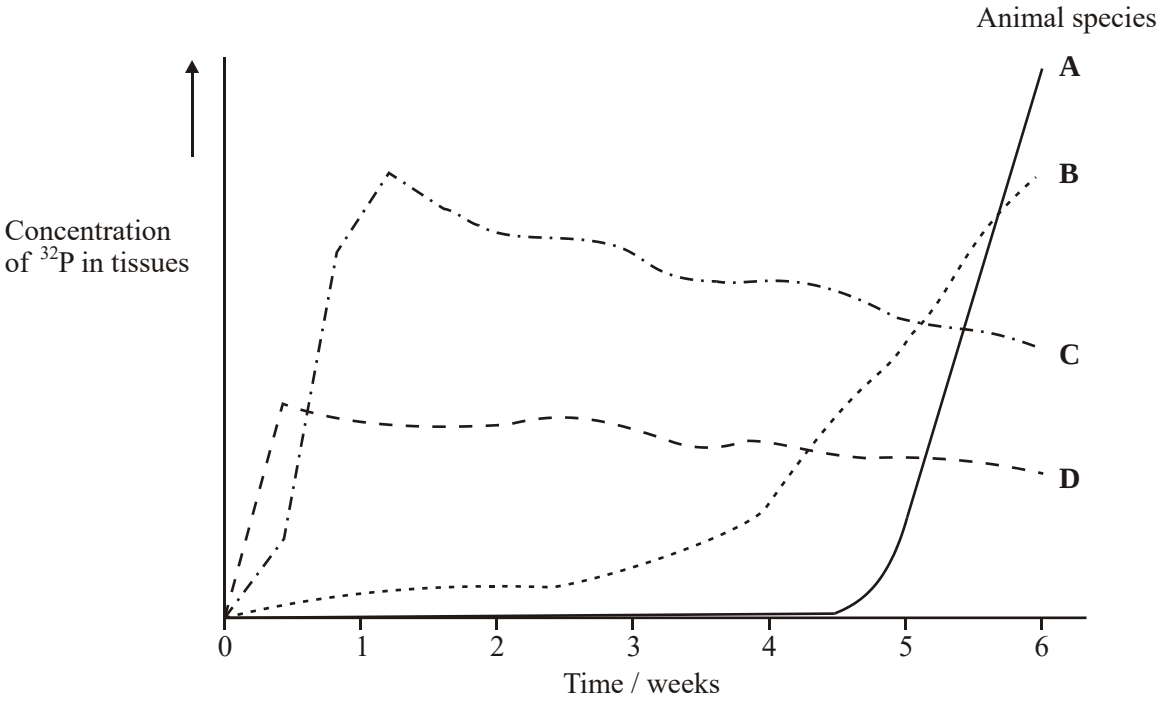
(2)

(Total 7 marks)

16. Plants growing in a field were supplied with a radioactive isotope of phosphorus, ^{32}P.
The plants took up this isotope and incorporated it into substances in their tissues.
At intervals, four different species of animal living in the field were sampled and the amount of radioactive phosphorus in their tissues was measured. The results are shown in the graph.



The four species of animal, **A** to **D**, were the consumers in a single food chain.

(a) To which trophic level does species **C** belong? Give a reason for your answer.

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(2)

(b) Explain why a food chain does not usually have more than five species.

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(1)

S (c) Name **two** biological compounds into which radioactive phosphorus could be incorporated.

1 .....

2 .....

(2)
(Total 5 marks)

17. A species of tropical plant has leaves that fold over to produce sac-like structures. Ants live in these sacs, where they build up a store of dead insects which they eat. The plants benefit from the carbon in the dead insects.

Explain how the carbon in the dead insects is made available to the plant.

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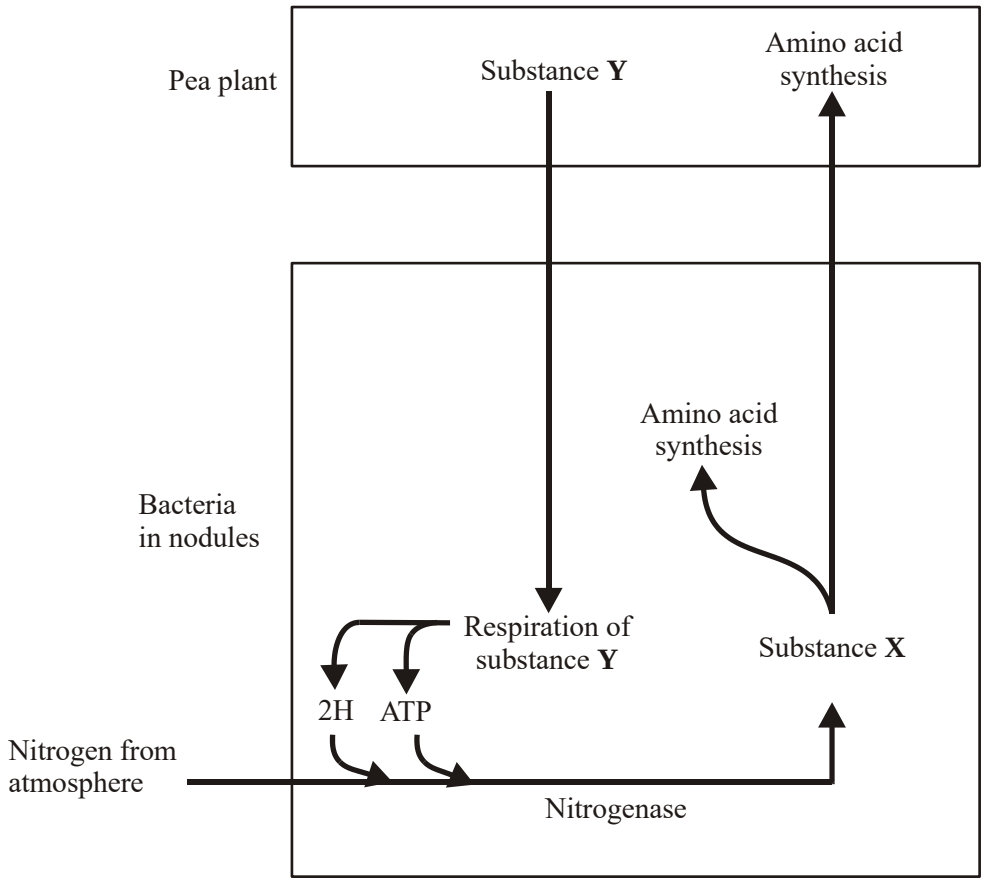
(Total 3 marks)

18. 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**;

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(1)

(ii) substance **Y**.

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(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)

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

High nitrate concentration

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Increased growth of algae

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Death and decay of submerged plants rooted in the mud

↓

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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(6)

(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)

20. (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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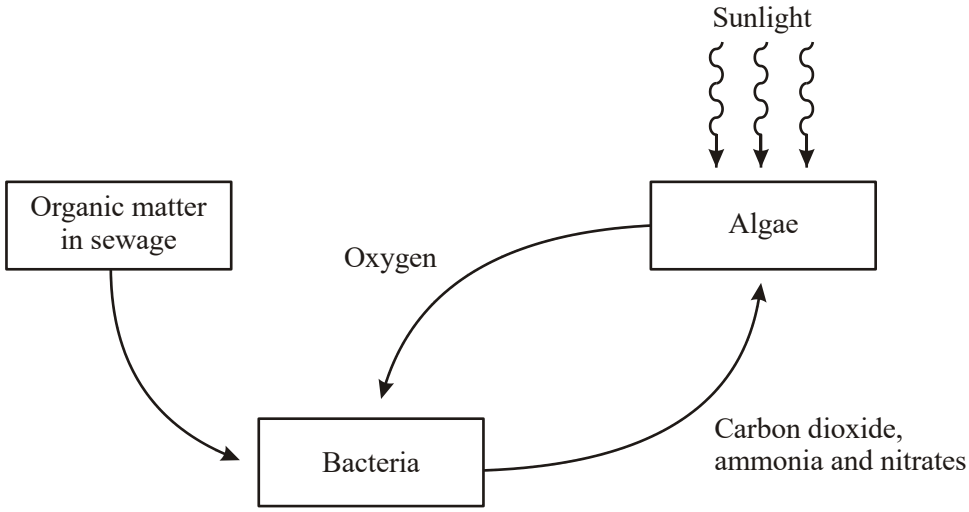
(2)
(Total 6 marks)

21. 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)