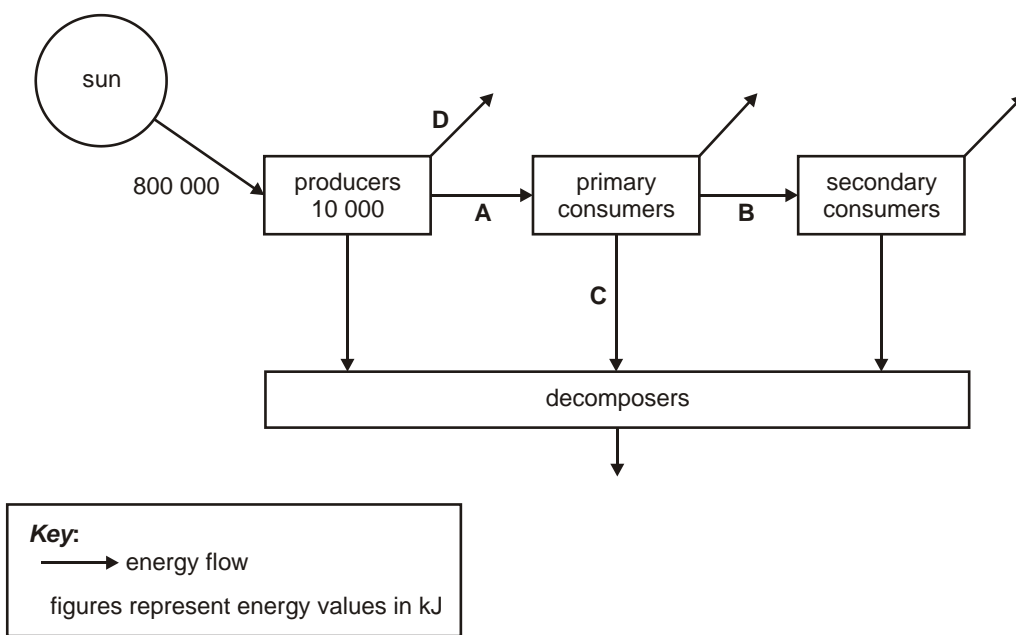


1. The figure below represents the transfer of energy through a woodland ecosystem.



- (a) Of the 800 000 kJ of energy which reaches the producers, only 10 000 kJ of energy is converted to growth in the producers.
- (i) Calculate the percentage of the energy reaching the producers that is converted to growth in the producers. Show your working.

Answer = %

[2]

- (ii) Explain what happens to the energy reaching the producers that is **not** converted to growth.

.....

.....

.....

.....

[2]

(iii) Name **one** decomposer.

.....

[1]

(iv) State two ways in which energy is transferred from primary consumers to decomposers at **C**.

1

2

[2]

(b) Suggest why the percentage energy transfer between producers and primary consumers at **A** is less than that between the primary consumers and secondary consumers at **B**.

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[3]

[Total 10 marks]

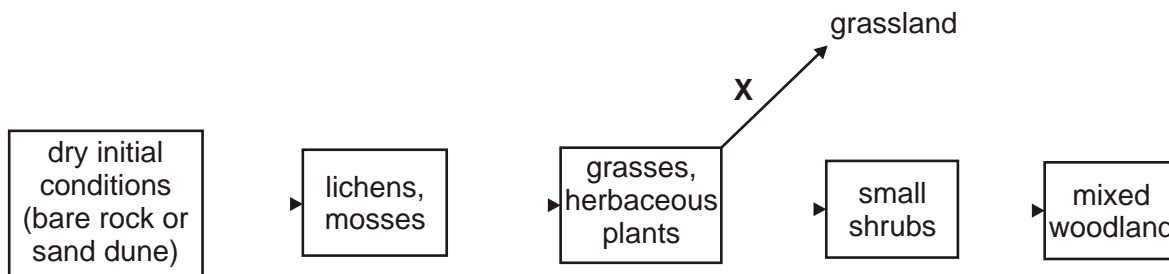
2. (a) Explain the meaning of the term *primary succession*.

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[2]

The figure below shows a primary succession in a temperate climate.

X represents an example of deflected succession.



(b) Explain the role of pioneer plants in succession on a bare rock or sand dune.

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[3]

(c) Suggest two ways in which deflected succession at **X** could be caused.

1

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2

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[2]

(d) Explain how biomass changes during a **primary** succession.

.....

.....

.....

.....

[2]

[Total 9 marks]

3. Complete the following passage by inserting the most suitable terms in the blank spaces.

Living organisms are interacting constantly with each other and with the environment.

Each individual organism is a member of a group, the,

which consists of all the individuals of a species in an area. This area is known as the

..... . All the organisms of the different species in an area form a group

called the All the species and the non-living components

interacting within an environment are collectively known as the

Photosynthetic organisms such as green plants form the first feeding or

..... level in the food chain and are known as

because they can manufacture their own food. Animals are dependent upon the

photosynthetic organisms to obtain energy and are known as

[Total 7 marks]

4. Over the last few years there has been much public concern over the diet of people in the UK and its effects upon their weight and health.

Body Mass Index is a calculation used by doctors to indicate whether a person is underweight or overweight.

- (a) State the medical term used to describe a person whose Body Mass Index is greater than 30.

.....

[1]

The table below shows the daily intake of certain components in three diets, **A**, **B** and **C** for men in the UK.

- Diet A**
- a normal balanced diet for a typical man
- Diet B**
- a weight-reducing low fat diet
 - restricted to avoid fats
 - includes any fruit, vegetables and proteins
 - energy intake is monitored carefully
- Diet C**
- a weight-reducing low carbohydrate diet
 - restricted to avoid carbohydrates
 - excludes fruit as these contain sugars
 - includes any non-starchy vegetables, proteins and fats
 - energy intake is not counted and may exceed 10 000 kJ on some days

	Diet A normal balanced diet	Diet B weight-reducing low fat diet	Diet C weight-reducing low carbohydrate diet
energy / kJ	9720	6000	8000
fats / g	87	34	124
carbohydrates / g	275	200	20
proteins / g	88	76	165
combined minerals / g	12	12	18

(b) In any unbalanced diet it is possible that there may be a deficiency of certain nutrients.

Suggest **one** nutrient that may be deficient in diet **B** and **one** in diet **C**.

Diet **B**

Diet **C**

[2]

(c) (i) Explain which diet, **B** or **C**, is likely to cause more rapid weight loss.

.....
.....
.....
.....

[2]

(ii) State the relationship between energy intake and energy use that would allow a person to lose weight.

.....

[1]

- (d) Doctors suggested that diet **C** may not be very healthy in the long term, as it contains unlimited amounts of fats and no fruit.

Suggest what potential health problems, **other than continued weight loss**, might result in a person who kept to a low carbohydrate diet, similar to diet **C**.

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[3]

[Total 9 marks]

- 5. Explain how the fungal decomposition of deadwood is of benefit to the living trees within a woodland.

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[Total 4 marks]

6. Some drinking water is extracted from the ground. Groundwater is tested for a range of substances including nitrate ions.

Explain why the presence of nitrate ions in ground water is a cause for concern.

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[Total 4 marks]

7. In this question, one mark is available for the quality of the use and organisation of scientific terms.

The caterpillar of the Large Elephant Hawk Moth feeds on willowherb. Describe in detail how you could investigate the distribution and abundance of willowherb in a nature reserve.

[7]

Quality of Written Communication [1]

[Total 8 marks]

8. All organisms can be classified according to where they get their energy and the element carbon. The table below shows the four forms of nutrition (photoautotrophic, photoheterotrophic, chemoautotrophic, chemoheterotrophic) that are possible. A number of different bacteria (kingdom Prokaryotes) are shown in the table to identify their forms of nutrition.

		CARBON SOURCE	
		carbon dioxide (autotrophic)	organic carbon (heterotrophic)
ENERGY SOURCE	light (phototrophic)	photoautotrophic cyanobacteria	photoheterotrophic purple non-sulphur bacteria
	chemical reactions (chemotrophic)	chemoautotrophic nitrifying bacteria	chemoheterotrophic saprophytic bacteria

- (a) Complete the table with the names of two **other** kingdoms. **Write your answers on the dotted lines in the shaded boxes.**

[2]

- (b) Explain why organisms need to obtain energy and carbon.

energy

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.....

.....

.....

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carbon

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[4]

- (c) Nitrifying bacteria are chemoautotrophs. Some nitrifying bacteria gain energy from converting nitrite ions (NO_2^-) to nitrate ions (NO_3^-).

Explain how the activity of these bacteria affects the growth of plants in an ecosystem.

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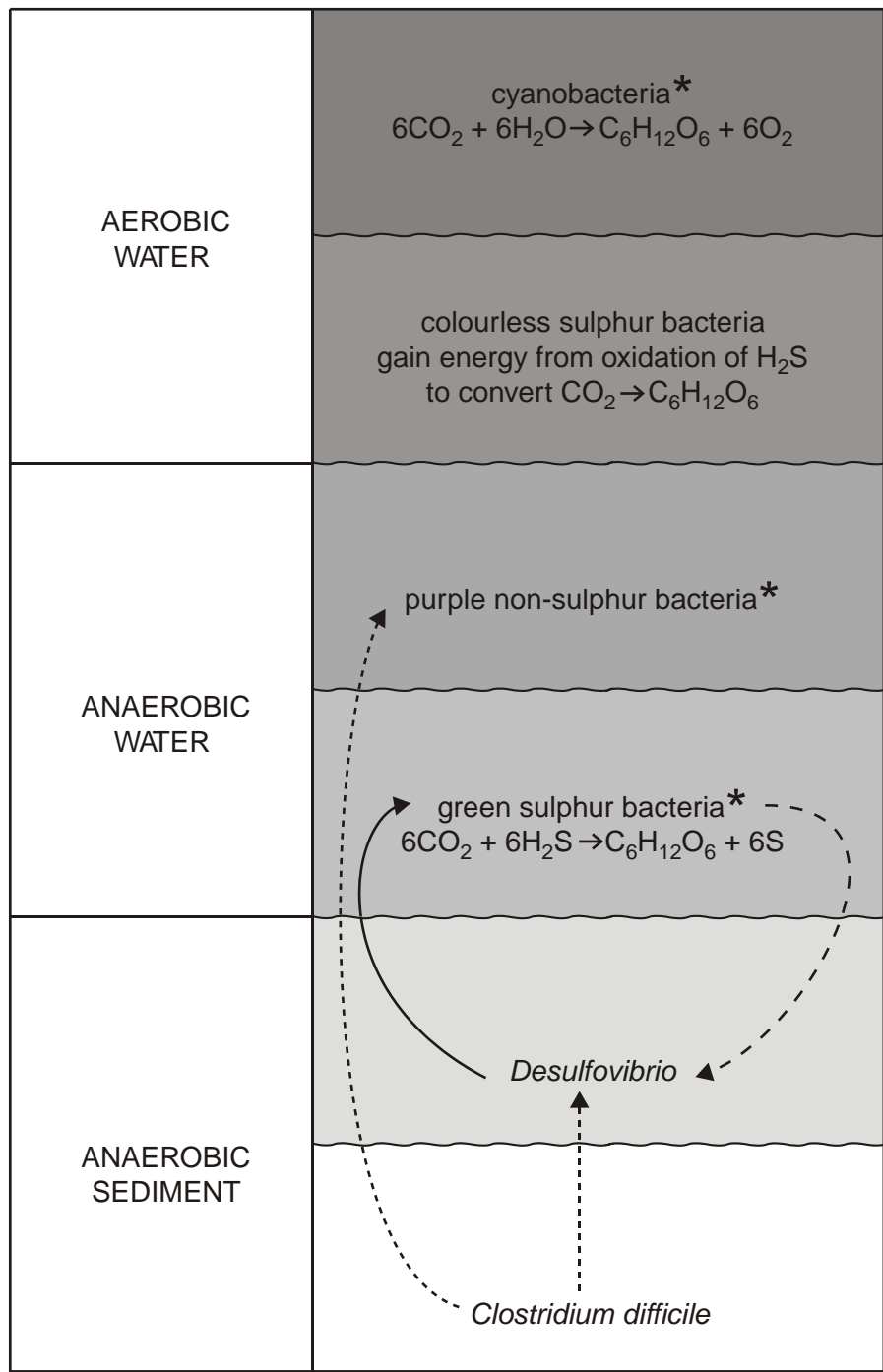
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[2]

Bacteria are metabolically very diverse and show all four forms of nutrition identified in the table above. This diversity can be shown in a simple piece of apparatus called a Winogradsky column.

A glass tube, 30 cm tall and 5 cm in diameter, is set up with the lower third containing river mud, some shredded newspaper as a source of cellulose, and the minerals sodium sulphate and calcium carbonate. The top two-thirds of the column is filled with river water and the tube is sealed and placed under a bright light source. After three months different types of bacteria establish themselves in zones.

Fig. 1 shows some chemical changes occurring in a Winogradsky column containing six types of bacteria.



Arrows show flow of:

-▶ organic acids
- ▶ hydrogen sulphide
- - - -▶ sulphur

Bacteria marked * depend on light for their metabolism.

Fig. 1

Fig. 2 gives more details of the metabolic activities of the six types of bacteria.

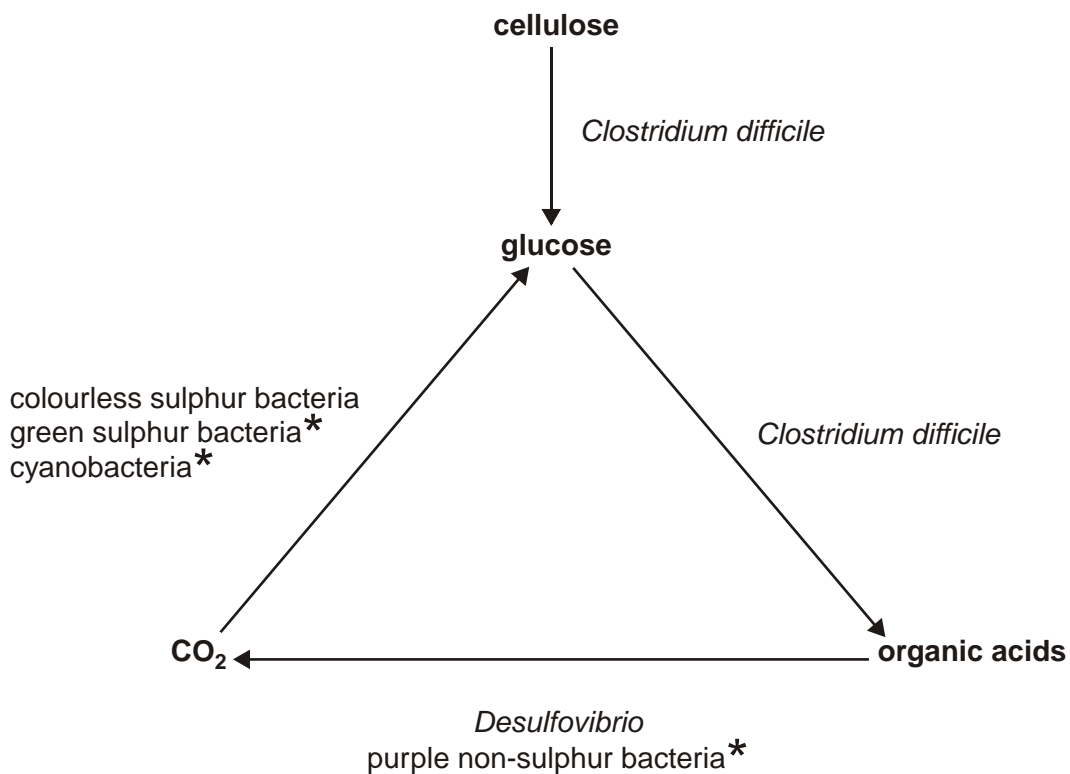


Fig. 2

(d) Use the information given in Figs. 1 and 2, and in the table to identify the forms of nutrition of

(i) *Clostridium* and *Desulfovibrio*

[1]

(ii) green sulphur bacteria

[1]

(e) (i) Name the element that is being recycled in Fig. 2.

.....

[1]

(ii) Use Fig. 1 to describe how **two** named types of bacteria recycle sulphur in the Winogradsky column.

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[2]

(f) Unusual communities of animals are found deep in the ocean in warm, sulphur-rich water.

Use the information given in Figs. 1 and 2 to suggest which type of bacteria is the **producer** at the base of food chains in these communities.

.....

[1]

(g) Gas gangrene is a condition caused by the bacterium *Clostridium perfringens*.

Suggest why gas gangrene only occurs in severely damaged tissue where blood supply is restricted.

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.....

[2]

[Total: 16 marks]

9. (a) Plants rely on the cycling of nitrogen to supply them with nitrogen in a form that they can absorb.

Select, from the list, the most suitable word or term that matches the statements (i) to (iv) below.

active transport	nitrogen fixation
denitrification	<i>Nitrobacter</i>
denitrifying bacterium	<i>Nitrosomonas</i>
diffusion	osmosis
endocytosis	<i>Rhizobium</i>
nitrification	

- (i) The conversion of nitrate ions into nitrogen gas.

.....

[1]

- (ii) A bacterium that fixes nitrogen.

.....

[1]

- (iii) A method by which nitrate ions pass into root hair cells.

.....

[1]

- (iv) The conversion of ammonium ions into nitrite ions.

.....

[1]

(b) Before the widespread use of artificial fertilisers, farmers used a variety of methods to improve the fertility of the soil and so improve the yield of their crops. Two of the methods in common use were:

- **Ploughing-in**
In which legumes, such as beans, alfalfa or clover, were grown in a field and then harvested. The roots were then ploughed back into the soil rather than being dug up or burnt.
- **Crop rotation**
In which different crops were grown in a field in each year for three years. In the fourth year, the 'fallow' year, the field was not used for crops. In the following year the crop cycle was started again.

Explain how ploughing-in and crop rotation are able to improve the fertility of the soil.

Ploughing-in
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Crop rotation
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.....

[4]
[Total 8 marks]

10. Primary succession is the simplest type of succession, beginning with a bare surface such as rock or sand. The first organisms to colonise the area form the pioneer community.

Describe **two** effects of the pioneer community on the habitat.

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[Total 2 marks]

11. Chalk grassland communities are found in areas of southern England such as the South Downs. Woodland rather than grassland is the climax community for this habitat. Grazing by sheep and rabbits maintains the grassland.

(i) Define the term *climax community*.

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.....

[1]

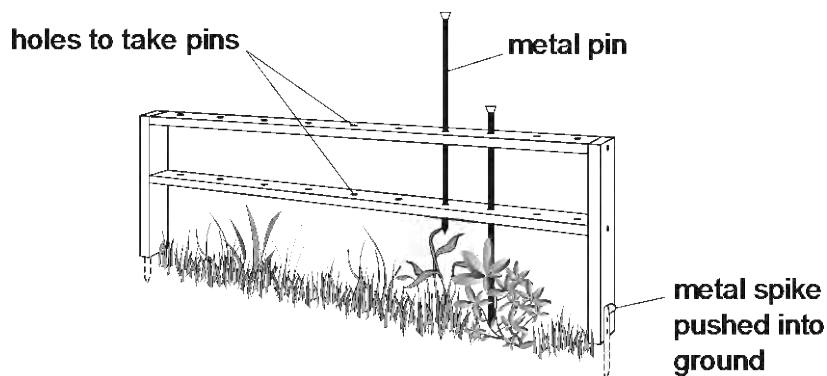
(ii) Suggest how grazing by sheep and rabbits could prevent a woodland climax community from developing.

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[1]

[Total 2 marks]

12. A common plant found in chalk grassland communities is bird's foot trefoil. A group of students used a point quadrat to determine the percentage cover of bird's foot trefoil in an area of chalk grassland. They placed the point quadrat at one position on the grassland and lowered the metal pins, as shown in the figure below. They recorded the first hit on each species made with each pin. This was repeated at nine other randomly selected locations within the area of grassland. Their results are shown in the following table.



quadrat number	1	2	3	4	5	6	7	8	9	10
number of hits on bird's foot trefoil	3	8	7	8	9	3	2	1	2	1
number of hits on other species	16	21	20	13	16	21	24	16	20	28

An estimate of percentage cover for a species can be made by calculating the number of hits as a percentage of the total hits.

- (a) Using the results in the table above, calculate the percentage cover for bird's foot trefoil. Show your working and express your answer to the nearest 0.1%.

Answer =%

[2]

- (b) A footpath runs through the area of grassland and one student observed that very few bird's foot trefoil plants were found on the trampled areas.

Explain how the students could use a transect to determine whether there is a link between trampling and the abundance of bird's foot trefoil on this footpath.

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[5]

[Total 7 marks]

13. A study was carried out in south-east Scotland on the release of nitrous oxide (N_2O) from agricultural land. Nitrous oxide is produced by the action of bacteria in the soil.

In the study, six plots of grassland, **A** to **F**, were treated in different ways. Plots **B** to **F** were treated with substances containing nitrogen. The quantities applied to each plot contained the same mass of nitrogen, although in different compounds. The table below shows the results obtained for the various treatments.

plot	treatment	N_2O produced / kg ha^{-1}
A	nothing added	57
B	inorganic fertiliser	531
C	urea	190
D	sewage sludge	13 537
E	cattle manure	319
F	poultry manure	6 612

Describe **three** variables in this experiment that the researchers would have taken into account to ensure that the results were valid.

1

.....

2

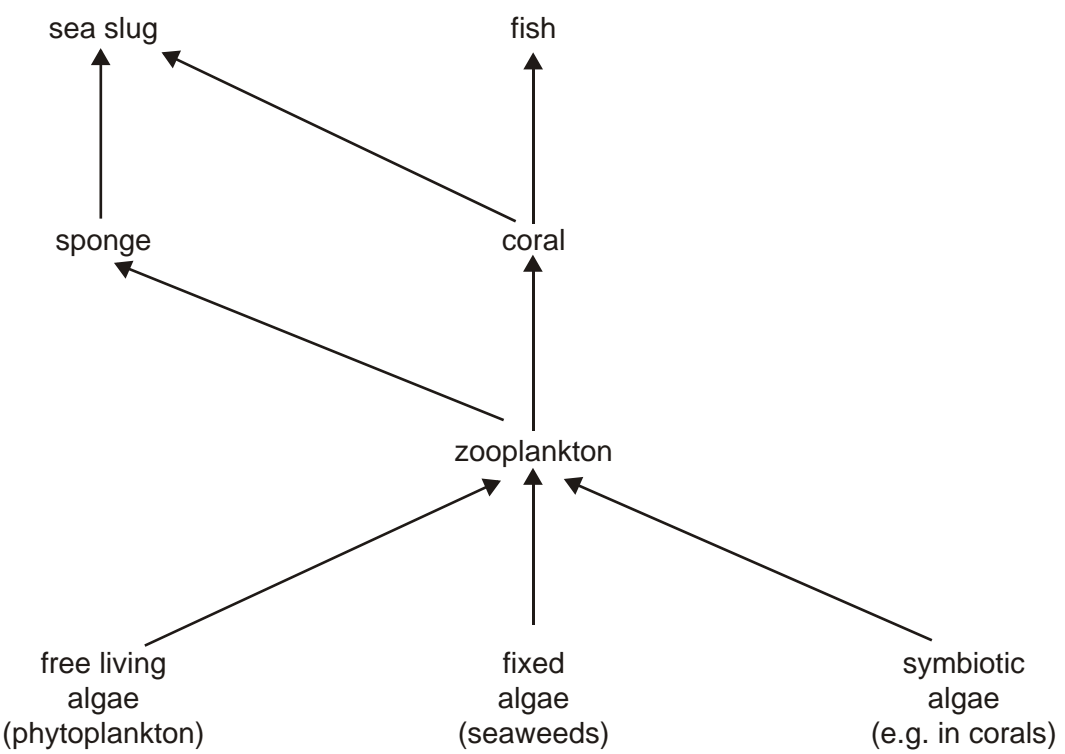
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3

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[Total 3 marks]

14. Coral reefs occupy 0.2% of the world's oceans but provide habitat and breeding grounds for 25% of the world's fish species. The figure below shows a food web for a coral reef community.



Reefs are under threat from a variety of sources. One of these is the water that drains from agricultural land that is rich in fertilisers. Another is the discharge of untreated sewage into the sea.

Explain how these forms of pollution could alter the ecological balance of a coral reef.

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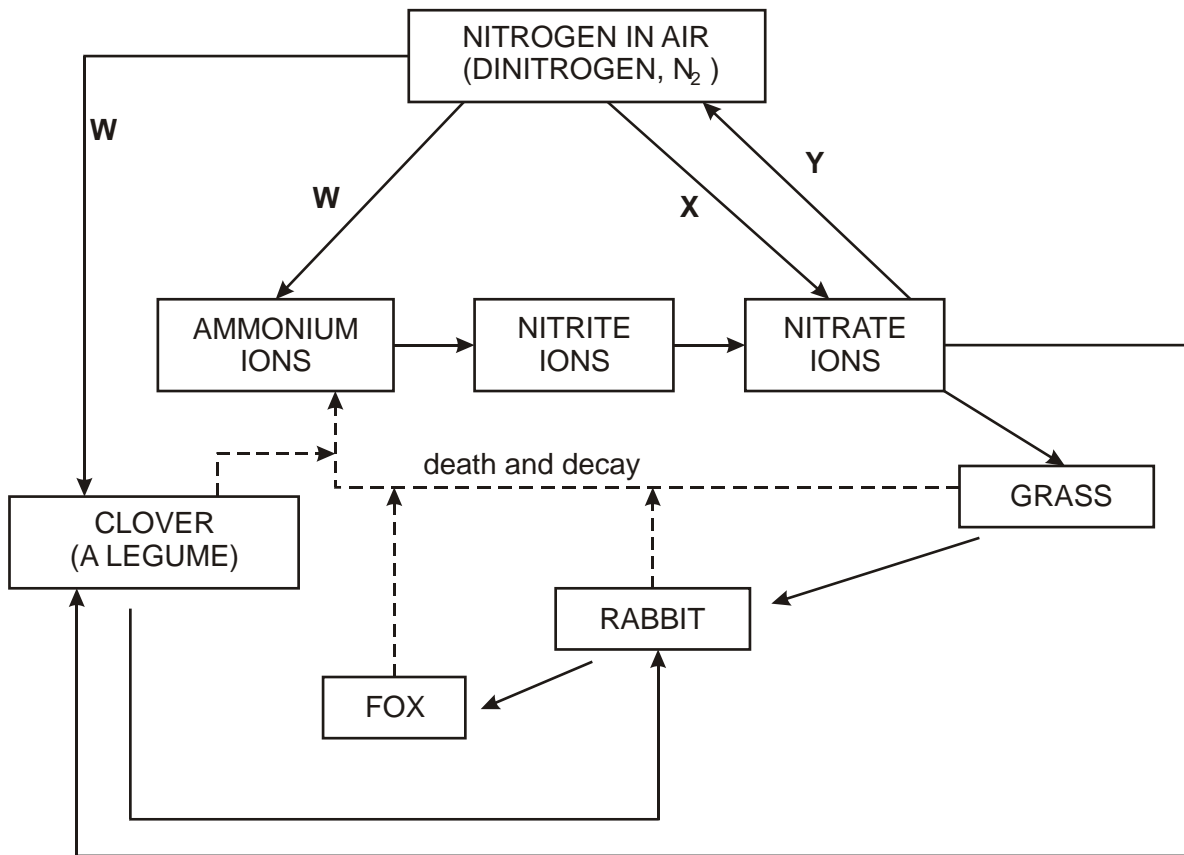
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[Total 4 marks]

15. The diagram below shows part of the nitrogen cycle.



(a) Using **only** the information in the diagram, state **one** example of each of the following:

(i) secondary consumer;

.....

[1]

(ii) producer.

.....

[1]

- (b) (i) Name the process **W**.

.....

[1]

- (ii) State a way in which nitrogen in air can be converted directly into nitrate ions, as indicated by arrow **X**.

.....

[1]

- (iii) State the type of bacteria that carry out process **Y**.

.....

[1]

- (iv) The bacterium *Rhizobium* also has a role in the cycle shown in the diagram.

Explain the importance of *Rhizobium* in the nitrogen cycle.

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[2]

[Total 7 marks]

16. Grasslands which have been left undisturbed for several years often have ant mounds. Ants make burrows in the soil and bring fine crumbs of soil to the surface, where it accumulates as a mound. Each mound is about 50 cm across and about 20 cm high.

Plants grow on the mounds. Ants of the type that make mounds in grassland do not feed on plants.

A student noticed that a plant called wild thyme, *Thymus drucei*, seemed to be more common on ant mounds than it was on other parts of the same grassland, not occupied by ants.

In order to test the hypothesis that wild thyme was indeed more common on ant mounds, the student examined all the mounds in an area of grassland about 100 m by 100 m, noting whether or not wild thyme was present.

After surveying all 47 ant mounds in the grassland, the student threw a bunch of keys, 47 times, to obtain random points on the grassland, equal in number to the ant mounds.

Each time the keys were thrown, the point where they landed was used to place a 1 m² quadrat frame. The presence or absence of wild thyme in the quadrat was noted.

The data obtained are shown in the table below.

	number of ant mounds or quadrats with:	
	at least one wild thyme plant present	no wild thyme plants present
ant mound	36	11
1 m ² quadrat	24	23

- (i) What evidence is there in the table to support the hypothesis that wild thyme is more common on ant mounds?

.....

(ii) Describe **two** ways in which the survey methods could have been improved. Give a reason for each of the changes you have suggested.

1

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2

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[4]

[Total 5 marks]

17. (a) State what ecologists mean by the following terms:

(i) *habitat*

.....

[1]

(ii) *niche*

.....

[1]

(iii) *ecosystem.*

.....

.....

[1]

(b) Two more terms commonly used by ecologists are *population* and *community*.

State the difference between a *population* and a *community*.

.....

.....

[1]

[Total 4 marks]

18. Fig. 1 shows the transfer of energy through a food chain in a wood.

The figures represent the energy in the levels of the ecosystem in $\text{MJ m}^{-2} \text{y}^{-1}$.

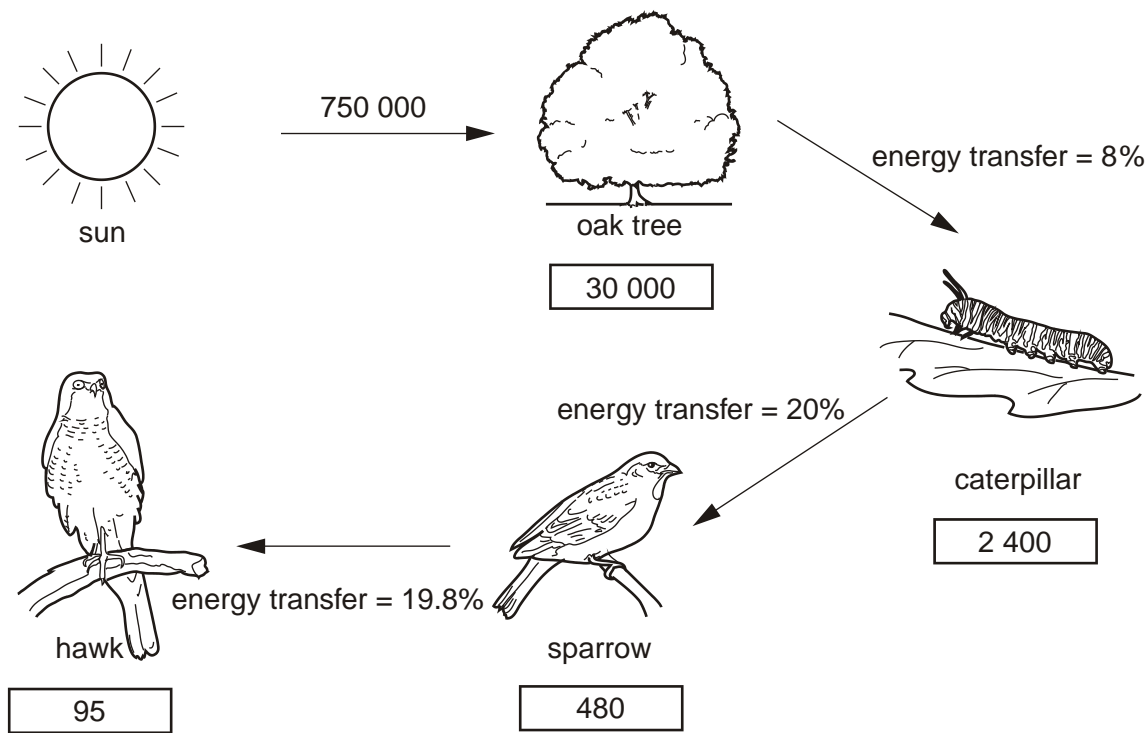


Fig. 1

Fig. 2 shows what happens to the food available to caterpillars in the food chain shown in Fig. 1.

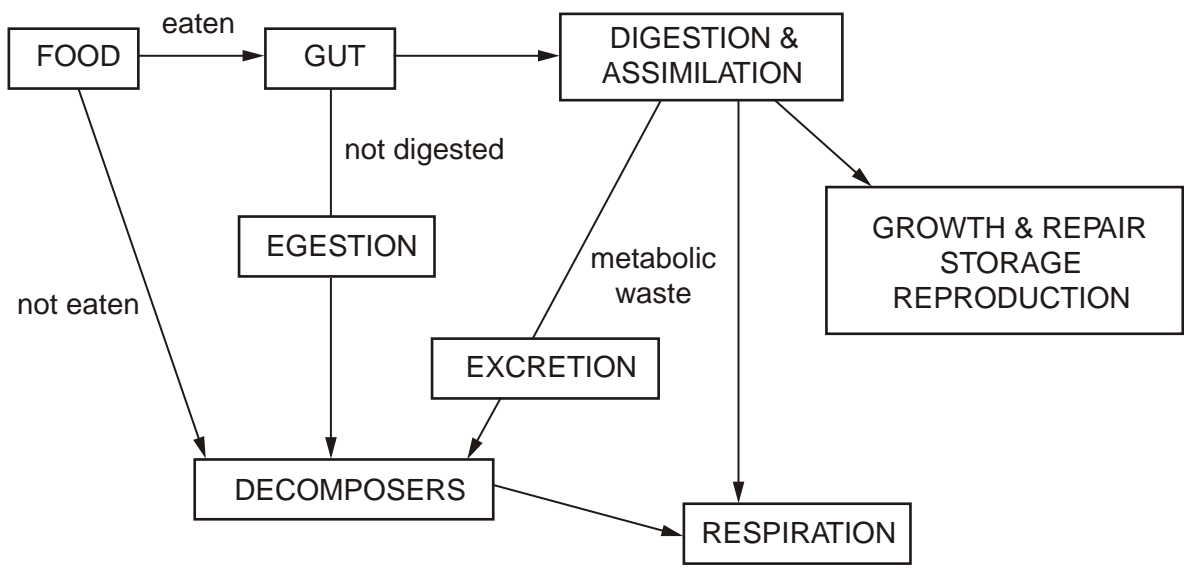


Fig. 2

- (i) Fig. 1 shows that each trophic level has less energy flowing through it than the previous trophic level.

Use the information in Fig. 2 to explain why this is the case.

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(ii) Explain the differences in the **percentage** of energy transferred between the trophic levels shown in Fig. 1.

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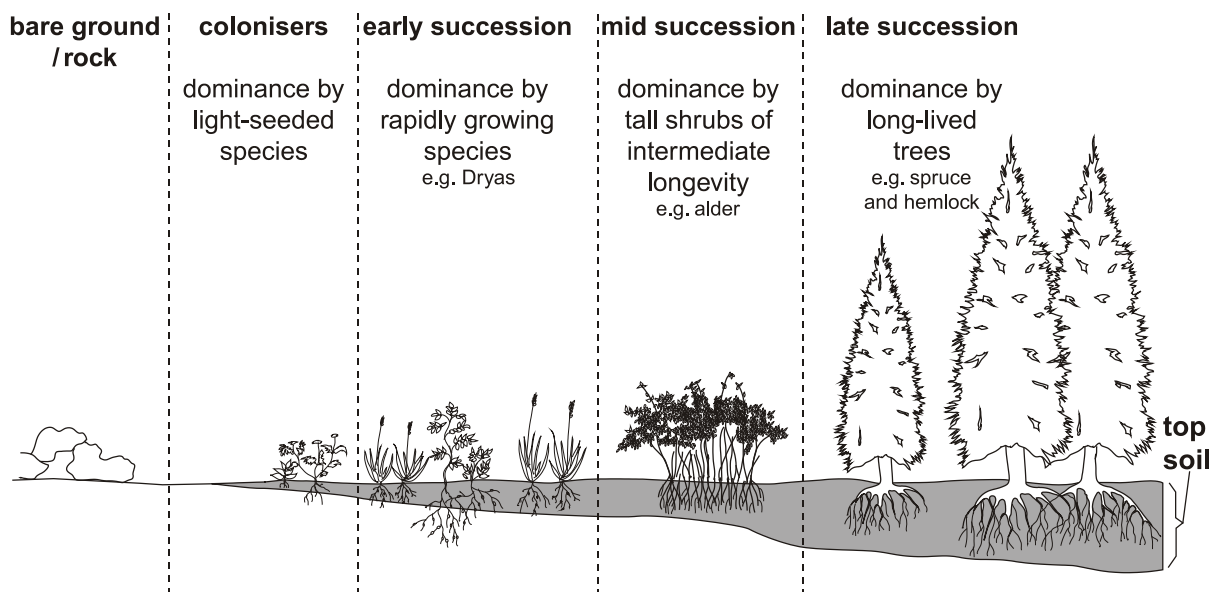
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[2]

[Total 5 marks]

19. The figure below shows some of the stages that have occurred during succession at Glacier Bay in Alaska.



Using the information in the figure,

(i) explain what is meant by the term *succession* ;

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[4]

(ii) outline **two** changes which occur between mid and late succession;

1

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2

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[2]

(iii) suggest **one** biotic and **one** abiotic change which are **not** indicated in the figure.

biotic

abiotic

[2]

[Total 8 marks]

20. Statements about the nitrogen cycle are written below.

1	a genus of bacterium associated with leguminous plants	T
2	conversion of nitrate ions to nitrogen	
3	swelling on the root of a leguminous plant	
4	conversion of ammonium ions to nitrate ions	
5	an animal that eats plants	

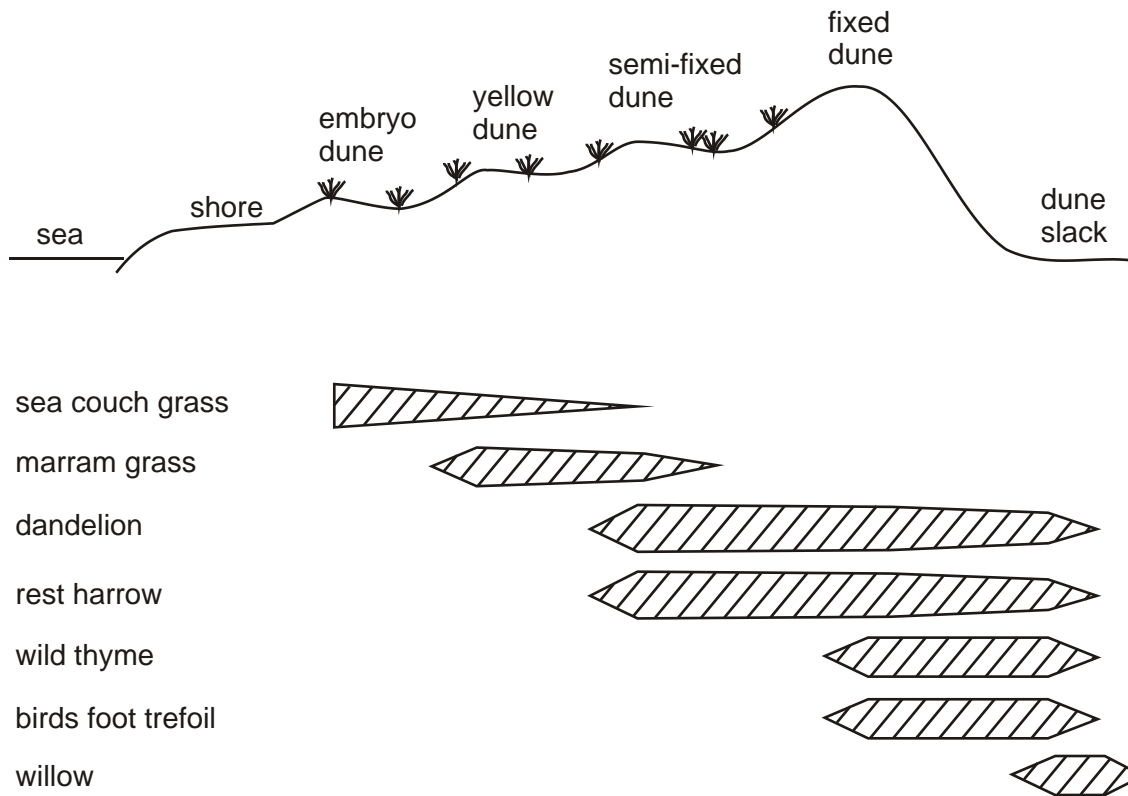
Select from the following terms the appropriate letter to match each statement. Write the letter in the box.

The first one has been done for you.

Q	secondary consumer	R	nitrogen fixation
S	primary consumer	T	<i>Rhizobium</i>
U	denitrification	V	nodule
W	niche	X	lightning
Y	decay	Z	nitrification

[Total 4 marks]

21. The figure below illustrates the profile of a sand dune system, together with kite diagrams of some plant species. This summarises the results of a belt transect carried out over the dunes.



The results of the transect were initially recorded using the ACFOR scale:

A – abundant

C – common

F – frequent

O – occasional

R – rare

- (a) Outline the advantages and disadvantages of using a scale, such as the ACFOR scale.

advantages

.....

.....

disadvantages

.....

.....

[3]

- (b) Explain

- (i) how such a transect would have been carried out;

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[4]

- (ii) how the ACFOR readings would have been converted to kite diagrams. You may use the space below for any diagrams to help your answer.

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[3]

- (c) The distribution of plant species in sand dunes will be influenced by a number of abiotic factors, such as temperature.

Explain how to measure, in different parts of the sand dune system, variations in temperature of the sand or soil.

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[2]

- (d) Sand dune systems are a result of the process of succession. The semi-fixed dunes represent an intermediate sere between yellow and fixed dunes.

Explain

- (i) what is meant by a sere;

.....
.....

[1]

- (ii) the process of succession in a system of sand dunes, or in an area you have studied.

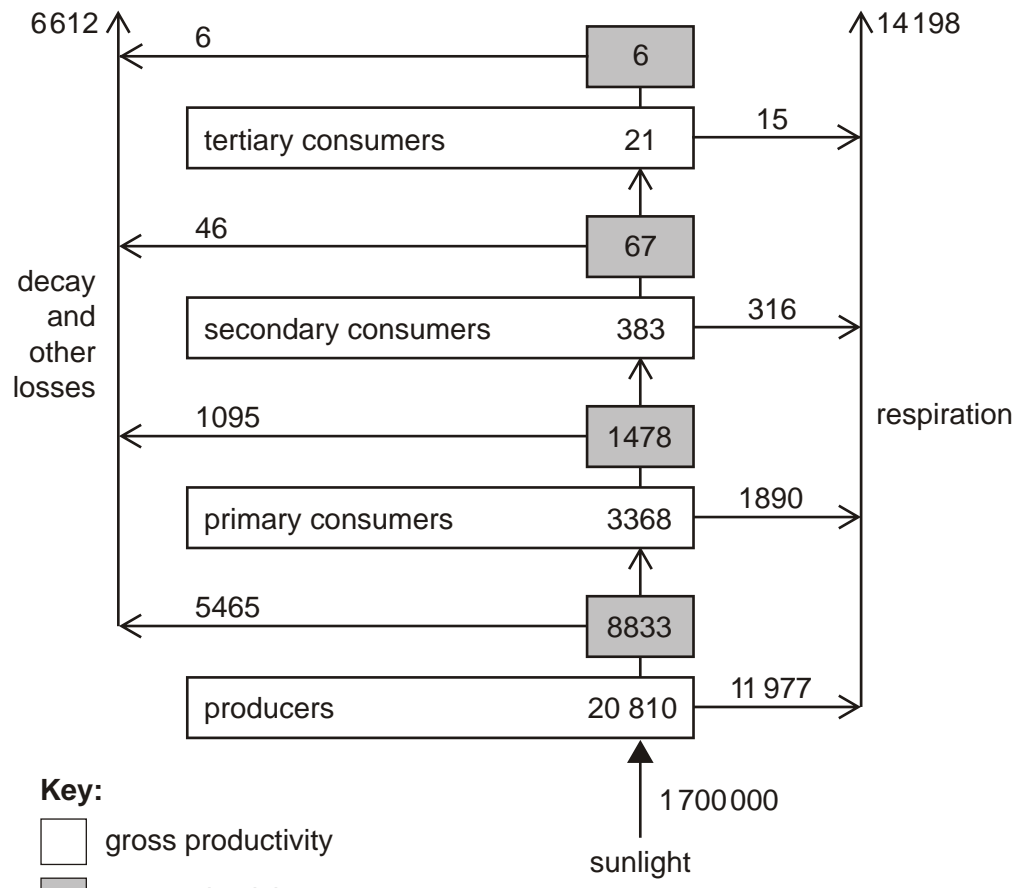
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[4]

[Total 17 marks]

22. In this question, one mark is available for the quality of spelling, punctuation and grammar.

The diagram below represents the energy flow through an ecosystem.



Key:

- gross productivity
- net productivity

all figures given are in kJ m⁻²yr⁻¹

Explain how energy is transferred through food chains and food webs in an ecosystem. You should refer to the efficiency of this transfer in your answer. You will gain credit if you make use of the information in the diagram.

[9]

Quality of Written Communication [1]

[Total 10 marks]

23. David Bellamy, the president of Plantlife, describes peat bogs as ‘the jewel of Britain’s habitats’.

‘You walk with a spring in your step – the peat underfoot is nine-tenths water – to the tireless song of a hovering skylark, on an undulating carpet of green, shot through with red, pink, burnished gold and orange, yellow and white flowers that thrive here. There are hundreds of insect species in the pools and on the plants and an abundance of round-leaved sundew, one of several carnivorous plants that get their nutrients (especially nitrogen compounds) from the insects they trap in their sticky leaves.’

Explain:

(i) why very wet soils are usually nitrogen-deficient **and** how the sundew is at a competitive advantage in such soils;

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[4]

(ii) why, in addition to nitrogen-deficiency, many plants cannot grow successfully in very wet soils.

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[3]

[Total 7 marks]

24. A group of students carried out an investigation into the growth of the Scotch Thistle, *Onopordum acanthium*, in two different sites, **A** and **B**.

At each site, 15 plants were selected and their heights measured and recorded. These are summarised in the table below.

height of plants / mm		
	site A	site B
	462	267
	484	295
	396	254
	421	147
	437	116
	365	189
	409	274
	427	196
	439	322
	416	168
	387	244
	488	267
	463	298
	472	321
	399	227
mean	431	239
standard deviation (s.d.)	37	63

- (a) Describe how the students would have ensured that they measured a **representative** sample of thistles.

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(b) Explain what is meant in the table above by:

(i) *mean*;

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.....
.....

[2]

(ii) *standard deviation*.

.....
.....
.....

[2]

(c) The figure for s.d. at site **B** is greater than the figure for site **A**. Explain what this means.

.....
.....

[1]

(d) In order to draw a statistically valid conclusion from their results, the students carried out a *t*-test.

Before calculating a *t* value, they had to state a Null Hypothesis.

(i) State what the Null Hypothesis would be in this investigation.

.....
.....
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[2]

The calculation gave a value for t of 9.64.

The table below shows critical t values at different levels of significance and degrees of freedom.

The number of degrees of freedom for a t -test is two less than the total number of samples.

		level of significance (p)			
		0.10	0.05	0.01	0.001
Degrees of freedom	14	1.76	2.15	2.98	4.14
	16	1.75	2.12	2.92	4.02
	18	1.73	2.10	2.88	3.92
	20	1.73	2.09	2.85	3.85
	22	1.72	2.07	2.82	3.79
	24	1.71	2.06	2.80	3.75
	26	1.71	2.06	2.78	3.71
	28	1.70	2.05	2.76	3.67
	30	1.70	2.04	2.75	3.65

- (ii) Using the table, state the conclusion that would be drawn from the calculation of a t value of 9.64 **and** explain how you reached this conclusion.

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[4]

[Total 15 marks]

25. The table below compares the mean protein yields of two cereal crops, with that of two legume crops.

	crop	mean protein yield / kg ha ⁻¹
cereal	maize	146
	sorghum	91
legume	soybean	509
	groundnut (peanut)	227

Explain how soybean and groundnut produce a significantly higher mean protein yield than either maize or sorghum.

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[Total 4 marks]

26. Vancouver Island, off the west coast of Canada, was covered by cool temperate rain forest until timber extraction began about one hundred years ago. A large area of this climatic climax community has been cut or burned, though much remains.

When timber is extracted from an area of forest, all trees, including those not required for timber, are usually cut down. The land is then left so that seeds of tree species can germinate and new forest can develop. It takes many decades for a complete canopy of mature trees to develop in an area which has been treated in this way.

Small soil animals of two arthropod orders – **mites** and **springtails** – were studied in several areas of forest on Vancouver Island. Each of the areas was similar in slope and soil type.

The study areas had different stages of tree growth. In each area, mites and springtails were extracted from soil samples and counted. The species of springtail in each sample were identified. The species of mite were not identified.

Some of the data from the investigation are shown in the table below.

stage of tree growth	numbers per 100 g of soil		
	mean number of individuals of all types of mite	mean number of individuals of all types of springtail	mean number of species of springtail
tree seedlings	1375	125	9
young trees	2564	300	13
mature trees	1981	312	11
climax forest, not cut or burned since records began	2890	715	16

State **three** conclusions that you can draw from the data in the table.

1

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2

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3

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[Total 3 marks]

27. Nitrifying and denitrifying bacteria are involved in the nitrogen cycle. Explain the role in the nitrogen cycle of

(i) nitrifying bacteria;

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(ii) denitrifying bacteria.

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[Total 4 marks]

28. Read the following passage carefully, then answer the questions below.

Rhizobium is a bacterium that is closely associated with the roots of certain plants known as legumes. These plants produce chemicals to attract the bacteria and extra root hairs are produced. The bacteria attach to the surface of the root hairs. Chemical links are formed between a complex
5 polysaccharide on the bacterial surface and lectin, a protein, formed by the plants. The bacteria penetrate the cell walls of the root hairs and enter the cells. The presence of the bacteria stimulates the cells of the root to divide, forming swellings known as nodules.

The bacteria produce an enzyme, nitrogenase, that is the catalyst for the
10 conversion of nitrogen gas to ammonia. The bacteria use carbon compounds manufactured by the plant to respire, making energy available for this conversion. The ammonia is then used to form amino acids. Nitrogenase only functions in low oxygen concentrations. The root cells produce a pigment, leghaemoglobin, that is very similar to haemoglobin. Leghaemoglobin absorbs
15 oxygen, leaving low concentrations in the nodules.

- (i) *Rhizobium* is a prokaryotic organism.

State **one** characteristic that is typical of prokaryotes, but not of eukaryotes.

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.....

[1]

- (ii) Lectin (line 5) and polysaccharides are compounds that are formed from small molecules joined together by chemical bonds.

Explain how the small molecules are joined together to form these compounds.

.....
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.....
.....

[3]

- (iii) Leghaemoglobin contains the same metal element as haemoglobin.

Name this metal element.

.....

[1]

- (iv) State the names of **two** proteins, **other than lectin**, mentioned in the passage.

1

2

[2]

- (v) Name the process that occurs in *Rhizobium* to convert nitrogen gas into ammonia.

.....

[1]

(vi) It has been suggested that oxygen is an inhibitor of nitrogenase.

Explain **one** way in which oxygen could act as an inhibitor.

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.....

[2]

[Total 10 marks]

29. State the word or phrase that best describes an organism that obtains its food by eating **only** producers.

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[Total 1 mark]