1 Fig. 4.1 is an electron micrograph of part of the lower surface of a leaf. Three stomata are visible.

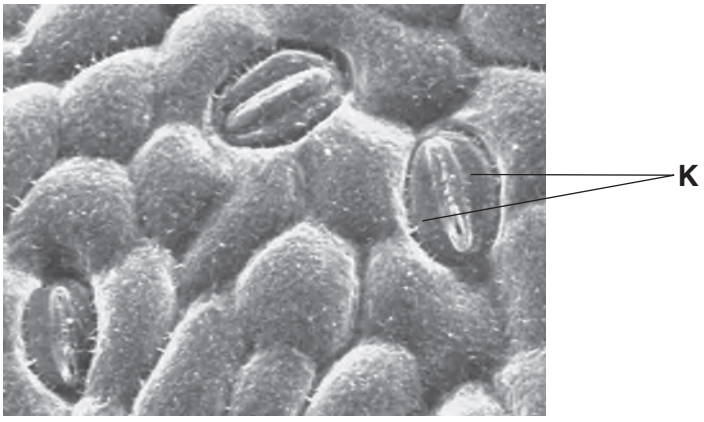

Fig. 4.1

(a) Name the cells labelled **K**.

.....[1]

(b) Stomata allow the movement of gases into and out of the leaf. During the daytime oxygen passes out and carbon dioxide passes in.

(i) Explain why oxygen passes out of the leaf during the daytime.

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.....[3]

(ii) Describe the path taken by a carbon dioxide molecule **after** it has passed through the stomata during the daytime until it becomes part of a glucose molecule.

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.....[3]

(c) Plants that live in different types of habitat have leaves that show adaptations for survival.

Table 4.1 shows some features of the leaves of three species of plant from different types of habitat.

Table 4.1

species	habitat	orientation of the leaves	individual leaf area / cm^2	mean stomatal density / number of stomata per mm^2	
				upper epidermis	lower epidermis
annual meadow grass, *Poa annua*	grassland	vertical	1 – 10	125	135
white water lily, *Nymphaea alba*	the surface of ponds and lakes	horizontal	more than 1000	460	none
common myrtle, *Myrtus communis*	dry scrubland	horizontal	2 – 4	none	508

(i) State how the stomatal density of annual meadow grass differs from the stomatal densities of the other two species in Table 4.1.

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.....[2]

(ii) Suggest explanations for the distribution and density of stomata in white water lily and common myrtle as shown in Table 4.1.

white water lily .....

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common myrtle .....

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[5]

[Total: 14]

2 **(a)** Fig. 4.1 shows a section through the anther of a lily flower. The cells in the centre are dividing by meiosis.

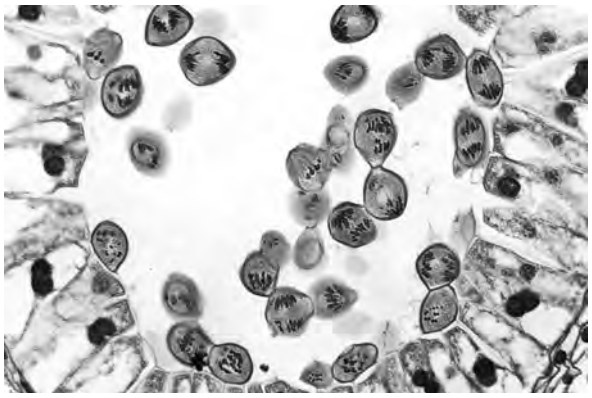

Fig. 4.1

(i) Name the product of meiosis that is formed in anthers.

.....[1]

(ii) Explain the importance of meiosis in sexual reproduction.

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.....[2]

(b) Fig. 4.2 shows a flower of *Lilium polyphyllum*, a lily that grows in the Himalayan mountains. This species is cross-pollinated by insects.

Fig. 4.2

(i) Explain what is meant by *cross-pollination*.

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.....[2]

(ii) Name **one** feature **visible** in Fig. 4.2 that helps to attract insects.

.....[1]

(c) Plants of this species that grow at low altitudes produce flowers 60 days before the plants of the same species that grow at high altitudes.

(i) Suggest **one** environmental reason why lilies that grow at lower altitudes flower earlier than the lilies at higher altitudes.

.....[1]

(ii) Explain why flowering time is an example of continuous variation.

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.....[2]

(d) Scientists think that plants of *L. polyphyllum* growing at high altitudes may evolve into a new species.

Explain how natural selection could lead to the evolution of a new species of lily.

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.....[5]

[Total: 14]

3 Fig. 6.1 shows Soay sheep on St. Kilda, a group of small remote islands off the coast of Scotland. These islands experience extreme conditions of cold, wind and rain.

Sheep were introduced to the islands thousands of years ago and the Soay sheep are descended from them.

The islands of St. Kilda have been uninhabited by people since 1930. The sheep are now left unfarmed and in their natural state.

Fig. 6.1

(a) The populations of Soay sheep on St. Kilda show much more variation in their phenotype than modern breeds of sheep.

Explain, by using an example from Fig. 6.1, what is meant by variation in their phenotype.

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..... [2]

(b) Scientists have recorded the numbers of Soay sheep and lambs on St. Kilda for many years.

Each year between 1985 and 1996, the lambs (young sheep) were caught, marked and weighed. In some years, the total number of sheep on St. Kilda was lower than in other years.

Fig. 6.2 shows the frequency of lambs of different body mass in years when the total number of sheep was low and years when the total number was high.

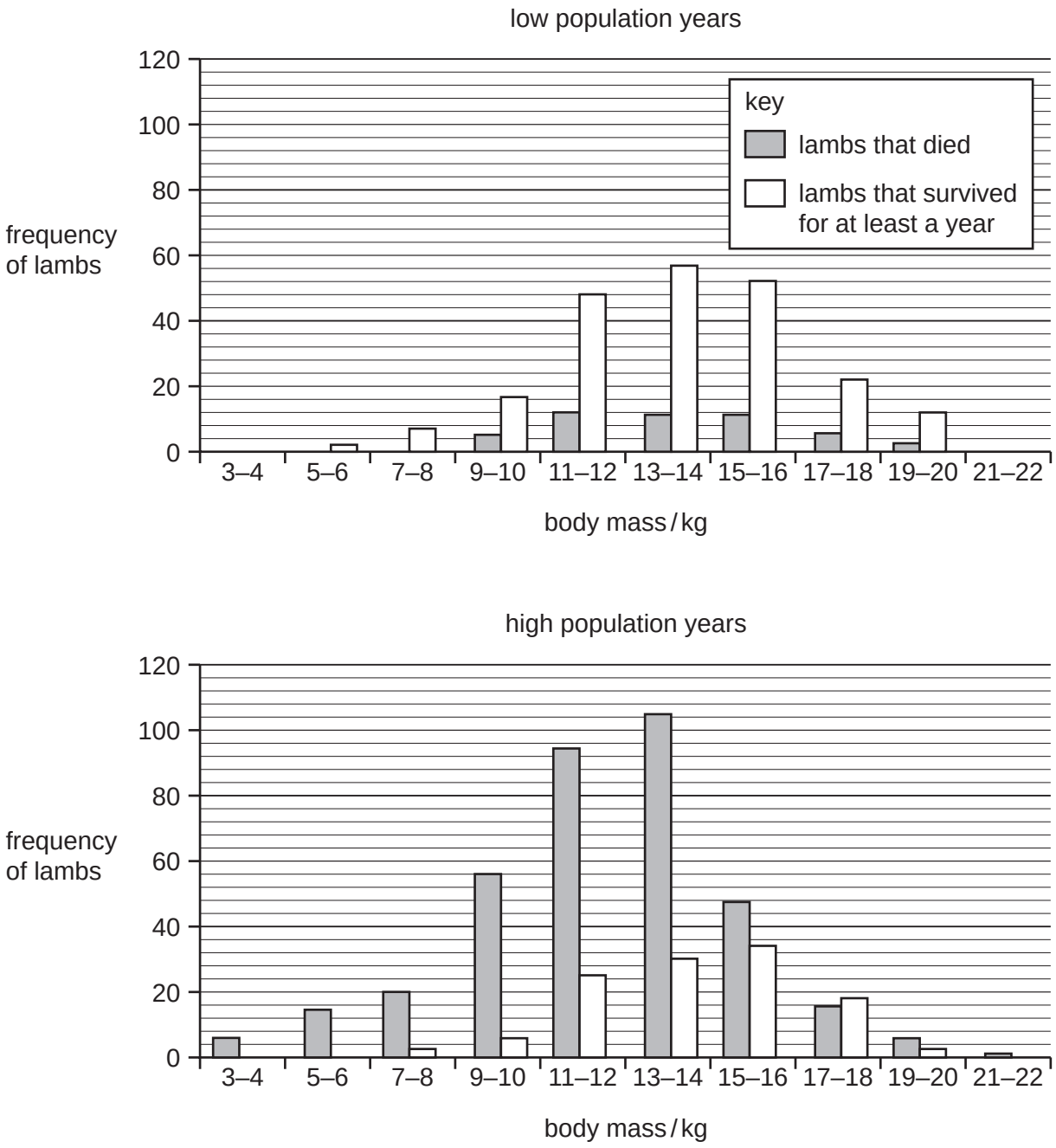

Fig. 6.2

(i) Population size has a great effect on the survival of lambs on St. Kilda.

Describe the evidence from Fig. 6.2 that supports this statement.

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(ii) Suggest an explanation for the effect that you have described.

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..... [3]

(c) Soay sheep are adapted to the extreme conditions experienced on St. Kilda.

Explain how natural selection could account for the adaptive features of Soay sheep.

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..... [4]

[Total: 11]

4 Nitrogen gas makes up about 80 % of the Earth's atmosphere. Only those organisms that are able to fix nitrogen can use it. All other organisms rely on the recycling of nitrogen from nitrogen-containing compounds, such as proteins and DNA. Fig. 6.1 shows the nitrogen cycle on a small farm in Ghana.

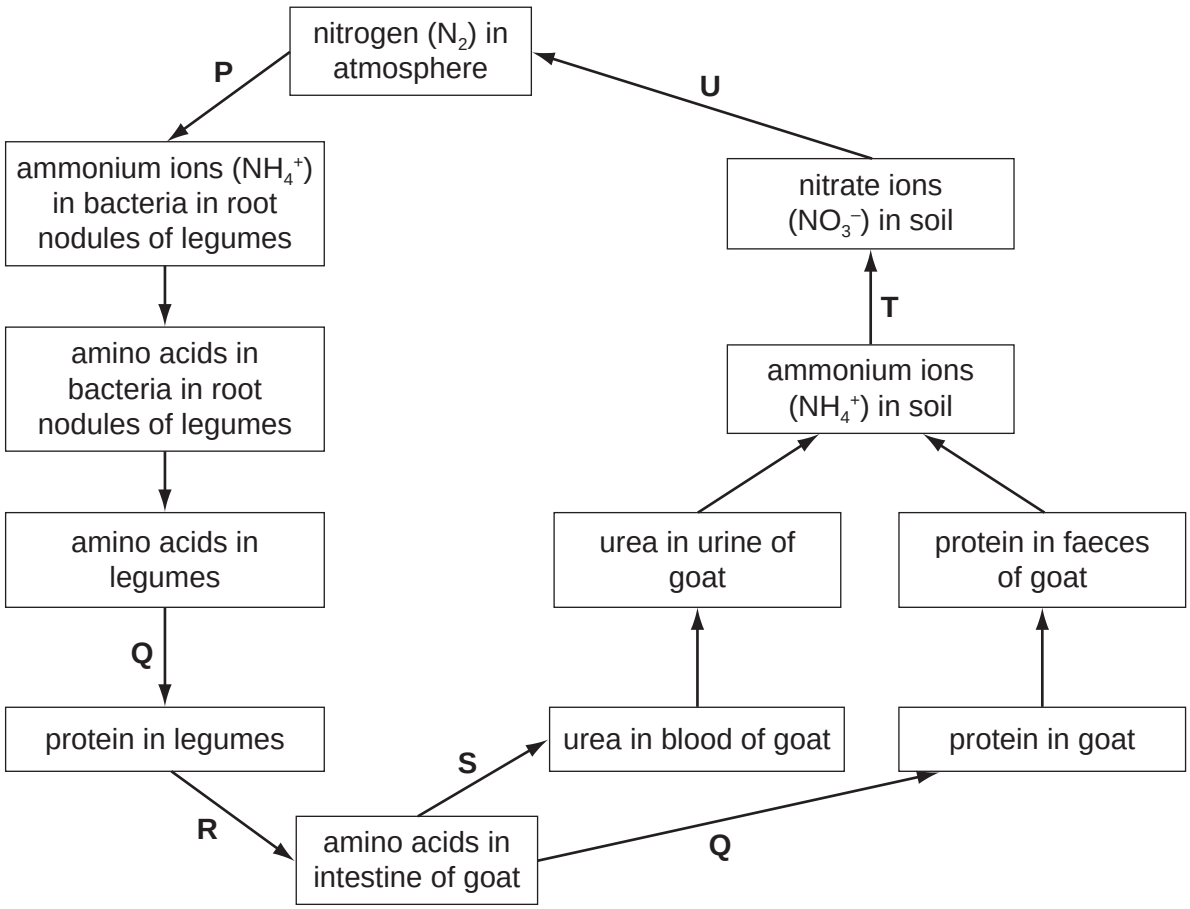

Fig. 6.1

(a) Complete Table 6.1 by identifying the processes, **P** to **U**, in the nitrogen cycle shown in Fig. 6.1.

One process, **S**, has been completed for you.

Table 6.1

stage	pr
P	
Q	
R	
S	deamination
T	
U	

[5]

It is difficult to improve legume crops by traditional plant breeding methods. Scientists in Ghana have used a different approach. They exposed seeds of two varieties of winged bean, *Psophocarpus tetragonolobus*, to ionising radiation.

Seeds that had been exposed to radiation (irradiated seeds) and seeds that had not been irradiated were grown under identical conditions.

After 45 days, the numbers of root nodules on the plants that grew from these seeds were recorded. The dry mass of the root nodules on each plant was also determined and recorded.

The results of the investigation are shown in Table 6.2.

Table 6.2

feature	variety 1		variety 2	
	non-irra	irradiated	non-irradiated	irradiated
mean number of nodules per plant at 45 days	12		7	21
mean dry mass of nodules per plant at 45 days / g	0.09			

(b) Use the results in Table 6.2 to describe the effect of radiation on the plants in both varieties.

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..... [3]

(c) Suggest and explain what happens to the seeds when they are exposed to ionising radiation.

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..... [2]

(d) Researchers use plants that show useful features in selective breeding to improve varieties of the winged bean. The improvement of winged beans by selective breeding is an example of artificial selection.

Suggest how selective breeding is carried out with plants.

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..... [4]

(e) Scientists in Australia have put a gene from the bacterium *Bacillus thuringiensis* (Bt) into the cowpea, an important crop in Africa. This gene gives resistance against the cowpea pod borer, an insect pest that reduces the yield of cowpeas.

Explain how the method used by the Australian scientists differs from the technique used by the Ghanaian scientists.

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..... [2]

(f) Legumes, such as cowpeas and winged beans, are grown in between maize plants in a method known as intercropping.

Suggest the advantages to farmers of growing legumes and maize together in the same field at the same time.

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..... [2]

[Total: 18]