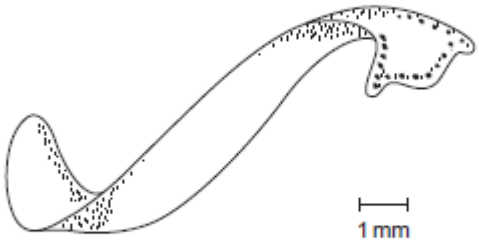
1)

(a) Flatworms are small animals that live in water. They have no specialised gas exchange or circulatory systems.
The drawing shows one type of flatworm.



(a) (i) Name the process by which oxygen reaches the cells inside the body of this flatworm.

.....

(1 mark)

(a) (ii) The body of a flatworm is adapted for efficient gas exchange between the water and the cells inside the body.
Using the diagram, explain how **two** features of the flatworm's body allow efficient gas exchange.

1 .....

.....

2 .....

.....

(2 marks)

(b) (i) A leaf is an organ. What is an organ?

.....

(1 mark)

(b) (ii) Describe how carbon dioxide in the air outside a leaf reaches mesophyll cells inside the leaf.

.....

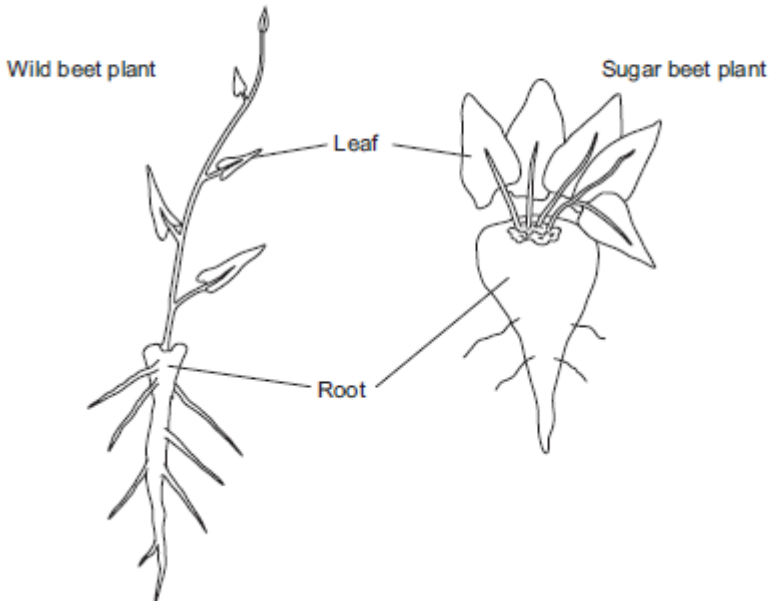
(3 marks)

(Extra space) .....

2)

Sugar beet is a crop grown for the sugar stored in its root. The sugar is produced by photosynthesis in the leaves of the plant. Plant breeders selected high-yielding wild beet plants. They used these plants to produce a strain of sugar beet to grow as a crop.

The drawings show a wild beet plant and a sugar beet plant. The drawings are to the same scale.



(a) Use the drawings to describe **two** ways in which a sugar beet plant is different from a wild beet plant.

Explain how each of these differences would give an increased yield of sugar.

Difference 1 .....

.....

Explanation .....

.....

Difference 2 .....

.....

Explanation .....

.....

(4 marks)

(b) Sugar beet plants have been selected for a faster rate of growth.

Suggest how the faster rate of growth may increase profit for a farmer.

.....

(1 mark)

(c) Describe and explain how selection will have affected the genetic diversity of sugar beet.

.....

(2 marks)

3)

Hummingbirds belong to the order Apodiformes. One genus in this order is *Topaza*.

(a) (i) Name **one** other taxonomic group to which all members of the Apodiformes belong.

.....

(1 mark)

(a) (ii) Name the taxonomic group between order and genus.

.....

(1 mark)

The crimson topaz and the fiery topaz are hummingbirds.

Biologists investigated whether the crimson topaz and the fiery topaz are different species of hummingbird, or different forms of the same species.

They caught large numbers of each type of hummingbird. For each bird they

- recorded its sex
- recorded its mass
- recorded the colour of its throat feathers
- took a sample of a blood protein.

The table shows some of their results.

	Crimson topaz		**Fiery topaz**	
	Male	**Female**	**Male**	**Female**
Mean mass / g (± standard deviation)	13.6 (±1.9)	10.8 (±1.3)	14.2 (±1.6)	11.6 (±0.63)
Colour of throat feathers	Green	Grey edges	Yellowish green	No grey edges

(b) (i) Explain how the standard deviation helps in the interpretation of these data.

.....

(2 marks)

(b) (ii) In hummingbirds throat colour is important in courtship. Explain the evidence in the table that shows that the crimson topaz and the fiery topaz may be different species of hummingbird.

.....

(2 marks)

(c) The biologists analysed the amino acid sequences of the blood protein samples from these hummingbirds.

Explain how these sequences could provide evidence as to whether the crimson topaz and the fiery topaz are different species.

.....

(2 marks)

4)

Scientists investigated the species of insects found in a wood and in a nearby wheat field. The scientists collected insects by placing traps at sites chosen at random both in the wood and in the wheat field.

The table shows the data collected in the wood and in the wheat field.

Species of insect	Number of organisms of each species	
	Wood	Wheat field
Bird-cherry oat aphid	0	216
Beech aphid	563	0
Large white butterfly	20	0
Lacewing	12	3
7-spot ladybird	36	0
2-spot ladybird	9	1
Total number of organisms of all species	640	220

(a) The scientists collected insects at sites chosen at random. Explain the importance of the sites being chosen at random.

.....

(1 mark)

(b) (i) Use the formula

$$d = \frac{N(N-1)}{\Sigma\, n(n-1)}$$

to calculate the index of diversity for the insects caught in the wood, where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

Show your working.

Answer .....

(2 marks)

(b) (ii) Without carrying out any further calculations, estimate whether the index of diversity for the wheat field would be higher or lower than the index of diversity for the wood.

Explain how you arrived at your answer.

.....

(2 marks)

(c) A journalist concluded that this investigation showed that farming reduces species diversity.
Evaluate this conclusion.

.....

(2 marks)

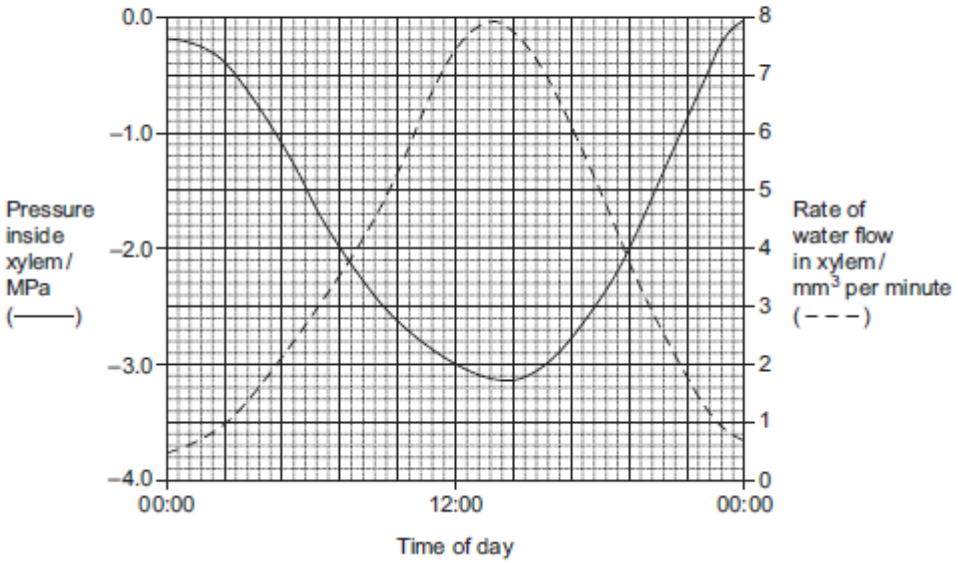
Farmers were offered grants by the government to plant hedges around their fields.
Explain the effect planting hedges could have on the index of diversity for animals.

.....

(2 marks)

5)

(a) Scientists measured the rate of water flow and the pressure in the xylem in a small branch. Their results are shown in the graph.



(a) (i) Use your knowledge of transpiration to explain the changes in the rate of flow in the xylem shown in the graph.

.....

(3 marks)

(a) (ii) Explain why the values for the pressure in the xylem are negative.

.....

(1 mark)

(b) Doctors measured the thickness of the walls of three blood vessels in a large group of people. Their results are given in the table.

Name of vessel	Mean wall thickness / mm (± standard deviation)
Aorta	5.7 ± 1.2
Pulmonary artery	1.0 ± 0.2
Pulmonary vein	0.5 ± 0.2

(b) (i) Explain the difference in thickness between the pulmonary artery and the pulmonary vein.

.....

(1 mark)

(b) (ii) The thickness of the aorta wall changes all the time during each cardiac cycle. Explain why.

.....

(3 marks)

(Extra space)

(b) (iii) Which of the three blood vessels shows the greatest variation in wall thickness? Explain your answer.

.....

(1 mark)

(c) Describe how tissue fluid is formed **and** how it is returned to the circulatory system.

(6 marks)

6)

(c) Give **two** ways in which a bacterium could become resistant to an antibiotic.

.....

.....

(2 marks)

(d) *S. aureus* lives inside people's mouths. Some dentists believe that this bacterium can get into the blood of people who have had teeth extracted and infect their heart valves.

Doctors carried out a survey to find out whether there was a risk of developing infected heart valves after tooth extraction. They asked patients whether they had had any teeth extracted in the last 2 or 3 months. They collected this information from patients who had infected heart valves. They also collected this information from the same number of other patients who did not have infected heart valves.

The information is summarised in the table.

Hospital patients	**Percentage of patients who had teeth extracted within the past**	
	2 months	**3 months**
Group that had infected heart valves	16.8	23.0
Group that did **not** have infected heart valves	14.4	23.0

The people chosen to be included in the survey were all of a similar age. Suggest why.

.....

(1 mark)

7)

In 2002, biologists identified a new group of insects. They called these insects gladiators.

(a) (i) *Mantophasma zephyra* is one species of gladiator. Complete the table to show how this species is classified.

Kingdom	Animalia
	Arthropoda
	Insecta
	Notoptera
Family	Mantophasmatodae
Species	

(2 marks)

(a) (ii) This system of classification consists of a hierarchy. Explain what is meant by a hierarchy.

.....

(2 marks)

(b) In 2002, very few gladiators were available for identification. Scientists around the world used photographs to establish the relationship of gladiators to other insects. Explain how.

.....

.....

(1 mark)

8)

(a) An increase in respiration in the tissues of a mammal affects the oxygen dissociation curve of haemoglobin. Describe and explain how.

.....

(2 marks)

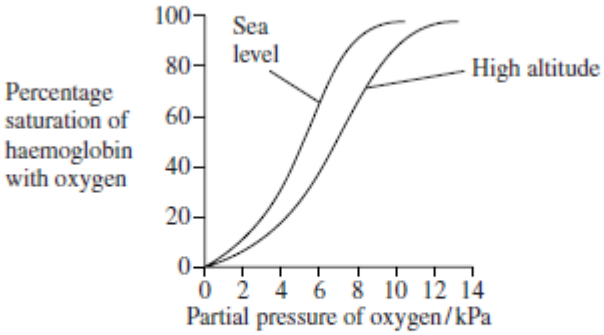
(b) There is less oxygen at high altitudes than at sea level.

(b) (i) People living at high altitudes have more red blood cells than people living at sea level. Explain the advantage of this to people living at high altitude.

.....

(2 marks)

(b) (ii) The graph shows oxygen dissociation curves for people living at high altitude and for people living at sea level.



Explain the advantage to people living at high altitude of having the oxygen dissociation curve shown in the graph.

.....

(2 marks)