1 Certain herbivores, such as cows, contain bacteria in their stomachs.

These bacteria produce enzymes that can digest cellulose and other organic compounds in the plant material that the cows eat.

As a result of the bacterial activity, methane and carbon dioxide are released. These gases pass into the atmosphere as the cow burps or exhales.

(a) (i) Place a cross ☒ in the box next to the term used to describe the type of chemical reaction involved in the digestion of cellulose by enzymes.

(1)

☒ **A** autolysis

☒ **B** haemolysis

☒ **C** hydrolysis

☒ **D** photolysis

(ii) Place a cross ☒ in the box next to the most likely product of the digestion of cellulose by the bacteria.

(1)

☒ **A** amino acids

☒ **B** fatty acids

☒ **C** glucose

☒ **D** glycerol

(b) Suggest why these bacteria need to have special adaptations to live in the stomach of a cow.

(3)

(c) On a farm in Wales, an investigation was carried out to assess the effect of diet on the milk yield and methane production of cows.

A herd of cows was divided into two groups, A and B. The cows in group A were fed a traditional diet and those in group B were fed the same diet with a mixture of chopped hay and straw added.

The table below shows the results of this investigation.

Group	Diet	Mean milk yield per cow / dm^3 day^{-1}	Methane emission for each dm^3 milk produced / dm^3
A	Traditional with no added material	24.0	30.0
B	Traditional with added chopped hay and straw	27.6	24.0

(i) Using the information in the table, calculate the rate of methane production per cow on each of the two diets.

(2)

Group A = ...

Group B = ...

*(ii) Scientists have estimated that if all cattle in Britain were fed on a diet with added chopped hay and straw, there would also be an annual reduction of at least 1.6 million tonnes of carbon dioxide released into the atmosphere.

With reference to your answer in (c)(i) and the information on carbon dioxide release, suggest why the new diet may be supported by organisations that are concerned about global warming.

(5)

(Total for Question 1 = 12 marks)

2 Organisms are adapted to their environment which increases their chances of survival.

(a) Read through the following passage about adaptations to the environment. Write on the dotted lines the most appropriate word or words to complete the passage.

(3)

The process of ..... selection can lead to adaptation, survival and

..... .

There are three types of adaptations to the environment: physiological, anatomical

and ..... .

(b) The table below describes some adaptations in humans. Complete the table by stating whether the adaptation is physiological or anatomical.

(3)

Description	Adaptation
Hearing becoming temporarily less sensitive after listening to loud music for a few hours	
Heart beats faster when the hormone adrenaline is released	
People living in a cold climate have a shorter neck than people living in a hot, dry climate	

(Total for Question 2 = 6 marks)

3 Nuthatches are small, colourful birds belonging to the genus, *Sitta*.
Many varieties of the species *Sitta europaea* (European nuthatch) can be found throughout mainland Europe.
These varieties form overlapping populations in different regions. These birds eat small invertebrates, living in tree bark, throughout the year.

European nuthatch. Magnification x0.5
Leslie J Borg/Science Photo Library

However, in the colder mountain forests on the island of Corsica, a small population of approximately 2500 pairs of nuthatches can be found. These birds are classified as the species *Sitta whiteheadi* (Corsican nuthatch). For most of the year, they feed on pine seeds. During the summer breeding season they also feed on small invertebrates.

Members of the two species, *S. europaea* and *S. whiteheadi*, are so similar in appearance and behaviour that they can usually only be distinguished by expert observation and research.

(a) Place a cross ☒ in the box next to the best definition of a species.

(1)

☒ **A** individuals can interbreed to produce fertile offspring

☒ **B** individuals can interbreed to produce hybrid offspring

☒ **C** individuals can interbreed to produce sterile offspring

☒ **D** individuals can interbreed to produce viable offspring

*(b) In mountainous regions of mainland Europe, only *S. europaea* is found. Suggest how a distinct species of nuthatch, *S. whiteheadi*, has evolved in the mountainous regions of the island of Corsica.

(5)

(c) (i) Suggest how environmental changes, such as those caused by global warming, are more likely to cause extinction of *S. whiteheadi* than *S.europaea*.

(3)

(ii) Suggest why *S. whiteheadi* might be able to survive an environmental change such as global warming.

(2)

.....

.....

.....

.....

(d) Explain how the work of zoos could be important to the survival of *S. whiteheadi*.

(2)

.....

.....

.....

.....

(Total for Question 3 = 13 marks)

4 Organisms survive in their environment because of their behavioural, physiological and anatomical adaptations.

(a) The table below gives some examples of adaptations. Complete the table by stating whether the example given is behavioural, physiological or anatomical.

(4)

Name of adaptation	Example
	Some metabolic reactions become less efficient in cold weather so the organism generates more heat to keep warm
	Sheep learn to ignore sounds that have no importance to them
	The ears of African elephants are larger than those of Asian elephants, due to differences in the environment
	Formation of a sun tan when human skin is exposed to sunlight

(b) The human egg cell is adapted for its function. Describe and explain **two** adaptations of the human egg cell.

(4)

1 .....

.....

.....

.....

2 .....

.....

.....

.....

(c) Pine needles, the leaves of pine trees, are believed to have antimicrobial properties.

Suggest how you could investigate the antimicrobial properties of pine needles.

(5)

(Total for Question 4 = 13 marks)