Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Biology

Advanced

Unit 4: The Natural Environment and Species Survival

Monday 24 January 2011 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6BI04/01

You do not need any other materials.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The removal of carbon dioxide from the atmosphere by green plants involves carbon fixation.

(a) The following statements are about carbon fixation.

(i) Place a cross ☒ in the box next to the stage in which RuBP combines with carbon dioxide.

(1)

☒ **A** The light-dependent reactions of the Calvin cycle

☒ **B** The light-independent reactions of the Calvin cycle

☒ **C** The light-dependent reactions of the Krebs cycle

☒ **D** The light-independent reactions of the Krebs cycle

(ii) Place a cross ☒ in the box next to the enzyme that catalyses carbon fixation.

(1)

☒ **A** GALP

☒ **B** GP

☒ **C** NADP

☒ **D** RUBISCO

(iii) Place a cross ☒ in the box next to the site of carbon fixation.

(1)

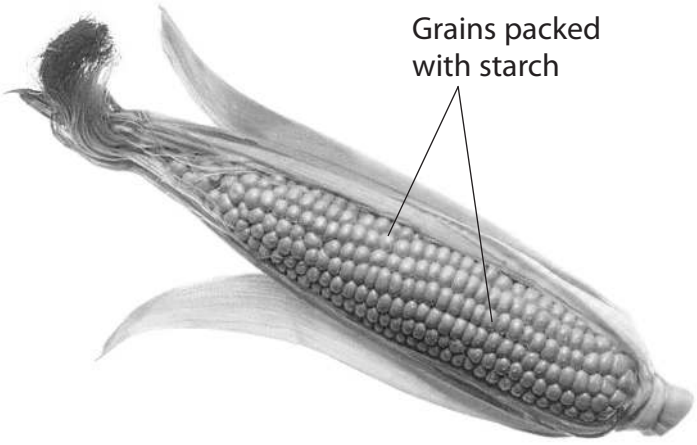
☒ **A** Cristae of a mitochondrion

☒ **B** Granum of a chloroplast

☒ **C** Matrix of a mitochondrion

☒ **D** Stroma of a chloroplast

(b) Varieties of the crop plant, maize (*Zea mays*), are grown in many countries which have relatively long, warm growing seasons. The seed heads, known as corn cobs, contain grains (seeds) that are used in the production of many cereal products. A typical corn cob is shown in the photograph below.



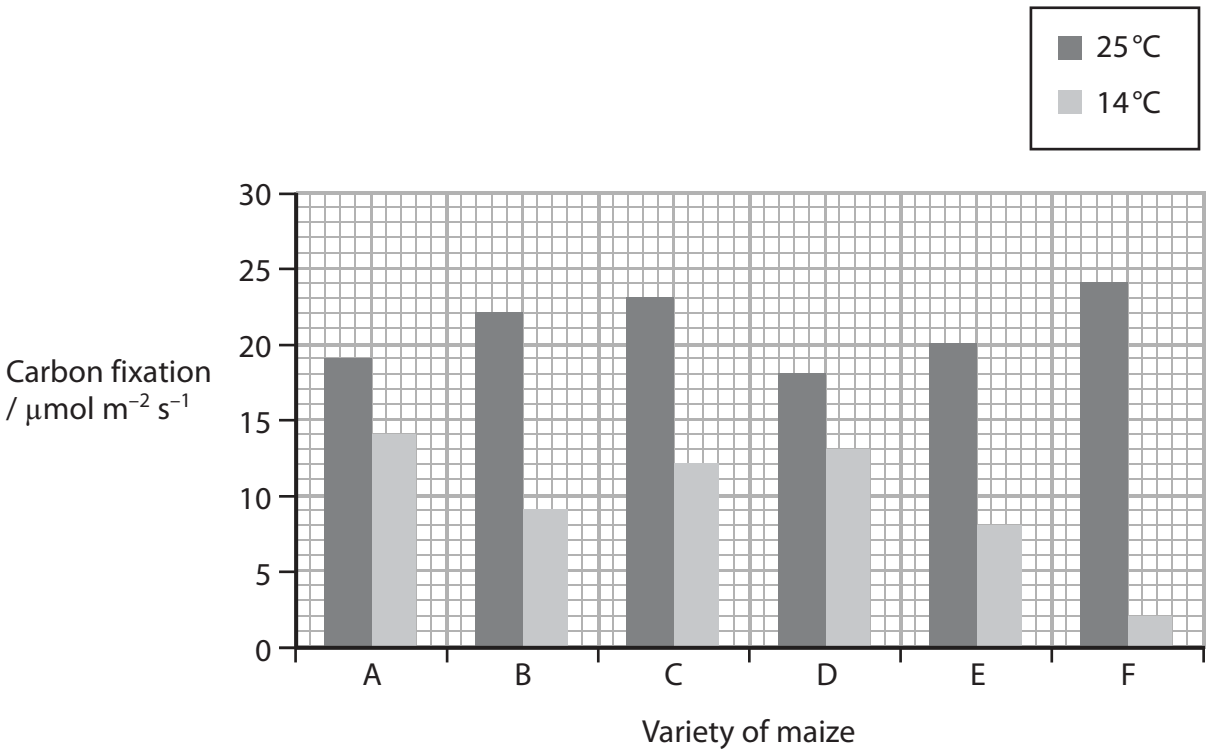
Magnification ×0.5

(i) Suggest why the development of corn cobs, suitable for producing cereal products, depends on the rate of carbon fixation in maize plants.

(3)

(ii) As the demand for maize has increased, it has started to be grown in many more regions of the World. In order to meet this demand, new varieties of maize have been developed from older traditional varieties by scientific breeding programmes.

The graph below shows the rate of carbon fixation for six new varieties (A to F) of maize at two different environmental temperatures, 25 °C and 14 °C.



The rate of carbon fixation is higher at 25 °C than at 14 °C for each of the six varieties of maize. Suggest an explanation for this.

(2)

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(iii) The table below shows the range of temperatures for the main crop-growing season for maize, in four regions of the World. The main maize variety grown in three of the regions is also shown.

Region	Temperature range / °C		Main maize variety
	Minimum	Maximum	
Central Africa	24.8	27.3	F
Central USA	20.2	28.3	F
Northern Africa	24.7	27.9	F
Central Europe	11.2	19.3	

Using the data shown in the graph, complete the table by selecting the most suitable maize variety for Central Europe. Explain the reasons for your choice.

(5)

(Total for Question 1 = 13 marks)

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2 Bovine respiratory diseases (BRD) are a major problem in cattle, causing serious economic losses. The causes of BRD are multiple and complex.
The most severe cases of BRD involve infections by both viruses and bacteria.

(a) The table below shows some features found in bacteria and viruses.
For each feature, place **one** cross ☒ in the appropriate box, in each row, to show whether it is found in bacteria only, in viruses only or in both bacteria and viruses.

(3)

Feature	Bacteria only	Viruses only	Both bacteria and viruses
Glycogen granules	☒	☒	☒
Nucleic acids	☒	☒	☒
Protein coat (capsid)	☒	☒	☒

(b) Mild cases of BRD can usually be treated using antibiotics.
The treatment of severe cases of BRD will involve the use of antibiotics and other medications.

(i) Suggest why medications, other than antibiotics, are needed to treat the most severe cases of BRD.

(2)

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(ii) The table below shows the effectiveness of various antibiotics on three species of bacteria that can contribute towards severe cases of BRD.

Antibiotic	**Effectiveness of various antibiotics on three BRD bacterial pathogens (%)**		
	Mannheimia haemolytica	***Pasteurella multocida***	***Histophilus somni***
Danofloxacin	71	88	84
Enrofloxacin	83	93	95
Florfenicol	85	90	95
Oxytetracycline	56	70	55
Spectinomycin	72	76	67
Tilmicosin	61	64	93

A group of cattle has BRD but the bacteria pathogen has not been identified. Suggest which antibiotics would be the most suitable to use to treat these cattle.
Give reasons for your answer.

(3)

(iii) Suggest why it might be advisable to change the antibiotic being used, in the treatment of these cattle, once the pathogen has been identified.

(3)

(Total for Question 2 = 11 marks)

3 The soils in wet, marshy lands usually have anaerobic conditions that inhibit decomposition. As a result of this, dense layers of semi-decayed organic matter, known as marshland peat, build up.

The table below shows some of the components of marshland peat.

Component	Chemical nature	Main source
Cutin	Polymer of organic acids linked by ester bonds	Waxy layers of leaves and fruits
Lignin	Polymers of phenyl propene	
Hemicellulose	Branched polysaccharide Monomers include hexoses and pentoses linked by glycosidic bonds	Cell walls of all plant cells
Cellulose		Cell walls of all plant cells

(a) Describe the chemical nature of cellulose.

(3)

(b) Name a plant tissue that could be the main source of the lignin found in marshland peat.

(1)

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(c) All of the components shown in the table are organic carbon compounds. Describe the role of microorganisms in the recycling of the carbon from these compounds.

(3)

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(d) Landscapes rich in peat act as carbon sinks. However, during recent decades, some countries have been draining and clearing marshy peatlands to grow crops, such as palms, to produce biofuels. During this clearance and drainage, the rate of decomposition in the peat increases and the organic debris is burnt. This change of use of the peatlands has turned carbon sinks into carbon sources.

(i) Suggest **one** reason why some countries may decide to drain their marshy peatlands for the production of biofuels.

(1)

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*(ii) Biofuels are considered to be carbon neutral.

Suggest why the continued draining and clearance of peatlands may contribute towards global warming even though they may be used to produce biofuels.

(5)

(Total for Question 3 = 13 marks)

4 Tuberculosis (TB) kills approximately three million people every year.
Droplets containing the organisms that cause TB are released into the air when a person suffering from TB coughs. Transmission of TB occurs if these droplets are inhaled into the alveoli of the lungs.

In the lungs, the organisms are taken up by macrophages and carried to lymph nodes.

(a) (i) State **one** characteristic symptom of TB other than coughing.

(1)

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(ii) Place a cross ☒ in the box next to the name of the organism that causes TB.

(1)

☒ **A** *Macrobacterium tuberculosis*

☒ **B** *Microbacterium tuberculosis*

☒ **C** *Monobacterium tuberculosis*

☒ **D** *Mycobacterium tuberculosis*

(iii) Describe how the organisms that cause TB are taken up by macrophages.

(3)

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(iv) Ingesting food containing these organisms is unlikely to lead to the development of TB. Give an explanation for this.

(2)

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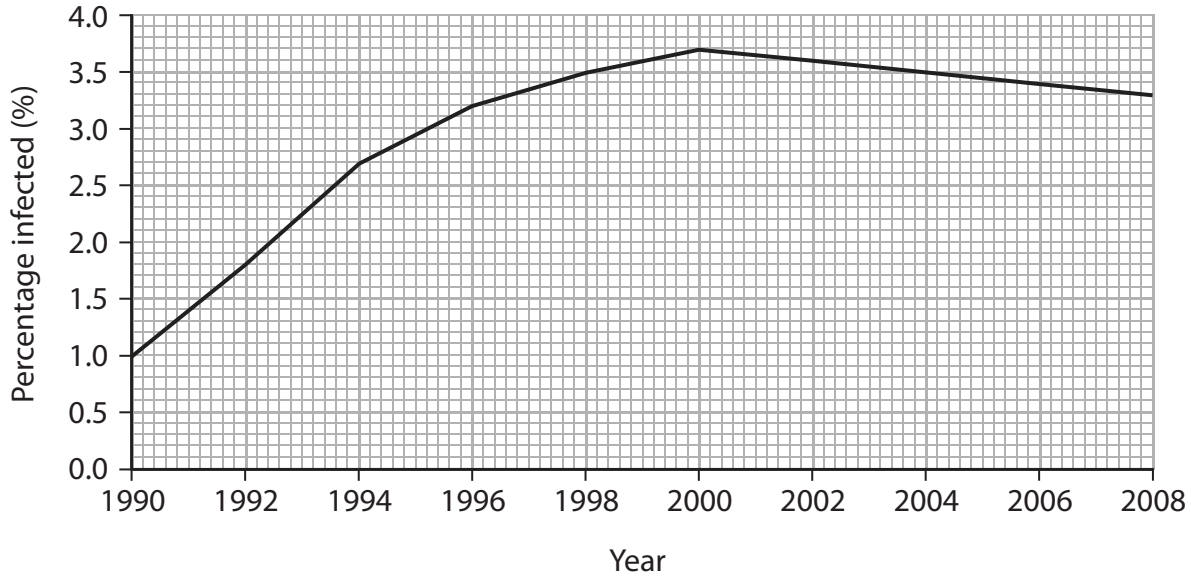
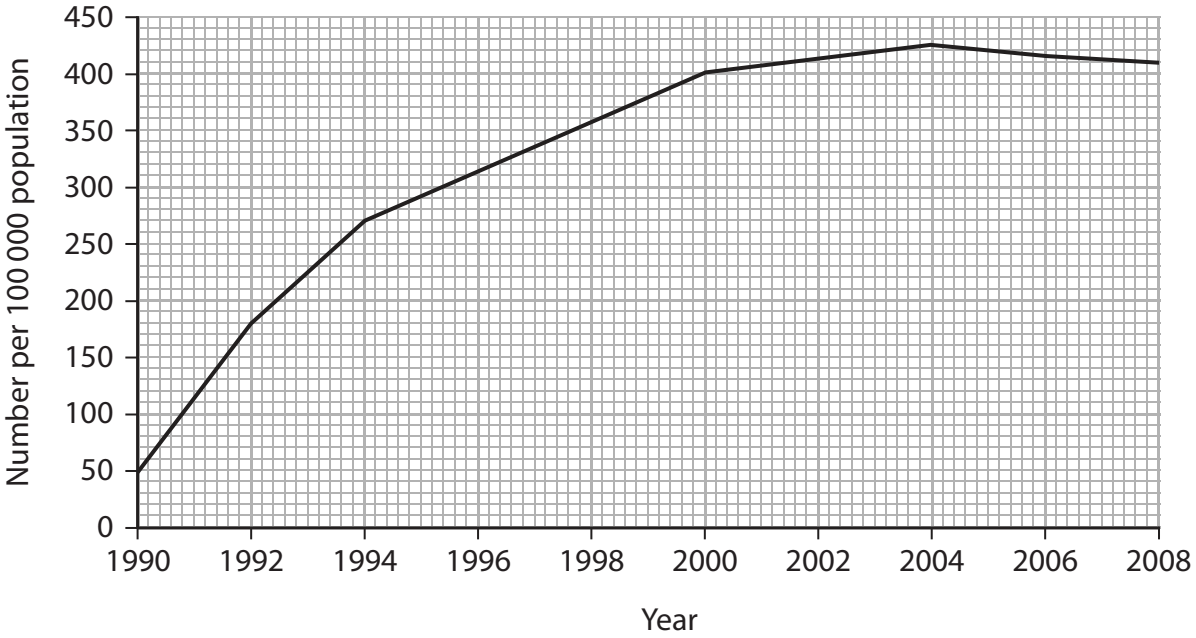
*(b) The graphs below show data related to TB and HIV infections in the population of central Africa from 1990 to 2008.

Graph 1 – The percentage of the population infected by TB



Graph 2 – The number of cases of HIV infection per 100 000 population



Discuss how far the data in the graphs support the following hypothesis.

The increase in HIV infection in central Africa has led to an increase in TB infection.

(4)

(Total for Question 4 = 11 marks)

5 A wetland is an area where the soil is saturated with moisture either permanently or seasonally. The distribution and abundance of organisms in a wetland will be influenced by various abiotic factors including the degree of saturation of the soil by water. Within most wetlands, there will be areas which are relatively dry and other areas which are submerged under water throughout the year.

(a) (i) Explain why the degree of saturation of the soil by water is considered to be an abiotic factor.

(1)

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(ii) Place a cross ☒ in the box next to the **biotic** factor that might influence the distribution and abundance of organisms in a wetland.

(1)

☒ **A** Mineral availability

☒ **B** pH

☒ **C** Predation

☒ **D** Water temperature

(b) A group of students studied an area of wetland. They placed twenty $1m^2$ quadrats on a line from a relatively dry area to an area where there was free-standing water. Each quadrat was divided up into 25 smaller sections.

(i) Place a cross ☒ in the box next to the term that describes the technique that uses a line of quadrats to investigate the distribution of organisms.

(1)

☒ **A** Transact

☒ **B** Transcript

☒ **C** Transect

☒ **D** Transept

(ii) Suggest why the quadrats were divided up into 25 smaller sections.

(2)

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Figure 1 – Percentage cover of each species at each quadrat

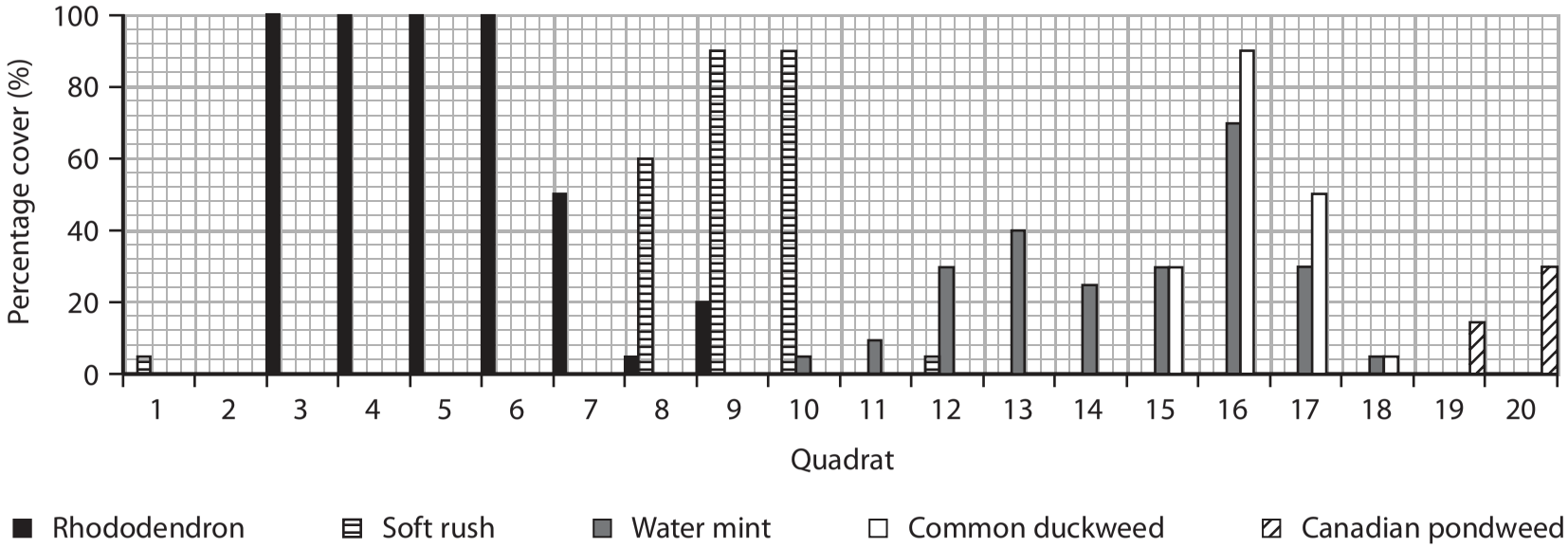

Figure 2 – Water depth at each quadrat

Quadrat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Water depth / cm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	20	30	40	50	60

(iii) The students estimated the percentage cover of each of five species of plant within each quadrat. They also measured the depth of free-standing water.

The results of this part of the study are shown in Figure 1 and Figure 2.

Use the data in Figure 1 and Figure 2 to complete the table below.

(2)

Species	Description
Canadian pondweed	Delicate plant that is suspended in the water
Rhododendron	Woody shrub that requires reasonably dry, firm soil
.....	Non-woody plant that requires very moist conditions
.....	Semi-submerged plant which floats in shallow water
.....	Semi-woody plant which requires fairly moist conditions

(iv) Suggest why the students were **not** able to draw valid conclusions about the effect of saturation of the soil by water on the distribution of the five plant species.

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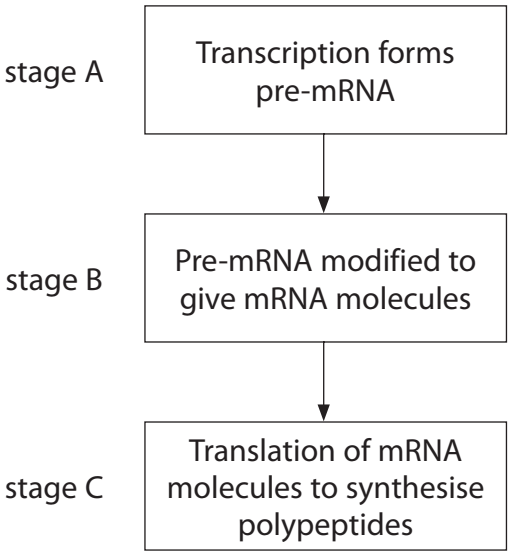
(Total for Question 5 = 10 marks)

6 The diagram below shows the sequence of events leading to polypeptide synthesis.



(a) Place a cross ☒ in the box next to the correct term that completes each of the following statements.

(i) Transcription takes place in the

(1)

☒ **A** Golgi apparatus

☒ **B** lysosome

☒ **C** nucleus

☒ **D** ribosome

(ii) A triplet of bases that could **not** be found in mRNA is

(1)

☒ **A** Adenine Adenine Guanine

☒ **B** Adenine Thymine Guanine

☒ **C** Adenine Cytosine Guanine

☒ **D** Adenine Uracil Guanine

(iii) The sequence of triplets on a section of DNA used to form a strand of pre-mRNA is a

(1)

- ☒ **A** cistron
- ☒ **B** codon
- ☒ **C** neutron
- ☒ **D** photon

(b) Describe how free nucleotides are bonded together in the correct sequence in pre-mRNA, at stage A.

(3)

(c) A strand of pre-mRNA consists of exons and introns. Exons are sections that can be used during translation for polypeptide synthesis. Introns are lost during the modification of pre-mRNA at stage B and are not used during translation.

During this modification, a variety of mRNA molecules is formed. Each molecule contains all or only some of the original exons in the pre-mRNA. However, the sequence of the exons in a strand of mRNA will always be the same as in the original pre-mRNA.

(i) Explain the function of the codons at each end of a strand of mRNA, during the process of translation.

(2)

(ii) Suggest why a variety of different protein structures could be formed from the polypeptides synthesised using the mRNA molecules from a single gene.

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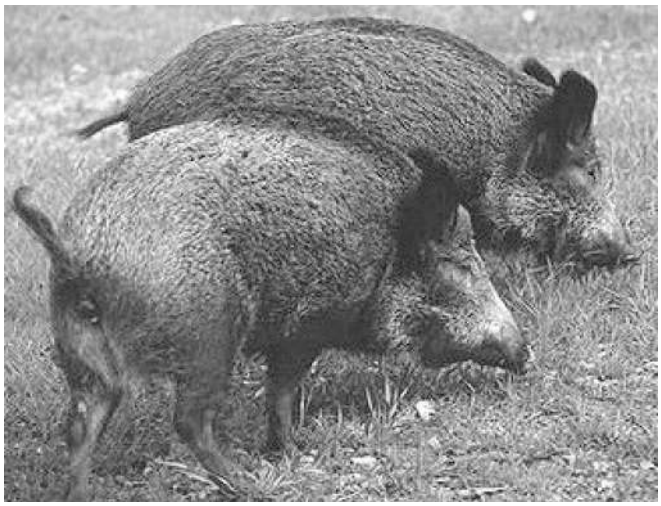
(Total for Question 6 = 11 marks)

7 Sardinia is an island in the Mediterranean Sea. Many of the plants and animals on islands, such as Sardinia, show distinct physical and behavioural features that are different from those found in closely-related mainland populations.
The Sardinian wild boar is an example of this, shown in the photograph below.



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(a) Explain what is meant by each of the following terms.

(i) Gene pool

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(ii) Allele frequency

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(b) The population of wild boar in mainland Italy and the population in Sardinia both belong to the species, *Sus scrofa*. The mainland population is placed in the sub-species, *Sus scrofa scrofa*, whilst the Sardinian population is placed in the sub-species, *Sus scrofa meridionalis*.

(i) Suggest why scientists classify the mainland and Sardinian wild boar as two sub-species rather than as two separate species.

(2)

*(ii) Suggest how the two sub-species, *Sus scrofa meridionalis* and *Sus scrofa scrofa*, have developed from a single ancestral population.

(5)

(iii) Explain how the results of DNA profiling of tissue samples from the two sub-species could be used to provide evidence that they share common ancestry.

(3)

(Total for Question 7 = 12 marks)

8 (a) Some of the ways by which a person may acquire antibodies to become immune to a disease are listed below.

A - artificial active

B - artificial passive

C - natural active

D - natural passive

Complete the table below by writing the letter of the most appropriate form of immunity shown in the list.

(2)

Source of antibodies	Form of immunity
Passed across placenta to fetus from mother	
Injected from another individual	
Produced as a result of suffering from the disease	
Produced following vaccination using antigen	

(b) Methicillin-resistant *Staphylococcus aureus* (MRSA) is a bacterium. When it enters the blood it can stimulate the production of several different clones of plasma cells. These produce a variety of antibodies (polyclonal antibodies). Suggest an explanation for this.

(4)

(c) In the laboratory, it is possible to produce clones of special cells that only produce one type of antibody (monoclonal antibodies). These monoclonal antibodies can be used to detect the presence of antigens in the blood.

Suggest the advantage of using monoclonal antibodies, rather than polyclonal antibodies, in the detection of antigens in the blood.
Give reasons for your answer.

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(Total for Question 8 = 9 marks)

TOTAL FOR PAPER = 90 MARKS

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