Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Biology A (Salters Nuffield)

Advanced

Paper 1: The Natural Environment and Species Survival

Monday 12 June 2017 – Afternoon

Time: 2 hours

Paper Reference **9BN0/01**

You must have:
Calculator, HB pencil, ruler

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.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

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

Turn over ▶

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P 4 8 1 7 4 A 0 1 3 2

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Answer ALL questions.

Write your answers in the spaces provided.

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 At the start of fertilisation, many sperm cells will surround the ovum.

(a) Fertilisation begins with the acrosome reaction.

(i) Which of the following describes the acrosome reaction?

(1)

☐ **A** the ovum releases enzymes that digest the egg cell membrane

☐ **B** the ovum releases enzymes that digest the zona pellucida

☐ **C** the sperm cell releases enzymes that digest the egg cell membrane

☐ **D** the sperm cell releases enzymes that digest the zona pellucida

(ii) Which of the following statements describes the genetic content of a sperm cell?

(1)

	Each sperm cell will contain	Different sperm cells will contain
☐ **A**	one copy of each gene	different alleles of some genes
☐ **B**	one copy of each gene	the same alleles for all genes
☐ **C**	two copies of each gene	different alleles of some genes
☐ **D**	two copies of each gene	the same alleles for all genes

(b) Describe the events of fertilisation that occur after the acrosome reaction.

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(Total for Question 1 = 5 marks)

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2 All cells have a cell surface membrane.

(a) Explain how phospholipids form a cell surface membrane.

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(b) Cell surface membranes regulate the movement of substances into and out of cells.

(i) Which of the following describes the movement of water by osmosis?

(1)

☒	**A**	against a solute concentration gradient	through a fully permeable membrane
☒	**B**	against a solute concentration gradient	through a partially permeable membrane
☒	**C**	down a solute concentration gradient	through a fully permeable membrane
☒	**D**	down a solute concentration gradient	through a partially permeable membrane

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(ii) The concentration of potassium ions inside an animal cell is many times higher than the concentration of potassium ions in the extracellular fluid.

Which mechanism is responsible for the uptake of potassium ions by this animal cell?

(1)

☒ **A** active transport

☒ **B** exocytosis

☒ **C** osmosis

☒ **D** passive diffusion

(iii) Glucose enters cells by facilitated diffusion.

Which part of the cell surface membrane allows facilitated diffusion of glucose?

(1)

☒ **A** cholesterol

☒ **B** glycolipid

☒ **C** phospholipid

☒ **D** protein

(c) Some epithelial cells in the lungs secrete mucus. If the mucus is too 'sticky', it cannot be easily removed from the lungs.

Other epithelial cells in the lungs contain CFTR proteins in their cell surface membranes.

(i) Describe the role of the CFTR protein in ensuring that the mucus produced in the lungs has the right consistency.

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(ii) The table shows part of the gene that codes for the CFTR protein and the corresponding amino acid sequence. Each amino acid is represented by a single letter.

Part of the CFTR gene	ATTAAAGAAAATATCATCTTTGGTGTTTCCTAT										
Amino acid sequence	I	K	E	N	I	I	F	G	V	S	Y

Explain how the information in the table demonstrates the nature of the genetic code.

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(Total for Question 2 = 12 marks)

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3 DNA synthesis in bacterial cell cultures has been investigated.

(a) Describe how DNA is organised in a bacterial cell.

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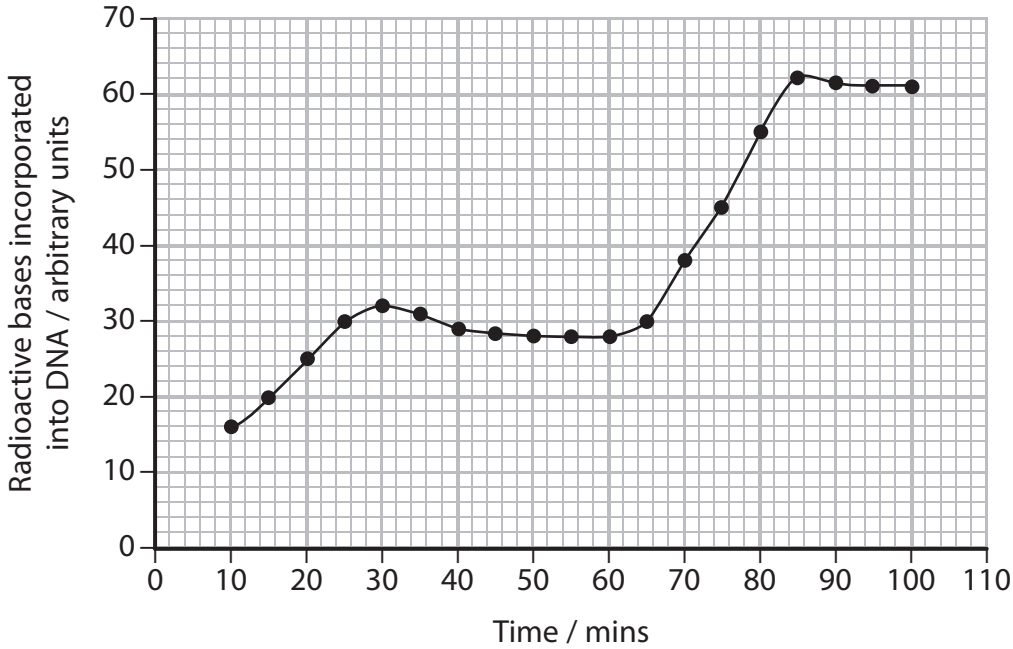
(b) In an experiment, a mixture of radioactive bases was added to a culture of dividing bacteria.

The results are shown in the graph.



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(i) Calculate the fastest rate of uptake of bases by these bacteria.

(2)

Answer .....

(ii) Deduce how many times the bacteria in the culture have divided during this experiment.

(2)

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(iii) Explain why the experiment would be improved if all the bases were provided but only the thymine was radioactive.

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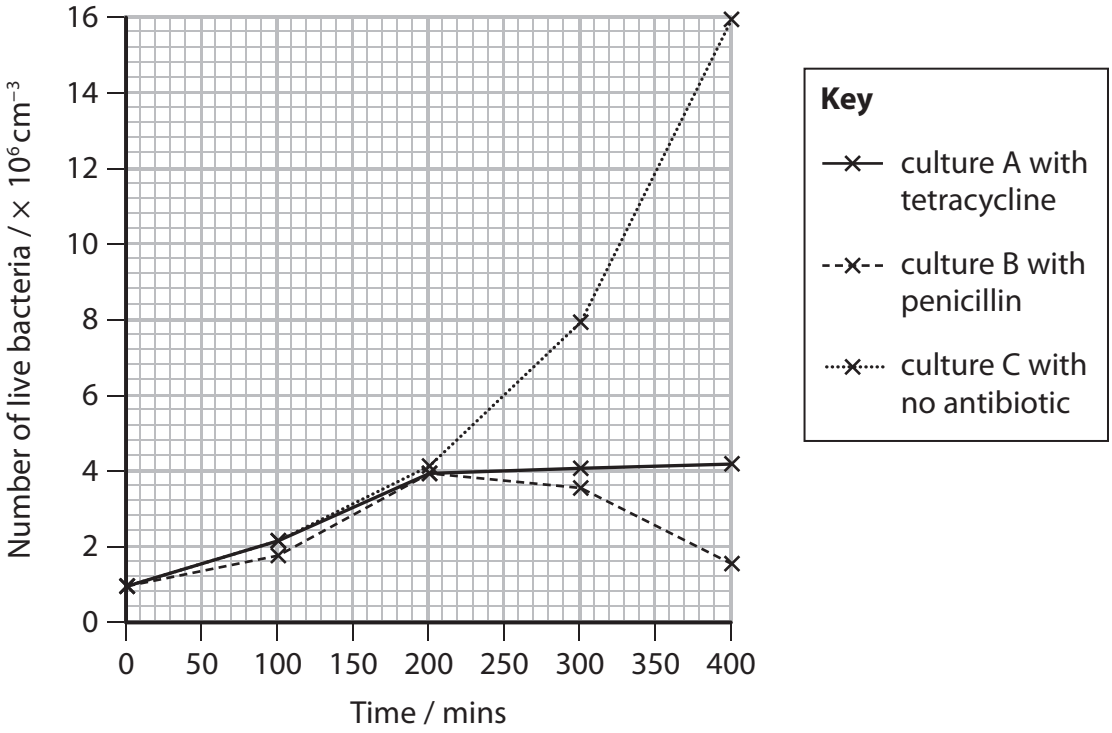
(c) Antibiotics can be used to control bacterial infections.

In an experiment, a culture of bacteria was grown in nutrient broth. The culture was then divided into three separate cultures, A, B and C. The bacterial cultures were grown for 200 minutes.

After 200 minutes the antibiotic tetracycline was added to culture A and the antibiotic penicillin was added to culture B. No antibiotics were added to culture C.

The three cultures were grown for a further 200 minutes.

The results of the experiment are shown in the graph.



Deduce the effects of these antibiotics on the growth of the bacterial cultures.

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4 Photosynthesis is a two-stage process by which plants fix carbon dioxide.

(a) Describe the light-dependent reactions of photosynthesis.

(5)

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(b) The products of the light-dependent reactions are used in the light-independent reactions.

(i) In which part of the chloroplast do the light-independent reactions take place?

(1)

☒ **A** envelope

☒ **B** granum

☒ **C** stroma

☒ **D** thylakoid

(ii) What is the name of the enzyme used by plants to fix carbon dioxide?

(1)

☒ **A** GALPase (glyceraldehyde-3-phosphatase)

☒ **B** GPase (glycerate-3-phosphatase)

☒ **C** RUBISCO (ribulose bisphosphate carboxylase/oxygenase)

☒ **D** RuBPase (ribulose bisphosphatase)

(iii) Which of the following is the immediate product of the light-independent reactions of photosynthesis?

(1)

☒ **A** glucose

☒ **B** GP

☒ **C** RuBP

☒ **D** starch

(Total for Question 4 = 8 marks)

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5 Climate change has been correlated with changing atmospheric carbon dioxide levels.

(a) Scientists studying climate change have examined peat bogs to observe pollen grains such as those shown in the photograph.

Explain how studying pollen grains in peat bogs can provide evidence of climate change.

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(b) Scientists measured the productivity of two types of forest and recorded the mass of carbon taken up per square metre per year (gC m^{-2} y^{-1}).

The table shows data on the mean net primary productivity (NPP) and mean gross primary productivity (GPP) of these two types of forest.

Type of forest	Mean NPP / gC m^{-2} y^{-1}	Mean GPP / gC m^{-2} y^{-1}	Ratio of NPP to GPP
Boreal	322	1013	0.32
Temperate deciduous	1301	2165	0.60

(i) Calculate the percentage increase in mass of carbon released due to respiration by temperate deciduous forests compared with that by boreal forests.

(3)

.....%

(ii) The ratio of net primary productivity to gross primary productivity is a measure of the ability of forests to transfer carbon from the atmosphere into biomass.

Scientists concluded that temperate deciduous forests would reduce levels of carbon dioxide in the atmosphere more than boreal forests.

Justify this conclusion.

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(Total for Question 5 = 10 marks)

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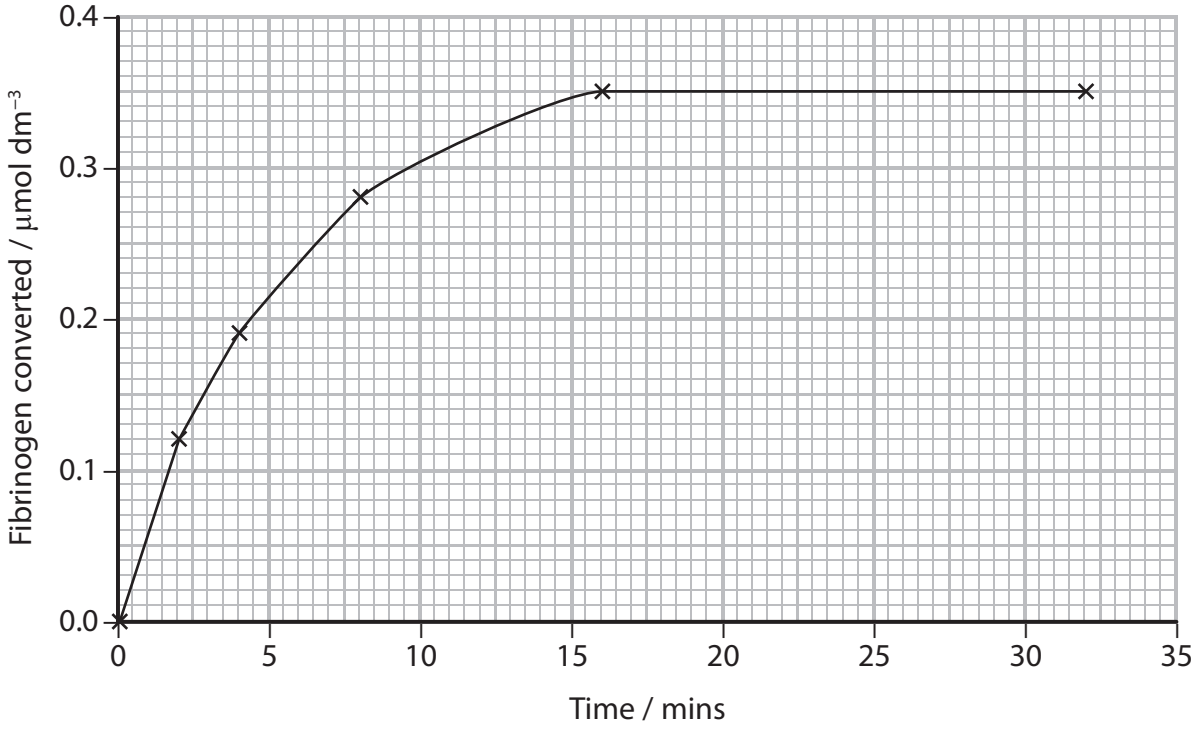
6 Fibrin is involved in the formation of blood clots.

Thrombin is an enzyme that converts fibrinogen to fibrin.

(a) The graph shows the effect of one concentration of thrombin on the conversion of fibrinogen to fibrin.



(i) Calculate the initial rate of reaction.

(2)

Answer .....

(ii) On the graph, draw a line to show the effect of halving the concentration of thrombin.

(1)

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(iii) Explain the effect of changes in the initial rate of reaction on the time taken for a blood clot to form.

(2)

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(b) The table shows the results of an investigation into the fibrinogen concentrations in the blood of males and females with and without cardiovascular disease (CVD).

	Mean fibrinogen concentration / mg 100 cm^{-3}	
	With CVD	**Without CVD**
Males	333 ± 5.16	322 ± 2.00
Females	336 ± 7.25	319 ± 1.89

(i) Explain how the results of this investigation could be used to identify individuals at risk of CVD.

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(ii) Explain how changes in fibrinogen concentration might be a risk factor for CVD.

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7 In birds and mammals, gas exchange takes place between the blood in the capillaries and the air in the alveoli.

There are three layers between the blood and the air in the alveoli: the capillary wall, a layer of extracellular matrix and the alveolar wall. This is called the blood-gas barrier.

(a) The extracellular matrix contains collagen.

(i) Describe the structure of collagen.

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(ii) Give a function for collagen in the blood-gas barrier.

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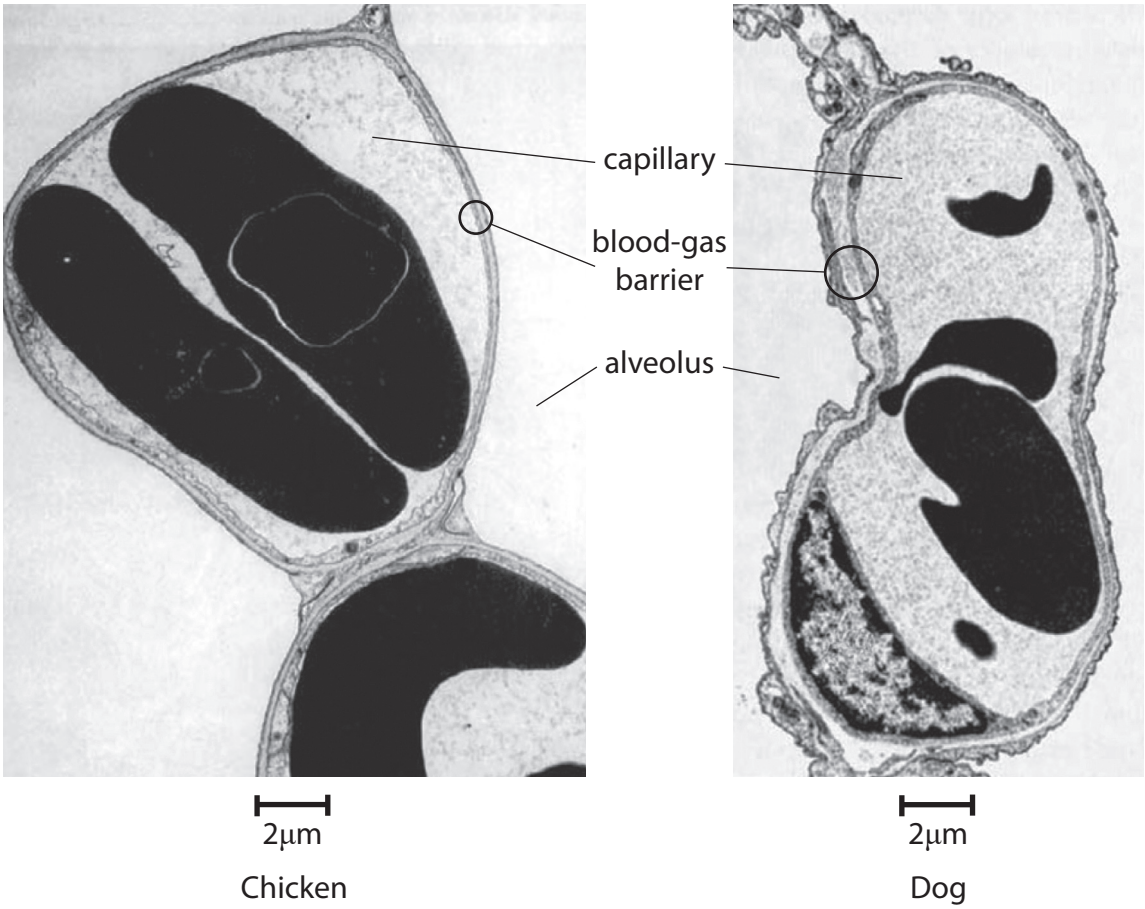
(b) The electron micrographs show the blood-gas barriers for a chicken and a dog.



Explain how the blood-gas barrier of the chicken is adapted to give more efficient gas exchange than the blood-gas barrier of the dog.

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(Total for Question 7 = 7 marks)

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8 Human papilloma virus (HPV) is a DNA virus.

(a) Some strains of HPV are sexually transmitted and can cause cervical cancer or genital warts.

The table shows some information about the conditions associated with four strains of HPV.

HPV strain	Condition associated with the strain	Percentage of all cases caused by the strain (%)
6	cervical cancer	<1
	genital warts	67
11	cervical cancer	<1
	genital warts	22
16	cervical cancer	55
	genital warts	<1
18	cervical cancer	13
	genital warts	<1

(i) Comment on the relationship between HPV and these two conditions.

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(ii) The table shows two vaccines developed from different combinations of HPV.

Vaccine	Strains of HPV used in development of the vaccine
Cervarix	16 and 18
Guardasil	6, 11, 16 and 18

Analyse all the data to explain why the Guardasil vaccine is preferred to the Cervarix vaccine.

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(iii) Which of the following describes the type of immunity developed by these vaccines?

(1)

☒ **A** artificial active immunity

☒ **B** artificial passive immunity

☒ **C** natural active immunity

☒ **D** natural passive immunity

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(b) Cervarix and Guardasil have been used in national vaccination programs.

A person who has been vaccinated becomes infected with HPV-16. Explain the role of the T cells in the body of this person.

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(c) In agammaglobulinaemia, stem cells in the bone marrow cannot differentiate into B cells.

Agammaglobulinaemia can be a sex-linked condition.

(i) Which of the following describes the production of B cells from bone marrow stem cells?

(1)

☒ **A** from differentiated cells by meiosis

☒ **B** from differentiated cells by mitosis

☒ **C** from undifferentiated cells by meiosis

☒ **D** from undifferentiated cells by mitosis

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(ii) State what is meant by the term **sex-linkage**.

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(Total for Question 8 = 14 marks)

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9 The coffee husks, shown in the photograph, are a waste product of coffee plantations.

Composting has been suggested as an environmentally friendly way of decomposing these coffee husks.

The effect of adding cow dung to coffee husks, before they are composted, has been investigated.

The table shows the percentages of organic carbon and nitrogen in two compost heaps at the start of composting and after 90 days.

	Husks alone		**Husks with added cow dung**	
Days composting	0	90	0	90
Organic carbon (%)	54.50	41.70	48.10	35.40
Nitrogen (%)	1.84	2.31	2.76	3.19

(a) Comment on the effect of adding cow dung to composting coffee husks.

(3)

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*(b) The changes in the compost heaps are due to the activity of decomposers and other organisms.

Devise an investigation to determine the effect of the carbon to nitrogen ratio on the succession of species in these compost heaps.

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10 Scientists have studied behavioural, anatomical and genetic variation in elephants.

The table shows some information about two populations of African elephants.

Population	Location	Feeding behaviour	Anatomical differences
Forest elephant	tropical forest of central and West Africa	feeds on leaves and fruits of high-growing plants such as shrubs and trees	• lower jaw longer and narrower • tusks straighter and downward facing • overall a much smaller size
Savannah elephant	African savannah	feeds on grass and leaves of low-growing shrubs	• lower jaw shorter and wider • tusks more curved and upward facing • overall a larger size

The photographs show elephants from the two populations.

Forest elephant

Savannah elephant

DNA samples were collected from these two populations of elephants.

(a) One of the genes showing variation was the GBA gene. The table shows the frequency of the alleles of the GBA gene in the two populations.

GBA allele	Frequency of allele in the elephant population	
	Savannah elephant	Forest elephant
J	0.05	0.43
K	0.00	0.57
L	0.95	0.00

(i) State what is meant by the term **allele**.

(1)

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(ii) Use the Hardy-Weinberg equation to show that more than 50% of the forest elephant population are homozygous for the GBA gene.

(3)

Answer.....

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(b) Scientists have concluded that the forest elephant and the savannah elephant are two different species.

*(i) Analyse the data and the information provided to comment on the validity of this conclusion.

(6)

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(ii) Explain how two species of African elephant could evolve from a common ancestor.

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