GradeMax

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 45 minutes

Paper reference **WBI14/01**

Biology

International Advanced Level
UNIT 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

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.*
- Calculators may be used.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

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.*
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- 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.

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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Pearson

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 The photograph shows a polar bear.



(Source: © Burcu Gultekin / Alamy Stock Photo)

Polar bears are adapted to live in the Arctic Circle.

Polar bears have a layer of fat beneath their skin. This fat insulates them from the cold and can be used to supply the polar bear with water (metabolic water).

They have a thick fur coat which also insulates them from the cold.

Polar bears feed on seals. The polar bear sits on the ice and waits for a seal to come to the surface of the water to breathe.

(a) Which row of the table describes the types of adaptation of polar bears?

(1)

		Anatomical	Behavioural	Physiological
☒	**A**	produces metabolic water	hunting by sitting on ice	thick fur coat
☒	**B**	hunting by sitting on ice	thick fur coat	produces metabolic water
☒	**C**	thick fur coat	produces metabolic water	hunting by sitting on ice
☒	**D**	thick fur coat	hunting by sitting on ice	produces metabolic water

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(b) What is the niche of a polar bear?

(1)

- ☒ **A** produces metabolic water
- ☒ **B** the Arctic Circle
- ☒ **C** controls the population size of seals
- ☒ **D** uses the layer of fat beneath the skin

(c) Suggest why the polar bear needs to rely on the store of fat to provide it with water.

(2)

(d) Climate change is resulting in habitat fragmentation. Habitat fragmentation causes groups of polar bears to become separated from one another.

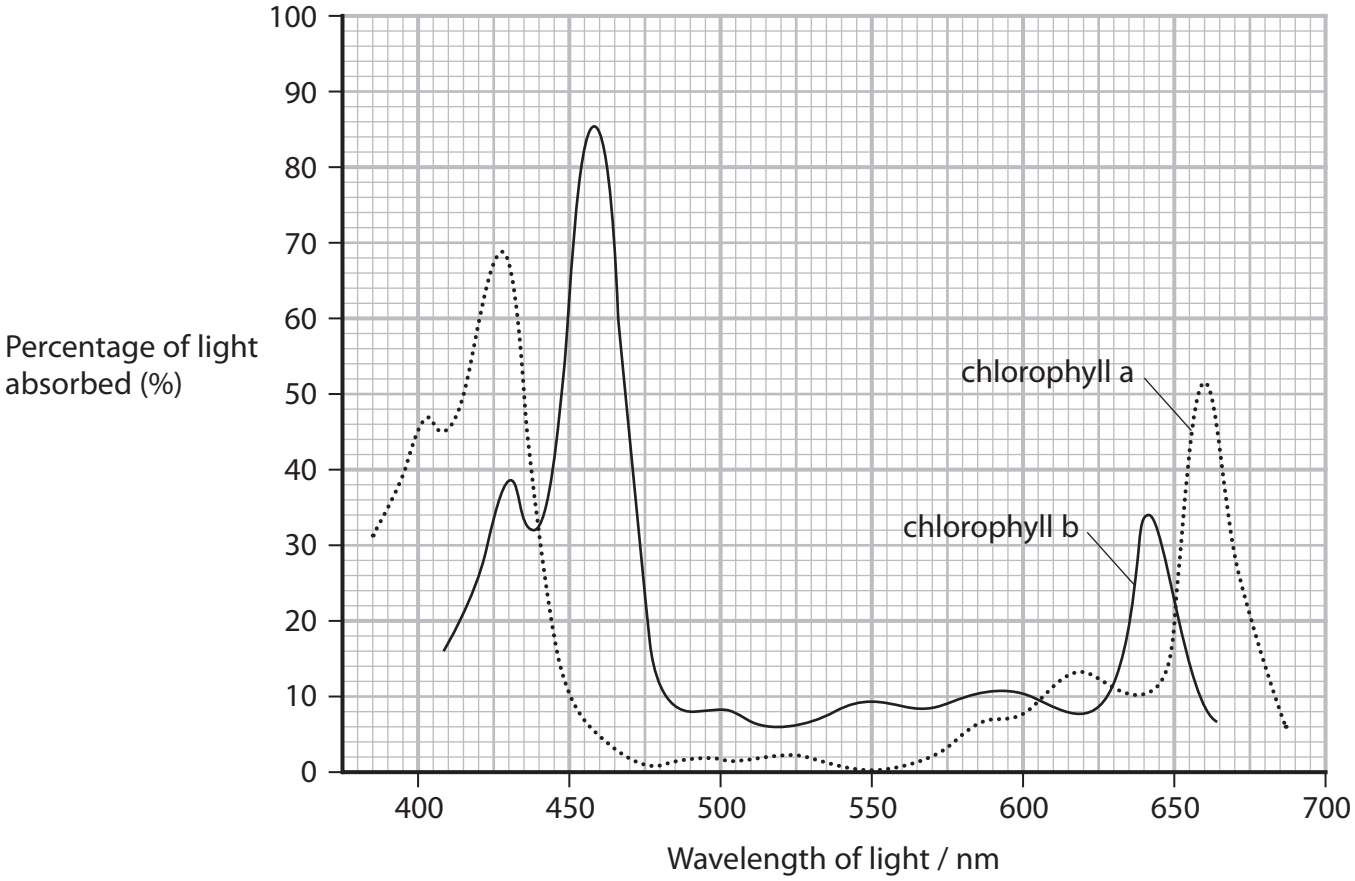
Explain the effect that habitat fragmentation could have on the genetic diversity of polar bears.

(3)

(Total for Question 1 = 7 marks)

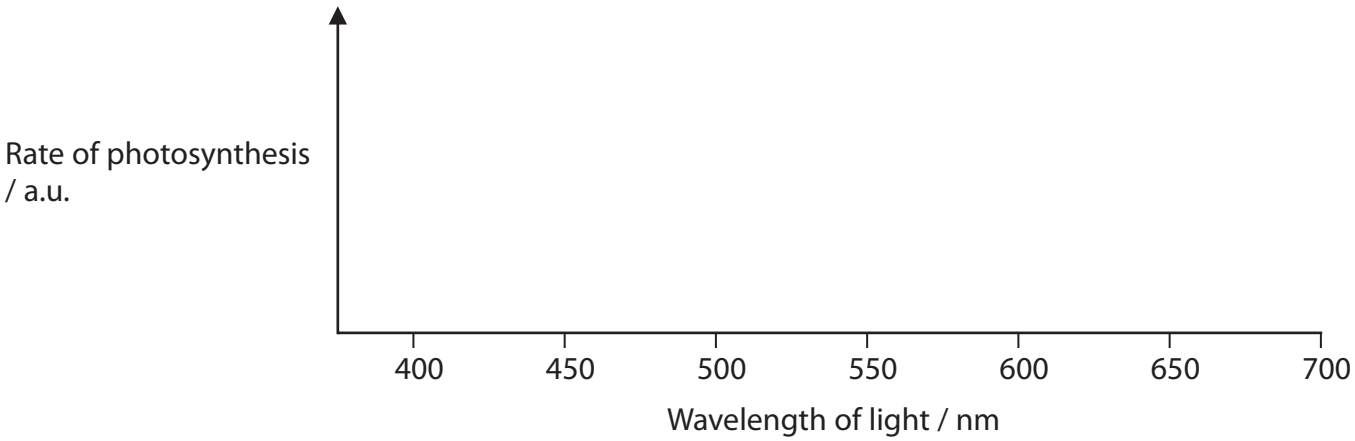
2 Thylakoid membranes contain chloroplast pigments and molecules of ATP synthase. These membranes are the site of the light-dependent reactions.

(a) The graph shows the absorption spectrums of two chloroplast pigments from one plant.



(i) Draw the action spectrum for this plant on the axes below.

(2)



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(ii) Calculate how many times greater the percentage of light absorbed by chlorophyll b is than that absorbed by chlorophyll a, at their maximum absorptions.

(1)

Answer .....

(iii) Thylakoid membranes contain different types of chlorophyll pigment.

Explain the advantage of this for a plant.

(2)

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(b) The ATP synthase molecules are proteins.

(i) Which row of the table describes the bonds that form between amino acids in a protein?

(1)

		Name of bond	Parts of the amino acid that the bond forms between
☒	**A**	peptide	amino group and carboxyl group
☒	**B**	peptide	carboxyl group and R group
☒	**C**	phosphodiester	amino group and carboxyl group
☒	**D**	phosphodiester	carboxyl group and R group

(ii) Products of the light-independent reactions are used to synthesise amino acids.

Describe how plants synthesise amino acids.

(2)

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(Total for Question 2 = 8 marks)

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3 Human Immunodeficiency Virus (HIV) infects human cells, causing symptoms that may result in death.

(a) Explain why the virus is an immunodeficiency virus.

(4)

(b) A number of antiretroviral drugs are given to patients with HIV.

These include reverse transcriptase inhibitors and integrase inhibitors.

(i) Explain how these two drugs reduce the development of HIV.

(2)

(ii) These two drugs are often given in combination with other antiretroviral drugs.

Suggest why patients are given combinations of drugs.

(2)

(iii) If a patient stops taking the antiretroviral drugs, the number of virus particles increases again.

Suggest why this increase occurs.

(2)

(Total for Question 3 = 10 marks)

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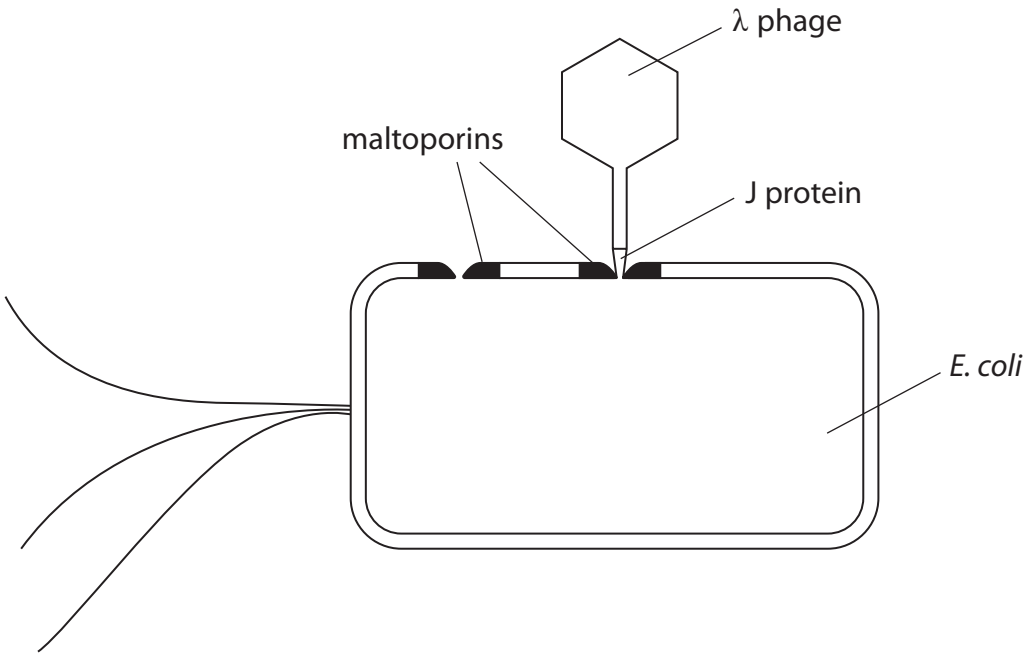
4 Pathogens continuously adapt to invade their host cells.

Host cells continuously adapt to avoid infection by pathogens.

This is an example of an 'evolutionary race'.

The diagram shows the pathogen lambda phage (λ phage) attached to its host cell, *E. coli*.



(a) How many of the following statements are correct for λ phage?

- the genetic material is DNA
- the capsid structure is described as complex
- the genetic material codes for the J protein

(1)

☒ **A** 0

☒ **B** 1

☒ **C** 2

☒ **D** 3

(b) Describe the role of the λ phage J protein.

Use the information in the diagram to support your answer.

(2)

(c) Maltoporin is coded for by the *lamβ* gene of *E. coli*.

Maltoporin is involved in the transport of some sugars into *E. coli*.

(i) Give **one** reason why sugars are important to *E. coli*.

(1)

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*(ii) Discuss how *E. coli* and λ phage could interact and develop in their evolutionary race for existence.

Use all the information in this question to support your answer.

(6)

(Total for Question 4 = 10 marks)

5 The photographs show a Northwestern crow and an American crow.



(Source: © All Canada Photos / Alamy Stock Photo)



(Source: © MichaelGrantBirds / Alamy Stock Photo)

These two crows look very similar and are therefore difficult to distinguish as two separate species.

Scientists have studied the nuclear DNA and the mitochondrial DNA (mtDNA) of these two species of birds.

(a) Give **two** differences between the structure of nuclear DNA and mtDNA.

(2)

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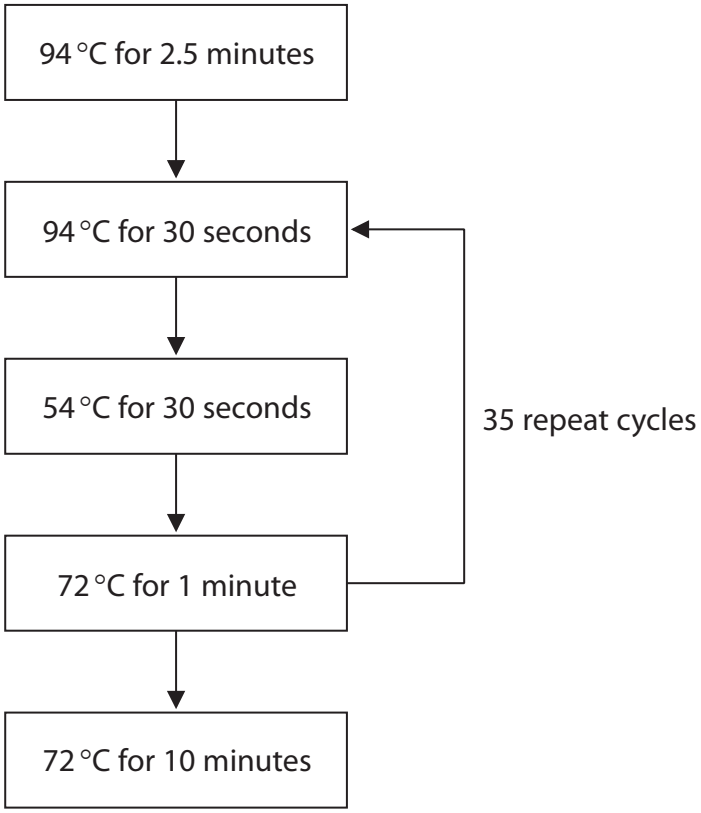
(b) The mtDNA was isolated from these two species of crow and amplified using the polymerase chain reaction (PCR).

The diagram shows details of the process used.



(i) Name **three** molecules, other than the mtDNA and water, that would be needed in this process.

(2)

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(ii) Calculate the total length of time, in hours, that this process would take.

Give your answer to two decimal places.

(2)

Answer ..... hours

(iii) Explain how this process amplifies the DNA.

Use information in the diagram to support your answer.

(3)

(c) Explain how the amplified mtDNA could be used to determine the genetic relationships between these two species of crow.

(3)

(Total for Question 5 = 12 marks)

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6 (a) The table gives some information about structures found in chloroplasts.

Structure	Function	Other information
P	protein synthesis	some are 20 nm in size
Q	site of light-independent reactions	colourless
R	compartment for accumulation of hydrogen ions	largest are 4.35×10^{-4} mm long
S	storage granule	1 to 35 μm in size

(i) Where in the chloroplast is RUBISCO active?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(ii) What is stored in S?

(1)

☒ **A** GALP

☒ **B** lipid

☒ **C** starch

☒ **D** sucrose

(iii) Where is GP formed?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

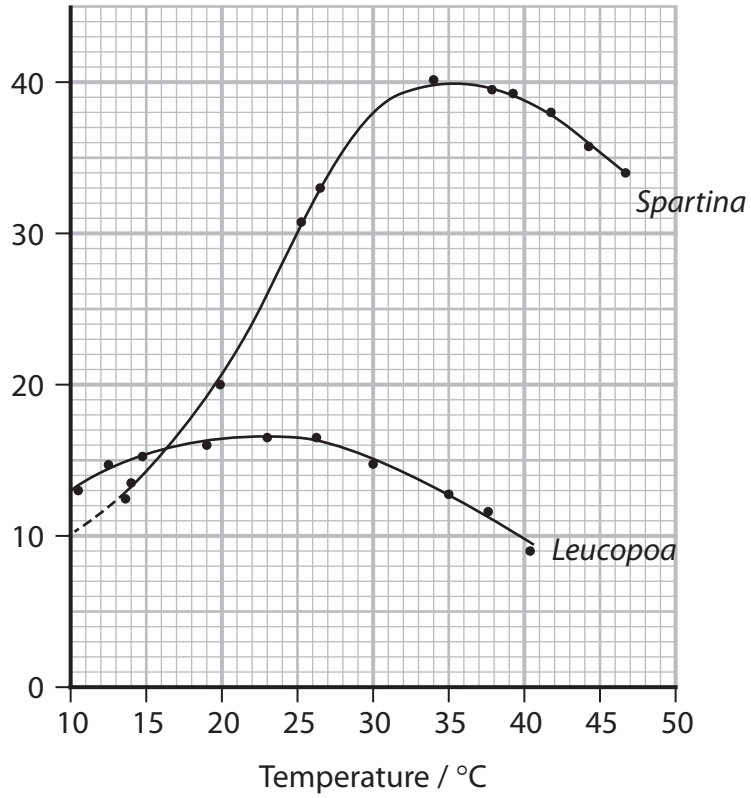
☒ **D** S

(iv) Which is the correct order of size, smallest to largest?

(1)

- ☒ **A** P R S
- ☒ **B** P S R
- ☒ **C** R S P
- ☒ **D** S R P

(b) The graph shows the rate of photosynthesis in two types of plant, *Spartina* and *Leucopoa*, at different temperatures.



(i) Which could be the units for rate of photosynthesis?

(1)

- ☒ **A** mg CO_2 produced $mm^{-2}\,hr^{-1}$
- ☒ **B** mg CO_2 produced $mm^{-1}\,hr^{-2}$
- ☒ **C** mg CO_2 used $mm^{-2}\,hr^{-1}$
- ☒ **D** mg CO_2 used $mm^{-1}\,hr^{-2}$

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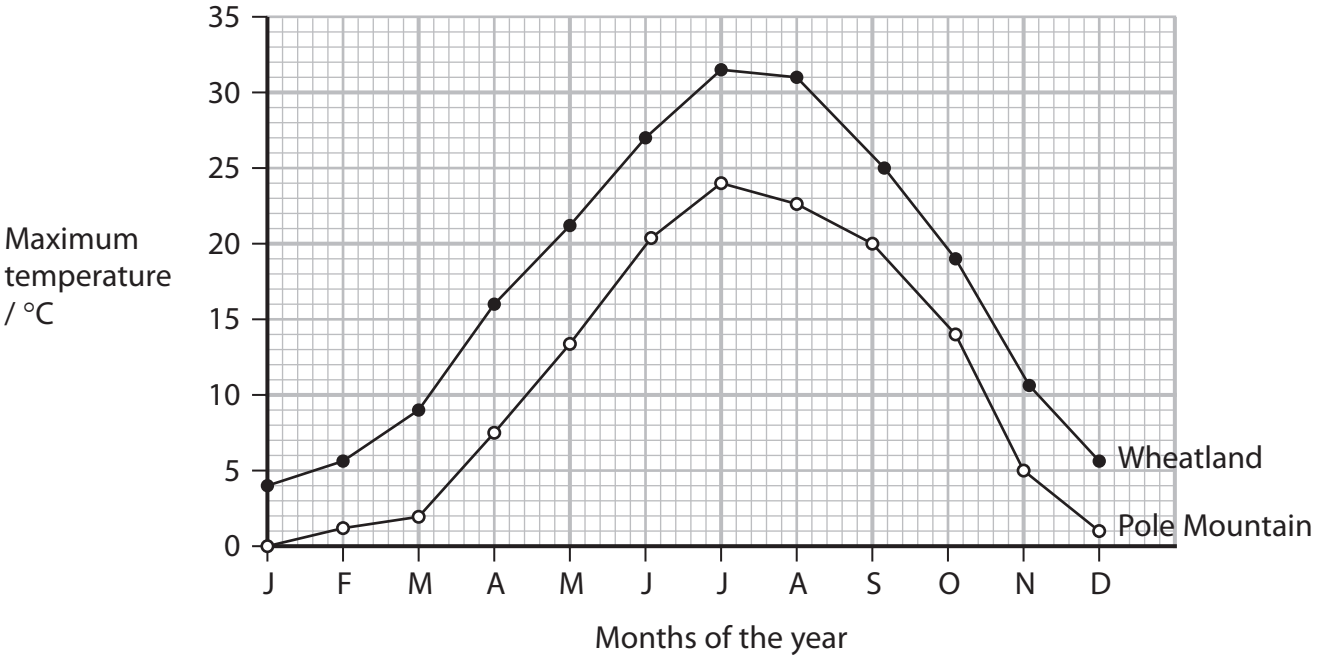
(ii) Compare and contrast the rate of photosynthesis of these two species of plant, at different temperatures.

(3)

(iii) Describe how a Q_{10} value for the rate of photosynthesis can be calculated, using this graph.

(2)

(iv) The graph shows the maximum temperature, for each month, in two regions of North America: Wheatland and Pole Mountain.



Explain in which of these two regions of North America *Spartina* is most likely to grow.

Use the information in both graphs to support your answer.

(3)

(Total for Question 6 = 13 marks)

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7 As the human population in the world has increased, the demand for food has increased.

The production of food has an impact on the environment, unless it can be done in a sustainable way.

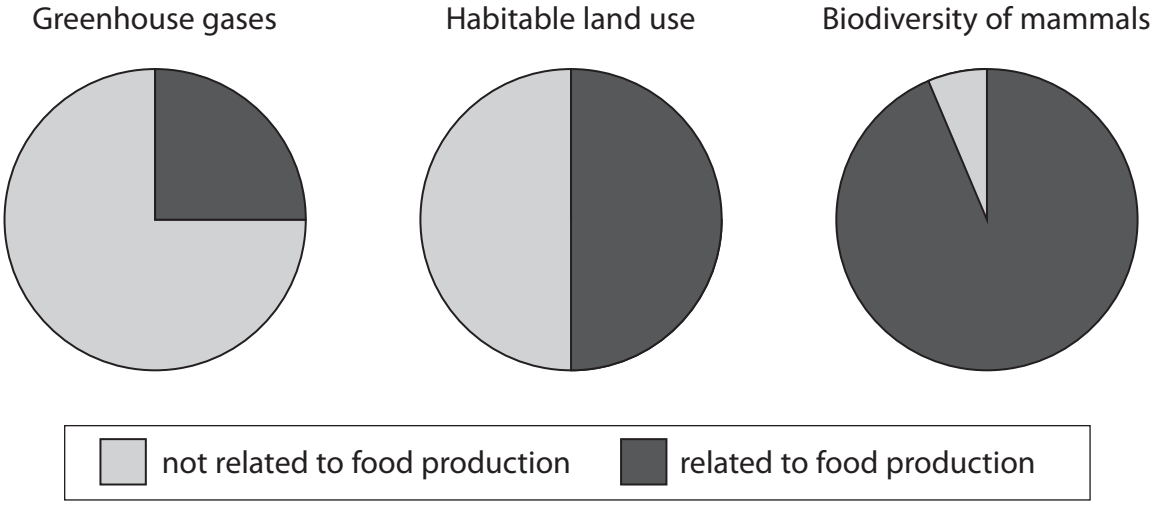
(a) (i) State the meaning of the term **population**, as it has been used in this context.

(1)

(ii) State the meaning of the term **sustainable**, as it has been used in this context.

(1)

(b) The diagram shows the impact of food production on three environmental factors.



(i) Explain how food production could contribute to the greenhouse effect.

(3)

(ii) Land occupies 149 million km^2 of the surface of the Earth.

Habitable land is 71% of this area and some of it is used for food production.

Calculate the area of the surface of the Earth used in food production.

Express your answer in standard form.

(3)

Answer ..... km^2

(iii) Estimate the effect of food production on the ratio of biodiversity of mammals.

(1)

Answer .....

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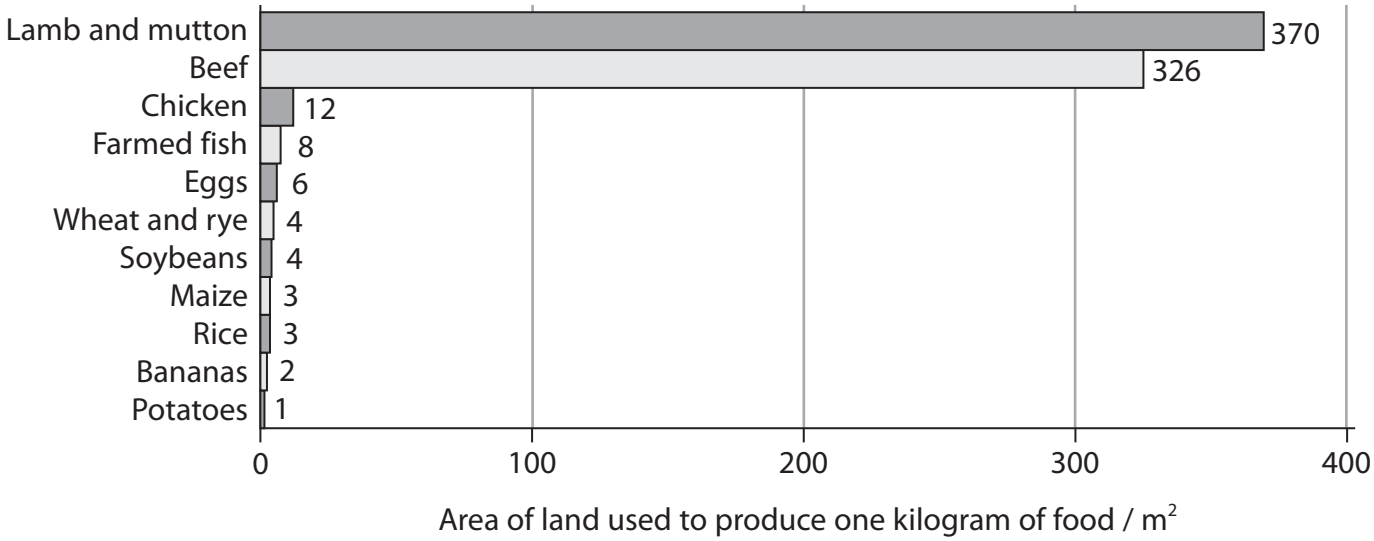
*(c) The diagram shows the area of land used to produce one kilogram of some food products.



Explain how food production could be made more sustainable.

Use the information in the diagram and your own knowledge to support your answer.

(6)

(Total for Question 7 = 15 marks)

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8 Forensic entomology is a method for estimating the time of death of a mammal.

(a) Seventy-two hours or more after death, forensic entomology is the most accurate method for estimating the time of death.

Forensic entomology can also provide information about the place of death and indicate if the body has been moved.

(i) Explain why forensic entomology is the most accurate method for estimating the time of death, if this is greater than 72 hours.

(2)

(ii) Explain how forensic entomology can indicate if a body has been moved from the place of death.

(2)

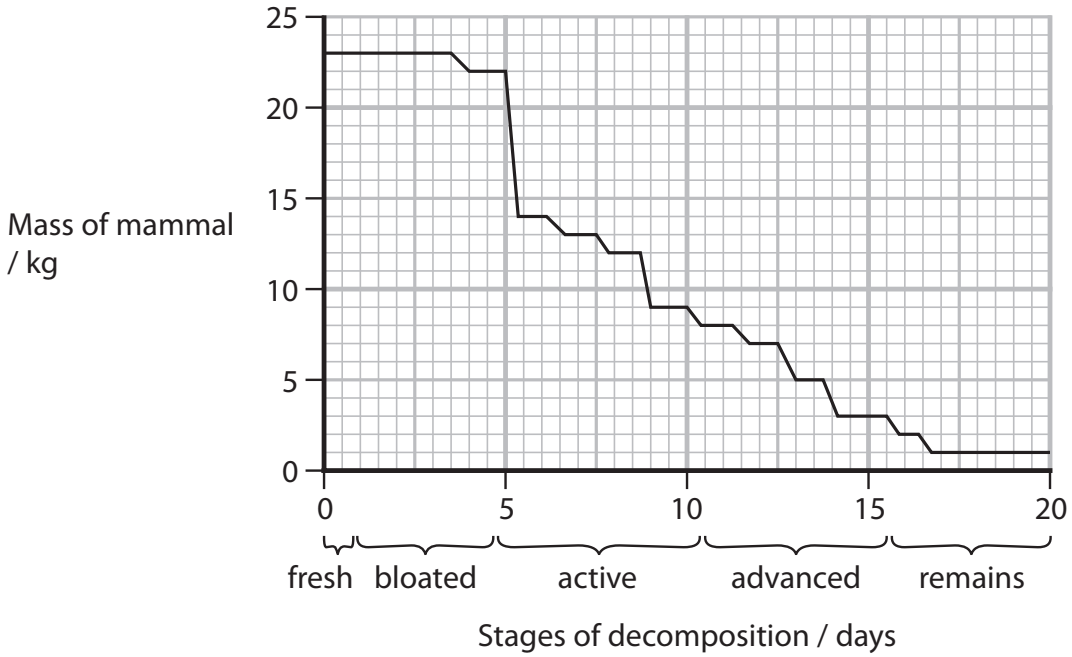
(b) A study looked at the succession of insects associated with the decomposition of a dead mammal in the Andean Coffee region.

In this study, a mammal was killed, placed inside a metal cage in this region and left until it had completely decomposed.

The body of this mammal was monitored regularly.

The stages of decomposition were identified and various measurements were taken and recorded. Insects in the different stages of their lifecycle were collected and identified.

The graph shows the changes in mass of this mammal during the decomposition period.



(i) Suggest why the mammal was placed inside a metal cage to decompose.

(1)

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(ii) Calculate the rate of change in mass between day 5 and day 15 of decomposition.

Express your answer in kg hr^{-1}.

Give your answer to two decimal places.

(2)

Answer ..... kg hr^{-1}

(iii) Explain the changes in mass of this mammal during decomposition.

(4)

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(iv) Suggest why some of the insect eggs, collected from the decomposing mammal, were taken back to the laboratory and kept for a few days.

(1)

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(v) The table shows data on some of the insects collected from this decomposing mammal.

Type of insect	Percentage of some of the insect found at each stage of decomposition (%)				
	Fresh	Bloated	Active	Advanced	Remains
Lucilia	100.0	61.4	1.8	3.7	0.0
Cochliomyia	0.0	15.5	68.4	35.1	0.0
Chrysomya	0.0	6.4	9.8	1.2	0.0
Ophyra	0.0	0.0	0.6	30.9	83.9
Fannia	0.0	0.0	0.0	0.1	0.0
Other types of insects	0.0	16.7	19.4	29.0	16.1

Explain how these results illustrate succession.

Use the information in the table to support your answer.

(3)

(Total for Question 8 = 15 marks)

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