Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Biology

Advanced

Unit 4: The Natural Environment and Species Survival

Tuesday 9 January 2018 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
WBI04/01

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.
- 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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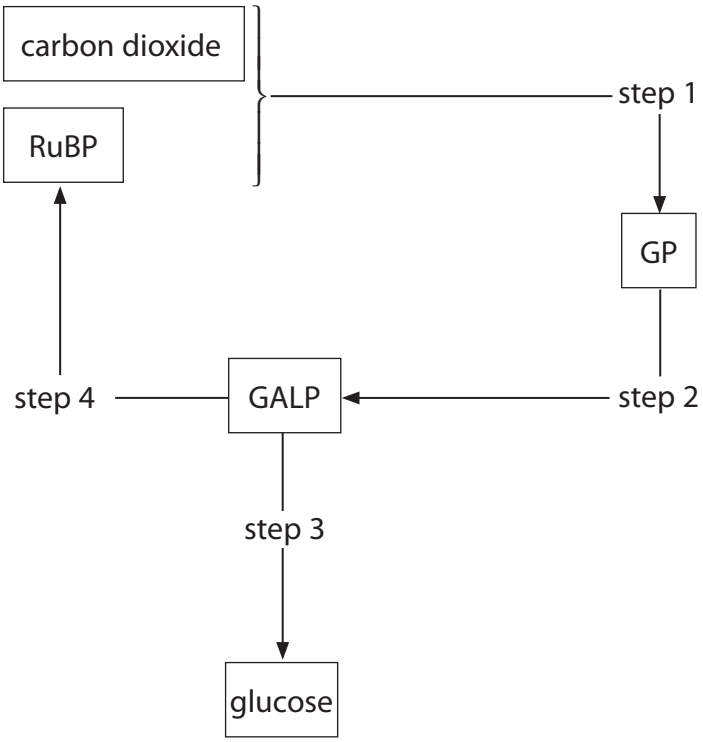
P 5 1 8 6 0 A 0 1 2 8

Pearson

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 (a) The diagram below shows part of the light-independent reaction of photosynthesis.



(i) Put a cross (☒) in the box to complete the following sentence.

The enzyme RUBISCO catalyses

(1)

☐ **A** step 1

☐ **B** step 2

☐ **C** step 3

☐ **D** step 4

(ii) Put a cross (☒) in the box to complete the following sentence.

Reduced NADP and ATP are needed in

(1)

☒ **A** step 1

☒ **B** step 2

☒ **C** step 3

☒ **D** step 4

(iii) Below is a list of carbohydrates:

- fructose
- α glucose
- β glucose
- sucrose.

Put a cross (☒) in the box next to the number of these carbohydrates that are monosaccharides.

(1)

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(iv) Sugars are used in the synthesis of polysaccharides.

Below is a list of polysaccharides:

- amylopectin
- amylose
- cellulose
- glycogen.

Put a cross (☒) in the box next to the number of these polysaccharides found in plants.

(1)

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(b) Temperature, light intensity and the availability of carbon dioxide have an effect on the rate of photosynthesis.

Twelve groups of plants, of the same species, were exposed to different temperatures, light intensities and percentages of carbon dioxide. The rate of photosynthesis of each group was measured.

The table below shows the rate of photosynthesis for some of these groups.

Group of plants	Temperature / °C	Light intensity / a.u.	Percentage of carbon dioxide (%)	Rate of photosynthesis / a.u.
A	20	3	0.04	75
B	20	6	0.04	75
C	20	3	0.14	150
D	20	6	0.14	195
E	30	3	0.04	75
F	30	6	0.04	75
G	30	3	0.14	180
H	30	6	0.14	270
I	40	3	0.04	75
J	40	6	0.04	75
K	40	3	0.14	
L	40	6	0.14	

(i) Using the information in the table, describe the effect of temperature on the rate of photosynthesis, when light intensity and the percentage of carbon dioxide are both high.

(2)

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(ii) Suggest why the rate of photosynthesis is the same in groups **A**, **B**, **E** and **F**.

(3)

(iii) Suggest values for the rate of photosynthesis in groups **K** and **L**. Give reasons for your answer.

(4)

(Total for Question 1 = 13 marks)

2 Patients who have an organ transplant are given drugs to reduce their immune response. Without these drugs, the transplanted organ will be rejected.

Three such drugs are steroids, azathioprine and cyclosporin.

(a) Steroids reduce inflammation.

Suggest why reducing inflammation could help to reduce a patient's immune response.

(3)

(b) Azathioprine blocks DNA replication.

Explain how azathioprine affects the number of T helper cells.

(2)

(c) The transplanted organ is rejected when it is destroyed by T killer cells.

Cyclosporin reduces the activity of T helper cells.

Explain how cyclosporin will prevent the destruction of the transplanted organ.

(3)

(Total for Question 2 = 8 marks)

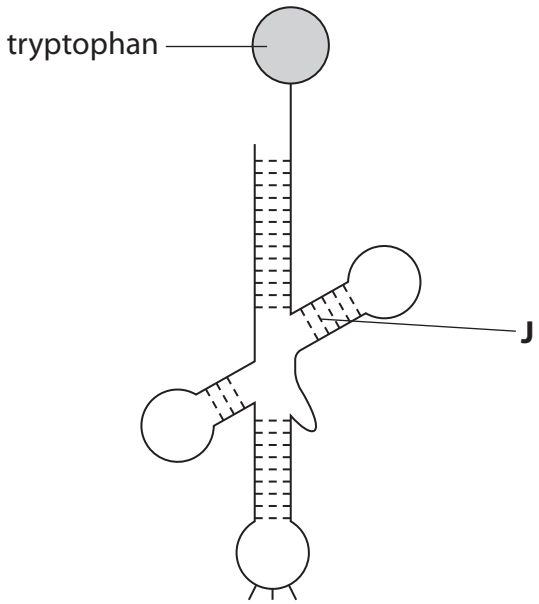
3 Protein synthesis involves messenger RNA (mRNA) and transfer RNA (tRNA).

(a) Describe the role of mRNA in protein synthesis.

(3)

(b) A tRNA molecule is formed from the folding of a single strand of RNA. This determines the shape of a tRNA molecule.

The diagram below shows a tRNA molecule attached to the amino acid tryptophan.



(i) Put a cross (☒) in the box next to the type of bond labelled **J**.

(1)

☒ **A** glycosidic

☒ **B** hydrogen

☒ **C** peptide

☒ **D** phosphodiester

(ii) Explain why it is important that this tRNA molecule can only attach to the amino acid tryptophan.

(2)

(iii) Explain why some amino acids can attach to more than one type of tRNA molecule.

(2)

(iv) There are 64 possible mRNA codons.

Explain why there are fewer than 64 different **anticodons**.

(2)

(Total for Question 3 = 10 marks)

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4 Global warming is affecting the climate. Changes to the climate are affecting the distribution and development of some animals.

One animal that could be affected by climate change is the Eastern painted turtle.

The photograph below shows an Eastern painted turtle.

Magnification $\times 0.2$

Turtles live in water but lay their eggs on land.

The female turtle comes out of the water, digs a hole in the sand and then lays her eggs in the hole. She then buries her eggs in the sand.

An investigation was carried out into the effect of sand temperature on the rate of development and survival of turtle embryos. The ratio of male to female turtles that hatched was also investigated.

Three temperatures were investigated:

- the optimal sand temperature (OST) for Eastern painted turtles
- a temperature below the OST
- a temperature above the OST.

The table below shows the results of this investigation.

Effect of sand temperature on	**Temperature of sand**		
	Below OST	**OST**	**Above OST**
Rate of development of turtle embryos	Faster than at OST	Fast	Slower than at OST
Proportion of turtle embryos that survive	More survive than at OST	Many survive	Fewer survive than at OST
Ratio of male to female turtles that hatch	More males than females	More females than males	Many more females than males

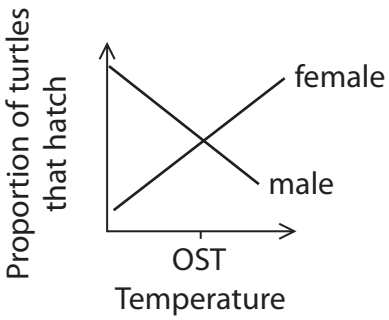
*(a) Using the information in the table, explain the effect of sand temperature on the rate of development of these turtle embryos.

(6)

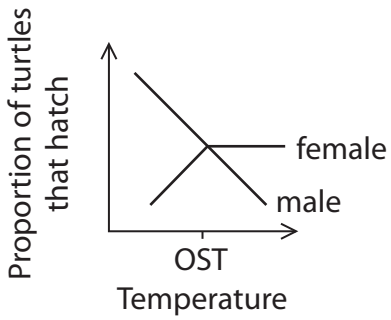
(b) (i) Put a cross (☒) in the box next to the graph showing how the proportion of male to female turtles that hatch changes with temperature.

(1)

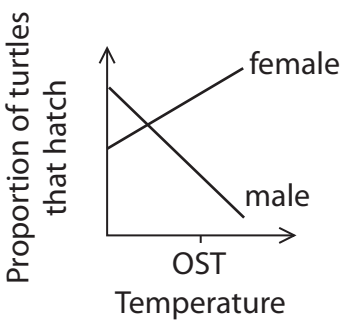
☒ **A**



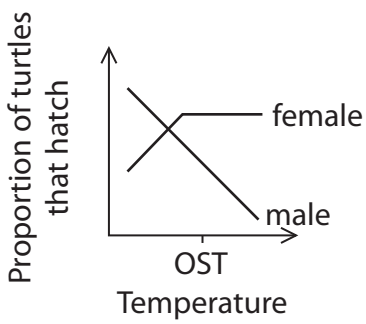
☒ **B**



☒ **C**



☒ **D**



(ii) Put a cross (☒) in the box to complete the following sentence.

Sex determination in these turtles is an example of

(1)

☒ **A** continuous variation

☒ **B** crossing over

☒ **C** interactions between genotype and the environment

☒ **D** polygenic inheritance

(c) Discuss how global warming could affect the numbers of these turtles.

(4)

(Total for Question 4 = 12 marks)

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5 Infection with *Mycobacterium tuberculosis* (TB) is a common cause of death from bacterial infections.

It is a difficult disease to cure as a combination of antibiotics is required over a long period of time.

(a) State the meaning of the term **bacterial infection**.

(1)

*(b) Describe an investigation, that could be carried out in a laboratory, to determine a suitable combination of antibiotics to use against *Mycobacterium tuberculosis*.

(6)

(c) Early diagnosis of TB is important in reducing the spread of this disease.

Hero rats are trained to identify the presence of *M. tuberculosis* by sniffing mouth swabs.

The photograph below shows a hero rat sniffing mouth swabs.

(i) One hero rat can analyse 100 samples in 20 minutes.

Using a microscope, technicians detect TB by looking for the presence of *M. tuberculosis* in mouth swabs.

One technician takes eight hours to analyse 30 samples.

Calculate how many more samples can be analysed by one hero rat in eight hours than by one technician.

Show your working.

(2)

Answer .....

(ii) One study showed that a hero rat will correctly identify 80% of infected mouth swabs whereas a technician will correctly identify only 58%.

Calculate how many more infected people could be identified by a hero rat than by a technician in a sample of 150 people.

Show your working.

(3)

Answer .....

(iii) One advantage of using hero rats to detect TB is that they do not get infected with *M. tuberculosis*.

Suggest why rats do not get infected with *M. tuberculosis*.

(1)

.....

.....

.....

.....

(Total for Question 5 = 13 marks)

6 Giant pandas are an endangered species.

(a) State the meaning of the term **species**.

(1)

(b) The photograph below shows a female panda and her cub.

Magnification $\times 0.1$

The majority of the existing population of giant pandas are living in captivity.

Giant pandas do not breed very well in captivity. Fertilisation of females is only successful if females are allowed to mate naturally, as well as being injected with sperm from several different males (artificial insemination).

(i) It is important to determine the father of any cub born.

Explain why it is important to determine the father of a cub.

(2)

(ii) Explain how gel electrophoresis can be used to determine the father of a cub.

(4)

(iii) In the majority of cases, the father of the cub is the male that mated naturally with the female.

It is possible that the quality of sperm used in artificial insemination has been reduced by freezing.

Suggest how the quality of the sperm could be investigated to produce valid conclusions.

(4)

(c) The DNA of wild giant pandas can be analysed using samples of their faeces.

Faeces contain DNA from the giant panda, plant material and bacteria.

The polymerase chain reaction can be used to amplify only the DNA from the giant panda.

Put a cross (☒) in the box next to the component that will ensure that only the DNA from the giant panda is amplified.

(1)

☒ **A** DNA polymerase

☒ **B** mononucleotides

☒ **C** primers

☒ **D** restriction enzymes

(Total for Question 6 = 12 marks)

7 Gene therapy is being developed for the treatment of a number of genetic disorders, including cystic fibrosis and severe combined immunodeficiency (SCID).

A number of types of SCID exist. They are all caused by gene mutations.

Adenosine deaminase deficiency is one type of SCID. This mutation results in a defective enzyme called adenosine deaminase. This affects the proliferation of both B cells and T cells.

(a) Adenosine deaminase deficiency is inherited in a similar fashion to cystic fibrosis, as a recessive disorder.

Explain how a baby can have adenosine deaminase deficiency when the parents do not.

(3)

(b) The symptoms that result from adenosine deaminase deficiency are similar to those of a person infected with human immunodeficiency virus (HIV).

Give **one** similarity and **one** difference between adenosine deaminase deficiency and HIV infection.

(2)

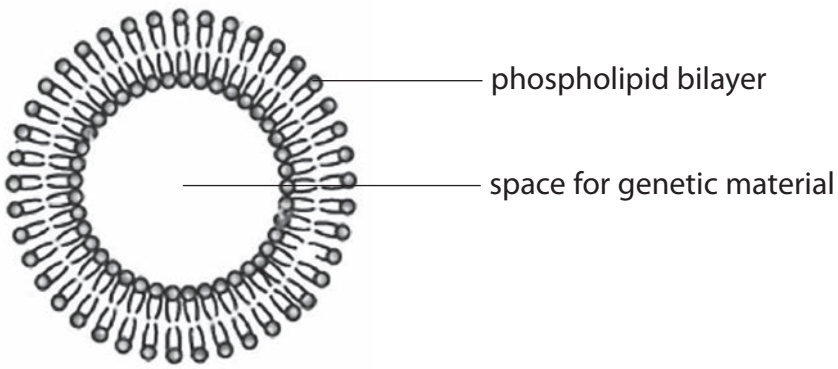
(c) Gene therapy requires a vector to introduce the gene into the affected cells.

Vectors include viruses and liposomes.

(i) Suggest the features of a virus that make it suitable as a vector for gene therapy.

(2)

(ii) The diagram below shows a liposome.



Using your knowledge of the properties of phospholipids, explain why a liposome is a suitable vector for gene therapy.

(2)

(Total for Question 7 = 9 marks)

8 In 1978, China began the Three-North Shelterbelt Forest Programme.

The idea of this programme was to create the Great Green Wall, a massive belt of trees deliberately planted across North China. The hope was that the Great Green Wall would prevent desert sand spreading across the country.

The aim is to have more than 100 billion trees planted in a 4500 km belt by 2050.

The diagram below shows the proposed location of the Great Green Wall. The photograph below shows an area of trees that have already been planted in the Wall.

(a) Using your knowledge of succession, suggest why the Great Green Wall should reduce the spread of desert sand.

(2)

(b) Some scientists were concerned that only a few types of tree were being planted and that these were fast-growing. They thought that this would reduce the biodiversity of the remaining natural forests.

Explain why the scientists thought that biodiversity in natural forests would fall.

(4)

(c) Some scientists suggested that the fast-growing trees would help to reduce global warming more than slow-growing trees.

Explain how planting fast-growing trees could reduce global warming.

(4)

(d) A study in 2016 showed that natural woodland is better at storing carbon than planted fast-growing trees.

(i) State how the findings of this study could be validated.

(1)

(ii) This programme has proved to be controversial.

Suggest why some scientists, politicians, economists and farmers do not agree that planting these trees has been a success.

(2)

(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

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