Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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10	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2012

Biology BIOL2

Unit 2 The variety of living organisms

Wednesday 18 January 2012 1.30 pm to 3.15 pm

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 85.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

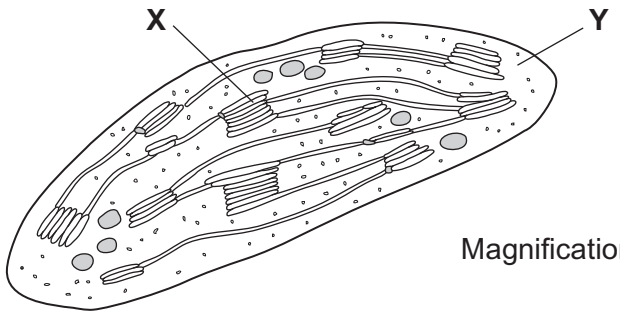
Question 1 starts on the next page

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ANSWER IN THE SPACES PROVIDED

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Answer **all** questions in the space provided.

1 The diagram shows a chloroplast as seen with an electron microscope.



Magnification × 30 000

1 (a) Name **X** and **Y**.

X .....

Y .....

(2 marks)

1 (b) Describe the function of a chloroplast.

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(2 marks)

1 (c) Calculate the maximum length of this chloroplast in micrometres (μm). Show your working.

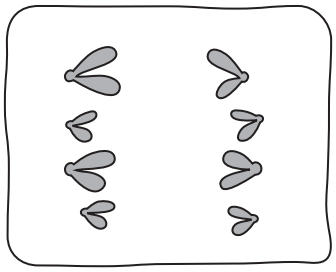
Answer ..... μm

(2 marks)

6

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2 (a) The diagram shows a stage of mitosis in an animal cell.



2 (a) (i) Name this stage.

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(1 mark)

2 (a) (ii) Describe what happens during this stage that results in the production of two genetically identical cells.

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(2 marks)

2 (b) A sample of epithelial tissue from the small intestine of an animal was analysed. Some of the cells had 8.4 units of DNA, others had only 4.2 units.

2 (b) (i) Use your knowledge of the cell cycle to explain why some cells had 8.4 units of DNA and others had only 4.2 units.

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(2 marks)

Do not write outside the box

2 (b) (ii) How many units of DNA would you expect to be present in a gamete formed in this animal as a result of meiosis?

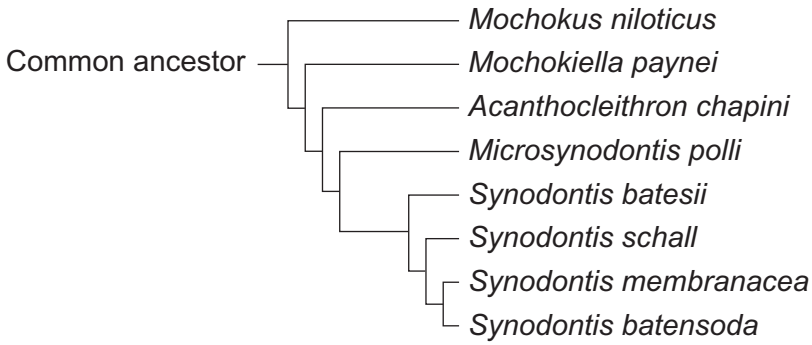
(1 mark)

6

Turn over for the next question

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3 There are over 200 species of catfish. All catfish evolved from a common ancestor. The diagram shows how some species of catfish are classified. This diagram is based on the evolutionary links between these species.



3 (a) (i) Which species of catfish is most closely related to *Synodontis membranacea*?

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(1 mark)

3 (a) (ii) Which species of catfish is most distantly related to *Synodontis membranacea*?

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(1 mark)

3 (b) How many different genera are shown in this diagram?

(1 mark)

Do not write outside the box

3 (c) (i) A scientist carried out breeding experiments with catfish from different populations. Describe how the results could show that the catfish belong to the same species.

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(1 mark)

3 (c) (ii) The variety of colours displayed by catfish is important in courtship. Give **two** ways in which courtship increases the probability of successful mating.

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2 .....

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(2 marks)

6

Turn over for the next question

Do not write outside the box

4 Phenylketonuria is a disease caused by mutations of the gene coding for the enzyme PAH. The table shows part of the DNA base sequence coding for PAH. It also shows a mutation of this sequence which leads to the production of non-functioning PAH.

DNA base sequence coding for PAH	C	A	G	T	T	C	G	C	T	A	C	G
DNA base sequence coding for non-functioning PAH	C	A	G	T	T	C	C	C	T	A	C	G

4 (a) (i) What is the maximum number of amino acids for which this base sequence could code?

(1 mark)

4 (a) (ii) Explain how this mutation leads to the formation of non-functioning PAH.

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(3 marks)

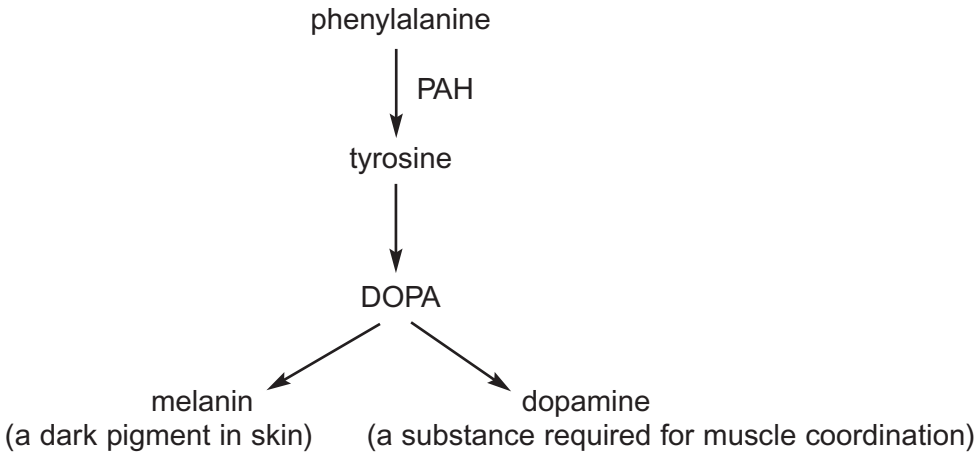
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PAH catalyses a reaction at the start of two enzyme-controlled pathways. The diagram shows these pathways.



4 (b) Use the information in the diagram to give **two** symptoms you might expect to be visible in a person who produces non-functioning PAH.

1 .....

2 .....

(2 marks)

4 (c) One mutation causing phenylketonuria was originally only found in one population in central Asia. It is now found in many different populations across Asia. Suggest how the spread of this mutation may have occurred.

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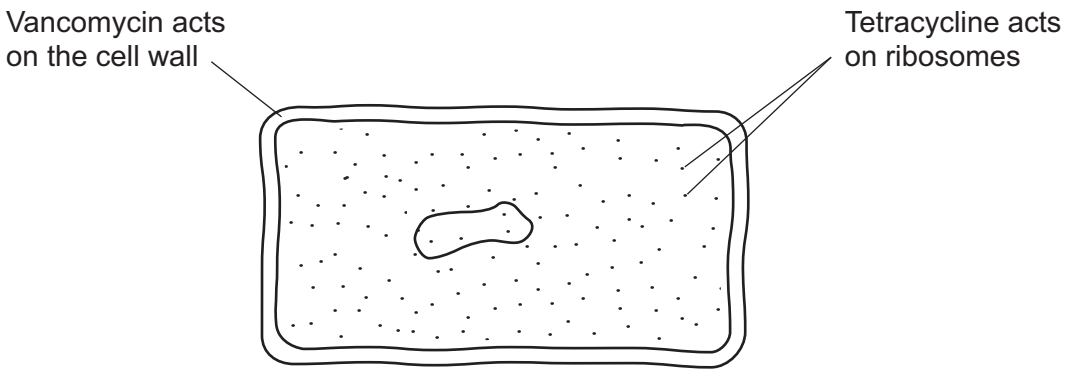
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(1 mark)

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5 The diagram shows the structure of a bacterium and the sites of action of two antibiotics.



5 (a) (i) Use information in the diagram to explain why vancomycin does **not** affect human cells.

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(1 mark)

5 (a) (ii) Use information in the diagram to explain how tetracycline prevents bacterial growth.

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(1 mark)

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5 (b) Frequent treatment with vancomycin can result in resistant strains of bacteria. Explain how.

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(3 marks)

(Extra space) .....

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5 (c) The gene for resistance to vancomycin is very common in the bacterium *Enterococcus faecalis*. The same gene has now been found in the bacterium *Staphylococcus aureus*.

Use your knowledge of gene transmission to explain how the gene was passed from one species of bacterium to another.

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(3 marks)

(Extra space) .....

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6 (a) Scientists can use protein structure to investigate the evolutionary relationships between different species. Explain why.

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(2 marks)

6 (b) Comparing the base sequence of genes provides more evolutionary information than comparing the structure of proteins. Explain why.

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(2 marks)

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6 (c) The proteins of different species can be compared using immunological techniques. The protein albumin obtained from a human was injected into a rabbit. The rabbit produced antibodies against the human albumin. These antibodies were extracted from the rabbit and then added to samples of albumin obtained from four different animal species. The amount of precipitate produced in each sample was then measured. The results are shown in the table.

Species from which albumin was obtained	Amount of precipitate / arbitrary units
Rat	23
Chimpanzee	96
Marmoset	65
Trout	11

What do the results suggest about the evolutionary relationship between humans and the other species?

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(2 marks)

6

Turn over for the next question

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7 (a) A student investigated the diversity of plants at several sites on a golf course. At each site she took a large number of random samples.

7 (a) (i) Explain the importance of taking a large number of samples at each site.

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(1 mark)

7 (a) (ii) Explain the importance of taking samples at random.

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(1 mark)

The student collected data from one part of the golf course and calculated an index of diversity.

The table shows her data.

Species	Number of plants per m^2
Sheep's fescue	11
Creeping buttercup	6
Clover	5
Dandelion	2
Sheep's sorrel	1
Lady's bedstraw	7
Stemless thistle	4

The index of diversity can be calculated from the formula

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

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7 (b) Use the formula to calculate the index of diversity for the plants on this part of the golf course. Show your working.

Answer .....

(2 marks)

7 (c) The golf course was surrounded by undeveloped grassland from which it had been produced.
The golf course had

- some areas of very short grass which was cut frequently
- some areas of longer grass which was cut less frequently
- some areas of long grass and shrubs which were never cut.

The index of diversity for the insects on the golf course was higher than that for the surrounding undeveloped grassland.

Explain the effect of developing this golf course on the index of diversity of insects.

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8 (a) Root pressure moves water through the xylem. Describe what causes root pressure.

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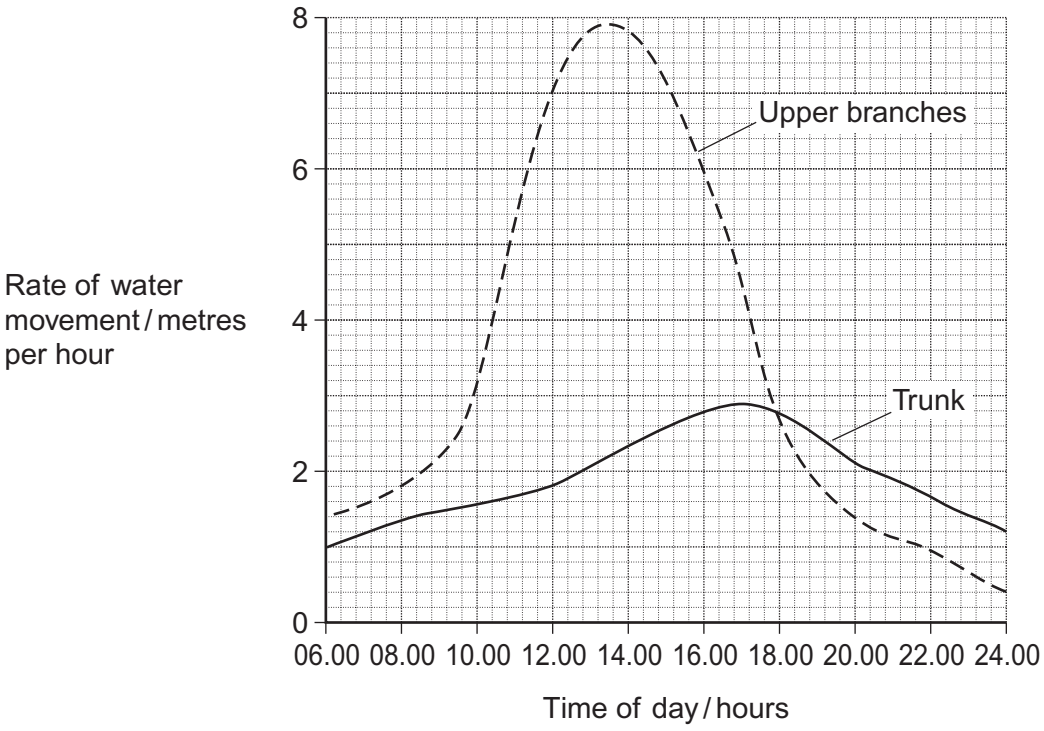
(3 marks)

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8 (b) A biologist investigated the rate of water movement during the day in different parts of a tree. The results are shown in the graph.



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8 (b) (i) Describe how the rate of water movement in the upper branches changed over the period shown in the graph.

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(2 marks)

8 (b) (ii) The rate of water movement in the upper branches was different from the rate of water movement in the trunk. Describe how.

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(2 marks)

8 (b) (iii) The results of this investigation support the cohesion tension theory. Explain how.

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(2 marks)

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9 (a) Explain how oxygen is loaded, transported and unloaded in the blood.

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(6 marks)

(Extra space) .....

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Midges are very small insects. The early stages of the life cycle of midges are called larvae. Midge larvae live in water. A biologist investigated the uptake of oxygen by the larvae of two species of midge. He measured the rate of uptake of oxygen by the larvae in water containing different concentrations of oxygen. The table shows his results.

Concentration of oxygen in water / $cm^3\ dm^{-3}$	**Mean rate of oxygen uptake / $cm^3\ g^{-1}\ h^{-1}$**	
	Chironomus longistylus	*Tanytarsus brunnipes*
1	220	141
2	285	246
3	304	342
4	313	362
5	320	367
6	318	430
7	320	469

9 (b) The larvae in this investigation were kept at a temperature of 17 °C. Why was it important that the larvae of both species were kept at the same temperature?

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(2 marks)

9 (c) Describe the effect of an increase in oxygen concentration on the mean rate of oxygen uptake in *Chironomus longistylus*.

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(2 marks)

Question 9 continues on the next page

Turn over ▶

Do not write outside the box

9 (d) *Chironomus longistylus* lives in still water whereas *Tanytarsus brunnipes* lives in fast running streams. The water in fast running streams has a higher concentration of oxygen than in still water. Use the table on page 19 to suggest how *Chironomus longistylus* is better adapted than *Tanytarsus brunnipes* to living in still water.

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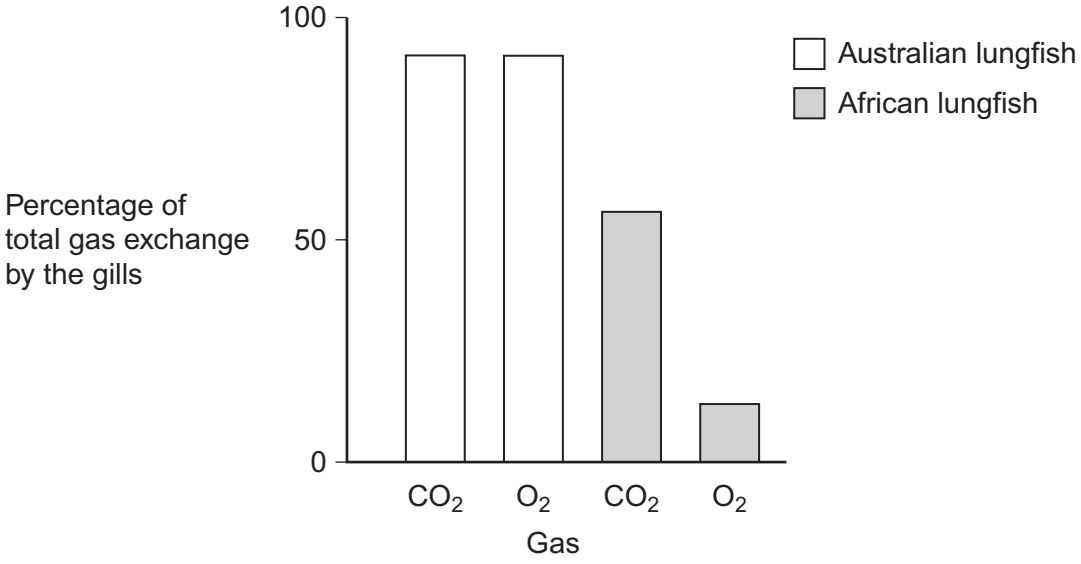
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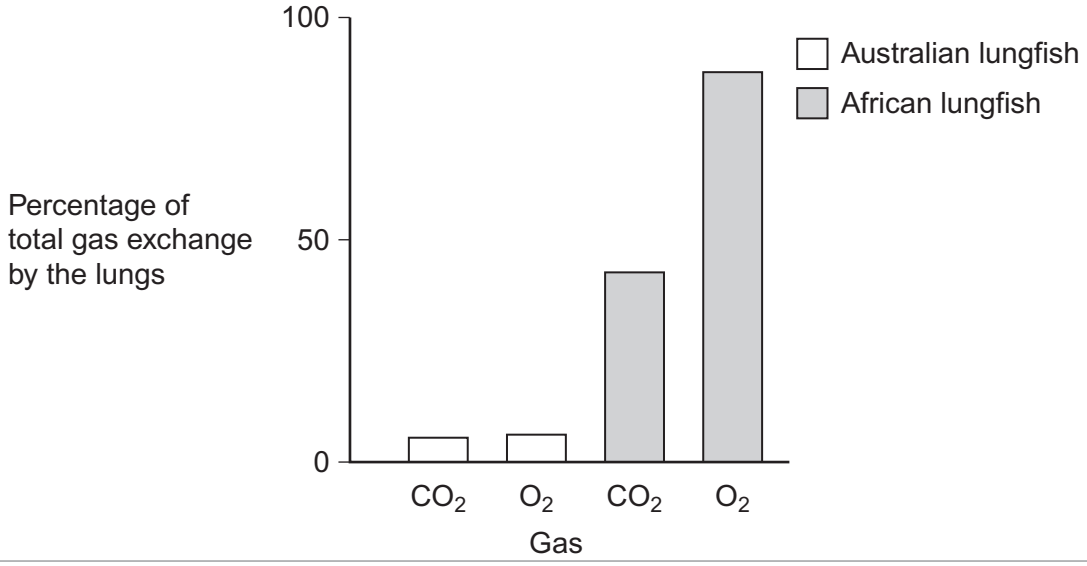
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(2 marks)

9 (e) Lungfish are freshwater fish which have gills and lungs. Scientists investigated how Australian and African lungfish use their lungs and gills for gas exchange. The graphs show the results of this investigation.





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9 (e) (i) Describe the difference in the way carbon dioxide is lost from the body of an Australian lungfish and an African lungfish.

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(1 mark)

9 (e) (ii) African lungfish are likely to survive for longer than Australian lungfish when living in pools that dry up. Explain why.

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(2 marks)

15

Turn over for the next question

Do not write outside the box

10 Scientists investigated the effect of drinking tea and coffee on reducing the risk of developing one type of brain cancer. The investigation involved 410 000 volunteers and was conducted in 10 European countries over a period of 8.5 years.

10 (a) (i) Apart from age, suggest **two** factors that the scientists should have considered when selecting volunteers for this trial.

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(2 marks)

10 (a) (ii) Give **two** features of the design of this investigation that would ensure the reliability of the results obtained.

1 .....

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(2 marks)

10 (b) The incidence for this type of brain cancer is 6 cases per 100 000 per year.
Use this information to calculate the expected number of volunteers developing this cancer during the 8.5 year period of this investigation. Show your working.

Answer .....

(2 marks)

10 (c) In analysing the results of this investigation, the scientists took into account the age of the volunteers. Suggest why.

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(1 mark)

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10 (d) During the investigation, the volunteers were asked to estimate the volume of tea and/or coffee that they drank each day. The types of tea and coffee consumed in different countries varied. When the data from all the countries were collected there was a correlation between drinking more than 100 cm^3 of tea or coffee each day and a reduced risk of developing this type of brain cancer.

Tea and coffee contain caffeine. A newspaper reported the results of this investigation under the headline 'Caffeine helps cut cancer risk'. Explain why scientists could **not** support this view solely on the basis of this investigation.

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(4 marks)

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Question 10 continues on the next page

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10 (e) Another group of scientists investigated the effect of caffeine on blood flow to certain parts of the brain. Volunteers were given different concentrations of caffeine solution to drink. A control group was also set up.

10 (e) (i) Describe how the control group should have been treated.

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(2 marks)

10 (e) (ii) Volunteers who drank the same concentration of caffeine solution often had different concentrations of caffeine in their blood. Suggest **one** reason for the difference in concentration of caffeine in the blood of volunteers.

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(1 mark)

10 (e) (iii) The investigation showed that caffeine reduces the blood flow to certain parts of the brain. Suggest **one** way in which this could lead to a reduced risk of brain cancers.

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(1 mark)

15

END OF QUESTIONS

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