



GCE A LEVEL

1400U30-1

BIOLOGY – A2 UNIT 3

Energy, Homeostasis and the Environment

THURSDAY, 7 JUNE 2018 – MORNING

2 hours plus your additional time allowance

Surname _____

Other Names _____

Centre Number _____

Candidate Number 2 _____

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	7	
2.	10	
3.	10	
4.	14	
5.	8	
6.	11	
7.	21	
8.	9	
Total	90	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces provided on the front cover.

Answer ALL questions.

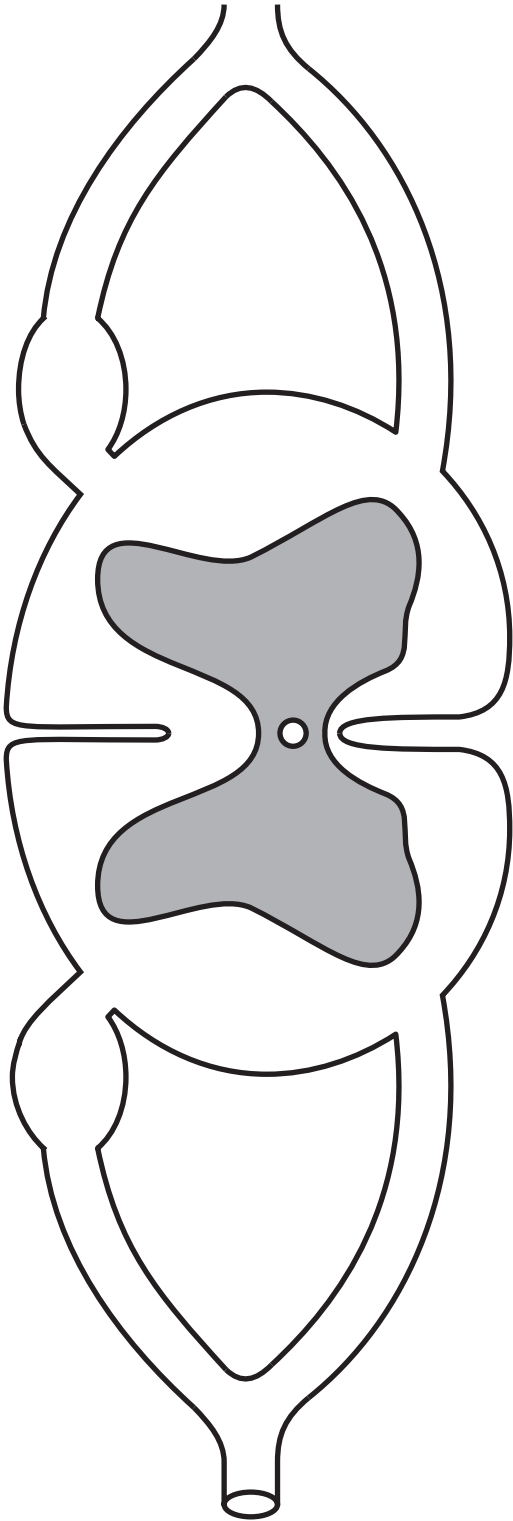
Write your answers in the spaces provided in this booklet. If you run out of space, use the continuation pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question 8.

The quality of written communication will affect the awarding of marks.

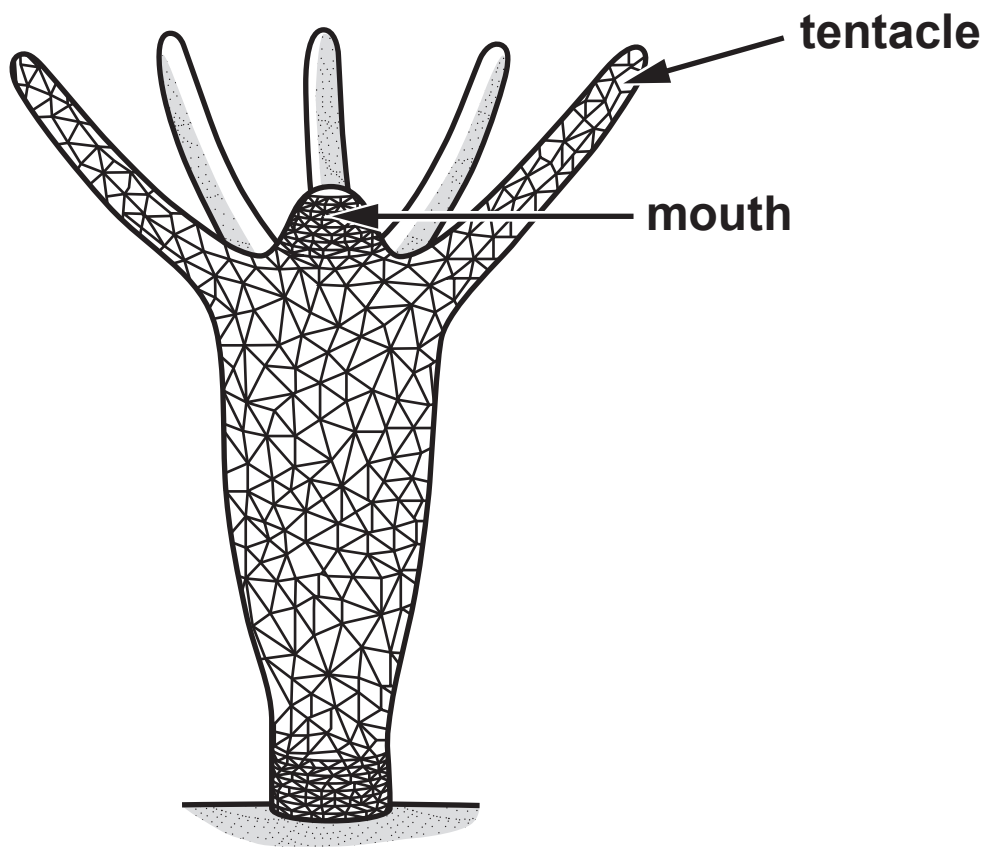


Answer ALL questions.

1. The diagram opposite shows a transverse section of the spinal cord.

(a) (i) DRAW AND LABEL THE POSITION of a sensory neurone and a motor neurone and label the cell bodies. [3]

(ii) When a person touches a hot object with their finger they will move away from the heat. State the advantage to humans of having this type of response to an external stimulus. [1]



1(b) Cnidaria is a phylum of invertebrate animals that are found in aquatic habitats. Their bodies consist of a jelly like substance sandwiched between two epithelial layers.

The diagram opposite shows the nervous system of a Cnidarian.

(i) State the name given to this type of nervous system. [1]

(ii) Explain why the non-myelinated neurones of Cnidarians result in slower nerve impulses than in mammals. [2]

7

7

2. Legionnaires' disease is a serious lung infection caused by LEGIONELLA bacteria.

(a) In 2015 there were 18 confirmed cases of Legionnaires' disease in Wales. The population of Wales in 2015 was 3 099 100.

Calculate the percentage of the population of Wales that suffered from Legionnaires' disease in 2015. Express your answer in STANDARD FORM.

[2]

Answer = _____

2(b) LEGIONELLA is a Gram negative, bacillus bacterium that can live in domestic water supplies. If small droplets of contaminated water are inhaled the bacteria can cause pneumonia-like symptoms.

State what is meant by a Gram negative, bacillus bacterium. [2]

Concentration of antibiotic / %	Number of colonies on plate		
	erythromycin	ciprofloxacin	azithromycin
0	86	86	86
10	70	43	0
20	47	22	0
30	32	0	0
40	24	0	0

2(c) During an outbreak, a sample of contaminated water was studied to find which antibiotic was most effective. The three antibiotics were erythromycin, ciprofloxacin and azithromycin. A range of concentrations of each antibiotic were used.

A microbiologist carried out the investigation as follows:

- **Sterile nutrient agar plates were set up containing different concentrations of erythromycin.**
- **0.5 cm³ of diluted contaminated water was transferred onto each plate.**
- **The same process was repeated for ciprofloxacin and azithromycin.**

The results following incubation are shown in the table opposite.

- 2(c) (i) The microbiologist had diluted the original sample of contaminated water by a factor of 10^{-3} . Use the information given to calculate the number of LEGIONELLA bacteria in 1 cm^3 of the original contaminated sample. Show your working. [2]

Number of LEGIONELLA bacteria in $1 \text{ cm}^3 =$ _____

2(c) (ii) Suggest a reason for the following:

I. When the microbiologist diluted the original sample by a factor of 10^{-2} she could not calculate the number of LEGIONELLA bacteria per cm^3 .

[1]

II. When she diluted the original sample by 10^{-6} a lower number of LEGIONELLA bacteria per cm^3 was calculated. [1]

2(d) The cost of ciprofloxacin and azithromycin are approximately the same per unit mass. Use the results of this experiment shown opposite page 10 to suggest and explain which antibiotic would most likely to be recommended by the Welsh Government to treat this disease. [2]

10

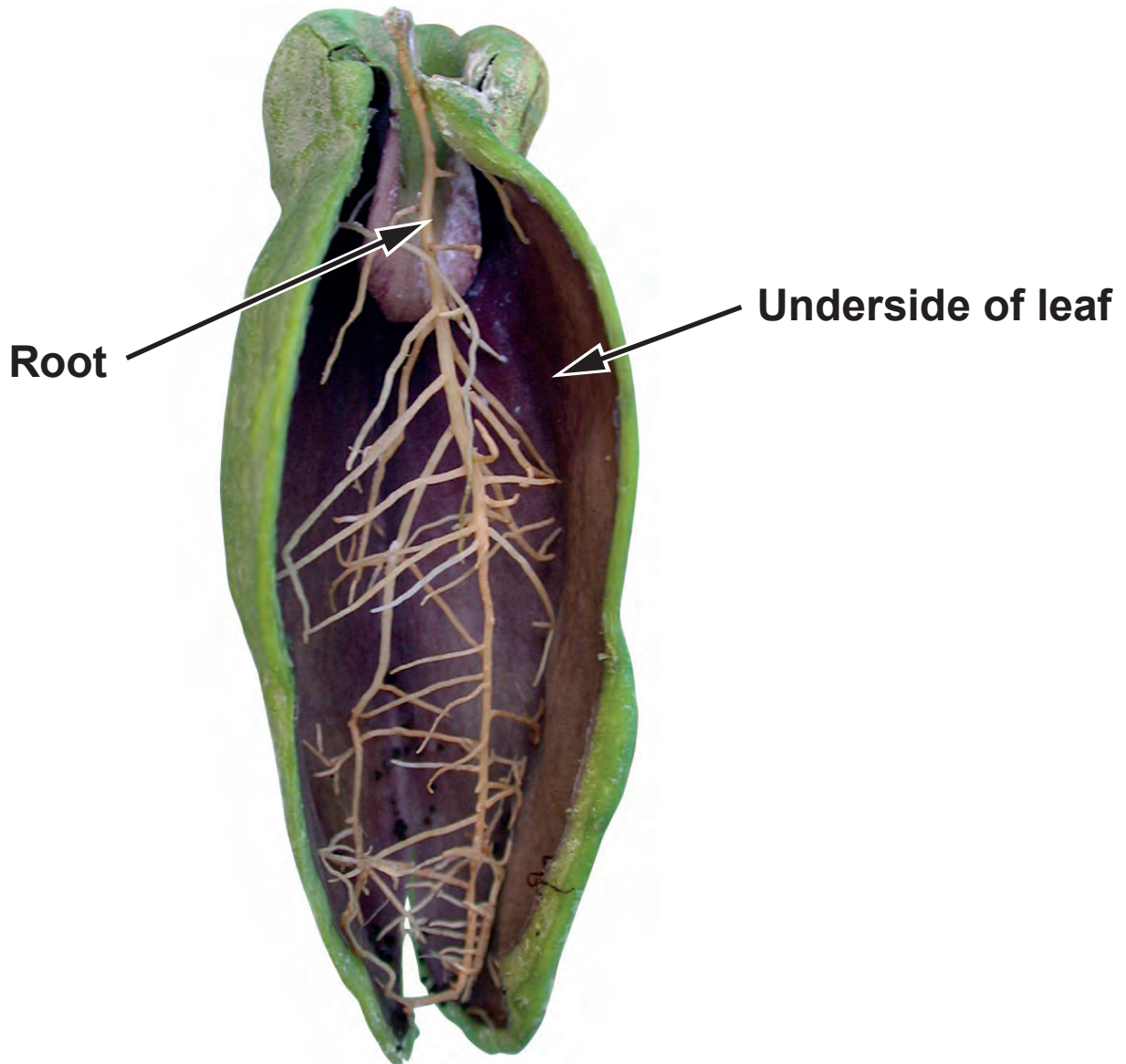
3. **DISCHIDIA MAJOR** is a plant found in the rainforests of Malaysia. It is an epiphyte, a non-parasitic plant that grows on other plants.

Some of the leaves of **DISCHIDIA** roll up to form pod-like structures (**PHOTOGRAPH 1**).



PHOTOGRAPH 1

3. The roots of DISCHIDIA grow into the pods. PHOTOGRAPH 2 shows an opened pod to show the underside of the leaf and the roots.



PHOTOGRAPH 2

3(b) In areas of Malaysia large-scale deforestation is taking place.

(i) Explain how this deforestation could INCREASE the concentration of carbon dioxide in the atmosphere in the area. [2]

3(b) (ii) Explain how this deforestation could DECREASE the concentration of carbon dioxide in the atmosphere in the area. [1]

10

Tube	Volume of chloroplast suspension /cm ³	Volume of DCPIP /cm ³	Volume of ice-cold isotonic solution /cm ³	Volume of distilled water /cm ³	Treatment	Colour	
						At start	After 15 minutes
1	0.5	5.0	0.0	0.0	kept in light	blue	green
2	0.5	5.0	0.0	0.0	kept in dark	blue	blue
3	0.0	5.0	0.5	0.0	kept in light	blue	blue
4	0.5	0.0	0.0	5.0	kept in light	green	green

4. **DCPIP is a blue dye which becomes colourless when it accepts electrons and is reduced.**

A group of students extracted chloroplasts from spinach leaves. To do this they ground the spinach leaves in a mortar containing an ice-cold, isotonic solution. The resulting material was filtered and centrifuged to leave a pellet of chloroplasts. The pellet was re-suspended in an ice-cold, isotonic solution.

Tubes were prepared and treated in different ways as shown in the table opposite. The students noted the colour of each tube at the start and after 15 minutes. The experiment was repeated three times and the same results were obtained each time.

- (a) (i) Explain why ice-cold, isotonic solution was used when extracting the chloroplasts. [2]**

4(d) Explain why, when students increased the carbon dioxide concentration present in the sample of chloroplasts, the results of the experiment were unchanged. [2]

5. An investigation was carried out into the productivity of grassland. Ecologists followed the method below.
- Three identical 1 m² areas of ungrazed grassland were selected.
 - All of the vegetation was removed from Area 1; the roots were washed and the vegetation dried.
 - Area 2 was covered with black plastic.
 - Area 3 was left undisturbed.
 - After two weeks, the vegetation was removed from Areas 2 and 3 and treated in the same way as Area 1.

The results were as follows:

Area	Dry mass / gm ⁻²
1	73
2	61
3	107

5(a) Explain why the dry mass was lower in Area 2.

[2]

(b) Using the information from Areas 1 and 3, calculate the net primary productivity of the grassland.

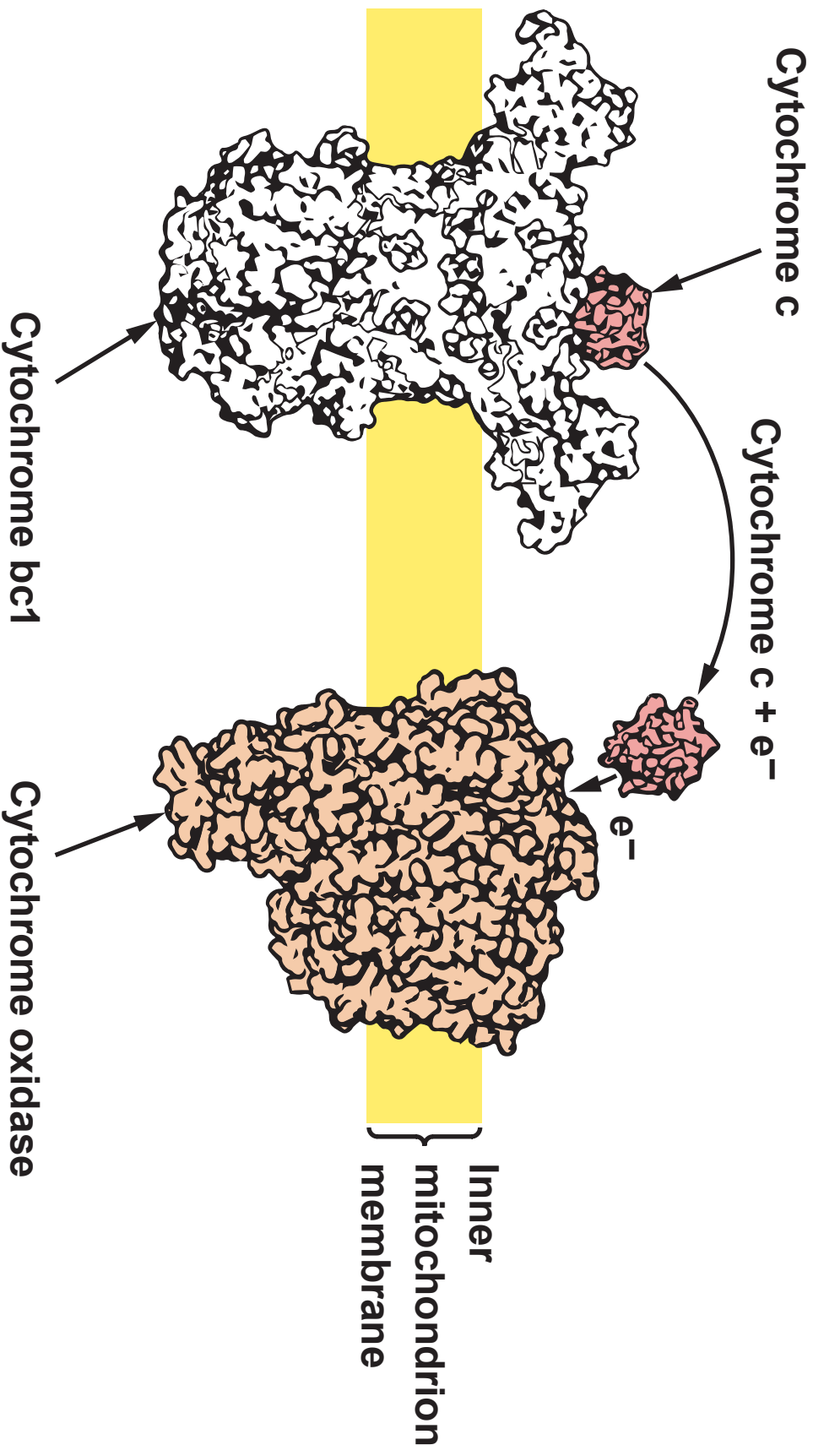
GIVE YOUR ANSWER TO 2 DECIMAL PLACES. [2]

Net primary productivity _____ $\text{g m}^{-2} \text{day}^{-1}$

5(c) Suggest why this method cannot be used to calculate the net primary productivity of tropical rainforest. [2]

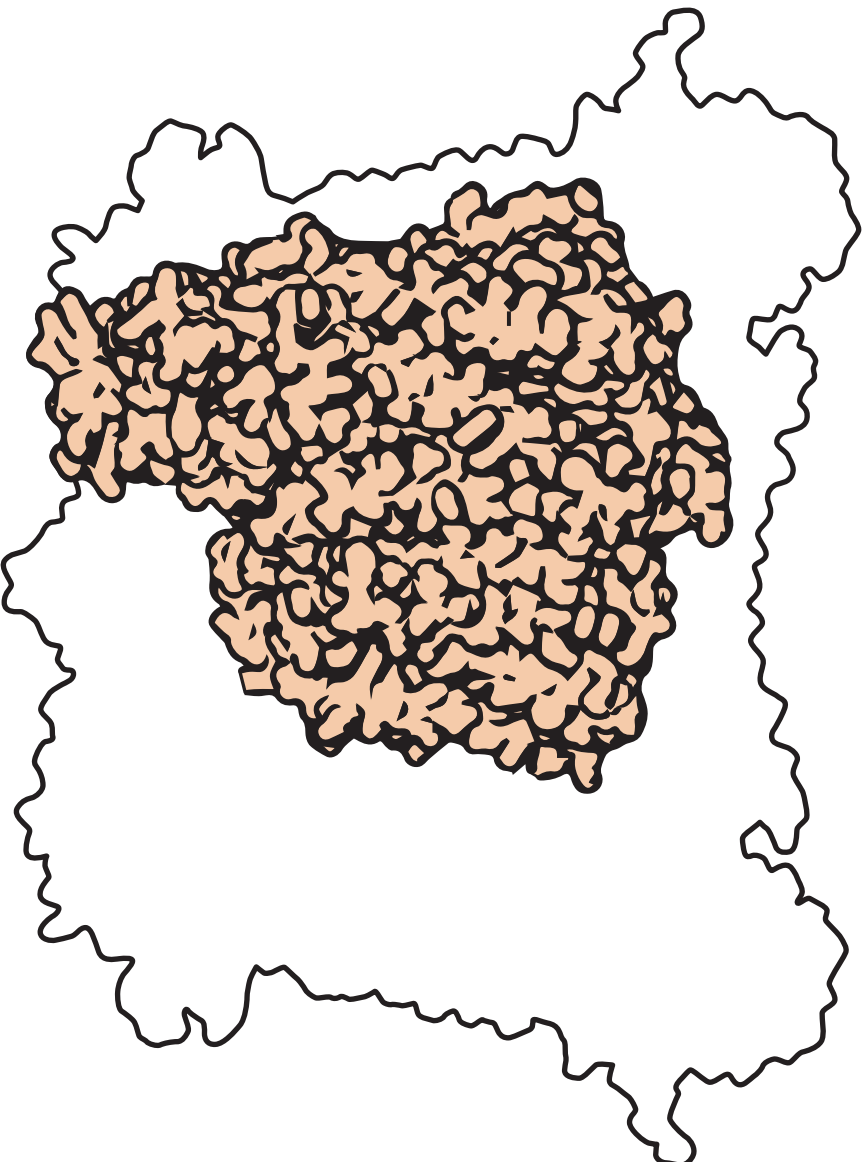
5(d) To find the dry mass the ecologists dried the grass samples in an oven at 65°C. Describe how the ecologists would be confident that all the water had been removed but none of the organic matter had been lost. [2]

8

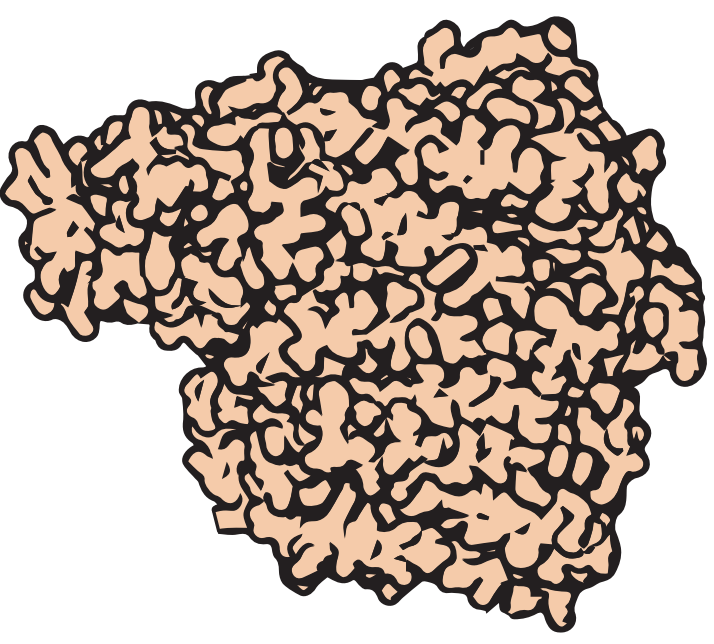


6. **Cytochrome c is an electron carrier involved in oxidative phosphorylation. It is a protein that transfers electrons between two large proteins found in the electron transport chain. It removes electrons from cytochrome bc1 and transfers them to cytochrome oxidase. This is shown on the diagram opposite.**
- (a) **Cytochrome oxidase is the final protein in the electron transport chain. It is an enzyme which transfers the electrons to an oxygen molecule.**

State the final product of this reaction in the mitochondrion. [1]



Enzyme from cow



Enzyme from bacterium

6(b) The cytochrome oxidase molecule is different in different species. The diagram opposite shows the enzyme from a cow and a bacterium. The shaded section in each represents the polypeptide chains which are very similar in both organisms. This is the area of the enzyme which binds to the cytochrome c.

- (i) Suggest why the shaded regions are similar in all organisms. [2]**

6(b) (ii) Suggest why cytochrome c detaches from the cytochrome oxidase molecule when the electrons it carries are removed. [2]

6(c) Cytochrome bc1 is a proton pump that transfers protons into the inter-membrane space.

Antimycin is a chemical that binds to cytochrome bc1 and blocks its action.

Explain what happens to the pH of the intermembrane space when antimycin is present.

[2]

6(d) Oligomycin A is another chemical which acts by inhibiting protons from passing through ATP synthase.

(i) Explain why the presence of oligomycin A in a human causes high levels of reduced NAD to form in the cell. [2]

7. The glomerulus and Bowman's capsule of the kidney nephron are the site of ultrafiltration.

IMAGE 1 opposite shows the main structures of this part of the nephron. **IMAGE 2** opposite shows an electron micrograph of part of the same structures.

- (a) (i) On **IMAGE 1**, label with a **P** the part of the nephron where the structures shown in **IMAGE 2** would be found. [1]
- (ii) Using the scale bar on **IMAGE 2** only, calculate the magnification of this electron micrograph. [2]

magnification = x _____

7(b) The effective pressure which forms the glomerular filtrate is due to several different pressures.

They are:

- the hydrostatic pressure in the glomerulus capillaries
- the osmotic pressure due to plasma proteins
- the intra-renal pressure (the pressure of the fluid already present in the Bowman's capsule and the tubules)

The pressures can be connected using the following formula:

$$\text{pressure forming glomerular filtrate} = \text{hydrostatic pressure in glomerulus} - \text{osmotic pressure of plasma} - \text{intra-renal pressure}$$

In a healthy adult the osmotic pressure of the plasma is 4 kPa, the intra-renal pressure is 2.6 kPa and the hydrostatic pressure in the glomerulus is 8 kPa.

- (i) Calculate the pressure forming the glomerular filtrate. [1]
-
-

7(b) (iii) The pressure forming the glomerular filtrate can be regulated. The muscles in the walls of the afferent and efferent arterioles are under hormonal and nervous control.

Describe how changes in the afferent and efferent arterioles could increase the pressure forming the filtrate. [2]

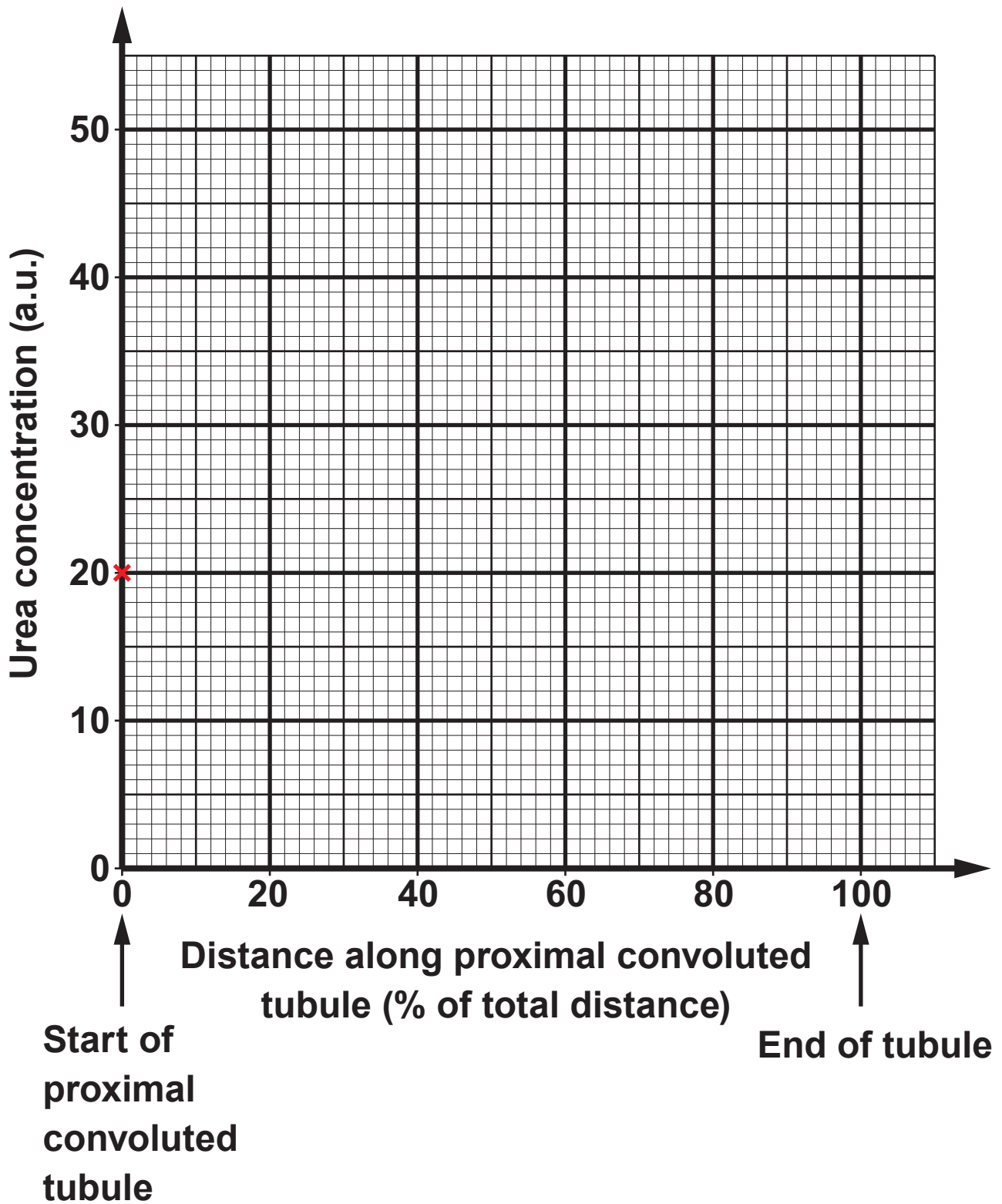
7(c) In diseases such as diabetes mellitus and glomerulonephritis the membranes in the glomerulus and Bowman's capsule are damaged and they become more permeable to proteins.

Suggest TWO reasons why the proteins are not usually reabsorbed back into the bloodstream.

[2]

7(d) The urea concentration increases as the filtrate moves along the proximal convoluted tubule. However the mass of urea remains constant.

(i) Explain why the urea concentration increases. [1]



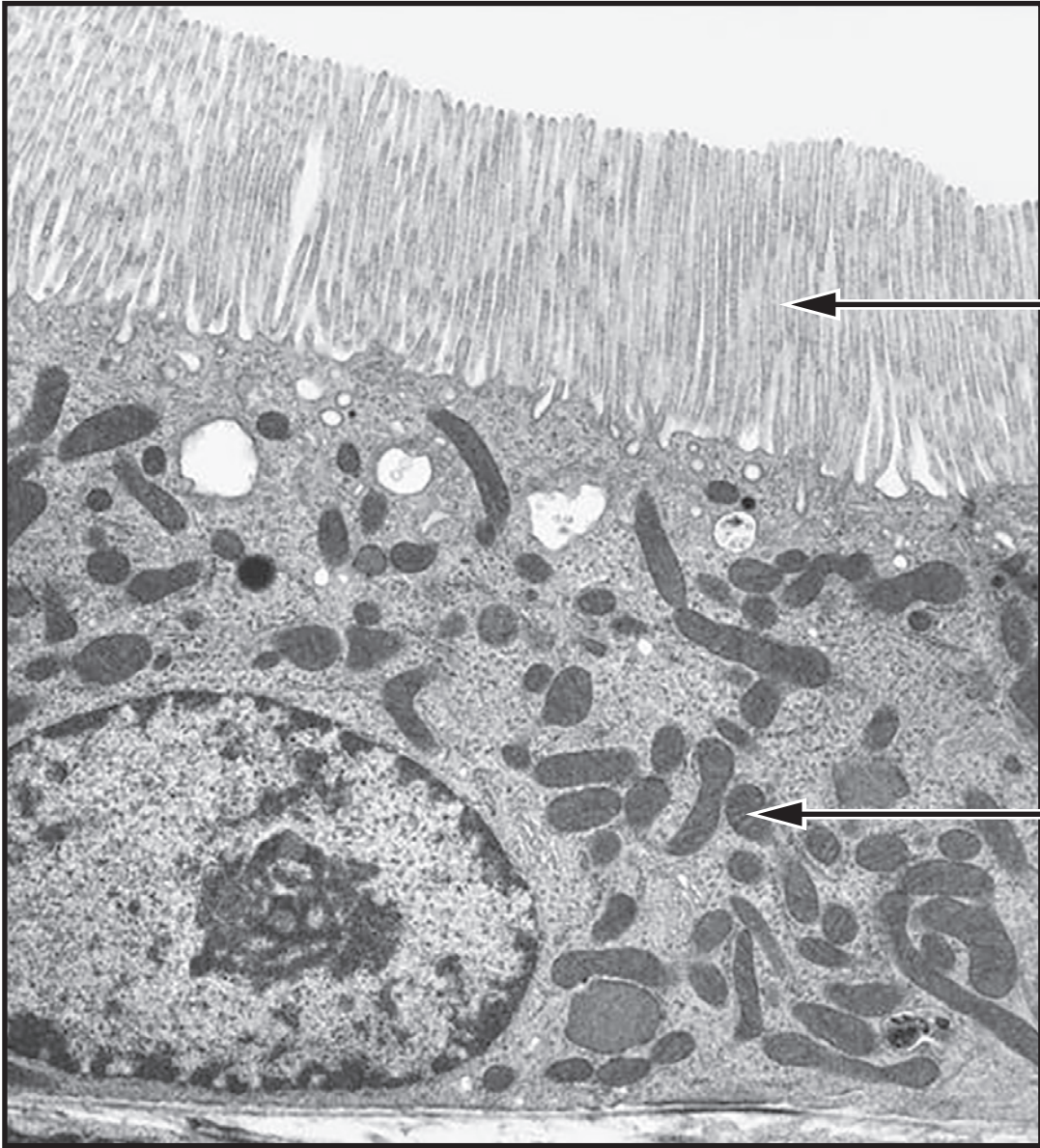
- 7(d) (ii) If the concentration of urea along the proximal convoluted tubule is plotted on a graph, the line of best fit would follow the equation shown below:

$$y = mx + c$$

The concentration of urea in the filtrate at the start of the proximal convoluted tubule is 20 arbitrary units (a.u.) and the value of m (the gradient) is 0.2 a.u./%.

Use the values provided to calculate the concentration of urea at the end of the tubule and draw a line on the axes opposite for the concentration of urea along the length of the proximal tubule. The concentration at the start of the proximal convoluted tubule has been plotted for you.

[2]



Z

A

7(e) The electron micrograph opposite shows a section through the wall of the proximal convoluted tubule.

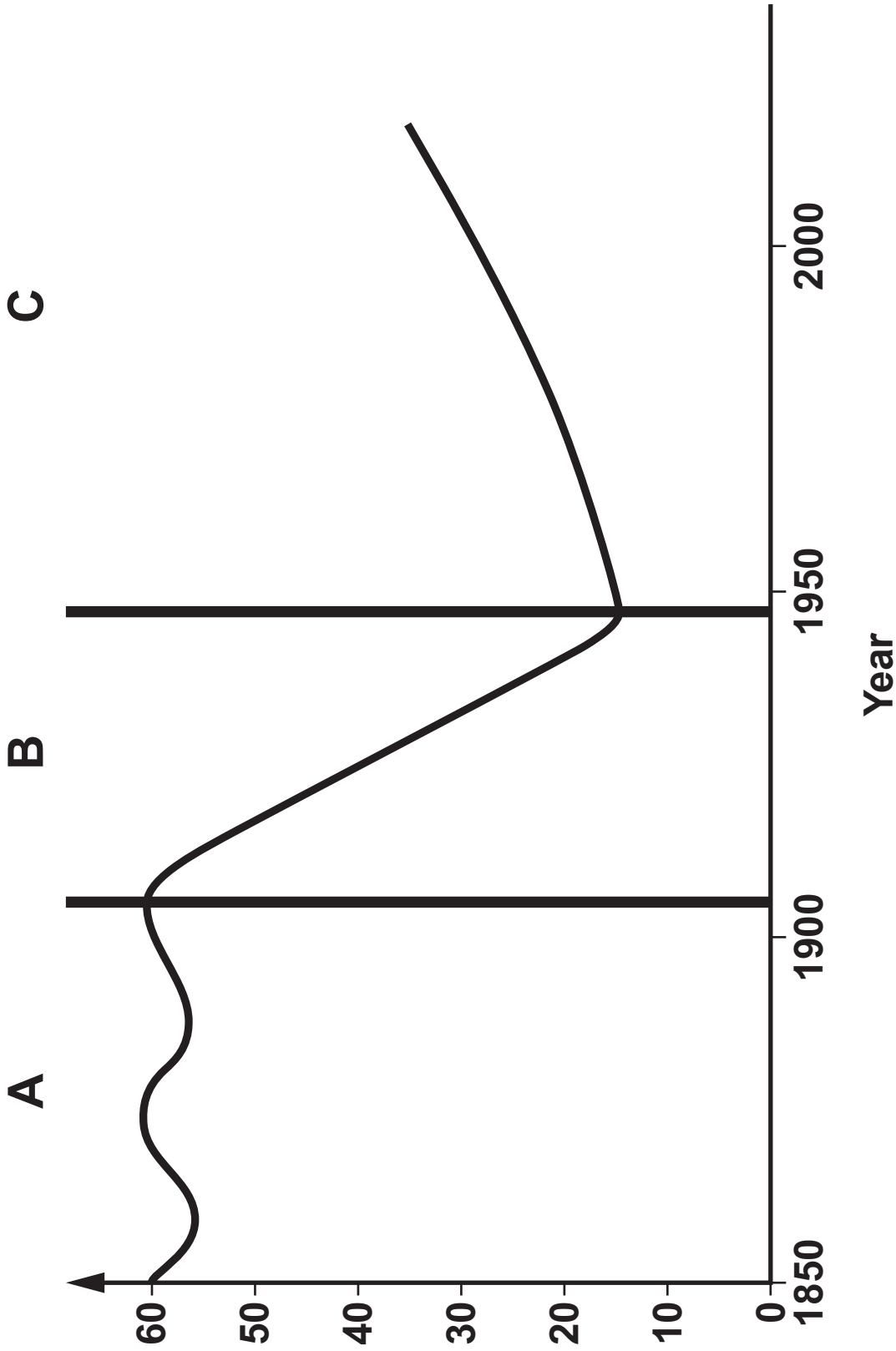
(i) Explain why there are many of the organelles labelled **X** in the cells shown.

[2]

7(e) (ii) Explain the presence of structures Z on the cell surface. [1]

(f) Lungfish survive the drying out of their habitats by burrowing into the mud and decreasing their metabolic rate. Explain why, when in water, they release the products of deamination as ammonia but when they are in the dried-out mud, they convert the products to urea. [4]

21



Approximate numbers of adult cheetahs

C

B

A

2000

1950

1900

1850

Year

8. A team of scientists from the Mara Cheetah Project estimated that the adult population of cheetahs in the Masai Mara Game Reserve in Kenya stood at 30 individuals in the summer of 2016.

The population between 1850 and 1900 has been estimated to have been around 55 individuals in this area. The graph opposite shows the approximate numbers of adult cheetahs in this area from 1850 to 2016.

With reference to the information provided and your own knowledge, explain the factors affecting the population of cheetahs in region **A** of the graph. Account for the drop in cheetah numbers in region **B**. Describe and explain the strategies being used to overcome the problem of low cheetah numbers in region **C**. [9 QER]

IMAGE 1

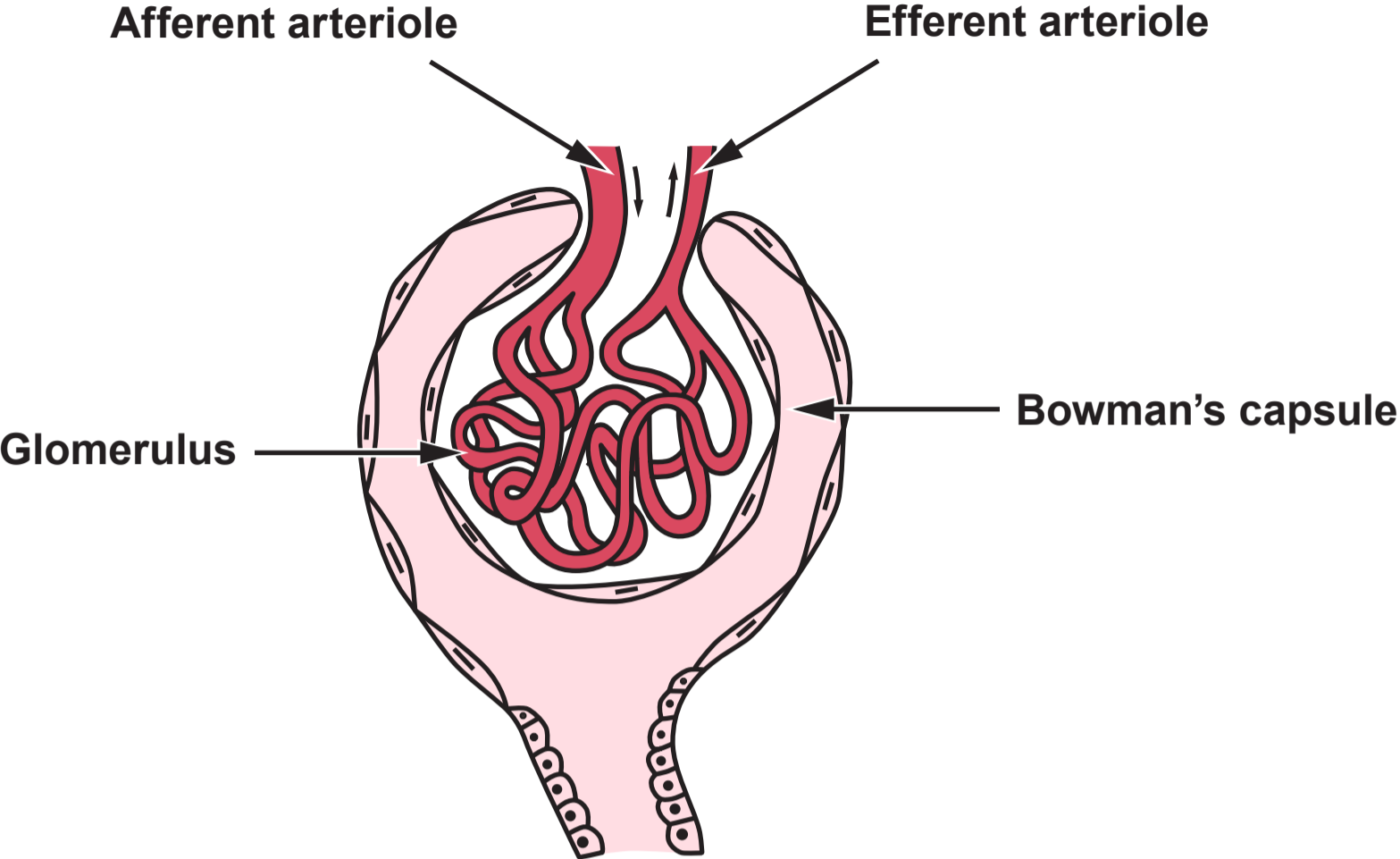
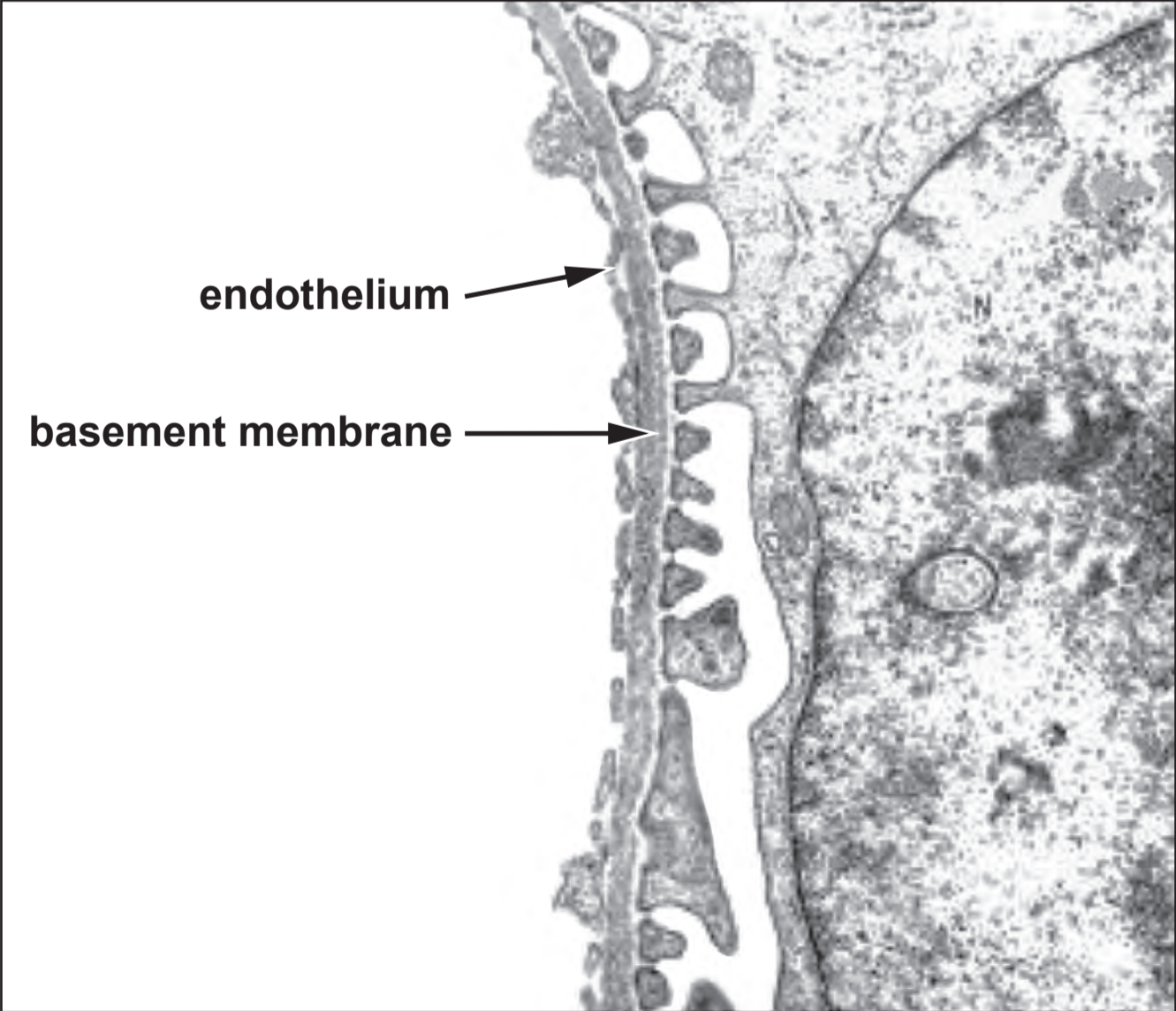


IMAGE 2



500 nm