Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL

1400U30-1

S18-1400U30-1

BIOLOGY – A2 unit 3

Energy, Homeostasis and the Environment

THURSDAY, 7 JUNE 2018 – MORNING

2 hours

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**	

1400U301
01

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional 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.

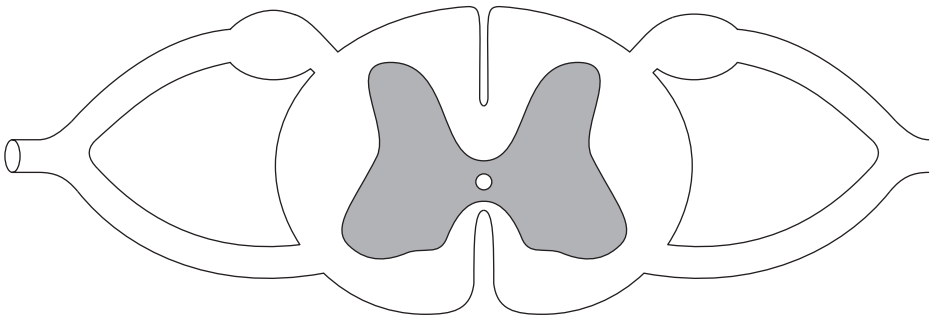
JUN181400U30101

© WJEC CBAC Ltd.

Examiner only

Answer **all** *questions.*

1. The diagram 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]

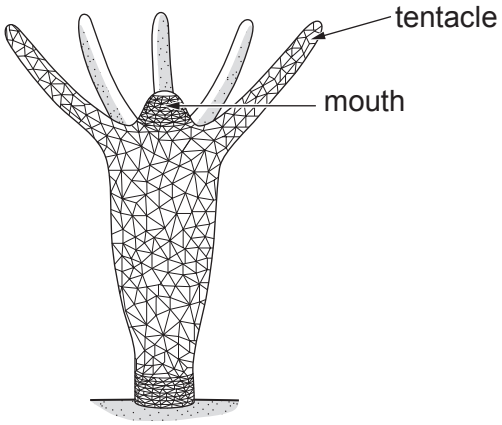
.....

© WJEC CBAC Ltd.

Examiner only

(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 below 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]

.....

.....

.....

.....

.....

.....

1400U301 03

7

© WJEC CBAC Ltd.

Examiner only

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 = ...

(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]

.....

.....

.....

.....

(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 cm^3 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.

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

© WJEC CBAC Ltd.

Examiner only

(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 cm^3 = ...

(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]

.....

.....

.....

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

.....

.....

.....

.....

10

1400U301 05

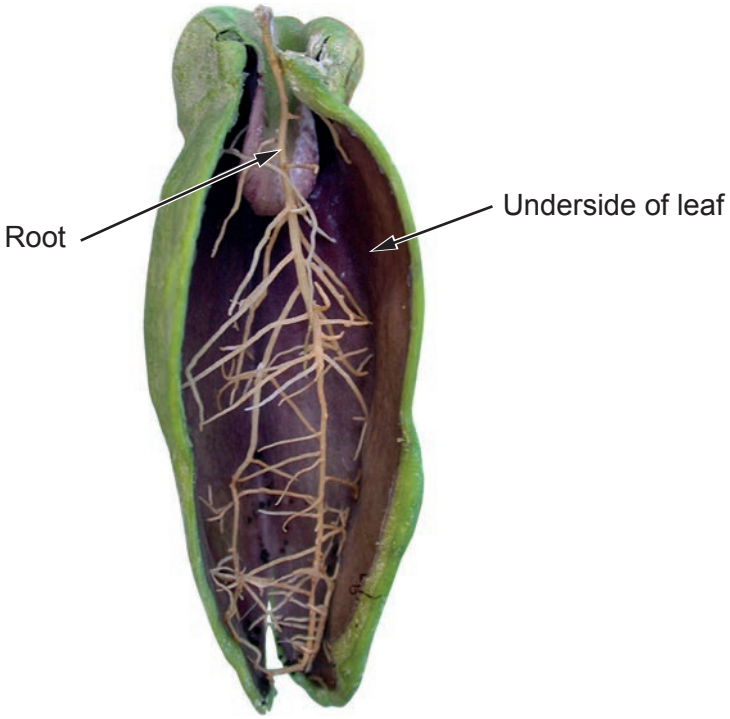
© WJEC CBAC Ltd.

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

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

© WJEC CBAC Ltd.

Examiner only

(a) Ants of the genus *Philidris* live inside these pods. The ants store dead insects and rear their young inside the pods. The ants and dead insects contribute to the nutrients available to these leaves.

(i) The main source of carbon for these leaves is from the air inside the pod, not the atmosphere. Describe how carbon inside the pod is made available for use by these leaves. [4]

.....

.....

.....

.....

.....

.....

(ii) Describe how nitrogen is made available for use by these leaves. [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]

.....

.....

.....

.....

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

.....

.....

10

1400U301 07

© WJEC CBAC Ltd.

Examiner only

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. 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.

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

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

.....

.....

(ii) Explain why the students repeated the experiment three times. [1]

.....

.....

(iii) Explain why the students set up tubes **3** and **4** as controls. [3]

.....

.....

.....

.....

.....

© WJEC CBAC Ltd.

Examiner only

(b) Explain the results seen in tube **1**. [3]

.....

.....

.....

.....

.....

.....

(c) When the chloroplasts are isolated, there may also be mitochondria present in the sample. Explain how the results show that mitochondria are not responsible for reducing the DCPIP in this experiment. [3]

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

14

1400U301 09

© WJEC CBAC Ltd.

Examiner only

5. An investigation was carried out into the productivity of grassland. Ecologists followed the method below.

- Three identical 1 m^2 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 / $g\,m^{-2}$
1	73
2	61
3	107

(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 ..... $g\,m^{-2}\,day^{-1}$

© WJEC CBAC Ltd.

Examiner only

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

.....

.....

.....

.....

(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]

.....

.....

.....

.....

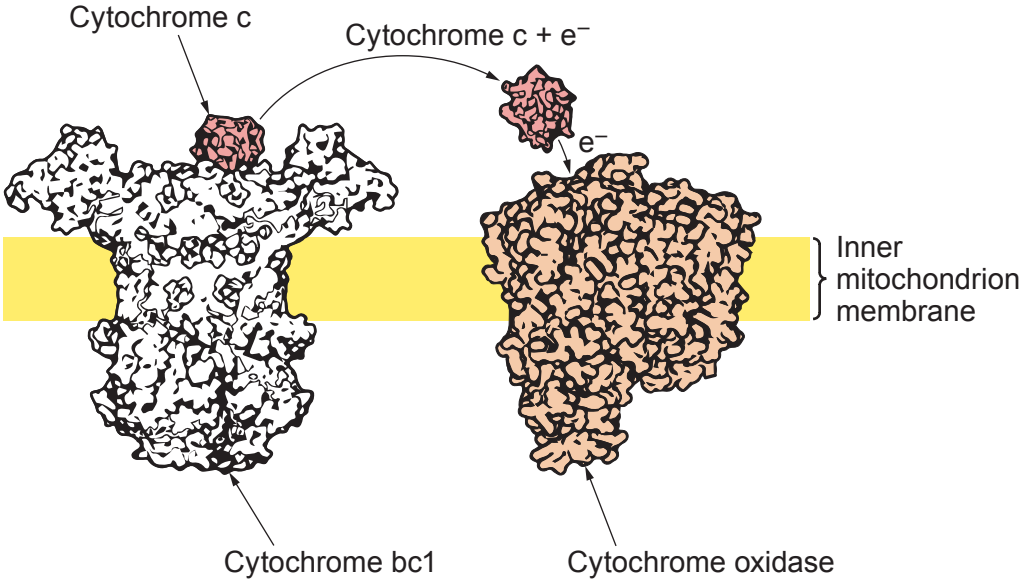
1400U301
11

8

© WJEC CBAC Ltd.

Examiner only

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 below.



(a) Cytochrome oxidase is the final protein in the electron transport chain. It is an enzyme which transfers the electrons to an oxygen molecule.

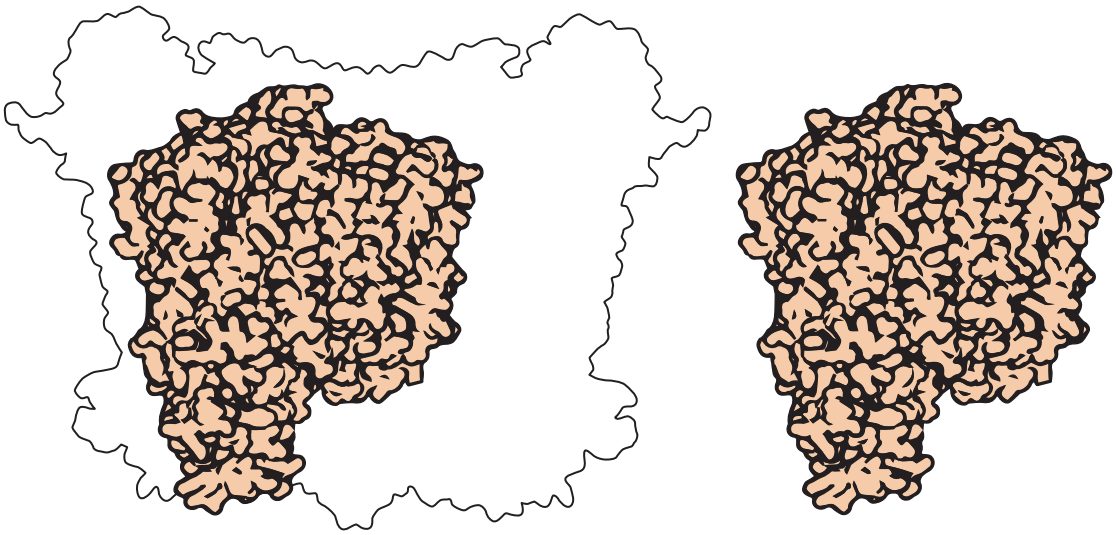
State the final product of this reaction in the mitochondrion. [1]

.....

© WJEC CBAC Ltd.

Examiner only

(b) The cytochrome oxidase molecule is different in different species. The diagram below 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.



Enzyme from cow Enzyme from bacterium

1400U301 13

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

.....

.....

.....

.....

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

.....

.....

.....

.....

© WJEC CBAC Ltd.

Examiner only

(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]

.....

.....

.....

.....

(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]

.....

.....

.....

.....

(ii) Suggest why lactate begins to accumulate in the blood if high levels of reduced NAD form. [2]

.....

.....

.....

.....

.....

.....

11

© WJEC CBAC Ltd.

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© WJEC CBAC Ltd.

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

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

Image 1

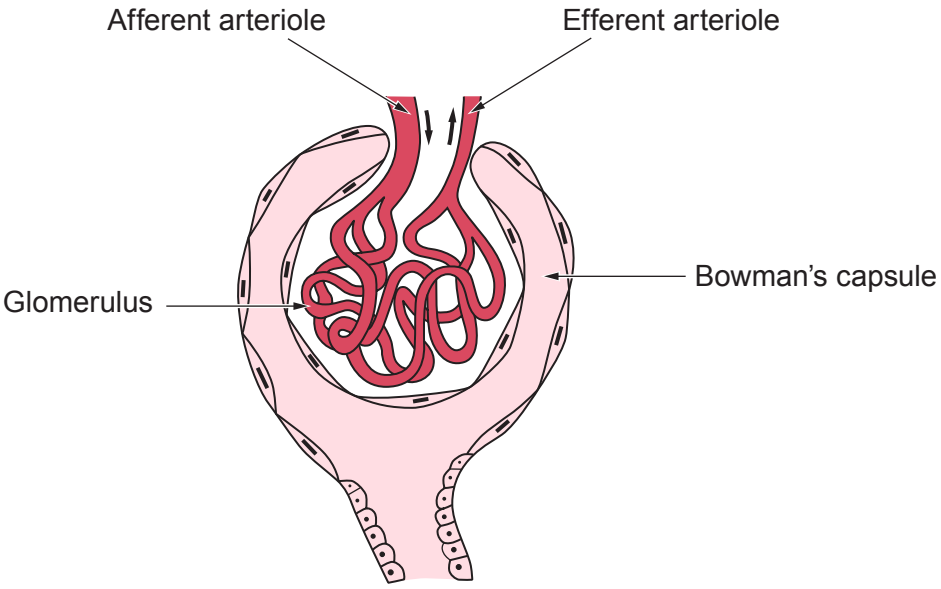
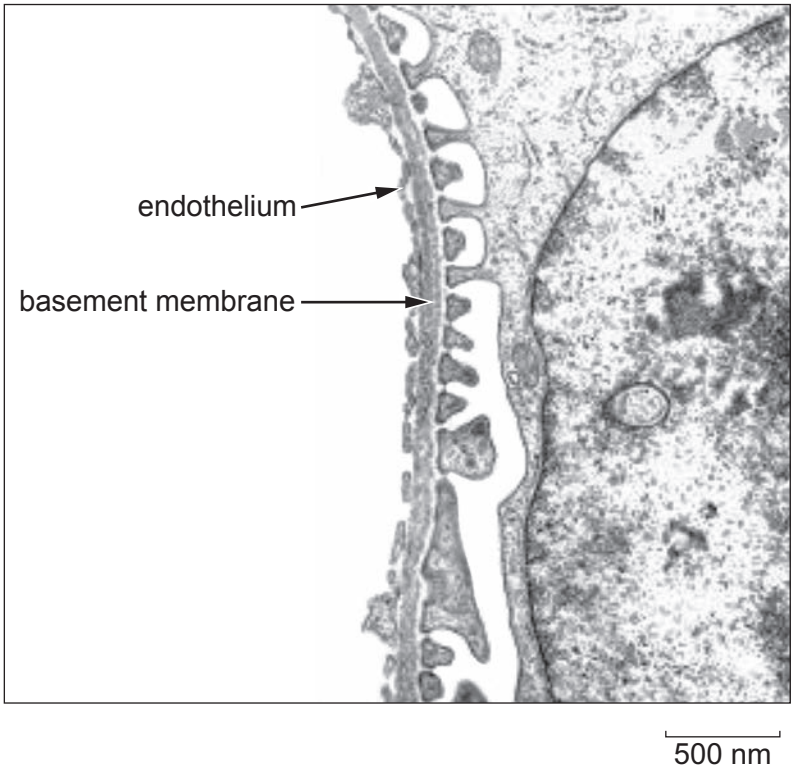


Image 2



© WJEC CBAC Ltd.

Examiner only

(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 .....

(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:

pressure forming glomerular filtrate = hydrostatic pressure in glomerulus – osmotic pressure of plasma – 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]

.....

(ii) Use the information provided to suggest how a low protein diet could affect the rate at which glomerular filtrate is formed. [3]

.....

.....

.....

.....

.....

.....

© WJEC CBAC Ltd.

Examiner only

(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]

.....

.....

.....

.....

(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]

.....

.....

.....

.....

(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]

.....

.....

© WJEC CBAC Ltd.

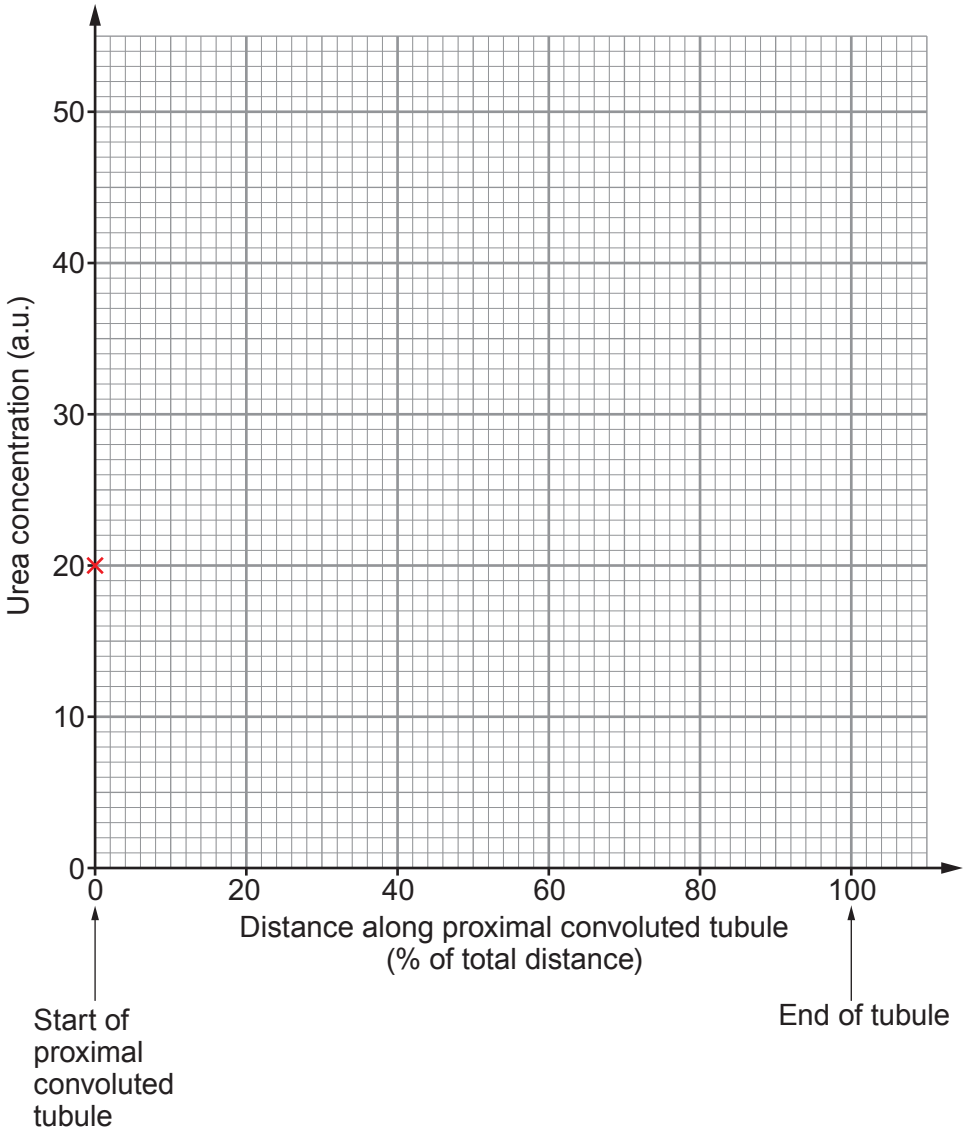
Examiner only

(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./%.

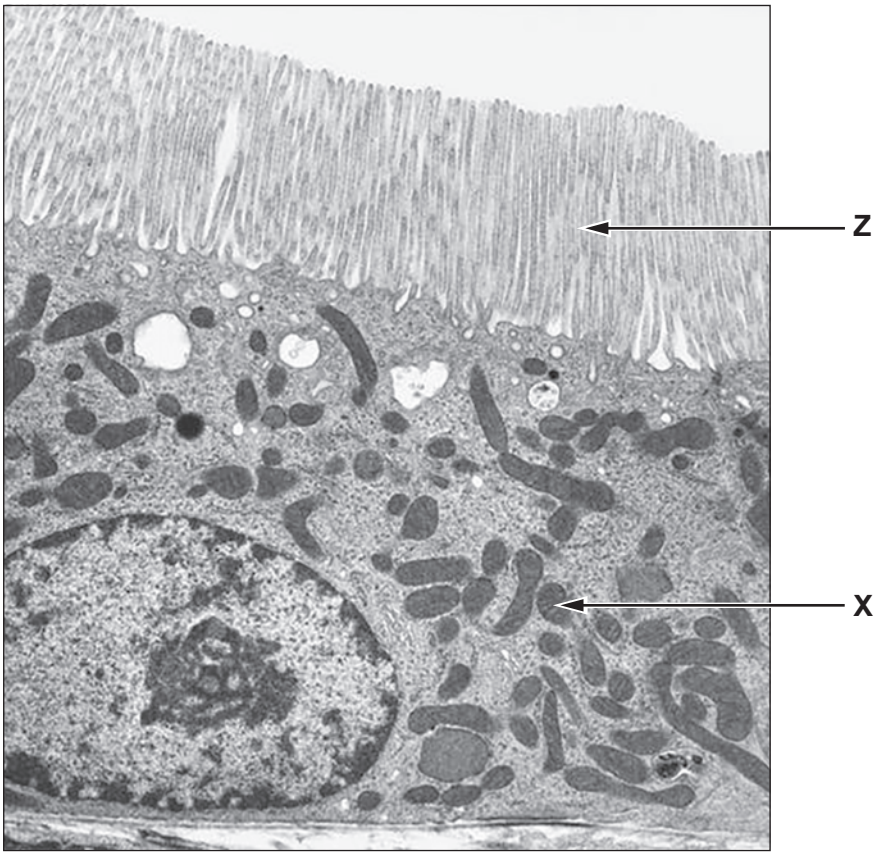
Use the values provided to calculate the concentration of urea at the end of the tubule and draw a line on the axes below for the concentration of urea along the length of the proximal tubule. The concentration at the start of the proximal convoluted tubule has been plotted for you. [2]



© WJEC CBAC Ltd.

Examiner only

(e) The electron micrograph below 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]

.....

.....

.....

.....

© WJEC CBAC Ltd.

Examiner only

(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]

.....

.....

.....

.....

.....

.....

.....

.....

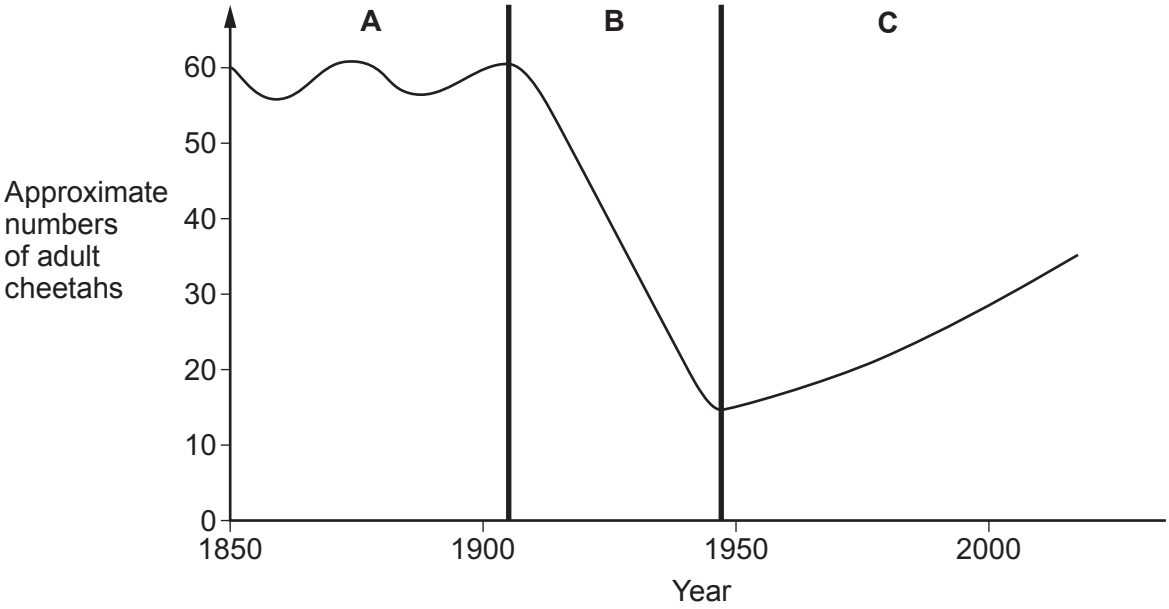
21

© WJEC CBAC Ltd.

8. The photograph below shows a group of young male cheetahs eating a wildebeest.

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 below shows the approximate numbers of adult cheetahs in this area from 1850 to 2016.



© WJEC CBAC Ltd.

Examiner only

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]

© WJEC CBAC Ltd.

Examiner only

© WJEC CBAC Ltd.

Examiner only

9

END OF PAPER

© WJEC CBAC Ltd.

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© WJEC CBAC Ltd.

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

© WJEC CBAC Ltd.

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.	Examiner only

© WJEC CBAC Ltd.