

Candidate Name	Centre Number				Candidate Number			
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**A LEVEL BIOLOGY****UNIT 3****Energy, Homeostasis and the Environment****SPECIMEN PAPER****(2 hours)****90 marks****ADDITIONAL MATERIALS**

In addition to this examination 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.

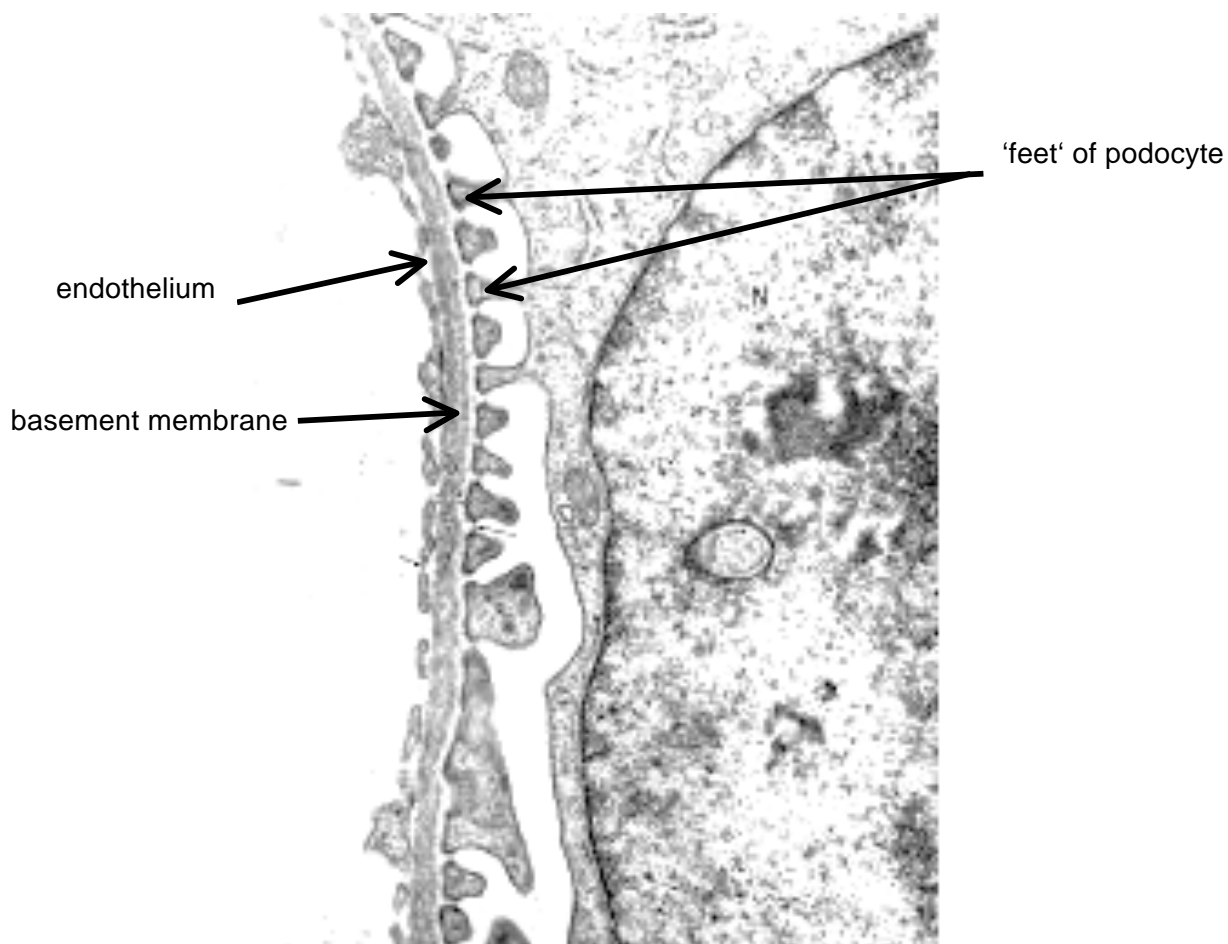
INFORMATION FOR CANDIDATES

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 7.

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1	16	
2	11	
3	11	
4	17	
5	10	
6	16	
7	9	
TOTAL	90	

1. Diabetes is a medical condition in which a person is unable to control their blood glucose levels. Phlorizin is a naturally occurring substance found in some plant tissues. Due to its effect on the reabsorption of glucose by nephrons it has been considered as a possible treatment for Type II diabetes, which is caused mainly by lifestyle choices such as a high sugar diet.

The photomicrograph below shows part of the glomerulus at a magnification of X 6 900.



- (a) Explain how the structures shown in the micrograph are adapted for the process of ultrafiltration. [3]

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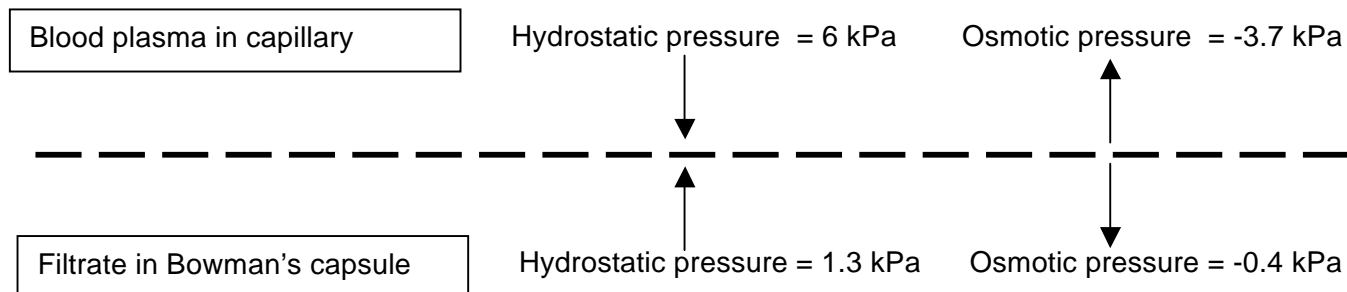
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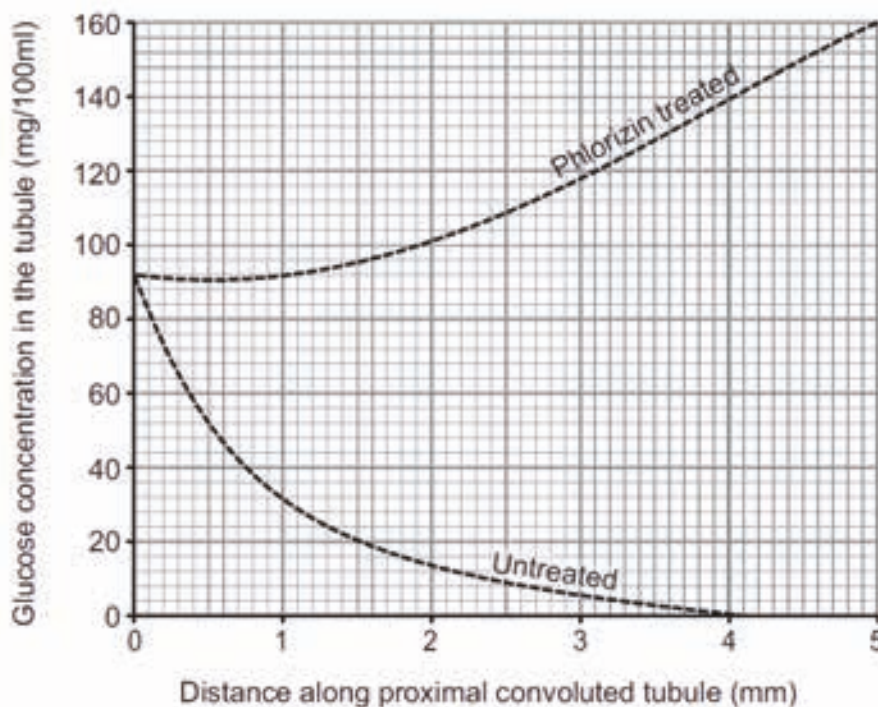
- (b) Ultrafiltration is caused by differences in the hydrostatic and osmotic pressures between the capillaries in the glomerulus and the filtrate in the Bowman's capsule. From the figures shown below calculate the net pressure forcing molecules into the Bowman's capsule. [1]



.....kPa

- (c) The proximal convoluted tubule of the kidney nephron selectively reabsorbs glucose and sodium ions into the surrounding blood capillaries. The uptake of glucose from the lumen of the tubule can be prevented completely by introducing a chemical called phlorizin.

The graph below shows the concentration of glucose as the filtrate passes along the tubule.



- (i) Calculate the % increase of glucose in the tubule from 0 to 4mm in the nephron treated with phlorizin. [2]

Answer = ----- %

- (ii) Research has shown that phlorizin stops ATP synthesis and binds to membrane proteins. Explain how phlorizin could prevent glucose reabsorption from the filtrate. [5]

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- (d) Type I diabetes is an inherited condition that has been linked to the inheritance of alleles of genes involved in the control of the immune response. Some genotypes have been found to increase the risk of developing Type I diabetes, while others appear to reduce this risk.

The table below shows information on some alleles that affect the risk of developing Type I diabetes. In a heterozygous individual both alleles are expressed in the phenotype.

Allele	Effect on risk of developing Type I diabetes
DR 2	Reduces risk
DR 3	Medium risk
DR 4	Medium risk

Genetic counselling was given to a couple. The woman had Type 1 diabetes and was homozygous for the DR3 allele while her partner did not have diabetes and was found to have DR2 and DR4 alleles in his genotype.

Identify the possible genotypes of their children and conclude their risk of developing Type 1 diabetes. [5]

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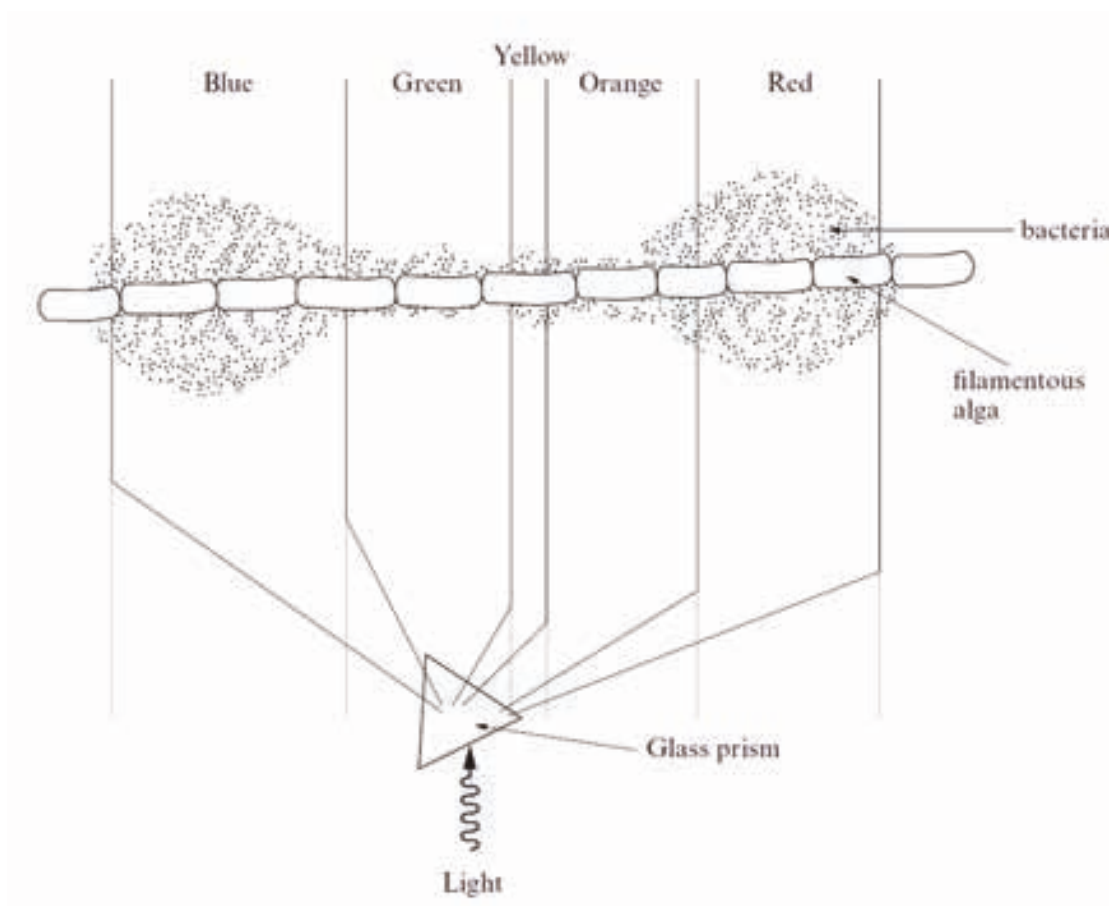
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2. A scientist called Engelmann set up an experiment to investigate the effect of wavelength of light on the production of oxygen during photosynthesis. He set up the experiment using a filamentous alga (a single strand of photosynthetic cells joined end to end) which was exposed to light that had been passed through a prism which split the light into different wavelengths.

Motile bacteria were introduced into the experimental set-up and they moved into areas along the alga as shown in the diagram below.



- (a) Describe the process by which the alga produces oxygen. [5]

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- (b) (i) Explain the distribution of bacteria along the algae. [3]

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- (ii) Describe how you could modify the experimental procedure to provide a suitable control and how this would affect the distribution of the bacteria. [3]

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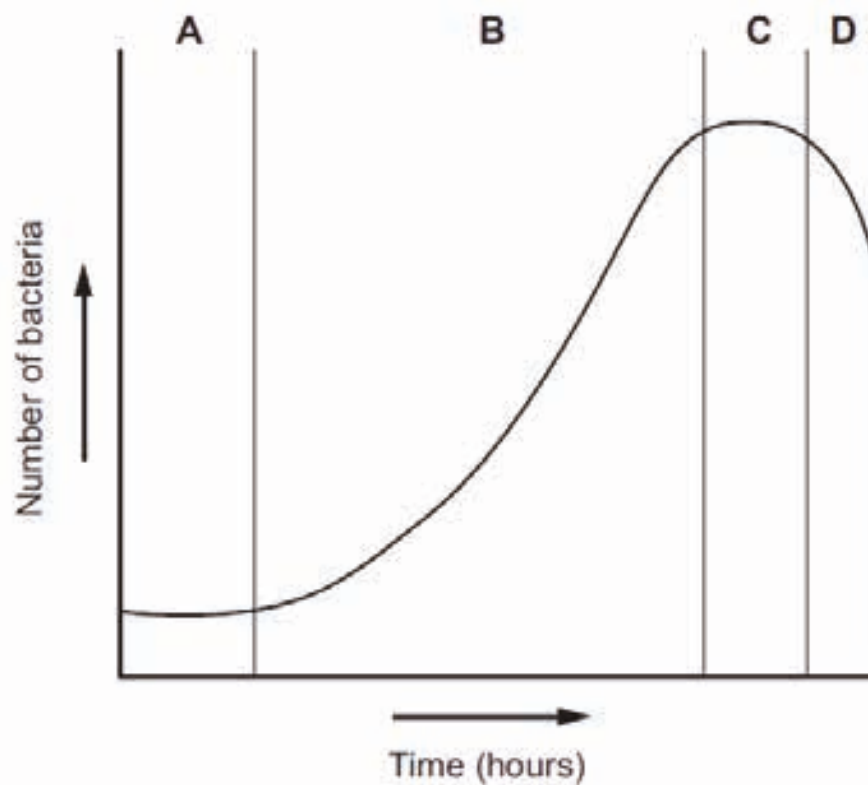
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3. A pharmaceutical company uses genetically modified bacteria to produce human insulin. It is important that they can monitor the numbers of bacteria in their culture vessels to ensure optimum production of the human protein. The graph shows the growth of a colony of bacteria in the laboratory.



At each time interval, using aseptic technique, a sample was taken from the culture and serially diluted before counting the bacteria under a microscope.

- (a) (i) Describe how a serial dilution is carried out and why it is necessary. [4]

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- (ii) The concentration of bacteria counted in a sample after four tenfold dilutions was 85 in 1cm^3 . Calculate the total number of bacteria in the original culture if its volume was 20cm^3 . Show your working and express your answer in standard form. [3]

Number of bacteria =

- (iii) What is the difference between a viable count and a total count? [1]

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- (b) In order to establish a new culture of these bacteria, a laboratory technician transferred a sample of the bacteria to a fresh culture medium.

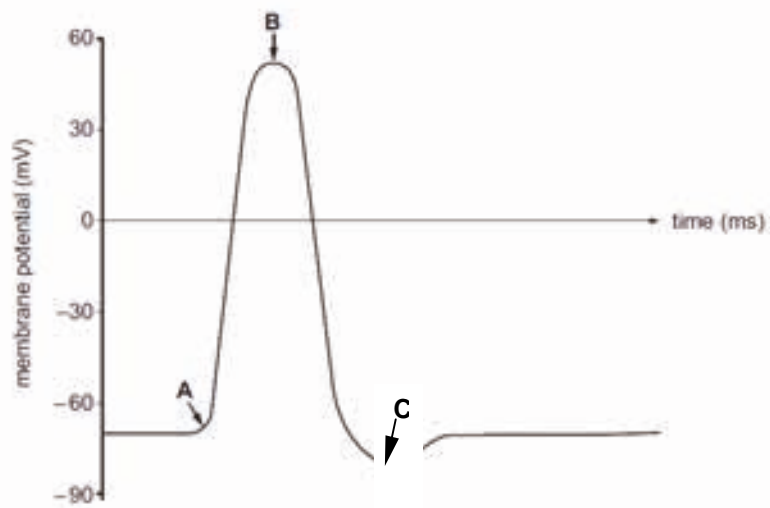
The technician decided to take the sample from phase B. Justify the decision to take the sample from this phase and not the other phases.

[3]

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4. The symptoms of multiple sclerosis include delayed reaction times and visual impairment. Alcohol can also delay reaction times.

The diagram shows the changes in the potential difference across the membrane of a neurone during the passage of an action potential.



- (a) Describe how the resting potential is maintained in the neurone. [3]

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- (b) (i) A strong stimulus at point A depolarised the axon membrane and resulted in the change in membrane potential seen at point B, called an action potential. Explain why and how this action potential was generated. [3]

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- (ii) Suggest why the hyperpolarisation seen at point C makes it difficult for the neurone to transmit another action potential. [2]

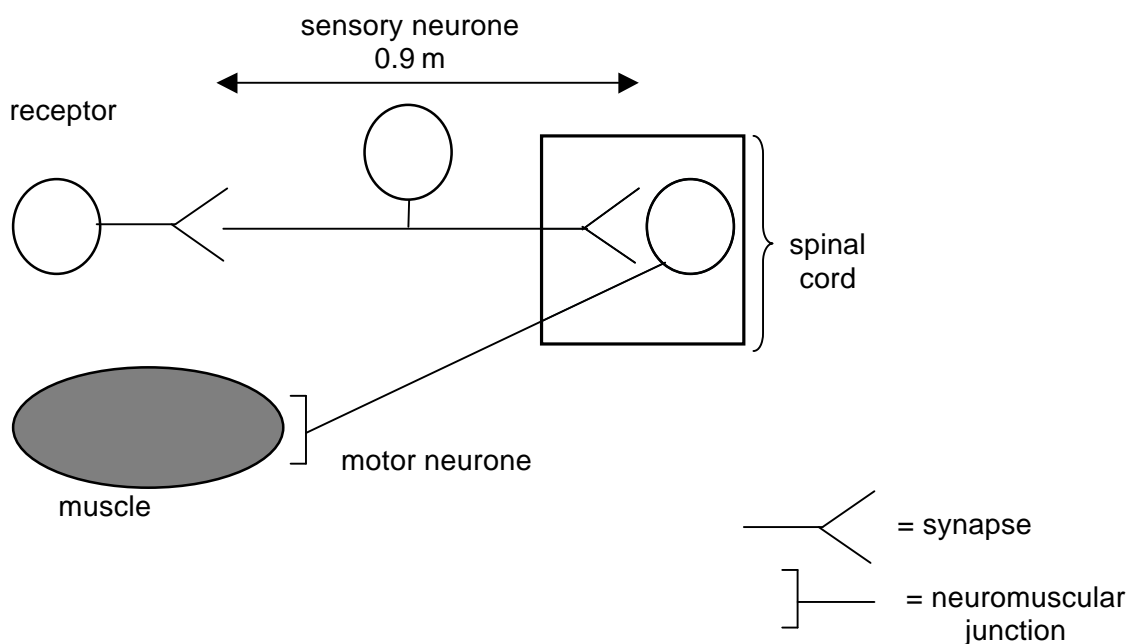
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- (c) Nerve impulses travel along different types of neurones at different speeds as shown in the table.

Type of neurone	Speed of transmission of impulse (m ms^{-1})
sensory	0.08
motor	0.12

The diagram below shows how a receptor cell is connected via neurones to a muscle.



The receptor is 0.9m from the spinal cord. There is a delay at each synapse/ neuromuscular junction of 2 ms. Calculate how long it would take for an impulse to be transmitted along a sensory neurone from this receptor and back along the same length motor neurone to a muscle. Show your working.

[3]

Answer =ms

- (d) Multiple sclerosis is caused by the immune system destroying the myelin sheath of neurones and can lead to delayed reaction times. Suggest why this condition leads to a slowing down of the transmission of a nerve impulse. [4]

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- (e) Alcohol has an inhibitory effect on synaptic transmission. Suggest **two** ways in which alcohol consumption could decrease the speed of transmission across a synapse. [2]

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II

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5. Some farmers in the developing countries of Southeast Asia use an agricultural system known as “shifting cultivation”. This involves felling and burning a plot of forest to provide ash in which to grow food crops. After one to three years, as weeds flourish and fertility declines, the plot is abandoned for a fallow period of about 20 years.

However recently, where the human population density is high, fallow periods have been reduced and food yields have dropped significantly. In some places the cultivation pattern has been replaced with permanent agriculture, such as rubber plantations.

- (a) Explain the advantage to these farmers of burning felled trees to produce ash before cultivation? [2]

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- (b) ‘Where the human population density is high, fallow periods have been reduced and food yields have dropped significantly.’

Explain why the food yields have decreased. [3]

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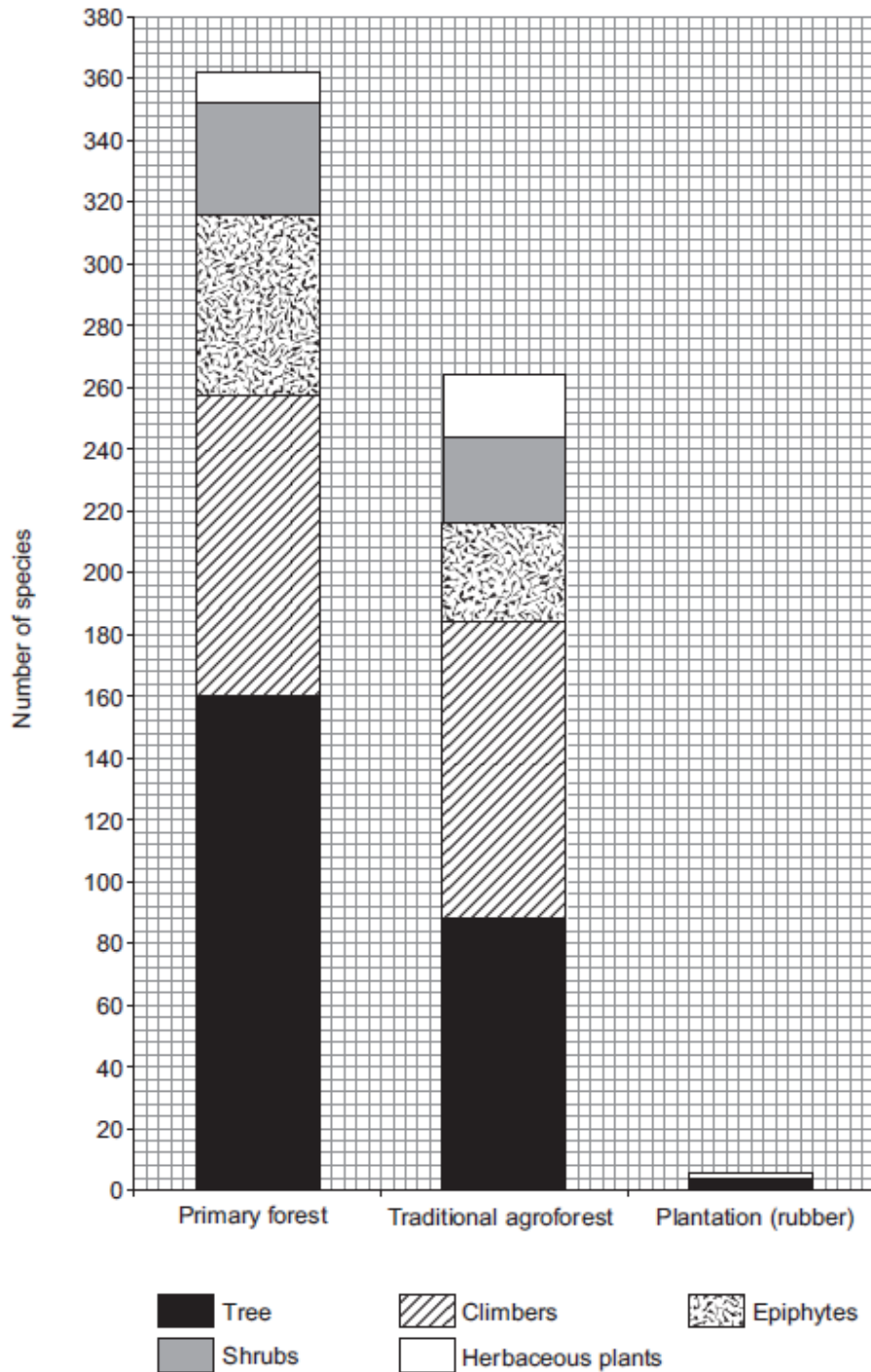
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A study was carried out in three areas of forest that had different types of agriculture. The number of species of five types of plant (trees, climbers, epiphytes, shrubs and herbaceous plants) were counted in:

- an area of undisturbed primary forest;
- an area that was used for traditional agroforest (shifting cultivation);
- a rubber plantation.

The results are shown below.



- (c) It is often stated that any cultivation of the rainforest is totally destructive. Evaluate the validity of this statement. [5]

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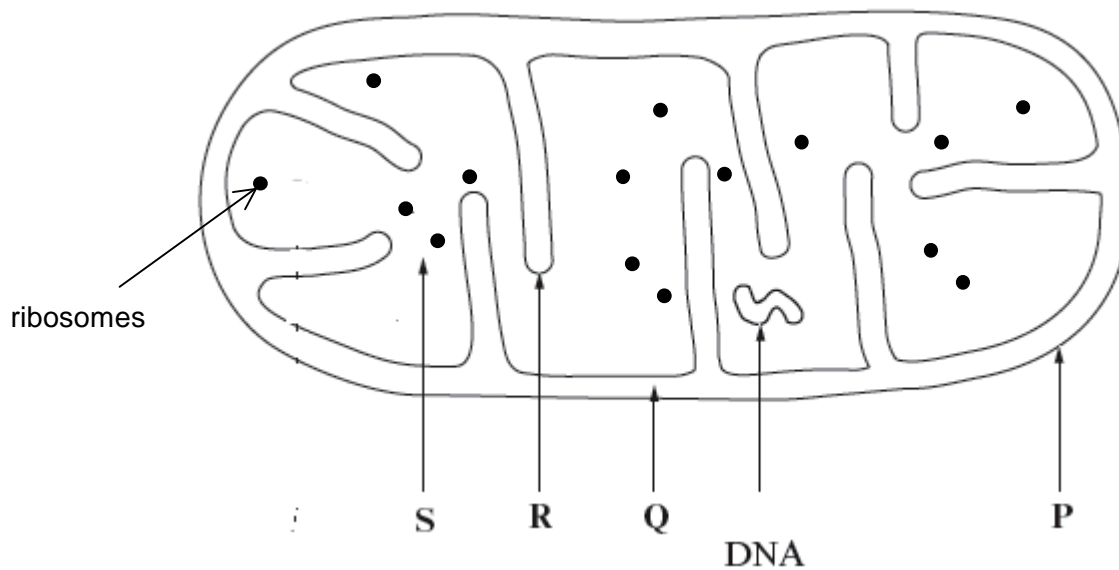
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6. The diagram below shows the structure of a mitochondrion as seen using an electron microscope.



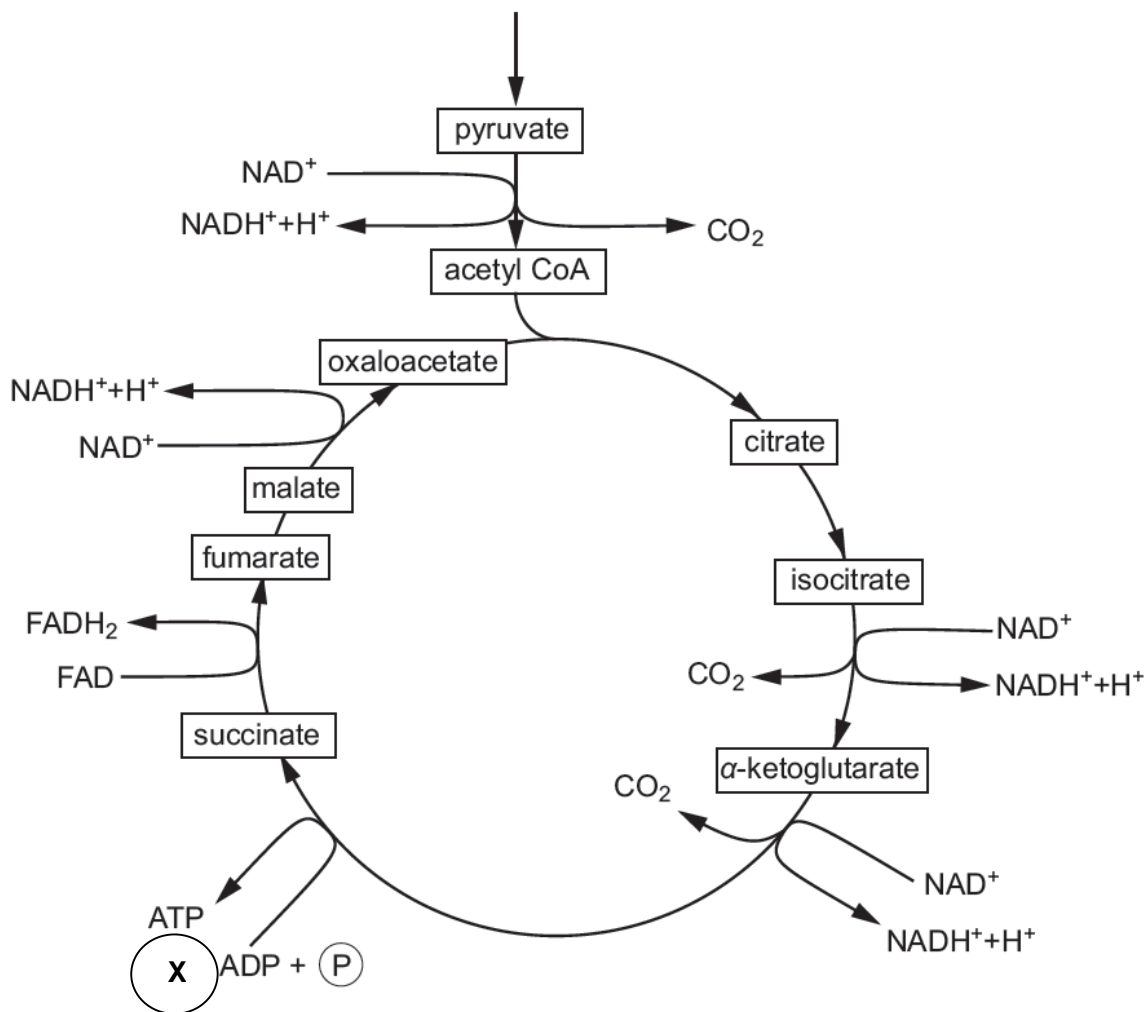
- (a) Using the letters on the diagram, identify the site of each of the following: [2]
- I the Krebs cycle;
 - II Oxidative phosphorylation;
 - III Decarboxylation;
 - IV Most acidic region

- (b) Suggest the function of the following in respiration. [2]

DNA

Ribosomes

- (c) The detailed diagram below shows the link reaction and the Krebs cycle. Most of the intermediates involved are named.



Using the diagram above, and your own knowledge, determine how many carbons there are in the following Krebs cycle intermediates.

[1]

- citrate
- α – ketoglutarate
- succinate

- (d) The incidence of mitochondrial disorders in the population of Wales is 1:8500. These disorders can be diagnosed in patients by taking a minimally invasive tissue biopsy to examine mitochondrial function, freezing the sample immediately after collection.

In addition to activity measurements of individual enzymes, analysis of mitochondrial respiration and ATP production rates are performed. This includes the measurement of mitochondrial oxygen consumption in the presence of different substrates, such as pyruvate and α -ketoglutarate. Analysis may show increased levels of a Krebs cycle intermediate, such as malate and succinate. Defects in mitochondrial ATP synthesis may lead to high lactate levels in blood.

- (i) Suggest a suitable tissue to examine mitochondrial function and explain why you have chosen this tissue with respect to patient safety. [2]

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- (ii) What explanations could be given for the following observations:

- I the oxygen consumption was low with the pyruvate as a substrate but high with α -ketoglutarate as a substrate? [3]

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- II there was a build up of any one of the Krebs cycle intermediates? [2]

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- (e) The endosymbiotic theory suggests that mitochondria have evolved from bacteria that had been engulfed by the other cells. Using your knowledge of the structure of bacteria and mitochondria, justify this theory. [4]

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