

Surname	Centre Number	Candidate Number
Other Names		2



**GCE A level**

1074/02



**HUMAN BIOLOGY – HB4**

P.M. THURSDAY, 16 June 2016

1 hour 45 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	6	
2.	13	
3.	12	
4.	15	
5.	7	
6.	17	
7.	10	
<b>Total</b>	<b>80</b>	

**ADDITIONAL MATERIALS**

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

**INSTRUCTIONS TO CANDIDATES**

Use black ink or black ball-point pen.

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.

You are reminded of the necessity for good English and orderly presentation in your answers.

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

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Answer **all** questions.

1. (a) State the word or term used for the statements below. [3]

(i) A bacterium that fixes nitrogen gas.

.....

(ii) The process by which nitrate ions pass into the cytoplasm of root hair cells.

.....

(iii) The conversion of ammonium ions into nitrite ions.

.....

(b) Apart from artificial fertiliser, describe and explain **three** methods by which humans can increase the nitrogen available to plants in agricultural soils. [3]

I. ....

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II. ....

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III. ....

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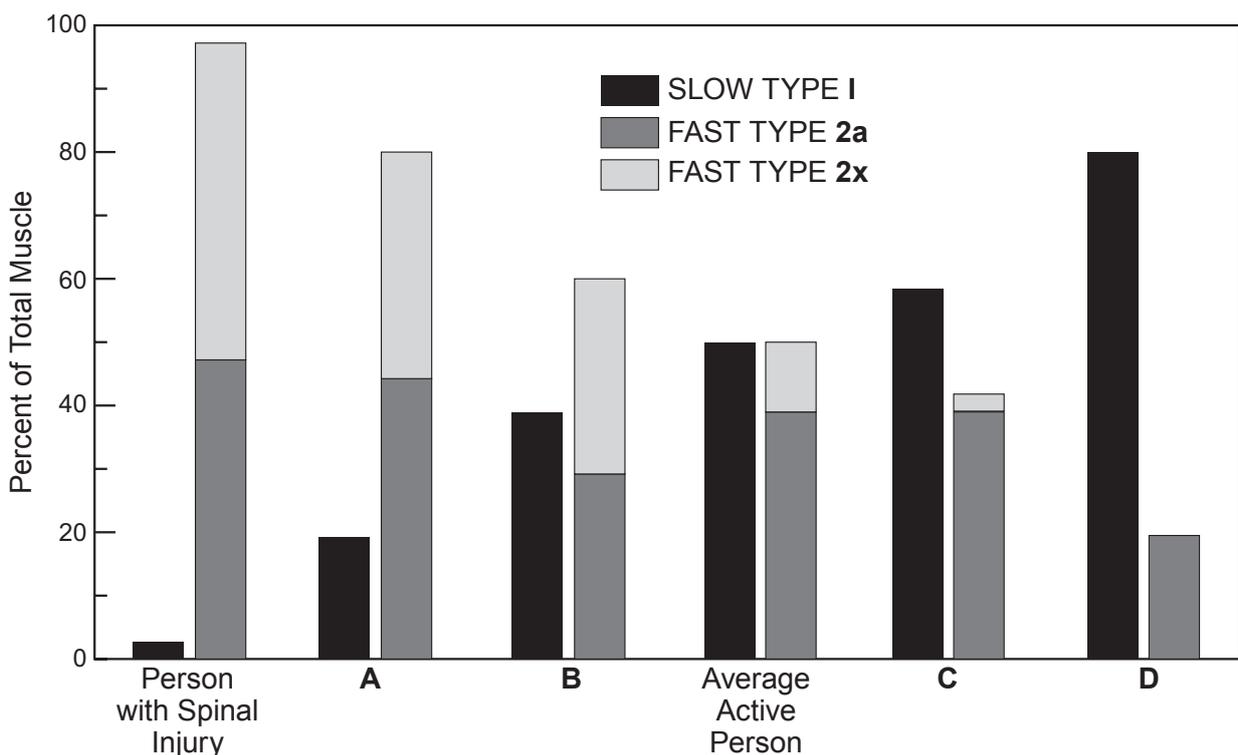
2. (a) Choose suitable biological terms to complete the sentences in the passage below. [5]

A muscle is a bundle of muscle fibres. Each fibre has many inner strands called ..... . The main proteins in the muscle are myosin and ..... . The myosin molecule is made from two heavy chains and four light chains of two distinct types and therefore is described as having a ..... structure. Three different forms of heavy chain polypeptides exist and these have a different ..... structure. Muscle fibres cannot divide, but can increase in diameter by increasing the amount of protein in the fibre. Nuclei in the muscle fibre are unable to divide and therefore nuclei are donated to the fibre by stem cells. The stem cells divide by .....

(b) The three different forms of heavy chain polypeptides are designated **I**, **2a** and **2x** as are the fibres that contain them.

- Type **I** fibres are known as slow fibres.
- Type **2a** and **2x** fibres are referred to as fast fibres.
- The maximum contraction velocity of type **I** fibres is approximately one tenth that of a type **2x** fibre.
- The velocity of type **2a** fibres is somewhere between type **I** and type **2x**.
- The average active adult has roughly equal numbers of slow and fast fibres but humans show a great variation in this regard.

The graph below compares fibre distribution in different individuals.



(i) From the bar chart use the letters given (**A – D**) to identify each of the following:[2]

World class Marathon runner .....

World class sprinter .....

(ii) Use the bar chart to describe the changes which occur in the muscles of the body in a person who has suffered a spinal injury compared with the average active person. [3]

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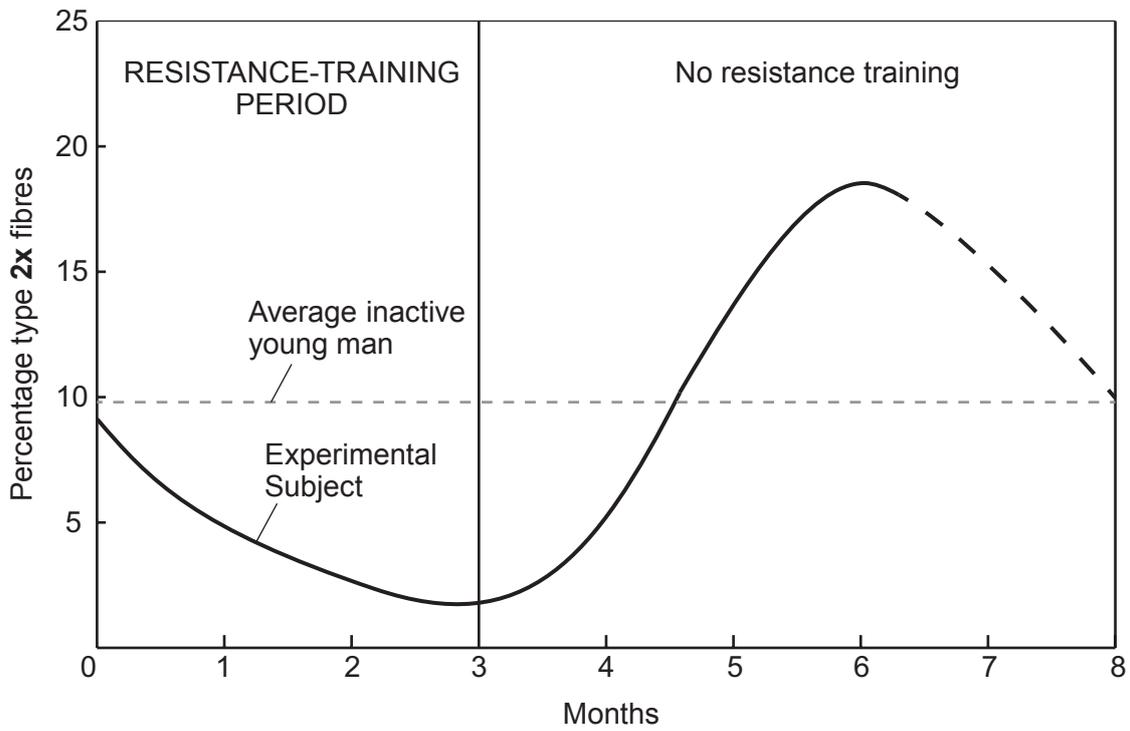
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- (c) When healthy muscles are loaded heavily and repeatedly, as in a weight-training programme, the number of fast **2x** fibres declines as they convert to fast **2a** fibres. An investigation was carried out where muscle samples were taken from nine young men during and after a heavy resistance training programme. The mean results are shown in the graph below.



Describe and explain how the results shown above could be used to advise a sprinter how resistance training could be used in the months leading up to a race. [3]

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(b) State **two** functions of a synapse other than the inhibition of an impulse. [2]

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(c) (i) Hydrolytic enzymes are released from the post synaptic membrane and these breakdown transmitter substances such as acetylcholine. Suggest how the hydrolytic enzymes break down acetylcholine. [2]

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(ii) Explain what would happen if the breakdown of the acetylcholine was prevented at a neuromuscular junction. [2]

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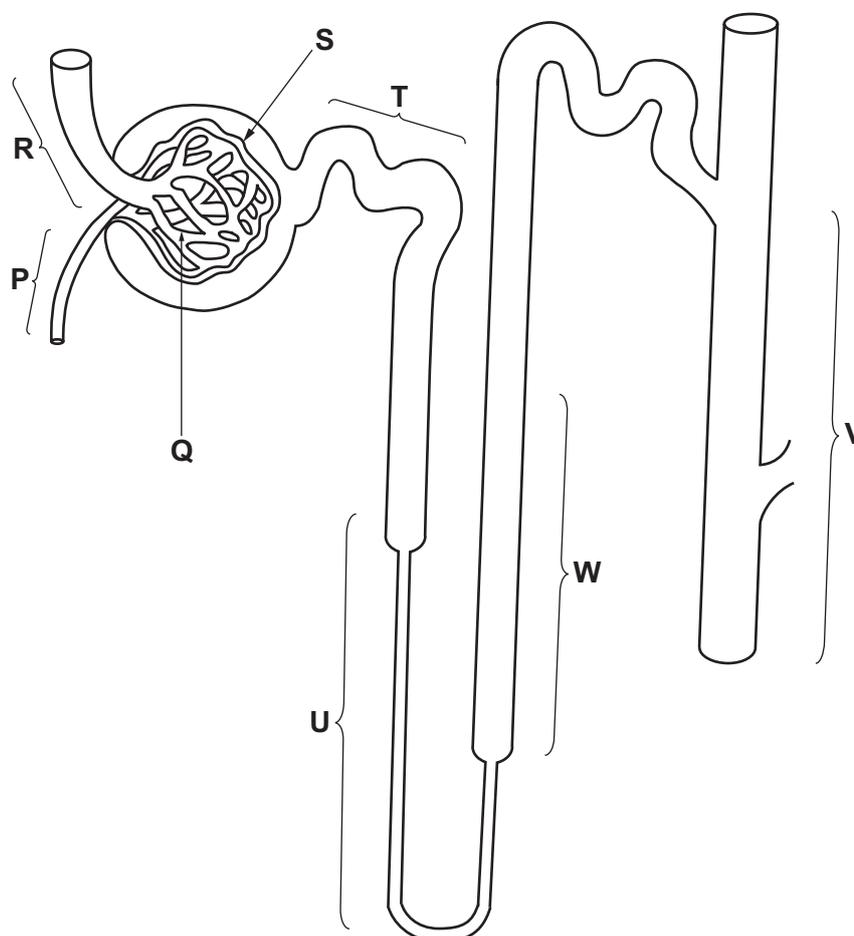
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4. (a) The diagram below represents a nephron and associated blood vessels.



Use the letters given on the diagram to complete the table below. You should list **all** letters which apply to each statement. [6]

Statement	Region(s)
where ultrafiltration occurs	
where ADH receptors are present in the membrane of cells	
always impermeable to water	
where sodium ions are actively transported out of the filtrate	
where there is an increase in water potential of the filtrate as it flows along	
where there is a decrease in water potential of the filtrate as it flows along	

- (b) (i) The volume of fluid filtered from the glomeruli into the Bowman's capsule space is known as the glomerular filtration rate (GFR).

To calculate the GFR a polysaccharide named inulin is used. Renal clearance is the volume of plasma from which inulin is completely cleared. The clearance value for inulin is equal to the GFR.

The following results were obtained:

Concentration of inulin in plasma	4 mg dm <sup>-3</sup>
Volume of urine collected	0.1 dm <sup>3</sup> hour <sup>-1</sup>
Concentration of inulin in urine	300 mg dm <sup>-3</sup>

Inulin clearance = GFR

$$\text{Inulin clearance} = \frac{\text{Urine inulin concentration} \times \text{volume of urine}}{\text{Plasma inulin concentration}}$$

Calculate the GFR of the kidneys per day.  
Show all your working.

[2]

GFR of the kidneys per day = ..... mg dm<sup>-3</sup> day<sup>-1</sup>

- (ii) The plasma volume in a 70 kg human male is approximately 3 dm<sup>3</sup>.  
Calculate how many times the plasma is filtered per day by the kidneys in this man.

[1]

Number of times plasma filtered per day = .....

(c) Selective reabsorption takes place in the proximal convoluted tubule (PCT).

(i) Name the process by which water is reabsorbed from the PCT. [1]

.....

(ii) Non-polar molecules, such as the insecticide DDT, can diffuse through the membranes of the cells in the PCT. Suggest and explain why more of these molecules diffuse through the cells into the blood at the terminal end of the PCT. [2]

.....  
.....  
.....  
.....

(iii) Some molecules like penicillin are too big to be filtered but are actively secreted by the PCT cells from the blood into the tubule. What would you expect to happen to the concentration of penicillin in the glomerular filtrate as it passes along the PCT? [1]

.....

(iv) People with uncontrolled diabetes have high concentrations of blood glucose. This results in high concentrations of glucose in the glomerular filtrate. Explain why all of this glucose cannot be reabsorbed. [2]

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.....  
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5. Chloroplasts are described as transducers because they convert one form of energy into another. They also fix carbon dioxide and are essential for the continued existence of life on this planet.

(a) What is the energy transformation which occurs in chloroplasts? [1]

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(b) (i) Explain what is meant by the term '*fix carbon dioxide*'. [1]

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(ii) Describe how chloroplasts fix carbon dioxide. [3]

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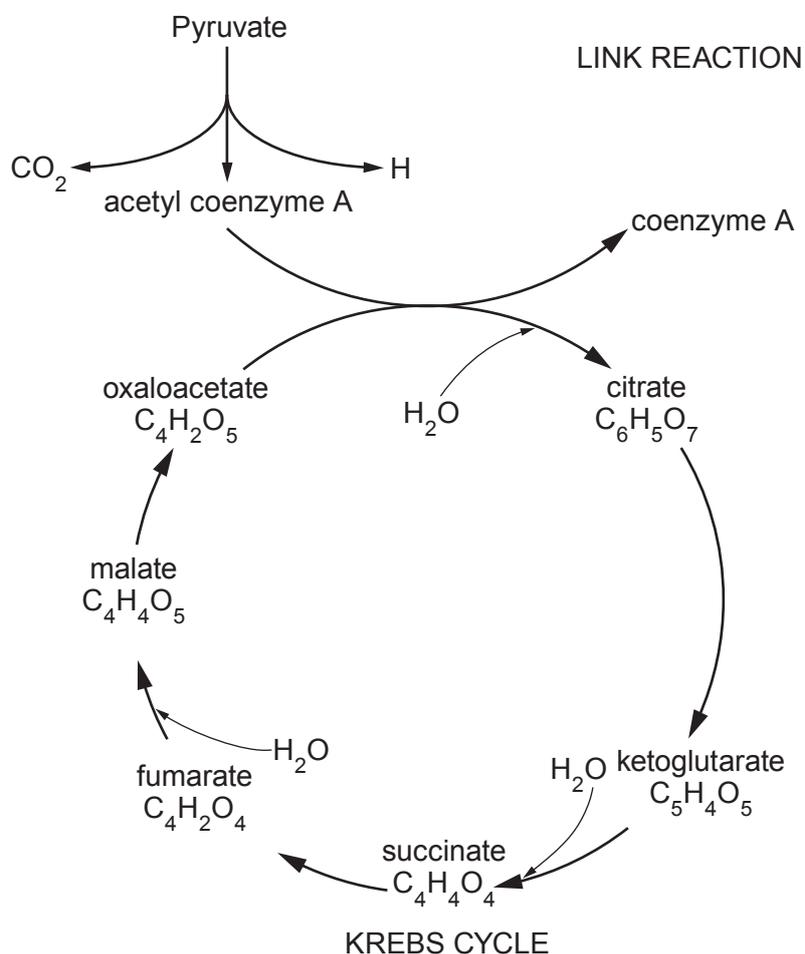
(c) Give an example of **one** organic molecule and **one** inorganic molecule produced by chloroplasts which are essential for the continued life on this planet. [2]

Organic .....

Inorganic .....

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6. (a) The diagram below represents the link reaction and the Krebs cycle. The formula for some of the intermediates involved is given.



- (i) The diagram above represents the link reaction and Krebs cycle. [3]
- I. Show, **using arrows labelled CO<sub>2</sub>**, the precise stages where decarboxylase enzymes remove carbon dioxide in the Krebs cycle.
  - II. Show, **using arrows labelled H**, the precise stages where dehydrogenase enzymes remove hydrogen in the Krebs cycle.
- (ii) Most of the hydrogen removed by dehydrogenase enzymes is passed to NAD but when hydrogen is removed from one intermediate in the Krebs cycle it is passed to another hydrogen acceptor. Name this acceptor. [1]
- .....

- (b) (i) When 1 molecule of glucose is completely broken down by aerobic respiration, sufficient energy is released to synthesise 40 ATP molecules. Although 40 ATP molecules can be made from one molecule of glucose the net gain is 38 ATP molecules.  
Explain why the net gain is less than the actual number of ATP molecules produced.

[1]

- (ii) Complete the table below to show the numbers of ATP molecules made from one molecule of glucose by the stages of respiration shown.

[4]

Stage of respiration	Number of ATP molecules made by substrate level phosphorylation	Number of ATP molecules made by oxidative phosphorylation
Glycolysis	4	6
Link reaction		
Krebs cycle		

- (iii) State what happens to the energy not used to produce ATP.

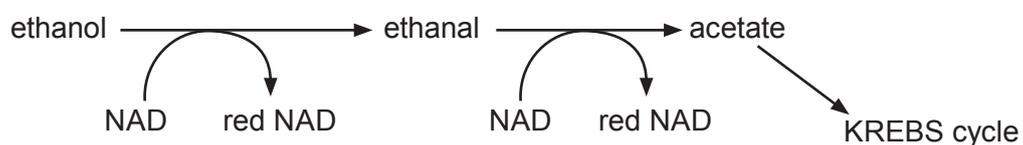
[1]

- (iv) Dinitrophenol is used in the manufacture of explosives and herbicides. During the second world war people working in factories producing explosives absorbed dinitrophenol through their skin. Dinitrophenol causes holes to be produced in the inner membrane of mitochondria, through which protons can pass.

Explain how this may affect oxidative phosphorylation and suggest why dinitrophenol causes a loss of weight and an increase in body temperature.

[5]

- (c) Fatty acids are normally broken down in the liver into 2 carbon acetate fragments which are then fed into the Krebs cycle, which uses dehydrogenase enzymes and many oxidised coenzyme molecules. Ethanol (alcohol) is also broken down in the liver as shown below.



Excess ethanol can lead to an accumulation of fatty acids in the liver (fatty liver disease). Suggest why the drinking of alcohol in excess can lead to the accumulation of fats in the liver. [2]

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Area with horizontal dotted lines for writing.

**END OF PAPER**