AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

AS BIOLOGY

Paper 1

Time allowed: 1 hour 30 minutes

Materials

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

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.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

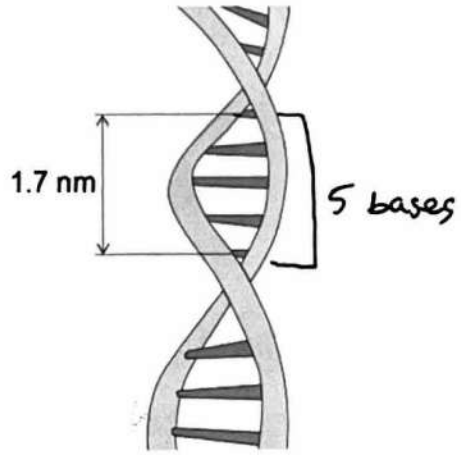
Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 75.

Do not write outside the box

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

0 1 **Figure 1** shows part of a DNA molecule.

Figure 1



0 1 . 1 Name the type of bond between:

[2 marks]

complementary base pairs hydrogen bonds

adjacent nucleotides in a DNA strand phosphodiester bond

0 1 . 2 The length of a gene is described as the number of nucleotide base pairs it contains.

Use information in **Figure 1** to calculate the length of a gene containing 4.38×10^3 base pairs.

[2 marks]

$\frac{1.7\text{ nm}}{5} = 0.34$

$0.34 \times 4.38 \times 10^3 = 1489.2$

Answer 1489 nm

$\Rightarrow 1489$

Do not write outside the box

0 1 . 3 Describe **two** differences between the structure of a tRNA molecule and the structure of an mRNA molecule.

[2 marks]

1 their shape: tRNA is folded into 'clover' shape while mRNA remains linear.

2 tRNA has amino acid binding site, while mRNA does not.

0 1 . 4 In a eukaryotic cell, the structure of the mRNA used in translation is different from the structure of the pre-mRNA produced by transcription.

Describe **and** explain a difference in the structure of these mRNA molecules.

[2 marks]

Pre-mRNA contains more nucleotides as it contains both exons and introns. But after splicing the produced mRNA only has the exons in it.

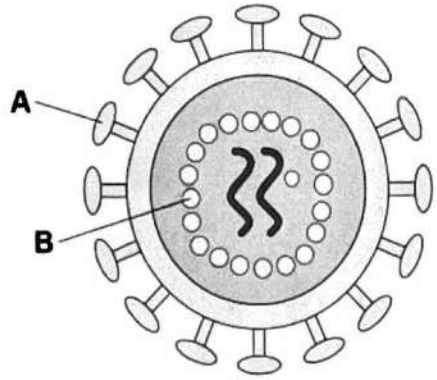
8

Turn over for the next question

Do not write outside the box

0 2 **Figure 2** shows the structure of the human immunodeficiency virus (HIV).

Figure 2



0 2 . 1 Name structures **A** and **B**.

[2 marks]

A attachment protein

B capsid

0 2 . 2 Describe how HIV is replicated.

[4 marks]

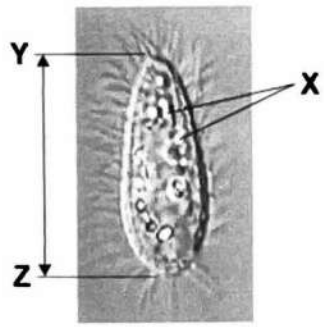
Attachment protein on the surface of HIV helps the virus to attach to receptors on a helper T cell. Once attached genetic material is injected into cell in the form of RNA. This RNA gets converted to DNA using an enzyme called reverse transcriptase. This DNA can then be expressed by the cell as viral proteins, such as enzymes. Different components of the virus are produced by the cell and assembled. Once virus is complete it gets released from the cell to infect other cells.

6

Do not write outside the box

0 3 *Uronema marinum* is a single-celled eukaryotic organism. **Figure 3** is a photograph of *U. marinum* taken through an optical microscope.

Figure 3



0 3 . 1 Explain why it is not possible to determine the identity of the structures labelled **X** using an optical microscope.

[2 marks]

The resolution of the image is too low. This is as light microscope uses light which has a wavelength to long to be able to be used to distinguish 2 structures from each other.

0 3 . 2 *U. marinum* cells ingest bacteria and digest them in the cytoplasm.

Describe the role of **one** named organelle in digesting these bacteria.

[3 marks]

The lysosome is a component that contains hydrolytic enzymes. Once the cell phagocytes the bacteria the lysosome fuses with the vesicle containing the bacteria. The enzymes then break down the bacteria, digesting it.

Do not write outside the box

0 3 . 3 Calculate the actual length of the cell shown between **Y** and **Z** in **Figure 3**.

The magnification of the image is × 900

Give your answer in µm **and** to **2** significant figures.

Show your working. $\text{Actual} = \frac{\text{Image}}{\text{Magnification}}$ **[2 marks]**

Y → Z = 2.9 cm = 29 mm = 29000 µm

$A = \frac{29000\,\mu m}{900} = 32.2\ldots\,\mu m$

2sf ⇒ 32 µm

Answer 32 µm

0 3 . 4 In large cells of *U. marinum*, most mitochondria are found close to the cell-surface membrane. In smaller cells, the mitochondria are distributed evenly throughout the cytoplasm. Mitochondria use oxygen during aerobic respiration.

Use this information and your knowledge of surface area to volume ratios to suggest an explanation for the position of mitochondria in **large** *U. marinum* cells.

[2 marks]

Larger cells have smaller surface area to volume ratio taking oxygen longer to diffuse to central parts. So, by having the mitochondria close to the surface the diffusion pathway is reduced, so enough oxygen can reach it for what it needs in respiration.

9

Turn over for the next question

Do not write outside the box

0 4 This question is about mitosis in cells.

Figure 4 shows the arrangement of the genetic material in a cell during prophase.

Figure 4

0 4 . 1 Describe and explain the arrangement of the genetic material shown in **Figure 4**.

[2 marks]

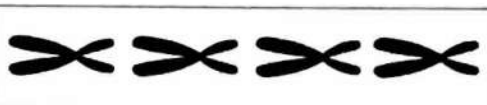
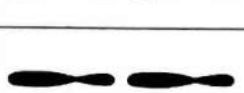
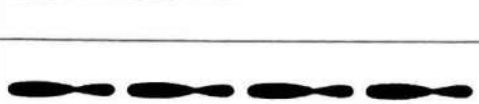
Chromosomes are visible as they are condensing to get ready for replication.

Do not write outside the box

0 4 . 2 The diploid number of chromosomes in the body cell of an insect species is four.

Tick (✓) the box next to the diagram **A**, **B**, **C** or **D** that represents the appearance of chromosomes in a cell during metaphase in this species.

[1 mark]

A		✓
B		
C		
D		

In metaphase chromatomes are not pulled apart yet.

0 4 . 3 Name the fixed position occupied by a gene on a DNA molecule.

[1 mark]

Loci

0 4 . 4 Describe how a gene is a code for the production of a polypeptide. Do **not** include information about transcription or translation in your answer.

[3 marks]

gene is coded by a sequence of base pairs. This sequence contains information on ~~how to~~ what sequence to join amino acids in. The nucleotide sequence is red in triplets and each triplet is converted into an amino acid in the polypeptide chain.

7

0 5 . 1 Describe how the structure of glycogen is related to its function.

[4 marks]

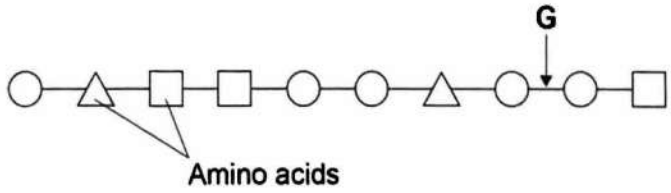
Glycogen is a polymer of glucose, so glucose molecules can easily be taken off through hydrolysing bonds in glycogen. As it is highly branced it can be hydrolysed much faster as more ends are exposed for it.

Its a large insoluable molecule so cant be lost from the cell easily and does not affect its water potential.

It is highly compact so lots of glucose can be stored in a small space.

Figure 5 shows the primary structure of part of a polypeptide. Each shape represents an amino acid. Identical amino acids have the same shape.

Figure 5



0 5 . 2 Name the type of peptidase which will hydrolyse the bond labelled **G** in **Figure 5**.

[1 mark]

endopeptidase

0 5 . 3 Give the number of different **R** groups in the polypeptide shown in **Figure 5**.

[1 mark]

3 (3 different amino acids as 3 different shapes, each amino acid has a different R group)

Do not write outside the box

A scientist used an enzyme to digest a polypeptide containing 101 amino acids. The digestion produced a range of smaller polypeptides.

The scientist determined the number of amino acids in each of the polypeptides produced. He also counted the number of polypeptides of each length.

Table 1 shows some of the scientist's results.

Table 1

Number of amino acids in polypeptide	Number of polypeptides of each length
5	2
6	
15	3
20	

10 AAs

15 AAs

0 5 . 4 Use the information in **Table 1** to calculate the number of polypeptides:

[2 marks]

101 - 10 - 45 = 46 → 2 × 20 / 1 × 6

6 amino acids in length 1

20 amino acids in length 2

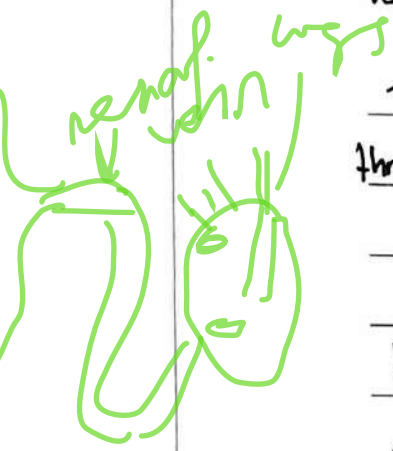
8

Turn over for the next question

0 6 . 1 Give the pathway a red blood cell takes when travelling in the human circulatory system from a kidney to the lungs.

Do **not** include descriptions of pressure changes in the heart or the role of heart valves in your answer.

[3 marks]



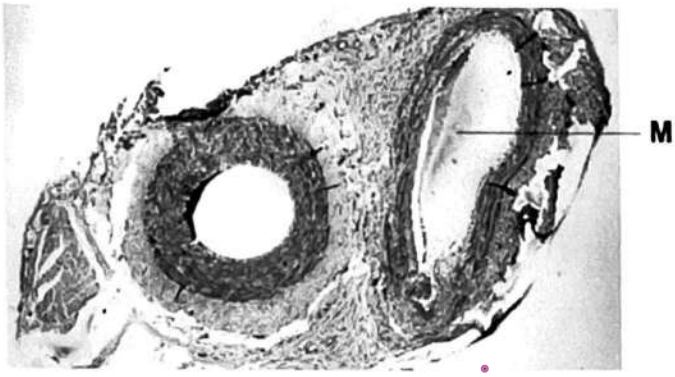
From the kidney the red blood cell travels away through the renal vein. ~~back toward the heart~~ It flows into the inferior vena cava that travels back to the right side of the heart. It enters the heart into the right atrium, from which its pushed over into the right ventricle. The ~~right~~ ~~out~~ heart pumps blood from there to the pulmonary artery which takes blood from the heart to the ~~lungs~~ lungs.

Do not write outside the box

Do not write outside the box

Figure 6 shows a section through two types of blood vessels observed using an optical microscope.

Figure 6



0 6 . 2 Identify the type of blood vessel labelled **M** in **Figure 6**.

Explain your answer.

[2 marks]

Type of blood vessel Vein

Explanation Has a wide lumen with thin walls so blood travels through it at low pressure.

Question 6 continues on the next page

0 6 . 3 Tissue fluid is formed from blood at the arteriole end of a capillary bed.

Explain how water from tissue fluid is returned to the circulatory system.

[4 marks]

When tissue fluid is forced out of the blood vessle, certain proteins remain in the blood that are to big to leave. These create a negative water potential in relation to tissue fluid. This causes water to move back into the blood vessle through osmosis.

Any water that is not reabsorbed by osmosis is collected by the lymphatic system and returned to the blood.

9

0 7

A meadow is an area of grassland with a wide range of plant and animal species. A student investigated whether cutting some of the plants in a meadow had any effect on the biodiversity of insects in that meadow.

The student created two sample areas, called plots, in the meadow. Each plot measured 10 m × 5 m

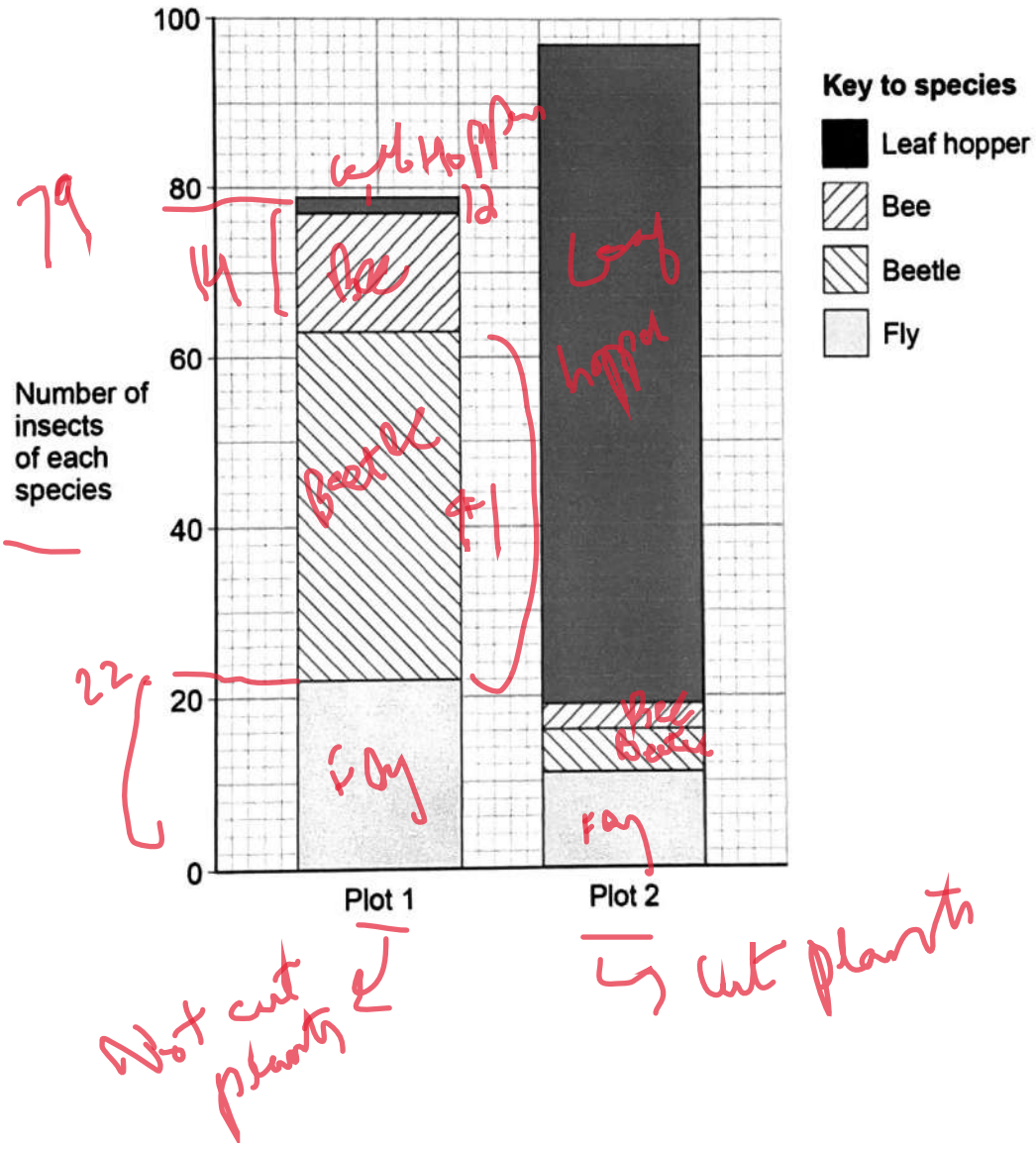
The student:

- did not cut plants in **plot 1**
- cut the plants in **plot 2** with a lawn mower once a week.

After 10 weeks, the student captured all of the organisms of four insect species found in each of these plots.

Figure 7 shows the student's results.

Figure 7



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0 7 . 1 Use the information in **Figure 7** to calculate the index of diversity for the insects captured in **plot 1**.

The formula to calculate the index of diversity (d) is

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

where N is the total number of insects of all species and n is the total number of insects of each species.

Give the answer to **2** significant figures and show your working.

[2 marks]

plot 1 → 79 insects in total → $N(N-1) = 79 \times (79-1) = 6162$ ✓

22 - fly → $n(n-1) = 22(22-1) = 22 \times 21 = 462$ ✓

41 - beetle → 1640 ✓

14 - bee → 182 ✓

2 - leaf hopper → 2 ✓

$\Sigma n(n-1) = 462 + 1640 + 182 + 2 = 2286$

$d = \frac{6162}{2286} = 2.695\ldots$

$\Rightarrow 2.7$

d 2.7 ✓

0 7 . 2 The student concluded that cutting plants with a lawn mower increased the species richness of insects in that meadow.

Use information in **Figure 7** to explain why the student's conclusion is incorrect.

[1 mark]

The number of species is still 4 (leaf hopper, bee, beetle, fly) after cutting. Only the number of individuals change.

Question 7 continues on the next page

Do not writ outside the box

0 7 . 3 The student wanted to use the data from **plot 1** to estimate the total number of the beetle species in the meadow.

Suggest how the student should use the data from **plot 1** and other information provided to estimate the total number of the beetle species in the meadow.

[4 marks]

They first have to calculate the area of the plot. This is 10m by 5m so $50m^2$. Then he has to calculate the total area of the whole meadow. They then can calculate how many times would the plot fit onto the area of the meddow. So divide the area of the meddow by the area of the plot. Use this number then to multiply it by 41, as this is the number of beetles you would expect to find in each area, the size of a plot.

7

0 8 An unfertilised chicken egg is a single cell surrounded by a shell.

A student investigated osmosis in chicken eggs. She dissolved the shells of two eggs without damaging the cell contained inside the shells. She then:

- measured the mass of each egg without its shell
- covered one egg with vinegar and covered the other egg with a sugar solution
- kept both eggs covered at 30 °C for 24 hours.

After 24 hours, she measured the mass of each egg.

The student designed **Table 2** and added her results to this table.

Table 2

Initial mass of egg / g	Final mass of egg / g	Name of solution covering egg	Ratio of final mass to initial mass
66	85	Vinegar	1.29:1
60	43	Sugar	0.7:1

0 8 . 1 Suggest **one** improvement to the design of **Table 2** and **one** improvement to the way she presented the data contained in **Table 2**.

[2 marks]

Improvement to design of table Have the name of the solution in the first column as this is the independent variable.

Improvement to presentation of data She used different number of decimal places to in the ratios, she should use the same number of decimal places for both.

1.3 Not OR 0.72 Not

Do not write outside the box

0 8 . 2 Suggest and explain an advantage of carrying out this investigation at 30 °C rather than at 20 °C.

[2 marks]

At a warmer temperature particles will have more kinetic energy, so their movement will be faster. As osmosis is taking place the change in mass would be noticable quicker.

0 8 . 3 The student concluded from the information in **Table 2** that the water potential of the solution inside the egg is higher than the water potential of the vinegar.

Is the student's conclusion correct? Justify your answer.

[3 marks]

No, the eggs end mass higher than its initial mass. This suggest water has moved into the egg by osmosis not out of it. Therefore, the water potential of the egg must be lower than the vinegar.

Question 8 continues on the next page.

Do not write outside the box

0 8 . 4 The student wanted to determine the water potential of chicken eggs. She:

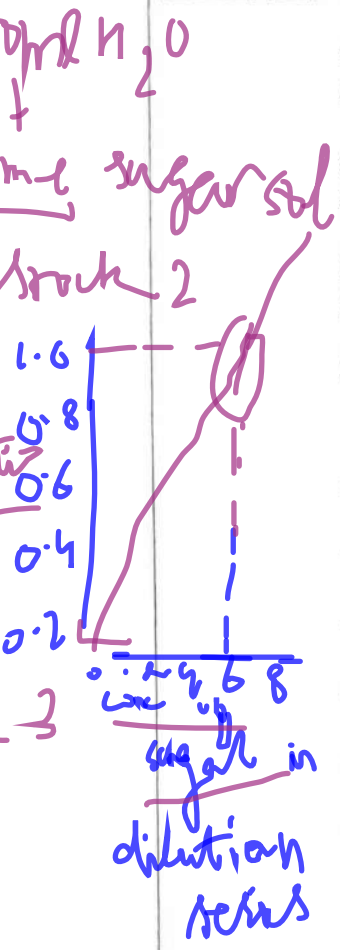
- produced a dilution series of sugar solution
- followed the procedure described on **page 20.**

She calculated the final mass to initial mass ratio of the egg covered in each sugar solution.

How would you advise the student to use her calculated ratios to determine the water potential of the eggs?

In your answer state the independent variable in the student's investigation.

[4 marks]



The independent variable is the concentration of the sugar solution, as this is what she is changing to see a change in her results.

She should plot a calibration curve of her results. She can then use this curve to interpolate from when the ratio is 1, she can from that read off a value for the concentration and convert that concentration into water potential.

Ratio = 1 with the potential of eggs

11

Do not write outside the box

0 9 Read the following passage.

Kidney cells produce a glycoprotein hormone called erythropoietin (EPO). An EPO molecule contains 165 amino acids and approximately 50% of its mass is carbohydrate.

EPO is transported in the blood and stimulates the bone marrow to produce red blood cells. In this way, enough red blood cells are produced to maintain the blood's oxygen-carrying capacity.

Some athletes choose to increase their blood EPO concentration by injecting synthetic EPO. This practice is called blood boosting and is banned in sport as a form of drug abuse. Athletics' authorities use a programme of drug testing to detect athletes who have injected EPO. In this programme, an ELISA test is performed on urine samples to measure the concentration of EPO in the athlete.

Two types of monoclonal antibody are used in this ELISA test:

- anti-human EPO antibody, prepared by injecting human EPO into mice
- anti-mouse antibody, prepared by injecting anti-human EPO antibody into goats. An enzyme is attached to the anti-mouse antibody.

Use the information in the passage and your own knowledge to answer the following questions.

0 9 . 1 Kidney cells produce a glycoprotein called erythropoietin (EPO) (line 1).

Identify **two** organelles in kidney cells that enable the production of EPO.

[1 mark]

1 Rough endoplasmic reticulum

2 Golgi apparatus

0 9 . 2 Explain the biological advantage to athletes of injecting synthetic EPO (lines 7–8).

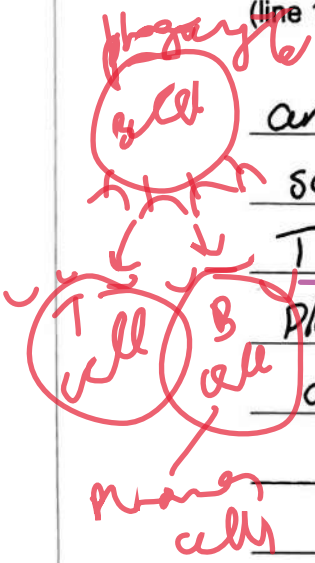
[2 marks]

By injecting EPO there will be a boost in their red blood cell numbers. Red blood cells carry oxygen, so more blood cells can carry more oxygen to cells. This allows athletes to respire aerobically longer when exercising, hence producing more ATP and less lactic acid, fatiguing later.

Do not write outside the box

0 9 . 3 Describe how mice injected with human EPO produce anti-human EPO antibody (line 14).

[3 marks]



antigens from the human EPO get displayed on the surface of phagocytes / B cells. This causes helper T cells to stimulate B cells to divide rapidly. Plasma cells then produce ~~for~~ antibodies that are specific to human EPO.

anti-human EPO antibody

0 9 . 4 Describe the roles of anti-human EPO antibody and anti-mouse antibody with enzyme attached (lines 14–16) in producing a positive result for EPO in the ELISA test.

[3 marks]

Role of anti-human EPO antibody This attaches to the EPO (the antigen on the surface of the EPO) to show its presence.

Role of anti-mouse antibody with enzyme attached This attaches to the anti human antibody. This has an enzyme attached which catalyses a reaction causing the colour change if non human EPO is present.

mouse antigen

0 9 . 5 Some people object to using monoclonal antibodies in testing programmes. Use information in the passage to suggest why.

[1 mark]

Ethical issues due to welfare of animals like: ~~egg~~ mice / goats used in the production of these antibodies.

10

END OF QUESTIONS