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Surname

StemUp Model Solution

Forename(s)

Candidate signature

I declare this is my own work.

# A-level BIOLOGY

## Paper 1

Thursday 10 June 2021

Afternoon

Time allowed: 2 hours

### 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.

### Information

- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 91.

#### For Examiner's Use

| Question     | Mark |
|--------------|------|
| 1            |      |
| 2            |      |
| 3            |      |
| 4            |      |
| 5            |      |
| 6            |      |
| 7            |      |
| 8            |      |
| 9            |      |
| 10           |      |
| <b>TOTAL</b> |      |



J U N 2 1 7 4 0 2 1 0 1

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

0 1 . 1

Describe the induced-fit model of enzyme action **and** how an enzyme acts as a catalyst.

[3 marks]

*In the induced-fit model, the substrate binds to the active site of the enzyme, forming an enzyme-substrate complex.*

*As the substrate binds, the active site changes shape slightly so that it becomes complementary to the substrate. This puts strain on the substrate, distorting and breaking (or forming) bonds in it.*

*The enzyme acts as a catalyst because this lowers the activation energy needed for the reaction.*

0 1 . 2

Scientists investigated the action of the enzyme ATP synthase. They made reaction mixtures each containing:

- ATP synthase
- buffer (to control pH)
- substrates.

One of the substrates required in these reaction mixtures is inorganic phosphate (Pi).

Tick (✓) **one** box to show which other substrate the scientists must add to the reaction mixtures to produce ATP.

[1 mark]

Adenine

☐

Adenosine diphosphate

☒

Glucose

☐

Ribose

☐

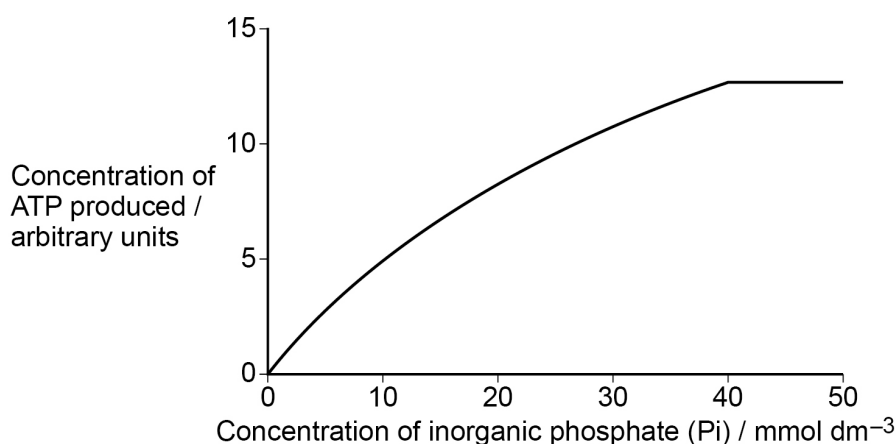

0 1 . 3

The scientists investigated the effect of concentration of inorganic phosphate (Pi) on ATP synthase activity.

After 2 minutes, they stopped each reaction and then measured the concentration of ATP.

Figure 1 shows the scientists' results.

Figure 1



Suggest and explain a procedure the scientists could have used to stop each reaction. **[2 marks]**

*Boil each reaction mixture (heat above 50 °C), or add a strong acid or alkali.*

*This denatures the ATP synthase, so its active site changes shape and no more enzyme-substrate complexes can form.*

0 1 . 4

Explain the change in ATP concentration with increasing inorganic phosphate concentration. **[2 marks]**

*As the Pi concentration increases up to 40 mmol dm<sup>-3</sup>, more enzyme-substrate complexes form, so more ATP is produced.*

*At and above 40 mmol dm<sup>-3</sup> the ATP concentration levels off because all the active sites are occupied, so the enzyme concentration is the limiting factor.*



0 2 . 1

Explain the advantage for larger animals of having a specialised system that facilitates oxygen uptake.

[2 marks]

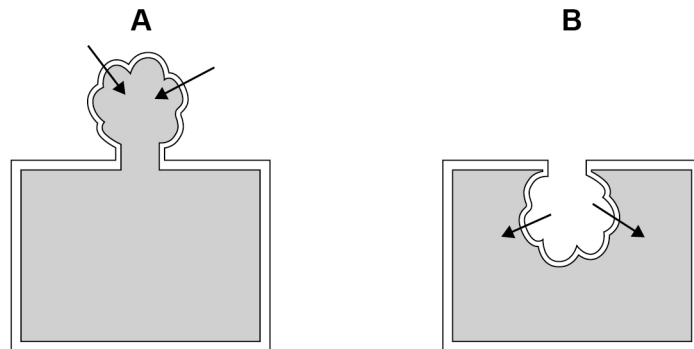
*Larger animals have a smaller surface area to volume ratio, so diffusion across the body surface alone could not supply enough oxygen.*

*A specialised gas exchange system overcomes the long diffusion pathway, giving a large surface area and short diffusion distance so oxygen diffuses in faster (and more is taken up).*



**Figure 2** shows two models of oxygen uptake found in animals.

**Figure 2**



Oxygen uptake through system developed to the outside of the body, eg fish gills

Oxygen uptake through system developed to the inside of the body, eg human lungs

0 2 . 2

Suggest how the environmental conditions have resulted in adaptations of systems using **Model A** rather than **Model B**.

**[2 marks]**

*Water has a lower concentration (partial pressure) of oxygen than air, so a system on the outside of the body, like gills, gives a large surface area in contact with the water and a short diffusion distance between the water and the blood.*

*Water is also denser than air, so the water supports the gills and they do not collapse.*

**Question 2 continues on the next page**

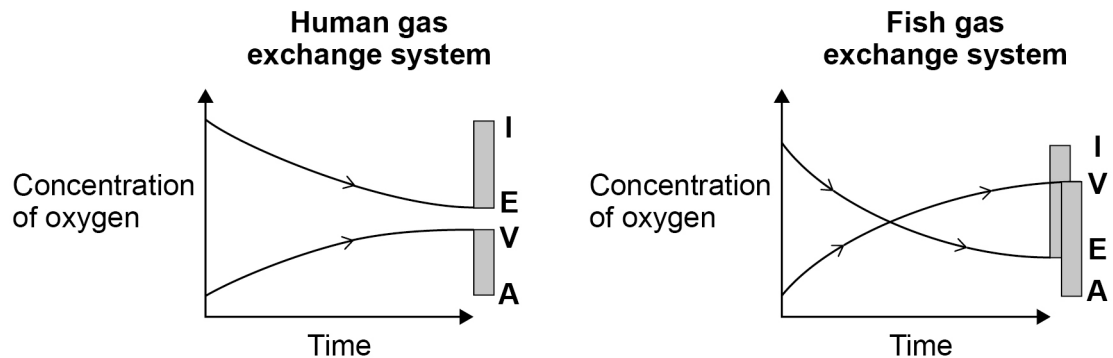
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0 2 . 3

**Figure 3** shows changes in concentration of oxygen in two gas exchange systems.

**Figure 3**



**Key**

- I Air/water entering the gas exchange system
- E Air/water leaving the gas exchange system
- A Arterial blood entering the gas exchange system
- V Venous blood leaving the gas exchange system

A student studied **Figure 3** and concluded that the fish gas exchange system is more efficient than the human gas exchange system.

Use **Figure 3** to justify this conclusion.

**[2 marks]**

*In fish, blood leaving (V) has more oxygen than water leaving (E), but in humans blood leaving (V) has less oxygen than air leaving (E).*

*The difference in oxygen between A and V is greater in fish, so fish remove a greater proportion of the oxygen they take in.*

0 2 . 4

Explain how the counter-current principle allows efficient oxygen uptake in the fish gas exchange system.

**[2 marks]**

*Blood in the lamellae and water flow over the gills in opposite directions.*

*So the blood always meets water with a higher oxygen concentration, which maintains a diffusion (concentration) gradient for oxygen along the whole length of the lamella / gill filament.*



**0 2 . 5** Table 1 shows features of two mammals.

Bats are flying mammals; shrews are ground-living mammals.

**Table 1**

| Mammal | Mean body mass / kg | Mean lung volume / cm <sup>3</sup> |
|--------|---------------------|------------------------------------|
| Bat    | 0.096               | 12.48                              |
| Shrew  | 0.024               | 0.72                               |

Calculate how many times the lung volume per unit of body mass of the bat is greater than that of the shrew.

Give your answer to an appropriate number of significant figures.

Give **one** suggestion to explain this difference.

**[3 marks]**

$$\text{Bat: } 12.48 \div 0.096 = 130 \text{ cm}^3 \text{ kg}^{-1}$$

$$\text{Shrew: } 0.72 \div 0.024 = 30 \text{ cm}^3 \text{ kg}^{-1}$$

$$130 \div 30 = 4.333...$$

$$= 4.3 \text{ times greater (2 s.f.)}$$

Answer 4.3

Explanation Bats fly, which needs a lot of energy, so they need more oxygen for (aerobic) respiration.

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0 3 . 1

Describe how **one** amino acid is added to a polypeptide that is being formed at a ribosome during translation.

[3 marks]

*A tRNA molecule brings a specific amino acid to the ribosome.*

*The anticodon on the tRNA binds to the complementary codon on the mRNA by complementary base pairing.*

*The amino acid is then joined to the adjacent amino acid on the growing polypeptide by a condensation reaction, forming a peptide bond (using ATP). The ribosome then moves along to the next codon.*

**Question 3 continues on the next page**

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**Table 2** shows:

- mRNA codons and the amino acid coded for by each codon
- the type of bond formed by the R group of some of the amino acids.

**Table 2**

| First base | Second base |     |      |             | Third base  |
|------------|-------------|-----|------|-------------|-------------|
|            | U           | C   | A    | G           |             |
| U          | Phe         | Ser | Tyr  | Cys         | U           |
|            | Leu         |     | Stop | Stop<br>Trp | C<br>A<br>G |
| C          | Leu         | Pro | His  | Arg         | U           |
|            |             |     | Gln  |             | C<br>A<br>G |
| A          | Ile         | Thr | Asn  | Ser         | U           |
|            | Met         |     | Lys  | Arg         | C<br>A<br>G |
| G          | Val         | Ala | Asp  | Gly         | U           |
|            |             |     | Glu  |             | C<br>A<br>G |

**Key** to the type of bond formed by the R group of each amino acid

☐ Hydrogen bonds   
 ☐ Ionic bonds   
 ☐ Disulfide bridges

0 3 . 2

Crystallin is a structural protein found in the human eye. An inherited disease that leads to blindness is caused by changes in properties of crystallin. The replacement of the amino acid Arg with the amino acid Gly causes these changes.

Use information in **Table 2** to suggest why this amino acid replacement changes the properties of crystallin.

**[2 marks]**

*Arg has an R group that forms ionic bonds, whereas Gly has an R group that forms hydrogen bonds, so hydrogen bonds form instead of ionic bonds.*

*This changes the tertiary structure (3D shape) of the crystallin protein, so its properties change.*



0 3 . 3

The amino acid replacement of Arg with Gly is caused by a single base substitution mutation in the DNA. The non-mutant DNA triplet is TCC.

Complete **Table 3**.

Give:

- the mRNA codon complementary to the non-mutant DNA triplet
- the mutated mRNA codon that could cause the change from Arg to Gly in the crystallin protein
- the DNA triplet complementary to this mutated mRNA codon.

[2 marks]

**Table 3**

|                                       |     |
|---------------------------------------|-----|
| mRNA codon for the non-mutant triplet | AGG |
| Mutated mRNA codon                    | GGG |
| Mutated DNA triplet                   | CCC |

---

 7

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|---|---|
| 0 | 4 |
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A student dissected an organ from a mammal to observe blood vessels.

He dissected a slice of the organ and identified two blood vessels.

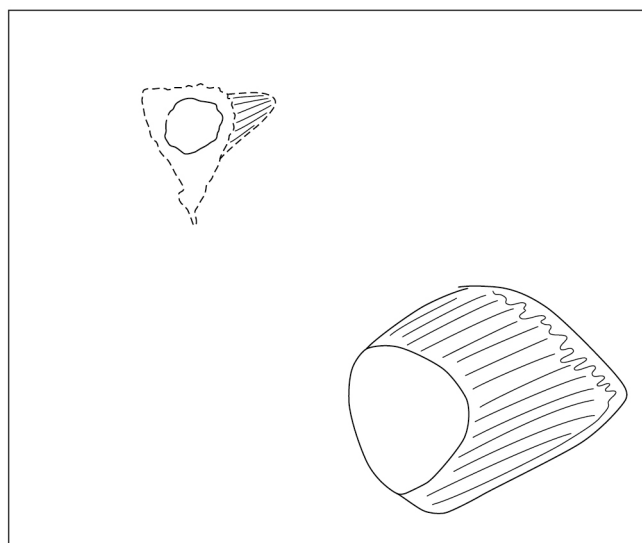
**Figure 4** shows a photograph of his dissection.

**Figure 4**



**Figure 5** shows a drawing of the blood vessels from his dissection.

**Figure 5**



0 4 . 1

Suggest **two** ways the student could improve the quality of his scientific drawing of the blood vessels in this dissection.

[2 marks]

1 *Only use single, continuous lines and do not use sketching or shading / hatching.*

2 *Add labels and a title, and a scale bar / magnification.*

0 4 . 2

Identify the type of blood vessel labelled as **X** and the type of blood vessel labelled as **Y** in **Figure 4**.

Describe **one** feature that allowed you to identify the blood vessels.

[2 marks]

Blood vessel **X** *Artery*

Blood vessel **Y** *Vein*

Feature *X has a thicker wall and a smaller lumen than Y.*

0 4 . 3

Describe **two** precautions the student should take when clearing away after the dissection.

[2 marks]

1 *Carry and wash the scalpel holding the handle, pointing the blade down / away from the body.*

2 *Disinfect the instruments, surfaces and hands, and put the organ and gloves in a separate bin to dispose of.*

6

Turn over ►



0 5 . 1

Describe how a sample of chloroplasts could be isolated from leaves.

**[4 marks]**

*Cut up the leaves and grind / blend them in a cold, buffered solution with the same water potential as the leaf cells (isotonic).*

*The cold reduces enzyme activity so the organelles are not digested, the buffer controls the pH so proteins do not denature, and the same water potential stops the chloroplasts bursting or shrinking by osmosis.*

*Filter the homogenate to remove large cell debris.*

*Centrifuge the filtrate at a low speed so that the nuclei and cell debris settle out as a pellet, and remove them.*

*Then centrifuge the supernatant at a higher speed so that the chloroplasts settle out as the pellet.*



0 5 . 2

Scientists grew two groups of plants:

- control plants with all the inorganic ions needed
- iron-deficient plants with all the inorganic ions needed **but** without iron ions.

After 1 week, the scientists measured the mass of protein and the mass of chlorophyll in the chloroplasts isolated from samples of leaves of these two groups of plants.

**Table 4** shows the scientists' results.

**Table 4**

| Mass of protein / percentage of control | Mass of chlorophyll / percentage of control |
|-----------------------------------------|---------------------------------------------|
| 40                                      | 10                                          |

Some proteins found inside the chloroplast are synthesised inside the chloroplast.

Give **one** feature of the chloroplast that allows protein to be synthesised inside the chloroplast **and** describe **one** difference between this feature in the chloroplast and similar features in the rest of the cell.

[2 marks]

Feature Ribosomes

Structural difference Chloroplast ribosomes are smaller (70S) than the ribosomes in the cytoplasm (80S).

0 5 . 3

The ratio of protein to chlorophyll in control plants is 9:1

Use the information in **Table 4** to calculate the ratio of protein to chlorophyll in iron-deficient plants.

[1 mark]

$$\text{Protein: } 9 \times 0.40 = 3.6$$

$$\text{Chlorophyll: } 1 \times 0.10 = 0.1$$

$$3.6 : 0.1 = 36 : 1$$

Ratio 36 : 1

**Question 5 continues on the next page**

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0 5 . 4

The scientists also observed the chloroplasts from the samples of leaves using an electron microscope.

**Figure 6** shows a chloroplast from a control plant (image **A**) and a chloroplast from an iron-deficient plant (image **B**).

**Figure 6**

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Use **Figure 6** to suggest why iron-deficient plants have a reduced growth rate.

**[3 marks]**

*The chloroplast from the iron-deficient plant (image B) has less thylakoid membrane, with fewer and smaller grana.*

*This gives a smaller surface area of membrane for chlorophyll, so there is less chlorophyll and less light is absorbed.*

*So less ATP and reduced NADP are made in the light-dependent reaction, the rate of photosynthesis is slower, and less sugar is made for growth.*

10



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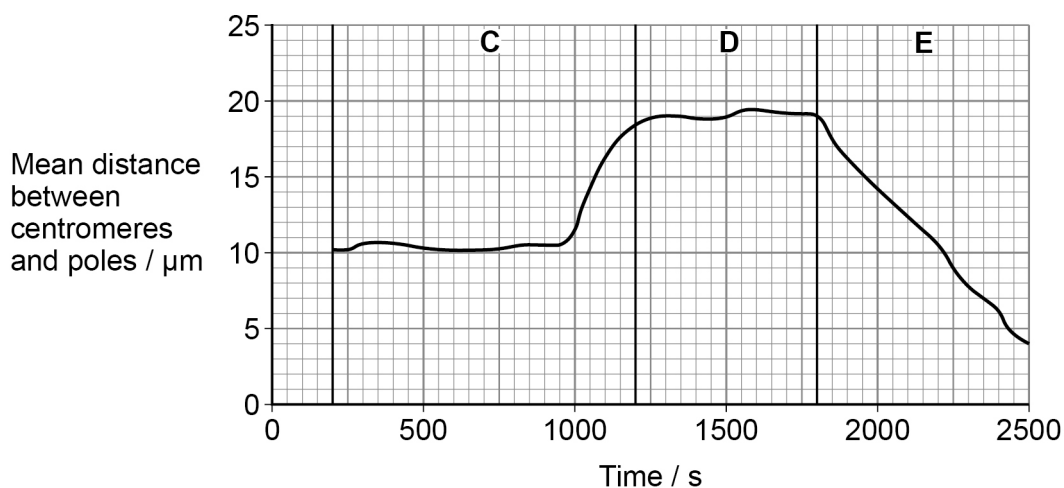
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0 6 . 1

**Figure 7** shows the mean distance between centromeres and the poles (ends) of the spindle during mitosis.

**Figure 7**



Calculate the rate of movement of the centromeres during phase **E**.

Give your answer in  $\mu\text{m minute}^{-1}$  **and** to 3 decimal places.

**[2 marks]**

*Phase E: 1800 s to 2500 s = 700 s*

*Distance: 19  $\mu\text{m}$  to 4  $\mu\text{m}$  = 15  $\mu\text{m}$*

*$15 \div 700 = 0.02142857 \mu\text{m s}^{-1}$*

*$\times 60 = 1.2857 \mu\text{m minute}^{-1}$*

1.286

$\mu\text{m minute}^{-1}$



0 6 . 2

Name the three phases of mitosis shown by **C**, **D** and **E** on **Figure 7**.

Describe the role of the spindle fibres and the behaviour of the chromosomes during each of these phases.

**[5 marks]****C** *Prophase***D** *Metaphase***E** *Anaphase**C, prophase: the chromosomes condense (shorten and thicken) and become visible as two sister chromatids joined at the centromere.**Spindle fibres form and the centromeres attach to the spindle fibres.**D, metaphase: the chromosomes (pairs of chromatids) line up at the equator of the spindle, attached by their centromeres to the spindle fibres.**E, anaphase: the centromeres divide and the spindle fibres shorten (contract), pulling the chromatids from each pair to opposite poles of the cell, so the distance to the poles falls.*

7

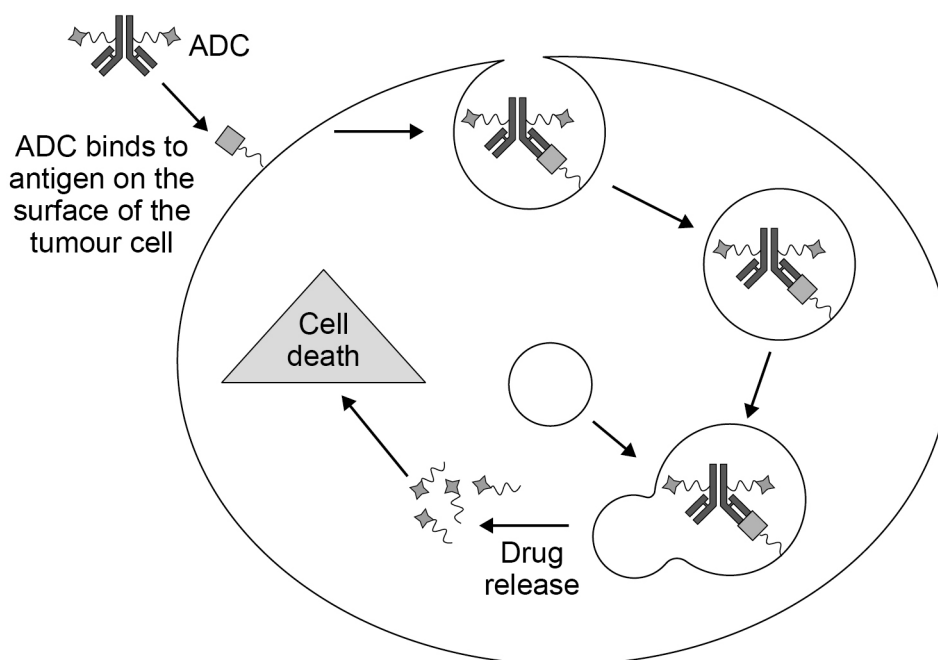
**Turn over for the next question****Turn over ►**

**0 7 . 1** ADCs are molecules made of a monoclonal antibody linked to a cancer drug.

**Figure 8** shows how an ADC enters and kills a tumour cell.

The process of entering the cell and the breakdown of the antibody to release the drug is very similar to phagocytosis.

**Figure 8**



Use your knowledge of phagocytosis to describe how an ADC enters and kills the tumour cell.

**[3 marks]**

*The antibody of the ADC binds to a complementary antigen on the tumour cell surface membrane.*

*The cell membrane surrounds the ADC and engulfs it by endocytosis, forming a vesicle (like a phagosome) inside the cell.*

*Lysosomes fuse with the vesicle and release lysozymes (hydrolytic enzymes), which digest / break down the antibody to release the drug, which then kills the tumour cell.*



07.2

Some of the antigens found on the surface of tumour cells are also found on the surface of healthy human cells.

Use this information to explain why treatment with an ADC often causes side effects.

**[2 marks]**

*The antibody in the ADC is complementary to the antigen, so the ADC will also bind to healthy (non-tumour) cells that have this antigen.*

*The drug is then released inside these healthy cells, causing damage to or death of healthy cells, which can damage other organs.*

**Question 7 continues on the next page**

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Scientists investigated whether one type of ADC could be used to treat human breast cancer.

This ADC is a monoclonal antibody combined with a drug to inhibit mitosis. The monoclonal antibody binds to a protein found on human breast cancer cells.

The scientists placed small pieces of human breast cancer tissue under the skin of mice.

The scientists then randomly divided the mice into three groups. They treated the groups as follows on day 0.

**Group G** – control

**Group H** – injected with monoclonal antibody only

**Group J** – injected with ADC (monoclonal antibody + drug).

Every few days, the scientists measured the volume of the tumours formed from the human breast cancer tissue.

**Figure 9** shows the scientists' results.

**Figure 9**

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0 7 . 3

Mice in **Group H** were injected with  $2 \text{ mg kg}^{-1}$  of monoclonal antibody. The monoclonal antibody was in a solution of concentration  $500 \text{ mg dm}^{-3}$

Calculate the volume of antibody solution that the scientists would have injected into a 23 g mouse. Give your answer in  $\text{dm}^3$  and in standard form.

[2 marks]

$$\text{Mass} = 2 \text{ mg kg}^{-1} \times 0.023 \text{ kg} = 0.046 \text{ mg}$$

$$\text{Volume} = 0.046 \div 500 = 0.000092 \text{ dm}^3$$

$$9.2 \times 10^{-5} \text{ dm}^3$$

0 7 . 4

Suggest **one** reason why there are no data for **Group G** and **Group H** after day 8

[1 mark]

*The mice in Groups G and H died because their tumours grew so large, or it was not ethical to continue.*

0 7 . 5

Suggest and explain **two** further investigations that should be done before this ADC is tested on human breast cancer patients.

[2 marks]

- 1 *Test the ADC on other mammals, e.g. rats, to check it is safe and for side effects.*
- 2 *Test different concentrations of ADC (on healthy humans) to find a safe dosage.*

10

Turn over for the next question

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08.1

Describe how a triglyceride molecule is formed.

**[3 marks]**

*A triglyceride is formed from one glycerol molecule and three fatty acids.*

*Each fatty acid joins to glycerol by a condensation reaction, so three molecules of water are removed in total.*

*Three ester bonds are formed between the glycerol and the fatty acids.*



0 8 . 2

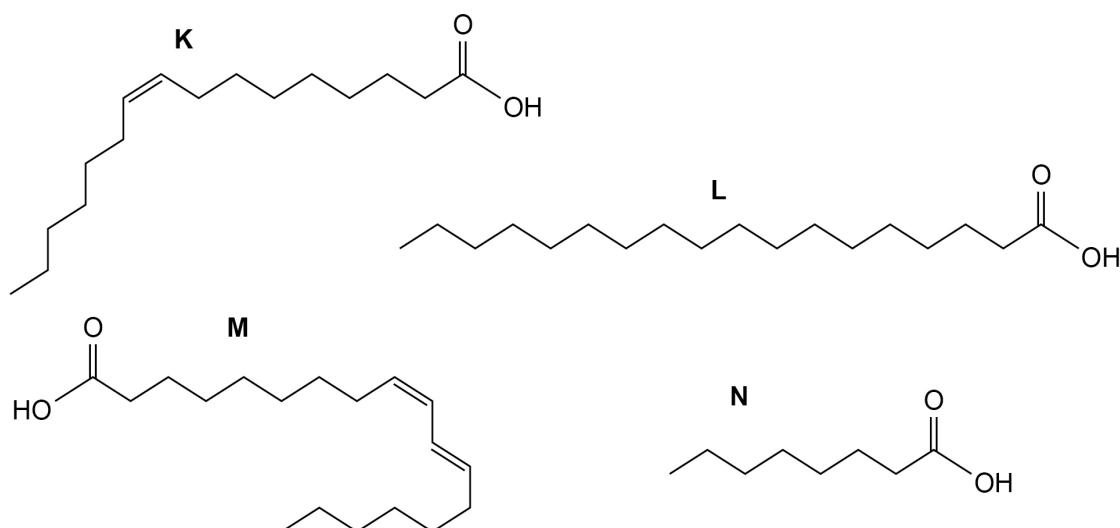
Table 5 shows some properties of four fatty acids.

Table 5

| Fatty acid       | Number of carbon atoms in the R group | Number of double bonds in the R group |
|------------------|---------------------------------------|---------------------------------------|
| Caprylic acid    | 8                                     | 0                                     |
| Palmitoleic acid | 16                                    | 1                                     |
| Stearic acid     | 18                                    | 0                                     |
| Linoleic acid    | 18                                    | 2                                     |

Figure 10 shows diagrams of these fatty acids.

Figure 10

Put a tick (✓) in **one** box that contains correct information about one of these fatty acids.

[1 mark]

Caprylic acid is an unsaturated fatty acid represented by diagram L.

☐

Linoleic acid is a saturated fatty acid represented by diagram N.

☐

Palmitoleic acid is an unsaturated fatty acid represented by diagram K.

☒

Stearic acid is a saturated fatty acid represented by diagram M.

☐

Turn over ►



The percentage of saturated fatty acids compared with unsaturated fatty acids found in lipid stores in seeds differs in different populations.

Scientists investigated two populations of the plant, *Helianthus annuus*.

The scientists grew young plants from seeds collected from each population. They placed the seeds on wet tissue paper so that the root growth was visible.

They grew seeds from each population at two temperatures:

- warm temperature of 24 °C
- cool temperature of 10 °C

After 10 days, the scientists measured the length of each root.

**Table 6** shows some of the properties of the two populations and the scientists' results.

**Table 6**

| Population | Temperature in natural environment | In the seed – Mean percentage of fatty acids that are saturated | Mean length of root after 10 days at 24 °C / mm ( $\pm 2 \times$ standard deviation) | Mean length of root after 10 days at 10 °C / mm ( $\pm 2 \times$ standard deviation) |
|------------|------------------------------------|-----------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 1          | Warm                               | 10.9                                                            | 8.2 ( $\pm 1.0$ )                                                                    | 3.1 ( $\pm 0.3$ )                                                                    |
| 2          | Cool                               | 6.1                                                             | 5.5 ( $\pm 0.9$ )                                                                    | 4.3 ( $\pm 0.2$ )                                                                    |

The mean  $\pm 2 \times$  standard deviation includes 95% of the data.

0 8 . 3

The scientists used a data logger to measure the length of the root rather than a ruler.

Suggest **one** reason why they used a data logger **and** explain why this was important in this investigation.

**[1 mark]**

*To increase accuracy (resolution), because the differences in root length are very small, and it reduces the risk of human error.*



0 8 . 4

It is known that:

- during respiration saturated fatty acids yield more energy than unsaturated fatty acids
- saturated fatty acids have higher melting points than unsaturated fatty acids
- lipases in seeds act more rapidly on liquid substrates.

Use this information and **Table 6** to show how each population is better adapted for its natural environment when compared with the other population.

**[4 marks]**

*Population 1 grew longer roots at the warm temperature (8.2 mm v 5.5 mm) and population 2 grew longer roots at the cool temperature (4.3 mm v 3.1 mm).*

*The  $\pm 2$  standard deviations do not overlap, so these differences are significant and unlikely to be due to chance.*

*Population 1 (warm) has more saturated fatty acids (10.9%), which yield more energy in respiration, so more energy is available for growth. In the warm, the high melting point does not matter as these fats are still liquid enough for lipases.*

*Population 2 (cool) has more unsaturated fatty acids, which have lower melting points, so they stay liquid at 10 °C. So lipases act more rapidly on them, releasing fatty acids for respiration and growth.*

0 8 . 5

Although these two populations are completely separate and show genetic variation, they are both called *Helianthus annuus*.

Explain why they are both given this name.

**[1 mark]**

*They are the same species, because if they mated they could produce fertile offspring. Helianthus annuus is the genus and species name.*

10

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0 9 . 1

Complete **Table 7** with ticks (✓) to show which elements are found in the following biological molecules.

[2 marks]

**Table 7**

| Biological molecules | Element |          |        |            |
|----------------------|---------|----------|--------|------------|
|                      | Carbon  | Nitrogen | Oxygen | Phosphorus |
| Galactose            | ✓       |          | ✓      |            |
| Phospholipid         | ✓       |          | ✓      | ✓          |
| RNA                  | ✓       | ✓        | ✓      | ✓          |
| Sucrose              | ✓       |          | ✓      |            |

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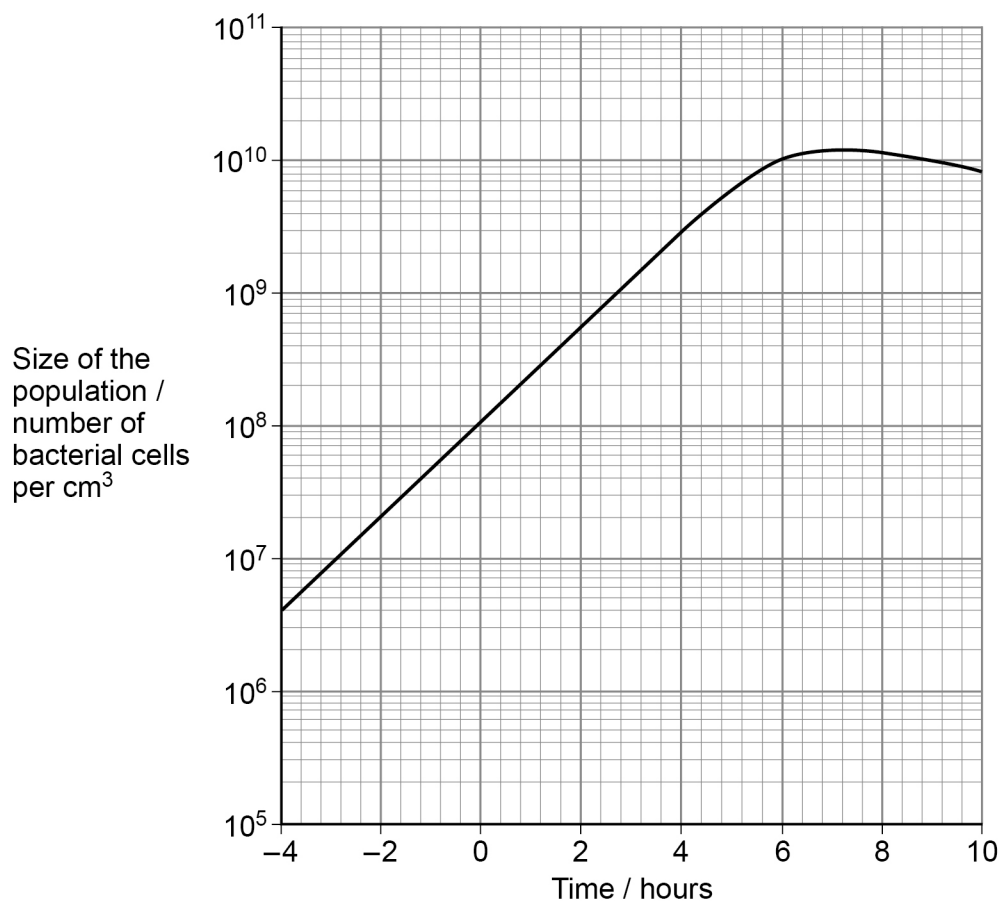
After Watson and Crick proposed the model of DNA structure, scientists investigated the possible mechanisms for DNA replication.

Two scientists grew a bacterial population, providing them with a nitrogen source containing only the heavy isotope of nitrogen,  $^{15}\text{N}$ . As soon as all the DNA in this population contained  $^{15}\text{N}$ , the scientists changed the nitrogen source to one containing only the lighter isotope of nitrogen,  $^{14}\text{N}$ . They changed the nitrogen source at 0 hours.

During the investigation, the scientists measured the size of the population of bacterial cells.

**Figure 11** shows the scientists' results.

**Figure 11**



09.2

The generation time for a population of bacteria is the time taken for all the bacteria to divide once by binary fission.

Use **Figure 11** and the following equation to calculate the generation time for this population of bacteria. Give your answer in hours.

[2 marks]

$$\text{Number of generations} = \frac{\log_{10} \left( \frac{\text{size of population at time +4 hours}}{\text{size of population at time -4 hours}} \right)}{\log_{10} 2}$$

$$\text{At +4 hours} = 3 \times 10^9; \text{ at -4 hours} = 4 \times 10^6$$

$$\text{Generations} = \log_{10}(3 \times 10^9 \div 4 \times 10^6) \div \log_{10} 2$$

$$= \log_{10}(750) \div 0.301 = 9.55 \text{ generations in 8 hours}$$

$$\text{Generation time} = 8 \div 9.55 = 0.838 \text{ hours}$$

Generation time 0.84 hours

**Question 9 continues on the next page**

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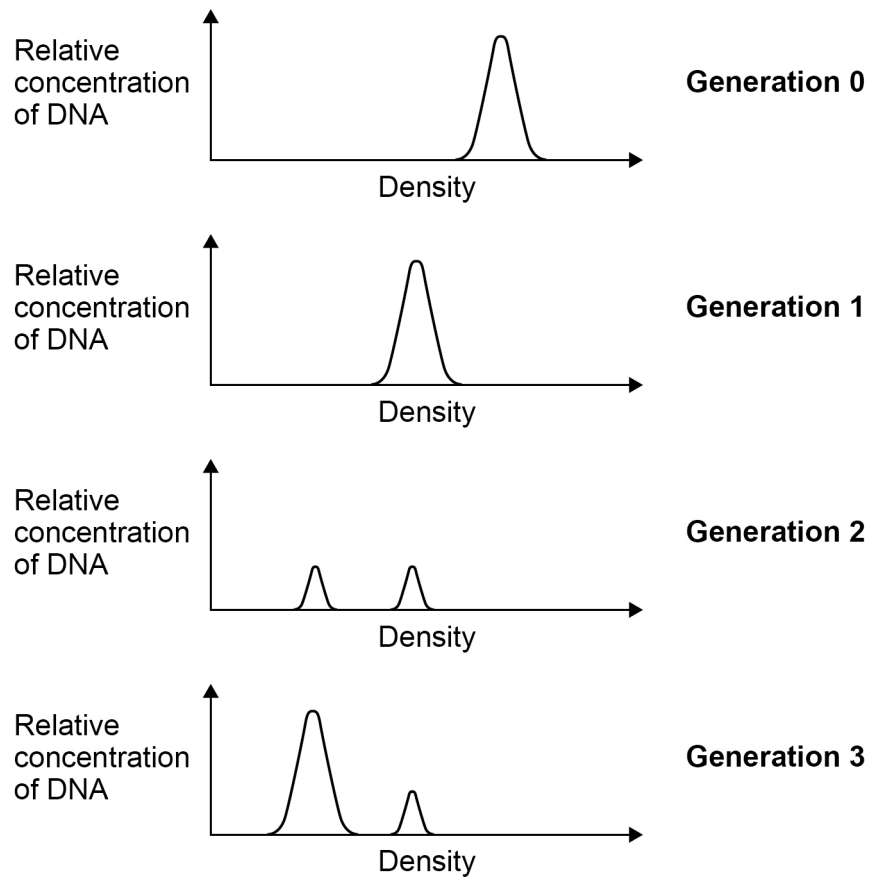


At intervals during this investigation, the scientists removed samples of the bacterial population, isolated the DNA and measured the density of the DNA.

DNA made using  $^{15}\text{N}$  has a higher density than DNA made using  $^{14}\text{N}$ .

**Figure 12** shows the scientists' results.

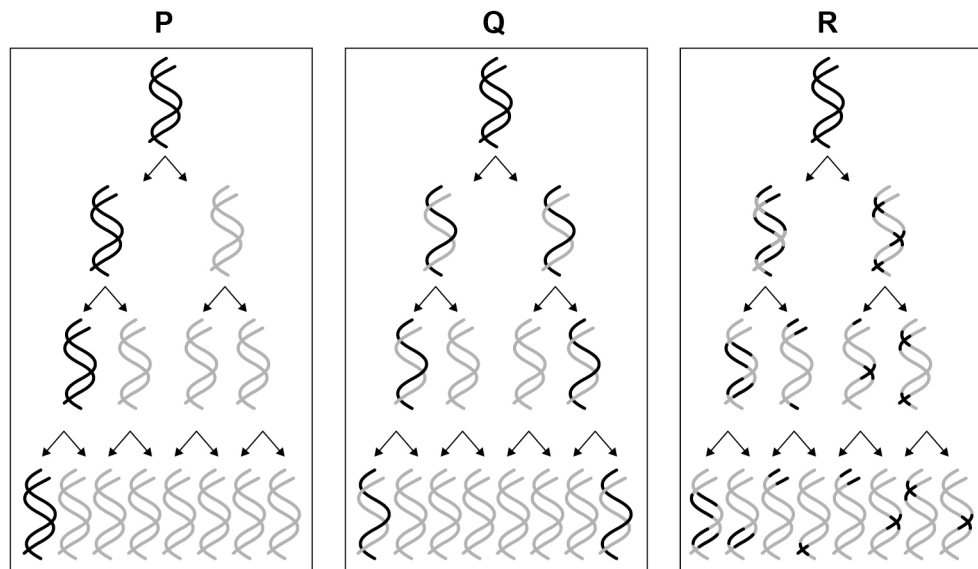
**Figure 12**



There are **three** possible models of DNA replication.

These models are shown in **Figure 13**.

**Figure 13**



0 9 . 3

Which of these models, **P**, **Q** or **R**, is supported by the results shown in **Figure 12**?

Give the letter and name of the model supported and explain why the results do **not** support the other models.

[3 marks]

Model Q

Name Semi-conservative replication

Explanation for first  
**unsupported** model P (conservative): there should be two peaks in  
generation 1 ( $^{15}\text{N}$  and  $^{14}\text{N}$ ), but only one intermediate peak is shown.

Explanation for second  
**unsupported** model R (dispersive): there should be one wide peak  
in generation 3, not two separate peaks.

7

Turn over ►



1 0 . 1

Describe the structure of DNA.

**[5 marks]**

*DNA is a polymer of nucleotides (a polynucleotide).*

*Each nucleotide is made of a deoxyribose sugar, a phosphate group and a nitrogenous (organic) base.*

*Nucleotides are joined by phosphodiester bonds between the phosphate of one nucleotide and the deoxyribose of the next, forming a sugar-phosphate backbone, in condensation reactions.*

*DNA is made of two polynucleotide strands that are antiparallel and wound into a double helix.*

*The two strands are held together by hydrogen bonds between complementary base pairs: adenine with thymine (two hydrogen bonds) and cytosine with guanine (three hydrogen bonds).*



1 0 . 2

Name **and** describe **five** ways substances can move across the cell-surface membrane into a cell.

[5 marks]

*Simple diffusion: small or non-polar (lipid-soluble) molecules such as oxygen move through the phospholipid bilayer down a concentration gradient. This is passive.*

*Facilitated diffusion: larger or charged substances such as glucose or ions move down a concentration gradient through channel or carrier proteins.*

*This is passive, so it does not use ATP.*

*Osmosis: water moves from a higher to a lower water potential, down a water potential gradient, across the partially permeable membrane (through aquaporins).*

*Active transport: substances move against a concentration gradient through carrier proteins, using energy from the hydrolysis of ATP.*

*Co-transport: two different substances, e.g. sodium ions and glucose, are moved together by the same carrier (co-transport) protein.  $\text{Na}^+$  moves down its gradient, carrying glucose against its gradient.*

**Question 10 continues on the next page**

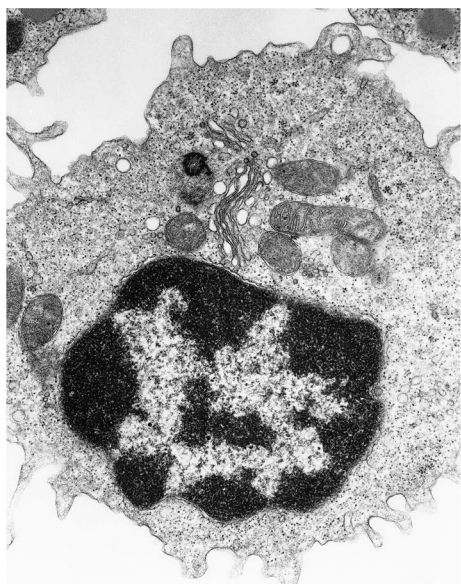
**Turn over ►**



**Figure 14** shows transmission electron micrographs of two cells, one animal cell and one prokaryotic cell.

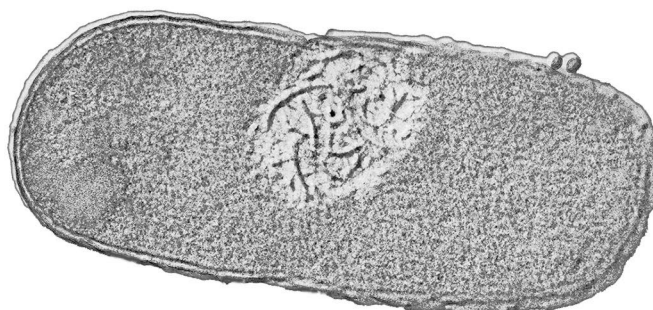
**Figure 14**

**Cell A**



Magnification  $\times 30\,000$

**Cell B**



Magnification  $\times 60\,000$

1 0 . 3

Contrast the structure of the two cells visible in the electron micrographs shown in **Figure 14**.

[5 marks]

*Using the magnifications, cell A (the animal cell) is bigger than cell B, since B is shown at  $\times 60\,000$  but A at only  $\times 30\,000$ .*

*Cell A has a nucleus with a nuclear envelope, whereas cell B (the prokaryote) has free DNA in the cytoplasm.*

*Cell A has mitochondria, whereas cell B does not.*

*Cell A has Golgi body and endoplasmic reticulum, whereas cell B has neither.*

*Cell A has no cell wall, whereas cell B has a murein (peptidoglycan) cell wall, and B may have a capsule which A does not.*

*In cell A the DNA is linear and bound to histone proteins, whereas in cell B it is circular and not associated with histones.*

*Cell A has larger (80S) ribosomes, whereas cell B has smaller (70S) ribosomes.*

15

**END OF QUESTIONS**



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