| Surname | Centre Number | Candidate Number |
|---|---|---|
| First name(s) | | 2 |

# GCE AS/A LEVEL

2400U10-1

S25-2400U10-1

**MONDAY, 12 MAY 2025 – MORNING**

## BIOLOGY – AS unit 1
### Basic Biochemistry and Cell Organisation

1 hour 30 minutes

| For Examiner's use only | | |
|---|---|---|
| **Question** | **Maximum Mark** | **Mark Awarded** |
| **1.** | **11** | |
| **2.** | **13** | |
| **3.** | **15** | |
| **4.** | **12** | |
| **5.** | **10** | |
| **6.** | **10** | |
| **7.** | **9** | |
| **Total** | **80** | |

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01

**ADDITIONAL MATERIALS**

A calculator and a ruler.

**INSTRUCTIONS TO CANDIDATES**

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

You may use a pencil for graphs and diagrams only.

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 **7**.

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

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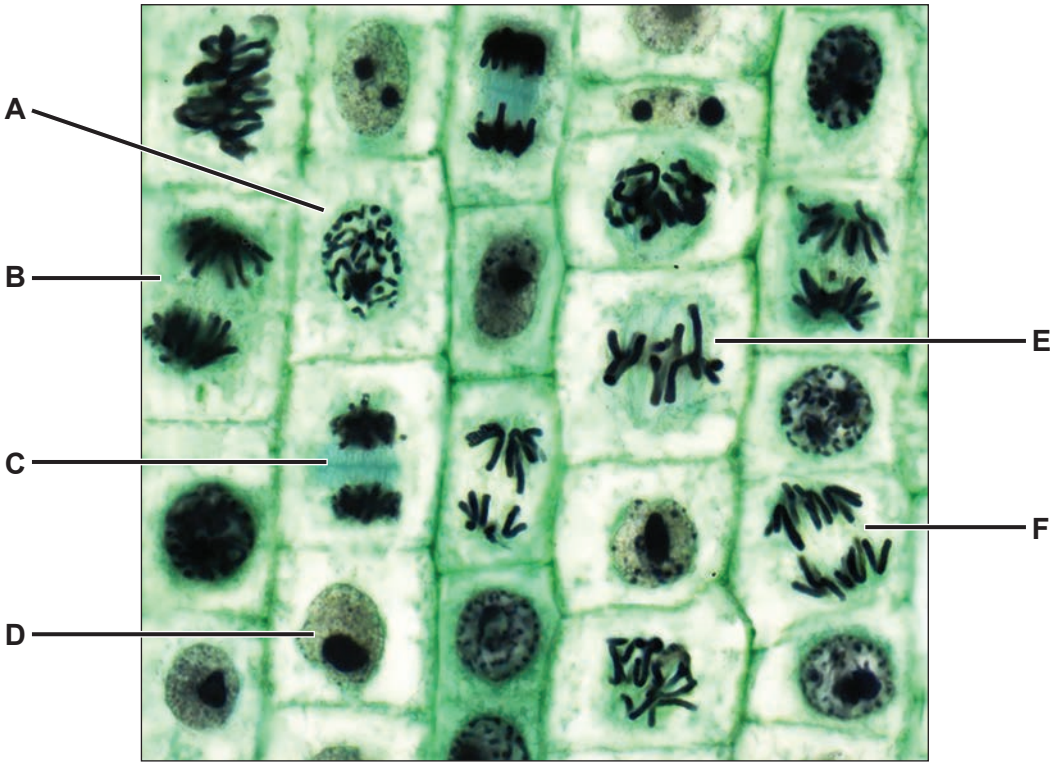
Answer **all** questions.

**1.** (a) **Image 1.1** shows some cells undergoing mitosis.

**Image 1.1**




(i) The cell labelled **D** is at interphase of the cell cycle.
State **two** events that occur during this stage. [2]

I. .....

II. .....

(ii) Use letters (**A-F**) from **Image 1.1** to identify **one** cell in each of the following stages of mitosis. [2]

Telophase: .....

Prophase: .....

Anaphase: .....

(iii) Starting with the letter **D**, place the letters from **Image 1.1** in the correct order during the cell cycle. [1]

**D** ..... ..... ..... ..... .....



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(b) Describe **three** differences between the processes of mitosis and meiosis. [3]

| Mitosis | Meiosis |
|---|---|
| ..... | ..... |
| ..... | ..... |
| ..... | ..... |
| ..... | ..... |
| ..... | ..... |
| ..... | ..... |

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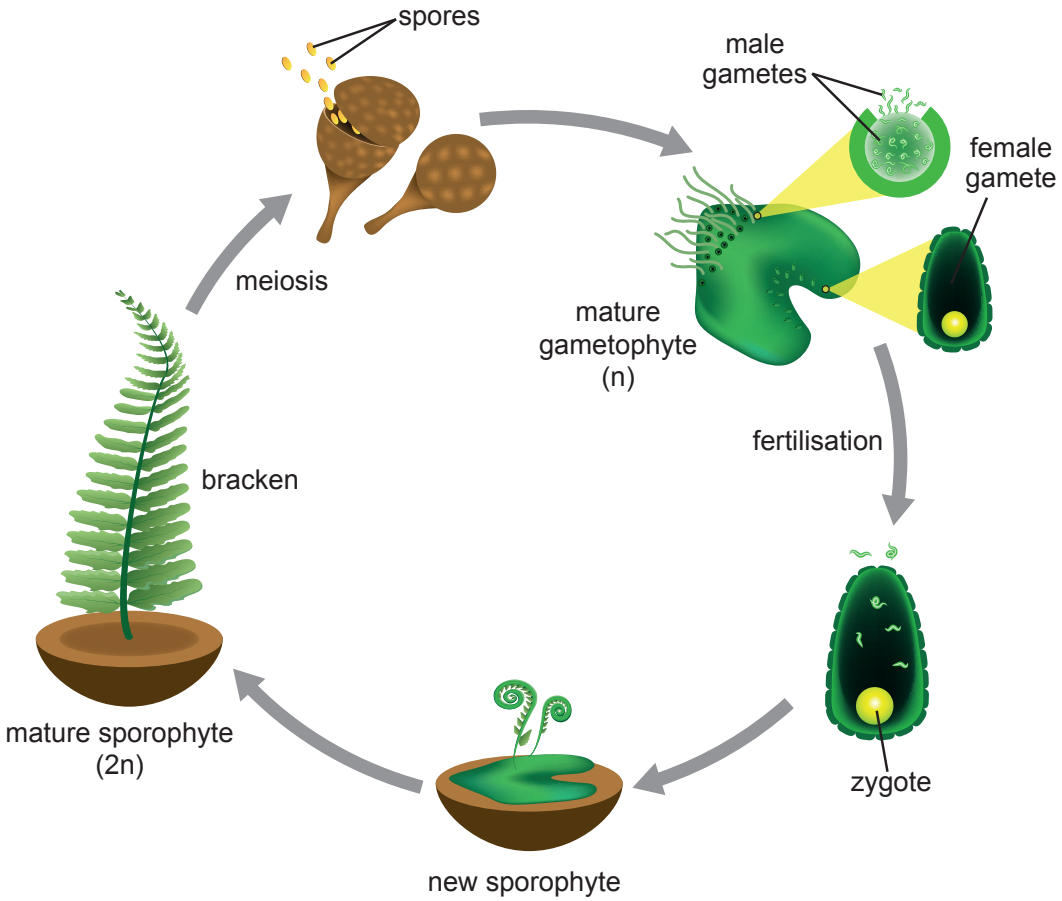
(c) Some organisms are capable of reproducing both sexually and asexually, for example bracken, a type of fern. **Image 1.2** shows the life cycle of bracken.

**Image 1.2**




During the life cycle, a mature plant (called a sporophyte) produces spores by meiosis. These spores germinate and grow into an offspring called a gametophyte. The gametophyte reproduces sexually. It produces gametes that undergo fertilisation. The zygote formed develops into a new sporophyte.

A species of bracken found in Wales has a diploid chromosome number of 104.

Use all the information given to answer the following questions.

(i) State the type of cell division involved in producing the gametes in bracken. [1]

.....

(ii) State the number of chromosomes that would be found inside each cell of the sporophyte and the gametophyte in this species of bracken. [2]

Sporophyte: .....

Gametophyte: .....

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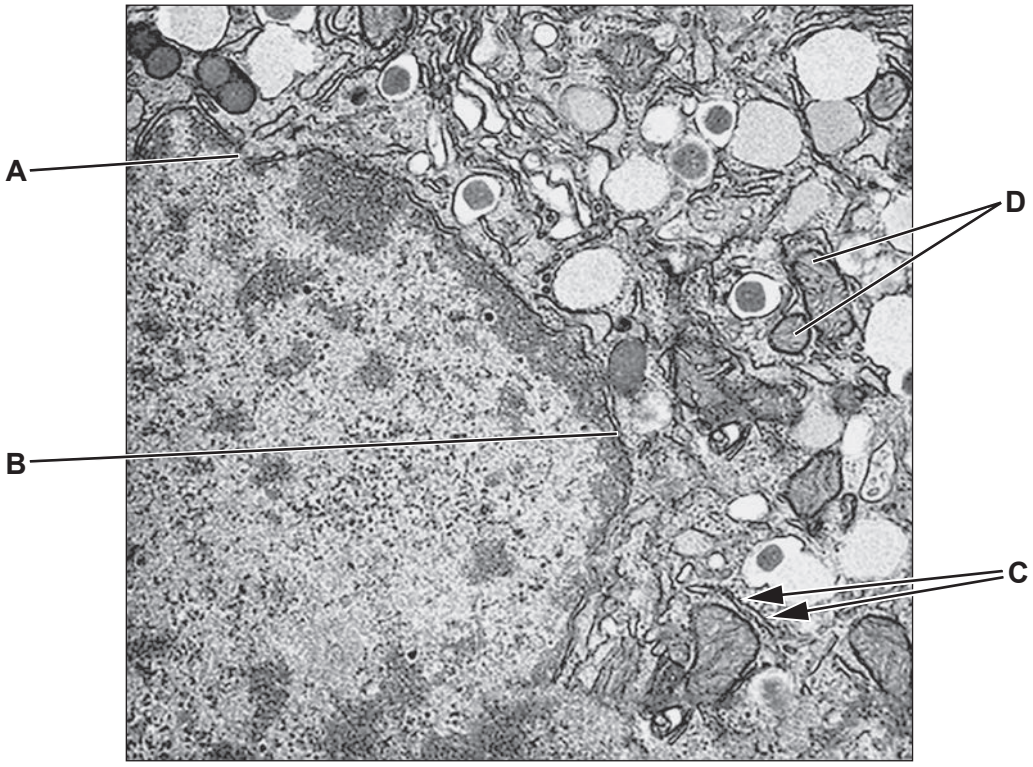
**2.** **Image 2.1** shows a transmission electron micrograph of a specialised cell from the pancreas. These cells are responsible for producing and secreting the hormone insulin.

**Image 2.1**




(a) (i) Identify the structures labelled **A** to **C** in **Image 2.1**. [2]

**A** .....

**B** .....

**C** .....

(ii) The two structures labelled **D** are both the same type of organelle. Explain why the two structures differ in appearance. [1]

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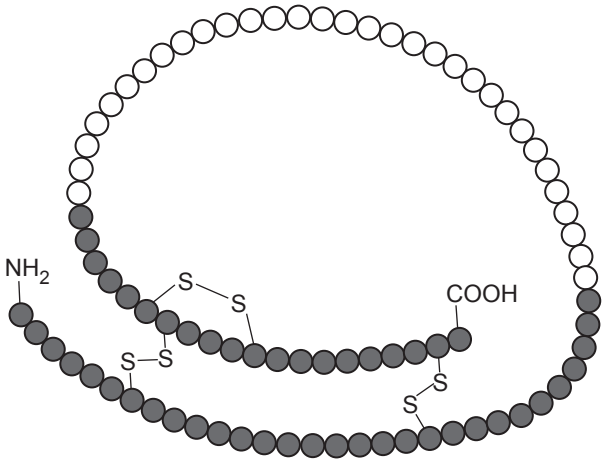
(b) Insulin is a globular protein. It is produced from a single polypeptide called proinsulin. This is shown in **Image 2.2**.

**Image 2.2**

Proinsulin




(i) State the highest level of protein structure shown by proinsulin in **Image 2.2**. [1]

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(ii) The polypeptide chain of proinsulin is composed of 86 amino acids.
State the minimum number of nucleotide bases contained in the gene coding for proinsulin. [1]

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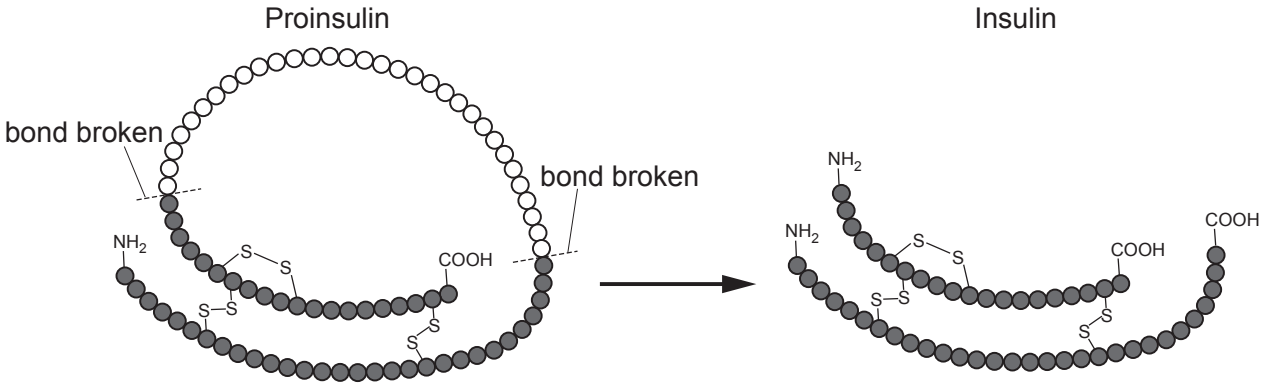
(c) Following synthesis of proinsulin by ribosomes, proinsulin must undergo post translational modification to form functional insulin. This is shown in **Image 2.3**.

**Image 2.3**




(i) Use **Image 2.3** and **your knowledge of cell organelles** to describe the production of functional insulin.
Your answer should describe the process from the point at which proinsulin has been synthesised by ribosomes to the point at which it is secreted from the cell.
Details of translation are not required. [5]

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(ii) Explain the role of organelle **D** on **Image 2.1** in the **production** and **secretion** of insulin. [3]

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**3.** (a) **Image 3.1a** shows a molecule of alpha glucose and **Image 3.1b** shows a molecule of glucose-1-phosphate.

**Image 3.1a**

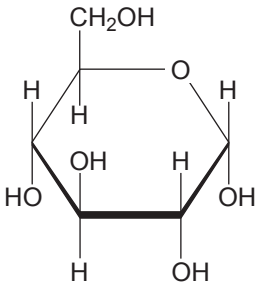
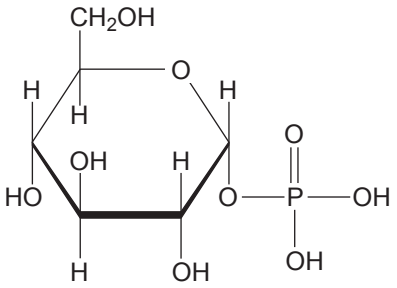



**Image 3.1b**




Alpha glucose and glucose-1-phosphate are not structural isomers of each other. Use **Images 3.1a** and **3.1b** to explain why. [1]

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(b) Starch phosphorylase is an enzyme that catalyses the **formation of starch** from glucose-1-phosphate.

A student investigated the effect of the concentration of glucose-1-phosphate on the activity of starch phosphorylase. They used the following method:

1. Add a drop of iodine into each of the wells on a spotting tile.
2. Add 5 $cm^3$ of 1% glucose-1-phosphate solution to a test tube.
3. Add 5 $cm^3$ of 1% starch phosphorylase into a separate test tube.
4. Place both test tubes in a thermostatically controlled water bath at 20 °C for 5 minutes.
5. Pour the starch phosphorylase into the test tube of glucose-1-phosphate solution and mix.
6. At one-minute intervals remove a drop of the mixture and add it to the iodine in the spotting tile and record the time taken for a blue-black colour to appear.
7. Repeat steps 1 to 6 for glucose-1-phosphate concentrations of 2%, 3%, 4% and 5%.

(i) The starch phosphorylase solution and the glucose-1-phosphate solution were both placed in the water bath for 5 minutes to equilibrate.
Explain why this is important in this experiment. [1]

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(ii) The student used a graduated pipette to transfer the 5 $cm^3$ of glucose-1-phosphate to the test tube. The graduated pipette was accurate to ±0.2 $cm^3$.

Calculate the percentage error of the volume measured. [2]

percentage error = ..... %

(iii) The results of the investigation are shown in **Table 3.2**.

**Table 3.2**

| Concentration of glucose-1-phosphate / % | Time taken for iodine solution to turn blue-black / minutes | | | | Mean rate of starch synthesis / $min^{-1} \times 10^{-2}$ |
|---|---|---|---|---|---|
| | Trial 1 | Trial 2 | Trial 3 | Mean | |
| 1 | 17 | 18 | 20 | 18.3 | 5.5 |
| 2 | 14 | 16 | 15 | 15.0 | 6.7 |
| 3 | 11 | 13 | 14 | 12.7 | ..... |
| 4 | 8 | 7 | 9 | 8.0 | 12.5 |
| 5 | 9 | 7 | 8 | 8.0 | 12.5 |

Use the data in **Table 3.2** to calculate the mean rate of starch synthesis at a glucose-1-phosphate concentration of **3%**.
**Write your answer in Table 3.2**. [2]

Space for working

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(iv) Describe and explain the effect of glucose-1-phosphate concentration on the mean **rate** of starch synthesis during this investigation. [3]

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(v) One of the limitations of this practical is that the results depend on a subjective judgement of the colour change.
State **two other** limitations **and** suggest how the method could be improved to reduce the effect of each. [4]

| Limitation | Improvement |
|---|---|
| .....<br>.....<br>..... | .....<br>.....<br>..... |
| .....<br>.....<br>..... | .....<br>.....<br>..... |



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(c) Describe a biochemical test the student could use to show that glucose-1-phosphate is a **reducing sugar**. [2]

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**4.** (a) Plasma membranes are described as being selectively permeable.
Explain what is meant by the term **selectively permeable**. [1]

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(b) Describe **one** similarity and **two** differences between facilitated diffusion and active transport. [3]

Similarity: .....

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Difference 1: .....

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Difference 2: .....

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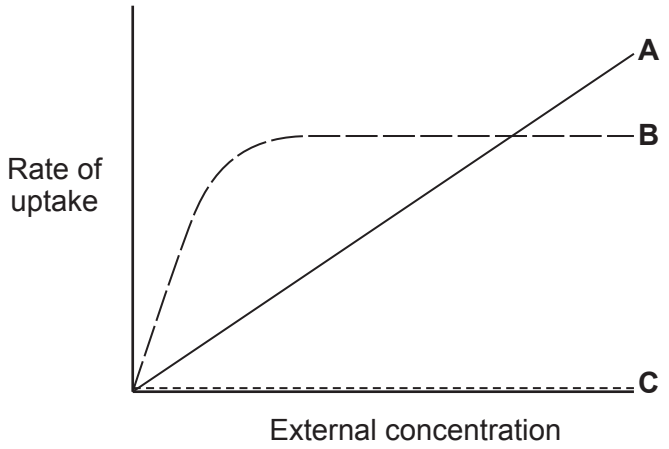
(c) An investigation was carried out to determine how different molecules are transported into cells across the plasma membrane. During the investigation epithelial cells were placed into solutions with increasing concentrations of molecules **A**, **B** and **C**. The solutions were maintained at 35 °C. The results are shown in **Graph 4**.

**Graph 4**



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(i) Molecule **A** is non-polar and molecule **B** is polar.
Explain how **Graph 4** provides evidence to support this statement. [4]

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(ii) Suggest an explanation for the result shown by molecule **C**. [1]

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(iii) When the investigation was repeated at temperatures higher than 35 °C the rate of uptake of molecule **C** increased.
Explain the reason for the change in the rate of uptake. [3]

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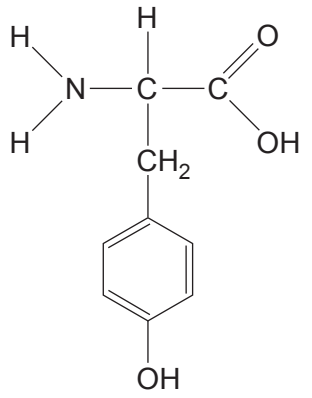
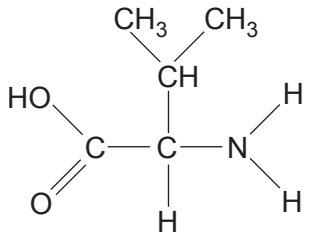
**5.** (a) **Image 5.1** shows the structure of two amino acids, tyrosine and valine.

**Image 5.1**

Tyrosine




Valine




(i) **Draw a circle** around the R-group of **each** amino acid. [1]

(ii) These two amino acids can be joined together during a chemical reaction.
State the type of reaction and name the bond formed when these two amino acids are joined together. [2]

Type of reaction .....

Bond formed .....

(b) The enzyme tyrosinase converts tyrosine into melanin.
Explain why only tyrosinase can catalyse this reaction. [3]

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(c) Melanin is a pigment that is responsible for dark fur colouration. The more melanin produced the darker the fur. In Siamese cats, the conversion of tyrosine to melanin by tyrosinase is affected by temperature. Above 35 °C tyrosinase is denatured.

**Image 5.2** shows the distribution of dark and light fur in a Siamese cat.

**Image 5.2**

Use the information given to explain why Siamese cats have dark faces, ears, paws and tails, but the main part of the body is light. [4]

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**6.** There are several types of lipids found in cells. These include triglycerides and phospholipids.

(a) State **one** similarity and **one** difference between the structure of a triglyceride and the structure of a phospholipid. [2]

**Similarity:** .....

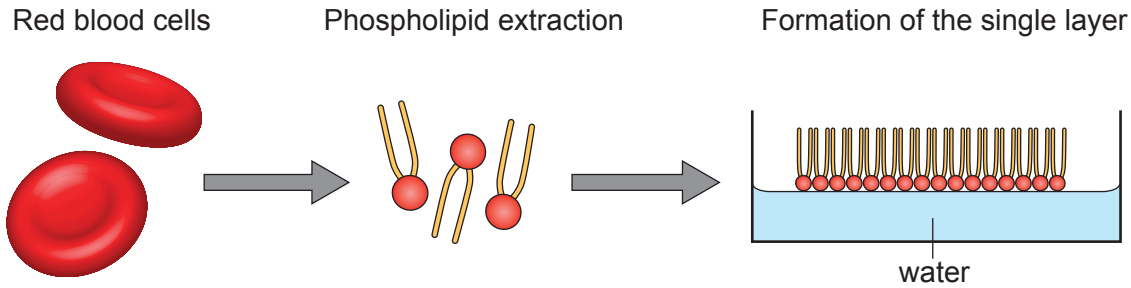
.....

**Difference:** .....

.....

(b) In 1925, two scientists, Gorter and Grendel, investigated the arrangement of phospholipids in the plasma membrane. This involved the removal of the phospholipids from the surface membrane of all the red blood cells in a sample of blood. The phospholipids were then placed on the surface of water and allowed to spread out to form a single layer. This is shown in **Image 6.1**.

**Image 6.1**




(i) Explain the arrangement of the phospholipids when placed on the surface of the water in **Image 6.1**. [2]

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The scientists recorded a number of different measurements for samples of blood from different animals as shown in **Table 6.2**.

**Table 6.2**

| Animal | Volume of blood sampled/ $cm^3$ | Number of red blood cells $\times 10^9$ in 1 $cm^3$ | Surface area of one red blood cell / $\mu m^2$ | Total surface area of red blood cells / $m^2$ | Total surface area of phospholipids extracted from red blood cells / $m^2$ | Ratio of total surface area of phospholipids to total surface area of red blood cells |
|---|---|---|---|---|---|---|
| Dog | 40 | 8.00 | ..... | 31.30 | 62.0 | 2.0 : 1 |
| Sheep | 10 | 9.90 | 29.8 | 2.95 | 6.2 | 2.1 : 1 |
| Rabbit | 10 | 5.90 | 92.5 | 5.46 | 9.9 | 1.8 : 1 |
| Guinea pig | 1 | 5.85 | 89.8 | 0.52 | 1.0 | 1.9 : 1 |
| Goat | 10 | 19.30 | 17.8 | 3.34 | 6.1 | 1.8 : 1 |
| Human | 1 | 4.74 | 99.4 | 0.47 | 0.9 | ..... : 1 |

(ii) Use the following equation to calculate the surface area of **one** red blood cell in the dog.
**Write your answer in Table 6.2**. [3]

$$A = \frac{T \times 10^{12}}{V \times N}$$

Where:
$A$ = surface area of one red blood cell
$T$ = total surface area of red blood cells
$V$ = volume of blood sampled
$N$ = the number of red blood cells in 1 $cm^3$

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(iii) I. Calculate the ratio of total surface area of phospholipids to total surface area of red blood cells for **humans**.
**Write your answer in Table 6.2**. [1]

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II. Suggest the conclusion reached by Gorter and Grendel regarding the arrangement of phospholipids in plasma membranes.
Describe how your answer to **6**(b)(iii)I. and the data in **Table 6.2** provides evidence to support their conclusion. [2]

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**7.** A key principle of molecular biology is that genetic information flows only in one direction, from DNA, to RNA, to protein.

The distribution of DNA and RNA within cells can be determined by using a specific type of microscopy. **Image 7.1** shows an isolated animal cell (the nucleus has been stained blue) with the two positions within a cell where analysis was carried out. The analysis in **Table 7.2** shows the percentage of total DNA and RNA at these two positions.

**Image 7.1**

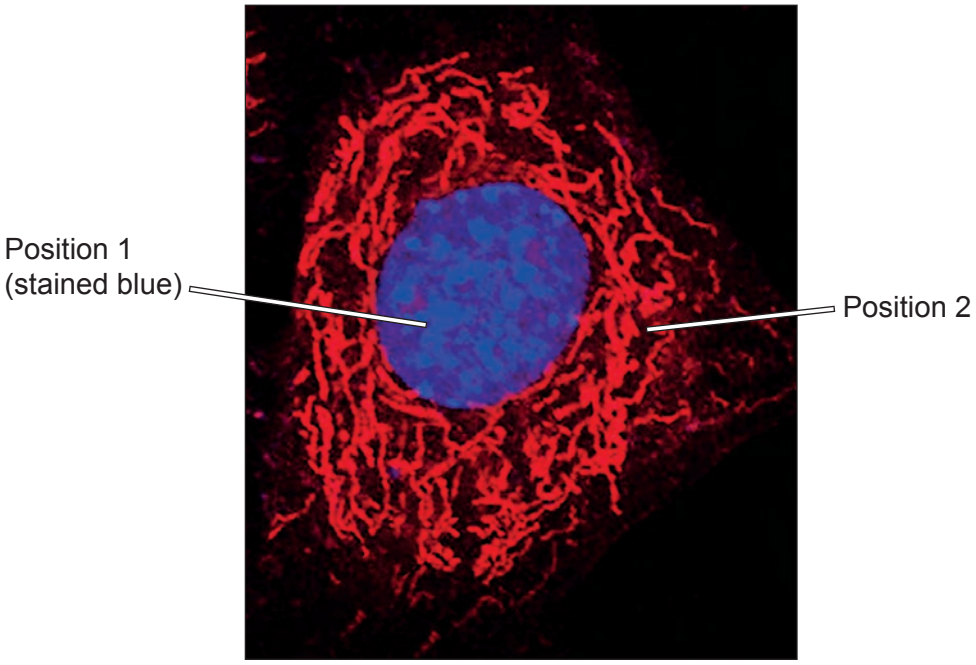


**Table 7.2**

| Nucleic acid | Percentage of nucleic acid | | |
|---|---|---|---|
| | Position 1 | Position 2 | Total |
| DNA | 99.9 | 0.1 | 100.0 |
| RNA | 34.2 | 65.8 | 100.0 |

Use the information provided and your knowledge of the functions of DNA and RNA to describe and explain the distribution of DNA and RNA within the cell.

Describe the process by which “genetic information flows from DNA to RNA”. [9 QER]

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