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Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **0610/61**

Paper 6 Alternative to Practical **May/June 2020**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Blank pages are indicated.

[Turn over

1 Sugars are a source of energy in the diet.

A student wanted to estimate the concentration of glucose in an energy drink (**D**).

Step 1   Three test-tubes were labelled **A**, **B** and **C**.

Step 2   Three different concentrations of glucose solution were prepared as shown in Table 1.1.

(a) (i) Complete Table 1.1 by calculating and writing in the volume of 4% glucose solution used in test-tube **B**.

Table 1.1

test-tube	volume of 4% glucose solution / cm^3	volume of distilled water / cm^3	percentage concentration of glucose solution
A	10.0	0.0	4
B		5.0	2
C	2.5	7.5	1

[1]

Step 3   5 cm^3 of Benedict's solution was added to each of the glucose solutions in test-tubes **A**, **B** and **C**. Each test-tube was gently shaken for 3 seconds to mix the contents.

Step 4   5 cm^3 of Benedict's solution was added to test-tube **D** which contained 10 cm^3 of energy drink **D**. The test-tube was gently shaken for 3 seconds to mix the contents.

Step 5   Hot water was put into a beaker that was used as a water-bath.

Step 6   The temperature of the hot water in the water-bath (initial temperature) was measured.

Step 7   Test-tube **A** was put into the water-bath and a stop-clock was started.

Step 8   Test-tube **A** was observed and the stop-clock was stopped when the contents of the test-tube **first** changed colour.

Step 9   Test-tube **A** was removed from the water-bath.

Step 10 Steps 7, 8 and 9 were repeated with test-tubes **B**, **C** and **D**.

Step 11 The final temperature of the water in the water-bath was measured at the end of the investigation.

(ii) Fig. 1.1 shows the appearance of the thermometer in step 6 and in step 11.
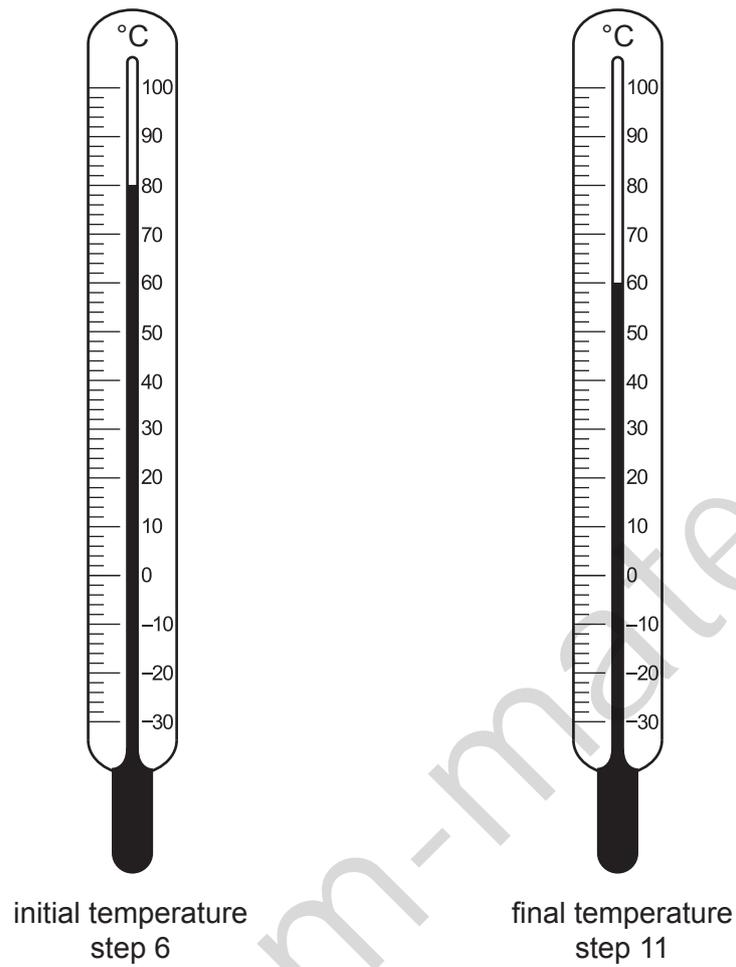
initial temperature
step 6

final temperature
step 11

Fig. 1.1

Record the temperatures shown in Fig. 1.1 in Table 1.2.

Table 1.2

step 6 initial temperature/°C	step 11 final temperature/°C

[1]

                                                 [Turn over

(iii) Fig. 1.2 shows the stop-clock readings for each test-tube in step 8.

minutes:seconds	minutes:seconds	minutes:seconds	minutes:seconds
00:36	01:27	02:45	01:30
test-tube **A**	test-tube **B**	test-tube **C**	test-tube **D**

Fig. 1.2

Convert the times shown in Fig. 1.2 to seconds.

Prepare a table and record these times in your table.

[3]

(iv) Estimate the concentration of glucose in energy drink **D** using the information in Table 1.1 and the results in your table in **1(a)(iii)**.

....% [1]

(v) Explain how you estimated the concentration of glucose in energy drink **D** in **1(a)(iv)**.

....

....

.... [1]

(b) Fig. 1.1 and Table 1.2 may indicate that there is a source of error in this investigation.

    (i) Identify the possible source of error **and** suggest **one** way the method could be improved to reduce this error.

source of error ....

....

improvement ....

....

....

[2]

    (ii) Explain how the error identified in **1(b)(i)** could affect the results and the estimation of the concentration of glucose in energy drink **D**.

....

....

.... [1]

(c) **(i)** State **two** variables that were kept constant in the investigation in **1(a)**.

1 ....

2 ....

[2]

    (ii) State **one** reason why the student should wear eye protection when carrying out this investigation.

....

....

.... [1]

                  [Turn over

(d) Barley grains are used in the food industry as a source of sugars. Barley grains contain starch. Starch can be broken down into sugars by enzymes.

Students made a starch suspension from barley grains to investigate the breakdown of starch by enzymes. The starch suspension contained 100 g of starch. They mixed the starch suspension with enzymes and recorded the mass of starch remaining in the mixture at different times.

The results are shown in Table 1.3.

Table 1.3

time / minutes	mass of starch remaining / g
0	100
5	58
10	40
20	32
40	28

(i) Plot a line graph on the grid of the data in Table 1.3.

[4]
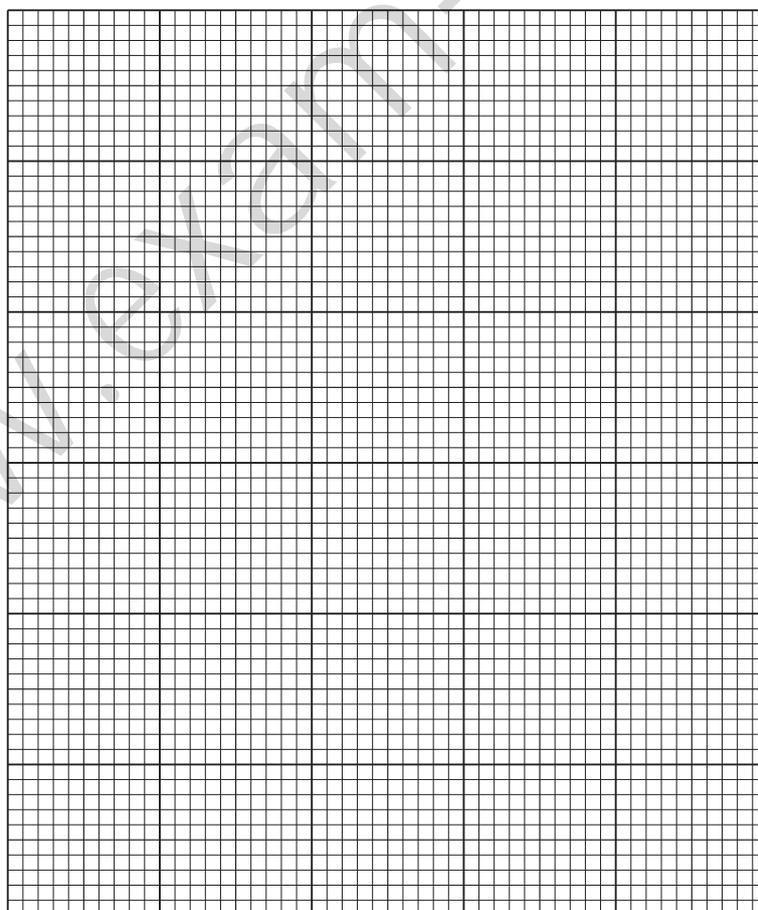
(ii) Describe the trend shown in your graph.

....

....

.... [1]

(iii) Estimate the mass of starch remaining at 15 minutes.

Show on your graph how you obtained your answer.

.... g

[2]

(iv) Calculate the rate of starch breakdown in the first five minutes using the information in Table 1.3 or your graph.

.... g per minute [1]

(e) Plan an investigation to determine the effect of temperature on the breakdown of starch by enzymes.

....

....

....

....

....

....

....

....

....

....

....

....

.... [6]

[Total: 27]

Question no. 1

(a)(i) Complete Table 1.1 (test-tube B)

In every tube, the **total volume of glucose solution + water is 10.0 cm3** (e.g. A is 10.0 + 0.0 and C is 2.5 + 7.5).

For test-tube **B**, the water volume is **5.0 cm3**, so the volume of 4% glucose solution must be:

10.0 − 5.0 = 5.0 cm3

☑ **Volume of 4% glucose solution in B = 5.0 cm3**

(a)(ii) Record the temperatures (Fig. 1.1 → Table 1.2)

From the thermometer readings:

- **Step 6 initial temperature = 80 °C**
- **Step 11 final temperature = 60 °C**

☑ Table 1.2: **80 °C** and **60 °C**

(a)(iii) Convert the stop-clock times to seconds and record in a table

Convert minutes:seconds to seconds using: **(minutes × 60) + seconds**

- A: 00:36 → **0 × 60 + 36 = 36 s**
- B: 01:27 → **1 × 60 + 27 = 87 s**
- C: 02:45 → **2 × 60 + 45 = 165 s**
- D: 01:30 → **1 × 60 + 30 = 90 s**

Table (required format):

test-tube time taken for colour change / s

test-tube	time taken for colour change / s
A	36

test-tube	time taken for colour change / s
B	87
C	165
D	90

(a)(iv) Estimate the concentration of glucose in energy drink D

Benedict's colour change happens **faster when glucose concentration is higher**.

Compare D (90 s) with the known standards:

- A (4%) = 36 s (much faster)
- **B (2%) = 87 s (very close)**
- C (1%) = 165 s (much slower)

Since **D's time (90 s) is closest to B (87 s)**:

☑ **Estimated glucose concentration in D = 2%**

(a)(v) Explain how the estimate was made

I estimated the glucose concentration in drink D by **comparing the time taken for D to first change colour** with the times for the known glucose concentrations in A, B and C. Since **drink D took 90 s**, and this was **closest to test-tube B (87 s), which was 2% glucose**, I concluded that **drink D contained about 2% glucose**.

(b)(i) Source of error and one improvement

Source of error:
The **water-bath temperature was not kept constant**; it **fell from 80 °C to 60 °C** during the investigation.

Improvement:
Use a **thermostatically controlled water-bath** (or keep heating/adding hot water and monitoring continuously) so the **temperature stays constant throughout**.

(b)(ii) Effect of this error on results and the estimate for D

As temperature decreases, the Benedict's reaction occurs **more slowly**, so the **time taken to first change colour becomes longer**. This makes results **less reliable** and could cause the student to **underestimate the glucose concentration in D**, because a longer time might be wrongly interpreted as meaning a lower glucose concentration.

(c)(i) Two variables kept constant in 1(a)

Two valid examples are:

1. **Volume of glucose solution / energy drink used (10 cm3 in each tube)**
2. **Volume of Benedict's solution added (5 cm3 in each tube)**

(Other acceptable constants include the **same Benedict's concentration** and the **same mixing time (3 s)**.)

(c)(ii) One reason for wearing eye protection

Eye protection should be worn because **hot liquids may splash** when the test-tubes are heated in the water-bath (and Benedict's solution can also be harmful if it splashes into eyes). **Goggles protect the eyes from burns/chemical splashes.**

(d)(i) Line graph for Table 1.3 (real image)

Here is a correctly plotted line graph with labelled axes and all five points joined:
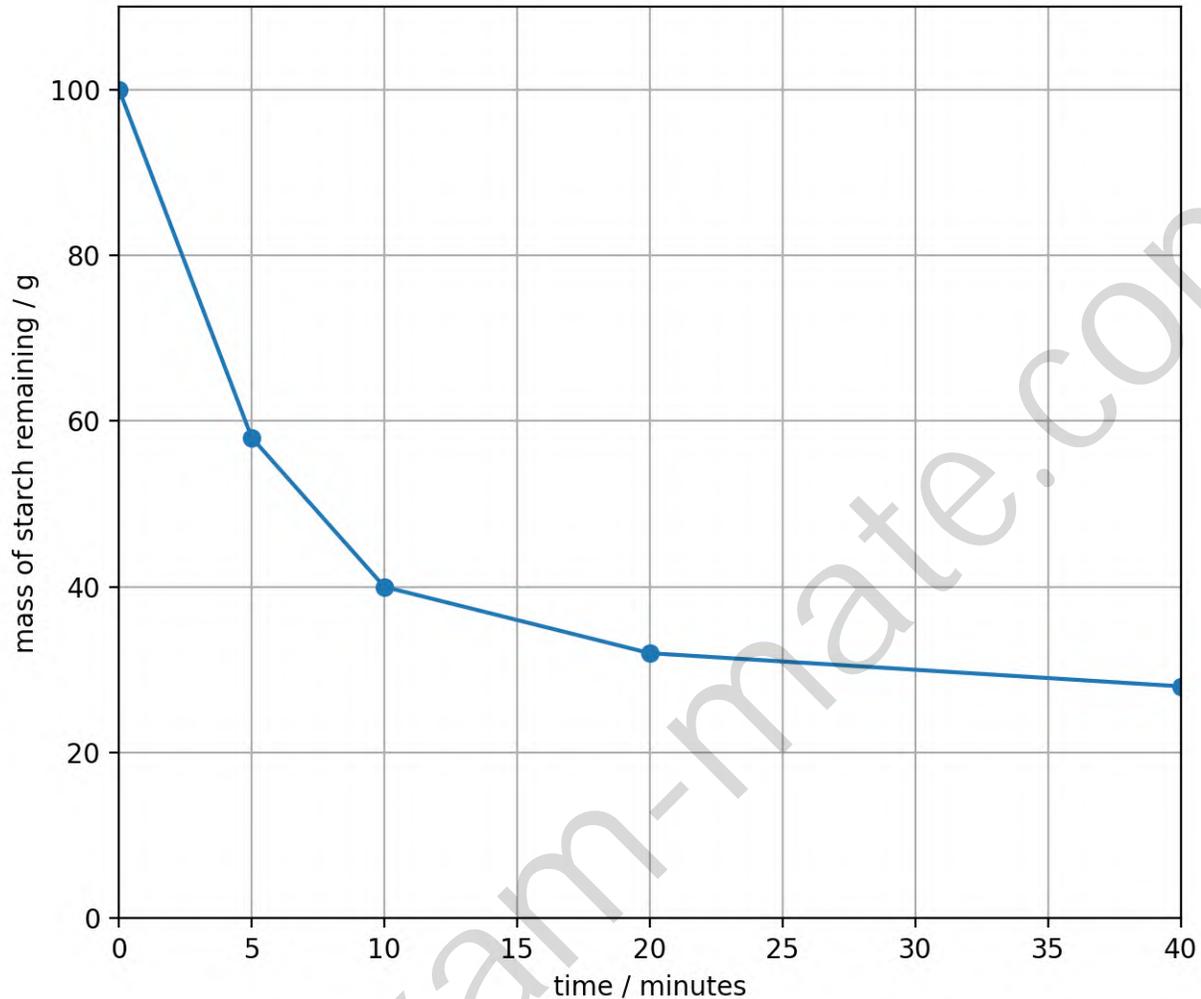
(d)(ii) Describe the pattern in the results

The **mass of starch remaining decreases with time**, showing starch is being broken down. The decrease is **rapid at first** (0 to 10 minutes), then it **slows down and begins to level off** (20 to 40 minutes), suggesting the reaction rate is reducing as substrate becomes limited (or products build up / enzyme becomes less effective over time).

(d)(iv) Calculate the rate over the first 5 minutes

From 0 to 5 minutes, starch mass falls from 100 g to 58 g.

Decrease in mass = **100 − 58 = 42 g** over **5 minutes**

Rate = **42 ÷ 5 = 8.4 g per minute**

☑ **Rate = 8.4 g min−1**

(e) Plan an investigation to determine the effect of temperature on starch breakdown by enzymes (6 marks)

To investigate how temperature affects starch breakdown, I would prepare a starch suspension and mix it with a fixed concentration of a starch-digesting enzyme (for example **amylase**). I would set up **at least two (preferably several) different temperatures**, such as **20 °C, 30 °C, 40 °C, 50 °C and 60 °C**, using **thermostatically controlled water-baths** so that each temperature is maintained accurately.

For each temperature, I would place equal volumes of starch suspension and enzyme solution into a test-tube (for example 5 cm3 starch + 5 cm3 enzyme), mix thoroughly, and immediately start timing. To measure the progress of starch breakdown, I could use **iodine solution**: at **regular intervals** (e.g. every 30 seconds), I would place a drop of the reaction mixture onto a spotting tile and add a drop of iodine. I would record the **time taken until the iodine stays brown** (no blue-black), which shows that **starch has been fully broken down**. Alternatively, I could use **Benedict's test** at fixed times to measure the **amount of reducing sugar produced**, but the iodine method directly tracks starch disappearance.

The **independent variable** is the **temperature** of the reaction mixture. The **dependent variable** is either the **time taken for iodine to remain brown** (no starch left) or the **amount of reducing sugar produced** in a fixed time. To make it a fair test, I would keep important variables constant: the **same type of enzyme**, the **same enzyme concentration**, the **same starch concentration**, the **same volumes**, the **same pH** (using a buffer), and the **same sampling intervals**. I would repeat each temperature condition **at least two more times** and calculate a mean, improving reliability.

For safety, I would wear **eye protection** and take care with **hot water-baths** to avoid splashes and burns.

2 (a) Human reproduction involves a male gamete (sperm) and a female gamete (ovum).

Fig. 2.1 is a photomicrograph of a single ovum and many sperm cells during fertilisation.

Line **AB** represents the diameter of the ovum.
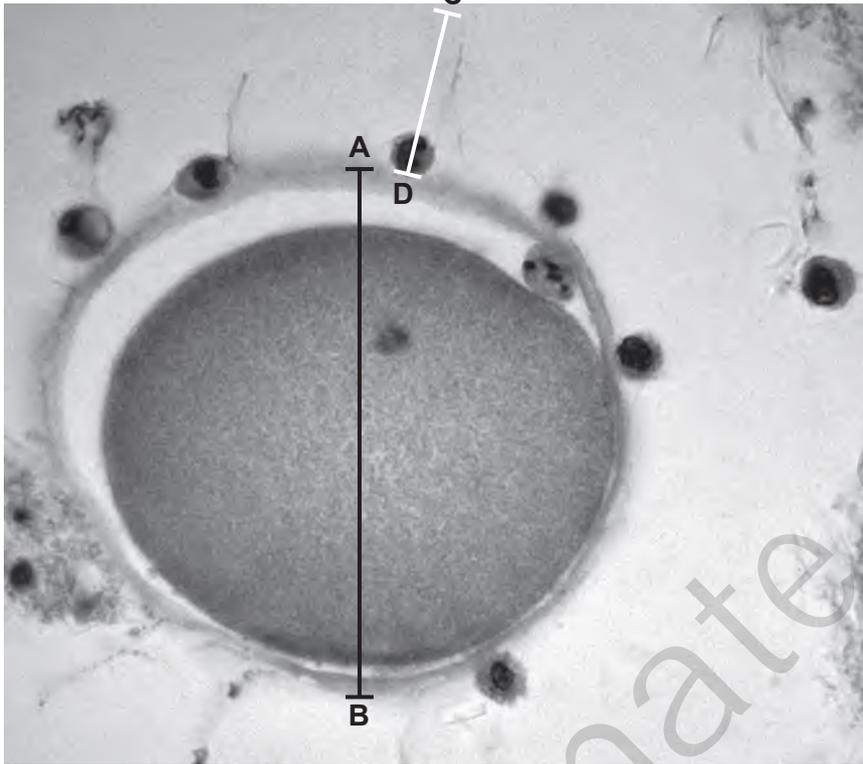
Line **CD** represents the length of one sperm cell.

Fig. 2.1

(i) Measure the lengths of lines **AB** and **CD** on Fig. 2.1. Include the unit.

length of line **AB** ....   length of line **CD** .... [1]

(ii) The actual diameter of the ovum is 0.10 mm.

Calculate the magnification of the ovum in Fig. 2.1 using the formula:

$$\text{magnification} = \frac{\text{length of line } \textbf{AB} \text{ on Fig. 2.1}}{\text{actual diameter of ovum}}$$

.... [1]

(iii) Calculate the actual length of the sperm cell using the magnification you calculated in **2(a)(ii)** and the formula:

$$\text{magnification} = \frac{\text{length of line } \textbf{CD} \text{ on Fig. 2.1}}{\text{actual length of sperm cell}}$$

Give your answer to two decimal places.

.... mm
[3]

(b) Fig. 2.2 is a different photomicrograph of an ovum and one sperm cell.
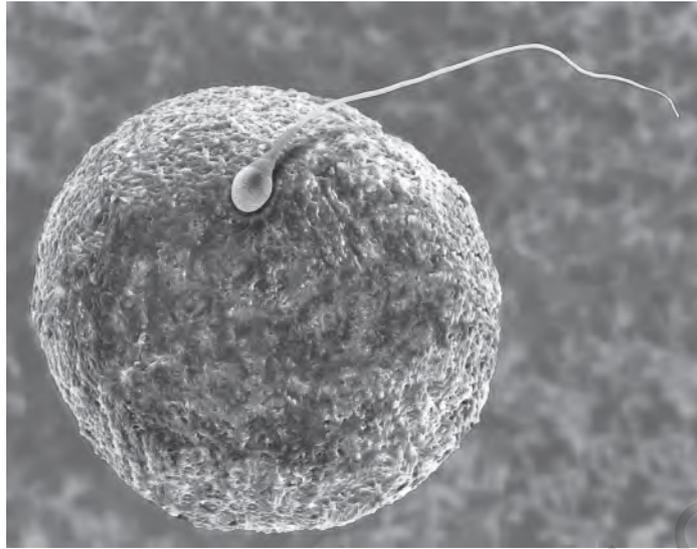
Fig. 2.2

(i) Make a large drawing of the ovum and the sperm cell shown in Fig. 2.2.

Label the ovum on your drawing.

[5]

(ii) State **three** visible differences between the ovum and the sperm cell that can be seen in Fig. 2.2.

1 ....

....

2 ....

....

3 ....

....

[3]

[Total: 13]

Question no. 2

(a)(i) Measuring lines AB and CD (with units)

From Fig. 2.1, the measured lengths are:

- **Length of line AB = 70 mm**
- **Length of line CD = 22 mm**

(These are within the accepted tolerance of ±1 mm.)

(a)(ii) Magnification of the ovum

You are told the **actual diameter of the ovum = 0.10 mm**.

Magnification is:

magnification = (length of AB on the figure) ÷ (actual diameter of ovum)

So:

magnification = 70 mm ÷ 0.10 mm = 700

Therefore, the **magnification of the ovum is 700×**.

(a)(iii) Actual length of the sperm cell

Using the given relationship:

magnification = (length of CD on the figure) ÷ (actual length of sperm cell)

Rearranging:

actual length of sperm cell = (length of CD on the figure) ÷ magnification

Substitute values:

actual length = 22 mm ÷ 700 = 0.031428… mm

To **two decimal places**:

actual length of sperm cell = 0.03 mm

(b)(i) Large drawing of the ovum and sperm cell (Fig. 2.2), with ovum labelled

Here is a **clear line drawing (no shading)**, with the **ovum labelled using a label line touching the ovum**, and with the **sperm head and long tail in correct proportions**:
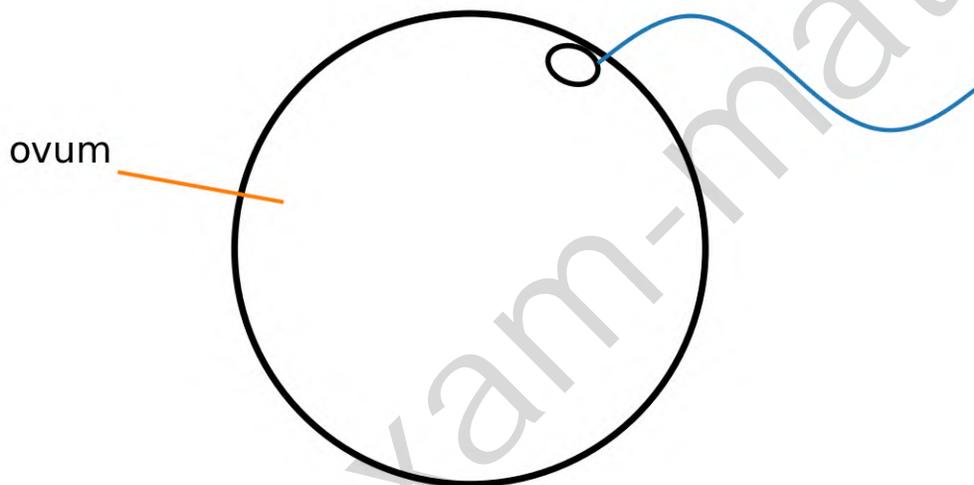
ovum

(b)(ii) Three visible differences between the ovum and the sperm cell (Fig. 2.2)

1. The **ovum is much larger** than the sperm cell.
2. The **ovum is roughly round**, whereas the **sperm cell is long and thin** with a tail.
3. The **ovum has a rough/textured surface**, while the **sperm cell surface appears smoother**.

12

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