A

AQA

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

AS

BIOLOGY

Paper 2

7401/2

Thursday 25 May 2023 **Morning**

Time allowed: 1 hour 30 minutes

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]

BLANK PAGE

MATERIALS

For this paper you must have:

- **a ruler with millimetre measurements**
- **a scientific calculator.**

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write 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 75.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

Answer ALL questions in the spaces provided.

0 1 . 1

Which statement about the function of ribosomes is correct?

Tick (✓) ONE box. [1 mark]

- ☐ **Site of transcription, catalyse the joining of amino acids by hydrolysis reactions**
- ☐ **Site of transcription, catalyse the joining of nucleotides by condensation reactions**
- ☐ **Site of translation, catalyse the joining of amino acids by condensation reactions**
- ☐ **Site of translation, catalyse the joining of nucleotides by hydrolysis reactions**

0 1 . 2

Name TWO biological molecules that can be coded for by a gene.

Do NOT include a polypeptide or protein in your answer. [1 mark]

1 _____

_____

2 _____

_____

[Turn over]

0 1 . 3

Scientists investigated the structure of the endoplasmic reticulum.

TABLE 1 shows some of the scientists' results.

TABLE 1

Type of endoplasmic reticulum	Percentage of endoplasmic reticulum made of phospholipids
Rough	46.8
Smooth	52.5

Use the data in TABLE 1 to suggest how the structure of rough endoplasmic reticulum is different from the structure of smooth endoplasmic reticulum AND how this is related to their functions. [3 marks]

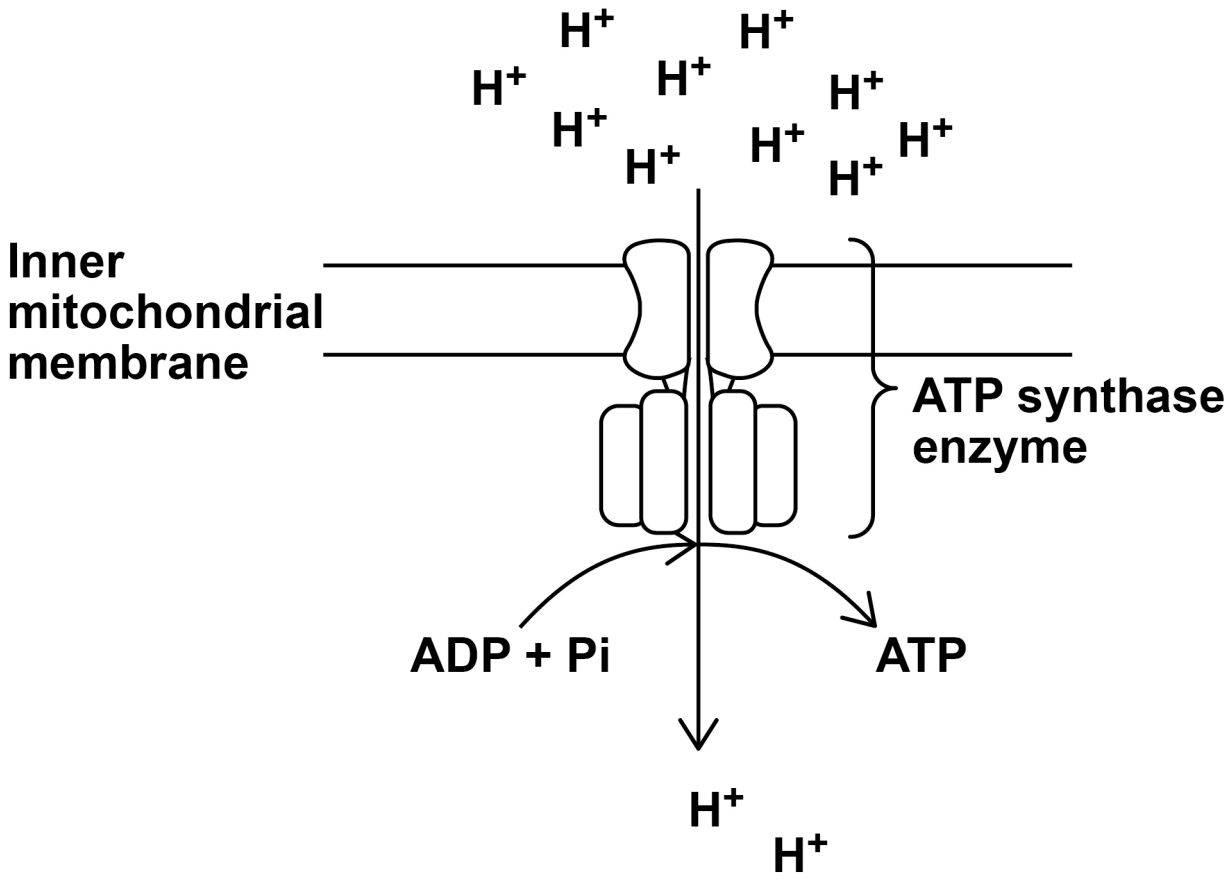
[Turn over]

5

0 2 . 1

FIGURE 1 shows an ATP synthase enzyme in the inner mitochondrial membrane.

FIGURE 1



Complete the passage with the appropriate terms.
[2 marks]

ATP synthase comprises several polypeptides, so is said to have a _____ structure. It catalyses the synthesis of an ATP molecule by a _____ reaction; this involves the _____ of a water molecule. The ATP synthase in FIGURE 1 is in a mitochondrion so would catalyse reactions during _____ _____ .

[Turn over]

0 2 . 2

As shown in FIGURE 1, on page 8, ATP synthase has two functions.

- **It catalyses the synthesis of ATP.**
- **It allows the movement of H^+ ions.**

Suggest how the shape of the ATP synthase allows it to have these two functions.

Explain your answers. [4 marks]

Catalyses the synthesis of ATP _____

Allows the movement of H^+ ions _____

[Turn over]

6

0 3

Galacto-oligosaccharides (GOS) are polymers of galactose.

0 3 . 1

Explain why GOS are described as polysaccharides.
[2 marks]

0 3 . 2

Give TWO differences between the structures of GOS and lactose. [2 marks]

1 _____

_____

_____

_____

_____

_____

2 _____

_____

_____

_____

_____

_____

_____

[Turn over]

0 3 . 3

Explain why amylase produced in the human digestive system does not digest GOS. [2 marks]

0 3 . 4

Prebiotics are foods used to promote good health in humans.

Prebiotics stimulate the growth of 'healthy' bacterial populations in the human digestive system.

The bacteria in these 'healthy' populations produce enzymes that hydrolyse GOS.

Suggest how GOS can work as a prebiotic. [3 marks]

9

BLANK PAGE

[Turn over]

0 4 . 1

This question is about the flow of blood into and through the heart.

Add the numbers 1 to 6 to TABLE 2, on the opposite page, to give the order of structures through which blood will pass as it enters the heart and flows through the left ventricle.

Use each number only once. Number 4 has been done for you. [2 marks]

TABLE 2

Aorta	
Left atrioventricular valve	
Right atrioventricular valve	
Left atrium	
Right atrium	
Pulmonary artery	
Pulmonary vein	
Left semi-lunar valve	
Vena cava	
Left ventricle	**4**
Right ventricle	
Right semi-lunar valve	

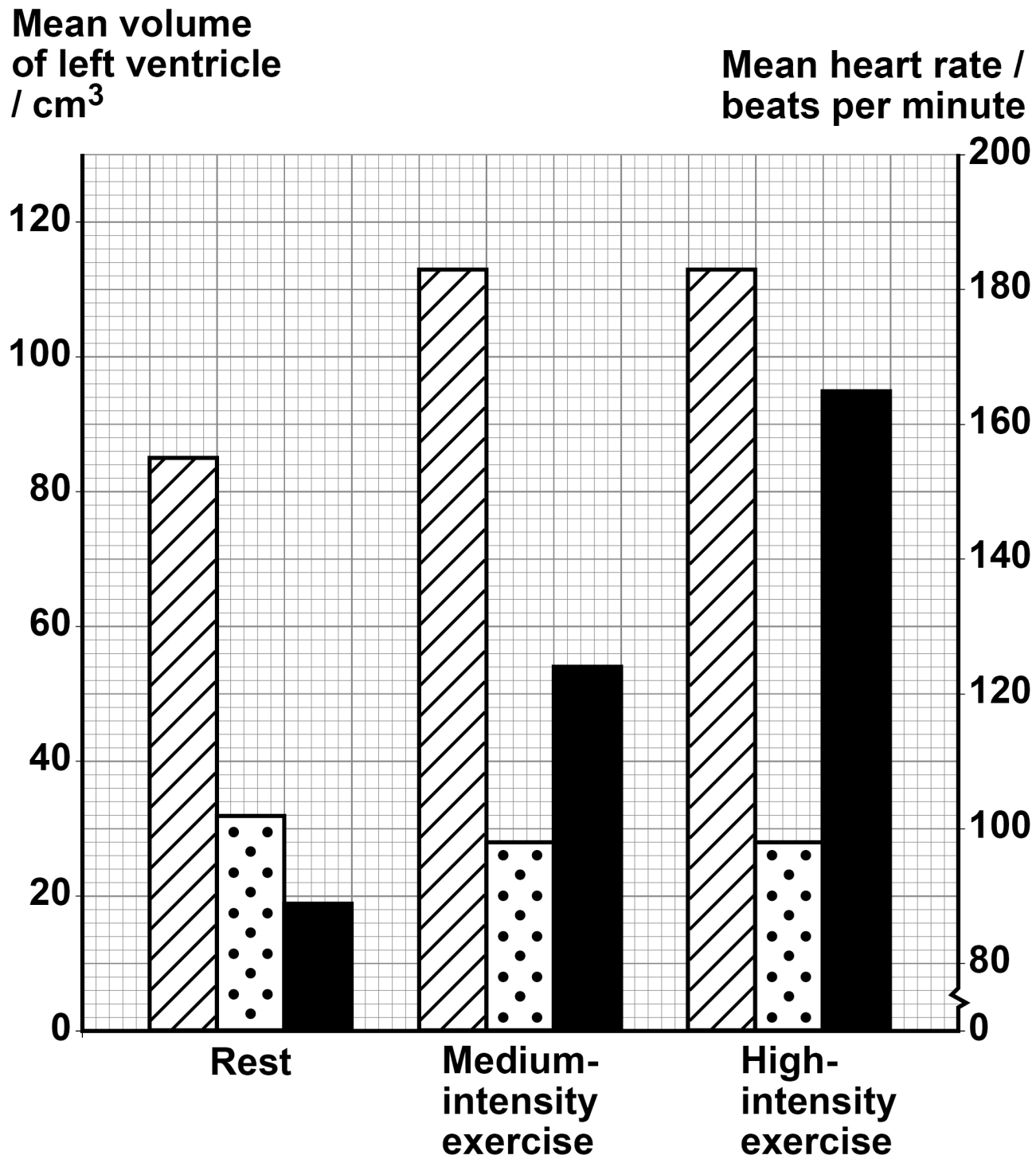
[Turn over]

0 4 . 2

Scientists investigated the heart activity of humans at rest, during medium-intensity exercise and during high-intensity exercise.

FIGURE 2, on the opposite page, shows the scientists' results.

FIGURE 2


Mean volume of left ventricle / cm3
Mean heart rate / beats per minute
120
100
80
60
40
20
0
200
180
160
140
120
100
80
0
Rest
Medium-intensity exercise
High-intensity exercise
KEY
Volume just before contraction
Volume at the end of contraction
Heart rate

BLANK PAGE

Stroke volume = volume of blood leaving a ventricle with each contraction

Cardiac output = stroke volume × heart rate

Use all the information, on page 20 and page 21 to describe what causes the increase in cardiac output:

- **from rest to medium-intensity exercise**
- **from medium-intensity exercise to high-intensity exercise.**

You do NOT need to calculate cardiac output to answer this question. [2 marks]

Rest to medium-intensity exercise _____

_____

_____

_____

_____

_____

_____

[Turn over]

Medium-intensity exercise to high-intensity exercise

BLANK PAGE

[Turn over]

0 4 . 3

Name the type of blood vessel that controls blood flow to muscles AND explain how these blood vessels change blood flow during exercise. [3 marks]

Name of blood vessel _____

_____

Explanation _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

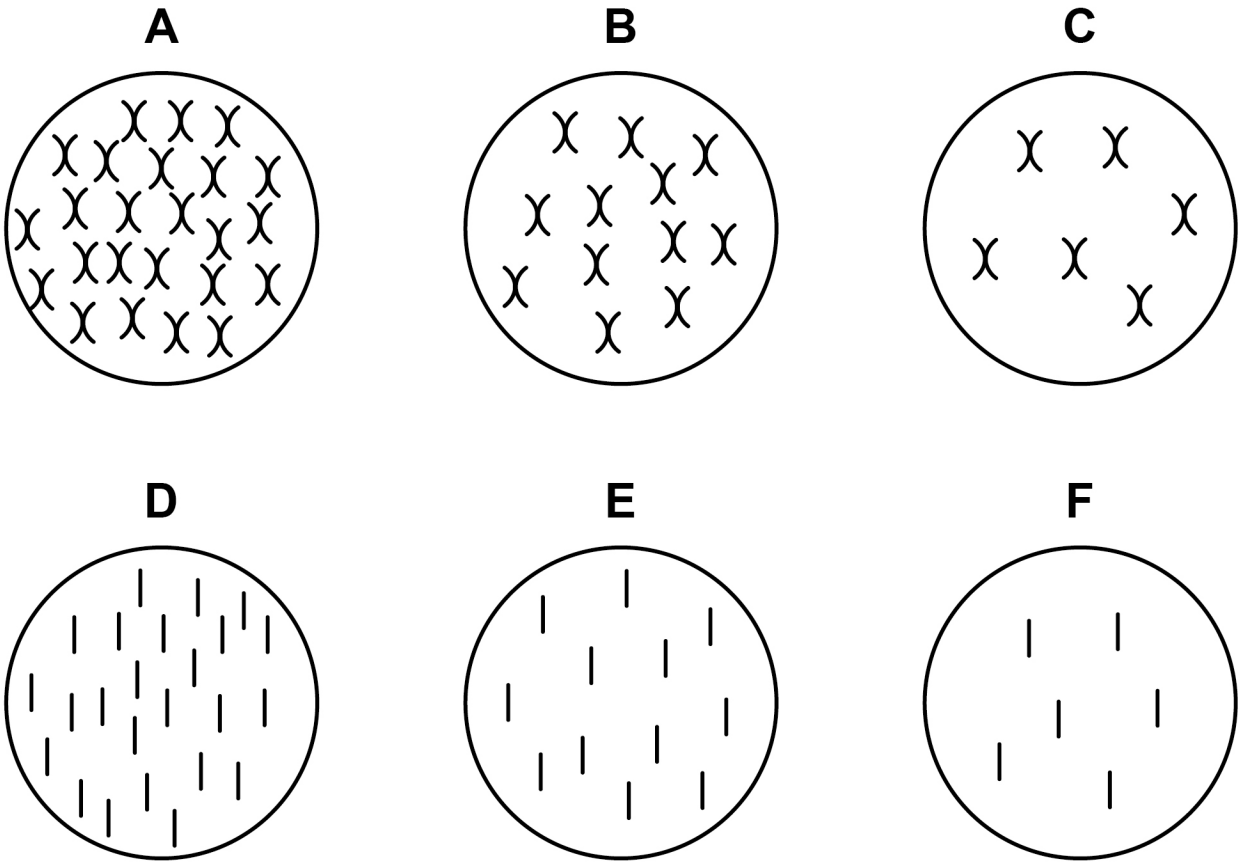
[Turn over]

7

0 5 . 1

FIGURE 3 shows diagrams of six possible arrangements of chromosomes in cells.

FIGURE 3



Before meiosis, a cell of a rice plant has 12 pairs of homologous chromosomes (24 chromosomes in total).

Give the letter of the diagram from FIGURE 3 that correctly shows the chromosome content of rice cells after the first meiotic division and after the second meiotic division. [2 marks]

After first meiotic division _____

After second meiotic division _____

[Turn over]

0 5 . 2

Scientists have produced a mutated rice variety in which there is NO crossing over.

A population of the mutant rice variety produced by sexual reproduction shows genetic variation. Populations of non-mutant rice varieties also show genetic variation.

Suggest and explain the similarities and differences in the causes of genetic variation within these rice populations. [3 marks]

5

0 6 . 1

Describe the hydrolysis reactions involved in the digestion of triglycerides.

Do NOT write about the activity of lipase. [2 marks]

0 6 . 2

All mammals produce a lipase called CEL.

CEL digests triglycerides.

CEL is activated by bile salts binding to the enzyme.

Describe TWO other functions of bile salts. [2 marks]

1 _____

_____

_____

_____

_____

2 _____

_____

_____

_____

_____

[Turn over]

0 6 . 3

Mammals feed their young on milk. CEL digests the triglycerides in milk. The ability to produce CEL occurred due to a gene mutation.

Describe how natural selection may have led to all mammals in a population producing CEL. [4 marks]

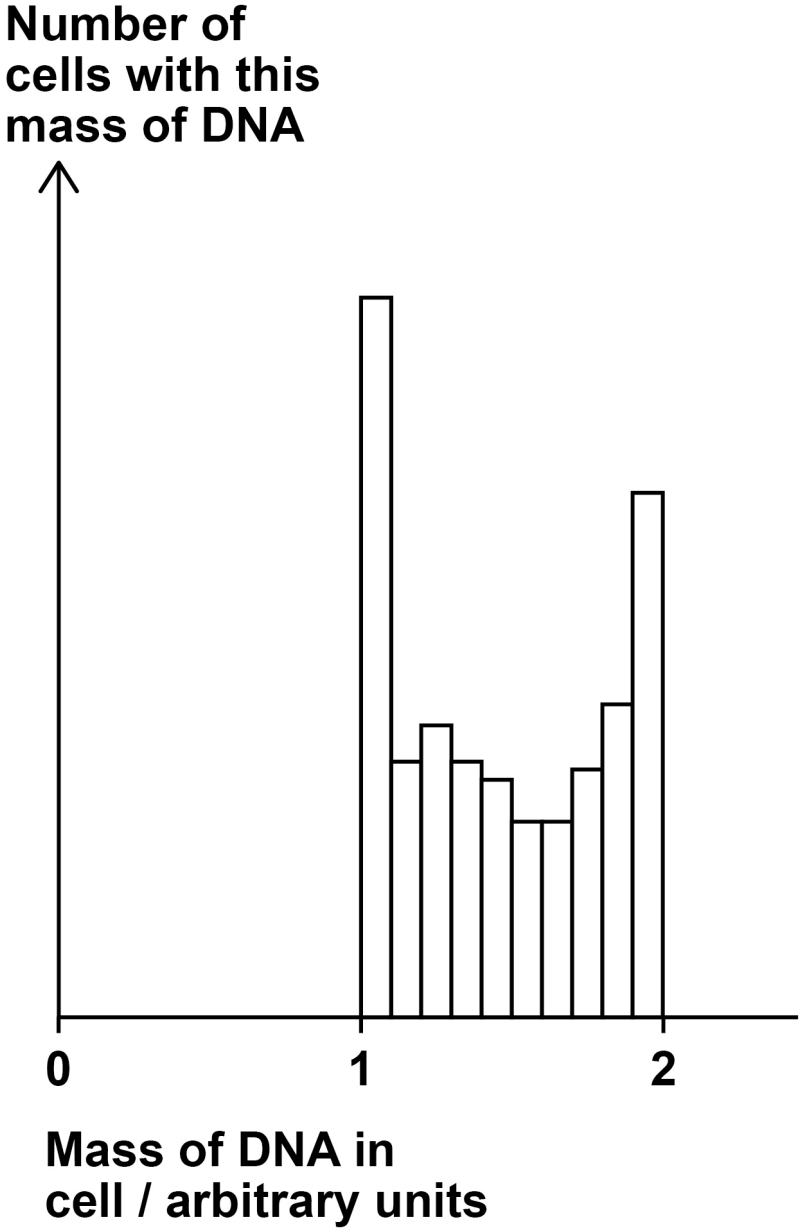
[Turn over]

8

0 7 . 1

FIGURE 4 shows the mass of DNA present in a group of healthy cells.

FIGURE 4



Use your knowledge of the cell cycle to explain the results shown in FIGURE 4. [3 marks]

0 7 . 2

Suggest ONE way FIGURE 4, on page 36, would be different if these cells were tumour cells.

Justify your answer. [2 marks]

0 7 . 3

Describe the behaviour of chromosomes in prophase and metaphase of mitosis. [2 marks]

Prophase

Metaphase

[Turn over]

0 7 . 4

During anaphase, the spindle exerts 3×10^{-11} N of force on each chromatid. This force generates 6×10^{-19} W of power.

Calculate the speed of movement, in nm s^{-1}, of one chromatid during anaphase using the following equation:

$P = F \times V$

Where P = power in W

F = force in N

V = speed in m s^{-1}

Show your working. [2 marks]

Answer _____ nm s^{-1}

[Turn over]

9

0 8 . 1

A student investigated a method for estimating the concentration of protein in solution by using a measure of the density of the solutions.

Copper sulfate solutions of different concentration have known densities, so they can be used to measure the density of other solutions.

The student prepared a dilution series of a copper sulfate solution.

Complete TABLE 3, on the opposite page, by giving all headings, units and volumes required to make 30 cm^3 of the concentration of the copper sulfate solution shown. [2 marks]

TABLE 3

Concentration of copper sulfate solution / g kg^{-1}	Volume of 100 g kg^{-1} copper sulfate solution / _____	Volume of water / _____
75	_____	_____

[Turn over]

0 8 . 2

TABLE 4 shows the densities of the dilution series of the copper sulfate solution.

TABLE 4

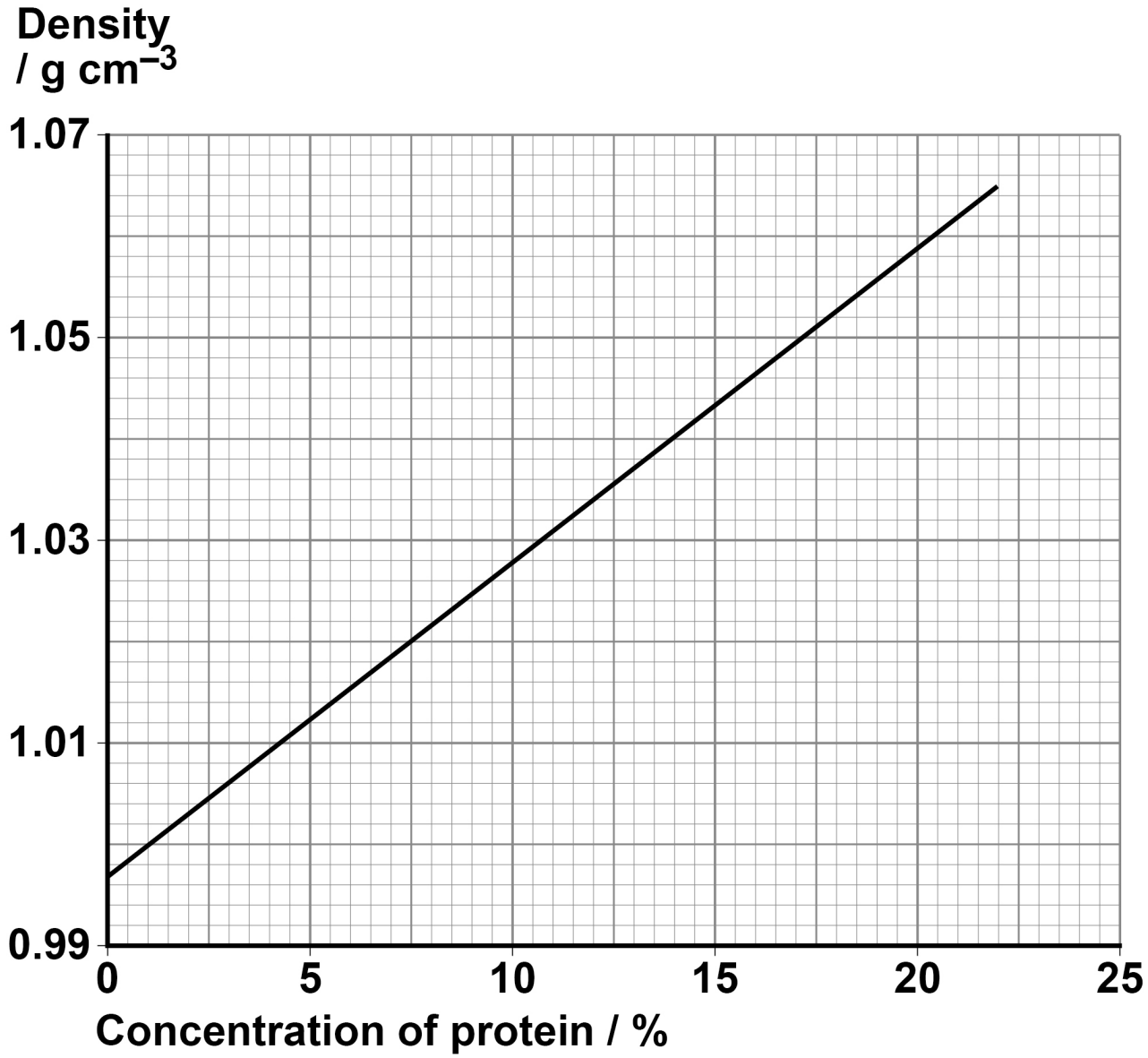
Concentration of copper sulfate solution / g kg^{-1}	Density of solution / g cm^{-3}
0	0.997
25	1.014
50	1.030
75	1.048
100	1.065

BLANK PAGE

[Turn over]

FIGURE 5 shows the densities of protein solutions of different concentration.

FIGURE 5



The student put one drop of 10% protein solution into each of the copper sulfate solutions shown in TABLE 4, on page 44.

Using FIGURE 5, on the opposite page, he predicted that the drop would sink in the 0 and 25 g kg^{-1} copper sulfate solutions and float in the 50, 75 and 100 g kg^{-1} copper sulfate solutions.

Give the density of the 10% protein solution AND explain why the student predicted that the drop would sink in the 25 g kg^{-1} copper sulfate solution. [2 marks]

Density of 10% protein solution

_____ g cm^{-3}

Explanation _____

_____

_____

_____

_____

_____

_____

[Turn over]

0 8 . 3

State the range of possible concentrations of a protein solution that sinks in 75 g kg^{-1} copper sulfate solution and floats in 100 g kg^{-1} copper sulfate solution.
[1 mark]

Minimum concentration _____ %

Maximum concentration _____ %

BLANK PAGE

[Turn over]

0 8 . 4

Blood donation involves healthy donors giving blood that can be used to treat hospital patients.

When donors arrive, the haemoglobin concentration of their blood is tested.

A sample of each donor's blood is added to a copper sulfate solution to determine whether the haemoglobin concentration is high enough to donate.

Errors sometimes occur with this test.

Tom has a concentration of haemoglobin high enough to donate.

Lucy has a concentration of haemoglobin too low to donate.

Evaluate the consequences of errors occurring when Tom's and Lucy's blood samples are tested. [3 marks]

Consequences of measurement error for Tom's blood

Consequences of measurement error for Lucy's blood

8

0 9

Scientists dissected gills from several species of fish. They recorded:

- **the mass of the whole fish**
- **the total number of gill filaments**
- **the mean length of one filament**
- **the mean number of lamellae per mm**
- **the mean surface area of one lamella.**

0 9 . 1

It was not possible for the scientists to measure the length of every filament and the surface area of every lamella.

Suggest how they collected data to give a reliable mean for these variables. [2 marks]

[Turn over]

0 9 . 2

From these measurements, the scientists calculated the total surface area of the gas exchange surface on the gills of each fish species.

Calculate the total surface area of the gills of a fish with the following measurements:

- **total number of gill filaments = 595**
- **mean length of one filament = 2.86 mm**
- **mean number of lamellae per mm = 16**
- **mean surface area of one lamella = 0.66 mm^2**

Give your answer in mm^2 AND to an appropriate number of significant figures.

Show your working. [2 marks]

_____ mm^2

[Turn over]

0 9 . 3

TABLE 5 shows the scientists' data for two species of fish.

TABLE 5

Fish species	Mean fish mass / g	Mean total surface area of the gills / mm^2
'Opsanus tau'	305	46 100
'Trachurus trachurus'	250	252 500

One of these fish spends most of its time not moving, waiting to catch passing prey. The other species is very active, hunting mobile prey.

Suggest which of the species in TABLE 5 is the very active fish species.

Explain your answer. [2 marks]

Very active fish species _____

_____

Explanation _____

_____

_____

_____

_____

_____

_____

_____

[Turn over]

0 9 . 4

Complete TABLE 6 to show the phylogenetic classification for these two species. [2 marks]

TABLE 6

TAXON	'OPSANUS TAU'	'TRACHURUS TRACHURUS'
		Animalia
	Chordata	
Class	Actinopterygii	Actinopterygii
	Batrachoidiformes	Carangiformes
Family	Batrachoididae	Carangidae
Genus		
Species	'tau'	'trachurus'

8

1 0 . 1

Outline the similarities in, and the differences between, the structures of DNA and RNA molecules. [6 marks]

[Turn over]

1 0 . 2

Outline the similarities in, and the differences between, the structures of chloroplasts and mitochondria.
[4 marks]

END OF QUESTIONS

10

Additional page, if required.

Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

BLANK PAGE

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	