Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S24-3400UB0-1

3400UB0-1

FRIDAY, 10 MAY 2024 – MORNING

BIOLOGY – Unit 2:
Variation, Homeostasis and Micro-organisms
HIGHER TIER

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**10**	
3.	**5**	
4.	**8**	
5.	**6**	
6.	**5**	
7.	**5**	
8.	**10**	
9.	**9**	
10.	**12**	
Total	**80**	

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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 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 page 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.

Question **9**(b) is a quality of extended response (QER) question where your writing skills will be assessed.

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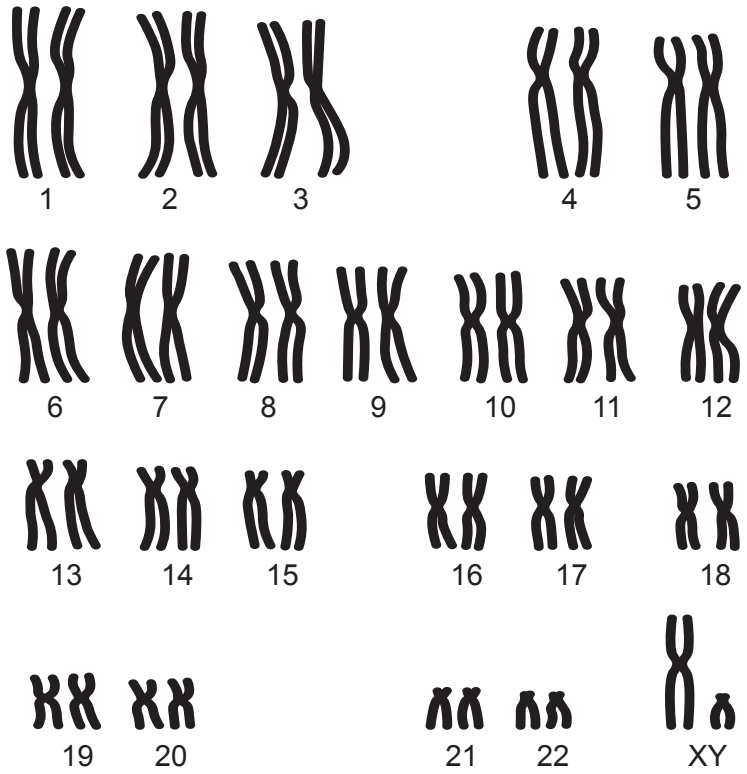
Answer **all** questions

1. **Image 1.1** shows a set of chromosomes from a human male body cell.

Image 1.1



(a) (i) State the number of chromosomes in a human body cell. [1]

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(ii) Draw a **circle** around the sex chromosomes in **Image 1.1**. [1]

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(b) **Images 1.2A** and **1.2B** show male and female lions.

Image 1.2A

Male

Image 1.2B

Female

(i) Complete the Punnett square below to show possible offspring when the male lion (XY) and the female lion (XX) mate. [2]

(ii) State the expected ratio of male:female lions in the offspring. [1]

..... : .....

(iii) State whether it is the male or female lion that determines the sex of the offspring. Explain your answer. [2]

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(c) Lions have 38 chromosomes in their body cells.

(i) State how many chromosomes there are in a **sex cell** of a lion. [1]

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(ii) State the scientific name for sex cells. [1]

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(iii) Name the type of cell division that produces sex cells. [1]

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2. A class of year 11 boys were investigating reaction time. The students suggested the following hypothesis:

"Year 11 students have faster reaction times than teachers"

A computer program was used to record the reaction time. Each individual had to press a button on the keyboard when the screen turned green (**Image 2.1**). Each individual had three attempts and the mean value was recorded.

Image 2.1

(a) (i) State the stimulus and the receptor involved in this investigation. [2]

Stimulus: .....

Receptor: .....

(ii) Describe how the information travels from the **receptor** to the **central nervous system**. [2]

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(b) The results for the students are shown in **Table 2.2** and the teachers in **Table 2.3**.

Table 2.2

Name	Age	Reaction time (ms)
Rhidian	15	382
Iestyn	15	412
Reuben	15	375
James	15	399
Harvey	15	401
		Mean reaction time = 394

Table 2.3

Name	Age	Reaction time (ms)
Miss Williams	42	479
Mr Davies	32	391
Mrs Wilcox	37	415
Mr Jones	55	475
Mrs Evans	48	431
		Mean reaction time = ...

(i) Complete **Table 2.3** by calculating the mean reaction time for the teachers **to the nearest whole number**. [2]
Space for working.

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(ii) Evaluate the extent to which the results in **Tables 2.2** and **2.3** support the students' hypothesis. [2]

You should do this by giving:
- **one** piece of evidence that supports the hypothesis
- **one** piece of evidence that does not support the hypothesis

Evidence that supports hypothesis

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Evidence that does not support the hypothesis

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(iii) State **one** variable that should have been controlled in this investigation. [1]

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(iv) State **one** way that the students could have increased their confidence in their results. [1]

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3. Researchers have created an artificial eye that models the constriction and dilation of the pupil. The change in size of the pupil in response to changing light levels is an example of a reflex arc.

Image 3.1A shows a diagram of the eye and **Image 3.1B** shows parts from the artificial eye model.

Image 3.1A

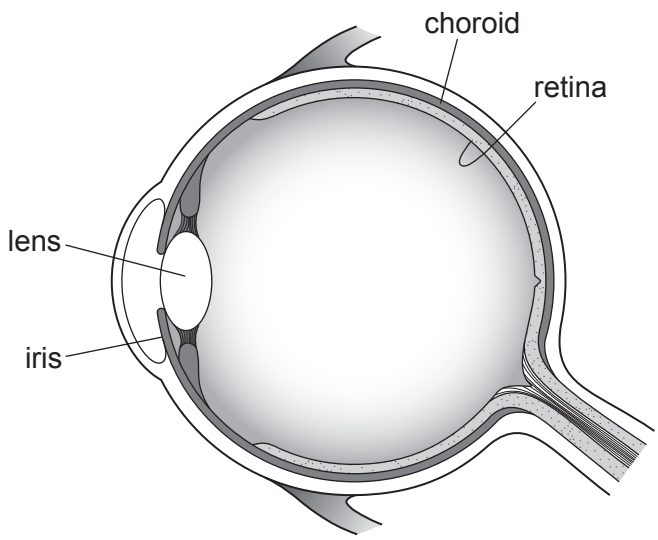
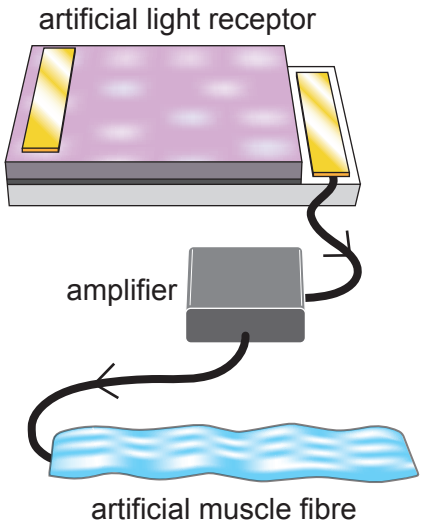


Image 3.1B



(a) **Draw an arrow** labelled **A** on **Image 3.1A** to show the sclera. [1]

(b) State **two** properties of a reflex arc. [1]

1. .....

2. .....

(c) State the name of the part of the eye represented by the artificial muscle fibre in **Image 3.1B**. [1]

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(d) Describe how the diameter of the pupil changes in response to bright light. State the advantage of this change to the eye. [2]

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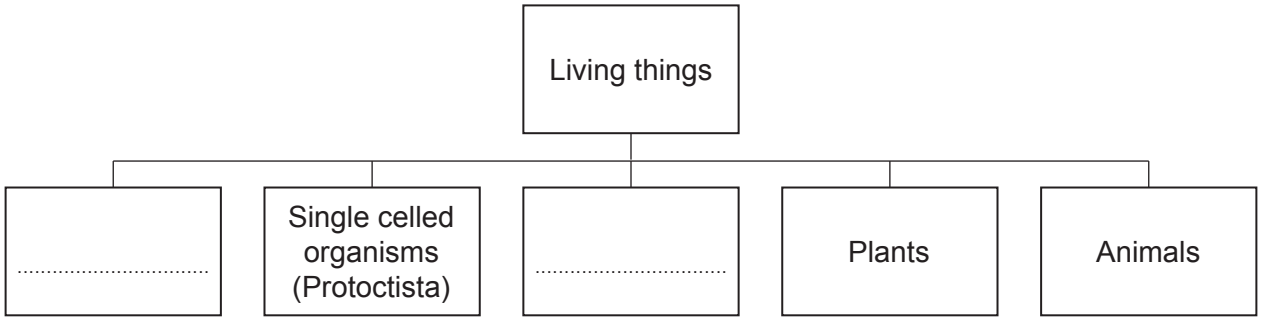
4. The five Kingdom system can be used to classify all living things.

(a) Complete the classification chart, **Image 4.1**, by inserting the names of the **two** missing Kingdoms. [2]

Image 4.1



(b) In 1825, red pandas were classified as members of the racoon family (Procyonidae). Later, they were classified as members of the bear family (Ursidae). The most recent research has classified red pandas in their own family (Ailuridae). **Image 4.2** shows red pandas.

Image 4.2

Suggest the evidence that would have been used in 1825 to classify red pandas. State the type of evidence available to researchers more recently that resulted in the reclassification of red pandas. [2]

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(c) In 2015, the International Union for Conservation of Nature (IUCN) assessed red pandas as endangered.

Table 4.3 shows the results of studies into population densities of red pandas in five districts of Nepal between 1989 and 2014.

Table 4.3

District	Year of study	Size of area studied (km^2)	Number of red pandas counted	Population density (number/km^2)
Rara	2014	35	11	.....
Langtang	1989	142	68	0.48
Panchthar	2004	178	100	0.56
Dhorpatan	2012	Known to be present but no data available		
Bhotkhola	2011	41	135	3.29

(i) Calculate the population density of red pandas in the Rara district in 2014.
Write your answer in Table 4.3. [1]
Space for working

(ii) In 1991, the population density of red pandas in Langtang had decreased to 0.17 per km^2.
Suggest **one** reason for the decrease.
State **one** method by which endangered species could be conserved. [2]

Reason for decrease

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Method of conservation

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(iii) Using data from **Table 4.3**, suggest the district in which red pandas have the highest chance of survival. Give a reason for your answer. [1]

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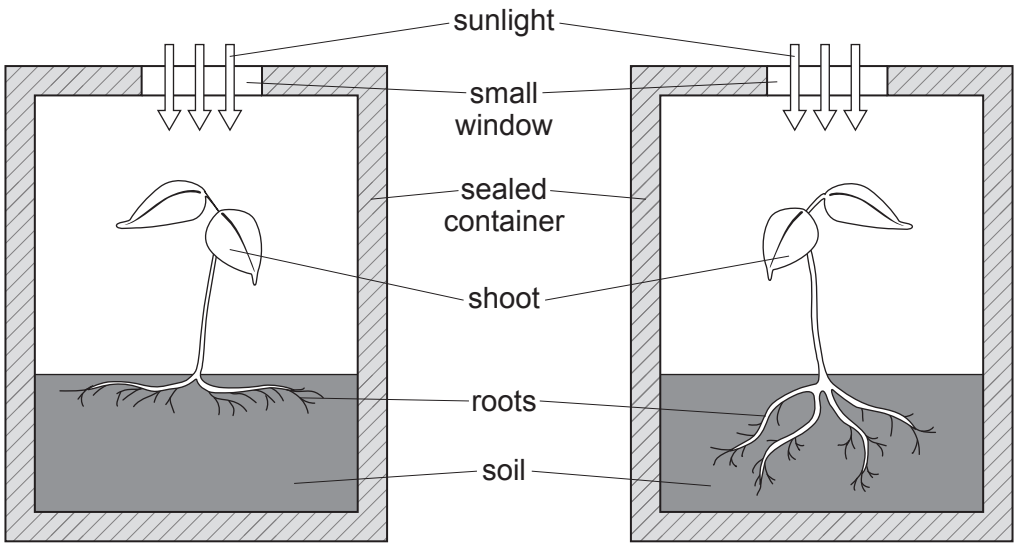
5. In 2010, scientists in China carried out an investigation to compare the growth of seeds on Earth and on the moon.

They sent seeds in a sealed container on board a rocket to the moon. The sealed container contained all the necessary conditions to allow the seeds to grow. The sealed container had a small window at the top, which allowed sunlight to reach the growing seeds. The container was at the same atmospheric pressure as the Earth.

An identical sealed container which contained identical seeds was kept on Earth. The scientists observed the seeds growing in both containers.

Images 5.1A and **5.1B** show the results of the investigations.

Image 5.1A **Image 5.1B**



a seed grown on the moon a seed grown on the Earth

(a) State the name of:

(i) the growth response shown by the **shoots** in **Image 5.1A** and **Image 5.1B**. [1]

.....

(ii) the hormone that controls growth responses in plants. [1]

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(b) (i) Describe **one** difference in the growth of the roots in **Images 5.1A** and **5.1B**. [1]

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(ii) Suggest **one** reason for the difference between the growth of seeds grown on the moon and those grown on Earth. [1]

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(c) State the term used for carrying out an identical investigation on Earth.
Suggest why this is important. [2]

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6

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6. Two students used modelling to illustrate the effect of camouflage in predator-prey relationships. In their investigation, spaghetti was used to model the prey and forceps to model the predator. They used the following method.

Method

1. Mark out a $1m^2$ area of green grass on a field.
2. Mix together 20 pieces of green spaghetti and 20 of red spaghetti, all 5 cm in length, in a beaker.
3. Empty the contents of the beaker in the marked area, ensure all the pieces are evenly spread out.
4. Use a pair of forceps to pick up as many pieces of spaghetti as possible in 30 seconds. Remove these from the model.
5. Count the number of spaghetti pieces left on the grass after 30 seconds.
6. For each pair of a colour left on the grass, add one more piece of spaghetti of the same colour to model the process of reproduction.
7. Repeat steps 4 to 6 twice more.

The results of the experiment are shown in **Table 6**.

Table 6

	Number of pieces of spaghetti present on the grass		Number of pieces of spaghetti added	
	Green	Red	Green	Red
At start	20	20		
After 1st pick	18	10	9	5
After 2nd pick	22	8	11	4
After 3rd pick	27	5		

(a) (i) Suggest what would happen to the number of red spaghetti pieces present on the grass, after a 4th pick. [1]

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(ii) State the name of the evolutionary process being modelled in this investigation. [1]

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(b) State the type of reproduction represented in this model. [1]

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(c) This model has limitations. Suggest **two** limitations in this model. [2]

Limitation 1 .....

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Limitation 2 .....

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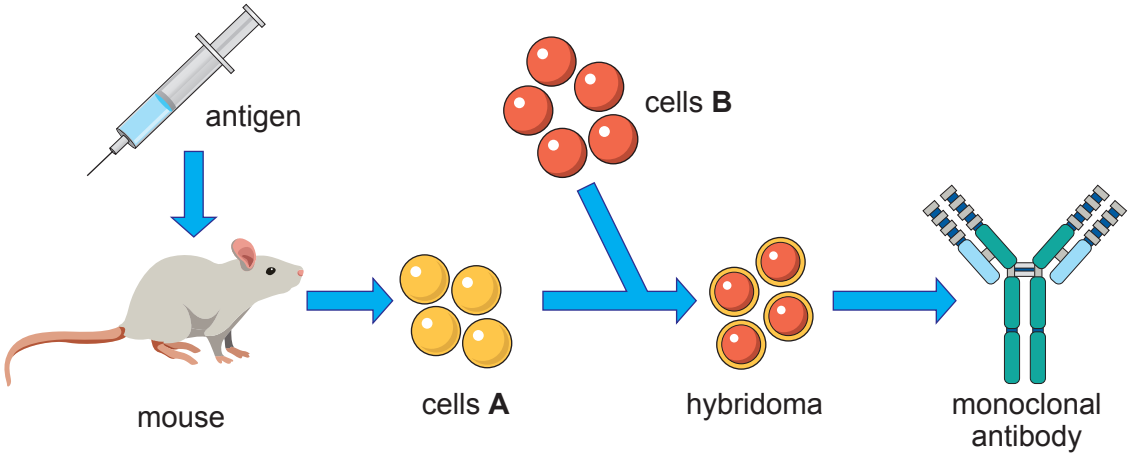
7. Strovimab is a monoclonal antibody that is used to treat coronavirus (COVID-19). In a randomised double-blind, placebo-controlled study, Strovimab was shown to reduce the risk of hospitalisation due to COVID-19 by 79%.

Image 7 shows a process for producing monoclonal antibodies.

Image 7



(a) With reference to **Image 7**, state the names of the cells labelled: [2]

A .....

B .....

(b) Strovimab is manufactured using cells grown in a laboratory instead of a live mouse, as shown in **Image 7**.
Suggest **one** ethical advantage of using cells grown in a laboratory instead of using a live mouse. [1]

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(c) State what is meant by the terms: [2]

(i) double-blind;

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(ii) placebo.

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8. Kidney transplants can save the lives of individuals with chronic kidney disease or kidney failure. In the UK in 2021, there were 2912 kidney transplants.
Individuals who receive organ transplants must take drugs to suppress their immune response. However, it is estimated that 12.5% of kidneys transplanted are still rejected in the first year after a transplant.

(a) Calculate the number of rejected kidney transplants in 2021. [2]
Space for working

number of rejected kidney transplants = ...

(b) In 2019, it was reported that an individual who had received a kidney transplant had survived for 19 months without taking drugs to suppress their immune response.
Before the transplant, this individual had a small number of stem cells taken from their bone marrow. The stem cells were grown and multiplied in the lab and then reinjected into the individual the day before the transplant.
Some scientists suggested that the injection of stem cells from the bone marrow caused the body to accept the foreign antigens on the transplanted kidney.

Not all scientists were confident that the stem cells were responsible, because a second person given the same treatment was not able to survive without drugs to suppress their immune response.

(i) State what is meant by the term **stem cell**. [2]

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(ii) I. Name the type of cell division that occurs when stem cells are grown in the laboratory. [1]

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II. Give **one** feature of this type of cell division which is important in the production of stem cells. [1]

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(iii) State **one** benefit to the patient of using stem cells from their own bone marrow rather than stem cells from the bone marrow of another individual. [1]

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(iv) Adult stem cells were used in this procedure. Name **one** other source of stem cells. [1]

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(c) Suggest **one** way in which the scientific community could increase their confidence that the injection of stem cells was responsible for the result observed. [1]

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(d) Dialysis is another treatment for kidney disease.
State **one** disadvantage of dialysis compared with kidney transplants. [1]

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9. The water intake of a female athlete was monitored before and after completing a marathon. In the 24 hours before the marathon her water intake was 2.70 litres. On the day of the marathon her water intake was 10.4 litres.

(a) Calculate the percentage increase in water intake on the day of the marathon compared to the 24 hours before the marathon. Give your answer to **three significant figures**. [3]
Space for working

Increase in water intake = ... %

(b) During a marathon, an athlete is at risk of becoming dehydrated.
Explain how the brain and kidneys control the level of water in blood during the race to reduce the risk of dehydration. [6 QER]

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10. The 4CMenB vaccine was created to target a bacterium called *Neisseria meningitidis*, which causes a form of a disease called meningitis. The vaccine has also been found to reduce the rates of a sexually transmitted infection (STI) called gonorrhoea. Gonorrhoea is caused by a bacterium called *Neisseria gonorrhoeae*.

(a) Explain how the 4CMenB vaccine causes the body to develop immunity against *Neisseria meningitidis*. [4]

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(b) Use your knowledge of classification to suggest why the 4CMenB vaccine is also effective against gonorrhoea. [2]

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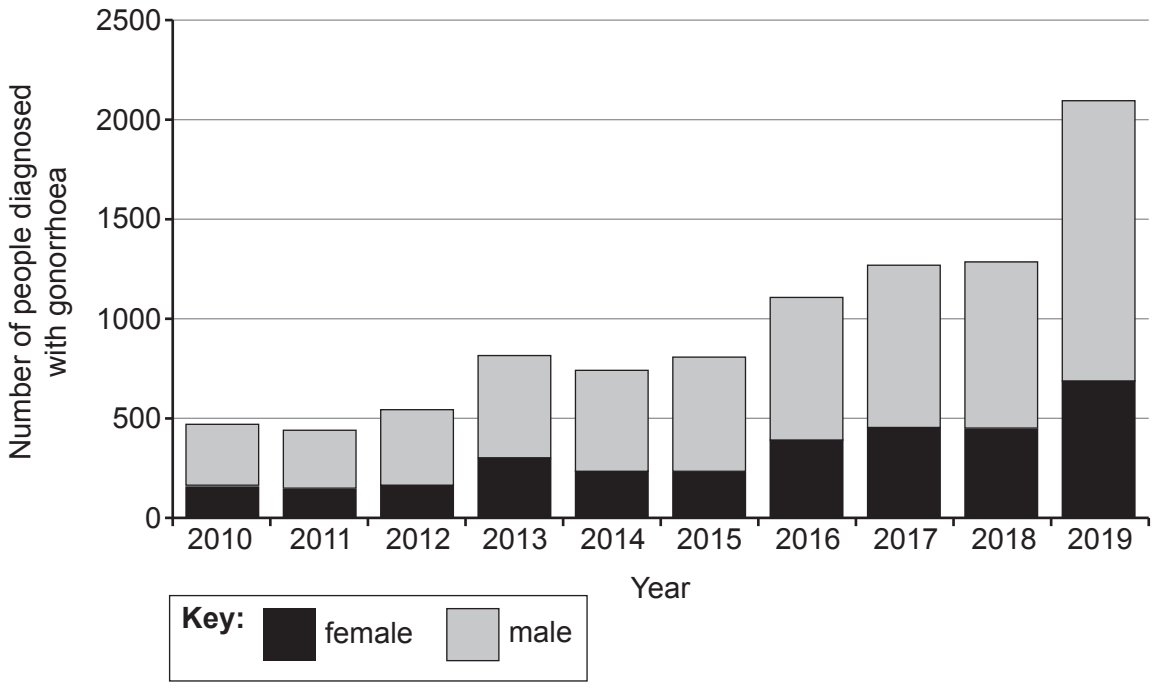
(c) Gonorrhoea is symptomless in up to 50% of females and 10% of males. Left untreated, it can cause infertility in women.

Graph 10 shows the number of people in Australia diagnosed with gonorrhoea between 2010 and 2019.

Graph 10



In 2019, the 4CMenB vaccine was introduced in Australia for people between 17 and 20 years old and the probability of getting gonorrhoea was reduced by 33%. In a similar study in the US, the vaccine was introduced for 16 to 23-year-olds, reducing the probability of getting gonorrhoea by 40%.

(i) Compare the trends shown in **Graph 10** for the number of males and females diagnosed with gonorrhoea between 2010 and 2019. [2]

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(ii) Suggest why it is more difficult to reduce the number of women with gonorrhoea compared with men. [1]

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(iii) Evaluate how the evidence provided shows that the 4CMenB vaccine could be effective against gonorrhoea worldwide. [2]

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(d) State **one** other way, apart from vaccination, to prevent the spread of an STI. [1]

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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