GCSE

3400UB0-1

FRIDAY, 10 MAY 2024 – MORNING

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

HIGHER TIER

1 hour 45 minutes plus your additional time allowance

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

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ADDITIONAL MATERIALS

A calculator and a ruler.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Diagram Booklet.

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces provided on the front cover.

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.

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

(Turn over)

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	

Answer ALL questions

1 **IMAGE 1.1 in the separate diagram booklet shows a set of chromosomes from a human male body cell.**

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

(ii) **Draw a CIRCLE around the sex chromosomes in IMAGE 1.1. [1 mark]**

1 (b) **IMAGES 1.2A and 1.2B in the separate diagram booklet show male and female lions.**

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

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

_____ : _____

1 (b)(iii)

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

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

(i) **State how many chromosomes there are in a SEX CELL of a lion. [1 mark]**

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

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

10

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 in the separate diagram booklet). Each individual had three attempts and the mean value was recorded.

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

Stimulus: _____

Receptor: _____

2 (a)(ii)

Describe how the information travels from the RECEPTOR to the CENTRAL NERVOUS SYSTEM. [2 marks]

2 (b) **The results for the students are shown in TABLE 2.2 in the separate diagram booklet and the teachers in TABLE 2.3 in the separate diagram booklet.**

(i) **Complete TABLE 2.3 by calculating the mean reaction time for the teachers TO THE NEAREST WHOLE NUMBER. [2 marks]**
Space for working.

2 (b)(ii)

Evaluate the extent to which the results in TABLES 2.2 and 2.3 support the students' hypothesis. [2 marks]

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

_____

_____

_____

Evidence that does not support the hypothesis

_____

_____

_____

2 (b)(iii)

State ONE variable that should have been controlled in this investigation. [1 mark]

_____

_____

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

_____

_____

_____

10

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 in the separate diagram booklet shows a diagram of the eye and IMAGE 3.1B in the separate diagram booklet shows parts from the artificial eye model.

(a) DRAW AN ARROW labelled A on IMAGE 3.1A to show the sclera. [1 mark]

(b) State TWO properties of a reflex arc. [1 mark]

1. _____

2. _____

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

_____

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

5

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

(a) **Complete the classification chart, IMAGE 4.1 in the separate diagram booklet, by inserting the names of the TWO missing Kingdoms. [2 marks]**

(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 in the separate diagram booklet shows red pandas.**

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 marks]

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

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

(i) **Calculate the population density of red pandas in the Rara district in 2014.**
WRITE YOUR ANSWER IN TABLE 4.3.
[1 mark]
Space for working

4 (c)(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 marks]

Reason for decrease

_____

_____

_____

Method of conservation

_____

_____

4 (c)(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 mark]

8

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 in the separate diagram booklet show the results of the investigations.

(a) **State the name of:**

(i) **the growth response shown by the SHOOTS in IMAGE 5.1A and IMAGE 5.1B. [1 mark]**

_____

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

_____

5 (b)(i) Describe ONE difference in the growth of the roots in IMAGES 5.1A and 5.1B. [1 mark]

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

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

6

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 $1 m^2$ 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 in the separate diagram booklet.

(Turn over)

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

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

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

6 (c) This model has limitations. Suggest TWO limitations in this model. [2 marks]

Limitation 1

Limitation 2

5

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 in the separate diagram booklet shows a process for producing monoclonal antibodies.

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

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 mark]

_____

_____

_____

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

(i) double-blind;

(ii) placebo.

5

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 marks]**
Space for working

number of rejected kidney transplants = _____

8 (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 marks]

_____

_____

_____

8 (b)(ii)

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

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

(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 mark]

8 (b)(iv)

Adult stem cells were used in this procedure.
Name ONE other source of stem cells.
[1 mark]

(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 mark]**

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

10

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 marks]**
Space for working

Increase in water intake = _____ %

9 (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 marks QER]

continue your answer on the next page

9

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 marks]

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

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

GRAPH 10 in the separate diagram booklet shows the number of people in Australia diagnosed with gonorrhoea between 2010 and 2019.

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 marks]

10 (c)(ii)

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

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

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

_____

_____

12

END OF PAPER

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

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1 hour 45 minutes plus your additional time allowance

DIAGRAM BOOKLET

This Diagram Booklet MUST be handed in to the invigilators and sent for marking.

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

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IMAGE 1.1

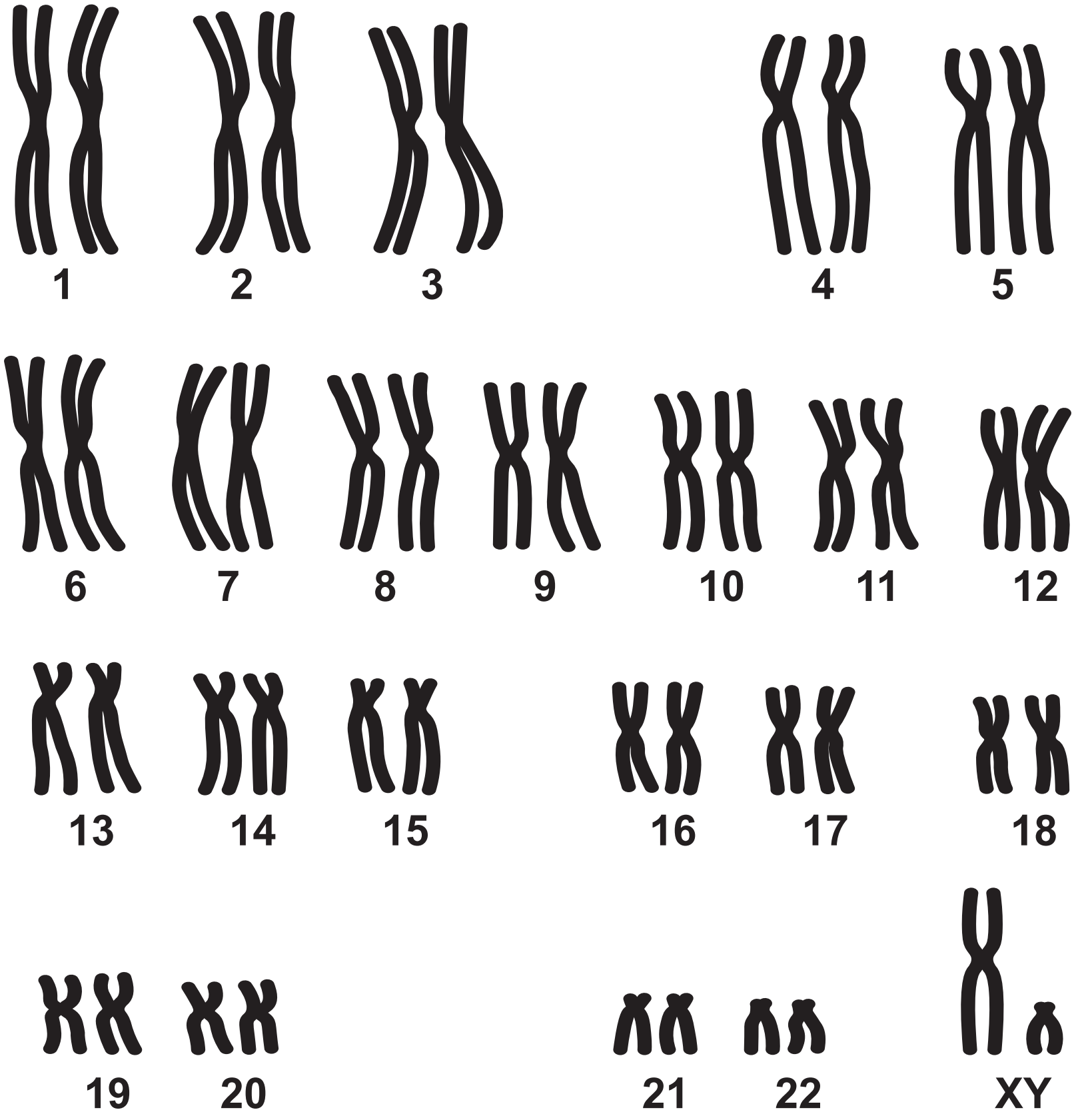


IMAGE 1.2A

Male

IMAGE 1.2B

Female

IMAGE 2.1

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 = _____

IMAGE 3.1A

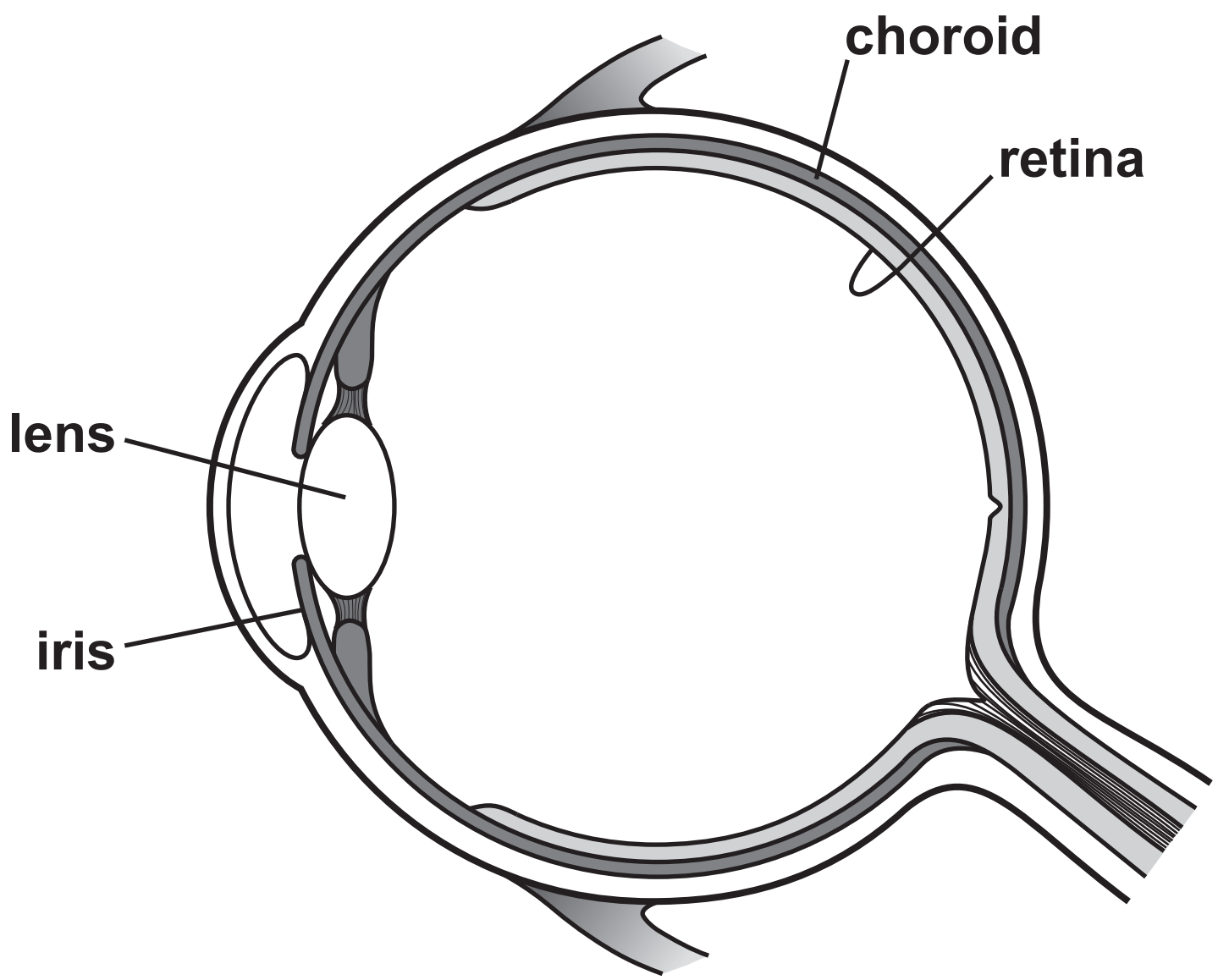


IMAGE 3.1B

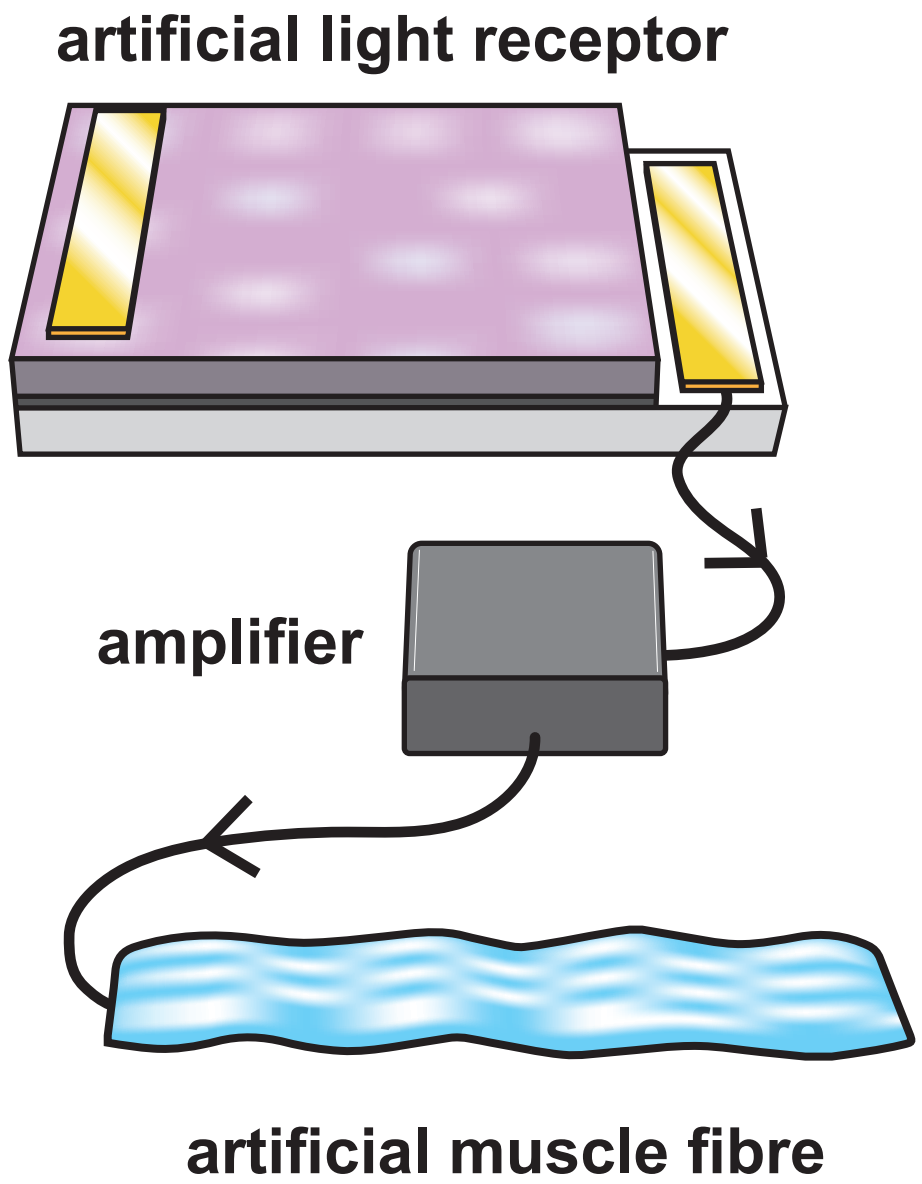


IMAGE 4.1

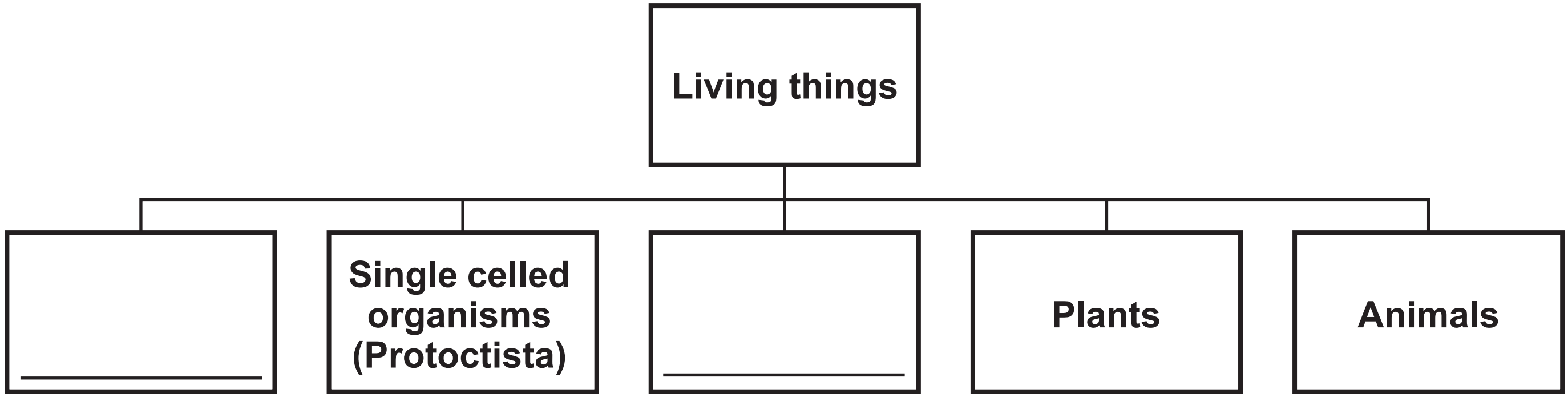

Living things
Single celled organisms (Protoctista)
Plants
Animals

IMAGE 4.2

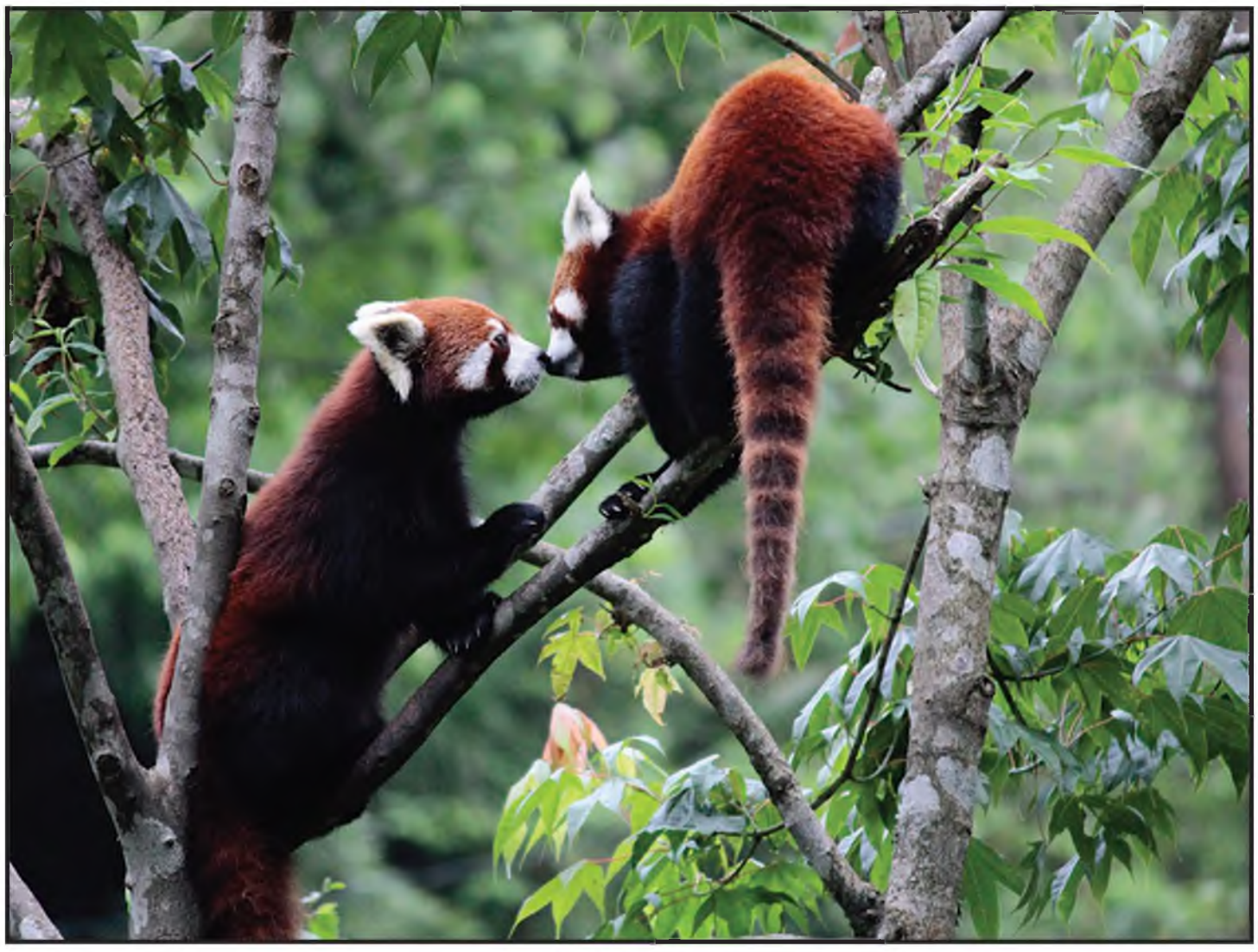


TABLE 4.3

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

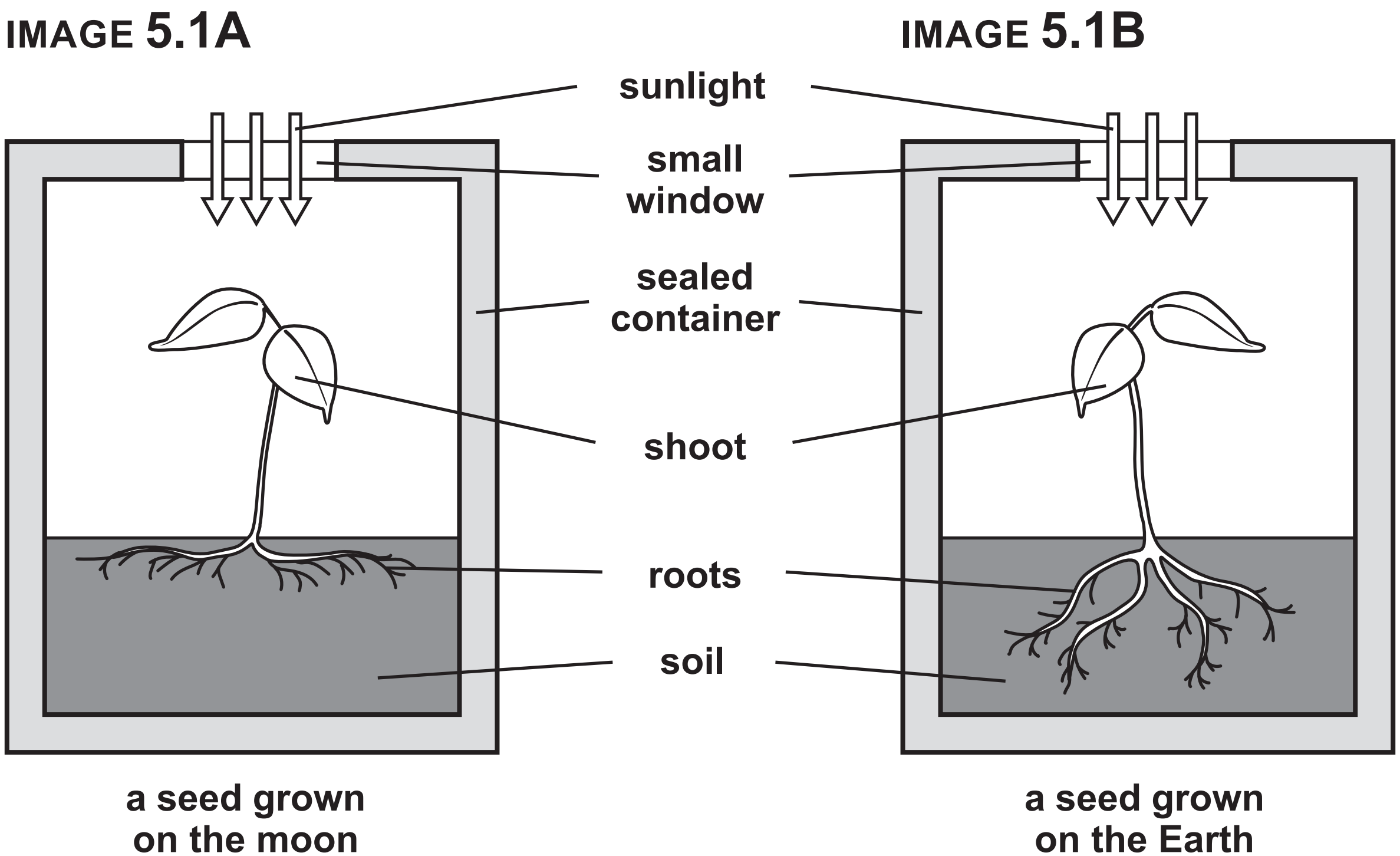
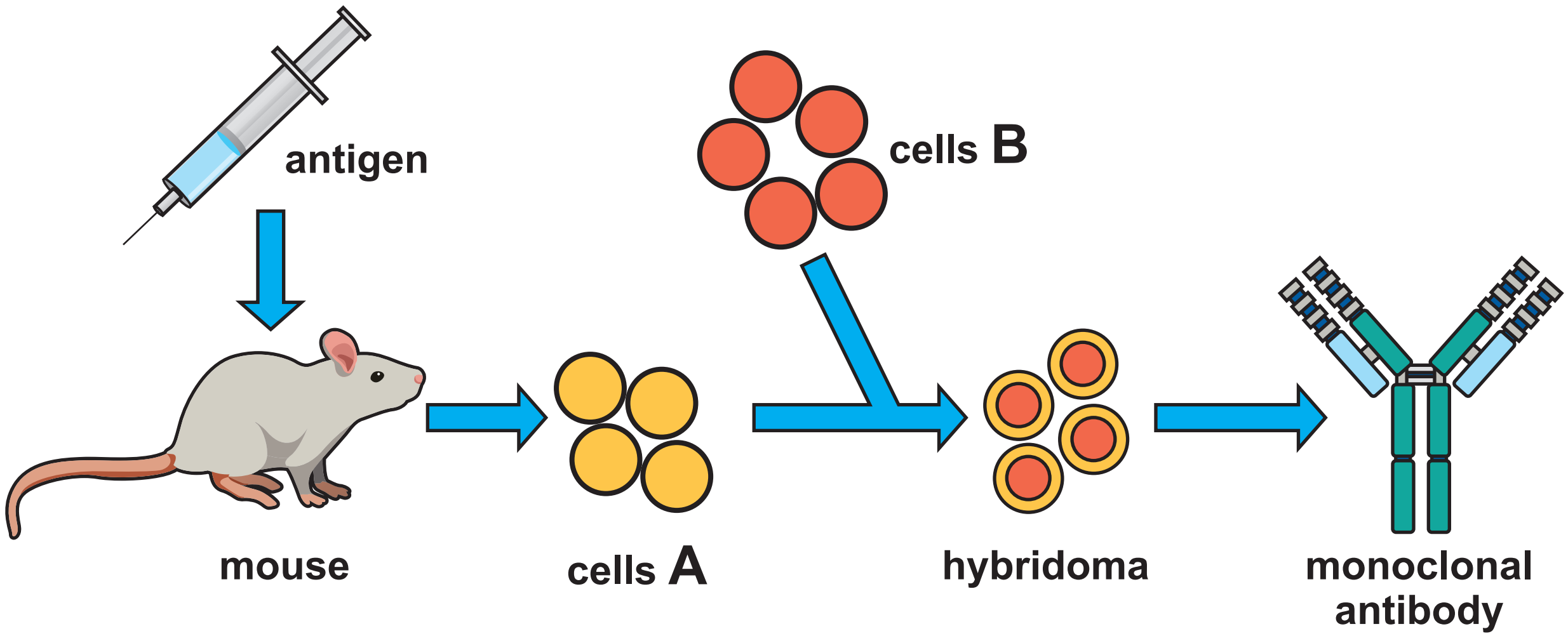


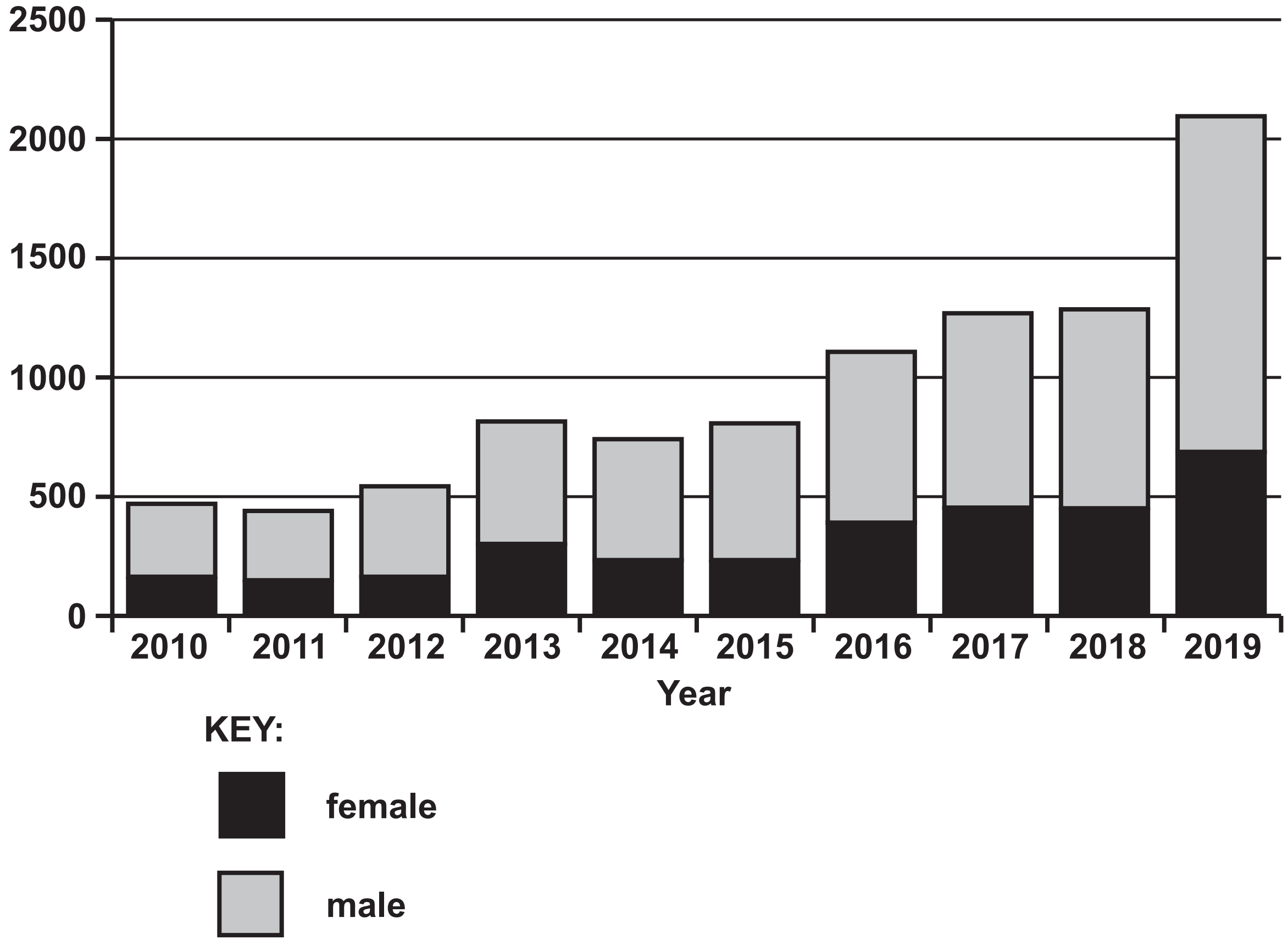
IMAGE 5.1A
IMAGE 5.1B
sunlight
small window
sealed container
shoot
roots
soil
a seed grown on the moon
a seed grown on the Earth

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		

IMAGE 7


antigen
cells B
mouse
cells A
hybridoma
monoclonal antibody

GRAPH 10

Number of people diagnosed with gonorrhoea