AQA GCSE Biology | 8461

SPECIFICATION POINT 4.6.1.6

Genetic inheritance

Past-paper questions

Tier	**Higher**
Question groups	**24**
Available paper years	**2008–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.6.1.6 Genetic inheritance

Question 01

June 2008 | BLY2H | Original Q2 | Legacy

2 Cystic fibrosis is an inherited disorder that can seriously affect health.

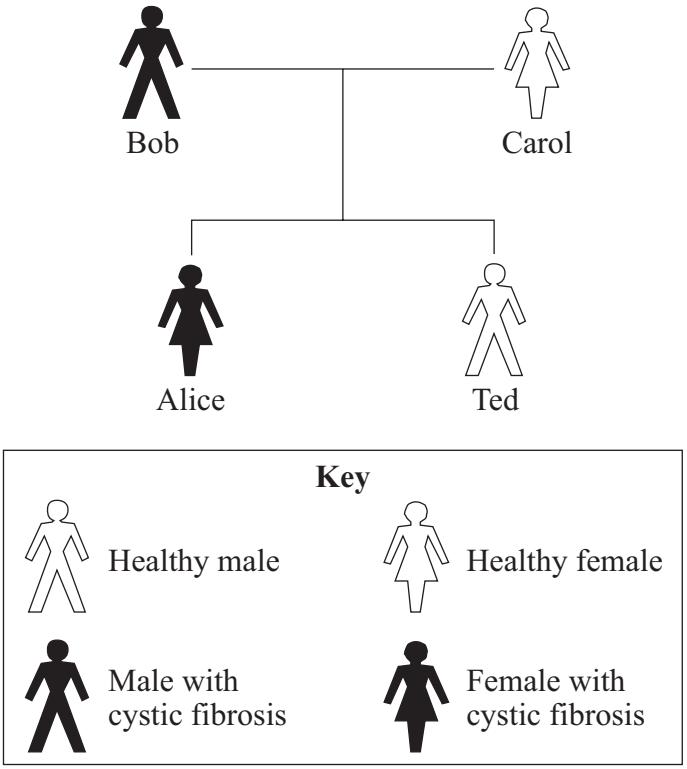
2 (a) Which **one** of these is affected by cystic fibrosis?

Draw a ring around your answer.

blood **cell membranes** **kidneys** **nervous system**

(1 mark)

2 (b) The diagram shows the inheritance of cystic fibrosis in a family. The allele that produces cystic fibrosis is recessive.



2 (b) (i) Explain why Alice inherited cystic fibrosis.

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(2 marks)

4.6.1.6 Genetic inheritance

Question 01 · continued

for mark

2 (b) (ii) Explain why Ted did **not** inherit cystic fibrosis.

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(2 marks)

2 (c) Bob and Carol know that there is a risk that their next baby will have cystic fibrosis.

Embryos can be screened for the allele that produces cystic fibrosis.

Many people support the screening of embryos, but others do not.

2 (c) (i) Suggest **one** reason why many people support the screening of embryos for the cystic fibrosis allele.

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(1 mark)

2 (c) (ii) Suggest **one** reason why many people are against the screening of embryos for the cystic fibrosis allele.

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(1 mark)

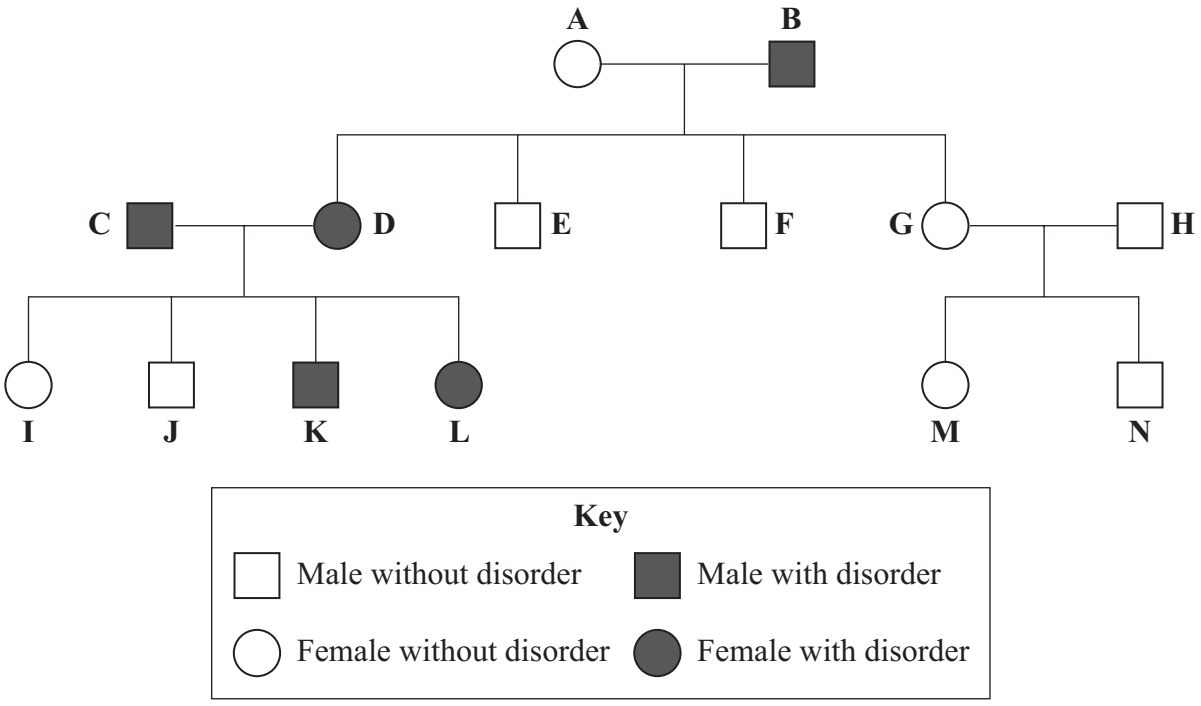
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4.6.1.6 Genetic inheritance

Question 02

January 2009 | BLY2H | Original Q6 | Legacy

6 The diagram shows a family tree in which some individuals have an inherited disorder, which may cause serious long-term health problems.



6 (a) What proportion of the children of **A** and **B** have the disorder?

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(1 mark)

6 (b) Explain the evidence from the diagram which shows that the allele for the disorder is dominant.

Use the appropriate letters to identify individuals in your answer.

You may use genetic diagrams in your explanation. There is space for you to draw a genetic diagram at the top of the facing page.

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4.6.1.6 Genetic inheritance

Question 02 · continued

for mark

(3 marks)

6 (c) (i) What is meant by 'embryo screening'?

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(1 mark)

6 (c) (ii) A doctor suggests that couple **C** and **D** should have their embryos screened but that couple **G** and **H** do **not** need this procedure.

Explain the reasons for the doctor's suggestions.

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(3 marks)

8

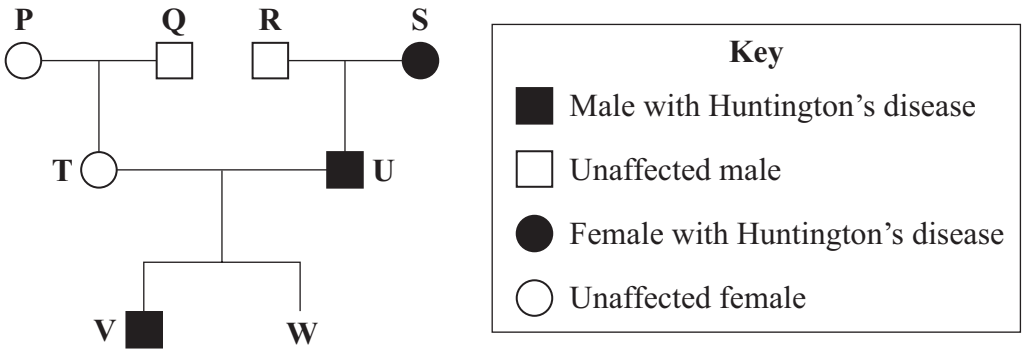
4.6.1.6 Genetic inheritance

Question 03

June 2009 | BLY2H | Original Q6 | Legacy

6 Huntington's disease is a disorder of the nervous system. It is caused by a dominant allele.

The family tree shows the inheritance of Huntington's disease in one family.



6 (a) **T** and **U** already have a son, **V**, with Huntington's disease. What is the chance that their next child, **W**, will also develop Huntington's disease?

Use a genetic diagram in your answer.

Use the symbols **H** to represent the dominant allele and **h** to represent the recessive allele.

Chance that child **W** will have Huntington's disease = ...

(4 marks)

4.6.1.6 Genetic inheritance

Question 03 · continued

for mark

6 (b) A doctor advises parents **T** and **U** that embryo **W** should be 'screened'.

6 (b) (i) What is embryo screening?

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(1 mark)

6 (b) (ii) Some people do not believe that embryos should be screened.

Give **one** reason why.

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(1 mark)

6 (c) Cystic fibrosis is an inherited disorder in which the person's mucus becomes thick.

6 (c) (i) For this gene, one allele in every 30 in the population is the cystic fibrosis allele. However, only one person in every 900 has cystic fibrosis.

Explain why.

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(2 marks)

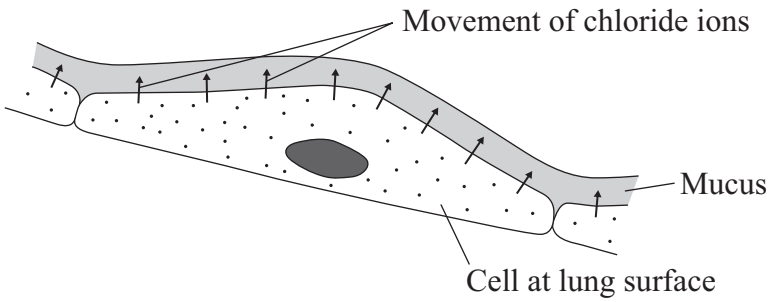
Question 6 continues on the next page

4.6.1.6 Genetic inheritance

Question 03 · continued

for mark

6 (c) (ii) The diagram shows how, in a healthy person, cells at the lung surface move chloride ions into the mucus surrounding the air passages.



This movement of chloride ions causes water to pass out of the cells into the mucus.

Explain why.

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(3 marks)

6 (c) (iii) Mucus contains protein.

Which parts of the lung cells manufacture the protein in mucus?

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(1 mark)

12

4.6.1.6 Genetic inheritance

Question 04

5 (a) Mr and Mrs Smith both have a history of cystic fibrosis in their families.
Neither of them has cystic fibrosis.
Mr and Mrs Smith are concerned that they may have a child with cystic fibrosis.

Use a genetic diagram to show how they could have a child with cystic fibrosis.

Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.

(3 marks)

4.6.1.6 Genetic inheritance

Question 04 · continued

for mark

5 (b) Mr and Mrs Smith decided to visit a genetic counsellor who discusses embryo screening.

Read the information which they received from the counsellor.

- Under an anaesthetic five eggs will be removed from Mrs Smith's ovary.
- The eggs will be fertilised in a dish using Mr Smith's sperm cells.
- The embryos will be grown in the dish until each embryo has about thirty cells.
- One cell will be removed from each embryo and tested for cystic fibrosis.
- A suitable embryo will be placed into Mrs. Smith's uterus and she may become pregnant.
- Any unsuitable embryos will be killed.

5 (b) (i) Suggest why it is helpful to take five eggs from the ovary, rather than just one.

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(1 mark)

5 (b) (ii) Evaluate the use of embryo screening in this case.

Remember to give a conclusion as part of your evaluation.

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(4 marks)

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4.6.1.6 Genetic inheritance

Question 05

January 2011 | BLY2H | Original Q4 | Legacy

4 A certain allele increases the chance of women developing one type of breast cancer.

A woman has this allele. She wants to be sure that she will not have daughters who also have the allele.

Doctors:

- collect several eggs from her ovaries
- fertilise the eggs with sperm, in dishes.

4 (a) The doctors expect half the embryos produced to be female.

Explain why.

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(2 marks)

4 (b) The embryos grow to around 100 cells.

Doctors:

- remove one cell from each embryo
- check the cell for the allele.

Complete the sentence.

This process is known as embryo ..... .

(1 mark)

4.6.1.6 Genetic inheritance

Question 05 · continued

4 (c) One of the female embryos did not have the allele.
This female embryo was implanted into the woman's uterus.

Evaluate the advantages and disadvantages of the whole procedure.

Use information from all parts of this question and your own knowledge.

Remember to give a conclusion to your evaluation.

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(4 marks)

7

4.6.1.6 Genetic inheritance

Question 06

January 2011 | BLY2H | Original Q6 | Legacy

6 Cystic fibrosis and Huntington's disease are inherited disorders.

6 (a) Someone can be a carrier of cystic fibrosis.

Explain how.

You may include a genetic diagram in your answer.

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(2 marks)

6 (b) Why does only one parent need to have the Huntington's disease allele for a child to inherit Huntington's disease?

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(1 mark)

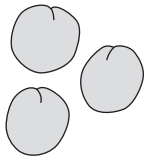
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4.6.1.6 Genetic inheritance

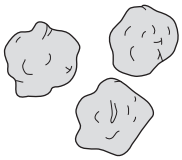
Question 07

June 2011 | BLY2H | Original Q6 | Legacy

6 In the 1860s, Gregor Mendel studied inheritance in nearly 30 000 pea plants.
Pea plants can produce either round seeds or wrinkled seeds.



Round pea seeds



Wrinkled pea seeds

6 (a) Mendel crossed plants that always produced round seeds with plants that always produced wrinkled seeds.

He found that all the seeds produced from the cross were round.

Use the symbol **A** to represent the dominant allele and **a** to represent the recessive allele.

Which alleles did the seeds from the cross have? .....

(1 mark)

4.6.1.6 Genetic inheritance

Question 07 · continued

6 (b) Mendel grew hundreds of plants from the seeds of the offspring.
He crossed these plants with each other.

6 (b) (i) Mendel's crosses produced 5496 round pea seeds and 1832 wrinkled pea seeds.

Explain why Mendel's crosses gave him these results.

In your answer you should use:

- a genetic diagram
- the symbols **A** and **a**.

(3 marks)

6 (b) (ii) One of Mendel's crosses produced 19 round seeds and 16 wrinkled seeds.

These numbers do **not** match the expected ratio of round and wrinkled seeds.

Suggest why.

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(1 mark)

6 (c) The importance of Mendel's discovery was not recognised until many years after his death.

Give **one** reason why.

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(1 mark)

6

4.6.1.6 Genetic inheritance

Question 08

June 2012 | BL2HP | Original Q7 | Legacy

7 People with cystic fibrosis make large amounts of thick, sticky mucus in their lungs. Cystic fibrosis is caused by the inheritance of recessive alleles.

7 (a) What do each of the following mean?

7 (a) (i) Alleles

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(1 mark)

7 (a) (ii) Recessive

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(1 mark)

7 (b) Mr and Mrs Brown have a child with cystic fibrosis. They hope to have another child. They want to know the probability that their next child will have cystic fibrosis. They visit a genetic counsellor who explains, "You are both heterozygous for cystic fibrosis. There is a 1 in 4 (25%) chance that your next child will have cystic fibrosis."

Use the following symbols in answering the questions.

N = allele for being unaffected by cystic fibrosis
n = allele for cystic fibrosis

7 (b) (i) Mr and Mrs Brown both have the same genotype.

What is their genotype? .....

(1 mark)

4.6.1.6 Genetic inheritance

Question 08 · continued

7 (b) (ii) There is a 1 in 4 chance that Mr and Mrs Brown's next child will have cystic fibrosis. Use a genetic diagram to explain why.

(3 marks)

Question 7 continues on the next page

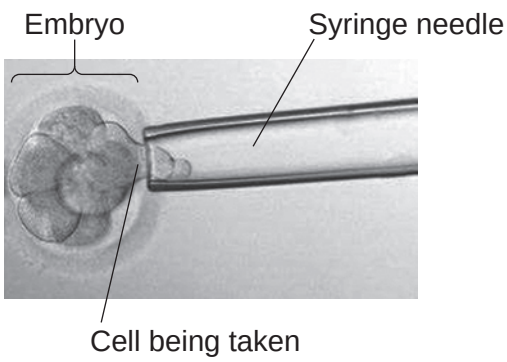
4.6.1.6 Genetic inheritance

Question 08 · continued

7 (c) Mr and Mrs Brown do **not** want to have another child with cystic fibrosis. The genetic counsellor explains two different methods for finding out whether an embryo has cystic fibrosis. The methods are:

- pre-implantation genetic diagnosis (**PGD**)
- chorionic villus sampling (**CVS**).

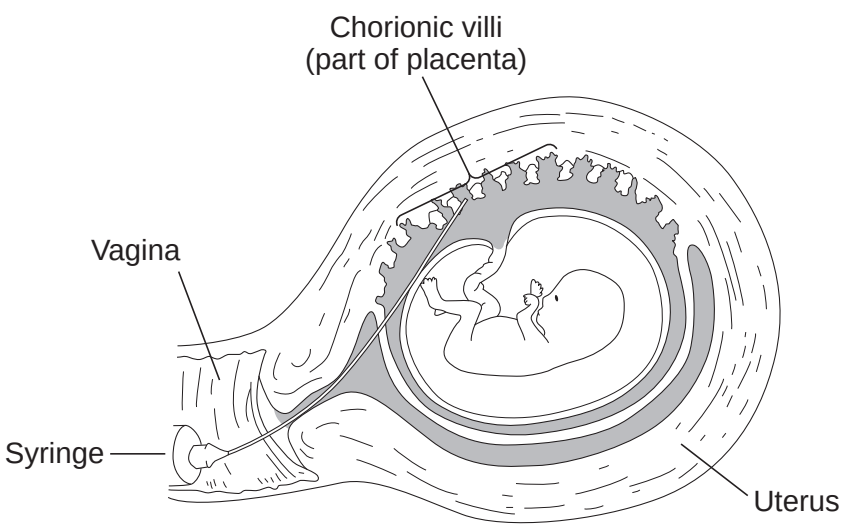
In **PGD**, eggs are fertilised in dishes and allowed to grow into embryos. A cell is taken from each embryo when the embryo is 3 days old. The photograph shows how the cell is taken.



Photograph: © Pascal Goetgheluck/Science Photo Library

The DNA in the cell can then be tested. The possibility of a false positive result is about 1 in 6. An unaffected embryo can then be placed in the woman's uterus. The procedure costs about £6000.

CVS can only be done after 9 weeks of pregnancy. A tiny piece of the placenta is taken out using a tube attached to a syringe. This is grown in tissue culture for about 7 days. The diagram below shows how **CVS** is done.



4.6.1.6 Genetic inheritance

Question 08 · continued

The DNA in the cells can then be tested. About 2 in every 100 women have a miscarriage because of **CVS**. The possibility of a false positive result is about 1%. The procedure costs about £600. Following a positive result, the parents must then decide whether to terminate the pregnancy.

7 (c) The genetic counsellor thinks that **PGD** is a better method than **CVS** for detecting cystic fibrosis in an embryo.

Evaluate this opinion.

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(4 marks)

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4.6.1.6 Genetic inheritance

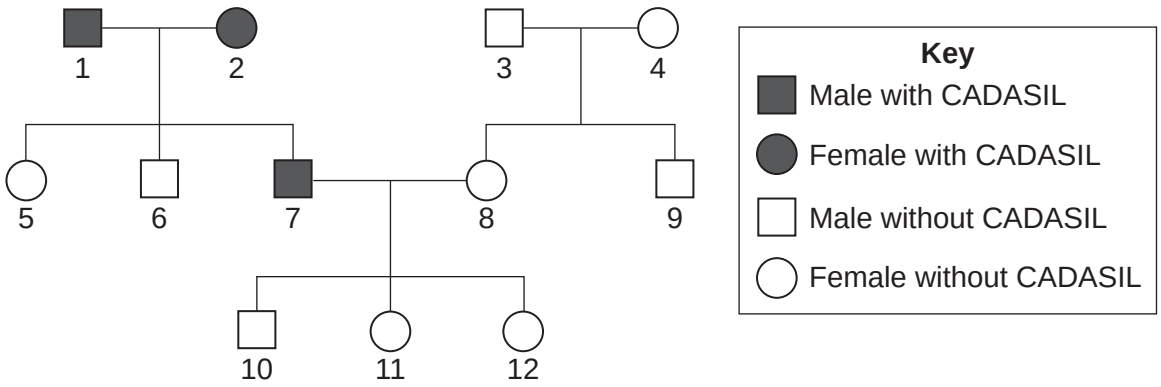
Question 09

January 2013 | BL2HP | Original Q6 | Legacy

6 CADASIL is an inherited disorder caused by a dominant allele.

CADASIL leads to weakening of blood vessels in the brain.

The diagram shows the inheritance of CADASIL in one family.



6 (a) CADASIL is caused by a *dominant allele*.

6 (a) (i) What is a *dominant allele*?

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(1 mark)

6 (a) (ii) What is the evidence in the diagram that CADASIL is caused by a dominant allele?

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(1 mark)

6 (a) (iii) Person **7** has CADASIL.

Is person **7** homozygous or heterozygous for the CADASIL allele?

Give evidence for your answer from the diagram.

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.....

(1 mark)

4.6.1.6 Genetic inheritance

Question 09 · continued

6 (b) Persons **7** and **8** are planning to have another baby.
Use a genetic diagram to find the probability that the new baby will develop into a person with CADASIL.

Use the following symbols to represent alleles.

D = allele for CADASIL
d = allele for not having CADASIL

Probability = ...
(4 marks)

6 (c) Scientists are trying to develop a treatment for CADASIL using stem cells.

Specially treated stem cells would be injected into the damaged part of the brain.

6 (c) (i) Why do the scientists use stem cells?

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(2 marks)

6 (c) (ii) Embryonic stem cells can be obtained by removing a few cells from a human embryo.

In 2006, scientists in Japan discovered how to change adult skin cells into stem cells.

Suggest **one** advantage of using stem cells from adult skin cells.

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(1 mark)

10

4.6.1.6 Genetic inheritance

Question 10

June 2013 | BL2HP | Original Q6 | Legacy

6 A certain gene codes for the production of an enzyme called 'HEXA'.

One human genetic disorder causes damage to nerve cells in the brain.
This disorder is caused by a small change in the DNA of the HEXA gene.
People with this disorder make a changed HEXA enzyme that does not work.

6 (a) Explain how a change in the DNA of the HEXA gene can result in the production of a changed HEXA enzyme that does not work.

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(3 marks)

6 (b) The gene coding for the HEXA enzyme is found on chromosome number 15.

6 (b) (i) How many chromosomes are there in the nucleus of a human nerve cell? .....

(1 mark)

6 (b) (ii) A boy had the changed HEXA gene on the chromosome number 15 that he inherited from his father.
The changed HEXA gene coded for a HEXA enzyme that does not work.
The boy did **not** develop the genetic disorder.

Explain why the boy did **not** develop the genetic disorder.

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(2 marks)

4.6.1.6 Genetic inheritance

Question 10 · continued

6 (b) (iii) The boy grew up and got married.

A blood test showed that his wife had also inherited the same changed HEXA gene.

There is a 1 in 4 chance that this couple's first child will have the genetic disorder.

Use a genetic diagram to explain why.

Use the following symbols in your explanation:

H = allele for making the normal HEXA enzyme
h = allele for making a HEXA enzyme that does not work.

(3 marks)

9

4.6.1.6 Genetic inheritance

Question 11

June 2014 | BL2HP | Original Q6 | Legacy

6 Phenylketonuria (PKU) is an inherited condition. PKU makes people ill.

6 (a) PKU is caused by a recessive allele.

6 (a) (i) What is an allele?

[1 mark]

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6 (a) (ii) What is meant by recessive?

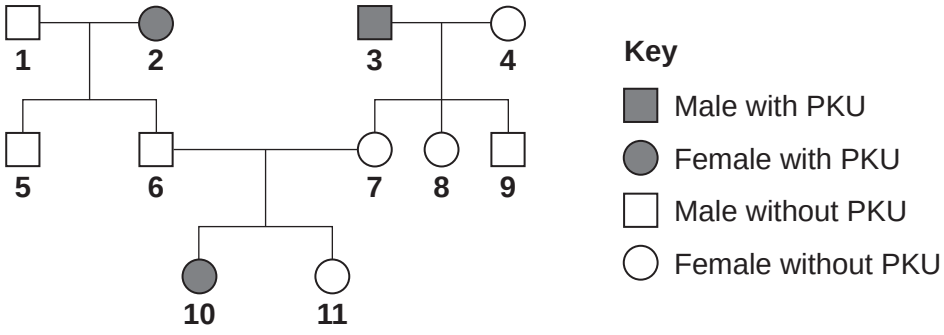
[1 mark]

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6 (b) **Figure 8** shows the inheritance of PKU in one family.

Figure 8



6 (b) (i) Give **one** piece of evidence from **Figure 8** that PKU is caused by a recessive allele.

[1 mark]

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4.6.1.6 Genetic inheritance

Question 11 · continued

6 (b) (ii) Persons **6** and **7** are planning to have another child.
Use a genetic diagram to find the probability that the new child will have PKU.

Use the following symbols in your answer:

N = the dominant allele for **not** having PKU
n = the recessive allele for PKU.

[4 marks]

Probability = ...

6 (c) Persons **6** and **7** wish to avoid having another child with PKU.

A genetic counsellor advises that they could produce several embryos by IVF treatment.

6 (c) (i) During IVF treatment, each fertilised egg cell forms an embryo by cell division.

Name this type of cell division.

[1 mark]

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6 (c) (ii) An embryo screening technique could be used to find the genotype of each embryo.

An unaffected embryo could then be placed in person **7**'s uterus.

The screening technique is carried out on a cell from an embryo after just three cell divisions of the fertilised egg.

How many cells will there be in an embryo after the fertilised egg has

divided three times? ☐

[1 mark]

Question 6 continues on the next page

4.6.1.6 Genetic inheritance

Question 11 · continued

6 (c) (iii) During embryo screening, a technician tests the genetic material of the embryo to find out which alleles are present.

The genetic material is made up of large molecules of a chemical substance.

Name this chemical substance.

[1 mark]

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6 (d) Some people have ethical objections to embryo screening.

6 (d) (i) Give **one** ethical objection to embryo screening.

[1 mark]

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6 (d) (ii) Give **one** reason in favour of embryo screening.

[1 mark]

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12

4.6.1.6 Genetic inheritance

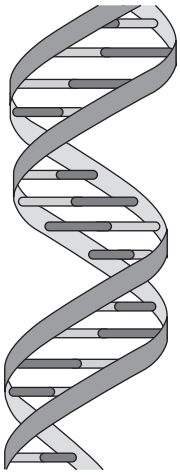
Question 12

June 2015 | BL2HP | Original Q3 | Legacy

3 DNA is the genetic material of human cells.

Figure 4 shows the structure of part of a DNA molecule.

Figure 4



3 (a) (i) Describe where DNA is found in a human cell.

[2 marks]

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3 (a) (ii) When a cell divides by mitosis the new cells are genetically identical.

What causes the cells to be genetically identical?

[1 mark]

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3 (b) Many genes have different forms called alleles.

3 (b) (i) A person has polydactyly (extra fingers or toes). Polydactyly is caused by a dominant allele.
What is the smallest number of copies of the dominant allele for polydactyly that could be found in a body cell of this person?

[1 mark]

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3 (b) (ii) Another person has cystic fibrosis. Cystic fibrosis (CF) is caused by a recessive allele.
How many copies of the recessive CF allele are there in a body cell of this person?

[1 mark]

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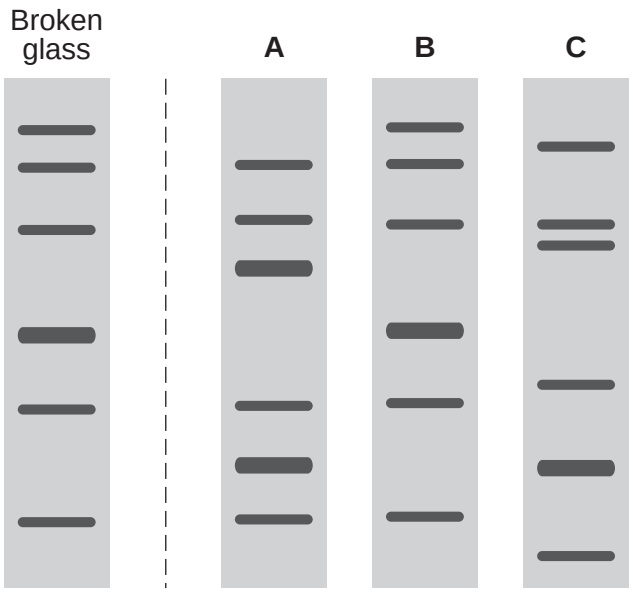
Question 12 · continued

3 (c) A burglar broke into a house. The burglar cut his hand on some broken glass. Scientists extracted DNA from the blood on the broken glass.

The scientists analysed the DNA from the glass and DNA from three suspects, **A**, **B** and **C**. The scientists used a method called DNA fingerprinting.

Figure 5 shows the scientists' results.

Figure 5



Which suspect, **A**, **B** or **C**, is most likely to have been the burglar?

[1 mark]

Tick (✓) **one** box.

A ☐

B ☐

C ☐

6

4.6.1.6 Genetic inheritance

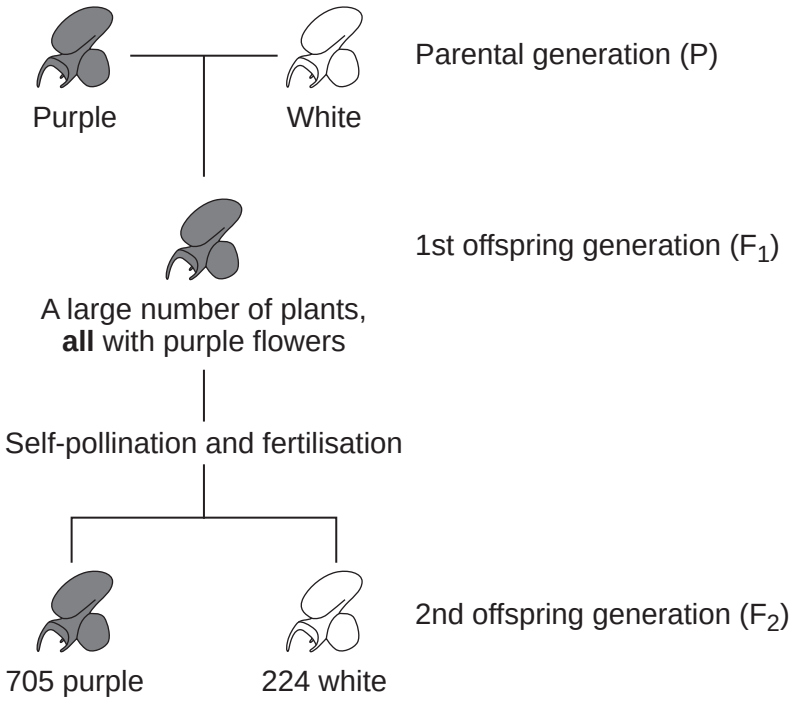
Question 13

June 2015 | BL2HP | Original Q8 | Legacy

8 In 1866, Gregor Mendel published the results of his investigations into inheritance in garden pea plants.

Figure 9 shows the results Mendel obtained in one investigation with purple-flowered and white-flowered pea plants.

Figure 9



8 (a) (i) Calculate the ratio of purple-flowered plants to white-flowered plants in the F_2 generation.

[1 mark]

Ratio of purple : white = ...

8 (a) (ii) There was a total of 929 plants in the F_2 generation.

Mendel thought that the production of a large number of offspring plants improved the investigation.

Explain why.

[2 marks]

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4.6.1.6 Genetic inheritance

Question 13 · continued

8 (b) (i) Some of the plants in **Figure 9** are homozygous for flower colour and some are heterozygous.

Complete **Table 1** to show whether each of the plants is homozygous or heterozygous. For each plant, tick (✓) **one** box.

[2 marks]

Table 1

	Homozygous	Heterozygous
Purple-flowered plant in the P generation		
White-flowered plant in the P generation		
Purple-flowered plant in the F_1 generation		

8 (b) (ii) Draw a genetic diagram to show how self-pollination of the F_1 purple-flowered plants produced mainly purple-flowered offspring in the F_2 generation together with some white-flowered offspring.

Use the following symbols:

N = allele for purple flower colour
n = allele for white flower colour

[3 marks]

8 (c) When Mendel published his work on genetics, other scientists at the time did not realise how important it was.

Suggest **two** reasons why.

[2 marks]

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2 .....

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10

4.6.1.6 Genetic inheritance

Question 14

June 2016 | BL2HP | Original Q6 | Legacy

6 (a) Polydactyly is an inherited condition caused by a dominant allele.

Figure 5 shows the hand of a man with polydactyly. The man has an extra finger on each hand.

The man's mother also has polydactyly but his father does not.

Figure 5



6 (a) (i) The man is **heterozygous** for polydactyly.

Explain how the information given above shows that the man is **heterozygous** for polydactyly.

[3 marks]

6 (a) (ii) The man marries a woman who does **not** have polydactyly.

What is the probability that their first child will have polydactyly?

[1 mark]

4.6.1.6 Genetic inheritance

Question 14 · continued

6 (b) The man has red hair. His sister has brown hair.

Both of their parents have brown hair.

Brown hair is caused by the dominant allele, **B**.

Red hair is caused by a recessive allele, **b**.

Complete the genetic diagram below to show how the man's parents were able to have some children with red hair and some with brown hair.

[5 marks]

	Father	**Mother**
Parental phenotypes:	_____	_____
Parental genotypes:	_____	_____
Gametes:	_____ _____	_____ _____

Offspring genotypes: _____

Offspring phenotypes: _____

9

4.6.1.6 Genetic inheritance

Question 15

June 2017 | BL2HP | Original Q6 | Legacy

6 Alkaptonuria (AKU) is a rare, inherited condition. A person with AKU produces brownish-black urine. Further health problems develop later in life.

6 (a) The allele that causes AKU is on chromosome number 3.
The allele is recessive.

6 (a) (i) How many chromosomes are there in most human cells?

[1 mark]

_____

6 (a) (ii) What are alleles?

[1 mark]

_____

_____

6 (a) (iii) What does recessive mean?

[1 mark]

_____

_____

Question 6 continues on the next page

4.6.1.6 Genetic inheritance

Question 15 · continued

6 (b) Two parents, who do **not** have AKU, have a child with AKU.

These two parents are heterozygous.

6 (b) (i) What does heterozygous mean?

[1 mark]

_____

_____

6 (b) (ii) Draw a genetic diagram to find the probability that the parents' next child will have AKU.

[4 marks]

You should identify in your diagram any children with AKU.

Use the following symbols: **N** = allele for **not** having AKU (non-AKU)
n = allele for AKU

Probability of having a child with AKU = _____

4.6.1.6 Genetic inheritance

Question 15 · continued

6 (c) The parents do not want to have another child with AKU.

A genetic counsellor tells the parents that this would be possible if they use IVF followed by embryo screening.

The procedure is:

1. several eggs from the woman are fertilised in a glass dish using sperm cells from the man (IVF)
2. each fertilised egg divides to form an embryo
3. at the 16-cell stage, one cell is removed from each embryo and the cell's DNA is tested (embryo screening)
4. one embryo, which does not have the recessive allele for AKU, is placed in the woman's uterus to develop into a baby
5. some of the other embryos may be frozen and stored.

In **Steps 2** and **3**, a 16-cell embryo is produced by cell division of the original fertilised egg cell.

6 (c) (i) Name the type of cell division in **Step 2**.

[1 mark]

_____

6 (c) (ii) How many cell divisions are needed to make 16 cells from one cell?

[1 mark]

_____

6 (d) Some people have ethical objections to embryo screening.

6 (d) (i) Suggest **one** ethical objection to embryo screening.

[1 mark]

_____

_____

6 (d) (ii) Suggest **one** reason in favour of embryo screening.

[1 mark]

_____

_____

12

4.6.1.6 Genetic inheritance

Question 16

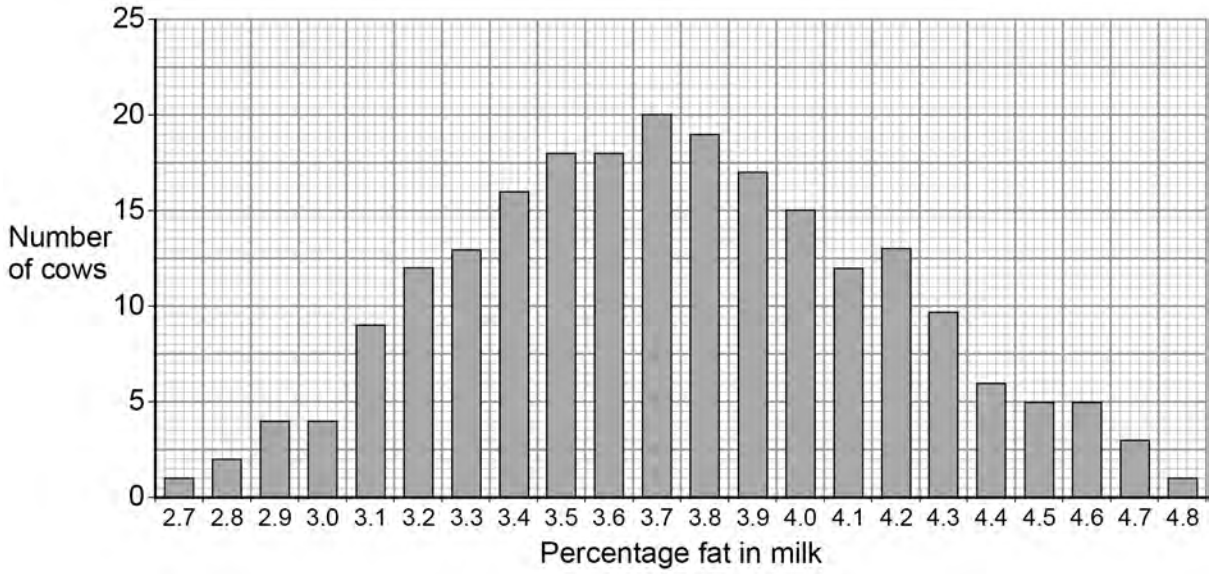
June 2018 | 8461/2H | Original Q8

0 8 Scientists want to breed cows that produce milk with a low concentration of fat.

Figure 10 shows information about the milk in one group of cows.

The cows were all the same type.

Figure 10



0 8 . 1 In **Figure 10** the mean percentage of fat in the milk is equal to the modal value.

Give the mean percentage of fat in the milk of these cows.

[1 mark]

Mean percentage = _____

0 8 . 2 A student suggested:

'The percentage of fat in milk is controlled by one dominant allele and one recessive allele.'

How many different phenotypes would this produce?

[1 mark]

Tick **one** box.

2		3		22		46	

4.6.1.6 Genetic inheritance

Question 16 · continued

0 8 . 3 Give the evidence from **Figure 10** which shows the percentage of fat in the milk is controlled by several genes.

[1 mark]

0 8 . 4 One of the genes codes for an enzyme used in fat metabolism.

A mutation in this gene causes a reduction in milk fat.

The mutation changes one amino acid in the enzyme molecule.

Explain how a change in one amino acid in an enzyme molecule could stop the enzyme working.

[3 marks]

Question 8 continues on the next page

4.6.1.6 Genetic inheritance

Question 16 · continued

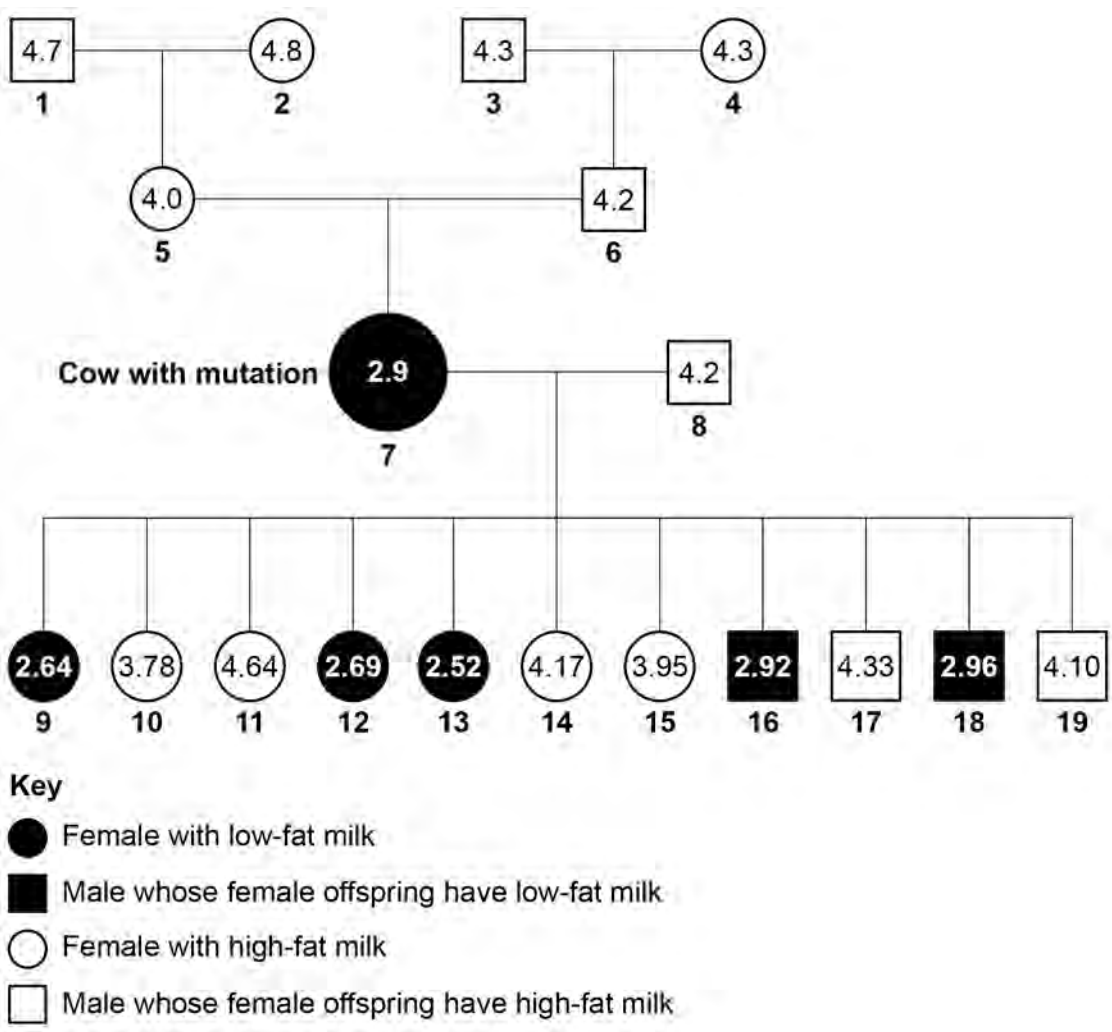
The scientists found one cow with a mutation.

The cow's milk contained only 2.9% fat.

Figure 11 shows the percentage of fat in the milk of cattle related to the cow with the mutation.

The values for male cattle are the mean values of their female offspring.

Figure 11



4.6.1.6 Genetic inheritance

Question 16 · continued

0 8 . 5 Animal **8** is homozygous.

The mutation in animal **7** produced a dominant allele for making low-fat milk.

Give evidence from **Figure 11** that animal **7** is heterozygous.

[1 mark]

0 8 . 6 Animals **7** and **8** produced 11 offspring. These offspring were produced by in vitro fertilisation (IVF).

The embryos from IVF were transferred into 11 other cows.

Suggest why IVF and embryo transfer were used rather than allowing animals **7** and **8** to mate naturally.

[1 mark]

0 8 . 7 Draw a Punnett square diagram to show a cross between animals **7** and **8**.

Identify which offspring produce low-fat milk and which offspring produce high-fat milk.

[4 marks]

Use the following symbols:

D = dominant allele for making low-fat milk

d = recessive allele for making high-fat milk

4.6.1.6 Genetic inheritance

Question 16 · continued

0 8 . 8 The scientists want to produce a type of cattle that makes large volumes of low-fat milk.

The scientists will selectively breed some of the animals shown in **Figure 11**.

Describe how the scientists would do this.

[4 marks]

16

4.6.1.6 Genetic inheritance

Question 17

June 2019 | 8461/2H | Original Q5

0 5 **Table 2** gives the classification of four plant species.

Table 2

Group	Species 1	Species 2	Species 3	Species 4
Kingdom	*Plantae*	*Plantae*	*Plantae*	*Plantae*
Phylum	*Spermatophyta*	*Spermatophyta*	*Spermatophyta*	*Spermatophyta*
Class	*Monocotyledonae*	*Dicotyledonae*	*Monocotyledonae*	*Dicotyledonae*
Order	*Poales*	*Fabales*	*Poales*	*Scrophulariales*
Family	*Cyperaceae*	*Fabaceae*	*Poaceae*	*Scrophulariaceae*
Genus	*Eriophorum*	*Pisum*	*Poa*	*Antirrhinum*
Species	*angustifolium*	*sativum*	*annua*	*majus*

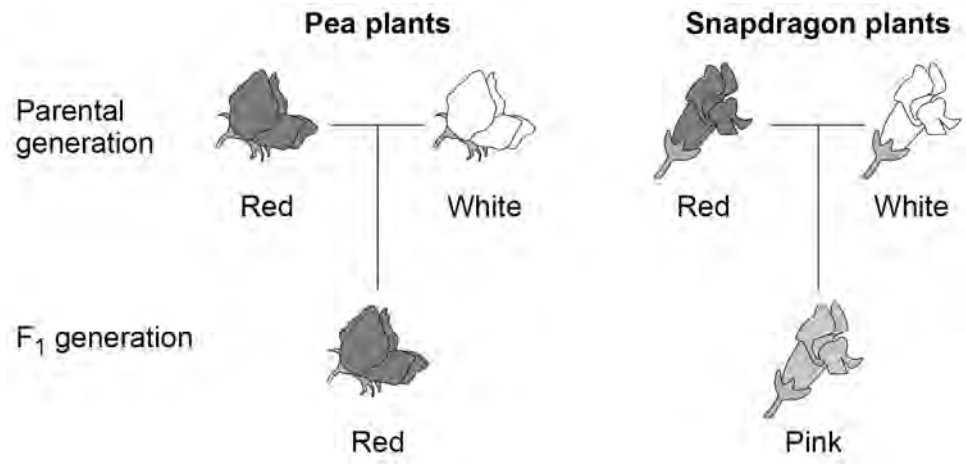
0 5 . 1 Species **1** and **3** are the most closely related.

What information in **Table 2** gives evidence for this?

[1 mark]

Figure 6 shows the inheritance of flower colour in two species of plant.

Figure 6



- In pea plants and in snapdragon plants, flower colour is controlled by one pair of alleles.
- In **Figure 6** the parental generation plants are homozygous for flower colour.
- In heterozygous **pea** plants, the allele for red flower colour is dominant.
- In heterozygous **snapdragon** plants, the alleles for flower colour are both expressed.

Question 17 · continued

Use the following symbols for alleles in your answers to Questions **05.2** to **05.4**:

Pea plants	**Snapdragon plants**
R = allele for red flowers	C^R = allele for red flowers
r = allele for white flowers	C^W = allele for white flowers

0 5 . 2 What is the genotype of the red-flowered pea plants in the F_1 generation?

[1 mark]

_____

0 5 . 3 What is the genotype of a white-flowered snapdragon plant?

[1 mark]

_____

A gardener crossed two pink-flowered snapdragon plants.

0 5 . 4 Draw a Punnett square diagram to show why only some of the next generation plants had pink flowers.

Identify the phenotypes of all the offspring plants.

[3 marks]

0 5 . 5 What percentage of the offspring would you expect to have pink flowers?

[1 mark]

Percentage = _____ %

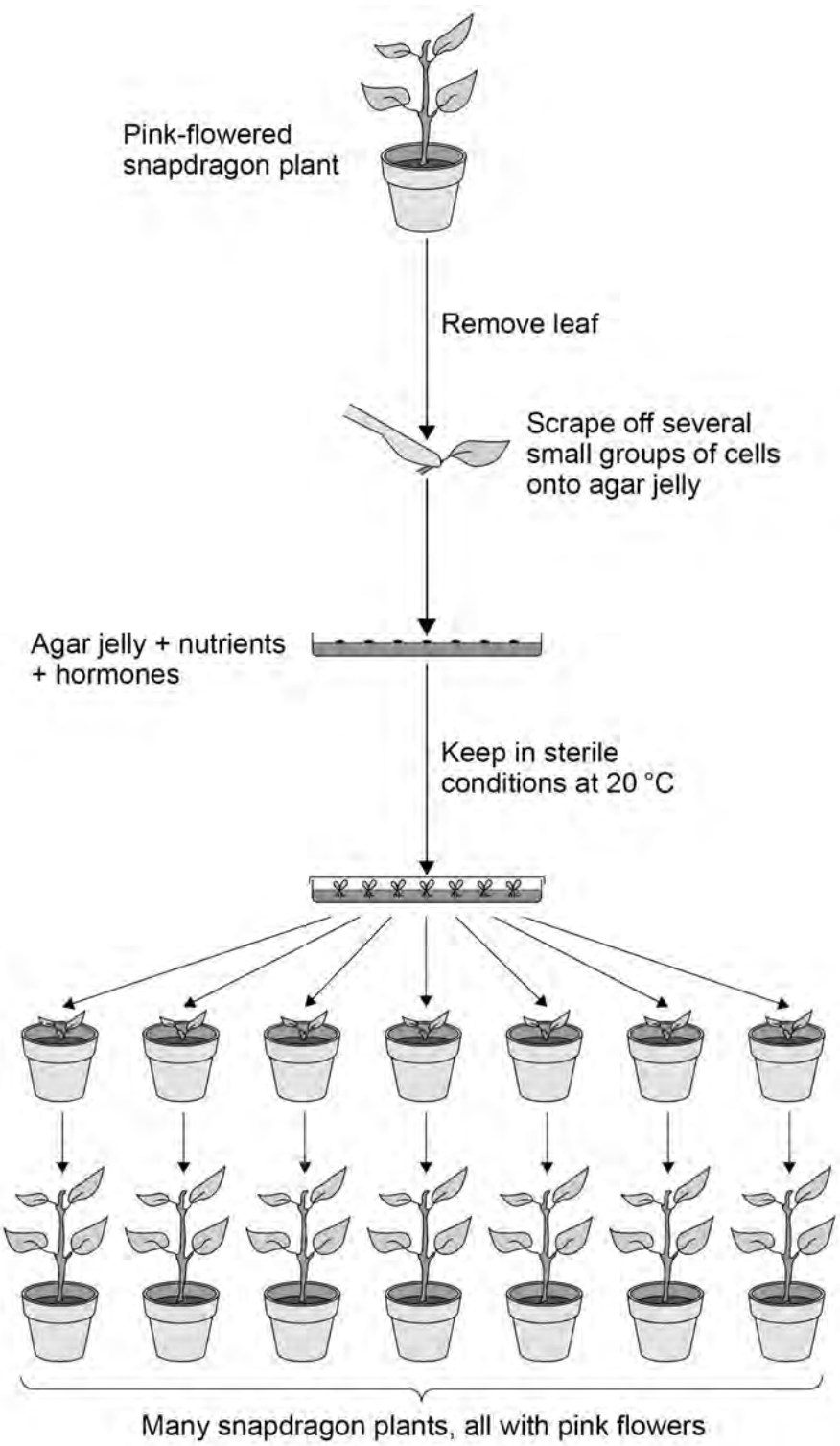
4.6.1.6 Genetic inheritance

Question 17 · continued

Commercially, hundreds of pink-flowered snapdragon plants can be produced from one pink-flowered plant.

Figure 7 shows a tissue culture technique used for producing many plants from one plant.

Figure 7



4.6.1.6 Genetic inheritance

Question 17 · continued

0 5 . 6 Give a reason for each of the following steps shown in **Figure 7**.

[5 marks]

Several groups of cells are scraped off the leaf: _____

Nutrients are added to the agar jelly: _____

Hormones are added to the agar jelly: _____

The plant cells are kept in **sterile** conditions: _____

The plant cells are kept at **20 °C**: _____

0 5 . 7 Explain why the method shown in **Figure 7** produces **only** pink-flowered plants.

[2 marks]

14

4.6.1.6 Genetic inheritance

Question 18

November 2020 | 8461/2H | Original Q5

0 5 There are two types of cell division: mitosis and meiosis.

0 5 . 1 Describe **three** differences between the processes of mitosis and meiosis.

[3 marks]

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

0 5 . 2 Describe **one** similarity between the processes of mitosis and meiosis.

[1 mark]

_____

_____

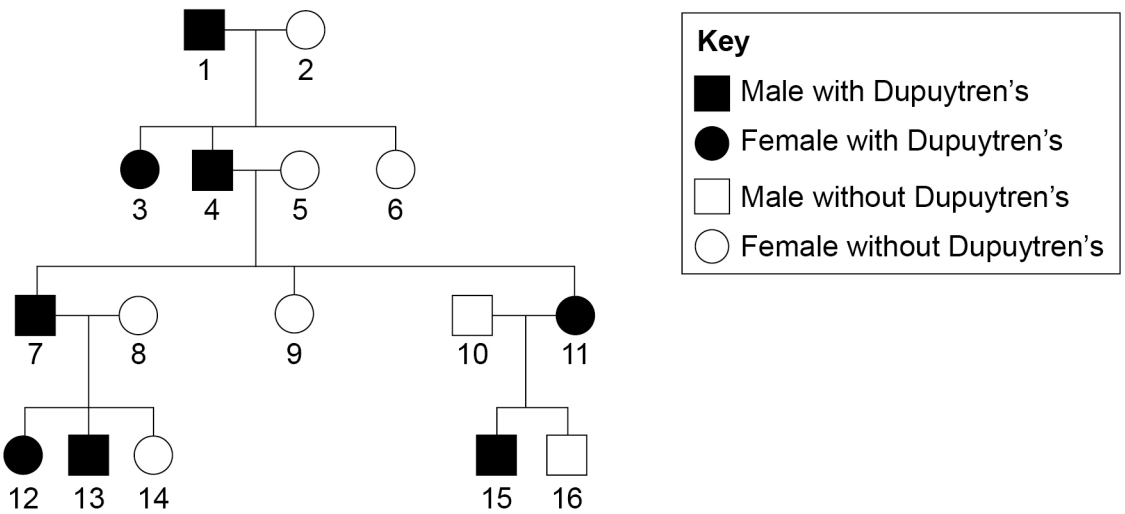
Question 5 continues on the next page

Question 18 · continued

Dupuytren's is a disorder that affects the hands.

Figure 6 shows the inheritance of Dupuytren's in one family.

Figure 6



Dupuytren's is caused by a dominant allele in this family.

D = dominant allele

d = recessive allele

0 5 . 3 Give the genotype of person **1**.

Explain your answer.

[2 marks]

Genotype _____

Question 18 · continued

0 5 . 4 Person **7** and person **8** in **Figure 6** are expecting a fourth child.

What is the probability of the child having Dupuytren's?

You should:

- draw a Punnett square diagram
- identify which offspring have Dupuytren's

[5 marks]

Probability = _____

0 5 . 5 Explain how **Figure 6** shows the allele for Dupuytren's is **not** on the Y chromosome.

[2 marks]

_____

_____

_____

_____

13

4.6.1.6 Genetic inheritance

Question 19

November 2021 | 8461/2H | Original Q8

0 8 Sickle cell anaemia is an inherited condition that affects red blood cells.

Sickle cell anaemia is caused by a mutation in the gene for haemoglobin. Haemoglobin is the red pigment found in red blood cells.

A person who is homozygous for the normal haemoglobin allele (H^A) produces normal red blood cells.

A person who is homozygous for the mutated allele (H^S):

- produces red blood cells with abnormal haemoglobin
- has red blood cells that can form an altered shape
- has sickle cell anaemia and becomes ill.

A person who is heterozygous:

- has both normal and abnormal haemoglobin in the red blood cells
- has sickle cell trait
- is generally healthy but can become ill in certain circumstances.

0 8 . 1 Give the reason why a mutation in the gene coding for haemoglobin could be harmful.

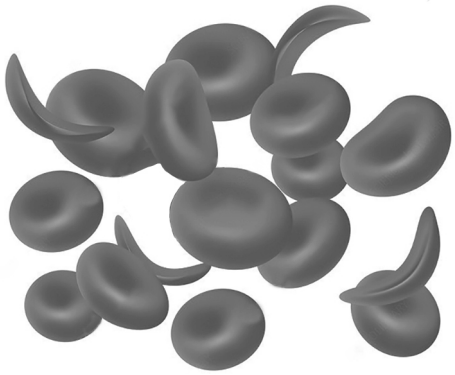
[1 mark]

4.6.1.6 Genetic inheritance

Question 19 · continued

0 8 . 2 **Figure 13** shows some red blood cells from the blood of a person with sickle cell trait.

Figure 13



Calculate the proportion of cells in **Figure 13** that have an altered shape.

[2 marks]

Proportion = _____

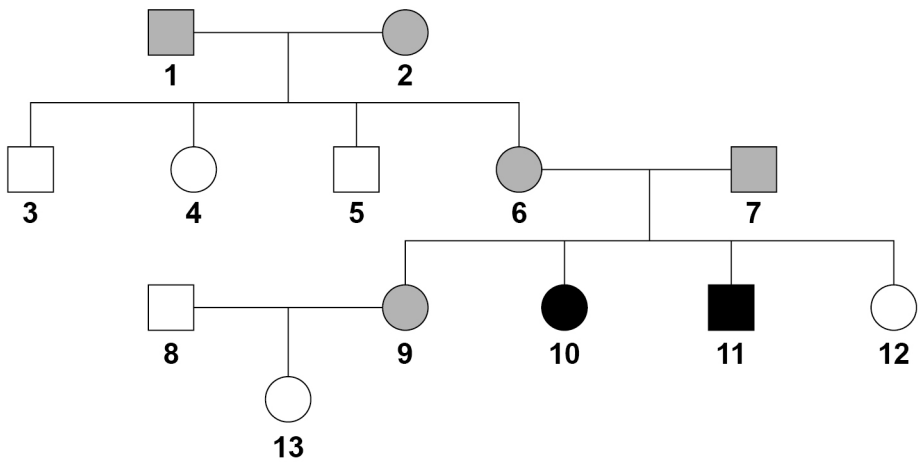
Question 8 continues on the next page

4.6.1.6 Genetic inheritance

Question 19 · continued

Figure 14 shows the inheritance of sickle cell anaemia in one family.

Figure 14



Key

- Unaffected male
- Unaffected female
- Male with sickle cell anaemia
- Female with sickle cell anaemia
- Male with sickle cell trait
- Female with sickle cell trait

4.6.1.6 Genetic inheritance

Question 19 · continued

0 8 . 3 Persons **8** and **9** in **Figure 14** are expecting a second child.

Determine the probability that the child will be a girl with sickle cell trait.

You should:

- draw a Punnett square diagram
- identify the phenotype of each offspring genotype
- use the symbols:

  H^A = normal haemoglobin allele

  H^S = mutated haemoglobin allele.

[5 marks]

Probability of a girl with sickle cell trait = _____

Question 8 continues on the next page

4.6.1.6 Genetic inheritance

Question 19 · continued

0 8 . 4 Without medical treatment, people with sickle cell anaemia are frequently ill and have a reduced life expectancy.

The malarial parasite cannot live in the red blood cells of a person who has the $\mathbf{H^S}$ allele.

A scientist stated:

'It is an advantage for people to have the $\mathbf{H^S}$ allele in countries where malaria occurs.'

Evaluate the scientist's statement.

[3 marks]

11

4.6.1.6 Genetic inheritance

Question 20

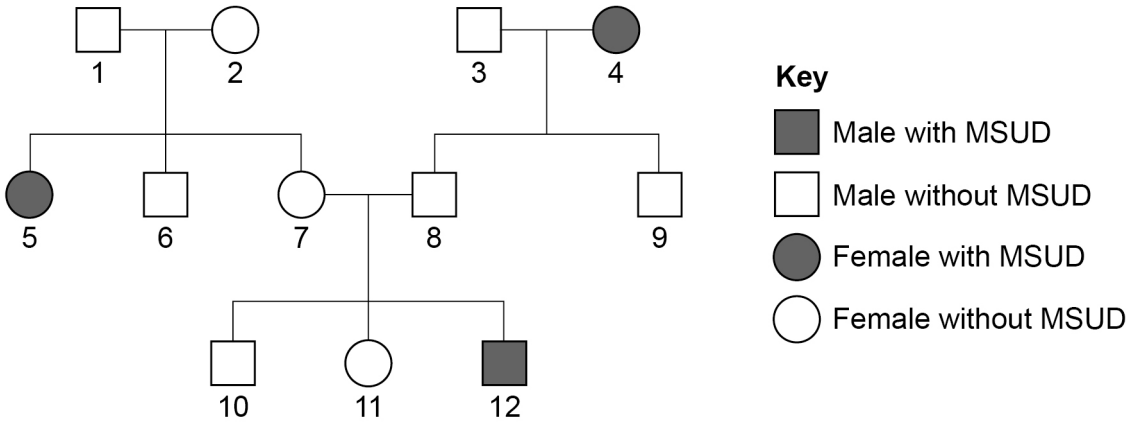
June 2022 | 8461/2H | Original Q5

0 5 Maple syrup urine disease (MSUD) is a rare inherited human condition.

MSUD is usually diagnosed early in childhood and can be controlled by having a low-protein diet.

Figure 4 shows the inheritance of MSUD in one family.

Figure 4



The allele for MSUD is recessive.

0 5 . 1 Give **one** piece of evidence from **Figure 4** which shows that MSUD is a recessive condition.

[1 mark]

4.6.1.6 Genetic inheritance

Question 20 · continued

0 5 . 2 Persons **7** and **8** in **Figure 4** are expecting a fourth child.

Determine the probability that the child will have MSUD.

You should:

- draw a Punnett square diagram
- identify the phenotype of each offspring genotype
- use the symbols:

N = allele for **not** having MSUD
n = allele for MSUD.

[4 marks]

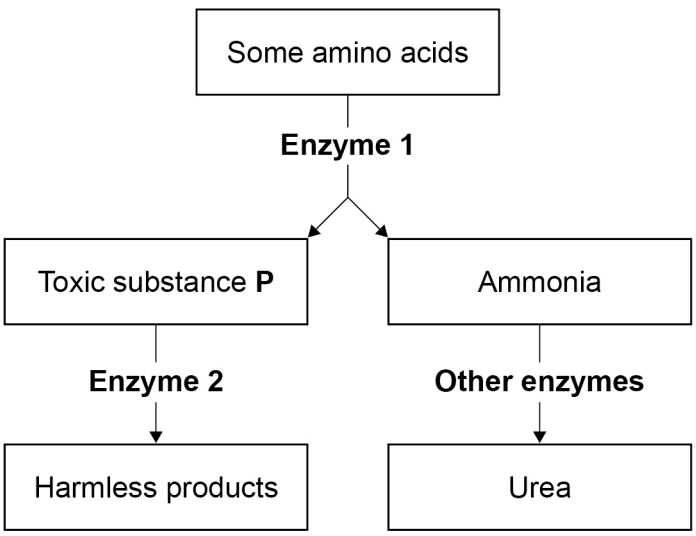
Probability = _____

Question 5 continues on the next page

Question 20 · continued

Figure 5 shows chemical reactions involved in the normal breakdown of some types of amino acid inside body cells.

Figure 5



A person with MSUD **cannot** make **Enzyme 2**.

0 5 . 3 One of the final products shown in **Figure 5** is urea.

Where in the human body are the reactions shown in **Figure 5** most likely to occur?

[1 mark]

Tick (✓) **one** box.

Kidney ☐

Liver ☐

Pancreas ☐

Small intestine ☐

4.6.1.6 Genetic inheritance

Question 20 · continued

Scientists can analyse blood samples or urine samples to see if a person has MSUD.

The test identifies high concentrations of toxic substance **P**, shown in **Figure 5**.

0 5 . 4 Explain why the **blood** of a person with MSUD will have a high concentration of toxic substance **P**.

Use information from **Figure 5**.

[3 marks]

0 5 . 5 Explain why the **urine** of a person with MSUD will have a high concentration of toxic substance **P**.

[2 marks]

Question 5 continues on the next page

4.6.1.6 Genetic inheritance

Question 20 · continued

0 5 . 6 Explain why a person with MSUD must have a low-protein diet.

[3 marks]

14

4.6.1.6 Genetic inheritance

Question 21

June 2023 | 8461/2H | Original Q3

0 3 Reproduction can produce offspring which are:

- genetically different

  or

- genetically identical.

Farmers grow tomato plants in greenhouses.

The tomatoes are sold in supermarkets.

0 3 . 1 Suggest **one** advantage of growing tomato plants that are genetically different.

[1 mark]

0 3 . 2 Suggest **one** advantage of growing tomato plants that are genetically identical.

[1 mark]

0 3 . 3 Scientists can grow genetically identical tomato plants using tissue culture.

What is tissue culture?

[1 mark]

0 3 . 4 Genetically identical tomato plants growing in the same garden do **not** all grow to the same height.

Give **one** reason why.

[1 mark]

Question 21 · continued

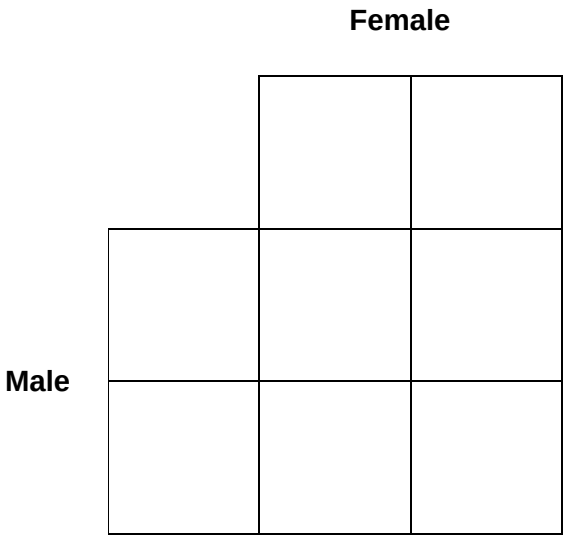
The sex of dogs is determined by **X** and **Y** chromosomes in the same way as in humans.

0 3 . 5 Complete the Punnett square diagram in **Figure 4** to show the inheritance of sex in dogs.

Use the symbols **X** and **Y**.

[3 marks]

Figure 4



0 3 . 6 A female dog gave birth to six offspring.

Why would you expect there to be three male offspring and three female offspring?

Use your answer to Question **03.5**.

[1 mark]

Question 3 continues on the next page

Question 21 · continued

Farmers keep chickens for:

- meat production
- egg production.

Some varieties of chicken grow more quickly and are more suitable for meat production.

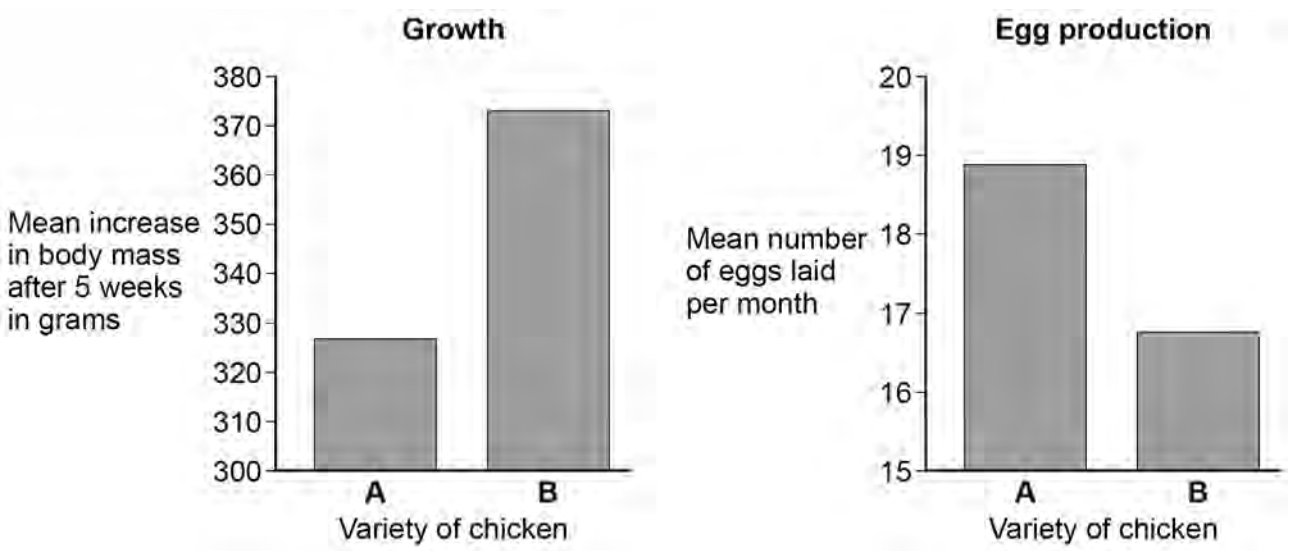
Other varieties of chicken produce more eggs.

A farmer keeps two varieties of chicken, **A** and **B**.

The farmer investigated the growth rates and egg-production rates of both varieties.

Figure 5 shows the results.

Figure 5



0 3 . 7 Suggest **two** control variables the farmer should have used in this investigation.

[2 marks]

1 _____

_____

2 _____

_____

4.6.1.6 Genetic inheritance

Question 21 · continued

0 3 . 8 **Figure 5** shows mean values from 500 chickens of each variety.

Give the reason the farmer used a large number of chickens.

[1 mark]

0 3 . 9 The farmer wants to produce a new variety of chicken that is good for **both** meat production **and** egg production.

Describe how selective breeding of chicken varieties **A** and **B** can produce the new variety of chicken.

[4 marks]

15

4.6.1.6 Genetic inheritance

Question 22

June 2023 | 8461/2H | Original Q7

0 7 Hormones are important for regulating the menstrual cycle.

During the menstrual cycle, eggs mature inside follicles in the ovaries.

A 27-year-old woman was infertile.

A doctor tested a sample of the woman's blood.

The test did **not** detect any follicle stimulating hormone (FSH) in the woman's blood.

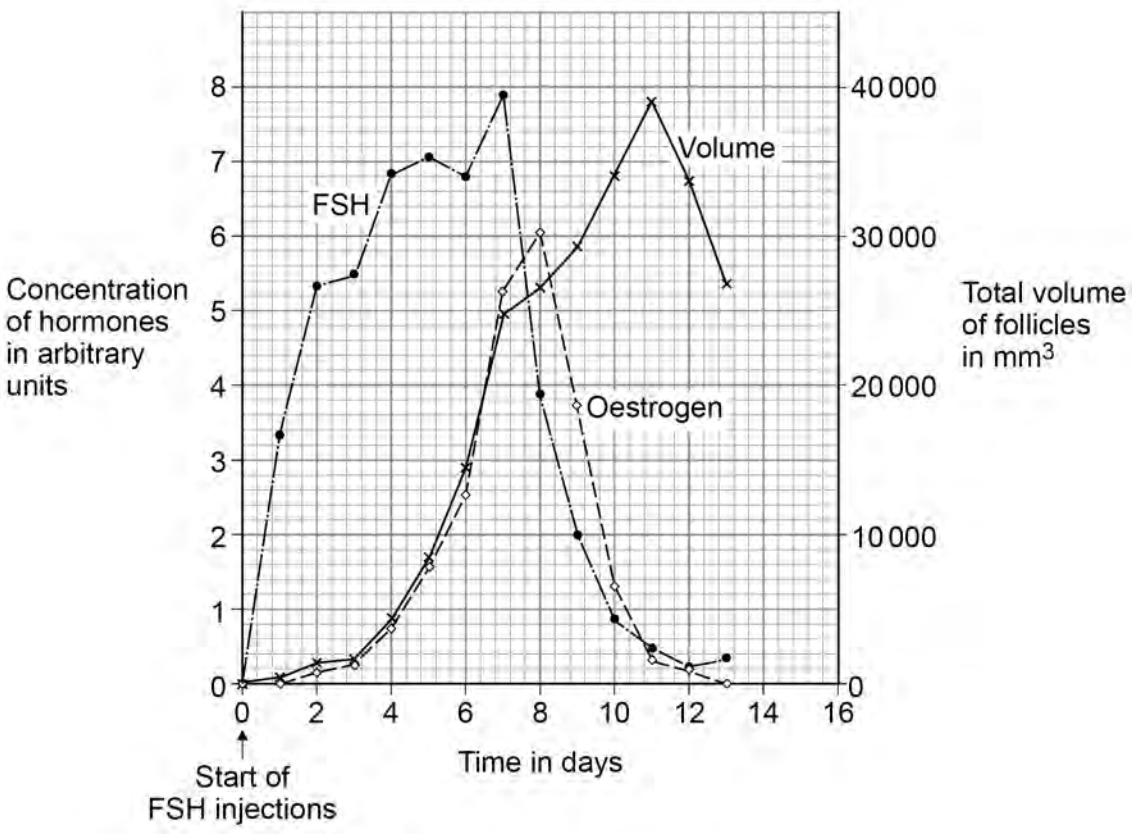
The doctor gave the woman daily injections of FSH for 7 days.

The doctor measured:

- the concentration of FSH in the woman's blood
- the concentration of oestrogen in the woman's blood
- the volumes of developing follicles in the ovaries.

Figure 12 shows the results.

Figure 12



4.6.1.6 Genetic inheritance

Question 22 · continued

0 7 . 1 Give evidence from **Figure 12** that the follicles in the ovaries release oestrogen.

[1 mark]

0 7 . 2 Injection of FSH caused the development of a number of follicles.

The mean diameter of the follicles on day 11 was 22 millimetres.

Calculate the number of follicles in the woman's ovaries on day 11.

Assume each follicle is a sphere.

Volume of a sphere = $\frac{4}{3}\pi r^3$

r = radius
π = 3.14

Give your answer to the nearest whole number.

[5 marks]

Number of follicles (to the nearest whole number) = _____

Question 7 continues on the next page

4.6.1.6 Genetic inheritance

Question 22 · continued

0 7 . 3 Before treatment with FSH, the woman had underdeveloped breasts.

Explain why the lack of FSH in the woman's blood caused underdeveloped breasts.

[2 marks]

0 7 . 4 Usually males and females both produce FSH.

The woman had inherited a faulty gene for FSH production from each of her parents.

The woman's parents both produce FSH.

Show how the **woman's parents** could have a child that does **not** produce FSH.

You should:

- draw a Punnett square diagram
- identify the phenotype of each offspring genotype
- use the symbols below:

  H = allele for making FSH

  h = allele for **not** making FSH

[3 marks]

4.6.1.6 Genetic inheritance

Question 22 · continued

0 7 . 5 The woman continues to have injections of FSH.

The woman has a child with a man who is heterozygous for the FSH gene.

Explain why the probability that the child will be able to produce FSH is 0.5.

[3 marks]

14

Turn over for the next question

4.6.1.6 Genetic inheritance

Question 23

0 6 Some human disorders are inherited.

Polydactyly is an inherited disorder.

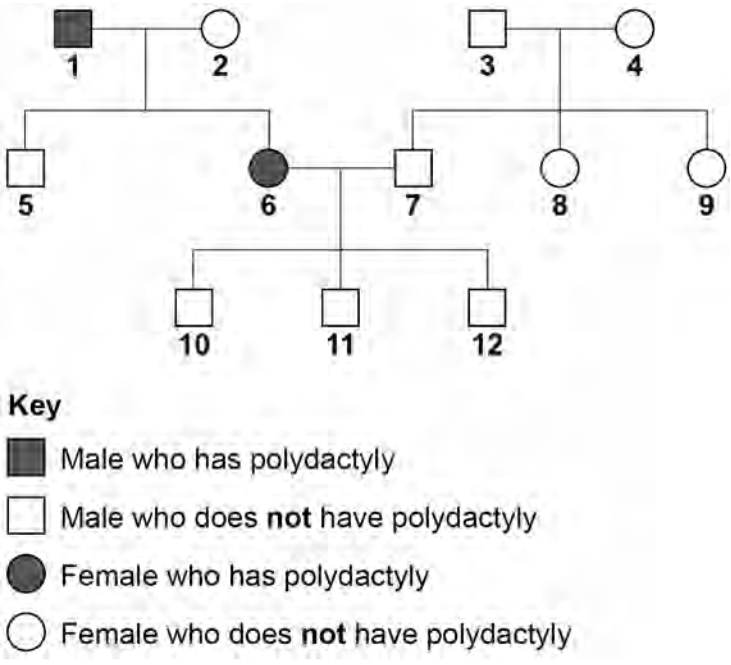
- A person with polydactyly has extra fingers or toes.
- Polydactyly is caused by a dominant allele.

0 6 . 1 What is a dominant allele?

[1 mark]

Figure 10 shows the inheritance of polydactyly in one family.

Figure 10



4.6.1.6 Genetic inheritance

Question 23 · continued

In questions **06.2** and **06.3**, use the following symbols:

D = allele for having polydactyly

d = allele for **not** having polydactyly.

0 6 . 2 Person **1** is heterozygous.

Explain how **Figure 10** shows that person **1** is heterozygous.

[2 marks]

0 6 . 3 Persons **6** and **7** are expecting a fourth child.

A doctor states that the probability of having a child with polydactyly is 0.5

Explain how the doctor determined this probability.

[4 marks]

You should:

- draw a Punnett square diagram
- give the genotype of person **6** and the genotype of person **7**
- identify **all** the offspring that will have polydactyly.

Question 6 continues on the next page

4.6.1.6 Genetic inheritance

Question 23 · continued

0 6 . 4 Cystic fibrosis (CF) is another inherited disorder caused by a mutation.

The mutation occurs in a gene called CFTR.

For the CFTR gene, one **allele** in every 50 in the UK population is the cystic fibrosis allele.

Explain why only one person in 2500 in the UK population has cystic fibrosis.

[4 marks]

11

4.6.1.6 Genetic inheritance

Question 24

0 8 Some people keep rabbits as pets.

Figure 8 shows two types of rabbit.

Figure 8



Himalayan rabbit
has black patches



White rabbit
has no black patches

The Himalayan fur pattern is controlled by a dominant allele.

A heterozygous male Himalayan rabbit was crossed many times with each of two female Himalayan rabbits, **A** and **B**.

The results of the two types of cross were different.

- Crosses with female **A**: **all** of the 210 offspring were Himalayan rabbits.
- Crosses with female **B**: **some** of the 240 offspring were Himalayan rabbits and **some** were white rabbits.

In Questions **08.1** and **08.2**, use the following symbols to represent alleles:

H = dominant allele for Himalayan fur

h = recessive allele for white fur.

0 8 . 1 What is the genotype of female Himalayan rabbit **A**?

Give the reason for your answer.

[2 marks]

Genotype _____

Reason _____

_____

4.6.1.6 Genetic inheritance

Question 24 · continued

0 8 . 2 Determine the probability that one of the offspring from a cross with female Himalayan rabbit **B** will be white.

You should:

- draw a Punnett square diagram
- use the symbols **H** and **h**
- identify the phenotype of each offspring genotype.

[4 marks]

Probability of offspring being white = _____

Question 8 continues on the next page

Question 24 · continued

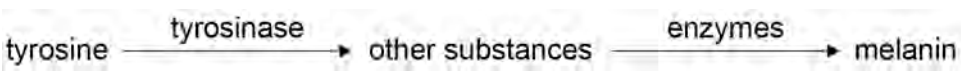
Adult Himalayan rabbits have:

- white fur over most of the body
- black fur on the nose, ears and feet.

The black colour is caused by production of a substance called melanin.

Figure 9 shows how melanin is made from another substance called tyrosine.

Figure 9



0 8 . 3 White rabbits have one base change in the gene that codes for the enzyme tyrosinase.

Explain how a change of one base in the DNA of the gene coding for tyrosinase could stop the tyrosinase working.

[4 marks]

4.6.1.6 Genetic inheritance

Question 24 · continued

For the first four weeks of life, Himalayan rabbits produce white fur over the whole body.

The black areas of fur start to develop after four weeks.

In the first four weeks, young rabbits stay in the nest with their mother.

A rabbit's body temperature is 39 °C.

The tyrosinase in Himalayan rabbits is:

- most active between 15 °C and 25 °C
- **not** active above 35 °C.

0 8 . 4 The fur on the nose, ears and feet of Himalayan rabbits is white for the first four weeks of life.

Explain what causes the fur to be white in the first four weeks of life.

[2 marks]

0 8 . 5 From the age of four weeks, young rabbits move from the nest to the outside environment.

Explain why a Himalayan rabbit develops black nose, ears and feet from the age of four weeks.

[3 marks]

4.6.1.6 Genetic inheritance

Question 24 · continued

0 8 . 6 Melanin is also produced in human skin.

Melanin absorbs ultraviolet (UV) radiation from sunlight and prevents the radiation reaching deep into the skin.

UV radiation is a type of ionising radiation.

Explain the advantage of producing melanin in human skin when exposed to bright sunlight.

[2 marks]

17