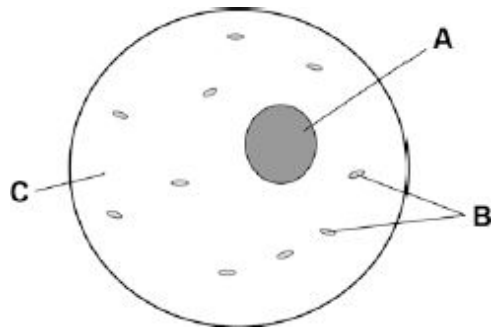


**1** **Figure 1** shows a human body cell.

**Figure 1**



(a) Which part in **Figure 1** contains chromosomes?

Tick **one** box.

A       B       C

(1)

(b) Humans have pairs of chromosomes in their body cells.

Draw **one** line from each type of cell to the number of chromosomes it contains.

Type of cell	Number of Chromosomes
	10
Human body cell	23
	46
Sperm cell	60
	92

(2)

- (c) Humans have two different sex chromosomes, **X** and **Y**.

**Figure 2** shows the inheritance of sex in humans.

**Figure 2**

		<b>Mother</b>	
		X	X
<b>Father</b>	X	XX	XX
	Y	XY	XY

**Circle** a part of **Figure 2** that shows an egg cell.

(1)

- (d) Give the genotype of male offspring.

.....

(1)

- (e) A man and a woman have two sons. The woman is pregnant with a third child.

What is the chance that this child will also be a boy?

Tick **one** box.

0%

25%

50%

100%

(1)  
(Total 6 marks)

**2**

Our understanding of genetics and inheritance has improved due to the work of many scientists.

(a) Draw **one** line from each scientist to the description of their significant work.

Scientist	Description of significant work
Charles Darwin	Carried out breeding experiments on pea plants.
Alfred Russel Wallace	Wrote 'On the origin of species'.
Gregor Mendel	Worked on plant defence systems.
	Worked on warning colouration in animals.

(3)

(b) In the mid-20th century the structure of DNA was discovered.

What is a section of DNA which codes for one specific protein called?

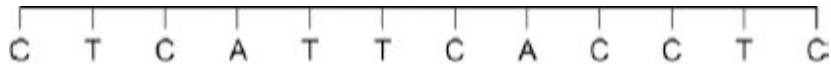
.....

(1)

(c) **Figure 1** shows one strand of DNA.

The strand has a sequence of bases (A, C, G and T).

**Figure 1**



How many amino acids does the strand of DNA in **Figure 1** code for?

Tick **one** box.

2

3

4

6

(1)

(d) Mutations of DNA cause some inherited disorders.

One inherited disorder is cystic fibrosis (CF).

A recessive allele causes CF.

Complete the genetic diagram in **Figure 2**.

- Identify any children with CF.
- Give the probability of any children having CF.

Each parent does not have CF.

The following symbols have been used:

**D** = dominant allele for **not** having CF

**d** = recessive allele for having CF

**Figure 2**

	<b>Mother</b>	
	D	d
<b>Father</b>	D	DD
	d	

Probability of a child with CF = .....

(3)

(e) What is the genotype of the mother shown in **Figure 2**?

Tick **one** box.

Heterozygous

Homozygous dominant

Homozygous recessive

(1)  
(Total 9 marks)

3

**Figure 1** shows an image of a small section of DNA.

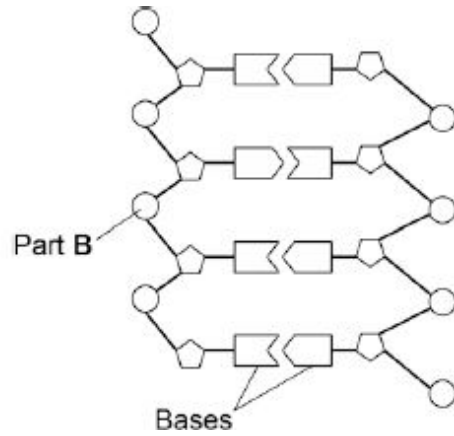
**Figure 2** shows the structure of a small section of DNA.

**Figure 1**



© Svisio/iStock/Thinkstock

**Figure 2**



(a) What is **Part B**?

.....  
.....

(1)

(b) In **Figure 1** the structure of DNA shows four different bases.

There are four different bases and they always pair up in the same pairs.

Which bases pair up together?

.....

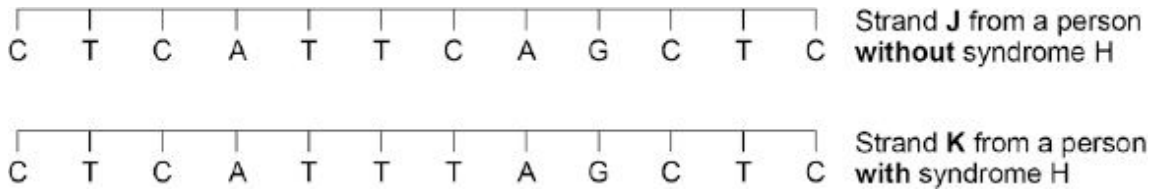
(1)

(c) Syndrome H is an inherited condition.

People with syndrome H do **not** produce the enzyme IDUA.

**Figure 3** shows part of the gene coding for the enzyme IDUA.

**Figure 3**



Strand **K** shows a mutation in the DNA which has caused syndrome H.

The enzyme IDUA helps to break down a carbohydrate in the human body.

The enzyme IDUA produced from Strand **K** will not work.

Explain how the mutation could cause the enzyme **not** to work.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5)

(d) A recessive allele causes syndrome H.

A heterozygous woman and a homozygous recessive man want to have a child.

Draw a Punnett square diagram to determine the probability of the child having syndrome H.

Identify any children with syndrome H.

Use the following symbols:

**A** = dominant allele

**a** = recessive allele

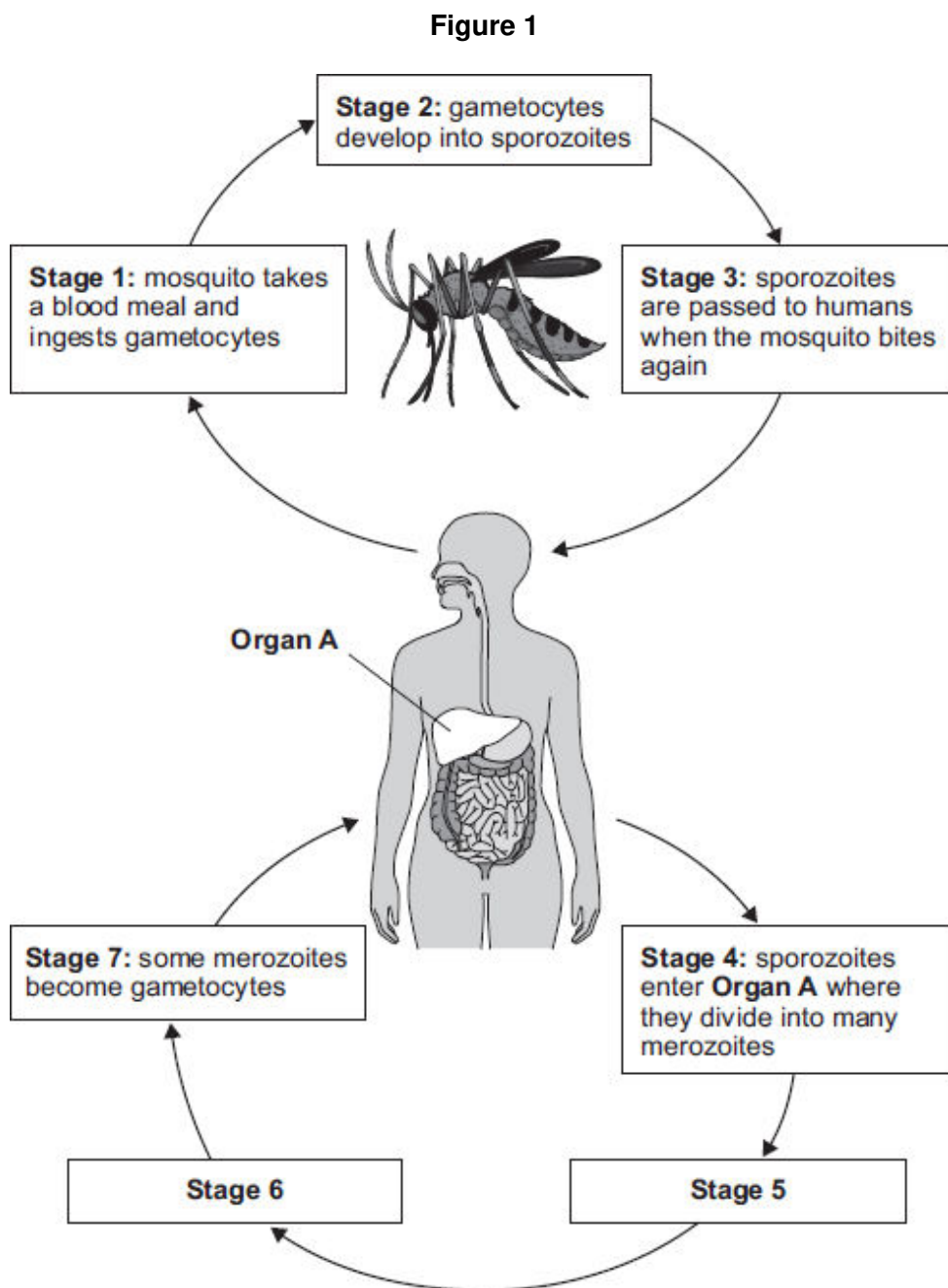
Probability = ..... %

(5)  
(Total 12 marks)



4

Figure 1 shows the stages in the transmission of the malaria parasite by mosquitoes to humans.



(a) Where in the mosquito does **Stage 2** happen?

Draw a ring around the correct answer.

**brain      salivary glands      stomach**

(1)

(b) What is **Organ A** in the human?

Draw a ring around the correct answer.

**liver      pancreas      small intestine**

(1)

(c) What happens in the human at **Stages 5 and 6**?

.....

.....

.....

.....

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.....

.....

**(4)**

- (d) Sickle-cell anaemia is an inherited disease caused by a mutation in the haemoglobin gene.
- (i) Genes are small pieces of DNA. The DNA in a gene consists of a sequence of bases.

**Figure 2** shows part of the base sequence in the DNA of a normal haemoglobin gene and the same section in the sickle-cell gene. **A, C, G** and **T** represent the different bases.

**Figure 2**

Normal gene	<b>GGACTCCTC</b>
Sickle-cell gene	<b>GGACACCTC</b>

Describe how the mutation causes a change in the shape of the haemoglobin protein molecule.

.....

.....

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.....

**(4)**

- (ii) Sickle-cell anaemia is caused by a recessive allele, **a**. The normal haemoglobin allele is dominant, **A**.

Use a genetic diagram to find the probability that two heterozygous parents will produce a child who is homozygous for sickle-cell anaemia.

Probability = .....

(4)

- (iii) What is the benefit of the heterozygous genotype in areas where malaria is common?

.....  
.....

(1)

**(Total 15 marks)**

**5**

- (a) A healthy diet should be balanced.

What is meant by a balanced diet?

.....  
.....  
.....  
.....

(2)

(b) Cholesterol has important functions in the body.  
Some cholesterol is produced by the liver.  
Cholesterol is needed in the body to make the hormone oestrogen.

(i) Name the organ in the body which produces oestrogen.

.....

(1)

(ii) What effect does oestrogen have on the female reproductive cycle?

.....

.....

(1)

(iii) Oestrogen is a naturally occurring steroid hormone.

Give **one** artificial use of a steroid hormone in the body.

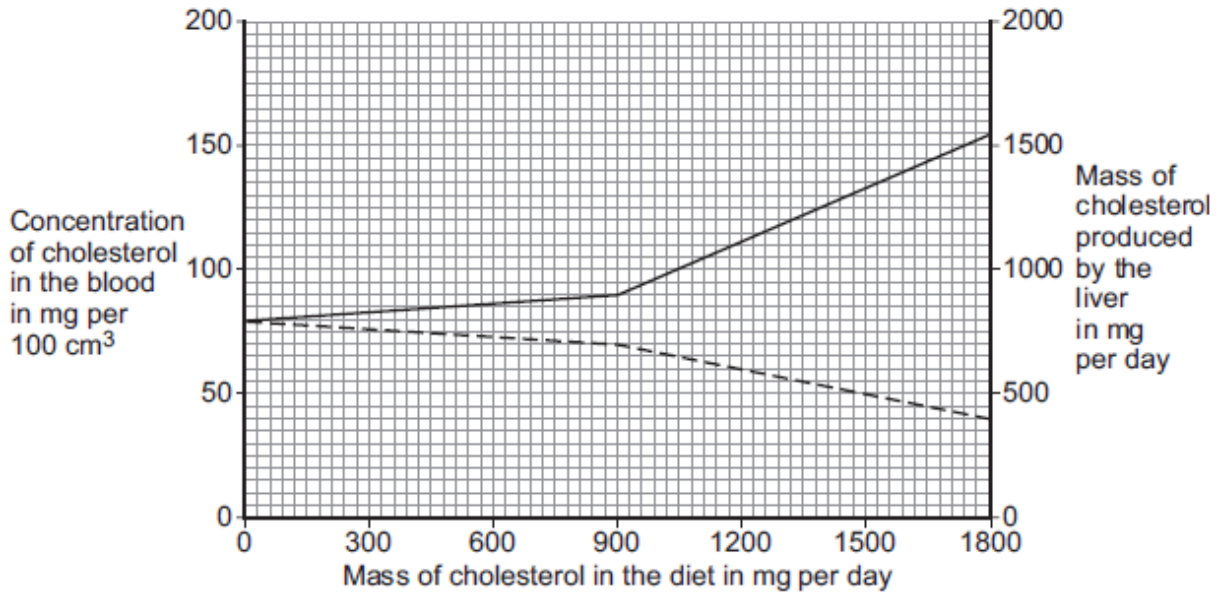
.....

.....

(1)

(c) The graph below shows the effect of the mass of cholesterol in the diet on:

- the concentration of cholesterol in the blood
- the mass of cholesterol produced by the liver.



**Key**

- Blood cholesterol concentration
- Production by the liver

Describe the effect of increasing the mass of cholesterol in the diet on the mass of cholesterol produced by the liver.

To gain full marks you should include data from the graph in your answer.

.....

.....

.....

.....

.....

.....

.....

(2)

- (d) Large amounts of cholesterol in the diet switch off the production of an enzyme called reductase, in the liver.

An increase of the enzyme reductase increases the production of cholesterol by the liver.

- (i) Which part of a liver cell is responsible for controlling the production of reductase?

.....  
.....

(1)

- (ii) High blood cholesterol concentrations increase the likelihood of heart and circulatory diseases.

Doctors can prescribe statins to control the concentration of cholesterol in the blood.

Suggest how statins work.

.....  
.....

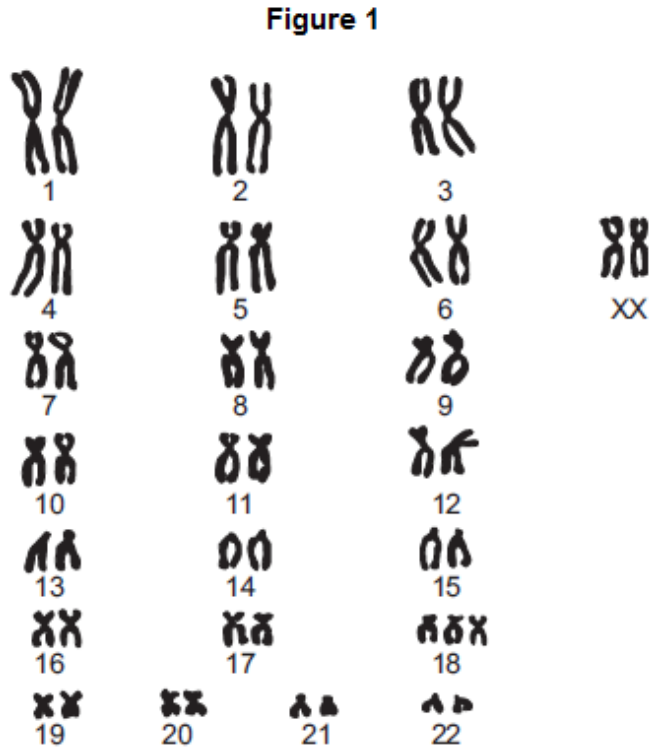
(1)

**(Total 9 marks)**

6

Genetic disorder **E** is a condition caused by a change in the chromosomes.

(a) **Figure 1** shows the chromosomes from one cell of a person with genetic disorder **E**.



(i) How do you know this person is female?

Use information from **Figure 1**.

.....  
.....

(1)

(ii) Describe how the chromosomes shown in **Figure 1** are different from the chromosomes from a person who does not have genetic disorder **E**.

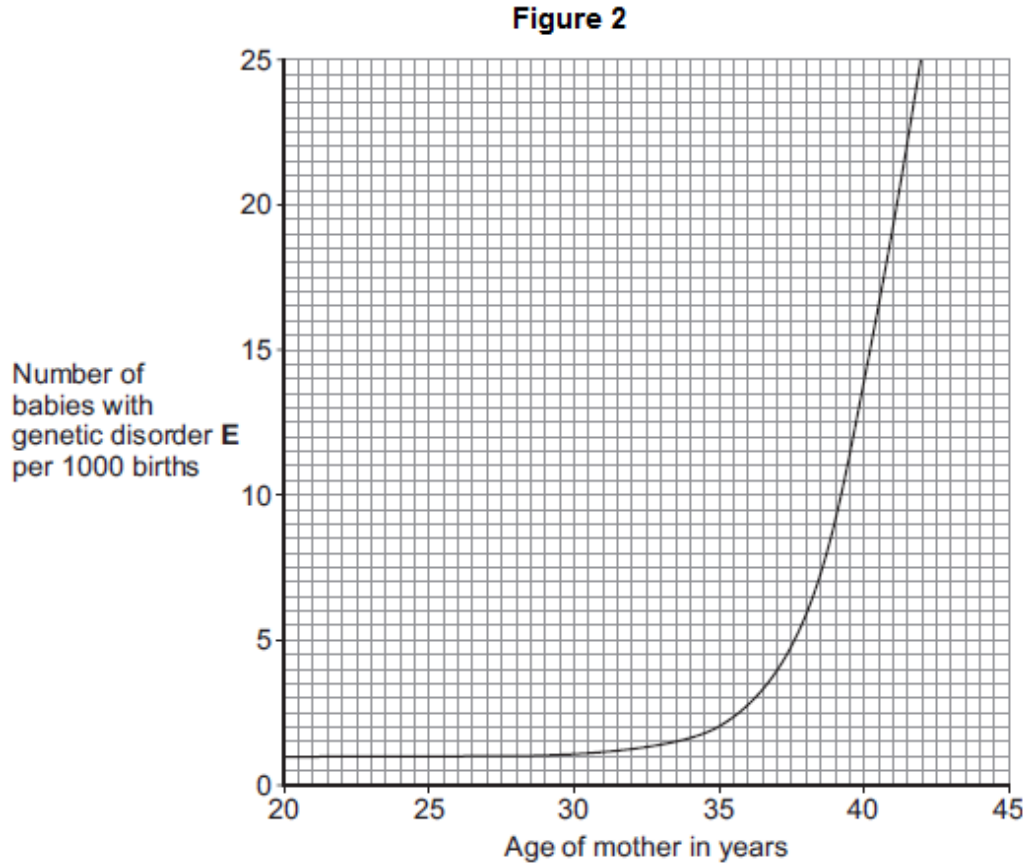
.....  
.....  
.....  
.....

(2)



- (b) As a woman gets older, the chance of her having a baby with genetic disorder **E** increases.

Figure 2 shows this.



- (i) The chance of a 35-year-old woman having a baby with genetic disorder **E** is 2 per 1000 births.

What is the chance of a 40-year-old woman having a baby with genetic disorder **E**?

..... per 1000 births

(1)

- (ii) A 40-year-old woman is more likely than a 35-year-old woman to have a baby with genetic disorder **E**.

How many times more likely?

..... times

(1)

- (c) A 41-year-old woman wants to have a baby. A 41-year-old woman has an increased chance of having a baby with genetic disorder **E**.

Doctors can screen embryos for genetic disorder **E**.

The table gives some information about two methods of embryo screening.

Method 1	Method 2
1. The woman is given hormones to cause the release of a few eggs. The eggs are taken from her body in a minor operation. The eggs are fertilised in a glass dish.	1. The woman gets pregnant in the normal way.
2. One cell is taken from each embryo when the embryo is 3 days old.	2. Cells are taken when the embryo is 10 weeks old.
3. Cells are screened for genetic disorder <b>E</b> .	3. Cells are screened for genetic disorder <b>E</b> .
4. An unaffected embryo is placed in the woman's uterus. Embryos that are not used are destroyed or used in medical research.	4. An unaffected fetus is allowed to develop. If the fetus has genetic disorder <b>E</b> , the woman can choose to have an abortion.
5. This method costs about £6000.	5. This method costs about £600.

Use information from the table to give **two** advantages and **one** disadvantage of **Method 1** compared with **Method 2** for detecting genetic disorder **E**.

Advantages of **Method 1**:

1.....

.....

2.....

.....

Disadvantage of **Method 1**:

.....

.....

(3)  
(Total 8 marks)

7

DNA is the genetic material of human cells.

Figure 1 shows the structure of part of a DNA molecule.



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

.....  
.....  
.....

(2)

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

What causes the cells to be genetically identical?

.....  
.....

(1)

(b) Many genes have different forms called alleles.

(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)

(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?

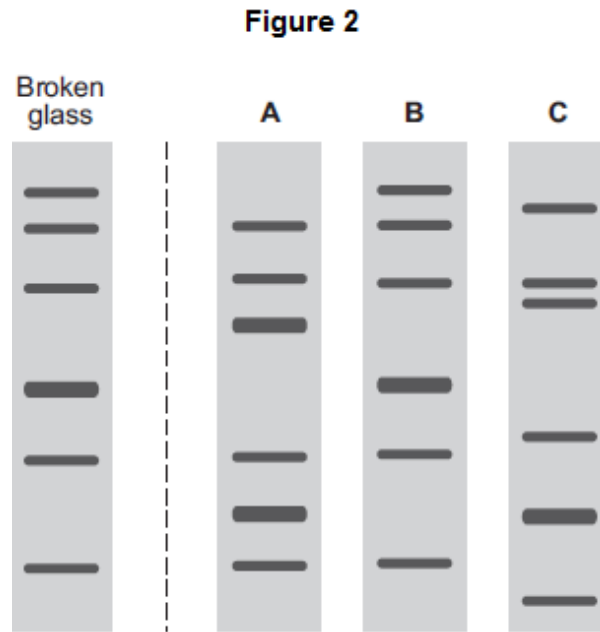
.....

(1)

- (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 2** shows the scientists' results.



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

Tick (✓) **one** box.

**A**

**B**

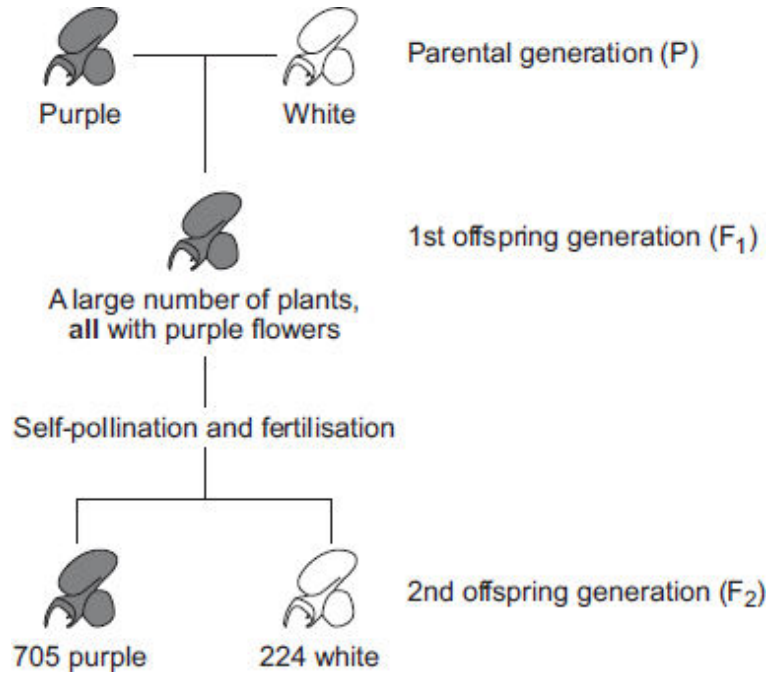
**C**

(1)  
(Total 6 marks)

**8**

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

The diagram below shows the results Mendel obtained in one investigation with purple-flowered and white-flowered pea plants.



- (a) (i) Calculate the ratio of purple-flowered plants to white-flowered plants in the F<sub>2</sub> generation.

Ratio of purple : white = .....

(1)

- (ii) There was a total of 929 plants in the F<sub>2</sub> generation.

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

Explain why.

.....

.....

.....

.....

(2)

- (b) (i) Some of the plants in the diagram are homozygous for flower colour and some are heterozygous.

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

	Homozygous	Heterozygous
Purple-flowered plant in the P generation		
White-flowered plant in the P generation		
Purple-flowered plant in the F <sub>1</sub> generation		

(2)

- (ii) Draw a genetic diagram to show how self-pollination of the F<sub>1</sub> purple-flowered plants produced mainly purple-flowered offspring in the F<sub>2</sub> generation together with some white-flowered offspring.

Use the following symbols:

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

(3)

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

Suggest **two** reasons why.

- 1.....  
 .....  
 2.....  
 .....

(2)

(Total 10 marks)

**9**

Some genetic disorders are caused by alleles inherited from the parents.

- (a) What are **alleles**?

- .....  
 .....

(1)

(b) Describe how embryos can be screened for the alleles that cause genetic disorders.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(c) Polydactyly is a genetic disorder that leads to extra fingers or toes.

Polydactyly is caused by a dominant allele, **D**.

The photograph shows the hand of a person with polydactyly.



© Adem Demir/Hemera.

A man has polydactyly. His wife does not have polydactyly.

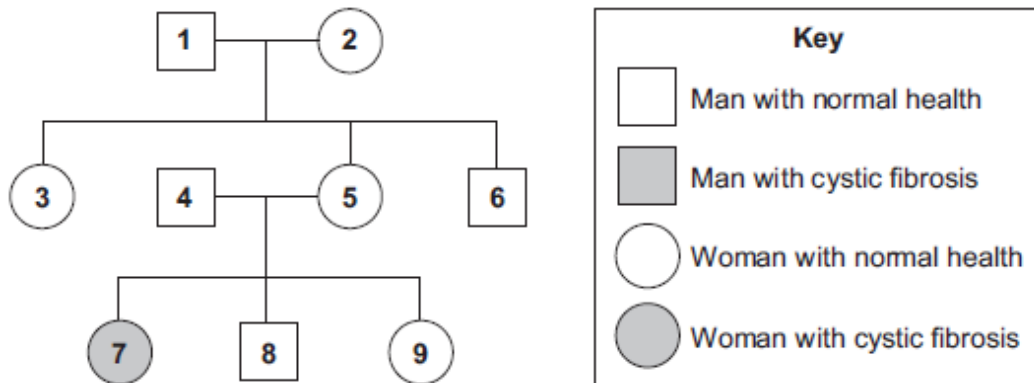
This couple's children have a 50% chance of having polydactyly.

Draw a genetic diagram to explain why.

(3)

(d) Cystic fibrosis is another genetic disorder. It is caused by a recessive allele.

The diagram shows the inheritance of cystic fibrosis in one family.





Woman 5 is pregnant with her fourth child.

What is the probability that this child will have cystic fibrosis?

Draw a genetic diagram to explain your answer.

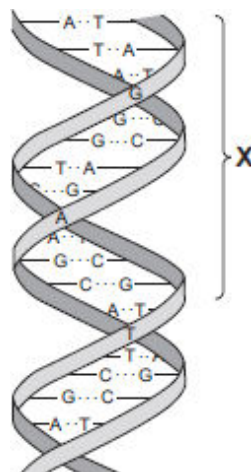
Use the following symbols.

**N** = allele for normal health

**n** = allele for cystic fibrosis

(4)  
(Total 12 marks)

**10** The diagram shows part of a DNA molecule.



(a) (i) In which part of an animal cell is DNA found?

.....

(1)

(ii) Complete the following sentence.

The letters **A**, **C**, **G** and **T** in the diagram represent four different compounds called .....

(1)

(iii) One strand of the DNA, in the section labelled **X**, contains the following sequence of these compounds:

**T A T G G G T C T T C G**

How many amino acids would this section of the DNA code for?

(1)

(iv) The section of DNA described in part (a) (iii) is a small part of a gene.

The sequence of compounds **A**, **C**, **G** and **T** in the gene is important.

Explain why.

.....

.....

.....

.....

(2)

(b) *Read the following information about genetic engineering.*

The caterpillar of the European Corn Borer moth feeds on the fruits of maize (sweet corn). There is a chemical called Bt-toxin which is poisonous to the corn borer caterpillar but not to humans.

Scientists carried out the following steps.

1. The Scientists made a bacterial plasmid to which they added two genes:
  - **Bt** gene, which coded for production of the Bt-toxin
  - **kan<sup>r</sup>** gene, which coded for resistance to an antibiotic called kanamycin.
2. They used this plasmid to produce genetically modified bacteria which could invade plant cells.
3. They mixed these genetically modified bacteria with pieces cut from maize leaves.
4. They placed the pieces of maize leaf on agar jelly in a Petri dish. The agar jelly contained the antibiotic, kanamycin. The kanamycin killed most of the pieces of maize leaf, but a few survived.
5. They took some cells from the surviving pieces of maize leaf and grew them in tissue culture.

The result was maize plants that now contained the **Bt** gene, as well as the **kan<sup>r</sup>** gene, in all of their cells.

(i) What is a **plasmid** (Step 1)?

.....  
.....  
.....  
.....

(2)

(ii) Why did the scientists add **kanamycin** to the agar jelly (Step 4)?

.....  
.....  
.....  
.....

(2)

- (iii) The scientists grew each Bt-maize plant from a single cell which contained the **Bt** gene.

Explain why **all** the cells in the Bt-maize plant contained the **Bt** gene.

.....

.....

.....

.....

(2)

- (iv) Kanamycin is an antibiotic.

Some scientists are concerned that the gene for kanamycin resistance has been put into maize.

Suggest why.

.....

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.....

.....

.....

(2)

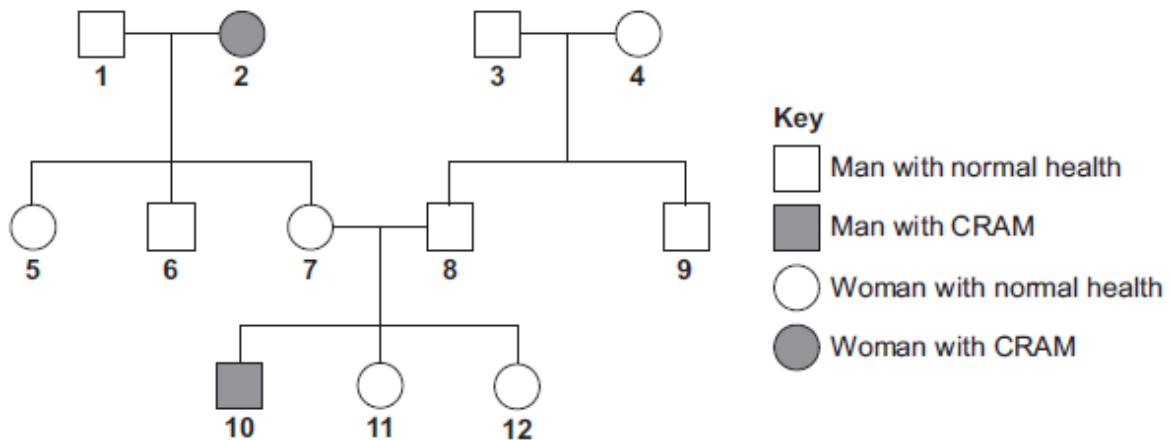
(Total 13 marks)

11

CRAM is an inherited condition which causes muscle breakdown.

The breakdown products enter the urine, making it dark-coloured.

The diagram below shows the inheritance of CRAM in one family.



CRAM is caused by a recessive allele, **n**.

The allele for normal health is **N**.

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

.....  
.....

(1)

(ii) What does **recessive** mean?

.....  
.....

(1)

(iii) Give evidence from the diagram that CRAM is caused by a **recessive** allele.

.....  
.....

(1)

(b) (i) Person **2** is homozygous for CRAM.

What does **homozygous** mean?

.....  
.....

(1)

(ii) None of person **2**s children have CRAM.

Explain why.

.....  
.....  
.....

(2)

(c) Persons **7** and **8** want to have another child.

(i) What is the probability that this child will have CRAM?

Draw a genetic diagram to explain your answer.

Probability = .....

(4)

- (ii) To avoid having another child with CRAM, persons **7** and **8** may decide to use embryo screening.

Two ways of doing this are:

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

PGD involves IVF (in vitro fertilisation) of a few eggs, then taking a cell from each embryo when it is 3 days old.

The image below shows how the cell is removed.



© Rtimages/iStock/Thinkstock

The DNA in the cell can then be tested. An unaffected embryo can be implanted in the woman's uterus. The possibility of a false positive result is around 1 in 6. The procedure costs about £6000. Affected embryos would be discarded. Extra unaffected embryos might be frozen and kept for later implantation. Alternatively, the extra embryos might be used in scientific research.

CVS involves taking a sample of blood from the placenta a few weeks into pregnancy. DNA from white blood cells can then be tested. If an affected embryo is detected, the parents then have to decide whether to terminate the pregnancy or allow it to continue.

CVS has a 1 percent chance of giving an incorrect result and a 0.9 percent chance of causing a miscarriage. CVS costs about £600.

Evaluate the benefits of these two methods of embryo screening.  
You should include a conclusion to your evaluation.

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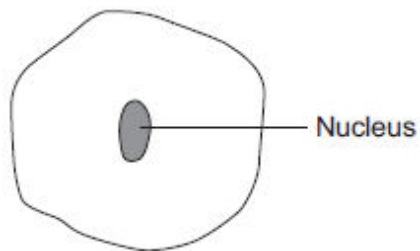
.....

.....

.....

(5)  
(Total 15 marks)

**12** The diagram below shows a cell.



(a) Draw a ring around the correct answer to complete each sentence.

(i) In the nucleus of a cell, genes are part of

- chromosomes.
- membranes.
- receptors.

(1)

(ii) Different genes control different

- characteristics
- gametes
- nuclei

of an organism.

(1)

(iii) Studying the similarities and differences between organisms allows us to

- classify
- clone
- grow

the organisms.

(1)

(b) Complete the following sentence.

Living things can be grouped into animals, microorganisms and .....

(1)

**(Total 4 marks)**

**13**

Most cows produce milk with a fat content of 3.4%.

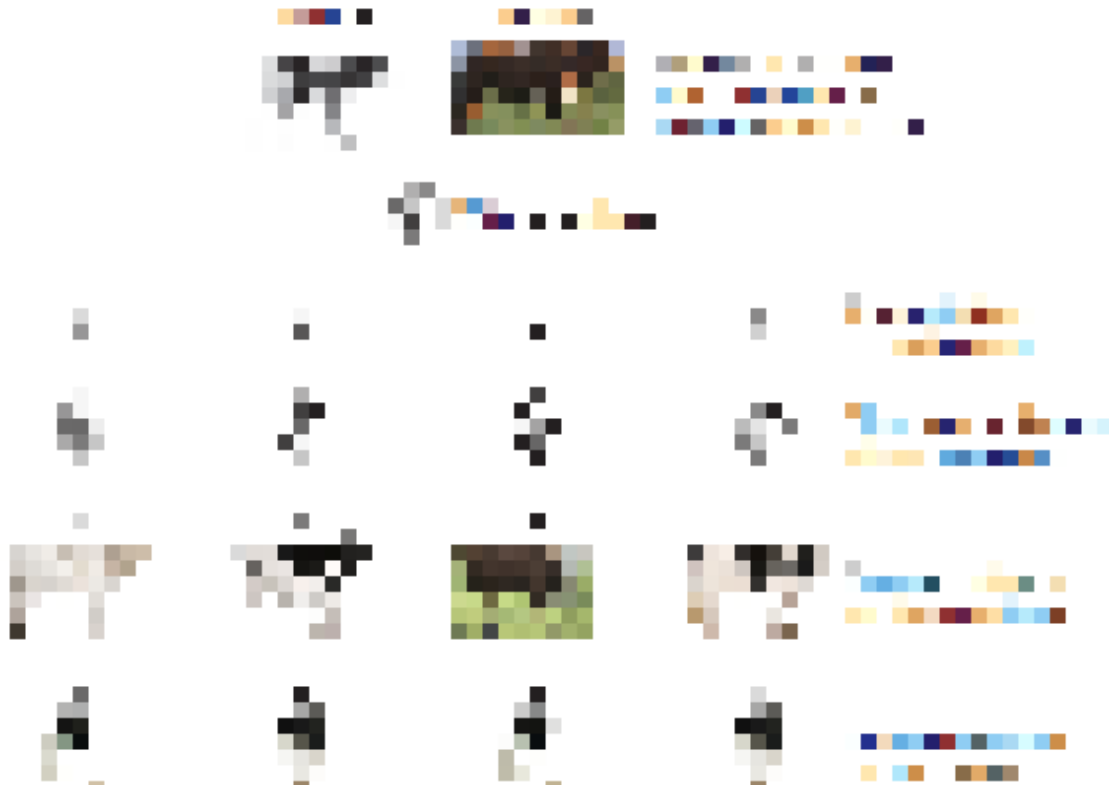
Cow **S** produces milk with a fat content of 1.2%.

Only cow **S** has the gene to produce this low-fat milk.

(a) A farmer plans to develop more cows like cow **S**.



The diagram below shows how the farmer plans to do this.



**Cow S** © GlobalP/iStock/Thinkstock, **Bull** © Fuse/Thinkstock, **Whitish cow** © Eric Isselee/iStock/Thinkstock, **Brown cow** © DC Productions/Photodisc/Thinkstock, **Holstein cow(1)** © GlobalP/iStock/Thinkstock, **Holstein cow(2)** © GlobalP/iStock/Thinkstock, **Calf** © Eric Isselee/iStock/Thinkstock.

- (i) An egg cell from cow **S** is fertilised by a sperm cell from a bull. This is part of sexual reproduction.

What is the scientific name for sex cells such as egg cells and sperm cells?

.....

(1)

- (ii) After fertilisation, cells are taken from the original embryo.

These cells develop into new embryos.

Which part of the host mother's body should each new embryo be put into?

.....

(1)

- (b) (i) The calves born to all of the host mothers are genetically identical to each other.

Draw a ring around the correct answer to complete the sentence.

The calves are genetically identical to each other because

they	are formed from the same original embryo.
	have the same host mother.
	have the same two parents.

(1)

- (ii) What term is used to describe the method of producing calves shown in the diagram in part (a)?

Tick (✓) **one** box.

Adult cell cloning

Embryo transplantation

Genetic modification

- (iii) Why are the calves born to the host mothers **not** genetically identical to cow **S**?

.....

.....

(1)

(Total 5 marks)

14

Read the information.

Insects can be both useful and harmful to crop plants.  
 Insects such as bees pollinate the flowers of some crop plants. Pollination is needed for successful sexual reproduction of crop plants.  
 Some insects eat crops and other insects eat the insects that eat crops.

Corn borers are insects that eat maize plants.  
 A toxin produced by the bacterium *Bacillus thuringiensis* kills insects.  
 Scientists grow *Bacillus thuringiensis* in large containers. The toxin is collected from the containers and is sprayed over maize crops to kill corn borers.

A company has developed genetically modified (GM) maize plants. GM maize plants contain a gene from *Bacillus thuringiensis*. This gene changes the GM maize plants so that they produce the toxin.



**15**

In sexual reproduction, an egg fuses with a sperm.

(a) (i) Draw a ring around the correct answer to complete the sentence.

An egg and a sperm fuse together in the process of

- |                |
|----------------|
| cloning.       |
| fertilisation. |
| mitosis.       |

(1)

(ii) Egg cells and sperm cells each contain the structures given in the box.

- |            |      |         |
|------------|------|---------|
| chromosome | gene | nucleus |
|------------|------|---------|

List these three structures in size order, starting with the smallest.

- 1 ..... (smallest)
- 2 .....
- 3 ..... (largest)

(2)

(iii) The egg and the sperm contain genetic material.

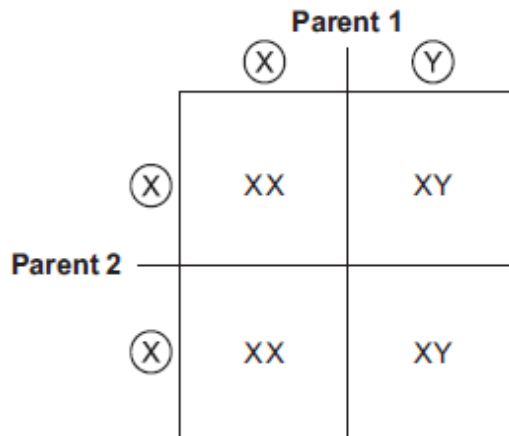
Draw a ring around the correct answer to complete the sentence.

The genetic material is made of

- |               |
|---------------|
| carbohydrate. |
| DNA.          |
| protein.      |

(1)

(b) The diagram below shows the inheritance of **X** and **Y** chromosomes.



(i) Draw a tick (✓) on the part of the diagram that shows a sperm cell.

(1)

(ii) What is the chance of having a female child?

Give the reason for your answer.

.....

.....

.....

.....

(2)  
(Total 7 marks)

**16**

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

(a) PKU is caused by a recessive allele.

(i) What is an allele?

.....

.....

(1)

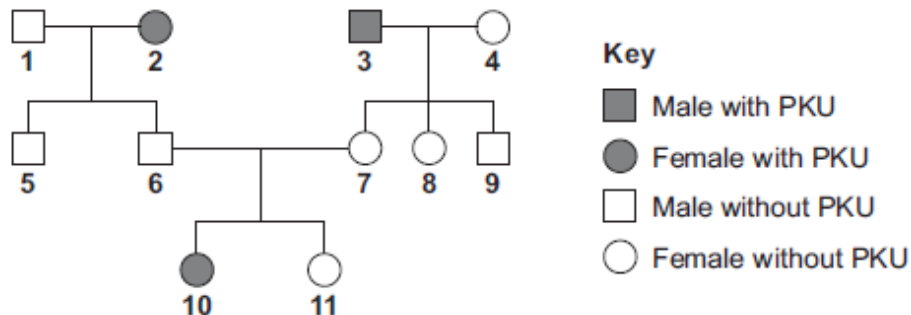
(ii) What is meant by recessive?

.....

.....

(1)

(b) The diagram below shows the inheritance of PKU in one family.



(i) Give **one** piece of evidence from the diagram that PKU is caused by a recessive allele.

.....

.....

(1)

- (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.

Probability = .....

(4)

- (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.

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

Name this type of cell division.

.....

(1)

- (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)

- (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)

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

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

.....

(1)

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

.....

(1)  
(Total 12 marks)

**17**

When humans reproduce, chromosomes and genes are passed on to the next generation.

In each of the following questions, draw a ring around the correct answer to complete the sentence.

(a) A gene is a small section of

- cellulose.
- DNA.
- protein.

(1)

(b) The sex chromosomes in the human male are

- X and X.
- X and Y.
- Y and Y.

(1)

(c) (i) Most human body cells contain

- 23 chromosomes.
- 46 chromosomes.
- 92 chromosomes.

(1)

(ii) The number of chromosomes in a human gamete (sex cell)

is the same number as  
half the number  
twice the number in body cells.

(1)

(d) Gametes are produced by

fertilisation.

meiosis.

mitosis.

(1)  
(Total 5 marks)

18

In each question, draw a ring around the correct answer to complete the sentence.

(a) Our understanding of how genes are inherited is mostly because of

the work of

Darwin.

Lamarck.

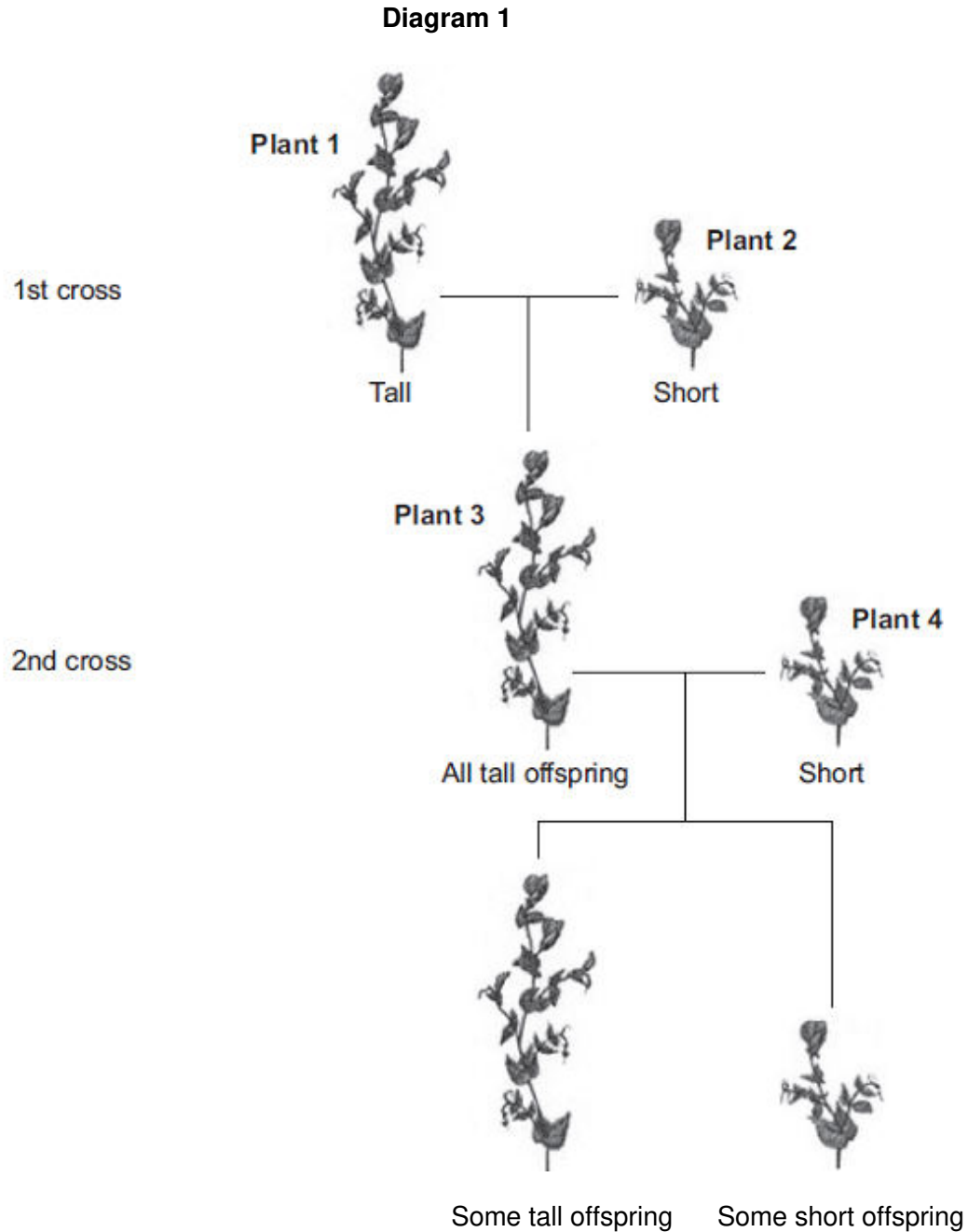
Mendel.

(1)



(b) A scientist investigated inheritance in pea plants.

The scientist crossed tall pea plants with short pea plants. **Diagram 1** shows the results.



In the rest of this question, the following symbols are used to represent alleles.

**T** = allele for tall

**t** = allele for short

(i) The 1st cross in **Diagram 1** produced 120 offspring. All of these offspring were tall.

This shows that **plant 1** contained the alleles

**TT.**

**Tt.**

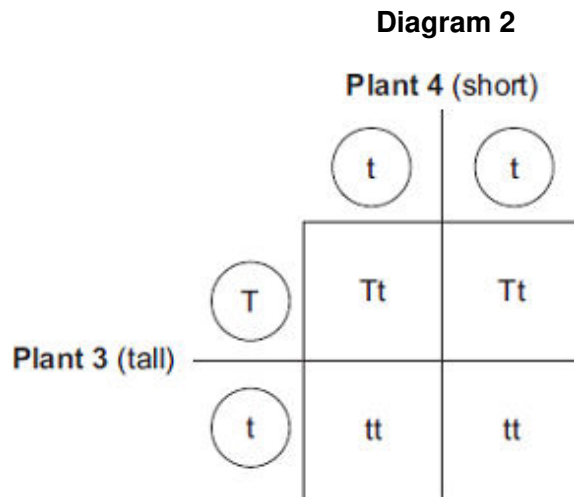
**tt.**

(ii) **Plant 3** is tall because of

a dominant allele.  
the environment.  
a recessive allele.

(1)

(c) **Diagram 2** gives more information about the cross between **plant 3** and **plant 4**.



This cross produced some tall offspring and some short offspring.

The ratio of tall to short offspring in **Diagram 2** is

1:1.  
2:1.  
3:1.

(1)

(d) Two short plants were crossed. This cross produced 100 offspring.

The expected offspring would be

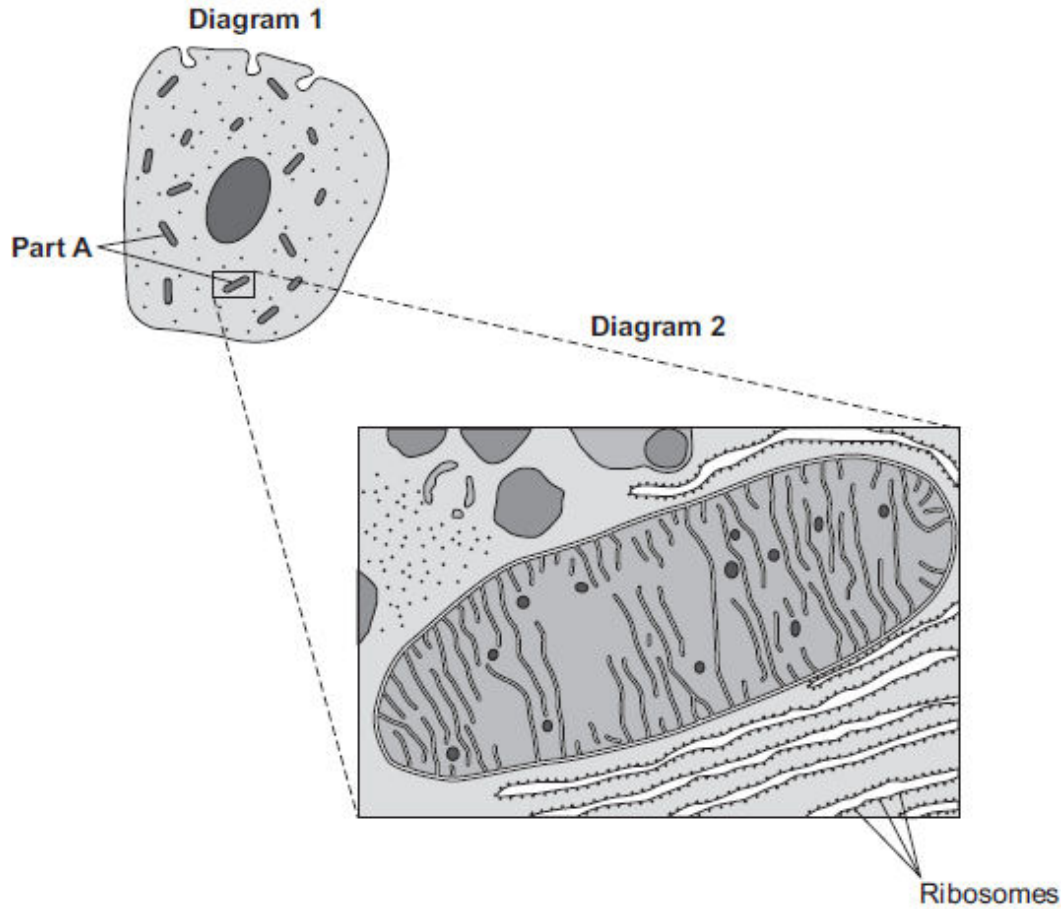
100 short plants.  
50 tall plants and 50 short plants.  
75 tall plants and 25 short plants.

(1)  
(Total 5 marks)

19

Diagram 1 shows a cell from the pancreas.

Diagram 2 shows part of the cell seen under an electron microscope.



Part **A** is where most of the reactions of aerobic respiration happen.

(a) (i) Name part **A**.

.....

(1)

(ii) Complete the equation for aerobic respiration.



(2)

(iii) Part **A** uses oxygen.

Explain how oxygen passes from the blood to part **A**.

.....

.....

.....

.....

.....

.....

.....

.....

**(3)**

(b) The pancreas cell makes enzymes.

Enzymes are proteins.

Describe how the ribosomes and part **A** help the cell to make enzymes.

.....

.....

.....

.....

.....

.....

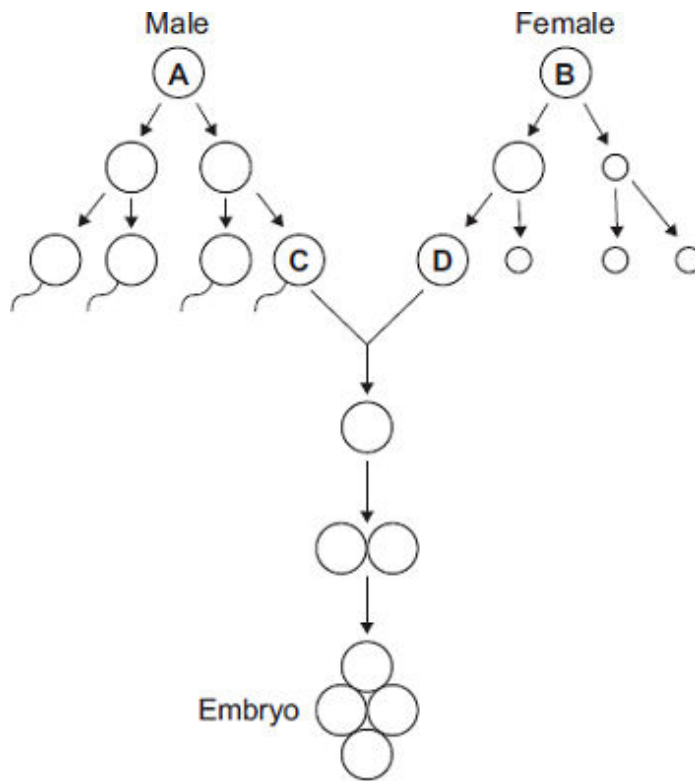
.....

.....

**(3)**  
**(Total 9 marks)**

20

The diagram shows some of the cell divisions that occur during human reproduction.



(a) (i) Name the type of cell division that produces cell **D** from cell **B**.

.....

(1)

(ii) Which organ in the male body produces cell **C** from cell **A**?

.....

(1)

(b) (i) Cells **A** and **B** each contain 46 chromosomes.

How many chromosomes would there be in the nucleus of cell **C**?

(1)

(ii) Why is it important that cell **C** has this number of chromosomes?

.....  
 .....  
 .....  
 .....

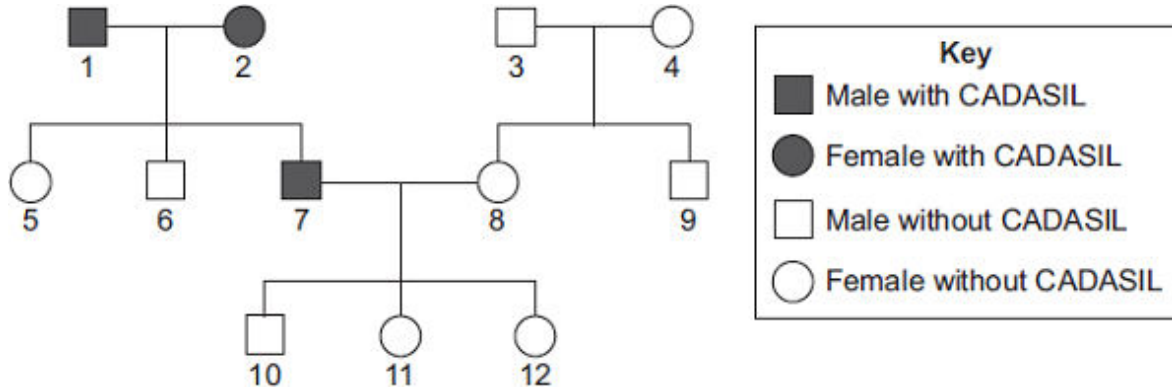
(2)  
**(Total 5 marks)**

21

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.



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

(i) What is a *dominant allele*?

.....  
 .....

(1)

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

.....  
 .....

(1)

(iii) Person 7 has CADASIL.

Is person 7 homozygous or heterozygous for the CADASIL allele?

Give evidence for your answer from the diagram.

.....  
 .....

(1)

- (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)

- (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.

- (i) Why do the scientists use stem cells?

.....  
.....  
.....  
.....

(2)

- (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.

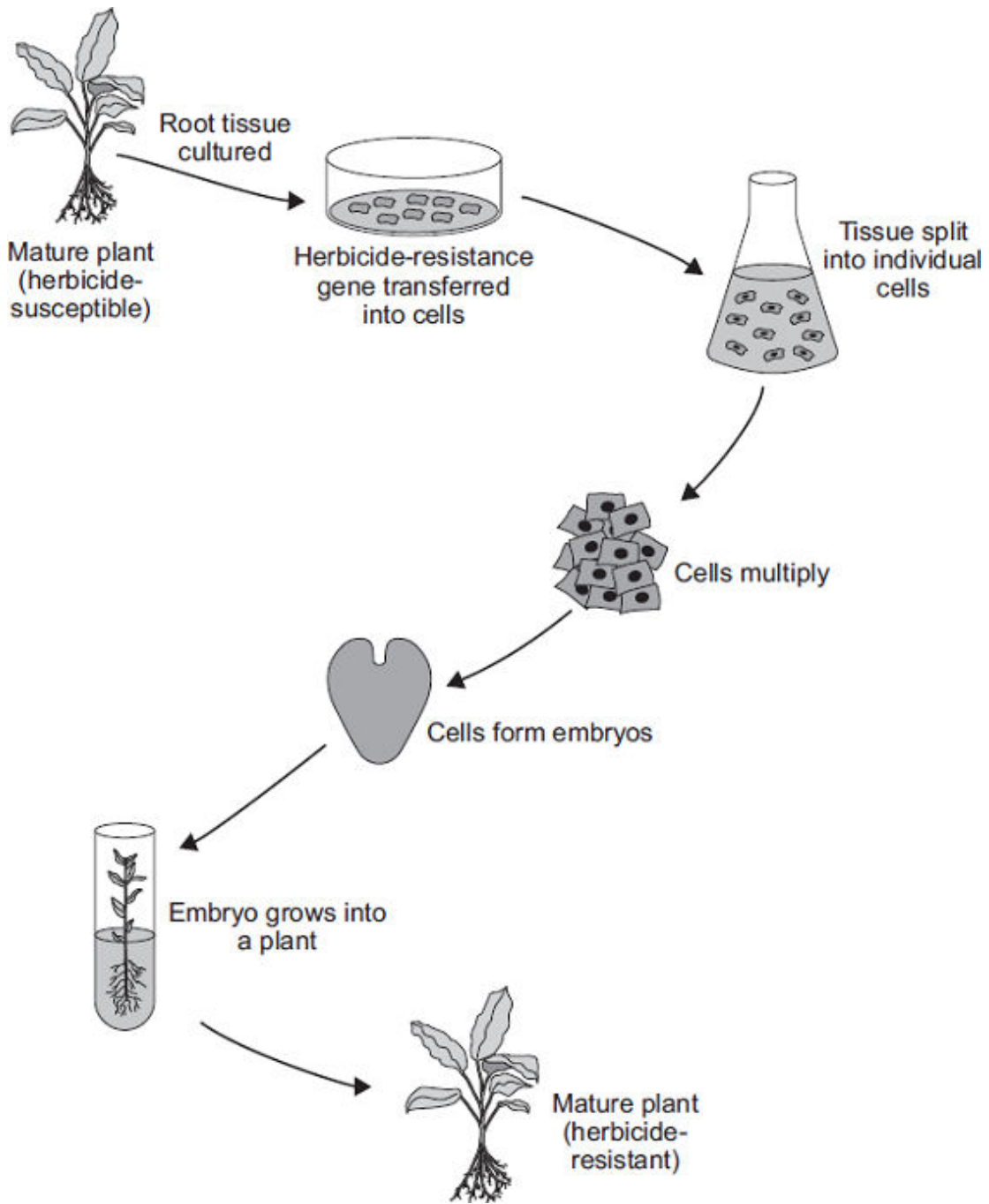
.....  
.....

(1)

(Total 10 marks)

22

The diagram shows one method of producing herbicide-resistant crop plants.



- (a) The herbicide-resistance gene is cut out of a chromosome of a herbicide-resistant plant.  
How is the herbicide-resistance gene cut out of the chromosome?

.....  
.....

(1)



- (b) Apart from having the herbicide-resistance gene, the herbicide-resistant plants are identical to the herbicide-susceptible plants.

Explain why.

.....

.....

.....

.....

(2)

- (c) Suggest **one** advantage to a farmer of growing herbicide-resistant crops.

.....

.....

(1)

- (d) Many people are opposed to the growing of herbicide-resistant crops produced in this way.

Suggest **one** reason why.

.....

.....

(1)

(Total 5 marks)

23

Humans reproduce sexually.

- (a) Draw a ring around the correct answer to complete each sentence.

(i) At fertilisation

chromosomes
genes
gametes

join together.

(1)

(ii) At fertilisation a single cell forms. The cell has new pairs of

chromosomes.
nuclei.
gametes.

(1)

(b) A child inherits cystic fibrosis. The child's parents do **not** have cystic fibrosis.

(i) What does this information tell us about the cystic fibrosis allele?

Tick (✓) **one** box.

The allele is dominant.

The allele is recessive.

The allele is strong.

(1)

(ii) How many copies of the cystic fibrosis allele does the child have?

Draw a ring around your answer.

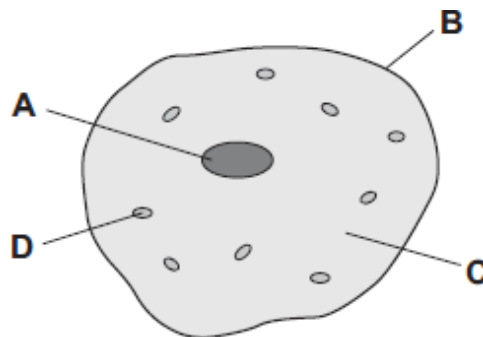
**one**

**two**

**four**

(1)

(c) The diagram shows a human body cell.



Which part of the cell, **A**, **B**, **C** or **D**:

(i) contains the allele for cystic fibrosis

(1)

(ii) is affected by cystic fibrosis?

(1)

**(Total 6 marks)**

24

- (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)

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

Read the information which they received from the genetic counsellor.

- Five eggs will be removed from Mrs Smith's ovary while she is under an anaesthetic.
- 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 destroyed.

- (i) Suggest why it is helpful to take five eggs from the ovary and not just one egg.

.....

.....

(1)

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

Remember to give a conclusion to your evaluation.

.....

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.....

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.....

.....

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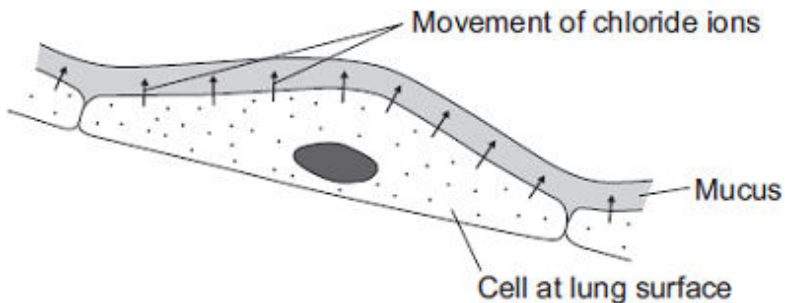
.....

.....

**(4)**

(c) In someone who has cystic fibrosis the person's mucus becomes thick.

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



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

Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

(3)  
(Total 11 marks)

25

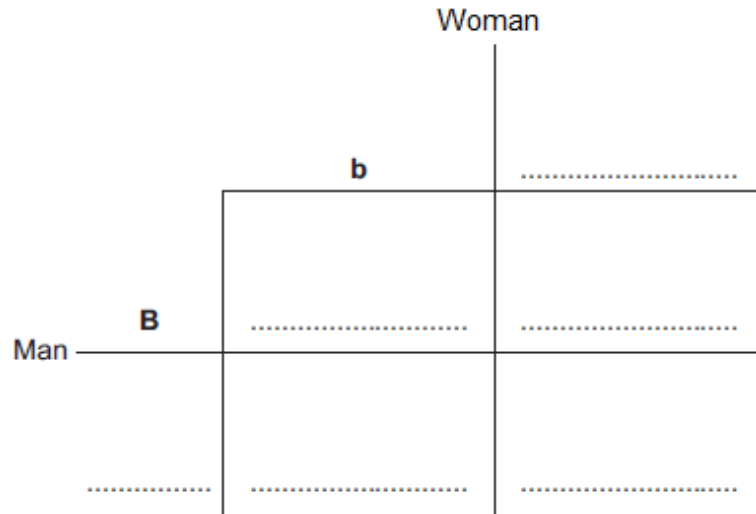
Eye colour is controlled by genes.

The dominant allele of the gene (**B**) produces brown eyes. The recessive allele (**b**) produces blue eyes.

A homozygous blue-eyed woman married a homozygous brown-eyed man.

All of their three children had brown eyes.

(a) (i) Complete the genetic diagram.



(2)

(ii) Give the reason why all of the children had brown eyes.

.....

.....

(1)

(b) The couple's brown-eyed son and his brown-eyed partner had five children. Two of the children had blue eyes and three of the children had brown eyes.

Use a genetic diagram to show how two of their children came to have blue eyes.

.....

.....

.....

(3)  
(Total 6 marks)

26

The photographs show two breeds of cow.

**Friesian cow**



By Keith Weller/USDA (www.ars.usda.gov: Image Number K5176-3) [Public domain], via Wikimedia Commons

**Jersey cow**



By Jamain (Own work) [CC-BY-SA-3.0-2.5-2.0-1.0], via Wikimedia Commons

In parts (a) and (b) draw a ring around the correct answer to complete each sentence.

(a) Cows produce their young (calves) by

- asexual reproduction.
- cloning.
- sexual reproduction.

(1)

(b) Cows and their calves have many similar characteristics.

(i) The information for characteristics is carried by

- clones.
- embryos.
- genes

(1)

(ii) The information for characteristics is passed to the next generation in cells

called

- body cells.
- gametes.
- neurones.

(1)

(c) Friesian and Jersey cows can both be used for meat or to produce milk.

The information shows features of Friesian and Jersey cows.

Friesian cows	Jersey cows
Body mass up to 600 kg	Body mass up to 400 kg
Milk contains 3.4% protein	Milk contains 3.8% protein
Can be milked for 325 days after giving birth	Can be milked for 250 days after giving birth
Produce no milk for 55 days before having a calf	Produce no milk for 45 days before having a calf
Produce > 30 litres of milk per day	Produce < 30 litres of milk per day

Use **only** the information above to answer these questions.

In your answers you must make comparisons between the two breeds of cow.

(i) Give **two** advantages of a farmer keeping Friesian cows and **not** Jersey cows.

1.....  
.....  
2.....  
.....

(2)

(ii) Give **two** advantages of a farmer keeping Jersey cows and **not** Friesian cows.

1.....  
.....  
2.....  
.....

(2)



- (d) Cow's milk is different from human milk. Cow's milk should **not** be given to young human babies.

Scientists in China have *genetically engineered* cows to produce human milk. Milk from these cows can be fed to young human babies.

- (i) What is *genetic engineering* ?

Tick (✓) **one** box.

Genes from one organism are transferred to a different organism

Cells are separated from an embryo and are transferred to host mothers

The nucleus from a body cell is transferred to an egg cell

(1)

- (ii) Some people are worried about using milk from genetically engineered cows, to feed human babies.

Give **one** reason why.

.....  
.....

(1)

**(Total 9 marks)**

**27**

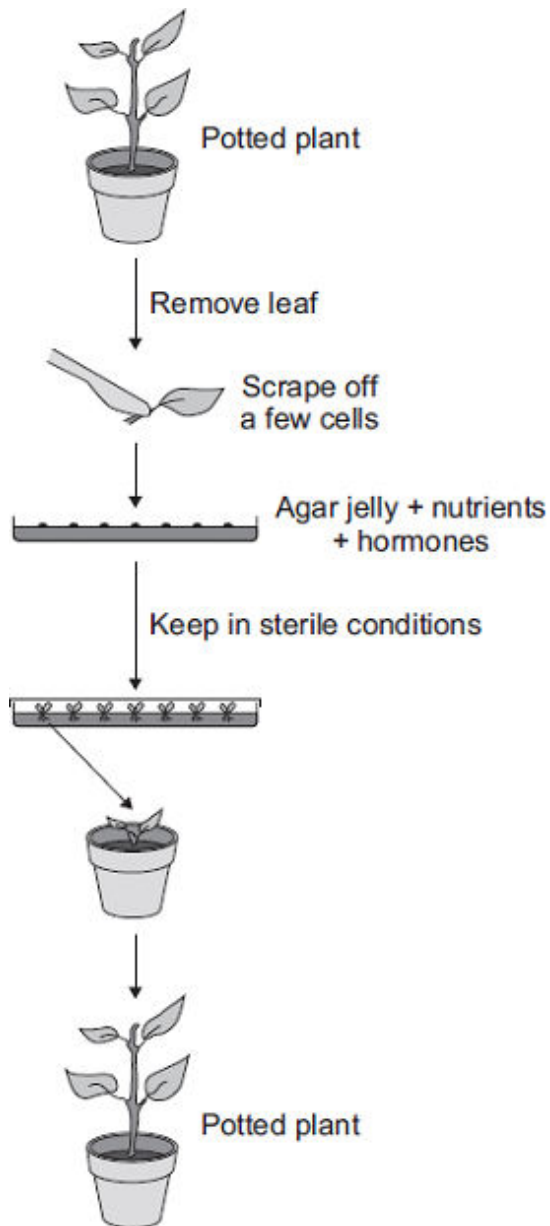
Plant hormones are used in horticulture.

- (a) Name **one** plant hormone.

.....

(1)

(b) The diagram shows how new plants are produced using tissue culture.



(i) Tissue culture is a type of *asexual reproduction* .

Give the main features of *asexual reproduction* .

.....

.....

.....

.....

.....

.....

(3)

(ii) Another method of producing new plants is by taking cuttings.

Suggest **one** advantage of using tissue culture and **not** using cuttings to produce plants.

.....

.....

.....

(1)  
(Total 5 marks)

**28**

(a) (i) Mitosis and meiosis are types of cell division.

For each feature in the table, tick (✓) **one** box to show if the feature occurs:

- only in mitosis
- only in meiosis.

Feature	Only in mitosis (✓)	Only in meiosis (✓)
Produces new cells during growth and repair		
Produces gametes (sex cells)		
Produces genetically identical cells		

(2)

(ii) Name the organ that produces gametes (sex cells) in:

a man .....

a woman. ....

(2)

(b) **X** and **Y** chromosomes are the sex chromosomes. They determine a person's sex.

What sex chromosomes will be found in the body cells of:

(i) a man .....

(1)

(ii) a woman? .....

(1)

(c) A man and a woman decide to have a child.

What is the chance that the child will be a boy? .....

(1)  
(Total 7 marks)

**29**

Polydactyly is an inherited condition. Polydactyly is controlled by a dominant allele.

The photograph shows the foot of a baby with polydactyly.



CNRI/Science photo library

A man and his wife have three children. The man has polydactyly.

The diagram shows the inheritance of polydactyly in this family.

The diagram also shows the number of toes each person has on each foot.



In the rest of this question, the following symbols are used to represent alleles.

**D** = allele for polydactyly (6 toes on each foot)

**d** = allele for 5 toes on each foot

(a) (i) How many alleles for the number of toes will there be in **one** sperm cell?  (1)

(ii) Complete the sentence.

A sperm cell joins with an egg cell in a process called .....

(1)

- (b) (i) What combination of alleles does the man have?

Tick (✓) **one** box.

**DD**

**Dd**

**dd**

(1)

- (ii) What combination of alleles does the man's wife have?

Tick (✓) **one** box.

**DD**

**Dd**

**dd**

(1)

- (c) Draw a ring around the correct answer to complete each sentence.

- (i) The man and his wife plan to have a fourth child.

The probability that this child will have 6 toes on each foot is

1 in 2.

1 in 3.

1 in 4.

(1)

- (ii) When Child 2 grows up, he marries a woman with 5 toes on each foot.

The probability that their first child will have 6 toes on each foot is

0.

1 in 2.

1 in 4.

(1)

**(Total 6 marks)**

30

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.

- (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.

.....

.....

.....

.....

.....

.....

.....

(3)

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

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

(1)

- (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.

.....

.....

.....

.....

(2)

(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)  
(Total 9 marks)

31

The photographs show the flowers of two closely-related species of plant.

**Species A**



**Species B**



Images: © iStock/Thinkstock

The drawings show chromosomes from one cell in the root of each plant during cell division.

**Species A**



**One chromosome**

**Species B**



**One chromosome**

(a) The drawings show that each chromosome has two strands of genetic material.

(i) How does a chromosome become two strands?

.....  
.....

(1)

(ii) Explain why each chromosome must become two strands before the cell divides.

.....  
.....  
.....  
.....

(2)

(b) For sexual reproduction, the plants produce gametes.

(i) Name the type of cell division that produces gametes.

.....

(1)



- (ii) How many chromosomes would there be in a gamete from each of these two plant species?

**Species A**  **Species B**

(1)

- (iii) It is possible for gametes from **Species A** to combine with gametes from **Species B** to produce healthy offspring plants.  
How many chromosomes would there be in each cell of one of the offspring

plants?

(1)

- (c) (i) Look back at the information at the start of the question and the information from part (b).

What evidence from these two pieces of information supports the belief that **Species A** and **Species B** evolved from a common ancestor?

.....  
.....  
.....  
.....

(2)

- (ii) For successful gamete production to take place, chromosomes that contain the same genes must pair up.

The drawings showing the chromosomes of **Species A** and of **Species B** are repeated below.

**Species A**



**Species B**



The offspring plants cannot reproduce sexually.

Suggest an explanation for this.

.....

.....

.....

.....

.....

.....

(2)  
(Total 10 marks)

32

The photograph shows a zorse.



By Kumana @ Wild Equines [CC-BY-2.0], via Wikimedia Commons

A zorse is a cross between a male zebra and a female horse.  
The zorse has characteristics of both parents.

(a) The zorse was produced by *sexual reproduction*.

(i) What is *sexual reproduction*?

.....  
.....

(1)

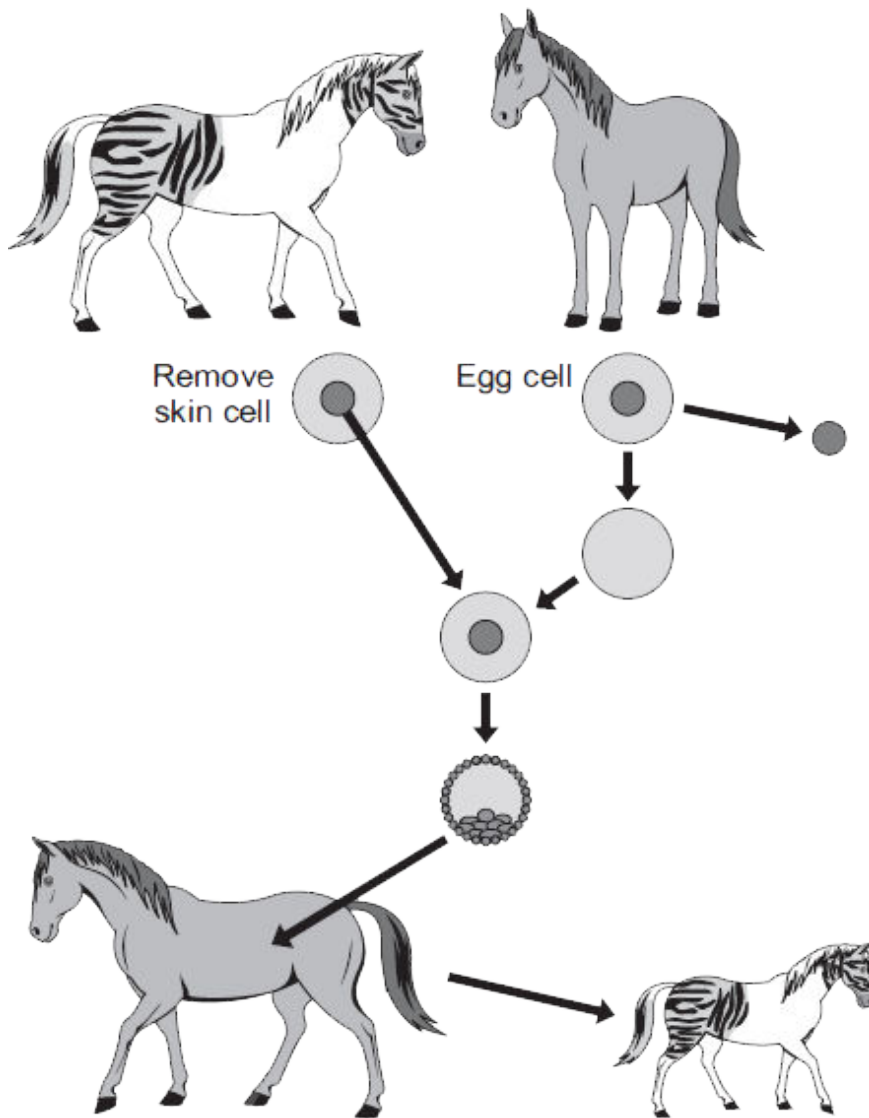
(ii) The zorse has characteristics of a zebra and a horse.  
Why?

.....  
.....  
.....  
.....

(2)

- (b) Zorses are **not** able to breed.  
Scientists could produce more zorses from this zorse by adult cell cloning.

The diagram shows how the scientists might clone a zorse.



*In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Use information from the diagram and your own knowledge to describe how adult cell cloning could be used to clone a zorse.

.....

.....

.....

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.....

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.....

.....

**(6)**  
**(Total 9 marks)**

33

The Blue-moon butterfly lives on a small island called Samoa, in the Pacific Ocean.



By Eموke Dénes [CC-BY-SA-2.5], via Wikimedia Commons

In 2006 Blue-moon butterflies almost became extinct.

*Wolbachia* bacteria killed males before they could hatch from eggs. Only females were resistant to the bacteria.

In 2006 the number of male Blue-moon butterflies had decreased to only 1 per cent of the population. Two years later, the number of males was equal to the number of females.

- (a) Scientists believe that a change in a gene suddenly occurred to make some males resistant to the bacteria.

What scientific term describes a change in a gene?

.....

(1)

- (b) The numbers of male Blue-moon butterflies in the population increased quickly after the new form of the gene had appeared.

Suggest why.

.....

.....

.....

.....

.....

.....

.....

.....

(4)  
(Total 5 marks)

34

Kangaroos have brown coats. The two parent kangaroos in the photograph produced a baby kangaroo with a white coat.



Photographs supplied by iStockphoto/Thinkstock

- (a) Use words from the box to complete the sentences.

<b>asexual</b>	<b>characteristic</b>	<b>chromosome</b>
<b>mutation</b>	<b>nucleus</b>	<b>sexual</b>

The baby kangaroo was produced by ..... reproduction.

The coat colour of the adult kangaroo is a .....

The different coat colour of the baby kangaroo is the result of a ..... of a gene.

The gene is found on a thread-like structure called a .....

(4)

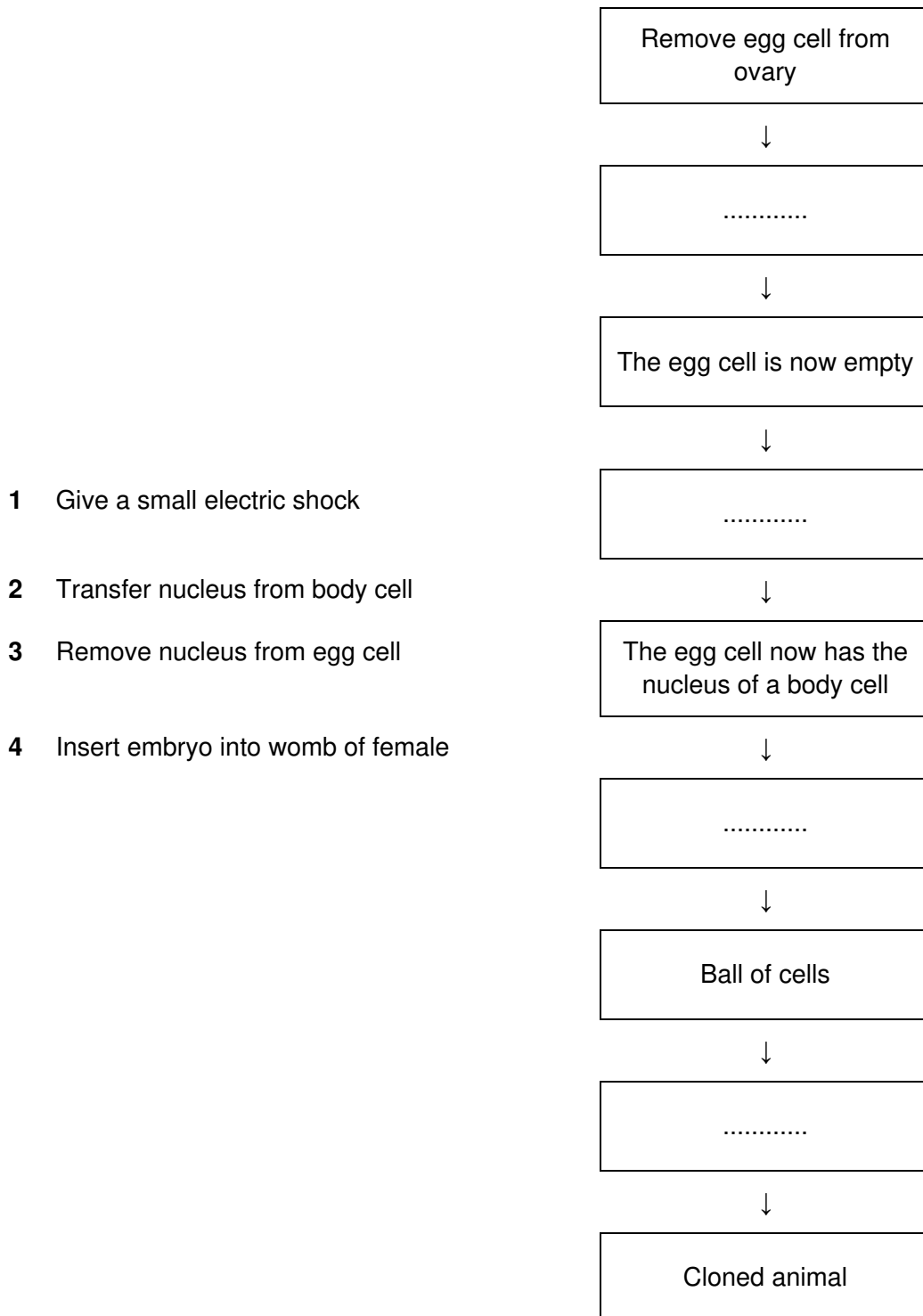
(b) Some animals similar to kangaroos are endangered species.

Cloning is one way of making sure that endangered species do not die out.  
The flowchart below shows one way of cloning an animal.

The four statements needed to complete the flowchart are numbered **1**, **2**, **3** and **4**.

Complete the flow chart by writing the **number** of the correct statement in the empty box.

Each number should be used **once** only.



(3)  
(Total 7 marks)



35

(a) Animal breeders use sexual reproduction to produce new strains of animals.

How does sexual reproduction produce variation?

.....  
.....  
.....  
.....

(2)

(b) A salmon is a type of fish.

Scientists have created a GM (genetically modified) 'super' salmon.

The scientists transferred a gene from a fish called a pout into a salmon. The gene increases the secretion of growth hormone in the salmon. The GM salmon grows much faster than an ordinary salmon, reaching market size up to one year earlier. Many more GM salmon will be grown in fish farms.

(i) Describe how a gene can be transferred from a pout into a salmon.

.....  
.....  
.....  
.....  
.....  
.....

(3)

(ii) The government might not allow the production of GM salmon.

Suggest **one** reason why.

.....  
.....

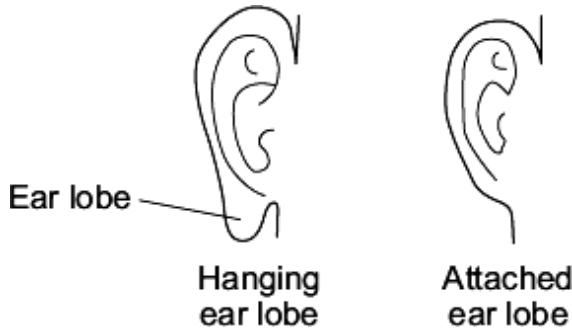
(1)

(Total 6 marks)

36

People have different shaped ear lobes, either 'hanging' or 'attached'.

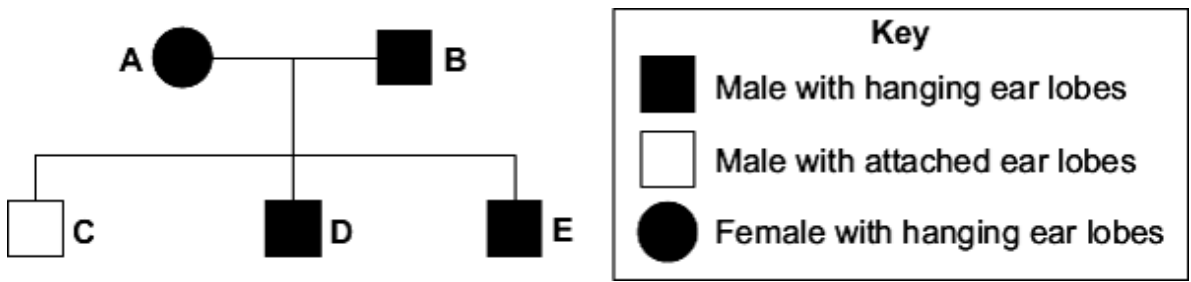
The diagrams show the two shapes of ear lobe.



A gene controls the shape of a person's ear lobes.

The diagram shows a family tree.

Parents **A** and **B** both have hanging ear lobes.



(a) The key does **not** show the symbol for a female with attached ear lobes.

Draw the symbol for the key to show a female with attached ear lobes.

Use information in the family tree and the key.

Symbol = .....

(1)

(b) Look at the family tree.

What does the information in the family tree tell you about the allele for hanging ear lobes?

Draw a ring around the correct word to complete the sentence.

The allele for hanging ear lobes is

- dominant.
- weak.
- recessive.

(1)

- (c) (i) Parents **A** and **B** have three children, **C**, **D** and **E**.  
All three children are boys.

What are the chances that the next child of parents **A** and **B** will be a girl?

Draw a ring around **one** answer.

**no chance (0 %)**      **a half (50 %)**      **certain (100 %)**

(1)

- (ii) Which statement explains your answer to part (c)(i)?

Tick (✓) **one** box.

Some of **B**'s sperm cells have an X chromosome.

Some of **A**'s egg cells have a Y chromosome.

All of **B**'s sperm cells have an X chromosome.

(1)  
(Total 4 marks)

**37**

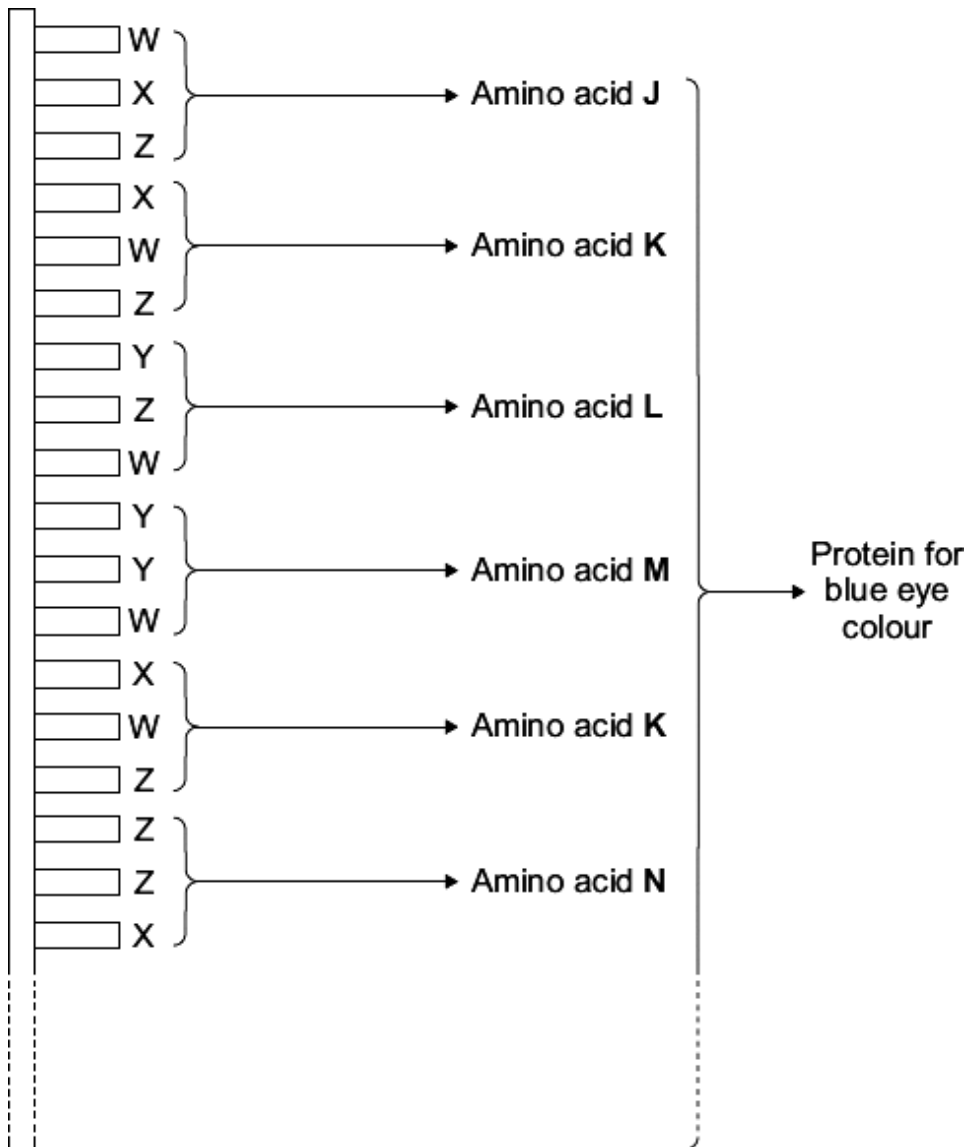
A molecule of DNA contains four different bases, **W**, **X**, **Y** and **Z**.

The four bases are arranged in a long chain.

The chain of bases controls the synthesis of a protein.

The diagram shows a small section of a DNA molecule.

This section is responsible for synthesising the protein for blue eye colour.



(a) What word is used to describe 'a small section of a DNA molecule that controls the synthesis of a protein?'

.....

(1)

(b) In the cell, where are proteins synthesised?

.....

(1)

(c) Describe how the protein for blue eye colour is synthesised.

To gain full marks you must use information from the diagram.

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(3)

(d) Mistakes sometimes occur when DNA molecules are copied during cell division.

Suppose that one of the **W** bases shown in the diagram was substituted by an **X** base.

(i) What would happen to the structure of the protein synthesised by this part of the DNA molecule?

.....  
.....

(1)

(ii) What might be the effect of this change in structure of the protein?

.....  
.....

(1)

(Total 7 marks)

**38**

(a) Human body cells contain 46 chromosomes.

(i) How many chromosomes are there in a human sperm cell?

(1)

(ii) Name the part of the sperm cell that contains the chromosomes.

.....

(1)

(b) Draw a ring around the correct answer to complete each sentence.

(i) In human females, the sex chromosomes are

**X and X.**

**X and Y.**

**Y and Y.**

(1)

(ii) In human males, the sex chromosomes are

**X and X.**

**X and Y.**

**Y and Y.**

(1)

(c) A man might release 300 million sperm cells at a time.

How many of these sperm cells would contain an **X** chromosome?

.....

(1)

**(Total 5 marks)**

**39**

Cystic fibrosis is an inherited disorder.

Mr and Mrs Brown do **not** have cystic fibrosis but they have a child with cystic fibrosis.

(a) Draw a ring around the correct answer to complete each sentence.

(i) The allele for cystic fibrosis is a

carrier allele.

dominant allele.

recessive allele.

(1)

(ii) Mr and Mrs Brown are both

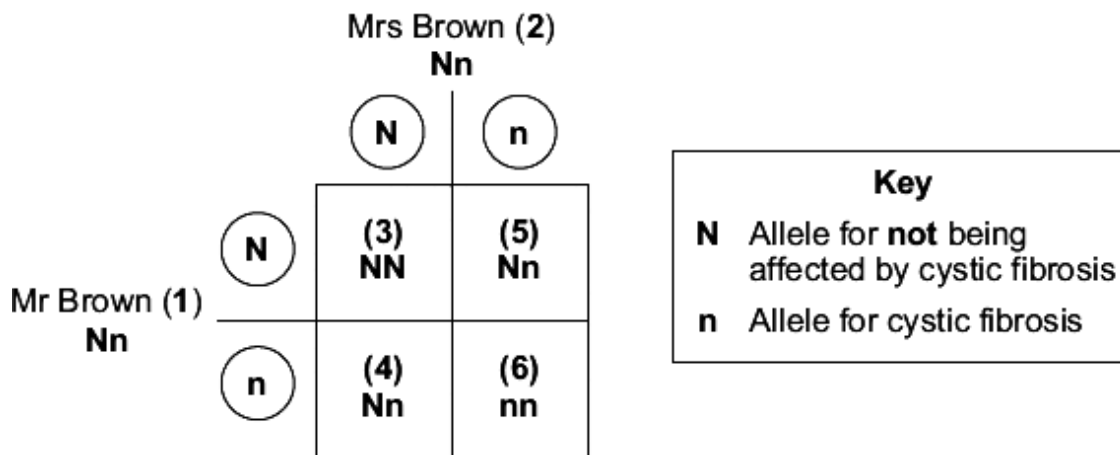
carriers.

immune.

infected.

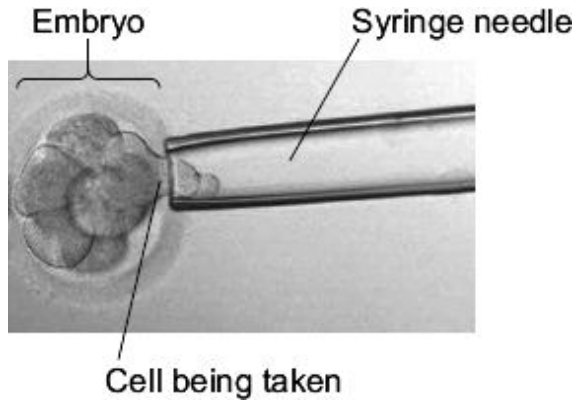
(1)

- (b) The diagram shows how the allele for cystic fibrosis can be inherited by Mr and Mrs Brown's children.



- (i) Give the number of **one** person in the diagram who has cystic fibrosis.  (1)
- (ii) The chance that Mr and Mrs Brown's next child will have cystic fibrosis is  
 ..... (1)
- (c) A genetic counsellor describes to Mr and Mrs Brown one way of screening embryos for cystic fibrosis.
- Some eggs are collected from Mrs Brown.
  - The eggs are then fertilised in a dish.
  - Several embryos may start to develop.

The photograph shows how doctors take one cell from each embryo when it is only 3 days old.



©Pascal Goetgheluck/Science Photo Library

- The DNA in the cell from each embryo is tested for cystic fibrosis.
- Doctors select one embryo that is unaffected and place it in Mrs Brown's uterus.
- The embryo then develops into a baby.

Use the information to suggest **one** advantage and **one** disadvantage of screening embryos in this way.

Advantage .....

.....

Disadvantage .....

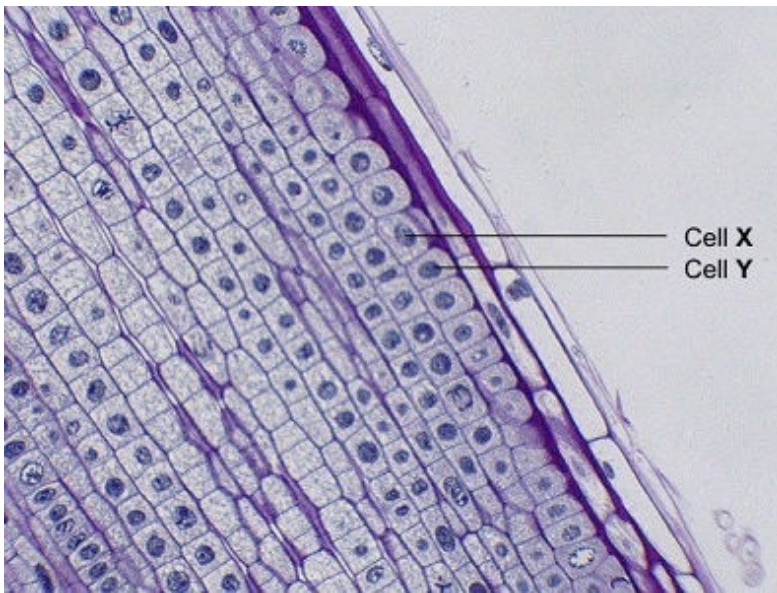
.....

(2)  
(Total 6 marks)



40

The photograph shows some cells in the root of an onion plant.



By UAF Center for Distance Education [CC BY 2.0], via Flickr

(a) Cells X and Y have just been produced by cell division.

(i) Name the type of cell division that produced cells X and Y.

.....

(1)

(ii) What happens to the genetic material before the cell divides?

.....

(1)

(b) A gardener wanted to produce a new variety of onion.

Explain why sexual reproduction could produce a new variety of onion.

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(3)  
(Total 5 marks)

**41**

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

(a) What do each of the following mean?

(i) Alleles

.....  
.....

(1)

(ii) Recessive

.....  
.....

(1)

(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

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

What is their genotype? .....

(1)

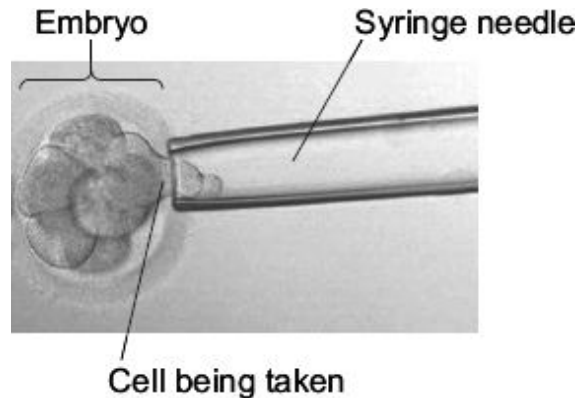
(ii) There is a 1 in 4 chance that Mr and Mrs Brown's next child will have cystic fibrosis. Use a genetic diagram to explain why.

(3)

- (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** ).

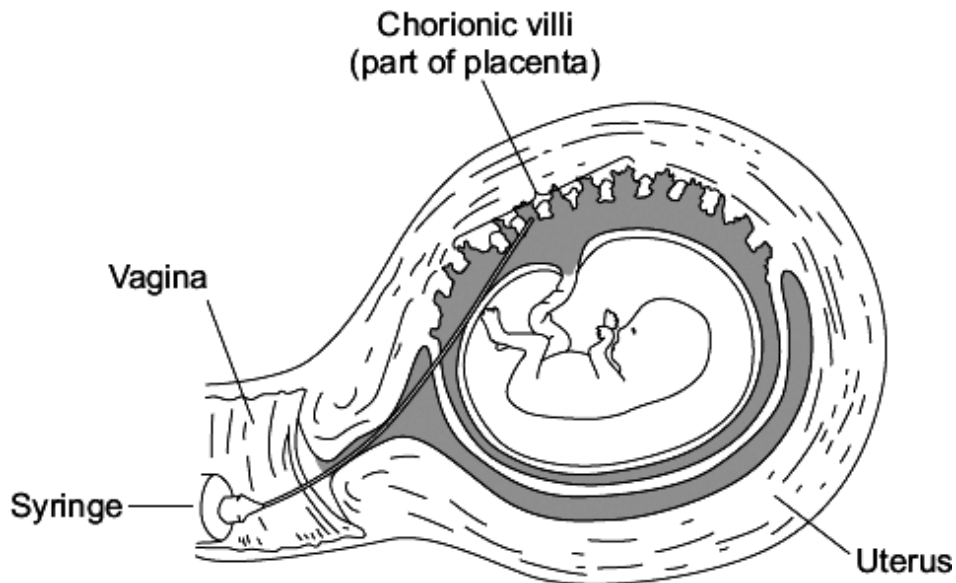
In **PGD**, eggs are fertilised in dishes and allowed to grow into embryos. A cell is taken from each embryo when the embryo is 3 days old. The photograph shows how the cell is taken.



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.



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.

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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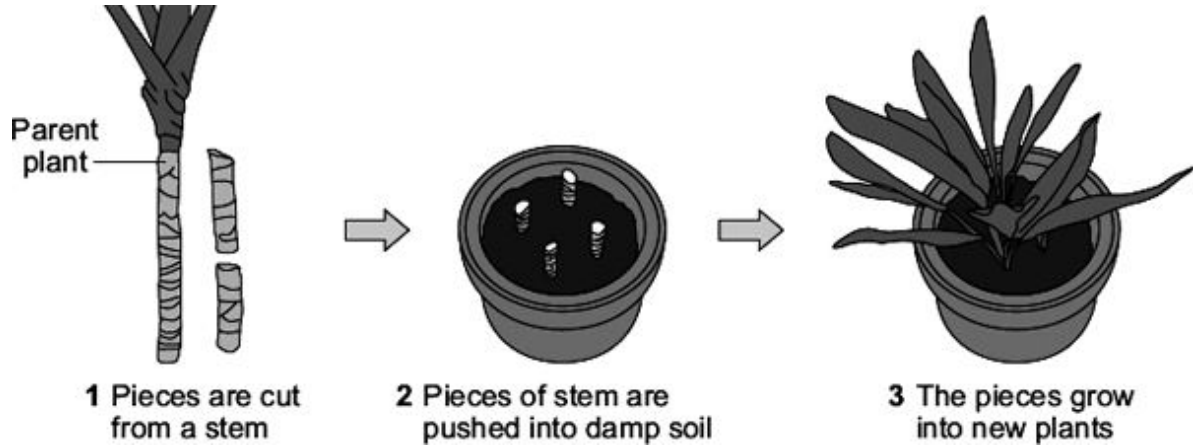
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(4)  
(Total 10 marks)

42

(a) The drawings show one way of producing new plants. The new plants are identical to the parent plant.



Use words from the box to complete the sentences.

asexual    characteristics    clones    engineering    genes    sexual

The colour and shape of the leaves are known as .....

The information for leaf colour is stored in parts of chromosomes called .....

The new plants are known as .....

The new plants have been produced by .....reproduction.

(4)

(b) (i) Name **one** other way of producing plants that are identical to their parents.

.....

(1)

(ii) Name **one** way of producing animals that are identical to each other.

.....

(1)

(Total 6 marks)

43

A child saved apple seeds from an apple she ate. She planted the seeds in the garden. A few years later the apple trees she had grown produced apples.

(a) The apples from the new trees did **not** taste like the original apple.

Explain why.

.....  
.....  
.....  
.....  
.....

(2)

(b) (i) Apple trees can be reproduced so that the apples from the new trees will taste the same as the apples from the parent trees.

Give **one** method used to reproduce apple trees in this way.

.....  
.....

(1)

(ii) Explain why the method you have suggested in part **(b)(i)** will produce apples that taste the same as the apples from the parent trees.

.....  
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.....  
.....  
.....

(2)

(Total 5 marks)

44

The diagram shows a strawberry plant.

The parent plant grows side shoots.

New plants grow on the side shoots.



© D.G. Mackean

The new plants will all have the same inherited characteristics as the original parent plant.

Complete the sentences to explain why.

Use words from the box.

<b>asexual</b>	<b>differentiation</b>	<b>embryos</b>	<b>fertilisation</b>
<b>gametes</b>	<b>genes</b>	<b>mitosis</b>	<b>sexual</b>

(a) The new plant is produced by ..... reproduction.

(1)

(b) In this type of reproduction, body cells divide by .....

(1)

(c) The new plant has the same ..... as the parent plant.

(1)

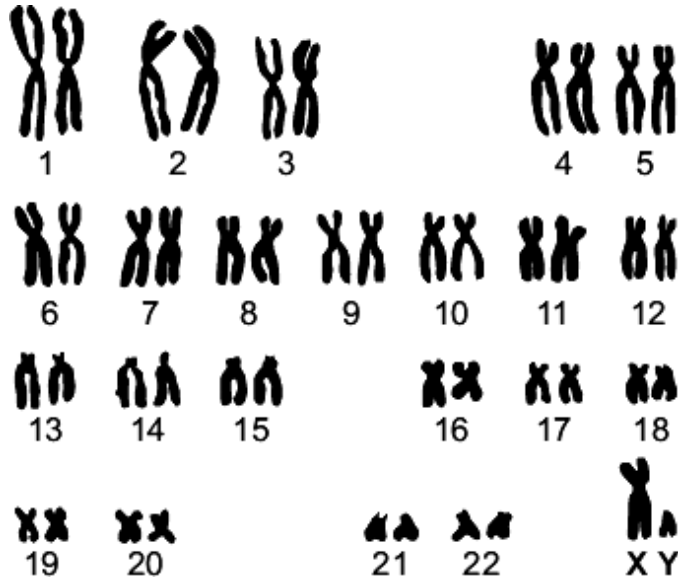
**(Total 3 marks)**

45

When scientists look at dividing cells under a microscope, they can see strands that contain a chemical called DNA.

A photograph of these strands can be cut up and re-arranged.

The diagram shows an arrangement of the strands from a human cell.



(a) What name is given to the strands containing DNA shown in the diagram?

Draw a ring around **one** answer.

alleles

chromosomes

genes

(1)

(b) Look carefully at the diagram.

(i) The cell was taken from a man and not from a woman.

How can you tell?

.....

(1)



(ii) What evidence is there that the strands are from a body cell, and not from a gamete?

Tick (✓) **one** box.

The strands are arranged in order of size.

The strands are in pairs.

Gametes are made in the testes and ovaries.

(1)

(iii) When a human cell is not dividing the strands containing DNA are **not** clearly visible.

Draw a ring around the correct answer to complete the sentence.

In a human cell, the DNA is normally found in  
the

cell membrane.

cytoplasm.

nucleus.

(1)

(Total 4 marks)

46

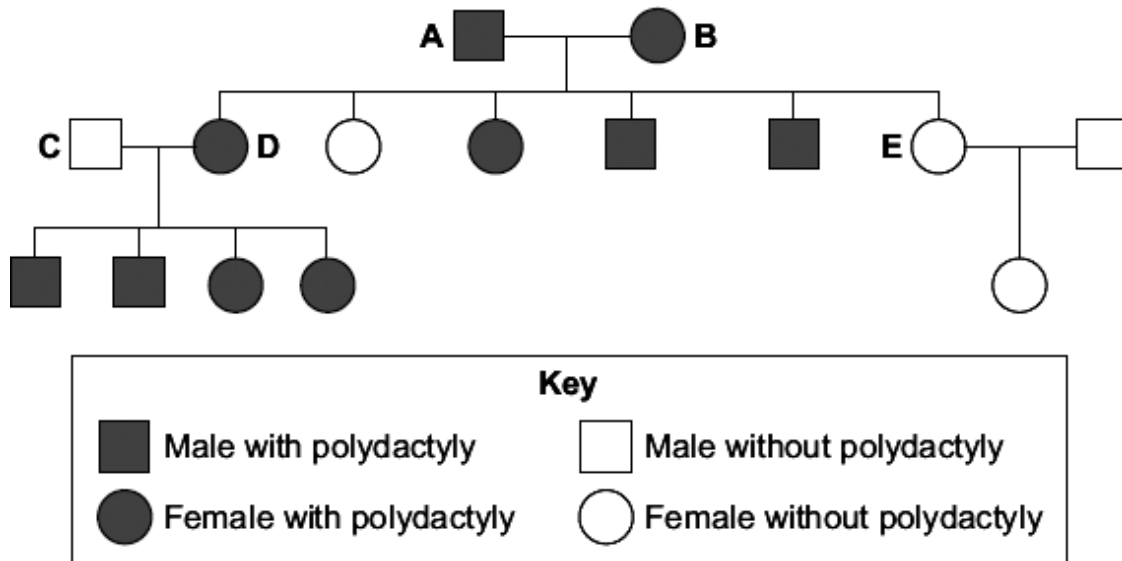
Cats normally have four toes on each back paw.

The picture shows the back paw of a cat with an inherited condition called polydactyly.



By Onyxrain (Own work) [Public domain], via Wikimedia Commons

The family tree shows the inheritance of polydactyly in three generations of cats.



(a) What combination of alleles did the original parents, **A** and **B**, have?

Explain how you work out your answer.

You may use a genetic diagram in your answer.

Use the symbol **H** to represent the dominant allele.

Use the symbol **h** to represent the recessive allele.

.....

.....

.....

.....

.....

.....

.....

A = ..... B = .....

(4)

(b) (i) Give **two** possible combinations of alleles for cat **D**.

1 ..... 2 .....

(1)

(ii) You cannot be sure which one of these two is the correct combination of alleles for cat **D**.

Why?

.....  
 .....  
 .....

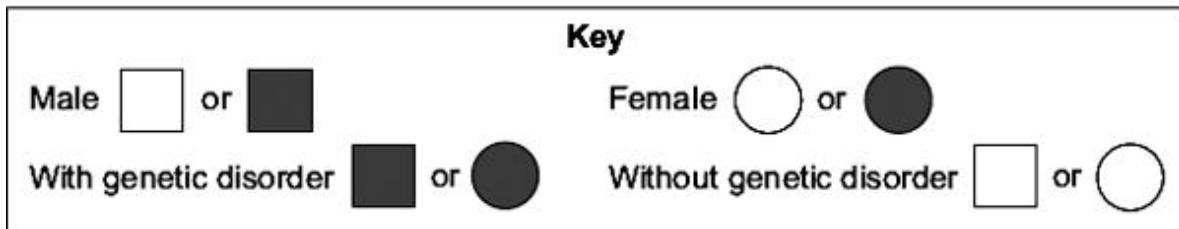
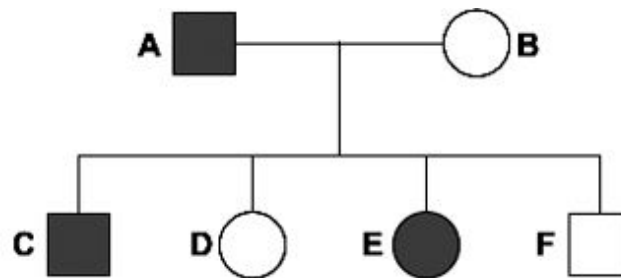
(1)

(Total 6 marks)

47

The diagram shows the family tree of a pair of pigs, **A** and **B**. Pigs **A** and **B** have four offspring, **C**, **D**, **E** and **F**.

Some of the pigs have a genetic disorder.



(a) Which pig, **A**, **B**, **C**, **D**, **E** or **F**, is:

(i) a male pig with the genetic disorder

(1)

(ii) a female pig without the genetic disorder?

(1)

(b) Draw a ring around the correct answer to complete the sentences.

Pig **C** has the genetic disorder.

(i) Pig **C** inherited the genetic disorder from

- pig **A**.
- pig **B**.
- pig **E**.

(1)

(ii) The gene for the genetic disorder was passed on in

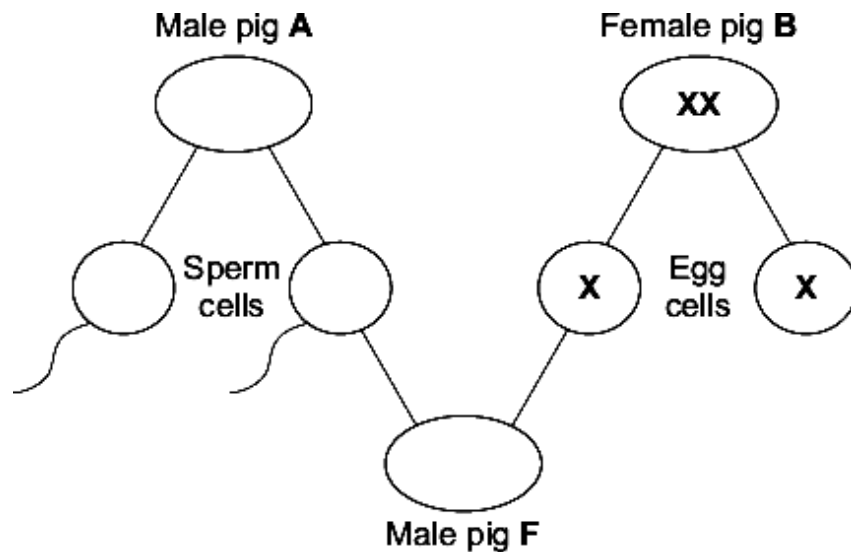
- an embryo.
- an enzyme.
- a gamete.

(1)

(c) Pig **F** is a male.

Complete the diagram to show how the sex of pig **F** depends on the inheritance of the sex chromosomes **X** and **Y**.

The sex chromosomes of pig **B** and the egg cells have been completed for you.



(3)  
(Total 7 marks)

**48**

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

Explain why.

.....

.....

.....

.....

**(2)**

- (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)**

- (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)**  
**(Total 7 marks)**

**49**

Cystic fibrosis and Huntington's disease are inherited disorders.

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

Explain how.

You may include a genetic diagram in your answer.

.....

.....

.....

.....

(2)

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

.....

.....

(1)

**(Total 3 marks)**

50

Soay sheep live wild on an island off the north coast of Scotland. No people live on the island.



By Owen Jones = Jonesor [CC-BY-SA-2.5], via Wikimedia Commons

Over the last 25 years, the average height and mass of the wild Soay sheep have decreased.

The scientists think that climate change might have affected the size of the sheep.

(a) More Soay sheep are now able to survive winter than 25 years ago.

What change in the climate may have helped more Soay sheep to survive winters?

.....  
.....

(1)

(b) Complete the sentences.

(i) Soay sheep show variation in size because of differences in their

.....

(1)

(ii) The change in the size of the Soay sheep over 25 years can be explained by Darwin's

theory of .....

(1)

(Total 3 marks)

51

Organisms can be produced by asexual reproduction and by sexual reproduction.

(a) Give **two** differences between asexual reproduction and sexual reproduction.

1 .....

.....

2 .....

.....

(2)



(b) Adult cell cloning is a type of asexual reproduction.

Explain why.

.....

.....

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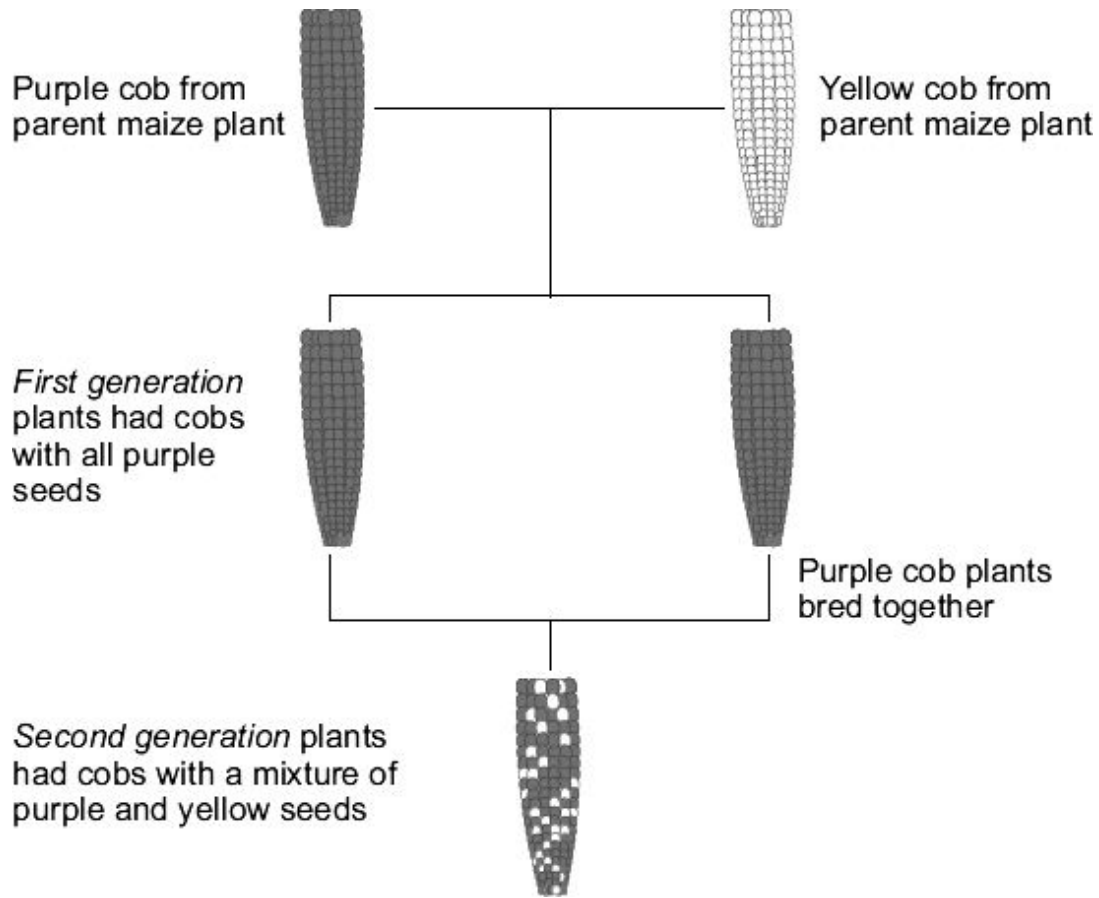
(2)  
**(Total 4 marks)**

52

Maize plants reproduce sexually to form maize cobs.  
Each maize cob has many seeds.

The colour of the seeds is controlled by a gene.  
The gene has two alleles, purple and yellow.

The diagram shows the cobs produced by breeding maize plants.



(a) Use words from the box to complete the sentences.

<b>dominant</b>	<b>environmental</b>	<b>recessive</b>
-----------------	----------------------	------------------

(i) The first generation plants show that the purple allele is

.....

(1)

(ii) The second generation plants show that the yellow allele is

.....

(1)

- (b) The allele for purple can be represented by the letter **A**.  
The allele for yellow can be represented by the letter **a**.

(i) What alleles does a yellow seed have?

Draw a ring around **one** answer.

**AA**

**Aa**

**aa**

(1)

(ii) What alleles does a purple seed from a *first* generation plant have?

Draw a ring around **one** answer.

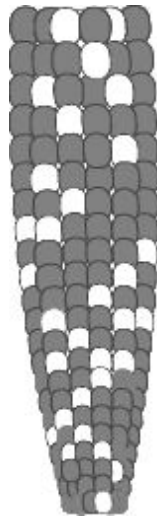
**AA**

**Aa**

**aa**

(1)

- (c) The drawing shows a cob from one of the *second generation* plants.



A student counted 334 purple seeds and 110 yellow seeds on this maize cob.

What is the approximate ratio of purple seeds to yellow seeds on the cob?

Tick (✓) **one** box.

3 purple : 1 yellow

1 purple : 3 yellow

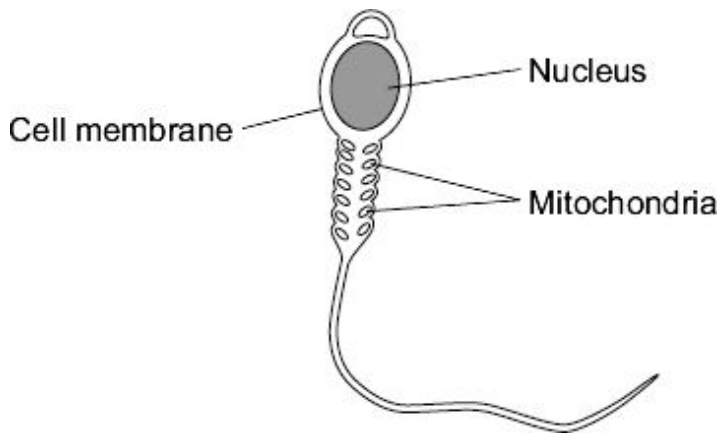
1 purple : 1 yellow

(1)  
(Total 5 marks)

53

Cells in the human body are specialised to carry out their particular function.

(a) The diagram shows a sperm cell.



The sperm cell is adapted for travelling to, then fertilising, an egg.

(i) How do the mitochondria help the sperm to carry out its function?

.....  
.....

(1)

(ii) The nucleus of the sperm cell is different from the nucleus of body cells.  
Give **one** way in which the nucleus is different.

.....  
.....

(1)

(b) Stem cells from human embryos are used to treat some diseases in humans.

Explain why.

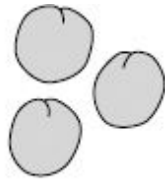
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.....  
.....  
.....

(2)

(Total 4 marks)

54

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

- (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)

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

- (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)

(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.

.....  
.....

(1)

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

Give **one** reason why.

.....  
.....

(1)

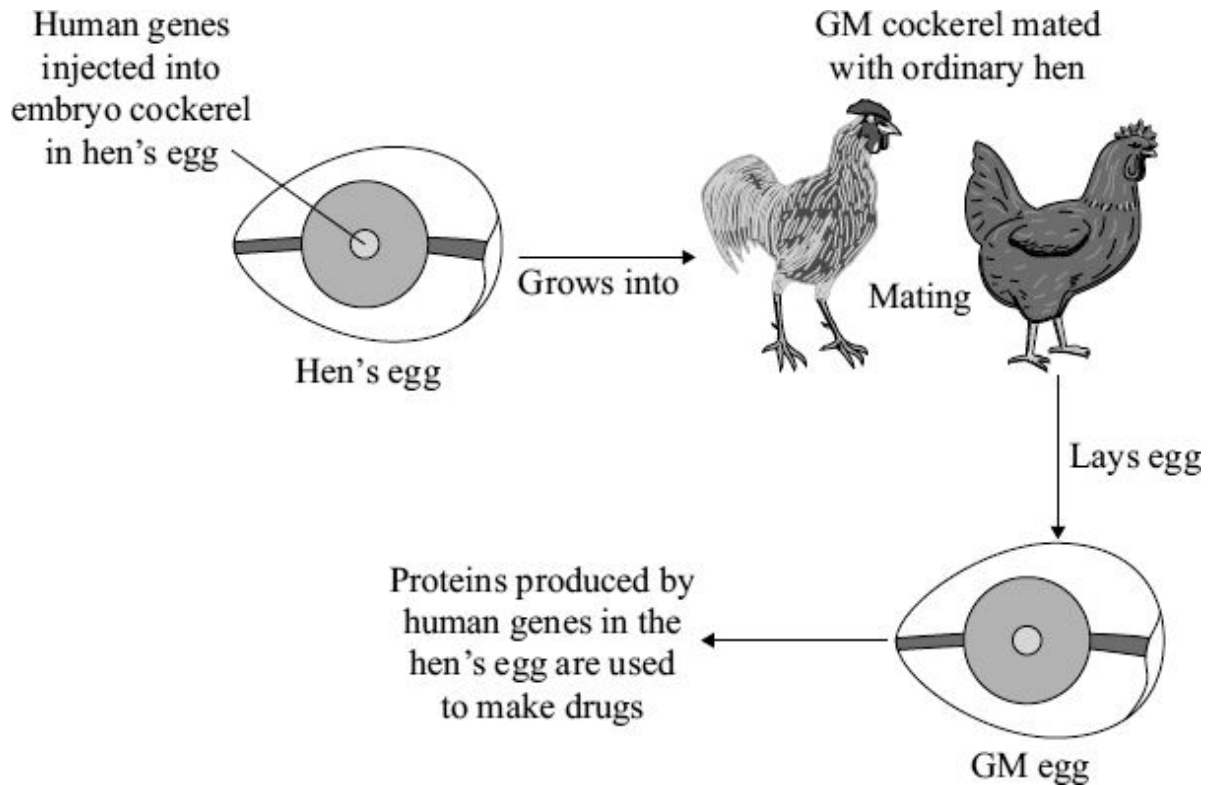
(Total 6 marks)

55

Scientists have discovered how to produce genetically modified (GM) hens' eggs.

Some proteins produced in GM eggs can be used as drugs to treat humans.

The diagram shows how this is done.



(a) Which type of reproduction is involved when the cockerel mates with the hen?

Tick (✓) **one** box.

Asexual

Cloning

Sexual

(1)

(b) From which part of a human are the genes cut?

Tick (✓) **one** box.

Chromosome	<input type="checkbox"/>
Embryo	<input type="checkbox"/>
Glands	<input type="checkbox"/>

(1)

(c) Read the information about genetically modified animals.

- GM animals might escape and breed with wild animals.
- Genetic modification can produce fast-growing animals for food.
- Genetic modification can be used to clone animals in danger of extinction.
- Using GM animals can reduce the number of animals used in medical research.
- Animals have the right to be free from genetic modification.

Use **only** this information to answer these questions.

(i) Give **two** reasons why many people are in favour of genetically modified animals.

1 .....

2 .....

(2)

(ii) Give **two** reasons why many people are against genetically modified animals.

1 .....

2 .....

(2)

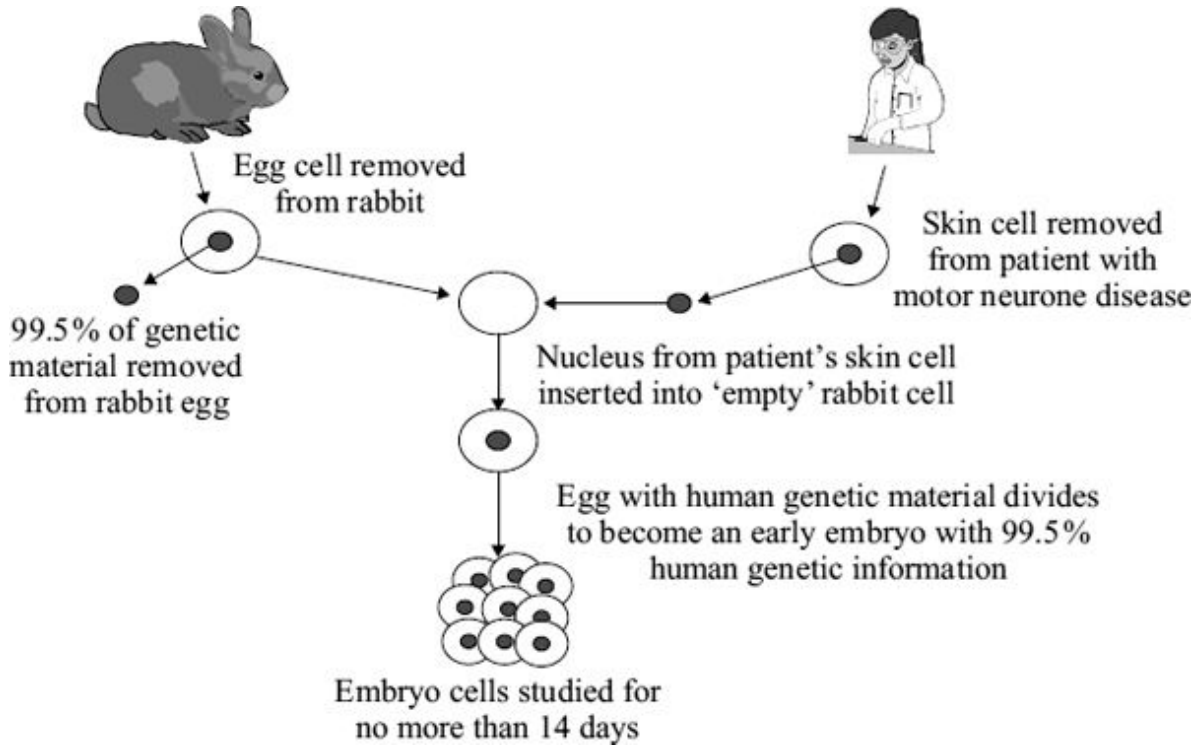
**(Total 6 marks)**



56

Scientists in Korea have discovered a method of producing rabbit–human embryos. Rabbit–human embryos could provide cells for research into human diseases such as motor neurone disease. Rabbits produce large numbers of eggs. Rabbit–human embryos could overcome a shortage of human embryo cells for research.

The diagram shows how rabbit–human embryos are produced.



(a) Which structures in the nucleus contain 99.5% of a cell's genetic information?

.....

(1)

- (b) Use the above information and your own knowledge and understanding to evaluate how the production of rabbit–human embryos may help research into human diseases.

Remember to give a conclusion as part of your evaluation.

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(4)  
(Total 5 marks)

57

Humans reproduce sexually.

Draw a ring around the correct answer to complete each sentence.

(a) (i) At fertilisation 

chromosomes
genes
sex cells

 join together.

(1)

(ii) At fertilisation a single cell forms, which has new pairs of 

chromosomes.
nuclei.
sex cells.

(1)

(b) Cystic fibrosis can be inherited by children whose parents do not have it.

(i) A person who has cystic fibrosis has

- two
- three
- four

copies of the cystic fibrosis allele.

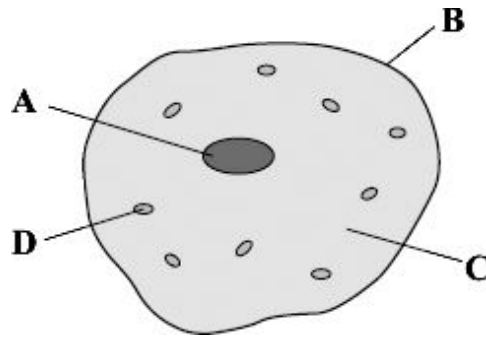
(1)

(ii) The cystic fibrosis allele is

- large.
- recessive.
- strong.

(1)

(c) The diagram shows a human body cell.



Choose the correct answer from the box to complete each sentence.

- cell membrane
- cell wall
- cytoplasm
- nucleus

(i) The part of the cell labelled **B** is the .....

(1)

(ii) The part of the cell labelled **C** is the .....

(1)

(d) Which part of the cell, **A**, **B**, **C** or **D**:

(i) contains the allele for cystic fibrosis

(1)

(ii) is affected by cystic fibrosis?

(1)  
(Total 8 marks)

58

- (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)

(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.

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

.....  
.....

(1)

(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)  
**(Total 8 marks)**