1 In humans, hair colour is an inherited characteristic.

Red hair is caused by a recessive allele.

(a) When does a recessive allele control the development of a characteristic?
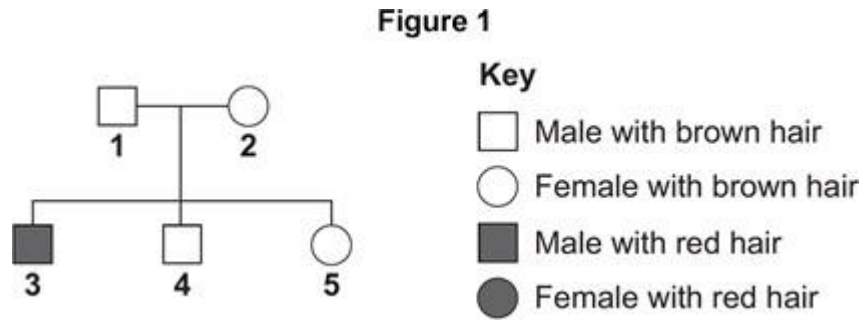
Tick (✓) **one** box.

When the allele is present on only one of the chromosomes. ☐

When the dominant allele is not present. ☐

When the allele is inherited from the female parent. ☐

(1)

(b) **Figure 1** shows the inheritance of hair colour in one family.

Figure 1

Key

☐ Male with brown hair

◯ Female with brown hair

■ Male with red hair

● Female with red hair

(i) Brown hair is caused by a dominant allele, **B**.

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

What combination of alleles does person **1** have?

Tick (✓) **one** box.

BB ☐

Bb ☐

bb ☐

(1)

(ii)   Person **3** married a woman with brown hair.

Figure 2 shows how hair colour could be inherited by their children.

Figure 2

Woman
Brown hair

	B	b
b	Bb	
b		

Person **3**
Red hair

Complete **Figure 2** to show the combination of alleles that the children would inherit.
One has been done for you.

(2)

(iii)   What is the probability that one of the children would have red hair?

Tick (✓) **one** box.

1 in 2   ☐

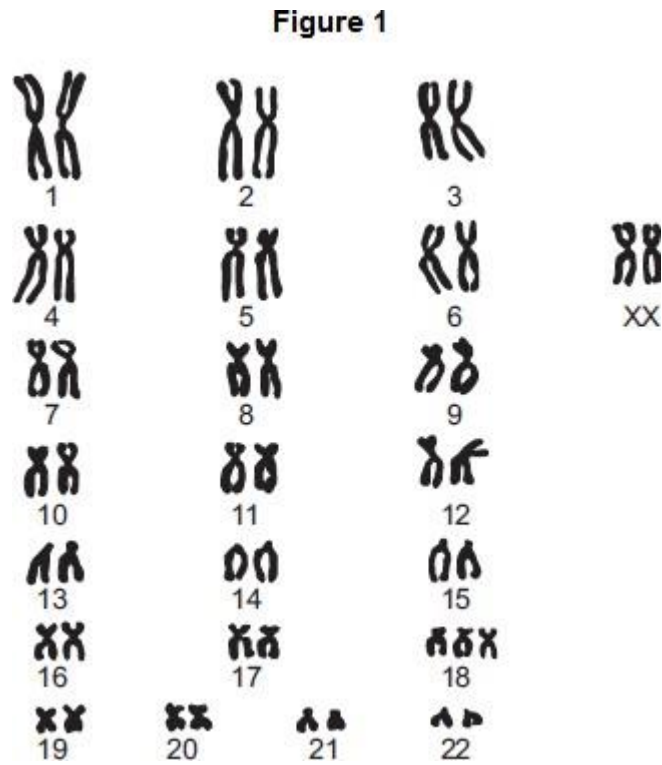1 in 3   ☐

1 in 4   ☐

(1)
(Total 5 marks)

2 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**.

Figure 1

(i) How do you know this person is female?
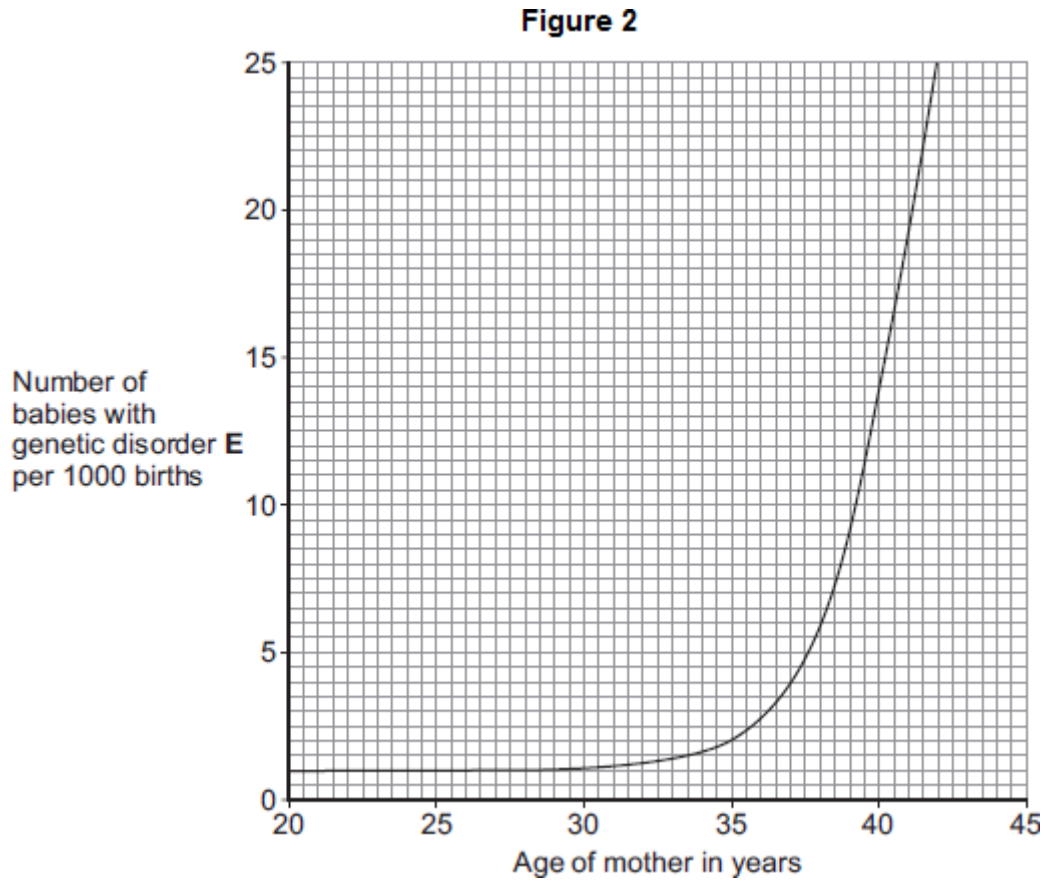
Use information from **Figure 1**.

_____

_____

(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.

Figure 2

(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 **E**.	3. Cells are screened for genetic disorder **E**.
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 **E**, 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)

3   Over millions of years:

• new groups of organisms have evolved

• other groups of organisms have become extinct.

(a)   If an asteroid collided with the Earth, large amounts of dust and water vapour would be thrown up into the air. This would mean less light and heat would reach the Earth's surface from the Sun.

(i)   A reduced amount of light and heat could have caused the extinction of plants.

Suggest how.

_____

_____

(1)

(ii)   How could the extinction of plants have caused the extinction of some animals?

_____

_____

(1)
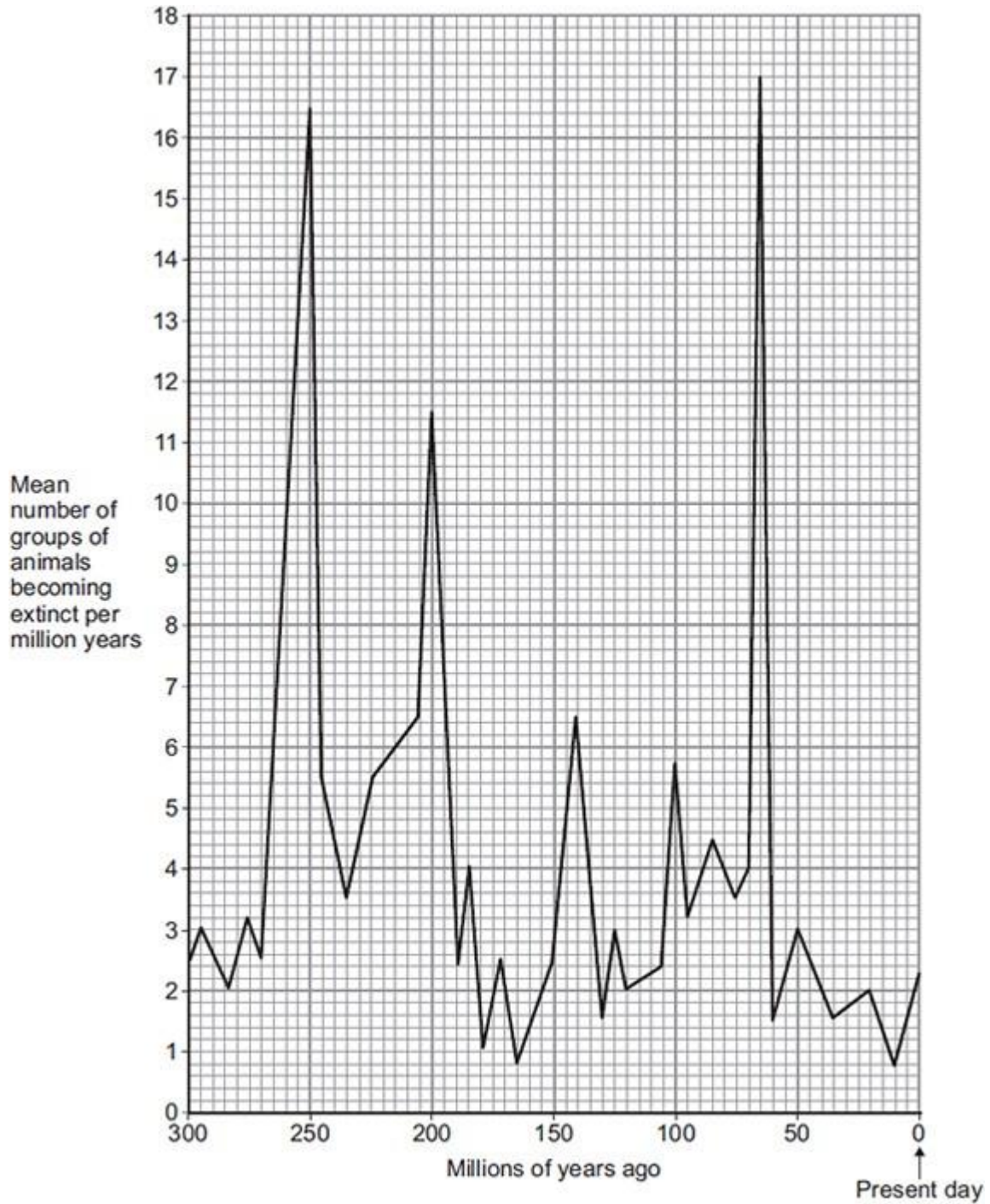
(iii)   Give **two** reasons, other than collision with an asteroid, why groups of animals may become extinct.

1. _____

_____

2. _____

_____

(2)

(b)   The graph shows how the rate of extinction of groups of animals has varied over the past 300 million years.

(i)   If more than 10 groups of animals become extinct in a 1 million year period, scientists call this a 'mass extinction'.

How many mass extinctions occurred over the past 300 million years?

_____

(1)

(ii) How do we know what types of animals lived hundreds of millions of years ago?

_____

_____

(1)

(c) Use information from the graph to answer part (i) and (ii).

(i) How many years ago did the most recent mass extinction of animals occur?

Tick (✓) **one** box.

50 million years ago ☐

65 million years ago ☐

250 million years ago ☐

(1)

(ii) What was the mean number of groups of animals becoming extinct per million years in the most recent mass extinction?

_____groups per million years

(1)

(iii) Why are scientists not sure how many groups of animals became extinct in the most recent mass extinction?

_____

_____

(1)
(Total 9 marks)

4 (a) Which organ of the human body produces egg cells?

Draw a ring around the correct answer.

liver   ovary   testis

(1)

(b)   An egg joins with a sperm and develops into an embryo.

How many chromosomes are there in each cell of a human embryo?

Draw a ring around the correct answer.

23   46   48

(1)

(c)   Some women find it difficult to have a baby. A doctor may suggest that these women should use In Vitro Fertilisation (IVF) to help them have a baby.

Table 1 shows how successful IVF was for women of different ages at one clinic.

Table 1

Age of women in years	Percentage of women who had a baby
<35	35
35–37	31
38–39	25
40–42	32
43–44	7
>44	0

(i)   A student thought that the result for women aged 40–42 was anomalous.

Suggest why the student thought this result was anomalous.

_____

_____

(1)

(ii)   Describe the general trend in the results in **Table 1**.

You should ignore the anomalous result.

_____

_____

(1)

(d) Some babies are born with a faulty chromosome.

Scientists investigated whether the chance of having a baby with a faulty chromosome is also related to the age of the woman.

Table 2 shows the scientists' results.

Table 2

Age of women in years	Number of women per 1000 who had a baby with a faulty chromosome
25	2.0
30	2.6
35	6.1
40	19.6
45	66.0

(i) A 45-year-old woman is more likely than a 25-year-old woman to have a baby with a faulty chromosome.

How many times more likely?

_____

_____

Answer =_____times

(2)

(ii) Suggest **two** reasons why many fertility clinics will **not** accept women over 40 years of age for IVF treatment.

Use information from **Table 1** and **Table 2** in your answer.

1. _____
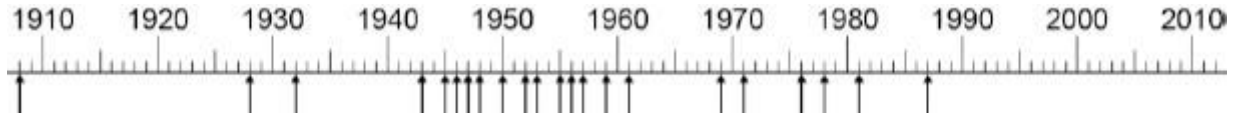
_____

2. _____

_____

(2)
(Total 8 marks)

5 (a) Some antibiotics work by destroying the cell membranes of bacteria.

Suggest why these antibiotics may have side effects in the animals that are given these antibiotics.

_____

(1)

(b) Each arrow on the figure below shows the date of discovery of each new type of antibiotic.

In which 10 year period were most new types of antibiotic discovered?

_____

(1)

(c) The figure above shows 22 new types of antibiotic. These were discovered before 2010.

Determine the percentage of types of antibiotic that have been discovered between 1980 and 2010.

Use information from the figure above.

Give your answer to 2 significant figures.

_____

_____

_____%

(2)

(d) Bacteria can evolve rapidly.

Many bacteria can develop into new strains which are resistant to antibiotics.

Complete the table below to show if each action is **more likely** or **less likely** to help bacteria to become antibiotic resistant.

Put a tick in each row.

Action	More likely	Less likely
Take painkillers for headache		
Washing with antiseptic hand gel		
Adding antibiotics to food for cows		
Giving antibiotics for colds and flu		
Stopping antibiotics as soon as you feel better		

(4)

(Total 8 marks)

6 A person's characteristics can be due to:

•   environmental causes

•   genetic causes

•   both environmental and genetic causes.

(a) Complete **Table 1**.

Put a tick to show what each characteristic is due to.

Table 1

Characteristic	Characteristic due to		
	Environmental causes	**Genetic causes**	**Both environmental and genetic causes**
Eye colour			
A scar			
Weight			

(3)

(b) Draw **one** line from each key term to the correct definition.

Key term   **Definition**

| The set of alleles for a characteristic |

Genotype

| The genus of an organism |

| The inheritance of chromosomes |

Phenotype

| The mutation of genes |

| The physical characteristic of an organism |

(2)

(c) Farmers use selective breeding to control the characteristics in cows.

Table 2 shows the stages of selective breeding in cows.

Complete **Table 2** to show the correct order of the stages.

The first stage has been numbered for you.

Table 2

Stage in selective breeding	Order of stage
Cows are bred over many generations	
Parents are bred together	
Cows with the desired characteristics are chosen	1
Calves with the most desired characteristics are bred together	

(2)

(d)   Farmers selectively breed cows for many different reasons.

Suggest **two** characteristics that cows may be bred for.

Do **not** suggest coat colour.

1. _____

_____

2. _____

_____

(2)

(e)   Selective breeding can lead to problems.

Suggest how problems caused by selective breeding in cows can have negative financial effects for the farmer.

_____

_____

_____

_____

(2)
(Total 11 marks)

7   Sexual reproduction in humans involves the joining together of an egg cell and a sperm cell.

The sex of an embryo is decided by the chromosomes they inherit from their mother and father.

(a)   Where in the cell are the chromosomes?

Tick **one** box.

Cell membrane   ☐

Cytoplasm   ☐

Nucleus   ☐

Ribosomes   ☐

(1)

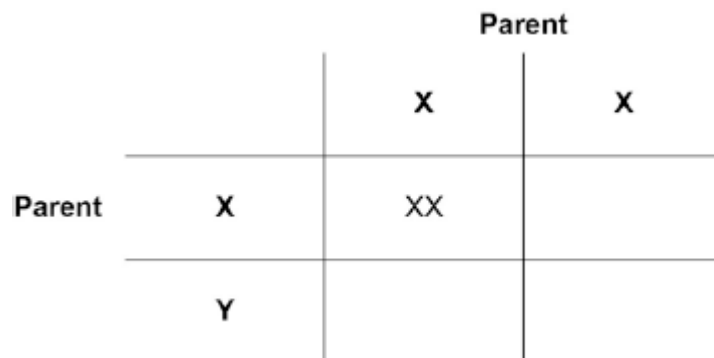(b)   Draw **one** line from each type of cell to the number of chromosomes in the cell.

Type of cell   **Number of chromosomes**

23

Sperm cell   26

46

Embryo cell   52

69

(2)

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

Complete the genetic diagram in the figure below.

Parent

		X	X
Parent	X	XX	
	Y		

(2)

(d)   On the figure above, circle a male child.

(1)

(e)   What is the chance of the man and woman having a boy?

Tick **one** box.

1 in 2   ☐

1 in 3   ☐

1 in 4   ☐

1 in 8   ☐

(1)
(Total 7 marks)

Mark schemes

1   (a)   When the dominant allele is not present.

      1

    (b)   (i)   Bb

      1

        (ii)

	Woman Brown hair	
	B	**b**
b		**bb**
b	**Bb**	**bb**

Person 3 / Red hair (left label)

3 correct = 2 marks
2 correct = 1 mark
1 or 0 correct = 0 marks
allow bB for Bb

      2

        (iii)   1 in 2

allow ecf from part ii

      1

                                                      [5]

2   (a)   (i)   (female) has XX / only X's / no Y

allow has X chromosome<u>s</u>
ignore ref to genes / cells

      1

        (ii)   extra chromosome / has 47 chromosomes / one set has 3 copies

ignore reference to chromosome numbers other than 47 or no. 18

      1

           no. 18

      1

    (b)   (i)   14

allow in range of 13.5 to 14.5

      1

        (ii)   7

allow in range of 6.75 to 7.25
accept ecf from 5bi

      1

(c)   Advantages:
       any **two** from:
       •   more than 1 embryo (so more chance of success)
              allow method 2 may cause a miscarriage
       •   tested at 3 days cf 10 weeks **or** tested earlier
              tested when only 3 days old
       •   tested before pregnancy
       •   no termination / abortion
       •   spare embryos have a potential use.

2

       Disadvantages:
       any **one** from:
       •   needs an operation
              accept described hazard of operation
       •   (spare) embryos / human life destroyed / harmed
              must be comparative
       •   high er cost
       •   embryos might not implant / might not develop.

1

[8]

3   (a)   (i)   reduced photosynthesis
                     ignore growth
                     *do **not** allow need light for respiration*

1

              (ii)   less food (for animals) **or** less oxygen (for animals)
                     allow loss of habitat

1

(iii) any **two** from:

accept 2 physical factors or 2 biological factors or one of each for full marks

examples of physical factors, eg
- flooding
- drought
- ice age / temperature change
  ignore pollution
- volcanic activity

examples of biological factors, eg
- (new) predators (allow hunters / poachers)
- (new) disease / named pathogen
- competition for food
- competition for mates
- cyclical nature of speciation
- isolation
- lack of habitat or habitat change
  If no other answers given allow natural disaster / climate change / weather change / catastrophic event / environmental change for 1 mark

2

(b) (i) 3

1

(ii) fossils

ignore bones, remains, fossil fuels

1

(c) (i) 65 million years ago

1

(ii) 17

allow ecf

1

(iii) fossil record incomplete
or
some fossils destroyed

accept not enough evidence

or

cannot perform experiment to test

1

[9]

4 (a) ovary

1

(b) 46

1

(c) (i) does not fit the pattern
or
it is higher than the 3rd value / it should be lower than the 3rd value / it should be between the 3rd and 5th values

*do **not** allow use of incorrect figures*

1

(ii) As age increases % of women (having a baby) decreases

1

(d) (i) 33

allow 1 mark for $\dfrac{66}{2}$

if no answer / wrong answer

2

(ii) low success rate

1

more likely to have a baby with health problems / abnormalities / a faulty chromosome

1

[8]

5 (a) animal cells also have cell membrane

1

(b) 1945–1955

allow 1946–1956
***or** 1947–1957*

1

(c) $(2 / 22 =) 9.0\overset{\bullet\bullet}{9}$

*allow 9.09 (%) or 9 (%) with no working shown for **1** mark*

1

9.1 (%)

*allow 9.1 (%) with no working shown for **2** marks*

1

(d)

More likely	Less likely
	✓
	✓
✓	
✓	
✓	

*allow **3** marks for 4 correct*

*allow **2** marks for 3 correct*

*allow **1** mark for 2 correct*

4

more than one tick in a row negates a mark

[8]

6

(a)

Characteristic	Environmental	Genetic	Both
Eye colour		✓	
A scar	✓		
Weight			✓

3

(b) **Key term**   **Definition**

Genotype — The set of alleles for a characteristic

The genus of an organism

The inheritance of chromosomes

Phenotype — The mutation of genes

The physical characteristics of an organism
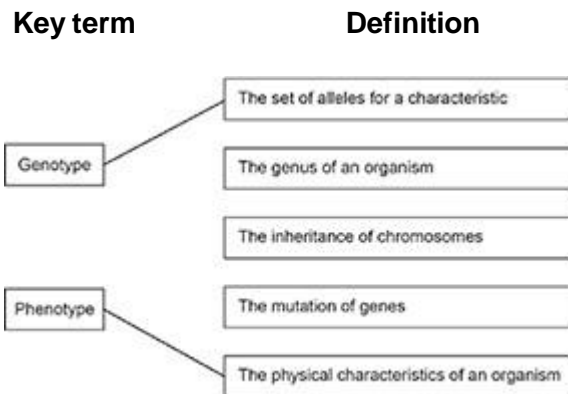
extra lines from the left negate the mark

2

(c)

Stage in selective breeding	Order of stage
Cows are bred over many generations	4
Parents are bred together	2
Cows with the desired characteristics are chosen	1
Calves with the most desired characteristics are bred together	3

*all 3 correct for **2** marks*

*1 or 2 correct for **1** mark*

max. 2

(d)　beef / meat

allow hardiness, disease resistance

1

milk yield

1

(e)　higher veterinary costs

1

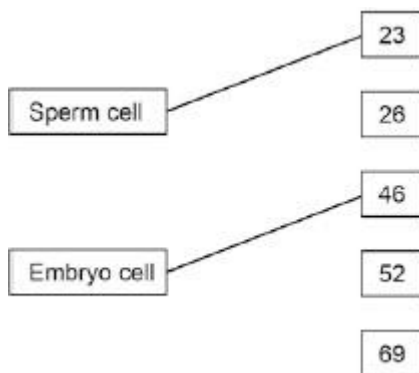less income from sale of (milk and meat) products

1

[11]

7　(a)　Nucleus

1

(b)　**Type of cell**　　　　**Number of chromosomes**

extra lines from left cancel the mark

2

(c)

	X	X
X	XX	XX
Y	XY	XY

*all three correct for **2** marks*
*one or two correct for **1** mark*
allow XY or YX in correct places

2

(d)

	X	X
X	XX	XX
Y	(XY)	(XY)

either circled

1

(e)   1 in 2

1

[7]