Name: _____

Class: _____

Date: _____

Inheritance, Variation and Evolution part 1 AQA Triple Biology

Time: **79 minutes**

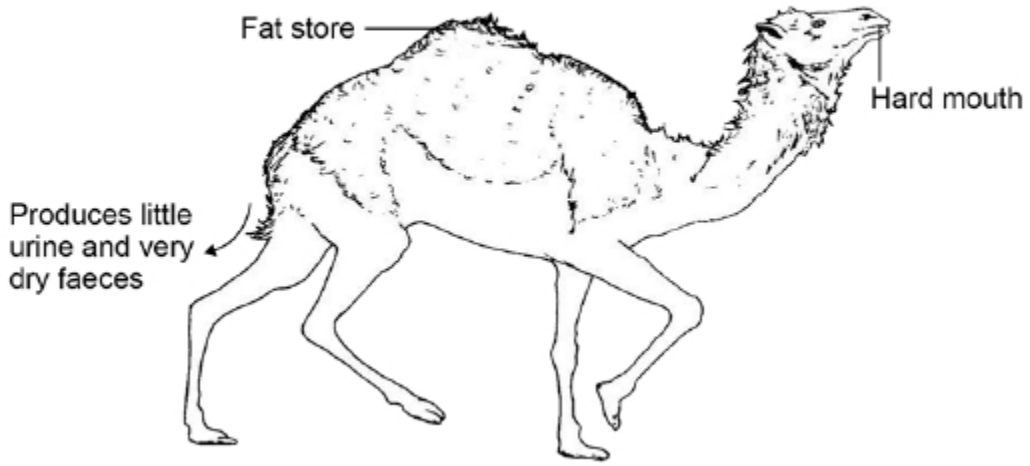
Marks: **77 marks**

Comments:

1. **Figure 1** shows a type of camel called a dromedary (*Camelus dromedarius*).

The dromedary lives in hot, dry deserts.

Figure 1



(a) One adaptation of the dromedary is 'temperature tolerance'.

This means that the animal's body temperature can rise by up to 6 °C before it starts to sweat.

Explain how temperature tolerance can help the dromedary to survive in the desert.

_____

_____

_____

_____

(2)

(b) Three more adaptations of the dromedary are given in **Figure 1**.

Give a reason why each adaptation helps the animal survive in the desert.

Fat store _____

_____

Produces little urine and very dry faeces _____

_____

Hard mouth _____

_____

(3)

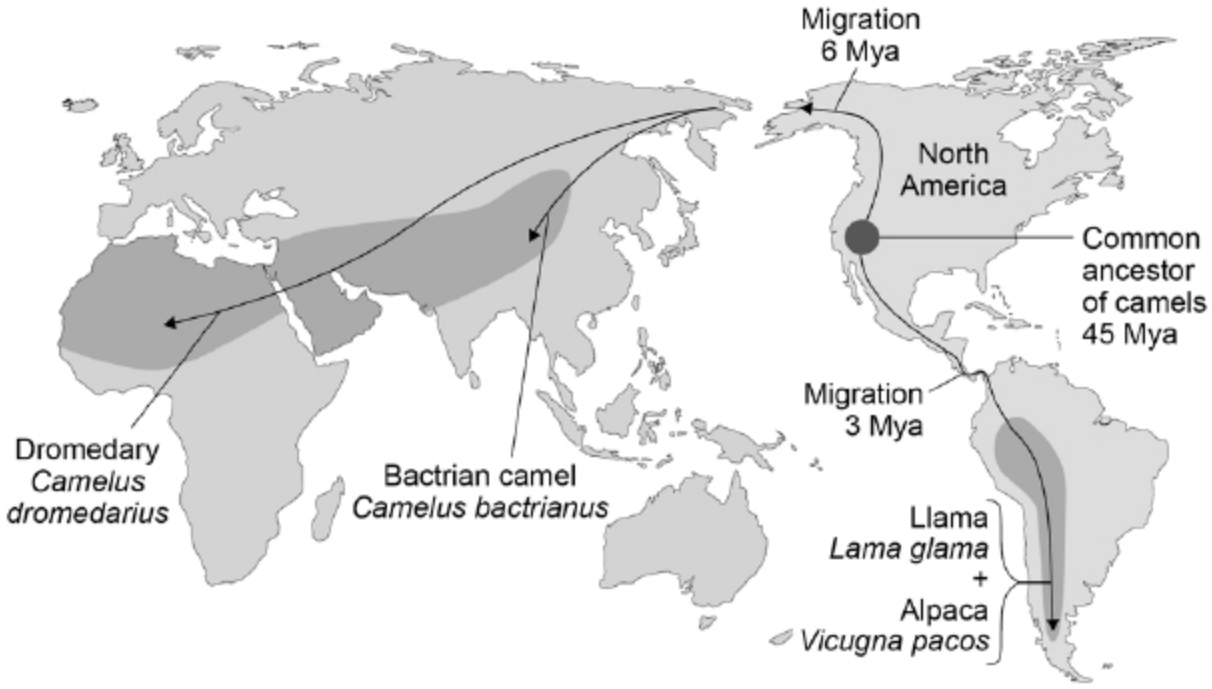
There are several species of the camel family alive today.

Scientists think these species evolved from a common ancestor that lived in North America about 45 million years ago (Mya).

Figure 2 shows:

- where four modern species of the camel family live today
- how the ancestors of these camels migrated from North America.

Figure 2



(c) Which **two** of the four modern species of camel do scientists believe to be most closely related to each other?

Give the reason for your answer.

_____ and _____

Reason _____

_____

(1)

(d) Describe the type of evidence used for developing the theory of camel migration shown in **Figure 2**.

_____

_____

_____

_____

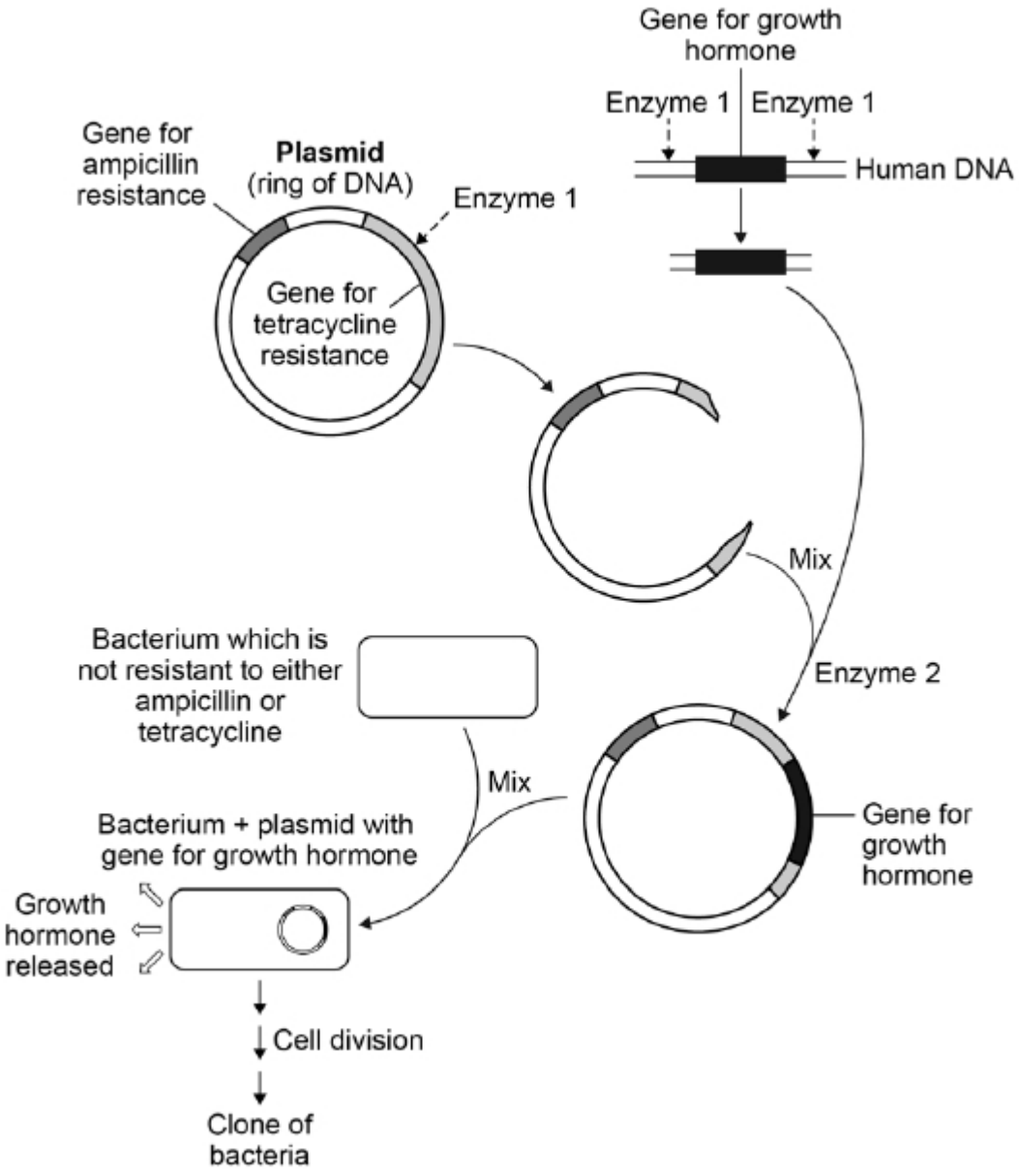
(2)

(e) Explain how several different species of camel could have evolved from a common ancestor over 45 million years.

(6)

(Total 14 marks)

2. The diagram shows how scientists can use genetic engineering to produce human growth hormone.



(a) Human growth hormone is made by the pituitary gland.

The human DNA containing the gene for growth hormone can be taken from a white blood cell.

Give the reason why the gene does **not** have to be taken from cells in the pituitary gland.

_____

_____

(1)

The figure above shows that the plasmid contains two genes for antibiotic resistance:

- a gene for resistance to the antibiotic ampicillin
- a gene for resistance to the antibiotic tetracycline.

(b) Explain how the structure of **Enzyme 1** allows it to cut the gene for tetracycline resistance, but **not** the gene for ampicillin resistance.

_____

_____

_____

_____

_____

_____

(3)

(c) In the final step of the diagram above, very few bacteria take up a plasmid containing the gene for growth hormone.

Some bacteria take up an unmodified plasmid.

Most bacteria do **not** take up a plasmid.

Complete the table below.

- Put a tick in the box if the bacterium **can** multiply in the presence of the given antibiotic.
- Put a cross in the box if the bacterium **cannot** multiply in the presence of the given antibiotic.

	Bacterium can multiply in the presence of	
	Ampicillin	**Tetracycline**
Bacterium + plasmid with growth hormone gene		
Bacterium without a plasmid		
Bacterium with an unmodified plasmid		

(d) The figure above shows that the bacterium containing the gene for human growth hormone multiplies by cell division.

This produces a clone of bacteria.

Explain why **all** the bacteria in this clone are able to produce growth hormone.

_____

_____

_____

_____

_____

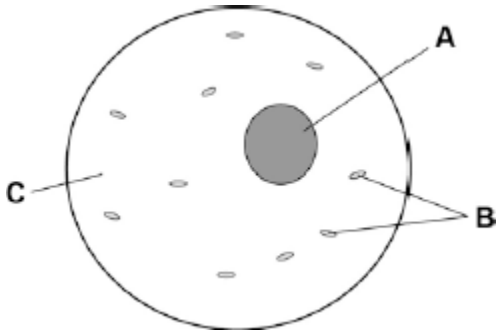
_____

(3)

(Total 10 marks)

3. **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.

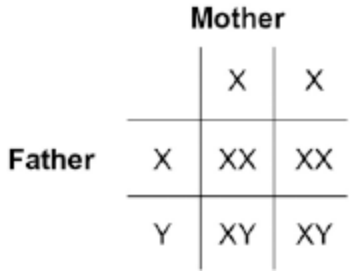
Type of cell	Number of Chromosomes
	10
Human body cell	23
	46
Sperm cell	60
	92

(2)

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

Figure 2 shows the inheritance of sex in humans.

Figure 2



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)

4. 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 Wallance	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?

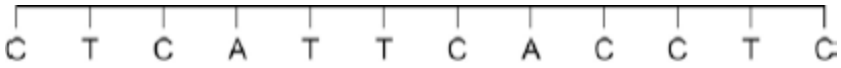
_____

(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

		Mother	
		D	d
Father	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)

5. Charles Darwin proposed the theory of natural selection.

Many people at the time did not accept his theory.

(a) There was a different theory at the same time as Darwin's theory.

The different theory said that changes in an organism during its life could be inherited.

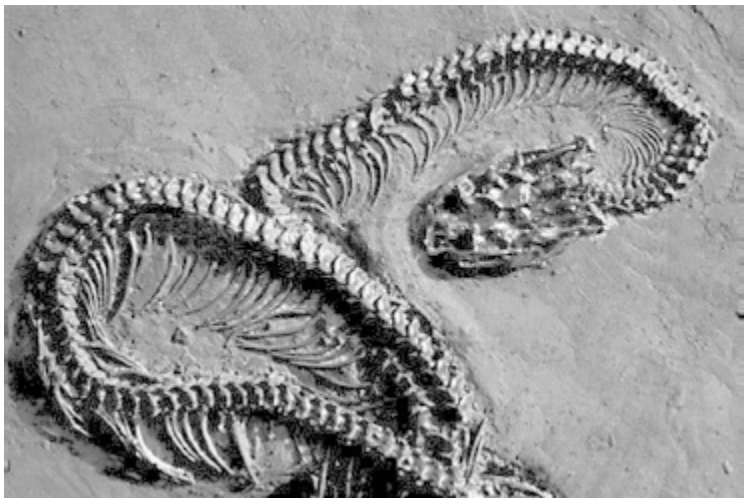
Who proposed this theory?

_____

(1)

(b) Studying fossils helps scientists understand how living things have evolved.

The diagram below shows a fossilised snake.



© Peter Menzel/Science Photo Library

Explain how the fossil in the diagram above may have formed.

_____

_____

_____

_____

_____

_____

(3)

(c) There are many types of rat snake in the world.

The table below shows two types of rat snake.

	 © Kazzpix/iStock/Thinkstock	 © Talkir/iStock/Thinkstock
Type of snake	Japanese rat snake	Texas rat snake
Colour of snake	Green	Pale brown
Type of environment	Grass	Dry and dusty

The different types of rat snake have evolved from similar ancestors.

The rat snakes have evolved to to suit their environments.

Explain how the Japanese rat snake evolved to be different from the Texas rat snake.

(4)

(d) Many species of snake have become extinct.

Give **one** reason why a species might become extinct.

_____

_____

(1)

(Total 9 marks)

6. Many different types of animals are produced using selective breeding.

Some cats are selectively bred so that they do not cause allergies in people.

(a) Suggest **two other** reasons why people might selectively breed cats.

1. _____

_____

2. _____

_____

(2)

(b) Selective breeding could cause problems of inbreeding in cats.

Describe **one** problem inbreeding causes.

_____

(1)

(c) Many people have breathing problems because they are allergic to cats.

The allergy is caused by a chemical called Fel D1.

Different cats produce different amounts of Fel D1.

A cat has been bred so that it does not produce Fel D1.

The cat does **not** cause an allergic reaction.

Explain how the cat has been produced using selective breeding.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 7 marks)

7. 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. _____

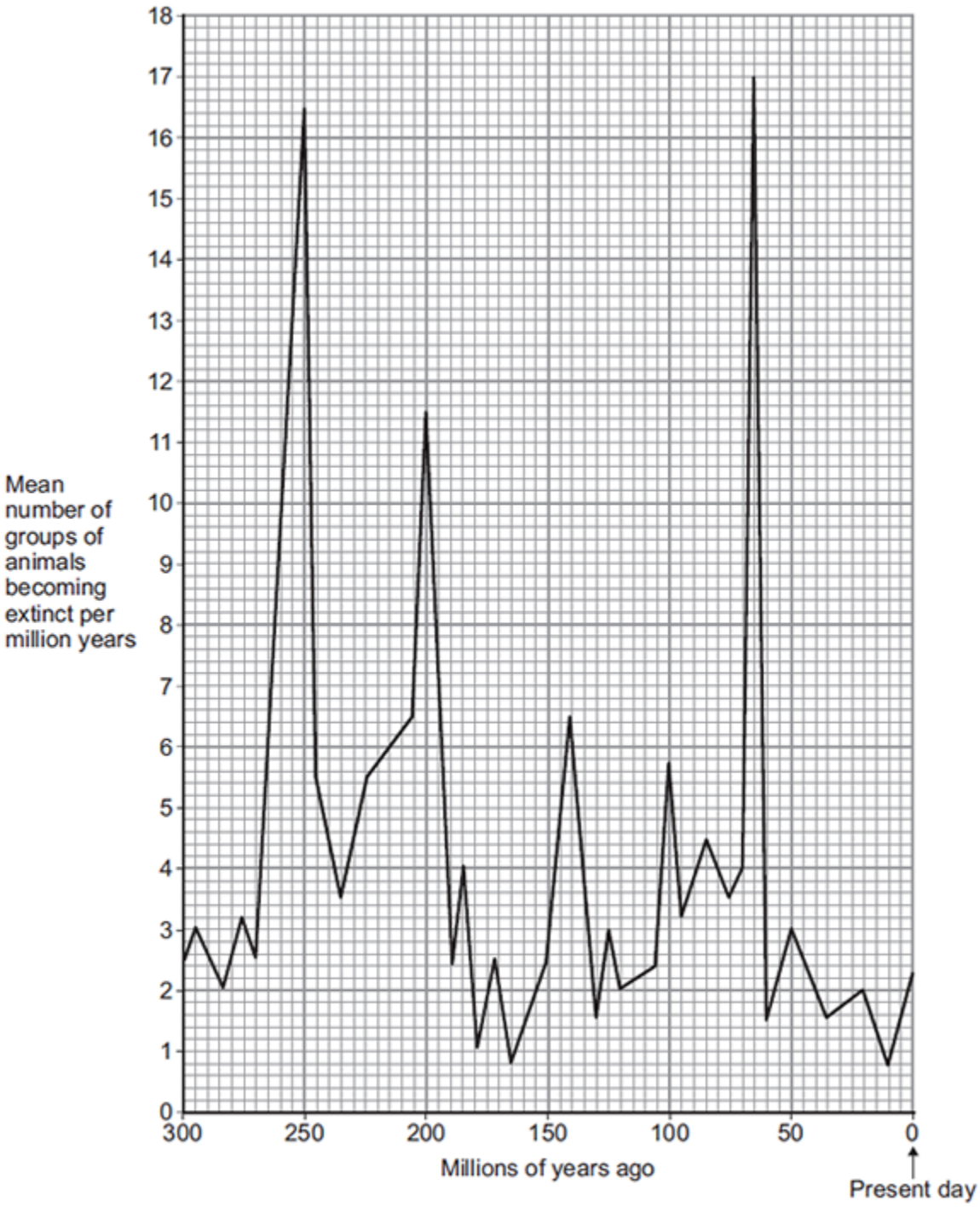
_____

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)

8. 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. ☐

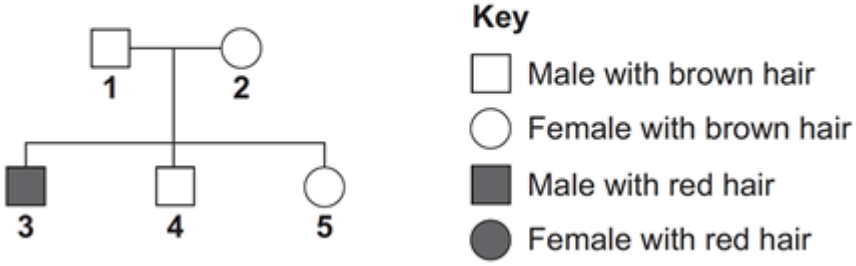
When the dominant allele is not present. ☐

When the allele is inherited from the female parent. ☐

(1)

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

Figure 1



(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 ☐

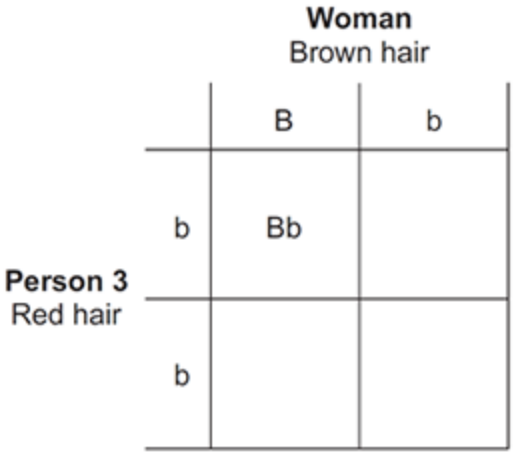
bb ☐

(1)

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

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

Figure 2



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)

9. (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)

1.

(a) less sweating so less water loss

1

(as) no / little water available in desert

1

(b) (fat store) can be metabolised / respired to water

1

(little urine…) conserve water

1

(hard mouth) not damaged by spines on plants / on food
or
not damaged by hard / dry food

1

(c) dromedary / *C.dromedarius*
and bactrian / *C. bactrianus*

no mark for the names, but must be identified

because
same genus

ignore 'both are Camelus'

1

(d) any **two** from:

- the fossil record
- oldest fossils in N. America
  or
- newer fossils in S. America / in Asia / in Africa

*allow numbers for ages (45 Mya **and** 3 Mya / 6 Mya)*

- chemical / DNA analysis of living species

allow radioactive dating of fossils

2

(e) isolation of separate camel populations by sea
or
by mountains

1

habitat variation / described between populations
allow examples – biotic (e.g. food / predators) or abiotic

1

genetic variation / mutation in each population

1

45 million years is sufficient time to accumulate enough mutations

1

natural selection
or
better adapted survive to reproduce

1

pass on favourable allele(s)
allow gene(s)

1

[14]

2. (a) white blood cells have the same DNA / genes / chromosomes
or
have the gene for GH
allow have all the genes
allow all body cells (except RBCs) have all of the genes

1

(b) enzyme has specifically-shaped <u>active site</u>

1

the 2 antibiotic resistance genes have different (sequence of) <u>bases</u>

1

only Tetracycline-resistance gene fits (active site of) enzyme
or
only Tetracycline-resistance gene is complementary to (active site of) enzyme

1

(c)

Ampicillin	Tetracycline
✓	×
×	×
✓	✓

1 *mark for each correct row*

if no other mark, allow ***1*** *mark for one correct column*

1
1
1

(d) clone produced by asexual reproduction

allow by 'mitosis'

1

all DNA / all genes are copied

allow GH gene copied

allow plasmid copied

1

every cell receives a copy
or
receives every gene
or
receives GH gene
or
receives plasmid
or
genetically-identical cells

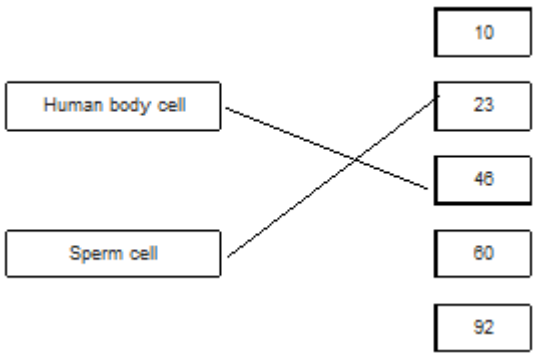
1

[10]

3. (a) **A**

1

(b)



2

(c) one x circled under mother

accept if clearly indicated choice even if not circled

1

(d) XY

allow YX

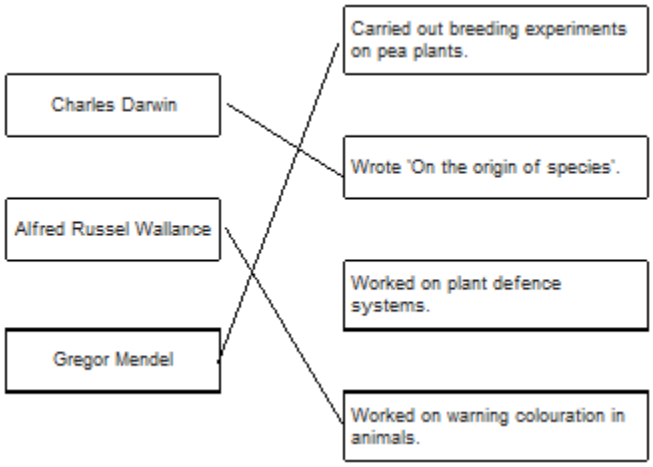
1

(e) 50 (%)

1

[6]

4. (a)



3

(b) a gene

allow allele

1

(c) 4

1

(d) correct derivation of children's genotypes

1

identification of children with cystic fibrosis (dd)

1

0.25

allow ecf

allow ¼ / 25% / 1 in 4 / 1:3

1

*do **not** accept 1:4*

(e) heterozygous

1

[9]

5. (a) (Jean Baptiste) Lamarck

allow phonetic spelling

1

(b) (snake is) covered in sediment / mud
or
sinks into the mud

1

(then) the soft parts decay / are eaten
or
bones / hard parts do not decay

1

(so) minerals enter bones
or
bones are replaced by minerals

1

(c) **Level 3 (3–4 marks):**
A detailed and coherent explanation is provided. Logical links between clearly identified, relevant points explain how the rat snake evolved through the process of natural selection.

Level 2 (1–2 marks):
Simple statements made, but not precisely. The logic is unclear.

0 marks:
No relevant content.

Indicative content

statements:
- there are lots of different colours of snakes
- some shades of green are closer to the colour of the environment (in Japan) than others
- survivors (in each generation) will breed and produce offspring

explanations:
- different colours are controlled by different genes / alleles / are caused by mutations
- being green means they are best suited to grassy / green environments
- being green means they are camouflaged
- those that are camouflaged best will be able to catch more food
- those that are camouflaged best will be able to avoid being eaten
- survivors' offspring will inherit the genes / alleles / mutation for the shade of green colouration

additional examiner guidance:
- allow converse points relating to the Texas rat snake if they clearly identify the reasons why this snake was at an evolutionary disadvantage, ie more likely to be caught and eaten by a predator
- a good level 2 answer will clearly link survival and breeding to the passing on of the advantageous genes / alleles / mutations and link the idea of colour (AO2) to a correct explanation of its significance for survival

4

(d) any **one** from:
- changes to the environment
- new predators
- new diseases
- new (more successful) competitors
- catastrophic event / described event

1

[9]

6. (a) any **two** from:
- so that they do not have specific genetic defects
- to produce docile cats or so they are not aggressive

  allow descriptions of aggression such as biting and scratching
- for aesthetic reasons

  allow descriptions of suitable aesthetic reasons

2

(b) (cats) are more likely to pass on (recessive) disorders
or
more likely to be susceptible to diseases

1

(c) **Level 2 (3–4 marks):**
A detailed and coherent explanation is given, which logically links the process of selective breeding with explanations of how this produces cats that do not cause allergic reactions.

Level 1 (1–2 marks):
Simple statements are made relating to process of selective breeding, but no attempt to link to explanations.

0 marks:
No relevant content.

Indicative content

process:
- parents with the desired characteristic are selected
- the parents are bred together to produce offspring
- offspring with the desired characteristics are selected and bred
- this is repeated over many generations.

explanations:
- parents who produce the least Fel D1 are initially selected
- in their offspring there will be individuals with differing amounts of Fel D1 produced
- care is taken to ensure cats are healthy and avoid possible problems associated with selective breeding
- over time the population of (selectively bred) cats will produce less Fel D1

4

[7]

7. (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]

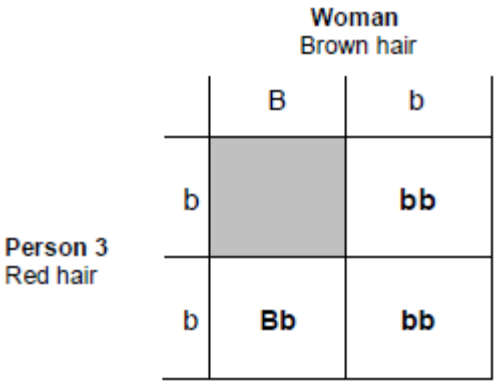
8. (a) When the dominant allele is not present.

1

(b) (i) Bb

1

(ii)



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]

9. (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 $\frac{66}{2}$

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]