

Inheritance 6

Name: _____

Class: _____

Date: _____

Time: **81 minutes**

Marks: **81 marks**

Comments:

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.

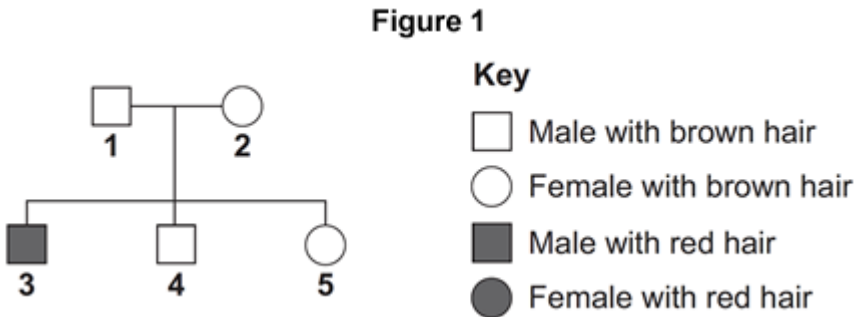
When the allele is present on only one of the chromosomes.

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.



(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
Person 3 Red hair	b	Bb	
	b		

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.

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)

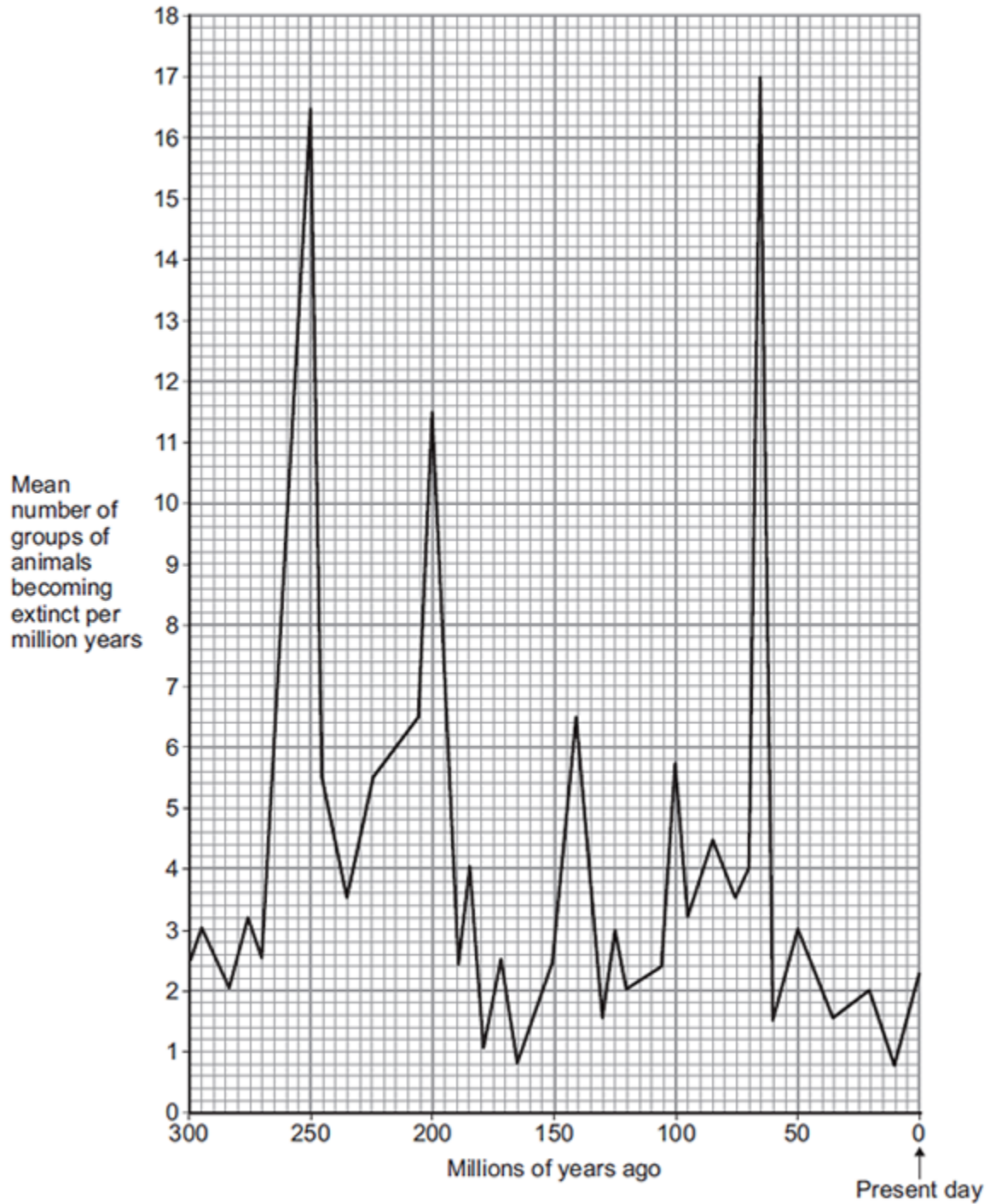
(iii) Give **two** reasons, other than collision with an asteroid, why groups of animals may become extinct.

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)

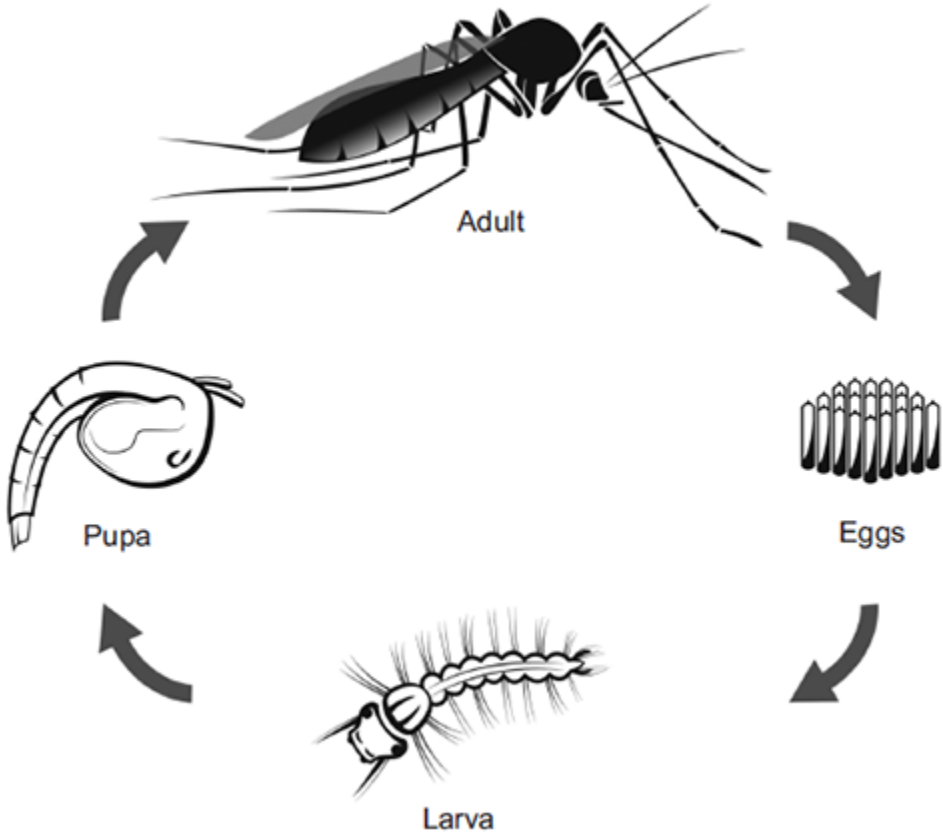
(Total 9 marks)

3.

Malaria is a disease caused by a microorganism carried by mosquitoes.

The microorganism is transferred to humans when adult female mosquitoes feed on human blood.

The figure below shows the life cycle of a mosquito.



© watcharapon/iStock

The World Health Organisation estimates that 3×10^8 people are infected with malaria every year.

Scientists estimate that malaria kills 2×10^6 people every year.

The people who are infected with malaria but do not die, may be seriously ill and need health care for the rest of their lives.

(a) Based on the estimated figures, what percentage of people infected with malaria die from the disease?

(2)

- (b) An internet article states:
- 1 Mosquito larvae are at the start of the food chain for some fish.
 - 2 Adult mosquitoes provide food for bats and birds.
 - 3 Mosquitoes are also important in plant reproduction because they feed from flowers of crop plants.

(i) The first sentence in the article is **not** correct.

Explain why.

(2)

(ii) A company plans to produce genetically modified (GM) adult male mosquitoes. The GM mosquitoes will carry a gene from bacteria. The gene causes the death of offspring before they become adults.

Male mosquitoes do **not** feed on blood.

Scientists are considering releasing millions of adult male GM mosquitoes into the wild.

Do you think scientists should release millions of male GM mosquitoes into the wild?

In your answer you should give advantages and disadvantages of releasing GM mosquitoes into the wild.

(4)

(iii) Describe the process for creating a GM mosquito.

(3)
(Total 11 marks)

4.

Polydactyly is an inherited condition caused by a dominant allele.

(a) The figure below shows the hand of a man with polydactyly. The man has an extra finger on each hand.

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



© Ifness/iStock

- (i) The man is **heterozygous** for polydactyly.

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

(3)

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

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

(1)

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

Both of their parents have brown hair.

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

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

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

	Father	Mother
Parental phenotypes	_____	_____
Parental Genotypes	_____	_____
Gametes	_____	_____

Offspring genotypes: _____

Offspring phenotypes: _____

(5)
(Total 9 marks)

5.

(a) Which of the following is the **best** definition of a species?

Tick (✓) **one** box.

Organisms with many features in common

Organisms that live in the same habitat and eat the same food

Organisms that reproduce together to form fertile offspring

(1)

(b) **Figure 1** is a photograph of the Grand Canyon.

The layers of rock contain fossils.

Figure 1



© Sumikophoto/iStock/Thinkstock

Scientists found five fossils of different species of animal, **P**, **Q**, **R**, **S** and **T**, at the positions shown in **Figure 1**.

(i) What is the evidence in **Figure 1** that animals **P** and **Q** were alive at the same time?

(1)

(ii) Was animal **R** alive at an earlier time or at a later time than animals **P** and **Q**?

Give the reason for your answer.

(1)

(iii) Which **two** of the following would be evidence that animal **T** may have evolved from animal **S**?

Tick (✓) **two** boxes.

The fossils of animals **S** and **T** have many features in common, but **T** is more complex than **S**.

The fossils of animals **S** and **T** are the same size.

The fossils of animals **S** and **T** have the same skin colour.

The fossil of animal **S** was found in a deeper layer of rock than the fossil of animal **T**.

The fossil of animal **T** is more similar to the fossil of animal **R** than to the fossil of animal **S**.

(2)

(c) **Figure 2** shows two species of ground squirrel, **W** and **X**.

Figure 2

Squirrel W



Squirrel X



Squirrel **W** lives on the high ground to the south of the Grand Canyon.

Squirrel **X** lives on the high ground to the north of the Grand Canyon.

The land to the north of the Grand Canyon is about 300 metres higher than the land on the south side. The north side also has lower winter temperatures and has more rain and snow than the south side.

(i) The two species of squirrel are very similar.

Describe **one** way, which you can see in **Figure 2**, in which squirrel **X** is different from squirrel **W**.

(1)

(ii) The Grand Canyon was formed about 6 million years ago.

Explain how the two different species of squirrel could have developed from a common ancestor.

(6)

(iii) Squirrels **W** and **X** are separate species, but they are still very similar.

Suggest why the two species have **not** become more different over time.

(2)

(Total 14 marks)

6.

Glyphosate is a herbicide.

Crop plants have been genetically modified to make them resistant to glyphosate.

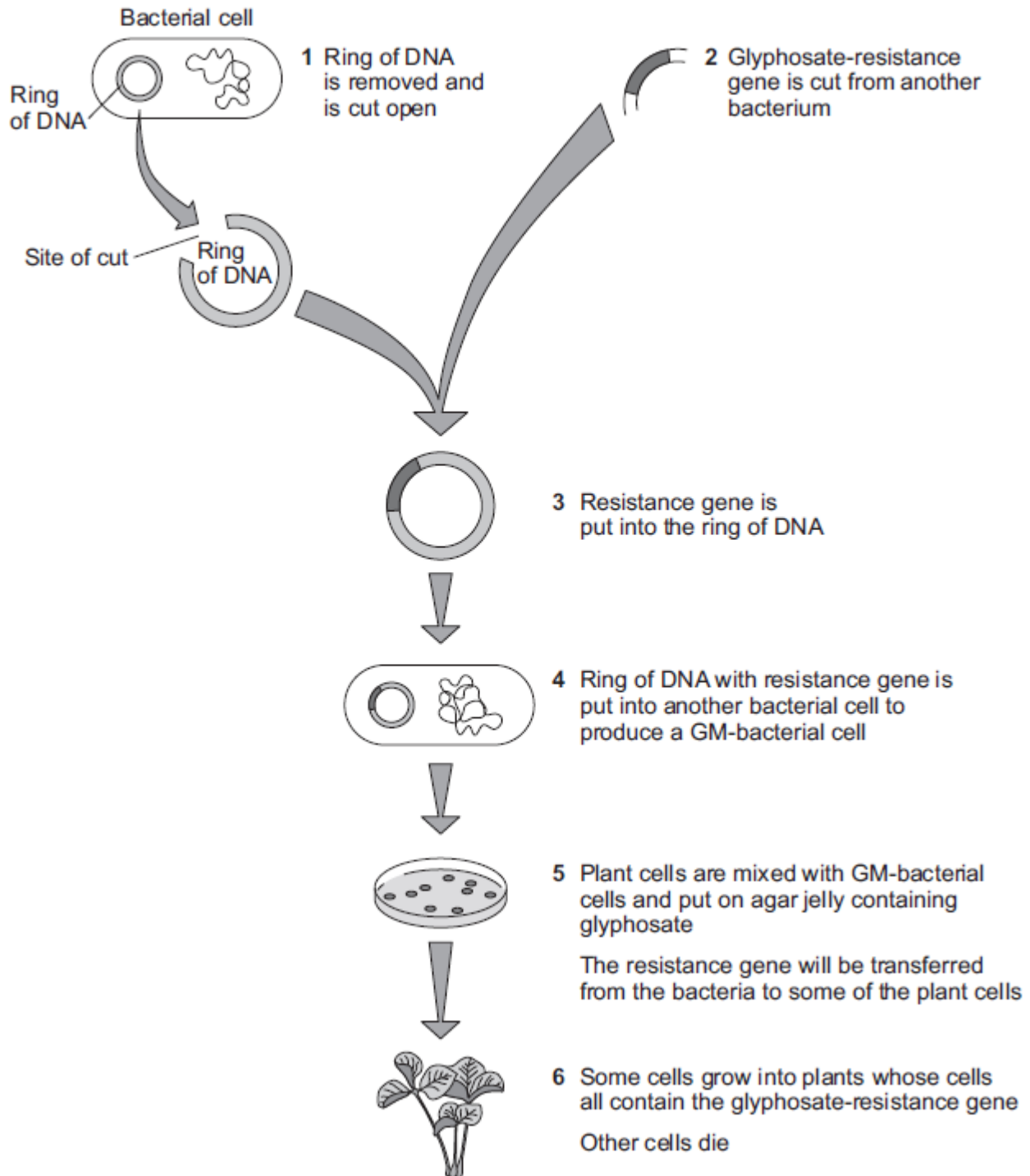
(a) Why is it an advantage to make crop plants resistant to glyphosate?

(3)

(b) **Figure 1** shows how scientists produce genetically modified (GM) crop plants.

The scientists use a GM-bacterium that can invade plant cells.

Figure 1



(i) The ring of DNA shown in **Figure 1** acts as a vector for the resistance gene.

What is the scientific name for this ring of DNA?

(ii) At step **1** in **Figure 1**, the ring of DNA is cut open.

How do scientists cut open the ring of DNA?

(1)

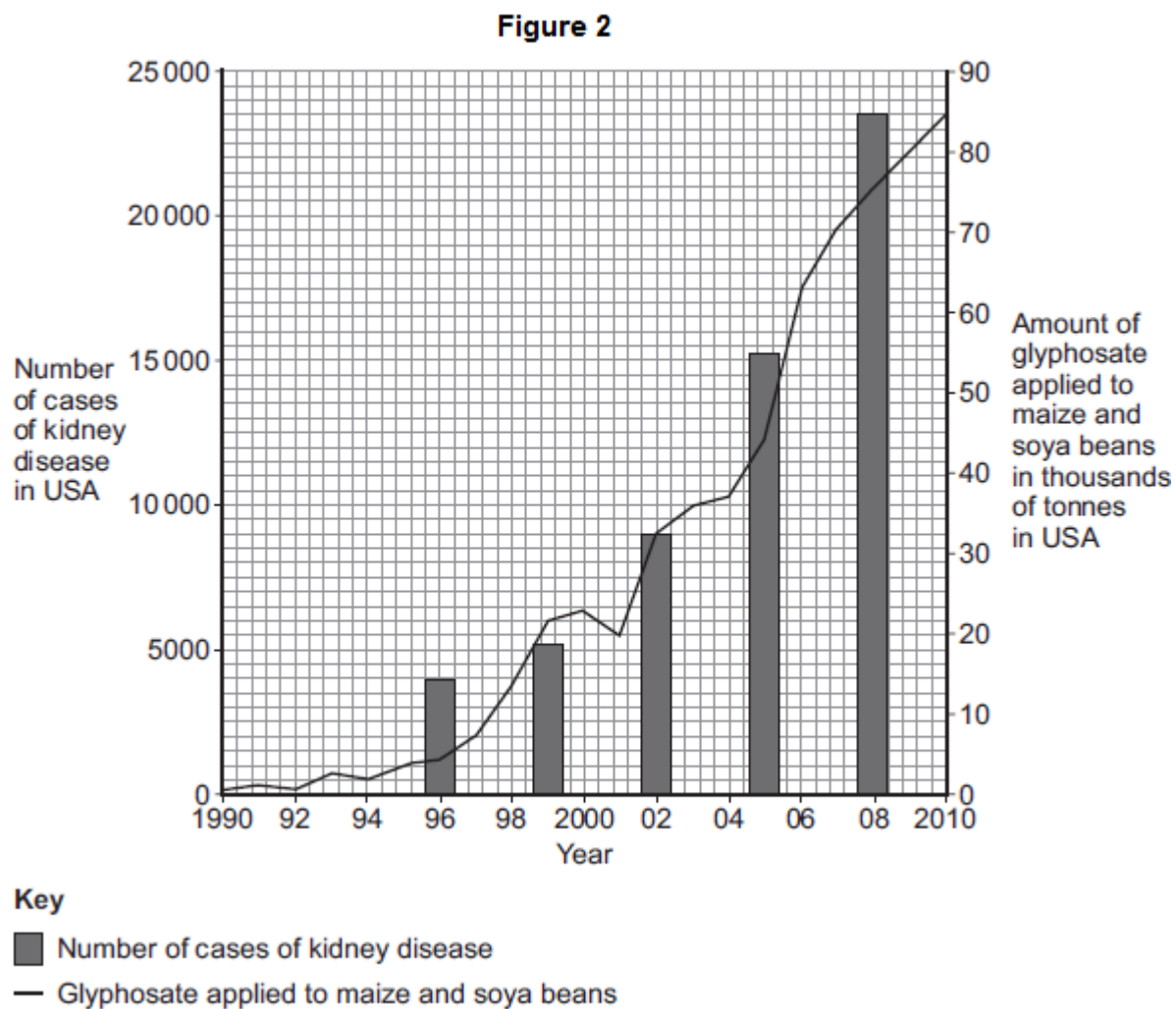
(iii) At step **5** in **Figure 1**, plant cells and GM-bacteria are put on agar containing glyphosate.

Explain why the scientists add glyphosate to the agar.

(2)

(c) Some people disagree with the use of GM herbicide-resistant crop plants.

Figure 2 shows data published on a website in 2013.



A journalist used the data to claim: 'Scientists show that GM crops cause kidney disease in humans.'

Use information from **Figure 2** to evaluate the evidence for this claim.

(4)

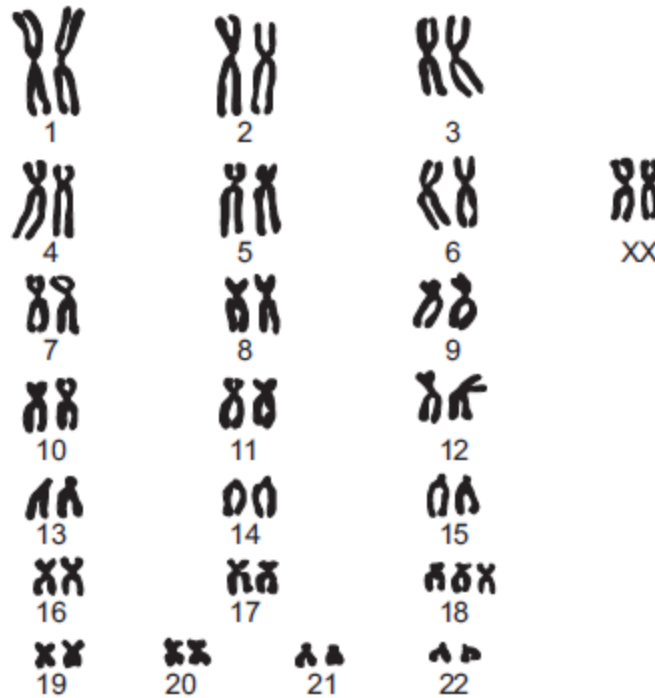
(Total 11 marks)

7.

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**.

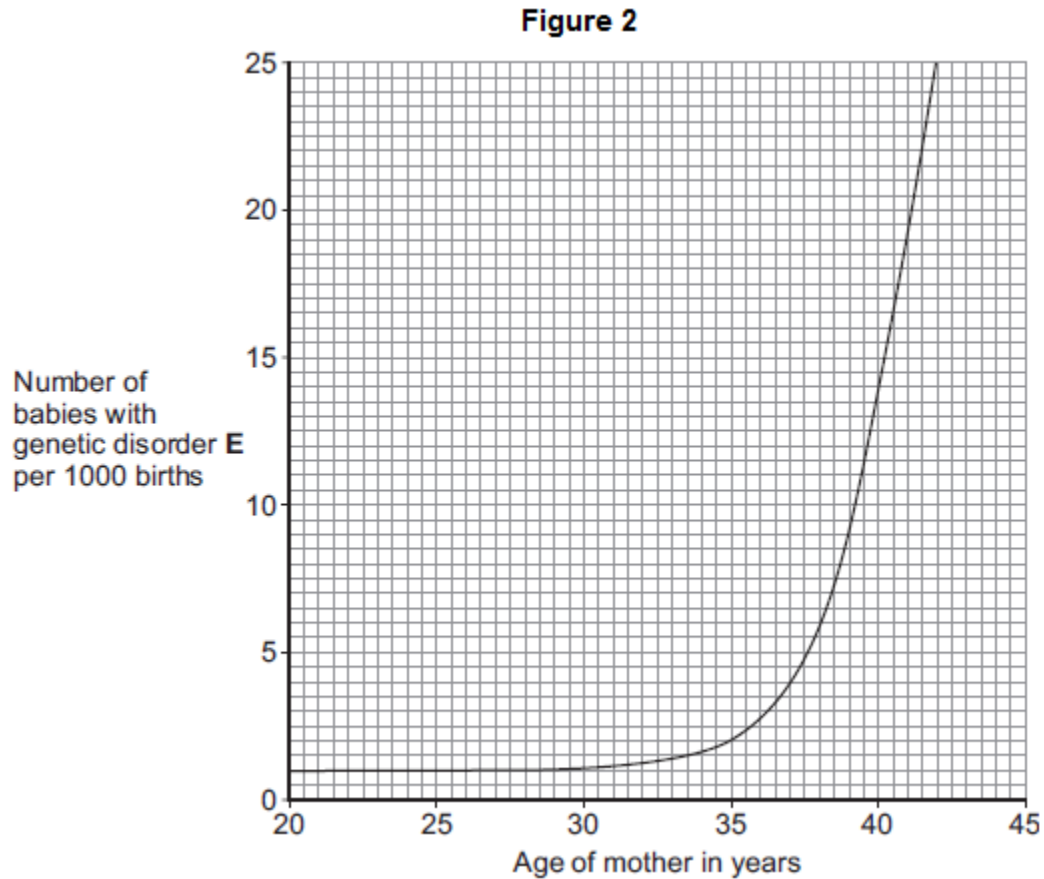
(1)

(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.



- (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)

8.

(a) Evidence about extinct species of animals and plants comes from fossils.

Below is a photograph of a fossil of a bird-like animal called *Archaeopteryx*. *Archaeopteryx* lived about 150 million years ago.



© Wlad74/iStock/Thinkstock

(i) Suggest how the fossil of *Archaeopteryx* was formed.

(2)

(ii) Scientists have found other fossils of the ancestors of modern birds, but the fossil record is very incomplete.

Suggest **two** reasons why there are gaps in the fossil record.

1. _____

2. _____

(2)

9.

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.

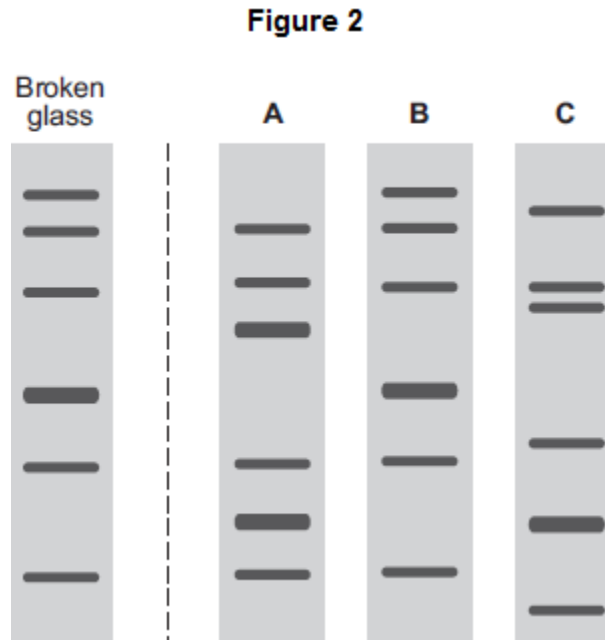
How many copies of the recessive CF allele are there in a body cell of this person?

(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)

Mark schemes

1.

(a) When the dominant allele is not present.

1

(b) (i) Bb

1

(ii)

		Woman Brown hair	
		B	b
Person 3 Red hair	b		bb
	b	Bb	bb

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) 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 1
ignore bones, remains, fossil fuels
- (c) (i) 65 million years ago 1
- (ii) 17 1
allow ecf
- (iii) fossil record incomplete 1
or
some fossils destroyed
accept not enough evidence
or
cannot perform experiment to test

[9]

3.

(a) 0.67(%)

allow 0.6̇ or 0.7

allow 1 mark for evidence of $(2 \times 10^6) \div (3 \times 10^8)$

or

allow 1 mark for 0.0067 or 0.6

2

(b) (i) idea that food chains start with plants / producers

*allow food chains do not start with animals **or** larvae are consumers*

1

idea that these make food (for other organisms in the chain)

*allow idea that plants / producers photosynthesise **or** plants / producers get energy from the sun*

*allow mosquito larvae do not make food / photosynthesise **or** mosquito larvae do not get energy from the sun*

1

(ii) any **four** from:

- reasoned argument for **or** against release
must refer to at least one advantage and one disadvantage.
*max 3 marks for either only advantages **or** only disadvantages*

advantages:

- fewer mosquitos biting **or** spreading malaria
- fewer people get / die from malaria
allow people won't get / die from malaria
- lower medical costs (for those infected **or** for treatment) **or** less healthcare needed
- better economically for developing / tropical countries.

disadvantages:

- fewer crops reproduce
allow fewer crops pollinated
- poorer crop yield
- possible starvation (of people)
- high cost of GM production / mosquito release
- less food for bats / birds **or** bats / birds die
*allow disruption to food chain / ecosystem **or** reduction of biodiversity*
- gene could 'escape' into other wildlife / species
ignore into plants

4

- (iii) any **three** from:
- gene from bacteria cut out
allow allele for gene
 - ref to enzymes (anywhere in process)
allow at any point in process, ie in cutting or in splicing
 - (gene) transferred to chromosome of mosquito
allow DNA for chromosome
 - at an early stage of development
allow egg / embryo

3

[11]

4.

- (a) (i) man has (inherited) polydactyly (PD) allele (from mother)

1

man has (inherited) other / normal / recessive allele from father

1

because father does not have PD allele **or** if father had it father would have had PD
or father only has normal allele **or** father is homozygous recessive

1

allow gene for allele

- (ii) 0.5 / $\frac{1}{2}$ / 1 in 2 / 1:1 / 50%
do not allow 1:2 or 50/50
allow 50:50

1

- (b) parental phenotypes: both brown

1

parental genotypes: both **Bb**

1

gametes: **B b** and **B b**

1

allow only on gametes answer line

allow ecf from genotypes

offspring genotypes: **BB (2)Bb bb**

allow ecf from gametes

1

offspring phenotypes correctly assigned to genotypes:

BB & Bb = brown **bb** = red

do not penalise confusion of 'phenotypes' & 'genotypes' here

1

[9]

- 5.** (a) organisms that reproduce together to form fertile offspring 1
- (b) (i) fossils of **P** and **Q** in same stratum / layer / level / height 1
- (ii) earlier – fossil in deeper layer / further down 1
- (iii) the fossils of animals **S** and **T** have many features in common, but **T** is more complex than **S** 1
- the fossil of animal **S** was found in a deeper layer of rock than the fossil of animal **T** 1
- (c) (i) **X** has white tail / shorter tail 1
allow other points eg X has furrier tail / smaller feet / is furrier
or
W has sharper claws / W has larger claws
- (ii) two (ancestral) populations separated / isolated (by geographical barrier / by canyon / river) 1
- genetic variation (in each population) / different alleles / different genotypes / (different) mutation(s) 1
- different environmental conditions / example described
allow abiotic or biotic example 1
- the better adapted survive / natural selection occurs
allow survival of the fittest
ignore they adapt to the environment 1
- so (different / favourable) alleles / genes passed on (in each population) 1
- eventually two types cannot interbreed successfully
allow to produce fertile offspring 1

- (iii) any **two** from:
- environments similar / described
allow example, e.g. similar predator(s) / food / climate
 - therefore similar adaptations / features / phenotypes suit
accept suitable named feature
 - original ancestor already well adapted
ignore reference to not enough time for evolution.

2

[14]

- 6.** (a) kills weeds among crops / does not kill crops

1

(kills weeds) so less competition for named factor eg light / water / ions
ignore space

1

crops grow better / higher yield

1

- (b) (i) plasmid

1

(ii) use an enzyme
allow correct example

1

(iii) only some cells become GM / take up the plasmid / take up resistance gene
allow idea of transfer of gene / plasmid to some plant cells from bacteria

1

GM cells survive / non-GM cells are killed

1

- (c) Pro:
(positive) correlation between use of glyphosate and number of cases of kidney disease

allow 1 mark for justified conclusion that the claim is not justified

1

+ any **three** from:

Con:

- lack of controls / control group
- correlation does not prove a causal link
- some other factor could be the cause
accept obesity / infection
- no evidence that kidney patients actually consumed GM crops / crops treated with glyphosate / no evidence about amount consumed
or graph shows amount of herbicide not amount of GM crops grown
or graph shows data only for maize and soya / not for other (GM) crops
- data have been manipulated by carefully chosen scales to make it look like they coincide
- data from some years is missing
- no data for the dosage of herbicide used

allow kidney disease has been around for much longer than GM crops / better diagnosis of kidney disease.

3

[11]

7.

- (a) (i) (female) has XX / only X's / no Y
allow has X chromosomes
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]

8.

(a) (i) any **two** from:

- (dead) animal buried in sediment
allow imprint in mud
- hard parts / bones do not decay **or** soft parts do decay
allow (one of) the conditions for decay is missing – accept example, eg oxygen / water / correct temperature / bacteria
- mineralisation (of hard parts / bones)
allow replacement by other materials

2

(ii) any **two** from:

- conditions not right for fossilisation
ignore references to soft-bodied
- geological activity has destroyed fossils / has destroyed evidence
allow a named / described example – eg vulcanism / earth movements / erosion
- fossils not yet found
allow description of why not yet found

2

(b) any **four** from:

- separation / isolation (of different populations)
- different environmental conditions (between locations)
- mutation(s) occur **or** genetic variation (within each population)
- better adapted survive **or** natural selection occurs
allow 'survival of the fittest'
ignore animals adapt to their environment
ignore reference to stronger survive
- favourable alleles passed on (in each population)
allow genes for alleles
- eventually different populations unable to breed successfully with each other
allow unable to produce fertile offspring

4

[8]

9.

(a) (i) in the chromosome(s)

ignore genes / alleles

1

in the nucleus

allow nuclei

allow mitochondria

1

(ii) the DNA / chromosomes / genes are replicated / copied / multiplied / doubled / duplicated

allow DNA is cloned

ignore same DNA / chromosomes / genes if unqualified

1

(b) (i) 1 / one

1

(ii) 2 / two

1

(c) **B**

1

[6]