Name: _____

Class: _____

Date: _____

Inheritance, Variation and Evolution part 2 AQA Triple Biology

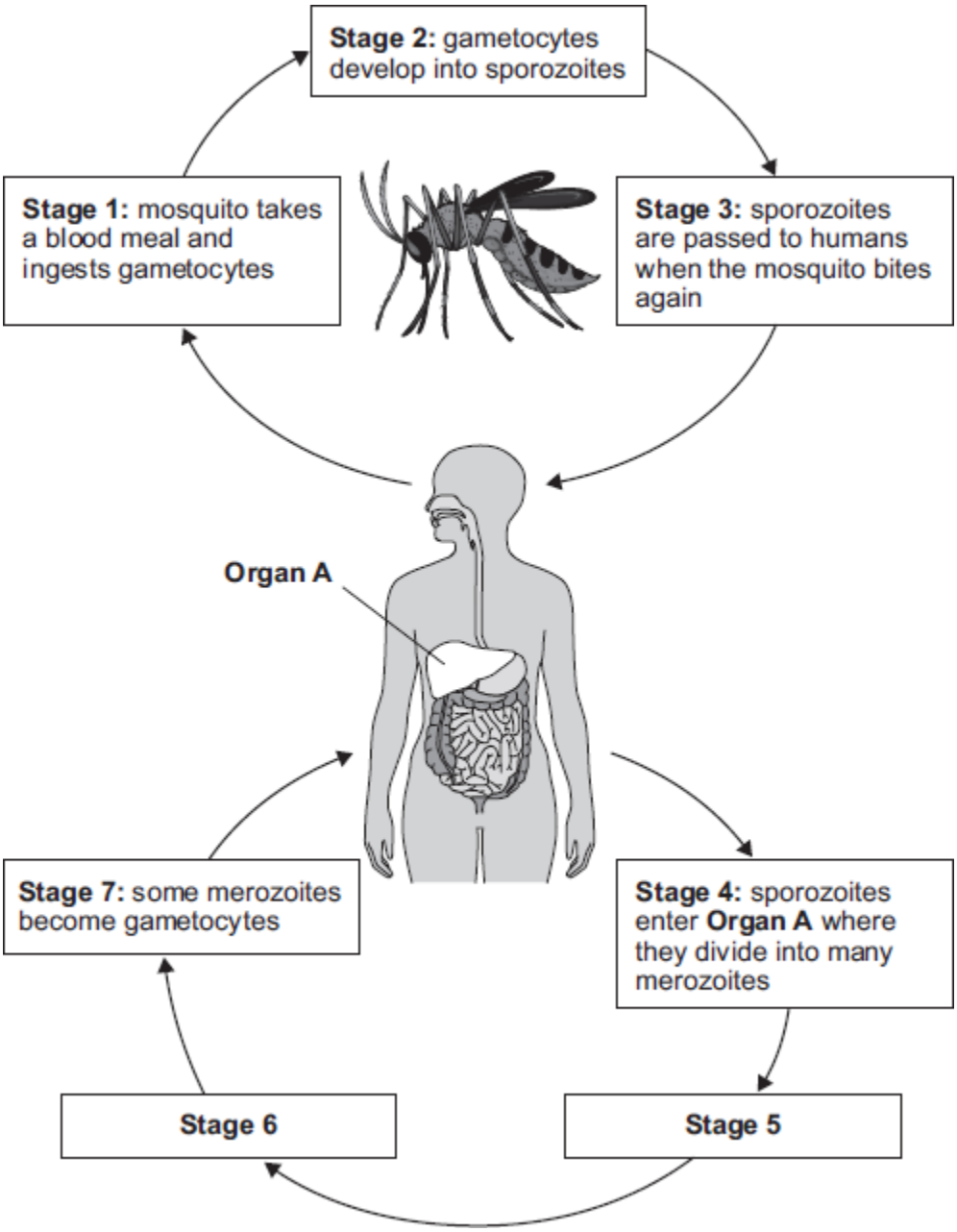
Time: **91 minutes**

Marks: **91 marks**

Comments:

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

Figure 1



(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**?

(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	**GGACTCCTC**
Sickle-cell gene	**GGACACCTC**

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

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(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)

2. 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?

_____

_____

_____

_____

_____

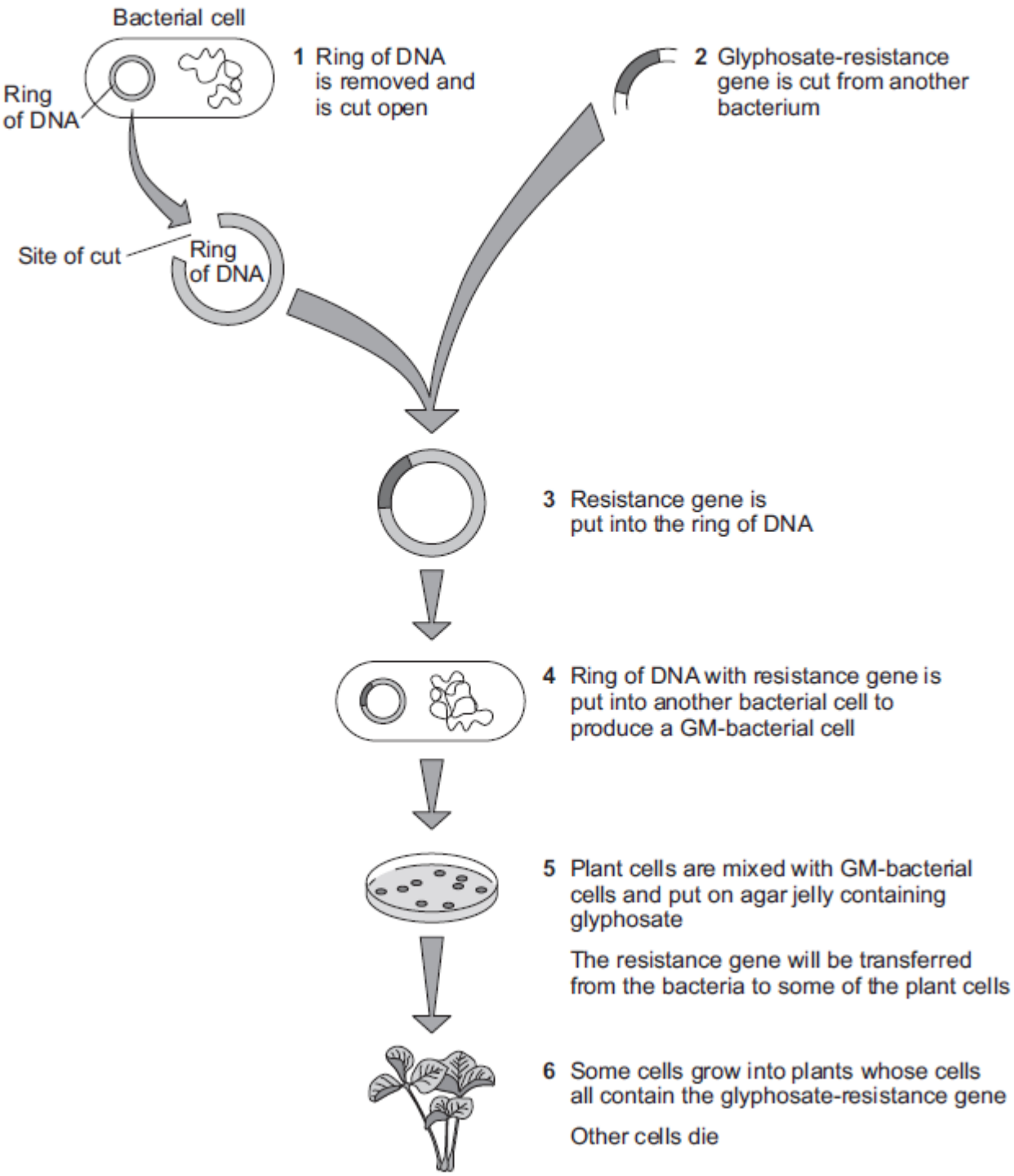
_____

(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?

_____

(1)

(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.

_____

_____

_____

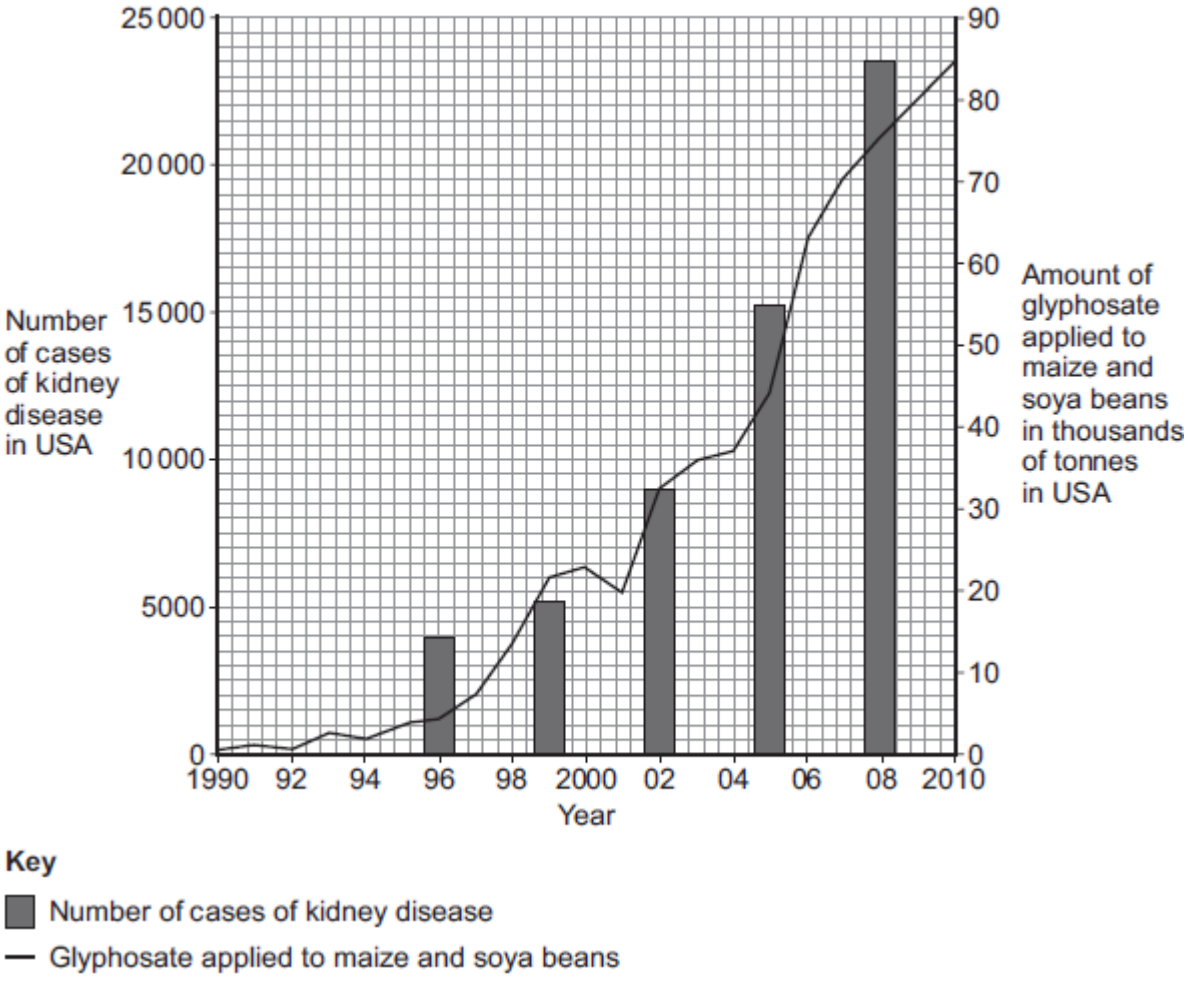
_____

(2)

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

Figure 2 shows data published on a website in 2013.

Figure 2



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)

3. (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 ☐

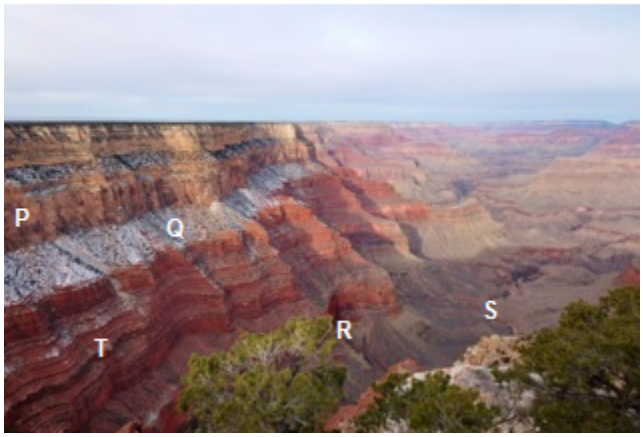
Organisms that reproduce together to form fertile offspring ☐

(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)

4. DNA is the genetic material of human cells.

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

Figure 1

(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?

_____

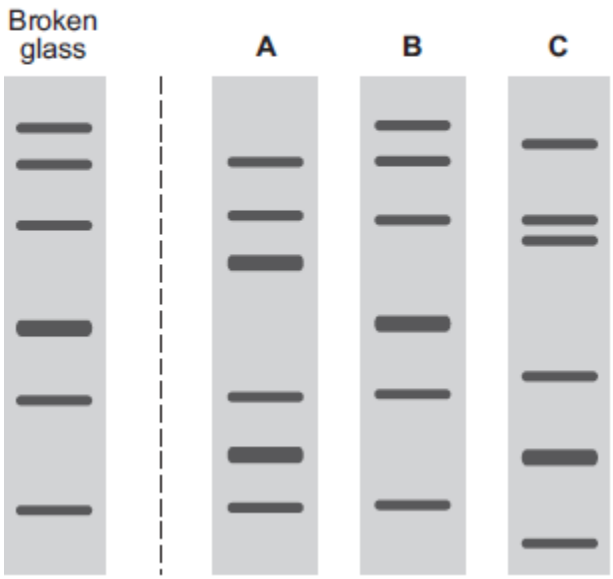
(1)

(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.

Figure 2



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

Tick (✓) **one** box.

A ☐

B ☐

C ☐

(1)

(Total 6 marks)

5. (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)

(b) There are many different species of bird on the Earth today.

Describe how these different species may have evolved from an ancestor such as *Archaeopteryx*.

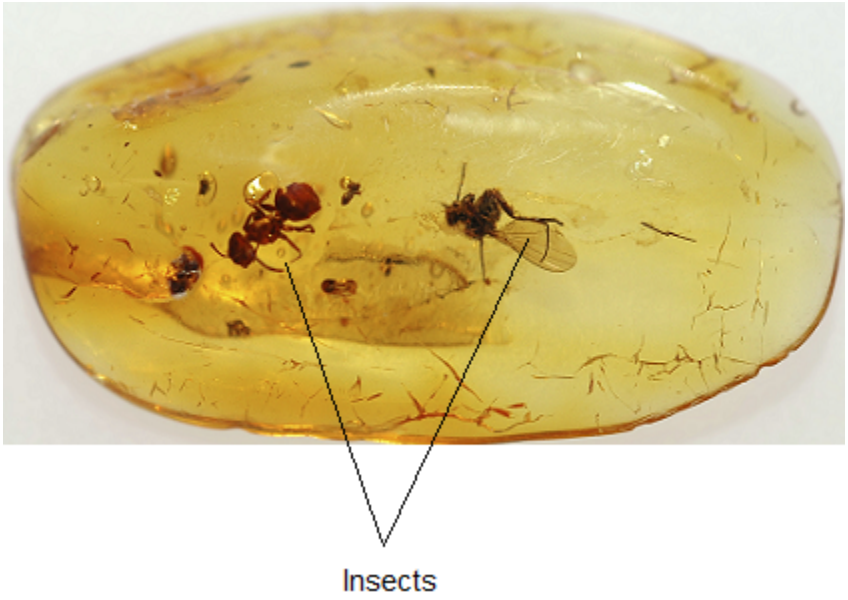
(4)

(Total 8 marks)

6. Fossils give us information about organisms from a long time ago.

(a) Amber is a solid, glass-like material. Amber is formed from a thick, sticky liquid which oozes out of pine trees.

The image shows two fossil insects in amber.



(i) Suggest how the insects came to be preserved in the amber.

_____

_____

_____

_____

(2)

(ii) Give **two** other ways fossils are formed.

1. _____

_____

2. _____

_____

(2)

(b) The fossil record shows that many organisms, including the dinosaurs, became extinct 65 million years ago.

One theory was that volcanic activity might have caused this mass extinction. Many scientists believe that this extinction was caused when an asteroid collided with the Earth.

(i) A new scientific theory may replace an old theory.

Why might this happen?

Tick (✓) **one** box.

Evidence from amber is unreliable.	☐
Internet evidence is more reliable than fossil evidence.	☐
New technology provides more valid evidence.	☐

(1)

(ii) Give **three** reasons, other than volcanic activity and collision with an asteroid, why a species may become extinct.

1. _____

_____

2. _____

_____

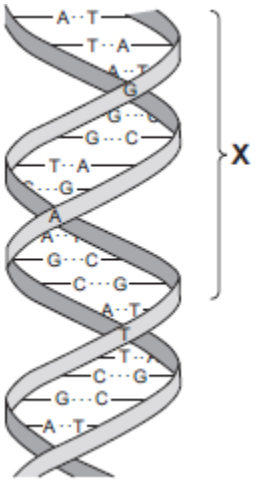
3. _____

_____

(3)

(Total 8 marks)

7. 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^r** 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^r** 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.

_____

_____

_____

_____

_____

_____

(2)

(Total 13 marks)

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

(a) What are **alleles**?

_____

_____

(1)

(b) 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.

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

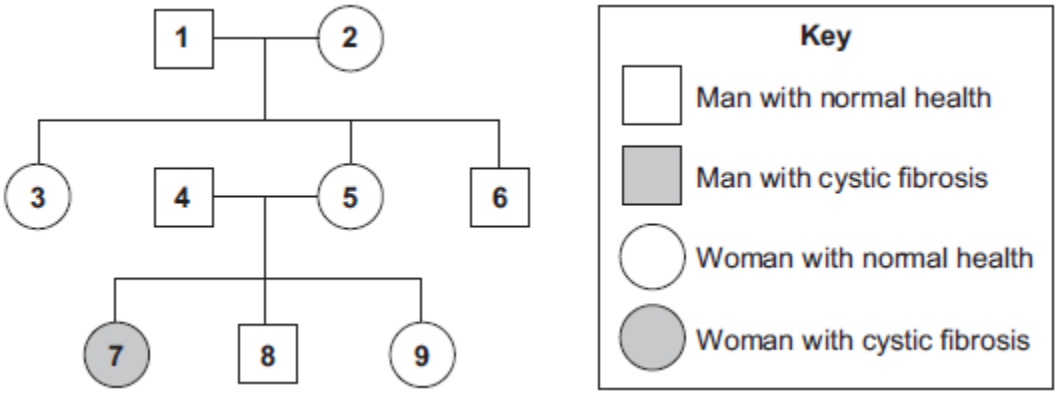
This couple's children have a 50% chance of having polydactyly.

Draw a genetic diagram to explain why.

(3)

(c) 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 8 marks)

9. The photograph shows a fossil of a prehistoric bird called *Archaeopteryx*.

By Ghedoghedo (own work) [CC-BY-SA-3.0 (http://creativecommons.org/licenses/BY-SA-3.0) or GFDL (http://www.gnu.org/copyleft/fdl.html)], via Wikimedia Commons; By Steenbergs from Ripon, United Kingdom (Small Fishing Boat In North Sea) [CC-BY-2.0 (http://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons.

(a) Describe **three** ways fossils can be made.

_____

_____

_____

_____

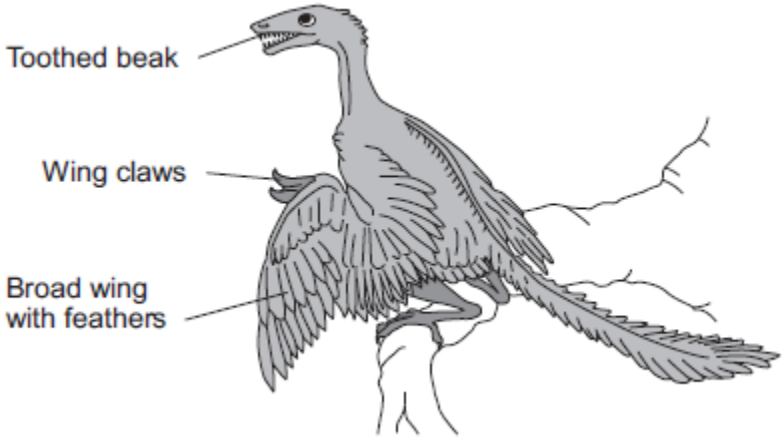
_____

_____

(3)

(b) The drawing shows what an *Archaeopteryx* might have looked like when it was alive.

Scientists think that *Archaeopteryx* was a predator.



(i) Look at the drawing.

Write down **three** adaptations that might have helped *Archaeopteryx* to catch prey.

How would **each** adaptation have helped *Archaeopteryx* to catch prey?

Adaptation 1 _____

How it helps _____

_____

Adaptation 2 _____

How it helps _____

_____

Adaptation 3 _____

How it helps _____

_____

(3)

(ii) *Archaeopteryx* is now extinct.

Give **two** reasons why animals may become extinct.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

1.

(a) salivary gland

1

(b) liver

1

(c) any **four** from:

- merozoites released (from liver) and enter the red blood cells
- (some of these) turn into schizonts
- (which) burst the red blood cells
- releasing (more) merozoites
- coincides with fever attacks.

points credited must be in correct sequence

4

(d) (i) three bases code for one amino acid

1

middle code of CTC is now CAC / T changed to A

1

so will be a different amino acid (in the chain)

1

(and so chain / protein will have a different shape) due to a different sequence of amino acids

1

(ii) correct parental genotypes (both **Aa**)

allow ecf for 2nd and 4th marking points

or correct gametes (**A+a** **A+a**)

allow alternative symbols if defined

1

correct derivation of offspring genotypes from gametes

1

aa identified (homozygous for) SCA

1

0.25

allow 25% or 1 in 4 or 1:3 or 1 / 4

1

(iii) **(Aa)** less likely to get malaria (than homozygous dominant / **AA**)

allow resistance or protection if correctly qualified eg some protection

***do not accept** 'immune'*

1

[15]

2. (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]

3. (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 that **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

*allow other points eg **X** has furrier tail / smaller feet / is furrier*

or

***W** has sharper claws / **W** has larger claws*

1

(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]

4. (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]

5. (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]

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

- trapped / held (since sticky)
- engulfed / covered by resin

  allow engulfed / covered by amber
- prevented decay.

2

(ii) any **two** from:

- animal / plant (dies and) body covered in sediment / mud

  ignore ref to rock

  allow covered in tar / ice
- bones / shells / hard parts do not decay
- minerals enter bones / parts are replaced by other materials / mineralisation
- preserved traces / footprints / burrows / rootlet traces / impressions / casts.

2

(b) (i) New technology provides more valid evidence.

1

(ii) any **three** from:
examples of physical factors, e.g.

accept 3 physical factors or 3 biological factors or some of each for full marks

- flooding
- drought
- ice age / temperature change.

ignore pollution

examples of biological factors, e.g.
- (new) predators (allow hunters)
- (new) disease / named pathogen
- competition for food
- competition for mates

competition must be qualified
- cyclical nature of speciation
- isolation
- lack of habitat or habitat change.

***if no other answers given allow** natural disaster / weather change / catastrophic event / environmental change / climate change for **1** mark*

3

[8]

7. (a) (i) nucleus

correct spelling only

accept mitochondrion

ignore genes / genetic material / chromosomes

1

(ii) base(s)

Accept all four correct names of bases

ignore nucleotides and refs to organic / N-containing

1

(iii) 4

1

(iv) codes for sequence / order of amino acids

ignore references to characteristics

1

codes for a (specific) protein / enzyme

or

the sequence / order of three bases / compounds / letters

codes for a specific amino acid

or

the sequence / order of 3 bases / compounds / letters

codes for the order / sequence of amino acids

1

(b) (i) DNA

1

circular / a ring **or** a vector / described

1

(ii) kills any cells not having **kan^r** gene / so only cells with **kan^r** gene survive

1

hence surviving cells will also contain **Bt** gene / plasmid

1

(iii) cells divide by mitosis

ignore ref to asexual reproduction

correct spelling only

1

genetic information is copied / each cell receives a copy of (all) the gene(s) / all cells produced are genetically identical / form a clone

1

(iv) any **two** from:

- gene may be passed to pathogenic bacteria
- cannot then kill these pathogens with kanamycin
  or
  cannot treat disease with kanamycin
- may need to develop new antibiotics
- gene may get into other organisms
- outcome unpredictable

2

[13]

8. (a) (different / alternative) forms of a gene

*do **not** accept types of genes*

1

(b) genotypes of parents and gametes correct (Man **D** and **d**, Wife **d** and **d**)

*allow half-size genetic diagram with only one **d** from wife*

1

offspring genotypes correct (½ = **Dd** and ½ = **dd**)

allow ecf if parental genotypes are wrong

1

offspring phenotypes correctly assigned to genotypes

1

(c) genotypes of parents and gametes correct (**N** and **n**)

allow ecf if parental genotypes are wrong

1

offspring genotypes correct (**NN**, 2 × **Nn**, and **nn**)

1

offspring phenotypes correctly assigned to genotypes;

1

correct probability = 0.25 / ¼ / 25% / 1 in 4 / 1:3, only;

*do **not** allow '3:1' / '1:4'*

1

[8]

9. (a) any **three** from:

- parts of organisms have not decayed

  accept in amber / resin

  allow bones are preserved
- conditions needed for decay are absent

  accept appropriate examples, eg acidic in bogs / lack of oxygen
- parts of the organism are replaced by other materials as they decay

  accept mineralised
- or other preserved traces of organisms, eg footprints, burrows and rootlet traces

  allow imprint or marking of organism

3

(b) (i) teeth for biting (prey)

must give structure + explanation

1

claws to grip (prey)

accept sensible uses

1

wing / tail for flight to find (prey)

1

(ii) any **two** from:

- new predators
- new diseases
- better competitors
- catastrophe eg volcanic eruption, meteor
- changes to environment over geological time

  accept climate change

  allow change in weather
- prey dies out **or** lack of food

  allow hunted to extinction

2

[8]