



**4.6b Inheritance, Variation
and Evolution**

Foundation / Higher

Name: _____

Class: _____

Date: _____

Time: **291 minutes**

Marks: **290 marks**

Comments:

Q1.

When animals die, bacteria make them decay.
Warmth, moisture and oxygen are needed for this to happen.

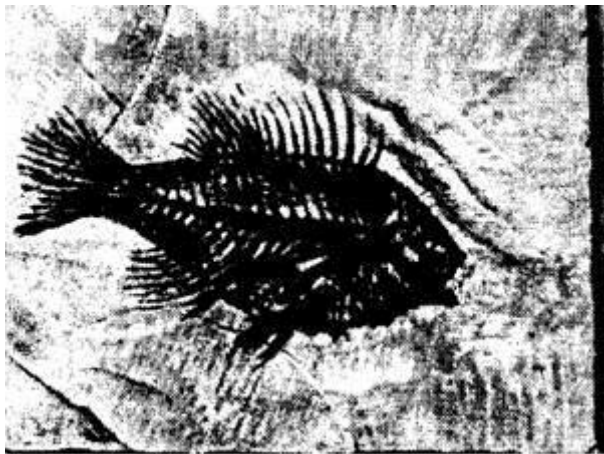
- (a) (i) In northern Russia whole bodies of mammoths have been found in the frozen soils.

Explain why they did not decay.



(1)

- (ii) Fish fossils have been found in mudstone rock. Explain why they did not decay?



(2)

- (b) Some of the mammoths had flint weapons in their bodies.

Suggest **two** things that this tells us about human evolution.

1. _____

2. _____

(2)

- (c) Mammoths are now extinct. Suggest **two** reasons for this.

1. _____

2. _____

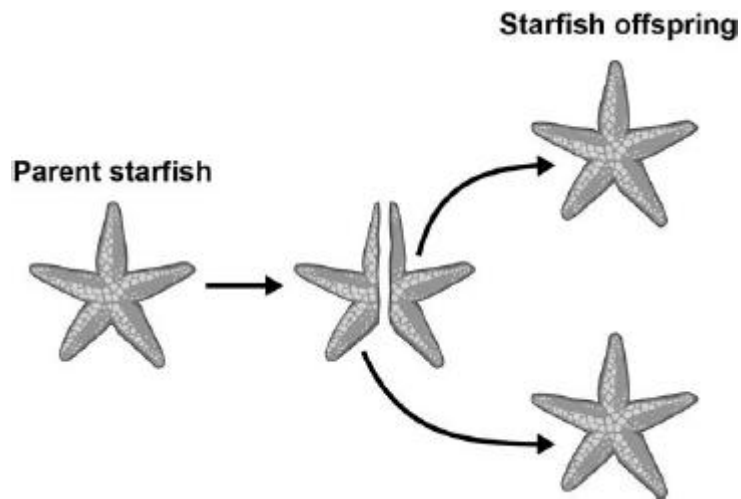
(2)

(Total 7 marks)

Q2.

Starfish can split in half. Each half can then grow new arms to form offspring.

This process is shown in the figure below.



(a) What process produces the starfish offspring?

Tick **one** box.

Asexual reproduction

Fertilisation

Selective breeding

Sexual reproduction

(1)

(b) More cells are produced as the starfish grows more arms.

What process will produce more cells in the starfish as they grow?

(1)

(c) All the offspring produced are genetically identical.

What name is given to genetically identical organisms?

(1)

(d) Each body cell of the parent starfish contains 44 chromosomes.

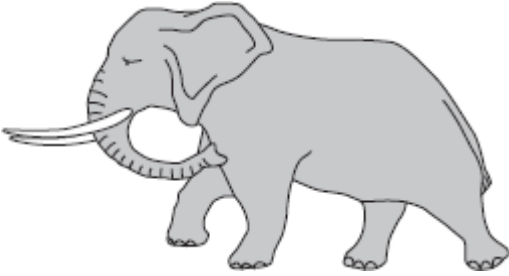
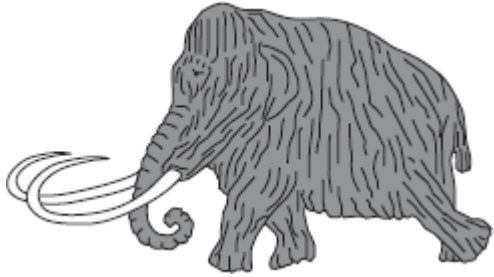
How many chromosomes are in each body cell of the offspring?

(1)

(Total 4 marks)

Q3.

The table gives some information about the African elephant and the woolly mammoth.

African elephant	Woolly mammoth
	
Mass of male: 6000 kg	Mass of male: 8000 kg
Habitat: near the equator	Habitat: northern Europe
An endangered species	Extinct

(a) Use information from the table to help you to answer the following questions.

(i) The diagrams show that both animals have tusks. Tusks help animals to compete.

Suggest **two** things animals may compete for.

1. _____

2. _____

(2)

(ii) The woolly mammoth was adapted to survive during the ice age.

Use information from the table to suggest **two** ways the woolly mammoth was adapted to survive in the cold.

Adaptation 1: _____

How this helped the woolly mammoth survive: _____

Adaptation 2: _____

How this helped the woolly mammoth survive: _____

(4)

- (b) Darwin's theory of evolution says that elephants developed a trunk because animals with a longer nose had an advantage over animals with a shorter nose.

The elephants with a longer nose survived to breed and pass on the gene for a longer nose to their offspring.

- (i) Name the process by which evolution happens.

(1)

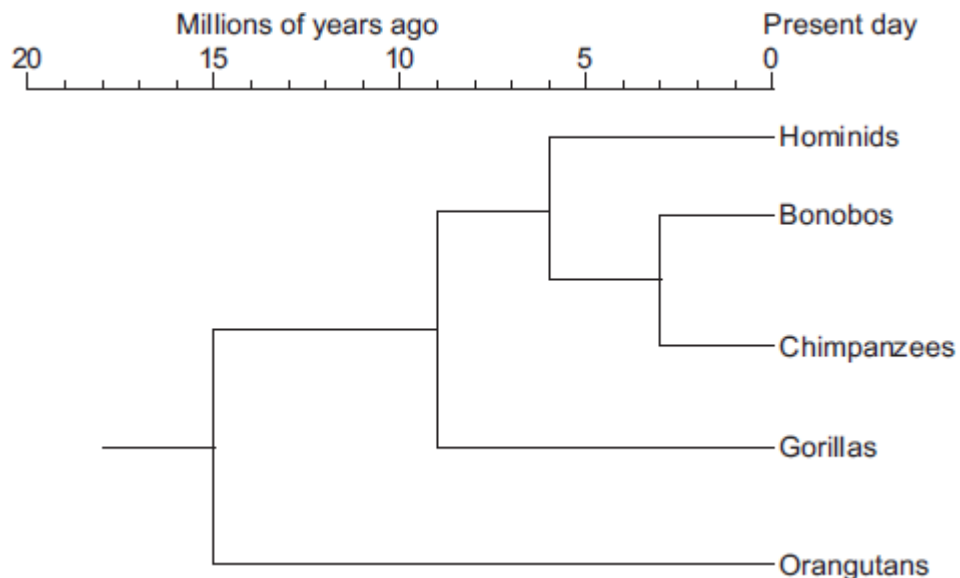
- (ii) Describe how Lamarck's theory would explain how elephants developed a trunk.

(2)

(Total 9 marks)

Q4.

The diagram shows an evolutionary tree for the great apes.



- (a) (i) How many years after gorillas did hominids evolve?

_____ millions of years

(1)

- (ii) Which animal in the diagram is the most distant relative of chimpanzees?

(1)

(b) Charles Darwin is well known for his theory of evolution.

Complete the sentence.

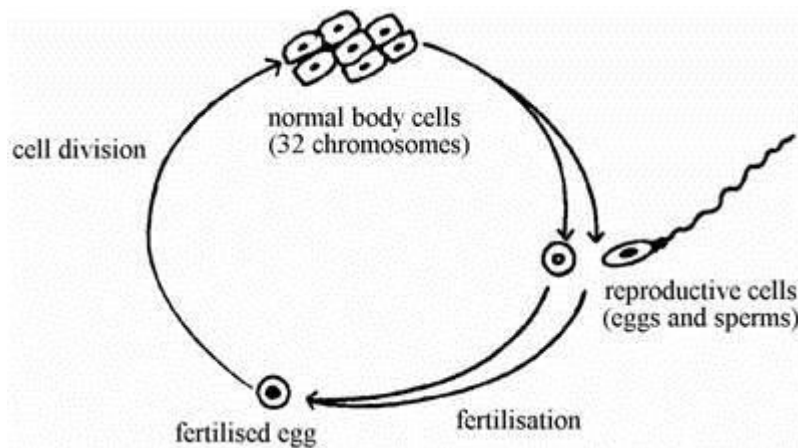
Darwin's theory states that evolution happens by a process called

(1)

(Total 3 marks)

Q5.

The diagram shows three types of cells in a life history of a simple animal.



(a) How do the chromosomes of the body cells compare with the chromosomes in the fertilised egg from which they came?

(1)

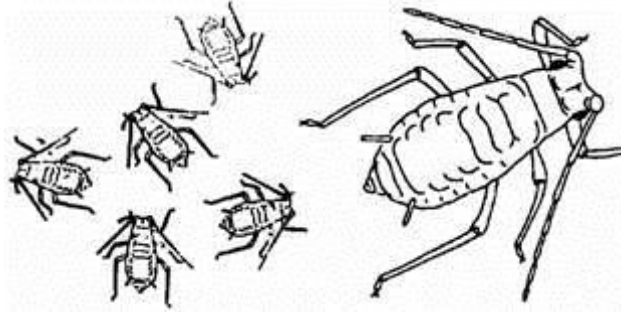
(b) Describe what happens to chromosomes in the nucleus of a body cell when it forms reproductive cells.

(4)

(Total 5 marks)

Q6.

The bean aphid is a type of black-fly which lives on broad bean plants in summer. In the autumn, males and females mate and produce eggs.



- (a) Name the type of reproduction which produces the eggs.

_____ (1)

- (b) In spring these eggs hatch. The young aphids are all female.
Explain why they are all similar but not identical to each other.

_____ (1)

- (c) These females are then able to produce offspring without needing any males.

- (i) Name the type of reproduction where females do **not** need males to produce offspring.

_____ (1)

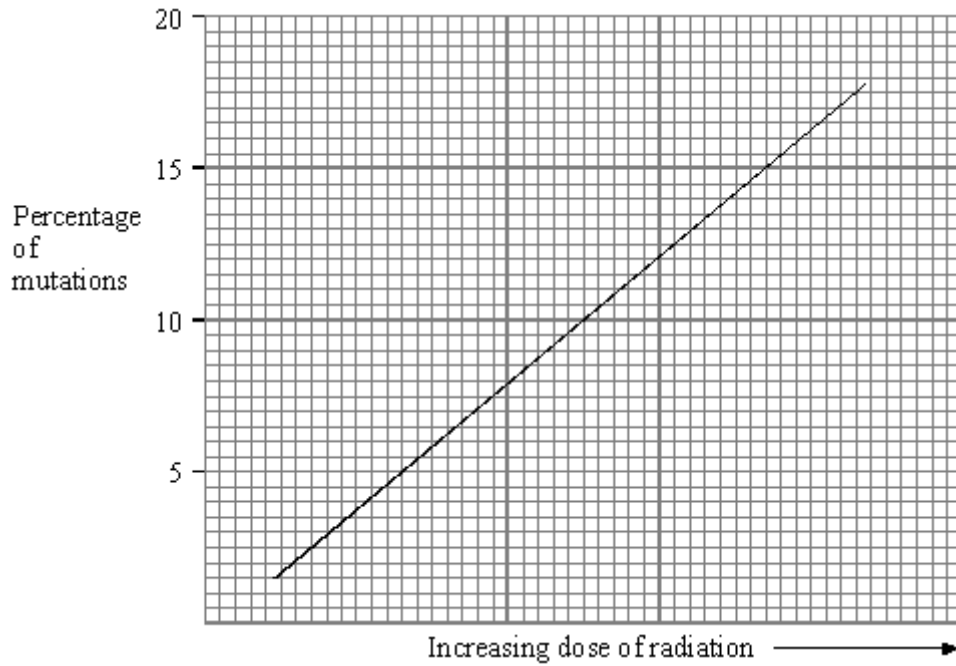
- (ii) How will the offspring from one of these females:

A compare with each other

B compare with the offspring from other females?

_____ (2)

- (d) Some scientists investigated mutations in these aphids. They exposed the aphids to X-rays.
They plotted their results.



- (i) What was the connection between the dose of X-rays and the percentage of mutations?

(1)

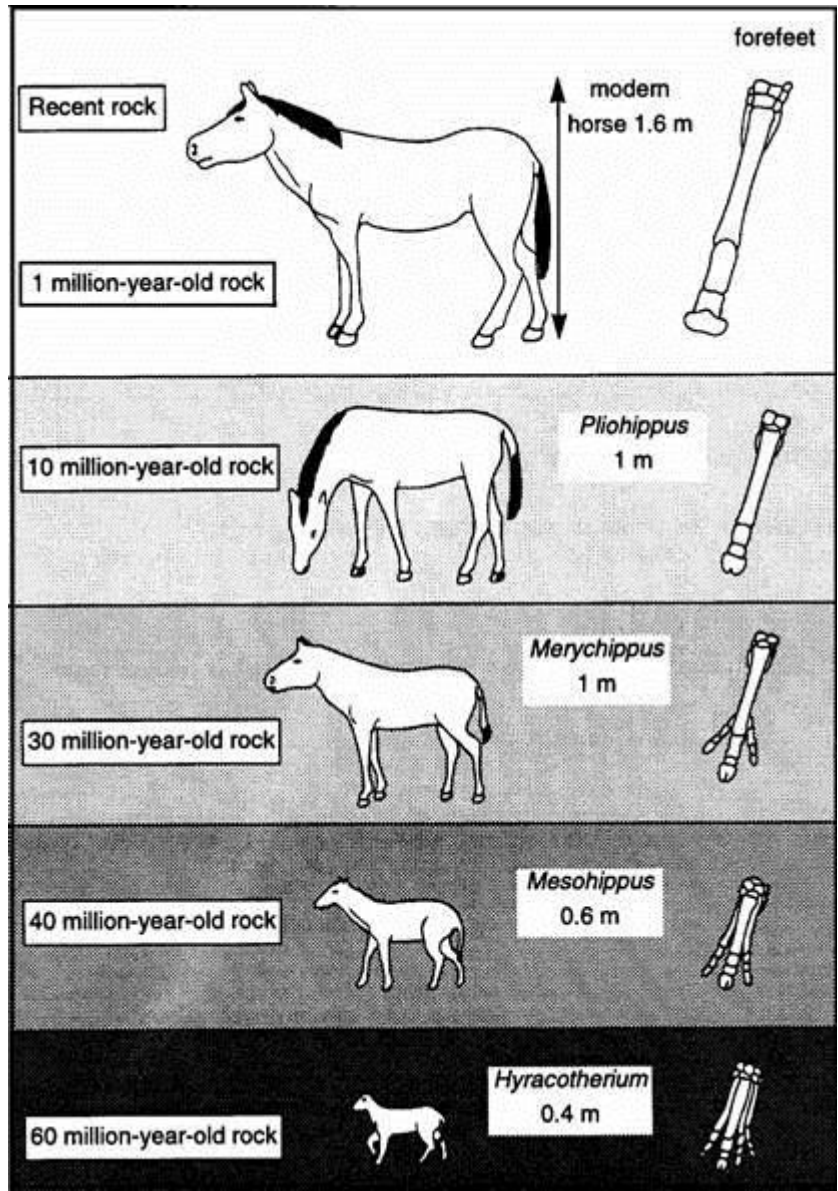
- (ii) Name **one** other possible cause of mutations.

(1)

(Total 7 marks)

Q7.

The diagrams show fossil animals found in rocks of different ages. Scientists have used this information to work out how the modern horse evolved.



(a) *Mesohippus* became extinct over thirty million years ago. Use information from the diagrams to suggest **two** reasons why this happened.

1. _____

2. _____

(2)

(b) (i) How do scientists know how big these early horses were?

(1)

(ii) How do scientists know when they lived?

(1)

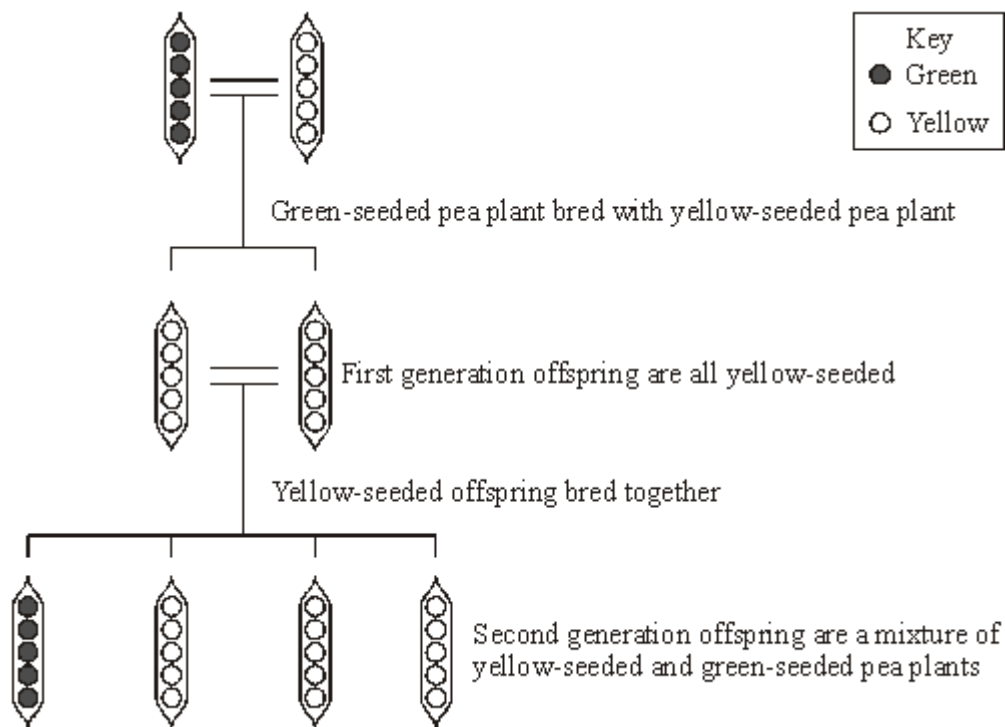
(c) Explain how the information in the diagrams supports the theory of evolution.

(3)

(Total 7 marks)

Q8.

The diagram shows one of the experiments performed by a scientist called Mendel in the 1850s. He bred pea plants which had different coloured pea seeds.



(a) Use words from the box to help you to explain the results of this experiment.

dominant	factor	recessive
----------	--------	-----------

(3)

(b) Mendel explained these results in terms of *inherited factors*.

(i) What do we now call *inherited factors*?

(1)

(ii) Where, in a cell, are these *inherited factors* found?

(1)

(Total 5 marks)

Q9.

A particular species of snail has a shell which may be pink, yellow or brown. It may also be plain or have bands running round it.

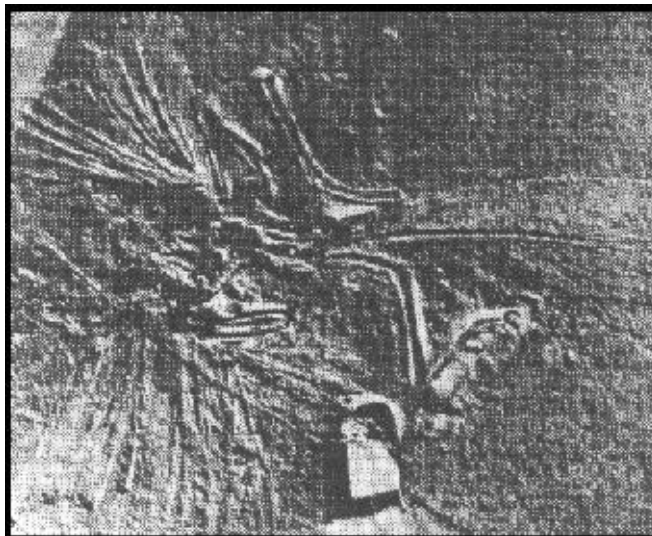
The snails are eaten by song thrushes.

Explain why snails with plain brown shells are the most common in hedgerows.

(Total 4 marks)

Q10.

The picture shows a fossil.



(a) (i) What is a fossil?

(3)

(ii) Describe **one** way in which fossils are formed.

(2)

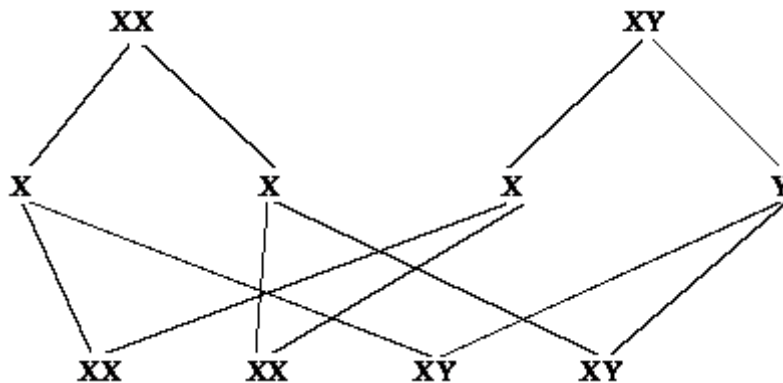
(b) We only know about extinct animals and plants because they have left fossils. What does the word "extinct" mean?

(1)

(Total 6 marks)

Q11.

The genetic diagram shows how the chromosomes divide and combine in human reproduction.



(a) Draw circles around the symbols for the **two** male gametes.

(2)

(b) State the chance of a child being a girl.

(1)

(c) (i) How many pairs of chromosomes are there in a human body cell?

(1)

(ii) How many chromosomes are there in a human egg cell?

(1)

(d) Chromosomes contain genes. From what substance are genes made?

(1)

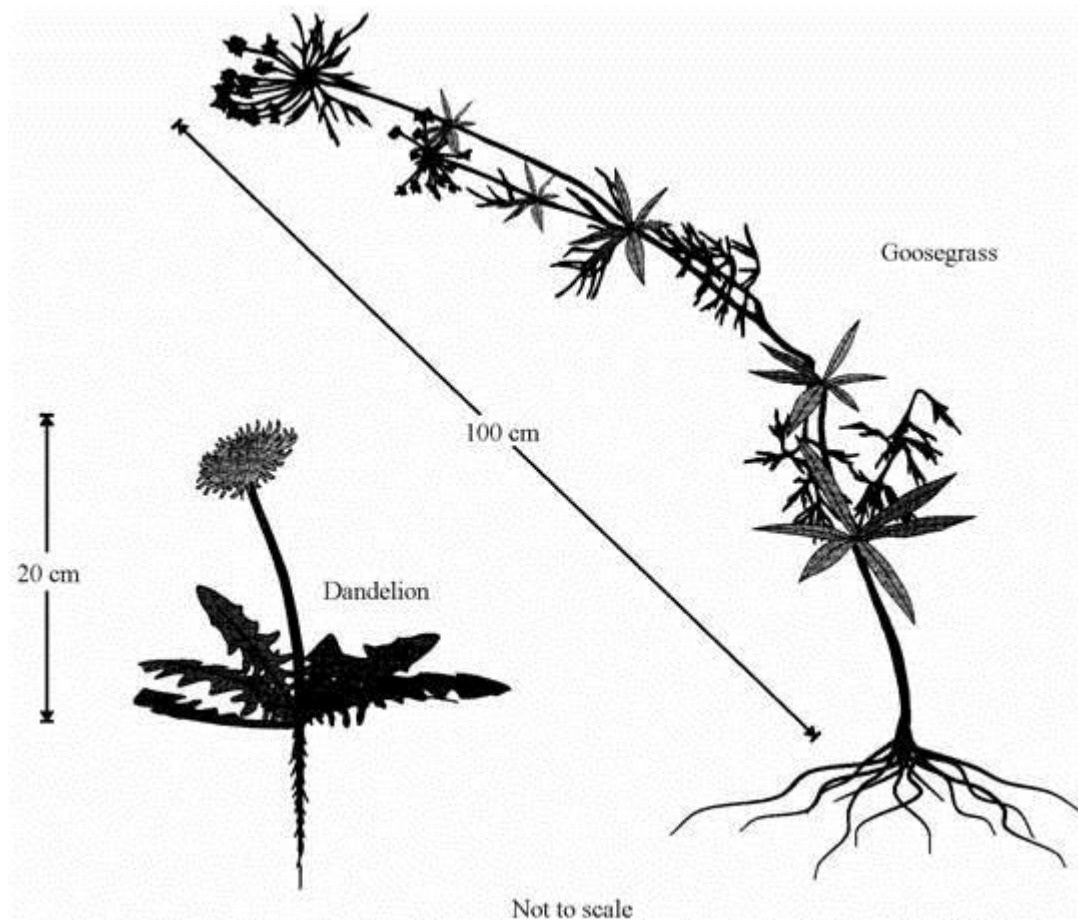
(e) In the process of mitosis, how do the number of chromosomes in the daughter cells compare to that in the original cell?

(1)

(Total 7 marks)

Q12.

Dandelions have become adapted to live in lawns and grass areas where animals graze. Goosegrass, however, has become adapted to live alongside hedgerows and cannot survive being mown.



(a) Use the information in the drawings to suggest **one** advantage of each of the following adaptations.

(i) Dandelion leaves lie flat on the ground.

(1)

(ii) A dandelion has a thick tapered root.

(1)

(iii) Goosegrass stems are long.

(1)

(iv) Goosegrass roots are thin and very long.

(1)

(b) Dandelions and goosegrass are different species of plants.

(i) What name is given to the unit of inheritance which controls one particular characteristic of a plant or animal?

(1)

(ii) Why would you be unlikely to succeed if you tried to breed a new species of plant by crossing a dandelion with goosegrass?

(1)

(c) Animals as well as plants have become adapted to live in different environments.

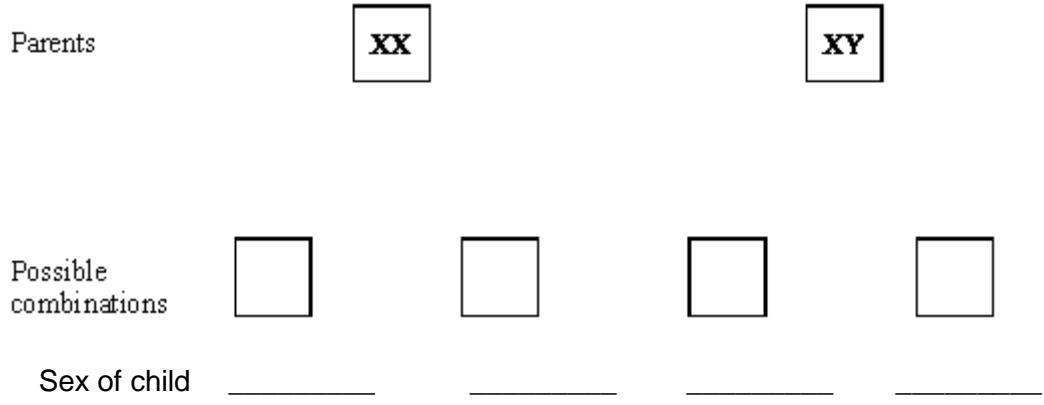
State **one** way a polar bear has become adapted to living in the Arctic, and the reason for the adaptation.

(2)

(Total 8 marks)

Q13.

(a) (i) Complete the genetic diagram to show the possible combinations of gametes for the four children and state the sex of the child for each combination.



(1)

(ii) What name is given to the process when a cell divides to produce gametes?

(1)

(iii) How many pairs of chromosomes are there in each human body cell?

(1)

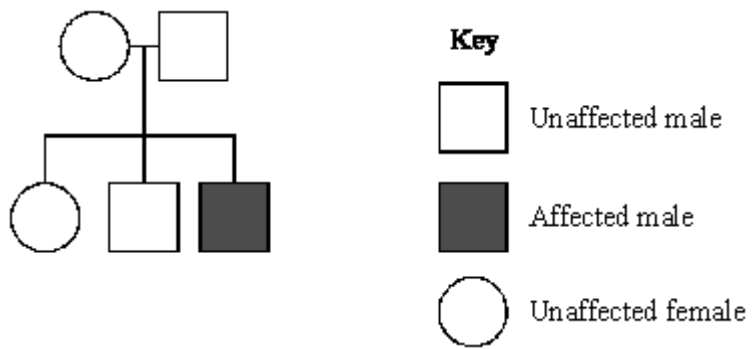
(iv) How many chromosomes are present in a human ovum?

(1)

(b) (i) Give **two** advantages to living things of reproducing sexually rather than asexually.

(2)

(ii) The genetic diagram shows two parents and three children.



Only the son has cystic fibrosis, which is caused by a recessive allele. What conclusion may be made about the parents' genes?

(1)

Q14.

Read the passage about antibiotics.

People do not always agree about the use of antibiotics in food production.

If we put low doses of antibiotics in feed for animals such as cattle and sheep, it helps to produce high-quality, low-cost food. Antibiotics help to keep animals disease-free. They also help animals to grow. Animals get fatter quicker because they do not waste energy trying to overcome illness.

The use of antibiotics in livestock feed means that there is a higher risk of antibiotic-resistant bacteria developing. The rapid reproduction of bacteria means there is always a chance that a population of bacteria will develop which is antibiotic-resistant. These could be dangerous to human health.

- (a) *To gain full marks for this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

Explain how a population of antibiotic-resistant bacteria might develop from non-resistant bacteria.

(3)

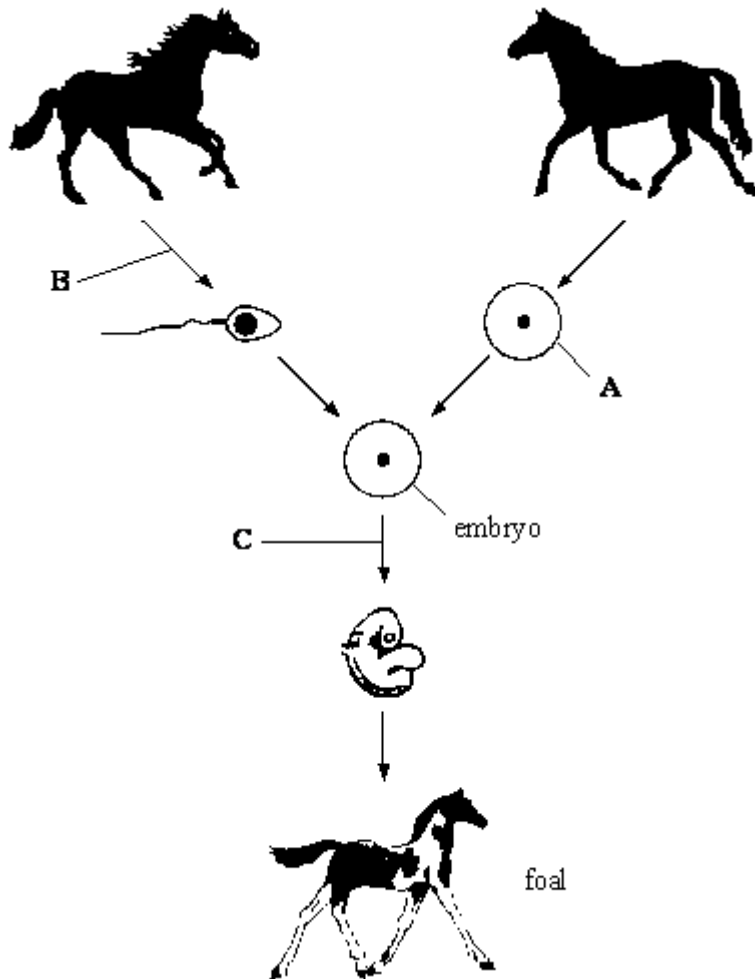
- (b) Do you think that farmers should be allowed to put low doses of antibiotics in animal feed? Explain the reasons for your answer.

(2)

(Total 5 marks)

Q15.

The drawing shows some of the stages of reproduction in horses.

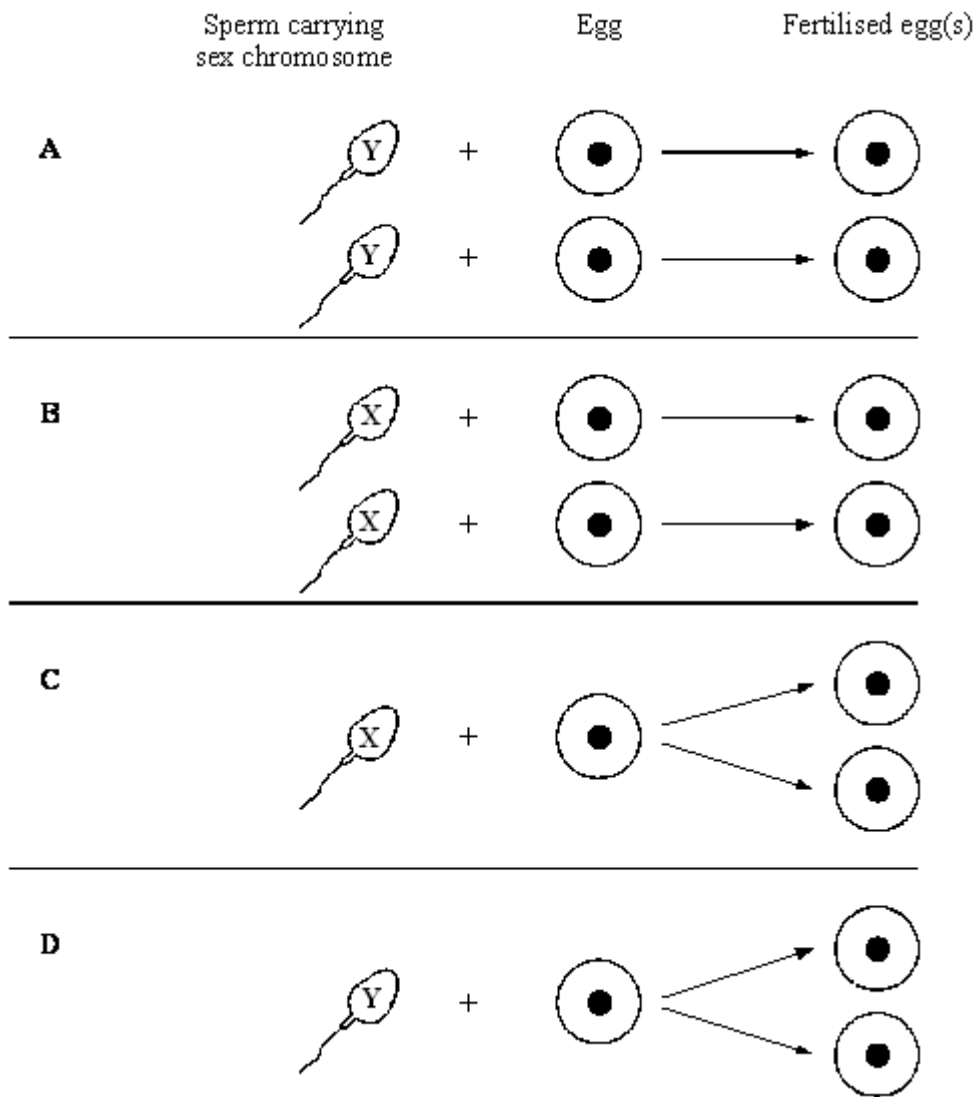


- (a) (i) Name this type of reproduction _____ (1)
- (ii) Name the type of cell labelled **A** _____ (1)
- (b) Name the type of cell division taking place at the stage labelled:
- (i) **B** _____
- (ii) **C** _____ (2)
- (c) How does the number of chromosomes in each cell of the embryo compare with the number of chromosomes in cell **A**?
- _____ (1)
- (d) When the foal grows up it will look similar to its parents but it will **not** be identical to either parent.
- (i) Explain why it will look similar to its parents.
- _____
- _____ (1)
- (ii) Explain why it will **not** be identical to either of its parents.

(2)
(Total 8 marks)

Q16.

The diagrams show four ways in which human twins may be formed.



Which diagram, **A**, **B**, **C** or **D**, shows the process which will produce genetically identical twin boys?

Explain the reason for your choice.

Q17.

This couple has just found out that the woman is pregnant. They wonder whether the child will be a boy or a girl.



Sex chromosomes

Sex chromosomes

(a) Fill in the boxes to show the sex chromosomes of the woman and the man.

(2)

(b) The couple already has one girl. What is the chance that the new baby will be another girl?

Explain the reason for your answer. You may use a genetic diagram if you wish.

Q18.

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

alleles chromosomes gametes genes mutations

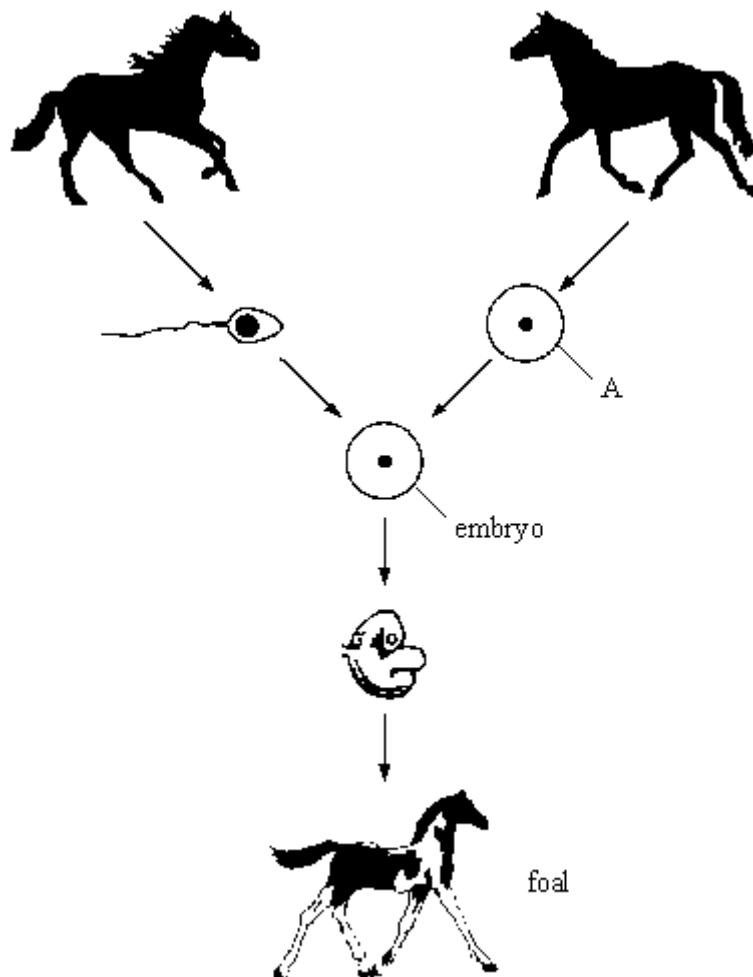
The nucleus of a cell contains thread-like structures called _____ .

The characteristics of a person are controlled by _____

which may exist in different forms called _____ .

(3)

- (b) The drawing shows some of the stages of reproduction in horses.



- (i) Name this type of reproduction _____

(1)

- (ii) Name the type of cell labelled **A** _____

(1)

- (c) When the foal grows up it will look similar to its parents but it will **not** be identical to either parent.

- (i) Explain why it will look similar to its parents.

(1)

(ii) Explain why it will **not** be identical to either of its parents.

(2)

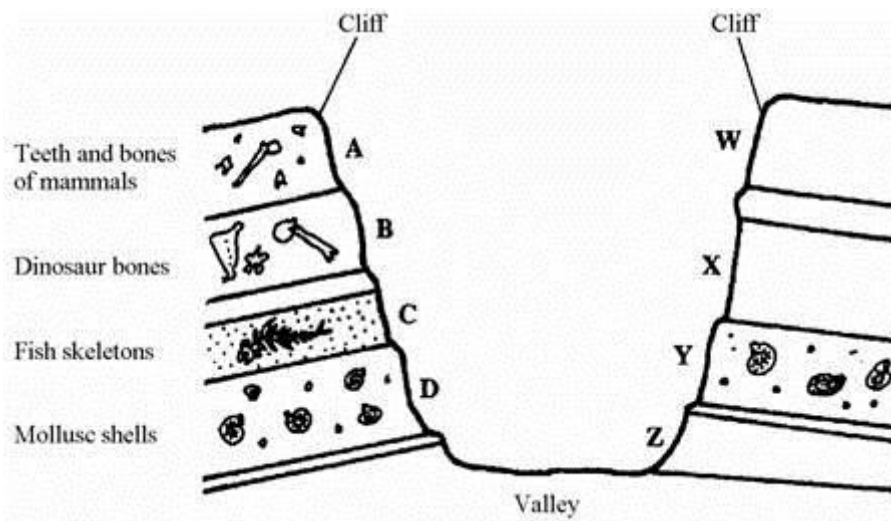
(Total 8 marks)

Q19.

The drawing shows some of the fossils found in the layers of rock in two cliffs.

The two cliffs are on opposite sides of a large valley.

Geologists think that the valley has been carved out by rivers, and that the order of rock layers has not changed.



(a) (i) Which of the rock layers, **A**, **B**, **C** or **D**, is the oldest? _____

(1)

(ii) Give the letters of **two** layers of rock on opposite sides of the valley that are the same age.

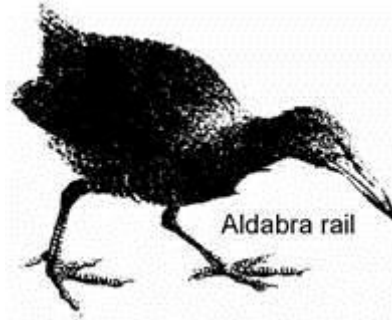
_____ and _____

(1)

(b) How do fossils provide evidence for the theory of evolution?

Q20.

Flightless birds called Rails once inhabited 20 islands in the Pacific Ocean. During the last two centuries they have disappeared from 15 of these islands. The Aldabra Rail, shown below, is one of the few survivors. The island which it lives on is very remote.



Suggest **three** reasons why Rails have disappeared from 15 of the 20 islands they once inhabited.

1. _____

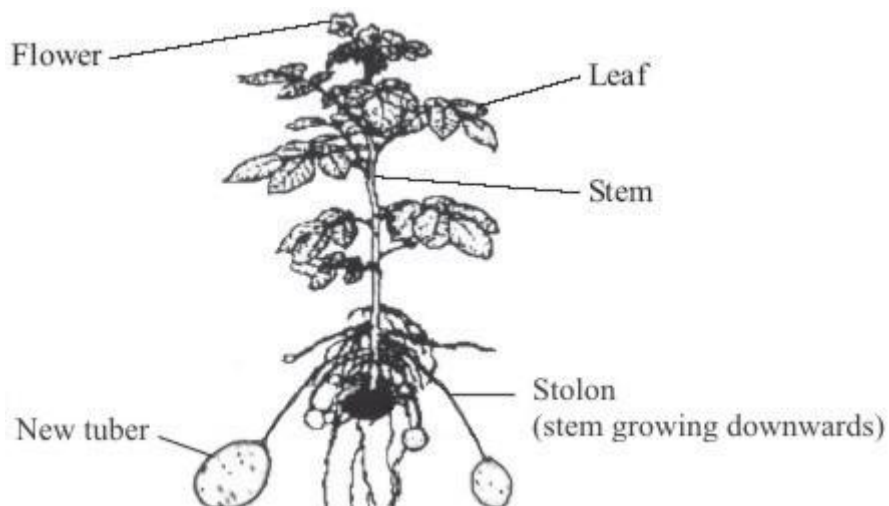
2. _____

3. _____

(Total 3 marks)

Q21.

The drawing shows a potato plant producing new tubers (potatoes). Buds on the stem of the parent plant produce stolons. The new tubers are formed at the ends of the stolons (stems that grow downwards).



- (a) Explain why the new tubers are genetically identical to each other.

(2)

(b) Some of the tubers are used to produce potato plants. These new potato plants will not all grow to the same height.

Give **one** reason why.

(1)

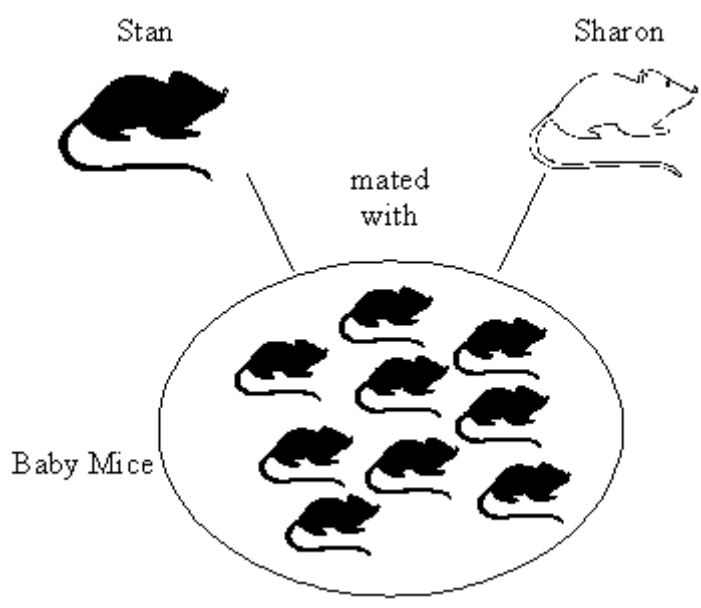
(Total 3 marks)

Q22.

A student's hobby was breeding pet mice. Three of the pet mice were called Stan, Tom and Sharon. Stan and Tom had black fur. Sharon had white fur.

The colour of the fur is controlled by a single gene which has two alleles B and b.

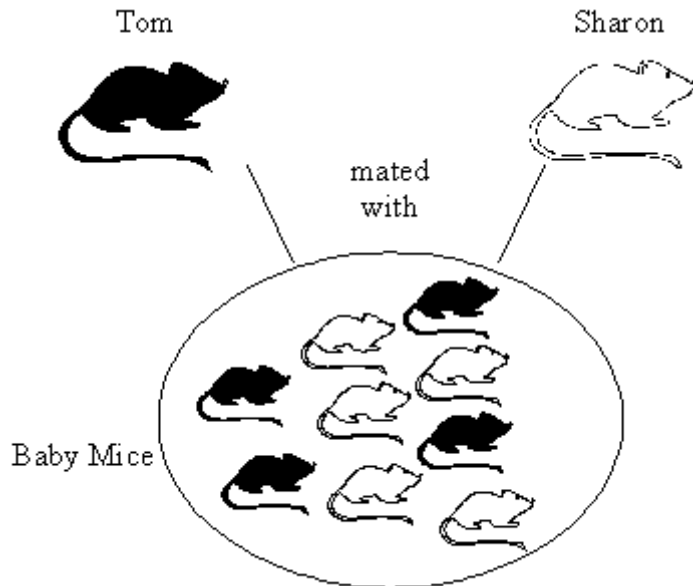
(a) The student first crossed Stan with Sharon. The results are shown on the diagram.



Explain why the baby mice produced by crossing Stan and Sharon all had black fur. You may use a genetic diagram if you wish.

(3)

(b) The student then crossed Tom with Sharon. The results are shown on the diagram.



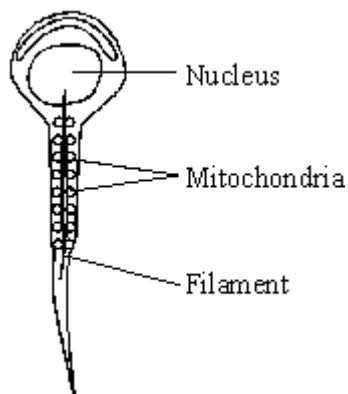
When Tom was crossed with Sharon, some of the baby mice had black fur and some white.

Explain why. You may use a genetic diagram if you wish.

(3)
(Total 6 marks)

Q23.

The diagram shows a human sperm. Inside the tail of the sperm is a filament mechanism that causes the side to side movement of the tail, which moves the sperm.



- (a) Describe the function of the mitochondria and suggest a reason why they are arranged around the filament near the tail of the sperm.

(3)

- (b) Explain the significance of the nucleus in determining the characteristics of the offspring.

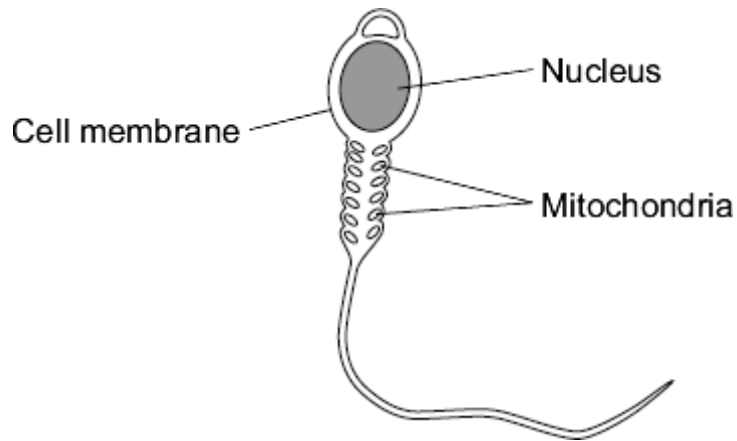
(2)

(Total 5 marks)

Q24.

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.

(2)

(Total 4 marks)

Q25.

- (a) (i) Some diseases can be tackled by using antibiotics and vaccination. Explain fully why antibiotics cannot be used to cure viral diseases.

(2)

- (ii) A recent study found that babies in 90 % of hospitals are infected with the MRSA bacterium.

Explain how the MRSA bacterium has developed resistance to antibiotics.

(2)

- (b) A person can be immunised against a disease by injecting them with an inactive form of a pathogen.

Explain how this makes the person immune to the disease.

(3)

(Total 7 marks)

Q26.

Doctors give antibiotics to patients to kill bacteria in their bodies.

Explain how the overuse of antibiotics has led to the evolution of antibiotic-resistant

bacteria.

To gain full marks in this question you should write your ideas in good English.
Put them into a sensible order and use the correct scientific words.

(Total 3 marks)

Q27.

Cystic fibrosis is an inherited disorder that can seriously affect health.

- (a) Which **one** of these is affected by cystic fibrosis?

Draw a ring around your answer.

blood

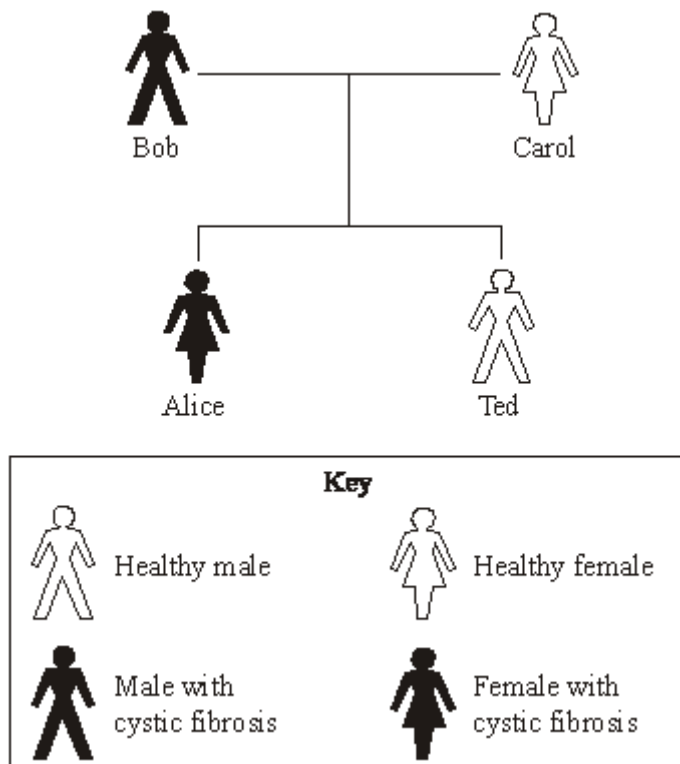
cell membranes

kidneys

nervous system

(1)

- (b) The diagram shows the inheritance of cystic fibrosis in a family. The allele that produces cystic fibrosis is recessive.



- (i) Explain why Alice inherited cystic fibrosis.

(2)

(ii) Explain why Ted did **not** inherit cystic fibrosis.

(2)

(c) Bob and Carol know that there is a risk that their next baby will have cystic fibrosis.

Embryos can be screened for the allele that produces cystic fibrosis.

Many people support the screening of embryos, but others do not.

(i) Suggest **one** reason why many people support the screening of embryos for the cystic fibrosis allele.

(1)

(ii) Suggest **one** reason why many people are against the screening of embryos for the cystic fibrosis allele.

(1)

(Total 7 marks)

Q28.

MRSA strains of bacteria are causing problems in many hospitals.

(a) The diagram shows a hand-gel dispenser.



Hand-gel dispensers are now placed at the entrance of most hospital wards.

Explain why.

(2)

(b) Explain, as fully as you can, how MRSA strains of bacteria became difficult to treat.

(3)

(Total 5 marks)

Q29.

An animal called *Tiktaalik* became extinct about 360 million years ago.

The photograph shows the fossilised skeleton of *Tiktaalik* and a model of what scientists think *Tiktaalik* looked like.

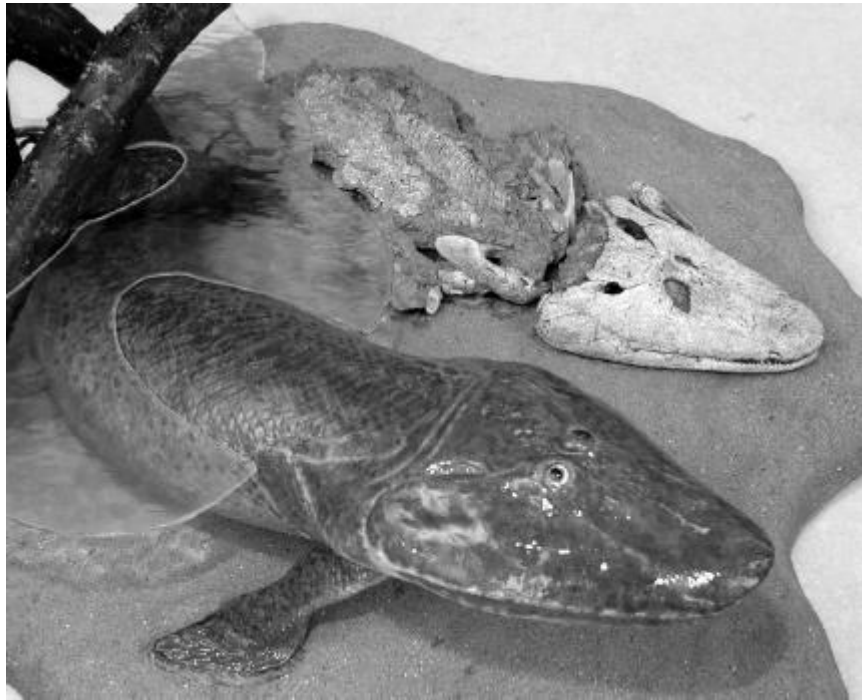


Image © University of Chicago, Shubin Lab. Model by Tyler Keillor

- (a) Scientists found only the fossilised skeleton of *Tiktaalik*.

Explain why.

(2)

- (b) Scientists think that *Tiktaalik* lived mostly in water, but that it was one of the first animals to be able to move onto land.

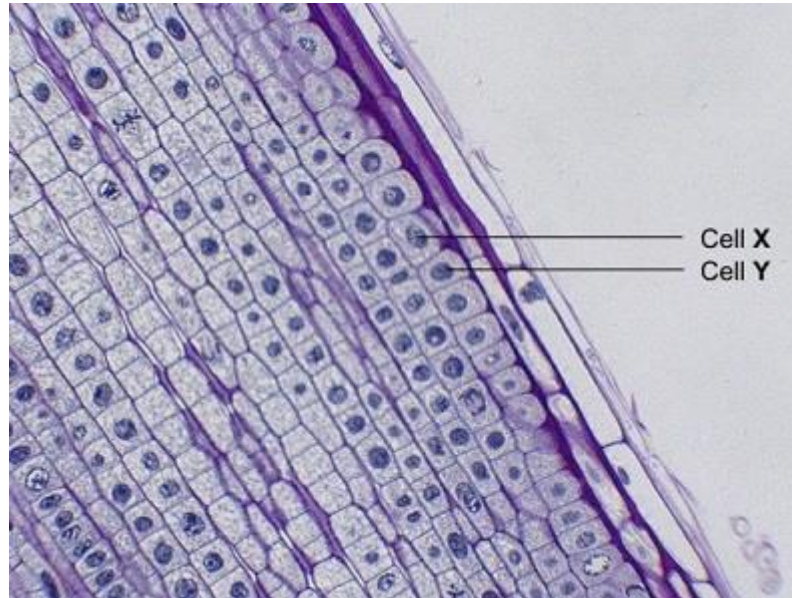
Use evidence from the photograph to suggest why.

(2)

(Total 4 marks)

Q30.

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.

(3)

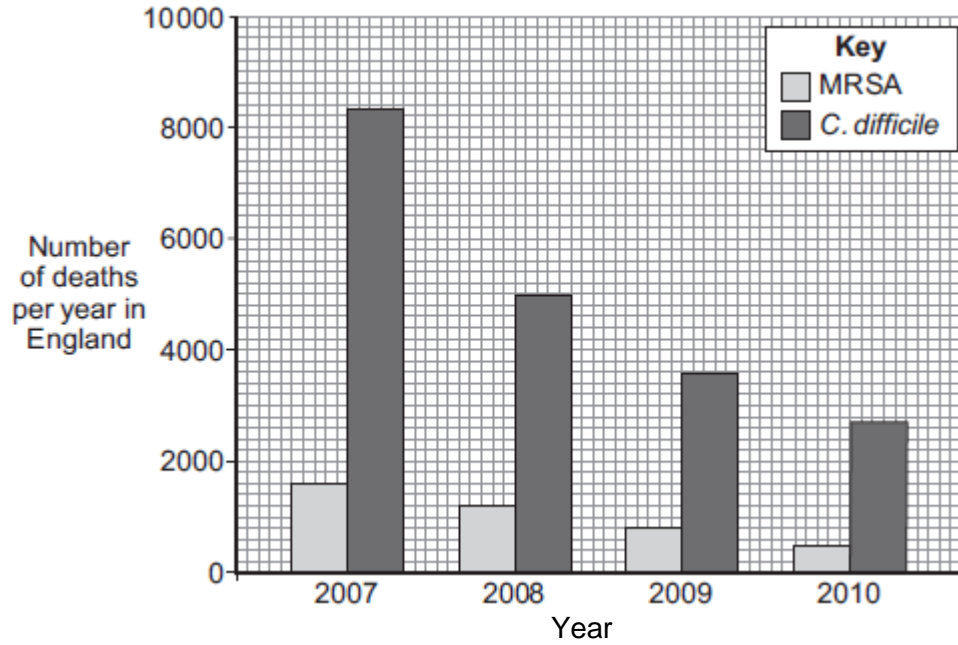
(Total 5 marks)

Q31.

Infections by antibiotic resistant bacteria cause many deaths.

The bar chart below shows information about the number of deaths per year in England

from *Methicillin-resistant Staphylococcus aureus* (MRSA) and from *Clostridium difficile* (*C.difficile*) over 4 years.



(a) (i) Describe the trend for deaths caused by *C.difficile*.

(2)

(ii) Suggest a reason for the trend you have described in part (a)(i).

Explain your answer.

(2)

(iii) Calculate the percentage change in deaths caused by MRSA from 2009 to 2010.

Percentage change in deaths caused by MRSA = _____ %

(2)

(iv) Numbers have not yet been published for 2011.

When the numbers are published, scientists do **not** expect to see such a large percentage change from 2010 to 2011 as the one you have calculated for 2009 to 2010.

Suggest **one** reason why.

(1)

- (b) Before 2007 there was a rapid increase in the number of deaths caused by MRSA.

Describe how the overuse of the antibiotic methicillin led to this increase.

(3)

(Total 10 marks)

Q32.

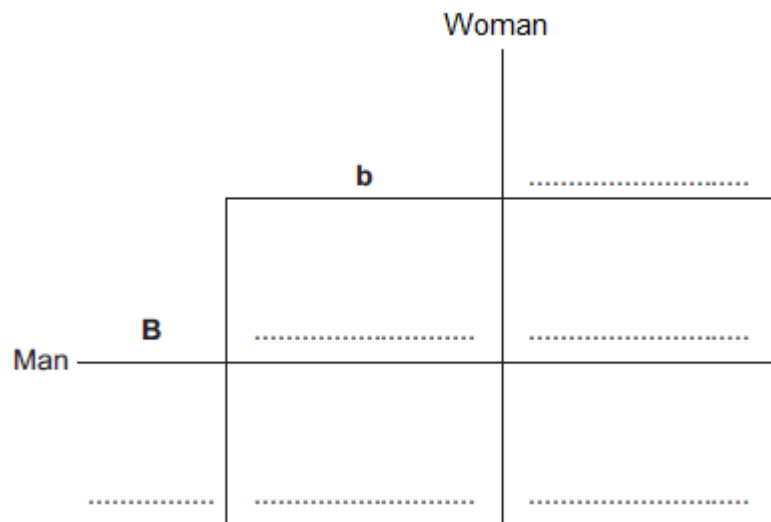
Eye colour is controlled by genes.

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.

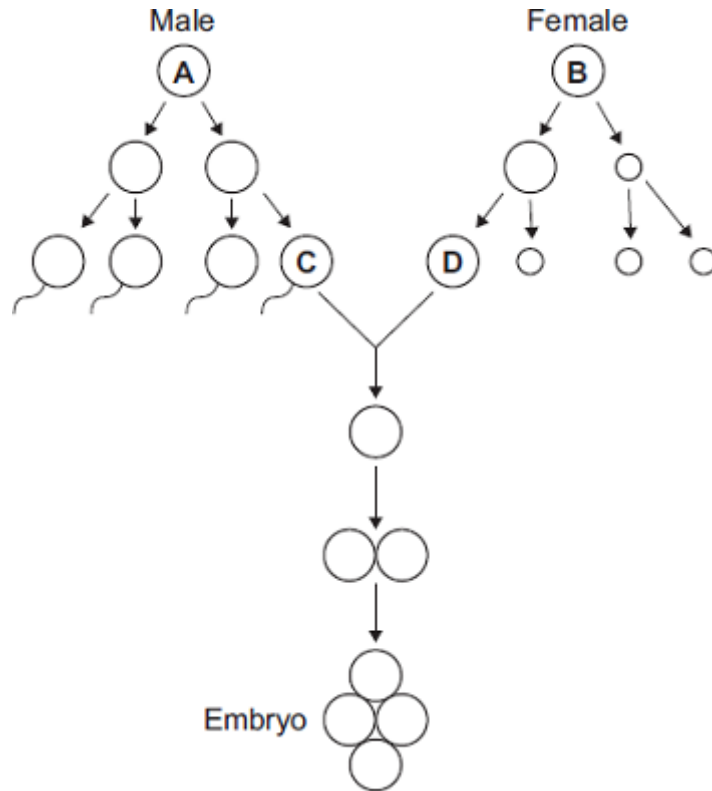
Use a genetic diagram to show how two of their children came to have blue eyes.

(3)

(Total 6 marks)

Q33.

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)

Q34.

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.

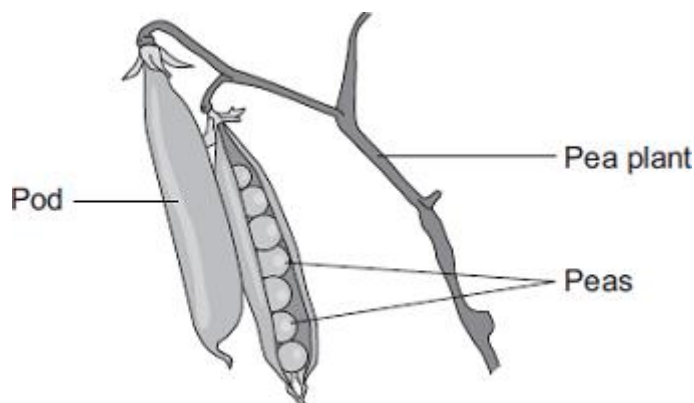
Some scientists are concerned that the gene for kanamycin resistance has been put into maize.

Suggest why.

(2)
(Total 13 marks)

Q35.

Peas grow in pods on pea plants.



A gardener grew four varieties of pea plants, **A**, **B**, **C** and **D**, in his garden. The gardener counted the number of peas in each pod growing on each plant.

The table shows his results.

Variety	Range of number of peas in each pod	Mean number of peas in each pod
A	2–6	4
B	3–7	5
C	3–8	6
D	6–8	7

- (a) Give **one** environmental factor and **one other** factor that might affect the number of peas in a pod.

Environmental factor _____

Other factor _____

(2)

- (b) The gardener thinks that he will get the largest mass of peas from his garden if he grows variety **D**.

Why is the gardener **not** correct?

Suggest **one** reason.

(1)

- (c) It is important that carbon is cycled through living things.

After he has picked the peas, the gardener puts the dead pea plants onto a compost heap.

Over the next few months, the carbon in the carbon compounds from the pea plants is returned to the air.

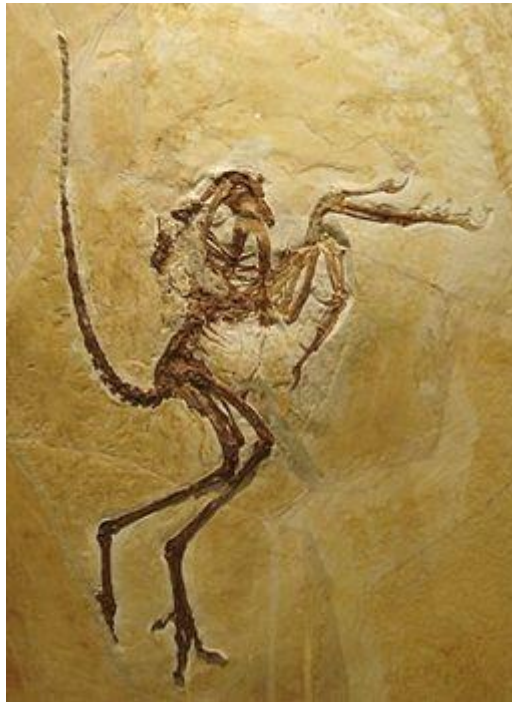
Describe how.

(4)

(Total 7 marks)

Q36.

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



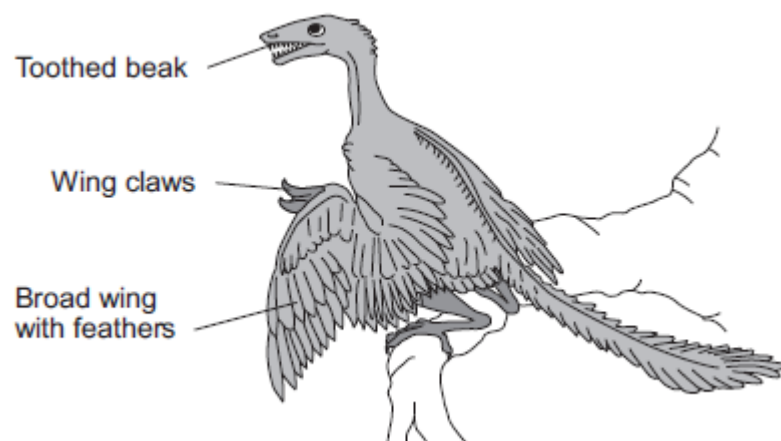
By Ghedoghedo (own work) [CC-BY-SA-3.0 (<http://creativecommons.org/licenses/by-sa/3.0>) or GFDL (<http://www.gnu.org/copyleft/fdl.html>)], via Wikimedia Commons; By Steenberg from Ripon, United Kingdom (Small Fishing Boat In North Sea) [CC-BY-2.0 (<http://creativecommons.org/licenses/by/2.0>)], via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

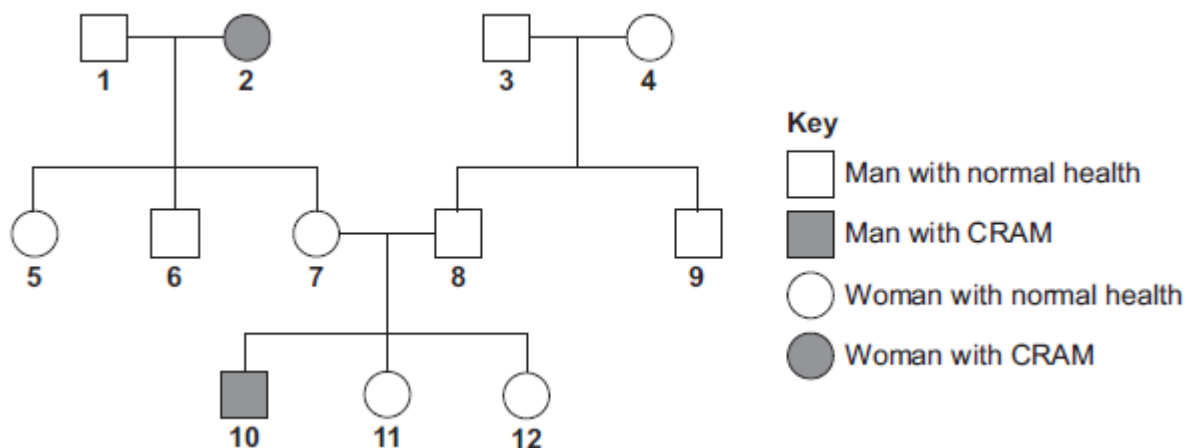
(Total 8 marks)

Q37.

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.

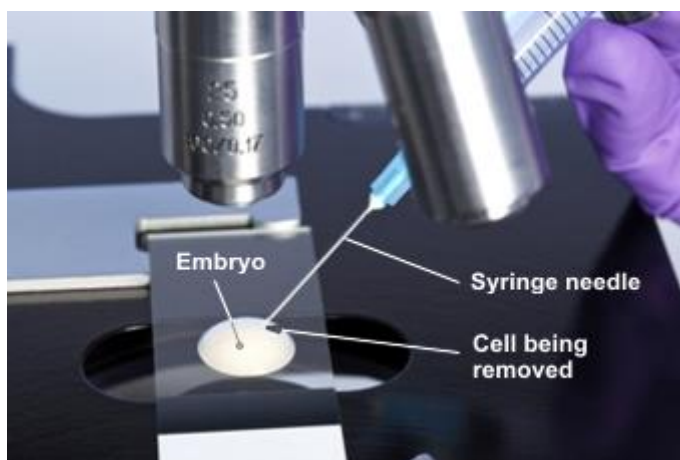
Two ways of doing this are:

- 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.

(5)

(Total 15 marks)

Q38.

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.

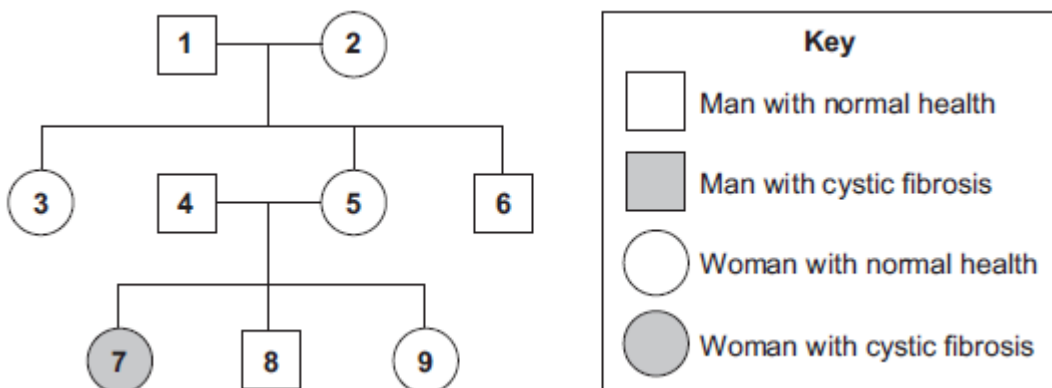


© Adem Demir/Hemera.

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)

Q39.

Moose are animals that eat grass.

Figure 1 shows a moose.

Figure 1



© Wildnerdpix/iStock/Thinkstock

Figure 2 shows a food chain.

Figure 2

Grass → Moose → Wolves

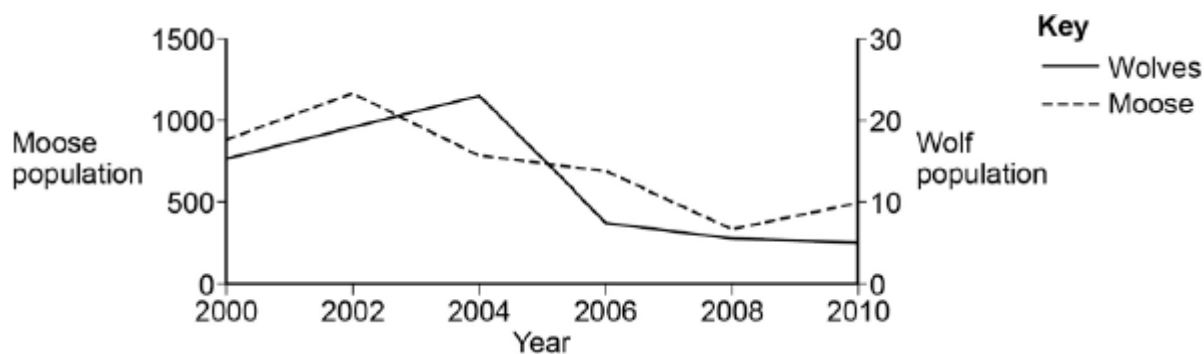
- (a) Name the secondary consumer shown in **Figure 2**.

(1)

- (b) **Figure 3** shows how the moose population and wolf population have changed in one area.

This is a predator-prey cycle.

Figure 3



In 2004 the line on **Figure 3** for wolves is above the line for moose.

How does **Figure 3** show that there are more moose than wolves in 2004?

(1)

- (c) Suggest why the moose population decreased between 2002 and 2004.

Use information from **Figure 3**.

(1)

- (d) The number of wolves is one biotic factor that could affect the size of the moose population.

Give **two** other biotic factors that could affect the size of the moose population.

1. _____

2. _____

(2)

- (e) Moose have distinct characteristics such as antlers.

Describe how moose may have evolved to have large antlers.

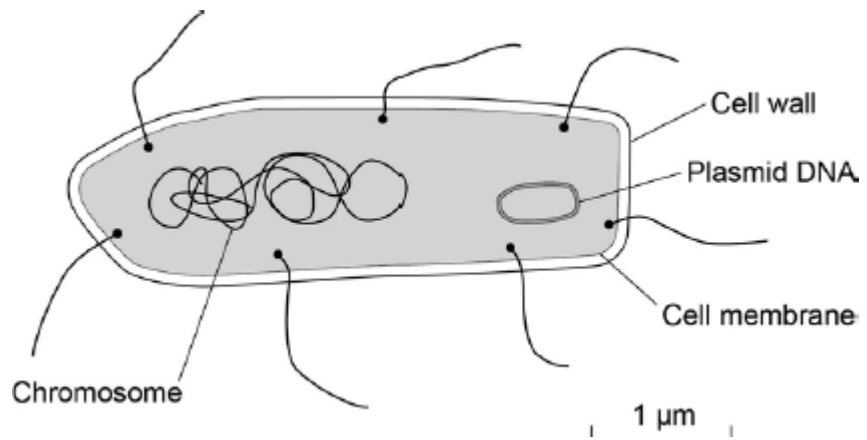
(5)
(Total 10 marks)

Q40.

Bacteria can cause disease.

Figure 1 shows some features of a *Salmonella* bacterium.

Figure 1



(a) Draw **one** line from each feature of the *Salmonella* bacterium to the function.

Feature	Function
Cell membrane	Controls the movement of substances into and out of the cell
Plasmid DNA	Carries genetic information
	Provides support and protection

The site of protein synthesis

(2)

(b) How is *Salmonella* spread between people?

Tick **one** box.

Animal bites

Contaminated food

Sneezing

Sexual contact

(1)

(c) Give **two** ways you could stop *Salmonella* from spreading.

1. _____

2. _____

(2)

(d) Harmful bacteria can also be useful.

Scientists are doing research to find out if *Salmonella* can be used in a vaccine to treat cancer.

The *Salmonella* vaccine can be injected into the blood or swallowed in a tablet.

One benefit of injecting the vaccine is that it gets to the cancer quickly in the blood.

What is another benefit?

Tick **one** box.

All cancers can be treated by the injection

It will not cause sickness and diarrhoea side effects

The injection is not painful to the patient

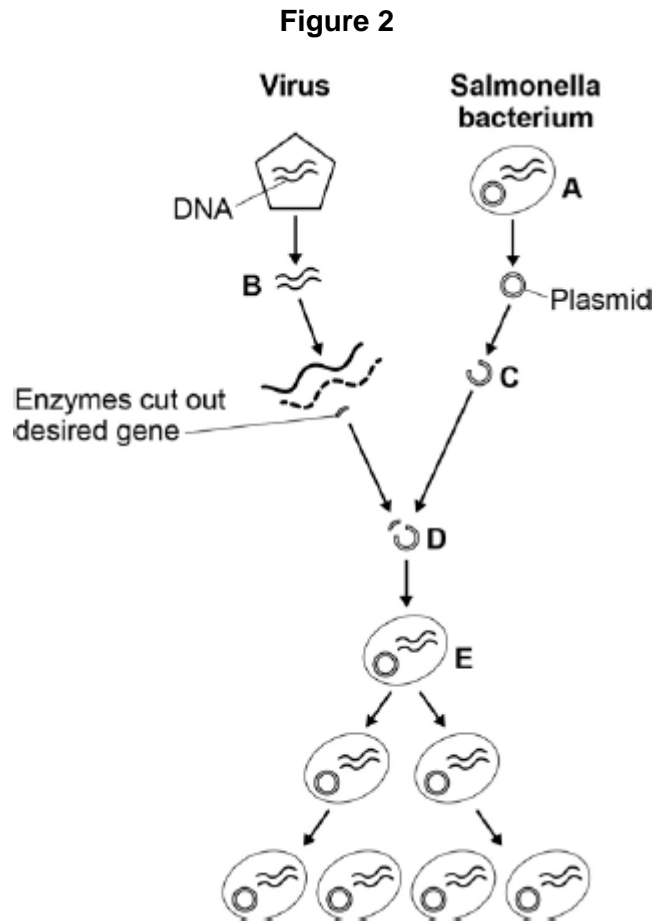
The injection introduces cancer cells into the body



(1)

- (e) The *Salmonella* bacterium used in the vaccine is genetically modified using part of a virus.

Look at **Figure 2**.



Complete the sentences.

Use the letters from **Figure 2**.

Bacteria reproduce quickly in part _____

DNA with the desired gene is removed from the virus in part _____

The chosen gene is inserted into the plasmid in part _____

(3)

(Total 9 marks)

Q41.

- (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

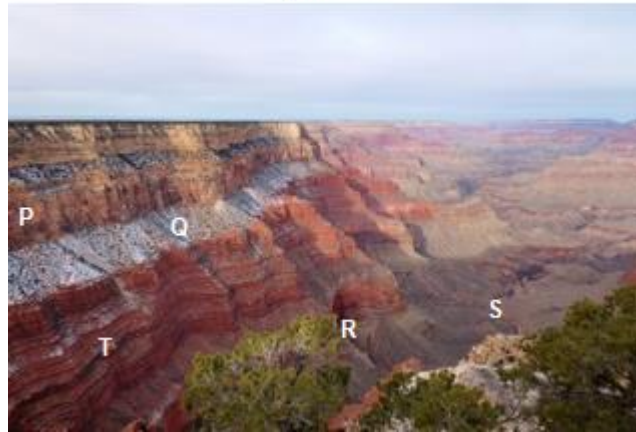
Organisms that reproduce together to form fertile offspring

(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)

Q42.

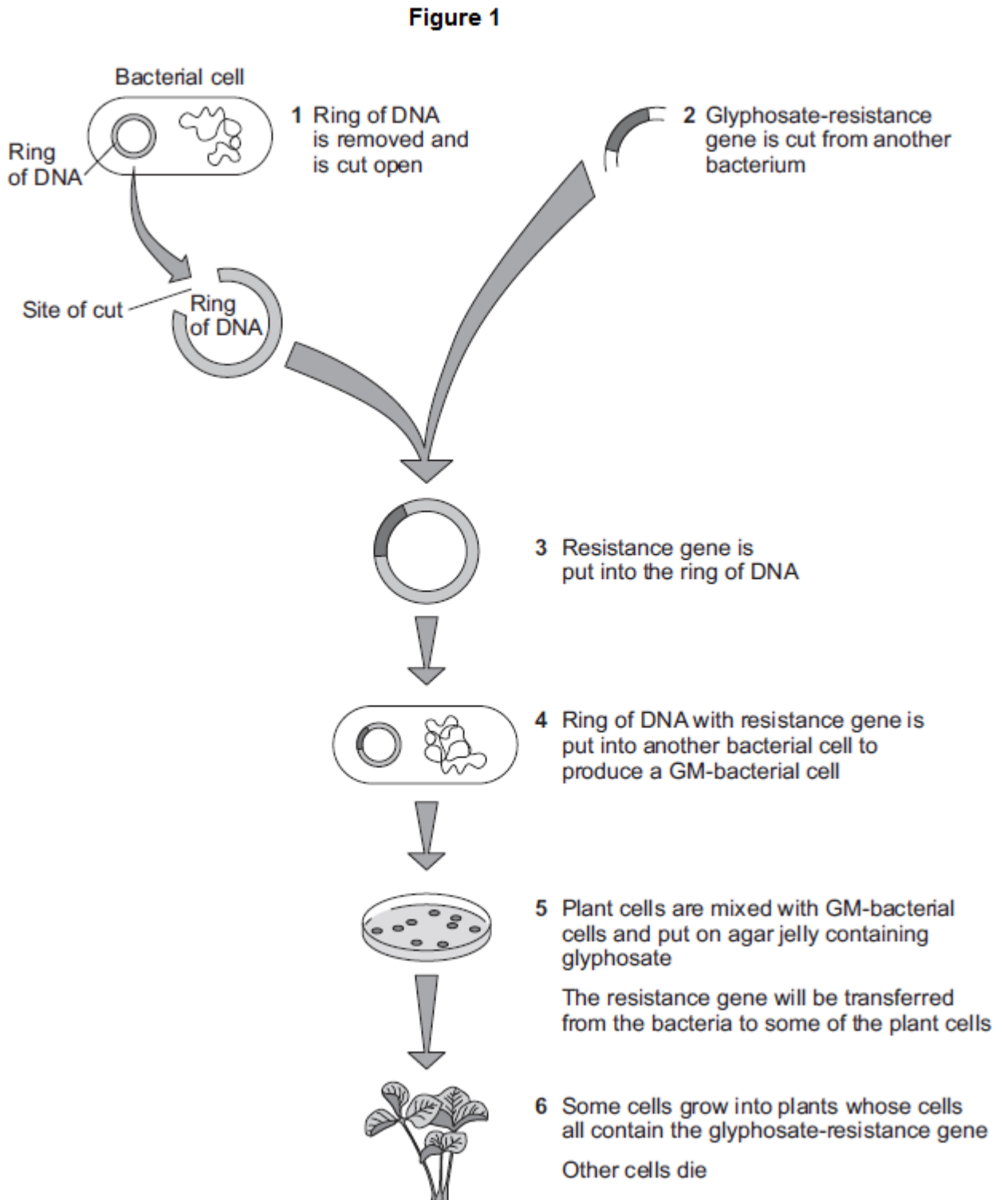
Glyphosate is a herbicide.

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?

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

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



- (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.

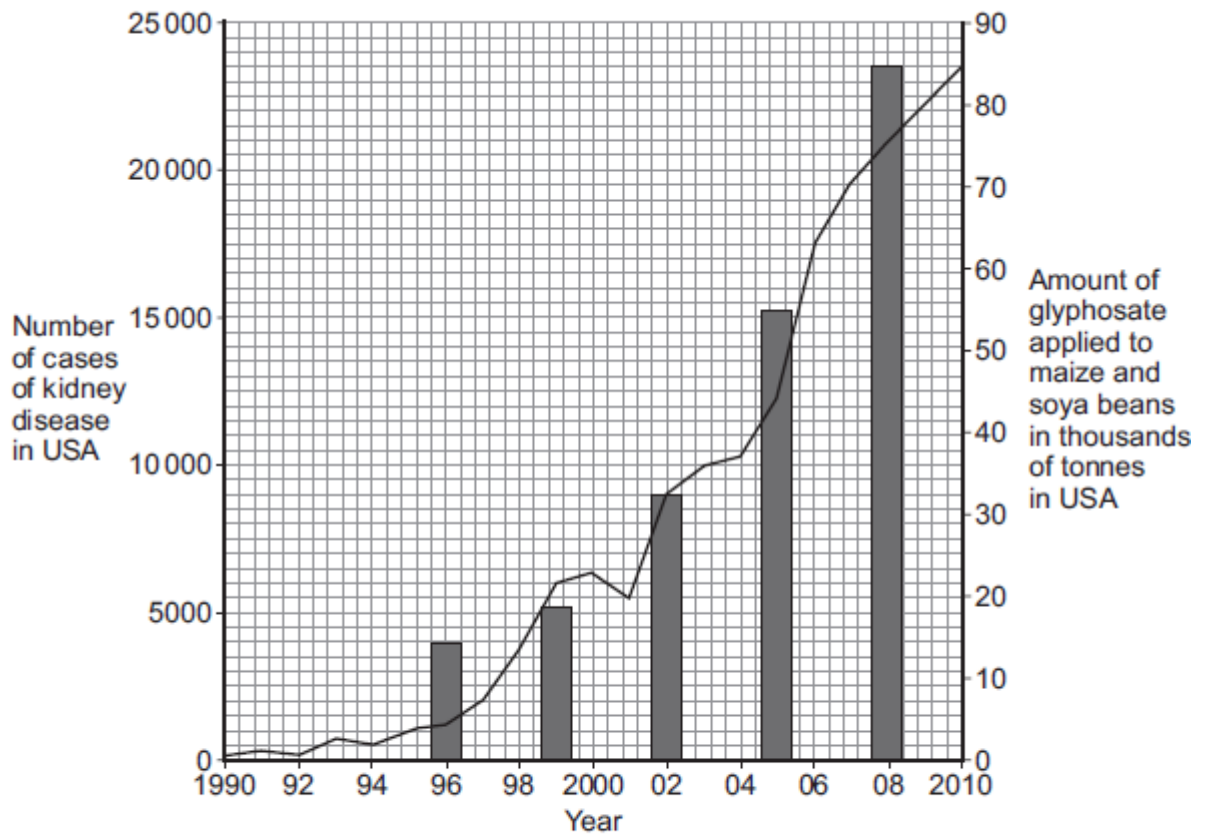
Explain why the scientists add glyphosate to the agar.

(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



Key

- Number of cases of kidney disease
- Glyphosate applied to maize and soya beans

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.

Q43.

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.

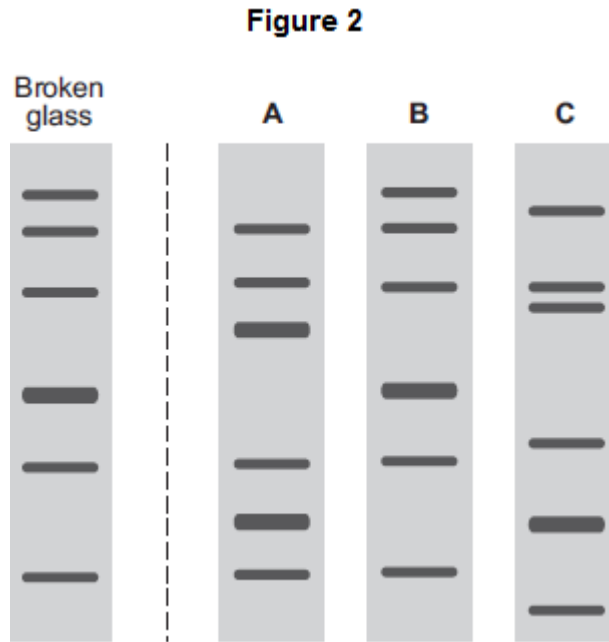
How many copies of the recessive CF allele are there in a body cell of this person?

(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.



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

Q1.

- (a) (i) (too) cold / all moisture / water frozen / no moisture / no warmth / conditions for decay are absent.

for 1 mark

(No oxygen is neutral)

(Do not accept frozen or ice has preserved them)

1

- (ii) • (bacteria have) no oxygen / air (because dead fish covered in mud)

(No moisture x)

(No moisture and no oxygen or warmth x)

- bones / hard parts do not decay easily

idea that

- material of fish replaced by minerals

any two for 1 mark each

2

- (b) *ideas that*

- mammoths lived at the same time as humans / there was man in these times

- mammoths lived in the same place as humans

- humans hunted mammoths / ate mammoths / were carnivorous / for fur etc

- reference to later use of more advanced weapons

- humans needed to protect themselves from mammoths

- humans used flints / weapons / tools

any two for 1 mark each

2

- (c) *idea that*

- environment changed / became too cold / became too warm / vegetation changed / humans destroyed environment

- (new) predator / humans killed them

- new disease

- new competitor / type of elephant

- shortage of food / no food / ran out of prey

- mammoths reproduced too slowly

- mammoths didn't adapt to changes
any two for 1 mark each

2

[7]

Q2.

(a) asexual reproduction

1

(b) mitosis

1

(c) clones

1

(d) 44

1

[4]

Q3.

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

- food
- mates
- territory / space
ignore habitat, land
ignore water

2

(ii) any **two** adaptations with explanations from:

1 mark for adaptation
1 mark for correct explanation
ignore prevents / no heat loss

- long / thick hair or wool
allow a lot of
allow long / thick / a lot of fur
ignore fat although reason can still be credited
ignore coat

(for) insulation

allow (to) trap energy / heat / air
allow to keep warm

- small surface area : volume ratio
ignore large body mass although reason can still be credited

(therefore) lose less energy

allow (to) keep warm
allow heat for energy
ignore (to) insulate

- small ears / tail

allow (to) keep warm
allow heat for energy

(therefore) lose less energy

ignore (to) insulate

only allow big tusks if qualified eg digging through snow / ice for(food) for 2 marks

ignore references to predators and prey

only allow big feet if qualified eg for walking on snow / ice for 2 marks

4

(b) (i) natural selection

1

(ii) if some animals grew a long nose / acquired characteristic (during their lifetime)

ignore answers about Darwin's theory

allow trunk for nose

allow used trunk / nose / it a lot

allow stretched trunk / nose / it

1

their offspring would inherit / also have a long nose

*do **not** accept references to genes / DNA / chromosomes*

1

[9]

Q4.

(a) (i) 3 (millions of years)

1

(ii) orangutans

1

(b) natural selection

ignore survival of the fittest

1

[3]

Q5.

(a) *idea*

identical (do not allow simply "the same number")

for 1 mark

1

(b) *idea*

chromosomes double/duplicate/copies made

for 1 mark

separate into 2 sets/divide*

gains 1 mark

but

separate into 4 sets/divide twice*

gains 2 marks

number halved compared to bodycell

or

single set (only) 16

accept in terms of cells but only if chromosomes referred to in first and/or last items)

for 1 mark

4

[5]

Q6.

(a) sexual / sex

for 1 mark

1

(b) *idea that*

sexual reproduction brings about a mixture of genes
or similar / different genes / parents / gametes / DNA /
characteristics / chromosomes (*not* features)

for 1 mark

1

(c) (i) asexual / cloning (*allow* vegetative)

for 1 mark

1

(ii) (A) *idea that* (they are exactly the same). *Do not allow*
similar or just one named feature.

for 1 mark

2

(B) different (*allow* similar but *do not allow* same).
Allow any one named difference

for 1 mark

(d) (i) greater the X-ray dose, greater the % of mutations
or % of mutations increases steadily / in proportion to X-ray dose

for 1 mark

1

(ii) ionising radiations / ultra-violet light / alpha particles / beta particles
/ gamma rays / radio activity / chemicals / drugs / smoking / natural
in meiosis / spontaneous / cell replication / toxic waste / pollution

1

Accept radioactivity but not radiations alone.

for 1 mark

[7]

Q7.

(a) *idea about*

- environment change / habitat drier / climate change

- couldn't escape from predators / ref to predators / killed / eaten
[Do not allow "died"]
- because feet not adapted to run on dry ground
- couldn't compete (with Merychippus) / more difficult to get food

[Use v + x = x principle]

any two for 1 mark each

2

- (b) (i) fossil remains / from the bones
for 1 mark

1

- (ii) (known) age of rock **or** any reason for knowing the age of the rock
eg by the rock layers by RA dating (not C-dating)
for 1 mark

1

- (c) *idea that*
(present day) horses / species evolved / adapted / developed from earlier species/ horses

- over a long period of time / millions of years
- via many / gradual changes
- which gave a survival advantage / passed on genes / characteristics
any three for 1 mark each

[First bullet point answer is required before marks can be awarded for others]

3

[7]

Q8.

- (a) any **three** from:

factor for colour has two forms

accept gene for factor and allele for form

yellow dominant since all first generation yellow

accept F1 for first generation

green recessive since reappears in second generation

accept F2 for second generation

3

- (b) (i) genes

accept alleles / genetic

1

- (ii) nucleus

accept chromosomes / DNA

1

[5]

Q9.

idea brown colour/plain shell inconspicuous
for 1 mark

less likely to be eaten
gains 1 mark

but
less likely to be eaten before breeding
gains 2 marks

so alleles (genes) passed on
for 1 mark
(N.B. accept inverse of any of the above)

[4]

Q10.

(a) (i) *ideas that*

- remains of animal/plant of specific organism
 - (from) many years ago/thousands or millions of years
 - found in rocks/covered by sediments
- for 1 mark each*
Mark (a) as a whole to a total of 5 marks.

3

(ii) *ideas that*

- hard parts/bones/shells/skeletons
link required
 - don't decay
- or**
- no decay
link required
 - conditions needed absent/no oxygen/no water

or

- parts replaced by rock mineral chemicals;
Do not accept 'materials' or 'substances'.
- as they decay
Accept 'hard' or 'soft' parts for 1 mark each

2

(b) *idea*

died out/none left/died off
Do not accept 'died' alone
for 1 mark

1

Q11.

- (a) circles round right hand **X** and **Y** gametes
put two ticks or crosses by the circles 2
- (b) 50:50 **or** 1:1 **or** 50% **or** 0.5 **or** ½ equal **or** evens
credit even
do not accept 2:1 or 50 / 50 1
- (c) (i) 23 1
- (ii) 23
credit the same as the one above to be marked consequential 1
- (d) DNA
do not accept nucleic acid 1
- (e) same 1

Q12.

- (a) (i) to go under teeth **or** mower
accept not damaged by grazing animals
accept do not get cut or bitten
accept reduces competition by other plants
do not credit maximum surface of leaves facing Sun 1
- (ii) any **one** from

it can force its way through grass roots
accept in competition with grass roots

it is a store of food (to help the plant recover)
do not credit a good store of water

to reach down to water

to give good anchorage
accept it is hard to pull up 1
- (iii) any **one** from

to reach more light
accept to get out of the shadow of the hedge or tall grass

to let seeds be caught on animals' coats
(more easily)

*accept improves access **or** visibility **or** ease for pollination
do not credit to help it grow up the hedge*

1

(iv) any one from

(they reach out from hedge) to find
water

*accept increase surface area
accept to find nutrients **or** minerals
do not award mark if food mentioned*

to give good anchorage

1

(b) (i) gene **or** allele

do not credit chromosome

1

(ii) any **one** from

they do not crossbreed **or** interbreed

*accept different species do not breed together **or** do not
fertilise each other*

do not produce fertile offspring

have different numbers or types of chromosomes

*accept genes are incompatible
do not credit have different genes **or** are genetically different
do not credit do not pollinate each other*

1

(c) one mark is for the adaptation and one
is for an appropriate reason

have white fur

for camouflage

are huge

for large volume to surface area

thick layer of fat

*for insulation or to reduce heat loss **or** retain heat
do not credit to stop it losing heat **or** withstand the cold **or**
keep it warm*

have thick fur

*for insulation **or** to reduce heat loss **or** retain heat*

hibernate

to avoid the coldest part of year

is a carnivore

because animals provide high energy food

has big paws **or** claws
to be able to walk on snow

have small ears
to reduce heat loss

have furry feet
for insulation from the snow

2

[8]

Q13.

(a) (i) XX XY XY XX
 female male male female
the four correct genotypes and sex are required they may be in any order

1

(ii) meiosis
correct spelling required but accept meisosis not miosis or meosis

1

(iii) 23

1

(iv) 23

1

(b) (i) any **two** from
 (introduces) variation
*accept can crossbreed **or** offspring may gain beneficial characteristics*

prevents the risk of all being the same
 and a disease wiping out population
or prevent monoculture

two parents to raise offspring

2

(ii) both parents carry a recessive allele
or gene **or** are heterozygous
accept both parents are carriers

1

[7]

Q14.

(a) **Quality of written communication**

The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme

idea of mutation **or** variation

do **not** allow 'bacteria get used to antibiotics' **or** idea that antibiotics change the bacteria **or** 'bacteria become immune' **or** references to adaptation or evolution

1

(resistant cells) survive antibiotic

1

(resistant cells) breed

1

(b) **EITHER** (yes)

keep animals disease free (1) so grow faster (1 mark) **or** live longer

OR (no)

resistant bacteria may develop (1)
risk to human **or** animal health (1)

allow bacteria become resistant / immune

2

[5]

Q15.

(a) (i) sexual / sex

(ii) egg / gamete / sex cell / ovum (*reject ovule*)
for 1 mark each

2

(b) (i) meiosis / reduction

(ii) mitosis / somatic
for 1 mark each

2

(c) twice as many (*reject answers based on 23 / 46 chromosomes*)
for one mark

1

(d) (i) information / genes / DNA passed from parents
(chromosomes neutral)
for one mark

1

(ii) genes / genetic information / chromosomes from two parents
alleles may be different
environmental effect / named may have been mutation
any two for 1 mark each

2

[8]

Q16.

D

idea that twins have come from one (fertilised) egg
idea that Y sperm / Y chromosome produces boys
each for 1 mark

allow 1 mark if candidate selects **A and** states that Y sperm / Y chromosome produce boys (reject Y gene unqualified) OR
allow 1 mark if candidate selects **C and** states that twins must have come from one (fertilised) egg

[3]

Q17.

- (a) woman XX
man XY

for 1 mark each

2

- (b) 50% / 1 in 2 / evens / 0.5 / 50:50

for 1 mark

mark scheme for genetic diagram

gametes all correct

genotypes of offspring all correct in relation to gametes

for 1 mark each

1

mark scheme for written explanation

half sperm have X chromosome, half have Y
and
all eggs have X chromosome

50% / 1 in 2 / evens / 0.5 chance of egg being fertilised
by X or Y sperm

for 1 mark each

2

[5]

Q18.

- (a) chromosomes
genes (reject alleles)
alleles

for 1 mark each

3

- (b) (i) sexual / sex

for one mark

1

- (ii) egg / gamete / sex cell / ovum (reject ovule)

for one mark

1

- (c) (i) information / genes / DNA passed from parents (reject chromosomes)

for one mark

1

- (ii) genes / genetic information / chromosomes from two parents
alleles may be different
environmental effect / named may have been mutation

any two for 1 mark each

2

[8]

Q19.

(a) (i) D

for 1 mark

1

(ii) D Y (both) or C X (both) or B W (both)

for 1 mark

1

(b) *N.B. answers must relate to fossils providing evidence*
show types of animals / plants that no longer exist / named ref eg dinosaur
show changes in types (*of animals / plants*)
similar fossils found in rocks of similar age
reference to sequence of change
or example
e.g. horse / limb

any two for 1 mark each

2

[4]

Q20.

3 of e.g.
new predators
new diseases
new competitors
environmental changes (initiated by Man)

each for 1 mark

[3]

Q21.

(a) grow from parents,
by vegetative reproduction/asexual reproduction/
no sexual reproduction

for 1 mark each

2

(b) e.g. different environmental conditions/named condition

for 1 mark

1

[3]

Q22.

(a) Stan BB
Sharon bb
all offspring Bb

3

(b) Tom Bb
black offspring Bb
white offspring bb

Q23.

- (a)
- award one mark for each key idea**

energy released **or** energy transferred **or** respiration*allow provides **or** gives**do **not** allow produces **or** makes*

3

near to the site of movement **or**
energy available quickly **or** more
energy*accept allows more mitochondria to fit in*(mitochondria) packed (around
filament) **or** efficient arrangement **or**
spiral arrangement

- (b) contains chromosomes
- or**
- genes
- or**
-
- DNA

***not** genetic material*

1

(which) contribute half (the genes) to
the fetus **or** offspring*23 chromosomes **or** half the genes****or** reference to X,Y chromosome determining sex (if the
notion of halfness is there)**nucleus contains half genes for the offspring = 2 marks*

1

Q24.

- (a) (i) release energy

*allow provide / supply / give energy**do **not** accept produce / create / generate / make energy**do **not** allow release energy for respiration*

1

- (ii) contain half the (number of) chromosomes
- or**
- contains
-
- one set of chromosomes
- or**
- contains 23 chromosomes

*allow genetic information / DNA / genes / alleles instead of
chromosomes**accept haploid*

1

- (b) any two from:

- (stem cells) are unspecialised / undifferentiated
allow description eg 'no particular job'
- are able to become differentiated
or can form other types of cell / tissue / organ

- stem cells can / able to divide / multiply

2

[4]

Q25.

- (a) (i) viruses live inside cells

1

viruses inaccessible to antibiotic

allow drug / antibiotic (if used) would (have to) kill cell

1

- (ii) mutation

ignore mutation caused by antibiotic

1

natural selection **or** no longer recognised by antibiotics

accept description of natural selection

1

- (b) (stimulate) antibody production

ignore antitoxin

1

(by) white cells

1

rapidly produce antibody on re-infection

ignore antibodies remain in blood

1

[7]

Q26.

Quality of written communication

*for correct use of at least **two** scientific terms eg mutation, resistant (**not** just 'antibiotic-resistant', **not** 'immune') / selection / natural selection / survival / reproduction / gene / allele / DNA*

1

any **two** from:

mutation occurs in bacteria or change in DNA / gene occurs

cancel if mutation 'caused by' antibiotic

(when antibiotic used) only resistant bacteria survive **or** non-resistant bacteria are killed **or** reference to 'natural selection'

resistant bacteria pass on the gene / allele

allow pass on the mutation

*do **not** accept just 'pass on resistance'*

2

[3]

Q27.

- (a) cell membranes

- 1
- (b) (i) two recessive / cystic fibrosis / faulty / diseased / the allele(s) / genes
two can be implied by second marking point
ignore chromosomes
- 1
- from Bob **and** Carol / both parents / the parents
if no other marks awarded 'Carol is a carrier' gains 1 mark
- 1
- (ii) (inherited) dominant / normal allele / gene
- 1
- from Carol / mother
ignore references to recessive allele / gene from father / Bob
if no other marks awarded he has just / only one recessive allele gains 1 mark
- 1
- (c) (i) reduce number of people with cystic fibrosis (in population)
- or**
- reduce health-care costs
- or**
- expensive to have baby with cystic fibrosis
accept to allow decision / emotional argument qualified
eg allows abortion
- or**
- allows people to make choices about termination*
- or**
- help to prepare financially / emotionally etc*
- 1
- (ii) any **one** from:
- possible damage / risk to embryo / fetus / baby
allow possible harm / risk to mother
 - screening / it is expensive
 - (may) have to make ethical / moral / religious decisions
ignore not natural / playing God / unethical / immoral / religious unqualified
 - right to life
- 1

[7]

Q28.

- (a) kills / destroys bacteria / MRSA
*do **not** allow germs*

1

prevents / reduces transfer
allow stops MRSA entering ward 1

(b) mutation
*do **not** accept antibiotics causes mutation* 1

(causes) resistance
allow not effective
ignore immunity 1

to antibiotics 1

[5]

Q29.

(a) (soft) body parts / other parts / named parts
accept flesh 1

decayed / decomposed / rotted / eaten
or
bones do not decay / decompose / rot / get eaten
ignore disintegrated / dissolved
ignore microorganisms 1

(b) any **one** aquatic feature from: eg

- streamlined body shape
- long tail
- eyes on top of head
- scales
- fins / paddles / flippers / webbed feet
ignore gills 1

any **one** terrestrial feature from:

- (front) legs / limbs / hands
- could lift front end upwards
ignore feet
accept for 2 marks eg fin / flipper can be used for walking
***or** fins like legs* 1

[4]

Q30.

- (a) (i) mitosis
correct spelling only 1
- (ii) replicates / doubles / is copied / duplicates
accept cloned
ignore multiplied / reproduced 1
- (b) fertilisation occurs / fusion (of gametes)
accept converse for asexual, eg none in asexual / just division in asexual 1
- so leading to mixing of genetic information / genes / DNA / chromosomes
genes / DNA / chromosomes / genetic information comes from 1 parent in asexual
ignore characteristics 1
- one copy (of each allele / gene / chromosome) from each parent
or
gametes produced by meiosis
or
meiosis causes variation
meiosis must be spelt correctly 1

[5]

Q31.

- (a) (i) decrease 1
- rate of decrease slows 1
- (ii) any **one** from:
 - more use of disinfectant
allow any reasonable increase in hygiene or sterilisation precautions
 - more use of hand washing
 - more careful / more often cleaning of patient facilities
 - raised awareness / education about hygiene
 1
- Explanation:
stops / reduces the bacteria being transferred / spreading 1
- (iii) $800 - 500 / 800 \times 100 =$ 1
- 37.5 (%)
correct answer with or without working gains 2 marks 1
- (iv) any **one** from:
 - numbers quite low now so hard to reduce further

- was a big campaign / much publicity (in 2009) so more people already doing it
- hygiene / cleaning now good so hard to improve
- hospitals short of money so less staff to clean

1

- (b) mutation occurred giving resistance (to methicillin)
do not accept overuse caused mutation

1

resistant bacteria not able to be treated / not killed

1

these bacteria multiplied / reproduced / spread quickly

1

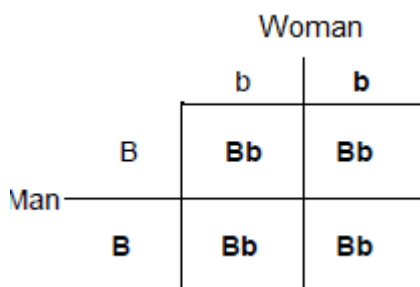
[10]

Q32.

- (a) (i) correct parental genotypes (man BB and woman bb)

1

all offspring Bb



ignore 'brown' or 'brown eyes' on diagram

1

- (ii) they have one B / dominant allele / heterozygous

or

B / brown allele / dominant allele is expressed even if only on one chromosome

1

- (b) correct parental genotypes (both Bb)
can be shown in a diagram
can be shown as gametes

1

correct derivation of offspring genotypes from gametes
allow correct derivation from wrong gametes

1

bb identified as blue-eyed

1

[6]

Q33.

- (a) (i) meiosis

- allow mieosis* 1
- (ii) testis / testes 1
allow testicle
- (b) (i) 23 1
- (ii) fuses / joins with cell D / with egg cell **or** used in fertilisation 1
allow fuse with another cell
- prevents doubling of chromosome number / restores original no. / 46 /
diploid no. / normal no. / full no. 1
accept 23 from each parent / from each gamete

[5]

Q34.

- (a) (i) nucleus 1
correct spelling only
accept mitochondrion
ignore genes / genetic material / chromosomes
- (ii) base(s) 1
Accept all four correct names of bases
ignore nucleotides and refs to organic / N-containing
- (iii) 4 1
- (iv) codes for sequence / order of amino acids 1
ignore references to characteristics
- 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]

Q35.

- (a) any correct named physical environmental condition, e.g. light / water / rain / temperature / minerals / nutrients / space (between plants)
ignore carbon dioxide / climate / weather / sun / pollution 1
- genes / inheritance
ignore 'variety'
- OR
- any correct named biotic factor e.g. predation / disease 1
- (b) mass of crop also depends on number of pods (per plant) / size / mass of each pea
ignore number of plants 1
- (c) microorganisms / bacteria / fungi / decomposers / detritus feeders / named 1
- decompose / rot / break down / decay / digest
ignore feed / eat 1
- (these organisms) respire
*do **not** allow respiration by pea (plants)* 1
- (decay / respiration / microorganisms etc) releases carbon dioxide
*do **not** allow combustion / fossilisation*

Q36.(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

Q37.(a) (i) alternative / different / one form of a gene**or**

a mutation of a gene

*do not allow a type of gene**(For info: CRAM = Childhood Recurrent Acute Myoglobinuria)*

1

(ii) not expressed if dominant / other allele is present or it is heterozygous

or

only expressed if dominant allele not present / no other allele present or it is homozygous

need two copies to be expressed / not expressed if only one copy

allow 'gene' for allele

1

(iii) unaffected parents have an affected child

allow 7 and 8 have 10

allow skips a generation

1

(b) (i) has two alleles that are the same

*accept (person is) **nn** / **NN** or has two recessive / dominant alleles*

1

(ii) (all) inherit **N** / normal / dominant allele from 1 / from father

ignore they are carriers

1

all are **Nn** / none are **nn** / all are heterozygous

1

(c) (i) genetic diagram including:

1 gametes correct **or** parental genotypes correct:

N and **n** + **N** and **n** **or** **Nn** + **Nn**

accept alternative symbols, if defined

1

2 derivation of offspring genotypes:

NN + **Nn** + **Nn** + **nn**

allow alternative if correct for parental gametes

1

3 **nn** identified as CRAM

accept 1/4 / 25% / 1 in 4 / 1 out of 4 / 1:3

1

4 correct probability: 0.25

*do **not** accept 3:1 / 1:4*

1

(ii) any **four** points + conclusion:

pro PGD:

detected at earlier stage / at 3 days c.f. several weeks / before becoming pregnant

no / less chance of miscarriage c.f. CVS

does not involve abortion / less trauma / less pain / ethical comparison

higher chance of having unaffected child – eg ref to use of spare

embryos

provides embryos for research

4

pro CVS:

PGD may destroy some embryos

ethical implications of research on embryos (with PGD)

lower incidence of false positives / false results

low(er) financial cost

conclusion:

must relate to candidate's argument

must have at least one point from each technique for max marks

1

[15]

Q38.

(a) (different / alternative) forms of a gene
do not accept types of genes

1

(b) DNA isolated from embryo

1

(fluorescent) probe mixed with embryo DNA

1

probe (then) binds with embryo DNA

1

(UV light) to show alleles / gene for disorder

1

(c) 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 ($\frac{1}{2} = \mathbf{Dd}$ and $\frac{1}{2} = \mathbf{dd}$)
allow ecf if parental genotypes are wrong

1

offspring phenotypes correctly assigned to genotypes

1

(d) 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
[12]

Q39.

- (a) wolves 1
- (b) moose and wolves are on different scales 1
- (c) wolf population has increased so more moose are eaten
do not accept there are more wolves than moose 1
- (d) any **two** from:
- (other) predators
allow correct examples
allow 'humans hunting moose'
 - (new) pathogens
allow diseases
 - competition 2
- (e) any **four** from:
- variation (within species) of antler size
allow description relating to antlers
 - (caused by) different genes
 - as a result of sexual reproduction / process of meiosis / mutation
 - (phenotype) most suited to environment most likely to survive and breed
ignore natural selection unqualified
 - genes for large antlers (more likely to be) passed on to next generation 4

reference to mate selection

or

fighting

or

gaining territory

or

competition for mates

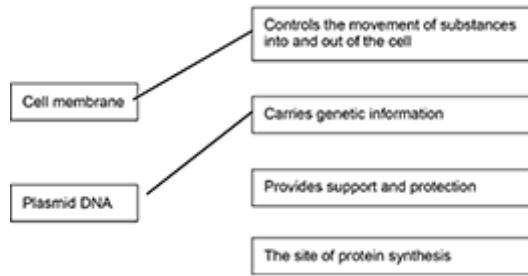
or

avoiding predation

1
[10]

Q40.

- (a) **Feature** **Function**



extra lines from the left negate the mark

(b) Contaminated food

2

1

(c) any **two** from:

- cook food (thoroughly)
- pasteurise food
- wash hands properly
- disinfect work surfaces
- keep raw and cooked foods separate
- only drink clean water

2

(d) It will not cause sickness and diarrhoea side effects

1

(e) **E**

1

B

1

D

1

[9]

Q41.

(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

*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]

Q42.

- (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]

Q43.

- (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]