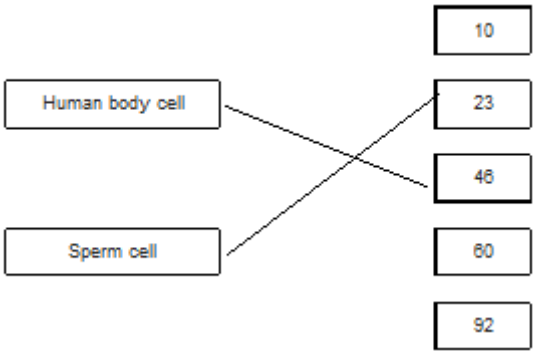
M1.(a) **A**

1

(b)



2

1

(c) one x circled under mother

accept if clearly indicated choice even if not circled

1

(d) XY

allow YX

1

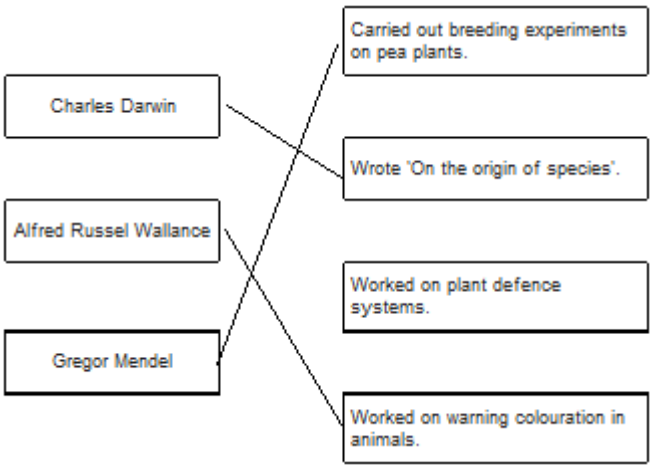
(e) 50 (%)

1

[6]

M2.

(a)



3

(b) a gene

allow allele

1

(c) 4

1

(d) correct derivation of children's genotypes

1

identification of children with cystic fibrosis (dd)

1

0.25

allow ecf

allow ¼ / 25% / 1 in 4 / 1:3

1

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

(e) heterozygous

1

[9]

M3.(a) (i) (female) has XX / only X's / no Y

allow has X chromosomes

ignore ref to genes / cells

1

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

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

1

no. 18

1

(b) (i) 14

allow in range of 13.5 to 14.5

1

(ii) 7

allow in range of 6.75 to 7.25

accept ecf from 5bi

1

(c) Advantages:

any **two** from:

- more than 1 embryo (so more chance of success)

  allow method 2 may cause a miscarriage
- tested at 3 days cf 10 weeks **or** tested earlier

  tested when only 3 days old
- tested before pregnancy
- no termination / abortion
- spare embryos have a potential use.

2

Disadvantages:

any **one** from:

- needs an operation

  accept described hazard of operation
- (spare) embryos / human life destroyed / harmed

  must be comparative
- higher cost
- embryos might not implant / might not develop.

1

[8]

M4.(a) (i) Chromosomes

1

(ii) Characteristics

1

(iii) Classify

1

(b) Plants

ignore algae

1

[4]

M5.(a) (i) gamete(s)

ignore reproductive cells

1

(ii) womb / uterus

allow phonetic spellings

1

(b) (i) are formed from the same original embryo

1

(ii) embryo transplantation

1

(iii) any **one** from:

- (calves will have some) genes / DNA from bull / sperm
  allow not all genes from the cow
- idea that sexual reproduction produces variation
  allow may be male
  allow idea that gene for low fat milk may not be passed on

1

[5]

M6.(a) (i) fertilisation

1

(ii) in sequence:

accept 1 next to gene, 2 next to chromosome and 3 next to nucleus in box

1 gene
2 chromosome
3 nucleus

*allow 1 mark for smallest **or** largest in correct position*

2

(iii) DNA

1

(b) (i) On diagram:

tick drawn next to **X** and / or **Y** from Parent 1

tick(s) must be totally outside grid squares
allow ticks around "parent "
extra ticks elsewhere cancel

1

(ii) 0.5 / ½ / 50% / 1:1 / 50:50 / 1 in 2

allow 2/4 / 2 in 4 / 2 out of 4 / 'even(s)' / 'fifty – fifty'
*do **not** allow 1:2 or '50 / 50' or '50 – 50'*

1

2 (out of 4) boxes are **XX**

or

half of the sperm contain an **X**-chromosome

*allow **XY** is male and 2 (out of 4) boxes are **XY***

1

[7]

M7.(a) DNA

1

(b) X and Y

1

(c) (i) 46 chromosomes

1

(ii) half the number

1

(d) meiosis

1

[5]

M8.(a) Mendel

1

(b) (i) **TT**

1

(ii) a dominant allele

1

(c) 1 : 1

1

(d) 100 short plants

1

[5]

M9.(a) (i) gametes

apply list principle

1

(ii) chromosomes

apply list principle

1

(b) (i) The allele is recessive

no mark if more than one box is ticked

1

(ii) two

apply list principle

1

(c) (i) **A**

apply list principle

1

(ii) **B**

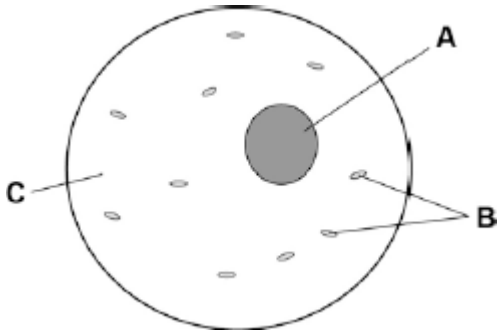
apply list principle

1

[6]

Q1.Figure 1 shows a human body cell.

Figure 1



(a) Which part in **Figure 1** contains chromosomes?

Tick **one** box.

A ☐ **B** ☐ **C** ☐

(1)

(b) Humans have pairs of chromosomes in their body cells.

Draw **one** line from each type of cell to the number of chromosomes it contains.

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

(2)

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

Figure 2 shows the inheritance of sex in humans.

Figure 2

		Mother	
		X	X
Father	X	XX	XX
	Y	XY	XY

Circle a part of **Figure 2** that shows an egg cell.

(1)

(d) Give the genotype of male offspring.

.....

(1)

(e) A man and a woman have two sons. The woman is pregnant with a third child.

What is the chance that this child will also be a boy?

Tick **one** box.

0% ☐

25% ☐

50% ☐

100% ☐

(1)
(Total 6 marks)

Q2. Our understanding of genetics and inheritance has improved due to the work of many scientists.

(a) Draw **one** line from each scientist to the description of their significant work.

Scientist	Description of significant work
Charles Darwin	Carried out breeding experiments on pea plants.
Alfred Russel Wallance	Wrote 'On the origin of species'.
Gregor Mendel	Worked on plant defence systems.
	Worked on warning colouration in animals.

(3)

(b) In the mid-20th century the structure of DNA was discovered.

What is a section of DNA which codes for one specific protein called?

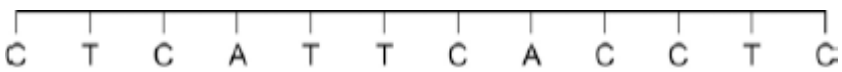
.....

(1)

(c) **Figure 1** shows one strand of DNA.

The strand has a sequence of bases (A, C, G and T).

Figure 1



How many amino acids does the strand of DNA in **Figure 1** code for?

Tick **one** box.

2 ☐

3 ☐

4 ☐

6 ☐

(1)

(d) Mutations of DNA cause some inherited disorders.

One inherited disorder is cystic fibrosis (CF).

A recessive allele causes CF.

Complete the genetic diagram in **Figure 2**.

- Identify any children with CF.
- Give the probability of any children having CF.

Each parent does not have CF.

The following symbols have been used:

D = dominant allele for **not** having CF

d = recessive allele for having CF

Figure 2

		Mother	
		D	d
Father	D	DD	
	d		

Probability of a child with CF = ...

(3)

(e) What is the genotype of the mother shown in **Figure 2**?

Tick **one** box.

Heterozygous ☐

Homozygous dominant ☐

Homozygous recessive ☐

(1)
(Total 9 marks)

Q3. Genetic disorder **E** is a condition caused by a change in the chromosomes.

(a) **Figure 1** shows the chromosomes from one cell of a person with genetic disorder **E**.

Figure 1

(i) How do you know this person is female?

Use information from **Figure 1**.

.....

.....

(1)

(ii) Describe how the chromosomes shown in **Figure 1** are different from the chromosomes from a person who does not have genetic disorder **E**.

.....

.....

.....

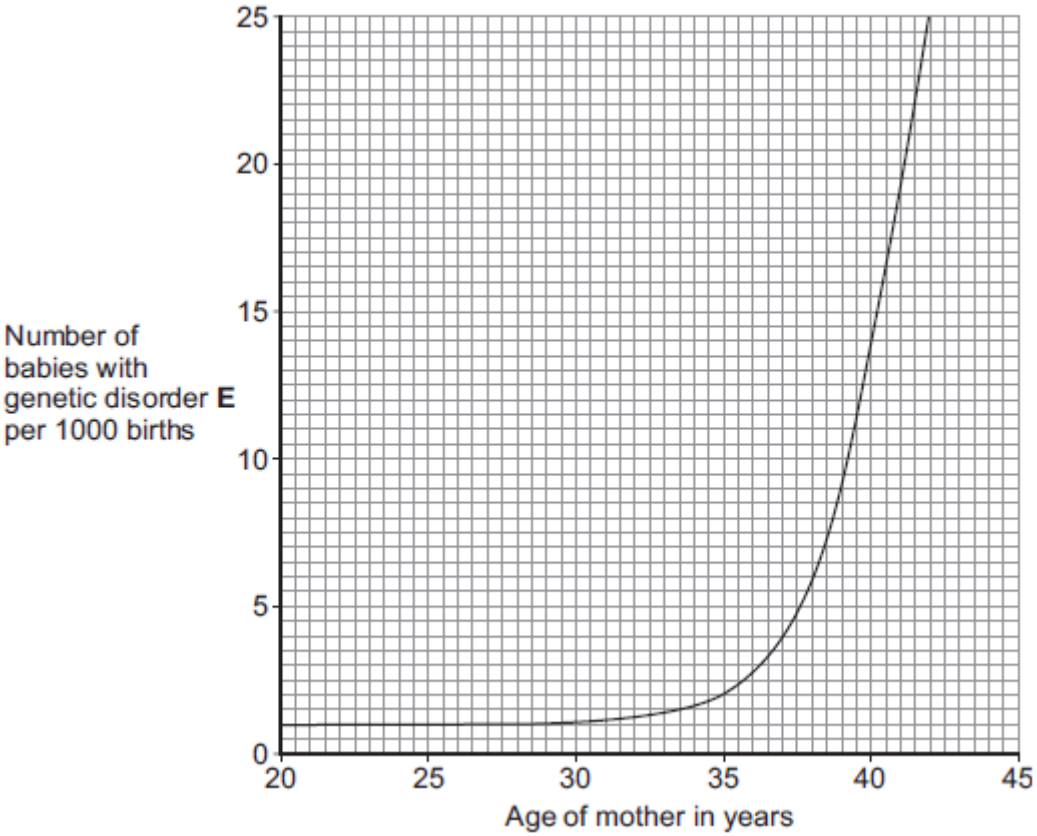
.....

(2)

(b) As a woman gets older, the chance of her having a baby with genetic disorder **E** increases.

Figure 2 shows this.

Figure 2



(i) The chance of a 35-year-old woman having a baby with genetic disorder **E** is 2 per 1000 births.

What is the chance of a 40-year-old woman having a baby with genetic disorder **E**?

..... per 1000 births

(1)

(ii) A 40-year-old woman is more likely than a 35-year-old woman to have a baby with genetic disorder **E**.

How many times more likely?

..... times

(1)

(c) A 41-year-old woman wants to have a baby. A 41-year-old woman has an increased chance of having a baby with genetic disorder **E**.

Doctors can screen embryos for genetic disorder **E**.

The table gives some information about two methods of embryo screening.

Method 1	**Method 2**
1. The woman is given hormones to cause the release of a few eggs. The eggs are taken from her body in a minor operation. The eggs are fertilised in a glass dish.	1. The woman gets pregnant in the normal way.
2. One cell is taken from each embryo when the embryo is 3 days old.	2. Cells are taken when the embryo is 10 weeks old.
3. Cells are screened for genetic disorder **E**.	3. Cells are screened for genetic disorder **E**.
4. An unaffected embryo is placed in the woman's uterus. Embryos that are not used are destroyed or used in medical research.	4. An unaffected fetus is allowed to develop. If the fetus has genetic disorder **E**, the woman can choose to have an abortion.
5. This method costs about £6000.	5. This method costs about £600.

Use information from the table to give **two** advantages and **one** disadvantage of **Method 1** compared with **Method 2** for detecting genetic disorder **E**.

Advantages of **Method 1**:

1.....

.....

2.....

.....

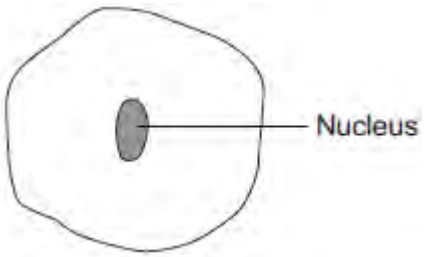
Disadvantage of **Method 1**:

.....

.....

(3)
(Total 8 marks)

Q4. The diagram below shows a cell.



(a) Draw a ring around the correct answer to complete each sentence.

(i) In the nucleus of a cell, genes are part of

chromosomes.
membranes.
receptors.

(1)

(ii) Different genes control different

characteristics
gametes
nuclei

of an organism.

(1)

(iii) Studying the similarities and differences between organisms allows us to

classify
clone
grow

the organisms.

(1)

(b) Complete the following sentence.

Living things can be grouped into animals, microorganisms and ..... .

(1)
(Total 4 marks)

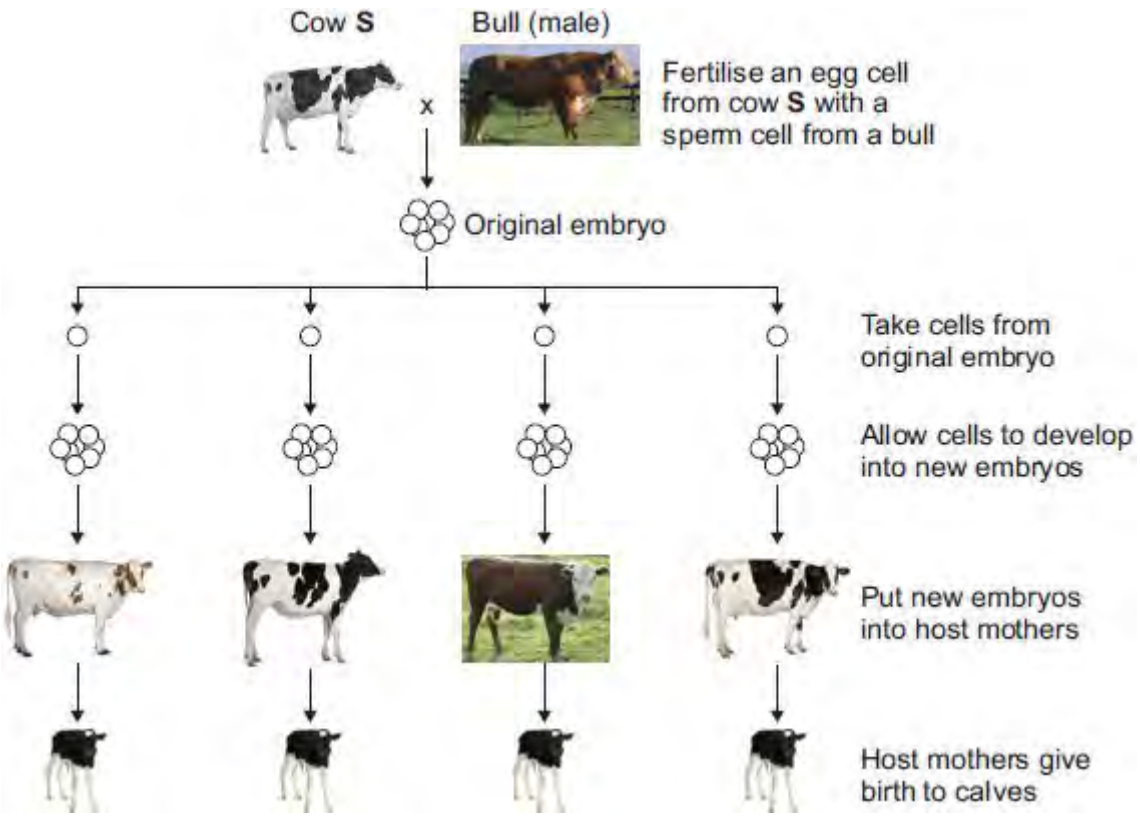
Q5. Most cows produce milk with a fat content of 3.4%.

Cow **S** produces milk with a fat content of 1.2%.

Only cow **S** has the gene to produce this low-fat milk.

(a) A farmer plans to develop more cows like cow **S**.

The diagram below shows how the farmer plans to do this.



Cow S © GlobalP/iStock/Thinkstock, **Bull** © Fuse/Thinkstock, **Whitish cow** © Eric Isselee/iStock/Thinkstock, **Brown cow** © DC Productions/Photodisc/Thinkstock, **Holstein cow(1)** © GlobalP/iStock/Thinkstock, **Holstein cow(2)** © GlobalP/iStock/Thinkstock, **Calf** © Eric Isselee/iStock/Thinkstock.

(i) An egg cell from cow **S** is fertilised by a sperm cell from a bull. This is part of sexual reproduction.

What is the scientific name for sex cells such as egg cells and sperm cells?

.....

(1)

(ii) After fertilisation, cells are taken from the original embryo.

These cells develop into new embryos.

Which part of the host mother's body should each new embryo be put into?

.....

(1)

(b) (i) The calves born to all of the host mothers are genetically identical to each other.

Draw a ring around the correct answer to complete the sentence.

The calves are genetically identical to each other because

they

are formed from the same original embryo.
have the same host mother.
have the same two parents.

(1)

(ii) What term is used to describe the method of producing calves shown in the diagram in part (a)?

Tick (✓) **one** box.

Adult cell cloning ☐

Embryo transplantation ☐

Genetic modification ☐

(iii) Why are the calves born to the host mothers **not** genetically identical to cow **S**?

.....

.....

(1)

(Total 5 marks)

Q6. In sexual reproduction, an egg fuses with a sperm.

(a) (i) Draw a ring around the correct answer to complete the sentence.

An egg and a sperm fuse together in the process of

cloning.
fertilisation.

mitosis.

(1)

(ii) Egg cells and sperm cells each contain the structures given in the box.

chromosome	**gene**	**nucleus**

List these three structures in size order, starting with the smallest.

1 ..... (smallest)

2 .....

3 ..... (largest)

(2)

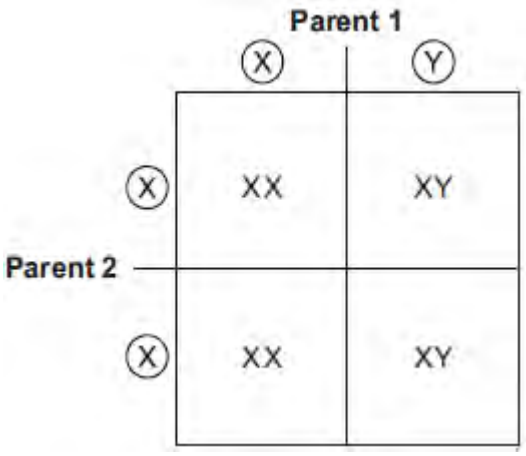
(iii) The egg and the sperm contain genetic material.

Draw a ring around the correct answer to complete the sentence.

The genetic material is made of	carbohydrate.
	DNA.
	protein.

(1)

(b) The diagram below shows the inheritance of **X** and **Y** chromosomes.



(i) Draw a tick (✓) on the part of the diagram that shows a sperm cell.

(1)

(ii) What is the chance of having a female child?

Give the reason for your answer.

.....

.....

.....

.....

(2)

(Total 7 marks)

Q7. When humans reproduce, chromosomes and genes are passed on to the next generation.

In each of the following questions, draw a ring around the correct answer to complete the sentence.

(a) A gene is a small section of

cellulose.
DNA.
protein.

(1)

(b) The sex chromosomes in the human male are

X and X.
X and Y.
Y and Y.

(1)

(c) (i) Most human body cells contain

23 chromosomes.
46 chromosomes.
92 chromosomes.

(1)

(ii) The number of chromosomes in a human gamete (sex cell)

is

the same number as
half the number
twice the number

n body cells.

(1)

(d) Gametes are produced by

fertilisation.
meiosis.
mitosis.

(1)
(Total 5 marks)

Q8. In each question, draw a ring around the correct answer to complete the sentence.

(a) Our understanding of how genes are inherited is mostly because of

the work of

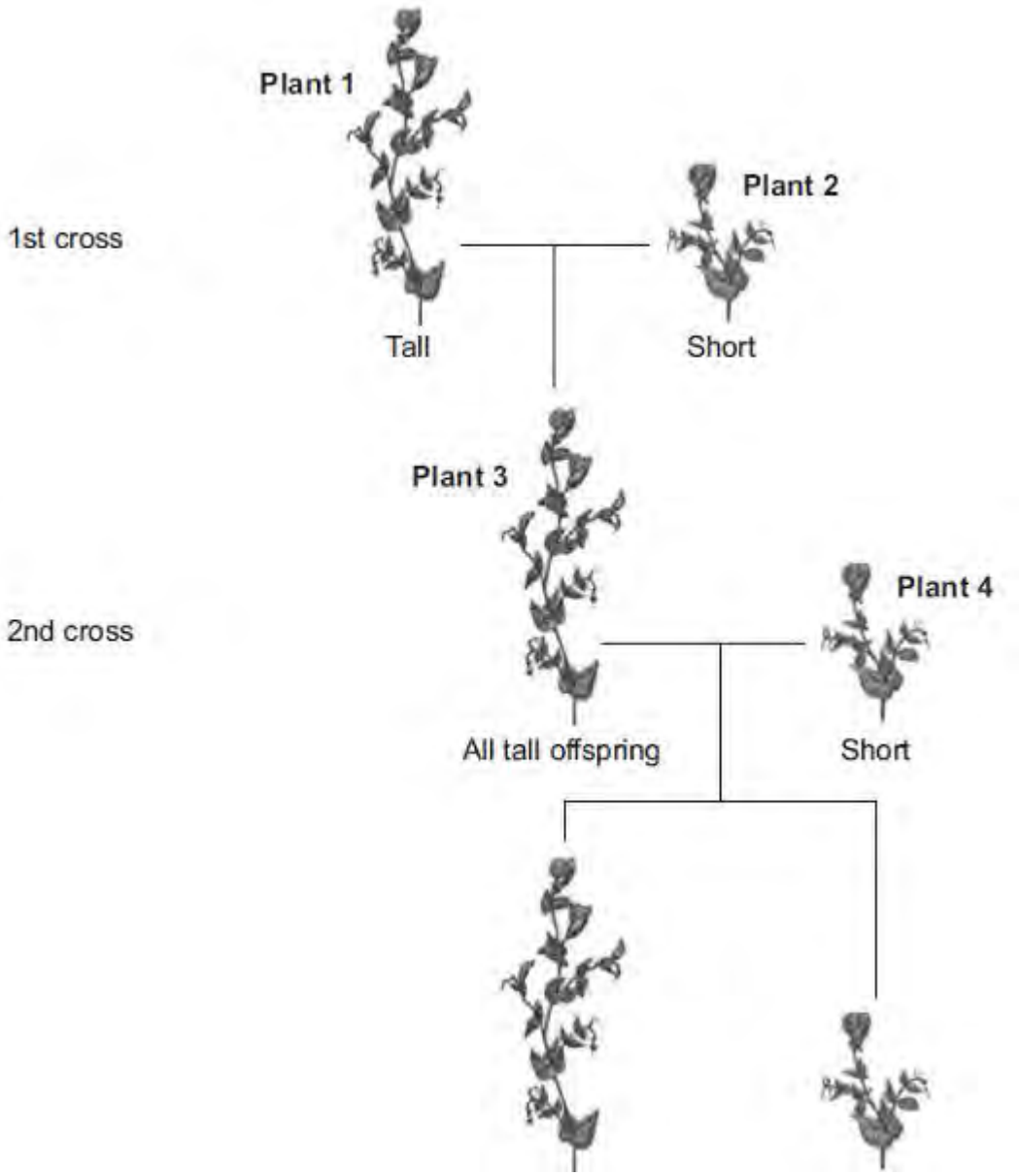
- Darwin.
- Lamarck.
- Mendel.

(1)

(b) A scientist investigated inheritance in pea plants.

The scientist crossed tall pea plants with short pea plants. **Diagram 1** shows the results.

Diagram 1



In the rest of this question, the following symbols are used to represent alleles.

T = allele for tall
t = allele for short

(i) The 1st cross in **Diagram 1** produced 120 offspring. All of these offspring were tall.

This shows that **plant 1** contained the alleles

TT.

Tt.

tt.

(1)

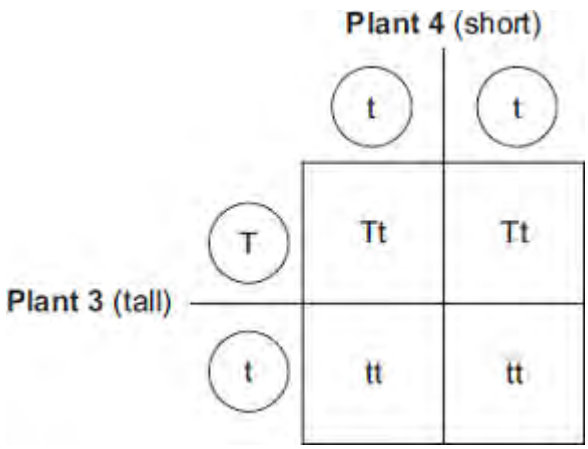
(ii) **Plant 3** is tall because of

a dominant allele.
the environment.
a recessive allele.

(1)

(c) **Diagram 2** gives more information about the cross between **plant 3** and **plant 4**.

Diagram 2



This cross produced some tall offspring and some short offspring.

The ratio of tall to short offspring in **Diagram 2** is

1:1.
2:1.
3:1.

(1)

(d) Two short plants were crossed. This cross produced 100 offspring.

100 short plants.

The expected offspring would be

50 tall plants and 50 short plants.
75 tall plants and 25 short plants.

(1)
(Total 5 marks)

Q9. Humans reproduce sexually.

(a) Draw a ring around the correct answer to complete each sentence.

(i) At fertilisation

chromosomes
genes
gametes

join together.

(1)

(ii) At fertilisation a single cell forms. The cell has new pairs of

chromosomes.
nuclei.
gametes.

(1)

(b) A child inherits cystic fibrosis. The child's parents do **not** have cystic fibrosis.

(i) What does this information tell us about the cystic fibrosis allele?

Tick (✓) **one** box.

The allele is dominant. ☐

The allele is recessive. ☐

The allele is strong. ☐

(1)

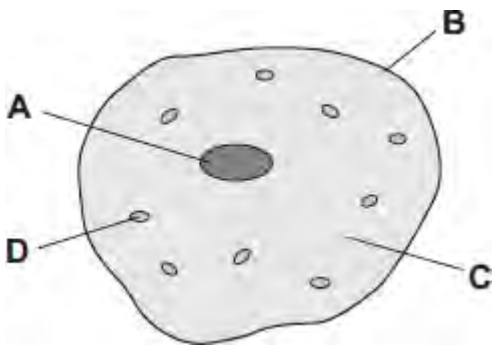
(ii) How many copies of the cystic fibrosis allele does the child have?

Draw a ring around your answer.

one **two** **four**

(1)

(c) The diagram shows a human body cell.



Which part of the cell, **A**, **B**, **C** or **D**:

(i) contains the allele for cystic fibrosis ☐

(1)

(ii) is affected by cystic fibrosis? ☐

(1)

(Total 6 marks)

M1.(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]

M2.(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]

M3.(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 (½ = **Dd** and ½ = **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]

M4.(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 <u>three</u> 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 <u>mitosis</u>

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:

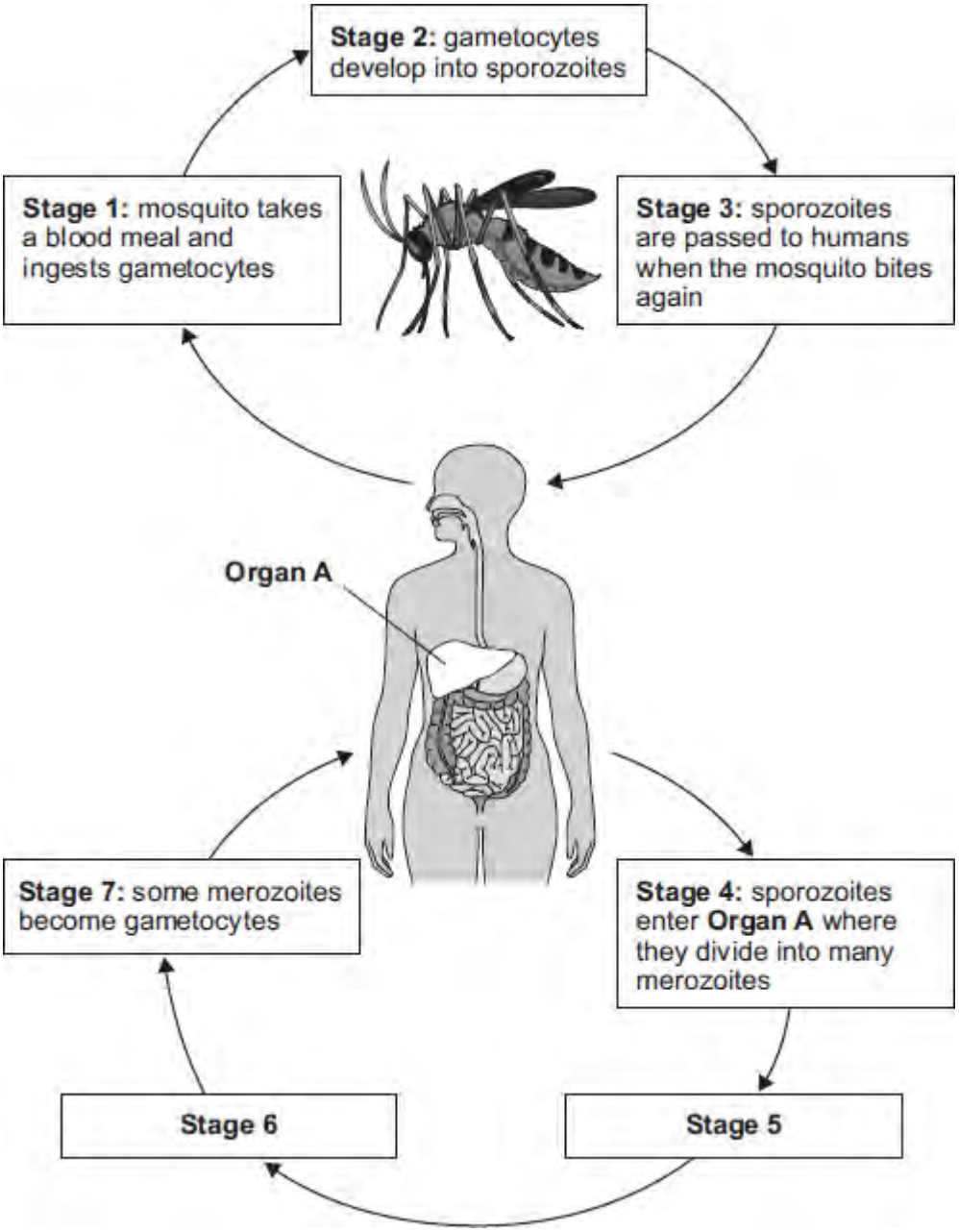
- gene may be passed to pathogenic bacteria
- cannot then kill these pathogens with kanamycin
  or
  cannot treat disease with kanamycin
- may need to develop new antibiotics
- gene may get into other organisms
- outcome unpredictable

2

[13]

Q1.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)

Q2. 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?

.....

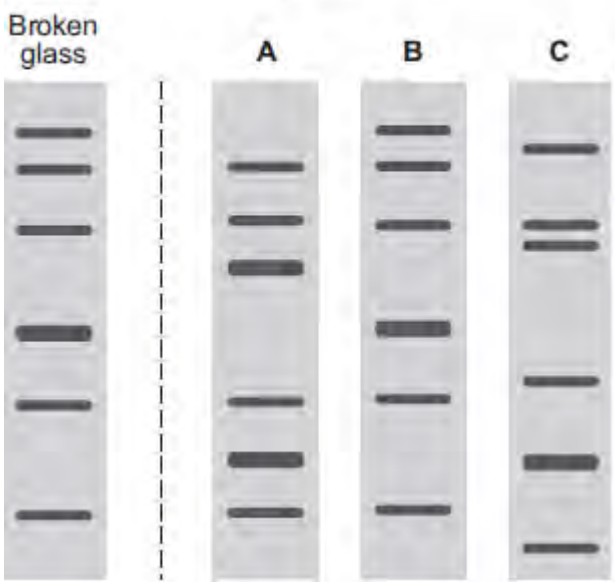
(1)

(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)

Q3. 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.

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

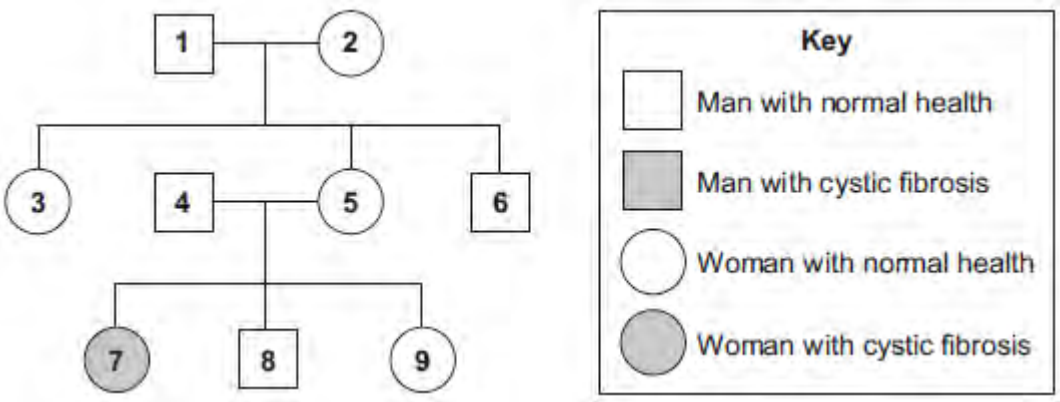
This couple's children have a 50% chance of having polydactyly.

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?

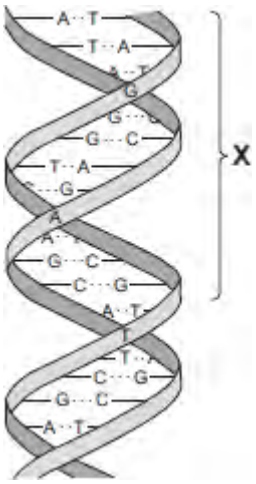
Draw a genetic diagram to explain your answer.

Use the following symbols.

N = allele for normal health
n = allele for cystic fibrosis

(4)
(Total 12 marks)

Q4. 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)

M1.(a) phosphate

allow PO_4^{3-}

1

*do **not** allow P*

(b) A / adenine and T / thymine
and
C / cytosine and G / guanine

*do **not** allow U / uracil*

1

(c) (mutation) changes from C to T DNA code
or
there is a change in the three bases / triplet from CAG to TAG

1

(mutation) changes the amino acid

1

(this could) change the protein

1

(so it) forms a different shape / changed active site

accept different tertiary structure

1

(therefore) the enzyme no longer fits the substrate / carbohydrate

1

(d) mother / woman's gametes correct: A a

1

father / man's gametes correct: a a

1

correct derivation of offspring

ecf

1

identification of child with syndrome H or genotype aa

1

0.5

ecf

allow 50% / 1 / 2 / 1 in 2 / 1:1

1

*do **not** accept 1:2*

[12]

M2.(a) any **two** from:

- right amount of nutrients **or** different / all foods
- right amount of energy
- for (individual) needs

'right amount' only needed once for both marks to be awarded

2

(b) (i) ovaries / ovary

allow placenta

1

(ii) any **one** from:

- inhibits follicle stimulating hormone / FSH production
- inhibits maturation of eggs

ignore ref to site of production of FSH

*allow stimulates LH production **or** stimulates preparation of womb lining*

1

(iii) any **one** from:

- stimulate muscle growth
- used in (oral) contraceptives

1

(c) small (rate of) decrease then bigger (rate of) decrease

1

idea that change of rate (of decrease) at 900 (mg per day)

*If no other mark awarded allow **1** mark for decrease*

1

(d) (i) gene(s) / nucleus / chromosome(s) / DNA

allow ribosome

1

(ii) reduces production of cholesterol (by liver)

allow idea of switching off gene for reductase (production)

allow switch off / reduce / inhibit reductase (production)

allow reduces absorption of cholesterol (by intestine)

allow statins (might) breakdown / destroy cholesterol

1

[9]

M3.(a) (i) 3.15 : 1

*accept 3.147:1 **or** 3.1 : 1 **or** 3 : 1*

*do **not** accept 3.14 : 1*

Ignore 705:224

1

(ii) any **two** from:

- fertilisation is random **or** ref. to chance combinations (of alleles / genes / chromosomes)
- more likely to get theoretical ratios **or** see (correct) pattern **or** get valid results if large number

  allow ref. to more representative / reliable

  *do **not** allow more accurate **or** precise*

  ignore fair / repeatable
- anomalies have limited effect / anomalies can be identified

  accept example of an anomaly

2

(b) (i) in sequence:

Homozygous
Homozygous
Heterozygous

All 3 correct = 2 marks

2 correct = 1 mark

1 or 0 correct = 0 marks

2

(ii) genetic diagram including:

Parental genotypes: **Nn** and **Nn**

allow other characters / symbols only if clearly defined

1

or

Gametes: **N** and **n + N** and **n** derivation of offspring genotypes:
NN Nn Nn nn

allow genotypes correctly derived from candidate's P gametes

1

identification: **NN** and **Nn** as purple **and nn** as white

allow correct identification of candidate's offspring genotypes but only if some F_2 are purple and some are white

1

(c) any **two** from:

- did not know about chromosomes / genes / DNA
  or did not know chromosomes occurred in pairs
  ignore genetics
- had pre-conceived theories
  eg blending of inherited characters
  ignore religious ideas unless qualified
- Mendel's (mathematical) approach was novel concept
  allow his work was not understood or no other scientist had similar ideas
- Mendel was not part of academic establishment
  allow he was not considered to be a scientist / not well known / he was only a monk
- work published in obscure journal / work lost for many years
- peas gave unusual results cf other species
  allow he only worked on pea plants
- Mendel's results were not corroborated until later / 1900

2

[10]

M4.(a) any **three** from:

- (gene) cut out
- (gene / cut out) from (bacterial) chromosome / DNA
  accept (gene / cut out) from (bacterial) plasmid
- ref to enzymes (at any point)
- (gene spliced) into maize chromosome / DNA
- (gene added) at an early stage of development

3

(b) any **four** from:

- justification based on comparison of the relative merits of at least one advantage and one disadvantage
  *max **3** marks if only advantages or disadvantages given*

Advantages:

- less effort for farmer **or** less likely to harm farmer
  ignore ref to cost
- (pesticide) always there **or** doesn't wash away
  allow examples eg no need to spray
- less insects to eat crop / maize **or** carry disease
  allow pesticide doesn't contaminate water courses
- so greater crop production / yield

Disadvantages:

- (toxin) kills other insects
  ignore ref to cost
- so (some) crops don't get pollinated / (sexually) reproduce
  allow maize not pollinated
- possible harm when eaten by humans / animals
  allow may have unpleasant taste
- damage to food chains
  allow reduced biodiversity
- gene may spread to other species

4

[7]

M5.(a) (i) one form of a / one gene
*do **not** allow 'a type of gene'*
allow a mutation of a gene

1

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

or

only expressed if dominant allele not present / or no other allele present
allow need two copies to be expressed / not expressed if only one copy / only expressed if homozygous

1

(b) (i) two parents without PKU produce a child with PKU / **6** and **7** → **10**
allow 'it skips a generation'

1

(ii) genetic diagram including:

accept alternative symbols if defined

Parental gametes:

6: **N** and **n**
and 7: **N** and **n**

1

derivation of offspring genotypes:

NN Nn Nn nn

allow genotypes correctly derived from student's parental gametes

1

identification: **NN** and **Nn** as non-PKU

OR nn as PKU

allow correct identification of student's offspring genotypes

1

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

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

*do **not** allow if extra incorrect probabilities given*

1

(c) (i) mitosis

correct spelling only

1

(ii) 8

1

(iii) DNA

allow deoxyribonucleic acid

*do **not** allow RNA / ribonucleic acid*

1

(d) (i) may lead to damage to embryo / may destroy embryos / embryo cannot give consent

allow avoid abortion

allow emotive terms – eg murder religious argument must be

qualified
allow ref to miscarriage
allow idea of avoiding prejudice against disabled people
allow idea of not producing designer babies

1

(ii) any **one** from:

- prevent having child with the disorder / prevent future suffering / reduce incidence of the disease
  ignore ref to having a healthy child
  ignore ref to selection of gender
- embryo cells could be used in stem cell treatment
  allow ref to long term cost of treating a child (with a disorder)
  allow ref to time for parents to become prepared

1

[12]

M6.(a) (i) mitochondrion / mitochondria
must be phonetically correct

1

(ii) carbon dioxide / CO_2

1

water / H_2O

1

in either order
*accept CO2 but **not** CO^2*
*accept H2O **or** HOH but not H^2O*

(iii) diffusion

1

high to low concentration
allow down a concentration gradient

1

through (cell) membrane **or** through cytoplasm
*do **not** accept cell wall*

1

(b) ribosomes make proteins / enzymes

1

using amino acids

1

part A / mitochondria provide the energy for the process

allow ATP

*do **not** accept produce or make energy*

1

[9]

Q1.Figure 1 shows an image of a small section of DNA.

Figure 2 shows the structure of a small section of DNA.

Figure 1

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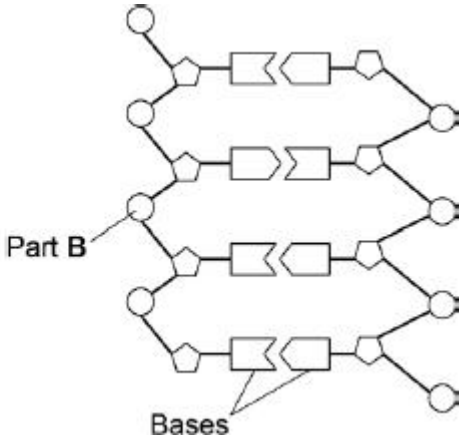
Figure 2



(a) What is Part **B**?

.....

.....

(1)

(b) In **Figure 1** the structure of DNA shows four different bases.

There are four different bases and they always pair up in the same pairs.

Which bases pair up together?

.....

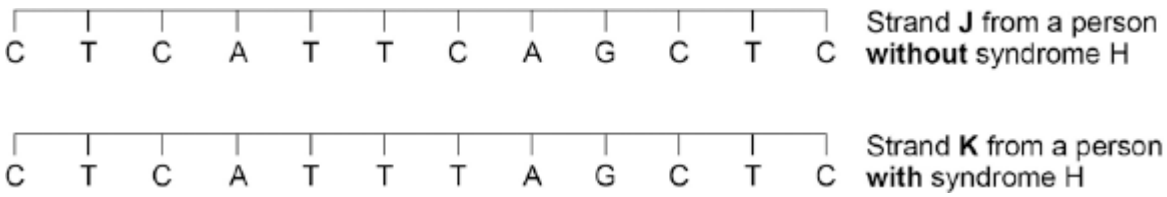
(1)

(c) Syndrome H is an inherited condition.

People with syndrome H do **not** produce the enzyme IDUA.

Figure 3 shows part of the gene coding for the enzyme IDUA.

Figure 3



Strand **K** shows a mutation in the DNA which has caused syndrome H.

The enzyme IDUA helps to break down a carbohydrate in the human body.

The enzyme IDUA produced from Strand **K** will not work.

Explain how the mutation could cause the enzyme **not** to work.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5)

(d) A recessive allele causes syndrome H.

A heterozygous woman and a homozygous recessive man want to have a child.

Draw a Punnett square diagram to determine the probability of the child having syndrome H.

Identify any children with syndrome H.

Use the following symbols:

A = dominant allele

a = recessive allele

Probability = ... %

(5)

(Total 12 marks)

Q2.(a) A healthy diet should be balanced.

What is meant by a balanced diet?

.....

.....

.....

.....

(2)

(b) Cholesterol has important functions in the body.
Some cholesterol is produced by the liver.
Cholesterol is needed in the body to make the hormone oestrogen.

(i) Name the organ in the body which produces oestrogen.

.....

(1)

(ii) What effect does oestrogen have on the female reproductive cycle?

.....

.....

(1)

(iii) Oestrogen is a naturally occurring steroid hormone.

Give **one** artificial use of a steroid hormone in the body.

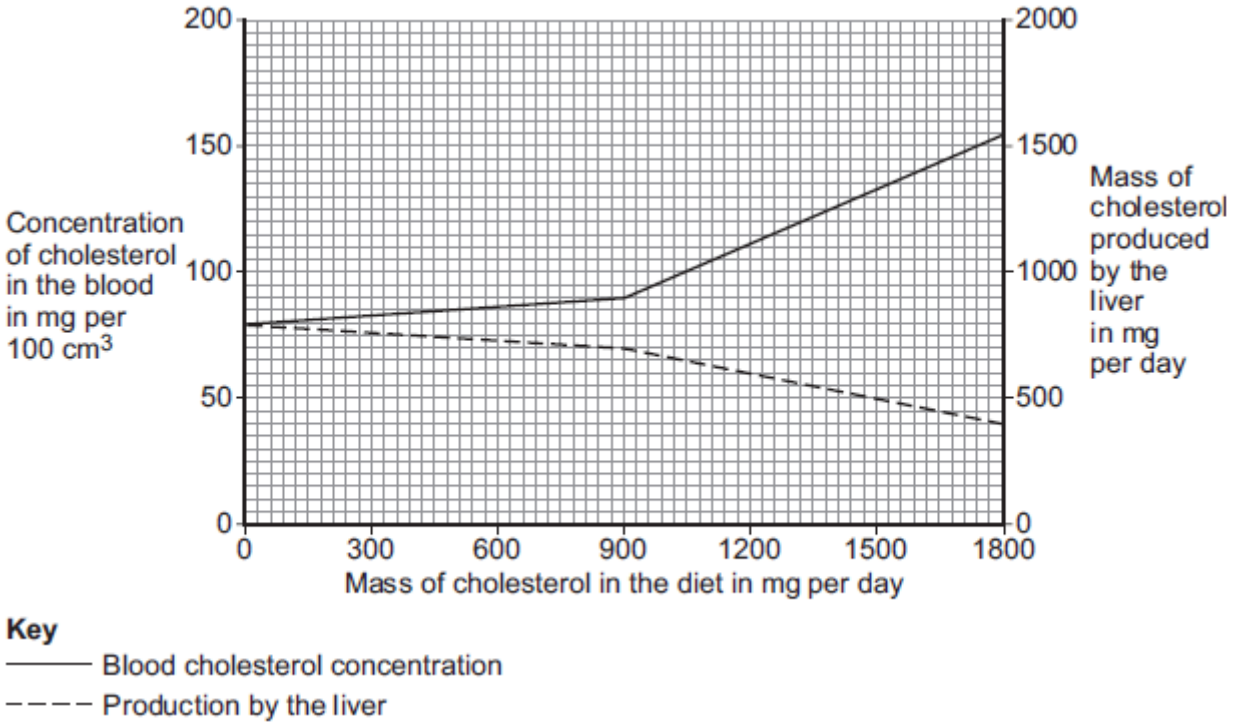
.....

.....

(1)

(c) The graph below shows the effect of the mass of cholesterol in the diet on:

- the concentration of cholesterol in the blood
- the mass of cholesterol produced by the liver.



Describe the effect of increasing the mass of cholesterol in the diet on the mass of cholesterol produced by the liver.

To gain full marks you should include data from the graph in your answer.

.....

.....

.....

.....

.....

.....

(2)

(d) Large amounts of cholesterol in the diet switch off the production of an enzyme called reductase, in the liver.

An increase of the enzyme reductase increases the production of cholesterol by the liver.

(i) Which part of a liver cell is responsible for controlling the production of reductase?

.....

.....

(1)

(ii) High blood cholesterol concentrations increase the likelihood of heart and circulatory diseases.

Doctors can prescribe statins to control the concentration of cholesterol in the blood.

Suggest how statins work.

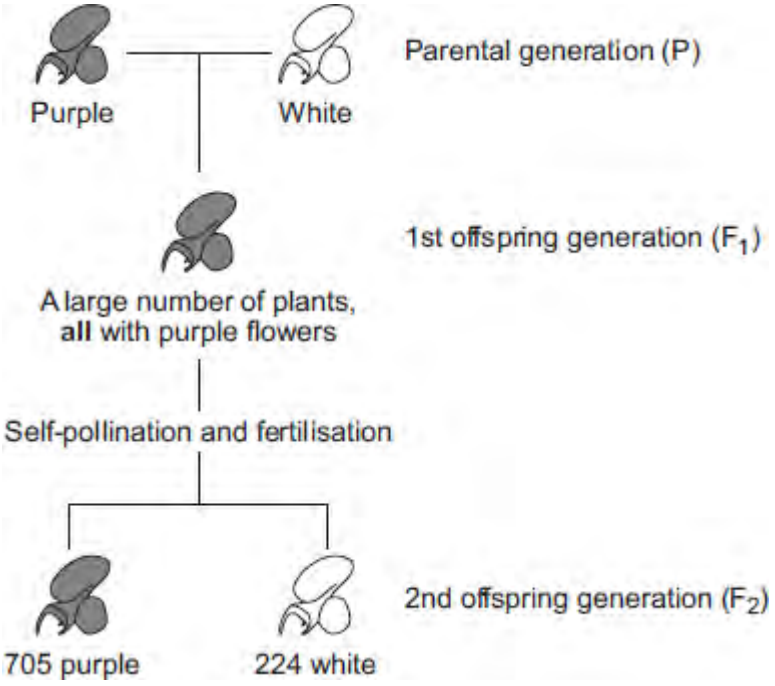
.....

.....

(1)
(Total 9 marks)

Q3. In 1866, Gregor Mendel published the results of his investigations into inheritance in garden pea plants.

The diagram below shows the results Mendel obtained in one investigation with purple-flowered and white-flowered pea plants.



(a) (i) Calculate the ratio of purple-flowered plants to white-flowered plants in the F_2 generation.

Ratio of purple : white = ...

(1)

(ii) There was a total of 929 plants in the F_2 generation.

Mendel thought that the production of a large number of offspring plants improved the investigation.

Explain why.

.....

.....

.....

.....

(2)

(b) (i) Some of the plants in the diagram are homozygous for flower colour and some are heterozygous.

Complete the table to show whether each of the plants is homozygous or heterozygous. For each plant, tick (✓) **one** box.

	Homozygous	**Heterozygous**
Purple-flowered plant in the P generation		
White-flowered plant in the P generation		
Purple-flowered plant in the F_1 generation		

(2)

(ii) Draw a genetic diagram to show how self-pollination of the F_1 purple-flowered plants produced mainly purple-flowered offspring in the F_2 generation together with some white-flowered offspring.

Use the following symbols:

N = allele for purple flower colour
n = allele for white flower colour

(3)

(c) When Mendel published his work on genetics, other scientists at the time did not realise how important it was.

Suggest **two** reasons why.

1.....

.....

2.....

.....

(2)
(Total 10 marks)

Q4. Read the information.

Insects can be both useful and harmful to crop plants.
Insects such as bees pollinate the flowers of some crop plants. Pollination is needed for successful sexual reproduction of crop plants.
Some insects eat crops and other insects eat the insects that eat crops.

Corn borers are insects that eat maize plants.
A toxin produced by the bacterium *Bacillus thuringiensis* kills insects.
Scientists grow *Bacillus thuringiensis* in large containers. The toxin is collected from the containers and is sprayed over maize crops to kill corn borers.

A company has developed genetically modified (GM) maize plants. GM maize plants contain a gene from *Bacillus thuringiensis*. This gene changes the GM maize plants so that they produce the toxin.

(a) Describe how scientists can transfer the gene from *Bacillus thuringiensis* to maize plants.

.....

.....

.....

.....

.....

.....

.....

(3)

(b) Would you advise farmers to grow GM maize plants?

Justify your answer by giving advantages and disadvantages of growing GM maize plants.

Use the information from the box and your own knowledge to help you.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)
(Total 7 marks)

Q5. Phenylketonuria (PKU) is an inherited condition. PKU makes people ill.

(a) PKU is caused by a recessive allele.

(i) What is an allele?

.....

.....

(1)

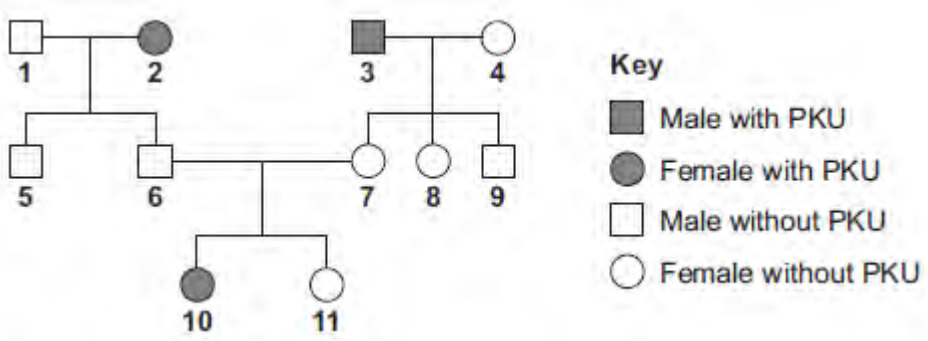
(ii) What is meant by recessive?

.....

.....

(1)

(b) The diagram below shows the inheritance of PKU in one family.



(i) Give **one** piece of evidence from the diagram that PKU is caused by a recessive allele.

.....

.....

(1)

(ii) Persons **6** and **7** are planning to have another child.
Use a genetic diagram to find the probability that the new child will have PKU.

Use the following symbols in your answer:

N = the dominant allele for **not** having PKU

n = the recessive allele for PKU.

Probability = ...

(4)

(c) Persons **6** and **7** wish to avoid having another child with PKU.

A genetic counsellor advises that they could produce several embryos by IVF treatment.

(i) During IVF treatment, each fertilised egg cell forms an embryo by cell division.

Name this type of cell division.

.....

(1)

(ii) An embryo screening technique could be used to find the genotype of each embryo.

An unaffected embryo could then be placed in person **7**'s uterus.

The screening technique is carried out on a cell from an embryo after just three cell divisions of the fertilised egg.

How many cells will there be in an embryo after the fertilised egg has

divided three times? ☐

(1)

(iii) During embryo screening, a technician tests the genetic material of the embryo to find out which alleles are present.

The genetic material is made up of large molecules of a chemical substance.

Name this chemical substance.

.....

(1)

(d) Some people have ethical objections to embryo screening.

(i) Give **one** ethical objection to embryo screening.

.....

(1)

(ii) Give **one** reason in favour of embryo screening.

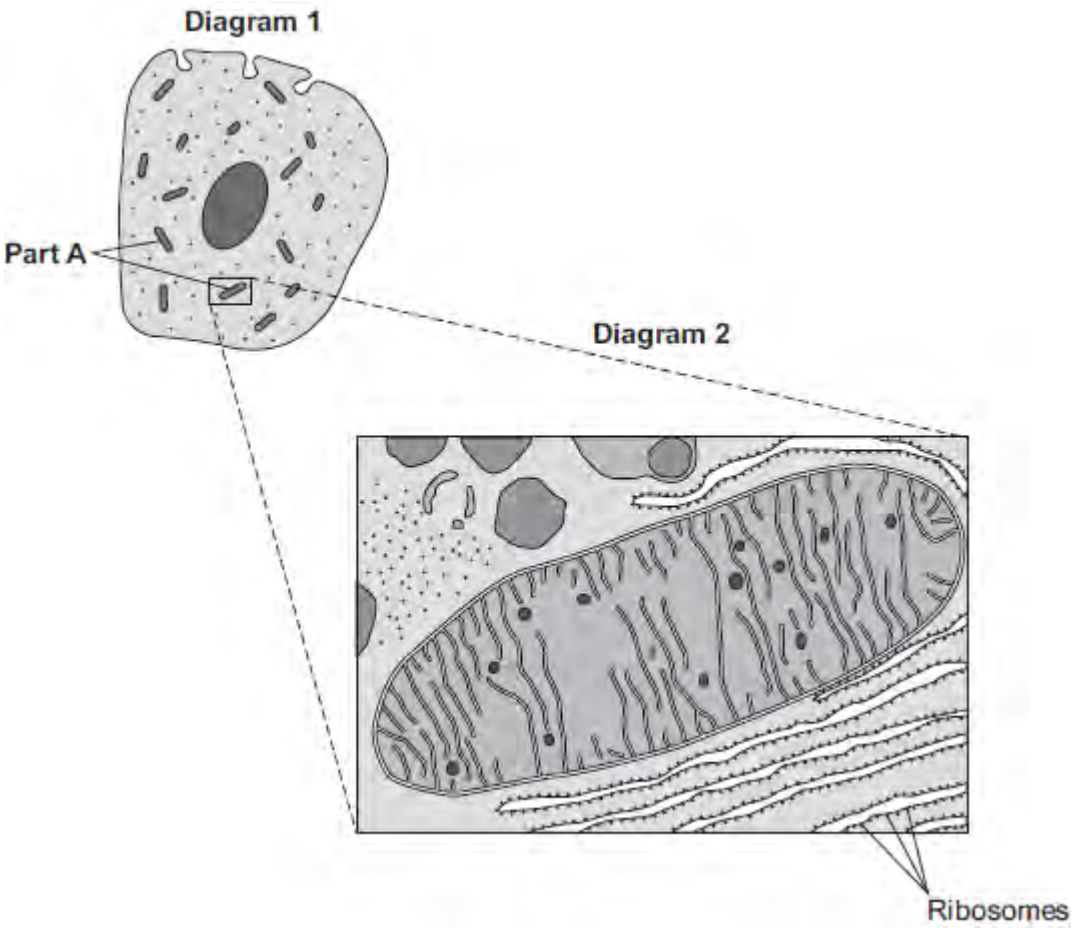
.....

(1)

(Total 12 marks)

Q6.Diagram 1 shows a cell from the pancreas.

Diagram 2 shows part of the cell seen under an electron microscope.



Part **A** is where most of the reactions of aerobic respiration happen.

(a) (i) Name part **A**.

.....

(1)

(ii) Complete the equation for aerobic respiration.

glucose + oxygen ⟶ ..... + ... (+ energy)

(2)

(iii) Part **A** uses oxygen.

Explain how oxygen passes from the blood to part **A**.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(b) The pancreas cell makes enzymes.

Enzymes are proteins.

Describe how the ribosomes and part **A** help the cell to make enzymes.

.....

.....

.....

.....

.....

.....

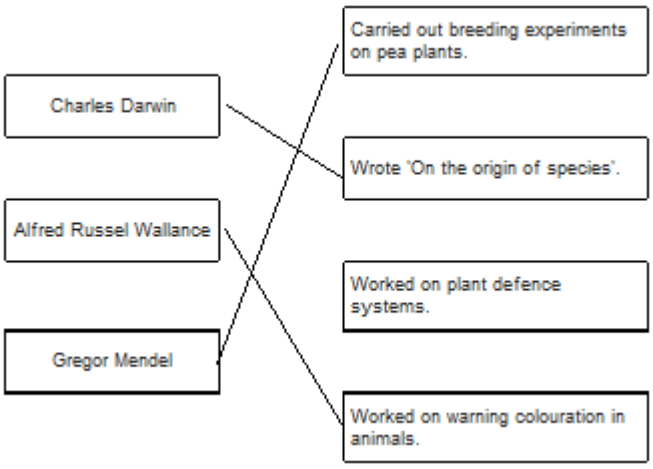
.....

.....

(3)
(Total 9 marks)

M1.

(a)



3

(b) a gene

allow allele

1

(c) 4

1

(d) correct derivation of children's genotypes

1

identification of children with cystic fibrosis (dd)

1

0.25

allow ecf

allow ¼ / 25% / 1 in 4 / 1:3

1

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

(e) heterozygous

1

[9]

M2.(a) selection

1

(b) (i) 4

1

(ii) ground finch / lives on the ground

1

(only) eats seeds

*allow eg eats seeds on / from the ground for **2** marks*

1

(c) Lamarck

1

[5]

M3.(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]

M4.(a) (i) (volume) increases (with time)

ignore numbers

1

(ii) there is more evidence / specimens / results (for Homo sapiens)

allow examples of this, eg more / better fossils

allow converse if clearly referring to Australopithecus

ignore reference to being 'more recent'

1

(b) 2.5 – 3.15 (million years ago)

accept any number in range

1

(c) (i) Darwin

1

(ii) any **one** from:

- they believed in other theories
  allow they believed that God made all life
- insufficient evidence
  ignore 'no evidence'
- no proof
  allow not enough proof
- genes / mechanism of inheritance not known / discovered

1

[5]

M5.(a) fossils show change over time.

1

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

1

soft parts decay / are eaten
or
bones / hard parts / shell do not decay

1

minerals enter bones / parts are replaced by minerals / mineralisation
accept turns to rock
allow 'is an impression' / 'imprint' / 'cast'

1

(c) skin is soft / skin not preserved / not fossilised / skin decays
accept not enough / no evidence / no-one has seen one
allow 'this fossil is only bones'

1

(d) any **two** examples of:

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

physical factors such as volcanic activity (allow volcanoes) / earthquakes / asteroid (collision) / ice age / temperature change

ignore pollution

and / or

biological factors such as predators / disease / named pathogen / competition/ lack of food / mates / cyclical nature of speciation / isolation / lack of habitat or habitat change

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

2

[7]

M6.(a) pathogens

1

(b) (i) A disease affecting people in many countries

1

(ii) birds fly / migrate

accept converse

OR

human contact with birds more likely

birds not contained / difficult to control movement

OR

there are more birds (than pigs)

1

(c) (i) antibiotics (only) kill bacteria

ignore flu is caused by a virus unqualified

OR

antibiotics don't kill viruses

ignore virus resistant / immune

1

(ii) painkillers

accept any correct named painkiller, eg aspirin or paracetamol

allow antivirals / Tamiflu

ignore medicine / tablets

1

(iii) resistant

1

bacteria

1

in this order

[7]

M7.(a) (i) natural

1

(ii) simple

1

(iii) three billion

1

(b) any **two** from:

- reference to religion
- insufficient evidence / couldn't prove it / no proof
  ignore no evidence
- mechanism of inheritance / variation not known
  allow genes / DNA not known about

- reference to other theories
- reference to Darwin's status

2

(c) (i) tree

1

(ii) hippopotamus **and** pig

both required, either order

allow hippo

1

(iii) new evidence from fossils

1

[8]

M8.(a) (i) animal walking on soft material **or** suitably named material

or

further detail – eg dries out / buried / hardens / turns to rock

*do **not** allow general descriptions of how fossils are formed*
***or** reference to bones not decaying*

1

(ii) any **one** from:

- (from) bones / shells / hard parts **or** from parts that do not decay / rot or are preserved

  ignore imprint / impression
- animal trapped in resin / amber / ice / peat

  allow frozen
- infiltration with minerals / named

1

(b) any **two** from:

examples of physical factors such as flooding, volcanic activity (allow volcanoes) asteroid collision, drought, ice age / temperature change

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

ignore pollution

examples of biological factors such as predators (allow hunters), disease / named pathogen, competition lack of food / mates, cyclical nature of speciation / isolation / lack of habitat or habitat change

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

2

(c) older fossils simpler

to gain the mark there must be implication of change

or

change (with time)

ignore evolve
ignore extinction

1

(d) insufficient / no evidence / no remains **or** fossils survive

ignore no people were there

allow no proof

1

[6]

M9. any **two** from:

- religious objections
- insufficient evidence

  allow 'could not prove'
  *ignore '**no** evidence'*
- mechanism of heredity not known

[2]

Q1. Our understanding of genetics and inheritance has improved due to the work of many scientists.

(a) Draw **one** line from each scientist to the description of their significant work.

Scientist	Description of significant work
Charles Darwin	Carried out breeding experiments on pea plants.
Alfred Russel Wallance	Wrote 'On the origin of species'.
Gregor Mendel	Worked on plant defence systems.
	Worked on warning colouration in animals.

(3)

(b) In the mid-20th century the structure of DNA was discovered.

What is a section of DNA which codes for one specific protein called?

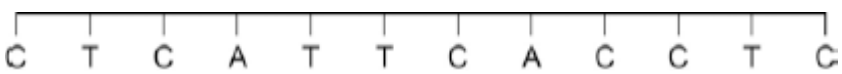
.....

(1)

(c) **Figure 1** shows one strand of DNA.

The strand has a sequence of bases (A, C, G and T).

Figure 1



How many amino acids does the strand of DNA in **Figure 1** code for?

Tick **one** box.

2 ☐

3 ☐

4 ☐

6 ☐

(1)

(d) Mutations of DNA cause some inherited disorders.

One inherited disorder is cystic fibrosis (CF).

A recessive allele causes CF.

Complete the genetic diagram in **Figure 2**.

- Identify any children with CF.
- Give the probability of any children having CF.

Each parent does not have CF.

The following symbols have been used:

D = dominant allele for **not** having CF

d = recessive allele for having CF

Figure 2

		Mother	
		D	d
Father	D	DD	
	d		

Probability of a child with CF = ...

(3)

(e) What is the genotype of the mother shown in **Figure 2**?

Tick **one** box.

Heterozygous ☐

Homozygous dominant ☐

Homozygous recessive ☐

(1)
(Total 9 marks)

Q2. In the 1800s, Charles Darwin visited the Galapagos Islands. On the islands he found many different species of bird called finches. Darwin thought that all the different finch species had evolved from one species of finch that had reached the islands many years before.

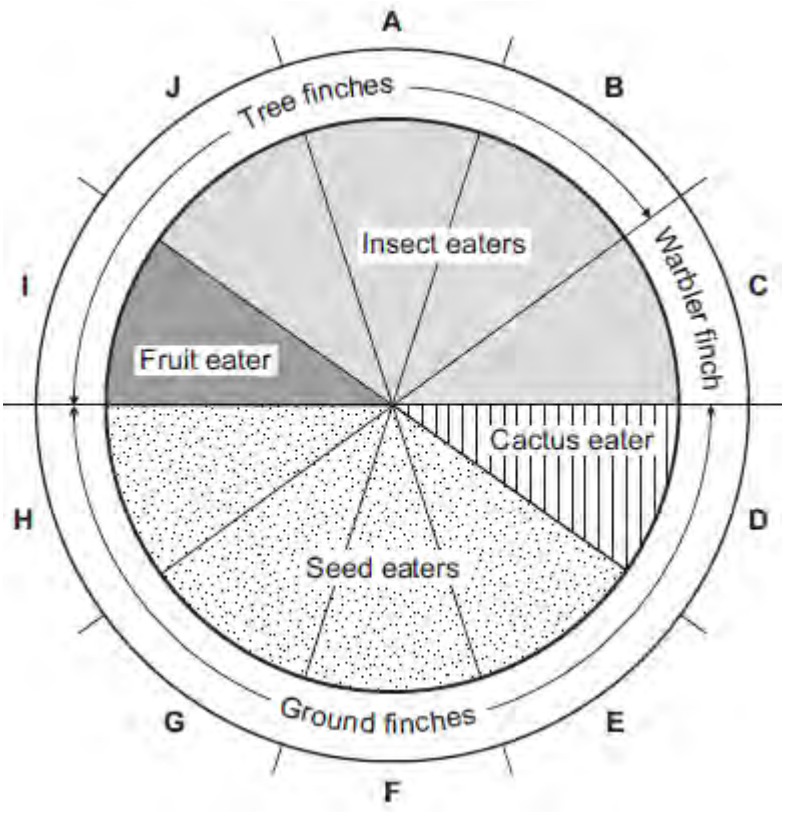
(a) Complete the following sentence.

Darwin suggested the theory of evolution by natural

.....

(1)

(b) The pie chart shows information about ten species of finch, **A – J**.



(i) How many of the species of finch eat insects?

Draw a ring around the correct answer.

4 **5** **6**

(1)

(ii) Describe finch species **G**.
Use **only** information from the pie chart.

.....

.....

.....

.....

(2)

(c) When Darwin returned to the UK very few people believed his theory of evolution.

A different scientist suggested that the changes that occur in an organism during its

lifetime can be inherited by its offspring.

What was the name of this scientist?

Tick (✓) **one** box.

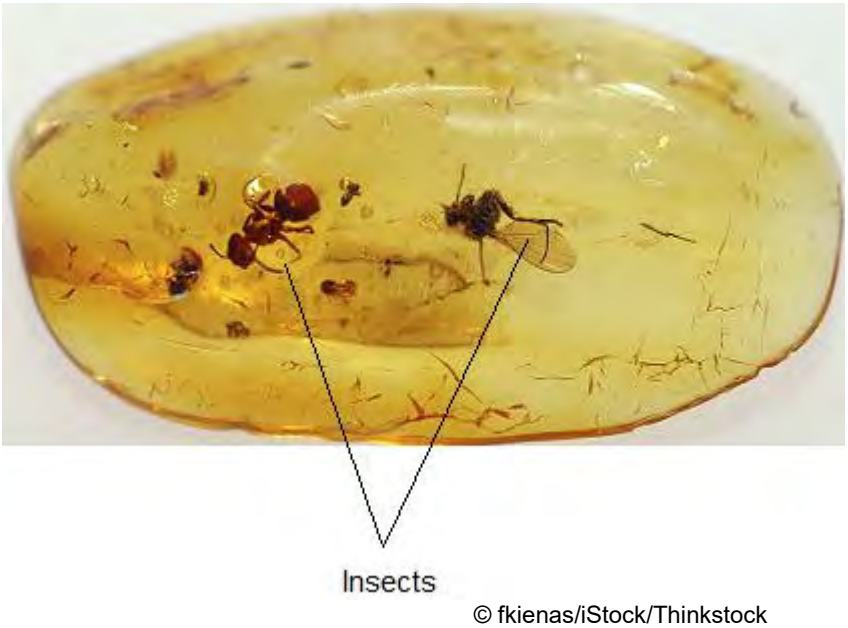
Lamarck	☐
Mendel	☐
Semmelweis	☐

(1)
(Total 5 marks)

Q3. 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.....

.....

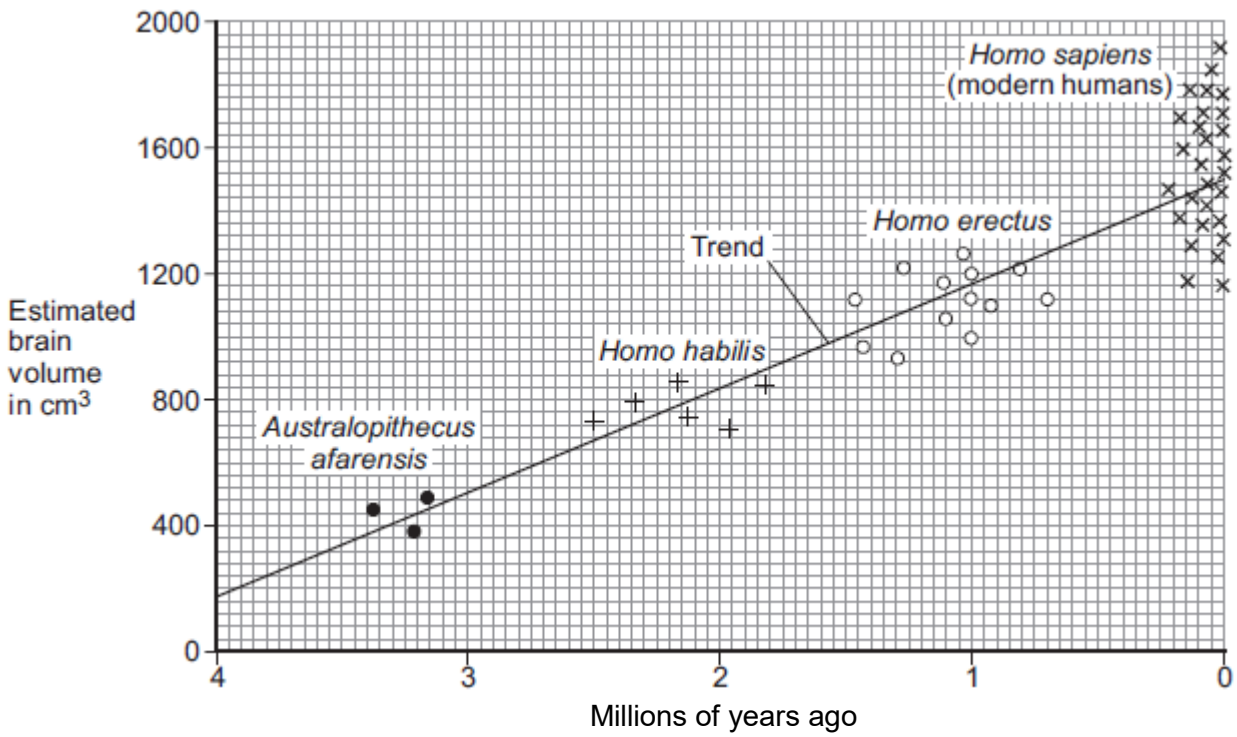
(3)
(Total 8 marks)

Q4. This question is about evolution in humans.

The graph shows:

- the estimated brain volume of different species of humans
- the time when the different species existed on Earth.

The data is plotted for modern humans (Homo sapiens) and for three types of extinct ancestors of humans.



Key
Each point plotted on the graph shows the estimate for one human.

(a) (i) As humans evolved, their brain volume changed.

What has happened to human brain volume over the past 4 million years?

.....

.....

(1)

(ii) Why is the evidence for estimated brain volume for *Homo sapiens* stronger than the evidence for *Australopithecus afarensis*?

.....

.....

(1)

(b) In a book, the brain volume of a different species, *Australopithecus africanus*, is stated to be about 600 cm^3.

Use evidence from the graphic above to estimate when *Australopithecus africanus* lived on Earth.

Estimate = ... million years ago

(1)

(c) Scientists believe that modern humans evolved by natural selection from *Australopithecus afarensis.*

(i) Complete the following sentence.

In the nineteenth century, the scientist who suggested the theory of evolution by natural selection was Charles ..... .

(1)

(ii) In the nineteenth century, many people did not accept this scientist's theory.

Give **one** reason why.

.....

.....

(1)
(Total 5 marks)

Q5.Figure 1 shows a fossil of a sea animal called a Plesiosaur.
The Plesiosaur was alive about 135 million years ago.

Figure 1

By Andy Dingley (Own work) [CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons

(a) How can fossils give evidence for evolution?

Tick (✓) **one** box.

Newer fossils are simpler than older fossils. ☐

Fossils show change over time. ☐

All fossils show the bones of animals. ☐

(1)

(b) Plesiosaurs lived in the sea. There was mud at the bottom of the sea.

Suggest how the fossil shown in **Figure 1** may have been formed after the animal died.

.....

.....

.....

.....

.....

.....

(3)

(c) **Figure 2** shows what scientists think a living Plesiosaur may have looked like.

Figure 2

© Andreas Meyer/Hemera/Thinkstock

Scientists think that the Plesiosaur had smooth skin, with no scales.

The scientists **cannot** be certain what the skin of a Plesiosaur was like. Suggest why.

.....

.....

(1)

(d) Plesiosaurs are now extinct.

Give **two** possible reasons why.

1 .....

.....

2 .....

.....

(2)
(Total 7 marks)

Q6. Viruses and bacteria cause diseases in humans.

(a) Draw a ring around the correct word to complete the sentence.

Organisms that cause disease are called	algae.
	pathogens.
	vaccines.

(1)

(b) In August 2011 the United Nations gave a warning that there was a new strain of the bird flu virus in China.

Bird flu may kill humans. The new strain of the bird flu virus could cause a *pandemic* very quickly.

(i) What is a *pandemic*?

Tick (✓) **one** box.

A disease affecting the people all over one country. ☐

A disease affecting hundreds of people. ☐

A disease affecting people in many countries. ☐

(1)

(ii) The swine flu virus is carried by pigs.

The bird flu virus is likely to spread much more quickly than the swine flu virus.

Suggest **one** reason why.

.....

.....

(1)

This notice is from a doctor's surgery.

Unfortunately,
antibiotics
will NOT get
rid of your flu.

(c) (i) Why will antibiotics **not** get rid of flu?

.....

.....

(1)

(ii) The symptoms of flu include a sore throat and aching muscles.

What would a doctor give to a patient to relieve the symptoms of flu?

.....

(1)

(iii) It is important that antibiotics are **not** overused.

Explain why.

Use words from the box to complete the sentence.

antibody	**bacteria**	**immune**	**resistant**	**viruses**

Overuse of antibiotics might speed up the development

of ..... strains of ..... .

(2)

(Total 7 marks)

Q7.(a) Complete the sentences about evolution.

Draw a ring around the correct answer to complete each sentence.

(i) Darwin suggested the theory of evolution by

artificial
natural
asexual

selection.

(1)

(ii) Darwin's theory of evolution says that all species of living things have evolved from

artificial
complex
simple

life forms.

(1)

(iii) Most scientists believe that life first developed about

three billion
three million
three thousand

years ago.

(1)

(b) Darwin's theory of evolution was only slowly accepted by other people.

Give **two** reasons why.

1.....

.....

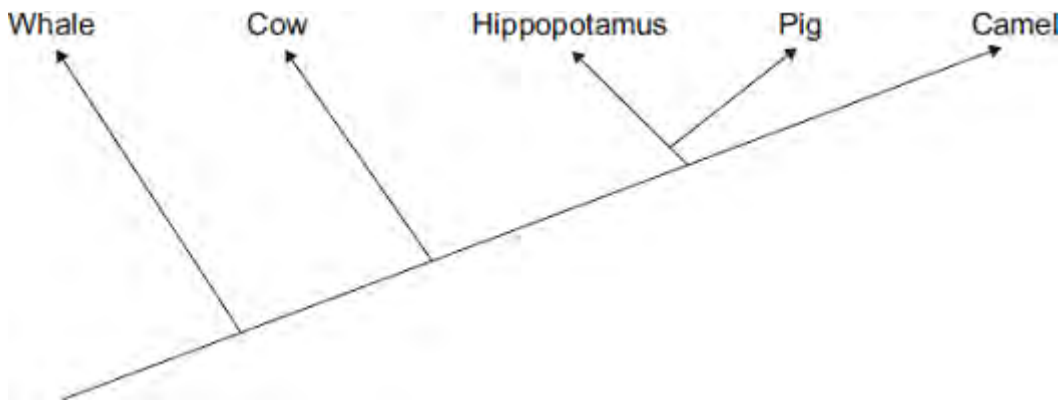
2.....

.....

(2)

(c) **Diagram 1** shows one model of the relationship between some animals.

Diagram 1



(i) Complete the sentence.

The model shown in **Diagram 1** is an evolutionary ..... .

(1)

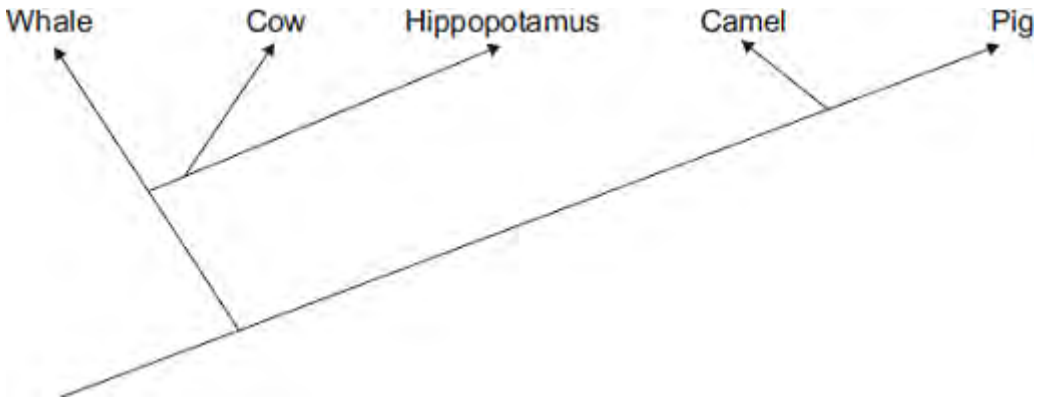
(ii) Which **two** of the animals in **Diagram 1** are most closely related?

..... and .....

(1)

(iii) Diagram **2** shows a more recent model of the relationship between the animals.

Diagram 2



Suggest **one** reason why scientists have changed the model of the relationships between the animals shown in the diagram.

Draw a ring around the correct answer.

more powerful computers	**new evidence from fossils**	**new species discovered**

(1)
(Total 8 marks)

Q8. The photograph shows a fossil footprint. The fossil was found in a rock at the bottom of a shallow river.

Scientists believe this is the footprint of a dinosaur. The dinosaur was alive 110 million years ago.

© Pearl Jackson/iStock

(a) (i) Suggest how the fossil shown in the photograph was formed.

.....

.....

(1)

(ii) Fossils may also be formed by other methods.

Describe **one** other method of forming a fossil.

.....

.....

(1)

(b) Dinosaurs are now extinct.

Give **two** factors that can cause extinction.

1 .....

.....

2 .....

.....

(2)

(c) How can fossils give evidence for evolution?

.....

.....

(1)

(d) Scientists are uncertain about how life began on Earth.

Why?

.....

.....

(1)

(Total 6 marks)

Q9. Darwin was the first scientist to state that humans and other primates had common ancestors.

Many people were against Darwin's ideas at that time.

Give **two** reasons why they were against his ideas.

1 .....

.....

2 .....

.....

(Total 2 marks)

M1.(a) (Jean Baptiste) Lamarck

allow phonetic spelling

1

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

1

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

1

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

1

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

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

0 marks:
No relevant content.

Indicative content

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

explanations:
- different colours are controlled by different genes / alleles / are caused by

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

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

4

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

1

[9]

M2.(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]

M3.(a) microorganism / bacteria / virus / fungus that causes (infectious) disease

1

(b) reduce / stop use of (current) antibiotics

1

(reduce / stop use) for non-serious / mild / viral infections

allow ensure course is completed

allow use of variety of antibiotics

1

(c) (i) 40 °C

1

(ii) any **one** from:

- microorganisms grow / reproduce / work / act faster
- results / product acquired sooner

1

[5]

M4.(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]

M5.(a) any **two** from:

- most people still believed that God made all the animals / plants on Earth

  allow against their 'religion'
- insufficient evidence

  do not allow no proof / evidence

  ignore 'fossil'
- the mechanism of inheritance / genes unknown (at the time)

2

(b) any **four** from:

- finches separated / isolated
- genetic variation / mutation (in finch population(s))
- finches with alleles / genes best suited to their environment survive

  Do not allow 'characteristics'
- advantageous alleles / genes passed on (to offspring)
- after many generations / a long time, the populations can no longer successfully interbreed

  Ignore 'speciation'

4

(c) (i) vegetarian finch

1

(ii) **R**

1

(iii) mangrove **and** woodpecker finches

1

[9]

M6.(a) mumps

in either order rubella / German measles
both needed for the mark
ignore measles unqualified

1

(b) (i) 80(.0)

*allow **1** mark for* $\frac{504}{630}$ ***or** 0.8*

2

(ii) less chance of epidemic / pandemic

or

less chance of spread of disease / measles / mumps / rubella

allow idea of herd immunity (increased protection for those who are not vaccinated)
*ignore less chance of getting the disease **or** to eradicate the disease*

1

(c) (i) dead / inactive pathogens / viruses / bacteria

allow antigens / proteins from pathogens / viruses / bacteria
ignore microorganisms

1

(ii) white blood cells produce <u>antibodies</u>

1

antibodies produced rapidly (on re-infection) **or** response rapid (on re-infection)

allow ecf if antibodies incorrectly identified in first marking point

1

these antibodies kill pathogens / viruses / bacteria

*do **not** accept idea that original antibodies remain in blood and kill pathogens*

1

(d) (i) antibiotics don't kill viruses

allow antibiotics only kill bacteria

1

(because measles) virus / pathogen lives inside cells

*allow antibiotics do not work inside cells **or** killing virus / pathogen would kill / damage cell*

1

(ii) (bacteria / pathogens) develop resistance (to antibiotic)

ignore reference to immunity

ignore viruses develop resistance

1

[11]

Q1. Charles Darwin proposed the theory of natural selection.

Many people at the time did not accept his theory.

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

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

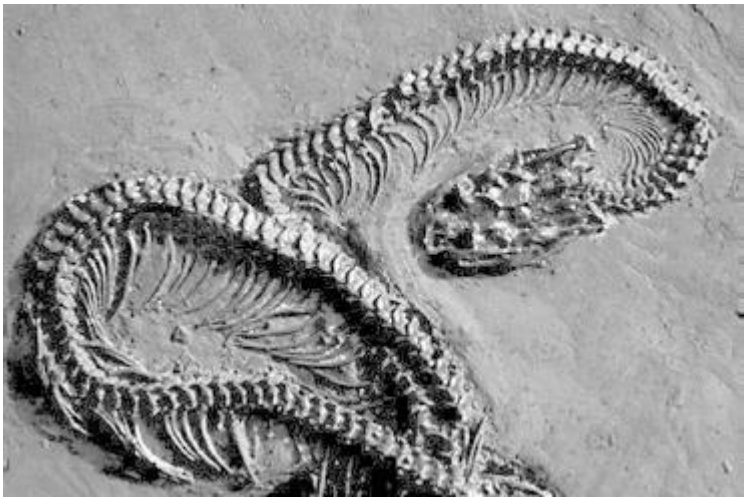
Who proposed this theory?

.....

(1)

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

The diagram below shows a fossilised snake.



© Peter Menzel/Science Photo Library

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

.....

.....

.....

.....

.....

.....

(3)

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

The table below shows two types of rat snake.

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

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

The rat snakes have evolved to to suit their environments.

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

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(d) Many species of snake have become extinct.

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

.....

.....

(1)
(Total 9 marks)

Q2.(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)

Q3. Antibiotics can be used to protect our bodies from pathogens.

(a) What is a pathogen?

.....

.....

(1)

(b) Bacteria may become resistant to antibiotics.

How can doctors reduce the number of bacteria that become resistant to antibiotics?

.....

.....

.....

.....

(2)

(c) Scientists grow microorganisms in industrial conditions at a higher temperature than is used in school laboratories.

(i) Which temperature would be most suitable for growing bacteria in industrial conditions?

Draw a ring around the correct answer.

25 °C **40 °C** **100 °C**

(1)

(ii) What is the advantage of using the temperature you gave in part (c)(i)?

.....

.....

(1)
(Total 5 marks)

Q4. 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 W kimedia 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.

.....

.....

.....

.....

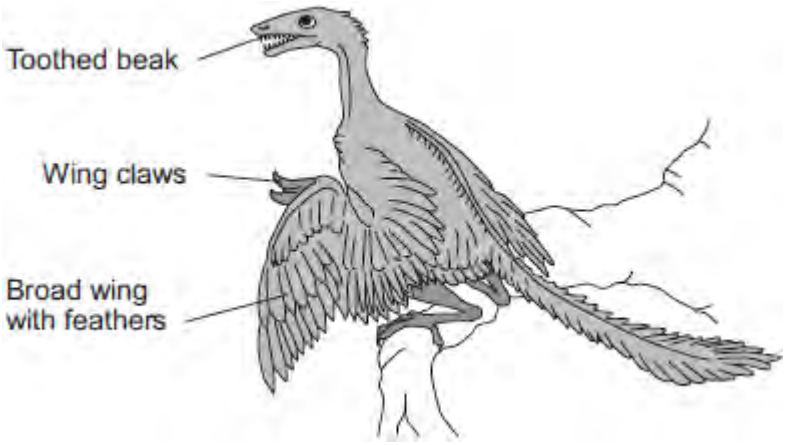
.....

.....

(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)

Q5. Darwin's theory of evolution states that all species of living things have evolved from simple life forms.

Darwin's theory was published in 1859.

(a) Give **two** reasons why Darwin's theory was only slowly accepted.

.....

.....

.....

.....

(2)

(b) Darwin observed birds called finches on the Galapagos Islands, 1000 km from the coast of South America.

He saw that the birds were similar to, but not the same as, birds he had seen on the mainland of South America.

Recent evidence suggests that 13 different species of finch on the islands evolved from 1 species of finch that arrived from the mainland about 1 million years ago.

Describe how a new finch species may have evolved from the original species of finch that arrived from the mainland.

.....

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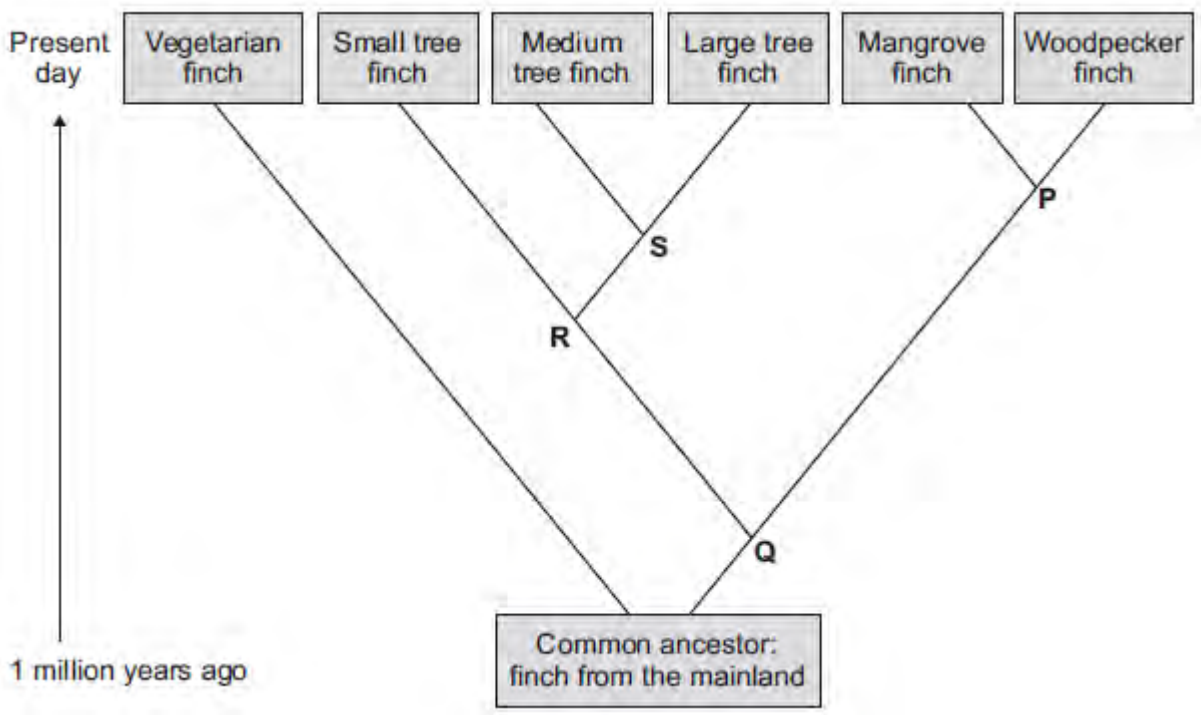
.....

.....

(4)

(c) The diagram below shows the evolutionary tree for some Galapagos finches.



(i) Which type of present-day finch is **least** closely related to all the others?

.....

(1)

(ii) Which branching point, **P, Q, R** or **S**, on the diagram above shows the most recent common ancestor of all the **tree finches**?

Write the correct answer in the box. ☐

(1)

(iii) Which **two** finches have the most recent common ancestor?

1 .....

2 .....

(1)

(Total 9 marks)

Q6. The MMR vaccine is used to protect against measles.

(a) Apart from measles, which **two** other diseases does the MMR vaccine protect against?

..... and .....

(1)

(b) Read the information.

Measles is a dangerous disease caused by a virus. Normally, MMR vaccinations are given at 1 year old and again at 4 years old. Each vaccination is 90% effective in protecting against the measles virus. In April 2013, there were 630 cases of measles in children aged 4 and over in a small area of the UK. Of these cases, 504 children had not been vaccinated against MMR at all and only a few had been given a second vaccination.

(i) Calculate the percentage of the children who caught measles in April 2013 who had **not** been vaccinated against MMR.

.....

.....

.....

Percentage = ...

(2)

(ii) Suggest **one** advantage to the population as a whole of children having the second MMR vaccination.

.....

(1)

(c) (i) What does a vaccine contain?

.....

.....

(1)

(ii) Explain how a vaccination prevents infection.

.....

.....

.....

.....

.....

.....

.....

(3)

(d) (i) Antibiotics can only be used to treat some infections.

Explain why antibiotics **cannot** be used to treat measles.

.....

.....

.....

.....

(2)

(ii) Why do antibiotics become less useful at treating an infection if the antibiotic is

overused?

.....

.....

(1)
(Total 11 marks)

M1.(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]

M2.(a) (i) 3.15 : 1

accept 3.147:1 ***or*** *3.1 : 1* ***or*** *3 : 1*
do ***not*** *accept 3.14 : 1*
Ignore 705:224

1

(ii) any **two** from:

- fertilisation is random **or** ref. to chance combinations (of alleles / genes / chromosomes)
- more likely to get theoretical ratios **or** see (correct) pattern **or** get valid results if large number
  allow ref. to more representative / reliable
  do ***not*** *allow more accurate* ***or*** *precise*
  ignore fair / repeatable
- anomalies have limited effect / anomalies can be identified
  accept example of an anomaly

2

(b) (i) in sequence:

Homozygous
Homozygous
Heterozygous

All 3 correct = 2 marks
2 correct = 1 mark
1 or 0 correct = 0 marks

2

(ii) genetic diagram including:

Parental genotypes: **Nn** and **Nn**
allow other characters / symbols only if clearly defined

1

or

Gametes: **N** and **n + N** and **n** <u>derivation</u> of offspring genotypes:
NN Nn Nn nn
allow genotypes correctly derived from candidate's P gametes

1

identification: **NN** and **Nn** as purple **and nn** as white

allow correct identification of candidate's offspring genotypes but only if some F_2 are purple and some are white

1

(c) any **two** from:

- did not know about chromosomes / genes / DNA
  or did not know chromosomes occurred in pairs

  ignore genetics
- had pre-conceived theories

  eg blending of inherited characters

  ignore religious ideas unless qualified
- Mendel's (mathematical) approach was novel concept

  allow his work was not understood or no other scientist had similar ideas
- Mendel was not part of academic establishment

  allow he was not considered to be a scientist / not well known / he was only a monk
- work published in obscure journal / work lost for many years
- peas gave unusual results cf other species

  allow he only worked on pea plants
- Mendel's results were not corroborated until later / 1900

2

[10]

M3.(a) (i) variation (in population) / mutation

1

longer nosed individuals get more food / leaves

allow longer nosed individuals more likely to survive

1

(these) survivors breed (more)

1

pass on genes / alleles / DNA (for long nose)

allow pass on mutation

1

(ii) Phiomia / ancestor stretched its nose (during its lifetime) to reach food / leaves

1

passed on (stretched nose) to offspring

allow offspring inherit (stretched nose)

*do **not** allow ref to genes*

1

(b) (i) insufficient evidence / no proof

ignore other theories, eg religion

*do **not** allow no evidence*

1

mechanism of inheritance not known

allow genes / DNA not discovered

1

(ii) God made all living things / them

allow creationism

ignore religion

1

[9]

M4.(a) lack of fossils / fossils destroyed

allow lack of evidence

1

(due to soft parts) decaying / geological activity

allow an example – eg vulcanism or earth movements or erosion

allow converse points re skeletons, shells, hard parts

1

(b) (i) **A** and **B** did not mate successfully

*'**A** and **B** did not mate' insufficient*

allow did not produce fertile offspring

1

(ii) any **two** from:

- may not be mating season
- **A** and **B** may not find each other attractive
- this is just a one-off attempt / an anomaly / need repeats
- may be juvenile / immature
- may be the same sex

allow other sensible suggestion eg were put in unfavourable environment or one / both could be infertile

2

(c) 1. (two ancestral populations) separated (by geographical barrier / by land) / were isolated

1

2. genetic variation (in each population) **or** different / new alleles **or** mutations occur

1

3. different environment / conditions

allow abiotic or biotic example

1

4. natural selection occurs **or** some phenotypes survived **or** some genotypes survived

1

5. (favourable) alleles / genes / mutations passed on (in each population)

1

6. eventually two types cannot interbreed successfully

allow eventually cannot produce fertile offspring

1

[11]

M5.(a) variation (between organisms within species)

allow described example
*allow mutation – but **not** if caused by change in conditions*

1

those most suited / fittest survive

1

genes / alleles passed on (to offspring / next generation)
allow mutation passed on

1

(b) (i) any **two** from:
allow converse

- increase in latitude reduces number of (living) species
  ignore references to severity of conditions
- increase in latitude reduces time for evolution (of new species)
- the less the time to evolve the fewer the number of (living) species

2

(ii) any **two** from:
*do **not** accept intention or need to evolve*

- (increase in latitude reduces number of (living) species because) less food / habitats / more competition <u>at high latitude</u>
  allow only extremophiles / well-adapted species can survive
- (increase in latitude reduces time for evolution (of new species) because) severe conditions act more quickly / to a greater extent on the weakest
- (the less the time to evolve the fewer the number of (living) species because) species that evolve slowly don't survive

2

[7]

M6.(a) organisms that can breed together

accept converse points re. 2 different species

1

successfully

accept produces fertile offspring

1

(b) any **two** from:
(live at)

- different pH of soil
- different height above sea level
- different flowering times

2

AND

genetic variation / mutation / different alleles (produced in isolated populations)

1

natural selection acts differently on the two populations

or different characteristics in the two populations survive

or different alleles passed on in the two groups

1

eventually resulting in interbreeding no longer possible

1

[7]

M7.(a) wing pattern similar to *Amauris*

allow looks similar to Amauris

1

birds assume it will have an unpleasant taste

1

(b) mutation / variation produced wing pattern similar to *Amauris*

*do **not** accept breeds with Amauris*

*do **not** accept idea of intentional adaptation*

1

these butterflies not eaten (by birds)

1

these butterflies breed **or** their genes are passed to the next generation

1

[5]

Q1.(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.

(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*.

.....

.....

.....

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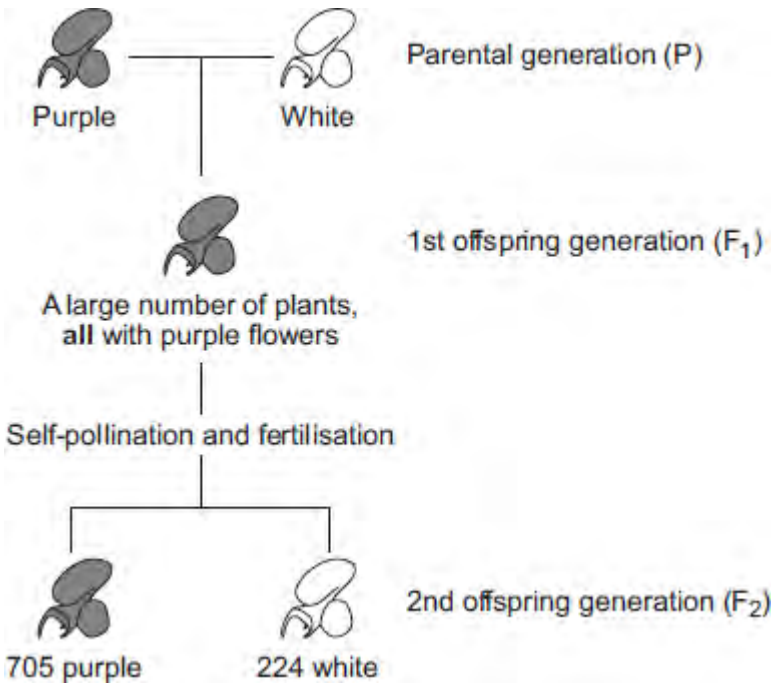
.....

(4)
(Total 8 marks)

Q2. In 1866, Gregor Mendel published the results of his investigations into inheritance in garden pea plants.

The diagram below shows the results Mendel obtained in one investigation with purple-flowered and white-flowered pea plants.



(a) (i) Calculate the ratio of purple-flowered plants to white-flowered plants in the F_2 generation.

Ratio of purple : white = ...

(1)

(ii) There was a total of 929 plants in the F_2 generation.

Mendel thought that the production of a large number of offspring plants improved the investigation.

Explain why.

.....

.....

.....

.....

(2)

(b) (i) Some of the plants in the diagram are homozygous for flower colour and some are heterozygous.

Complete the table to show whether each of the plants is homozygous or heterozygous. For each plant, tick (✓) **one** box.

	Homozygous	Heterozygous
Purple-flowered plant in the P generation		
White-flowered plant in the P generation		
Purple-flowered plant in the F_1 generation		

(2)

(ii) Draw a genetic diagram to show how self-pollination of the F_1 purple-flowered plants produced mainly purple-flowered offspring in the F_2 generation together with some white-flowered offspring.

Use the following symbols:

N = allele for purple flower colour
n = allele for white flower colour

(3)

(c) When Mendel published his work on genetics, other scientists at the time did not realise how important it was.

Suggest **two** reasons why.

1.....

.....

2.....

.....

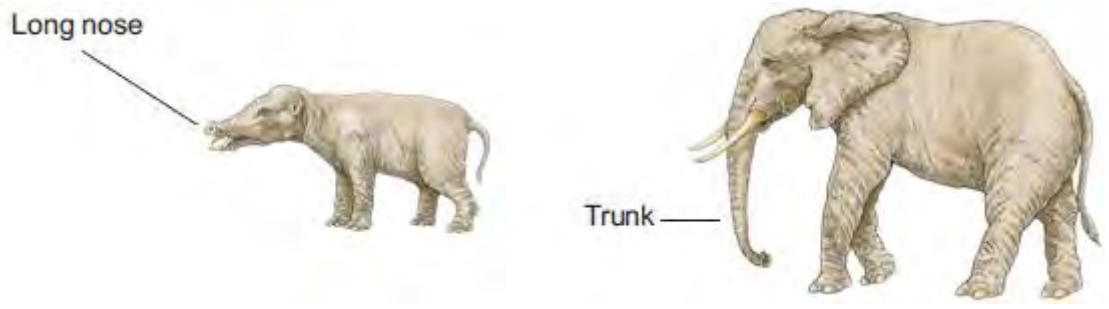
(2)
(Total 10 marks)

Q3. The image below shows:

- *Phiomia*, an ancestor of elephants
- a modern African elephant.

Phiomia lived about 35 million years ago.

Phiomia **African elephant**



Both *Phiomia* and the African elephant reach up into trees to get leaves.

In the 1800s, Darwin and Lamarck had different theories about how the long nose of *Phiomia* evolved into the trunk of the African elephant.

(a) (i) Use Darwin's theory of natural selection to explain how the elephant's trunk evolved.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(ii) Lamarck's theory is different from Darwin's theory.

Use Lamarck's theory to explain how the elephant's trunk evolved.

.....

.....

.....

.....

(2)

(b) (i) In the 1800s, many scientists could **not** decide whether Lamarck's theory or Darwin's theory was the right one.

Give **two** reasons why.

1 .....

.....

2 .....

.....

(2)

(ii) Before the 1800s, many people had a different idea to explain where all the living things on Earth came from.

What idea was this?

.....

.....

(1)
(Total 9 marks)

Q4.(a) Fossils provide evidence for what early life forms were like. From the evidence, scientists think that life began on Earth more than 3 billion years ago.

Many early life forms were soft-bodied.
Explain why this makes it difficult for scientists to be certain about what these early life forms were like.

.....

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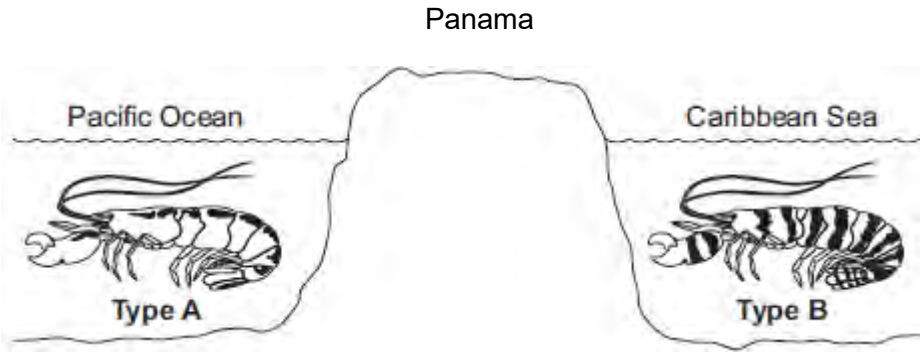
.....

(2)

(b) The illustration below shows two types of pistol shrimp.

The shrimps live in shallow, tropical seas on opposite sides of Panama.



Not to scale

Scientists put one **Type A** shrimp and one **Type B** shrimp together in a tank of seawater.
The two types of shrimp snapped their claws aggressively at each other.
They did not mate.

The scientists said that this was evidence for the **Type A** and **Type B** shrimps being classified as two different species.

(i) Give **one** reason why the scientists' opinion may be correct.

.....

.....

(1)

(ii) Suggest **two** reasons why the scientists' opinion may **not** be correct.

1 .....

.....

2 .....

.....

(2)

(c) Panama is a narrow strip of land which today joins North America and South America.
It was formed by land moving up from beneath the sea. Panama has separated the Pacific Ocean and the Caribbean Sea for the past 3 million years.

Explain how two different species of pistol shrimp could have developed from an ancestral species of shrimp.

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(6)
(Total 11 marks)

Q5. Darwin suggested the theory of natural selection.

(a) Explain how natural selection occurs.

.....

.....

.....

.....

.....

.....

.....

(3)

(b) Latitude is a measure of distance from the Earth's equator.

Scientists investigated the effect of latitude on:

- the time taken for new species to evolve
- the number of living species.

The table shows the scientists' results.

Latitude in degrees North of equator	Time taken for new species to evolve in millions of years	Relative number of living species
0 (at the equator)	3–4	100
25	2	80
50	1	30
75 (in the Arctic)	0.5	20

As latitude increases environmental conditions become more severe.

(i) Describe the patterns shown by the data.

.....

.....

.....

.....

.....

.....

(2)

(ii) Suggest explanations for the patterns you have described in part (b)(i).

.....

.....

.....

.....

.....

.....

(2)
(Total 7 marks)

Q6.*Howea forsteriana* and *Howea belmoreana* are two species of palm tree.

The two *species* grow together on a small island in the South Pacific.

(a) What is meant by the term *species* ?

.....

.....

.....

.....

(2)

(b) The table gives some information about these two species of palm tree.

	Howea forsteriana	*Howea belmoreana*
Optimum pH of the soil for growth of the palm tree	pH 8	pH 6
Height above sea level of most common habitat	30 to 60 metres	above 120 metres
Month when most palm trees flower	October	December
Method of pollination	Wind carries pollen	Wind carries pollen

Scientists believe that these two species of palm tree began to evolve from a single species over 2 million years ago.

Suggest how these two different species developed.

In your answer you should use information from the table and your own knowledge.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5)
(Total 7 marks)

Q7. The drawings show two different species of butterfly.

Amauris

Hypolimnas

- Both species can be eaten by most birds.
- *Amauris* has an unpleasant taste which birds do **not** like, so birds have learned**not** to prey on it.
- *Hypolimnas* does **not** have an unpleasant taste but most birds do **not** prey on it.

(a) Suggest why most birds do **not** prey on *Hypolimnas*.

.....

.....

.....

.....

(2)

(b) Suggest an explanation, in terms of natural selection, for the markings on the wings of *Hypolimnas*.

.....

.....

.....

.....

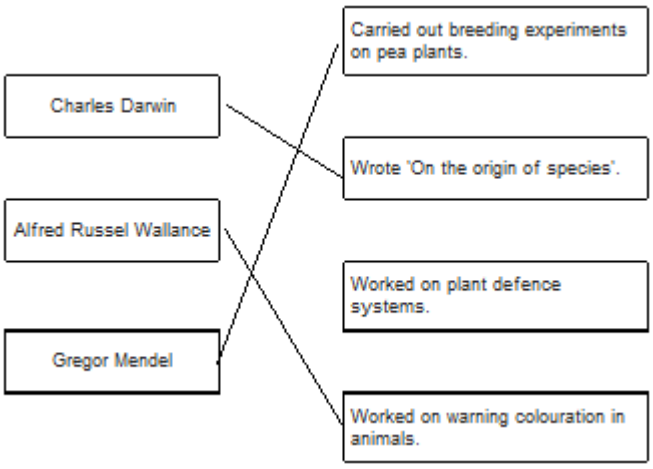
.....

.....

(3)
(Total 5 marks)

M1.

(a)



3

(b) a gene

allow allele

1

(c) 4

1

(d) correct derivation of children's genotypes

1

identification of children with cystic fibrosis (dd)

1

0.25

allow ecf

allow ¼ / 25% / 1 in 4 / 1:3

1

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

(e) heterozygous

1

[9]

M2.(a) Taking cuttings from plants

1

(b) (i) Adult cell cloning

1

(ii) an egg cell

1

(iii) nucleus

1

(iv) an electric shock

1

(v) uterus / womb

accept phonetic spelling

1

(c) any **two** from:

- unethical / immoral

  allow 'rights' of the cloned child

  allow against religious teachings
- cloned child would have to give up a kidney
- possible operation complications.

  allow illegal

  allow parents may not want another child

  allow a long time to wait (for the kidney)

2

[8]

M3.(a) selection

1

(b) (i) 4

1

(ii) ground finch / lives on the ground

1

(only) eats seeds

*allow eg eats seeds on / from the ground for **2** marks*

1

(c) Lamarck

1

[5]

M4.(a) (i) gamete(s)

ignore reproductive cells

1

(ii) womb / uterus

allow phonetic spellings

1

(b) (i) are formed from the same original embryo

1

(ii) embryo transplantation

1

(iii) any **one** from:

- (calves will have some) genes / DNA from bull / sperm
  allow not all genes from the cow
- idea that sexual reproduction produces variation
  allow may be male
  allow idea that gene for low fat milk may not be passed on

1

[5]

M5.(a) (i) (volume) increases (with time)

ignore numbers

1

(ii) there is more evidence / specimens / results (for Homo sapiens)

allow examples of this, eg more / better fossils
allow converse if clearly referring to Australopithecus
ignore reference to being 'more recent'

1

(b) 2.5 – 3.15 (million years ago)

accept any number in range

1

(c) (i) Darwin

1

(ii) any **one** from:

- they believed in other theories
  allow they believed that God made all life
- insufficient evidence
  ignore 'no evidence'
- no proof
  allow not enough proof
- genes / mechanism of inheritance not known / discovered

1

[5]

M6.(a) (i) natural

1

(ii) simple

1

(iii) three billion

1

(b) any **two** from:

- reference to religion
- insufficient evidence / couldn't prove it / no proof
  ignore no evidence
- mechanism of inheritance / variation not known
  allow genes / DNA not known about
- reference to other theories
- reference to Darwin's status

2

(c) (i) tree

1

(ii) hippopotamus **and** pig
both required, either order
allow hippo

1

(iii) new evidence from fossils

1

[8]

M7.(a) genes

1

chromosomes

1

(b) (i) higher yield

1

less use of pesticides

1

(ii) any **two** from:

- uncertain about effects on health
- fewer bees
- might breed with wild plant
- seeds only from one manufacturer

2

[6]

M8.(a) sulfur dioxide

1

(b) (i) mutation

1

(ii) pale form now (more) easily seen (by predators) **or** dark form now less easily seen (by predators)

accept ref to camouflage

1

so pale form (more) likely to be eaten **or** dark form less likely to be eaten

1

so dark form (more likely to) breed / pass on genes

or

pale form less likely to breed / pass on genes

1

(c) (i) pyramid of three layers of diminishing size

either way up

1

three labels in food chain order

award 2 marks only if the pyramid is correctly labelled

accept trees / birch

accept (peppered) moth(s) / larvae

1

(ii) some material is lost in waste from the birds

1

peppered moth larvae do not eat all the leaves from the trees

1

[9]

Q1. Our understanding of genetics and inheritance has improved due to the work of many scientists.

(a) Draw **one** line from each scientist to the description of their significant work.

Scientist	Description of significant work
Charles Darwin	Carried out breeding experiments on pea plants.
Alfred Russel Wallance	Wrote 'On the origin of species'.
Gregor Mendel	Worked on plant defence systems.
	Worked on warning colouration in animals.

(3)

(b) In the mid-20th century the structure of DNA was discovered.

What is a section of DNA which codes for one specific protein called?

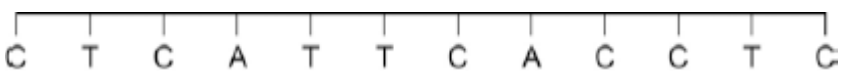
.....

(1)

(c) **Figure 1** shows one strand of DNA.

The strand has a sequence of bases (A, C, G and T).

Figure 1



How many amino acids does the strand of DNA in **Figure 1** code for?

Tick **one** box.

2 ☐

3 ☐

4 ☐

6 ☐

(1)

(d) Mutations of DNA cause some inherited disorders.

One inherited disorder is cystic fibrosis (CF).

A recessive allele causes CF.

Complete the genetic diagram in **Figure 2**.

- Identify any children with CF.
- Give the probability of any children having CF.

Each parent does not have CF.

The following symbols have been used:

D = dominant allele for **not** having CF

d = recessive allele for having CF

Figure 2

		Mother	
		D	d
Father	D	DD	
	d		

Probability of a child with CF = ...

(3)

(e) What is the genotype of the mother shown in **Figure 2**?

Tick **one** box.

Heterozygous ☐

Homozygous dominant ☐

Homozygous recessive ☐

(1)
(Total 9 marks)

Q2. Modern scientists use cloning techniques.

(a) Which **one** of the following is a method of producing cloned plants?

Tick (✓) **one** box.

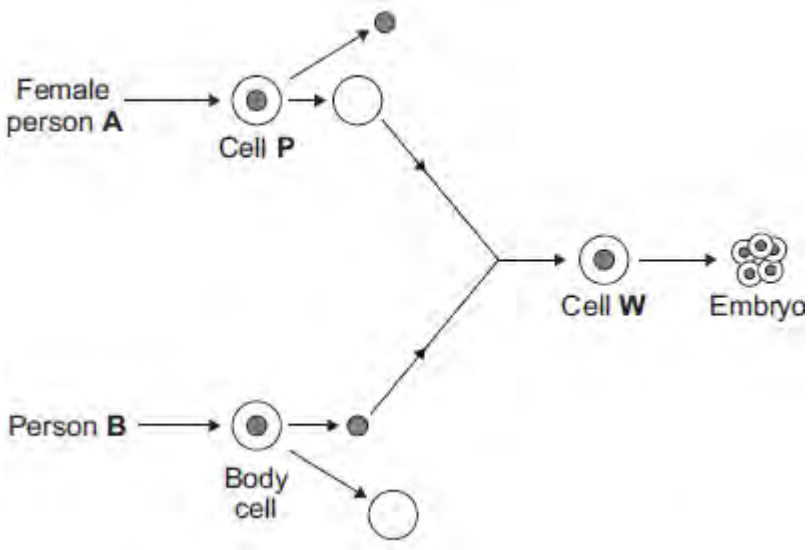
Joining male and female sex cells ☐

Taking cuttings from plants ☐

Transferring genes from one plant to another plant ☐

(1)

(b) The diagram shows a method that could be used in the future to produce a human.



(i) What is the name of the method shown?

Tick (✓) **one** box.

Adult cell cloning ☐

Embryo transplant ☐

Tissue culture ☐

(1)

(ii) What type of cell is cell **P**?

Draw a ring around the correct answer.

an egg cell **a skin cell** **a sperm cell**

(1)

(iii) Use the correct answer from the box to complete the sentence.

cell membrane	**cytoplasm**	**nucleus**

The ..... of cell **P** is removed and is discarded.

(1)

(iv) Use the correct answer from the box to complete the sentence.

an electric shock	**enzymes**	**hormones**

To make cell **W** divide to form an embryo, the cell must be treated with

..... .

(1)

(v) The embryo must be placed in an adult female to develop into a child.

Where, in the adult female, should the embryo be placed?

.....

(1)

(c) Some children have kidney disease. Kidney disease cannot be cured.
In the future, scientists could make a healthy clone of a child with kidney disease. One kidney could then be transplanted from the cloned child into the child with kidney
disease. The cloned child would still live with only one remaining kidney.

Suggest **two** reasons why people might disagree with cloning a child to get a kidney for transplanting.

1.....

.....

2.....

.....

(2)
(Total 8 marks)

Q3. In the 1800s, Charles Darwin visited the Galapagos Islands. On the islands he found many different species of bird called finches. Darwin thought that all the different finch species had evolved from one species of finch that had reached the islands many years before.

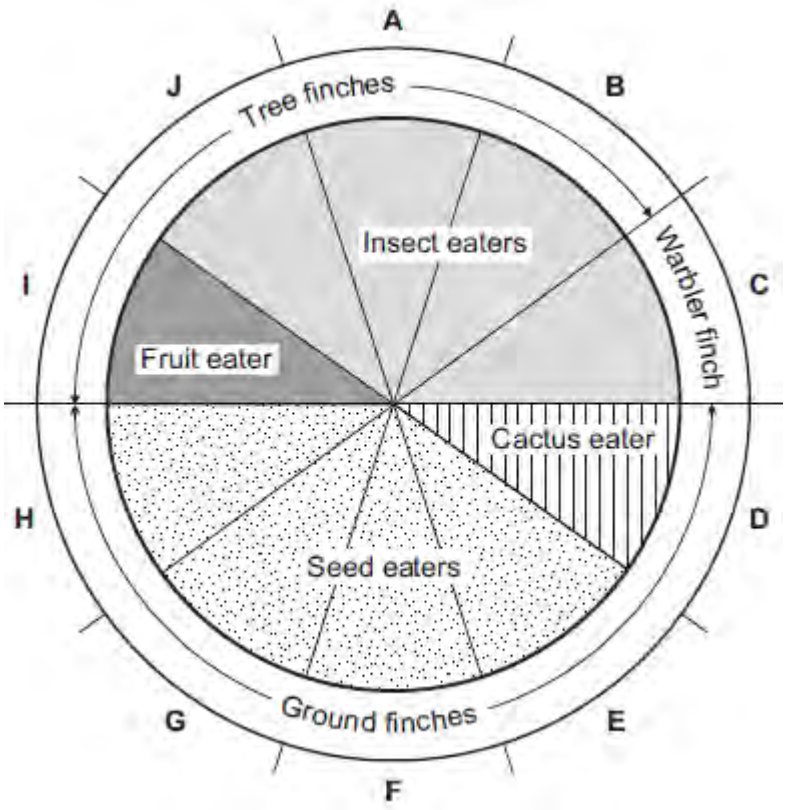
(a) Complete the following sentence.

Darwin suggested the theory of evolution by natural

.....

(1)

(b) The pie chart shows information about ten species of finch, **A – J**.



(i) How many of the species of finch eat insects?

Draw a ring around the correct answer.

4 **5** **6**

(1)

(ii) Describe finch species **G**.
Use **only** information from the pie chart.

.....

.....

.....

.....

(2)

(c) When Darwin returned to the UK very few people believed his theory of evolution.

A different scientist suggested that the changes that occur in an organism during its lifetime can be inherited by its offspring.

What was the name of this scientist?

Tick (✓) **one** box.

Lamarck	☐
Mendel	☐
Semmelweis	☐

(1)
(Total 5 marks)

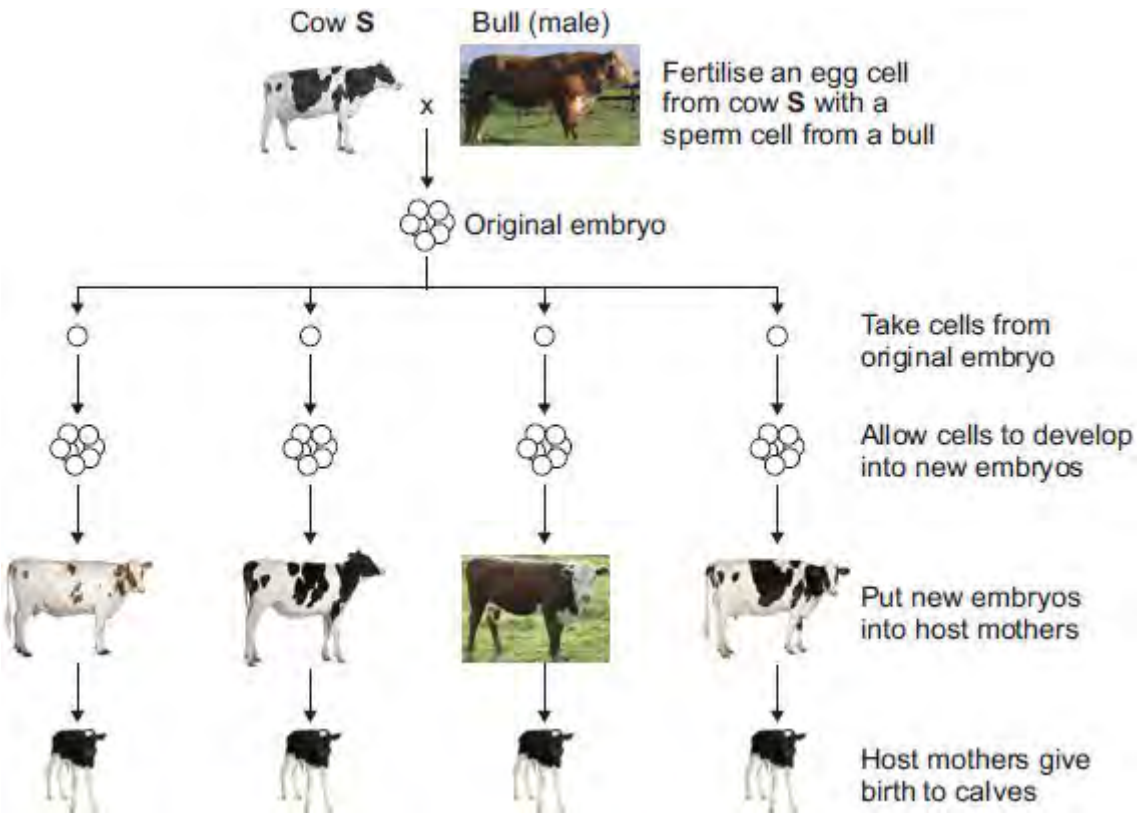
Q4. Most cows produce milk with a fat content of 3.4%.

Cow **S** produces milk with a fat content of 1.2%.

Only cow **S** has the gene to produce this low-fat milk.

(a) A farmer plans to develop more cows like cow **S**.

The diagram below shows how the farmer plans to do this.



Cow S © GlobalP/iStock/Thinkstock, **Bull** © Fuse/Thinkstock, **Whitish cow** © Eric Isselee/iStock/Thinkstock, **Brown cow** © DC Productions/Photodisc/Thinkstock, **Holstein cow(1)** © GlobalP/iStock/Thinkstock, **Holstein cow(2)** © GlobalP/iStock/Thinkstock, **Calf** © Eric Isselee/iStock/Thinkstock.

(i) An egg cell from cow **S** is fertilised by a sperm cell from a bull. This is part of sexual reproduction.

What is the scientific name for sex cells such as egg cells and sperm cells?

.....

(1)

(ii) After fertilisation, cells are taken from the original embryo.

These cells develop into new embryos.

Which part of the host mother's body should each new embryo be put into?

.....

(1)

(b) (i) The calves born to all of the host mothers are genetically identical to each other.

Draw a ring around the correct answer to complete the sentence.

The calves are genetically identical to each other because

they

are formed from the same original embryo.
have the same host mother.
have the same two parents.

(1)

(ii) What term is used to describe the method of producing calves shown in the diagram in part (a)?

Tick (✓) **one** box.

Adult cell cloning ☐

Embryo transplantation ☐

Genetic modification ☐

(iii) Why are the calves born to the host mothers **not** genetically identical to cow **S**?

.....

.....

(1)

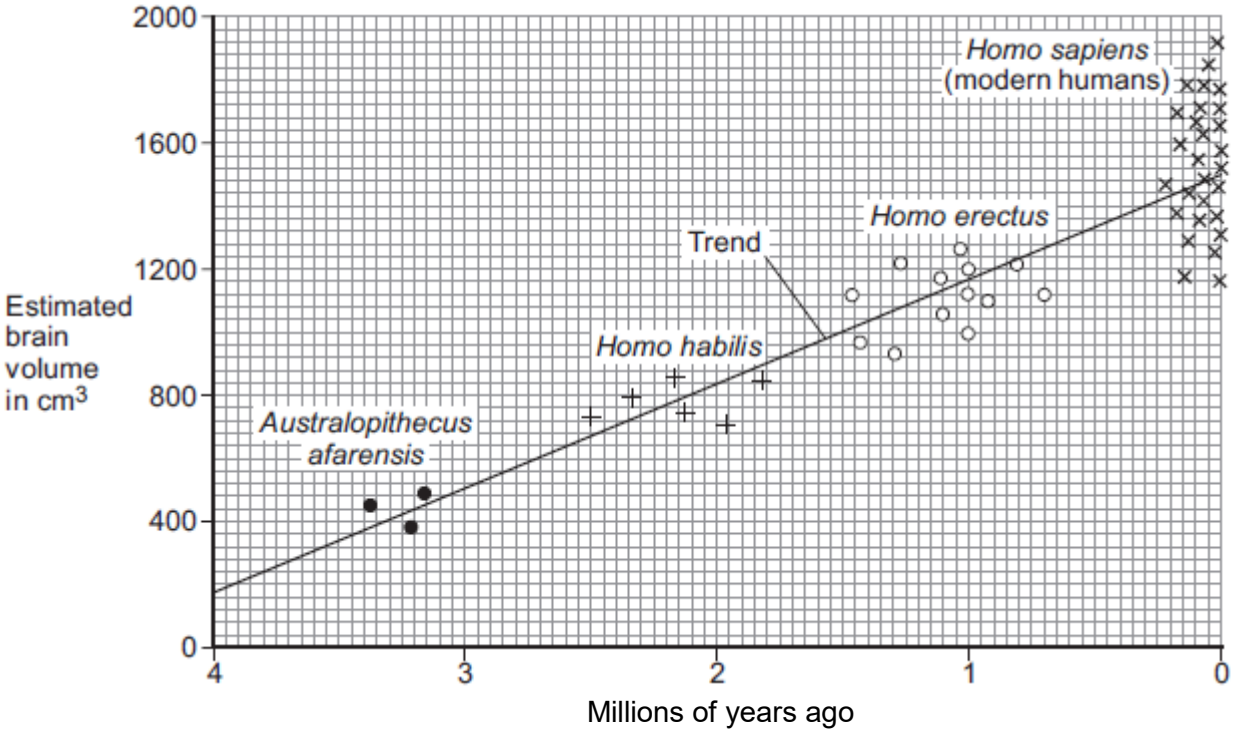
(Total 5 marks)

Q5. This question is about evolution in humans.

The graph shows:

- the estimated brain volume of different species of humans
- the time when the different species existed on Earth.

The data is plotted for modern humans (Homo sapiens) and for three types of extinct ancestors of humans.



Key
Each point plotted on the graph shows the estimate for one human.

(a) (i) As humans evolved, their brain volume changed.

What has happened to human brain volume over the past 4 million years?

.....

.....

(1)

(ii) Why is the evidence for estimated brain volume for *Homo sapiens* stronger than the evidence for *Australopithecus afarensis*?

.....

.....

(1)

(b) In a book, the brain volume of a different species, *Australopithecus africanus*, is stated to be about 600 cm^3.

Use evidence from the graphic above to estimate when *Australopithecus africanus* lived on Earth.

Estimate = ... million years ago

(1)

(c) Scientists believe that modern humans evolved by natural selection from *Australopithecus afarensis.*

(i) Complete the following sentence.

In the nineteenth century, the scientist who suggested the theory of evolution by natural selection was Charles ..... .

(1)

(ii) In the nineteenth century, many people did not accept this scientist's theory.

Give **one** reason why.

.....

.....

(1)

(Total 5 marks)

Q6.(a) Complete the sentences about evolution.

Draw a ring around the correct answer to complete each sentence.

(i) Darwin suggested the theory of evolution by

artificial
natural
asexual

selection.

(1)

(ii) Darwin's theory of evolution says that all species of living things have

evolved from | artificial / complex / simple | life forms.

(1)

(iii) Most scientists believe that life first developed about | three billion / three million / three thousand | years ago.

(1)

(b) Darwin's theory of evolution was only slowly accepted by other people.

Give **two** reasons why.

1.....

.....

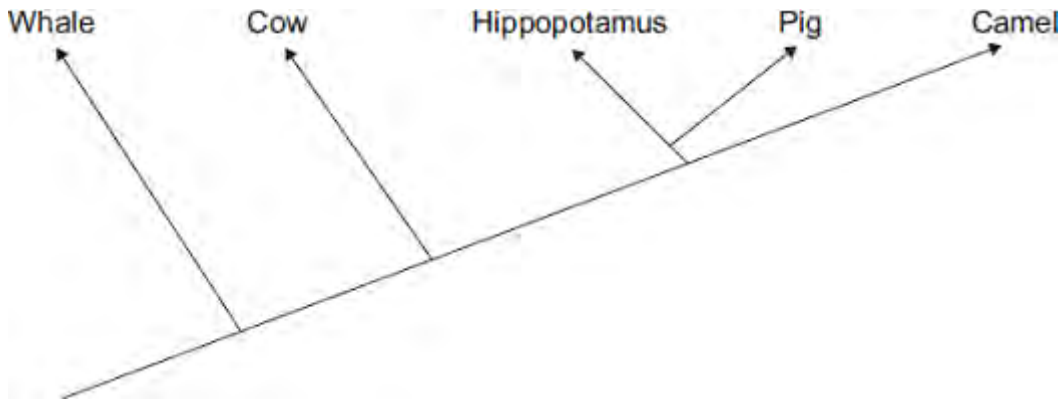
2.....

.....

(2)

(c) **Diagram 1** shows one model of the relationship between some animals.

Diagram 1



(i) Complete the sentence.

The model shown in **Diagram 1** is an evolutionary ..... .

(1)

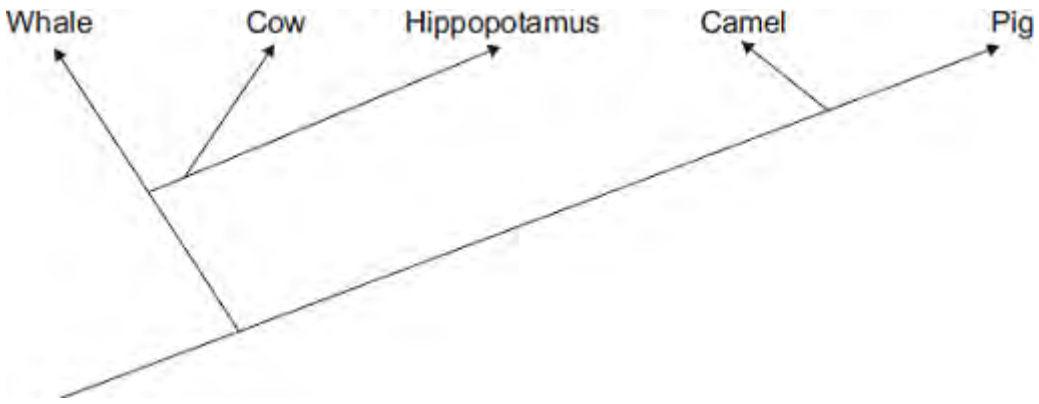
(ii) Which **two** of the animals in **Diagram 1** are most closely related?

..... and .....

(1)

(iii) Diagram **2** shows a more recent model of the relationship between the animals.

Diagram 2



Suggest **one** reason why scientists have changed the model of the relationships between the animals shown in the diagram.

Draw a ring around the correct answer.

more powerful computers	**new evidence from fossils**	**new species discovered**

(1)
(Total 8 marks)

Q7. Scientists have produced many different types of GM (genetically modified) food crops.

(a) Use words from the box to complete the sentence about genetic engineering.

clones	**chromosomes**	**embryos**	**genes**

GM crops are produced by cutting ..... out of the

..... of one plant and inserting them into the cells of a crop plant.

(2)

(b) Read the information about GM food crops.

- Herbicide-resistant GM crops produce higher yields.
- Scientists are uncertain about how eating GM food affects our health.
- Insect-resistant GM crops reduce the total use of pesticides.
- GM crops might breed naturally with wild plants.
- Seeds for a GM crop can only be bought from one manufacturer.
- The numbers of bees will fall in areas where GM crops are grown.

Use this information to answer these questions.

(i) Give **two** reasons why some farmers are in favour of growing GM crops.

1 .....

.....

2 .....

.....

(2)

(ii) Give **two** reasons why many people are against the growing of GM crops.

1 .....

.....

2 .....

.....

(2)
(Total 6 marks)

Q8. There are two forms of peppered moth, dark and pale.
Birds eat the moths when the moths are resting on tree bark.

Pollution in the atmosphere may:

- kill lichens living on tree bark
- make the bark of trees go black.

(a) Draw a ring around the correct answer to complete the sentence.

Lichens are very sensitive to air pollution caused by

carbon dioxide.
nitrogen.
sulfur dioxide.

(1)

(b) The photographs show the two forms of peppered moth, on tree bark.

Tree bark covered with lichens Tree bark made black by pollution

(i) The dark form of the peppered moth was produced by a change in the genetic material of a pale moth.

Use **one** word from the box to complete the sentence.

characteristic	**clone**	**mutation**

A change in genetic material is called a
.....

(1)

(ii) In the 19th century, pollution made the bark of many trees go black.

Explain why:

- the population of the pale form of the moth in forests decreased
- the population of the dark form of the moth in forests increased.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(c) (i) The larvae (young) of the peppered moths eat the leaves of birch trees.

The diagram shows the food chain:

birch trees → peppered moth larvae → birds

Draw a pyramid of biomass for this food chain.

Label the pyramid.

(2)

(ii) Which **two** reasons explain the shape of the pyramid you drew in part (c)(i)?

Tick (✓) **two** boxes.

Some material is lost in waste from the birds	☐
The trees are much larger than peppered moth larvae	☐
Peppered moth larvae do not eat all the leaves from the trees	☐
The trees do not use all of the Sun's energy	☐

(2)
(Total 9 marks)

M1.(a) (Jean Baptiste) Lamarck

allow phonetic spelling

1

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

1

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

1

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

1

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

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

0 marks:
No relevant content.

Indicative content

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

explanations:
- different colours are controlled by different genes / alleles / are caused by

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

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

4

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

1

[9]

M2.(a) any **two** from:
- so that they do not have specific genetic defects
- to produce docile cats or so they are not aggressive

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

  allow descriptions of suitable aesthetic reasons

2

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

1

(c) **Level 2 (3–4 marks):**
A detailed and coherent explanation is given, which logically links the process of

selective breeding with explanations of how this produces cats that do not cause allergic reactions.

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

0 marks:
No relevant content.

Indicative content

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

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

4

[7]

M3.(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]

M4.(a) kills weeds among crops / does not kill crops

1

(kills weeds) so less competition for <u>named</u> 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]

M5.(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 <u>three</u> 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 <u>mitosis</u>

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]

Q1. Charles Darwin proposed the theory of natural selection.

Many people at the time did not accept his theory.

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

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

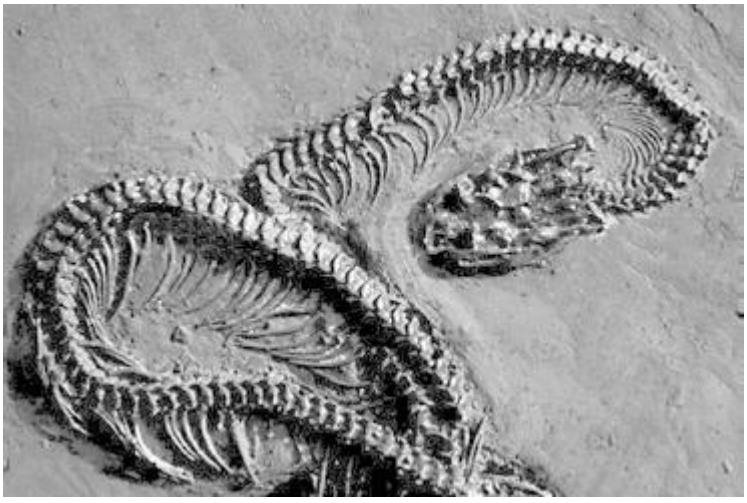
Who proposed this theory?

.....

(1)

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

The diagram below shows a fossilised snake.



© Peter Menzel/Science Photo Library

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

.....

.....

.....

.....

.....

.....

(3)

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

The table below shows two types of rat snake.

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

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

The rat snakes have evolved to to suit their environments.

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

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(d) Many species of snake have become extinct.

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

.....

.....

(1)

(Total 9 marks)

Q2. Many different types of animals are produced using selective breeding.

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

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

1 .....

.....

2 .....

.....

(2)

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

Describe **one** problem inbreeding causes.

.....

(1)

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

The allergy is caused by a chemical called Fel D1.

Different cats produce different amounts of Fel D1.

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

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

Explain how the cat has been produced using selective breeding.

.....

.....

.....

.....

.....

.....

.....

.....

(4)
(Total 7 marks)

Q3.(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

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. ☐

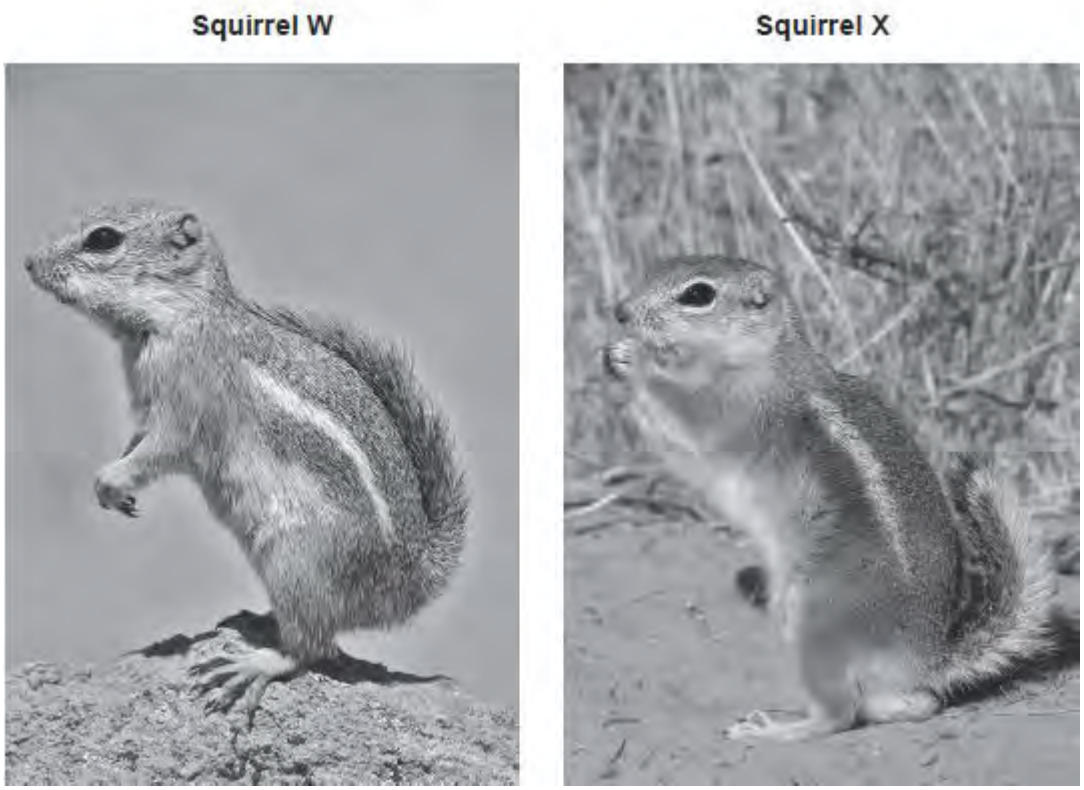
The fossil of animal **S** was found in a deeper layer of rock than the fossil of animal **T**. ☐

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** 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)

Q4. 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?

.....

.....

.....

.....

.....

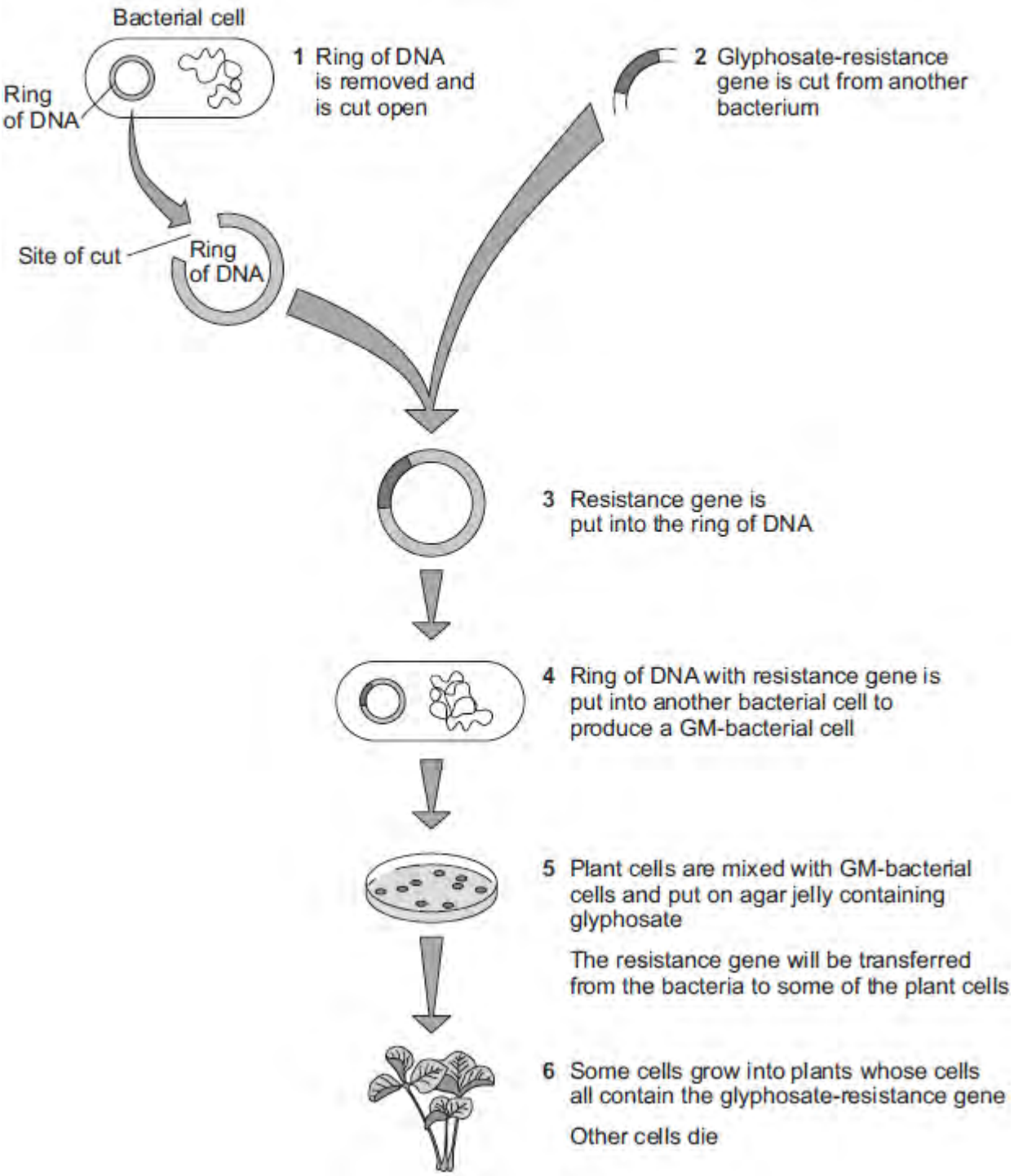
.....

(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.

.....

.....

.....

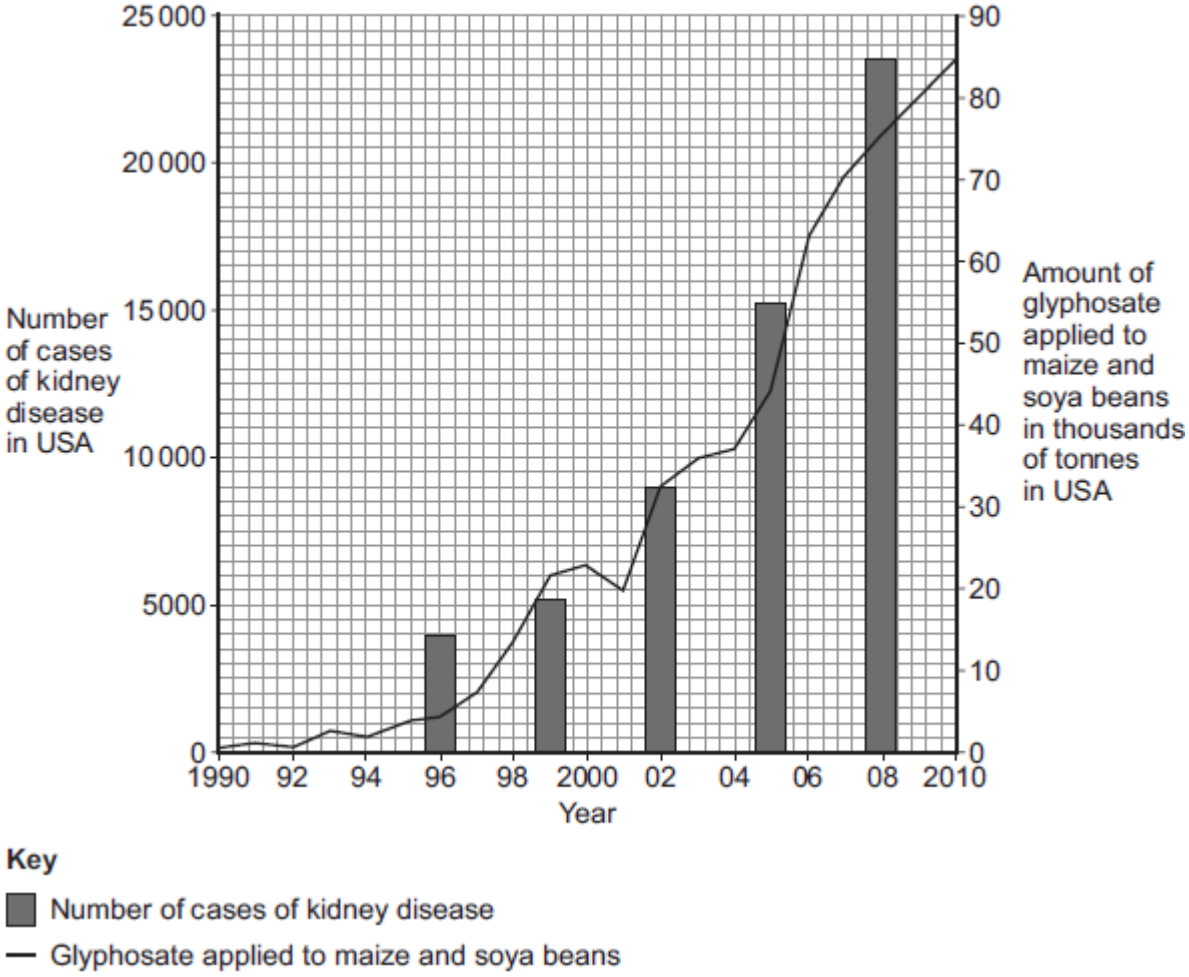
.....

(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.

.....

.....

.....

.....

.....

.....

.....

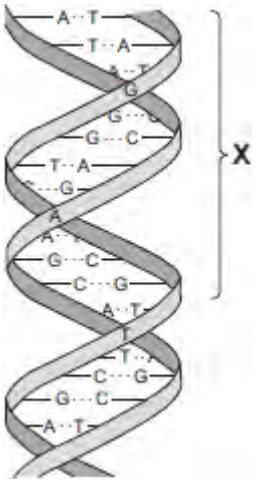
.....

.....

.....

(4)
(Total 11 marks)

Q5. 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)

M1.(a) part of a chromosome

allow piece of DNA
allow parts of chromosomes

1

controls a characteristic

allow controls characteristics
*allow codes for (**or** controls production of) protein / enzyme*
ignore examples of characteristics

1

(b) (iPS method)

*max **3** similarities or differences*
allow converse if clearly referring to adult cell cloning

similarities

- (both) use of skin / body cell
- (both) ref to (formation of) embryo
- (both) transfer (embryo) into womb / uterus
- (both) use surrogate mothers

differences

- (iPS) uses sexual reproduction
  *allow ref to egg **and** sperm **or** gametes **or** fertilisation*
- (iPS) surrogate mother is different species
- (iPS) no nucleus transfer / removal
- (iPS) offspring genetically different from parent
  allow not a clone
- (iPS) no electric shock

4

(c) any **one** from:

- idea of retaining biodiversity
- may be (economically) useful (in the future)
- idea of maintaining food chain / ecosystem

1

[7]

M2.(a) (i) variation (in population) / mutation

1

longer nosed individuals get more food / leaves

allow longer nosed individuals more likely to survive

1

(these) survivors breed (more)

1

pass on genes / alleles / DNA (for long nose)

allow pass on mutation

1

(ii) Phiomia / ancestor stretched its nose (during its lifetime) to reach food / leaves

1

passed on (stretched nose) to offspring

allow offspring inherit (stretched nose)

*do **not** allow ref to genes*

1

(b) (i) insufficient evidence / no proof

ignore other theories, eg religion

*do **not** allow no evidence*

1

mechanism of inheritance not known

allow genes / DNA not discovered

1

(ii) God made all living things / them

allow creationism

ignore religion

1

[9]

M3.(a) lack of fossils / fossils destroyed

allow lack of evidence

1

(due to soft parts) decaying / geological activity

allow an example – eg vulcanism or earth movements or erosion

allow converse points re skeletons, shells, hard parts

1

(b) (i) **A** and **B** did not mate successfully

*'**A** and **B** did not mate' insufficient*

allow did not produce fertile offspring

1

(ii) any **two** from:

- may not be mating season
- **A** and **B** may not find each other attractive
- this is just a one-off attempt / an anomaly / need repeats
- may be juvenile / immature
- may be the same sex

allow other sensible suggestion eg were put in unfavourable environment or one / both could be infertile

2

(c) 1. (two ancestral populations) separated (by geographical barrier / by land) / were isolated

1

2. genetic variation (in each population) **or** different / new alleles **or** mutations occur

1

3. different environment / conditions

allow abiotic or biotic example

1

4. natural selection occurs **or** some phenotypes survived **or** some genotypes survived

1

5. (favourable) alleles / genes / mutations passed on (in each population)

1

6. eventually two types cannot interbreed successfully

allow eventually cannot produce fertile offspring

1

[11]

M4.(a) organisms that can breed together

accept converse points re. 2 different species

1

successfully

accept produces fertile offspring

1

(b) any **two** from:
(live at)

- different pH of soil
- different height above sea level
- different flowering times

2

AND

genetic variation / mutation / different alleles (produced in isolated populations)

1

natural selection acts differently on the two populations

or different characteristics in the two populations survive

or <u>different</u> alleles passed on in the two groups

1

eventually resulting in interbreeding no longer possible

1

[7]

M5.(a) wing pattern similar to *Amauris*

allow looks similar to Amauris

1

birds assume it will have an unpleasant taste

1

(b) mutation / variation produced wing pattern similar to *Amauris*

*do **not** accept breeds with Amauris*

*do **not** accept idea of intentional adaptation*

1

these butterflies not eaten (by birds)

1

these butterflies breed **or** their genes are passed to the next generation

1

[5]

M6.(a) (use of) enzymes

1

(b) asexual reproduction / no gametes / no fusion / only one parent

ignore clones

1

cells all contain same genetic information / same genes (as parent) / same DNA

1

(c) can spray crop with herbicide – only weeds killed

crop survives herbicide insufficient

1

(d) any **one** from:

allow 'think that GM food is bad for health'

- fears / lack of knowledge about effects of GM food on health

  ignore not natural or against religion

- crop plants may pass on gene to wild plants
- encourages use of herbicides

1

[5]

M7.(a) Lamarck

ignore any first name(s)

1

(b) (i) variation / range of sword lengths (in ancestors)

accept mutation produced longer sword

1

those with long swords get more food

accept those with short swords get less food

1

swordfish (with long swords) survive **and** breed

allow have offspring for breed

1

(survivors) pass on gene(s) / allele(s) (for long sword)

allow mutation for gene(s) / allele(s)

1

(ii) any **one** from:

- more evidence (now)
  accept examples of evidence, e.g. more fossils
- DNA / genes / mechanism of inheritance discovered
  allow Lamarck's theory has been disproved
  ignore religious arguments
  ignore proof

1

[6]

M8.(a) (i) DNA replication / copies of genetic material were made

'it' = a chromosome

allow chromosomes replicate / duplicate / are copied

ignore chromosomes divide / split / double

1

(ii) one copy of each (chromosome / chromatid / strand) to each offspring cell

ignore ref. to gametes and fertilisation

1

each offspring cell receives a complete set of / the same genetic material

allow 'so offspring (cells) are identical'

1

(b) (i) meiosis

allow mieosis as the only alternative spelling

1

(ii) Species A = 4 **and** Species B = 8

1

(iii) sum of A + B from (b)(ii) e.g. 12

1

(c) (i) similarities between chromosomes**or**similarities between flowers described

e.g. shape of petals / pattern on petals / colour / stamens

1

can breed / can sexually reproduce

allow can reproduce with each other / they can produce offspring

1

(ii) any **two** from:

- offspring contain 3 copies of each gene / of each chromosome / odd number of each of the chromosomes
- some chromosomes unable to pair (in meiosis)
- (viable) gametes not formed / some gametes with extra / too many genes / chromosomes

orsome gametes with missing genes / chromosomes

2

[10]

Q1. As embryos develop, some genes in cells are turned off and some genes are turned on. This allows cells to become specialised for particular functions.

Usually, after cells have become specialised, they cannot change again into different types of cells.

(a) What is a gene?

.....

.....

.....

.....

(2)

(b) Scientists have developed a way to change specialised cells back into embryo-like cells by a method called iPS.

Read the information in the box.

Cells made using iPS can be changed into different types of cells. Scientists plan to take skin cells from an endangered species of monkey called a drill and change these cells into iPS cells. These iPS cells can then be changed into egg cells or sperm cells. After fertilisation, the embryo can be inserted into the womb of a female of a non-endangered species called a mandrill. The mandrill is closely related to the drill.

Describe similarities and differences between the iPS method and adult cell cloning.

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(4)

(c) Suggest **one** advantage of trying to preserve endangered species such as the drill.

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.....

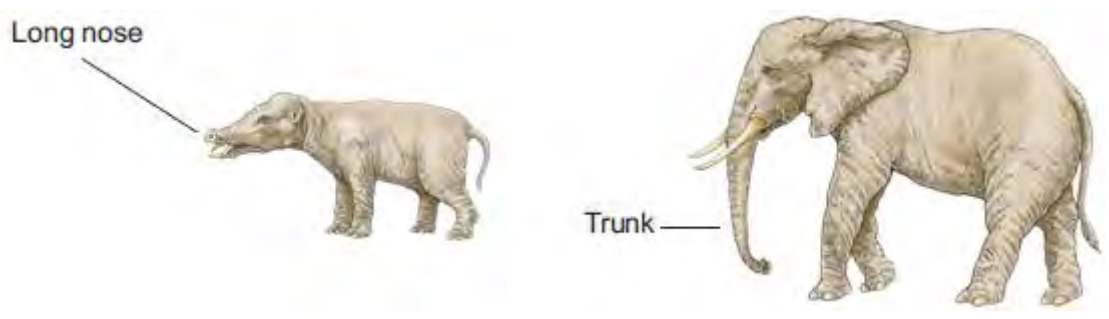
(1)
(Total 7 marks)

Q2. The image below shows:

- *Phiomia*, an ancestor of elephants
- a modern African elephant.

Phiomia lived about 35 million years ago.

Phiomia **African elephant**



Both *Phiomia* and the African elephant reach up into trees to get leaves.

In the 1800s, Darwin and Lamarck had different theories about how the long nose of *Phiomia* evolved into the trunk of the African elephant.

(a) (i) Use Darwin's theory of natural selection to explain how the elephant's trunk evolved.

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(4)

(ii) Lamarck's theory is different from Darwin's theory.

Use Lamarck's theory to explain how the elephant's trunk evolved.

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(2)

(b) (i) In the 1800s, many scientists could **not** decide whether Lamarck's theory or Darwin's theory was the right one.

Give **two** reasons why.

1 .....

.....

2 .....

.....

(2)

(ii) Before the 1800s, many people had a different idea to explain where all the living things on Earth came from.

What idea was this?

.....

.....

(1)

(Total 9 marks)

Q3.(a) Fossils provide evidence for what early life forms were like. From the evidence, scientists think that life began on Earth more than 3 billion years ago.

Many early life forms were soft-bodied.
Explain why this makes it difficult for scientists to be certain about what these early life forms were like.

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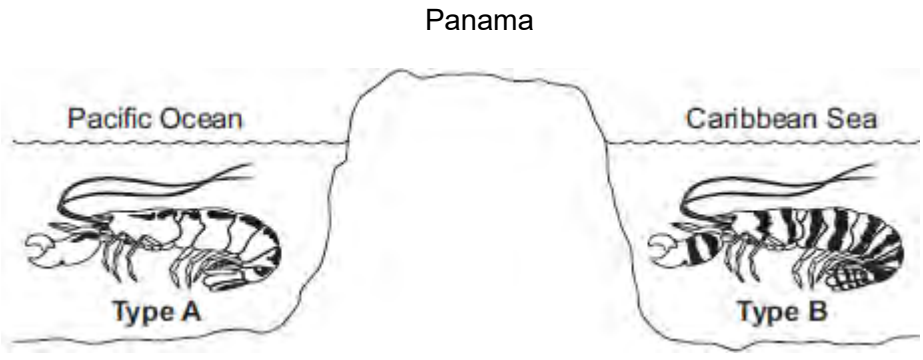
(2)

(b) The illustration below shows two types of pistol shrimp.

The shrimps live in shallow, tropical seas on opposite sides of Panama.



Not to scale

Scientists put one **Type A** shrimp and one **Type B** shrimp together in a tank of seawater.
The two types of shrimp snapped their claws aggressively at each other.
They did not mate.

The scientists said that this was evidence for the **Type A** and **Type B** shrimps being classified as two different species.

(i) Give **one** reason why the scientists' opinion may be correct.

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.....

(1)

(ii) Suggest **two** reasons why the scientists' opinion may **not** be correct.

1 .....

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2 .....

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(2)

(c) Panama is a narrow strip of land which today joins North America and South America.
It was formed by land moving up from beneath the sea. Panama has separated the Pacific Ocean and the Caribbean Sea for the past 3 million years.

Explain how two different species of pistol shrimp could have developed from an ancestral species of shrimp.

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(6)
(Total 11 marks)

Q4.*Howea forsteriana* and *Howea belmoreana* are two species of palm tree.

The two *species* grow together on a small island in the South Pacific.

(a) What is meant by the term *species* ?

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.....

(2)

(b) The table gives some information about these two species of palm tree.

	Howea forsteriana	***Howea belmoreana***
Optimum pH of the soil for growth of the palm tree	pH 8	pH 6
Height above sea level of most common habitat	30 to 60 metres	above 120 metres
Month when most palm trees flower	October	December
Method of pollination	Wind carries pollen	Wind carries pollen

Scientists believe that these two species of palm tree began to evolve from a single species over 2 million years ago.

Suggest how these two different species developed.

In your answer you should use information from the table and your own knowledge.

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(5)
(Total 7 marks)

Q5. The drawings show two different species of butterfly.

Amauris

Hypolimnas

- Both species can be eaten by most birds.
- *Amauris* has an unpleasant taste which birds do **not** like, so birds have learned**not** to prey on it.
- *Hypolimnas* does **not** have an unpleasant taste but most birds do **not** prey on it.

(a) Suggest why most birds do **not** prey on *Hypolimnas*.

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(2)

(b) Suggest an explanation, in terms of natural selection, for the markings on the wings of *Hypolimnas*.

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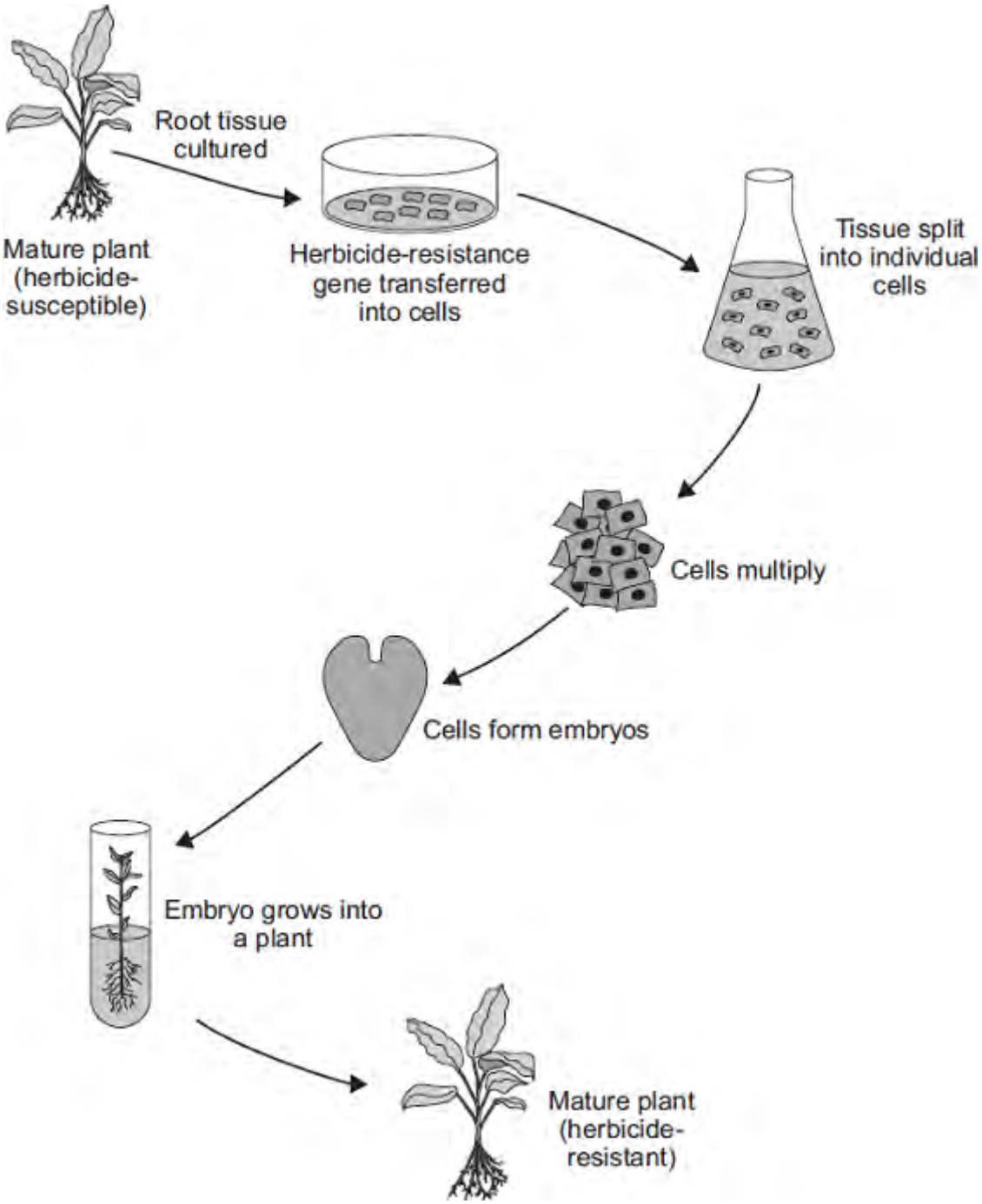
(3)
(Total 5 marks)

Q6. The diagram shows one method of producing herbicide-resistant crop plants.



(a) The herbicide-resistance gene is cut out of a chromosome of a herbicide-resistant plant.

How is the herbicide-resistance gene cut out of the chromosome?

.....

.....

(1)

(b) Apart from having the herbicide-resistance gene, the herbicide-resistant plants are identical to the herbicide-susceptible plants.

Explain why.

.....

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.....

(2)

(c) Suggest **one** advantage to a farmer of growing herbicide-resistant crops.

.....

.....

(1)

(d) Many people are opposed to the growing of herbicide-resistant crops produced in this way.

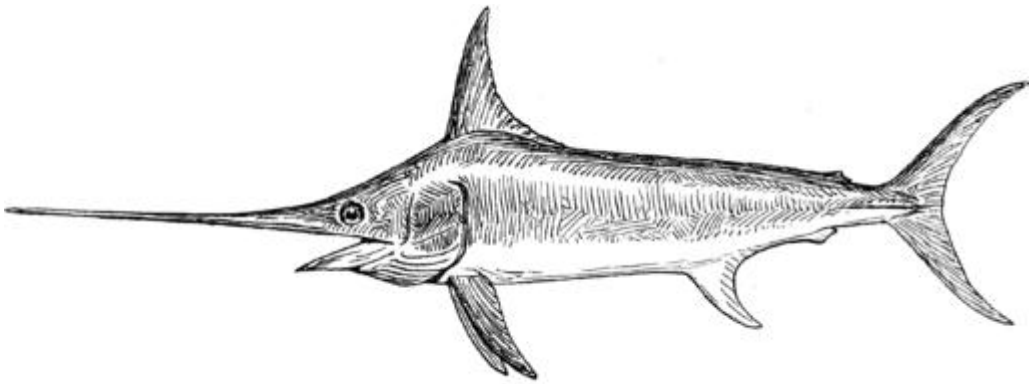
Suggest **one** reason why.

.....

.....

(1)
(Total 5 marks)

Q7. The picture shows a modern swordfish.

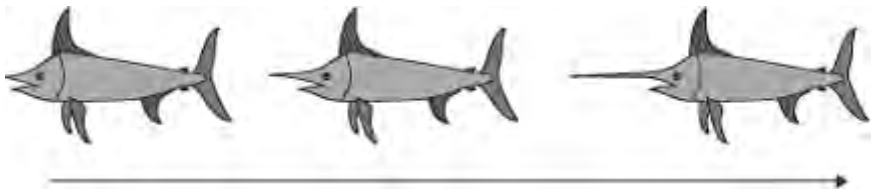


By Pearson Scott Foresman [Public domain], via Wikimedia Commons

Ancestors of swordfish had short swords. Modern swordfish have long swords. Swordfish use their swords to injure prey. The injured prey are easier to catch.

The information in the box shows one theory of how the length of the sword of swordfish changed.

The sword grew longer as each swordfish used its sword more and more.
Each time a swordfish reproduced, the longer sword was passed on to its offspring.



Many generations

(a) Which scientist suggested the theory shown in the box?

.....

(1)

(b) (i) Darwin suggested that evolution is a result of natural selection.

Describe how natural selection could result in modern swordfish with long swords
developing from ancestors with short swords.

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(4)

(ii) Scientists in the 1800s accepted both the theory shown in the box, and Darwin's theory.

Now most scientists only accept Darwin's theory.

Give **one** reason why.

.....

.....

.....

(1)
(Total 6 marks)

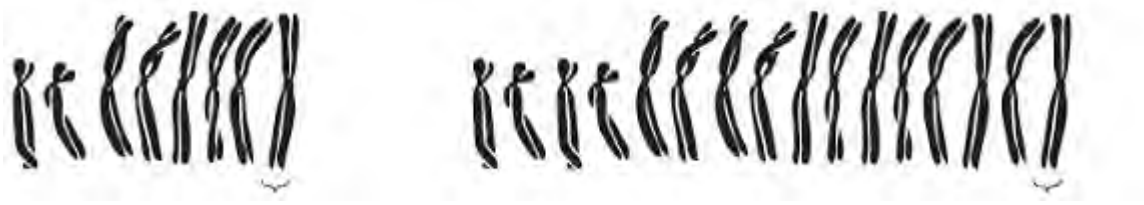
Q8. The photographs show the flowers of two closely-related species of plant.

Species A Species B

Images: © iStock/Thinkstock

The drawings show chromosomes from one cell in the root of each plant during cell division.

Species A **Species B**



One chromosome **One chromosome**

(a) The drawings show that each chromosome has two strands of genetic material.

(i) How does a chromosome become two strands?

.....

.....

(1)

(ii) Explain why each chromosome must become two strands before the cell divides.

.....

.....

.....

.....

(2)

(b) For sexual reproduction, the plants produce gametes.

(i) Name the type of cell division that produces gametes.
.....

(1)

(ii) How many chromosomes would there be in a gamete from each of these two plant species?

Species A ☐ **Species B** ☐

(1)

(iii) It is possible for gametes from **Species A** to combine with gametes from **Species B** to produce healthy offspring plants.
How many chromosomes would there be in each cell of one of the offspring plants? ☐

(1)

(c) (i) Look back at the information at the start of the question and the information from part (b).

What evidence from these two pieces of information supports the belief that **Species A** and **Species B** evolved from a common ancestor?

.....

.....

.....

.....

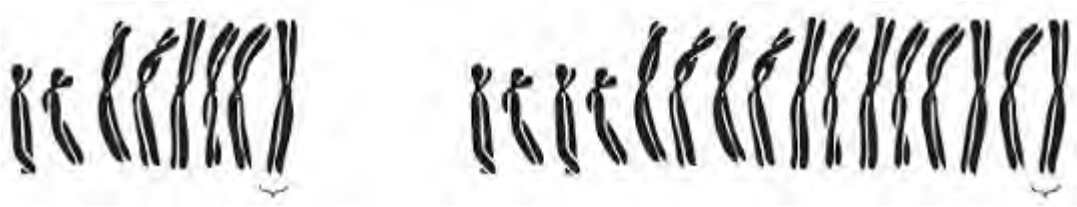
(2)

(ii) For successful gamete production to take place, chromosomes that contain the same genes must pair up.

The drawings showing the chromosomes of **Species A** and of **Species B** are

repeated below.

Species A Species B



The offspring plants cannot reproduce sexually.

Suggest an explanation for this.

.....

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.....

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.....

.....

(2)
(Total 10 marks)