Name: _____

Class: _____

Date: _____

Inheritance, Variation and Evolution part 7 AQA Triple Biology

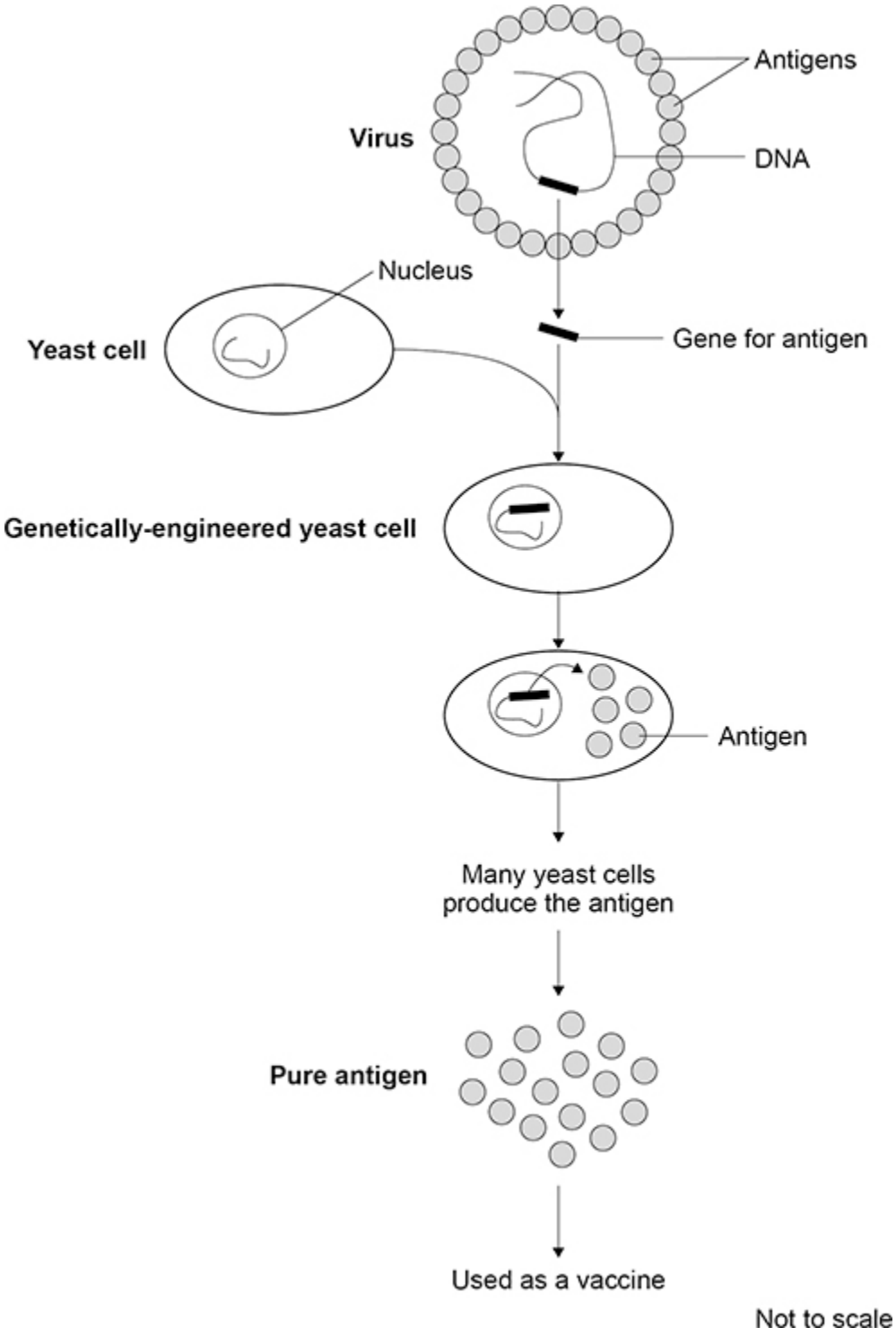
Time: **91 minutes**

Marks: **87 marks**

Comments:

1. Genetic engineering can be used for making many useful products.

The figure below shows how a vaccine against a virus can be made by genetic engineering.



Use information from above figure to answer parts (a) and (b).

(a) Which part of the virus is put into the yeast cell?

_____

(1)

(b) Which part of the virus is made by the yeast cell?

_____

(1)

(c) A long time ago, vaccines were made in a different way.

The virus was heated to stop it reproducing.

The vaccine contained whole viruses.

Why might the vaccine containing heat-treated viruses be dangerous?

Tick (✓) **one** box.

The viruses may be inactive.	☐
The viruses may cause an infection.	☐
The viruses will not mutate.	☐

(1)

Genetic engineering can also be used in agriculture.

Weeds are a problem for farmers because the weeds compete with crop plants.

(d) Give **three** factors that the weeds and crop plants compete for.

1 _____

2 _____

3 _____

(3)

Glyphosate is a weed killer used in agriculture.

Genetically modified (GM) maize is a food crop that is resistant to glyphosate weed killer.

Farmers can spray glyphosate on a field to kill the weeds where the GM maize is growing.

(e) Suggest **one** advantage of using glyphosate on fields where GM maize is growing.

_____

_____

(1)

(f) Suggest **one** problem of using glyphosate on fields where GM maize is growing.

Do **not** refer to cost in your answer.

_____

_____

(1)

(Total 8 marks)

2. Gardeners can grow plants from:

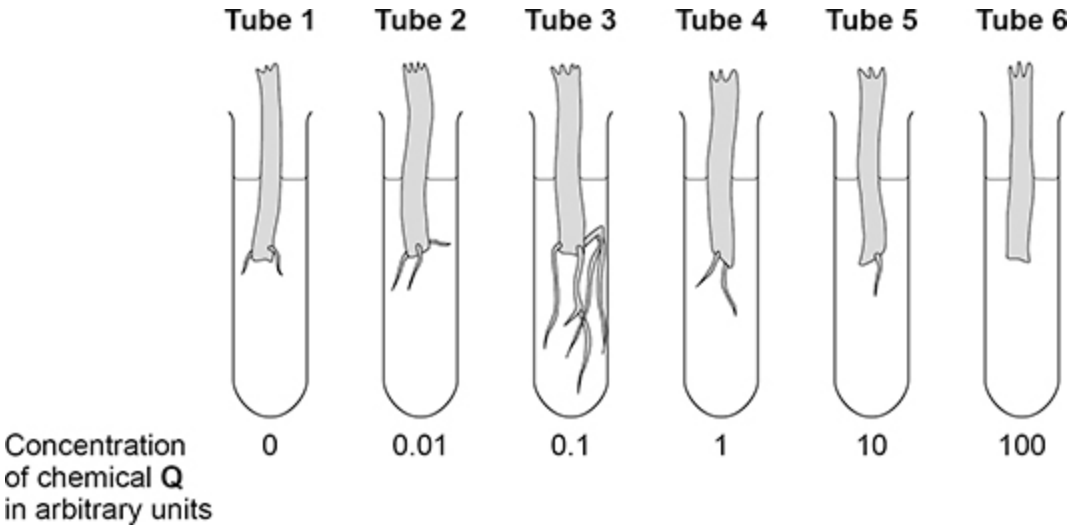
- seeds
- cuttings taken from adult plants.

A gardener investigated the growth of roots on cuttings from a geranium plant.

This is the method used.

1. Take 6 cuttings from the stems of the same plant.
2. Prepare 6 test tubes, each containing a different concentration of a solution of chemical **Q**.
3. Place 1 cutting in each test tube with the cut end of each stem in the solution.
4. Leave the test tubes at room temperature for 10 days.

The figure below shows the results.



(a) Tube **1** contains no chemical **Q**.

Tube **1** is a control.

Why did the gardener include tube **1** in the investigation?

_____

_____

(1)

(b) How many times more concentrated is chemical **Q** in tube **6** than in tube **2**?

_____

_____

Number of times more concentrated = _____

(2)

(c) What was the best concentration of chemical **Q** for stimulating root growth?

Tick (✓) **one** box.

0.01 arbitrary units	☐
0.1 arbitrary units	☐
1 arbitrary unit	☐
10 arbitrary units	☐

(1)

(d) Give evidence from the figure above that a high concentration of chemical **Q** may be toxic to geranium plants.

_____

_____

(1)

(e) The gardener has four types of geranium plant: **A**, **B**, **C** and **D**.

Plant **A** produces larger, more brightly-coloured flowers than any of the other plants.

The gardener wants to grow more plants of type **A**.

Explain why the gardener chooses to take cuttings from plant **A** instead of growing seeds from plant **A**.

(4)

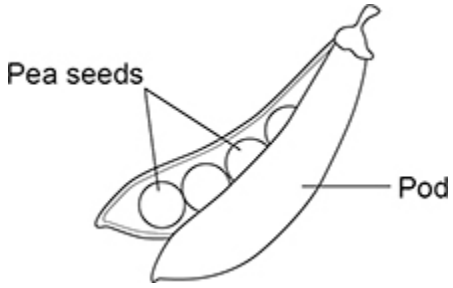
(Total 9 marks)

3. In 1866, a monk called Gregor Mendel published the results of his investigations into inheritance in pea plants.

Pea plants produce seeds in a pod.

Figure 1 shows a pea pod.

Figure 1

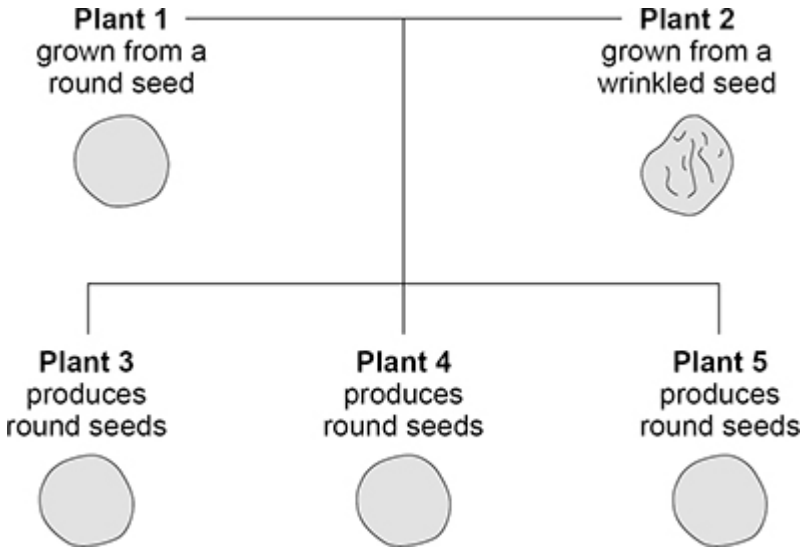


Pea seeds can be round or wrinkled in shape.

Mendel crossed pea plants that produced round seeds with pea plants that produced wrinkled seeds.

Figure 2 shows the results.

Figure 2



In parts (a) to (c) use the following symbols to represent the alleles:

R = dominant allele for round seeds

r = recessive allele for wrinkled seeds.

(a) In **Figure 2**, the genotype of plant **1** is **RR**.

Give the genotype of plant **2**.

_____

(1)

Mendel collected the seeds from plants **3** and **4** and grew new plants from the seeds.

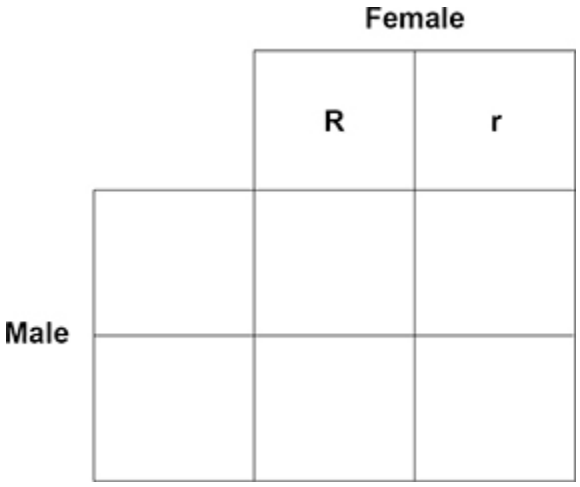
Mendel crossed the new plants.

(b) Complete the Punnett square diagram in **Figure 3**.

You should show:

- the male gametes
- the offspring genotypes.

Figure 3



(3)

(c) Give the ratio of round seeds to wrinkled seeds in the offspring in **Figure 3**.

Ratio of round seeds to wrinkled seeds = _____ **:** _____

(1)

(d) Some of the offspring in **Figure 3** are homozygous and some are heterozygous.

What does 'heterozygous' mean?

_____

_____

(1)

(e) Mendel published his work in 1866.

Suggest **two** reasons why the importance of Mendel's work was **not** recognised until the early 1900s.

1 _____

_____

2 _____

_____

(2)

(Total 8 marks)

4. Evolution of new species occurs by mutation and natural selection.

(a) What is a mutation?

_____

_____

(1)

(b) Describe the process of natural selection.

_____

_____

_____

_____

_____

_____

(3)

(c) Which scientists suggested the theory of evolution by natural selection?

Tick (✓) **one** box.

Alexander Fleming and Carl Woese ☐

Alfred Wallace and Alexander Fleming ☐

Alfred Wallace and Charles Darwin ☐

Charles Darwin and Carl Woese ☐

(1)

(d) The hoverfly and the wasp are insects with bright yellow and black markings.

The figure below shows a hoverfly and a wasp.

Hoverfly

Wasp

The wasp has a sting to defend itself against predators.

The hoverfly does **not** have a sting.

Hoverflies and wasps live in the same habitat.

Explain how having yellow and black markings helps the **hoverfly** survive.

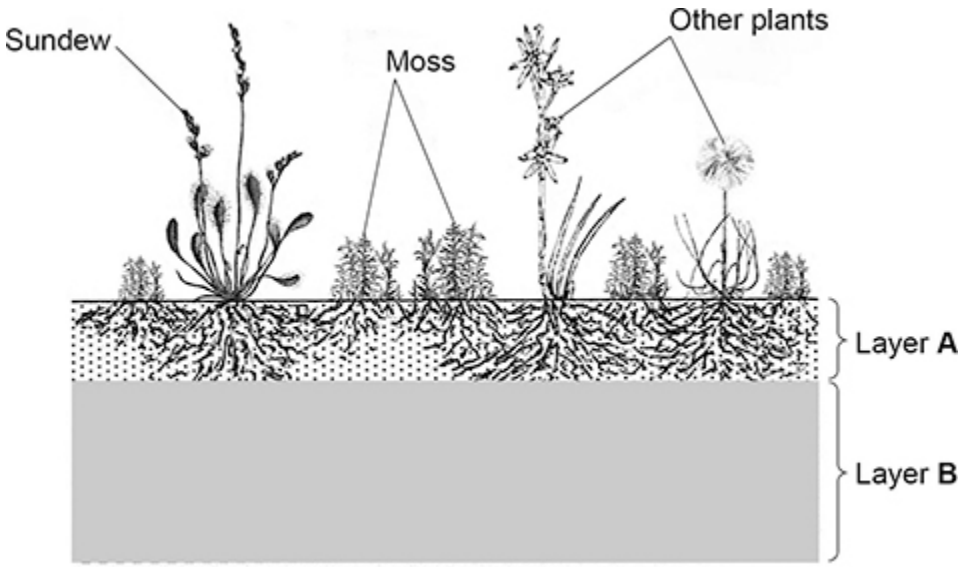
(3)

(Total 8 marks)

5. Peat bogs are estimated to contain twice as much carbon as all the world's forests.

Figure 1 shows a section through part of a peat bog.

Figure 1



Layer **A** contains a lot of air.

Layer **B**:

- contains the dead remains of plants
- has a low pH
- contains very little oxygen
- contains carbon dioxide and methane.

(a) Explain why most of the dead remains of plants in layer **B** do **not** decay.

_____

_____

_____

_____

_____

_____

(3)

(b) The peat bog in **Figure 1** is a stable community.

The moss produces biomass at a rate of 340 g/m^2/year.

What is the approximate biomass of the moss that becomes biomass in primary consumers?

Tick (✓) **one** box.

0.34 g/m^2/year ☐

3.4 g/m^2/year ☐

34 g/m^2/year ☐

340 g/m^2/year ☐

(1)

The sundew plant shown in **Figure 1** has leaves with sticky hairs that trap and digest insects.

Digestion of the insects releases phosphates and simple compounds of nitrogen that are used by the sundew plant.

(c) What substance can the sundew plant make using the **phosphates**?

Tick (✓) **one** box.

- Cellulose ☐
- DNA ☐
- Glycerol ☐
- Starch ☐

(1)

(d) What substance can the sundew plant make using the **nitrogen**?

Tick (✓) **one** box.

- Fatty acid ☐
- Glucose ☐
- Lactic acid ☐
- Protein ☐

(1)

(e) Humans have destroyed large areas of peat bog to collect peat.

The peat provides fuel and provides compost for gardeners to use.

The peat comes from layer **B** in **Figure 1**.

Layer **B**:

- contains the dead remains of plants
- has a low pH
- contains very little oxygen
- contains carbon dioxide and methane.

Figure 2 shows the removal of peat from a peat bog.

Figure 2

Explain how the destruction of peat bogs and the use of peat affects the temperature of the Earth's atmosphere.

(4)

(Total 10 marks)

6. Some human disorders are inherited.

Polydactyly is an inherited disorder.

- A person with polydactyly has extra fingers or toes.
- Polydactyly is caused by a dominant allele.

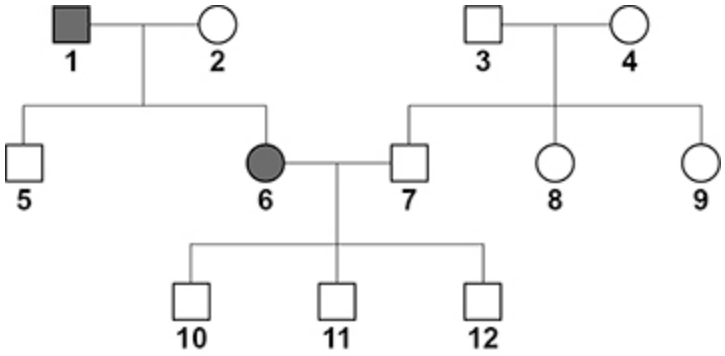
(a) What is a dominant allele?

_____

_____

(1)

The figure below shows the inheritance of polydactyly in one family.



Key

- Male who has polydactyly
- Male who does **not** have polydactyly
- Female who has polydactyly
- Female who does **not** have polydactyly

In part (b) and (c), use the following symbols:

D = allele for having polydactyly

d = allele for **not** having polydactyly.

(b) Person **1** is heterozygous.

Explain how above figure shows that person **1** is heterozygous.

_____

_____

_____

_____

(2)

(c) Persons **6** and **7** are expecting a fourth child.

A doctor states that the probability of having a child with polydactyly is 0.5

Explain how the doctor determined this probability.

You should:

- draw a Punnett square diagram
- give the genotype of person **6** and the genotype of person **7**
- identify **all** the offspring that will have polydactyly.

(4)

(d) Cystic fibrosis (CF) is another inherited disorder caused by a mutation.

The mutation occurs in a gene called CFTR.

For the CFTR gene, one **allele** in every 50 in the UK population is the cystic fibrosis allele.

Explain why only one person in 2500 in the UK population has cystic fibrosis.

(4)

(Total 11 marks)

7. Glyphosate is a herbicide used in agriculture.

Soya bean plants have been genetically modified (GM) to be resistant to glyphosate.

A farmer can increase the yield of soya beans by:

- growing GM soya bean plants
- spraying glyphosate on the field.

(a) Explain how the use of GM soya bean plants **and** glyphosate can increase the yield of soya beans.

(6)

(b) Suggest **two** reasons why some people are concerned about the use of GM soya bean plants.

Do **not** refer to ethical concerns or religion in your answer.

1 _____

2 _____

(2)

(Total 8 marks)

8. Reproduction can produce offspring which are:

- genetically different

  or

- genetically identical.

Farmers grow tomato plants in greenhouses.

The tomatoes are sold in supermarkets.

(a) Suggest **one** advantage of growing tomato plants that are genetically different.

_____

_____

(1)

(b) Suggest **one** advantage of growing tomato plants that are genetically identical.

_____

_____

(1)

(c) Scientists can grow genetically identical tomato plants using tissue culture.

What is tissue culture?

_____

_____

(1)

(d) Genetically identical tomato plants growing in the same garden do **not** all grow to the same height.

Give **one** reason why.

_____

_____

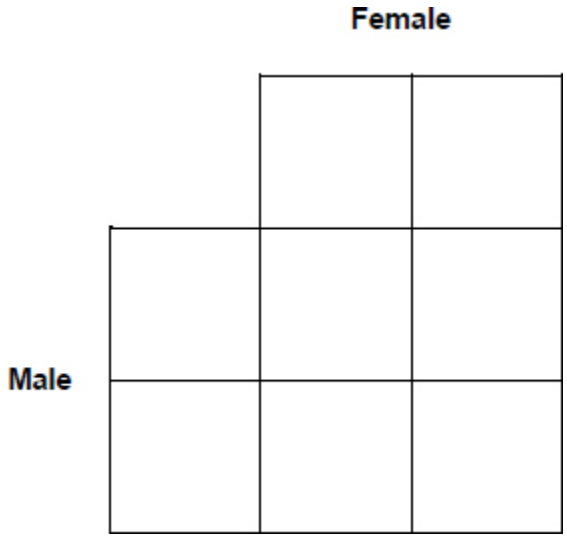
(1)

The sex of dogs is determined by **X** and **Y** chromosomes in the same way as in humans.

(e) Complete the Punnett square diagram in **Figure 1** to show the inheritance of sex in dogs.

Use the symbols **X** and **Y**.

Figure 1



(3)

(f) A female dog gave birth to six offspring.

Why would you expect there to be three male offspring and three female offspring?

Use your answer to part (e).

_____

_____

(1)

Farmers keep chickens for:

- meat production
- egg production.

Some varieties of chicken grow more quickly and are more suitable for meat production.

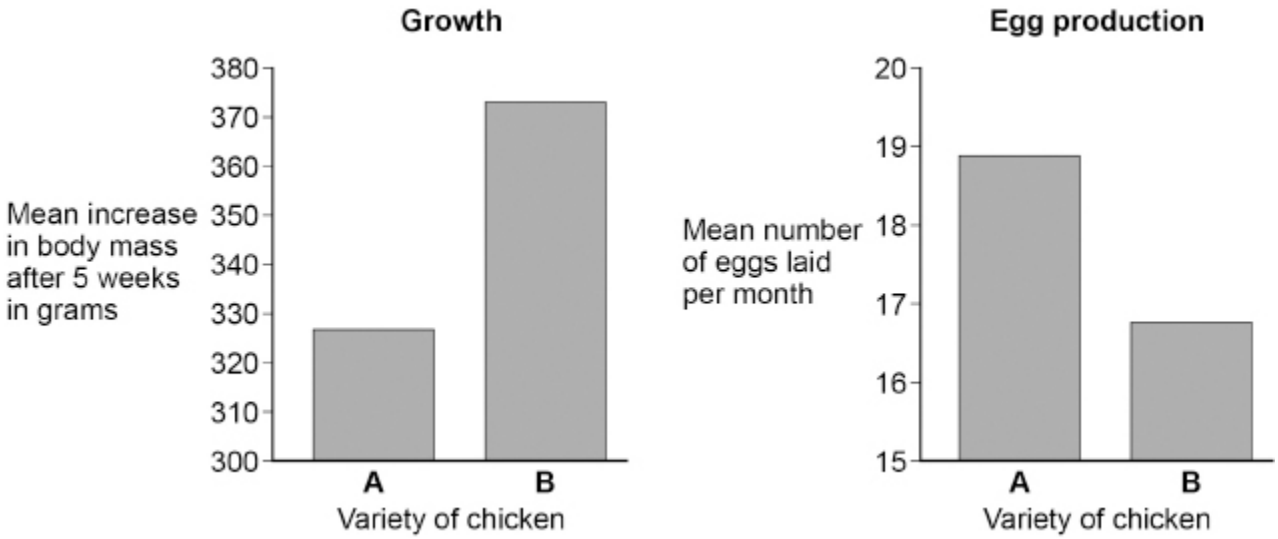
Other varieties of chicken produce more eggs.

A farmer keeps two varieties of chicken, **A** and **B**.

The farmer investigated the growth rates and egg-production rates of both varieties.

Figure 2 shows the results.

Figure 2



(g) Suggest **two** control variables the farmer should have used in this investigation.

1 _____

_____

2 _____

_____

(2)

(h) **Figure 2** shows mean values from 500 chickens of each variety.

Give the reason the farmer used a large number of chickens.

_____

_____

(1)

(i) The farmer wants to produce a new variety of chicken that is good for **both** meat production **and** egg production.

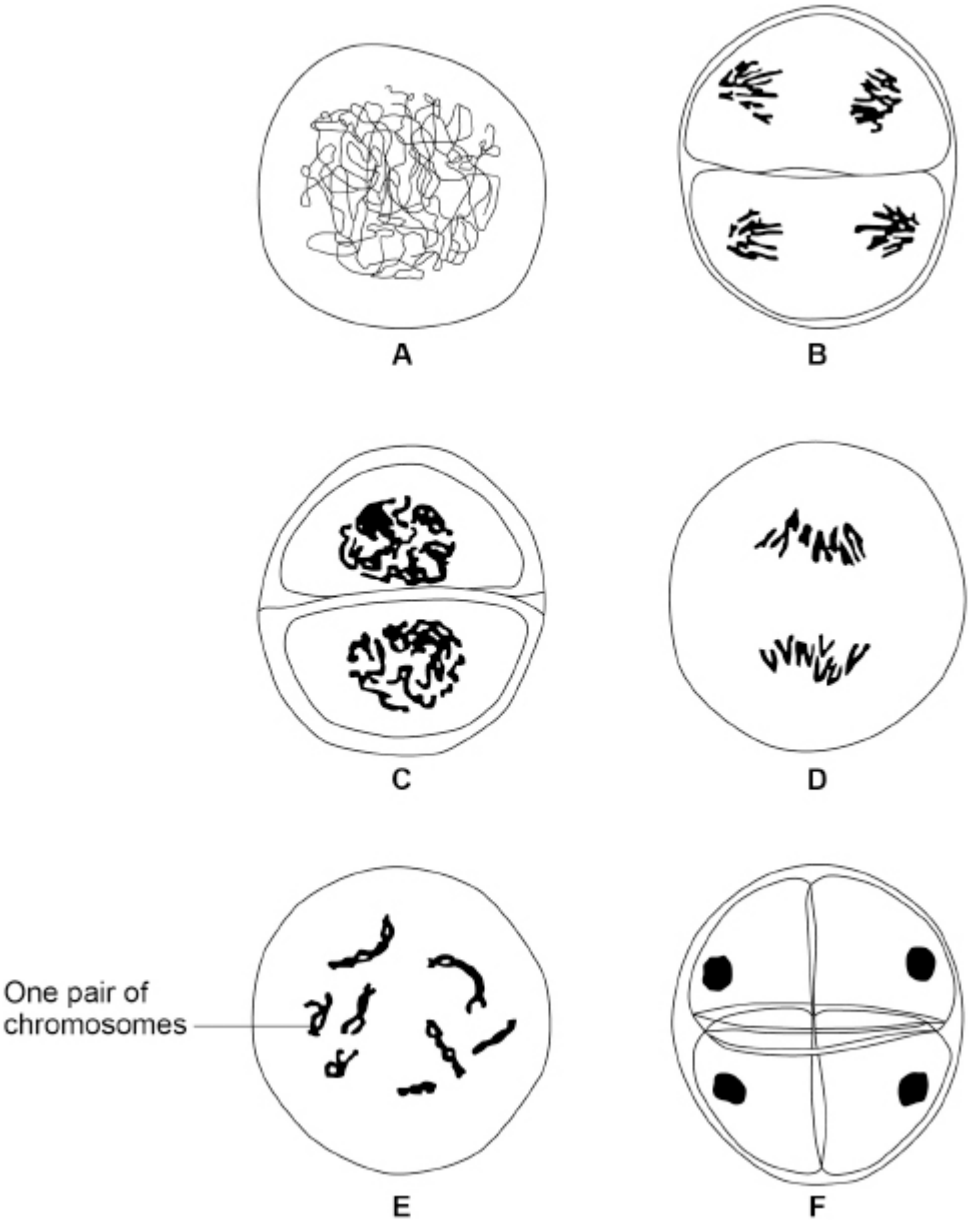
Describe how selective breeding of chicken varieties **A** and **B** can produce the new variety of chicken.

(4)

(Total 15 marks)

9. **Figure 1** shows six stages in the process of meiosis.

Figure 1



(a) In **Figure 1**, **A** is the first stage and **F** is the final stage.

Stages **B** to **E** are **not** in the correct order.

Give the correct order of stages **A** to **F**.

A → _____ → _____ → _____ → _____ → **F**

(1)

At the end of meiosis the number of chromosomes is different from the number of chromosomes at the start of meiosis.

(b) Give the number of chromosomes in **one** cell in **Figure 1**:

- at the start of meiosis
- at the end of meiosis.

Start _____

End _____

(2)

(c) Explain why the change in the number of chromosomes is important.

_____

_____

_____

_____

_____

_____

(3)

(d) Meiosis produces cells that are genetically different.

Describe how meiosis produces cells that are genetically different.

_____

_____

_____

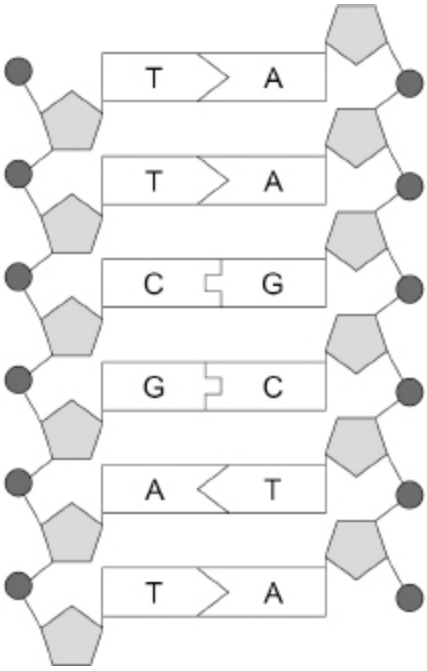
_____

(2)

Chromosomes contain DNA.

Figure 2 shows part of a DNA molecule.

Figure 2



(e) What type of substances are labelled **A**, **C**, **G** and **T** in **Figure 2**?

_____

(1)

(f) DNA is made of nucleotides.

How many nucleotides are shown in **Figure 2**?

_____

(1)

(Total 10 marks)

1.

(a) gene (for antigen)

allow DNA / allele for antigen

ignore DNA / allele unqualified

1

(b) (pure) antigen(s)

1

(c) the viruses may cause an infection

1

(d) any **three** from:

- (sun) light
  ignore sun
- water
  allow moisture / rain
- ions / minerals / salts
  allow a named example
  *allow **two** named ions for **2** marks*
  ignore nutrients / food
- oxygen in the soil
  ignore carbon dioxide
- space

3

(e) crop plants grow better

or

crop plants have higher yield

ignore reference to competition

1

(f) any **one** from:

- may kill / harm / poison **other** plants
  ignore it is poisonous unqualified
- may pollute streams / rivers / soil
- may kill / harm / poison humans / animals
  allow may alter taste of (GM) maize
  allow may reduce biodiversity
  ignore reference to cost

1

[8]

2. (a) to compare (with the other tubes)

or

to show the effect of chemical **Q**

ignore as a control

*do **not** accept control variable*

allow to show the difference

1

(b) $\frac{100}{0.01}$

1

10 000 / 10^4 (times)

1

(c) 0.1 arbitrary units

1

(d) reduced / no (root) growth at high(er) concentrations

allow no (root) growth in tube 6 / 100

allow answer in terms of specific tubes / concentrations

ignore the higher the concentration, the fewer roots grow unqualified

1

(e) **Level 2:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical thinking.

1–2

No relevant content

0

Indicative content

Taking cuttings:

- quicker
  - (because) do not have to wait as long for flowers / fruits / seeds (to form)
- all offspring identical (in appearance) **or** all have large / brightly-coloured flowers
  - (because) all have the same alleles / genes / DNA
- asexual reproduction **or** not sexual reproduction **or** cloning
  - (so) no fusing of gametes
  - (so) no mixing of alleles / genes from two parents
  - (so) offspring are identical (in appearance)
- involves mitosis
  - (which) copies genetic material / chromosomes
- does not involve meiosis
  - (which) gives different genetic material / chromosomes
- avoids variation in flowers
  - due to pollination / cross pollination (from other geraniums)
  - (as) no mixing of alleles / genes from two parents
- increased profitability
  - less resources needed
  - quicker turnover
  - consistent quality of plants / flowers

[9]

3. (a) **r r**

allow homozygous recessive

1

(b) male gametes correct: **R** and **r**

1

all four offspring genotypes correctly derived from gametes (given)

*allow **1** mark for 2 or 3 correct*

2

(c) correct ratio from the figure

*allow 3 : 1 if no answer to **(b)***

1

(d) having (two) different alleles (of a gene)

ignore example(s)

*do **not** accept having two different genes*

1

(e) any **two** from:

- other scientists not aware of his work **or** work published in obscure journal

  allow work lost for many years

- other theories accepted at the time

  allow eg theory of blending inheritance

  ignore religion

- not considered to be a scientist **or** not eminent **or** not respected

  *allow he was **only** a monk*

  allow he was not believed

- Mendel's (mathematical) approach was novel concept

  *allow his work was not understood **or** no other scientist had similar ideas*

  allow his results were not corroborated (at the time)

- peas gave unusual results compared with other species

  allow Mendel only worked on pea plants

  allow insufficient results / research

- new discoveries made Mendel's work relevant

  allow specific discoveries

2

[8]

4. (a) a change in:

- DNA
- base code **or** nucleotide sequence
- base (in DNA)
- gene / allele
- part of a chromosome
- number of chromosomes
- genetic code / material

  ignore genetic information / variation

  ignore reference to amino acids or proteins

1

(b) any **three** from:

allow in terms of an example

ignore mutation

- variation (between members of a species)
- better adapted survive
- (better adapted or survivors) reproduce
- pass on (favourable) allele(s) / gene(s) / mutation(s)

  allow survival of the fittest

  allow converse

  *ignore passing on genetic material **or** chromosomes **or** characteristic*

3

(c) Alfred Wallace and Charles Darwin

1

(d) hoverfly looks like a wasp

allow pattern of the markings is similar (on the hoverfly and wasp)

ignore predator / animal thinks the hoverfly is a wasp

1

predator / animal avoids **wasps** so it does not get stung

1

(so) predator / animal does not attack / eat hoverfly

allow correctly named predator

ignore bite / harm

1

[8]

5. (a) lack of oxygen for (aerobic) respiration

*do **not** accept ref to respiration in dead plants*

1

(so) less / no energy (released)

*do **not** accept energy produced / made / created*

1

(for) microorganisms / bacteria / fungi / microbes / decomposers

OR

low pH denatures enzymes (1)

allow low pH / acidity reduces enzyme activity

(so) less / no (chemical) reactions / metabolism / respiration **or** less **/** no energy released (1)

*do **not** accept energy produced / made / created*

in microorganisms / bacteria / fungi / microbes / decomposers (1)

1

(b) 34 g/m^2/year

1

(c) DNA

1

(d) protein

1

(e) increase in temperature

allow global warming

allow heat (energy) is trapped

1

(because) carbon dioxide is released (from the peat bog)

1

(because) carbon dioxide is produced by burning / decay of peat

ignore reference to greenhouse gases

ignore methane is released from burning / decay of peat

allow fewer plants to take in carbon dioxide (for photosynthesis)

1

(because) methane is released (from the peat bog)

1

[10]

6.

(a) (an allele) that is always expressed
or
(an allele) that is expressed even when the other / recessive allele is present
or
(an allele) that is expressed in the heterozygote
or
(an allele) that is expressed when only one copy is present

allow always shows in the phenotype

ignore stronger

1

(b) (person **1**) has polydactyly so must have **D**

*allow an annotated genetic diagram for up to **2** marks*

*allow (person **1**) has polydactyly so must have a dominant allele*

1

has offspring / (person) **5** who does not have polydactyly so must have **d** from person **1**
or
person **5** does not have polydactyly so must be **dd** and must inherit **d** from person **1**

1

(c) Female / **6**'s gametes correct **D** + **d**

1

Male / **7**'s gametes correct **d** + **d**

*allow **1** mark for both sets of gametes if parents not identified*

1

correct derivation of offspring genotypes: **Dd Dd dd dd**

derivation must be consistent with parental gametes

1

Dd correctly identified as polydactyly in **only** half of offspring

mp4 only awarded if mp3 is correct

1

(d) CF allele is recessive

allow CF is recessive

1

to have CF, must have 2 CF alleles

1

chance of having one CF allele is $\frac{1}{50}$

ignore chance of having one CF allele is one in 50

1

(chance of having two CF alleles is)

$$\frac{1}{50} \times \frac{1}{50} = \frac{1}{2500}$$

ignore 50 × 50 = 2500

1

[11]

7. (a) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- glyphosate kills weeds but does not harm GM soya
- (so) less competition for light / water / ions / (named) minerals / (named) salts / space
- more light / water for <u>photosynthesis</u>
  - (so) more glucose produced
- more glucose for
  - respiration for energy
  - cellulose for cell walls
  - starch for stored energy / glucose (in soya beans)
  - protein for cell structure / storage (in soya beans)
  - lipids for energy storage (in soya beans)
- more water for
  - turgor / support
  - transport
  - medium for reactions
  - hydrolysis / digestion of (stored) organic substances
- more magnesium
  - for chlorophyll
- more nitrate
  - for amino acids / proteins
- more phosphate
  - for DNA

For **Level 3**, answers must include detail of factors that increase the yield of GM maize.

(b) any **two** from:

- do not know effects on animals / humans (when eaten)

  ignore reference to ethical concerns or religion

  allow do not know side effects on animals / humans (when eaten)

- gene / allele may be transferred to other (wild) plants

- reduce biodiversity

- increased cost of seed (for farmers)
  or
  increased cost to consumer (for product)

  ignore cost unqualified

- may affect flavour / taste (of product)

2

[8]

8.

(a) any **one** from:

- variation of a named / described (desirable) characteristic

  allow eg different flavour / colour

- not all susceptible to the same disease / pathogen
- maintain / increase gene pool

  allow different customer preferences

1

(b) any **one** from:

- they have the same named /(desirable) characteristic(s)

  *allow eg all high yield **or** all disease-resistant **or** same (desirable) flavour*

- they grow at the same rate
- they ready to harvest at same time

1

(c) (a group of) cells are grown (into a new organism)

ignore clones

1

(d) any **one** from:

different

- water

  allow rain
- minerals / ions

  allow named example

  ignore nutrients
- light

  ignore sun unqualified
- herbivores

  allow named example
- disease

  allow named example
- plant density
- soil pH

1

allow different temperature

allow different environmental conditions

(e) male gametes = **X** + **Y**

1

female gametes = **X** + **X**

1

*if neither mark awarded, allow **1** mark for*

*male = **X** + **X and** female = **X** + **Y***

offspring genotypes correctly derived from gametes

allow correct for chromosome assignment in mp1 & mp2

1

(f) any **one** from:

- half are XX and half are XY
- equal probability of X or Y sperm fertilising an egg
- (the Punnett square shows) 50% (chance of) male / female

1

(g) any **two** from:

- temperature
- type / amount of food

allow (volume / amount of) water

- light
- whether chickens are kept indoors or outdoors
- amount of movement / space (allowed)

allow same stocking density

allow same number of each type

ignore same number unqualified

- time of year

allow mass at start

allow age of chicken(s)

*allow same medication **or** all healthy*

2

(h) any **one** from:

- (more) valid / representative

or

reduce the effect of anomalies

allow can calculate a valid mean

- (more) accurate mean

allow (more) accurate results

allow (more) reliable mean / results

1

(i) breed best of **A** and **B** (together)

*allow cross / mate best of **A** and **B***

1

select offspring with highest egg numbers **and** heaviest / fastest growing

allow select the best offspring for both desired characteristics

1

breed (these) offspring together

1

repeat over many / several generations

*do **not** accept reference to repeated breeding of the original parents*

1

[15]

9. (a) (A) → E → D → C → B → (F)

must be in this order

1

(b) (start) 16

allow 8 pairs

1

(end) 8

the answer must be half the value of the number at the start

1

(c) (meiosis) forms gametes

allow (meiosis) forms sex cells

*allow (meiosis) forms eggs **and** sperm*

1

(two gametes) fuse / fertilise

1

(so) keeps chromosome number constant (from generation to generation)
or
(so) prevents doubling / increase in chromosome number (in each generation)
or
(so) gives normal / correct chromosome number (for embryo / new cell)

allow gives correct chromosome number (for offspring)

1

(d) random chromosome from each pair (of chromosomes)

ignore half the chromosomes

ignore half the DNA

allow other processes for creating variation

ignore mutation

1

moves to one end of the cell
or
goes into each new cell **or** gamete

1

(e) base(s)

allow organic / nitrogenous base(s)

ignore adenine / cytosine / guanine / thymine

1

(f) 12 / twelve

*allow 6 <u>pairs</u> **or** six <u>pairs</u>*

1

[10]