Name: _____

Class: _____

Date: _____

Inheritance, Variation and Evolution part 8 AQA Triple Biology

Time: **73 minutes**

Marks: **70 marks**

Comments:

1. A wide variety of species exists on Earth.

Most scientists accept Darwin's theory of evolution by natural selection as the explanation for this variety of species.

Explain how our understanding of evolution has developed due to:

- fossil evidence
- increased understanding of the mechanisms of genetics.

(Total 6 marks)

2. Maple syrup urine disease (MSUD) is a rare inherited human condition.

The allele for MSUD is recessive.

(a) What is a recessive allele?

Tick (✓) **one** box.

An allele expressed only if a person has two copies of the allele ☐

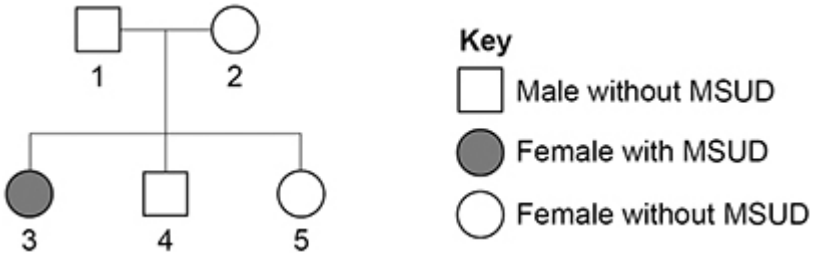
An allele expressed only if it is inherited from the male parent ☐

An allele expressed when it is found on only one of the chromosomes ☐

(1)

Figure 1 shows the inheritance of MSUD in one family.

Figure 1



(b) The symbol ■ is **not** in the key for **Figure 1**.

What would this symbol represent?

_____

(1)

Persons **1** and **2** in **Figure 1** have a child with MSUD and some children without MSUD.

(c) Complete **Figure 2** to show the possible genotypes of the children.

Use the following symbols:

N = allele for **not** having MSUD
n = allele for MSUD

(2)

Figure 2

Person 1 \ Person 2	N	n
N		Nn
n		

(d) What is the phenotype of a person with the genotype **Nn**?

_____

(1)

(e) What percentage of the offspring in **Figure 2** will have MSUD?

Tick (✓) **one** box.

25% ☐ 50% ☐ 75% ☐ 100% ☐

(1)

(f) Which scientific term describes the allele **N**?

Tick (✓) **one** box.

Dominant ☐

Genetic ☐

Heterozygous ☐

(1)

(g) Alleles are found in the nucleus of a cell.

What chemical substance are alleles made from?

_____

(1)

(h) People with MSUD must eat a special diet to reduce their intake of some types of amino acid.

Which component of the diet is made of amino acids?

Tick (✓) **one** box.

Carbohydrates ☐

Minerals ☐

Proteins ☐

(1)

(Total 9 marks)

3. Living organisms can be classified into groups.

Trilobites are animals that lived in the sea 400 to 500 million years ago.

The table below gives the classification of two species of trilobite.

Classification group	**Trilobite A**	**Trilobite B**
	Animalia	*Animalia*
Phylum	*Arthropoda*	*Arthropoda*
Class	*Trilobita*	*Trilobita*
Order	*Ptychopariida*	*Ptychopariida*
Family	*Alokistocaridae*	*Marjumiidae*
	Elrathia	*Modocia*
Species	*kingii*	*typicalis*

(a) Complete the table above.

Choose answers from the box.

Community	**Genus**	**Kingdom**	**Mammal**	**Population**

(2)

(b) Which scientist invented the classification system given in the table above?

Tick (✓) **one** box.

Darwin ☐

Lamarck ☐

Linnaeus ☐

Mendel ☐

(1)

(c) What is the binomial name of trilobite **A**?

Use information from above table.

Tick (✓) **one** box.

Arthropoda kingii ☐

Elrathia kingii ☐

Trilobita kingii ☐

(1)

Figure 1 shows fossils of the two species of trilobite.

Figure 1

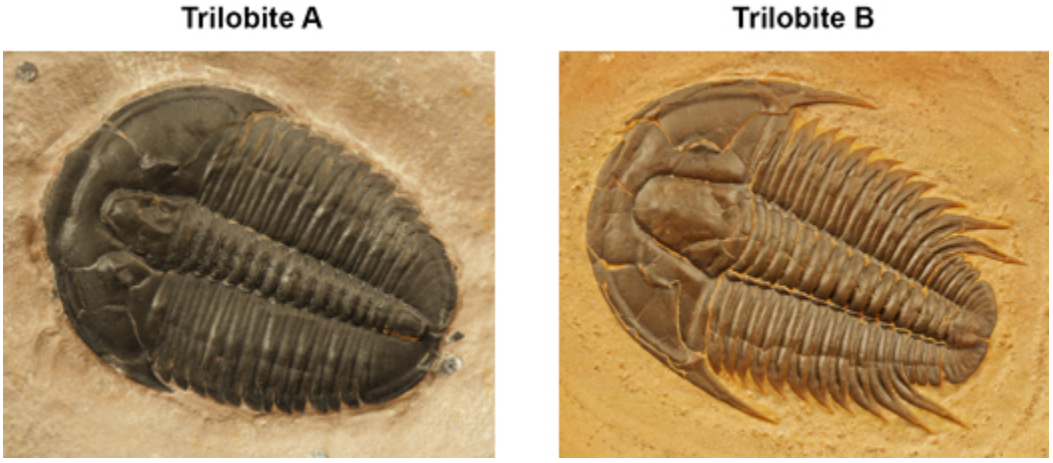
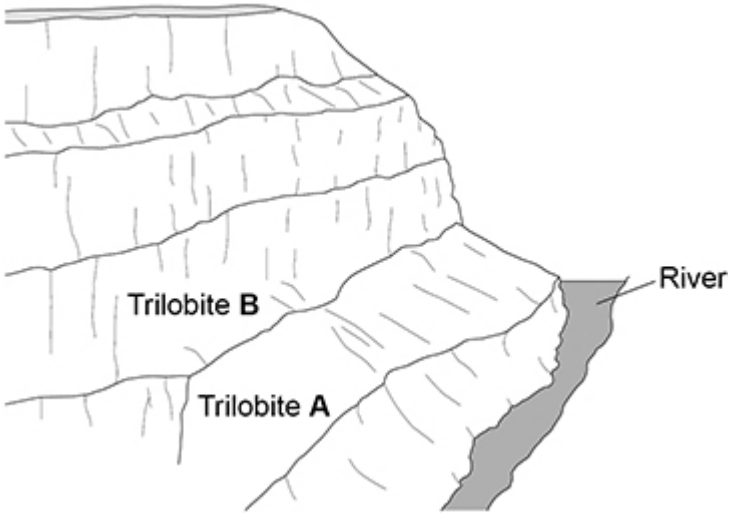


Figure 2 shows:

- layers of rock in a cliff
- where the trilobite fossils were found.

Figure 2



A scientist made the hypothesis:

'Trilobite **B** may have evolved from trilobite **A**.'

(d) What **two** pieces of evidence from **Figure 1** and **Figure 2** support the scientist's hypothesis?

Tick (✓) **two** boxes.

Trilobite **A** and trilobite **B** were in the same type of rock. ☐

Trilobite **A** was found in older rocks than trilobite **B**. ☐

Trilobite **B** has a smaller mass than trilobite **A**. ☐

Trilobite **B** is a different colour from trilobite **A**. ☐

Trilobite **B** is more complex than trilobite **A**. ☐

(2)

(e) Trilobites are animals that lived in the sea.

Complete the sentences about how the fossils of trilobites **A** and **B** were formed.

Choose answers from the box.

acids	**bones**		**hard parts**	**minerals**
	rocks	**sediments**	**soft parts**	

The animal dies and falls to the sea bed.

The animal is buried in _____.

The _____ of the animal decay.

The remains which do **not** decay are replaced by _____.

(3)

(f) Trilobites **A** and **B** are now extinct.

Give **three** possible causes of extinction.

1 _____

_____

2 _____

_____

3 _____

_____

(3)

(g) Suggest **one** reason why scientists **cannot** be sure what caused the trilobites to become extinct.

_____

_____

(1)

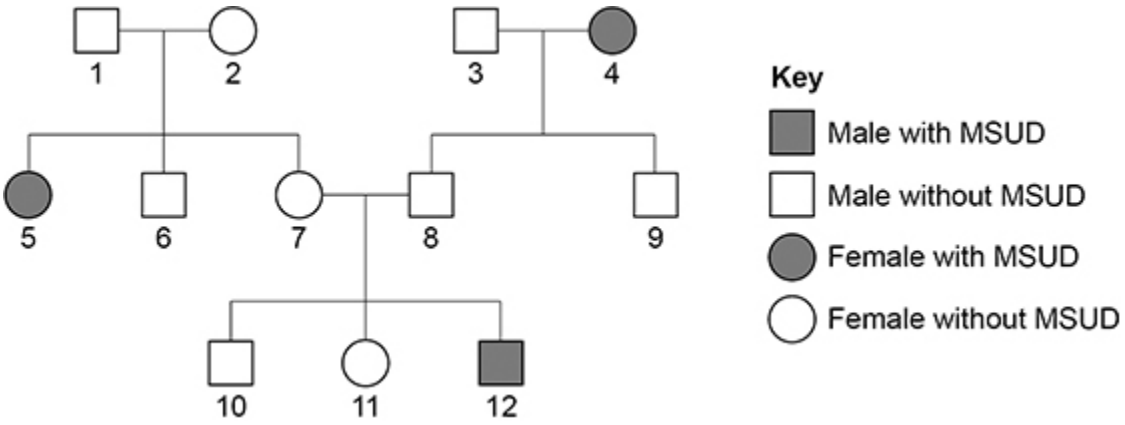
(Total 13 marks)

4. Maple syrup urine disease (MSUD) is a rare inherited human condition.

MSUD is usually diagnosed early in childhood and can be controlled by having a low-protein diet.

Figure 1 shows the inheritance of MSUD in one family.

Figure 1



The allele for MSUD is recessive.

(a) Give **one** piece of evidence from **Figure 1** which shows that MSUD is a recessive condition.

_____

_____

(1)

(b) Persons **7** and **8** in **Figure 1** are expecting a fourth child.

Determine the probability that the child will have MSUD.

You should:

- draw a Punnett square diagram
- identify the phenotype of each offspring genotype
- use the symbols:

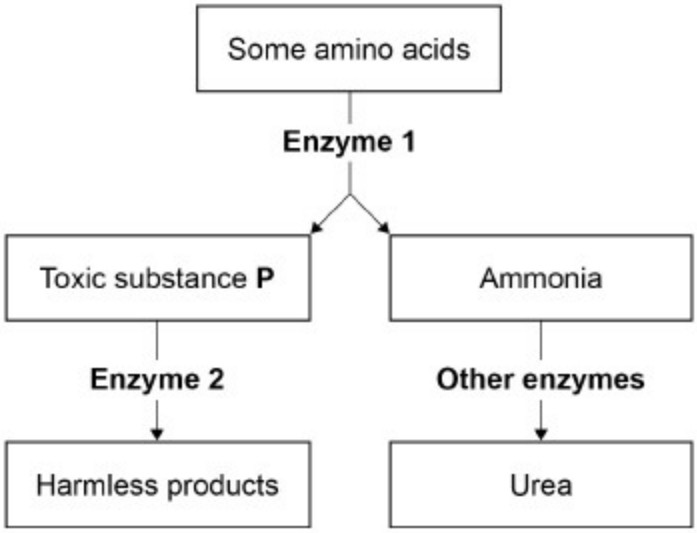
N = allele for **not** having MSUD
n = allele for MSUD.

Probability = _____

(4)

Figure 2 shows chemical reactions involved in the normal breakdown of some types of amino acid inside body cells.

Figure 2



A person with MSUD **cannot** make **Enzyme 2**.

(c) One of the final products shown in **Figure 2** is urea.

Where in the human body are the reactions shown in **Figure 2** most likely to occur?

Tick (✓) **one** box.

Kidney ☐

Liver ☐

Pancreas ☐

Small intestine ☐

(1)

Scientists can analyse blood samples or urine samples to see if a person has MSUD.

The test identifies high concentrations of toxic substance **P**, shown in **Figure 2**.

(d) Explain why the **blood** of a person with MSUD will have a high concentration of toxic substance **P**.

Use information from **Figure 2**.

(3)

(e) Explain why the **urine** of a person with MSUD will have a high concentration of toxic substance **P**.

(2)

(f) Explain why a person with MSUD must have a low-protein diet.

(3)

(Total 14 marks)

5. There are two types of reproduction:

- sexual reproduction
- asexual reproduction.

(a) Complete below table to compare sexual reproduction with asexual reproduction.

Write a tick (✓) in the box if the statement is true.

The first row has been completed for you.

	Sexual reproduction	**Asexual reproduction**
Cell division occurs	✓	✓
Fertilisation occurs		
Genes are passed on from parent to offspring		
Offspring are genetically identical to each other		

(2)

(b) Gametes are formed in sexual reproduction.

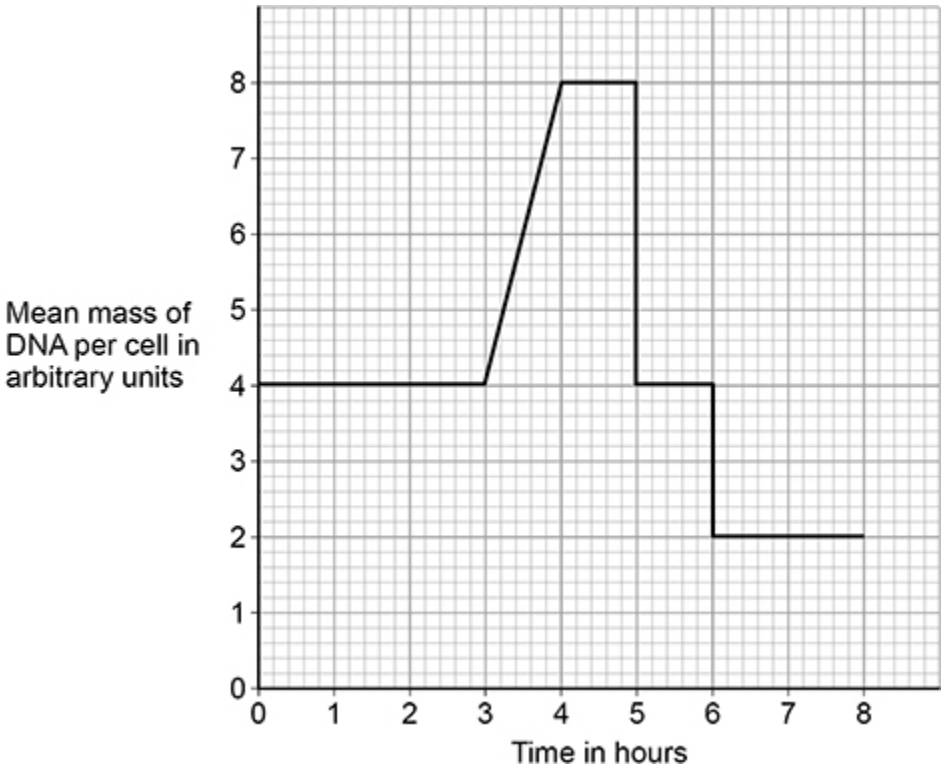
Name the male gamete formed in flowering plants.

_____

(1)

Cell division by meiosis forms gametes.

The figure below shows the mean mass of DNA per cell before, during and after meiosis.



Use information from the figure above to answer part (c) to (f).

(c) When is the DNA in the chromosomes being copied?

Tick (✓) **one** box.

Between 0 and 3 hours ☐

Between 3 and 4 hours ☐

Between 4 and 5 hours ☐

Between 5 and 6 hours ☐

(1)

(d) Cells divide twice during meiosis.

Which **two** times in above graph show one cell dividing into two cells?

Tick (✓) **two** boxes.

3 hours ☐

4 hours ☐

5 hours ☐

6 hours ☐

8 hours ☐

(2)

(e) What is the mean mass of DNA in arbitrary units in a sperm cell?

Tick (✓) **one** box.

2 ☐ 4 ☐ 8 ☐ 16 ☐

(1)

(f) What is the mean mass of DNA in arbitrary units in each cell in an embryo?

Tick (✓) **one** box.

2 ☐ 4 ☐ 8 ☐ 16 ☐

(1)

(Total 8 marks)

6. A scientist found a polluted pond which had a new type of blue algae in the water.

The blue colour of the algae was caused by a mutation.

(a) What is a mutation?

_____

_____

(1)

The scientist measured the number of blue algal cells in a sample of the pond water.

The scientist used a special slide which has a counting grid.

This is the method used.

1. Dilute 2.5 cm^3 of pond water to a volume of 10 cm^3 with distilled water.
2. Place a drop of the diluted pond water on the special slide, as shown in **Figure 1**.
3. Place a thick coverslip over the diluted pond water to give a depth of 0.1 mm of pond water.
4. Use a microscope to count the number of algal cells in a 0.2 mm × 0.2 mm square on the counting grid.

Figure 1 shows a side view of the special slide.

Figure 1

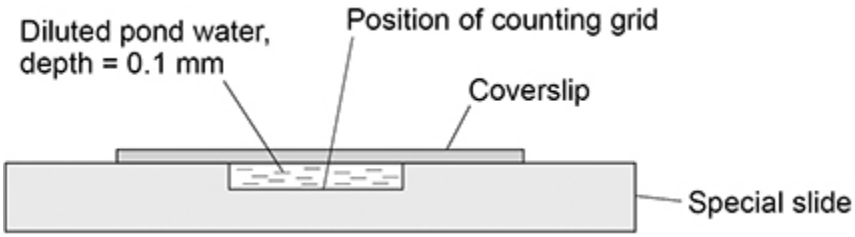
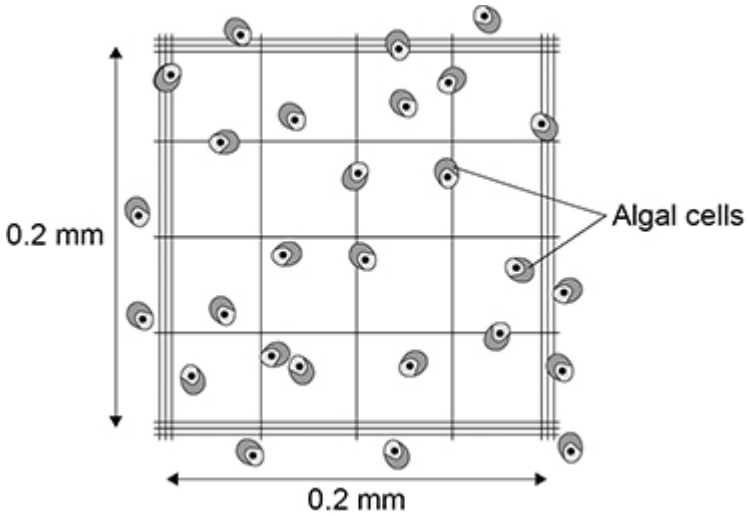


Figure 2 shows the view of the counting grid through a microscope.

Figure 2



(b) How many algal cells are in the 0.2 mm × 0.2 mm square in **Figure 2**?

Use the following procedure:

- Count all cells that are completely within the 0.2 mm × 0.2 mm square in the counting grid.
- Count cells that are touching the left side or the lower side of the square.
- Do **not** count cells that are touching the right side or the top side of the square.

Number of algal cells in the 0.2 mm × 0.2 mm square = _____

(1)

(c) One week later the scientist repeated the test and counted 14 cells on the 0.2 mm × 0.2 mm counting grid.

Calculate the number of algal cells in 1.0 mm^3 of **undiluted** pond water.

Use the scientist's second count of 14 cells.

Number of algal cells in 1.0 mm^3 of undiluted pond water = _____

(6)

(d) Suggest why the scientist diluted the pond water before placing it on the special slide.

(1)

(e) A student repeated the scientist's method.

The student used a thin coverslip over the diluted pond water instead of the thick coverslip.

The liquid pulled the thin coverslip downwards slightly.

Explain how the use of the thin coverslip would affect the results for the cell count.

_____

_____

_____

_____

(2)

(Total 11 marks)

7. The theory of evolution states that organisms alive today evolved by natural selection from other species that are now extinct.

(a) Which **two** scientists proposed the theory of evolution by natural selection?

Tick (✓) **two** boxes.

Alexander Fleming ☐

Alfred Russel Wallace ☐

Carl Linnaeus ☐

Carl Woese ☐

Charles Darwin ☐

(2)

Fossils provide evidence for evolution.

The figure below shows a fossil footprint of a dinosaur.

(b) What is a fossil?

_____

_____

_____

_____

(2)

(c) How was the fossil in the figure above formed?

Tick (✓) **one** box.

Body parts were replaced by minerals. ☐

The animal walked on mud. ☐

The animal was frozen in ice. ☐

(1)

(d) Dinosaurs are extinct.

Give **two** causes of extinction.

1 _____

_____

2 _____

_____

(2)

(e) Which **two** of the following provide evidence for evolution?

Tick (✓) **two** boxes.

Bacteria can become resistant to an antibiotic. ☐

Early forms of life lived in the ocean. ☐

Older fossils are simpler than more recent ones. ☐

Older layers of rock are closer to the surface. ☐

(2)

(Total 9 marks)

1. (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

Fossil evidence:

- fossils show evidence of life in the past
- fossils show change over time
- fossil record shows development of species over time
- fossils show evidence of extinction
- fossil record shows how organisms from the past are related to species alive today

- gaps in fossil record
- gaps in fossil record are being filled in with new evidence
- ref to evolutionary trees
- description of how fossils are formed

Genetics:

- ref to Mendel's breeding experiments with plants
- Mendel's description / idea of units / factors of inheritance
- dominant and recessive units / alleles / genes
- observation of chromosome behaviour during cell division
- chromosome behaviour and Mendel's units work in similar ways
- structure of DNA worked out
- gene mechanism in determining protein synthesis worked out

- (genetic) variation in a species
- (variation) due to mutation or change in gene (structure)
- individuals with advantageous characteristics more likely to survive
- individuals with advantageous characteristics more likely to reproduce
- (survivors) pass on (advantageous) alleles / genes
- eg of evolution (such as antibiotic resistance in bacteria)
- new species arise when sufficient changes occur to prevent (successful) reproduction

For **Level 3**, the response must include details about fossils and about the mechanisms of genetics

For **Level 2**, the response should include descriptions about fossils and / or genetics

[6]

2. (a) an allele expressed only if a person has two copies of the allele

1

(b) male with MSUD

*allow equivalent statements e.g. affected male **or** MSUD male **or** man with the disease*

1

(c) *mark with (d), (e)*

Person 1

	N	n
N	**NN**	Nn
n	**Nn**	**nn**

*3 correct = **2** marks*

*2 or 1 correct = **1** mark*

2

(d) *mark with (c), (e)*

does not have MSUD

*allow equivalent statements – eg normal **or** not affected **or** healthy*

ignore carrier

1

(e) *mark with (c), (d)*

correct percentage from **Figure 2**

*if no answer in part **(c)** allow 25%*

1

(f) dominant

1

(g) DNA

allow deoxyribonucleic acid

allow nucleotide(s)

1

(h) proteins

1

[9]

3. (a) *view with the table*

kingdom

1

genus

1

in this order only

(b) Linnaeus

1

(c) *Elrathia kingii*

1

(d) trilobite **A** was found in older rocks than trilobite **B**

1

trilobite **B** is more complex than trilobite **A**

1

(e) sediments

1

soft parts

1

minerals

1

in this order only

(f) any **three** from:

- drought
- ice age
- global warming

  *if none of these, allow climate change for **1** mark*

  ignore weather

- volcanic activity
- asteroid collision

  *if neither of these, allow catastrophic event **or** natural disaster for **1** mark*

- (new) predators

  allow named example

  allow hunters

- (new) disease / pathogen

  allow named example

- competition for food

  allow lack of food

- competition for mates

  allow lack of mates

  ignore competition unqualified

- lack of habitat or habitat change

  ignore isolation

  ignore pollution

3

(g) no / insufficient evidence

allow lack of evidence

or

cannot perform experiment to find out

allow no-one was there to observe

1

[13]

4. (a) parents without MSUD have a child with MSUD

allow 1 and 2 (without MSUD) have child 5 (with MSUD)

or

7 and 8 (without MSUD) have child 12 (with MSUD)

ignore MSUD skips a generation

1

(b) gametes correct:
N + **n** and **N** + **n**

1

correct derivation of offspring genotypes:
NN **Nn** **Nn** **nn**

allow correct for gametes stated

1

correct phenotype for each genotype

allow correct for offspring genotypes

ignore carrier

1

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

allow correct answer only

allow 1:3

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

1

(c) liver

1

(d) (no enzyme 2 made **so**) cannot break down the toxic substance

*allow (no enzyme 2 made **so**) cannot change toxic substance into harmless products*

1

the toxic substance is still made (from the amino acids)

allow toxic substance builds up over time

ignore concentration of toxic substance is high(er)

1

toxic substance diffuses / moves (from cells) into the blood

ignore incorrect name of organ

*allow **P** for toxic substance throughout*

1

(e) the toxic substance passes through filter in kidney
or
P passes through filter in kidney

1

(some / all) not reabsorbed

*allow (some / all) not absorbed **back** into the blood*

***or** (some / all) not taken **back** into the blood*

ignore (some / all) not absorbed into the blood

***or** (some / all) not taken into the blood*

1

(f) proteins contain amino acids

or

proteins are made of amino acids

allow proteins are broken down into amino acids

1

must keep (certain) amino acids in low amount

allow (so) (certain) amino acids do not build up

allow (so) less of (certain) amino acids are produced

1

(so) toxic substance **or P** does not build up in the body **and** cause damage to cells / tissues / organs

1

[14]

5. (a)

	Sexual reproduction	Asexual reproduction
Cell division occurs	✓	✓
Fertilisation occurs	✓	
Genes are passed on from parent to offspring	✓	✓
Offspring are genetically identical to each other		✓

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

ignore 'x' in blank boxes

2

(b) pollen (grain)

allow nucleus in pollen (grain)

1

(c) between 3 and 4 hours

1

(d) 5 hours

1

6 hours

1

(e) 2

1

(f) 4

1

[8]

6.

(a) any **one** from:

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

ignore genetic information

1

(b) 16 / sixteen

1

(c) *volume of sample in mm^3*
0.004

1

number of cells in 1 mm^3 ***diluted*** *pond water*
14 ÷ 0.004

allow 14 ÷ (0.2 × 0.2 × 0.1)

allow use of an incorrectly calculated volume of 0.04

1

3 500

allow ecf from answer to part (b) for number of algal cells

1

correct dilution factor
¼

allow dilution = ×4

or *4 times*

1

number of cells in 1 mm^3 ***undiluted*** *pond water*
3 500 × 4

allow a calculation based on a dilution factor of 5

1

14 000 **or** 1.4×10^4

1

(d) to make it easier to count

ignore easier to see ***or*** *more spread out*

ignore quicker to count

1

(e) smaller volume

allow (some) liquid / cells would leak out (from under the cover slip)

1

so fewer cells **or** lower cell count

*allow this mark **only** if there is an attempt at an explanation*

1

[11]

7. (a) Alfred Russel Wallace

1

Charles Darwin

1

(b) remains of an organism

allow remains of an animal / plant

1

from a long time ago

allow from thousands / millions of years ago

1

(c) the animal walked on mud

1

(d) any **two** from:

- flooding
- drought
- ice age
- global warming

if none of these, allow

*climate change for **1** mark*

ignore weather

- volcanic activity
- asteroid collision

if neither of these, allow

catastrophic event

***or** natural disaster for **1** mark*

- (new) predators
- (new) disease / pathogen
- competition for food
- competition for mates

allow hunters / poachers

allow named example

allow lack of food

allow lack of mates

ignore competition unqualified

ignore environment change

- lack of habitat **or** habitat change

ignore isolation

ignore pollution

2

(e) bacteria can become resistant to an antibiotic

1

older fossils are simpler than more recent ones

1

[9]