Inheritance 2

Name: _____

Class: _____

Date: _____

Time: **94 minutes**

Marks: **86 marks**

Comments:

1. Potatoes are a food crop.

(a) Potato plants are classified as eukaryota.

What type of classification group is eukaryota?

Tick (✓) **one** box.

- Class ☐
- Domain ☐
- Kingdom ☐
- Phylum ☐

(1)

(b) Potato plants can reproduce by asexual reproduction.

Which statement is true for asexual reproduction?

Tick (✓) **one** box.

- Meiosis occurs. ☐
- Offspring are genetically identical. ☐
- Pollen and egg cells are produced. ☐

(1)

(c) Flowers of potato plants contain gametes for sexual reproduction.

How is a gamete different from other cells in a potato plant?

Tick (✓) **one** box.

A gamete contains one-quarter of the number of chromosomes. ☐

A gamete contains half of the number of chromosomes. ☐

A gamete contains double the number of chromosomes. ☐

(1)

(d) Plants in the same genus as potatoes have been studied by scientists.

Describe **one** way a new plant species could be identified as being in the same genus as potatoes.

_____

_____

(1)

(e) Scientists have collected and stored seeds from species in the same genus as potatoes.

In the future, these seeds may be used for genetic modification of potato plants.

Genetically modified potato plants could help supply food to the human population as the climate changes.

Explain why genetic modification of crop plants may be important for the human population to survive climate change.

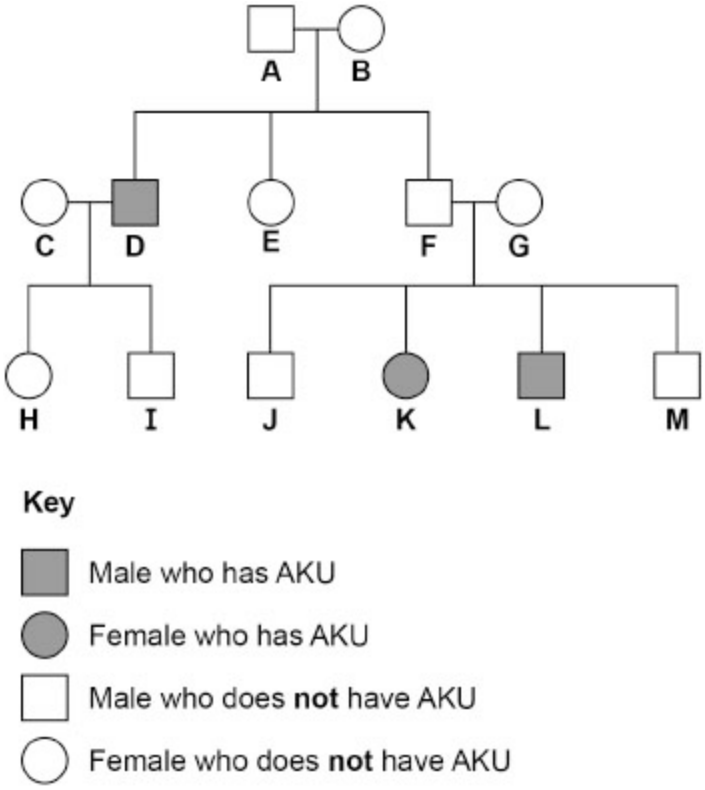
(6)

(Total 10 marks)

2. AKU is a genetic disorder.

Figure 1 shows the inheritance of AKU in one family.

Figure 1



(a) Describe how **Figure 1** shows that the allele for AKU is recessive.

_____

_____

_____

(1)

(b) Which person is **definitely** heterozygous for AKU?

Tick (✓) **one** box.

C ☐ **D** ☐ **E** ☐ **G** ☐

(1)

(c) A female who has AKU and a male who is heterozygous for AKU plan to have a child.

Determine the probability that the child will have AKU.

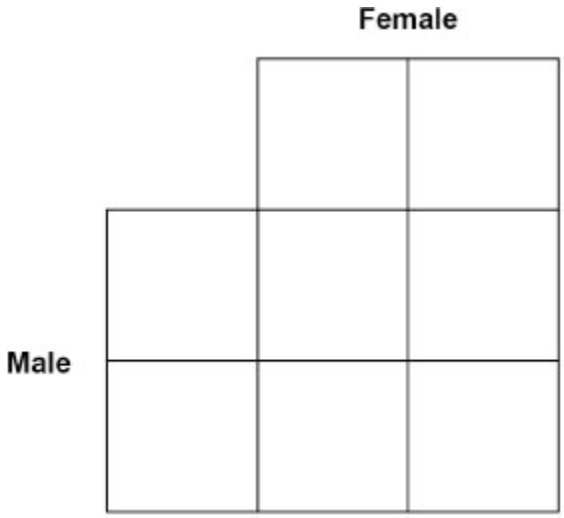
You should:

- complete **Figure 2**
- identify the phenotype of each offspring genotype
- use the symbols:

  A = dominant allele

  a = recessive allele.

Figure 2



Probability that the child will have AKU = _____

(5)

(d) A mutation is a change in a gene.

People who have AKU have a mutation that causes the production of a non-functioning enzyme.

Enzymes are proteins.

Suggest how a mutation can result in the production of a non-functioning enzyme.

_____

_____

_____

_____

(2)

(e) Some people have In Vitro Fertilisation (IVF) treatment to increase the chance of becoming pregnant.

Describe how the process of IVF can result in pregnancy.

(4)

(f) Embryos can be screened to detect inherited disorders.

Give **two** arguments **against** embryo screening.

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

1

2

(2)

(Total 15 marks)

3. Salmon are fish.

A species of salmon has the binomial name *Oncorhynchus keta*.

(a) The table below shows the classification for this species of salmon.

Complete the table.

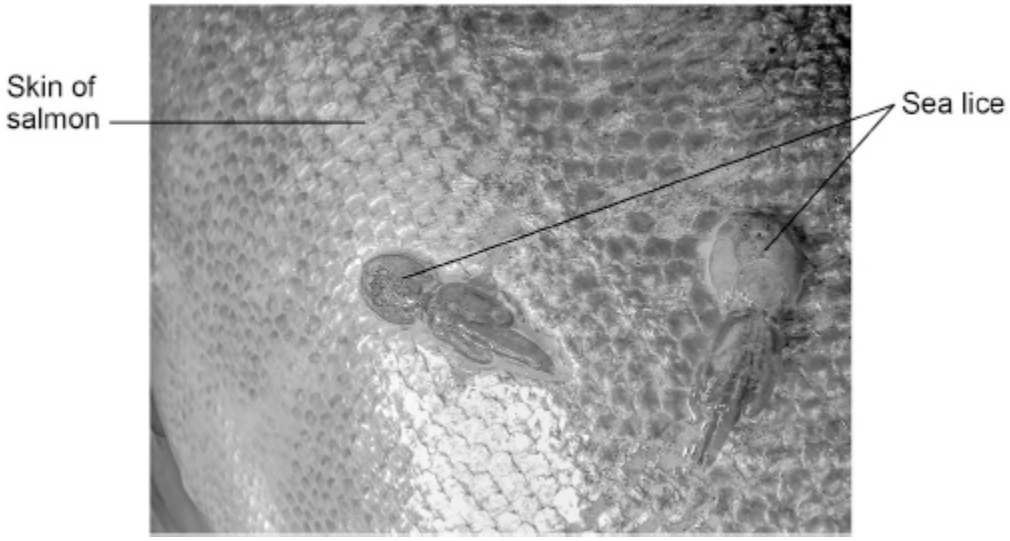
Choose answers from the box.

Class	Domain	Genus	Kingdom	Species

Group	Classification for salmon
	Animalia
Phylum	Chordata
Family	Salmonidae
	Oncorhynchus
	keta

(3)

The figure below shows sea lice attached to the skin of a salmon.



Sea lice are small animals that feed on the skin and blood of salmon.

On a salmon farm, the salmon are fed with food made from soya plants.

(b) Which food chain represents the salmon, sea lice and soya plants?

Tick (✓) **one** box.

salmon	→ sea lice	→ soya plants	☐
sea lice	→ soya plants	→ salmon	☐
soya plants	→ salmon	→ sea lice	☐

(1)

(c) What do the arrows in a food chain represent?

Tick (✓) **one** box.

- The different numbers in the food chain ☐
- The predators in the food chain ☐
- The producers in the food chain ☐
- The transfer of energy in the food chain ☐

(1)

Some salmon are more resistant than other salmon to sea lice infections.

Salmon farmers selectively breed salmon.

(d) Salmon farmers select salmon that are most resistant to sea lice and breed these salmon together.

What is the next stage in selectively breeding salmon that are resistant to sea lice?

Tick (✓) **one** box.

Breed together the offspring that are most resistant to sea lice. ☐

Kill any offspring that are resistant to sea lice before the lice can attach. ☐

Remove the gene for resistance to sea lice from the selected salmon. ☐

(1)

(e) When is the process of selective breeding finished?

Tick (✓) **one** box.

After one generation have produced offspring ☐

When all offspring are resistant to sea lice ☐

When sea lice are living on all salmon ☐

(1)

(f) Salmon that do **not** have sea lice are more profitable for the salmon farmer.

Suggest **one** reason why.

_____

_____

(1)

(g) What is a **disadvantage** of selectively breeding salmon?

Tick (✓) **one** box.

All the salmon may suffer from the same diseases. ☐

Fewer sea lice will infect the salmon. ☐

The salmon will have a large variety of genes. ☐

(1)

Other fish farmers have produced genetically modified (GM) salmon.

GM salmon grow large enough to sell in 18 months.

Non-GM salmon grow large enough to sell in 3 years.

GM salmon need 25% less food than non-GM salmon to get to the same size.

(h) Suggest **two** advantages of farming GM salmon instead of farming non-GM salmon.

1 _____

_____

2 _____

_____

(2)

(i) GM salmon are often farmed a long distance from where wild, non-GM salmon live.

What is an advantage of farming GM salmon a long distance from where wild salmon live?

Tick (✓) **one** box.

To give the GM salmon different conditions to wild salmon ☐

To increase the genetic differences between GM salmon and wild salmon ☐

To reduce the risk of GM salmon breeding with wild salmon ☐

(1)

(Total 12 marks)

4. Sexual reproduction in humans involves the production of egg cells and sperm cells.

(a) Name the type of cell division that produces egg cells and sperm cells.

_____

(1)

(b) Sexual reproduction produces offspring that are genetically different from each other.

Give **two** reasons why sexual reproduction causes variation in the offspring.

1 _____

_____

2 _____

_____

(2)

Polydactyly is an inherited disorder.

The allele for polydactyly is dominant, **D**.

A person with two copies of the allele **d** will **not** have polydactyly.

(c) A person with the genotype **DD** is homozygous.

What word describes the genotype **Dd**?

_____

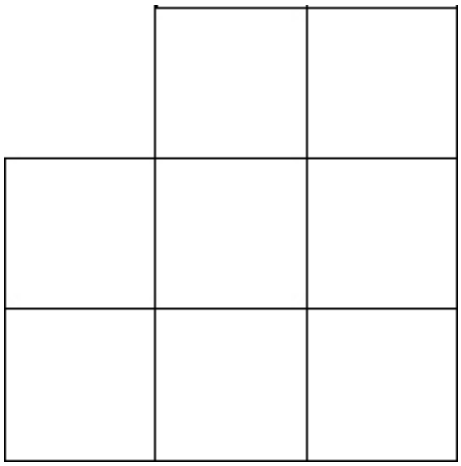
(1)

(d) A person with the genotype **Dd** and a person with the genotype **dd** plan to have a child.

Determine the probability that the child will have polydactyly.

You should:

- complete the Punnett square diagram
- identify any offspring genotype that would have polydactyly.



Probability that the child will have polydactyly = _____

(5)

(e) Embryos can be screened for the alleles that cause inherited disorders.

Give **two** advantages of embryo screening.

1 _____

_____

2 _____

_____

(2)

(Total 11 marks)

5. It is estimated that 99.9% of all species that have ever existed are now extinct.

(a) Why is the percentage of species that are extinct only an estimate?

Tick (✓) **one** box.

All individuals of one species have the same genes.	☐
Extinction is always caused by humans.	☐
Humans have not found evidence of every species.	☐

(1)

(b) What evidence is used to study species that have become extinct?

_____

_____

(1)

(c) A bacterium called *Clostridioides difficile* (*C. difficile*) can infect the human digestive system.

C. difficile can multiply and produce toxins. The toxins cause diarrhoea.

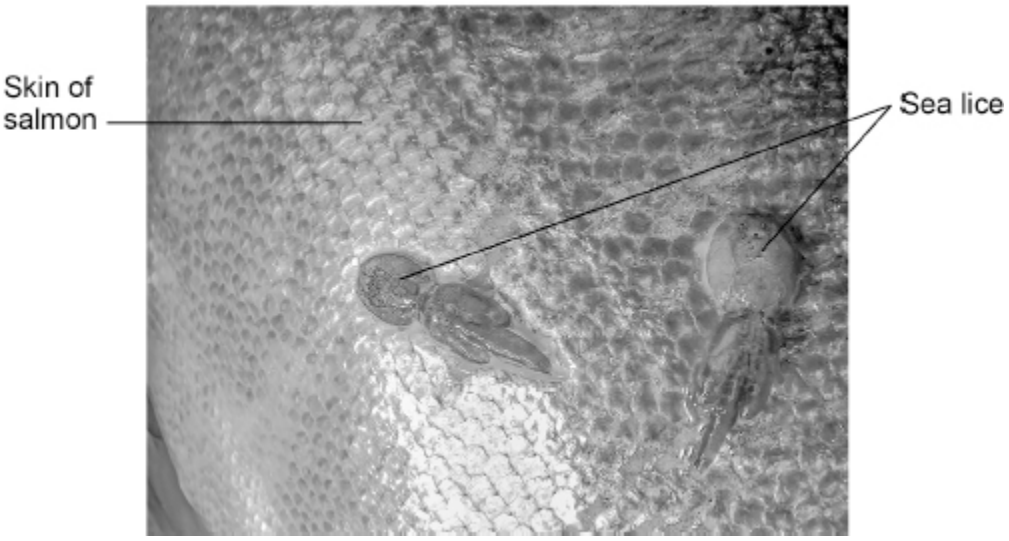
Doctors are concerned that new strains of *C. difficile* may evolve.
Antibiotics may **not** be able to kill these new strains.

Explain how the evolution of antibiotic resistant *C. difficile* can be slowed down.

(6)
(Total 8 marks)

6. Sea lice are small animals that feed on the skin and blood of salmon fish.

The figure below shows sea lice attached to the skin of a salmon, *Oncorhynchus keta*.



(a) What is the genus name of salmon?

_____

(1)

(b) Which domain are sea lice classified in?

_____

(1)

(c) Some salmon have genes that result in fewer sea lice attaching to the skin.

Describe how fish farmers can selectively breed salmon that sea lice **cannot** attach to.

_____

_____

_____

_____

_____

_____

(3)

(d) Explain the advantages to salmon farmers of producing salmon that do **not** have sea lice attached to their skin.

_____

_____

_____

_____

_____

_____

(3)

(e) Explain the **disadvantage** of selectively breeding salmon.

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

_____

_____

_____

_____

(2)

(Total 10 marks)

7. This question is about genetics.

(a) Crop plants are genetically modified (GM) for useful characteristics.

Which useful characteristic are crops genetically modified for?

Tick (✓) **one** box.

Fewer roots ☐

Larger yields ☐

Smaller fruits ☐

(1)

(b) What is **one** concern about GM crops?

Tick (✓) **one** box.

GM crops will add to global warming. ☐

GM crops will cause air pollution. ☐

GM crops will harm wildlife. ☐

GM crops will produce too much food. ☐

(1)

Some inherited disorders are caused by a faulty piece of DNA.

(c) What is the name of a piece of DNA that codes for a characteristic?

_____

(1)

(d) DNA contains a code for making substances in the cell.

What type of substance is made using the DNA code?

Tick (✓) **one** box.

Fat ☐

Protein ☐

Starch ☐

Sugar ☐

(1)

Cystic fibrosis (CF) is an inherited disorder.

The allele for having CF is recessive (**h**).

The allele for **not** having CF is dominant (**H**).

(e) What is a recessive allele?

Tick (✓) **one** box.

An allele that is always expressed. ☐

An allele that is expressed if only one copy is present. ☐

An allele that is only expressed if two copies are present. ☐

(1)

A man and a woman do **not** have CF. The man has the alleles **Hh**.

(f) What word describes the alleles of the man?

Tick (✓) **one** box.

Heterozygous ☐

Homozygous ☐

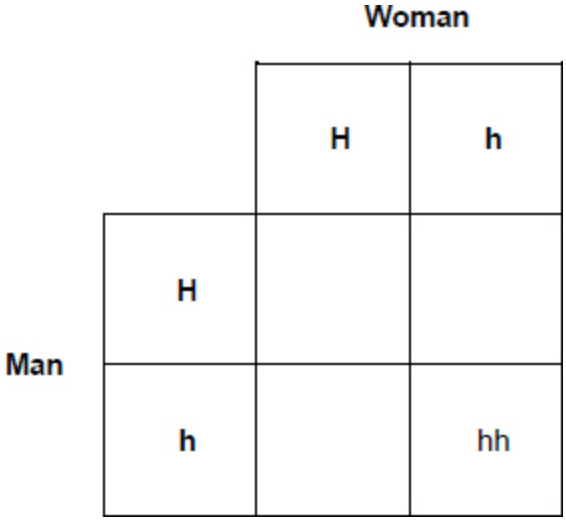
Phenotype ☐

(1)

(g) The man and the woman want to have a child.

Complete below diagram to show the possible genotypes of the child.

Draw a ring around the genotype of a child who will have CF.



(3)

(h) What is the chance that a child of the man and the woman will have CF?

Tick (✓) **one** box.

25% ☐ 50% ☐ 75% ☐ 100% ☐

(1)

(i) The woman is pregnant.

The woman can have embryo screening to find out if the child will have CF.

Suggest **one** reason why the woman might **not** want to have embryo screening.

_____

_____

_____

(1)

(Total 11 marks)

8. The theory of evolution by natural selection was suggested by Charles Darwin in 1859.

Evidence from fossils supports Darwin's theory.

(a) What evidence supports the theory of evolution by natural selection?

Tick (✓) **one** box.

Knowledge of how DNA controls inheritance ☐

Knowledge of how the dinosaurs became extinct ☐

Knowledge of how the Earth was formed ☐

Knowledge of what causes global warming ☐

(1)

(b) **Figure 1** shows a fossil fly preserved in amber.

The fossil formed when the amber solidified with the fly trapped inside.

Figure 1

Fossil fly preserved in amber © Philippe Gouveia / iStock

Why has the fly been preserved?

Tick (✓) **one** box.

The amber has been kept at a constant temperature. ☐

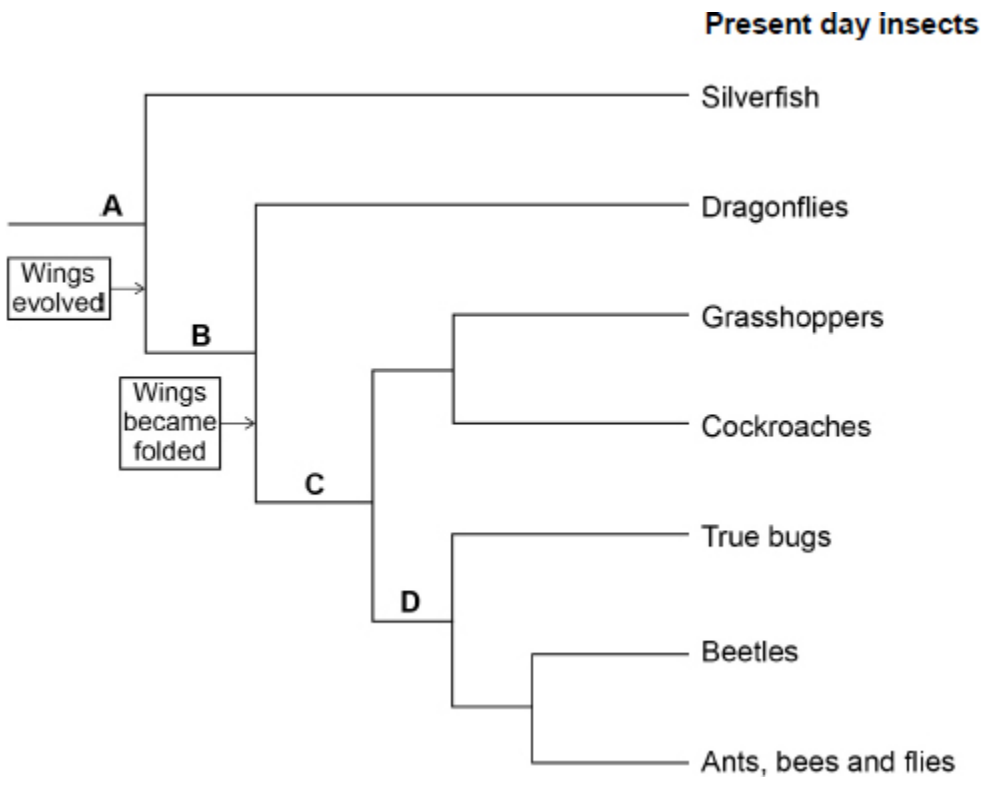
The fly was soft-bodied. ☐

There was no oxygen in the amber. ☐

(1)

Figure 2 shows a simplified evolutionary tree for the insect group of animals.

Figure 2



(c) Which present day insect evolved first?

_____

(1)

(d) Animals **A**, **B**, **C** and **D** were ancestors of present day insects.

Which animal is the most recent ancestor of both grasshoppers and beetles?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(e) Name the group of present day insects which have wings which do **not** fold.

_____

(1)

(f) The house fly has the binomial name *Musca domestica*.

The table below shows part of the classification for the house fly.

Classification group	**Name**
Kingdom	
Phylum	arthropoda
Class	
Order	diptera
Family	muscidae
Genus	
Species	

Complete the table above.

Choose answers from the box.

animalia	**domestica**	**Musca**	**insecta**

(3)

(g) Carl Woese proposed the 'three-domain system' of classification.

Which domain are insects in?

Tick (✓) **one** box.

Archaea ☐

Eukaryota ☐

Prokaryota ☐

(1)

(Total 9 marks)

1. (a) domain

1

(b) offspring are genetically identical

1

(c) a gamete contains half of the number of chromosomes

1

(d) any **one** from:

- similar / same structure / characteristics / phenotype (as potatoes)

  allow named similar structure / characteristics such as same shape / leaves / flowers / taste

  allow studied with microscopes

  ignore 'look the same / similar' unqualified

- similar DNA / genes

  allow DNA analysis
  allow analysis of genetic material
  allow similar genetic material
  ignore genetic information
  *do **not** accept same DNA / genes*

- similar / same biochemistry

- same first part of binomial (name)

  allow same first part of Latin / scientific name

1

(e) **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

allow reference to named crop throughout

effects of climate change

- climate change will change weather patterns / trends
- climate change causes flooding **or** drought **or** temperature change
- farming land decreased by sea level rise / flooding / desertification
- current crops cannot grow / survive (in changing conditions)

benefits of GM

- GM may allow crops to grow in wider range of conditions
- GM may allow crops to be resistant to wider range of pests / diseases
- GM may allow crops to be stored for longer
- GM may increase crop yield **or** increase growth rate

- to feed the increasing human population
- useful if less area available for farming
- larger human population needs more land for housing

other relevant content

- variation amongst current crops reduced by asexual reproduction **or** selective breeding
- rate of evolution (by natural selection) may be slower than rate of climate change

For **Level 3**, answers must explain effect(s) of climate change **and** benefit(s) of GM with logical link.

[10]

2. (a) parents of child with AKU / disorder do not have AKU / disorder

*allow **A** and **B** do not have AKU, but child / **D** does (have AKU)*

*allow **F** and **G** do not have AKU, but child / children / **K** / **L** does (have AKU)*

or

child(ren) with AKU / disorder have parents who do not

allow child(ren) with AKU / disorder have parents who are carriers

1

(b) G

1

(c) (parental gametes)
(female) **a and a**
(male) **A and a**

*allow **1** mark for **a a and A a** parental gametes reversed*

1
1

offspring correctly derived
Aa Aa aa aa

allow correctly derived offspring from incorrect parental gametes

1

offspring phenotype correctly derived
Aa = no AKU
aa = AKU

allow correctly derived phenotypes from incorrect parental gametes or incorrect offspring genotypes
*allow inclusion of **AA** = no AKU, if their cross derives this genotype*
ignore reference to carriers

1

(probability =) 0.5

*allow 50% **or** ½ **or** 1 in 2 **or** 1:1 **or** 50:50*
probability must match offspring genotype
*do **not** accept 1:2 **or** 50/50*

1

(d) (mutation causes) incorrect sequence of amino acids

1

(which) causes the enzyme to be a different shape

allow (which) causes the active site to be a different shape
allow which means the enzyme and substrate cannot bind
ignore the enzyme is denatured
do not accept no enzyme produced

1

(e) FSH **and** LH given / injected (into female) to stimulate maturation of egg(s)

1

(collected) egg(s) are fertilised (in laboratory)

allow (collected) egg(s) fused with sperm (in laboratory)
allow sperm is injected into egg (in laboratory)

1

fertilised egg undergoes mitosis

allow cell(s) undergo mitosis
allow fertilised egg divides / develops to form embryo

1

(one or two) embryo(s) inserted into uterus / womb
or
(one or two) ball(s) of cells inserted into uterus / womb

1

(f) any **two** from:

- risk to embryo

  allow risk of miscarriage
  *do **not** accept risk to embryo due to radiation*
- risk to female / mother
- stressful process
- may lead to termination of the pregnancy

  allow may lead to destruction of the embryo
- (high) cost (of the screening process)
- embryo cannot give consent

  allow idea of increased prejudice against other people with (inherited) disorders

  ignore references to religion / ethics

2

[15]

3. (a)

Group	**Classification for salmon**
Kingdom	
Genus	
Species	

ignore upper case and italics

3

(b) soya plants → salmon → sea lice

1

(c) the transfer of energy in the food chain

1

(d) breed together the offspring that are most resistant to sea lice

1

(e) when all offspring are resistant to sea lice

1

(f) any **one** from:

allow converse for salmon that have sea lice if clearly stated

- salmon grow larger
- salmon grow faster
- salmon need less food
- salmon lose less energy
- do not have to remove sea lice
- no / less need for pesticides

allow no / less need for insecticides

- not off-putting (to consumers / buyers)
- (salmon) more likely to be sold / bought
- salmon less likely to be damaged / infected
- no / less need for antibiotics / medication

*do **not** accept the idea of antibiotics / medication killing sea lice*

ignore sea lice are not feeding on salmon unqualified

1

(g) all the salmon may suffer from the same diseases

1

(h) any **two** from:

(GM salmon)

- more profit(able) / cost-effective

allow sell for more money / revenue

- cost less to feed

ignore less food unqualified

- grow faster

allow can be sold sooner

allow sell twice as many (in 3 years)

allow grow bigger (in 3 years)

- do not need to be farmed / kept as long
- feeds more people

allow cheaper to buy salmon

ignore reference to sea lice

2

answers must be comparative

allow converse for non-GM salmon if clearly stated

(i) to reduce the risk of GM salmon breeding with wild salmon

1

[12]

4. (a) meiosis

allow phonetic spelling

1

(b) gametes / eggs / sperm are not (genetically) identical

allow gametes / eggs / sperm are (genetically) different

allow cells produced by meiosis are not (genetically) identical

1

(there is) mixing of genetic information / genes / DNA
or
genetic information / genes / DNA from two / both parents

allow genetic information / genes / DNA from each parent ignore gametes fuse unqualified

ignore two parents unqualified

1

*if no other mark awarded allow **1** mark for mutations*

(c) heterozygous

ignore dominant / recessive

1

(d) (parents gamete genotypes shown)

D d and **d d**

allow in either position in Punnett square

1

(possible offspring genotypes correctly derived)

Dd Dd dd dd

allow correct derivation of offspring genotypes from incorrect gametes

*allow 3 correct offspring genotypes for **1** mark*

2

correct identification of **Dd** offspring as having polydactyly

*if derivation not correct and shows **DD** and **Dd**, both must be identified as having polydactyly*

1

probability must match derived offspring genotypes

*if no derivation shown allow 0.5 **or** 50% **or** 1 in 2 **or** 1:1 **or** ½*

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

allow correct probability from incorrectly derived offspring

1

(e) any **two** from:

- can find out if the embryo has an (inherited) disorder

  allow can find out if the embryo has inherited disease

  ignore can find out if the embryo has disease(s)
- can prepare for baby (with the disorder)

  allow description of preparation for the baby eg access to early treatment
- can decide whether to continue with the pregnancy

  allow choice of (in vitro) embryos (to be implanted)
- fewer people with (inherited) disorders over time

2

[11]

5. (a) humans have not found evidence of every species

1

(b) fossils

allow fossil record

allow remains of organisms

allow DNA

*do **not** accept fossil fuels*

1

(c) **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

Methods of reducing rate of evolution and linked explanation

- doctors should not prescribe antibiotics inappropriately
  - so fewer *C. difficile* are exposed to antibiotic(s)

- do not use antibiotics to treat mild (bacterial) infection
  - because the immune system can respond (to mild bacterial infection)

- do not use antibiotics to treat (any) viral infections
  - because antibiotics do not kill viruses

- patients should complete their course of antibiotics
  - so (more likely that) all *C. difficile* are killed
  - so none survive to mutate (and form resistant strains)

- the agricultural use of antibiotics should be restricted
  - so fewer *C. difficile* are exposed to antibiotic(s)

- hand washing after going to toilet
  - will reduce spread of *C. difficile*

- people with diarrhoea / *C. difficile* should stay away from school / work
  - to reduce spread of *C. difficile*

- develop new antibiotic against *C. difficile*
  - so all *C. difficile* are killed
  - so none survive to mutate and form (another) resistant strain

- develop vaccine against *C. difficile*
  - would decrease the use of antibiotics

For **Level 3**, answers must refer to method(s) and linked explanation(s).

[8]

6. (a) Oncorhynchus

ignore capitals

ignore italics

*do **not** accept*

Oncorhynchus keta

1

(b) eukaryota

allow eukaryote

1

(c) select fish that have / get least / less / no (attachment of) sea lice
and breed (selected fish) together

ignore with desired genes

1

select offspring that have least sea lice
and
breed (selected offspring) together

*allow select offspring with desired characteristic **and** breed together*

1

repeat over many generations until all offspring have no sea lice (attached)

*do **not** accept idea of repeating with the same parents*

1

(d) sea lice will not be feeding on salmon (skin / blood)

allow skin less likely to be damaged / infected

1

(so) salmon grow larger / faster

allow (so) salmon lose less energy
allow no / less need for pesticides / insecticides
allow (so) not off-putting (to consumers / buyers)
allow (so) more (likely to be) sold
allow salmon with sea lice cannot be sold

1

(so) salmon can be sold for more money

allow more profit
allow no need to remove lice

1

(e) all fish genetically similar

allow all fish have many / mostly same genes
ignore inbreeding unqualified
*do **not** accept fish are clones*
*do **not** accept fish are genetically identical*

1

(therefore) all may have (same) inherited disorder / defect
or
(therefore) prone / susceptible to same disease
or
(therefore) lack of variation to survive future environmental change

1

[10]

7. (a) larger yields

1

(b) GM crops will harm wildlife

1

(c) gene(s)

allow allele(s)

1

(d) protein

1

(e) an allele is only expressed if two copies are present

1

(f) heterozygous

1

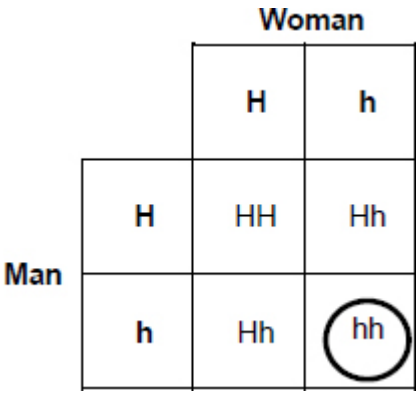
(g) **Mark with (h)**

offspring genotypes correctly derived

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

2

hh circled Woman



1

(h) **Mark with (g)**

25%

*probability must match derivations (hh) in part **(g)***

1

(i) any **one** from:

- it might harm the embryo / baby / mother

  ignore harmful / dangerous unqualified

- it might cause a miscarriage
- they do not want to make a choice about having an abortion
- it is against their religious beliefs

  allow against their religion

  ignore cost

1

[11]

8. (a) knowledge of how DNA controls inheritance

1

(b) there was no oxygen in the amber

1

(c) silverfish

ignore A

1

(d) C

1

(e) dragonflies

ignore A / B

1

(f)

	animalia	*allow animals*
	insecta	*allow insects*
	Musca	
	domestica	

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

ignore italics and upper / lower case letters

3

(f) eukaryota

1

[9]