

1

- (a) Mr and Mrs Smith both have a history of cystic fibrosis in their families. Neither of them has cystic fibrosis. Mr and Mrs Smith are concerned that they may have a child with cystic fibrosis.

Use a genetic diagram to show how they could have a child with cystic fibrosis.

Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.

(3)

- (b) Mr and Mrs Smith decided to visit a genetic counsellor who discussed embryo screening.

Read the information which they received from the genetic counsellor.

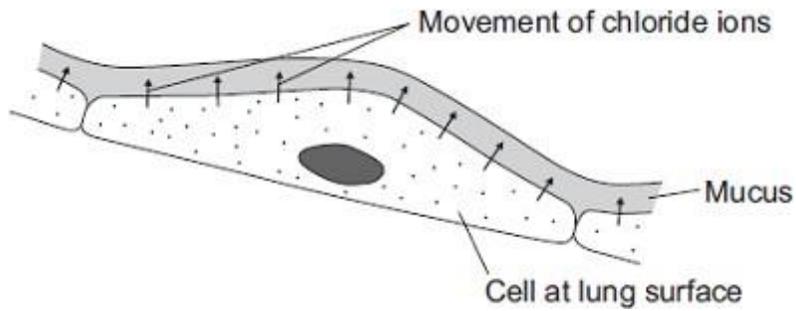
- Five eggs will be removed from Mrs Smith's ovary while she is under an anaesthetic.
- The eggs will be fertilised in a dish using Mr Smith's sperm cells.
- The embryos will be grown in the dish until each embryo has about thirty cells.
- One cell will be removed from each embryo and tested for cystic fibrosis.
- A suitable embryo will be placed into Mrs Smith's uterus and she may become pregnant.
- Any unsuitable embryos will be destroyed.

- (i) Suggest why it is helpful to take five eggs from the ovary and not just one egg.

(1)

(c) In someone who has cystic fibrosis the person's mucus becomes thick.

The diagram shows how, in a healthy person, cells at the lung surface move chloride ions into the mucus surrounding the air passages.



The movement of chloride ions causes water to pass out of the cells into the mucus.

Explain why.

(3)
(Total 11 marks)

2

The picture shows a zebra fish.



Illustration © Emily S. Damstra

Zebra fish are small freshwater fish that usually have black and silver stripes. Zebra fish can tolerate a wide range of environmental conditions.

- (a) Scientists have genetically modified zebra fish to act as pollution indicators. The genetically modified zebra fish have a gene transferred from a jellyfish. The gene allows the stripes of the zebra fish to change colour.

Describe how the scientists produced the genetically modified zebra fish.

(3)

- (b) Some scientists are worried about the production of genetically modified zebra fish. Suggest reasons why.

(2)

(Total 5 marks)

3

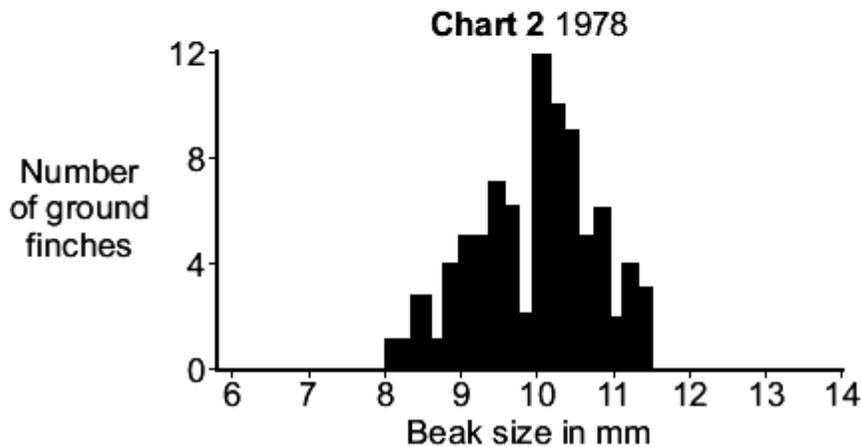
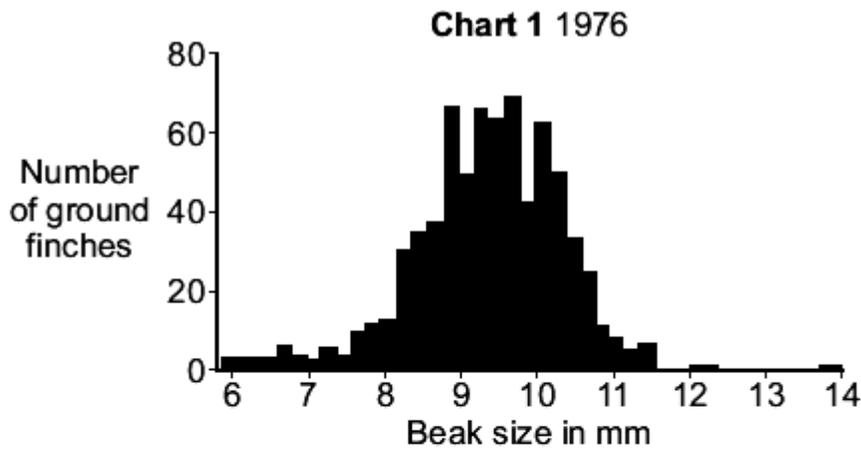
The Galapagos Islands are in the Pacific Ocean, 1400 km from South America. A type of bird called a ground finch lives on the islands. The picture shows a ground finch.



By Charlesjsharp (Own work) [CC-BY-SA-3.0], via Wikimedia Commons

The size of the seeds the ground finch can eat depends upon the size of the beak. To eat large seeds, a large beak is needed.

The bar charts show the sizes of the beaks of ground finches on **one** island, in 1976 and in 1978.



- (a) The population of the ground finches and their beak sizes changed between 1976 and 1978.

Describe these changes.

(3)

- (b) In 1977 there was very little rain on the island. The lack of rain affected the seeds that the finches ate.

The table shows how the seeds were affected.

Year	Mean number of seeds per m ²	Mean mass of each seed in mg
1976	8.5	3.5
1978	2.8	4.2

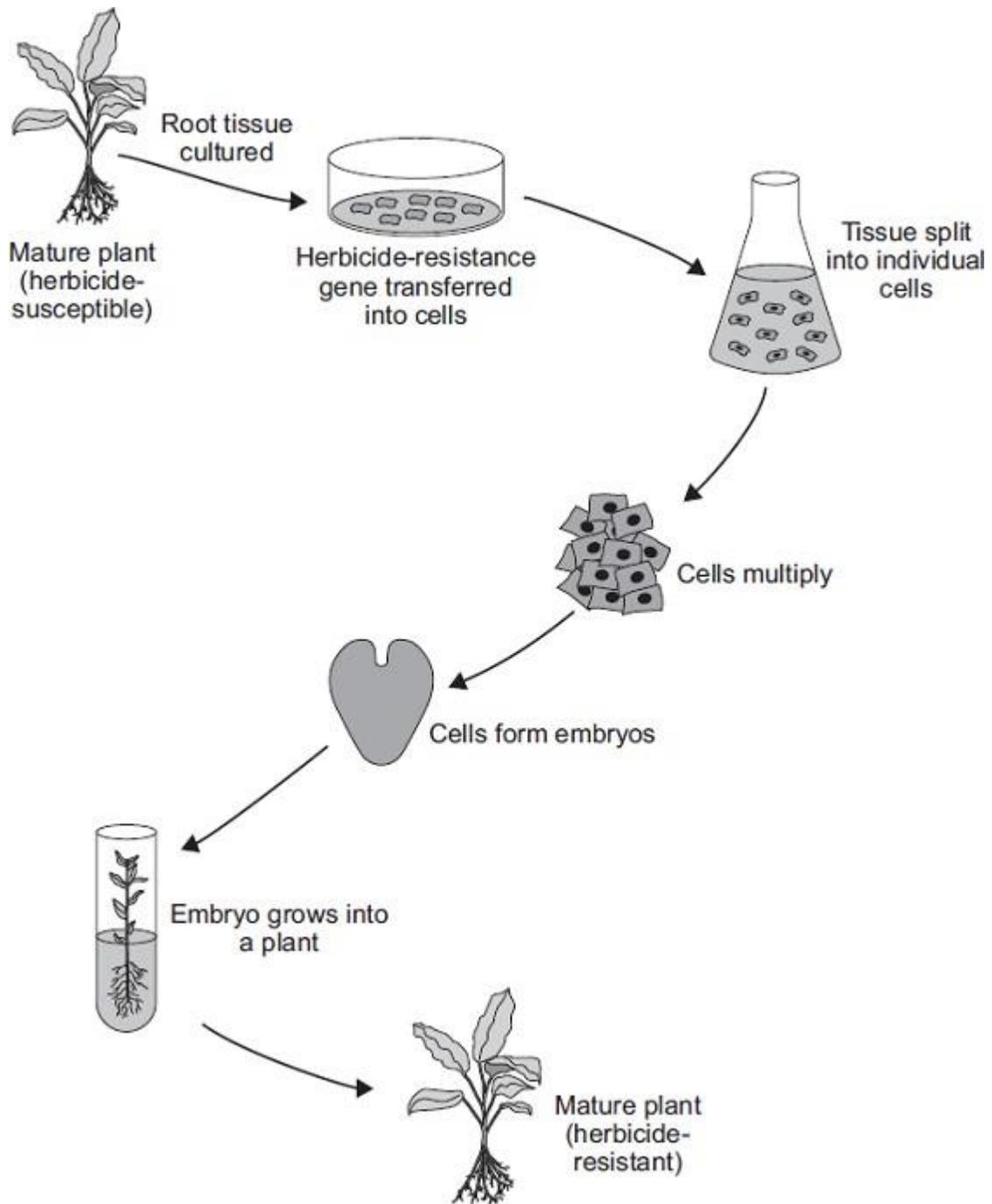
Suggest an explanation for the changes in beak sizes between 1976 and 1978.

(4)

(Total 7 marks)

4

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.

(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)

5

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

Species A

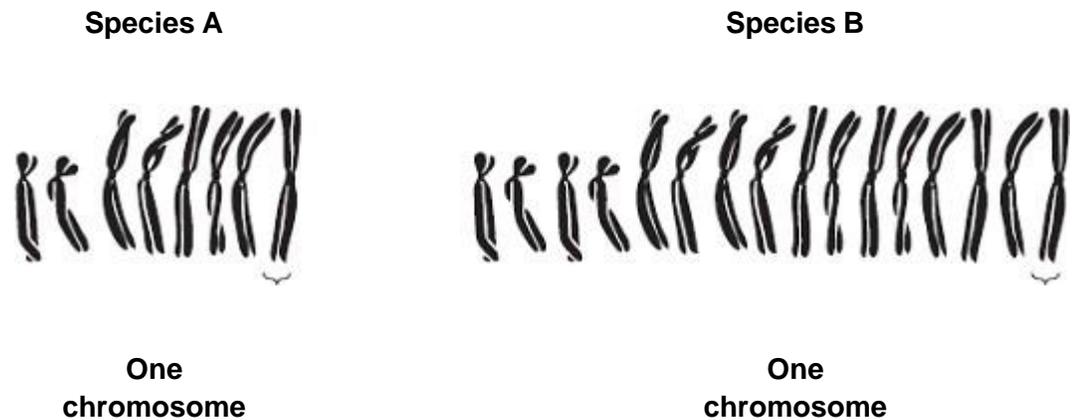


Species B



Images: © iStock/Thinkstock

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



(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.

(2)

(Total 10 marks)

6

- (a) Animal breeders use sexual reproduction to produce new strains of animals.

How does sexual reproduction produce variation?

(2)

(b) A salmon is a type of fish.

Scientists have created a GM (genetically modified) 'super' salmon.

The scientists transferred a gene from a fish called a pout into a salmon. The gene increases the secretion of growth hormone in the salmon. The GM salmon grows much faster than an ordinary salmon, reaching market size up to one year earlier. Many more GM salmon will be grown in fish farms.

(i) Describe how a gene can be transferred from a pout into a salmon.

(3)

(ii) The government might not allow the production of GM salmon.

Suggest **one** reason why.

(1)

(Total 6 marks)

7

People may be immunised against diseases using vaccines.

(a) (i) Which part of the vaccine stimulates the body's defence system?

(2)

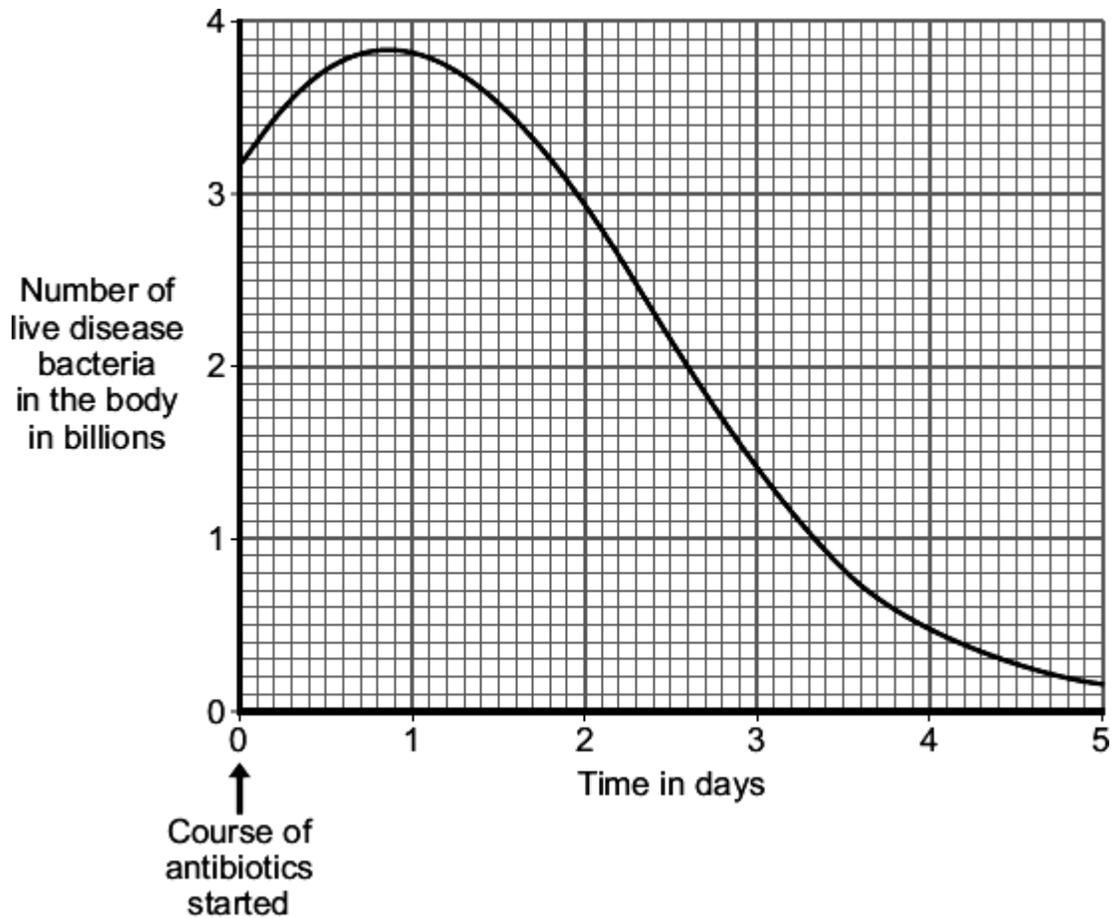
- (ii) A person has been vaccinated against measles. The person comes in contact with the measles pathogen. The person does **not** catch measles.

Explain why.

(3)

- (b) A man catches a disease. The man has **not** been immunised against this disease. A doctor gives the man a course of antibiotics.

The graph shows how the number of live disease bacteria in the body changes when the man is taking the antibiotics.



- (i) Four days after starting the course of antibiotics the man feels well again. It is important that the man does **not** stop taking the antibiotics.

Explain why.

Use information from the graph.

(2)

- (ii) Occasionally a new, resistant strain of a pathogen appears.

The new strain may spread rapidly.

Explain why.

(3)

(Total 10 marks)

8

The Blue-moon butterfly lives on a small island called Samoa, in the Pacific Ocean.



By Eموke Dénes [CC-BY-SA-2.5], via Wikimedia Commons

In 2006 Blue-moon butterflies almost became extinct.

Wolbachia bacteria killed males before they could hatch from eggs. Only females were resistant to the bacteria.

In 2006 the number of male Blue-moon butterflies had decreased to only 1 per cent of the population. Two years later, the number of males was equal to the number of females.

- (a) Scientists believe that a change in a gene suddenly occurred to make some males resistant to the bacteria.

What scientific term describes a change in a gene?

(1)

- (b) The numbers of male Blue-moon butterflies in the population increased quickly after the new form of the gene had appeared.

Suggest why.

(4)

(Total 5 marks)

Mark schemes

1

(a) both parents **Aa**

*accept other upper and lower case letter without key **or** symbols with a key*

allow as gametes shown in Punnett square

1

aa in offspring correctly derived from parents

or

aa correctly derived from the parents given

ignore other offspring / gametes

for this mark parents do not have to be correct

1

offspring **aa** identified as having cystic fibrosis

*may be the only offspring shown **or** circled / highlighted / described*

1

(b) (i) any **one** from:

accept converse if clear, eg if you (only) took one it might have cystic fibrosis / might not be fertilised

- (more) sure / greater chance of healthy / non-cystic fibrosis egg / embryo / child

accept some may have the allele

reference to 'suitable / good embryo' is insufficient

- greater chance of fertilisation

1

(ii) **advantages**

to gain 3 marks both advantage(s) and disadvantage(s) must be given

max 3

any **two** from:

ignore references to abortion unless qualified by later screening

- greater / certain chance of having child / embryo without cystic fibrosis / healthy
- child with cystic fibrosis difficult / expensive to bring up
- cystic fibrosis (gene / allele) not passed on to future generations

disadvantages

any **two** from:

- operation dangers / named eg infection
ignore risk unqualified
- ethical or religious issues linked with killing embryos
accept wrong / cruel to embryos accept right to life argument
ignore embryos are destroyed
- (high) cost of procedure
- possible damage to embryo (during testing for cystic fibrosis / operation)

plus

conclusion

a statement that implies a qualified value judgement

eg it is right because the child will (probably) not have cystic fibrosis even though it is expensive

or

eg it is wrong because embryos are killed despite a greater chance of having a healthy baby

***note:** the conclusion mark cannot be given unless a reasonable attempt to give both an advantage and a disadvantage is made*

*do **not** award the mark if the conclusion only states that advantages outweigh the disadvantages*

(c) any **three** from:

- osmosis / diffusion
*do **not** accept movement of ions / solution by osmosis / diffusion*
- more concentrated solution outside cell / in mucus
assume concentration is concentration of solute unless answer indicates otherwise or accept correct description of 'water concentration'
- water moves from dilute to more concentrated solution
allow correct references to movement of water in relation to concentration gradient
- partially permeable membrane (of cell)
allow semi / selectively permeable

3

[11]

2

(a) (jellyfish) gene(s) cut out

1

ref to enzymes (at any stage)

1

(gene) transferred to zebra fish at early stage of development / embryo / egg

ignore removal of zebra fish genes

1

(b) any **two** from:

ignore unethical / religious / unnatural

- could transfer gene to other (fish) species
- effects on food chains
accept effects on other species / humans who eat them
- effects on zebra fish themselves, eg may out compete non GM zebra fish

2

[5]

3

(a) in 1978
fewer finches **or** population smaller

1

any **two** from:

- no beaks less than 8mm
- no beaks greater than 11.5 / 12mm
if these points not given allow smaller range of beak sizes for 1 mark
- mean / average beak size higher

2

(b) variation or range or mutation of beak sizes

*do **not** accept idea that drought / seed size caused mutation*

1

birds with larg(er) beaks are better adapted for feeding

accept idea of competition for food / seeds amongst finches

1

birds with larg(er) beaks survive

accept (only / more) birds with large beaks were better competitors

1

birds with larg(er) beaks breed **or** gene / allele for large beak passed on

*do **not** accept large beak passed on*

1

[7]

4

(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]

- 5 (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
- or**
 some gametes with missing genes / chromosomes 2
- [10]
- 6 (a) fusion of gametes / named gametes
allow meet / join / fertilise 1

results in mixing of genetic information / DNA / chromosomes
accept genetic information / DNA / chromosomes from two parents

1

(b) (i) use enzyme
1

to cut gene from pout chromosome / DNA
1

insert gene into salmon chromosome / DNA / egg / embryo / nucleus
accept use of plasmid as carrier
ignore salmon / cell
1

(ii) eg fear of gene transfer to wild salmon / extinction of wild salmon /
fear of harmful effect on consumers / unsure of long term effects
ignore cruel / ethics / morals / religion / unnatural / economics
1

[6]

7 (a) (i) dead / inactive / weakened
allow antigen / protein
ignore ref to other components
ignore small amount
1

pathogen / bacterium / virus / microorganism
ignore germs / disease
1

(ii) *antigen / antibiotic instead of antibody = max 2*
white blood cells produce / release antibodies
accept lymphocytes / leucocytes / memory cells produce antibodies
*do **not** accept phagocytes*
1

antibodies produced quickly
1

(these) antibodies destroy the pathogen
allow kill
*do **not** accept antibodies engulf pathogens*
1

(b) (i) (live) bacteria still in body
ignore numbers
1

would reproduce
ignore mutation / growth
1

(ii) antibiotics / treatment ineffective **or** resistant pathogens survive
accept resistant out compete non-resistant

1

these reproduce

1

population of resistant pathogens increases

allow (resistant pathogens reproduce) rapidly

1

[10]

8

(a) mutation

correct spelling only

ignore other adjectives eg random / spontaneous

1

(b) *ignore references to X / Y chromosomes*

idea of mutant gene / new form / this allows hatching (of males)

1

(individual with advantage) (more) survive / (more) live / (more) don't die

allow immunity rather than resistance throughout

1

(so survivors) breed / reproduce

1

mutation / gene passed (from survivors) to offspring / next generation

allow resistance / characteristic for gene

'gene passed on' is insufficient

1

[5]