PEARSON EDEXCEL IGCSE BIOLOGY · 4BI1

BIOLOGY



EXAM QUESTION PACK

SECTION 5: USE OF BIOLOGICAL RESOURCES (PACK 1)

SCORE	PERCENTAGE
/162	%

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Q1.

Read the passage below.

Use the information in the passage and your own knowledge to answer the questions that follow.

Toystory

Toystory is a bull who was born in 2001. The photograph shows Toystory.



In the world of dairy farming Toystory is a famous bull. He fathered 500 000 offspring but did not mate with any cows. He was able to father so many offspring because his semen was collected and then used to fertilise cows using artificial insemination.

Toystory's mother was a high milk producer and his father was a popular bull. He was sold for $4 000 by his owner to a specialist breeding company called Genex.

Genex started to collect semen from Toystory when he was four years old. The semen is carefully collected, using a teaser animal and an artificial rubber vagina.

The semen is divided into many separate samples. These samples are put in small straws and frozen in liquid nitrogen. The straws can then be sold and sent to dairy farmers around the world to inseminate their cows. A total of 2.4 million samples of semen from Toystory was sold in more than 50 countries around the world.

Toystory's reputation grew as the offspring he fathered went on to be high milk producers. His semen straws sold for over $60 each. Bull semen can now be sold as sexed or unsexed samples, with sexed samples being more expensive to purchase.

Toystory was highly valued because his offspring produced large quantities of milk of a desired composition. His semen was effective at getting cows pregnant, his daughters gave birth easily and were strong. He had a rare mix of fertility, genetics and appearance.

One of his daughters sold for $300 000 in 2009. His record number of offspring is unlikely to be beaten. This is because bulls are often retired earlier as new genetic advances are discovered.

(a) Suggest why Genex waited until Toystory was four years old before beginning to collect his semen (line 9).

(1)

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(b) Explain how the semen from the bull is used to fertilise cows using artificial insemination.

(2)

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(c) (i) Suggest why the semen is stored in liquid nitrogen (line 13).

(1)

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(ii) Sexed semen is guaranteed to produce offspring of one sex.

Suggest why dairy farmers would prefer to used sexed semen (line 19).

(1)

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(d) Determine the percentage success of Toystory's semen samples in producing offspring (line 2 and line 15).

(2)

percentage success = ... %

(e) Describe how scientists could investigate which of two bulls is the best to use as a father in dairy farming.

(3)

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(f) Explain why the composition of milk is important to consumers (line 22).

(2)

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(g) (i) Scientists are now using cloning to produce animals.

Describe the stages that are required to clone a bull.

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(ii) Give two advantages of using cloning rather than selective breeding to produce offspring.

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(Total for question = 18 marks)

Q2.

Beta thalassaemia is a genetic condition caused by a mutation in a gene for haemoglobin.

People with beta thalassaemia produce less haemoglobin and fewer red blood cells than people without the condition.

(a) Explain why people with beta thalassaemia may experience severe tiredness.

(2)

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(b) A new treatment for beta thalassaemia has been developed that edits the haemoglobin gene. These are the steps in the treatment.

• remove blood stem cells from a patient's bone marrow

• put a strand of RNA and an enzyme into the blood stem cells to correct the haemoglobin gene

• use drugs to destroy the patient's remaining bone marrow cells

• replace the patient's bone marrow cells with the modified stem cells

The modified stem cells that are in the bone marrow now produce red blood cells containing sufficient haemoglobin.

(i) The strand of RNA used in this treatment is complementary to one strand of the DNA in the haemoglobin gene.

Give the base sequence of RNA that is complementary to this sequence of DNA.

(2)

DNA strand A A T G G C G G C T C A

RNA strand

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(ii) Protein synthesis of the modified gene will produce haemoglobin.

Describe the stages of this protein synthesis.

(4)

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(iii) The standard treatment for beta thalassaemia is a weekly blood transfusion.

The new treatment has so far been tested on two patients, with these results.

• both patients started making large numbers of red blood cells with sufficient haemoglobin

• both patients experienced serious side effects from the drugs used, needing to spend several months in isolation in hospital before recovering

• 15 months after the treatment, neither patient required further blood transfusions

• both patients were able to exercise normally without feeling tired

Evaluate the use of the new treatment compared to weekly blood transfusions.

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(Total for question = 12 marks)

Q3.

Blood clotting is an important process in humans.

The process is controlled by enzymes.

(a) (i) Give two reasons why blood clotting is important.

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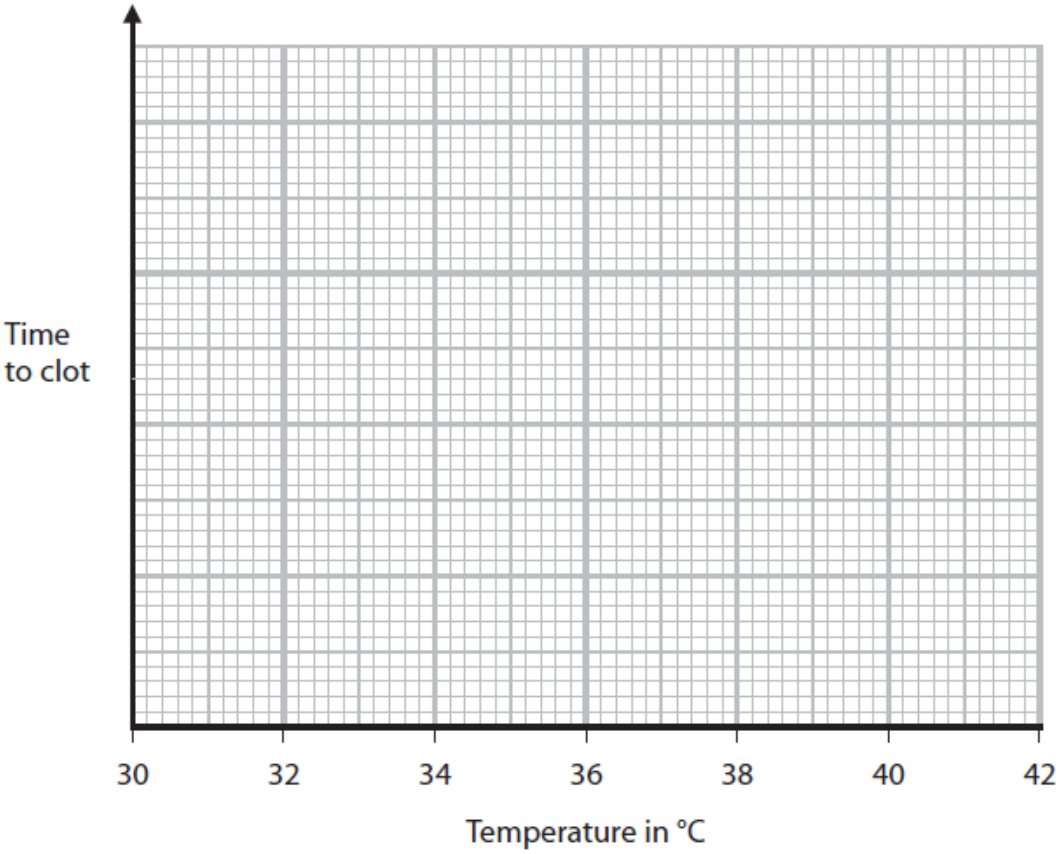
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(ii) The optimum temperature for the enzymes involved in blood clotting is 37 °C.

Sketch a graph to show how temperature affects the time taken for blood to clot.

(1)



(b) Some people cannot make the proteins needed for blood clotting.

Cloning is used to produce large numbers of transgenic mammals.

These transgenic mammals can make the human blood-clotting proteins. The human blood-clotting proteins can then be removed from the mammals' milk and injected into people who cannot make the proteins.

(i) Explain why these mammals are described as transgenic.

(2)

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(ii) Describe how a mammal is cloned.

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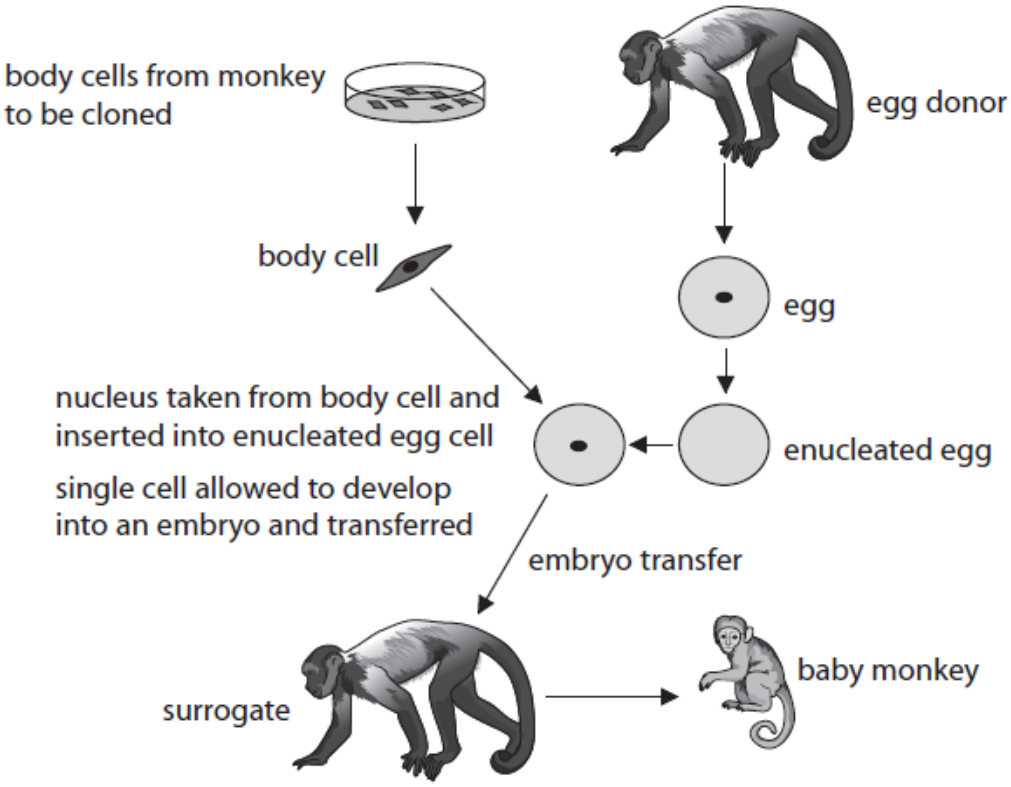
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(Total for question = 11 marks)

Q4.

Scientists have produced cloned monkeys.

The diagram shows the procedure used to produce cloned monkeys.



(a) (i) State the meaning of the term **enucleated**.

(1)

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(ii) Describe how the single cell develops into an embryo.

(2)

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(b) Scientists can use adult body cells or fetal body cells to clone monkeys.

The table gives information about cloning using body cells from different sources.

Source of body cells	Number of surrogates used	Number of successful pregnancies	Offspring produced
adult	42	22	2 short-lived
fetus	21	6	2 healthy

Evaluate this data to decide which source of body cells is more successful in cloning monkeys.

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(Total for question = 7 marks)

Q5.

Scientists can now produce farm animals by cloning. Since Dolly the sheep was born in 1996 many different species have been cloned.

The form of cloning used is called somatic cell cloning.

The first ever clone of a champion racehorse was announced in 2005 in Italy.

The foal was cloned from Pieraz, a world champion in long-distance horse races.

(a) Describe the stages scientists could use to clone a male horse.

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(b) Pieraz was castrated (had his testicles removed) at a young age.

Explain why this stopped him reproducing normally but did not stop him being used to produce a foal by cloning.

(3)

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(c) Suggest why horseracing does not allow the use of non-natural methods of breeding, including cloning.

(1)

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(d) State one difference between cloning an organism and genetically modifying an organism.

(1)

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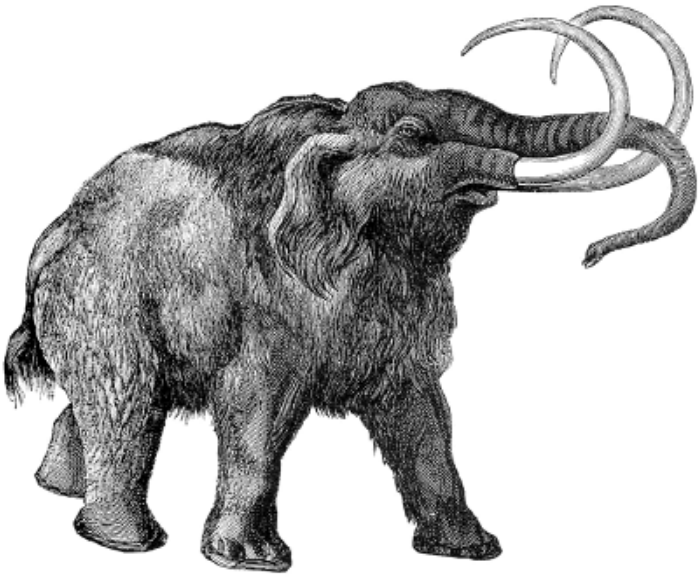
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(Total for question = 9 marks)

Q6.

Mammoths were large animals that existed from 5 million to 4500 years ago, but are now extinct. They shared a common ancestor with modern-day elephants.

The drawing shows a mammoth.



Scientists recently found a thigh bone of a frozen mammoth in Russia.

The bone had been frozen for 40 000 years. The scientists intend to use the bone cells to clone a mammoth.

Describe the method that could be used to clone a mammoth.

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(Total for question = 4 marks)

Q7.

Many mammals have been cloned since Dolly the sheep was produced by cloning in 1996.

(a) It took 277 attempts at cloning to produce one sheep.

Calculate how many attempts would have been needed to produce 50 cloned sheep in 1996.

Assume the same number of attempts are needed to produce each sheep as were needed to produce Dolly.

(1)

number of attempts = ...

(b) Describe the stages used to clone a male dog.

(5)

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(c) Pet owners can now pay scientists to use cells from their pet to produce a clone.

The process costs $50 000 for a dog and $25 000 for a cat.

Cloning is not always successful and as with Dolly, many attempts may need to be made to produce one clone.

Many scientists disagree with this use of cloning.

Comment on whether cloning of pets is a good idea.

Use the information in this question and your own knowledge to support your answer.

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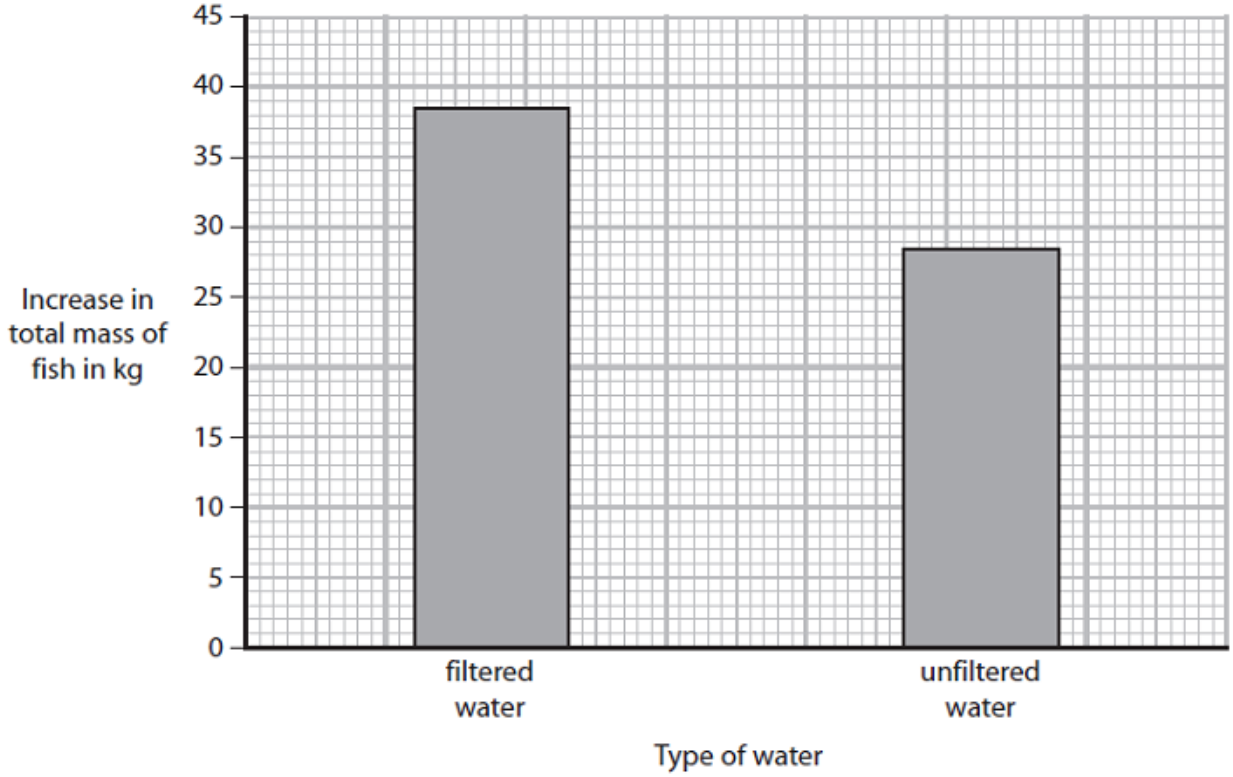
(Total for question = 10 marks)

Q8.

A scientist uses this method to investigate the effect of water quality on the growth of fish.

- fill a pond with filtered water
- fill another pond with unfiltered water
- place the same mass of fish of the same species in each pond
- determine the increase in total mass of fish in each pond after 180 days

The graph shows the scientist's results.



(a) The mean rate of increase in total mass of the fish in the filtered water is 0.214 kg per day.

Calculate the difference between the mean rate of increase in the total mass of the fish in filtered and unfiltered water.

(3)

difference in mean rate = ... kg per day

(b) Unfiltered water contains more bacteria.

Explain why unfiltered water containing more bacteria affects the growth of fish.

(3)

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(c) Give one biotic variable the scientist controlled in the investigation.

(1)

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(d) Give a method the scientist could use to control interspecific predation in the ponds.

(1)

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(Total for question = 8 marks)

Q9.

Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Badgers and bovine tuberculosis

The bacterium *Mycobacterium bovis* causes the lung disease bovine tuberculosis (TB) in cattle. Infected cattle have damaged lungs, which causes gas exchange problems and makes them cough into the air. The pathogen spreads to humans if they inhale air containing the bacterium. Humans also become infected if they drink unpasteurised milk from infected cattle. Milk is usually pasteurised by heating it for a period of time at a high temperature.

Bovine TB can kill humans. In one year, 13 400 people died from a total of 149 000 reported cases of TB. Some of these cases were from Europe, where 103 people died from 1290 reported cases. The rest of the cases were from outside Europe.

Some farmers in the United Kingdom are concerned that badgers spread the TB pathogen to cattle.

The photograph shows a badger.



Badgers act as a reservoir for the TB pathogen and can live for several years without showing any signs of TB. Some farmers want badgers to be culled (killed) to stop the spread of bovine TB to cattle.

However, some scientists claim that only a fraction of cattle catch TB from badgers, and that culling badgers could spread the disease to new areas. This is because badger culling changes the behaviour of the badgers that survive. Normally, badgers live in social groups and will defend their territory from other badgers by being aggressive. This territorial behaviour reduces the spread of disease between groups. If badgers are culled, then their territories cannot be defended. Surviving badgers could move in to occupy the undefended territory, bringing TB with them. This could spread TB to new animals and new areas.

Some people believe that badgers should be vaccinated to stop the spread of TB. However, there is some concern that vaccination may increase the spread of TB because it might also change badger behaviour.

An investigation is needed to find out if badger vaccination can reduce TB both in badgers and in cattle.

(a) Explain why cattle with damaged lungs have gas exchange problems (lines 2 to 3).

(2)

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(b) Explain the advantage of drinking pasteurised milk rather than unpasteurised milk (lines 4 to 5).

(2)

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(c) Suggest two reasons why there were fewer cases of bovine TB in Europe compared with outside Europe (lines 7 to 9).

(2)

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2 .....

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(d) The case to death ratio in Europe is 12.5 : 1 (lines 7 to 9).

Calculate the case to death ratio from outside Europe.

(2)

case to death ratio = ...

(e) Territorial behaviour reduces the spread of disease between badger groups (lines 19 to 20).

Suggest two other ways that badgers benefit from territorial behaviour.

(2)

1 .....

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(f) Explain how vaccination reduces the risk of infection in badgers (line 24).

(3)

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(g) Describe how scientists could find out if badger vaccination reduces TB in cattle (lines 27 to 28).

(3)

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(Total for question = 16 marks)

Q10.

Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Supercharging plants to reduce global warming

The proportion of carbon dioxide in the atmosphere has increased in the last 100 years. In 2020, a mass of 727 gigatonnes of carbon dioxide was released into the atmosphere from natural processes, along with a mass of 37 gigatonnes from human activities. Scientists have estimated that plants naturally remove a mass of 746 gigatonnes of carbon dioxide from the atmosphere every year. The difference between what is removed and what is released causes atmospheric carbon dioxide to rise every year. Carbon dioxide is a greenhouse gas, and a significant rise will cause global warming.

To help solve the problem of rising concentrations of atmospheric carbon dioxide, scientists are planning to produce transgenic, supercharged plants that can remove atmospheric carbon dioxide and store it in their roots. The scientists estimate that if these plants can be developed, the plants could remove a mass of carbon dioxide equivalent to 50% of the emissions from human activities.

Coastal plants that have their roots in seawater contain a substance called suberin in the cell walls of the outer layer of the roots. Suberin is a waterproof substance that contains a high proportion of carbon atoms. Suberin is decomposed very slowly so remains in the soil for a long time.

The photograph shows a coastal plant called a mangrove.



(Source: © Snow At Night/Shutterstock)

To produce the supercharged plants, scientists intend to take the gene that codes for high suberin production from a coastal plant and insert it into crop plants. The crop plants used are perennial plants. Perennial plants live for many years rather than dying each winter. The transgenic crops would take in large amounts of carbon dioxide and use the carbon atoms to make suberin. The carbon would then be locked up and stored as suberin in the roots. After successfully producing one plant, they will use micropropagation rather than pollination to produce others.

These supercharged crop plants may have other uses. Suberin in roots helps to make them tolerant to soil with a high salt concentration, helping to produce higher crop yields in areas that have difficult growing conditions.

(a) (i) Carbon dioxide is a greenhouse gas.

State the name of another greenhouse gas (line 7).

(1)

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(ii) Calculate the increase in mass, in kg, of atmospheric carbon dioxide in 2020 (lines 2 to 7).

Give your answer in standard form.

[1 gigatonne = 1 000 000 000 000 kg]

(3)

Increase in mass = ... kg

(iii) State two consequences of global warming for the environment.

(2)

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2 .....

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(b) Explain why producing genetically engineered plants with additional suberin in their roots could reduce atmospheric carbon dioxide (lines 14 to 17 and lines 19 to 24).

(4)

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(c) Which enzyme is used to remove a gene from a section of DNA?

(1)

☒ **A** amylase

☒ **B** ligase

☒ **C** lipase

☒ **D** restriction

(d) Explain why the additional suberin in the cell walls of the roots will make the transgenic plants tolerant to soil with a high salt concentration (lines 26 to 28).

(2)

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(e) Give three reasons why the scientists use micropropagation to reproduce the transgenic crop plants (lines 24 to 25).

(3)

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(Total for question = 16 marks)

Q11.

Micropropagation is used to produce plant clones.

The process involves growing explants *in vitro*.

(a) State what is meant by the term ***in vitro***.

(1)

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(b) The explants grow new roots and shoots.

A student investigates the effect of pH on the growth of new shoots.

The table shows the student's results.

pH	Mean number of shoots per explant
4.5	3.0
5.0	4.8
5.5	5.4
6.0	6.4
6.5	4.3

(i) Explain the relationship between pH and the mean number of shoots per explant.

(2)

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(ii) Describe a procedure the student could use to obtain explants and produce these results.

(6)

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(c) Give two benefits of using micropropagation to produce new plants rather than using seeds.

(2)

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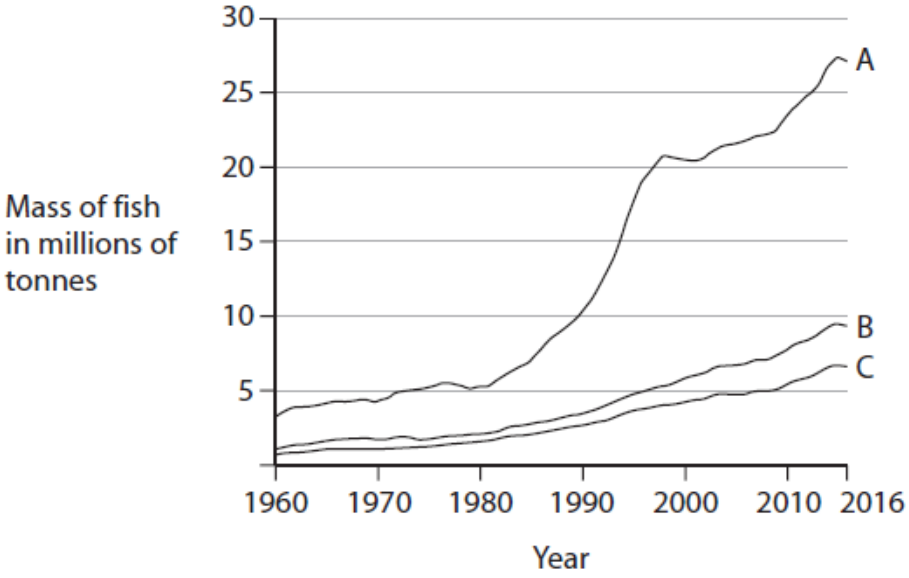
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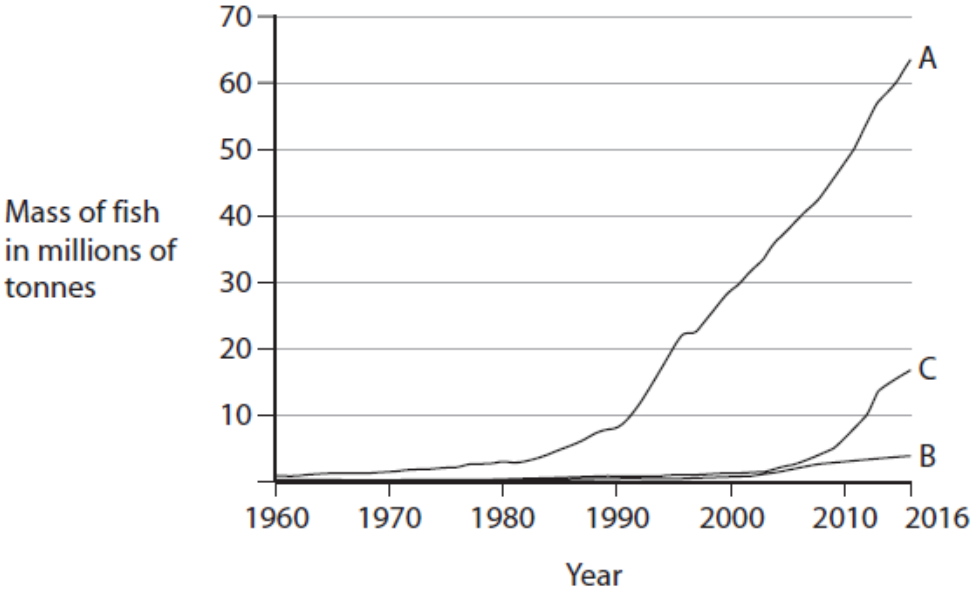
Q12.

Graph 1 shows the mass of fish caught by traditional fishing in tonnes from 1960 to 2016 in three countries.



Graph 1

Graph 2 shows the mass of fish produced by fish farming from 1960 to 2016 in the same three countries.



Graph 2

(a) Comment on the changes in the mass of fish caught by traditional fishing and the mass of fish produced by fish farming from 1960 to 2016.

Use information from the graphs to support your answer.

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(b) Explain the methods a fish farmer can use to maximise production of fish.

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(Total for question = 10 marks)

Q13.

Fish farming is often used to produce protein rich food.

(a) Selective breeding is often used to produce fish that grow rapidly and do not waste much food.

Explain how selective breeding can be used to produce fish that grow rapidly.

(2)

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(b) Fish farming systems can often release ammonia into the water. The ammonia is converted into nitrates.

Describe how ammonia is converted into nitrates.

(2)

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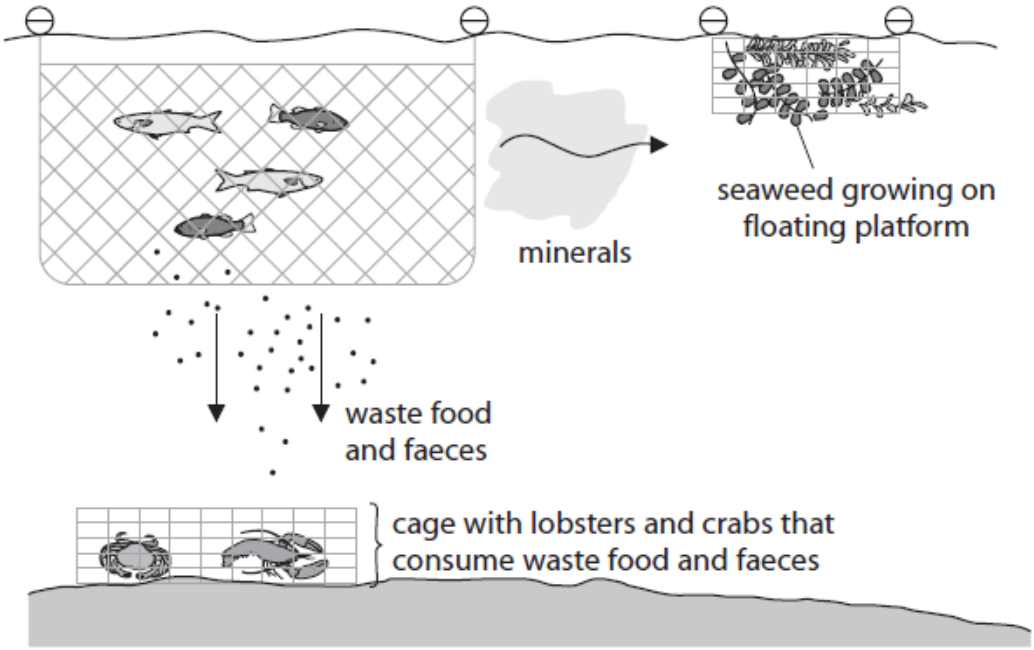
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(c) Multi-trophic level aquaculture is a method of fish farming that has been developed to reduce environmental pollution and increase profits.

The diagram shows a multi-trophic level aquaculture system.



Explain how the multi-trophic level aquaculture system reduces environmental pollution, and increases the profits of fish farming.

Use information from the diagram and your own knowledge to support your answer.

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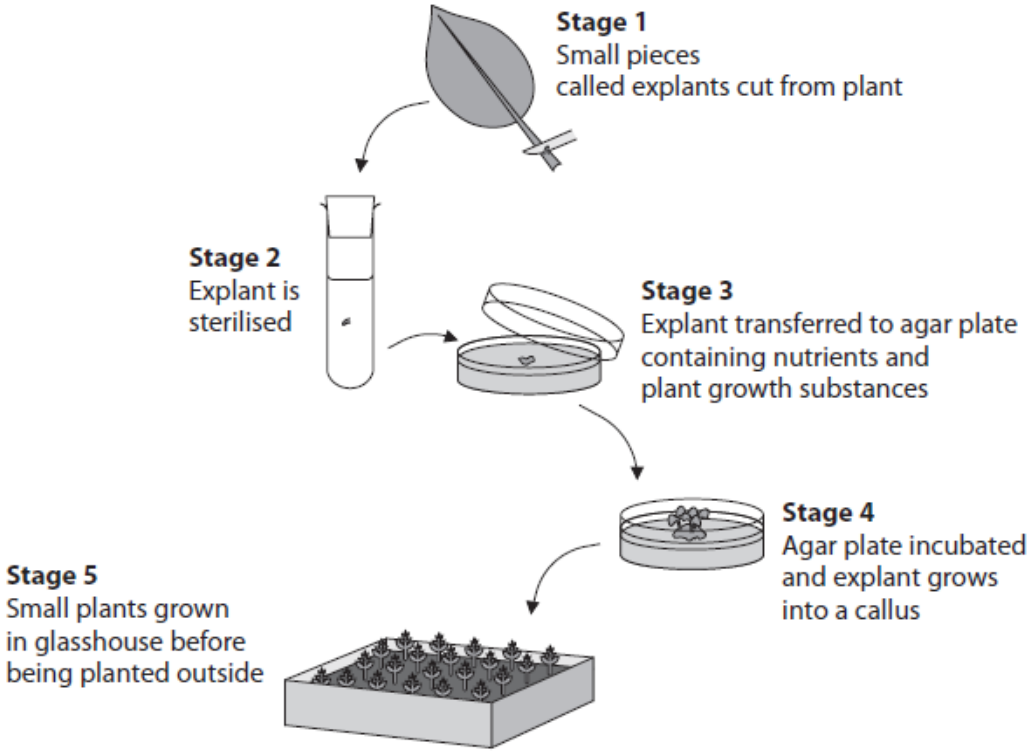
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(Total for question = 9 marks)

Q14.

Scientists produce large numbers of genetically identical plants using micropropagation.

The diagram shows some of the stages of micropropagation.



(a) (i) Give a method that could be used to sterilise the explants in stage 2.

(1)

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(ii) Give the name of one of the nutrients that should be added to the agar plate in stage 3.

(1)

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(b) In micropropagation, small pieces of plant tissue can grow into new individuals.

Explain why small pieces of animal tissue cannot grow into new individuals.

(2)

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(Total for question = 4 marks)

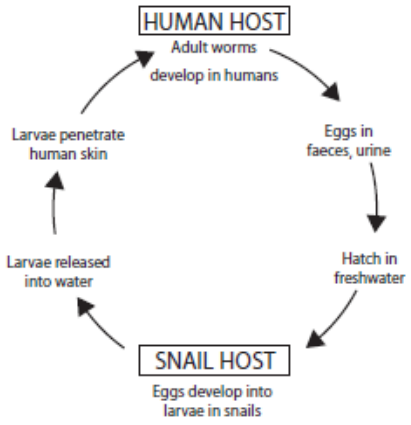
Q15.

Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Schistosomiasis

Schistosomiasis is an infection caused by a parasitic worm called a schistosome. The immature or larvae of the worm live in rivers and lakes in tropical parts of the world.

The diagram shows the life cycle of the schistosome worm.



Some people in tropical parts of the world use water from these rivers and lakes for their daily lives. These people risk infection because the larvae burrow into their skin. The larvae are then transported to other parts of the body where they damage organs such as the kidneys, intestines, lungs and brain. The larvae develop into adult worms.

The adult worms lay eggs in the human body. Some of these eggs are destroyed by the immune system, but most eggs survive. These eggs can get into water if faeces or urine from infected people pass into rivers or lakes. In the water, the eggs develop into small larvae which grow inside freshwater snails. Larvae are released from the snails and infect any person they contact. These larvae develop into adult worms inside the human body.

Doctors diagnose schistosomiasis when they find eggs in the faeces or urine of infected people. Infected people also have blood cells in their urine and antibodies for the pathogen in their blood.

At present, the drug praziquantel is used to kill the worms. A dose of 0.040 g per kg of body mass is usually effective. With no treatment, affected organs can be permanently damaged, leading to death. It is estimated that 240 million people (in the world) have schistosomiasis. Every year 8×10^{-4} per cent of infected people die from the disease.

A vaccine is being developed using a plasmid. The plasmid has DNA inserted that makes a protein found on the body surface of the adult schistosome worm.

In one investigation, a vaccine made using the DNA plasmid was given to a group of infected people. The results showed a mean number of 21.53 worms per person in this group. In the control group, a mean number of 40.53 worms per person was found.

(a) Which process is affected if kidneys are damaged (line 8)?

(1)

- ☒ **A** digestion
- ☒ **B** mutation
- ☒ **C** ultrafiltration
- ☒ **D** vaccination

(b) Suggest three ways to reduce the risk of being infected by schistosomes.

(3)

1 .....

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2 .....

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3 .....

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(c) Name two different blood cells that would be found in the urine of infected people (line 17).

(2)

1 .....

2 .....

(d) An infected person has a body mass of 120 kg.

What dose of drugs would be effective for this person (lines 19 to 20)?

(1)

☒ **A** 0.04 mg

☒ **B** 4.8 mg

☒ **C** 40 mg

☒ **D** 4800 mg

(e) Using the estimated number of people in the world who have schistosomiasis (lines 21 to 22), calculate the number of people who die each year from schistosomiasis.

(2)

number = ...

(f) Which of these is the correct description of a plasmid?

(1)

☒ **A** a circle of DNA

☒ **B** a circle of mRNA

☒ **C** a circle of protein

☒ **D** a circle of tRNA

(g) Explain how a vaccine could protect people from schistosomiasis (lines 24 to 25).

(3)

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(h) (i) Suggest what is given to the control group (lines 27 to 29).

(1)

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(ii) A scientist claims that the investigation proves the vaccine is effective against schistosomiasis (lines 27 to 29).

Comment on this claim.

(3)

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(Total for question = 17 marks)