PEARSON EDEXCEL IGCSE BIOLOGY · 4BI1

BIOLOGY



EXAM QUESTION PACK

SECTION 2: STRUCTURE AND FUNCTIONS IN LIVING ORGANISMS (PACK 3)

SCORE	PERCENTAGE
/249	%

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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.

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)

1 .....

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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)

Q2.

The human heart pumps blood when its muscle tissue contracts.

Diagram 1 shows a human heart and a cross-section through its ventricles.

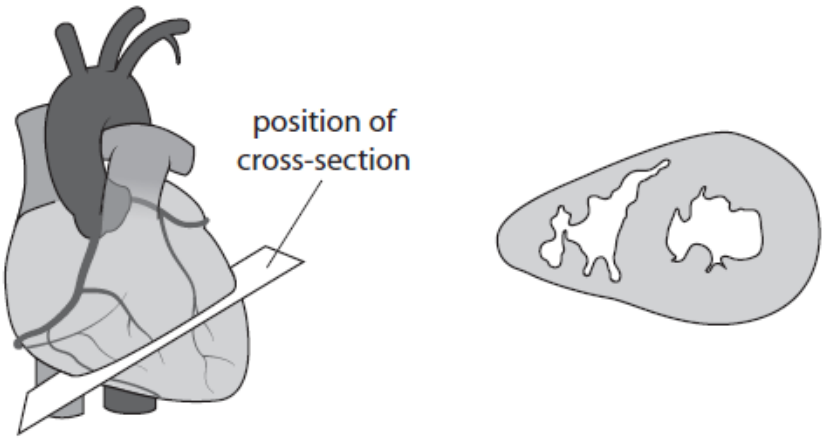


Diagram 1

(a) Which of these statements about the ventricles is correct?

(1)

☒ **A** the left ventricle wall is thick because it has to pump blood to the body

☒ **B** the left ventricle wall is thin because it has to pump blood to the lungs

☒ **C** the right ventricle wall is thin because it has to pump blood to the body

☒ **D** the right ventricle wall is thick because it has to pump blood to the lungs

(b) Ventricle muscle tissue is damaged if the blood supply is reduced.

Diagram 2 shows the damaged part of a human heart and a cross-section through its ventricles.

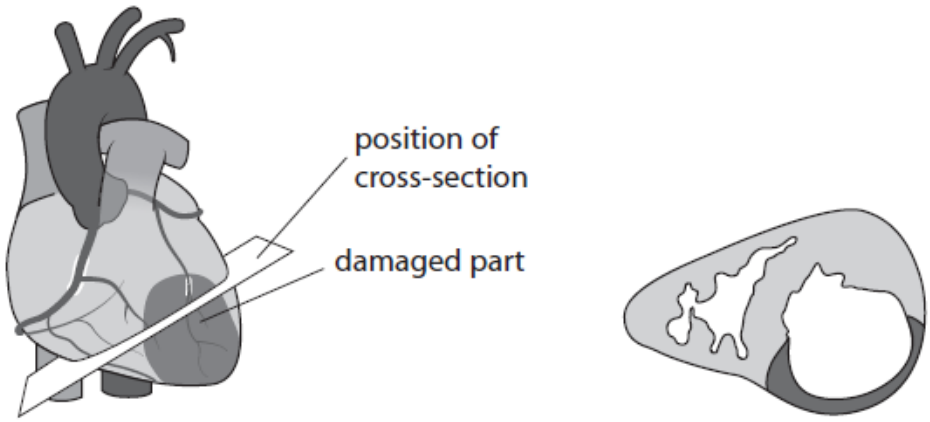


Diagram 2

Explain the cause of the change in the appearance of the muscle tissue in diagram 2.

(3)

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(c) Scientists are investigating the use of stem cells to repair damaged hearts.

The stem cells are injected into the ventricle muscle tissue.

(i) Explain why stem cells could repair a damaged heart.

(2)

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(ii) The stem cells are obtained from the person who has the damaged heart.

Explain why using stem cells from the same person is better than using stem cells from a different person.

(2)

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(Total for question = 8 marks)

Q3.

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

Heart transplant

A heart transplant is an operation to replace a damaged or failing heart with a healthy heart from a donor who has recently died. In the United Kingdom, 200 heart transplants are carried out each year.

A heart transplant may be considered if you have severe heart failure and medical treatments are not helping. Conditions that may eventually require a heart transplant include coronary heart disease and cardiomyopathy, where the walls of the heart have become stretched, thickened or stiff. Some people born with an abnormal heart may also benefit from a heart transplant.

A heart transplant needs to be carried out as soon as possible after a donor heart becomes available. The procedure is performed under general anaesthetic where the patient is unconscious. During the operation, a heart-lung bypass machine is used to keep the patient alive.

A cut is made in the middle of the patient's chest. The patient's heart is removed, leaving behind a section of the right and left atria, the two upper chambers of the heart. The new heart is connected to the aorta, the pulmonary artery, and the remaining part of the atria. The new heart is stimulated to start beating and the patient is taken off the bypass machine.

The patient will need to stay in hospital for around two or three weeks after a heart transplant. The patient will also need to take medicines called immunosuppressants for the rest of their life. Without these medicines, the transplant will not be successful.

After going home, the patient is encouraged to take part in a cardiac rehabilitation programme. This involves following an exercise plan to help regain strength and mobility. They should avoid strenuous activities such as pushing, pulling or lifting anything heavy for 6 to 12 weeks. Most people can start returning to many of their normal activities within a few months.

The patient does not usually need to have a special diet after a heart transplant. A balanced diet can ensure they stay as healthy as possible. They should not smoke and should avoid drinking alcohol.

A balanced diet may also help reduce the risk of some of the side effects of the immunosuppressant drugs including weight gain, osteoporosis and diabetes. Immunosuppressants also make the patient more vulnerable to infections, including food poisoning.

Most people can return to their normal activities after a heart transplant and experience a significant improvement in their symptoms for many years. After a heart transplant, 75% of people will live at least five years.

(a) Suggest why cardiomyopathy can cause heart failure (lines 6 to 7).

(1)

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(b) During the transplant procedure the patient's heart is removed, leaving behind a section of the right and left atria.

Describe the functions of the atria in the body.

(3)

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(c) Describe how the blood in the pulmonary artery differs from the blood in the aorta.

(2)

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(d) Explain the function of the heart-lung bypass machine (lines 11 to 12).

(3)

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(e) Explain why the patient needs to be given immunosuppressants (lines 19 to 20).

(2)

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(f) Explain why patients should not smoke after their heart transplant (lines 28 to 29).

(2)

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(g) State what is meant by the term **balanced diet**.

(1)

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(h) Calculate the number of patients in the United Kingdom who have a heart transplant in one year that are still alive five years later (lines 2 to 3 and lines 35 to 36).

(2)

number of patients = ...

(i) Suggest why patients are advised to avoid strenuous activities after their heart transplant (line 24).

(1)

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(j) Suggest why patients are more likely to be at risk of food poisoning after their heart transplant (lines 32 to 33).

(1)

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(Total for question = 18 marks)

Q4.

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

Human kidney disease

Human kidney disease can be caused by infection, high blood pressure, high blood cholesterol levels or diabetes. There is no cure for kidney disease, but suitable treatment can reduce the symptoms and stop the disease getting worse.

The treatments include lifestyle and dietary changes to help you remain as healthy as possible. Medicine is also used to control associated problems such as high blood pressure and high cholesterol levels. Other treatments need to be used for severe kidney disease when the kidneys stop working. These are dialysis and kidney transplants.

Dialysis carries out the excretory function of the kidney. There are two types of dialysis that are commonly used, haemodialysis and peritoneal dialysis. Haemodialysis involves diverting blood into an external machine, where it is filtered before being returned to the body. Peritoneal dialysis (PD) involves pumping dialysis fluid into a space inside your abdomen. Haemodialysis is usually done about three times a week, either at hospital or at home. PD is normally done at home, several times a day or overnight. If the patient does not have a kidney transplant, treatment with dialysis will usually need to continue for life.

PD became an alternative to haemodialysis a few years ago. Many patients prefer the independence PD lets them have. In PD, a soft tube called a catheter is used to fill the abdomen with a dialysis solution. The composition of the dialysis solution is water, glucose, and mineral ions at the same concentration that occurs naturally in the blood. The dialysis solution is prepared according to the individual patient's needs to help regulate their ion balance and remove metabolic waste products.

Inside the abdominal cavity is a natural membrane lining called the peritoneum. This membrane is partially permeable. The waste products and extra fluid and salts pass from the blood through the peritoneum into the dialysis solution. They then leave the body when the dialysis solution is drained. This used solution is thrown away. The process of draining and filling is called an exchange and takes about 30 to 40 minutes. The period that the dialysis solution is in your abdomen is called the dwell time. A typical schedule is four exchanges a day, each separated by a dwell time of four hours.

One form of PD, continuous ambulatory peritoneal dialysis (CAPD), does not require a machine and it is possible to walk around with the dialysis solution in your abdomen. Another form of PD, automated peritoneal dialysis (APD), requires a machine to fill and drain your abdomen. Three to five exchanges are performed during the night while you sleep. The whole process lasts a total of nine hours each night.

(a) Give one way that a person can change their diet to lower their risk of developing high

cholesterol (lines 4 to 6).

(1)

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(b) One function of the kidney is excretion (line 9). Another function is osmoregulation.

Explain what is meant by the term **osmoregulation**.

(2)

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(c) Explain why a person with severe kidney disease will need dialysis to continue for life (lines 15 to 16).

(2)

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(d) The peritoneum acts as a partially permeable membrane.

(i) Explain what is meant by a partially permeable membrane (lines 23 to 24).

(2)

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(ii) Explain why the dialysis solution must contain purified water, glucose and mineral ions (lines 19 to 21).

(2)

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(e) Explain how the composition of the dialysis solution results in the waste products being removed from the blood (lines 21 to 22).

(2)

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(f) (i) A person is using APD.

Calculate the percentage of their time used for treatment in a week (lines 33 to 35).

(2)

percentage = ... %

(ii) Suggest why people may prefer to use CAPD instead of haemodialysis (lines 31 to 32).

(1)

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(g) Describe how the structures in a human kidney result in the correct substances being

retained in the blood.

(3)

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(Total for question = 17 marks)

Q5.

(a) The table gives some information about different hormones.

Hormone	Organ that releases hormone	Location of target cells	Effect on target cells and tissues
FSH			growth of follicle
LH	pituitary	ovaries	
progesterone	ovaries	uterus	
	testes		growth of body hair

Complete the table by giving the missing information.

(6)

(b) Give three differences between hormones and neurotransmitters.

(3)

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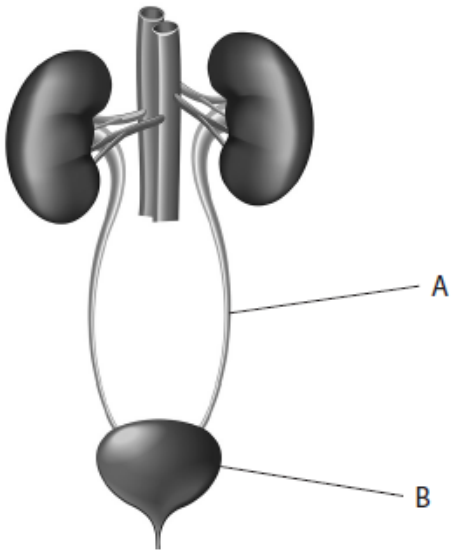
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(Total for question = 9 marks)

Q6.

The diagram shows part of the human urinary system.



(Source: © La Gorda/Shutterstock)

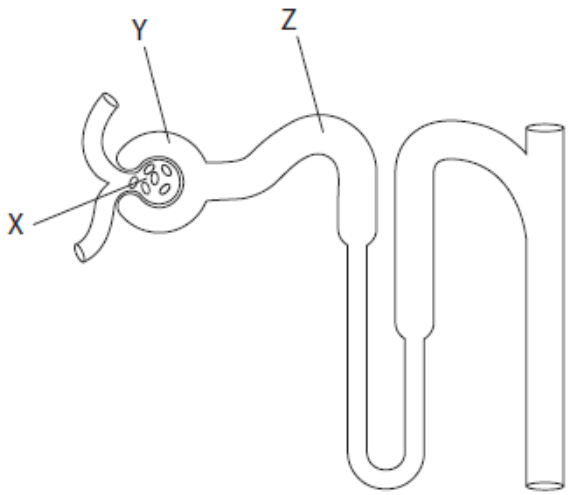
(a) Name the structures labelled A and B.

(2)

A .....

B .....

(b) The diagram shows a kidney nephron.



The table shows the relative concentrations of glucose and protein in the areas labelled X, Y and Z on the diagram.

Substance	Relative concentration of substance in arbitrary units		
	Area X	Area Y	Area Z
protein	100	0	0
glucose	100	50	0

(i) Explain the difference between the concentration of protein in area X and the concentration of protein in area Y.

(2)

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(ii) Explain the difference between the concentration of glucose in area Y and the concentration of glucose in area Z.

(2)

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(c) When the body becomes dehydrated, the concentration of urine increases.

Explain the changes that occur in the body that lead to the production of concentrated urine.

(4)

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(Total for question = 10 marks)

Q7.

Transpiration is the evaporation of water from the surface of a plant.

(a) Explain why transpiration is useful for plants.

(2)

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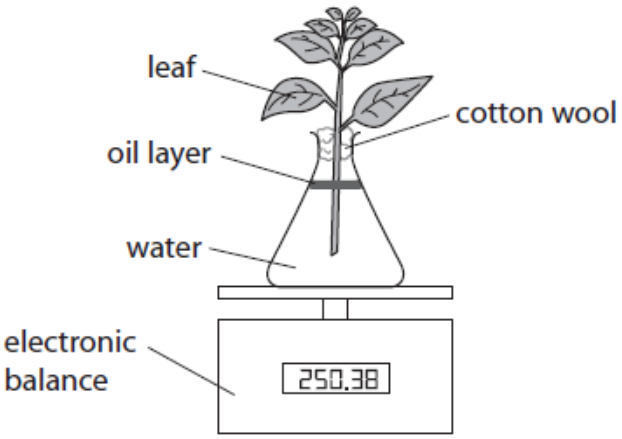
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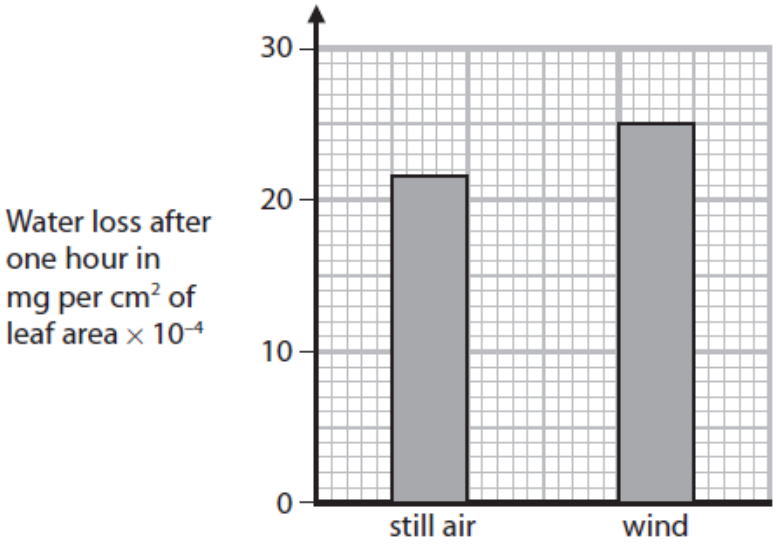
(b) A student uses this apparatus to measure the rate of transpiration in still air and the rate of transpiration in windy conditions.



The student calculates the total loss of water after one hour in mg per cm^2 of leaf area × 10–4 for the plant in still air.

He then repeats this calculation for the plant in windy conditions.

The graph shows the student's results.



(i) The total leaf surface area from which transpiration occurs is 250 cm^2.

Calculate the loss of water from this plant in still air in mg per hour.

(2)

loss of water = ... mg per hour

(ii) Explain the results shown by the graph.

(3)

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(c) Justify two factors that the student needs to control to make a valid comparison of transpiration in still air and in windy conditions.

(4)

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(Total for question = 11 marks)

Q8.

Bags made from starch are better for the environment than plastic bags made from fossil fuels.

Bags made from starch are decomposed by microorganisms such as soil fungi.

(a) (i) Which of these is a feature of fungi?

(1)

☒ **A** chloroplasts in the cytoplasm

☒ **B** starch stored in the cytoplasm

☒ **C** thread-like hyphae

☒ **D** walls made of cellulose

(ii) The soil fungi release an enzyme called amylase that digests the bag.

What is the product of this digestion?

(1)

☒ **A** amino acids

☒ **B** fatty acids

☒ **C** glycerol

☒ **D** maltose

(iii) Amylase is a protein.

Describe how protein is made in a cell.

(5)

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(b) A student investigates the effect of soil pH on the decomposition of bags made from starch.

She uses this method.

- cut two small squares from a bag
- measure the mass of each small square
- place one square in a beaker of soil with a pH of 7.0
- place the other square in a beaker of soil with a pH of 9.0
- after 10 days, remove the squares and measure their mass again

The table shows the student's results.

pH of soil	Mass of square in g		Percentage loss in mass (%)
	at start	after 10 days	
7.0	2.00	1.00	50.0
9.0	2.10	0.62	

(i) Calculate the percentage loss in mass shown by the square in pH 9.0 soil.

(1)

percentage = ...

(ii) Calculate the difference between the percentage loss in mass for the two squares.

(1)

difference = ...

(iii) Explain how the student could improve her method so that she can obtain more accurate results.

(4)

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(Total for question = 13 marks)

Q9.

The leaves of plants make starch.

(a) Describe how you would test a leaf to show that it contains starch.

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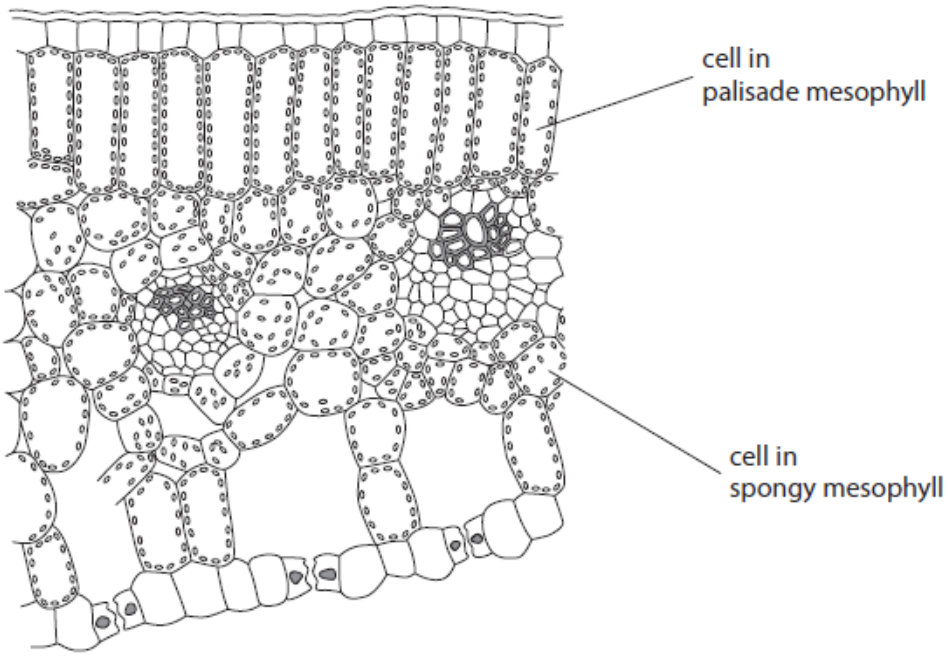
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(b) The diagram shows the structure of part of a leaf.



Explain the differences between the palisade mesophyll and the spongy mesophyll.

(4)

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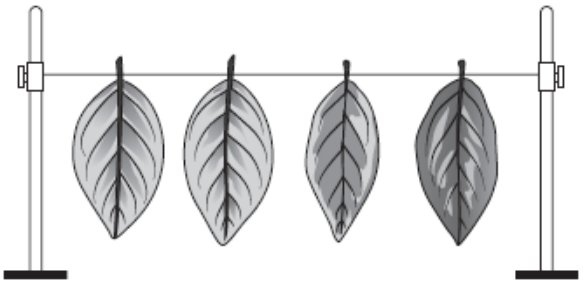
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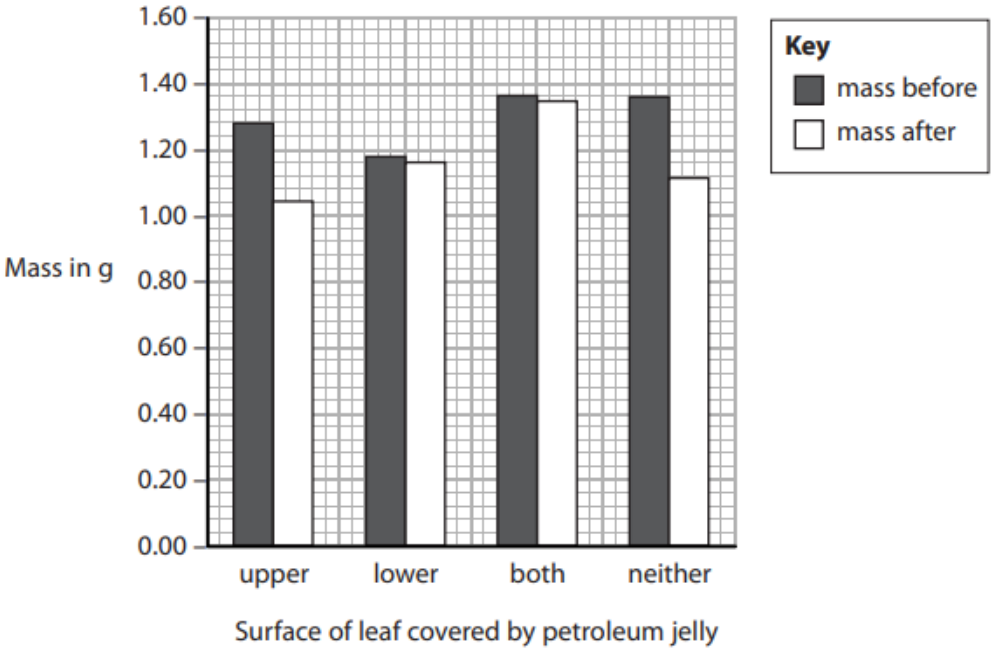
(c) A student uses this method to investigate the role of leaves in transpiration.

- remove four leaves from a plant
- cover the upper surface of one leaf with petroleum jelly
- cover the lower surface of one leaf with petroleum jelly
- cover both surfaces of one leaf with petroleum jelly
- keep one leaf uncovered
- measure the mass of each leaf
- suspend the leaves for several hours in air



After several hours, the student measures the mass of each leaf again.

The graph shows his results.



The student concludes that transpiration occurs mainly from the upper surface of leaves.

Evaluate this conclusion.

(3)

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(Total for question = 10 marks)

Q10.

Obesity is caused when energy input is greater than energy output.

A student likes to eat potato crisps but is concerned about obesity.

The student has a choice of two different types of crisp to eat.

Describe an experiment the student could use to determine which type of crisp contains the least energy.

(6)

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(Total for question = 6 marks)

Q11.

(a) The kidney carries out two functions in the human body.

State these functions.

(2)

1 .....

2 .....

(b) The data shows the concentration of substances in different liquids from different locations in the kidney.

Substance	Concentration of each substance / g per 100 cm^3		
	plasma	glomerular filtrate	urine
protein	8.0	0	0
glucose	0.10	0.90	0
urea	0.030	0.030	0.200

(i) Calculate the range of urea concentrations across the three different locations in the kidney.

(1)

range = ...

(ii) Explain the differences in the concentration of protein and glucose.
Use information from the table to support your answer.

(4)

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(iii) Describe an experiment you could carry out to compare the glucose concentration of samples of plasma and glomerular filtrate.

(4)

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(c) The composition of urine changes depending on the conditions within the body.

Explain how the composition of urine changes if a person is in a very warm environment.

(3)

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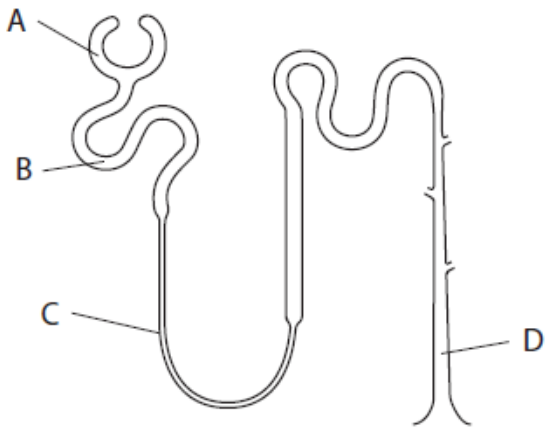
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(Total for question = 14 marks)

Q12.

The kidney contains nephrons involved in osmoregulation and excretion.

The diagram shows a nephron.



(a) Which part is the Bowman's capsule?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) The table gives the mass of three substances transported in part A and in part D for all kidney nephrons during one day.

Substance	Mass of substance in g	
	part A	part D
glucose	180	0
water	180 000	1500
urea	53	25

(i) Explain the change in the mass of glucose from part A to part D.

(3)

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(ii) Calculate the percentage reabsorption of water by kidney nephrons.

(2)

percentage = ... %

(iii) A substance containing nitrogen is broken down in the liver to produce urea.

Which substance is broken down to produce urea?

(1)

☒ **A** fat

☒ **B** glucose

☒ **C** protein

☒ **D** water

(c) A drug called MDMA increases the secretion of ADH.

Explain how this increase affects urine production.

(4)

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(Total for question = 11 marks)

Q13.

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

Male contraception

Hormonal contraception has been used by women for many years to control their fertility. A recent study investigated a new contraceptive injection to be used by men.

The study was done in seven different countries: the United Kingdom, Australia, Germany, Italy, India, Indonesia and Chile. The researchers investigated a total of 320 healthy men aged between 18 and 45, all with female partners aged between 18 and 38.

All the men had normal sperm counts and produced sperm with no abnormalities in shape or movement. They had no sexually transmitted infections and no medical or mental health illnesses. Their female partners were healthy and did not intend to become pregnant within the next two years. They were willing to accept a low, but unknown, chance of becoming pregnant.

The study had two phases. These were the initial suppression phase lasting 26 weeks, followed by a contraceptive effectiveness testing phase lasting just over one year. In the suppression phase, the men were given injections of a drug called progestin and the hormone testosterone. This was repeated at 8, 16 and 24 weeks. Progestin inhibits sperm production and reduces the release of testosterone. Semen samples were collected every two weeks to monitor the sperm count. During this phase, couples had to use alternative barrier methods of contraception, such as condoms.

When a man had produced two consecutive semen samples with a sperm count of less than one million per cm^3, they began the contraceptive effectiveness testing phase. During this phase, the men continued to receive regular injections every eight weeks for just over one year. Semen samples were taken at the same time as each injection to monitor the sperm count. If the sperm count went above one million per cm^3, the injections were stopped. At this point the men left the trial and other methods of contraception were resumed.

The contraceptive injections prevented pregnancies in the partners of 98.4% of the men. However, a number of men reported side effects. For example, just under half of the men developed acne (skin infections and irritation) and one in five reported mood disorders. In approximately 5% of the men, their sperm count had not returned to normal one year after stopping the injections. Despite the side effects, more than three-quarters of the men, and their partners, said they would be happy to continue to use this new method of contraception.

The scientists concluded that this was a valuable early-stage trial that gave a good indication of the potential safety and effectiveness of the progestin and testosterone injections for male contraception.

(a) Suggest why the men in the study had to be able to produce sperm with no abnormalities in shape or movement
(lines 8 and 9).

(2)

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(b) (i) The contraceptive injection contained the drug progestin (lines 15 and 16).

Progestin is similar in structure and function to progesterone.

Describe the roles of progesterone in the human female body.

(2)

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(ii) Suggest why the injections also contain the hormone testosterone (lines 15 and 16).

(1)

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(iii) State where in the male body testosterone is produced.

(1)

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(c) (i) Give the purpose of the initial suppression phase of the study (line 13).

(1)

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(ii) State why the sperm count is monitored during the suppression phase (lines 18 and 19).

(1)

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(iii) State why alternative contraception was used during the suppression phase (lines 19 and 20).

(1)

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(d) Suggest why sperm count continues to be monitored during the testing phase (lines 25 and 26).

(1)

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(e) Calculate the number of men whose partners became pregnant during the study (lines 6 and 28).

(2)

number of men = ...

(f) Evaluate the use of progestin and testosterone injections as a method of contraception.

(4)

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(Total for question = 16 marks)

Q14.

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)

1 .....

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2 .....

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(Total for question = 11 marks)

Q15.

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

Moving plants

Flowering plants reproduce using different methods to transfer the pollen from plant to plant. This cross-pollination enables plants to produce offspring that show genetic variation. The transfer can be done by animals such as insects or by wind.

The reliance on animals and wind for reproduction does not end with pollination. Flowering plants also need a mechanism to disperse their fruits or the seeds they contain. This seed dispersal means that seeds producing new young plants will germinate away from the parent plant.



wings on a sycamore

(Source: © joanna wnuk/Shutterstock)



fluff on a dandelion

(Source: © Viktorija Reuta/Shutterstock)



spines on burdock

(Source: © Paulpixs/Shutterstock)

The simplest method of seed dispersal uses gravity. The seeds are within heavy fruit, which fall from the tree when they are ripe. Although some of the fruit may roll away from the parent plant, most remain close to the parent plant.

Animal dispersal is when plants rely on animals to transport their seeds to a different area. This may be because the seeds are surrounded by a brightly-coloured and sweet-tasting fruit. Examples of this are soft fruits such as raspberry and hard fruits such as apple.

Animals may also carry seeds in a different way. Many plants produce fruits or individual seeds covered in hooks or spines that attach the seeds to the animals' fur. The seeds are then carried away from the parent plant. Eventually, the seeds may fall off, or be rubbed off by the animal. Examples of plants using this form of dispersal are burdock and sea holly.

Some plants provide seed pods with a mechanism that ejects the seeds from the pod by force. All of these rely on the effect of evaporation of water in the seed pod, so this method of seed dispersal usually takes place in sunlight. Examples of plants using this form of dispersal are gorse bushes and lupins.

Wind is one of the main methods of seed dispersal. Some tall trees produce seed pods that have wings, which allow the seeds to travel long distances. Some seed pods have two wings such as the sycamore while others have one wing such as the ash.

There are also lightweight adaptations that help seeds to be blown by the wind. These include various sorts of fluff that increase the surface area of the seed, so that it can be picked up by the slightest breeze. Examples of plants using this form of dispersal are thistle and dandelion.

The last method uses water. Trees found on tropical beaches often have their seeds carried away by the sea. The seeds have woody, waterproof coverings enabling them to float in the water for long periods. Coconuts are a well-known example.

(a) Explain how cross-pollination can lead to an increase in genetic variation. (Lines 2–3)

(2)

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(b) (i) Explain the advantages of the seeds germinating away from the parent plant. (Line 8)

(3)

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(ii) Give one advantage of a seed germinating close to the parent plant. (Line 11)

(1)

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(c) Explain the conditions needed for seed germination.

(3)

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(d) Explain why some seeds are surrounded by a brightly-coloured and sweet-tasting fruit. (Lines 13–14)

(2)

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(e) Large numbers of tomato plants are often found growing along the sides of drains and settling beds on sewage farms.

Suggest a reason for this observation.

(1)

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(f) Give the reason why sunlight is required for lupin seeds to be dispersed. (Lines 21–24)

(1)

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(g) Describe an experiment you could carry out to investigate how the presence of fluff on dandelion seeds affects how fast they fall. (Lines 30–31)

(3)

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(Total for question = 16 marks)

Q16.

Plant root hair cells absorb water from the soil by osmosis.

(a) (i) Explain how the structure of a root hair cell is adapted to absorb water.

(2)

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(ii) Give one difference between osmosis and diffusion.

(1)

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(b) A student investigates the effect of light on the volume of water taken up and lost by a plant shoot in one hour.

The table shows the student's results.

	Volume of water in cm^3	
	taken up	lost
Dark	2.0	1.6
Light	10.2	9.1

(i) Explain these results.

(3)

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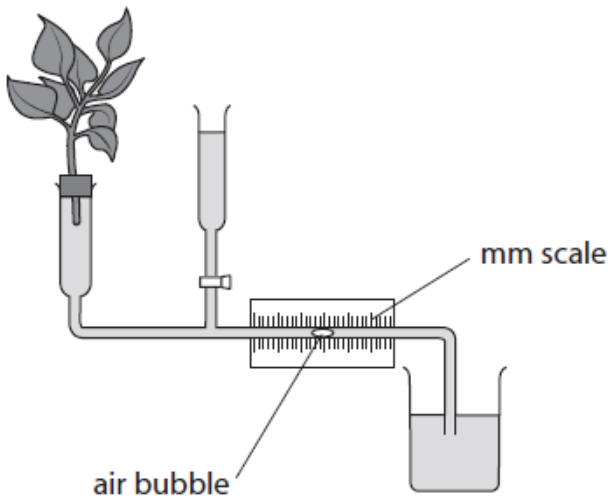
(ii) Give two abiotic variables the student should control.

(2)

1 .....

2 .....

(c) Another student uses this apparatus and a stop clock to find the mean (average) rate of water taken up by a plant shoot.



(i) Name the apparatus used by the student.

(1)

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(ii) Describe how the student could use this apparatus to find the mean rate of water taken up by the plant.

(3)

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(Total for question = 12 marks)

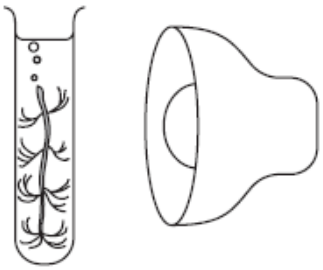
Q17.

A student investigates the effect of different colours of light on the rate of photosynthesis in a water plant.

This is the student's method.

- place a 1% sodium hydrogen carbonate solution in a boiling tube
- cut a 5 cm length of pondweed and place it in the tube
- place a lamp 10 cm from the tube containing the pondweed
- leave the pondweed for 10 minutes until it starts to produce bubbles from the cut end
- count the bubbles produced in one minute
- count the bubbles for two more one minute periods

The student repeats the experiment three more times using filters in front of the lamp that let through either red light, blue light or green light.



These are the student's results.

Colour of filter	Number of bubbles per minute			
	Test 1	Test 2	Test 3	Mean
no filter	47	84	80	
red	48	48	42	46
blue	55	56	50	54
green	9	8	10	9

(a) Write the balanced symbol equation for photosynthesis.

(2)

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(b) (i) Anomalous results are not included in the calculation of the mean.

Calculate the mean number of bubbles per minute for the lamp with no filter.

(2)

number = ... bubbles per minute

(ii) Explain the student's results.

(4)

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(iii) Give two abiotic variables that the student should control in her experiment.

(2)

1 .....

2 .....

(c) (i) Explain why measuring the rate of photosynthesis by counting bubbles may not be an accurate method to use.

(2)

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(ii) Suggest an alternative method that the student could use to measure the rate of photosynthesis in her experiment.

(2)

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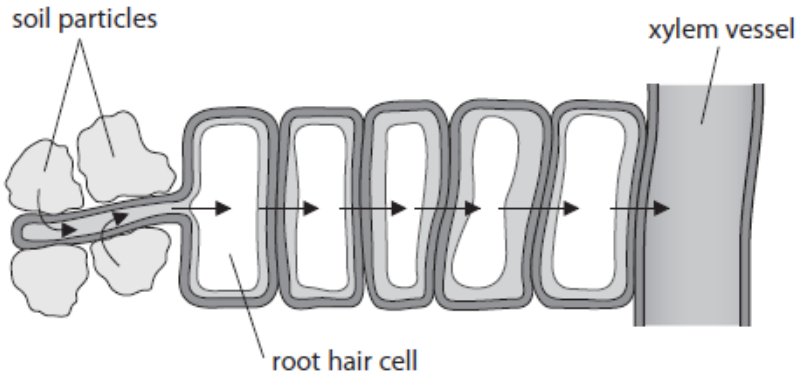
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(Total for question = 14 marks)

Q18.

The diagram shows the path that the water takes when it is absorbed from the soil into the xylem of a plant.



(a) (i) Explain how root hair cells are adapted for efficient absorption of water.

(2)

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(ii) Explain how water is transported from the soil to the leaves.

(4)

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(b) Describe how you could determine the rate of water loss from a leafy shoot.

(4)

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(Total for question = 10 marks)

Q19.

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

Plastic pollution

A mass of 12.7 million tonnes of plastic is dumped into our oceans every year. This is equivalent to the mass of 1.8 million adult elephants. This plastic pollution is a concern because of its harmful effect on living organisms.

Turtles eat plastic bags, mistaking them for jellyfish, and sea birds have been found with stomachs full of plastic. Researchers have reported 800 kg of plastic found in the carcass of a stranded whale in France. The stomach of another whale in Australia contained six square metres of plastic sheeting and 30 plastic carrier bags. Plastic items can block the tubes leading from the mouth to the stomach and to the lungs in some animals. This can cause death because it affects digestion and gas exchange.

Whale sharks are the largest fish in the world, yet feed on microscopic plankton that photosynthesise. The plankton is also eaten by crustaceans, which are then eaten by fish. These fish are eaten by humans. Many whales are filter feeders. They swallow hundreds of cubic metres of water a day to capture plankton and may take in microplastics during the process. The microplastics are produced from the breakdown of larger pieces of plastic. Microplastics are similar in size and mass to many types of plankton. These microplastics are not biodegradable and build up in the bodies of organisms that occupy higher trophic levels in food chains. This is called bioaccumulation.

Plastic pollution may be responsible for putting filter feeding whale sharks and other filter feeders at risk of extinction. The whale shark, for example, is listed as being endangered.

Studies have found toxic chemicals associated with plastics in the bodies of large filter feeders. Scientists think these chemicals might reduce the population sizes of the large filter feeders. This is because the toxins might affect many biological processes involving hormones that regulate the body's growth and development, metabolism, and reproduction.

Whale sharks feeding in the Sea of Cortez near Mexico, an important breeding ground, ingest 200 microplastic particles per day. Fin whales in the Mediterranean Sea ingest 2000 microplastic particles per day. Any reduction in the reproduction of these species will have consequences for biodiversity.

Attempts are being made to reduce the use of plastic. Coffee companies are being encouraged to use wooden spoons and straws rather than plastic ones. Also, shoppers are being given biodegradable plastic bags, or paper bags.

(a) (i) Which organism named in the passage is a producer?

(1)

☒ **A** crustaceans

☒ **B** microscopic plankton

☒ **C** sea birds

☒ **D** turtles

(ii) Which organism named in the passage is a tertiary consumer?

(1)

☒ **A** crustaceans

☒ **B** fin whale

☒ **C** human

☒ **D** whale shark

(b) Explain how blocked tubes leading from the mouth can lead to death in some animals. (lines 8 to 10)

(5)

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(c) Suggest why bioaccumulation of microplastics is a problem for humans. (lines 17–20)

(2)

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(d) Calculate the difference between the number of plastic particles ingested in a year by a fin whale and a whale shark. (lines 29–31)

Give your answer in standard form.

(3)

difference = ...

(e) Explain the effects of reduced reproduction on biodiversity. (lines 31–32)

(2)

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(f) Suggest a benefit of using biodegradable plastic bags. (line 35)

(2)

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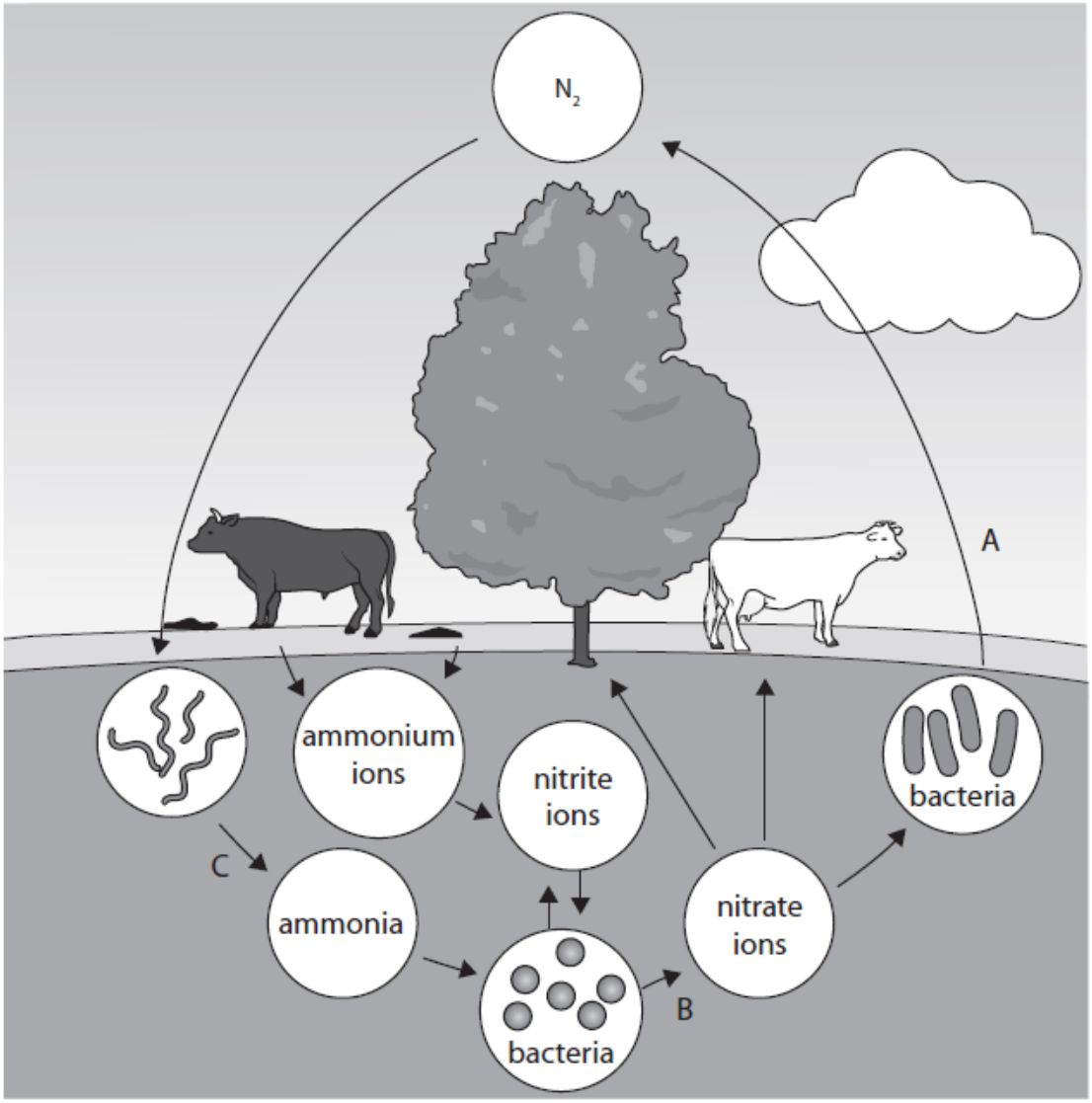
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(Total for question = 16 marks)

Q20.

The diagram shows some parts of the nitrogen cycle.



(a) Name the processes labelled A, B and C.

(3)

A .....

B .....

C .....

(b) The mass of nitrogen that moves within the nitrogen cycle has been estimated and some of the masses are given in the table.

Process	Mass of nitrogen per year in $g \times 10^{12}$
released into atmosphere by burning of biomass	40
removed from atmosphere for manufacture of fertiliser	120
released into atmosphere by denitrification	100
removed from atmosphere by nitrogen fixation	58
removed from atmosphere by lightning	5
released into atmosphere in the form of ammonia	60
released into atmosphere as oxides of nitrogen	5
removed from atmosphere by deposition of oxides of nitrogen	70

(i) Some of these processes remove nitrogen from the atmosphere.

Calculate the total mass of nitrogen removed from the atmosphere by these processes.

Give your answer in standard form.

(2)

mass = ... g

(ii) Calculate the percentage of the nitrogen released into the atmosphere that comes from burning of biomass.

(2)

percentage = ...

(iii) Explain how burning biomass returns nitrogen to the atmosphere.

(2)

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(c) Explain the effect of nitrous oxide on global warming.

(2)

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(Total for question = 11 marks)