**Q1.**(a)     Give **two** ways in which pathogens can cause disease.

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2 .....................................................................................................................

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**(2)**

(b)     Putting bee honey on a cut kills bacteria. Honey contains a high concentration of sugar.

Use your knowledge of water potential to suggest how putting honey on a cut kills bacteria.

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**[Extra space]** ................................................................................................

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**(3)**

**(Total 5 marks)**

 **Q2.**          Read the following passage.

During the course of a day, we come into contact with many poisonous substances. These include industrial and household chemicals. The skin acts as a barrier and prevents many of these substances entering and harming the body.

The skin is one of the largest organs in the body. It is composed of several layers of

5        tissue. The outer layer consists of dead cells packed with keratins. Keratins are a group of proteins that differ from each other in their primary structure. Each keratin molecule consists of several polypeptide chains, each individual chain wound into a spiral or helix. The polypeptide chains include many sulphur-containing amino acids and these help to give the keratin molecules their characteristic strength.

Use information from the passage and your own knowledge to answer the questions.

(a)     What is the evidence from the passage that keratin molecules have a quaternary structure?

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**(1)**

(b)     Explain how sulphur-containing amino acids help to give keratin molecules their characteristic strength (lines 8–9).

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**(2)**

(c)     Explain why differences in primary structure result in keratins with different properties
(line 6).

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**(2)**

(d)     The skin prevents poisonous substances entering and harming the body (line 3). Explain why these substances are unable to pass through the outer layer of skin cells by active transport.

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**(3)**

(e)     Skin cells may be studied with a transmission electron microscope or an optical microscope. Explain the advantages and limitations of using a transmission electron microscope to study cells.

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**(6)**

**(Total 14 marks)**

 **Q3.**          (a)     Discs of carrot were placed in a solution containing potassium ions (K+). The concentration of oxygen in air bubbled through the solution was changed and the rates of respiration and uptake of potassium ions were measured. The results are shown in the table.

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Concentration of oxygen / %** | **Rate of respiration / arbitrary units** | **Rate of uptake of potassium ions / arbitrary units** |
|   | 2.7 | 31 | 29 |
|   | 12.2 | 69 | 72 |
|   | 20.8 | 90 | 80 |

Describe and explain the link between oxygen concentration, rate of respiration and rate of uptake of potassium ions.

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(b)     Cylinders of potato were cut using a cork borer. Their initial lengths were measured.  Each cylinder was then put in a different concentration of sucrose solution for 12 hours. The graph shows the changes in length of the potato cylinders in the different sugar solutions.



(i)      In what concentration of sucrose did the length of the potato cylinder remain the same?

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**(1)**

(ii)     The initial length of the potato cylinder in the solution of concentration 0.1 mol dm–3 was 90 mm. Calculate its final length. Show your working.

Final length = .................................... mm

**(2)**

(iii)     Explain the change in length which occurs in a sucrose solution of concentration 0.5 mol dm–3.

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**(2)**

**(Total 9 marks)**

 **Q4.**(a)     Name the process by which some bacteria oxidise ammonia to nitrate.

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**(1)**

Reeds are plants that grow with their roots under water. A reed bed contains a large number of growing reeds. Reed beds may be used to absorb nitrates produced when bacteria break down human sewage. The diagram shows a reed bed.



(b)     Reeds have hollow, air-filled tissue in their stems which supplies oxygen to their roots.
Explain how this enables the roots to take up nitrogen-containing substances.

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**(2)**

(c)     (i)      There is an optimum rate at which human sewage should flow through the reed
bed. If the flow of human sewage is too fast, the nitrate concentration at point **A** falls.
Explain why.

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**(2)**

 (ii)     An increase in nitrate concentration in the water entering the lake could affect algae and fish in the lake. Explain how.

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*(Extra space)* ........................................................................................

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**(3)**

**(Total 8 marks)**

 **Q5.**          (a)     A plant cell was observed with an optical microscope. Describe how the length of the cell could be estimated.

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**(2)**

(b)     The water potential of a plant cell is –400 kPa. The cell is put in a solution with a water potential of –650 kPa. Describe and explain what will happen to the cell.

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**(3)**

(c)     A group of students investigated the effect of sucrose concentration on the change in length of cylinders of tissue cut from a young carrot. They measured the initial lengths of the carrot cylinders, then placed one in each of a number of sucrose solutions. After 18 hours, they removed the carrot cylinders and measured their final lengths. Some of the results are shown in the table.

|  |  |  |
| --- | --- | --- |
|   | **Concentration of sucrose /mol dm–3** | **Percentage decrease in length of carrot cylinder** |
|   | 0.4 | 4.2 |
|   | 0.5 | 8.7 |
|   | 0.6 | 13.0 |
|   | 0.7 | 16.8 |
|   | 0.8 | 18.1 |
|   | 0.9 | 18.1 |
|   | 1.0 | 18.1 |

(i)      The carrot cylinders were left for 18 hours in the sucrose solutions. Explain why they were left for a long time.

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**(1)**

(ii)     Explain how you would use a graph to predict the concentration of sucrose that would result in no change in length of the carrot cylinders.

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**(2)**

(iii)     Young carrots store sugars in their tissues but, in older carrots, some of this is converted to starch. How would using cylinders of tissue from older carrots affect the results obtained for a sucrose solution of 0.6 mol dm–3? Give a reason for your answer.

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**(2)**

**(Total 10 marks)**

 **Q6.**          Tradescantia is a house plant. There are small hairs on its flowers. These hairs are made of cells. **Figure 1** shows the appearance of cells from one of these hairs after 20 minutes in distilled water. **Figure 2** shows cells from another hair after 20 minutes in a solution of potassium nitrate.

**Figure 1** (in distilled water)



**Figure 2** (in potassium nitrate solution)



(a)     What does **Figure 2** suggest about the permeability of the plasma membranes surrounding these cells?

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**(1)**

(b)     What is present in the space labelled **F**? Explain your answer.

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**(2)**

(c)     How would the water potential of the sap in the vacuole of cell **E** differ from the water potential of the sap in the vacuole of cell **D**? Explain your answer.

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**(3)**

**(Total 6 marks)**

**Q7.**          The diagram shows the outer layers of three different cells, **A**, **B** and **C**.



(a)     What is the evidence from the diagram that

(i)      cell **B** is an animal cell,

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**(1)**

(ii)     cell **C** is a prokaryotic cell?

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**(1)**

(b)     Explain how you would calculate the magnification of cell **C**.

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**(1)**

(c)     Cell **A** is a plant cell. Name a polysaccharide which may be found in cell **A** but would not be found in the animal cell.

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**(1)**

(d)     Penicillin is an antibiotic. It prevents the formation of bacterial cell walls. As a result, bacterial cells that have been treated with penicillin swell and burst as water enters.

(i)      Explain how water enters a bacterial cell.

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**(2)**

(ii)     Suggest why penicillin has no effect on plant cells.

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**(1)**

**(Total 7 marks)**

**Q8.**          Read the following passage.

|  |  |  |
| --- | --- | --- |
|   |     5    10 | *Campylobacter jejuni* is a bacterium. It is one of the commonest causes of diarrhoea in humans. The illness that it causes does not usually last very long and many sufferers do not even go to the doctor. The only treatment required is the use of oral rehydration solutions to replace the water lost by diarrhoea. In 1998, laboratory tests confirmed 60 000 cases of diarrhoea caused by this bacterium in the UK. The bacterium was more frequently found in males than in females with a ratio of 1.5 : 1.In rare cases, the nervous system may be affected. Scientists are now beginning to understand the cause of this. Sugars in the antigens on the surface of the bacteria are identical to some of the sugars on the surface of nerve cells. Antibodies produced against the bacteria may therefore attack the body’s nerve cells. There can be serious problems if this leads to paralysis of the diaphragm. Breathing difficulties result and the patient may die. |

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

(a)     (i)      The number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in the UK in 1998 was 60 000 (lines 4–5). Explain why the true number of cases is thought to be more than this.

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**(1)**

(ii)     Calculate the number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in men in 1998.

Answer ..........................................

**(1)**

(b)     Explain why antibodies produced against *Campylobacter jejuni* also attack nerve cells (lines 9 –10).

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**(3)**

(c)     Explain how paralysis of the diaphragm leads to breathing difficulties (line 11).

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**(2)**

**(Total 7 marks)**

**Q9.**The effect of watering tomato plants with sodium chloride solution on the mass of tomatoes

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| --- | --- | --- | --- |
|   | **Type oftomato plant** | **Watered with** | **Mean mass of tomatoes / g** |
|   | **fresh mass** | **dry mass** |
|   | Normal | Distilled water | 115.9 | 6.5 |
|   | Normal | Sodium chloride solution |  87.8 | 6.6 |
|   | GM | Distilled water | 101.3 | 6.4 |
|   | GM | Sodium chloride solution |  57.4 | 6.5 |

(a)     What conclusions can you draw about the effects of watering plants with sodium chloride solution on the mass of tomatoes?

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**(2)**

(b)     Use your knowledge of water potential to suggest how watering plants with sodium chloride solution affects the fresh mass of the tomatoes.

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(Extra space) .................................................................................................

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**(3)**

**(Total 5 marks)**

**Q10.**          The diagram shows tissue fluid and cells surrounding a capillary.



(a)     Name fluid **F**.

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**(1)**

(b)     Give **one** way in which fluid **F** is different from tissue fluid.

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**(1)**

(c)     (i)      The blood pressure is high at the start of the capillary. Explain how the left ventricle causes the blood to be at high pressure.

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**(1)**

(ii)     The blood pressure decreases along the length of the capillary. What causes this decrease in pressure?

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**(1)**

(d)     In children, some diets may result in a low concentration of protein in fluid **F**. This can cause the accumulation of tissue fluid. Explain the link between a low concentration of protein in fluid **F** and the accumulation of tissue fluid.

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**(3)**

**(Total 7 marks)**

**Q11.**          The diagram shows a carrot.



A group of students investigated the effect of sucrose concentration on the length of cylinders cut from a carrot.

(a)     The students used a cork borer to cut cylinders from the carrot. Describe how the students should cut these cylinders to make sure that this was a fair test and would produce reliable results.

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**(2)**

(b)     They measured the initial length of each cylinder then placed the cylinders into test tubes containing different concentrations of sucrose solution. Bungs were placed in the tubes and the tubes were left overnight. Explain why the bungs were placed in the tubes.

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**(2)**

(c)     The students then measured the final lengths of the carrot cylinders. Their results are shown in the table.

|  |  |
| --- | --- |
| Concentration of sucrose / mol dm–3 |  |
| 0.0 | 1.4 |
| 0.2 | 1.4 |
| 0.4 | 1.2 |
| 0.6 | 1.1 |
| 0.8 | 0.9 |

(i)      The students used these results to find the concentration of sucrose that has the same water potential as the carrot cylinders. Describe how they could have done this.

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**(2)**

(ii)     Was it important in this investigation that the carrot cylinders had the same initial length? Explain your answer.

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**(1)**

**(Total 7 marks)**

**Q12.**          (a)     Many different substances enter and leave a cell by crossing its cell surface membrane. Describe how substances can cross a cell surface membrane.

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**(5)**

(b)     Describe and explain how the lungs are adapted to allow rapid exchange of oxygen between air in the alveoli and blood in the capillaries around them.

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**(5)**

**(Total 10 marks)**

**Q13.**Students investigated the effect of different concentrations of sodium chloride solution on discs cut from an apple. They weighed each disc and then put one disc into each of a range of sodium chloride solutions of different concentrations. They left the discs in the solutions for 24 hours and then weighed them again. Their results are shown in the table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | **Concentration of sodium chloride solution / mol dm–3** | **Mass of disc at start / g** | **Mass of disc at end / g** | **Ratio of mass at start to mass at end** |
|   | 0.00 | 16.1 | 17.2 | 0.94 |
|   | 0.15 | 19.1 | 20.2 | 0.95 |
|   | 0.30 | 24.3 | 23.2 | 1.05 |
|   | 0.45 | 20.2 | 18.7 | 1.08 |
|   | 0.60 | 23.7 | 21.9 |   |
|   | 0.75 | 14.9 | 13.7 | 1.09 |

(a)     (i)      Calculate the ratio of the mass at the start to the mass at the end for the disc placed in the 0.60 mol dm–3 sodium chloride solution.

Answer ......................................

**(1)**

(ii)     The students gave their results as a ratio. What is the advantage of giving the results as a ratio?

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**(2)**

(iii)    The students were advised that they could improve the reliability of their results by taking additional readings at the same concentrations of sodium chloride.

Explain how.

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**(2)**

(b)     (i)      The students used a graph of their results to find the sodium chloride solution with the same water potential as the apple tissue. Describe how they did this.

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**(2)**

(ii)     The students were advised that they could improve their graph by taking additional readings. Explain how.

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**(2)**

**(Total 9 marks)**

**Q14.**(a)     (i)      The equation shows the reaction catalysed by the enzyme lactase. Complete this equation.

Lactose + ...............................  Glucose + ...............................

**(2)**

(ii)     Name the type of chemical reaction shown in this equation.

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**(1)**

(b)     Lactase is an enzyme. Lactose is a reducing sugar.

(i)      Describe how you could use the biuret test to distinguish a solution of the enzyme, lactase from a solution of lactose.

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**(1)**

(ii)     Explain the result you would expect with the enzyme.

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**(1)**

**(Total 5 marks)**

**Q15.**Scientists investigated the effects of different concentrations of sodium chloride on the germination of the seeds of two varieties of barley. The seeds were soaked for one hour in different concentrations of sodium chloride solutions and then germinated in distilled water at 25°C. The scientists found the percentage of germinated seeds after 4 days and again after 8 days.





Describe what the data in above shows about the effect of sodium chloride concentration on germination in these two varieties of barley.

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*(Extra space)* ...........................................................................................................

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**(Total 3 marks)**

**Q16.**          The diagram shows an organism called *Chlamydomonas*.



(a)     Name **two** structures shown in the diagram that are present in plant cells but are **not** present in animal cells.

1 ...................................................................................................................

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2 ...................................................................................................................

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**(2)**

(b)*Chlamydomonas* lives in fresh water ponds. Use your knowledge of osmosis to suggest an advantage of using starch as a carbohydrate store.

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**(2)**

(c)*Chlamydomonas* has adaptations that help it to maintain a high rate of photosynthesis.

Use information in the diagram to explain what these adaptations are.

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*(Extra space) ..*.............................................................................................

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**(3)**

**(Total 7 marks)**

**Q17.**          A student investigated the effect of putting cylinders cut from a potato into sodium chloride solutions of different concentration. He cut cylinders from a potato and weighed each cylinder. He then placed each cylinder in a test tube. Each test tube contained a different concentration of sodium chloride solution. The tubes were left overnight. He then removed the cylinders from the solutions and reweighed them.

(a)     Before reweighing, the student blotted dry the outside of each cylinder. Explain why.

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**(2)**

The student repeated the experiment several times at each concentration of sodium chloride solution. His results are shown in the graph.



(b)     The student made up all the sodium chloride solutions using a 1.0 mol dm–3 sodium chloride solution and distilled water.

Complete the table to show how he made 20 cm3 of a 0.2 mol dm–3 sodium chloride solution.

|  |  |  |
| --- | --- | --- |
|   | **Volume of 1.0 mol dm–3 sodium chloride solution** | **Volume of distilled water** |
|   |   |   |

**(1)**

(c)     The student calculated the *percentage* change in mass rather than the change in mass. Explain the advantage of this.

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**(2)**

(d)     The student carried out several repeats at each concentration of sodium chloride solution. Explain why the repeats were important.

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**(2)**

(e)     Use the graph to find the concentration of sodium chloride solution that has the same water potential as the potato cylinders.

.............................. mol dm–3

**(1)**

**(Total 8 marks)**

**Q18.**          (a)     Give **two** ways in which active transport is different from facilitated diffusion.

1 ...................................................................................................................

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2 ...................................................................................................................

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**(2)**

Scientists investigated the effect of a drug called a proton pump inhibitor. The drug is given as a tablet to people who produce too much acid in their stomach. It binds to a carrier protein in the surface membrane of cells lining the stomach. This carrier protein usually moves hydrogen ions into the stomach by active transport.

The scientists used two groups of people in their investigation. All the people produced too much acid in their stomach. People in group **P** were given the drug. Group **Q** was the control group.

The graph shows the results.



(b)(i)      The scientists used a control group in this trial. Explain why.

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**(1)**

(ii)     Suggest how the control group would have been treated.

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**(2)**

(c)Describe the effect of taking the drug on acid secretion.

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**(1)**

**(Total 6 marks)**

**Q19.**         The equation shows the breakdown of lactose by the enzyme lactase.

Lactose + water   galactose + monosaccharide **X**

(a)     (i)      Name the type of reaction catalysed by the enzyme lactase.

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**(1)**

(ii)     Name monosaccharide **X**.

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**(1)**

(b)     (i)      Describe how you would use a biochemical test to show that a reducing sugar is present.

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**(2)**

(ii)     Lactose, galactose and monosaccharide **X** are all reducing sugars.
After the lactose has been broken down there is a higher concentration of reducing sugar. Explain why.

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**(1)**

(c)A high concentration of galactose slows down the breakdown of lactose by lactase.
Use your knowledge of competitive inhibition to suggest why.

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**(2)**

**(Total 7 marks)**

**Q20.**Many sports drinks contain water, sodium chloride and carbohydrates. The manufacturers of the sports drinks claim that carbohydrates provide an energy boost. The sodium chloride is used to increase absorption of glucose in the small intestine.

Scientists investigated the effect of a sports drink on the performance of runners in 5 km races.

They recruited 100 runners who had previously run a 5 km race in similar times. During this race, Race 1, they had water they could drink.

The scientists divided the runners into two equal groups, **P** and **Q**. Both groups ran a second 5 km race, Race 2. During this race:

•        group **P** had water available

•        group **Q** had the sports drink available.

The scientists recorded the mean time for each group to complete this race.

The following figure shows their results.



(a)     Use the figure to calculate the percentage decrease in the mean time taken for group **Q** to complete Race 2 compared with Race 1.

Show your working.

............................. %

**(2)**

(b)     One of the runners concluded that the sports drink improved performance.

Do these data support his conclusion?

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**(3)**

(c)     The runners were matched for the time taken to run the first race.

Give **three** other factors for which they should have been matched.

Factor 1 ..........................................................................................................

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Factor 2 ..........................................................................................................

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Factor 3 ..........................................................................................................

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**(3)**

(d)     The sports drink contains sodium chloride. Sodium chloride increases uptake of glucose in the small intestine.

Explain how.

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**(4)**

**(Total 12 marks)**

**Q21.**Vaccines protect people against disease. Explain how.

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(*Extra space*) ..........................................................................................................

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**(Total 5 marks)**

**Q22.**Some of the catalase produced by *Aspergillus niger* is intracellular and some is extracellular.

Intracellular enzymes stay inside the cells that produce them. Extracellular enzymes are secreted from the cells that produce them.

Another group of scientists grew a different strain of *A. niger*.

•        *A. niger* grows from tiny structures called spores. The scientists kept the spores in an isotonic medium at a low temperature until they needed them.

•        They put spores of *A. niger* into a 500 cm3 flask containing a sterile medium. The medium contained starch.

•        They measured the total amount of catalase and the amount of extracellular catalase produced by the fungus over a period of 100 hours.

The graph shows their results.

 

(a)     (i)      The scientists kept the spores in an isotonic medium until they were needed.
Suggest why it was important that the medium was isotonic.

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**(2)**

(ii)     The scientists kept the spores at a low temperature until they were needed.
Suggest why.

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**(1)**

(b)     Starch is a source of carbon, hydrogen and oxygen for the fungus. Name one other chemical element that must be in the culture medium before *A. niger* can synthesise catalase. Give the reason for your answer.

Chemical element ...........................................................................................

Reason ...........................................................................................................

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**(2)**

(c)     To get reliable results in this investigation, the medium must be sterile.
Explain why.

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**(2)**

(d)     (i)      At what time was the concentration of intracellular catalase highest?

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**(1)**

(ii)     Between what times was the rate of total catalase production highest?

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**(1)**

(e)     Technologists prefer to manufacture extracellular enzymes rather than intracellular enzymes. This is because intracellular enzymes are more expensive to purify than extracellular enzymes. Suggest why intracellular enzymes are more expensive to purify.

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**(2)**

**(Total 11 marks)**

**Q23.**Turkey meat can dry out when it is cooked in an oven. One way to overcome this is to soak the meat in a salt solution before cooking it. This is called brining.

A food writer organised a demonstration. He treated three similar pieces of turkey in different ways.

•        Piece **A** was untreated.

•        Piece **B** was soaked overnight in a 6% solution of salt. A 6% solution of salt has a greater solute concentration than the cells in turkey meat.

•        Piece **C** was soaked overnight in water.

He put all three pieces in an oven at 150 °C. He left each piece until it was cooked and the temperature in its centre was 65 °C. The writer weighed each piece at different stages in the demonstration. The graph shows his results.

 

(a)     (i)      Explain the advantage of using percentage change in mass in this investigation.

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**(2)**

(ii)     The pieces of turkey meat were cooked. Explain the advantage of leaving them in the oven until the temperature in the centre of each piece was 65 °C.

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**(2)**

(iii)     Recording mass is a valid way to measure the dependent variable in this investigation.
Evaluate this statement.

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**(2)**

(b)     Students suggested that osmosis resulted in cooked brined turkey meat containing more water than cooked untreated meat.

Use your knowledge of water potential and the data in the graph to explain why this suggestion could not be correct.

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**(2)**

**(Total 8 marks)**

**Q24.**Strawberries may be dehydrated by removing most of the water they contain. Dehydrated strawberries have many different uses in the food industry.

Food scientists investigated the effect of using osmosis to dehydrate strawberries.

1.      The scientists weighed a sample of strawberries and then cut them into 10 mm thick slices.

2.      They put the strawberry slices into a 1.2 mol dm–3 solution of sucrose at a temperature of 25 °C.

3.      After 1 hour, they removed the slices from the sucrose solution and washed them in water. They dried the slices by blotting them and then weighed them.

4.      They also measured the texture of the strawberry slices.

5.      The scientists repeated steps 1 to 4, but they left the strawberry slices in the sucrose solution for different amounts of time.

The results of the investigation are shown in the table.

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Length of time insucrose solution / hours** | **Percentage loss in mass** | **Texture / arbitrary units** |
|   | 0 | Not applicable | 1.2 |
|   | 1 | 15.96 | 0.9 |
|   | 2 | 22.88 | 0.7 |
|   | 4 | 32.36 | 0.7 |
|   | 6 | 38.78 | 0.7 |

(a)     (i)      In this investigation, the scientists cut the strawberries into slices (step 1).
Explain the advantage of this.

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**(2)**

(ii)     The scientists blotted the strawberry slices dry before weighing them (step 3).
Explain why.

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**(2)**

(b)     In the second column of the table, the percentage loss in mass for one of the values has been recorded as not applicable. Explain why.

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**(1)**

(c)     Use the table to describe how the length of time in the sucrose solution affected the strawberries.

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(Extra space) .................................................................................................

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**(3)**

(d)     You could use the data in the table to predict the time that strawberries should be left in sucrose solution to dehydrate them fully. Describe how you could use a graph to do this.

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**(3)**

**(Total 11 marks)**

**Q25.**          (a)     A student investigated the effect of pH on the activity of the enzyme amylase.
She set up the apparatus shown in the diagram.



The tubes were made from Visking tubing. Visking tubing is partially permeable.
She added an equal volume of amylase solution and starch to each tube.

•        She added a buffer solution at pH2 to tube **A**.

•        She added an equal volume of buffer solution at pH8 to tube **B**.

After 30 minutes, she measured the height of the solutions in both tubes.
She then tested the solutions in tubes **A** and **B** for the presence of reducing sugars.

Describe how the student would show that reducing sugars were present in a solution.

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**(3)**

(b)     After 30 minutes, the solution in tube **B** was higher than the solution in tube **A**.

(i)      Explain why the solution in tube **B** was higher.

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*(Extra space)* ........................................................................................

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**(3)**

(ii)     The student concluded from her investigation that the optimum pH of amylase was pH8. Is this conclusion valid? Explain your answer

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**(1)**

**(Total 7 marks)**

**Q26.**          (a)     Flatworms are small animals that live in water. They have no specialised gas exchange or circulatory systems.
The drawing shows one type of flatworm.



(i)      Name the process by which oxygen reaches the cells inside the body of this flatworm.

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**(1)**

(ii)     The body of a flatworm is adapted for efficient gas exchange between the water and the cells inside the body.
Using the diagram, explain how **two** features of the flatworm’s body allow efficient gas exchange.

1 ............................................................................................................

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2 ............................................................................................................

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**(2)**

(b)     (i)      A leaf is an organ. What is an organ?

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**(1)**

(ii)     Describe how carbon dioxide in the air outside a leaf reaches mesophyll cells inside the leaf.

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**(3)**

**(Total 7 marks)**

**Q27.**          Read the following passage.

Gluten is a protein found in wheat. When gluten is digested in the small intestine,
the products include peptides. Peptides are short chains of amino acids. These
peptides cannot be absorbed by facilitated diffusion and leave the gut in faeces

Some people have coeliac disease. The epithelial cells of people with coeliac disease
do not absorb the products of digestion very well. In these people, some of the                 5
peptides from gluten can pass between the epithelial cells lining the small intestine
and enter the intestine wall. Here, the peptides cause an immune response that leads
to the destruction of microvilli on the epithelial cells.

Scientists have identified a drug which might help people with coeliac disease.
It reduces the movement of peptides between epithelial cells. They have                        10
carried out trials of the drug with patients with coeliac disease.

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

(a)     Name the type of chemical reaction which produces amino acids from proteins.

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**(1)**

(b)     The peptides released when gluten is digested cannot be absorbed by facilitated diffusion (lines 2 – 3). Suggest why.

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**(3)**

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**(3)**

(c)     Explain why the peptides cause an immune response (lines 7 – 8).

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**(1)**

(d)     Scientists have carried out trials of a drug to treat coeliac disease (lines 10 – 11).
Suggest **two** factors that should be considered before the drug can be used on patients with the disease.

1 .....................................................................................................................

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2 .....................................................................................................................

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**(2)**

**(Total 7 marks)**

**Q28.**         A scientist investigated the effect of cyanide on the uptake of sodium ions by animal tissue.
He set up two beakers, **J** and **K**.
He put equal volumes of a solution containing sodium ions and equal masses of an animal tissue in each beaker.

•        He added cyanide to beaker **J**.

•        He did not add cyanide to beaker **K**.

He measured the concentration of sodium ions remaining in the solution in each beaker, for 80 minutes. The graph shows his results.



(a)     Calculate the rate of uptake of sodium ions by the tissue in beaker **K** for the first 30 minutes. Show your working.

                             Answer ........................... arbitrary units per minute

**(2)**

(b)     Adding cyanide affects the uptake of sodium ions by the tissue. Use the graph to describe how.

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**(2)**

(c)     Cyanide is a substance which affects respiration.
Use information in the question to explain the effect of cyanide on the uptake of sodium ions by the tissue.

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**(3)**

**(Total 7 marks)**

**Q29.**          The diagram shows the position of the diaphragm at times **P** and **Q**.



(a)     Describe what happens to the diaphragm between times **P** and **Q** to bring about the change in its shape.

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**(2)**

(b)     Air moves into the lungs between times **P** and **Q**. Explain how the diaphragm causes this.

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*(Extra space)* .................................................................................................

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**(3)**

(c)     Describe how oxygen in air in the alveoli enters the blood in capillaries.

**(2)**

**(Total 7 marks)**

**Q30.**Mycolic acids are substances that form part of the cell wall of the bacterium that causes tuberculosis. Mycolic acids are made from fatty acids. Isoniazid is an antibioticthat is used to treat tuberculosis. The diagram shows how this antibiotic inhibits the production of mycolic acids in this bacterium.

 

(a)     Treatment with isoniazid leads to the osmotic lysis of this bacterium. Use information in the diagram to suggest how.

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**(2)**

(b)     Human cells also produce fatty acids. Isoniazid does not affect the production of these fatty acids.

Use information in the diagram to suggest **one** reason why isoniazid does **not** affect the production of fatty acids in human cells.

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**(1)**

(c)     A mutation in the gene coding for enzyme **B** could lead to the production of a non-functional enzyme. Explain how.

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*(Extra space)*..................................................................................................

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**(3)**

**(Total 6 marks)**

**Q31.**(a)     (i)      An arteriole is described as an organ. Explain why.

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**(1)**

(ii)     An arteriole contains muscle fibres. Explain how these muscle fibres reduce blood flow to capillaries.

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**(2)**

(b)     (i)      A capillary has a thin wall. This leads to rapid exchange of substances between the blood and tissue fluid. Explain why.

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**(1)**

(ii)     Blood flow in capillaries is slow. Give the advantage of this.

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**(1)**

(c)     Kwashiorkor is a disease caused by a lack of protein in the blood. This leads to a swollen abdomen due to a build up of tissue fluid.

Explain why a lack of protein in the blood causes a build up of tissue fluid.

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**(3)**

**(Total 8 marks)**

**Q32.**Write an essay on the following topic.

The membranes of different types of cells are involved in many different functions.

**(25)**

**Q33.**Some substances can cross the cell-surface membrane of a cell by simple diffusion through the phospholipid bilayer. Describe other ways by which substances cross this membrane.

**(Total 5 marks)**

**Q34.**Doctors investigated the effect of the smoking habits of men on their non-smoking wives.

The doctors recruited 540 non-smoking women aged 40 or older. They divided these women into groups according to the smoking habits of their husbands.
After 14 years, the doctors recorded how many of the wives had died and their cause of death.

They used these data to determine the relative risk of a wife dying from a particular disease according to her husband’s smoking habit.

In this comparison, they gave the relative risk to the wife of a non-smoker as 1.00. A value greater than 1.00 shows an increased risk compared to the wife of a non-smoker.

The results are shown in the table below.

|  |  |  |
| --- | --- | --- |
|   | **Cause ofdeath** | **Relative risk of wife dying** |
|   | **Husbandnon-smoker** | **Husband smokes 1 to 19 cigarettes /day** | **Husband smokes more than 19 cigarettes / day** |
|   | Lung cancer | 1.00 | 1.61 | 2.08 |
|   | Emphysema | 1.00 | 1.29 | 1.49 |
|   | Cervical cancer | 1.00 | 1.15 | 1.14 |
|   | Stomach cancer | 1.00 | 1.02 | 0.99 |
|   | Heart disease | 1.00 | 0.97 | 1.03 |

A journalist concluded from these data that if a husband smoked, it greatly increased the risk of his wife dying of certain diseases. Evaluate this statement.

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**(Total 4 marks)**

**Q35.**Read the following passage.

Microfold cells are found in the epithelium of the small intestine. Unlike other epithelial cells in the small intestine, microfold cells do not have adaptations for the absorption of food.

Microfold cells help to protect against pathogens that enter the intestine. They have receptor proteins on their cell-surface membranes that bind to antigens on the surface of pathogens.    5
The microfold cells take up the antigens and transport them to cells of the immune system. Antibodies are then produced which give protection against the pathogen.

Scientists believe that it may be possible to develop vaccines that make use of microfold cells. These vaccines could be swallowed in tablet form.                                                                      10

Use information from the passage and your own knowledge to answer the following questions.

(a)    (i)      Microfold cells have receptor proteins on their cell-surface membranes that bind to antigens (line 5). What is an antigen?

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**(1)**

(ii)     Microfold cells take up the antigens and transport them to cells of the immune system (lines 6-7). Antigens are not able to pass through the cell-surface membranes of other epithelial cells. Suggest **two** reasons why.

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**(2)**

(b)     Scientists believe that it may be possible to develop vaccines that make use of microfold cells (lines 9-10). Explain how this sort of vaccine would lead to a person developing immunity to a pathogen.

**(5)**

**(Total 8 marks)**

**Q36.**Imatinib is a drug used to treat a type of cancer that affects white blood cells. Scientists investigated the rate of uptake of imatinib by white blood cells. They measured the rate of uptake at 4°C and at 37°C. Their results are shown in the table.

|  |  |  |
| --- | --- | --- |
|   |   | **Mean rate of uptake of imatinib into cells / μg per million cells per hour** |
|   | **Concentration of imatinib outside cells / μmol dm–3** | **4°C** | **37°C** |
|   | 0.5 | 4.0 | 10.5 |
|   | 1.0 | 10.7 | 32.5 |
|   | 5.0 | 40.4 | 420.5 |
|   | 10.0 | 51.9 | 794.6 |
|   | 50.0 | 249.9 | 3156.1 |
|   | 100.0 | 606.9 | 3173.0 |

(a)     The scientists measured the rate of uptake of imatinib in μg per million cells per hour. Explain the advantage of using this unit of rate in this investigation.

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**(2)**

(b)     Calculate the percentage increase in the mean rate of uptake of imatinib when the temperature is increased from 4°C to 37°C at a concentration of imatinib outside the cells of 1.0 μmol dm−3 .

Give your answer to one decimal place.

Answer .....................................

**(2)**

(c)     Imatinib is taken up by blood cells by active transport.

(i)      Explain how the data for the two different temperatures support this statement.

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**(2)**

(ii)     Explain how the data for concentrations of imatinib outside the blood cells at 50 and 100 μmol dm−3 at 37°C support the statement that imatinib is taken up by active transport.

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**(2)**

**(Total 8 marks)**

**Q37.**Many sports drinks contain water, sodium chloride and carbohydrates. The manufacturers of the sports drinks claim that carbohydrates provide an energy boost. The sodium chloride is used to increase absorption of glucose in the small intestine.

Scientists investigated the effect of a sports drink on the performance of runners in 5 km races.

They recruited 100 runners who had previously run a 5 km race in similar times. During this race, Race 1, they had water they could drink.

The scientists divided the runners into two equal groups, **P** and **Q**. Both groups ran a second 5 km race, Race 2. During this race:

•        group **P** had water available

•        group **Q** had the sports drink available.

The scientists recorded the mean time for each group to complete this race.

**Figure 1** shows their results.

**Figure 1**

 

The glycaemic index (GI) is a measure of the increase in blood glucose concentration after eating a given mass of a food compared with eating the same mass of pure glucose. The GI of pure glucose has a value of 100.

The GI of a food depends on several factors such as how much starch and sugars it contains. High GI foods include those containing lots of simple sugars or white flour. The carbohydrates in these foods are rapidly digested and absorbed. Low GI foods include wholegrain bread and breakfast cereals that contain a lot of fibre. The carbohydrates in these foods are digested and absorbed more slowly.

**Figure 2** shows changes in blood glucose concentration after eating meals of high GI food and meals of low GI food.

**Figure 2**

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Explain how a sports drink could provide an energy boost when running.

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**(3)**

**(Total 3 marks)**

**Q38.**In many parts of the world, crops have to be watered to grow enough food but fresh water is often in short supply.

Barley is a plant that grows a leafy shoot and then produces seed that is harvested for food.

Scientists investigated whether barley could be grown successfully using fresh water mixed with seawater. This would reduce the use of fresh water. However, seawater contains dissolved sodium chloride (salt).

The scientists grew barley in plots of equal size in the same large field. Each plot received one of four treatments.

**A**       No watering.

**B**       Watering with fresh water during growth and seed production.

**C**       Watering with a 1:1 mix of fresh water and seawater during growth and seed           production.

**D**       Watering with fresh water during growth and with a 1:1 mix of fresh water and seawater during seed production.

At the end of the investigation, the scientists measured the concentration of salt in the soil in each plot and the yield of barley seed harvested from each plot.

The scientists’ results are shown in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Watering treatment** | **Mean concentration of salt insoil / arbitrary units** | **Mean yield of barley seed / g** |
|   | **A** | 10.1 | 346 |
|   | **B** | 9.7 | 804 |
|   | **C** | 13.5 | 538 |
|   | **D** | 11.6 | 695 |

(a)     Watering treatment was the independent variable in this investigation.
Explain what is meant by the **independent** variable.

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**(1)**

(b)     The same variety of barley was used in all the plots. Why was this important?

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**(2)**

(c)     When barley plants are growing, the number of cells increases.
Name the process that increases the number of cells.

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**(1)**

(d)     What do the data in the table above show about the effect of watering barley with a mixture of fresh water and seawater?

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**(2)**

(e)     The scientists suggested that watering barley with diluted seawater might not be sustainable if repeated every year.
Do these data support this suggestion?

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**(3)**

**(Total 9 marks)**

**Q39.**The diagram shows the structure of the cell-surface membrane of a cell.



(a)     Name **A** and **B.**

**A**.....................................................................................................................

**B**.....................................................................................................................

**(2)**

(b)     (i)      **C** is a protein with a carbohydrate attached to it. This carbohydrate is formed by joining monosaccharides together. Name the type of reaction that joins monosaccharides together.

Name the type of reaction that joins monosaccharides together.

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**(1)**

(ii)     Some cells lining the bronchi of the lungs secrete large amounts of mucus. Mucus contains protein.

Name **one** organelle that you would expect to find in large numbers in a mucus-secreting cell and describe its role in the production of mucus.

Organelle...............................................................................................

Description of role..................................................................................

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**(2)**

**(Total 5 marks)**

**Q40.**If red blood cells are placed in pure water, water enters the cells by osmosis and they burst. This is called haemolysis. As red blood cells burst they release pigment.

Scientists placed samples of red blood cells in different concentrations of sodium chloride solution for the same period of time. They used red blood cells from four different mammals: dog, guinea pig, rabbit and sheep.

If haemolysis had taken place, the solution turned red. The scientists measured the intensity of the red colour using a colorimeter. The more intense the red colour, the greater the amount of haemolysis.

The scientists calculated the percentage of red blood cells that were haemolysed in each sodium chloride solution.

The following figure shows the scientists’ results.



(a)     Use the figure to give **two** differences between the results for dog and sheep.

Difference 1 ...................................................................................................

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Difference 2 ...................................................................................................

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**(2)**

(b)     Calculate the difference in the percentage of haemolysed cells between sheep and rabbit at a sodium chloride concentration of 0.5%.

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**(1)**

(c)     Explain the relationship between the depth of the red colour of the solution and how much haemolysis has taken place.

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**(2)**

(d)     During treatment in a veterinary surgery, any of the mammals in the figure above may be given an infusion of sodium chloride solution directly into a vein. The concentration of sodium chloride solution used is 0.9%, rather than 0.5%, regardless of the species of mammal.

Explain the advantage to the vet of using this concentration.

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**(2)**

**(Total 7 marks)**

**Q41.**(a)     Describe how oxygen in the air reaches capillaries surrounding alveoli in the lungs. Details of breathing are **not** required.

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**(4)**

Forced expiratory volume (FEV) is the greatest volume of air a person can breathe out in 1 second.

Forced vital capacity (FVC) is the greatest volume of air a person can breathe out in a single breath.

The figure below shows results for the volume of air breathed out by three groups of people, **A**, **B** and **C**. Group **A** had healthy lungs. Groups **B** and **C** had different lung conditions that affect breathing.

 
                          Time breathing out / s

(b)     Calculate the percentage drop in FEV for group **C** compared with the healthy people.

Answer = ...................................

**(1)**

(c)     Asthma affects bronchioles and reduces flow of air in and out of the lungs.
Fibrosis does not affect bronchioles; it reduces the volume of the lungs.

Which group, **B** or **C**, was the one containing people with fibrosis of their lungs? Use the information provided and evidence from the figure above to explain your answer.

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**(3)**

**(Total 8 marks)**

**Q42.**(a)     Contrast the processes of facilitated diffusion and active transport.

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**(3)**

Students investigated the uptake of chloride ions in barley plants. They divided the plants into two groups and placed their roots in solutions containing radioactive chloride ions.

•        Group **A** plants had a substance that inhibited respiration added to the solution.

•        Group **B** plants did not have the substance added to the solution.

The students calculated the total amount of chloride ions absorbed by the plants every 15 minutes. Their results are shown in the figure below.

 
                  Time / minutes

(b)     Calculate the ratio of the mean **rate** of uptake of chloride ions in the first hour to the **rate** of uptake of chloride ions in the second hour for group **B** plants.

Ratio = ................................... :1

**(2)**

(c)     Explain the results shown in the figure above.

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**(4)**

**(Total 9 marks)**

**Q43.**(a)     Describe how phospholipids are arranged in a plasma membrane.

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**(2)**

(b)     Cells that secrete enzymes contain a lot of rough endoplasmic reticulum (RER) and a large Golgi apparatus.

(i)      Describe how the RER is involved in the production of enzymes.

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**(2)**

(ii)     Describe how the Golgi apparatus is involved in the secretion of enzymes.

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**(1)**

**(Total 5 marks)**

**Q44.**Organic compounds synthesised in the leaves of a plant can be transported to the plant’s roots.
This transport is called translocation and occurs in the phloem tissue of the plant.

(a)     One theory of translocation states that organic substances are pushed from a high pressure in the leaves to a lower pressure in the roots.

Describe how a high pressure is produced in the leaves.

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**(Extra space)** ................................................................................................

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**(3)**

PCMBS is a substance that inhibits the uptake of sucrose by plant cells.

Scientists investigated the effect of PCMBS on the rate of translocation in sugar beet.
The figure below shows their results.

 
Time / minutes

(b)     During their experiment, the scientists ensured that the rate of photosynthesis of their plants remained constant.
Explain why this was important.

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**(2)**

(c)     The scientists concluded that some translocation must occur in the spaces in the cell walls.
Explain how the information in the figure above supports this conclusion.

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**(2)**

**(Total 7 marks)**

**Q45.**A scientist investigated the uptake of sodium ions by animal tissue.
To do this, he:

•        used two flasks, **F** and **G**

•        put equal masses of animal tissue into each flask

•        added equal volumes of a solution containing sodium ions to each flask

•        added to flask **F** a solution of a substance that prevents the formation of ATP by cells

•        measured the concentration of sodium ions **remaining** in the solution in each flask.

The graph below shows his results.

 
                        Time / minutes

(a)     Calculate the rate of uptake of sodium ions by the tissue in flask **G** during the first 20 minutes of this investigation.

Answer = ................................... arbitrary units per minute

**(1)**

(b)     The scientist concluded that the cells in flask **G** took up sodium ions by active transport. Explain how the information given supports this conclusion.

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**(Extra space)** ................................................................................................

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**(4)**

(c)     The curve for flask **F** levelled off after 20 minutes. Explain why.

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**(2)**

**(Total 7 marks)**

**Q46.**Read the following passage.

|  |  |  |
| --- | --- | --- |
|   | Low-density lipoprotein (LDL) is a substance found in blood. A high concentration of LDL in a person’s blood can increase the risk of atheroma formation. Liver cells have a receptor on their cell-surface membranes that LDL binds to. This leads to LDL entering the cell. A regulator protein, also found in blood, can bind to the same receptor as LDL. This prevents LDL entering the liver cell. People who have a high concentration of this regulator protein in their blood will have a high concentration of LDL in their blood. Scientists have made a monoclonal antibody that prevents this regulator protein working. They have suggested that these antibodies could be used to reduce the risk of coronary heart disease. | 5 |
|   | A trial was carried out on a small number of healthy volunteers, divided into two groups. The scientists injected one group with the monoclonal antibody in salt solution. The other group was a control group. They measured the concentration of LDL in the blood of each volunteer at the start and after 3 months. They found that the mean LDL concentration in the volunteers injected with the antibody was 64% lower than in the control group. | 10 |
|   | 15 |
|   | Use the information in the passage and your own knowledge to answer the following questions. |

(a)     The scientists gave an injection to a mouse to make it produce the monoclonal antibody used in this investigation (line 7).

What should this injection have contained?

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**(1)**

(b)     LDL enters the liver cells (lines 3−4).

Using your knowledge of the structure of the cell-surface membrane, suggest how LDL enters the cell.

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**(2)**

(c)     Explain how the monoclonal antibody would prevent the regulator protein from working (lines 7−8).

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**(2)**

(d)     Describe how the control group should have been treated.

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**(2)**

**(Total 7 marks)**

**Q47.**Scientists studied the rate of carbon dioxide uptake by grape plant leaves. Grape leaves have stomata on the lower surface but no stomata on the upper surface.

The scientists recorded the carbon dioxide uptake by grape leaves with three different treatments:

**Treatment 1** − No air-sealing grease was applied to either surface of the leaf.

**Treatment 2** − The lower surface of the leaf was covered in air-sealing grease that prevents gas exchange.

**Treatment 3** − Both the lower surface and the upper surface of the leaf were covered in air–sealing grease that prevents gas exchange.

The scientists measured the rate of carbon dioxide uptake by each leaf for 60 minutes in light and then for 20 minutes in the dark.

The scientists’ results are shown in the diagram below.



(a)     Suggest the purpose of each of the three leaf treatments.

**Treatment 1** ..................................................................................................

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**Treatment 2** ..................................................................................................

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**Treatment 3** ..................................................................................................

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**(3)**

(b)     (i)      Describe the results shown for **Treatment 1**.

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**(2)**

(ii)     The stomata close when the light is turned off.

Explain the advantage of this to the plant.

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**(2)**

(c)     (i)      **Treatment 2** shows that even when the lower surface of the leaf is sealed there is still some uptake of carbon dioxide.

Suggest how this uptake of carbon dioxide continues.

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**(1)**

(ii)     In both **Treatment 1** and **Treatment 2**, the uptake of carbon dioxide falls to zero when the light is turned off.

Explain why.

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**(2)**

**(Total 10 marks)**

**Q48.**A group of students carried out an investigation to find the water potential of potato tissue.

The students were each given a potato and 50 cm3 of a 1.0 mol dm−3 solution of sucrose.

•        They used the 1.0 mol dm−3 solution of sucrose to make a series of different concentrations.

•        They cut and weighed discs of potato tissue and left them in the sucrose solutions for a set time.

•        They then removed the discs of potato tissue and reweighed them.

The table below shows how one student presented his processed results.

|  |  |  |
| --- | --- | --- |
|   | **Concentration of sucrose solution / mol dm−3** | **Percentage change in mass of potato tissue** |
|   | 0.15 | +4.7 |
|   | 0.20 | +4.1 |
|   | 0.25 | +3.0 |
|   | 0.30 | +1.9 |
|   | 0.35 | −0.9 |
|   | 0.40 | −3.8 |

(a)     Explain why the data in the table above are described as **processed** results.

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**(1)**

(b)     Describe how you would use a 1.0 mol dm−3 solution of sucrose to produce 30 cm3 of a 0.15 mol dm−3 solution of sucrose.

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**(2)**

(c)     Explain the change in mass of potato tissue in the 0.40 mol dm−3 solution of sucrose.

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**(2)**

(d)     Describe how you would use the student’s results in the table above to find the water potential of the potato tissue.

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**(Extra space)** .................................................................................................

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**(3)**

**(Total 8 marks)**

**Q49.**(a)     Describe how you would test a piece of food for the presence of lipid.

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**(2)**

The figure below shows a phospholipid.


**X**         **Y**

(b)     The part of the phospholipid labelled **A** is formed from a particular molecule. Name this molecule.

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**(1)**

(c)     Name the type of bond between **A** and fatty acid **X**.

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**(1)**

(d)     Which of the fatty acids, **X** or **Y**, in the figure above is unsaturated? Explain your answer.

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**(1)**

Scientists investigated the percentages of different types of lipid in plasma membranes from different types of cell. The table shows some of their results.

|  |  |  |
| --- | --- | --- |
|   | **Type of lipid** | **Percentage of lipid in plasma membrane by mass** |
|   | **Cell lining ileum ofmammal** | **Red blood cell ofmammal** | **The bacterium*Escherichia coli*** |
|   | Cholesterol | 17 | 23 | 0 |
|   | Glycolipid | 7 | 3 | 0 |
|   | Phospholipid | 54 | 60 | 70 |
|   | Others | 22 | 14 | 30 |

(e)     The scientists expressed their results as **Percentage of lipid in plasma membrane by mass**. Explain how they would find these values.

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**(2)**

Cholesterol increases the stability of plasma membranes. Cholesterol does this by making membranes less flexible.

(f)     Suggest **one** advantage of the different percentage of cholesterol in red blood cells compared with cells lining the ileum.

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**(1)**

(g)     *E. coli* has no cholesterol in its cell-surface membrane. Despite this, the cell maintains a constant shape. Explain why.

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**(2)**

**(Total 10 marks)**

**Q50.**The figure below represents a capillary surrounded by tissue fluid.
The values of the hydrostatic pressure are shown.

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Arterioleend** | *direction of blood flow* | **Venuleend** |
|   | Hydrostatic pressure = 4.3 kPa                                Hydrostatic pressure = 1.6 kPa |
|   | **Tissue fluid**Hydrostatic pressure = 1.1 kPa |

(a)     Use the information in the figure above to explain how tissue fluid is formed.

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**(2)**

(b)     The hydrostatic pressure falls from the arteriole end of the capillary to the venule end of the capillary. Explain why.

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**(1)**

(c)     High blood pressure leads to an accumulation of tissue fluid. Explain how.

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**(Extra space)** .................................................................................................

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**(3)**

(d)     The water potential of the blood plasma is more negative at the venule end of the capillary than at the arteriole end of the capillary. Explain why.

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**(Extra space)** .................................................................................................

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**(3)**

**(Total 9 marks)**

**M1.**(a)     1.      (Releases) toxins;

2.      Kills cells / tissues.

*2. Accept any reference to cell / tissue damage*

*Ignore infecting / invading cells*

**2**

(b)     1.      Water potential in (bacterial) cells higher (than in honey) / water potential in honey lower (than in bacterial cells);

*Q candidates must express themselves clearly*

*1. Must be comparative e.g. high WP in cell and low WP in honey*

2.      Water leaves bacteria / cells by osmosis;

3.      (Loss of water) stops (metabolic) reactions.

*3. Needs a reason why lack of water kills the cell*

**3**

**[5]**

**M2.**          (a)     Several / more than one polypeptide chain in molecule;

*Evidence must only relate to 4ºstructure*

**1**

(b)     Chemical bonds formed between sulphur-containing groups /
R-groups / form stronger disulphide bonds;
Bind chain(s) to each other;

**2**

(c)     Different number / sequences of amino acids;
Bonds in different places which gives different shape;

**2**

(d)     Outer layer of skin cells are dead / do not respire
Do not contain mitochondria / do not produce ATP / release energy;
Cells do not have required proteins / carriers;

**3**

(e)     Advantages:

1       Small objects can be seen;

2       TEM has high resolution as wavelength of electrons shorter;

*Accept better*

Limitations:

3       Cannot look at living cells as cells must be in a vacuum;

4       must cut section / thin specimen;

5       Preparation may create artefact

6       Does not produce colour image;

**6**

**[14]**

**M3.**          (a)     greater rate of oxygen consumption / leads to greater rate of respiration and greater rate of uptake;

*(allow this mark even if spread through account but cause and effect must be within the correct context)*

oxygen required for respiration;
respiration produces ATP / releases energy;
*(ignore ref to producing or making energy)*potassium ions taken up by active transport / against concentration gradient;

**4**

(b)     (i)      0.25 (mol dm–3);

**1**

(ii)     1 mark        Incorrect answer but derived from ratio of 1.2 and initial
                   length of 90 mm
2 marks      Correct answer of 108 mm;

**2**

(iii)     water potential inside potato higher / less negative than in solution;
water moves out by osmosis;

**2**

**[9]**

**M4.**          (a)     Nitrification;

*Accept nitrifying.*

*Do not accept nitrogen fixing.*

**1**

(b)     1.      Uptake (by roots) involves active transport;

*Reject all references to bacteria*

2.      Requires ATP / aerobic respiration;

**2**

(c)     (i)      1.      Not enough time / fast flow washes bacteria away;

*“Not enough time for bacteria to convert all the ammonia to nitrate” gains 2 marks*

2.      (Not all / less) ammonia converted to nitrate / less nitrification;

**2**

(ii)     1.      Algal bloom / increase in algae blocks light / plants / algae die;

2.      Decomposers / saprobionts / bacteria break down dead plant materials;

3.      Bacteria / decomposers / saprobionts use up oxygen in respiration / increase BOD causing fish to die;

*3. Accept alternatives such as microbes / saprophytes.*

**3**

**[8]**

**M5.**          (a)     Measure diameter of field with ruler; And proportion taken up by the cell; or Measure length with (eyepiece) graticule / eyepiece scale;
Calibrated against stage micrometer / something of known length;

*Reject divide apparent length by magnification*

**2**

(b)     Membrane / cytoplasm shrinks / pulls away from cell wall / cell plasmolysed / goes flaccid; Water moves down water potential gradient / to lower / more negative water potential; By osmosis;

**3**

(c)     (i)      Reaches equilibrium / no further / maximum change in length;

*Reject osmosis takes time*

**1**

(ii)     Line / curve of best fit; Extrapolate (and read off) / find where it crosses x-axis;

**2**

(iii)     Greater decrease / length smaller; More water removed;
Greater difference in water potential / cell with higher / less negative water potential; Starch is insoluble / has no effect on osmosis

**max 2**

**[10]**

**M6.**          (a)     partially / selectively permeable *accept semi-permeable*allows water to pass through but not potassium nitrate / solute;

**1**

(b)     potassium nitrate (solution);
cell wall permeable;

**2**

(c)     water potential more negative / lower in cell E; water removed;
greater solute / sap concentration (in cell);

**3**

**[6]**

**M7.**          (a)     (i)      no cell wall / only has (plasma) membrane;

**1**

(ii)     has capsule / slime layer;

**1**

(b)     correct approach which makes use of scalebar; *ignore* reference to units.

**1**

(c)     cellulose / starch / amylose / amylopectin;

**1**

(d)     (i)      water potential lower / more negative in cell;
(water enters by) osmosis;

**2**

(ii)     plant cell wall made of a different substance / cellulose / penicillin
does not affect cellulose;

**1**

**[7]**

**M8.**          (a)     (i)      Many people do not go to the doctor;

**1**

(ii)     36000;

*No marks awarded for working here as calculation is very straightforward*

**1**

(b)     Same sugars / antigens on bacteria / nerve cells;

*Do not accept references to same shape as equivalent to complementary.*

Bind with antibody / form antigen-antibody complex;

*Reject react*

Have complementary shape / fit binding site;

*Reject active site*

**3**

(c)     Diaphragm will not move down / flatten / contract;

*Ignore references to breathing out*

Thoracic cavity / lung volume not increased so cannot breathe in;

**2**

**[7]**

**M9.**(a)     No effect on dry mass / small increase in dry mass;

Decrease in fresh mass;

*Ignore reference to figures.*

**2**

(b)     Water potential inside tomato plant becomes higher / less negative;

Water drawn out of tomato plants / more difficult for tomato plants to take up water;

By osmosis;

Most of the fresh mass is (mass of) water;

**3 max**

**[5]**

**M10.**          (a)     (Blood) plasma;

**1**

(b)     More / larger proteins / less urea / carbon dioxide / more glucose / amino acids / fatty acids / oxygen / high(hydrostatic) pressure;

***Q*** *Reference to blood cells / water potential = neutral****Q*** *No Protein should not be credited*

**1**

(c)     (i)      Contracts;

***Q*** *Do not accept pumping of heart / heart beating*

**1**

(ii)     Loss of fluid / volume;

         Friction / resistance (of capillary wall);

***Q*** *Reference to a narrow lumen is not sufficient to gain a mark unless friction or resistance is mentioned.*

**1 max**

(d)     Water potential (in capillary) not as low / is higher / less negative / water potential gradient is reduced;

More tissue fluid formed (at arteriole end);

Less / no water absorbed (into blood capillary) by osmosis; (into blood capillary);

***Q*** *The last two marking points must be in context of movement into the blood capillary*

**3**

**[7]**

**M11.**          (a)     Lengthways / down the root;

Through one tissue only / through same part / same proportion of tissues;

**2**

(b)     To prevent the water from evaporating / prevent evaporation;

Changing the concentrations / water potential (of solution);

**2**

(c)     (i)      Plot data on a graph;

Find (sucrose concentration) from the graph where the ratio is 1;

**2**

(ii)     No, because the results are given as a ratio / as a proportion of initial length;

**1**

**[7]**

**M12.**          (a)     1.      (Simple / facilitated) diffusion from high to low concentration / down concentration gradient;

***Q*** *Do not allow across / along / with concentration gradient*

2.      Small / non-polar / lipid-soluble molecules pass via phospholipids / bilayer;

*Reject: named molecule passing through membrane by an incorrect route*

*Accept: diagrams if annotated*

***OR***

Large / polar / water-soluble molecules go through proteins;

3.      Water moves by osmosis / from high water potential to low water potential / from less to more negative water potential;

4.      Active transport is movement from low to high concentration / against concentration gradient;

*Only penalise once if active transport is not named
e.g. ‘movement against the concentration gradient involves proteins and requires ATP’ = 2 marks*

5.      Active transport / facilitated diffusion involves proteins / carriers;

*Accept: facilitated diffusion involves channels*

*Reject: active transport involves channels*

6.      Active transport requires energy / ATP;

7.      Ref. to Na+ / glucose co-transport;

*Credit ref. to endo / exocytosis as an alternative*

**5 max**

(b)     1.      Many alveoli / alveoli walls folded provide a large surface area;

*Neutral: alveoli provide a large surface area*

2.      Many capillaries provide a large surface area;

3.      (So) fast diffusion;

*Neutral: greater / better diffusion
Neutral: fast gas exchange
Allow ‘fast diffusion’ only once*

4.      Alveoli or capillary walls / epithelium / lining are thin / short distance between alveoli and blood;

*Reject: thin membranes / cell walls
Accept: one cell thick for ‘thin’*

5.      Flattened / squamous epithelium;

*Accept: endothelial*

6.      (So) short diffusion distance / pathway;

7.      (So) fast diffusion;

8.      Ventilation / circulation;

*Accept: descriptions for ventilation / circulation*

9.      Maintains a diffusion / concentration gradient;

10.    (So) fast diffusion;

*Do not double penalise if description lacks detail
e.g. thin membranes so a short diffusion distance = 1 mark*

**5 max**

**[10]**

**M13.**(a)     (i)      1.08;

*Must be to 3 significant figures, as in the table*

**1**

(ii)     Allows comparison / shows proportional change;

*Neutral: sizes / amounts*

         Idea that discs had different starting masses / weights;

*Neutral: different masses*

**2**

(iii)    (Allows)

*Accept: outliers instead of anomalies*

Anomalies to be identified / effect of anomalies to be reduced / effect of variation in data to be minimised;

*Reject: idea of not recording anomalies / preventing anomalies from occurring*

         A mean to be calculated;

*Neutral: average*

**2**

(b)     (i)      Plot (sodium chloride) concentration against ratio / draw line of best fit;

*Reject: if wrong axes or type of graph*

Find (sodium chloride concentration from the graph) where the ratio is 1 / there is no change in mass;

**2**

(ii)     Line / curve of best fit is more reliable / precise;

*Neutral: graph*

         Intercept / point where line crosses axis is more reliable / precise;

*Reject: references to ‘more accurate’*

         **OR**

         Can plot SD values / error bars;

(To show) variability about the mean / how spread out the results are;

**2**

**[9]**

**M14.**(a)     (i)      (Lactose +) Water; → (Glucose +) Galactose;

*Accept: H2O for water*

**2**

(ii)     Hydrolysis;

*Accept: if phonetically correct*

**1**

(b)     (i)      (Add Biuret reagent to both solutions) – no mark;

*Neutral: positive / negative result*

         Lactase / enzyme will give purple / lilac / mauve;

*Neutral: incorrect reference to the method*

         **OR**

Lactose / reducing sugar will not give purple / lilac / mauve / will remain blue;

**1**

(ii)     Lactase / enzyme is a protein;

*Accept: lactase / enzyme contains peptide bonds*

**1**

**[5]**

**M15.**Affects germination of Y more than (germination of) X;

After four days:
No effect on (germination of) X up to 15 (mmol dm-3) and then constant decrease / (causes) sharp decrease in (germination of) Y up to 15 (mmol dm-3) and then more gradual decrease;

After eight days:
Decrease in (germination of) X up to 45 (mmol dm-3) and then no further decrease / sharp decrease in (germination of) Y up to 15(mmol dm-3) and then more gradual decrease;

**[3]**

**M16.**          (a)     Cell wall;

Starch (store);

Chloroplast;

*Accept: phonetic spelling*

**2 max**

(b)     Insoluble;

Reduces / ’stops’ water entry / osmosis / does not affect water
potential / is osmotically inactive;

*Accept: description for first point e.g. ‘does not dissolve’.*

**2**

(c)     Light sensitive eyespot / eyespot detects light;

Flagellum enables movement towards light;

Chloroplast / chlorophyll absorbs light / for photosynthesis;

*Do not penalise references to ‘many chloroplasts’.*

**3**

**[7]**

**M17.**          (a)     Water will affect the mass / only want to measure water taken up or lost;

Amount of water on cylinders varies / ensures same amount of water on outside;

*Neutral: removes water*

*Accept: ‘(sodium chloride) solution’ for water*

*Do not accept ‘sodium chloride’*

*Neutral: refs. to fair testing*

**2**

(b)     4 cm3 (of 1.0 mol dm–3 sodium chloride solution) and 16 cm3 (of distilled water);

*Reject: factors and multiples of these figures e.g. 2 cm3 and 8 cm3, as final volume should be 20 cm3*

**1**

(c)     Allows comparison / shows proportional change;

Idea that cylinders have different starting masses / weights;

*Reject: if comparison is in context of the start and final mass of the same cylinder*

*Neutral: different masses*

*Neutral: different starting sizes*

**2**

(d)     (Allows) anomalies to be identified / ignored / effect of anomalies to be reduced / effect of variation in data to be minimised;

Makes the average / mean / line of best fit more reliable / allows concordant results;

*Accept: ‘outliers’ instead of anomalies*

***Q*** *Reject: abnormalities*

*Reject: idea of not recording anomalies / preventing anomalies from occurring*

*Accept: ‘cancels out anomalies’ as bottom line response*

***Q*** *Reject: makes the average / mean more accurate*

*Neutral: makes the average / mean more valid*

*Neutral: makes ‘it’ / results / conclusion more reliable*

**2**

(e)     0.35 (mol dm–3)

**1**

**[8]**

**M18.**          (a)     1.      Uses energy / ATP;

2.      Against concentration gradient / low to high concentration;

3.      Does not use channel proteins / only uses carrier proteins;

*Assume “it” refers to active transport.*

*1. Facilitated diffusion is passive - neutral*

*2. Along / across concentration gradient - neutral*

*Accept up / down concentration gradient*

*Accept AT does not need concentration gradient.*

**2 max**

(b)     (i)      To see the effect of the drug / effect not due to anything else in the tablet;

*Neutral “to compare results”*

**1**

(ii)     Placebo / dummy drug / tablet without drug;

(Otherwise) treated the same;

*No drug - neutral*

*Accept: Example e.g. tablet given at same time*

**2**

(c)     Decrease for 3 hours;

*Accept decreases from 1 - 4 hours*

**1**

**[6]**

**M19.**          (a)     (i)      Hydrolysis;

*Accept phonetic spelling.*

*Ignore reaction.*

**1**

(ii)     (Alpha) glucose;

*Accept α glucose.*

*Reject β glucose / beta glucose*

**1**

(b)     (i)      Add Benedict’s (reagent) and heat / warm;

Red / orange / yellow / green (colour);

*Reject Add HCl*

*Accept brown, reject other colours*

**2**

(ii)     2 products / 2 sugars produced;

*Look for idea of* ***two***

*Accept named monosaccharides produced.*

*“More” insufficient for mark*

*Neutral if incorrect products named*

*Neutral “lactose is a polysaccharide”*

*Neutral “lactose is not a reducing sugar”*

*Neutral: Reference to surface area.*

**1**

(c)     1.      Galactose is a similar shape / structure to lactose / both complementary;

*Q Reject: Same shape / structure*

2.      (Inhibitor / Galactose) fits into / enters / binds with active site (of enzyme);

*Accept blocks active site*

3.      Prevents / less substrate fitting into / binding with (active site) / fewer or no E-S complexes;

*Look for principles:*

*1. Shape*

*2. Binding to active site*

*3. Consequence*

**2 max**

**[7]**

**M20.**(a)     Answer of 9.09 / 9.1;; = 2 marks

Calculation of the difference in mean time (2) divided by original time (22); = 1 mark

*Ignore number of decimal places as long as they are correct*

**2**

(b)     (Yes)

*Can mix and match yes or no approach, all 5 responses are available*

(No)

1.      Faster running time after sports drink;

*‘Faster running time in group Q’ is insufficient but accept ‘faster running time in group Q in Race 2’*

2.      Mean times given **so** there will be variation in the group;

3.      No standard deviations to know the spread of the data (about the mean) / whether they overlap;

*Accept ‘no stats analysis’*

4.      Improvement in running time only small in both groups / both groups improved in Race 2;

5.      Did not drink the same volumes;

**3 max**

(c)     1.      Age;

2.      Gender / sex;

3.      Ethnicity;

4.      Food / fluid intake before the race;

*Any fluid / food is included here eg coffee, alcohol*

5.      Amount of sleep / rest / exercise before the race;

6.      Reference to one named health factor eg diabetic or non-diabetic, smoker or non-smoker;

*Reference to medication is included here*

**3 max**

(d)     1.      Sodium ions and glucose absorbed by co-transport;

*Only penalise omission of ‘ions’ once in marking points 1, 3, 4
and 5*

2.      (Co-transport) via carrier / channel protein;

*Accept via symport*

*Only reward reference to carrier / channel proteins in the context of co-transport*

3.      Sodium ions removed (from epithelial cell) by active transport into blood;

4.      Maintains low concentration of sodium ions (in epithelial cell) / maintains sodium ion concentration gradient (between small intestine and epithelial cell);

*Principle: marking points 3, 5, and 6 require consideration of ‘what moves’, ‘where it moves to’ and ‘how it moves’ to achieve credit*

5.      Sodium ions enter epithelial cells by facilitated diffusion taking glucose with them (from small intestine);

*Reference to diffuse / diffusion for movement is required.
Accept facilitated diffusion*

6.      Glucose moved by facilitated diffusion into blood (from epithelial cells);

**4 max**

**[12]**

**M21.**1.      Vaccines contain antigens / dead / weakened pathogens / antigens dead / weakened
        pathogens are injected;

*Ignore references to T or B cells.*

2.      Memory cells made;

3.      On second exposure memory cells produce antibodies / become active / recognise pathogens;

*3. Idea of memory cells responding.*

4.      Rapidly produce antibodies / produces more antibodies;

*4. Production of antibodies must be qualified for mark. Underlined ideas essential.*

5.      Antibodies destroy pathogens;

*5. Accept bacteria / viruses etc but not disease*

**[5]**

**M22.**(a)     (i)      1.      Water potential same (inside and outside) / no
         water potential gradient;

*Accept symbol Ψ or abbreviation WP as alternatives to water potential.*

2.      Water does not enter / leave spores;

3.      By osmosis / prevents osmotic damage;

*Answer must refer to osmosis.*

**2 max**

(ii)     Prevents growth (before ready) / stops growth of (other) microorganisms / slows enzyme action / prevents enzymes being denatured;

**1**

(b)     1.      Nitrogen / N / sulfur / S;

2.      Catalase is a protein / catalase is made up of amino acids / enzymes are proteins / enzymes are made up of amino acids;

*Specific reference needed to proteins or amino acids.*

**2**

(c)     1.      Prevents contamination by (other) microorganisms;

*Accept alternatives such as microbes, bacteria, other fungi.*

2.      Which also produce the enzyme / catalase / which would produce substances that affect catalase;

**2**

(d)     (i)      90 hours;

*Hours must be specified in answer to (c)*

**1**

(ii)     70 – 80 (hours);

*Allow with no reference to units.*

*Incorrect units negates answer.*

**1**

(e)     1.      Extra steps (with intracellular enzymes);

2.      Cells have to be broken open;

3.      Cell walls / bits of cells have to be removed / separated from enzyme;

4.      Needs to be separated from all the other enzymes in the cell;

**2 max**

**[11]**

**M23.**(a)     (i)      1.      Allows results to be compared;

2.      Because initial masses may have been different;

**2**

(ii)     1.      Quantitative measure (of cooking);

2.      Ensures all cooked to same extent as not all turkey pieces same shape / thickness;

*2 Emphasis here must be on being cooked to the same extent. Do not accept reference to all being cooked.*

**2**

(iii)    1.      (Yes) Loss of water results in loss in mass;

2.      (No) Loss of other substances / other substances being burnt;

*No marks should be given for “Yes” or “No”*

**2**

(b)     1.      Water potential in brine lower than in cells / meat;

*Accept water potential more negative or converse answers*

2.      Water would move out of the meat / water does not move out of the meat;

**2**

**[8]**

**M24.**(a)     (i)      1.      Increases (surface) area / inside surface exposed / more
          cells exposed / shorter distance for water to move;

2.      Producing water loss;

*Accept better answers, such as diffusion or osmosis relating to water loss.*

**2**

(ii)     1.      Sucrose solution / water / liquid (on the slices) would add to the mass / weight of the slices;

2.      Would vary;

*Ignore references to reliability*

**2**

(b)     This is initial mass / the time is too short for water to have left / the time is too short for osmosis / have not been treated;

**1**

(c)     1.      Percentage loss in mass increases with time;

2.      Texture decreases then levels out;

*Only credit answers that refer to decreasing and levelling out.*

3.      (Texture levels out) after first 2 hours;

**3**

(d)     1.      Plot graph of percentage loss in mass against time;

2.      Draw curve (of best fit);

*Although curve is the technical term accept references to line etc*

3.      Extrapolate / record when no further change in mass / record when curve flattens out;

**3**

**[11]**

**M25.**          (a)     1.      Add Benedict’s;

*Hydrolyse with acid negates mp1*

2.      Heat;

*Accept warm, but not an unqualified reference to water bath*

3.      Red / orange / yellow / green (shows reducing sugar present);

*Accept brown*

**3**

(b)     (i)      1.      Starch hydrolysed / broken down / glucose / maltose produced;

*Neutral: Sugar produced*

2.      Lower water potential;

3.      Water enters by osmosis;

**3**

(ii)     Only 2 pHs studied / more pHs need to be tested;

*Accept: different amylase may have a different optimum pH*

**1**

**[7]**

**M26.**         (a)     (i)     Diffusion;

*Ignore references to structures, membrane components etc*

*Allow simple diffusion*

*Reject facilitated diffusion*

**1**

(ii)     1.      (Thin / flat body) so short distance for diffusion / short diffusion pathway;

*Ignore references to membrane, wall, body surface*

2.      (Thin / flat body so) large surface area to volume ratio;

*‘It’ refers to flatworm’s body*

**2**

(b)     (i)     A group of tissues;

*Ignore references to function Group = more than one*

**1**

(ii)     1.      (Carbon dioxide enters) via stomata;

*Reject stroma*

2.      (Stomata opened by) guard cells;

3.      Diffuses through air spaces;

*Allow concentration gradient. Reject along gradient unless direction made clear*

4.      Down diffusion gradient;

**3 max**

**[7]**

**M27.**          (a)     Hydrolysis (reaction);

*Accept phonetic spelling*

**1**

(b)     1.      Too big / wrong shape;

*Wrong charge - neutral*

*Accept insoluble*

2.      To fit / bind / pass through (membrane / into cell / through carrier / channel protein);

3.      Carrier / channel protein;

*Accept carrier / channel protein not present*

**3**

(c)     Foreign / (act as) antigen / non-self;

*Reject foreign cells*

**1**

(d)     1.      Dose to be given;

*Accept: interaction with other drugs*

2.      No (serious) side effects;

3.      How effective;

4.      Cost of drug;

**2 max**

**[7]**

**M28.**          (a)     2 marks for correct answer 0.2

*Accept concentration ÷ time*

1 mark for 6 / 30;

**2**

(b)     1.      (Uptake) decreases / slower, then no further uptake / uptake stops;

2.      (Decreases) to 20 - 22 / no uptake after 20 / 22 minutes;

*Accept: (only) 1.6 (arbitrary units) absorbed / (only) drops to 8.4*

*Is for correct use of data from graph*

**2**

(c)     1.      Stops / reduces / inhibits respiration;

*Accept: inhibits respiratory enzymes*

2.      No / less energy released / ATP produced;

*Ignore: less energy produced / made*

3.      (ATP / energy needed) for active transport;

*Accept ref to Na+ pump / description of active transport*

*Ignore consequences of less Na+ in cell*

**3**

**[7]**

**M29.**          (a)     1.      Flatten / moves down;

*1. Ignore: additional information about rib movements*

2.      (Diaphragm muscle) contracts;

**2**

(b)     1.      Diaphragm contracts / moves down / flattens;

*Ignore refs to rib movement*

2.      Increases volume (of thorax) and decrease in pressure;

*2. Accept pressure lower than atmospheric pressure*

3.      Air moves from high to lower pressure / down pressure gradient;

*3. Reject: by diffusion*

**3**

(c)     1.      Diffusion;

*Accept down diffusion gradient*

2.      Across (alveoli) epithelium / (capillary) endothelium;

*2. Accept: capillary epithelium / squamous cell*

**2 max**

**[7]**

**M30.**(a)     1.      Cell wall not formed / production inhibited;

*1.* ***Q*** *Accept: weakened cell wall, but do not accept ‘cell wall is broken down’*

2.      Lower water potential in bacterium;

*2. Accept: converse*

*2. Must be clear that the lower water potential is in the bacterium*

3.      Water enters and causes lysis / expansion / pressure;

**2 max**

(b)     Human cells lack enzyme (**B**) / have a different enzyme / produce different fatty acids / use different substrates;

*Neutral: ‘human cells do not have cell walls’ as out of context*

**1**

(c)     1.      Change in base sequence (of DNA / gene) leading to change in amino acid sequence / primary structure (of enzyme);

*1. Accept: different amino acids coded for*

*1. Reject: different amino acids produced*

2.      Change in hydrogen / ionic / disulphide bonds leading to change in the tertiary structure / active site (of enzyme);

*2. Neutral: alters 3D structure / 3D shape*

3.      Substrate not complementary / cannot bind (to enzyme / active site) / no enzyme-substrate complexes form;

**3**

**[6]**

**M31.**(a)     (i)      Made of (different) tissues / more than one tissue;

**1**

(ii)     1.      (Muscle) contracts;

*Assume that ‘they’ or ‘it’ = muscle*

2.      (Arteriole) narrows / constricts / reduces size of lumen / vessel / vasoconstriction;

*Ignore: references to pressure*

***Q*** *Correct context for muscle contracts, vessel constricts*

**2**

(b)     (i)      Short diffusion distance / pathway;

*Accept: thin diffusion pathway*

**1**

(ii)     (More) time for exchange / diffusion (of substances);

*Accept: example of more time for specific substance to be exchanged*

**1**

(c)     1.      Water potential (in capillary) not as low / is higher / less negative / water potential gradient is reduced;

*Accept: ‘blood or plasma’ instead of ‘capillary’*

2.      Less / no water removed (into capillary);

*Accept converse: water remains in the tissue*

3.      By osmosis (into capillary);

***Q*** *Marking points 2. and 3. must be in the context of movement into the capillary*

*Neutral: reference to more tissue fluid being formed as in the question stem*

*Neutral: reference to lymphatic drainage*

**3**

**[8]**

**M32.**

**1.M**        Membrane function as selectively permeable barrier

**1.T**        Transport mechanisms across membranes

**1.CT**     Absorption and co-transport of sodium ions and glucose

**2.P**        Photosynthesis, chloroplast, thylakoids

**2.R**        Respiration, mitochondrion and cristae.

**2.Ps**       Protein secretion, RER, SER and Golgi

**3.A**        Surface receptors / antigen and immune response

**3.CD**     Cell division

**3.B**        Vertical and horizontal transmission − membranes and bacteria

**3.Pc**       Pacinian corpuscle

**4.Tr**       Tropisms − movement of IAA

**4.N**        Nerve impulses / action potentials

**4.S**        Synaptic transmission

**4.Mc**      Muscle contraction, calcium ion movement / storage

**4.H**        Hormones - eg Blood glucose regulation − insulin and glucagon

**4.O**        Osmosis, including water movement in plants

*Examiners are free to select other letters if they wish*

*The emphasis in answers should be on the involvement of membranes in processes, not just the processes themselves*

*Breadth, one mark for use of an example from each of the following approaches:*

*1. Membranes − basic functions*

*2. Organelle membranes*

*3. Cell surface membranes*

*4. Processes − eg protein secretion, synaptic transmission, cell division*

**[25]**

**M33.**By osmosis (no mark)

*No mark awarded for naming terms e.g. osmosis, facilitated diffusion, active transport, co-transport etc.*

1.      From a high water potential to a low water potential / down a water potential gradient;

2.      Through aquaporins / water channels;

*QWC ignore large / small WP*

By facilitated diffusion (no mark)

*QWC ignore reference to high / low concentrations of water or high / low concentration of solution*

3.      Channel / carrier protein;

4.      Down concentration gradient;

By active transport (no mark)

*QWC ignore ‘ along’ concentration gradients*

5.      Carrier protein / protein pumps;

6.      Against concentration gradient;

7.     Using ATP / energy (from respiration);

*Co-transport subsumed into mark scheme for active transport and facilitated diffusion*

By phagocytosis / endocytosis (no mark)

*Can award MP2, 3, 5 for 3 marks with no context given*

8.     Engulfing by cell surface membrane to form vesicle / vacuole;

*Ignore lipid diffusion as in stem of question*

By exocytosis / role of Golgi vesicles (no mark)

9.     Fusion of vesicle with cell surface membrane;

**5 max**

**[5]**

**M34.**FOR

1.      (If the husband smokes) there’s a greater risk of dying from lung cancer / emphysema / cervical cancer;

2.      The more the husband smokes, the greater the risk of dying from lung cancer / emphysema;

3.      Suitable use of figures from the table to illustrate answer;

AGAINST

4.      Little difference in risk of dying of stomach / heart disease;

5.      Other factor (than husband smoking) / named factor might cause death;

6.      Only one sample / further studies needed;

**4 max**

**[4]**

**M35.**(a)     (i)      Substance that causes an immune response / production of antibodies;

*Ignore foreign / non-self*

**1**

(ii)     1.      Not lipid soluble;

2.      Too large (to diffuse through the membrane);

3.      Antigens do not have the complementary shape / cannot bind to receptor / channel / carrier proteins (in membranes of other epithelial cells);

**2 max**

(b)     1.      (Vaccine contains) antigen / attenuated / dead pathogen;

*1. Reject if in context of injection of vaccine*

2.       T-cells activate B-cells;

3.       B-cells divide / form clone / undergo mitosis;

4.      Plasma cells produce antibodies;

5.      Memory cells produced meaning more antibodies / antibodies produced faster in secondary response / on reinfection;

**5**

**[8]**

**M36.**(a)     1.      To allow comparison;

2.      Because different number of cells in samples / different times for incubation / numbers become easier to manipulate;

**2**

(b)     203.7(%);;

*Allow 1 mark for 21.8 / 10.7*

*Allow 1 mark for correct answer (203.74) but not correctly to 1 dp*

*204 = 1 mark*

**2**

(c)     (i)       1.      (At every concentration) uptake is faster at 37°C / at higher temperature;

2.      Due to faster respiration / ATP production;

**2**

(ii)     1.      Uptake at 37°C only small increase / levelling off / almost constant as carrier proteins full;

*Accept ‘no (significant) change’*

*Ignore use of numbers*

2.      Concentration of imatinib is not the limiting factor;

**2**

**[8]**

**M37.**1.      (Drink) contains carbohydrates / sugars **so** High GI / (drink) contains carbohydrates / sugars **so** raises blood glucose concentration quickly;

*Each alternative requires both aspects for credit*

*The second alternative requires a reference to speed eg ‘quickly’ or ‘immediately’*

2.      Contains salt so glucose more rapidly absorbed;

3.      Increases glucose to muscles for respiration;

4.      More / faster respiration so more / faster energy release;

*Reject reference to energy production*

*Accept more ATP produced*

**[3]**

**M38.**(a)     Variable that is changed;

*Reject ‘the variable that changes’.*

**1**

(b)     1.      Idea of a confounding variable;

2.      (So) genetically similar;

*2. Do not accept ‘genetically identical / same DNA’.*

3.      (So) have similar salt tolerance / response to salt water / response to watering treatment;

4.      (So) have similar yield / mass of seeds;

*Do not accept ‘amount / number of seeds’ or ‘growth rate’.*

**2 max**

(c)     Mitosis;

*Ignore cell division*

**1**

(d)     1.      Irrigation with sea water / **C** / **D** increased yield compared with no irrigation / **A**;

*For ‘yield’ accept ‘mass of seed’ throughout.*

2.      Yield was lower when irrigated with sea water / **C** / **D** compared with fresh water / **B**;

*Only penalise once for use of ‘amount / number of seeds’.*

3.      Yield was lower when watered with sea water throughout growth and seed formation / **C** than when watered with sea water just at seed formation / **D**;

*Accept use of figures from table.*

*’It’ refers to watering with seawater / mixture.*

**2 max**

(e)     1.      Irrigation with sea water / **C** / **D** increases concentration of salt in soil;

*Ignore reference to standard deviation / quality of the data.*

2.      Lower water potential in the soil linked to reduced uptake of water;

3.      Salt concentration in the soil might / might not increase in the future;

*Mark point 3 includes the principle for mark point 1 so mp3 gains 2 marks (for mp1 and mp3)*

4.      Might decrease plant growth / yield in the future;

5.      Less food / fewer seeds for future planting;

*Mp 3 and 4. Allow ‘further’ for the idea of ‘in the future’.*

**3 max**

**[9]**

**M39.**(a)     1.       **A**: phospholipid (layer);

*1. Reject hydrophobic / hydrophilic phospholipid*

2.      **B**: pore / channel / pump / carrier / transmembrane / intrinsic / transport protein;

*2. Ignore unqualified reference to protein*

**2**

(b)     (i)      Condensation (reaction);

**1**

(ii)     Organelle named; Function in protein production / secretion;

*Function must be for organelle named*

*Incorrect organelle = 0*

eg

1.      Golgi (apparatus);

*1. Accept smooth endoplasmic reticulum*

2.      Package / process proteins;

***OR***

3.      Rough endoplasmic reticulum / ribosomes;

*3. Accept alternative correct functions of rough endoplasmic reticulum. ER / RER is insufficient*

*3. Accept folding polypeptide / protein*

4.      Make polypeptide / protein / forming peptide bonds;

***OR***

5.      Mitochondria;

6.      Release of energy / make ATP;

*6. Reject produce / make energy*

*6. Accept produce energy in the form of ATP*

***OR***

7.      Vesicles;

8.      Secretion / transport of protein;

**2**

**[5]**

**M40.**(a)     1.      (Curve for) dog falls rapidly at the start but (curve for) sheep falls
         slowly at first;

*Do* ***not*** *allow curve for dog falls more steeply (since from 0.5% NaCl fall in sheep is just as steep as fall in dog)*

2.      Sheep doesn’t fall rapidly until 0.5 (but dog falls rapidly from 0);

3.      (Trend shows that) for any concentration of sodium chloride haemolysis is lower     in the dog;

*The idea of a trend is required. Statement of individual values alone is insufficient, eg ‘at 0.2, 34% in dog and 98% in sheep’ is insufficient*

*Accept dog reaches 0 at lower concentration of sodium chloride than for sheep / dog reaches 0 at 0.38% compared to 0.84 % in sheep;*

**2 max**

(b)     74 to 76;

*Accept a value within this range*

**1**

(c)     1.      (Red) colour is due to haemoglobin;

*Note: a correct response to marking point 2 also scores marking point 1*

2.      The more haemoglobin released the more red the solution;

*Need idea of haemoglobin release before giving credit*

**2**

(d)     1.      (Use of 0.9%) will not cause haemolysis in any (of the mammals);

*Full credit requires statement of marking point 1 and any approach from marking point 2*

2.      (So) will not kill any of the animals;

or

Only need to use / store / buy one concentration of sodium chloride solution / cheaper to have one concentration of sodium chloride solution / can buy in bulk;

or

Anyone can give it / no need to find out what concentration any animal requires;

*Different approaches available for this marking point*

**2 max**

**[7]**

**M41.**(a)      1.     Trachea and bronchi and bronchioles;

2.      Down pressure gradient;

3.      Down diffusion gradient;

4.      Across alveolar epithelium.

*Capillary wall neutral*

5.      Across capillary endothelium / epithelium.

**4 max**

(b)     (About) 80.0%.

**1**

(c)     1.      (Group **B** because) breathe out as quickly as healthy / have similar FEV to group **A**;

2.      So bronchioles not affected;

3.      FVC reduced / total volume breathed out reduced.

*Allow this marking point for group* ***C***

**3**

**[8]**

**M42.**(a)     1.      Facilitated diffusion involves channel or carrier proteins whereas active transport only involves carrier proteins;

2.      Facilitated diffusion does not use ATP / is passive whereas active transport uses ATP;

3.      Facilitated diffusion takes place down a concentration gradient whereas active transport can occur against a concentration gradient.

*Since ‘contrast’, both sides of the differences needed*

**3**

(b)     3.3:1.

*Correct answer = 2 marks*

*If incorrect, allow 1 mark for 470–360 / 60 for rate in second hour*

**2**

(c)     1.      Group **A** – initial uptake slower because by diffusion (only);

2.      Group **A** – levels off because same concentrations inside cells and outside cells / reached equilibrium;

3.      Group **B** – uptake faster because by diffusion plus active transport;

4.      Group **B** fails to level off because uptake against gradient / no equilibrium to be reached;

5.      Group **B** – rate slows because few / fewer chloride ions in external solution / respiratory substrate used up.

**4 max**

**[9]**

**M43.**(a)     1.      Bilayer;

*Accept double layer*

*Accept drawing which shows bilayer*

2.      Hydrophobic / fatty acid / lipid (tails) to inside;

3.      Polar / phosphate group / hydrophilic (head) to outside;

*2. &  3.  need labels*

*2. &  3.  accept water loving or hating*

**2 max**

(b)     (i)      1.      (Rough endoplasmic reticulum has) ribosomes;

*accept “contains / stores”*

2.      To make protein (which an enzyme is);

*Accept amino acids joined together / (poly)peptide*

*Reject makes amino acids*

*Ignore glycoprotein*

**2**

(ii)     (Golgi apparatus) modifies (protein)

**OR**

packages / put into (Golgi) vesicles

**OR**

transport to cell surface / vacuole;

*Accept protein has sugar added*

*Reject protein synthesis*

*Accept lysosome formation*

**1**

**[5]**

**M44.**(a)     1.      Water potential becomes lower / becomes more negative (as sugar enters phloem);

2.      Water enters phloem by osmosis;

3.      Increased volume (of water) causes increased pressure.

**3**

(b)     1.      Rate of photosynthesis related to rate of sucrose production;

2.      Rate of translocation higher when sucrose concentration is higher.

**2**

(c)     1.      Rate of translocation does not fall to zero / translocation still occurs after 120 minutes;

2.      But sucrose no longer able to enter cytoplasm of phloem cells.

**2**

**[7]**

**M45.**(a)     0.22;

**1**

(b)     1.      Uptake in flask **G** much greater than in flask **F**;

2.      Showing use of ATP in flask **G**;

3.      Sodium ion concentration in flask **G** falls to zero;

4.      Showing uptake against a concentration gradient.

**4**

(c)     1.      (Uptake of sodium ions occurring by) facilitated diffusion;

2.      Equilibrium reached / sodium ion concentrations in solution and in cells the same.

**2**

**[7]**

**M46.**(a)     Regulator protein.

*Accept regulator protein antigen*

*Reject regulator protein receptor*

*Ignore regular protein*

**1**

(b)     1.      Lipid soluble / hydrophobic

2.      Enters through (phospholipid) bilayer

***OR***

3.      (Protein part of) LDL attaches to receptor

4.      Goes through carrier / channel protein.

*4. Accept by facilitated diffusion or active transport*

*4. Reject active transport through channel protein*

**2**

(c)     Any **two** from:

1.      (Monoclonal antibody) has a specific tertiary structure / variable region / is complementary to regulator protein

*Do not award MP1 if reference to active site.*

2.      Binds to / forms complex with (regulator protein)

*“It” refers to monoclonal antibody in MP1 and MP2*

3.      (So regulator protein) would not fit / bind to the receptor / is not complementary to receptor

*3. Reject receptor on LDL*

**2 max**

(d)     1.      Injection with salt solution

*1. Accept inject placebo in salt solution*

2.      Otherwise treated the same.

**2**

**[7]**

**M47.**(a)     1.      (No grease)

            means stomata are open

            OR

            allows normal CO2 uptake;

*Allow ‘gas exchange’ for CO2 uptake.*

*‘As a control’ is insufficient on its own.*

2.      (Grease on lower surface)

seals stomata

OR

stops CO2 uptake through

stomata

OR

to find CO2 uptake through

stomata

OR

shows CO2 uptake through cuticle / upper surface;

3.      (Grease on both surfaces) shows sealing is effective

OR

stops all CO2 uptake.

**3**

(b)     (i)      1.      (Mean rate of) carbon dioxide uptake was constant *and* fell after the light turned off;

*Ignore absence of arbitrary units in both marking points.*

*Both ideas needed for mark.*

*Accept ‘stayed at 4.5’ as equivalent to ‘was constant’.*

2.      Uptake fell from 4.5 to 0 / uptake started to fall at 60 minutes and reached lowest at 80 minutes / uptake fell over period of 20 minutes;

*One correct use of figures required.*

*Accept fell to nothing / no uptake for 0.*

**2**

(ii)     1.      (Because) water is lost through stomata;

2.      (Closure) prevents / reduces water loss;

3.      Maintain water content of cells.

*This marking point rewards an understanding of reducing water loss e.g. reduce wilting, maintain turgor, and is not related to photosynthesis.*

**2 max**

(c)     (i)      (Carbon dioxide uptake) through the upper surface of the leaf / through cuticle.

**1**

(ii)     1.      No use of carbon dioxide in photosynthesis (in the dark);

2.      No diffusion gradient (maintained) for carbon dioxide into leaf / there is now a diffusion gradient for carbon dioxide out of leaf (due to respiration).

**2**

**[10]**

**M48.**(a)     Calculations made (from raw data) / raw data would have recorded initial and final masses.

**1**

(b)     Add 4.5 cm3 of (1.0 mol dm–3) solution to 25.5 cm3 (distilled) water.

*If incorrect, allow 1 mark for solution to water in a proportion of 0.15:0.85*

**2**

(c)     1.      Water potential of solution is less than / more negative than that of potato tissue;

*Allow Ψ as equivalent to water potential*

2.      Tissue loses water by osmosis.

**2**

(d)     1.      Plot a graph with concentration on the *x*-axis and percentage change in mass on the *y*-axis;

2.      Find concentration where curve crosses the *x*-axis / where percentage change is zero;

3.      Use (another) resource to find water potential of sucrose concentration (where curve crosses *x*-axis).

**3**

**[8]**

**M49.**(a)     1.      Dissolve in alcohol, then add water;

2.      White emulsion shows presence of lipid.

**2**

(b)     Glycerol.

**1**

(c)     Ester.

**1**

(d)     **Y** (no mark)

Contains double bond between (adjacent) carbon atoms in hydrocarbon chain.

**1**

(e)     1.      Divide mass of each lipid by total mass of all lipids (in that type of cell);

2.      Multiply answer by 100.

**2**

(f)     Red blood cells free in blood / not supported by other cells so cholesterol helps to maintain shape;

*Allow converse for cell from ileum – cell supported by others in endothelium so cholesterol has less effect on maintaining shape.*

**1**

(g)     1.      Cell unable to change shape;

2.      (Because) cell has a cell wall;

3.      (Wall is) rigid / made of peptidoglycan / murein.

**2 max**

**[10]**

**M50.**(a)      1.      (Overall) outward pressure of 3.2 kPa;

2.      Forces small molecules out of capillary.

**2**

(b)     Loss of water / loss of fluid / friction (against capillary lining).

**1**

(c)     1.      High blood pressure = high hydrostatic pressure;

2.      Increases outward pressure from (arterial) end of capillary / reduces inward pressure at (venule) end of capillary;

3.      (So) more tissue fluid formed / less tissue fluid is reabsorbed.

*Allow lymph system not able to drain tissues fast enough*

**3**

(d)     1.      Water has left the capillary;

2.      Proteins (in blood) too large to leave capillary;

3.      Increasing / giving higher concentration of blood proteins (and thus wp).

**3**

**[9]**

**E1.**(a)     Almost 80% of students scored both marks, in a question which tested straightforward recall. Some described pathogens entering cells and reproducing without going on to clarify the damage that would have been caused to the cells. A minority misinterpreted the question and described two ways in which pathogens were transmitted.

(b)     The context of this question proved difficult for many students with fewer than half the students explaining that water would move out of the bacterial cell by osmosis because of the water potential gradient. A large number incorrectly wrote about water being drawn out of the blood and washing away the bacteria and many argued that water would enter the bacteria causing osmotic lysis. Few students went on to explain why the loss of water would kill the bacteria

**E2.**          (a)     Difficulties were experienced with this question where answers were frequently unselective, relating not only to quaternary structure but to aspects of secondary and tertiary structure as well. To gain credit here, candidates needed to confine their answers to the fact that keratin molecules consisted of several polypeptide chains.

(b)     Most candidates clearly appreciated that the bonds formed between sulphur- containing amino acids were strong and helped to bind the individual polypeptide chains. Less able candidates often confused these bonds with peptide bonds or did little more than paraphrase the wording of the question.

(c)     As was not infrequently the case with the answers to many of the questions in this paper, less able candidates gave the impression of relying on the recall of mark schemes from broadly similar past questions. In this case they either simply described the primary structure of a protein, which gained little credit, or described how the primary structure of a protein affected its tertiary structure which was potentially, at least, a better option. Those who read the question carefully were usually able to comment on differences in the amino acid sequence leading to differences in bonding and in molecular shape. There was some confusion, presumably among candidates who had also completed Module 2 or 3, between amino acids, proteins and bases.

(d)     As in part (c), the principal requirement here was to answer the question as written. Unfortunately, the response offered by many was no more than a description of active transport. In this question candidates were expected to use this knowledge along with information available in the passage to explain why substances were unable to pass through the outer layer of skin cells. Those who approached the question in the right way generally pointed out that the cells were dead and progressed to make an appropriate comment about respiration and the release of energy or generation of ATP. A not infrequent misconception was that since movement against a concentration gradient involves active transport, active transport cannot be involved in movement down a gradient.

(e)     The many good answers to this part of the question suggested that most candidates had a clear understanding of the principles of electron microscopy and were able to offer a lucid account of its advantages and limitations. Less able candidates were usually able to explain the advantages associated with high resolution but the limitations they suggested concerning expense, size, the production of black and white images and the need for technical support were of a more anecdotal nature and seldom gained significant credit.

**E3.**          (a)     There were many candidates sitting this unit who displayed an excellent knowledge of the facts and principles contained in the module, but who revealed an inability to describe and interpret the data presented in the table in this part of the question. The descriptions revealed that such candidates often failed to appreciate that the experimenters had changed the concentration of oxygen bubbled through the mixture. They also occasionally referred to a decrease in the rate of uptake of potassium ions from 90 to 80 arbitrary units at a 20.8 % concentration of oxygen, further suggesting unfamiliarity with tabulated data. Candidates who recognised the table as relating to active transport, were generally able to produce a convincing interpretation of the figures. Others frequently suggested that potassium ions were used as a respiratory substrate, or combined with ADP to produce ATP.

(b)     An understanding of water potential should have resulted in candidates being able to interpret the graph, even if they experienced difficulties with understanding the ratio on the *y*-axis. They should also have appreciated that the *x*-axis represented sucrose concentration, not time.

(i)      Evidence that this was not the case came from the many who suggested that the length of the potato remained the same at a concentration of 0.5 mol dm–3, presumably identifying the point where the graph levelled out.

(ii)     An understanding of ratio was required. Answers based on 180 presumably reflected those who thought that 1.2 represented a ration of 1:2 but other responses suggested incorrect reading of the graph, or the inability to calculate the required length from the correct ratio.

(iii)     Answers need reference to water potential. Responses based simply on concentration were unable to gain maximum credit.

**E4.**(a)     Nitrogen-fixing was the commonest wrong answer in this question. The majority of responses were correct.

(b)     This question was answered poorly because students did not think through the processes that were taking place in the reed bed. There were many incorrect responses referring to processes in the reeds that result in the formation of nitrates from ammonia / nitrite. Some then went on to gain one mark for active transport of these nitrates into the plant roots. Better students correctly linked the use of ATP from aerobic respiration in the active transport of nitrates, and wrote clearly and concisely. There was a surprising amount of confusion between diffusion and active transport, with active transport being said to be needed to diffuse nitrogen-containing substances from areas of high to low concentration. The oxygen was also thought to create a concentration gradient to allow the roots to take up the nitrogen-containing substances by diffusion.

(c)     There were some very clear answers to part (i) from students who understood that too fast a flow would not allow time for the nitrification to occur, hence the decrease in concentration of nitrates. There was also not enough time for the saprophytes to decompose the sewage to release ammonium compounds. Some failed to mention the ammonia being converted. Other answers suggested that the soil would become waterlogged, preventing the action of the nitrifying bacteria, or that the reeds would take up more of the nitrates or that numbers of denitrifying bacteria would increase, converting the nitrate to nitrogen gas. A number thought that if the flow was too fast, the reeds would be unable to take up the nitrates, so they would end up in the lake. The fast flow was also thought to reduce the oxygen concentration in the water, thus preventing the action of the nitrifying bacteria. There was also confusion with leaching and eutrophication. There were only very occasional references to the bacteria being washed away by the fast flow. The fast flow was also said to maintain a steep diffusion gradient and increase uptake by the plant roots.

In part (ii), it was clear that many students had learnt this topic thoroughly and included all marking points. Weaker students could not explain the increase in decomposers breaking down the dead plants and using up the oxygen in the water in their respiration. The algae were often described as ‘feeding’ on the nitrates. A common incorrect reason for the death of the fish was a lack of food once the plants in the lake died. A minority of students had no understanding of the process of eutrophication and thought that dehydration and osmosis caused the fish to die or that high nitrate concentrations were toxic to both fish and algae. Increasing concentrations of carbon dioxide were also thought to be responsible for the death of the fish.

**E5.**(a)     It was apparent from the answers that few candidates were conversant with section 10.1 of the specification which refers to the requirement for practical microscopy including the estimation of size. Most simply measured the image without explaining how, and then used a formula to relate magnification and observed length to real length.

(b)     The answers were generally sound and many of the better candidates correctly related the water potential gradient to osmotic movement from the cell and plasmolysis. There was, however, evidence of less certainty about this topic than has been shown in the past, in particular with the direction of water movement. Candidates are free to discuss values of water potential either in terms of higher and lower values or as being less negative or more negative, respectively. They would be well advised, however, to stay with the same approach throughout. Combining both tends to lead to contradiction and an inevitable failure to gain credit.

(c)     There were few references in part (i) either to achieving equilibrium or to allowing a maximum change in length. Most candidates referred somewhat imprecisely to osmosis taking a long time or being slow. Candidates should be familiar from their practical work with the use of graphs as analytical tools. There was, however, a frequent misconception in part (ii) that the sucrose concentration equating with no change in length was where the curve levelled out, suggesting that many candidates failed to examine the data with sufficient care before attempting the question. What was required here was the drawing of a curve of best fit and extrapolating this to obtain the required value. Candidates found part (iii) difficult especially when they abandoned osmosis in favour of diffusion or hydolysis of starch. However, most candidates were able to gain some credit for recognising that starch was insoluble even if they subsequently failed to link sufficient steps in the reasoning to produce a coherent explanation.

**E6.**(a)     Candidates were usually able to gain credit where they confined their responses to appropriate terms such as “partially permeable”. They experienced difficulties, however, when they used less acceptable phrases such as “fairly permeable”, or attempted to explain what they meant in terms of “letting potassium nitrate through”.

(b)     Somewhat surprisingly many of the less able candidates appeared aware that potassium nitrate would be present in the space indicated, although they were unable to support this with a convincing explanation. Others had little idea, and there were frequent references to empty spaces, vacuums, cytoplasm and a variety of cell organelles. The examiners were of the opinion that although many candidates can reproduce the sequence of events associated with osmosis, they have little real understanding of plasmolysis.

(c)     Answers to this part of the question were much more convincing and the underlying principles were widely understood. Predictably, some candidates encountered difficulties over expressing comparisons between the negative values of different water potentials. Most of these arose where they attempted to use terminology relating to both more and less negative, and to higher and lower. Contradiction often resulted.

**E7.**(a)     Knowledge of cell structure was sound and most candidates provided evidence supporting the identity of cell B. Those who failed to gain credit often incorrectly identified the surrounding layer as a wall. Although most were also able to recognise the significance of the third cell layer possessed by cell C, terminology raised problems for some of the less able candidates. Although some of these offered acceptable alternatives to capsule, others suggested that there was an extra cell wall or even an extra membrane. Examiners were of the impression that some candidates attempted to recall similar questions from past papers and there were numerous references to nuclei and membrane-bound organelles, features that were not visible in the diagrams.

(b)     Few candidates attempted to make use of a scale bar in calculating magnification, many falling back on uncertain memory of the relationship between the size of the object, the size of the image and magnification. The simplest correct approach was to divide the actual length of the scale bar, in micrometres, by 0.5. Candidates who adopted this method experienced few difficulties in gaining the mark. Others recognised that they should involve the scale bar in some way but were uncertain of to how to progress. The most frequent approach was to divide the size of the cell by the length of the scale bar without appreciating that this technique would give rise to different “magnifications” depending on whether the length or breadth of the cell were measured.

(c)     While most candidates named an appropriate polysaccharide, there were many references to “chlorophyll” and “chloroplast”.

(d)     Despite the emphasis in the specification on the link between osmosis and water potential, many candidates fail to use the term in explaining osmotic phenomena. Such was the case here. Those who adopted the required approach frequently gained maximum credit for part (i) although there were possibly more instances than in the past of negative values presenting difficulties. There were many excellent answers to part (ii), but some less able candidates were clearly unable to link the lack of action of penicillin on plant cell walls to some aspect of their structure. Many such candidates appeared distracted by the content of later modules and sought responses based on aspects of immunology.

**E8.**(a)     Most candidates were able to extract the relevant information from the passage and explain that many of those with the illness failed to see a doctor. The concept of a ratio in part (ii) proved difficult for some to understand. Although there were many correct answers there were many that should have been considered, at best, to have been improbable.

(b)     Many candidates were able to comment on the identical nature of the sugars in the bacterial antigens and on the surface of nerve cells. For some, this led to a comprehensive account of antibody binding and the formation of an antibody-antigen complex. Others rather lost their way at this stage and did no more than suggest that this led to antibodies ‘attacking’ the nerve cells.

(c)     There were many lengthy accounts presented in answer to this part of the question.
Able candidates frequently described the entire process of ventilation and extended their answers onto additional sheets before eventually arriving at a point where they describe the effects of paralysis. It was clear, however, that many candidates had little idea of the precise role of the diaphragm. It was not infrequently described, for example, as ‘pushing the ribs up and out’. Such statements as ‘breathing in causes the diaphragm to flatten’ were common and revealed confusion between cause and effect.

**E9.**This question was answered well across the ability range, with most candidates gaining at least one mark for stating that the fresh mass decreased. The most common reason for candidates not achieving the second mark was for a lack of detail in describing the effect on the dry mass stating ‘dry mass increases’ without reference to the small size of this increase.

**E10.**(a)     Most candidates correctly named fluid **F** as plasma or blood plasma. A common response not credited was blood.

(b)     Very few candidates obtained this mark despite the large number of alternative answers available on the mark scheme. A very common error was to state that tissue fluid has no protein rather than less or smaller proteins. References to blood cells were not credited as fluid **F** is plasma rather than blood, the latter consisting of plasma and blood cells.

(c)     (i)      Many candidates did not obtain this mark as most referred to ‘pumping’ or ‘beating’ of the ventricle rather than using the precise term contraction.

(ii)     Unfortunately many candidates simply stated that the pressure decreases as distance from the heart increases. Better candidates explained the reason for this decrease in pressure in terms of friction or loss of fluid from capillaries.

(d)     Answers to this question were very disappointing with very few candidates obtaining all three marks and many candidates scoring zero. Candidates gaining credit often appreciated that a decrease in the concentration of protein in the blood would increase the water potential in the capillary. However, candidates often failed to use the term osmosis in the correct context, describing the movement of a wide range of substances by osmosis. Even better candidates often failed to gain credit by referring to fluid rather than water moving by osmosis. Additionally, there was considerable confusion in the direction of movement of water between the tissue fluid and plasma.

**E11.**This unit requires practical work to be undertaken that includes the effect of solute concentration of water uptake by plant tissue. In this question, therefore, candidates were required to demonstrate their understanding of such prescribed practical techniques. It was evident from the responses to this question that although many candidates had some experience of related practical investigations, they had little understanding of the procedures involved. Many otherwise sound candidates gained very little credit on this question.

(a)     The diagram clearly showed two different tissues, but only the best candidates based their answers on this information and described cutting the cylinders in such a way as to ensure that they consisted of the same tissue. Many of the answers did little more than reiterate what have become standard responses in past practical assessments without attempting to apply general principles to a novel situation. In this particular case, references to the same cork borer or the same length were irrelevant. There were also a number of vague references to ensuring that this would be a fair test. Candidates would be well advised not to use this term without appropriate amplification.

(b)     It was immediately apparent from marking this question that many of the less able candidates had undertaken practical investigations without any understanding of what they were trying to do. Thus there were numerous responses that indicated confusion with investigations of enzyme activity or respiration. Where candidates did appreciate that the essential purpose of the bungs was to minimise evaporation, it was uncommon for them to refer to the evaporation of water evaporating resulting in a change in the concentration of the sucrose solution.

(c)     Candidates who read this question with sufficient care should have noted that it referred to the results provided in the table. Accounts, therefore based on repeating the investigation with other sucrose solutions were inappropriate and did not gain credit. The investigations carried out for assessment of practical skills at AS all require candidates to plot their data as appropriate graphs, and it was hoped that candidates would have applied a similar approach here. Relatively few did, and of these, even fewer appreciated that they should identify the concentration of sucrose in which the ratio of final length to initial length was 1. Few candidates displayed an understanding of the concept of a ratio in part (ii).

**E12.**This question discriminated well across the ability range and there were many excellent answers to parts (a) and (b). Weaker candidates were often let down by poor expression and this was particularly notable for part (b).

(a)     Approximately half of the candidates gained at least three marks. Most correctly described movement down a concentration gradient by diffusion and against a concentration gradient by active transport. The requirement for energy or ATP in active transport was frequently noted. Similarly, many candidates were aware that membrane proteins are involved in active transport or facilitated diffusion. However, some disqualified this mark for stating that active transport involves channel proteins. Better candidates also referred to the movement of water by osmosis and related the property of a molecule to its route through the plasma membrane. Weaker candidates sometimes confused active transport and facilitated diffusion. Similarly, a minority described the structure of the membrane, without any reference to transport across it.

(b)     Just over half of candidates gained at least four marks. It was pleasing to see better candidates often scoring full marks. References to a flattened epithelium or many capillaries providing a large surface area were rare. However, all other marking points were frequently seen. Many candidates appreciated the role of ventilation or circulation in maintaining a concentration gradient. Unfortunately, weaker candidates often gave answers that lacked detail or were out of context e.g. ‘thin membranes’, ‘better diffusion’ and ‘faster gas exchange’. Similarly, they did not usually relate ‘large surface area’ to the many alveoli present. A minority of candidates started their answer with Fick’s equation but did not relate this to the question in sufficient detail.

**E13.**(a)     (i)      Almost three quarters of candidates gave the correct answer of 1.08. However, some answers showed an excessive number of decimal places. Similarly, some candidates subtracted the final mass from the starting mass to give an answer of 1.8.

(ii)     Most candidates were aware that a ratio enabled a comparison to be made between different sets of data. Unfortunately, some gave this in the wrong context by referring to a comparison of the start and final mass of the same disc. Similarly, it was usually only the better candidates who wrote that the discs had different starting masses. Some candidates narrowly missed out on this mark through a lack of detail e.g. ‘different sizes’ and ‘different masses’. The table showed the start and final masses of each disc. It therefore had to be clear which of these was being referred to. As was the case last year, weaker candidates had difficulty in understanding the concept of a ratio. Their answers usually made reference to a ratio allowing ‘a better graph to be plotted’ or ‘it being easier to draw conclusions’.

(iii)     Many candidates gained one mark for the idea that anomalies could be identified. However, some mistakenly thought that additional readings prevented anomalies from occurring or being recorded. These were not credited. Relatively few candidates mentioned that a mean could be calculated. There was also widespread failure by weaker candidates to read the stem of the question. This usually resulted in descriptions of methods that could be used to take additional readings.

(b)     (i)      This question was asked in the first paper of the series and it is encouraging to note that candidates did much better this time. Most candidates scored one mark for describing the correct graph to be plotted. There were, however, some suggestions to plot sodium chloride concentration against water potential. The second mark proved to be a good discriminator. It was usually only the better candidates who appreciated the concept of using a ratio of 1. Some candidates clearly remembered doing this practical but were let down by a lack of detail e.g. ‘read off where line crosses x-axis’, with no mention of a ratio. Once again, the concept of a ratio was too much for weaker candidates. Similarly, a minority of candidates were aware that there would be no change in mass but then disqualified this mark by using a ratio of 0.

(ii)     Only the most able candidates scored one mark on this question. This was either for mentioning a more reliable line of best fit or that error bars could be plotted. However, there was widespread failure by most candidates to distinguish between the terms ‘accurate’ and ‘reliable’. Taking additional readings does not necessarily allow results to be closer to the true value. Hence, references to ‘accuracy’ were not credited. The term ‘precise’ was rarely used. However, credit was given if this term was used in the correct context as highly precise and highly reliable results both have very little spread about the mean value.

**E14.**(a)     (i)      It was disappointing that only one third of candidates scored full marks on this question, given that it was targeted at grade E and involved straightforward recall. However, most candidates gained at least one mark for correctly naming water as the reactant or galactose as the product. A common incorrect response for the missing reactant was ‘lactase’, despite this being given in the stem of the question. There was a wide variety of suggestions for the missing product. These included water, fructose, maltose and sucrose.

(ii)     Over 70% of candidates correctly named the reaction as hydrolysis. The most common incorrect responses seen were ‘digestion’ and ‘condensation’.

(b)     There was widespread failure to read the stem of each question part, which resulted in only a minority of candidates gaining full credit. It was also clear that many candidates had failed to distinguish between the terms ‘describe’ and ‘explain’ for part (i) and (ii) respectively.

(i)      There were numerous references to the Benedict’s test for reducing sugars and, to a lesser extent, iodine solution and universal indicator. It was also clear from the colour changes given that many candidates were not familiar with basic food tests. Candidates who did refer to the biuret test often limited their answer to describing the method and naming the reagents involved. For those who did mention a purple colour, it was not often clear if they were referring to lactose or lactase.

(ii)     Many candidates gave the answer to (b)(i) here but failed to explain why this result would be achieved.

**E15.**Many students seemed confused by this apparatus and described the syringe as a gas syringe. Others related it to a type of potometer, where they were moving the bubble to the start of the scale to take the next reading (presumably thinking the measurement was of the bubble movement rather than the size of the bubble produced).

**E16.**(a)     The vast majority of candidates obtained both marks, usually by naming the cell wall and chloroplast as structures that are present in plant cells but not in animal cells. Very few candidates scored zero.

(b)     Most candidates gained one mark for stating that starch is insoluble. However, less than half the candidates were then able to suggest an advantage of this in terms of osmosis or water potential. A common error was to suggest that starch would not move into or out of the cell by osmosis.

(c)     Most candidates scored two on this question and over a third of candidates gained all three marks. Generally there was a clear understanding of the roles of the chloroplast and eyespot. A smaller percentage of candidates was able to explain the role of the flagellum. A significant number incorrectly involved the starch store in their answer.

**E17.**(a)     60% of candidates gained one mark for the idea that water on the outside of the cylinders would affect the mass, or that only the water taken up or lost should be measured. Only the very best candidates were aware that the amount of water on the cylinders would vary. A common response by weaker candidates was that water on the outside of the cylinders would allow further osmosis before reweighing. This was not credited. Vague responses that referred to greater reliability or accuracy were common.

(b)     One third of candidates gave the correct volumes of 4cm3 and 16cm3.

(c)     It was encouraging to note that candidates did better on this question than they did on a comparable question in January 2010. One third of candidates gained full credit. Many were aware that expressing a change as a percentage allows a comparison to be made. However, it was usually only better candidates who wrote that the cylinders would have different starting masses. The stem of the question made it clear that both the starting and final masses of the cylinders were recorded. It therefore had to be clear to which of these the candidates was referring. Weaker candidates often referred to ‘different sizes’ or ‘different masses’. These responses were not credited.

(d)     Two thirds of candidates gained one mark for the idea that anomalies could be identified. However, some thought that repeats prevented anomalies from occurring or being recorded. It was only the very able candidates who wrote that repeats allow a more reliable mean to be calculated. Taking additional readings does not necessarily allow results to be closer to the true value. Hence, references to ‘a more accurate mean’ were not credited. Weaker candidates often referred to ‘the results’ being more reliable or more accurate without qualifying their answers.

(e)     70% of candidates correctly read off the intercept on the *x*-axis at 0.35 mol dm–3.

**E18.**(a)     Most candidates were well prepared for this question and were able to differentiate between active transport and facilitated diffusion with many gaining both marks. Some candidates were unclear when referring to concentration gradient. Phrases such as ‘along the gradient’ or ‘across the gradient’ were not accepted. The specification terms ‘carrier protein’ and ‘channel protein’ were often not used.

(b)     (i)      The question asked why a control group was used „in this trial’. Candidates needed to apply their knowledge to an unfamiliar context and were required to do more than simply define the term. It was, therefore, not enough to say ‘to allow comparison’.

(ii)     This question was well answered with many candidates gaining both marks. A large number referred to a placebo tablet being used, although this term was not required. Some candidates failed to gain the first marking point as they stated that no drug would be given without appreciating that a tablet would still need to be administered. Most explained that both groups should be treated in the same way.

(c)     This question required the candidates to look carefully at the graph and describe it. Many incorrectly stated or implied that the volume of acid secreted per hour would decrease for 4 hours, failing to notice that the treatment started 1 hour after volumes were recorded. More able candidates realised that the acid secretion would decrease for 3 hours, or from 1 – 4 hours.

**E19.**(a)     (i)      Most candidates correctly named the type of reaction as hydrolysis.

(ii)     Most candidates correctly named glucose.

(b)     (i)      Most candidates gained full marks for describing the test for reducing sugars accurately. Some did not mention the need for heat, and a few could not recall the correct test – the biuret test being the most common error. A few candidates lost credit because they described the non-reducing sugar test and hydrolysed with hydrochloric acid first.

(ii)     The majority of the candidates could explain the idea that one molecule of lactose was being hydrolysed to give two molecules of product, both of which were reducing sugars. The commonest reason for missing the mark was when students paraphrased the stem of the question, stating that the reason there was a higher concentration of reducing sugar was because there was more reducing sugar present. A surprising number of candidates gave answers relating to an increase in surface area.

(c)     Although many candidates gained full marks on this question there was a significant number who were confused about the position of the active site, placing it on the sugar rather than the enzyme. A number of candidates thought that galactose would bind to lactose rather than lactase.

**E20.**(a)     Calculating percentage change still remains a problem for a number of students.

(b)     Students generally did not score more than two marks for this question. Most were able to gain the ‘Yes’ mark, identifying that running times were faster after the sports drink, and recognise that both groups had shown improvement. Few considered that the runners might have drunk different volumes or that, as mean times rather than individual times were given, there could be variation in performances. It was rare to see students comment on the lack of standard error bars and the implications of such.

(c)     Most students scored at least two marks in this question but some struggled to identify relevant factors beyond age and sex. There was often a lenient interpretation of marking point 6 despite the requirement that a health factor should be named.

(d)     There were some excellent answers to this question but, equally, there were some very poor ones as well. In some cases, assessors gave credit when the required answer for a particular marking point was incomplete. This was particularly noticeable with marking points 3, 5 and 6. Many students omitted a reference to sodium *ions* and this omission was not always recognised by assessors.

**E21.**The starting point for questions requiring longer responses must be careful determination of precisely what is required. This question required students to explain how vaccines protect people against disease but few could resist the temptation to describe in great detail everything they knew about immunology. This often resulted in the allocated space being filled with material that, at the very best, could only be regarded as of marginal relevance. Most students should have been able to access the first three points on the scheme and indicate that antigens on weakened or dead pathogens stimulated the production of memory cells. The fact that credit was not always awarded stemmed from interchangeability of the terms pathogen and disease, and uncertainty over the origin and nature of memory cells. The second part of the mark scheme referred to the generation of a secondary immune response. Those students who finally arrived at this concept, often did no more than offer a few passing thoughts at the very end of the page or on an extra sheet. As always with questions on this topic, the use of language was often far from convincing and there were many references to antibodies "fighting" and memory cells "remembering".

**E22.**(a)     (i)      The many students who understood the concept of water potential were able to gain maximum credit here.

(ii)     Many students appeared of the opinion that this was another question centred on water potential. Others sought, more appropriately, to link this to enzyme action and growth. Not all of these students, however, appeared to understand that cooling an enzyme does not lead to its denaturation.

(b)     Those students who could identify a chemical element as such and understood the protein nature of enzymes generally answered this question well. Some, who clearly appreciated the underlying principle, were handicapped by poor expression. Thus, it was not unusual to read such statements as “enzymes contain protein” or “proteins are turned into enzymes”.

(c)     Most answers centred round the idea of contamination but relatively few students amplified this basic statement with a reference to other microorganisms.

(d)     Most students gave appropriate values from the graph although there were occasional errors involving units. It was not unusual to find the time given in seconds rather than hours.

(e)     One of the key ideas in answering questions in examinations is that of adding value. Students were provided with the information that “intracellular enzymes stay inside the cells that produce them” and “intracellular enzymes are more expensive to produce”. The many students who took four or more lines to write that because intracellular enzymes stay inside the cells that produce them they are more expensive to purify therefore gained no credit.

**E23.**(a)     (i)      The advantage of using a percentage in the context of this question was widely appreciated, and many students gained full credit.

(ii)     Many students failed to appreciate the specific aspects of experimental design implicit in cooking the turkey pieces until the temperature in the centre of each reached a specific value. As with question **4 (a)**, they frequently fell back on answers based on “fair” and “reliable” and failed to offer the necessary amplification. Occasional students were more concerned about the health issues associated with eating undercooked poultry.

(iii)    Use of the command word “Evaluate” should have suggested that there were two sides to this statement. Most students attempted with some degree of success to link loss in mass with water loss, but very few appeared to appreciate that heating might remove other substances that contributed to the mass of the turkey pieces.

(b)     It was encouraging to note that a substantial number of students appreciated that the data in the graph could not be explained in terms of loss of water by osmosis. Less able students experienced difficulties, frequently because they were determined to fly in the face of the data provided and explain what they thought ought to have happened.

**E24.**(a)     (i)      The first part of this question was answered well by the many students who appreciated that the resulting increase in surface area would result in greater water loss.

(ii)     It was relatively uncommon to see full credit awarded for answers to this part of the question. Although most students appreciated that the solution would add to the mass of the strawberry slices, few appeared to appreciate that the quantity involved would be variable.

(b)     Good responses were generated to this question and most students were aware that this was the initial mass.

(c)     The table showed that the length of time in the sucrose solution affected both percentage loss in mass and texture. Despite the mark allocation and spacing suggesting that a response of some length or detail was required, many students confined their answers to comment on percentage loss in mass. Many of those who did refer to the change in texture failed to note the levelling out in values.

(d)     Most answers to this question focused on the use of a graph but, not infrequently, neglected to indicate what should have been plotted or, in some cases, incorrectly suggested plotting time against texture. A curve of best fit was usually suggested but relatively few students suggested that the point where there was no further change in mass should be determined. It was not uncommon to find answers suggesting that the time should be taken at which the mass off the strawberries fell to zero.

**E25.**(a)     The Benedict’s test for reducing sugars was well known with most students gaining all three marks. The main problem here was that many students failed to heat the solution, either by not mentioning heating at all or simply saying ‘put it in a water bath’ without specifying a temperature - water baths can be at any set temperature. There was a significant number who confused the tests for reducing and non-reducing sugars and a small number who described other biochemical tests.

(b)     (i)       It was encouraging to see that the best students were able to apply their knowledge of several different parts of the unit and explain their answers well. These answers were often concise, explaining that more maltose would be produced, lowering the water potential so that water entered by osmosis.

There were many confused answers, however, and it was evident that some students were unsure as to whether pH 2 was acidic or alkaline. Most understood that amylase would hydrolyse the starch into maltose but then went on to write at length about the effect of pH on the rate of enzyme action.

(ii)     Most students gained this mark, realising that you need to look at a range of pH values to be able to conclude what the optimum pH is, but some obviously thought that optimum simply meant the best of those considered. There was a surprising number of students who inexplicably referred to the optimum temperature.

**E26.**(a)      (i)      The term diffusion was known well, with the majority of students answering correctly.

(ii)     This question was successfully answered by the vast majority of students. Where students failed to gain a mark it was because they referred to the flatworm having a large surface area rather than a large surface area to volume ratio.

(b)     (i)      Many students could recall that an organ is a group of tissues.

(ii)     Few students gained all three marks for this question but most achieved one or two marks in clearly appreciating that carbon dioxide enters a leaf through the stomata. Students clearly understood the process of diffusion but failed to gain credit where they stated that diffusion occurs across or along, rather than down, the gradient.

**E27.**(a)     Many students gave the correct answer, hydrolysis. Those who failed to score usually confused hydrolysis with condensation.

(b)     Many students correctly identified that the peptide was too large or insoluble and therefore gained one mark. Only the more able students went on to explain that peptides would therefore not be able to pass through the carrier or channel protein. There was a significant number of students who wrote about active transport despite facilitated diffusion being referred to in the question.

(c)     This question was generally answered well with most students recognising that the peptide would be considered “foreign” or “non-self”. Those students who failed to score often referred to the peptides as cells.

(d)     Some students failed to use the information in the passage, which stated that the drug had already been tested on patients with coeliac disease, and produced answers referring to trialling on animals or people without the disease. The majority correctly wrote about side effects, though some gave this answer twice with slightly different wording. Large numbers of answers gave generic responses here such as age or gender, without giving any thought to the context of the question.

**E28.**(a)     The majority of the students were able to read the correct figures from the graph and divide concentration by time to gain both marks. Those who made errors in reading from the graph often gained one mark for the correct method. As in previous years, there was a significant number of students who did not attempt a calculation.

(b)     This was answered less well, with many students not describing how cyanide affects the uptake of ions. Instead they described changes in the shape of the graph or wrote about the concentration of ions in the solution. Data to support the answer were often incorrect, resulting from inaccurate reading of the y axis. The better students had read the question carefully and therefore answered in terms of changes to the rate of uptake of sodium ions and supported their answer with correct data from the graph.

(c)     Students were told that cyanide affects respiration and then asked to explain why cyanide reduced the uptake of sodium ions. Many students simply repeated that respiration would be affected without stating that respiration would be inhibited or slowed down. An encouraging number of students were able to make the link between a shortage of ATP from respiration and therefore a shortage of ATP for active uptake of sodium ions. Some students attempted to write about there being no co-transport of sodium and glucose and therefore no glucose for respiration. These students had clearly ignored the information given in the question stem and often failed to score.

**E29.**(a)     Many students complicated what should have been a straightforward question by adding a lot of unnecessary information. Many failed to recognise that the question was asking for what happened between times P and Q and described what was happening at P and at Q. Others did not distinguish between the instructions ‘describe’ and ‘explain’ and went on to give an unnecessary explanation. There was also some confusion as to whether the diaphragm moved up or down when the muscle contracted.

(b)     Over half the students answered well and gained all three marks. However, as in part (a) there were many who included a lot of unnecessary information, usually about the intercostal muscles. While this did not necessarily result in the student failing to gain credit, it did waste time. Students should be encouraged to use the correct terminology; it was common to see references to space and size rather than volume, and concentration rather than pressure. There was some confusion between cause and effect with students stating that it was the intake of air that caused the movement of the diaphragm and the increase in volume. Students who stated that the air entered by diffusion could not gain the final marking point.

(c)     Most students gained one mark for stating that the oxygen moved by diffusion but only the more able students referred to the epithelial or endothelial cells that made up the walls of the alveoli and capillary.

**E30.**(a)     This proved to be an excellent discriminator. Nearly half of students scored full marks. This was usually for stating that the cell wall does not form, leading to cell lysis due to entry of water. It was usually only the best responses that referred to a lower water potential in the bacterium. Weaker responses revealed a number of misconceptions. These often referred to the cell wall being broken down or that isoniazid *caused* the cell wall to become permeable to water.

(b)     Half of students were aware that human cells may lack enzyme **B**, use different substrates, or produce different fatty acids. Weaker responses usually fell into one of two types. The first suggested the idea that isoniazid is an enzyme. This led to widespread references to enzyme inhibition and active sites on a variety of molecules. The second used the fact that human cells do not have cell walls. The question asked why isoniazid does not affect the production of *fatty acids* in human cells. Hence, reference to cell walls was out of context and was not credited.

(c)     Two-thirds of students scored full marks and all marking points were regularly seen. Weaker responses were marked by the use of scientific terms in the wrong context, e.g. ‘different amino acids produced’, ‘base sequence of the enzyme’, ‘amino acid base sequence’, ‘amino acids coding for’ and ‘different hydrogen bonds form between bases’.

**E31.**(a)     (i)      Most students were aware that an organ consists of more than one tissue. Students who failed to score, usually described a tissue rather than an organ.

(ii)     This proved to be a good discriminator. Just over half the students gained full marks for being aware that muscles contract, causing vasoconstriction of an arteriole. Weaker responses often used scientific terms in the wrong context. It was not uncommon in such responses to read that muscles ‘constrict’ or that arterioles ‘contract’, ‘stretch’ or ‘recoil’. Similarly, some students did not seem to remember which way around these events occur in the context of *reducing* blood flow. Consequently, some students stated that muscles contract *and* relax, and arterioles constrict and dilate but did not make clear which of these *reduced* blood pressure.

(b)     (i)       Most students were aware that a thin wall provides a short diffusion pathway. Weaker responses often referred to a diffusion gradient being maintained or faster diffusion occurring.

(ii)      Most students correctly linked slow blood flow in capillaries to more time for exchange. Again, weaker responses usually referred to faster diffusion occurring.

(c)     It was disappointing that just over 40% of students scored zero. Many were aware that the water potential in the capillary would increase. However, the ability to tell the rest of the story proved to be an excellent discriminator. Weaker responses usually lacked precision or were out of context. They often referred to the movement of tissue fluid, rather than water. Similarly, some students described the movement of water out of the capillary, rather than less water moving into the capillary. It was clear that some students had difficulty in applying their knowledge of tissue fluid to an unfamiliar context and simply wrote all they knew about how tissue fluid is formed and reabsorbed.

**E32.**Large numbers of good and excellent essays were seen.

The vast majority of students appeared to understand that this is a synoptic exercise, where they have to draw on a wide range of examples to obtain a high mark. Some students only dealt with one or two topics but in great detail and depth. Unfortunately, this severely limited the mark they could obtain.

The membranes of different types of cells are involved in many different functions.

Most students started with a description of membrane structure. Many did no more than that and did not relate this to *function;* for example, selective permeability to lipid-soluble substances. There were quite frequent references to incorrect Biology; such as ‘the fluid-mosaic membrane usually found in animal cells’ and ‘the cellulose membrane in plant cells’. Transport mechanisms were often named but less frequently described in any correct detail. Credit was available for descriptions and explanations of facilitated diffusion and active transport. There was considerable confusion between the two processes and between channel and carrier proteins. Co-transport was a popular topic and most students identified as their example glucose transport with sodium ions by epithelial cells of the small intestine. There were some really good descriptions of the active transport of sodium ions to generate/maintain a concentration gradient for facilitated diffusion of glucose and sodium ions. It was not uncommon for students to get rather confused about what was transported, where and by which process.

The role of thylakoid membranes in photosynthesis was quite frequently described. The best examples gave these as the location of photosynthetic pigments and the electron transport chains, as well as describing the role of the membrane in the chemiosmotic synthesis of ATP and the production of reduced NADP. Poor responses often started by saying that thylakoids are important in photosynthesis, with no further detail of how. They then often moved on to irrelevant detail of all the other stages of photosynthesis. A similar picture was seen with the role of cristae in respiration, except that most students seemed to have a somewhat better grasp of this than the role of thylakoids.

The roles of membranes involved in protein synthesis and secretion were rarely seen. The nearest that many came was to write about nuclear pores and the passage of mRNA for protein synthesis. There were many good descriptions of the roles of membrane-bound receptors, antigens and antibodies in the immune response. These often included the fusion of lysosomes with phagocytic vesicles / vacuoles. Some students did get rather confused about which cells displayed receptors, antigens and antibodies on their surface. A few students strayed into details of vaccines, secondary responses, memory cells and antibody action with no reference to membrane function.Horizontal transmission of genetic material between bacteria was quite often seen. Some students did not make clear the function of the membrane in this and wrote mainly about plasmids and antibiotic resistance.

The Pacinian corpuscle was a popular choice. There were many good accounts of stretch-mediated sodium ion channels in membranes and the production of action potentials. Students often obtained credit here for the role of the membrane in the production of an action potential. Most students wrote about axons as a separate topic, sometimes going on to Pacinian corpuscles as an extension of the same paragraph. There were many good descriptions of how proteins in membranes are involved in maintaining resting potentials and producing action potentials. Some got the ion flows the wrong way round, or at the wrong times. A few wrote about the wrong ions, such as calcium.

Most students wrote about synaptic transmission and most focused on the functions of membrane. The best accounts wrote about calcium ion channels, fusion of vesicles with the pre-synaptic membrane, receptors being only on the post-synaptic membrane and the opening of sodium ion channels. This was a topic area where good extension material was often seen. One example seen in a number of essays was the role of GABA in opening chloride ion channels and the inhibitory effect on action potential formation. Those who wrote about synapses quite often went on to write about muscle contraction. There were good accounts of the role of the muscle membrane at the neuromuscular junction and the roles of T tubules and sarcoplasmic reticulum in calcium ion movements. Some weaker accounts just said that membranes are involved and then wrote about actin, myosin and contraction.

Hormones were frequently written about. The best accounts focused on the involvement of membranes. Many wrote about the lipid nature of oestrogen and how this allowed it to enter through the phospholipid bilayer of cells. Others wrote about insulin but details of its effects on transport of glucose across membranes were relatively rare. Glucagon and adrenaline were also commonly used as examples and frequently involved good outlines of the second messenger concept.

Large numbers of students wrote in one way or another about osmosis. Plant roots were a common setting for these accounts. There were some good accounts of active transport of mineral ions by root hairs, leading to lowering of water potential inside the cell and entry of water by osmosis. Accounts of the same sort of sequence involving endodermal cells were rare. Many students appeared to be totally confused between apoplast and symplast. This was a topic area where quite a few drifted into accounts of water movements in the xylem and through leaves which contained no references to membranes.

**E33.**In this question there was some confusion between channel and carrier proteins and their roles in facilitated diffusion and active transport. Quite a large number attempted to write about co-transport and obtained credit via the mark points for facilitated diffusion and active transport. Some who took this approach got themselves rather confused about what moved where, and how. About a third of students scored five marks.

**E34.**Students did not score highly on this question. They often failed to interpret the question and use the data appropriately. Few students quoted correct figures and many failed to realise that the figures for stomach cancer and heart disease showed little difference. Many wrote in terms of contracting the disease rather than dying from it, as referred to in the resource. Others vaguely referred to ‘certain diseases’ and therefore failed to gain credit. In many cases, students simply repeated answers they had learned from past papers. These answers often gained one mark for referring to the idea that other factors are involved.

**E35.**(a)    (i)      This was done well by many students. Where the mark was not given it was usually because a student stated that the antigen was foreign but did not go on to add that it would cause an immune response.

(ii)     Difficulties with this question were linked to poor understanding of the ways in which substances pass through membranes. Weaker answers referred to the antigens not being ‘allowed’ through, rather than incompatibility between the shape of the antigen and the shape of trans-membrane protein channels.

(b)     Many students scored full marks. Rather than microfold cells being the route by which vaccines could enter the body, weaker responses included ideas such as the vaccine being given as treatment for a disease, or people being injected with microfold cells.

**E36.**(a)     Generic answers that included ideas such as improved accuracy, reliability, validity and so on did not gain marks in this question. A few students clearly understood what the units meant and the way in which they would ensure comparability between results at different temperatures. The majority of the rest of the students who did gain these marks gave rather unconvincing responses and apparently hit the target by accident.

(b)     This calculation of percentage increase gave a significant number of students difficulty. The majority selected the correct figures from the table but then had little idea of how to use them, and many scripts showed much crossing out and re-writing. Quite a large number of students did not attempt the calculation. Some students with correct calculations did not do as instructed and give their answer to 1 decimal place.

(c)     (i)      A number of students did not answer the question as set. Many wrote about the effect of increasing temperature on the kinetic energy available in the system, rather than comparing the data for the two different temperatures. Some read ‘rate of uptake’ as the concentration of imatinib inside the cells and so gave movement up the concentration gradient as the evidence for active transport.

(ii)     This was another question that was quite frequently not attempted. Some students had a good understanding of active transport as a process involving trans-membrane carrier proteins and could apply this to the rate of uptake in the cells levelling off at 37°C. Others appeared to be guessing, suggesting that enzymes had been denatured, or that the imatinib had all been used up.

**E37.**This question was not answered well and, in some cases, not marked well either. Students and assessors alike did not consider responses in the context of an energy *boost*. Words like ‘quickly’, ‘rapidly’, ߢmore’ or ‘respiration’ were frequently lacking. It is vital that assessors appreciate both what a question is asking and the essence of the marking points.

**E38.**(a)     Very few students failed to score the mark on this question.

(b)     Very few students scored two marks here. Few used the term ‘confounding variable’, which made it necessary to explain the concept; weak powers of expression meant that these explanations often failed to be creditworthy. Better answers often scored on marking points 3 and / or 4.

(c)     Very few students failed to score the mark on this question. It was rare to come across a spelling error.

(d)     This question produced a full range of marks. Some students referred to the effect of watering on the concentration of salt in the soil, rather than the effect on yield. It was clear from the responses which students had carefully studied the resource and clearly understood the effects of the different watering treatment.

(e)     This question produced the whole range of marks. Some students simply repeated what they had written in the previous question. Many students could come up with the fact that irrigation with sea water increases the salt concentration in the soil. A few students correctly went on to relate this to lower water potential in the soil and linked this to a reduction in water uptake. Only a small number of students then considered the effects of this watering being repeated every year. This resulted in fewer responses relating to marking points 3, 4 and 5.

**E39.**(a)     The majority of students gained both of the marks on this question, although some failed to score because they made unqualified references to protein or lipid. Although some students had learnt the term ‘integral protein’, few qualified this to show they recognised this integral protein spanned the membrane. A few answers referred to guard cells, microvilli and mitochondria, suggesting that the students had not understood the difference between the molecular structure of a membrane and the gross structure of cells or organelles.

(b)     (i)       Most students knew this term although some were clearly guessing between condensation and hydrolysis, having written both down and then crossed out one or other of the terms.

(ii)     The great majority of students gave mark points 3 and 4, with a few failing to score because they used abbreviations such as ER or RER. These abbreviations were not accepted, since students were asked to name the organelle. The full name endoplasmic reticulum is given in the specification, with no abbreviation offered as an alternative. Where Golgi was given as the organelle, the associated function was not often correctly linked to protein formation. For mark point 6 (release of energy / make ATP), references to producing or making energy were not given credit. Incorrect references to cilia, microvilli, stomach acids and lysosomes suggested that some students did not understand what was meant by the term organelle.

**E40.**(a)     Students do need to refer to the Resource(s) when answering questions in this section. This question referred to differences between the curves for dog and sheep. This meant describing patterns within the curves and the overall trends. Some assessors incorrectly gave credit for statements suggesting that a higher percentage of dog cells haemolysed at lower concentrations of sodium chloride.

(b)     Few had difficulty with the calculation in this question.

(c)     It is generally the rule that repeating information given in a question stem, or in this case, the Resource material, attracts little or no credit. It was not enough to say that the red colour was due to a red pigment; identifying haemoglobin was vital. Furthermore, an expression of the relationship between depth of colour and the release of haemoglobin from ruptured cells was essential if full credit was to be achieved.

(d)     Many students scored the first marking point, appreciating that the 0.9% sodium chloride solution does not cause haemolysis in any of the mammals. Not all assessors took into account all of the various approaches that were possible for achieving the second marking point.

**E43.**This question was intended to provide an accessible start to the paper. In practice, it discriminated quite highly, with students who scored highly on the paper as a whole tending to get the highest marks.

(a)     About two thirds obtained both marks. Quite a few students used the terms hydrophilic and hydrophobic the wrong way round. Others appeared confused about the position of the ‘heads’ and ‘tails’ of phospholipids. Some had them the wrong way round in the membrane and others had heads facing out of the cell and tails facing into the cell.

(b)    (i)      There were many good answers and just over 60% obtained both marks. Some students confused the roles of the rough endoplasmic reticulum and the Golgi apparatus.

(ii)     A range of related functions was allowed in part (ii) and just over 70% obtained this mark.

**E46.**(a)     Over 40% gave the correct response of regulator protein. Students who failed to score often gave a generic response about what should be in a vaccine, ‘antigen’ being insufficient for this mark. Students should ensure that they relate their answer to the information given in the question.

(b)     Students were expected to have seen from the passage that the LDL would bind to a receptor on the surface membrane of the liver cell and then use their knowledge of the structure of the membrane to suggest a suitable route into the cell, for example through a carrier protein or channel protein. Many students failed to use the information in the passage and therefore could only gain one mark. A significant number of students recognised that the LDL would be lipid soluble and could pass through the phospholipid bilayer. This alternative was also credited.

(c)     This question discriminated well with weaker students struggling to interpret the information given in the passage. They frequently confused the antibody-antigen response with enzymes, referring to active sites on the antibody or antigen and the formation of enzyme-substrate complexes. There was also mention of receptor "cells" and "antigens on the cell surface membrane of the regulator protein" by students who clearly had a poor understanding of the molecules. However, the more able students were able to gain two marks, usually for referring to the antibody binding to the regulator protein which prevented it from binding to the receptor.

(d)     It was clear that many students had learnt a generic answer to this type of question. Most students knew that the control group would be treated the same as the experimental group but the generic response of ‘give a placebo’ was insufficient because the answer needs to be related to the information in the question. The mark scheme required students to write about injection of saline without the monoclonal antibody. The second marking point, ‘treated the same’ was sometimes expressed as ‘given the same diet’, or the ‘same amount of exercise’ or ‘have the same amount of LDLs’. It is worth noting that the same treatment will include the medical experience and measurements taken, so identifying a particular control variable, such as diet, in isolation, was insufficient to gain this mark.

**E47.**(a)     Most students gave reasonable suggestions for the purpose of treatments 1 and 2 but found the purpose of treatment 3 more difficult to explain. In this question and in question (c)(i), it was important that students had read the information in Resource B stating that these leaves have stomata only on their lower surface.

(b)     (i)      Students still find it difficult to describe a trend on a graph such as this accurately. Many students failed to state clearly that the rate stayed constant for the first 60 minutes and then fell (as required for mark point 1).

(ii)     Some students were not explicit enough in their answer that the water is lost through the stomata in order to achieve mark point 1.

(c)     (i)      Students who stated that there were stomata on the upper surface of the leaf could not be awarded this mark, as Resource B stated that these leaves have stomata only on their lower surface.

(ii)     Most students achieved mark point 1 but only better answers went on to explain why this meant there was no uptake of carbon dioxide.