**Unit 1 – Biological molecules**

**Homework booklet**

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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| --- | --- | --- |
| **Question** | **Mark** | **Areas to improve** |
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**Q1.**

Scientists measured the mean amino acid concentration in white wines made from grapes grown organically and white wines made from grapes that were not grown organically.

(a)     Which test could the scientists have used to identify that there are amino acids in white wine?

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**(1)**

(b)     All amino acids have the same general structure. The image below shows the structure of the amino acid isoleucine.

Draw a box around the part of the molecule that would be the same in all amino acids.

**(1)**

(c)     Name the chemical element found in all amino acids that is **not** found in triglycerides.

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**(1)**

(d)     The scientists used a statistical test to determine whether there was a significant difference in the amino acid concentration in the two types of white wine. They obtained a value for P of 0.04.

Name the statistical test the scientists used and give a reason for your answer.

Was the difference significant? Give a reason for your answer.

Name of statistical test \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reason for choice \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Explanation of test result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(3)**

**(Total 6 marks)**

**Q2.**

Glucose is a monosaccharide. Two glucose molecules join together to form a disaccharide.

(i)      Name the products of this reaction.

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**(2)**

(ii)     Name the type of reaction that joins the glucose molecules together.

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**(1)**

**(Total 3 marks)**

**Q3.**

A student investigated the effect of substrate concentration on the initial rate of an enzyme-catalysed reaction.

She added 10 cm3 of an enzyme solution to 10 cm3 of substrate solutions of different concentrations. At 30-second intervals, she tested samples of each mixture for the presence of substrate.

•        **A** – in the absence of an inhibitor.

•        **B** – with a competitive inhibitor added to the substrate solution.

•        **C** – with a non-competitive inhibitor added to the substrate solution.

Her results are shown in the graph below.

(a)     Explain the results **without** inhibitor (curve **A**) shown in the graph.

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**(2)**

(b)     The graph shows that the maximum initial rate of reaction (Vmax) when a competitive inhibitor was present (curve **B**) is different from that when a non-competitive inhibitor was present (curve **C**).

Explain this difference.

**(4)**

(c)     The Michaelis constant (Km) is the substrate concentration at which the initial rate of reaction is half its maximum value (Vmax).

How could you use the Michaelis constant to determine the type of inhibition occurring in an enzyme-catalysed reaction?

Use information from the graph to support your answer.

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**(1)**

**(Total 7 marks)**

**Q4.**

(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.

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| --- | --- | --- | --- |
| **Type of lipid** | **Percentage of lipid in plasma membrane by mass** |  |  |
| **Cell lining ileum of mammal** | **Red blood cell of mammal** | **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)**

**Q5.**

A student investigated the glucose concentration in five different drinks.

His results are shown below.

(a)     Using the data, calculate how many grams of glucose would be in 220 cm3 of drink **F**.

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(1)**

(b)     Calculate how much more glucose is in drink **C** than in drink **F**. Show your answer as a percentage.

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ %

**(1)**

**(Total 2 marks)**

**Q6.**

A student investigated the effect of chewing on the digestion of starch in cooked wheat.

He devised a laboratory model of starch digestion in the human gut. This is the method he used.

1.      Volunteers chewed cooked wheat for a set time. The wheat had been cooked in boiling water.

2.      This chewed wheat was mixed with water, hydrochloric acid and a protein-digesting enzyme and left at 37 °C for 30 minutes.

3.      A buffer was then added to bring the pH to 6.0 and pancreatic amylase was added. This mixture was then left at 37 °C for 120 minutes.

4.      Samples of the mixture were removed at 0, 10, 20, 40, 60 and 120 minutes, and the concentration of reducing sugar in each sample was measured.

5.      Control experiments were carried out using cooked wheat that had been chopped up in a blender, not chewed.

(a)     What reducing sugar, or sugars, would you expect to be produced during chewing? Give a reason for your answer.

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**(2)**

(b)     In this model of digestion in the human gut, what other enzyme is required for the complete digestion of starch?

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**(1)**

(c)     What was the purpose of step 2, in which samples were mixed with water, hydrochloric acid and pepsin?

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**(1)**

(d)     In the control experiments, cooked wheat was chopped up to copy the effect of chewing.

Suggest a more appropriate control experiment. Explain your suggestion.

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**(2)**

(e)     The figure below shows the student’s results.

                                 Incubation time / minutes

Explain what these results suggest about the effect of chewing on the digestion of starch in wheat.

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**(3)**

**(Total 9 marks)**

**Q7.**

The diagram shows part of a DNA molecule.

(a)     How many nucleotides are shown in the diagram above?

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**(1)**

(b)     Name the type of bond labelled **X** in the diagram.

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**(1)**

(c)     The enzymes DNA helicase and DNA polymerase are involved in DNA replication.

Describe the function of each of these enzymes.

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DNA polymerase \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(d)     Adenosine triphosphate (ATP) is a nucleotide derivative.

Contrast the structures of ATP and a nucleotide found in DNA to give **two** differences.

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**(2)**

**(Total 6 marks)**

**Q8.**

A technician investigated the effect of temperature on the rate of an enzyme-controlled reaction. At each temperature, he started the reaction using the same volume of substrate solution and the same volume of enzyme solution.

The figure below shows his results.

                 Time after start of reaction / s

(a)     Give **one** other factor the technician would have controlled.

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**(1)**

(b)     Calculate the rate of reaction at 25 °C.

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(c)     Describe and explain the differences between the two curves.

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**(5)**

**(Total 8 marks)**

**Q9.**

The diagram shows four biological molecules.

(a)     Give the **full** name of:

Molecule **A** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Molecule **B** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(b)     What type of molecule is molecule **C**?

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**(2)**

(c)     Glycine, shown in the diagram, is an amino acid.

In the space below, draw a diagram to show the dipeptide produced when two molecules of glycine are joined together.

**(2)**

(d)     Name the other molecule formed when two molecules of glycine are joined together.

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**(1)**

**(Total 7 marks)**

**Q10.**

The saliva of most humans contains α-amylase. The gene encoding α-amylase is called *AMY1;* it is located on chromosome 1.

As a result of mutation, humans might have more than one copy of the *AMY1* gene on one, or both, of their copies of chromosome 1. A team of scientists investigated whether the number of copies of the *AMY1* gene was associated with the concentration of α-amylase in the saliva of 58 human volunteers.

The graph shows their results. Each circle represents one volunteer.

(a)     What was the range in the number of copies of the *AMY1* gene?

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**(1)**

(b)     The scientists found the mean number of copies of gene *AMY1* was 4.4 genes per person.

Four values of the standard deviation of this mean are given below.

**Estimate** which of the four values for the standard deviation is most likely for this mean.

Indicate your choice by placing a tick in the appropriate box.

Use evidence from the graph to justify your answer.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | ± 0.002 |  | ± 0.02 |  | ± 0.20 |  | ± 2.00 |

Justification\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(c)     The scientists calculated a correlation coefficient, R, from their data.

They found R = 0.50, with P <0.0001

Explain the meaning of the result of their calculations.

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**(3)**

(d)     The number of copies of the *AMY1* gene is unlikely to affect people’s ability to digest starch.

Explain why.

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**(3)**

**(Total 9 marks)**

**Q11.**

(a)     Name the monomers from which a maltose molecule is made.

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**(1)**

(b)     Name the type of chemical bond that joins the **two** monomers to form maltose.

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**(1)**

A student wanted to produce a dilution series of a maltose solution so he could plot a calibration curve. He had a stock solution of maltose of concentration 0.6 mol dm−3 and distilled water. He made a series of dilutions from 0.1 to 0.6 mol dm−3.

(c)     Complete the table below by giving all headings, units and the concentration of the maltose solution produced.

|  |  |  |
| --- | --- | --- |
| **Concentration of maltose solution****/ \_\_\_\_\_\_\_\_\_\_\_\_** | **Volume of 0.6 mol dm−3 maltose solution / cm3** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****\_\_\_\_\_\_ / \_\_\_\_\_\_\_** |
| \_\_\_\_\_\_\_\_\_\_\_\_ | 5 | 10 |

**(2)**

The student performed the Benedict’s test on six maltose solutions ranging from 0.1 mol dm−3 to 0.6 mol dm−3. He placed a sample of each solution in a colorimeter and recorded the light absorbance.

His results are shown in the graph below.

(d)     Explain how you would use the graph to determine the maltose concentration with a light absorbance of 0.45 arbitrary units.

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**(2)**

**(Total 6 marks)**

**Q12.**

(a)     Name **two** enzymes involved in the semi-conservative replication of DNA.

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2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(b)     Sometimes, damage occurs during DNA replication. One enzyme involved in repairing damage to DNA is called ATR.

ATR works as follows.

•   ATR phosphorylates other enzymes involved in repairing DNA.

•   ATR **also** phosphorylates substrates required to repair DNA.

When ATR phosphorylates other enzymes, these enzymes become able to bind to their substrates.

Use your knowledge of enzyme structure to suggest why.

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**(2)**

(c)     The enzyme-catalysed reactions activated by ATR only occur if the substrates have been phosphorylated.

Use your knowledge of energy changes in enzyme-catalysed reactions to suggest why.

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**(1)**

(d)     Sometimes, a mutagenic agent causes DNA to break. A different enzyme called ATM binds to the broken DNA. This leads to the activation of a protein coded for by a tumour suppressor gene. The effect of ATM binding is to stop cell division until DNA is repaired.

A mutation could result in a person having non-functional forms of the gene that produces ATM.

What can you predict about the possible effects of having a non-functional form of ATM?

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**(3)**

**(Total 8 marks)**

**Q13.**

A biochemist isolated a protease from a bacterium. He investigated the effect of temperature on the rate of hydrolysis of a protein by this protease. He measured the mass of protein hydrolysed in **5 minutes** at each temperature.

The results are shown in the table below.

|  |  |  |
| --- | --- | --- |
| **Temperature / °C** | **Mass of protein hydrolysed / g** | **Rate of hydrolysis /****\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
| 5 | 0.48 |   |
| 10 | 1.11 |   |
| 15 | 1.23 |   |
| 20 | 1.05 |   |
| 30 | 0.78 |   |
| 45 | 0.12 |   |

(a)     Process the data in the table. Plot the processed data on the graph paper.

**(4)**

(b)     A student concluded from a graph of the data in the table that the bacterium lives at 15 °C.

Does the data support the student’s conclusion? Give reasons for your answer.

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**(4)**

(c)     Suggest **two** variables the biochemist controlled when investigating the effect of temperature on the rate of breakdown of a protein by the protease.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

**(Total 9 marks)**

**Q14.**

Water and inorganic ions have important biological functions within cells.

(a)     Give **two** properties of water that are important in the cytoplasm of cells.

For each property of water, explain its importance in the cytoplasm.

Property 1\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Biological importance within cells\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Property 2\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Biological importance within cells\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(4)**

(b)     Other than sodium, name **one** inorganic ion and give **one** example of its biological importance in a cell.

Name of inorganic ion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Biological importance\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(c)     Compare and contrast the processes by which water and inorganic ions enter cells.

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**(3)**

**(Total 9 marks)**

**Q15.**

(a)     The genetic code is **degenerate** and **non-overlapping**.

Explain the meaning of:

Degenerate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Non-overlapping \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

The table shows a short section of a messenger RNA (mRNA) molecule and the section of a polypeptide for which it codes.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **mRNA** | G G G | G C U | U C A | C C G | G C A | A C G |
| **Polypeptide** | glycine | alanine | serine | proline | alanine | threonine |

(b)     Name the bases represented in the table by:

A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

C \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

G \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

U \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(c)     Use information in the table to give the sequence of bases in **DNA** that codes for serine.

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**(1)**

**(Total 5 marks)**

**Q16.**

In mammals, in the early stages of pregnancy, a developing embryo exchanges substances with its mother via cells in the lining of the uterus. At this stage, there is a high concentration of glycogen in cells lining the uterus.

(a)     Describe the structure of glycogen.

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**(2)**

(b)     During early pregnancy, the glycogen in the cells lining the uterus is an important energy source for the embryo.

Suggest how glycogen acts as a source of energy.

Do **not** include transport across membranes in your answer.

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**(2)**

(c)     Suggest and explain **two** ways the cell-surface membranes of the cells lining the uterus may be adapted to allow rapid transport of nutrients.

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**(2)**

(d)     In humans, after the gametes join at fertilisation, every cell of the developing embryo undergoes mitotic divisions before the embryo attaches to the uterus lining.

•   The first cell division takes 24 hours.

•   The subsequent divisions each take 8 hours.

After 3 days, the embryo has a total volume of 4.2 × 10−3 mm3.

What is the mean volume of each cell after 3 days? Express your answer in standard form.

Show your working.

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mm3

**(2)**

**(Total 8 marks)**

**Q17.**

Trypsin is a protease. It is produced in an inactive form inside some of the cells of the pancreas.

(a)     Name the part of a pancreatic cell that produces the inactive form of trypsin.

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**(1)**

(b)     Suggest the advantage of producing trypsin in an inactive form inside cells in the pancreas.

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**(2)**

(c)     After the inactive form of trypsin enters the small intestine, another enzyme removes a short chain of amino acids from the end of the inactive trypsin molecules. This leads to the formation of the active form of trypsin.

(i)      Name the type of bond hydrolysed when the short chain of amino acids is removed.

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**(1)**

(ii)     Sometimes trypsin can become activated inside a pancreatic cell. A competitive inhibitor in the cell then binds to the trypsin and stops it working.

Explain how the competitive inhibitor stops trypsin working.

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**(3)**

**(Total 7 marks)**

**Q18.**

(a)     Bacteria are often used in industry as a source of enzymes. One reason is because bacteria divide rapidly, producing a large number of them in a short time.

Describe how bacteria divide.

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**(2)**

(b)     Washing powders often contain enzymes from bacteria. These enzymes include proteases that hydrolyse proteins in clothing stains.

The graph shows the effect of temperature on a protease that could be used in washing powder.

Explain the shape of the curves at 50 °C and 60 °C.

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**(4)**

(c)     Some proteases are secreted as extracellular enzymes by bacteria.

Suggest **one** advantage to a bacterium of secreting an extracellular protease in its natural environment.

Explain your answer.

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**(2)**

(d)     Mammals have some cells that produce extracellular proteases. They also have cells with membrane-bound dipeptidases.

Describe the action of these membrane-bound dipeptidases and explain their importance.

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**(2)**

**(Total 10 marks)**

**Q19.**

(a)     Glycogen and cellulose are both carbohydrates.

Describe **two** differences between the structure of a cellulose molecule and a glycogen molecule.

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**(2)**

(b)     Starch is a carbohydrate often stored in plant cells.

Describe and explain **two** features of starch that make it a good storage molecule.

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**(2)**

(c)     Tick (✔) the box that identifies the test which would be used to show the presence of starch.

|  |  |
| --- | --- |
| Acid hydrolysis test |  |
| Benedict’s test |  |
| Emulsion test |  |
| Iodine/potassium iodide test |  |

**(1)**

(d)     The diagram shows a section through a plant tissue at a magnification of ×500.

Calculate the actual diameter of the starch grain between points **A** and **B**.

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ μm

**(2)**

(e)     What type of microscope was used to obtain the image shown in the diagram above?

Give **one** piece of evidence to support your answer.

Type of microscope \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Evidence \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

**(Total 9 marks)**

**Q20.**

(a)     Most human cells contain two copies of each gene. However, there might be up to 15 copies of the gene for amylase (*AMY1*). Scientists investigated the number of copies of the *AMY1* gene in individual people in two populations. One population had a high-starch diet and the other population had a low-starch diet.

The graph below shows their results.

Describe what their results show.

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**(3)**

(b)     Multiple copies of the *AMY1* gene is an adaptation to a high-starch diet.

Use your knowledge of protein synthesis and enzyme action to explain the advantage of this adaptation.

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**(3)**

(c)     Multiple copies of the *AMY1* gene is an adaptation to a high-starch diet.

Suggest how this evolved through natural selection.

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**(3)**

**(Total 9 marks)**

Mark schemes

**Q1.**

(a)    Biuret;

*Ignore any other detail*

*Accept*

*•   Copper sulfate and sodium hydroxide*

*•   CuSO4 + NaOH*

*•   Alkaline copper sulfate*

*•   Copper sulphate and sodium hydroxide*

*•   Alkaline copper sulphate*

*•   Biurette*

*•   Buiret*

*•   Biruet*

*•   Bieuret*

*Reject burette or Beirut*

**1**

(b)     Draw around

**1**

(c)     Nitrogen;

*Ignore N*

**1**

(d)     Choice: (Student’s) *t*-test;

Reason for choice: Looking for differences between two means;

*Reason: Allow comparing contrasting two means*

Explanation: Difference is significant / not due to chance because the P value is 0.04 / is less than 0.05;

*Explanation: Assume ‘it’ means difference*

*Explanation: Reject result / data is significant / not due to chance*

*Explanation: do not accept P value is less than 0.04*

**3**

**[6]**

**Q2.**

(i)      1.     Maltose;

2.     Water;

*Accept H2O*

**2**

(ii)     Condensation;

**1**

**[3]**

**Q3.**

(a)     1.      Increases because more enzyme-substrate complexes formed;

*Neutral; more collisions*

2.      Levels off because all enzyme molecules involved in enzyme-substrate complexes (at a given time)

*1. and 2. Accept ES*

*2. Reject enzymes are used up*

**OR**

Levels off because no free active sites (at a given time)

**OR**

Levels off because enzyme (concentration) is limiting factor.

**2**

(b)     1.      Competitive inhibitor binds to active sites of enzyme but non-competitive inhibitor binds at allosteric site / away from active site;

2.      (Binding of) competitive inhibitor does not cause change in shape of active site but (binding of) non-competitive does (cause change in size of active site);

3.      So with competitive inhibitor, at high substrate concentrations (active) enzyme still available but with non-competitive inhibitor (active) enzymes no longer available;

4.      At higher substrate concentrations likelihood of enzyme-substrate collisions increases with competitive inhibitor but this is not possible with non-competitive inhibitor;

**4**

(c)     Reaction with non-competitive inhibitor has the same value of Km as with no inhibitor / value is 5 (g dm–3) / reaction with competitive inhibitor has higher Km value than with no inhibitor / value is 7 (g dm–3).

**1**

**[7]**

**Q4.**

(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]**

**Q5.**

(a)     1.1 (g);

**1**

(b)     300(%);

**1**

**[2]**

**Q6.**

(a)     1.      Maltose;

2.      Salivary amylase breaks down starch.

**2**

(b)     Maltase.

**1**

(c)     (Mimics / reproduces) effect of stomach.

**1**

(d)     1.      Add boiled saliva;

2.      Everything same as experiment but salivary amylase denatured.

**2**

(e)     1.      Some starch already digested when chewing / in mouth;

2.      Faster digestion of chewed starch;

3.      Same amount of digestion without chewing at end.

*Accept use of values from graph*

**3**

**[9]**

**Q7.**

(a)    8;

*Accept eight*

**1**

(b)     Phosphodiester (bond);

*Accept phonetic spellings*

**1**

(c)     1.      DNA helicase – (unwinding DNA and) breaking hydrogen bonds / bonds between chains / bases / strands;

2.      DNA polymerase – joins (adjacent) nucleotides **OR** forms phosphodiester bond / sugar-phosphate backbone;

*1.      Accept H bonds.*

*1.      Accept hydrolyses for breaks*

*2.      Reject forms hydrogen bonds (between nucleotides / bases)*

**2**

(d)     1.      ATP has ribose **and** DNA nucleotide has deoxyribose;

2.      ATP has 3 phosphate (groups) **and** DNA nucleotide has 1 phosphate (group);

3.      ATP – base always adenine **and** in DNA nucleotide base can be different / varies;

*Both parts of each MP needed*

*3.      Reject Uracil / U*

*3.      Accept C, T or G for different bases*

*Accept annotated diagram for any of the three marks*

**2 max**

**[6]**

**Q8.**

(a)     Concentration of substrate solution / of enzyme solution / pH.

**1**

(b)     1.      2.5 / 0.04;

*1 mark for correct value*

2.      g dm–3 minute–1 / g dm–3 s–1;

*1 mark for related unit*

**2**

(c)     1.      Initial rate of reaction faster at 37 °C;

2.      Because more kinetic energy;

3.      So more E–S collisions / more E–S complexes formed;

4.      Graph reaches plateau at 37 °C;

5.      Because all substrate used up.

*Allow converse for correct descriptions and explanations for curve at 25 °C*

**5**

**[8]**

**Q9.**

(a)     1.      A = *β* glucose;

B = Adenosine triphosphate;

*do not accept ATP*

**2**

(b)     1.      Saturated;

**1**

2.      Fatty acid;

**1**

(c)     1.      Peptide bond shown correctly;

2.      Rest of dipeptide structure shown correctly;

**2**

(d)      Water;

**1**

**[7]**

**Q10.**

(a)      2 to 11;

**1**

(b)     ± 2.0;

Data show great variation (around mean)

**OR**

4.4 ± 2 × SD includes most of the values measured.

**2**

(c)     1.      Shows a positive correlation;

2.      Their probability of getting this correlation by chance is less than 0.0001;

*Allow less than 0.01%*

3.      Correlation is highly significant.

*Reject ‘results’ are significant / not due to chance*

**3**

(d)     1.      Little digestion of starch by salivary amylase

**OR**

starch in mouth for a short period

**OR**

salivary amylase inactivated by stomach acid;

2.      Amylase also secreted by pancreas;

3.      So (most) starch digestion occurs in small intestine.

**3**

**[9]**

**Q11.**

(a)     Glucose (and glucose);

**1**

(b)     (α1,4) Glycosidic;

**1**

(c)     1.      Headings correct – mol dm–3 **and** volume of water / cm3;

2.      Concentration correct. ie 0.2;

**2**

(d)     Line of best fit drawn;

Read off value at 0.45.

**2**

**[6]**

**Q12.**

(a)     1.      (DNA) helicase;

2.      (DNA) polymerase;

***List Rule Applies***

*Accept (DNA) ligase / Primase / telomerase / Topoisomerase / DNA gyrase*

*Reject RNA*

*Accept phonetic spellings*

**2**

(b)     1.      Changes tertiary structure of the enzyme;

2.      (Enzyme) active site formed / able to be formed / active site becomes complementary;

*1.      Accept tertiary symbol 3 °*

*1.      Ignore 3D*

*2.      Reject refs to inhibition / inhibitors*

*2.      Ignore refs to E-S complexes form*

*2.      Ignore refs to substrate phosphorylation*

**2**

(c)     (Phosphorylation / phosphate) makes substrates more reactive / raises their energy level(s) / lowers activation energy for the reaction;

*Ignore provides energy unqualified*

*Ignore refs to kinetic energy unqualified*

**1**

(d)     1.      ATM will not bind to (broken) DNA;

2.      DNA not repaired / cell still has broken DNA;

3.      Cell division continues / tumour forms;

4.      Tumour suppressor (gene) not effective / not activated;

5.      May have no effect in diploid / heterozygous (organism);

6.      (Which) still has a functional ATM / ATM gene;

**3 max**

**[8]**

**Q13.**

(a)     1.      IV on x axis and DV on y axis **and** both axes on linear scales;

2.      Axes labelled clearly and with correct units separated from variable by solidus or in brackets;

3.      All rates calculated correctly;

4.      Points plotted correctly **and** joined by ruled lines and no extrapolation;

**4**

(b)     Yes:

1.      Expect optimum temperature of enzyme to be same

**OR**

Similar to temperature where bacterium lives;

2.      Optimum temperature for enzyme (appears to be around) 15 °C;

No:

3.      Need data from more temperatures (between 10 °C and 20 °C);

4.      Data for only isolated enzyme

**OR**

Isolation may affect activity;

**4**

(c)     1.      Initial / starting substrate concentration

2.      Enzyme concentration

3.      pH.

*Any* ***2*** *for* ***1*** *mark*

**1 max**

**[9]**

**Q14.**

(a)     1.      Polar molecule;

2.      Acts as a (universal) solvent;

**OR**

3.      (Universal) solvent;

4.      (Metabolic) reactions occur faster in solution;

**OR**

5.      Reactive;

6.      Takes place in hydrolysis / condensation / named reaction;

*Polar molecule so acts as (universal) solvent so (metabolic reactions are faster = 3 marks*

**4**

(b)     Name of ion;

Correct function within cell;

*Ions other than sodium in specification are H+, Fe2+ and PO43– but accept any correct ion (other than sodium) plus relevant function = 2.*

*Allow ion to be named in words but not as element, e.g, iron ion but not iron.*

**2**

(c)     1.      Comparison: both move down concentration gradient;

2.      Comparison: both move through (protein) channels in membrane;

*Accept aquaporins (for water) and ion channels*

3.      Contrast: ions can move against a concentration gradient by active transport

**3**

**[9]**

**Q15.**

(a)     1.      Degenerate: more than one (base) triplet for each amino acid;

2.      Non-overlapping: each base is part of only one triplet.

*Accept codon (as would be applicable to mRNA code)*

**2**

(b)     A = adenine

C = cytosine

G = guanine

U = uracil

*All four correct = 2*

*One error = 1*

*Two or more errors = 0*

**2 max**

(c)     AGT;

**1**

**[5]**

**Q16.**

(a)     1.      Polysaccharide of *α*-glucose;

**OR**

polymer of *α*-glucose;

2.      (Joined by) glycosidic bonds

**OR**

Branched structure;

**2**

(b)     1.      Hydrolysed (to glucose);

2.      Glucose used in respiration;

*1.      Ignore ‘Broken down’*

*2.      ‘Energy produced’ disqualifies mp2*

**2**

(c)     1.      Membrane folded **so** increased / large surface area;

**OR**

Membrane has increased / large surface area **for** (fast) diffusion / facilitated diffusion / active transport / co-transport;

2.      Large number of protein channels / carriers (in membrane) **for** facilitated diffusion;

3.      Large number of protein carriers (in membrane) **for** active transport;

4.      Large number of protein (channels / carriers in membrane) **for** co-transport;

*1.      Accept ‘microvilli to increase surface area’*

*1.      Reject reference to villi.*

*Note feature and function required for each marking point and reference to large / many / more.*

*List rule applies.*

**2 max**

(d)     3.3 × 10−5 **OR** 3.28 × 10−5 **OR** 3.281 × 10−5;

1 mark for

Evidence of 128 (cells)

Correct numerical calculation but not in standard form gains 1 mark (0.00003281 **OR** 0.0000328 **OR** 0.000033);

*Accept any number of significant figures as long as rounding correct (3.28125 × 10 −5 scores 2 marks)*

**2**

**[8]**

**Q17.**

(a)     Ribosome/rough endoplasmic reticulum;

*Ignore RER or endoplasmic reticulum unqualified*

**1**

(b)     1.       Does not digest protein inside cells;

*Accept named examples*

2.       So (pancreatic) cell/tissue/function not destroyed/damaged;

**2**

(c)     (i)      Peptide (bond);

**1**

(ii)     1.       Inhibitor is a similar shape to the substrate;

2.      (Inhibitor) blocks active site/is complementary to the active site/binds to the active site (of trypsin);

3.      Substrate can’t bind to active site / no/fewer ES complexes formed;

**3**

**[7]**

**Q18.**

(a)     1.      Binary fission;

2.      Replication of (circular) DNA;

3.      Division of cytoplasm to produce 2 daughter cells;

4.      Each with single copy of (circular) DNA;

*1.      Ignore reference to ‘chromosome’*

*2.      Ignore ‘copy’.*

*4.      Ignore references to number of plasmids.*

**2 max**

(b)     1.      Both denatured (by high temperature);

2.      Denaturation faster at 60 °C due to more (kinetic) energy;

3.      Breaks hydrogen / ionic bonds (between amino acids / R groups);

4.      Change in shape of the active site / active site no longer complementary **so** fewer enzyme-substrate complexes formed / substrate does not fit;

*3.      Ignore references to disulphide bonds*

*3.      Accept (at 60 °C) Change in shape of the active site / active site no longer complementary* ***so*** *no enzyme-substrate complexes formed / substrate does not fit;*

**4**

(c)     1.      To digest protein;

2.      (So) they can absorb amino acids for growth / reproduction / protein synthesis / synthesis of named cell component;

**OR**

(So) they can destroy a toxic substance / protein;

*1.      For ‘digest’ accept ‘break down’ here.*

*2.      Accept ‘(so) they can destroy antibodies / antibiotics / viral antigens / bacterial antigens’*

**2**

(d)     1.      Hydrolyse (peptide bonds) to release amino acids;

2.      Amino acids can cross (cell) membrane;

**OR**

Dipeptides cannot cross (cell) membrane;

**OR**

Maintain concentration gradient of amino acids for absorption;

**OR**

Ensure (nearly) maximum yield from protein breakdown;

*2.      Ignore references to crossing gut membranes.*

*2.      Accept ‘there are carrier proteins for amino acids’*

*2.      Accept ‘no carrier proteins for dipeptides’*

**2**

**[10]**

**Q19.**

(a)     1.      Cellulose is made up of β-glucose (monomers) **and** glycogen is made up of *α*-glucose (monomers);

2.      Cellulose molecule has straight chain **and** glycogen is branched;

3.      Cellulose molecule has straight chain **and** glycogen is coiled;

4.      glycogen has 1,4- and 1,6- glycosidic bonds **and** cellulose has only 1,4- glycosidic bonds;

*Ignore ref. to H bonds / microfibrils*

**2 max**

(b)    Any **two** from:

1.      Insoluble (in water), so doesn’t affect water potential;

2.      Branched / coiled / (*α*-)helix, so makes molecule compact;

**OR**

Branched / coiled / (*α*-)helix so can fit many (molecules) in small area;

3.      Polymer of (*α*-)glucose so provides glucose for respiration;

4.      Branched / more ends for fast breakdown / enzyme action;

5.      Large (molecule), so can’t cross the cell membrane

*Require feature* ***and*** *explanation for 1 mark*

*1.      Accept Ψ or WP*

*1.      Accept Insoluble so doesn’t affect osmosis*

*1.      Do* ***not*** *allow ref to ‘doesn’t affect water leaving cells*

*4.      Ignore ‘surface area’*

*4.      Accept ‘branched so glucose readily released’*

**2 max**

(c)     Iodine/potassium iodide;

**1**

(d)     For correct answer of 40 (μm) award 2 marks;

Evidence of division by 500: award 1 mark

*Allow tolerance of 0.5mm i.e. 20±0.5mm*

**2**

(e)     1.      Scanning electron (microscope);

2.      3D (image);

*Accept SE(M)*

*2.      Ignore any other correct features*

**2**

**[9]**

**Q20.**

(a)     1.      Low starch, fewer copies;

2.      Ranges overlap almost completely;

**OR**

Ranges overlap from 2 − 13 copies;

3.      (surprisingly) very few / 2 or 3% have only 2 copies / are diploid;

4.      the mode / highest percentage for low starch is 4 copies and for high starch is 6;

5.      the range / spread is greater with high starch;

*4.      “most people” is not equivalent to mode*

**3 max**

(b)     1.      More mRNA / more transcription;

2.      More translation / enzyme;

3.      So reaction faster;

*The idea of “more” must be stated at least once.*

*2.      Accept ‘amylase’ for enzyme*

*3.      “More starch digested” is insufficient*

**3**

(c)     1.      Mutation(s) produce extra copies of (*AMY1*) gene;

2.      Those with more copies / this adaptation/mutation reproduce / survive better on high starch diet;

2.      And pass on multiple copies / this adaptation/mutation (to offspring);

*Ignore ref. to single allele/gene*

**3**

**[9]**