0 5 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.

0 5 . 1 Which test could the scientists have used to identify that there are amino acids in white wine?

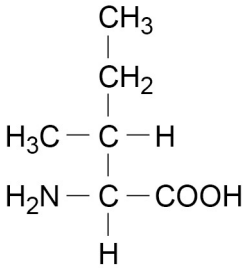
[1 mark]

0 5 . 2 All amino acids have the same general structure. **Figure 4** 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 mark]

Figure 4



Isoleucine

0 5 . 3 Name the chemical element found in all amino acids that is **not** found in triglycerides.

[1 mark]

0 5 . 4 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.

[3 marks]

Name of statistical test _____

Reason for choice _____

_____

_____

Explanation of test result _____

_____

_____

_____

_____

_____

6

Turn over for the next question

Do not write outside the box

0 2 . 1 Describe how a peptide bond is formed between two amino acids to form a dipeptide.

[2 marks]

0 2 . 2 The secondary structure of a polypeptide is produced by bonds between amino acids.

Describe how.

[2 marks]

Do not write outside the box

0 2 . 3 Two proteins have the same number and type of amino acids but different tertiary structures.

Explain why.

[2 marks]

6

Turn over for the next question

Do not write outside the box

0 7 . 1 Explain how the active site of an enzyme causes a high rate of reaction.

[3 marks]

Do not write outside the box

The action of the enzyme catalase is shown below.

$$\text{hydrogen peroxide} \xrightarrow{\text{catalase}} \text{water} + \text{oxygen}$$

A student investigated the effect of hydrogen peroxide concentration on the rate of this reaction. He used catalase from potato tissue.

The student:

- put five potato chips in a flask
- added 20 cm^3 of 0.5 mol dm^{-3} hydrogen peroxide solution to the flask
- measured the time in seconds for production of 10 cm^3 of oxygen gas
- repeated this procedure with four different concentrations of hydrogen peroxide solution.

His results are shown in **Table 5**.

Table 5

Hydrogen peroxide concentration / mol dm^{-3}	**Time for production of 10 cm^3 of oxygen gas / seconds**	**Rate of reaction / arbitrary units**
0.5	18	
1.0	10	
1.5	7	
2.0	6	
2.5	6	

0 7 . 2 Other than those stated, give **one** factor the student would have controlled in his investigation.

[1 mark]

Do not write outside the box

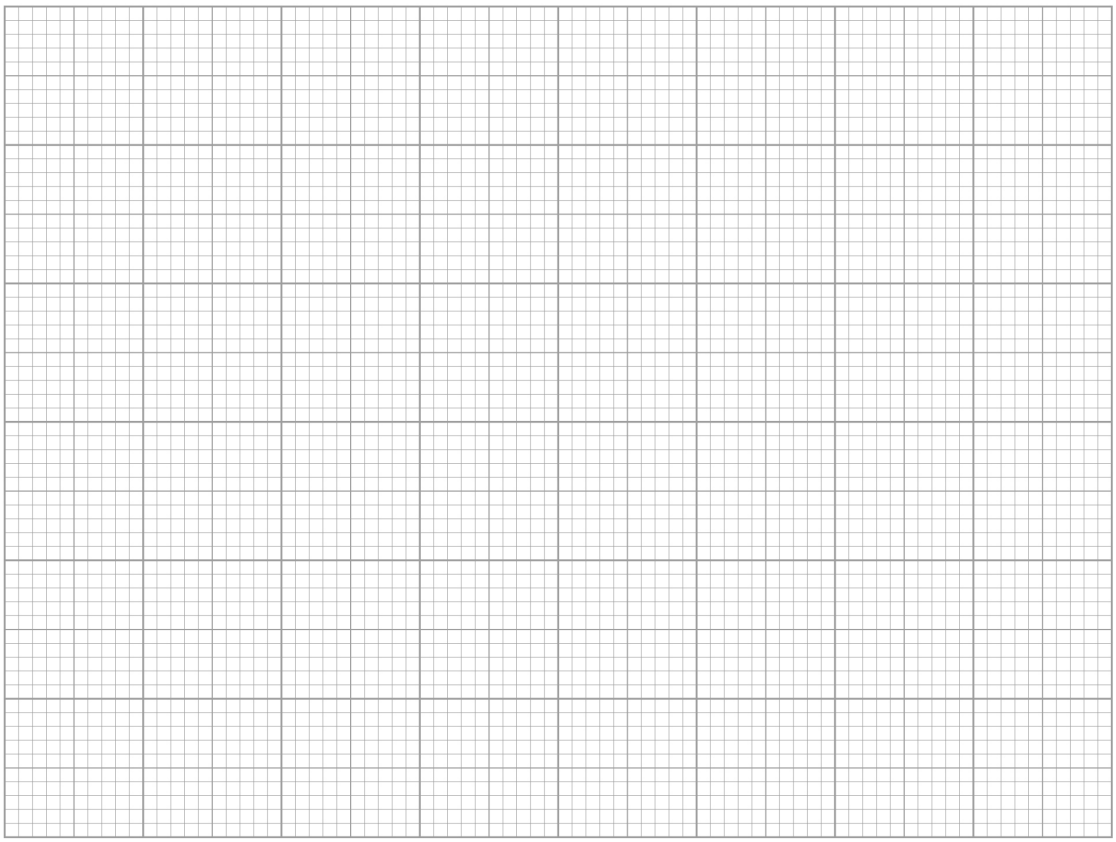
0 7 . 3 The student gave the maximum rate of reaction a value of 1.0 arbitrary units.

Complete **Table 5** by calculating the rate of reaction in arbitrary units at each hydrogen peroxide concentration. Record the rates using an appropriate number of significant figures.

[2 marks]

0 7 . 4 Plot a suitable graph of your processed data shown in **Table 5**.

[3 marks]



0 7 . 5 Suggest a change the student could make to his procedure so that 10 cm^3 of oxygen would be produced in less than 6 seconds.

[1 mark]

10

0 7 . 1 NMO is a disease that leads to damage to nerve cells in the spinal cord. A person with NMO produces anti-AQP4 antibody that attacks only these nerve cells.

Explain why the anti-AQP4 antibody only damages these cells.

[4 marks]

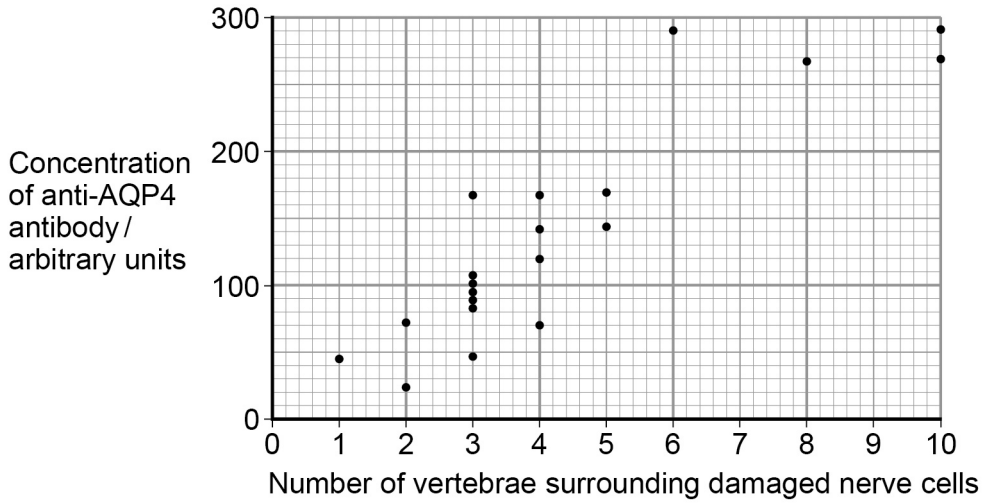
Question 7 continues on the next page

0 7 . 2 Scientists measured the concentration of anti-AQP4 antibody in the blood of people with NMO.

The spinal cord is surrounded by small bones called vertebrae. For each person, the scientists also determined the number of vertebrae surrounding damaged nerve cells.

Their results are shown in **Figure 7**.

Figure 7



A scientist suggested that the concentration of anti-AQP4 antibody in a person's blood could be used to predict the number of vertebrae surrounding damaged nerve cells they are likely to have.

Use **Figure 7** to suggest reasons why this suggestion might **not** be valid.

[3 marks]

0 7 . 3 A new treatment for NMO involves using a monoclonal antibody. The structure of the variable region of this monoclonal antibody is identical to the variable region of an anti-AQP4 antibody, but the rest of its structure is different.

Use this information and your knowledge of antigen-antibody complexes to suggest how this monoclonal antibody prevents anti-AQP4 damaging nerve cells.

[2 marks]

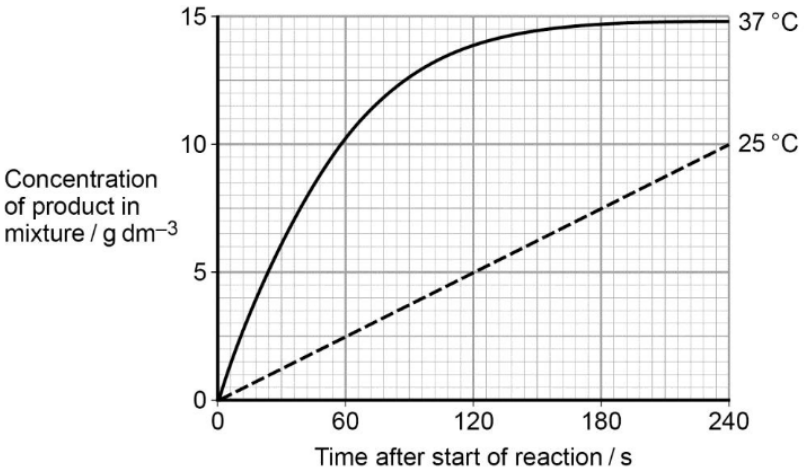
9

Turn over for the next question

2 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.

Figure 2 shows his results.

Figure 2



0 2 . 1 Give **one** other factor the technician would have controlled.

[1 mark]

_____

_____

0 2 . 2 Calculate the rate of reaction at 25 °C.

[2 marks]

Answer = _____

0 2 . 3 Describe and explain the differences between the two curves.

[5 marks]

[Extra space]

Turn over for the next question

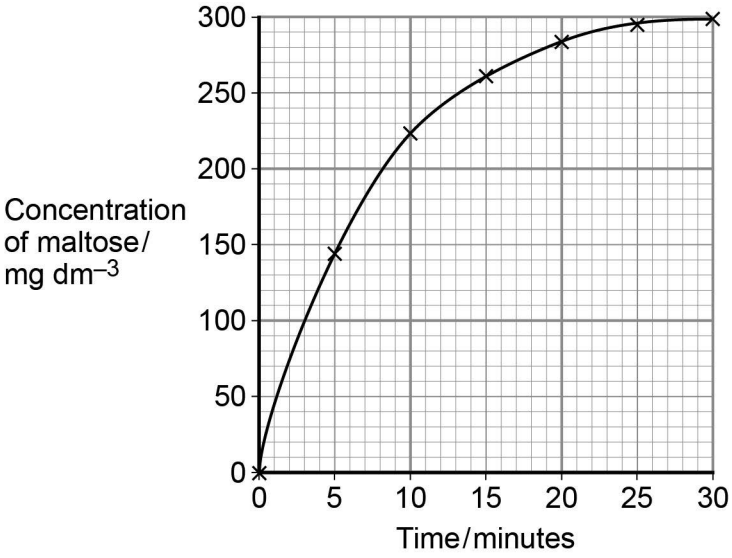
0 6 . 1 Describe the induced-fit model of enzyme action.

[2 marks]

0 6 . 2 A scientist investigated the hydrolysis of starch.
He added amylase to a suspension of starch and measured the concentration of maltose in the reaction mixture at regular intervals.

His results are shown in **Figure 4**.

Figure 4



Determine the rate of the reaction **at** 10 minutes.
Show how you obtained your answer.

[2 marks]

Rate of reaction _____ mg dm^{-3} min^{-1}

0 6 . 3 Explain the results shown in **Figure 4**.

[2 marks]

0 6 . 4 A quantitative Benedict's test produces a colour whose intensity depends on the concentration of reducing sugar in a solution. A colorimeter can be used to measure the intensity of this colour.

The scientist used quantitative Benedict's tests to produce a calibration curve of colorimeter reading against concentration of maltose.

Describe how the scientist would have produced the calibration curve and used it to obtain the results in **Figure 4**.

Do **not** include details of how to perform a Benedict's test in your answer.

[3 marks]

0 9 Read the following passage.

Alzheimer's disease leads to dementia. This involves small β-amyloid proteins binding together to form structures called plaques in the brain.

Nerve cells in the brain produce a large protein called amyloid-precursor protein that has a complex shape. This protein is the substrate of two different enzymes, α-secretase and β-secretase. These enzymes are normally produced in the brain. One product of the reaction catalysed by β-secretase is a smaller protein that can lead to β-amyloid protein formation. Many people with Alzheimer's disease have mutations that decrease α-secretase production, or increase β-secretase production.

One possible type of drug for treating Alzheimer's disease is a competitive inhibitor of β-secretase. When some of these types of drugs were trialled on patients, the trials had to be stopped because some patients developed serious side effects.

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

0 9 . 1 Suggest how amyloid-precursor protein can be the substrate of two different enzymes, α-secretase and β-secretase (lines 3–5).

[2 marks]

0 9 . 2 One product of the reaction catalysed by β-secretase is a smaller protein (lines 6–7).

Describe what happens in the hydrolysis reaction that produces the smaller protein from amyloid-precursor protein.

[2 marks]

0 9 . 3 Many people with Alzheimer's disease have mutations that decrease α-secretase production, or increase β-secretase production (lines 8–9).

Use the information provided to explain how these mutations can lead to Alzheimer's disease.

[3 marks]

0 9 . 4 One possible type of drug for treating Alzheimer's disease is a competitive inhibitor of β-secretase (lines 10–11).

Explain how this type of drug could prevent Alzheimer's disease becoming worse.

[2 marks]

0 9 . 5 When some of these types of drugs were trialled on patients, the trials were stopped because some patients developed serious side effects (lines 11–13).

Using the information provided, suggest why some patients developed serious side effects.

[1 mark]

END OF QUESTIONS

Question	Marking guidance	Mark	Comments
05.1	Biuret;	1	Ignore any other detail Accept • Copper sulfate and sodium hydroxide • $CuSO_4$ + NaOH • Alkaline copper sulfate • Copper sulphate and sodium hydroxide • Alkaline copper sulphate • Biurette • Buiret • Biruet • Bieuret Reject burette or Beirut
05.2	Draw around $H_2N - \underset{\displaystyle H}{\underset{\vert}{C}} - COOH$;	1	
05.3	Nitrogen;	1	Ignore N
05.4	Choice: (Student's) *t*-test; Reason for choice: Looking for differences between two means; Explanation: Difference is significant / not due to chance because the P value is 0.04 / is less than 0.05;	3	Reason: Allow comparing contrasting two means 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

Question	Marking Guidance	Mark	Comments
02.1	1. Condensation (reaction) / loss of water; 2. Between amine / NH_2 and carboxyl / COOH;	2	Accept each marking point if shown clearly in diagram. 2. Accept between amino (group) and carboxylic / acid (group)
02.2	1. Hydrogen bonds; 2. Between NH (group of one amino acid) and C=O (group); **OR** Forming β pleated sheets / α helix;	2	Accept as a diagram 1. Reject N - - - C / ionic / disulfide bridge / peptide bond
02.3	1. Different sequence of amino acids **OR** Different primary structure; 2. Forms ionic / hydrogen / disulfide bonds in different places;	2	1. If candidate assumes proteins are the same, accept effect of different pH/ temperature

Question	Marking Guidance	Mark	Comments
07.1	1. Lowers activation energy; 2. Induced fit **causes** active site (of enzyme) to change shape; 3. (So) enzyme-substrate complex **causes** bonds to form/break;	3	3. Accept: description, of induced fit 3. Accept: enzyme-substrate complex causes stress/strain on bonds.
07.2	Size/dimensions /mass/variety of potato **OR** Temperature (of solution/flask) **OR** pH (of solution);	1	Accept : weight of potato Ignore : amount of potato Ignore concentration/ volume of catalase
07.3	0.33, 0.60, 0.86, 1.0, 1.0 = 2 marks;; $\frac{6}{time}$ 2 significant figures If answer incorrect accept for 1 mark, Correct values but incorrect number of significant figures **OR** 1.0 written on row for hydrogen peroxide 2.0/2.5 in Table 5 **OR** Answers showing correct division, eg 0.3, 0.6, 0.9 **OR** Answers showing correct significant figures using incorrect calculation (÷18) 1.0, 0.56, 0.39, 0.33, 0.33	2	
07.4	1. Hydrogen peroxide concentration on x axis **and**	3	1. Graph should cover

	rate of reaction on Y axis, linear number sequence **and** appropriate scale; 2. Correct units /mol dm^{-3} **and** /arbitrary units/au; 3. All co-ordinates plotted accurately **with** point-to-point or smooth curve;		half or more of the grid; eg reject if Y axis covers only three big squares 2. Accept brackets instead of solidus 3. Accept accurate plotting of co-ordinates given in 07.3 3. Reject: bar chart 3. Reject: if ruled straight line of best fit 3. Accept: if x axis starts at 0.5 3. Accept: if line is extended to (0,0) Plot coordinates must be processed data, hydrogen peroxide vs time = 0
07.5	Cut up/use discs/homogenise/increase surface area (of potato chips) **OR** Use bigger chips **OR** Increase temperature **OR** Change pH;	1	Reject answer if the temperature is above 40°C Ignore: more/increase heat
TOTAL		**10**	

Question	Marking guidance	Mark	Comments
07.1	1. (Anti-AQP4) antibody has a (specific) tertiary structure; 2. Has binding site / variable region that only binds to / complementary to one antigen; 3. Antigen to this antibody (only) found on these nerve cells; 4. So, antibody (only) binds to / forms antigen-antibody complex with these nerve cells (causing damage);	4	Reject "active site" (only penalise once if it occurs throughout) 3. / 4. Accept 'receptor' for antigen
07.2	1. Only 20 in the study; OR Only one study; 2. For some concentrations of antibody there is a range in the number of vertebrae surrounding damaged nerve cells; 3. No statistical test used; 4. Correlation is weak;	3 max	1. Accept small sample 2. Accept suitable use of data 2. Accept converse
07.3	1. The monoclonal antibody binds to nerve cell antigen so less / no anti-AQP4 can bind; OR The monoclonal antibody forms antigen-antibody complex with nerve cell antigen so less / no anti-AQP4 can bind; 2. When monoclonal antibody binds it doesn't cause damage to nerve cell;	2 max	It = monoclonal antibody 1. Reject "active site" Ignore "competitive inhibitor" Accept receptor for antigen Do not credit responses in the context of enzymes

Question	Marking Guidance	Mark	Comments
02.1	Concentration of substrate solution / of enzyme solution / pH;	1	
02.2	1. 2.5/0.04; 2. g dm^{-3} $minute^{-1}$ / g dm^{-3} s^{-1};	2	1 mark for correct value 1 mark for related unit
02.3	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;	5	Allow converse for correct descriptions and explanations for curve at 25 °C

Question	Marking Guidance	Mark	Comments
06.1	1. (before reaction) active site not complementary to/does not fit substrate; 2. Shape of active site changes as substrate binds/as enzyme-substrate complex forms; 3. Stressing/distorting/bending bonds (in substrate leading to reaction);	2 max	Note. Points 1 and 2 may be made in one statement and 'complementary' introduced at any point. 2. Ignore references to how shape change is caused Points 1&2 – active site mentioned once applies for both points
06.2	1. Tangent to curve drawn; 2. Value in range of 8 to 11;	2	1.Tangent drawn at about 10 minutes 2.1 mark only for correct answer
06.3	1. (Rate of) increase in concentration of maltose slows as substrate/starch is used up **OR** High initial rate as plenty of starch/substrate/more E-S complexes; 2. No increase after 25 minutes/at end/levels off because no substrate/starch left;	2	1.Reject ref. to amylase being used up 2. accept 'little' 2. Ignore references to substrate a limiting factor
06.4	1. Make/use maltose solutions of known/different concentrations (and carry out quantitative Benedict's test on each); 2. (Use colorimeter to) measure colour/colorimeter value of each solution and plot calibration curve/graph described; 3. Find concentration of sample from calibration curve;	3	2.Axes must be correct if axes mentioned, concentration on x-axis and colorimeter reading on y-axis

Question	Marking Guidance	Mark	Comments
09.1	1. Different parts/areas/amino acid sequences (of amyloid-precursor) protein; 2. Each enzyme is specific /fits/binds/ complementary to a different part of the APP;	2	1.Accept APP 2.Point 2 subsumes point 1 and is worth 2 marks total.
09.2	1. Peptide bond broken; 2. Using water;	2	Hydrolysis in stem
09.3	1. Mutations prevent production of enzyme(s)/functional enzyme; 2. (Increase in β-secretase) leads to faster/more β-amyloid production **OR** (Decrease in α-secretase) leads to more substrate for β-secretase; 3. (Leads to) more/greater plaque formation;	3	2.'This' must refer to α-secretase
09.4	1. (Inhibitor) binds to/blocks active site of β-secretase/enzyme; 2. Stops/reduces production of β-amyloid/plaque;	2	
09.5	1. Some β-amyloid required/needed (to prevent side effects) **OR** (Some) β-secretase needed; 2. Leads to build-up of amyloid-precursor protein (that causes harm) **OR** Too much product of α-secretase (causes harm);	1 max	1.Accept 'Both enzymes needed' 2. Accept build-up of substrate (leads to harm)