

Please check the examination details below before entering your candidate information

Candidate surname

StemUp Model Solution

Other names

Pearson Edexcel
Level 3 GCE

Centre Number

--	--	--	--	--

Candidate Number

--	--	--	--	--

Tuesday 21 May 2019

Afternoon (Time: 1 hour 30 minutes)

Paper Reference **8BI0/01**

Biology B

Advanced Subsidiary

Paper 1: Core Cellular Biology and Microbiology

You must have:

Calculator, HB pencil, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You may use a scientific calculator.
- In question(s) marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep your eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

P55918A

©2019 Pearson Education Ltd.

1/1/1/1/



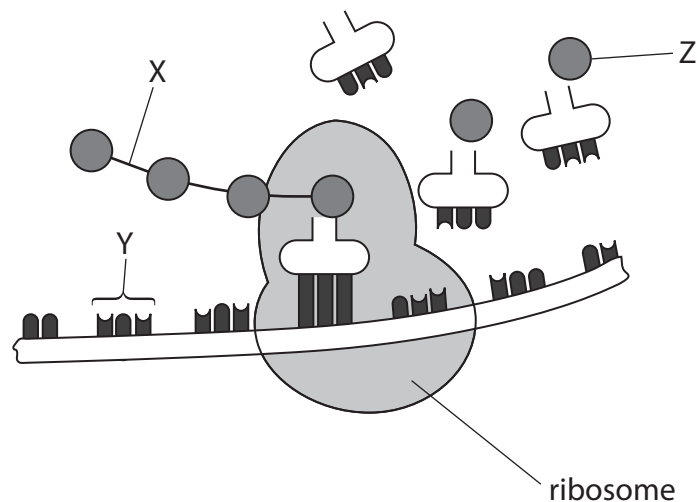
P 5 5 9 1 8 A 0 1 2 8


Pearson

Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☒.

- 1 (a) The diagram represents part of protein synthesis.



- (i) Name the stage of protein synthesis shown in the diagram.

(1)

Translation

- (ii) The stage shown in the diagram takes place in the

(1)

- ☒ **A** cytoplasm
- ☐ **B** Golgi apparatus
- ☐ **C** nucleus
- ☐ **D** smooth endoplasmic reticulum

- (iii) The part labelled X on the diagram represents

(1)

- ☐ **A** an ester bond
- ☐ **B** a glycosidic bond
- ☐ **C** a hydrogen bond
- ☒ **D** a peptide bond



(iv) The part labelled Y on the diagram represents

(1)

- ☐ A an anticodon
- ☐ B a base pair
- ☒ C a codon
- ☐ D a DNA triplet

(v) Name the molecule represented by the part labelled Z on the diagram.

(1)

Amino acid

(b) The table shows the number of bases in the DNA strand used in the synthesis of mRNA.

Complete the table to show the percentage of bases in the mRNA synthesised.

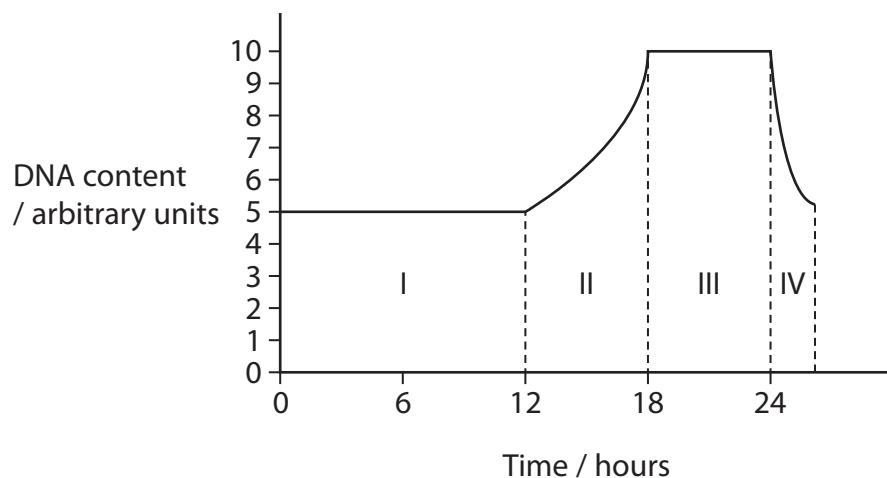
(3)

Bases	Number of bases in the DNA strand	Percentage of bases in the mRNA (%)
Adenine	31 000	23.3
Cytosine	22 000	25.2
Guanine	26 000	21.4
Thymine	24 000	0.0

(Total for Question 1 = 8 marks)



- 2 The graph shows the DNA content of a cell during four stages, I, II, III and IV, of one cell cycle.



- (a) (i) In which stage does DNA replication take place?

(1)

- ☐ A stage I
- ☒ B stage II
- ☐ C stage III
- ☐ D stage IV

- (ii) Explain the role of the enzyme ligase in DNA replication.

(3)

DNA ligase joins sections of DNA together, i.e. it joins the Okazaki fragments produced when the lagging strand is copied (DNA polymerase can only work in the 5' to 3' direction).

It does this by forming phosphodiester bonds, which repairs the breaks in the sugar-phosphate (phosphodiester) backbone.

These bonds form between the phosphate of one nucleotide and the deoxyribose (sugar) of the adjacent nucleotide.



(b) Describe what is happening during stage IV in the cell cycle.

(3)

The DNA content halves, from 10 to 5 arbitrary units.

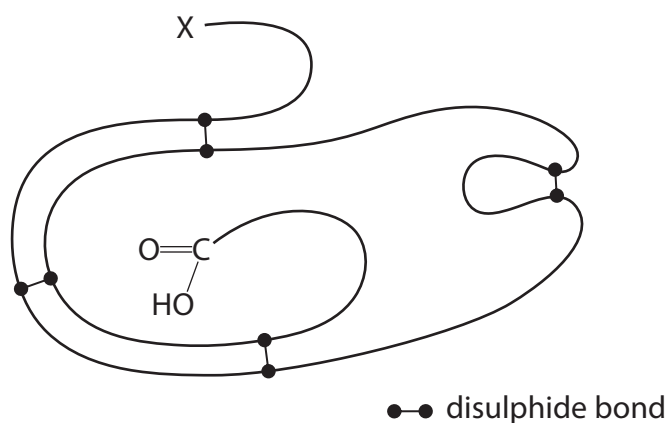
This is because the cytoplasm is dividing (cytokinesis): the cell membrane contracts (pinches in) at the equator of the cell.

So two daughter cells are formed, each with half the DNA content.

(Total for Question 2 = 7 marks)



3 The diagram shows the tertiary structure of a molecule of the enzyme RNase.



(a) (i) Which chemical group is found at position X?

(1)

- ☒ A amino
- ☐ B carboxyl
- ☐ C hydroxyl
- ☐ D nitrate

(ii) Give the meaning of the term tertiary structure of a protein.

(2)

The tertiary structure is the overall three-dimensional shape (folding) of the polypeptide chain (protein).

It is held together by bonds between the R groups, e.g. disulphide bonds, ionic bonds and hydrogen bonds.

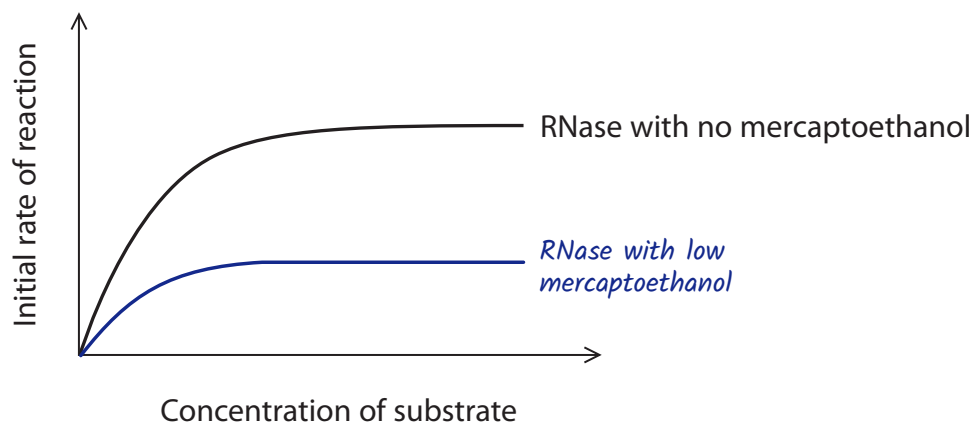


- (b) The chemical mercaptoethanol breaks disulfide bonds.

The graph shows the initial rate of reaction of RNase with no added mercaptoethanol.

Sketch a line on the graph to show the effect of a low concentration of mercaptoethanol on the activity of RNase.

(1)



- (c) Analyse the information to explain the effect of adding mercaptoethanol on the activity of RNase.

(3)

Mercaptoethanol breaks the disulphide bonds, so it changes the tertiary structure of the RNase.

Therefore the RNase is denatured, as the shape of the active site has changed.

So the substrate no longer fits the active site and fewer enzyme-substrate complexes form, so the RNase can no longer catalyse the reaction (fewer functioning enzymes are available).

Therefore the initial rate of reaction is much lower than with no mercaptoethanol.

(Total for Question 3 = 7 marks)



P 5 5 9 1 8 A 0 7 2 8

- 4 (a) A queen bee can lay both fertilised and unfertilised eggs.

Fertilised eggs develop into diploid females.

Unfertilised eggs develop into haploid males.

- (i) Explain which type of cell division produces gametes in female bees.

(2)

Meiosis, because the female is diploid and the gametes must be haploid.

Meiosis is a reduction division that halves the number of chromosomes, so haploid

gametes are produced from a diploid cell.

- (ii) Explain which type of cell division produces gametes in male bees.

(2)

Mitosis, because the male is already haploid.

The number of chromosomes remains the same in mitosis, so haploid gametes are

produced; haploid cells do not need (cannot carry out) a reduction division.

- (iii) Which row identifies the features that contribute to genetic variation in the offspring of bees?

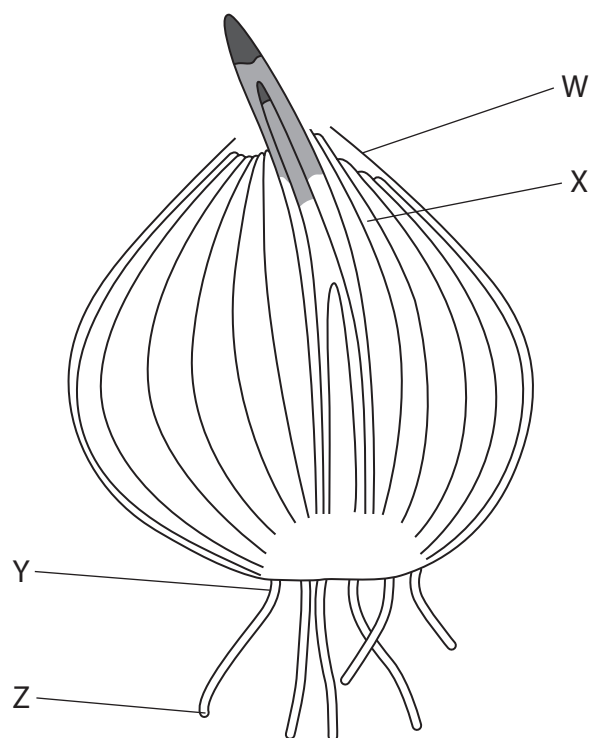
(1)

	Random fusion of gametes		Independent assortment of chromosomes		Crossing over	
	Female offspring	Male offspring	Female offspring	Male offspring	Female offspring	Male offspring
☐ A	✓	✓	✓	✓	✓	✓
☐ B	✓	×	×	✓	×	✓
☒ C	✓	×	✓	×	✓	×
☐ D	×	×	✓	×	✓	×



- (b) Onion bulbs that are growing can be used to make slides of plant tissue to observe the stages of mitosis.

The diagram shows a section through an onion bulb that is starting to grow.



- (i) Which of the parts, W, X, Y or Z, should be used to prepare a slide showing mitosis?

(1)

- ☐ A W
☐ B X
☐ C Y
☒ D Z

- (ii) Name a stain that can be used to show the stages of mitosis.

(1)

Acetic orcein



P 5 5 9 1 8 A 0 9 2 8

(iii) Explain how to make a temporary preparation to show the stages of mitosis, after adding the stain to the slide.

(2)

Warm (heat) the slide gently to intensify the stain.

Squash (tease) the tissue to separate the cells into a single layer, then apply a coverslip, which stops evaporation and allows viewing at high magnification.

(Total for Question 4 = 9 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

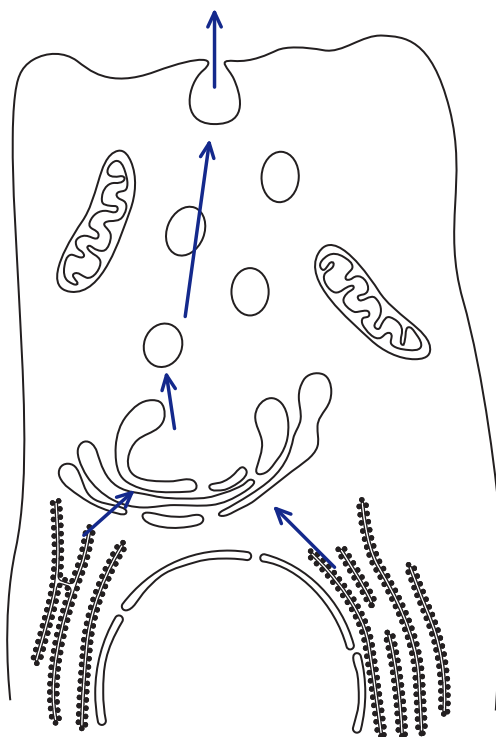
DO NOT WRITE IN THIS AREA

BLANK PAGE



P 5 5 9 1 8 A 0 1 1 2 8

- 5 The diagram shows part of a cell from the pancreas that produces enzymes for use in the digestion of food.



- (a) State one way in which the structure of a prokaryotic cell would differ from the cell shown in this diagram.

(1)

It would not have membrane-bound organelles, e.g. no nucleus or mitochondria.

- (b) In an investigation, cells from the pancreas were grown in a culture medium containing radioactive amino acids.

Samples of these cells were taken and the level of radioactivity in three organelles was measured.

The table shows the results of this investigation.

Time after radioactive amino acids were added to the culture medium / min	Level of radioactivity present / arbitrary units		
	Golgi apparatus	Rough endoplasmic reticulum	Vesicles
1	21	120	6
20	52	88	6
40	86	39	8
60	71	23	15
90	50	27	28
120	23	11	51



- (i) Using the information in the table, draw arrows on the diagram showing the path of radioactivity through and out of the cell.

(2)

- (ii) Comment on the results of this investigation.

(4)

The radioactive amino acids are incorporated into proteins (polypeptides, enzymes) on the RER, so the RER is highest at 1 minute.

Radioactivity then decreases in the RER as the proteins are moved to the Golgi apparatus, which peaks at 40 minutes.

Radioactivity decreases in the Golgi apparatus after 40 minutes as protein is packaged into vesicles.

Radioactivity increases in the vesicles (6 to 51 a.u.) as they carry the enzymes ready for secretion.

The total radioactivity decreases (147 to 85 a.u.) as proteins are secreted from the cell by exocytosis.

- (c) The diagram shows the position of the pancreas and the small intestine.



Lipase and protease enzymes produced by the pancreas are used in the small intestine during digestion.

Pancreatitis is a condition that occurs when the pancreatic duct becomes blocked.



- (i) Explain how the contents of the small intestine in a patient with pancreatitis would differ from the contents of the small intestine in a healthy person.

(2)

Fewer (no) lipase and protease enzymes reach the small intestine, because the pancreatic duct is blocked.

Therefore there would be a higher concentration of undigested food, i.e. more undigested protein and lipid, and a lower concentration of amino acids, fatty acids and glycerol.

- (ii) Some of the enzymes are produced in an inactive form.

In patients with pancreatitis, these enzymes can become active in the pancreas.

Explain how this activation could affect the pancreas.

(2)

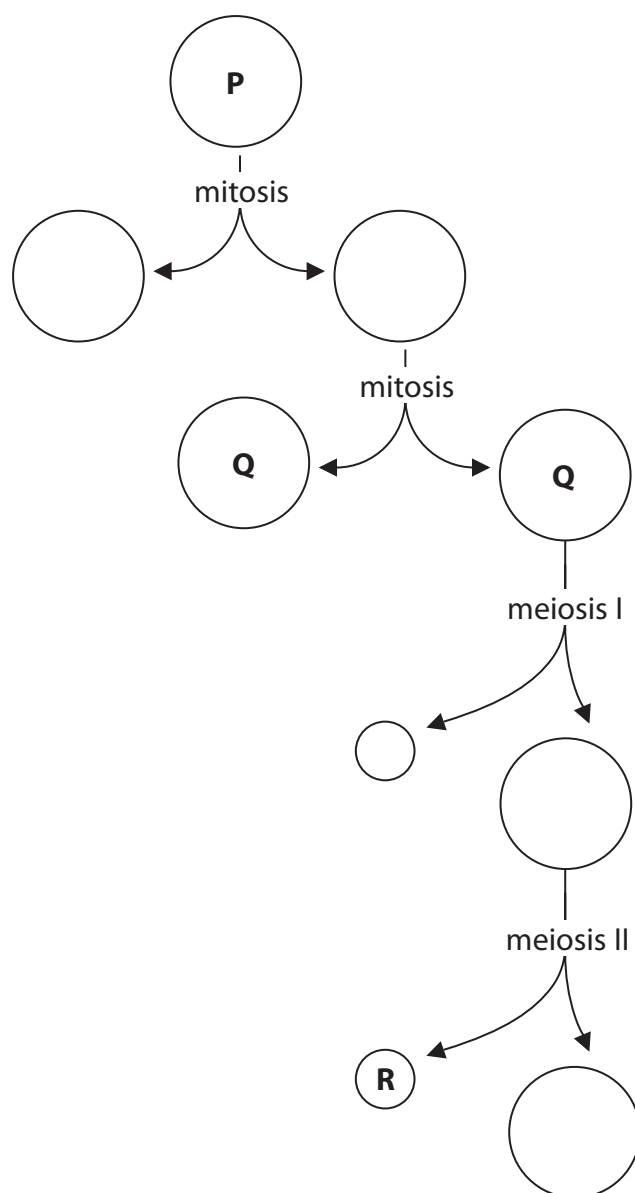
The active enzymes (protease and lipase) would digest the cells of the pancreas, so the pancreas will be damaged.

Resulting in fewer enzymes and hormones being produced, e.g. insulin is digested (less is produced), which can cause diabetes.

(Total for Question 5 = 11 marks)



6 The diagram summarises the process of oogenesis in humans.



(a) Which row contains the names for cells **P**, **Q** and **R**?

(1)

	P	Q	R
☒ A	germ cell	oocyte	polar body
☐ B	germ cell	polar body	ovum
☐ C	oocyte	polar body	ovum
☐ D	ovum	germ cell	oocyte



P 5 5 9 1 8 A 0 1 5 2 8

(b) A study determined the number of oocytes in human females of different ages.

The table shows the results of this study.

Age / years	Mean number of oocytes per female
at birth	733 000
4 to 10	499 200
11 to 17	389 300
18 to 24	161 800
25 to 31	80 200
32 to 38	32 500
39 to 45	10 900

- (i) Calculate the percentage change in the mean oocyte numbers between birth and 11 to 17 years.

(2)

$$733\,000 - 389\,300 = 343\,700$$

$$343\,700 \div 733\,000 \times 100 = 46.89$$

Answer 46.9 % decrease

- (ii) Deduce when oocytes are produced in a female human.

(1)

Oocytes are produced before birth (during gestation), as the number is highest at birth
and then only decreases.



- (c) Some men are infertile due to a condition called azoospermia.

Men with this condition produce semen that contains spermatids instead of mature spermatozoa.

- (i) State one structural difference between a spermatid and a mature spermatozoon.

(1)

A spermatid has no tail (flagellum), whereas a mature spermatozoon has a tail.

- (ii) Explain why men with azoospermia are infertile.

(2)

Spermatids are non-motile, so they cannot swim to the egg (oocyte).

Therefore they are unable to penetrate the egg (no acrosome reaction), so no fusion with the oocyte occurs and the egg cannot be fertilised.

- (iii) Infertility caused by azoospermia can be treated by using intracytoplasmic sperm injection (ICSI).

This procedure injects a single spermatid directly into an oocyte.

One concern about this procedure is that it uses selected spermatids. This eliminates the normal competition between sperm that precedes fertilisation.

Explain the advantage of competition between sperm.

(2)

Competition means that the fittest (fastest, healthiest, most developed) sperm will fertilise the oocyte, so natural selection can take place.

Therefore advantageous alleles are passed on to the offspring.



P 5 5 9 1 8 A 0 1 7 2 8

(iv) Describe two ethical implications of the use of ICSI.

(2)

It interferes with a natural process: the fertilising male gamete is chosen by a doctor rather than by natural competition between sperm.

The embryo may be abnormal, because of the lack of natural selection, damage due to the technique or a chromosome abnormality (gene mutation) being passed on. It could also lead to artificial selection (designer babies).

(Total for Question 6 = 11 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE



7 When apples are cut, the enzyme polyphenol oxidase is released from the cells.

This enzyme converts colourless phenols into a brown pigment called melanin.

Citric acid or a protease enzyme can be added to apple slices to prevent this browning.

(a) (i) Explain why the addition of citric acid prevents the browning of apple slices.

(2)

Citric acid lowers the pH, which denatures the polyphenol oxidase (changes the shape of its active site).

So the phenols no longer fit the active site, and no enzyme-substrate complexes can form, so no melanin is made.

(ii) Explain why the addition of a protease enzyme prevents the browning of apple slices.

(2)

The protease digests (hydrolyses) the polyphenol oxidase.

Because polyphenol oxidase is an enzyme, so it is a protein, so the phenols are not converted to melanin.



- (b) An investigation was carried out into the activity of polyphenol oxidase by measuring the quantity of melanin formed.

An apple was cut into five equal slices and the first slice finely crushed and filtered.

The concentration of melanin in the filtrate was then measured.

The remaining four slices were finely crushed and filtered at 60 second intervals.

The table shows the results of this investigation.

Apple slice	Time / s	Melanin concentration / a.u
1	0	0
2	60	19
3	120	38
4	180	51
5	240	62

- (i) Analyse the data to explain the results of this investigation.

(3)

As time increases, more melanin is produced, from 0 a.u. at 0 s to 62 a.u. at 240 s, because the polyphenol oxidase keeps converting the phenols into melanin.

The increase is linear up to 120 s (19 a.u. every 60 s), but then it is non-linear: the rate reduces after 120 seconds, to 13 a.u. and then 11 a.u. per 60 s.

This is because the substrate (phenol) concentration is reducing as it is used up, so there are fewer enzyme-substrate collisions. End product inhibition by melanin may also slow the reaction.



P 5 5 9 1 8 A 0 2 1 2 8

- * (ii) The temperature at which apple slices are stored can affect the activity of the enzyme polyphenol oxidase.

Devise a valid method to investigate the effect of temperature on the browning of apple slices.

(6)

The independent variable is temperature and the dependent variable is the concentration of melanin produced, measured in the same way as in the investigation in (b).

Use at least five temperatures, e.g. 10, 20, 30, 40 and 50 °C. Control each temperature with a thermostatically controlled water bath, and check it with a thermometer.

Cut slices from the same apple (same variety and source), each with the same mass (e.g. 5 g on a balance) and the same size and surface area, so the quantity of enzyme and phenol substrate is the same. A larger slice would release more enzyme and substrate and so produce more melanin.

Place each slice in a boiling tube with the same volume of pH 7 buffer solution, because pH affects the activity of polyphenol oxidase, and leave the tubes in the water bath to equilibrate at each temperature.

After a fixed time, crush and filter each slice in the same way and measure the concentration of melanin in the filtrate using a colorimeter (absorbance). Use a time of 120 seconds, because the data in (b) show that the rate is still constant (linear) up to 120 s, so the initial rate is measured before the substrate runs out.

Carry out at least three repeats at each temperature and calculate a mean, to identify anomalies and improve the validity of the data.

As a control, use a slice in which the enzyme has been denatured by boiling, to show that the browning is caused by polyphenol oxidase and not by temperature alone.

Plot a graph of mean melanin concentration (rate of browning) against temperature to find the optimum temperature for storage.

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Handwriting practice area with horizontal dotted lines.

(Total for Question 7 =13 marks)



8 During mitosis, microtubules form the spindle.

These microtubules are made of a protein called tubulin.

Individual tubulin molecules are globular with a diameter of 25 nm.

Thousands of tubulin molecules are assembled together to form long, hollow microtubules.

(a) (i) Describe the differences between a fibrous protein and an individual tubulin molecule. (2)

Fibrous proteins have little or no tertiary structure, whereas tubulin has a tertiary structure, as it is folded into a globular shape.

Fibrous proteins are made of long polypeptide chains (with cross-linkages), so they are long and tough, whereas tubulin is compact and spherical.

Fibrous proteins are insoluble in water, whereas tubulin is (semi) soluble, as its hydrophobic groups are on the inside.

(ii) A microtubule is 40 μm in length.

Calculate how many times longer this microtubule is than a single tubulin molecule. (2)

$$40 \mu\text{m} = 40 \times 1000 = 40\,000 \text{ nm}$$

$$40\,000 \div 25 = 1600$$

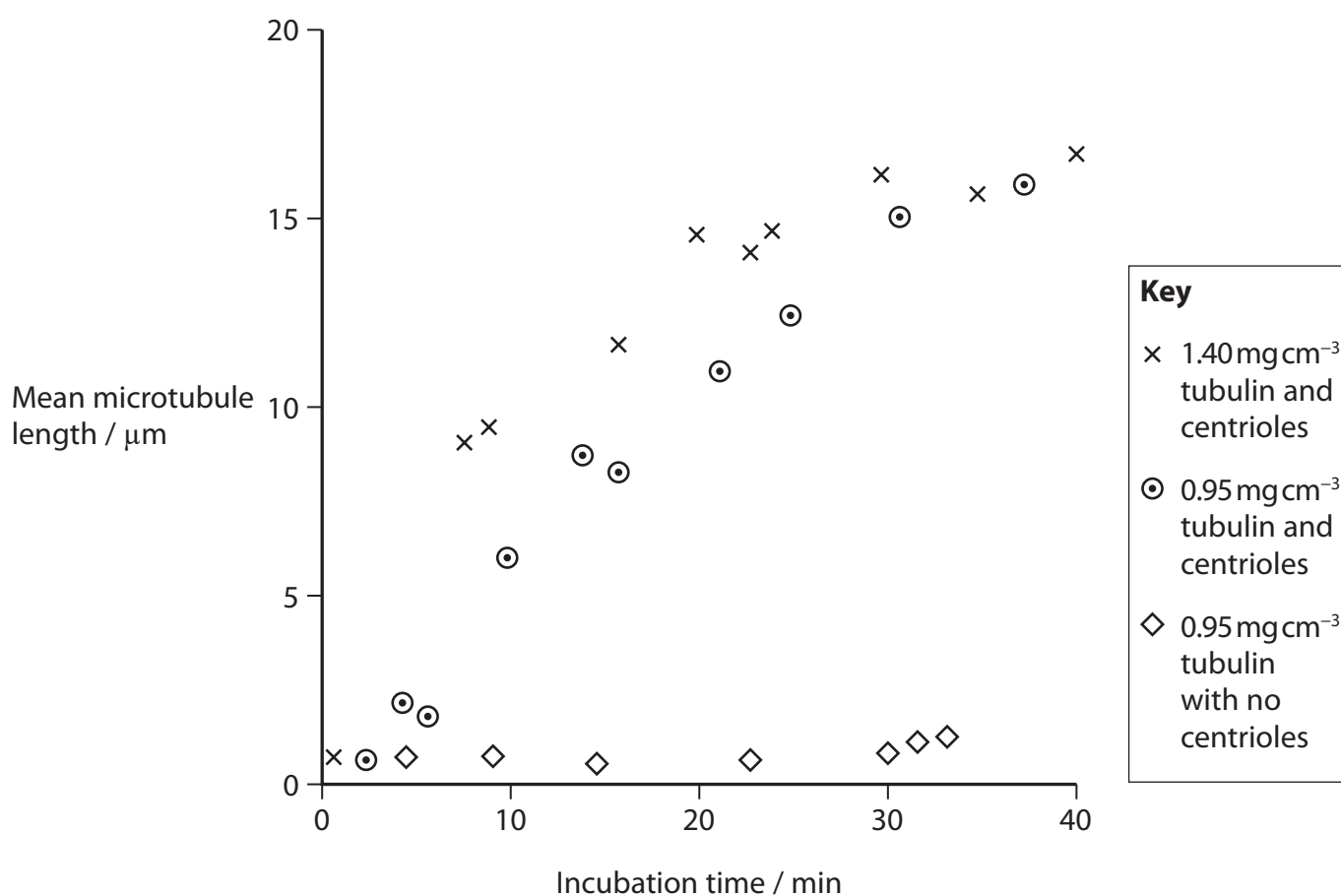
Answer *1600 times*



(b) The involvement of centrioles in spindle formation was investigated using the following method:

- in the first experiment, purified tubulin at a concentration of 1.40 mg cm^{-3} was mixed with centriole fragments
- the mixture was incubated at 35°C
- every few minutes, the length of any microtubules formed was measured
- in a second experiment, a mixture containing 0.95 mg cm^{-3} tubulin and centriole fragments was used
- in a third experiment, 0.95 mg cm^{-3} tubulin with no centriole fragments present was used
- each of these three experiments was repeated several times.

The graph shows the results of this investigation.



P 5 5 9 1 8 A 0 2 5 2 8

- (i) Analyse the data to comment on the relationship between centrioles and tubulin in the production of microtubules.

(4)

Centrioles are clearly needed, because the microtubules did not increase in length (significantly) in the absence of centrioles; they stayed below about $1\text{ }\mu\text{m}$.

The concentration of tubulin is also significant, because 1.40 mg cm^{-3} produced longer microtubules than 0.95 mg cm^{-3} in the first 30 minutes, e.g. about $14.5\text{ }\mu\text{m}$ compared with $11\text{ }\mu\text{m}$ at 20 minutes.

This is because the higher concentration of substrate (tubulin) increased the number of collisions with the centrioles, so the rate of assembly is faster.

The microtubule growth is non-linear; the mean length appears to reach a maximum at about $17\text{ }\mu\text{m}$ after 30 minutes. This suggests that there is another limiting factor.

- (ii) Explain why the centriole fragments and tubulin were each in a buffer solution at $35\text{ }^{\circ}\text{C}$ before being used in these experiments.

(4)

A buffer prevents any change in the pH.

This is because a change in pH may denature (change the shape of) the proteins, i.e. the tubulin and the centriole fragments, as the hydrogen and ionic bonds holding their tertiary structure are disrupted.

This may prevent bonding between tubulin molecules, and between the tubulin and the centrioles.

Keeping them at $35\text{ }^{\circ}\text{C}$ lets them equilibrate to the temperature at which the experiment is carried out, so the reaction starts at the correct temperature, and a too high temperature would also denature the proteins.

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

- (c) It was observed that for the mixture of 1.40 mg cm^{-3} tubulin with centriole fragments the mean length of microtubules decreased after 40 minutes.

Explain why the microtubule length decreased after 40 minutes.

(2)

Tubulin can detach from the microtubules as well as join them, and an equilibrium between forming and breaking was reached at about 30 minutes.

Some of the microtubules may break, or are shortened by the centriole, in the same way as they shorten during cell division.

(Total for Question 8 = 14 marks)

TOTAL FOR PAPER = 80 MARKS



P 5 5 9 1 8 A 0 2 7 2 8

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE

Every effort has been made to contact copyright holders to obtain their permission for the use of copyright material. Pearson Education Ltd. will, if notified, be happy to rectify any errors or omissions and include any such rectifications in future editions.

