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Pearson Edexcel
Level 3 GCE

Centre Number

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Candidate Number

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Biology B

Advanced Subsidiary

Paper 1: Core Cellular Biology and Microbiology

Thursday 24 May 2018 – Afternoon

Time: 1 hour 30 minutes

Paper Reference

8BI0/01

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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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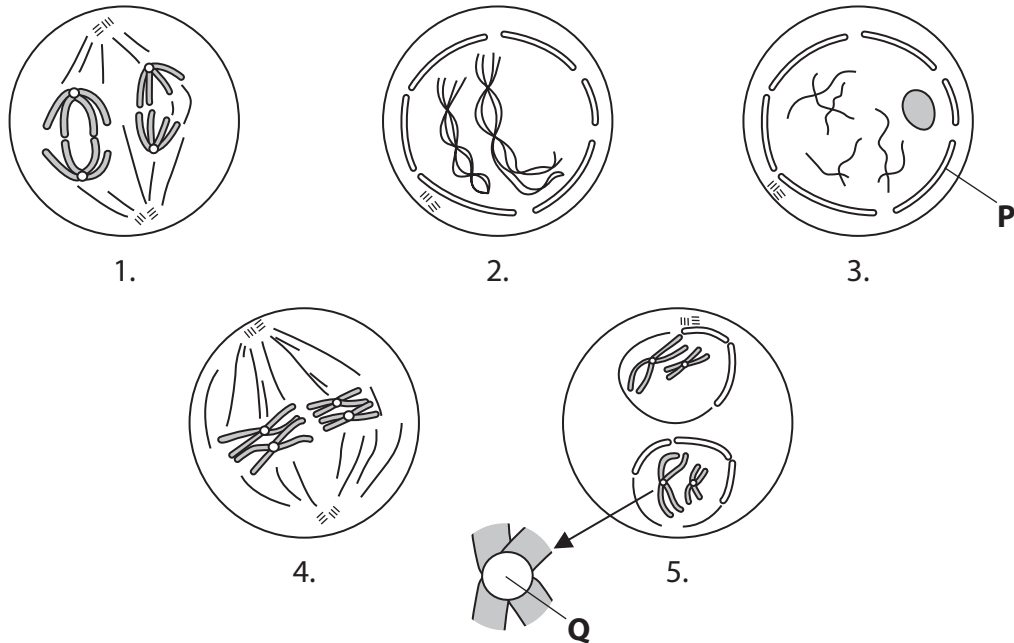
stemup.co.uk

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** In some diploid organisms, haploid cells are produced by meiosis.

The diagram shows an animal cell at various stages during the first division of meiosis.



- (a) (i) Identify the correct sequence in the diagram that shows the first division of meiosis.

(1)

- ☐ **A** 1, 2, 3, 4, 5
- ☐ **B** 2, 5, 4, 1, 3
- ☒ **C** 3, 2, 4, 1, 5
- ☐ **D** 5, 4, 1, 2, 3

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(ii) Identify the parts labelled P and Q.

(2)

P *nuclear envelope (nuclear membrane)*

Q *centromere*

(b) In mammals, meiosis occurs during oogenesis and spermatogenesis.

Describe how the products of oogenesis differ from the products of spermatogenesis in mammals.

(4)

Ova (eggs) are much larger cells than spermatozoa, with more cytoplasm and food stores.

Spermatozoa have an acrosome and a tail (flagellum) so they are motile, but ova do not.

Ova are surrounded by a zona pellucida (and follicle cells), spermatozoa are not.

Oogenesis also produces polar bodies, but spermatogenesis does not; far more spermatozoa are produced than ova.

(Total for Question 1 = 7 marks)



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2 Enzymes are catalysts that are sensitive to changes in temperature.

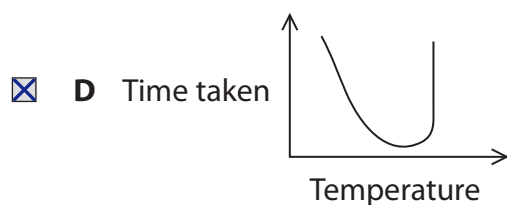
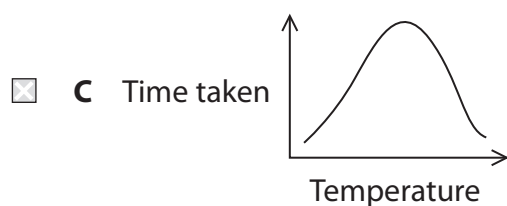
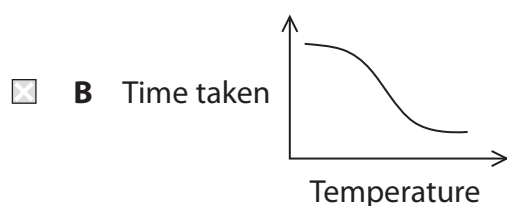
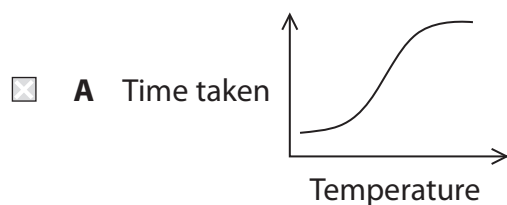
(a) The effect of temperature on the activity of a mammalian enzyme was investigated.

The enzyme was added to a known concentration of the substrate.

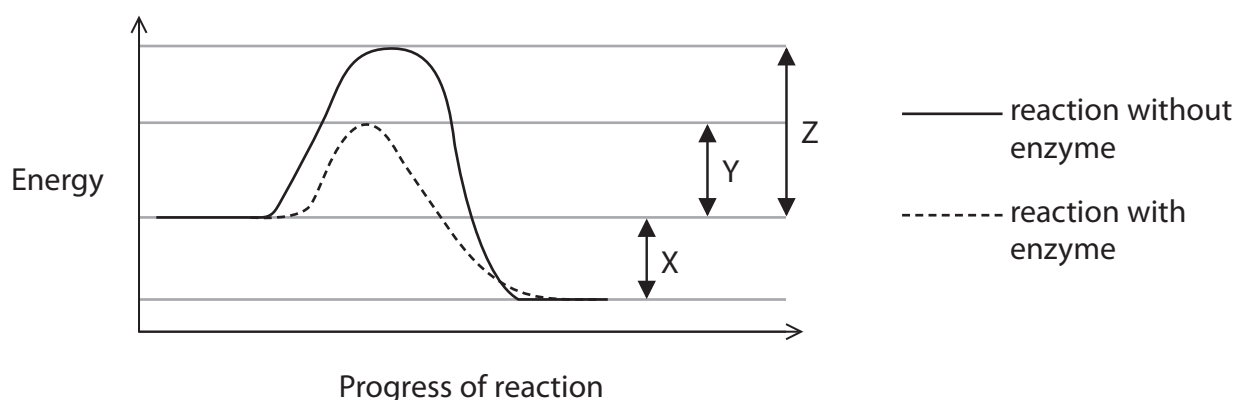
The time taken for all of the substrate to be used up was recorded at several temperatures.

(i) Which graph shows the results of this investigation?

(1)



(ii) The graph shows the energy changes during a reaction with and without an enzyme.



Which of the following represents the decrease in the activation energy of this reaction?

(1)

- ☐ A X
- ☐ B $X + Y$
- ☐ C Z
- ☒ D $Z - Y$

(b) Some antibiotics affect the enzymes involved in the growth of bacteria.

- (i) Explain why Gram positive bacteria and Gram negative bacteria react differently to some antibiotics.

(3)

Gram positive bacteria have a thick layer of peptidoglycan in their cell wall, whereas

Gram negative bacteria have a thin peptidoglycan layer covered by an outer membrane.

Some antibiotics (e.g. penicillin) inhibit the enzymes involved in forming peptidoglycan, so they are more effective against Gram positive bacteria.

Other antibiotics are not able to cross the thick peptidoglycan layer, so they are only effective against Gram negative bacteria.

- (ii) Explain why viruses are not affected by antibiotics.

(2)

Viruses are not living cells, so they have no metabolism of their own for antibiotics to target.

Viruses do not have a cell wall (or ribosomes), which is what antibiotics usually target.

(Total for Question 2 = 7 marks)



- 3 Leeches are parasites that feed by sucking blood. When they bite, they secrete saliva into the wound. The saliva contains a globular protein called hirudin.

(a) Explain why this protein is soluble in water.

(3)

Hirudin is a globular protein, so the polypeptide is folded so that the hydrophilic R groups are on the outside of the molecule and the hydrophobic R groups are on the inside.

These exposed R groups are polar (or ionic / charged).

Water is a polar solvent (water molecules are dipoles, with a slightly negative oxygen and slightly positive hydrogens).

Therefore the polar R groups on the surface form hydrogen bonds with water molecules, so the protein dissolves.



(b) Hirudin is an inhibitor that forms hydrogen bonds with an enzyme.

Explain how hirudin would inhibit the activity of the enzyme.

(3)

Hirudin binds to the enzyme (by hydrogen bonds), which changes the tertiary structure (shape) of the enzyme.

This results in a change in the shape of the active site of the enzyme (or hirudin binds in the active site and blocks it).

This prevents the substrate from binding to the active site, so no enzyme-substrate complexes can form and the enzyme activity is inhibited.

(Total for Question 3 = 6 marks)



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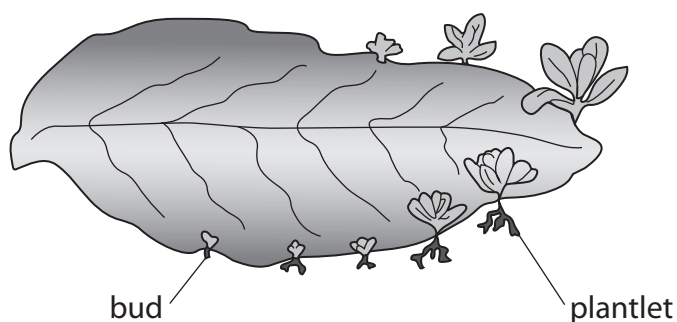
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4 The diagram shows a leaf of *Bryophyllum*.

Some of the cells at the edges of the leaf divide to form buds. These buds can develop into individual plantlets.



- (a) (i) Name the type of nuclear division that produces the plantlets.

(1)

mitosis

- (ii) State **two** advantages of this type of reproduction.

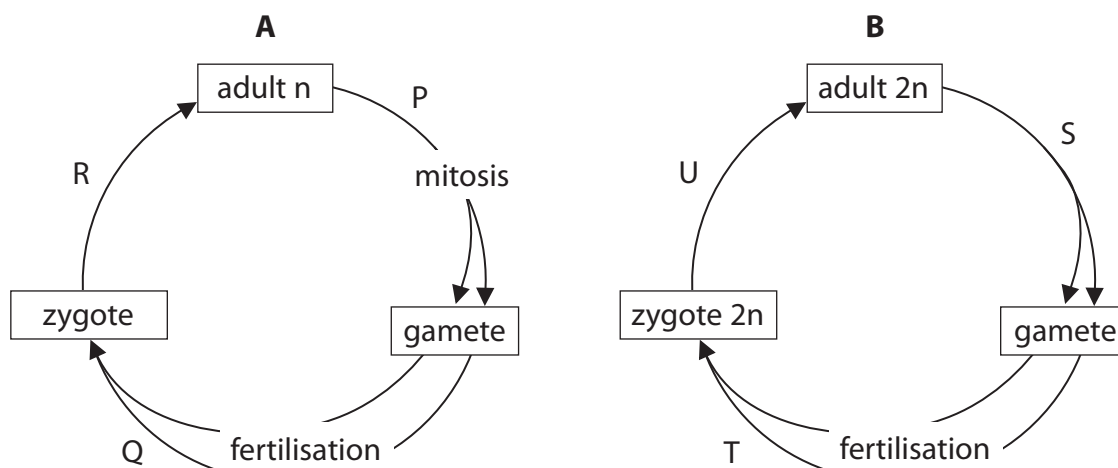
(2)

It can produce large numbers of offspring and reproduce rapidly.

It does not need another plant (no mate or pollinator is needed).



(b) The diagrams show the life cycles of two organisms, **A** and **B**.



(i) Which row of the table correctly describes the zygote of organism **A** and the gametes of organism **B**?

(1)

	Zygote of organism A	Gametes of organism B
☐ A	diploid	diploid
☒ B	diploid	haploid
☐ C	haploid	diploid
☐ D	haploid	haploid

(ii) Which row in the table shows where meiosis occurs in each life cycle?

(1)

	Life cycle A	Life cycle B
☐ A	P	T
☐ B	Q	U
☒ C	R	S
☐ D	R	T

(iii) Explain the significance of meiosis in living organisms.

(3)

Meiosis halves the chromosome number, so the diploid number is restored at fertilisation, and it is a source of genetic variation.

This is because it involves crossing over and independent (random) assortment of chromosomes, and the gametes then fuse by random fertilisation.

It allows the contribution of DNA (alleles) from two individuals, producing new combinations of alleles.

Genetic variation allows organisms (populations) to adapt to environmental change, so some survive and evolve by natural selection.

(Total for Question 4 = 8 marks)



- 5 Cattle with bovine spongiform encephalopathy (BSE) have microscopic holes in their brain tissue. This disease involves the misfolding of proteins which then form clumps. Clumps of misfolded proteins can be seen with an electron microscope.

(a) BSE is diagnosed by examination of brain tissue.

- (i) Explain why the clumps of misfolded proteins can be seen with an electron microscope, but not with a light microscope.

(2)

A light microscope has limited resolution (and limited useful magnification), so the small clumps cannot be distinguished.

This is because the wavelength of visible light is longer than that of a beam of electrons, so an electron microscope has a much higher resolution.

- (ii) Explain why stains are used when preparing tissue for examination using a light microscope.

(2)

Stains provide greater contrast, as most cell structures are transparent.

This is because the stain attaches to (is taken up by) specific parts or types of cell, so these structures can be distinguished.



(b) The misfolded proteins have a changed secondary structure. Therefore they cannot be digested by some protease enzymes.

(i) Describe what is meant by the secondary structure of a protein.

(2)

The secondary structure is the folding (coiling) of the primary structure (polypeptide chain) into an α -helix or a β -pleated sheet.

This is held in place by hydrogen bonds between the C=O and N-H groups of the peptide bonds.

(ii) Explain why the misfolded protein cannot be digested by some protease enzymes.

(3)

Protease enzymes have an active site with a specific shape, specific to certain amino acid sequences (substrates).

The misfolded protein has a different shape, so it will not fit into (is not complementary to) the active site of the protease, and no enzyme-substrate complex forms.

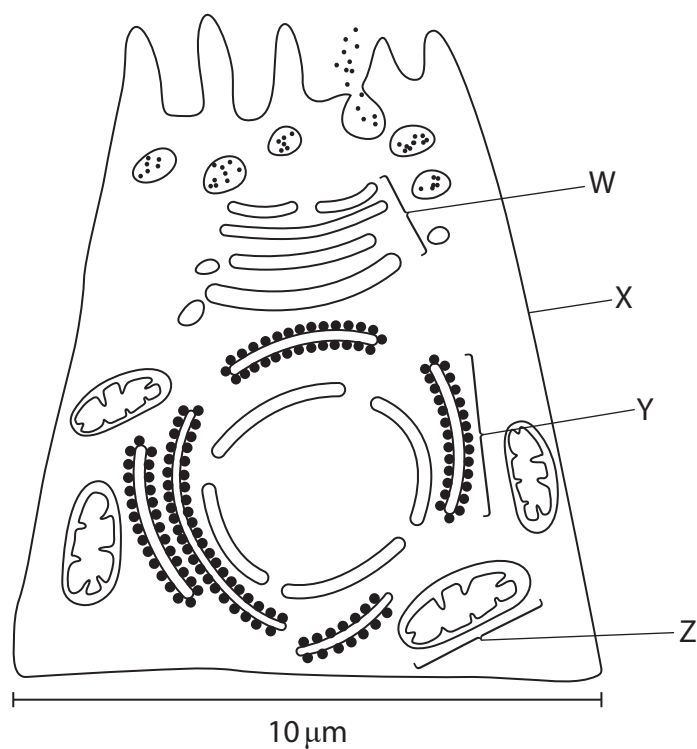
Therefore the enzyme is unable to hydrolyse the peptide bonds in the misfolded protein.

(Total for Question 5 = 9 marks)



6 Some of the cells in the pancreas secrete proteins.

The diagram represents a pancreatic cell.



(a) (i) The structure labelled **Y** represents the

(1)

- ☐ **A** centrioles
- ☐ **B** Golgi apparatus
- ☒ **C** rough endoplasmic reticulum
- ☐ **D** smooth endoplasmic reticulum

(ii) The structure also found in a prokaryotic cell is labelled

(1)

- ☐ **A** W
- ☒ **B** X
- ☐ **C** Y
- ☐ **D** Z

(iii) Calculate the magnification of this cell.

(2)

length of scale bar = 78 mm = 78 000 μm

magnification = image size $\div$ actual size

= 78 000 μm $\div$ 10 μm = 7800

Answer *$\times 7800$*

(iv) Explain why these pancreatic cells contain large numbers of organelle Z.

(3)

Organelle Z is the mitochondrion, the site of aerobic respiration, which produces ATP.

The ATP supplies the energy for the synthesis of proteins (enzymes and hormones) at the ribosomes, as these cells secrete large amounts of protein.

ATP also supplies the energy for the modification and transport of the proteins (via the Golgi apparatus) and for their secretion by exocytosis.

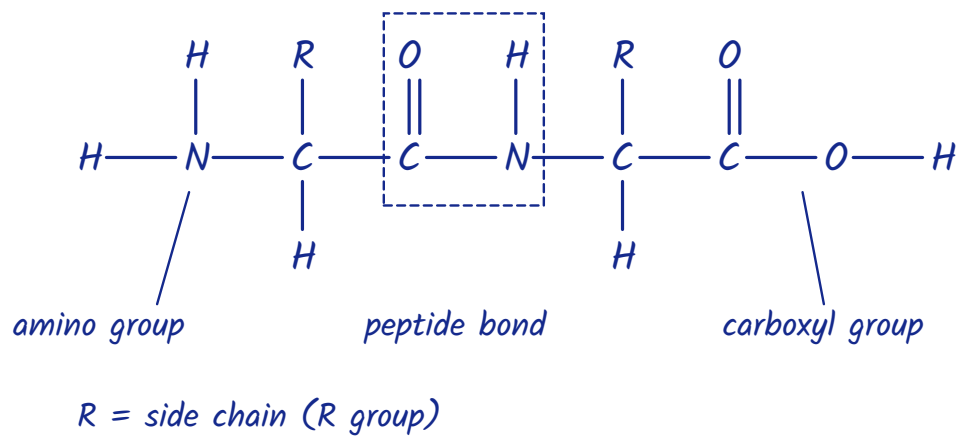


(b) The secreted proteins are made from amino acids.

Two amino acids join together to form a dipeptide.

Draw a diagram to show the structure of a dipeptide.

(3)



(Total for Question 6 = 10 marks)

- 7 Only monosaccharides and most disaccharides are reducing sugars.

Reducing sugars produce a red precipitate when heated with blue Benedict's reagent.

- (a) Identify the row that shows the correct results after heating three carbohydrates, maltose, amylose and fructose, with Benedict's reagent.

(1)

	maltose	amylose	fructose
☐ A	no precipitate	no precipitate	no precipitate
☒ B	red precipitate	no precipitate	red precipitate
☐ C	red precipitate	red precipitate	no precipitate
☐ D	red precipitate	red precipitate	red precipitate

- (b) The Benedict's test can be made quantitative and used to determine the concentration of a glucose solution.

The red precipitate formed is removed by filtration. The precipitate is dried and the mass recorded.

The table shows the mass of precipitate formed from a range of glucose concentrations heated with 5 cm³ of Benedict's reagent.

Glucose concentration / mg cm ⁻³	Mass of precipitate formed / g
0	0.00
2	0.28
4	0.57
6	0.92
8	1.33
10	1.63
12	1.92
14	1.98
16	2.00
18	2.00
20	2.00



- (i) Analyse the data to explain the relationship between the glucose concentration and the mass of precipitate formed.

(4)

Between 0 and 12 mg cm⁻³ there is a linear increase: as the glucose concentration doubles the mass of precipitate doubles (e.g. 0.28 g at 2 and 0.57 g at 4 mg cm⁻³).

This is because all the glucose reacts with the Benedict's reagent, which is in excess.

Above 12 mg cm⁻³ the increase is non-linear and the mass stops increasing above 16 mg cm⁻³ (2.00 g).

This is because all the Benedict's reagent (copper(II) ions) is used up, so the Benedict's reagent becomes limiting and glucose is in excess.

- (ii) When the investigation was repeated, the mean error for each measurement was calculated.

The mean error for each measurement was 0.05 g.

Calculate the percentage error for the mass of precipitate measured at the glucose concentration of 2 mg cm⁻³.

(1)

$$0.05 \div 0.28 \times 100$$

Answer 17.9 %



(iii) Explain one way in which the mean error in measuring the mass of precipitate could be reduced.

(2)

Increase the drying time, repeatedly drying and weighing the precipitate until a constant mass is achieved.

This ensures all the water is removed, so only the mass of the precipitate is measured.

(Total for Question 7 = 8 marks)

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8 Some viruses cause infections in humans.

Antiviral drugs affect the virus without affecting the cells of the host.

(a) Explain why viruses are dependent on living cells.

(2)

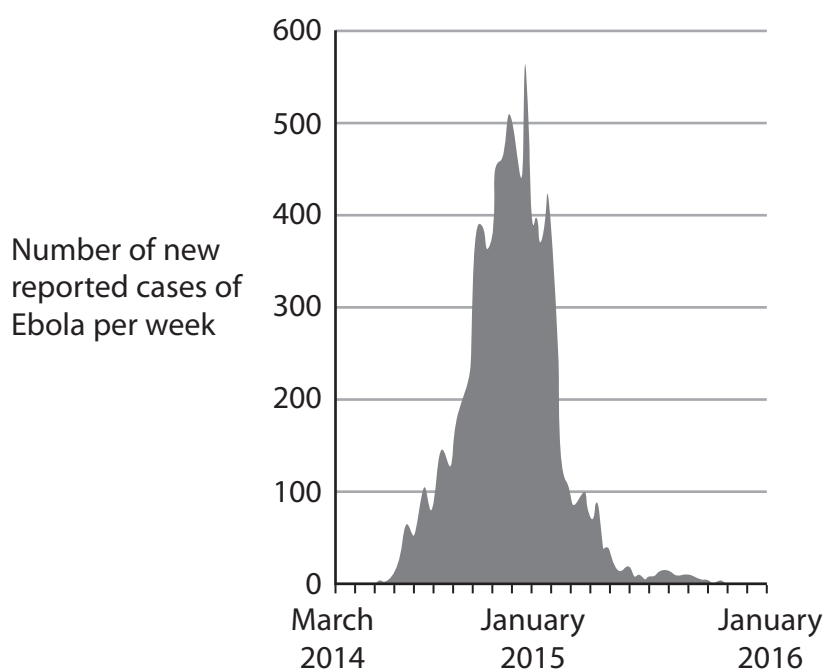
Viruses are unable to replicate (reproduce) independently, as they are not living cells.

This is because they do not have the appropriate organelles (ribosomes) or enzymes, so they must use the host cell's ribosomes, enzymes and ATP to make new viral proteins and nucleic acid.

(b) Ebola is a disease that has a high mortality rate.

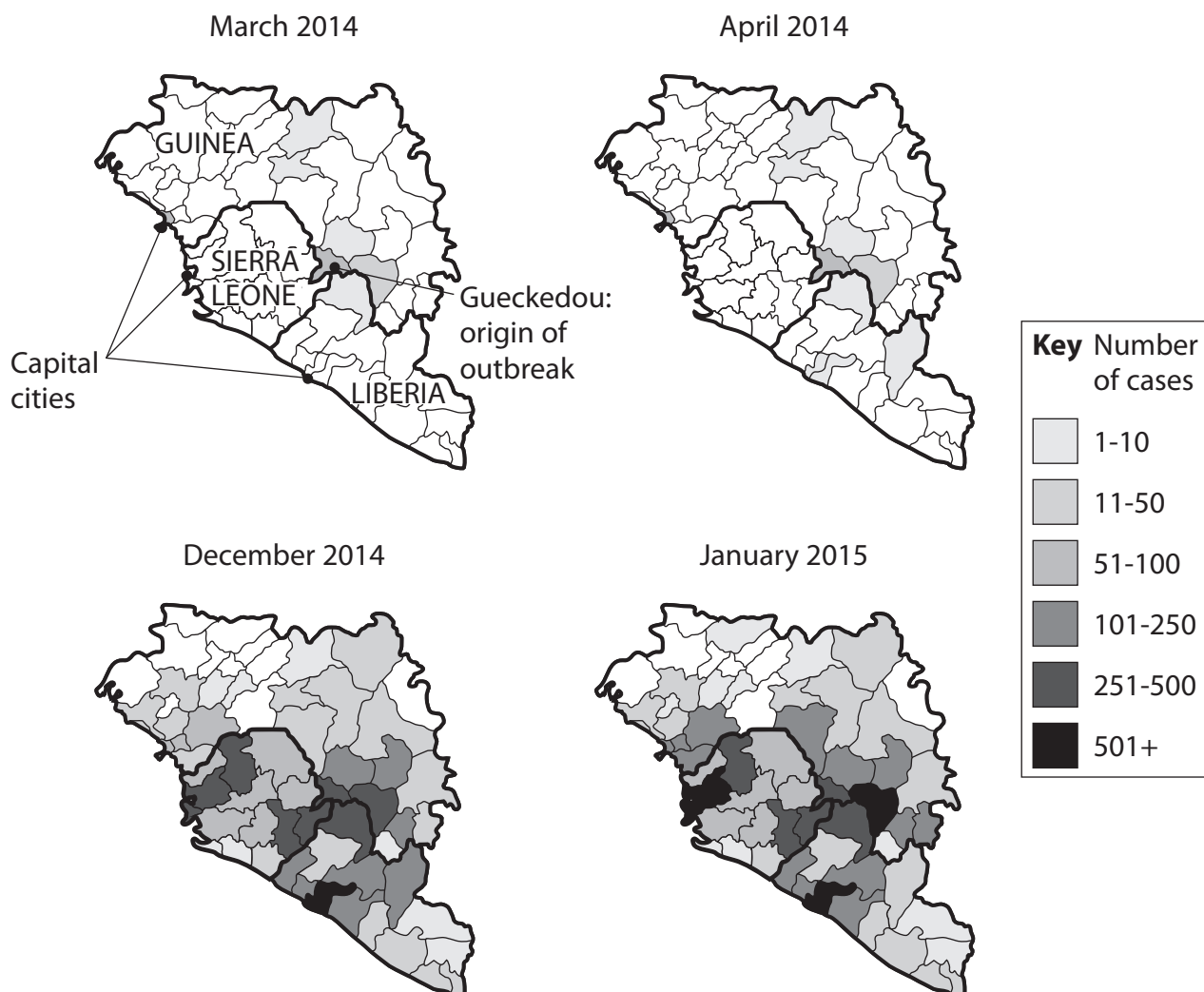
In 2014, there was an outbreak of Ebola in West Africa resulting in the deaths of over 11 000 people.

The graph shows the number of reported cases in Sierra Leone from March 2014 to January 2016.



The maps show the number of reported cases in districts of Sierra Leone, Guinea and Liberia in four months recorded during the outbreak.

The capital cities of these three countries are also shown.



*(i) Analyse the information in the graph and maps to comment on the spread of Ebola in West Africa.

(6)

The outbreak started at Gueckedou in Guinea, near the border between Guinea, Sierra Leone and Liberia, and in March 2014 the cases were mainly in Guinea.

By April 2014 Ebola had spread from this border area further into Liberia and into eastern Sierra Leone, but there were still only a few districts with 1 to 50 cases.

The graph shows that the number of new cases in Sierra Leone stayed low until about mid 2014, then rose rapidly between about August and December 2014 to a peak of over 500 new cases per week.



This matches the maps, which show rapid spread between April and December 2014 in all three countries, with many more districts affected and many districts with 101 to 250 or more cases.

The increase was greater in Sierra Leone than in Liberia and Guinea, and Sierra Leone had the greatest density of cases at the height of the outbreak. The spread in Sierra Leone appears to have come from Guinea and the eastern border districts, moving west. The most rapid increase was in the districts near the capital cities, probably because of the high population density, so there was more contact between people and faster transmission.

There was significant variation between districts: some areas of Guinea had few or no cases even at the height of the outbreak.

In January 2015 the graph shows a slight decrease in Sierra Leone, and one region of Sierra Leone also shows fewer cases on the map; after January 2015 the graph shows a rapid fall, to almost no cases by January 2016.

However, there are no maps after January 2015 and the graph is only for Sierra Leone, so there is no information on whether there was also a fall in Guinea and Liberia. The data are reported cases only, so the true number of cases may be higher.



(ii) Describe the methods used to prevent the spread of Ebola.

(3)

Rapid identification (diagnosis) of the disease, then isolation (quarantine) of infected individuals.

Preventing transmission: good hygiene, wearing protective clothing, sterilisation or disposal of equipment, bedding and clothes, and increased border security.

Contact tracing: identify who may have been in contact with the infected individual and isolate them.

An education programme for the safe burial of corpses.

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(c) During this outbreak of Ebola, no vaccine had been developed.

The World Health Organisation recommended that untested antiviral drugs could be used to treat patients, due to the scale of the outbreak.

Evaluate the ethical implications of using an untested drug during this outbreak.

(4)

For: Ebola has a high mortality rate and the epidemic may be difficult to control, so patients are likely to die without treatment. The drug is unlikely to affect other people, and using it may help to develop the drug for other patients.

Against: the drug may have unknown side effects. Very ill patients may not be able to give informed consent. If the drug is in limited supply, who decides which patients can be treated?

Conclusion: the benefits outweigh the risks because of the severity and scale of the Ebola outbreak, so the untested drug should be used, with informed consent where possible.

(Total for Question 8 = 15 marks)



- 9 Chymosin is an enzyme used to clot milk for the production of cheese.

A farmer investigated the effect of chymosin concentration on the rate of milk clotting.

1 cm³ of a 0.2% chymosin solution was added to 9 cm³ milk and the time taken for the milk to clot was recorded. This was repeated using five other concentrations of chymosin.

The results are shown in the table.

Chymosin concentration (%)	Time for milk to clot / min		Mean rate of milk clotting / min ⁻¹
	Trial 1	Trial 2	
0.2	7.0	7.5	0.14
0.5	3.5	3.0	0.31
1.0	1.5	1.5	0.67
1.5	1.0	1.5	0.80
2.0	0.8	0.7	1.33
3.0	0.5	0.3	2.50

- (a) (i) Calculate the mean rate of milk clotting at a chymosin concentration of 0.5%.

(3)

$$\text{mean time} = (3.5 + 3.0) \div 2 = 3.25 \text{ min}$$

$$\text{mean rate} = 1 \div 3.25 = 0.3077 \text{ min}^{-1}$$

$$= 0.31 \text{ min}^{-1} \text{ (2 s.f.)}$$

Answer..... 0.31 min⁻¹



- (ii) Give one reason why the information in the table is insufficient to conclude which concentration of chymosin would be best for cheese production.

(1)

There is no information about the effect of other variables, e.g. temperature or the type of milk used.

- (b) The chymosin used for the investigation costs 3.6p to treat 100 cm³ of milk.

Calculate how much it would cost to treat 200 dm³ milk.

(2)

$$200 \text{ dm}^3 = 200\,000 \text{ cm}^3$$

$$200\,000 \div 100 = 2000$$

$$\text{cost} = 3.6\text{p} \times 2000 = 7200\text{p} = \text{£}72$$

Answer £ 72

- (c) Devise a valid investigation to compare the effect of chymosin on the clotting time of milk from two different breeds of cattle.

(4)

The independent variable is the source of milk: milk from the two different breeds of cattle (e.g. Jersey and Holstein), collected at the same time of day and stored in the same way.

The dependent variable is the time taken for the milk to clot. Add 1 cm³ of chymosin to 9 cm³ of milk in a test tube and start a stopwatch. The end point is when the milk clots, e.g. when the tube is tilted and the milk no longer flows (or when a set amount of curd forms).

Control variables: the volume of milk (9 cm³), and the volume, concentration and source of the chymosin (1 cm³ of 1.0% chymosin solution).

The temperature is controlled using a thermostatically controlled water bath, e.g. at 35 °C, with the milk and enzyme equilibrated to this temperature before mixing. The pH is controlled using a buffer.



If the temperature was not controlled, a higher temperature would give the enzyme and substrate molecules more kinetic energy and more successful collisions, so the milk would clot faster; too high a temperature would denature the chymosin. If the pH changed, the active site could change shape.

Carry out at least three repeats for each breed (using milk from several cows of each breed), identify and repeat any anomalous results, and calculate a mean clotting time (and rate) for each breed. A statistical test can then be used to see if the difference between the breeds is significant.

(Total for Question 9 = 10 marks)

TOTAL FOR PAPER = 80 MARKS



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