Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Biology B

Advanced
Paper 1: Advanced Biochemistry, Microbiology and Genetics

Monday 12 June 2017 – Afternoon
Time: 1 hour 45 minutes

Paper Reference
9BI0/01

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 questions 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 90.
- 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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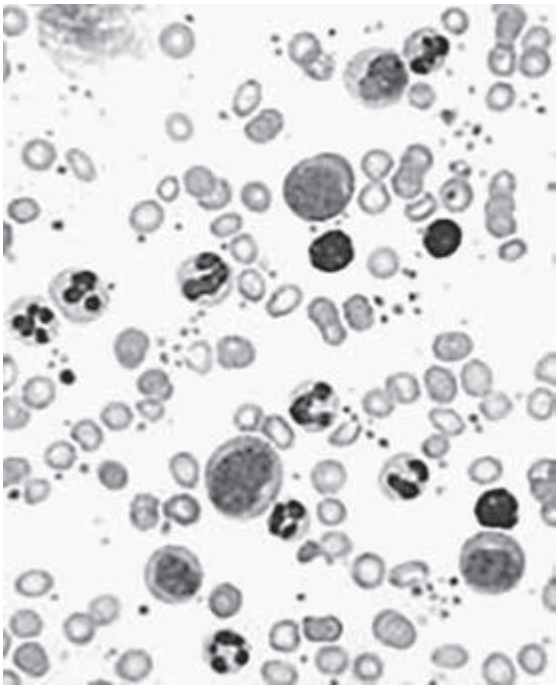
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Answer ALL questions.

Write your answers in the spaces provided.

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 photograph shows a blood smear.



Which row of the table gives the correct number of each type of white blood cell in this photograph?

(1)

	Number of lymphocytes	Number of monocytes	Number of neutrophils
☒ **A**	3	5	8
☒ **B**	3	8	5
☒ **C**	5	3	8
☒ **D**	8	5	3

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(b) Which row of the table gives the correct role of each of the blood components?

(1)

	Erythrocytes	Leucocytes	Platelets
☒ **A**	defence	transport	defence
☒ **B**	defence	defence	transport
☒ **C**	transport	defence	defence
☒ **D**	transport	transport	defence

(c) Blood taken from a patient had an unusually high proportion of eosinophils.

Explain why this patient had an unusually high proportion of eosinophils.

(2)

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(Total for Question 1 = 4 marks)

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2 Minke whales, killer whales and dolphins are all cetaceans.

These animals are different species that all belong to the order Cetacea.

(a) The five-kingdom model of classification is hierarchical.

Part of this hierarchy is: kingdom

phylum

class

family

genus

Where in this hierarchy should the order Cetacea appear?

(1)

☒ **A** between kingdom and phylum

☒ **B** between phylum and class

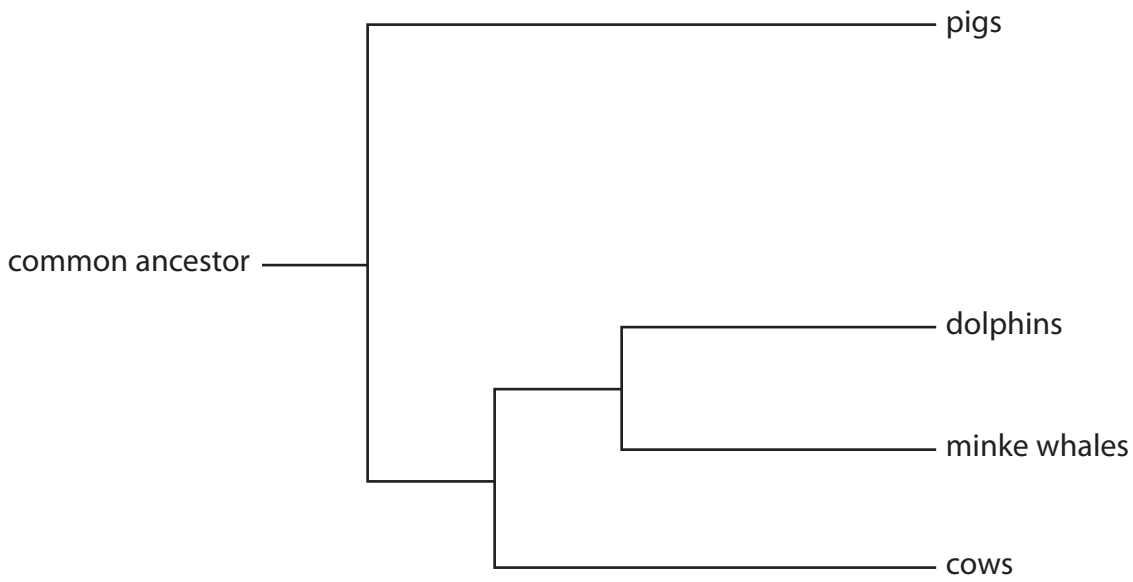
☒ **C** between class and family

☒ **D** between family and genus

(b) Cetaceans evolved between 55 and 60 million years ago.

Their closest living relatives are thought to be pigs and cows.

The diagram shows the evolutionary relationship between minke whales, dolphins, pigs and cows.

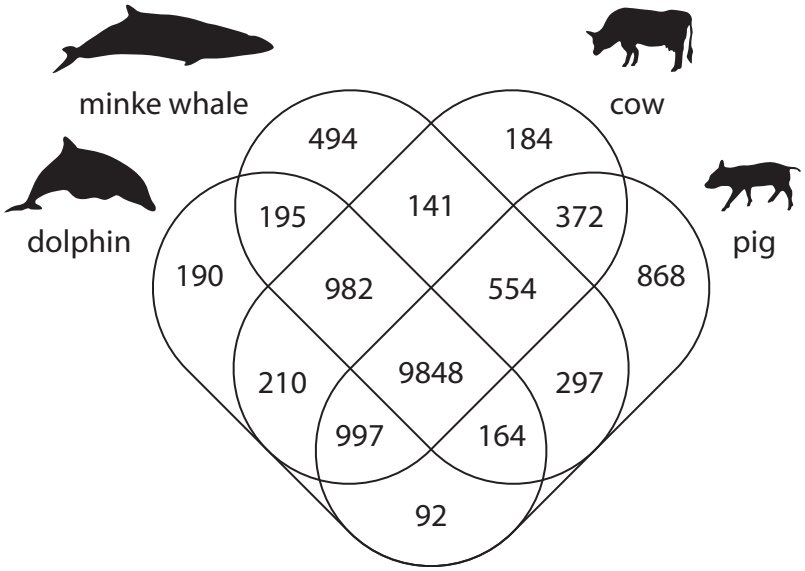


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Analyse the diagram to explain the evolutionary relationship between these four animals.

(3)

(c) The Venn diagram shows unique and shared gene families in the genomes of minke whales, dolphins, pigs and cows.



Calculate the percentage of a dolphin's gene families that are shared with the minke whale.

(2)

Answer ..... %

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(d) A wholphin is an extremely rare hybrid animal born from the mating of a female dolphin and a male killer whale.

Kekaimalu was a wholphin born in the United States in 1985. Kekaimalu was mated with a dolphin and on three occasions gave birth to live offspring.

Explain how this case study illustrates the limitations of the definition of a species.

(2)

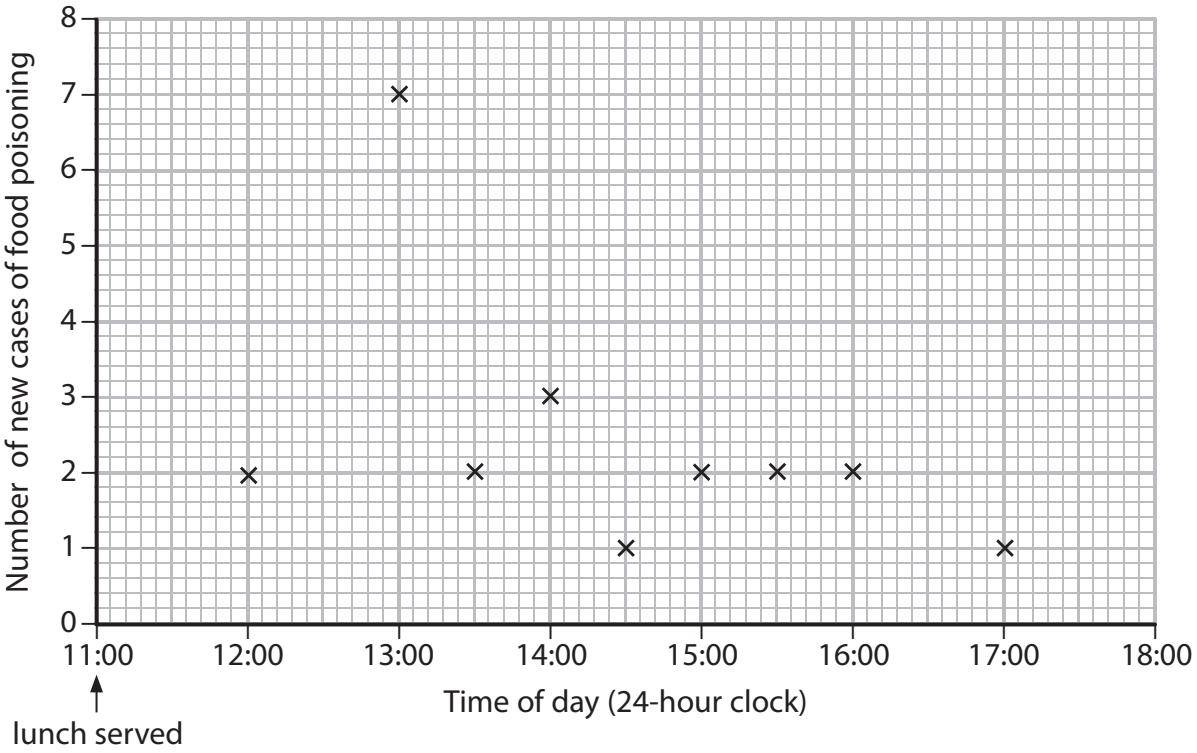
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3 Food poisoning can be caused by food that is contaminated with pathogenic microorganisms.

(a) A number of different bacteria can cause food poisoning.

The graph shows the number of new cases of food poisoning after a lunch party.



(i) Explain why it is likely that this food poisoning resulted from food contaminated with *Staphylococcus* rather than with *Salmonella*.

(3)

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(ii) Describe the techniques microbiologists could use to confirm that this food poisoning was caused by *Staphylococcus*.

(4)

(b) A number of different viruses can cause food poisoning.

One virus that can cause food poisoning is the Norovirus.

Noroviruses are RNA viruses.

(i) The following four statements are features of viruses:

1. have envelopes
2. contain reverse transcriptase
3. surrounded by a protein coat
4. have a helical structure

Which of the following is correct for all RNA viruses?

(1)

☒ **A** statement 1, statement 2 and statement 3

☒ **B** statement 2 only

☒ **C** statement 3 only

☒ **D** statement 1 and statement 4

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(ii) Which of the following groups of viruses are also RNA viruses?

(1)

☒ **A** Ebola virus, human immunodeficiency virus and tobacco mosaic virus

☒ **B** Ebola virus, λ phage and tobacco mosaic virus

☒ **C** Human immunodeficiency virus, λ phage and tobacco mosaic virus

☒ **D** λ phage and tobacco mosaic virus

(Total for Question 3 = 9 marks)

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4 Scientists are developing ways of using stem cells to replace heart cells that have been damaged as a result of heart disease.

(a) The table shows the results of a survey of the incidence of heart disease.

Age / years	Incidence of heart disease per 1000 population	
	In women	In men
18 to 44	3	5
45 to 64	118	138
65 to 74	220	305
75 and older	358	422

Analyse the data to explain the factors affecting the incidence of heart disease.

(2)

(b) Explain why heart cells are damaged as a result of heart disease.

(2)

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(c) Both embryonic stem cells and induced pluripotent stem cells (iPS cells) can be used to create new heart cells.

Compare and contrast the properties and uses of embryonic stem cells with those of iPS cells.

(5)

(Total for Question 4 = 9 marks)

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5 A student planned to keep two species of fish in an aquarium.

One species of fish should be kept at a minimum temperature of 25 °C. The other species requires a minimum concentration of oxygen of 7.5 mg dm^{-3} water.

(a) The student investigated the effect of water temperature on the solubility of oxygen in water.

The table shows the results of this investigation.

Water temperature / °C	Solubility of oxygen in water / mg dm^{-3}
0	14.2
10	11.5
20	12.0
30	7.7
40	7.8
50	5.9
60	5.3

The student used a statistical test on these data.

(i) Which is the correct statistical test to use on these data?

(1)

☒ **A** Chi squared test

☒ **B** correlation coefficient

☒ **C** standard deviation

☒ **D** Student's t test

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(ii) The student analysed the data using the formula:

$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

The student calculated $\sum d^2$ to be 108.

Use the formula to calculate r_s.

(3)

Answer .....

(iii) Explain how the student should use the r_s value calculated in (a)(ii) to find the strength of the relationship between these two variables.

(2)

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(b) Explain why the student chose to keep these two species of fish in an aquarium at 30°C.

(4)

(Total for Question 5 = 10 marks)

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6 Mitochondria and chloroplasts in eukaryotic cells are thought to have originated millions of years ago by a process called endosymbiosis.

In endosymbiosis, free-living prokaryotic organisms were engulfed by their new host cells.

(a) The table shows the lipid composition of the membranes of these two organelles.

Type of lipid	Percentage of total lipid composition of membranes (%)	
	In mitochondria	In chloroplasts
phosphatidyl A	43	0
phosphatidyl B	35	0
phosphatidyl C	6	1
phosphatidyl D	3	7
phosphatidyl E	13	0
monogalactosyldiacylglycerol F	0	55
digalactosyldiacylglycerol G	0	24
sulfolipid H	0	8

(i) Analyse the data and use your knowledge to explain why these two organelles are thought to have originated from different prokaryotic organisms.

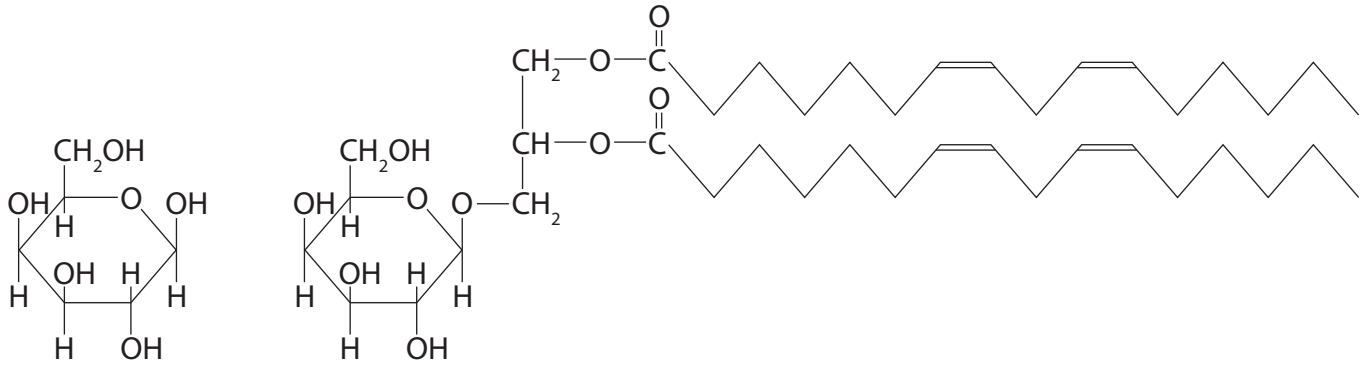
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(ii) Digalactosyldiacylglycerol (DGDG) is synthesised from galactose and monogalactosyldiacylglycerol (MGDG).

The galactose forms a 1,6 glycosidic bond with the MGDG.

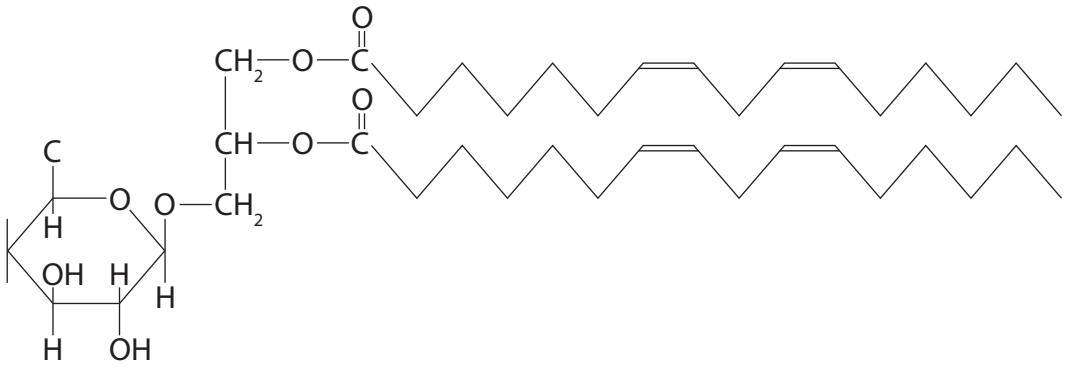
The diagram shows the structure of galactose and MGDG.



galactose MGDG

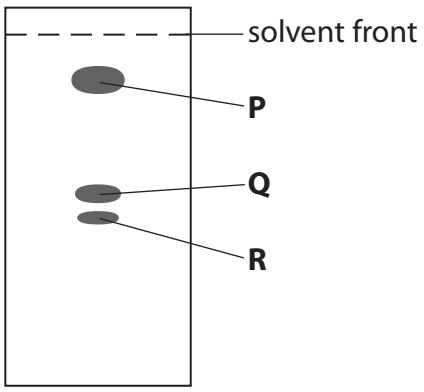
Complete the diagram below to show the structures of the products formed when DGDG is synthesised from galactose and MGDG.

(3)



(iii) Chromatography can be used to separate MGDG, DGDG and sulfolipid extracted from chloroplasts.

The diagram shows the position of these three lipids, **P**, **Q** and **R**, on a chromatogram.



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Which row in the table identifies the position of these three lipids in this chromatogram ?

(1)

	Lipid in position P	Lipid in position Q	Lipid in position R
☒ **A**	DGDG	sulfolipid	MGDG
☒ **B**	MGDG	DGDG	sulfolipid
☒ **C**	sulfolipid	DGDG	MGDG
☒ **D**	sulfolipid	MGDG	DGDG

(b) Chloroplasts are thought to be derived from cyanobacteria.

It is estimated that there are 1×10^{10} carbon atoms in one cyanobacterial cell.

Ten photons of light are needed to fix one carbon atom.

(i) Calculate the number of photons of light needed to fix enough carbon to form one cyanobacterial cell.

(1)

(ii) Explain why the value calculated in (b)(i) is likely to be an underestimate.

(2)

(iii) Describe how carbon fixation takes place in chloroplasts.

(3)

(Total for Question 6 = 13 marks)

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7 Mitochondrial disorders may be caused by mutations in the genes coding for mitochondrial components. Some of these genes are found in mitochondrial DNA (mtDNA) and some are found in nuclear DNA.

Leigh syndrome is an example of a mitochondrial disorder. In this syndrome, a number of different proteins involved in respiration are affected.

These mutations may be inherited or may occur when DNA replicates.

(a) Explain why mutations in nuclear DNA can be inherited from either the mother or the father whereas mutations in mtDNA are only inherited from the mother.

(2)

(b) Some people with Leigh syndrome have a mutation in the MT-ATP6 gene. This gene codes for ATP synthase.

This is a point mutation at nucleotide 8993 that changes thymine to guanine.

(i) What type of mutation is this?

(1)

- ☒ **A** insertion
- ☒ **B** monosomy
- ☒ **C** substitution
- ☒ **D** translocation

(ii) Explain how this mutation could affect oxidative phosphorylation.

(3)

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(c) Leigh syndrome can also be due to a mutation in the SURF1 gene.

This mutation results in a shortened protein.

Explain how a mutation can result in a shortened protein being produced.

(2)

(d) Some people with Leigh syndrome have mutations that affect proteins involved in the electron transport chain.

Explain why these mutations lead to a build-up of lactate.

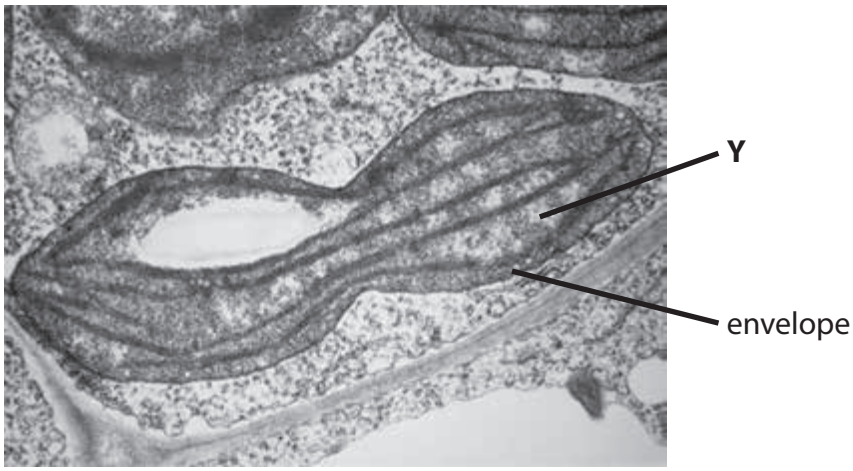
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(Total for Question 7 = 11 marks)

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8 When a photosynthetic plant cell grows, the number of chloroplasts in the cell increases. This increase in the number of chloroplasts can result from the division of chloroplasts already present in the cell.

The electron micrograph shows a chloroplast dividing.



(a) What is the name of the part of the chloroplast labelled **Y**?

(1)

☒ **A** cytoplasm

☒ **B** matrix

☒ **C** nucleoplasm

☒ **D** stroma

(b) The envelope consists of two membranes. These membranes are separated by a gap of 10×10^{-3} to 20×10^{-3} μm.

The magnification of this electron micrograph is ×12 000.

(i) Calculate the maximum width of this gap in this electron micrograph.

(2)

Answer .....

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(ii) Explain why the envelope in this electron micrograph cannot be seen as two separate membranes.

(2)

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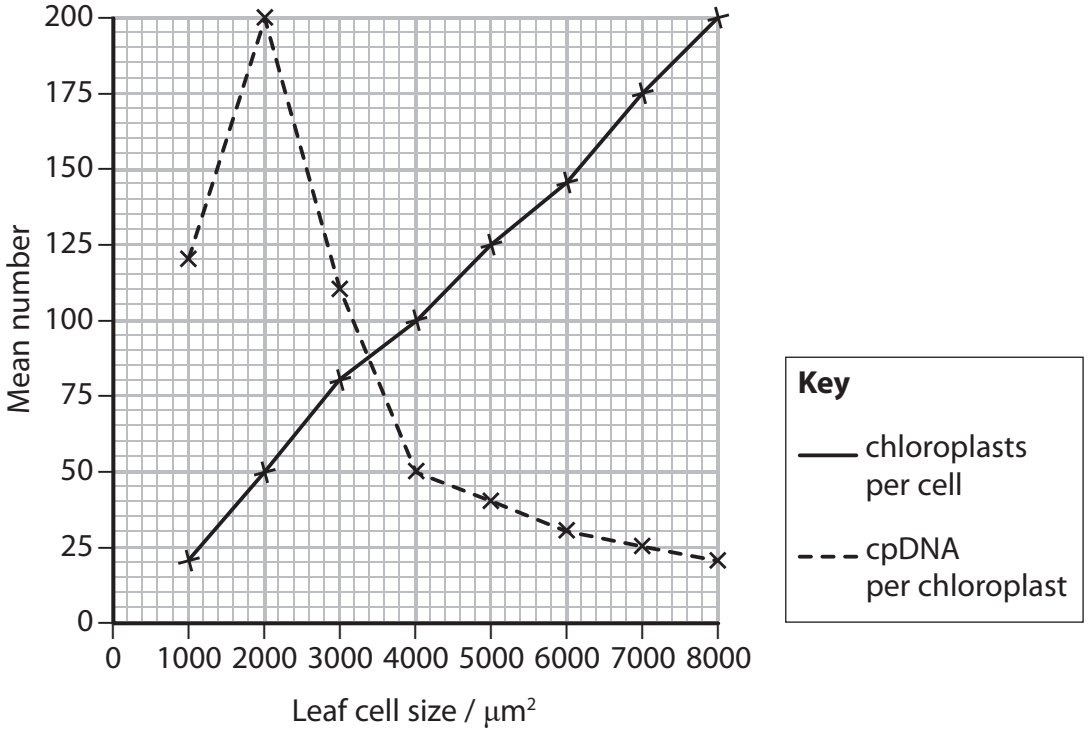
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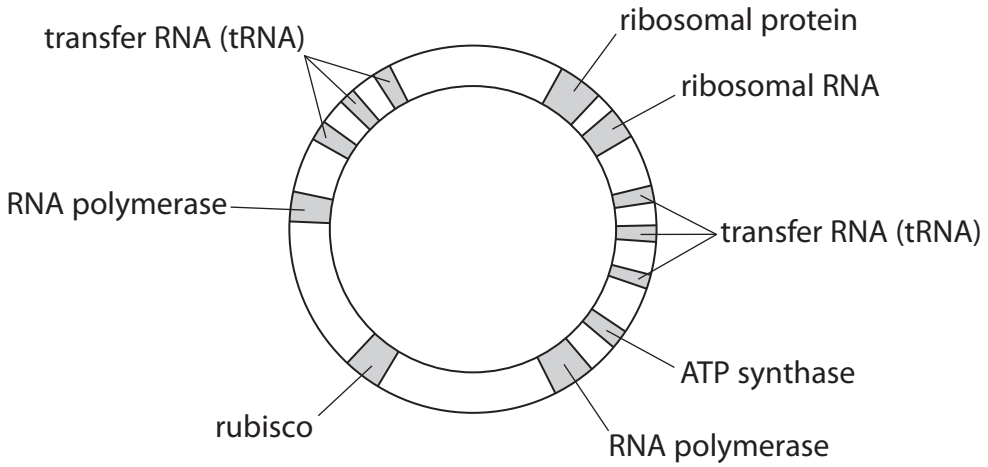
*(c) In an investigation, the mean size of leaf cells was determined. The mean number of chloroplasts per cell and the mean number of DNA molecules (cpDNA) per chloroplast were also determined.

The graph shows the results of this investigation.



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The diagram shows the location of some genes found in cpDNA.



Analyse the information to explain the changes that occur in a leaf cell as it grows.

(6)

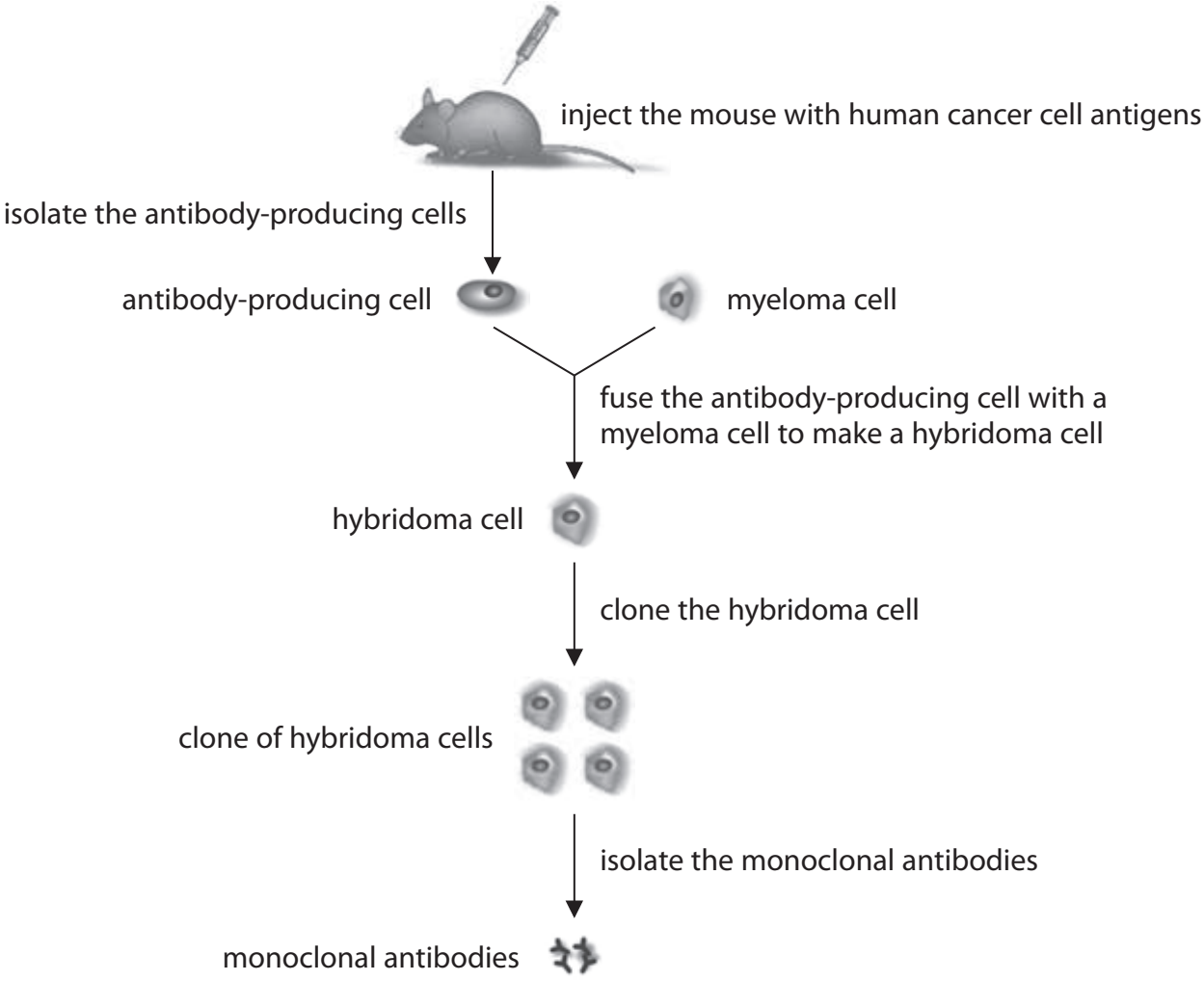
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9 Monoclonal antibodies can be made against a wide range of different antigens. They are used in research and medicine.

Monoclonal antibodies are made by fusing an antibody-producing cell with a myeloma cell.

The diagram shows some of the steps involved in making monoclonal antibodies against human cancer cell antigens.



(a) What is the name of the antibody-producing cell?

(1)

☒ **A** macrophage

☒ **B** memory cell

☒ **C** neutrophil

☒ **D** plasma cell

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(b) Epigenetic modification is involved in the formation of the antibody-producing cells.

Describe epigenetic modification.

(3)

(c) Myeloma cells have the potential to divide indefinitely.

Explain why myeloma cells are used in the production of monoclonal antibodies.

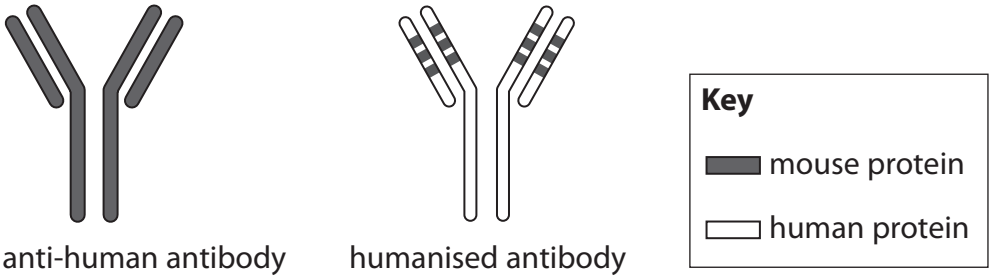
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(d) The antibodies made by this method are called 'mouse anti-human antibodies'. These antibodies are made by a mouse but are specific to human antigens.

Mouse anti-human antibodies are humanised using recombinant DNA methods.

The diagram shows a mouse anti-human antibody and a humanised antibody.



mouse anti-human antibody humanised antibody

(i) Explain the advantages of using humanised antibodies in the treatment of cancer.

(3)

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*(ii) Explain why mouse anti-human antibodies need to be humanised in order to treat cancer.

(6)

(Total for Question 9 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

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