



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
 Cambridge International Level 3 Pre-U Certificate
 Principal Subject

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BIOLOGY

9790/01

Paper 1 Structured Questions

May/June 2013

2 hours 30 minutes

Candidates answer on the Question Paper.

No additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

Section A

Twenty questions for which you must choose what you consider to be the right answer. Marks will not be deducted for any wrong answers. Write your answers in the spaces provided on the Question Paper.

Section B

Write your answers in the spaces provided on the Question Paper.

You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [] at the end of each question or part question.

| For Examiner's Use | |
|--------------------|--|
| Section A | |
| 21 | |
| 22 | |
| 23 | |
| 24 | |
| Total | |

This document consists of **27** printed pages and **1** blank page.

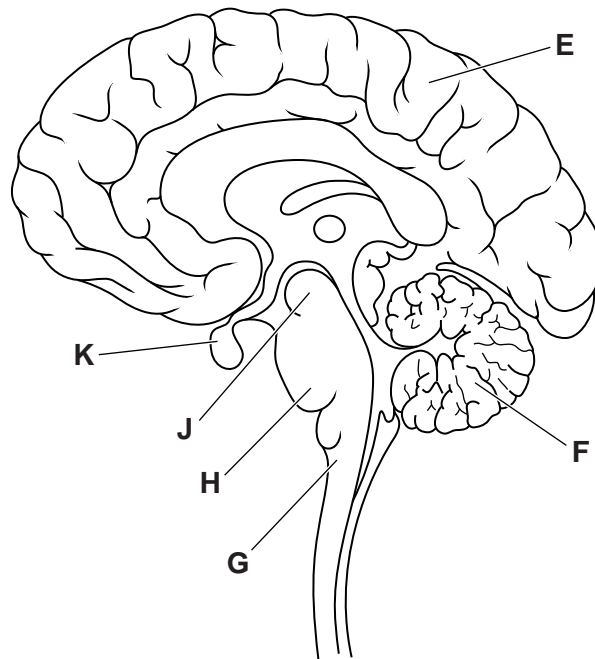


Section A

- 1 Which is a correct statement about classifying and ranking organisms using a phenetic system?
- A A phenetic classification system is most useful when applied to higher organisms that have many characteristics.
 - B A phenetic-based classification always produces different results to a phylogenetically-based classification.
 - C In a phenetic system, one factor used to classify organisms is how recently they diverged.
 - D Slight changes in features used for a phenetic classification may result in very different outcomes.

answer[1]

- 2 Which set of labels is a correct match for the parts of the brain shown below?



| | E | F | G | H | J | K |
|----------|------------|------------|-------------------|--------------|--------------|----------------|
| A | cerebellum | cerebrum | medulla oblongata | pons varolii | midbrain | pituitary body |
| B | cerebellum | cerebrum | thalamus | hind brain | pons varolii | midbrain |
| C | cerebrum | cerebellum | medulla oblongata | pons varolii | midbrain | pituitary body |
| D | cerebrum | cerebellum | thalamus | hind brain | pons varolii | midbrain |

answer[1]

3 The table shows some functional features of various structures in the human body.

Which set of features is correct?

| | hypothalamus | distal convoluted tubule | medulla oblongata | posterior pituitary |
|----------|---|---|---|--|
| A | lowers heart rate by sending impulses along the vagus nerve | selective reabsorption of amino acids involving active uptake | receives impulses that have originated from chemoreceptors in the aortic arch | secretes ADH into the bloodstream |
| B | osmoreceptors detect changes in water potential of blood | receptors in cell surface membranes respond to ADH | receives impulses that have originated from carotid baroreceptors | secretes ADH into the bloodstream |
| C | synthesises and releases ADH in response to increased water potential | aquaporins added to cell surface membranes in response to ADH | osmoreceptors detect changes in water potential of blood | secretes luteinising hormone into the bloodstream |
| D | synthesises and releases ADH in response to decreased water potential | aquaporins added to cell surface membranes in response to ADH | osmoreceptors detect changes in water potential of blood | secretes follicle stimulating hormone into the bloodstream |

answer [1]

4 Which is the correct set of true or false answers concerning cholesterol, LDLs and HDLs?

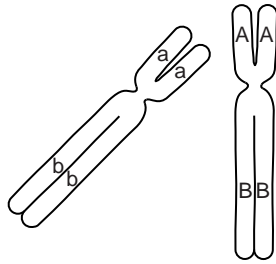
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| | | | | | |
|----------|--|--|--|--|---|
| | LDLs reduce the concentration of blood cholesterol by transporting cholesterol to the liver for breakdown. | Liver cells have receptors for HDLs to allow cholesterol uptake and subsequent addition to bile. | Cholesterol is carried to the ovaries for the synthesis of steroid hormones such as oestrogen. | HDLs take up cholesterol deposited by LDLs in damaged endothelium, reducing the effects of atheroma. | LDLs bind to cell surface membrane receptors for cholesterol uptake into cells. |
| A | false | false | false | true | true |
| B | false | true | true | true | true |
| C | true | true | false | false | false |
| D | true | true | true | false | false |

answer[1]

- 5 The diagram shows two homologous chromosomes in early prophase I of meiosis in an animal cell. Two genes, **A/a** and **B/b**, whose loci occur on the homologous chromosomes are also shown.

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Which row of diagrams is a possible representation of these chromosomes as they progress from anaphase I to prophase II?

| | anaphase I | prophase II |
|----------|------------|-------------|
| A | | |
| B | | |
| C | | |
| D | | |

answer [1]

6 Membranes are important features of many eukaryotic cell structures.

How many statements are correct?

- 1 Cell structures bound by a double membrane include mitochondria, nuclei and chloroplasts.
- 2 Cell structures bound by a single membrane include Golgi apparatus, centrioles and ribosomes.
- 3 Cell structures bound by a single membrane include lysosomes, nucleoli and RER.
- 4 Cell structures bound by a single membrane include proteasomes, SER and cilia.

- A** none
B one
C two
D three

answer [1]

7 The presence of auxin can lead to changes in a plant cell, such as the promotion of cell elongation.

Which is a correct description of a change in a plant cell caused by the presence of auxin?

- A** A decrease in pH optimises conditions for respiratory enzymes and the rate of aerobic respiration increases.
- B** In the cell wall, cross-links between cellulose microfibrils break owing to acid hydrolysis.
- C** Proteins responsible for binding to transcription factors are destroyed and gene transcription begins.
- D** The cell is stimulated to activate proton pumps and transport hydrogen ions across the cell surface membrane into the cell.

answer [1]

- 8 Two areas of molecular biology that have received considerable attention in evolutionary studies are the genetic code and cytochrome C. Cytochrome C is an essential component of all respiratory electron transport chains.

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Which statements lend evidence to the ideas that

- all living organisms are related
 - there is a single, rather than a multiple, origin of life?
- 1 The almost universal nature of the genetic code is a result of evolutionary convergence from multiple lineages.
 - 2 The sequence of amino acids in cytochrome C is similar in organisms that are from similar environments or with similar metabolic demands.
 - 3 The majority of organisms have the same, or similar, amino acid sequences for cytochrome C.
 - 4 When transferred into a very dissimilar organism, a gene coding for cytochrome C will lead to the expression of a protein that will function in the other organism.
- A 1 and 2 only
- B 2 and 3 only
- C 3 and 4 only
- D 1, 3 and 4 only

answer [1]

- 9 Stomatal opening is correlated with which one of the following events?

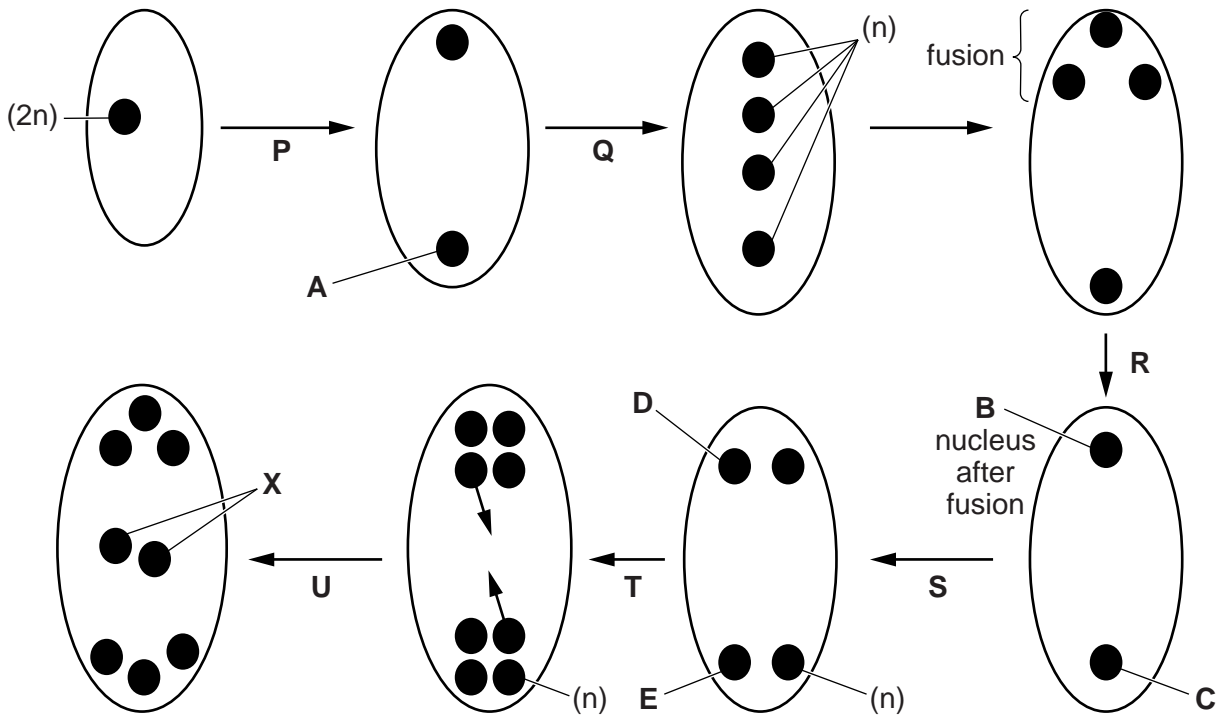
- A accumulation of potassium ions in the neighbouring epidermal cells by active uptake from the guard cells
- B membrane potential generated by ion movement so that the inside of the guard cell is more positive in charge relative to the outside
- C more negative water potential inside guard cells with respect to the external environment of the guard cells
- D proton pumps in the cell surface membrane of guard cells allow active uptake of hydrogen ions from neighbouring epidermal cells

answer [1]

Questions 10, 11 and 12

The development of the embryo sac in flowering plants involves both mitosis and meiosis. Details of this development can vary in different plants.

The diagrams summarise the development of the egg cell within the embryo sac of *Lilium* sp. Some of the nuclei have been labelled to indicate the ploidy: n = haploid; $2n$ = diploid.



10 Which stage or stages, from **P**, **Q**, **R**, **S** and **T**, represent meiosis II?

answer [1]

11 Which nucleus, **A**, **B**, **C**, **D** or **E**, is the first triploid nucleus to be formed?

answer [1]

12 The endosperm in most flowering plants results from a double fusion event. Endosperm formation in the example shown in the diagrams is from a triple fusion event involving both nuclei labelled **X** and the male gamete nucleus, which is haploid.

Following fertilisation, what is the ploidy, **2n**, **3n**, **4n**, **5n** or **6n**, of the endosperm nucleus?

answer [1]

Questions 13, 14, 15 and 16

The processes numbered 1 to 7 in the table represent different photosynthetic processes in C3, C4 and CAM plants.

| process number | process |
|----------------|---------------------------------------|
| 1 | cyclic photophosphorylation |
| 2 | non-cyclic photophosphorylation |
| 3 | photolysis of water |
| 4 | regeneration of ribulose bisphosphate |
| 5 | C3 plant, light-independent stage |
| 6 | C4 plant, light-independent stage |
| 7 | CAM plant, light-independent stage |

Match each of the following to the correct process number.

- 13** Carbon fixation occurs to produce organic acid which is stored overnight in vacuoles.

answer [1]

- 14** The ATP that is produced involves photosystem 1, but not photosystem 2.

answer [1]

- 15** Carbon fixation occurs in the mesophyll cells and the products are transported to bundle sheath cells for decarboxylation.

answer [1]

- 16** The coenzyme NADP is reduced.

answer [1]

Questions 17, 18, 19 and 20

For each of the questions 17–20 only one statement is correct. The correct statements describe the sequence of events that occur at a neuromuscular junction, leading to muscle contraction. For each question identify the correct statement.

- 17**
- A** Acetylcholine hydrolysed by acetylcholinesterase on post-synaptic membrane.
 - B** Acetylcholine released from the pre-synaptic membrane of the sensory neurone.
 - C** Neurotransmitter released from the post-synaptic membrane of the motor neurone.
 - D** Neurotransmitter released from the pre-synaptic membrane of the motor neurone.

answer[1]

- 18**
- A** Muscle fibre depolarised.
 - B** Muscle fibre in absolute refractory period.
 - C** Muscle fibre in relative refractory period.
 - D** Muscle fibre repolarised.

answer[1]

- 19**
- A** Action potential propagation along muscle fibre sarcolemma allows calcium ions to flow in down their concentration gradient from surrounding tissue fluid.
 - B** Action potential propagation along muscle fibre sarcolemma results in active uptake of calcium ions from the sarcoplasmic reticulum.
 - C** Action potential propagation into T-tubules of muscle fibre allows calcium ions to flow out of the sarcoplasmic reticulum, down their concentration gradient.
 - D** Action potential propagation into T-tubules of muscle fibre allows calcium ions to flow into the muscle fibre from surrounding tissue fluid, down their concentration gradient.

answer[1]

- 20**
- A** Binding of calcium ions to myosin heads repels tropomyosin, exposing myosin heads for cross-bridge formation.
 - B** Binding of calcium ions to myosin heads repels troponin, exposing myosin heads for cross-bridge formation.
 - C** Binding of a calcium ion to troponin causes attached tropomyosin to be pulled away from the myosin binding site.
 - D** Binding of a calcium ion to tropomyosin causes a change in shape of the attached troponin, exposing myosin heads.

answer[1]

Section B

Answer **all** the questions.

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21 Lactate dehydrogenase (LDH) is an enzyme found in many organisms. Within the same organism, it can be found in different forms, called isoenzymes. The isoenzymes are structurally different but all catalyse the same reaction.

(a) (i) Fig. 21.1 shows a reaction catalysed by lactate dehydrogenase that occurs during anaerobic respiration in muscle tissue.

Complete Fig. 21.1 by identifying the compounds **A**, **B** and **C**.

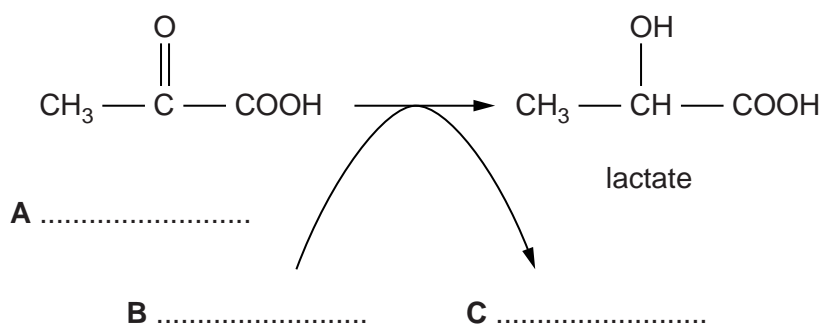


Fig. 21.1

[2]

(ii) State where in the cell this reaction takes place.

.....[1]

(iii) Explain the importance of this reaction in mammalian muscle tissue.

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.....[4]

Lactate dehydrogenase isoenzymes are globular proteins, each consisting of four polypeptides.

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- (b) Describe the structure of an enzyme, such as lactate dehydrogenase, and explain how this structure is suited to its role.

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..... [4]

Lactate dehydrogenase isoenzymes are made up of two types of polypeptide: polypeptide M, which is coded for by the *LDH-A* gene and polypeptide H, which is coded for by the *LDH-B* gene.

Table 21.1 shows the composition of different human lactate dehydrogenase isoenzymes and examples of tissues and organs where each can be found.

Table 21.1

| isoenzyme | polypeptide composition of enzyme | example of isoenzyme location |
|-----------|-----------------------------------|-------------------------------|
| LDH-1 | HHHH | heart red blood cells |
| LDH-2 | HHHM | heart red blood cells |
| LDH-3 | HHMM | brain lungs |
| LDH-4 | HMMM | kidneys placenta |
| LDH-5 | MMMM | liver skeletal muscles |

(c) With reference to Table 21.1, suggest how cells of different tissues of the same individual can produce different isoenzymes.

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..... [2]

(d) LDH can be present in blood plasma as a result of tissue damage.

Blood samples can be taken and tested to measure the concentrations of different LDH isoenzymes.

(i) This test can help in the diagnosis of heart attacks resulting from atheroma formation.

Explain how atheroma can lead to a heart attack.

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(ii) Suggest how a test for LDH isoenzymes can help in the diagnosis of different conditions.

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..... [4]

- (e) The base sequences of the *LDH-A* and *LDH-B* genes and the sequences of the amino acids encoded by these genes were determined.

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Use

Fig. 21.2 shows the first ten amino acids of polypeptides M and H and the corresponding base sequences of one of the DNA strands of each gene.

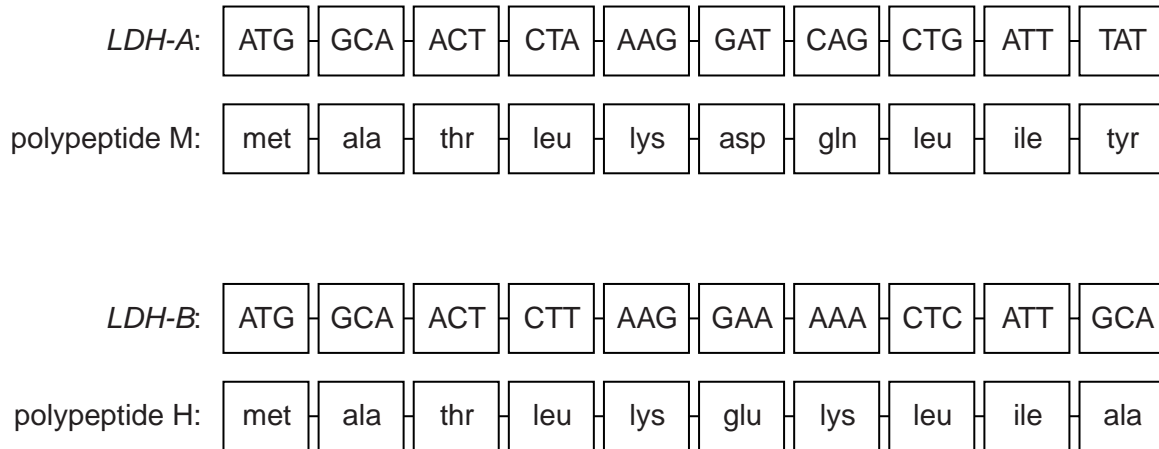


Fig. 21.2

Table 21.2 shows the genetic code (mRNA codons).

Table 21.2

| first position | second position | | | | third position |
|----------------|-----------------|-----|------|------|----------------|
| | U | C | A | G | |
| U | phe | ser | tyr | cys | U |
| | phe | ser | tyr | cys | C |
| | leu | ser | STOP | STOP | A |
| | leu | ser | STOP | trp | G |
| C | leu | pro | his | arg | U |
| | leu | pro | his | arg | C |
| | leu | pro | gln | arg | A |
| | leu | pro | gln | arg | G |
| A | ile | thr | asn | ser | U |
| | ile | thr | asn | ser | C |
| | ile | thr | lys | arg | A |
| | met | thr | lys | arg | G |
| G | val | ala | asp | gly | U |
| | val | ala | asp | gly | C |
| | val | ala | glu | gly | A |
| | val | ala | glu | gly | G |

22 The bacterium *Helicobacter pylori* can colonise the lining of the stomach. It is also found in dental plaque and saliva.

For
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- (a) In some people, infection with *H. pylori* has been associated with changes to the normal structure of the stomach lining and with diseases such as gastric ulcers and stomach cancer.

Fig. 22.1 is a diagram of a longitudinal section of a gastric gland from the stomach of a healthy person. The cells labelled **A**, **B** and **C** each secrete a different product.

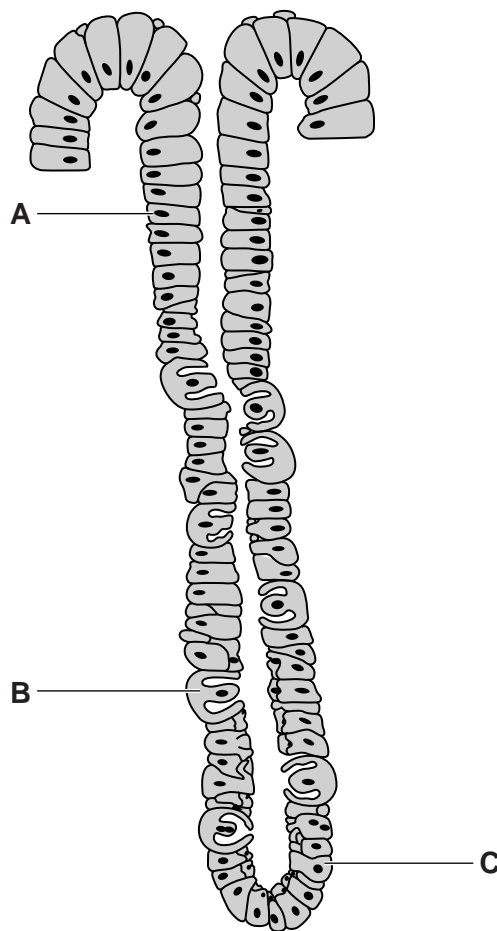


Fig. 22.1

Complete the table to name the cells labelled **A**, **B** and **C** in Fig. 22.1 and state the product secreted by each cell.

| cell | name of cell | product secreted by cell |
|----------|--------------|--------------------------|
| A | | |
| B | | |
| C | | |

[6]

(b) There are a number of different modes of transmission of *H. pylori* from person to person.

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Suggest two ways that *H. pylori* may be transmitted.

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2

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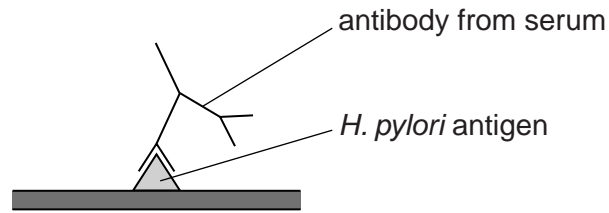
[2]

- (c) An infection with *H. pylori* can be diagnosed by testing for the antibodies produced in response to *H. pylori* antigens, as shown in Fig. 22.2.

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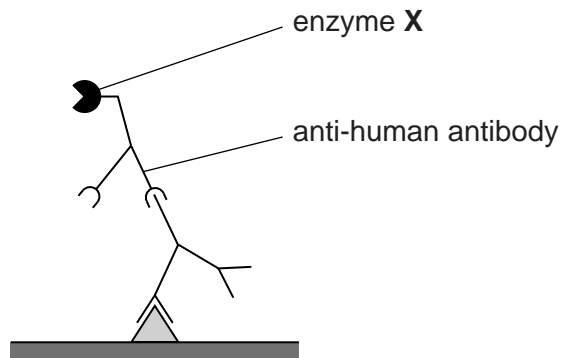
step 1

add blood serum samples to antigens of *H. pylori* attached to wells in a testing plate



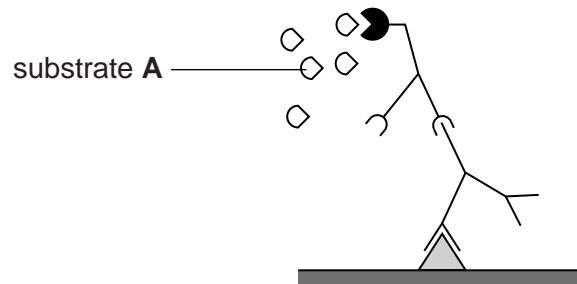
step 2

rinse the testing plate and add anti-human (secondary) antibody linked to enzyme X



step 3

rinse the testing plate and add substrate A, which is converted to a coloured product by enzyme X



step 4

reaction stopped and colour noted

Fig. 22.2

Using Fig. 22.2, explain the importance of the following in this test:

- the use of antibodies
- the rinsing in step 3
- the use of enzyme **X**.

the use of antibodies

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the rinsing in step 3

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the use of enzyme **X**

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[7]

(d) Antibiotics can be used to treat a person with *H. pylori*.

Suggest why a doctor, who has recently prescribed antibiotics to a person infected by *H. pylori*, should not use the test described in (c) to see if *H. pylori* has been eradicated.

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..... [2]

(e) In some people, *H. pylori* infection can be difficult to treat because, over time, new strains of bacteria arise that have resistance to commonly used antibiotics.

(i) Explain how resistance to antibiotics may arise and spread in a population of bacteria.

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..... [4]

(ii) The antibiotics used to treat *H. pylori* infections disrupt cell wall synthesis and protein synthesis. The same antibiotics have little success at treating gastric infections caused by protoctists.

Suggest why this is so.

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..... [3]

[Total: 24]

23 The first clinical trials that used gene therapy to treat cystic fibrosis began in 1993. The trials concentrated on treating affected cells in the lungs.

Two types of vector, viruses and liposomes, have been used to deliver the normal functioning *CFTR* allele to affected cells.

(a) Suggest two features of a virus that would make it a suitable vector for gene therapy for cystic fibrosis.

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[2]

(b) Explain the limitations of gene therapy as a treatment for cystic fibrosis.

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..... [3]

(c) Outline the role of the product of the normal *CFTR* allele.

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..... [3]

Fig. 23.1 outlines some of the steps in a method of obtaining liposomes for use as vectors of the normal *CFTR* allele.

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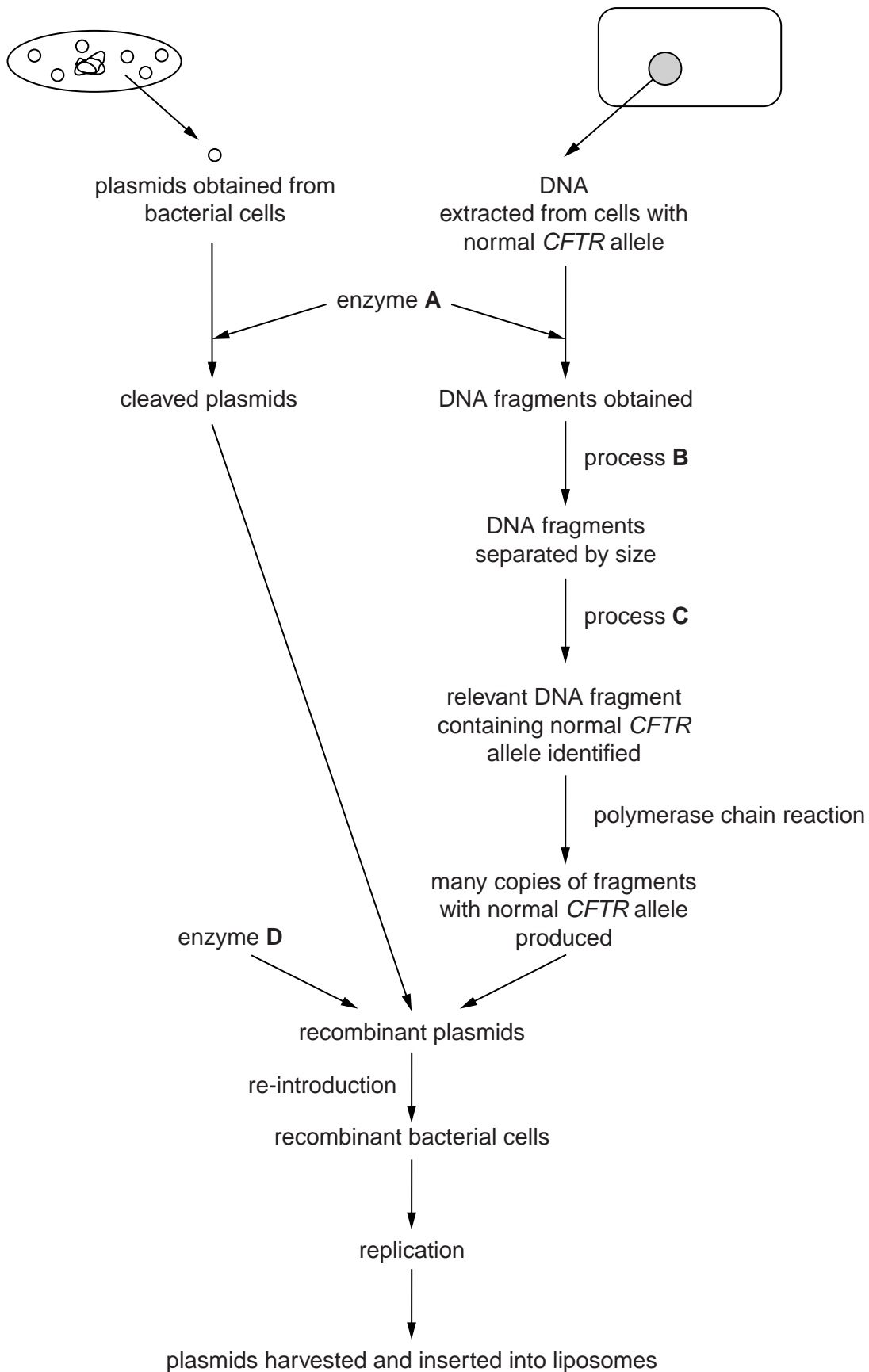


Fig. 23.1

(d) Identify:

(i) enzyme **A**

..... [1]

(ii) process **B**

..... [1]

(iii) enzyme **D**.

..... [1]

(e) Describe what is added in process **C** to identify the DNA fragment containing the normal *CFTR* allele.

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..... [1]

(f) Outline the main steps in the polymerase chain reaction that allow many copies of the DNA fragment containing the normal *CFTR* allele to be produced.

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..... [4]

[Total: 16]

24 Reef-building corals are marine invertebrates found in shallow, clear, tropical oceans. The corals secrete an exoskeleton of calcium carbonate that becomes the underlying structure of the coral reef ecosystem.

Zooxanthellae are a group of unicellular algae from the genus *Symbiodinium* that live within the cells of reef-building corals. The relationship has been described as mutualistic since it is beneficial to both coral and zooxanthellae.

(a) Evidence shows that the mutualistic relationship between zooxanthellae and reef-building corals has evolved by free-living algae invading corals that did not contain algae.

(i) Corals that do not need zooxanthellae can live at a greater depth than reef-building corals.

Explain why this is so.

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(ii) Suggest the benefits **to the zooxanthellae** of their association with the corals.

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..... [2]

Under conditions of stress the relationship between the reef-building corals and the zooxanthellae can break down. Loss of zooxanthellae and the subsequent whitening that occurs, shown in Fig. 24.1, is known as coral bleaching. Coral bleaching can lead to death of the coral.



Fig. 24.1

- (b) Suggest **one** reason why permanent loss of zooxanthellae can lead to death of the coral.

.....
 [1]

- (c) Increased sea temperature associated with global climate change is known to be an environmental stress that can cause coral bleaching. The temperature range for healthy survival of reef-building coral is 25 °C–29 °C.

- (i) Explain why the areas of sea containing coral reefs are susceptible to increased temperature resulting from global climate change.

.....
 [1]

- (ii) Raw sewage released into the oceans can contain bacteria that cause disease in corals.

Suggest how global warming increases the rate of coral bleaching caused by bacterial disease.

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 [1]

Recently, the International Union for Conservation of Nature (IUCN) has assessed over 47% of reef-building coral species as threatened, or near-threatened, with a global risk of extinction.

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(d) Explain why the loss of reef-building corals has been described as an example of 'reduced biodiversity on a number of levels'.

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..... [4]

- (e) Elkhorn coral, *Acropora palmata*, is one species of coral that is threatened. It has been suggested that elkhorn coral is a keystone species.

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What are the features of a keystone species?

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..... [3]

[Total: 14]

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