Respiration (12.2): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 67 marks · about 80 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · Paper 4 · February/March 2023 (42) · Q6(b) · 3 marks

(b) Outline the role of the mitochondrial matrix in respiration.

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1 (a) Glycolysis is a biochemical pathway that occurs in the cytoplasm of cells.

In glycolysis, a molecule of glucose is metabolised to two molecules of pyruvate. The process is outlined in Fig. 1.1.

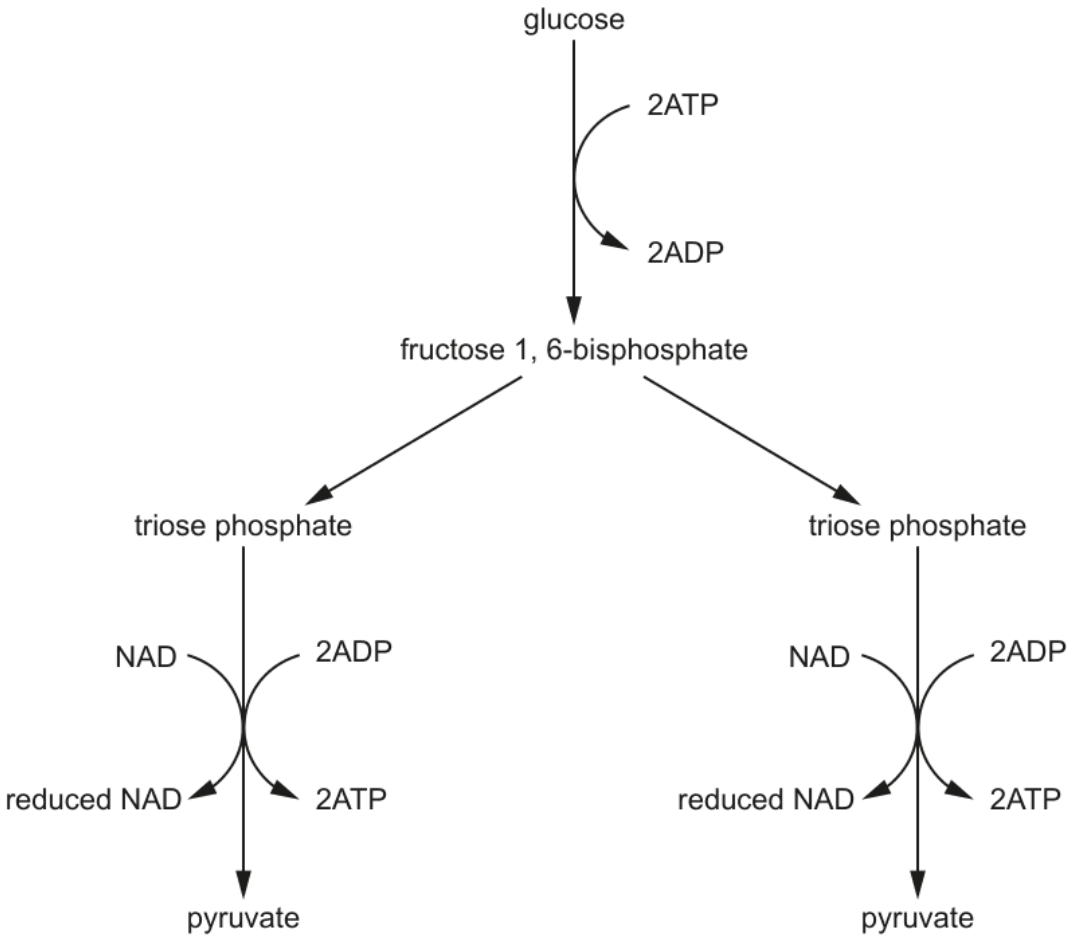


Fig. 1.1

(i) Explain why glucose is phosphorylated at the beginning of glycolysis.

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Question 3 · Paper 4 · May/June 2022 (42) · Q3(b) · 5 marks

(b) Outline the stage of aerobic respiration that occurs in the cytoplasm of eukaryotic cells.

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Question 4 · Paper 4 · May/June 2023 (42) · Q1(b) · 3 marks

(b) Pyruvate can enter the mitochondrion by active transport.

Describe the main conditions that are required for pyruvate to enter the mitochondrion by active transport.

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Question 5 · Paper 4 · May/June 2023 (42) · Q1(c) · 3 marks

(c) Pyruvate is involved in the link reaction in the matrix of the mitochondrion.

Describe the link reaction.

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1 (a) The Krebs cycle was named after the biochemist Sir Hans Krebs, who worked out the sequence in 1937.

Fig. 1.1 is an outline of the Krebs cycle.

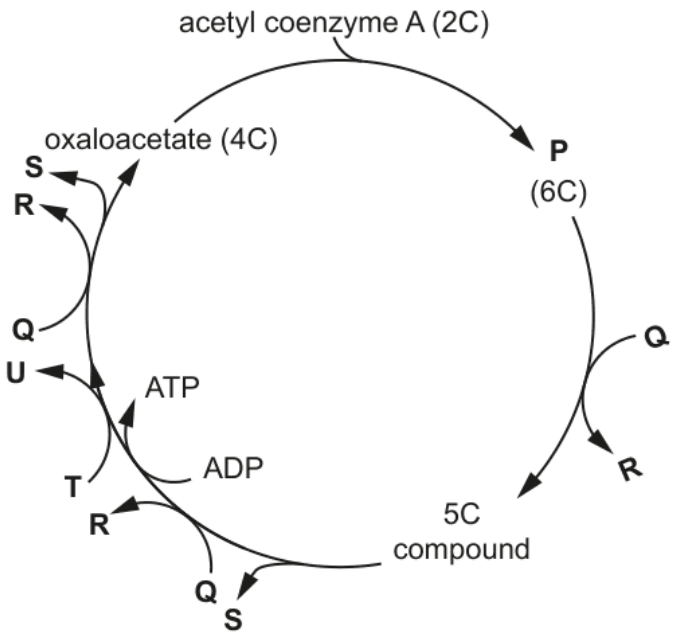


Fig. 1.1

Identify substances **P**–**U**.

P .....

Q .....

R .....

S .....

T .....

U .....

[3]

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Question 7 · Paper 4 · February/March 2023 (42) · Q6(a)(i) · 1 mark

6 (a) Fig. 6.1 is a diagram of a section through a mitochondrion.

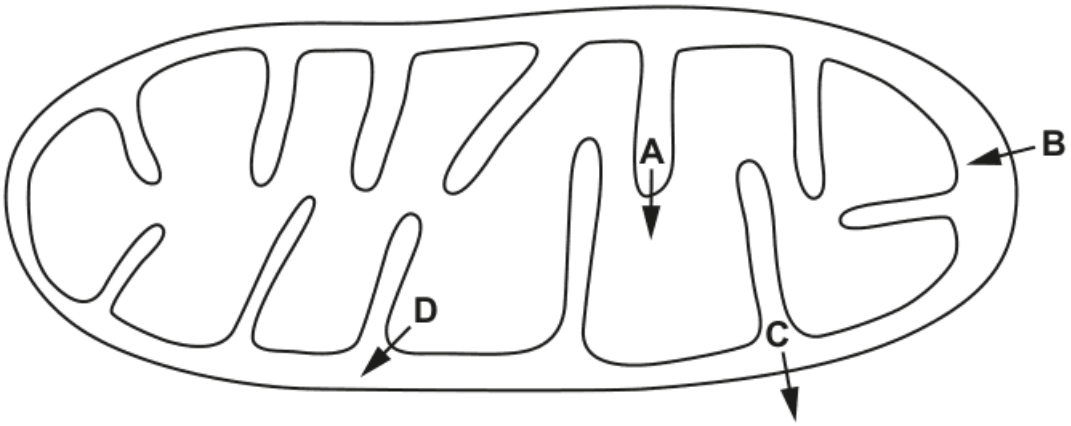


Fig. 6.1

The four arrows, **A**, **B**, **C** and **D**, show the movement of molecules and ions.

Use the letters to identify **all** the arrows (one or more) that show:

(i) active transport of protons

Question 8 · Paper 4 · February/March 2023 (42) · Q6(a)(ii) · 1 mark

(ii) diffusion of carbon dioxide.

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Question 9 · Paper 4 · February/March 2025 (42) · Q8(c) · 4 marks

(c) The coenzyme NAD plays an important role in respiration.

Describe the role of NAD in the stages of aerobic respiration that occur in a mitochondrion.

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Question 10 · Paper 4 · May/June 2022 (43) · Q3(b) · 6 marks

(b) Coenzymes are important in all four stages of aerobic respiration.

Describe **and** explain the role of the coenzymes NAD and FAD in aerobic respiration.

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Question 11 · information from earlier in the question

1 Fig. 1.1 is a diagram of part of the inner membrane of a mitochondrion.

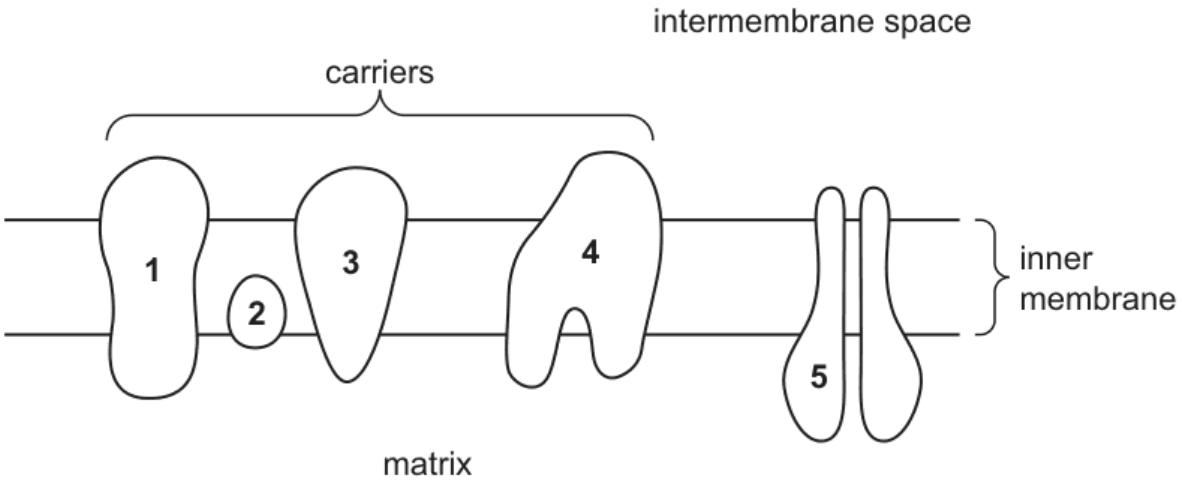


Fig. 1.1

Question 11 · Paper 4 · May/June 2025 (42) · Q1(a)(iii) · 3 marks

(iii) Describe how structure **5** in Fig. 1.1 is involved in oxidative phosphorylation.

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(b) Cyanide ions (CN^-) are highly toxic.

Cyanide ions bind to carrier **4** in Fig. 1.1 and inactivate the carrier.

Suggest **and** explain how the binding of cyanide ions to carrier **4** can have an effect on respiration.

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Question 13 · Paper 4 · February/March 2022 (42) · Q7(a) · 7 marks

7 **(a)** In aerobic respiration, ATP is synthesised by substrate-linked reactions and by oxidative phosphorylation.

Outline the process of oxidative phosphorylation.

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(b) Fig. 6.1 is a diagram of mitochondrion.

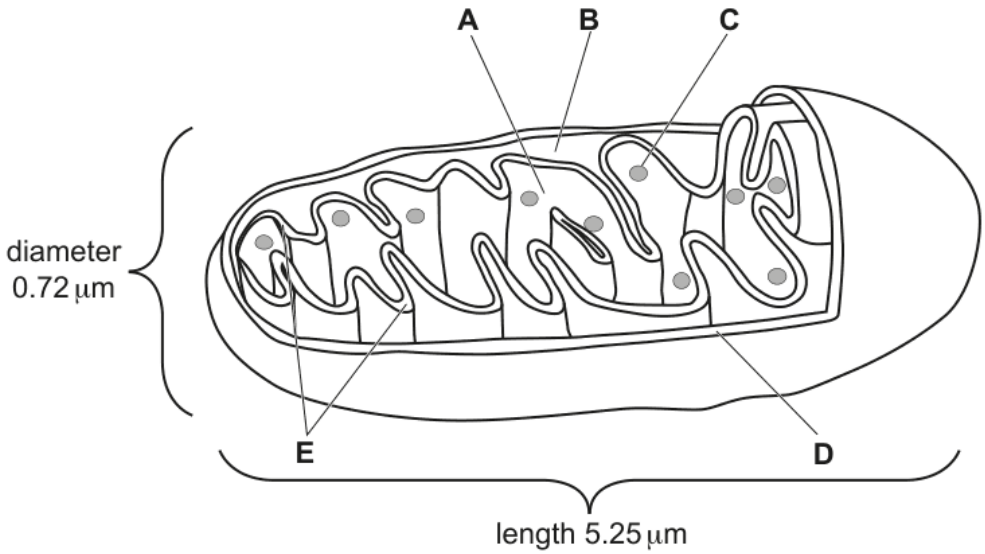


Fig. 6.1

(i) Complete Table 6.1 using the letters **A** to **E** from Fig. 6.1.

Each letter may be used once, more than once, or not at all.

Table 6.1

statement	letter
the site of the Krebs Cycle	.....
a phospholipid bilayer impermeable to H^+ ions	.....
the site of translation	.....

[2]

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1 (a) Some organisms carry out respiration in anaerobic conditions when oxygen is not available or when there is a low concentration of oxygen. In yeast and some plants, this is called ethanol fermentation. In mammals, it is called lactate fermentation.

Fig. 1.1 outlines ethanol fermentation and lactate fermentation.

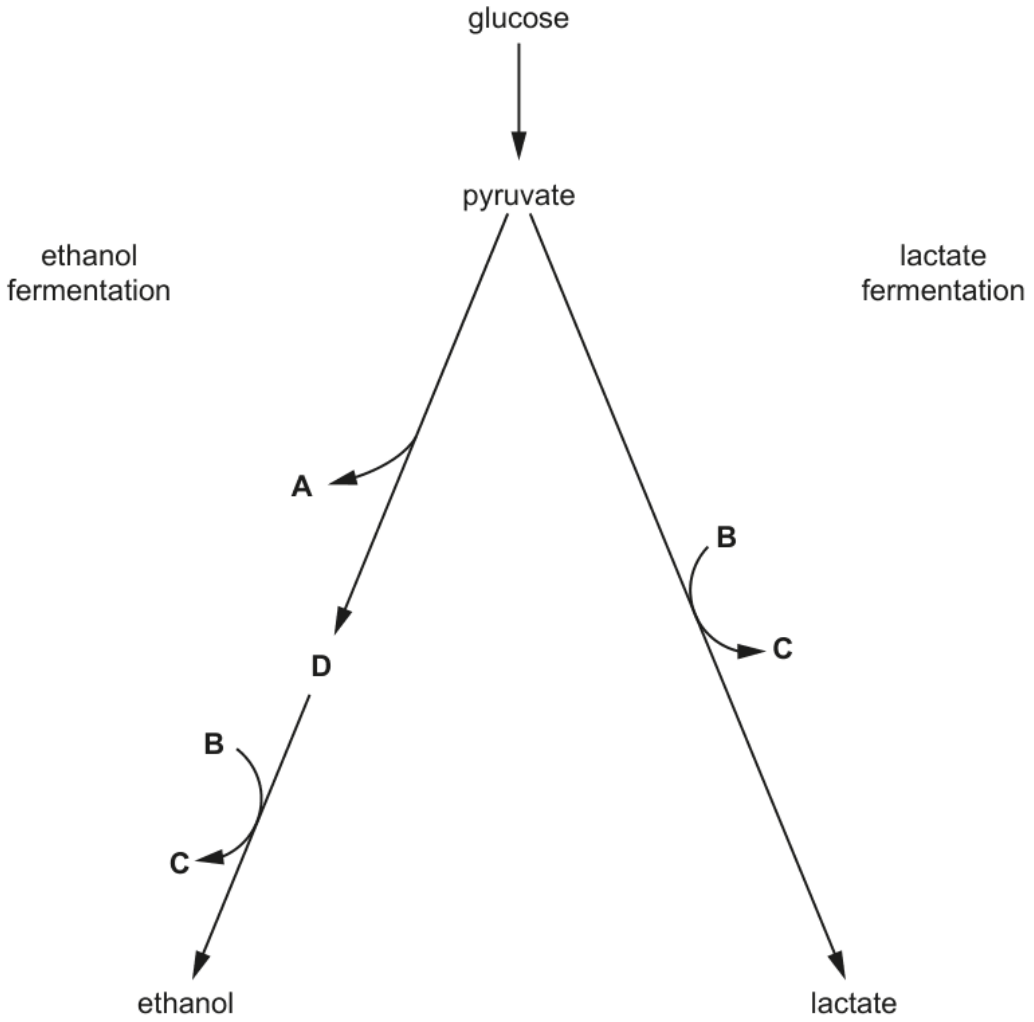


Fig. 1.1

Identify substances **A**–**D**.

A .....

B .....

C .....

D .....

[3]

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Question 16 · Paper 4 · October/November 2023 (42) · Q1(b) · 3 marks

(b) Explain how processes such as ethanol fermentation and lactate fermentation allow cells to continue to function in the absence of oxygen.

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Question 17 · Paper 4 · February/March 2022 (42) · Q7(b) · 4 marks

(b) In an experiment on respiration, two different populations of yeast cells were used: **A** and **B**.

- Yeast cells in population **A** had no mitochondria in their cells.
- Yeast cells in population **B** did have mitochondria in their cells.

Both populations were provided with glucose in solution and the concentration of ATP was measured every minute for seven minutes.

Fig. 7.1 shows the results of the experiment.

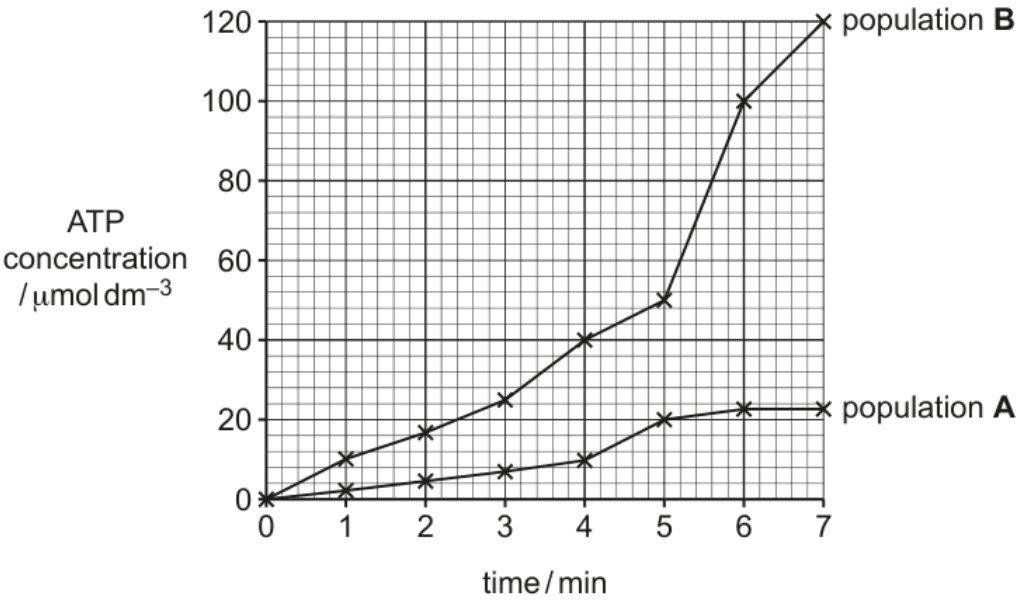


Fig. 7.1

Describe **and** explain the difference in results between population **A** and population **B**, as shown in Fig. 7.1.

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Question 18 · Paper 4 · October/November 2023 (42) · Q1(c) · 3 marks

(c) The cereal crop rice, *Oryza sativa*, grows in fields that are flooded with water. The roots of the rice plants are submerged in water that contains very little oxygen.

Describe **and** explain how rice plants are adapted to grow in flooded fields.

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(b) An investigation was carried out to determine the effect of temperature on the rate of respiration of yeast.

- A suspension of yeast cells was added to a test-tube containing glucose solution.
- A further four test-tubes were set up in the same way.
- One test-tube was placed in a water-bath at 10 °C for 5 minutes.
- DCPIP was added to the test-tube and the time taken for the DCPIP to change colour was measured.
- The experiment was repeated using the other test-tubes at 20 °C, 30 °C, 40 °C and 50 °C.

The results are shown in Fig. 6.1.

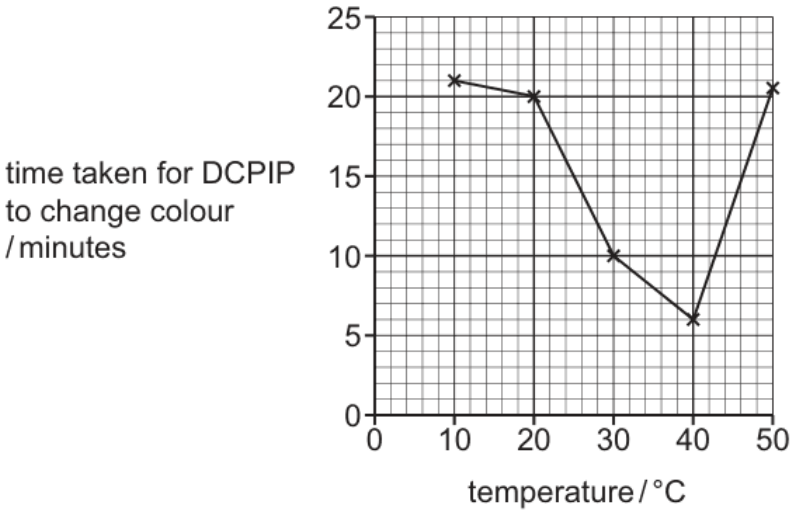


Fig. 6.1

(i) State **two** variables that need to be kept constant in this experiment.

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Question 20 · Paper 4 · October/November 2024 (42) · Q6(b)(ii) · 3 marks

(ii) Explain the results shown in Fig. 6.1.

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(b) A respirometer can be used to measure the rate of respiration of germinating seeds.

Fig. 8.1 shows a respirometer.

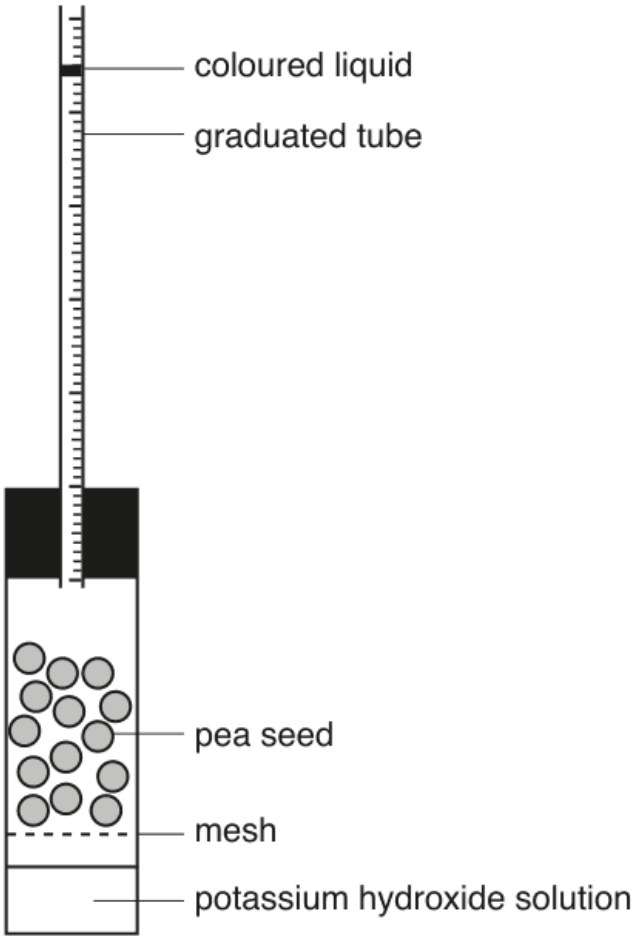


Fig. 8.1

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(c) Respirometers, as shown in Fig. 8.1, were used to investigate the effect of temperature on the rate of respiration of germinating pea seeds.

Four respirometers, **A**, **B**, **C** and **D** were set up:

- **A** and **B** in a water-bath maintained at 10 °C.
- **C** and **D** in a water-bath maintained at 25 °C.
- **A** and **C** each contained 30 germinating pea seeds.
- **B** and **D** each contained glass beads with a total volume equivalent to 30 pea seeds.

- The respirometers were left in the water-baths for 10 minutes.
- In each respirometer the position of the coloured liquid in the graduated tube was then marked (time 0 minutes).
- After 5 minutes the distance moved by the coloured liquid was measured.
- The volume of oxygen taken up was calculated for each respirometer.
- This was repeated after 10, 15 and 20 minutes.

Fig. 8.2 shows the results of the experiment.

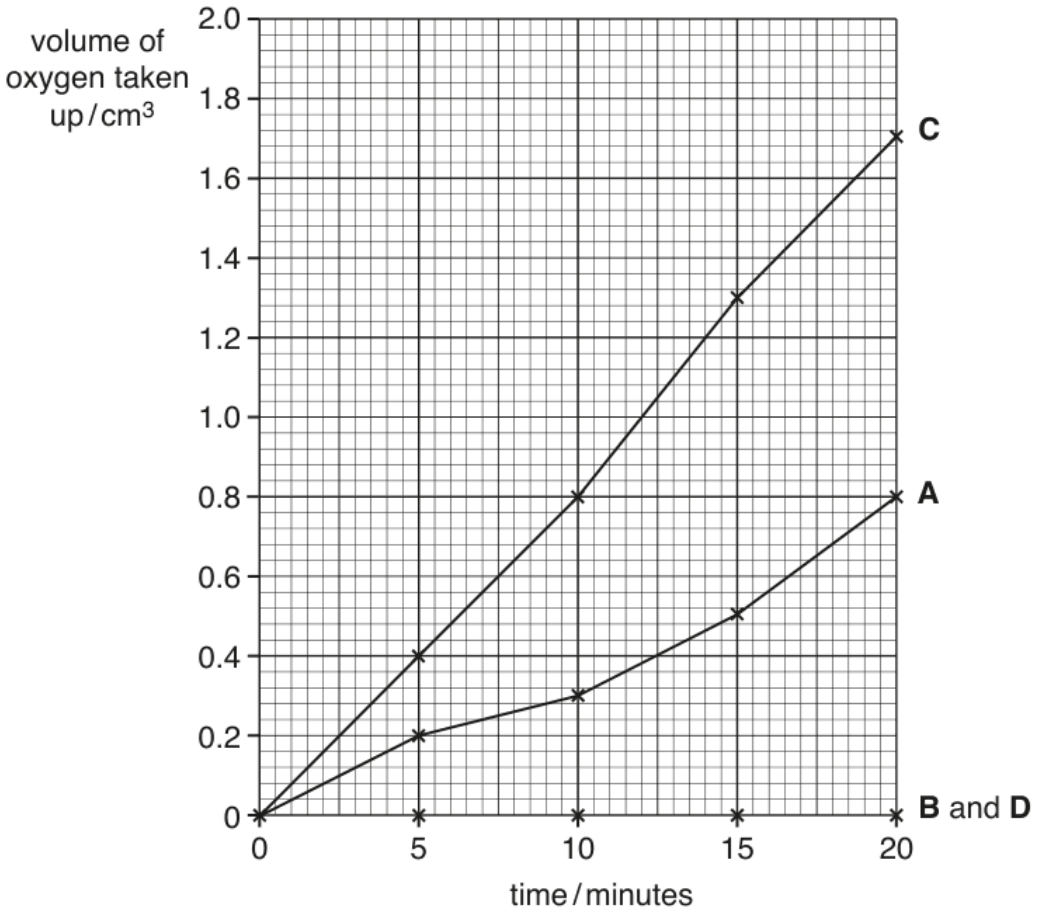


Fig. 8.2

(i) Suggest why the respirometers were left for 10 minutes before measurements were made.

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Question 22 · Paper 4 · October/November 2016 (42) · Q8(c)(ii) · 2 marks

(ii) Suggest why respirometers **B** and **D** were used in this investigation.

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Mark schemes

Question 1 · Paper 4 · February/March 2023 (42) · Q6(b) · 3 marks

6(b)	*any **three** from:* 1 site of, link reaction / Krebs cycle ; 2 DNA / ribosomes, for production of proteins (used in respiration) ; 3 named example ; e.g. enzymes / coenzymes / electron carriers ; 4 production of, reduced FAD / reduced NAD, for oxidative phosphorylation ; 5 substrate-linked phosphorylation ;	**3**

Question 2 · Paper 4 · May/June 2023 (42) · Q1(a)(i) · 1 mark

1(a)(i)	*any **one** from:* *glucose* is activated / made reactive ; becomes unstable ; cannot leave cell ; energy level increased ; concentration gradient maintained ;	**1**

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Question 3 · Paper 4 · May/June 2022 (42) · Q3(b) · 5 marks

3(b)	*any **five** from:*	**5**
	1 glycolysis ;	
	2 phosphorylation of glucose ;	
	3 splitting of fructose (1,6) bi(s)phosphate / AW ;	
	4 (into) two, triose phosphate / TP ;	
	5 (TP) oxidised / dehydrogenated, to pyruvate ;	
	6 net 2 ATP / 4 ATP, produced ;	
	7 (2) reduced NAD produced ;	

Question 4 · Paper 4 · May/June 2023 (42) · Q1(b) · 3 marks

1(b)	*any **three** from:*	**3**
	1 (inner) mitochondrial membrane impermeable (to pyruvate) ;	
	2 carrier (protein) ; **A** symport / MPC (mitochondrial pyruvate carrier)	
	3 lower concentration of pyruvate outside mitochondrion **ora** **or** against concentration gradient ;	
	4 oxygen available ;	
	5 ATP / energy ;	

Question 5 · Paper 4 · May/June 2023 (42) · Q1(c) · 3 marks

1(c)	*any **three** from:*	**3**
	1 decarboxylation ; **A** description	
	2 dehydrogenation / oxidation, (of pyruvate) ; **A** description	
	3 reduced NAD produced ;	
	4 formation of, acetyl coenzyme A / acetyl CoA ;	

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Question 6 · Paper 4 · May/June 2023 (43) · Q1(a) · 3 marks

1(a)	**P** – citrate **A** citric acid **Q** – NAD / NAD^+ **R** – reduced NAD / NADH **A** $NADH_2$ **S** – carbon dioxide / CO_2 **T** – FAD **U** – reduced FAD / $FADH_2$;;; *6 correct = 3 marks* *5/4 correct = 2 marks* *3/2 correct = 1 mark*	**3**

Question 7 · Paper 4 · February/March 2023 (42) · Q6(a)(i) · 1 mark

6(a)(i)	**D ;**	**1**

Question 8 · Paper 4 · February/March 2023 (42) · Q6(a)(ii) · 1 mark

6(a)(ii)	**D** and **C ;**	**1**

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Question 9 · Paper 4 · February/March 2025 (42) · Q8(c) · 4 marks

8(c)	*any **four** from:*	**4**
	1 hydrogen carrier / reduced ;	
	2 in, link reaction / Krebs cycle ;	
	3 moves to, inner mitochondrial membrane / cristae ;	
	4 releases hydrogen (atoms) ; **A** protons and electrons	
	5 for use in, oxidative phosphorylation ;	
	6 NAD, oxidised / recycled ;	

Question 10 · Paper 4 · May/June 2022 (43) · Q3(b) · 6 marks

3(b)	*any **six** from:*	**6**
	1 hydrogen / electron, carriers ; **R** hydrogen ions / hydrogen molecules	
	2 in glycolysis NAD becomes reduced ;	
	3 (so that) triose phosphate becomes, oxidised / dehydrogenated ;	
	4 in the link reaction NAD becomes reduced ;	
	5 (so that) pyruvate becomes, oxidised / dehydrogenated **or** for production of acetyl coenzyme A ;	
	6 in the Krebs cycle both NAD **and** FAD become reduced ;	
	7 to regenerate oxaloacetate ;	
	8 (deliver, hydrogen / H^+ and e^-), to inner mitochondrial membrane / to cristae / to ETC / for oxidative phosphorylation / for chemiosmosis ;	
	9 *ref. to* ATP production ;	
	10 *ref. to* recycling of, NAD / FAD ;	

Question 11 · Paper 4 · May/June 2025 (42) · Q1(a)(iii) · 3 marks

1(a)(iii)	*any **three** from:*	**3**
	1 ATP synthase ;	
	2 protons / hydrogen ions, move (from intermembrane space) to matrix ;	
	3 by facilitated diffusion ;	
	4 ATP synthesised from ADP + Pi ; **A** ADP is phosphorylated to ATP	
	5 *ref. to* chemiosmosis ;	

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Question 12 · Paper 4 · May/June 2025 (42) · Q1(b) · 4 marks

1(b)	*any **four** from:* 1 electron transport chain / ETC, stops / reduced ; 2 oxygen does not act as (final) electron acceptor ; 3 no / less , protons pumped into intermembrane space **or** no / less steep, proton gradient ; 4 build-up of, reduced NAD / reduced FAD **or** no / less, reduced NAD / reduced FAD, oxidised / recycled **or** no / less, NAD / FAD, regenerate / recycled ; 5 no / less, ATP production **or** no / fewer, protons pass through ATP synthase ; 6 Krebs cycle / link reaction / oxidative phosphorylation, stops / reduced ; 7 *ref. to* glycolysis / anaerobic respiration / lactate produced / ethanol produced / substrate level phosphorylation ;	**4**

Question 13 · Paper 4 · February/March 2022 (42) · Q7(a) · 7 marks

7(a)	*any **seven** from:* 1 reduced, NAD / FAD ; 2 releases hydrogen / hydrogen splits into proton and electron ; 3 ref. to, inner mitochondrial membrane / cristae ; 4 electrons pass through, electron transport chain / ETC ; 5 ref. to energy release ; 6 protons transferred, through inner membrane / into intermembrane space ; 7 proton gradient established / high proton concentration in intermembrane space ; 8 protons diffuse through ATP synth(et)ase ; 9 ATP produced from ADP and Pi ; 10 ref. to chemiosmosis ; 11 oxygen acts as final electron acceptor (to form water) / described ;	**7**

Question 14 · Paper 4 · October/November 2021 (42) · Q6(b)(i) · 2 marks

6(b)(i) **2**

statement	letter
the site of the Krebs Cycle	**A**
a phospholipid bilayer impermeable to H+ ions	**E / D**
the site of translation	**C**

;;

all correct = 2 marks
1 or 2 correct = 1 mark

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Question 15 · Paper 4 · October/November 2023 (42) · Q1(a) · 3 marks

1(a)	**A**: carbon dioxide / CO_2 ; **B**: reduced NAD / NADH and **C**: NAD / NAD^+ ; **D**: ethanal ;	**3**

Question 16 · Paper 4 · October/November 2023 (42) · Q1(b) · 3 marks

1(b)	*any **three** from:* 1 (recycles / produces) NAD ; **I** *ref. to* reduced NAD produced ; 2 *ref. to* glycolysis ; 3 *ref. to* ATP (produced) ; 4 by substrate-linked phosphorylation ;	**3**

Question 17 · Paper 4 · February/March 2022 (42) · Q7(b) · 4 marks

7(b)	*any **four** from:* 1 population **B** produces more ATP (than population **A**) ; ora 2 production of ATP increases at a higher rate for population **B** (than for population **A**) ; ora 3 paired data quote ; 4 population **B** carries out, glycolysis / substrate-linked phosphorylation, **and** oxidative phosphorylation ; 5 population **A** carries out (only) glycolysis / respiration in anaerobic conditions / (ethanol) fermentation / substrate-linked phosphorylation **or** population **A** cannot carry out oxidative phosphorylation ;	**4**

Question 18 · Paper 4 · October/November 2023 (42) · Q1(c) · 3 marks

1(c)	*any **three** from:* 1 aerenchyma provides oxygen for aerobic respiration ; 2 high concentration of ethanol dehydrogenase / high tolerance for ethanol, allows (higher rate of), ethanol fermentation / anaerobic respiration ; 3 fast growth / grow tall, so leaves, out of water / exposed to air ; 4 AVP ; e.g. ridges in submerged leaves to trap air	**3**

Question 19 · Paper 4 · October/November 2024 (42) · Q6(b)(i) · 2 marks

6(b)(i)	*any **two** from:* 1 volume / mass / concentration, of yeast suspension ; 2 volume / mass / concentration, of glucose (solution) ; 3 volume / concentration, of DCPIP ; 4 AVP ; e.g. time when DCPIP is added / pH	**2**

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Question 20 · Paper 4 · October/November 2024 (42) · Q6(b)(ii) · 3 marks

6(b)(ii)	*any **three** from:* 1 the less time taken (for DCPIP) to change colour the higher the rate of respiration **; ora** *rate increases up to 40 °C* 2 due to increase in, kinetic energy / KE **;** 3 due to **more** enzyme-substrate complexes formed **or** due to **more** (successful / effective) collisions between enzymes and substrates **or more** enzyme catalysed reactions **;** *rate decreases after 40 °C* 4 due to denaturation of (named respiration) enzyme **;** 5 further detail **;** e.g. active site shape change / optimum temperature 40 °C	**3**

Question 21 · Paper 4 · October/November 2016 (42) · Q8(c)(i) · 1 mark

8(c)(i)	equilibration / acclimatising / adjusting ;	**1**

Question 22 · Paper 4 · October/November 2016 (42) · Q8(c)(ii) · 2 marks

8(c)(ii)	*two from* 1 act as a control **;** 2 *idea of* control eliminates effects of variables other than, the independent variable / temperature **;** 3 (changes in **A** and **C** are) due to, seeds / respiration **; ora**	**2**

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