Topical Past Paper Questions Worksheets

AS & A Level Biology (9700) Paper 4

Exam Series: Feb/Mar 2017 – May/June 2023

Format Type A:
Answers to all questions are provided as an appendix

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Introduction

Each Topical Past Paper Questions Compilation contains a comprehensive collection of hundreds of questions and corresponding answer schemes, presented in worksheet format. The questions are carefully arranged according to their respective chapters and topics, which align with the latest IGCSE or AS/A Level subject content. Here are the key features of these resources:

1. The workbook covers a wide range of topics, which are organized according to the latest syllabus content for Cambridge IGCSE or AS/A Level exams.
2. Each topic includes numerous questions, allowing students to practice and reinforce their understanding of key concepts and skills.
3. The questions are accompanied by detailed answer schemes, which provide clear explanations and guidance for students to improve their performance.
4. The workbook's format is user-friendly, with worksheets that are easy to read and navigate.
5. This workbook is an ideal resource for students who want to familiarize themselves with the types of questions that may appear in their exams and to develop their problem-solving and analytical skills.

Overall, Topical Past Paper Questions Workbooks are a valuable tool for students preparing for IGCSE or AS/A level exams, providing them with the opportunity to practice and refine their knowledge and skills in a structured and comprehensive manner. To provide a clearer description of this book's specifications, here are some key details:

- Title: Cambridge AS & A Level Biology (9700) Paper 4 Topical Past Paper Questions
- Subtitle: Exam Practice Worksheets With Answer Scheme
- Examination board: Cambridge Assessment International Education (CAIE)
- Subject code: 9700
- Years covered: Feb/Mar 2017 – May/June 2023
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A Answers **913**

Chapter 1

Energy and respiration

1.1 Energy

1. 9700_w18_qp_42 Q: 9

(a) Explain why carbohydrates, lipids and proteins have different relative energy values as substrates in respiration in aerobic conditions. [6]

(b) Define the term respiratory quotient (RQ) **and** describe how you would carry out an investigation to determine the RQ of germinating barley seeds. [9]

[Total: 15]

1.2 Respiration

2. 9700_m23_qp_42 Q: 6

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

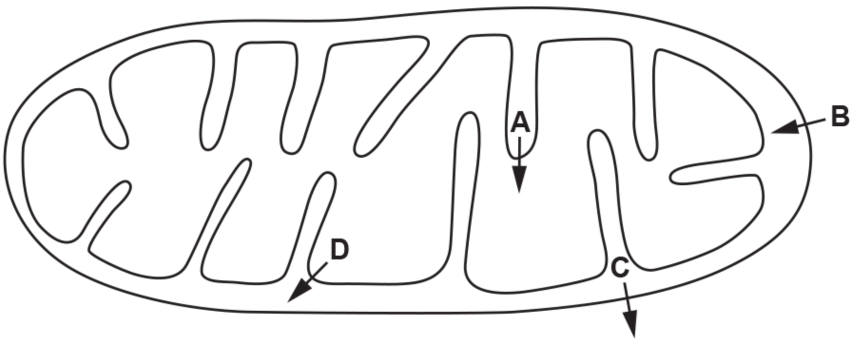

Fig. 6.1

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

.... [1]

(ii) diffusion of carbon dioxide.

.... [1]

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

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.... [3]

(c) Explain how a lack of oxygen affects oxidative phosphorylation.

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.... [4]

[Total: 9]

3. 9700_s23_qp_41 Q: 9

Many factors affect the rate of cellular respiration.

(a) Pyruvate carboxylase (PC) deficiency is a rare disease. The rate of respiration in the cells of a person with PC deficiency is much lower than normal.

The passage describes the occurrence of PC deficiency in human populations.

Complete the passage by using the most appropriate scientific terms.

PC deficiency affects one in 250 000 people. A person either has the disease or does not, so there are no intermediate forms of the disease. PC deficiency is caused by a genetic mutation in one gene. Whether a person develops the disease is not influenced by .... factors. The distribution of PC deficiency in human populations shows .... variation. [2]

(b) Coenzymes are important in aerobic respiration.

Outline the roles of named coenzymes in aerobic respiration.

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.... [5]

[Total: 7]

4. 9700_s23_qp_42 Q: 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.

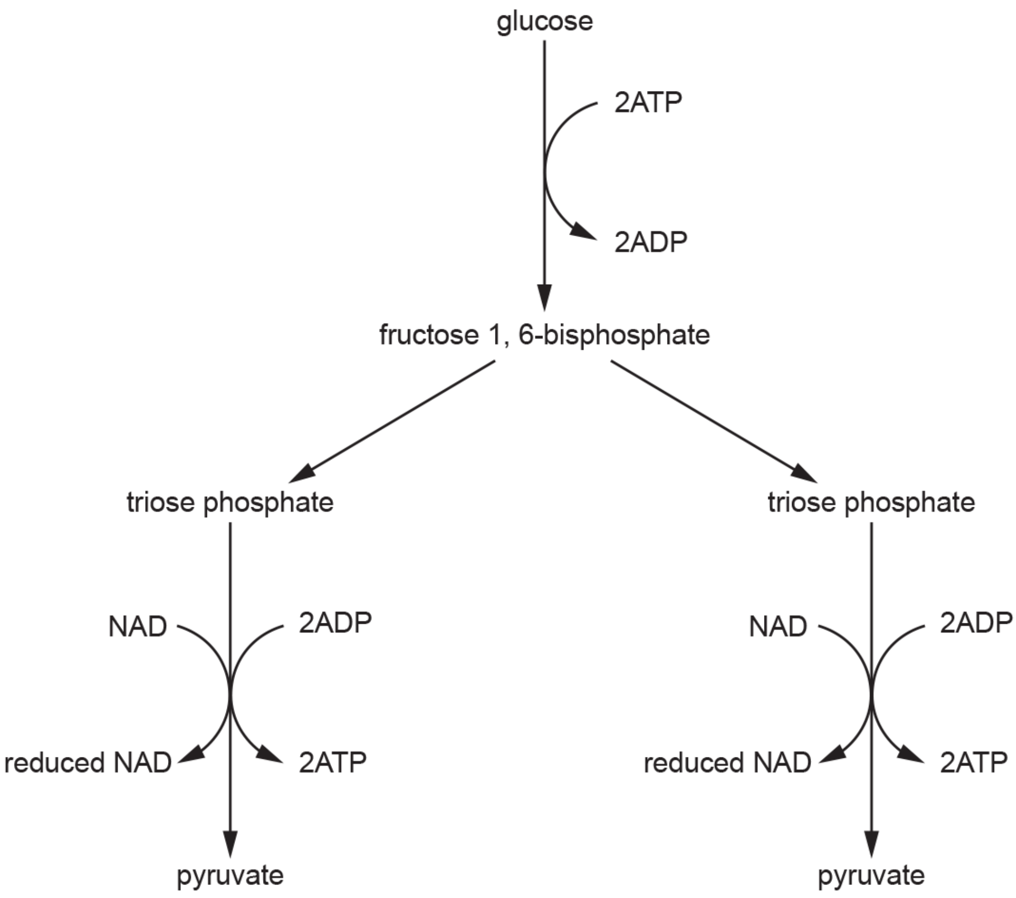

Fig. 1.1

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

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.... [1]

(ii) Suggest **one** use of the reduced NAD that is produced in glycolysis.

....

.... [1]

(iii) Name the type of phosphorylation reaction by which ATP is made during glycolysis.

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.... [1]

(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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.... [3]

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

Describe the link reaction.

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.... [3]

[Total: 9]

5. 9700_s23_qp_43 Q: 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.

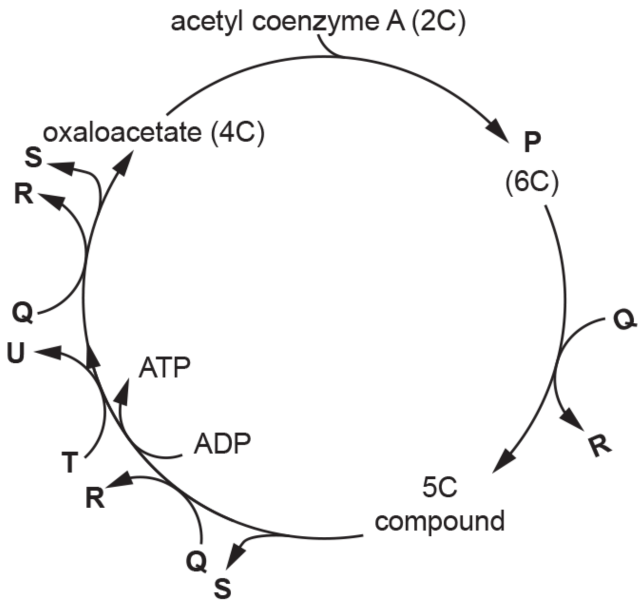

Fig. 1.1

Identify substances **P**–**U**.

P ....

Q ....

R ....

S ....

T ....

U ....

[3]

(b) Describe how ATP is produced from ADP in the Krebs cycle.

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....

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.... [2]

(c) Describe **and** explain the features of ATP that make it suitable as the universal energy currency.

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.... [4]

[Total: 9]

6. 9700_m22_qp_42 Q: 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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.... [7]

(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.

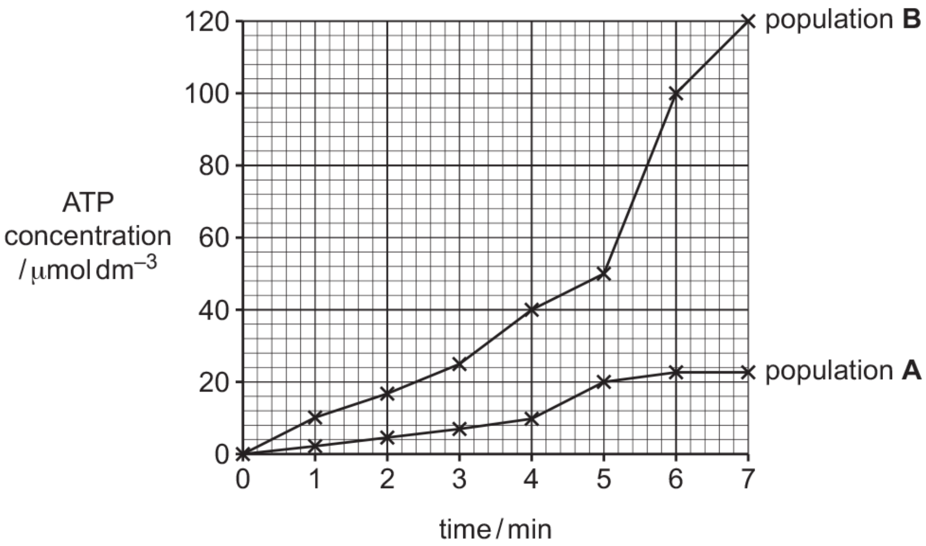

Fig. 7.1

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

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.... [4]

[Total: 11]

7. 9700_s22_qp_41 Q: 3

Respiration is a process that results in the synthesis of ATP. The ATP can be used within the cell for energy-requiring reactions and processes.

There are four stages in aerobic respiration: glycolysis, the link reaction, the Krebs cycle and oxidative phosphorylation.

(a) The ATP synthesised in respiration can be used to make larger and more complex biological molecules from smaller molecules.

Name the type of reaction that occurs when larger more complex biological molecules are made from smaller molecules.

.... [1]

(b) The first part of glycolysis uses ATP.

Explain why ATP is needed in the first part of glycolysis.

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.... [2]

(c) State the precise locations of substrate-linked phosphorylation reactions in aerobic respiration.

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.... [1]

(d) Explain what happens to pyruvate in the link reaction in aerobic respiration.

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.... [2]

(e) Chemiosmosis is a process that occurs in mitochondria during aerobic respiration and in chloroplasts during photosynthesis.

Describe the differences between the process of chemiosmosis in mitochondria and the process of chemiosmosis in chloroplasts.

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.... [3]

[Total: 9]

8. 9700_s22_qp_42 Q: 3

Aerobic respiration occurs when oxygen is available. A much greater energy yield is obtained from aerobic respiration than from respiration in anaerobic conditions.

(a) Explain why the link reaction only occurs when oxygen is available.

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.... [4]

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

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.... [5]

[Total: 9]

9. 9700_s22_qp_43 Q: 3

(a) ATP is synthesised from ADP and P_i in a phosphorylation reaction.

State the **two** different ways in which this phosphorylation reaction occurs in aerobic respiration.

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.... [2]

(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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.... [6]

(c) The enzyme pyruvate dehydrogenase catalyses the link reaction. Pyruvate dehydrogenase is inhibited when the ratio of acetyl coenzyme A to coenzyme A increases.

Suggest the importance of this inhibition to the functioning of the cell.

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.... [2]

[Total: 10]

10. 9700_w22_qp_41 Q: 3

(a) The results of investigations carried out on mitochondria show how the structure of a mitochondrion is related to its role in aerobic respiration.

- Intact mitochondria (not damaged) were removed from cells.
- A technique was used to remove the outer mitochondrial membrane, leaving the inner membrane intact.
- The inner mitochondrial membrane was separated from the contents of the matrix so that both could be analysed.

(i) The removal of the outer membranes of mitochondria involves placing the organelles in pure water. This results in the rupture (bursting) of the outer membrane. The inner mitochondrial membrane does not rupture and remains intact.

Suggest **and** explain why the inner membrane of a mitochondrion remains intact when the organelle is placed in pure water.

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.... [2]

(ii) Name **three** molecules, other than coenzymes, that are found in the mitochondrial matrix **and** explain their role in aerobic respiration.

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.... [3]

(iii) The inner membrane contains a very high proportion of the molecule cardiolipin. Cardiolipin makes the membrane impermeable to some ions.

Suggest why the inner membrane contains a very high proportion of cardiolipin.

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.... [1]

(b) In further experiments it was found that, in an intact mitochondrion:

- there is a membrane potential across the inner mitochondrial membrane, with the matrix having a negative charge
- the transport of ATP, ADP and inorganic phosphate (P_i) is driven by the membrane potential across the inner membrane.

Fig. 3.1 shows the location of some inner membrane carrier proteins.

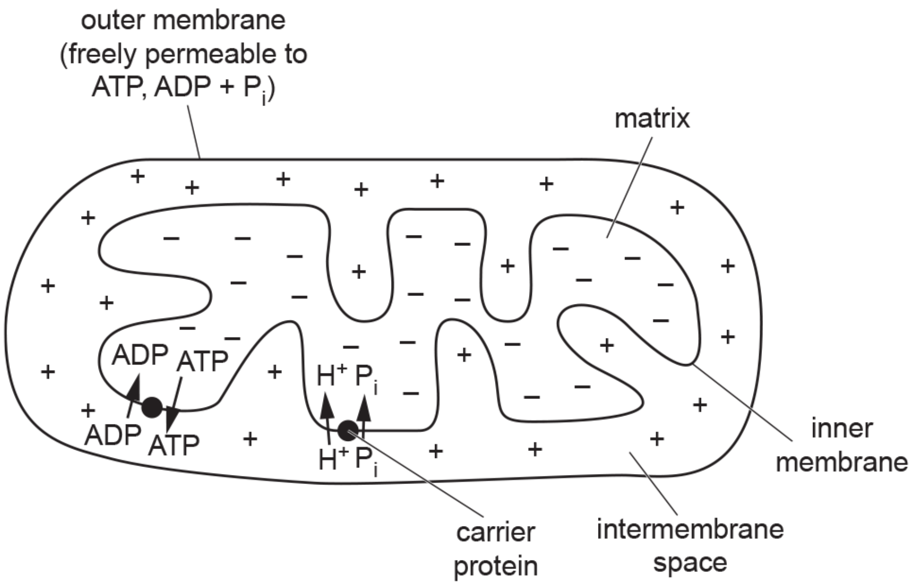

Fig. 3.1

(i) Reduced NAD and reduced FAD transfer hydrogen atoms to carriers located in the inner mitochondrial membrane.

Explain how hydrogen atoms from reduced NAD and reduced FAD lead to a membrane potential forming across the inner mitochondrial membrane during oxidative phosphorylation.

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.... [4]

(ii) Suggest **and** explain how P_i is transported across the inner membrane of the mitochondrion into the matrix.

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.... [2]

(iii) Suggest the advantages of linking ATP transport to ADP transport across the inner membrane of the mitochondrion.

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.... [2]

[Total: 14]

Appendix A

Answers

1. 9700_w18_ms_42 Q: 9

Question	Answer	Marks
(a)	*any six from* **1** different substrates have different numbers of, hydrogens / C-H bonds ; **2** lipids have (relatively) more, hydrogens / C-H bonds (than carbohydrates or proteins) ; **3** hydrogens / C-H bonds, located in fatty acid (tails of lipids) ; **4** breakdown / oxidation, of substrate provides hydrogen (atoms) ; **5** for reduction of, NAD / FAD ; **6** (reduced, NAD / FAD) provides / releases, hydrogen to ETC ; **7** hydrogen (dissociates) into protons and electrons ; **8** *ref.* energy used to set up proton gradient ; **9** chemiosmosis / oxidative phosphorylation / AW ; **10** (so) more, ATP / energy, from lipids per unit mass (than, carbohydrates / proteins) or lipids, more energy dense / have higher (relative) energy value ;	**6**
(b)	*RQ* **1** (ratio of) carbon dioxide given out divided by oxygen taken in ; **2** ref. volume / moles ; **R** amount **3** per unit time ; *any eight from* *investigation* **4** use respirometer ; **5** seeds placed on, mesh / gauze ; **6** KOH / NaOH / sodalime, to absorb carbon dioxide ; **7** manometer / capillary tube / syringe ; **8** movement of fluid (in manometer / capillary tube / syringe) = uptake of oxygen ; **9** keep, temperature / air pressure, constant ; **10** measure oxygen uptake after certain time ; **11** repeat without KOH / NaOH / sodalime ; **12** difference in manometer readings due to carbon dioxide given out ;	**9**

2. 9700_m23_ms_42 Q: 6

Question	Answer	Marks
(a)(i)	**D** ;	**1**
(a)(ii)	**D** and **C** ;	**1**
(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	Answer	Marks
(c)	*any **four** from:* *process, stops / decreases, because:* 1 no / fewer, electrons accepted by oxygen **or** oxygen is the final electron acceptor ; 2 no / fewer, electrons, enter / move along, electron transport chain / ETC **or** ETC stops ; 3 no /fewer, H^+ pumped into intermembrane space **or** no / less steep, proton gradient ; 4 no / less, chemiosmosis ; 5 reduced NAD / reduced FAD, not oxidised / **or** NAD / FAD, not recycled ; 6 no / less, ATP produced ; 7 AVP ; e.g. no / less, pyruvate enters mitochondrion.	4

3. 9700_s23_ms_41 Q: 9

Question	Answer	Marks
(a)	**1** environmental ; **2** discontinuous ;	2
(b)	*any **five** from*: *coenzyme A:* **1** accepts / binds to / transfers, acetyl (group) ; **2** acetyl / 2C fragment, + oxaloacetate → citrate ; **3** (joins) link reaction **and** Krebs cycle ; *NAD / FAD:* **4** transfer / transport / carry / accept / reduced by, H^+ and e^- / H (atoms) / hydrogen (atoms) ; **5** *ref.* dehydrogenation (reactions) / dehydrogenase (enzymes) ; **6** transport, to cristae / to inner mitochondrial membrane / to ETC / for oxidative phosphorylation ; **7** NAD (accepts H) in glycolysis **and** link reaction **and** Krebs cycle ;	5

4. 9700_s23_ms_42 Q: 1

Question	Answer	Marks
(a)(i)	*any **one** from:* *glucose* is activated / made reactive ; becomes unstable ; cannot leave cell ; energy level increased ; concentration gradient maintained ;	1
(a)(ii)	*any **one** from:* carrier / acceptor / provider, of, hydrogen (atoms) / electrons **or** provider of H ions **and** electrons ; **R** H ions alone used for redox reactions ; used to reduce, ethanal / pyruvate ;	1
(a)(iii)	substrate-linked / substrate level ;	1

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

5. 9700_s23_ms_43 Q: 1

Question	Answer	Marks
(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
(b)	*any **two** from:* 1 transfer of phosphate group to ADP / ADP phosphorylated / ADP + $P_i \rightarrow$ ATP ; 2 substrate-linked phosphorylation ; **A** substrate-level phosphorylation **R** if oxidative phosphorylation 3 enzyme (catalysed reaction) ;	2

Question	Answer	Marks
(c)	*any **four** from:* 1 small / water-soluble, so can move around cell ; 2 loss of phosphate / hydrolysis, leads to energy release ; 3 (release energy) immediately / in small packets **or** *ref.* 30.5 kJ (mol^{-1}) ; 4 can be, recycled / regenerated **or** ATP $\leftrightarrows$ ADP + Pi ; 5 link between energy-yielding and energy-requiring reactions / AW ; 6 high turnover / described ; 7 *ref to* ATPase ;	4

6. 9700_m22_ms_42 Q: 7

Question	Answer	Marks
(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	Answer	Marks
(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**

7. 9700_s22_ms_41 Q: 3

Question	Answer	Marks
(a)	anabolic / condensation / polymerisation ;	**1**
(b)	**1** to, phosphorylate / add phosphate to, glucose ; *and any **one** from:* **2** stops glucose leaving the cell ; **3** activates glucose / makes glucose less stable ; **4** to make fructose (1,6) bi(s)phosphate ;	**2**
(c)	cytoplasm **and** mitochondrial matrix ;	**1**

Question	Answer	Marks
(d)	*any **two** from:* **1** decarboxylated / loses carbon dioxide ; **2** dehydrogenated / oxidised / loses H ; **3** →, 2C / acetyl, (group) joins coenzyme A to make acetyl coA ;	**2**
(e)	*any **three** from:*	**3**

	mitochondria	**chloroplasts**
1	oxidative phosphorylation	photophosphorylation ;
2	inner mitochondrial membrane / crista(e)	thylakoid membrane ;
3	reduced NAD / reduced FAD, give e^- / H^+	photolysis / water / PS1 / chlorophyll, give e^- / H^+ ;
4	(H^+ →) intermembrane space	(H^+ →) thylakoid, space / lumen ;
5	oxygen, final, e^- / H^+, acceptor	NADP final, e^- / H^+, acceptor ;
6	(makes) water / H_2O	(makes) reduced NADP ;

8. 9700_s22_ms_42 Q: 3

Question	Answer	Marks
(a)	*any **four** from:* *accept **ora*** 1 pyruvate converted to, acetyl group / 2C group / acetyl CoA (in link reaction) ; 2 NAD needed (in link reaction) ; 3 (where) NAD becomes reduced ; 4 reduced NAD goes to ETC ; 5 ETC / oxidative phosphorylation, works if oxygen is present **or** oxygen is the final electron acceptor ; 6 (so) reduced NAD is oxidised / NAD is regenerated ;	**4**
(b)	*any **five** from:* 1 <u>glycolysis</u> ; 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 ;	**5**

9. 9700_s22_ms_43 Q: 3

Question	Answer	Marks
(a)	*any* ***two*** *from:* substrate-linked (phosphorylation) **;** **A** substrate level phosphorylation chemiosmosis / oxidative (phosphorylation) **;**	**2**
(b)	*any* ***six*** *from:* 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 **;**	**6**

Question	Answer	Marks
(c)	*any* ***two*** *from:* 1 *ref. to* increase / decrease / control, of (rate of the) link reaction **;** 2 allows build-up of acetyl CoA to be used in the Krebs cycle **;** 3 enzyme becomes active again when, coenzyme A increases / ratio falls **;** 4 allows more coenzyme A, to enter / return to, the link reaction **;** **A** not enough CoA to enter the link reaction **ora** 5 AVP **;** e.g. end product inhibition	**2**

10. 9700_w22_ms_41 Q: 3

Question	Answer	Marks
(a)(i)	*any **pair** (max 2) from:* 1 cristae / folds, let inner membrane expand ; 2 when water enters (matrix), by osmosis / down water potential gradient ; 3 inner membrane (relatively) impermeable to water ; 4 (so) water does not enter (matrix), by osmosis / down water potential gradient ; 5 inner membrane moves (H^+) ions out of matrix ; 6 so less water enters (matrix), by osmosis / down water potential gradient ;	**2**
(a)(ii)	*any **three** names plus explanations from:* 1 <u>pyruvate</u>, for link reaction / to bind to coenzyme A / to make acetyl (CoA) / to make reduced NAD / be dehydrogenated ; 2 <u>oxaloacetate</u> to, accept acetyl / make citrate ; 3 <u>citrate</u> to, make reduced NAD / be dehydrogenated ; 4 <u>enzymes</u> to catalyse, link reaction / Krebs cycle ; 5 <u>oxygen</u> to, accept electrons / accept protons / form water ; 6 <u>water</u> as a, solvent / medium for reactions ; 7 <u>DNA</u> / <u>RNA</u>, to make (named) respiratory, enzymes / proteins ;	**3**

Question	Answer	Marks
(a)(iii)	*any **one** from:* 1 so H^+, cannot move through / must move through ATP synthase ; 2 to maintain proton gradient ;	**1**
(b)(i)	*any **four** from:* 1 (H atoms) split into protons and electrons ; 2 electrons, flow / move, down ETC ; 3 (releases) energy used to move H^+ to intermembrane space ; 4 more / build-up of, H^+ / positive charge, in intermembrane space ; 5 (causes / sets up) proton / electrochemical, <u>gradient</u> ;	**4**
3(b)(ii)	*any **two** from:* 1 (P_i) by facilitated diffusion **or** through a protein, channel / carrier ; 2 P_i and H^+ move together ; 3 (as) H^+ ions <u>diffuse</u> (through ATP synth(et)ase / to matrix) ;	**2**
(b)(iii)	1 constant / sufficient / correct, supply / amount of, ADP / reactant ; 2 (so) ATP can continue to be made / so enough ATP can be made ;	**2**