

# Interactive Example Candidate Responses

## Paper 4 (May/June 2016), Question 9

### Cambridge International AS & A Level

### Biology 9700

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- 9 (a) Outline how ATP is synthesised by oxidative phosphorylation. [8]
- (b). Describe respiration in yeast cells in anaerobic conditions. [7]
- [Total: 15]

Q9 a) In oxidative phosphorylation, ATP is synthesised by a process known as chemiosmosis. Oxidative phosphorylation occurs in the mitochondrial cristae. Reduced NAD and FAD from glycolysis and Krebs cycle pass their hydrogen to the first protein in a series of electron transport chain in inner mitochondrial membrane. NAD and reduced NAD and FAD become free to bind to hydrogen again. Hydrogen is split into a proton and an electron. The electron is passed along a series of electron transport chain from high energy level to lower energy level down an energy gradient releasing energy. Energy released by the electron is used to actively pump protons into the intermembrane space creating a concentration gradient across the inner membrane. Protons concentration gradient by facilitated diffusion through a channel protein. These channel proteins have the enzyme ATP synthase attached to them that uses the chemical potential energy of protons passing through it to synthesise ATP, by converting ADP and  $P_i$  to ATP.

Your  
Mark

9(a)

9(b)

Q9	Mark scheme
(a)	<p>accept proton / hydrogen ion / <math>H^+</math> / H ion as equivalent throughout</p> <p>1 reduced, NAD / FAD ; A NADH / NADH<sub>2</sub> / NADH + <math>H^+</math> for reduced NAD</p> <p>2 passed to ETC ;</p> <p>3 inner membrane / cristae ;</p> <p>4 hydrogen released (from reduced, NAD / FAD) ; R <math>H_2</math></p> <p>5 split into electrons and protons ; A released as electron and proton</p> <p>6 electrons pass along, carriers / cytochromes ; A electrons pass along proteins of, ETC / carrier chain</p> <p>7 energy released pumps protons into intermembrane space ;</p> <p>8 proton gradient is set up ; A concentration gradient of protons is created A full description</p> <p>9 protons diffuse, (back) through membrane / down gradient ; A protons <u>diffuse</u> into matrix</p> <p>10 ATP synthase / stalked particles / protein channels ; A ATP synthetase R ATPase</p> <p>11 (ATP produced from) ADP and (inorganic) phosphate ; A context for 'final'</p> <p>12 idea of oxygen as final electron acceptor ;</p> <p>13 addition of proton (to oxygen) to form water / (oxygen) reduced to water ; [max 8]</p>
(b)	<p>1 pyruvate formed by <u>glycolysis</u> ;</p> <p>2 reduced NAD formed by <u>glycolysis</u> ;</p> <p>3 pyruvate decarboxylated / AW ;</p> <p>4 ethanol produced ;</p> <p>5 pyruvate decarboxylase ;</p> <p>6 ethanol is, hydrogen acceptor / reduced ; A gains H or gains <math>H^+</math> and <math>e^-</math></p> <p>7 from / by, reduced NAD ;</p> <p>8 ethanol formed ;</p> <p>9 ethanol / alcohol, dehydrogenase ;</p> <p>10 not reversible reaction ;</p> <p>11 NAD, regenerated / can now accept hydrogen atoms ; A reduced NAD oxidised</p> <p>12 so glycolysis can continue ; [max7]</p> <p>[Total: 15]</p>

Hydrogen, electrons and protons then bind to oxygen which acts as final electron acceptor, reducing it to water.

b) During anaerobic respiration in yeast cells, only glycolysis takes place in the cytoplasm. Glucose is phosphorylated using 2 ATP molecules to produce fructose biphosphate, which then breaks down into 2 triose phosphate molecules. Triose phosphate is then dehydrogenated producing 2 reduced NAD molecules, also 4 ATP molecules are produced by substrate level phosphorylation. Triose phosphate is converted to pyruvate, a 3-carbon compound. Pyruvate is then decarboxylated to produce ethanol and a carbon dioxide molecule. Ethanol accepts hydrogen from (NAD<sup>+</sup>) reduced NAD converting it to ethanol. NAD is now free to bind to hydrogen again so that glycolysis can (continue) continue. Ethanol is converted to ethanol by an enzyme called ethanol dehydrogenase. Net 2 ATP molecules are made. Link reaction, Krebs cycle and oxidative phosphorylation doesn't take place.

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9(a)

9(b)

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9(a)

9(b)

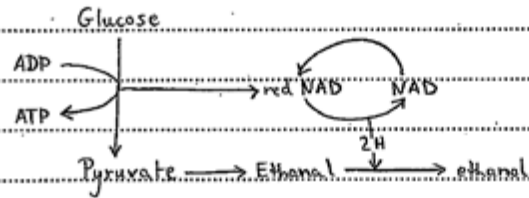
9

(a) Hydrogens <sup>from red NAD & FAD are</sup> are split into protons ( $H^+$ ) and electrons ( $e^-$ ). Electrons are then transported to the ~~etc~~  $e^-$  transport chain, releasing energy.  $H^+$  are pumped from the mitochondrial matrix into the intermembrane space, using the energy released from the  $e^-$  Transport chain.  $H^+$  are then pumped back to the matrix down a concentration gradient, releasing energy. The energy released ~~from~~ <sup>from the proton</sup> pump is used by the enzyme ATP synthase, to <sup>phosphorylate</sup> ~~phosphorylate~~ ADP  $\rightarrow$  ATP, by a process known as Chemiosmosis. Oxygen is the final electron acceptor and combines with  $H^+$  and  $e^-$  to make water. This is the last stage of aerobic respiration.

Q9	Mark scheme
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(b) Anaerobic respiration - (Yeast cells).



Your  
Mark

9(a)

9(b)

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9 (a) Outline how ATP is synthesised by oxidative phosphorylation. [8]

(b) Describe respiration in yeast cells in anaerobic conditions. [7]

[Total: 15]

(9)(a) NADPH loses its  $H^+$  ions as it reaches the cristae.

by photolysis using energy from ATP that was produced earlier from glycolysis, and Krebs cycle, energy pumps  $H^+$  ions against their concentration gradient from high to low into the intermembrane space of the mitochondria.

As the concentration of  $H^+$  ions increases, then they diffuse down their concentration gradient through ATP synthase that is placed in membrane of cristae.

For each  $3H^+$  passing through it, one ATP molecule is produced.

also water breaks down to

Your  
Mark

9(a)

9(b)

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(b) Because of ~~oxygen~~ lack of oxygen during respiration, the yeast cells will respire anaerobically. The ~~pyruvate~~ that 2 C<sub>3</sub> compounds are converted by into 2 pyruvate compounds that act as final hydrogen acceptor instead of oxygen from NADH that was reduced during glycolysis. by hydrogenation, pyruvate ~~is~~ ~~for~~ is converted into lactate. With help of enzyme called lactate. lactate is then stored in the cell, till oxygen debt is repaid to break down lactate.

Your  
Mark

9(a)

9(b)

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Cambridge Assessment International Education  
The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA, United Kingdom  
t: +44 1223 553554 f: +44 1223 553558  
e: [info@cambridgeinternational.org](mailto:info@cambridgeinternational.org) [www.cambridgeinternational.org](http://www.cambridgeinternational.org)

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