



ANSWER BOOK

Anaerobic respiration and the respiratory quotient

Respiration and cellular energy · Unit B12

AQA 3.5.2 · OCR A 5.2.2, 5.2.3 · Edexcel A Topic 7.5–7.7 · CAIE 12.2, 12.3

7 questions · 23 marks

NAVY EDITION

SECTION A · Short, 1 to 2 marks

- A1** **B1** ethanol and carbon dioxide are the products of the fermentation itself. **B1** the net gain is 2 ATP per molecule of glucose, all of it from glycolysis, since neither fermentation step makes any ATP. [2]
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SECTION B · Standard, 3 to 5 marks

- B1** **B1** no step of glycolysis uses oxygen; what it needs is oxidised NAD, to accept the hydrogen removed when triose phosphate is oxidised. **B1** without oxygen the electron transport chain cannot oxidise reduced NAD, so oxidised NAD is no longer returned to the cytoplasm and glycolysis would stall within seconds. **B1** pyruvate accepts the hydrogen from reduced NAD instead, catalysed by lactate dehydrogenase, so pyruvate is reduced to lactate and oxidised NAD is regenerated. **B1** glycolysis can therefore keep running and keep supplying 2 ATP per glucose, quickly and without waiting for oxygen, so the lactate is a by-product of solving the coenzyme problem rather than the purpose of the pathway. [4]
- B2** **B1** in an animal, pyruvate is reduced to lactate in a single step, whereas in yeast pyruvate is first decarboxylated to ethanal and the ethanal is then reduced to ethanol, which is two steps. **B1** the animal route keeps all three carbons in the lactate, whereas the yeast route loses one as carbon dioxide, so only the yeast route releases a gas. **B1** the animal route is reversible, so lactate can be converted back to pyruvate and respired once oxygen returns, whereas the yeast route is irreversible because the carbon has left as gas. **B1** both routes exist to regenerate oxidised NAD for glycolysis, and both give the same net yield of 2 ATP per molecule of glucose. [4]
- B3** **M1** with soda lime the carbon dioxide is absorbed as fast as it is made, so the movement measures oxygen uptake alone: $50 \times 1.0 = 50 \text{ mm}^3$. **M1** without soda lime the movement measures oxygen consumed minus carbon dioxide released: $5 \times 1.0 = 5 \text{ mm}^3$, so the carbon dioxide produced is $50 - 5 = 45 \text{ mm}^3$. **M1** $\text{RQ} = \text{volume of carbon dioxide produced} \div \text{volume of oxygen consumed} = 45 \div 50$. **A1** $\text{RQ} = 0.90$, quoted with no units, which indicates protein as the main substrate, or a mixture of substrates. [4]
- B4** **B1** a fatty acid chain is almost entirely carbon and hydrogen, with very little oxygen already attached, so it is highly reduced and carries many more hydrogen atoms per gram than glucose, which holds an oxygen for every carbon. **B1** more hydrogen per gram means more reduced NAD and reduced FAD are produced, so more electrons pass along the chain and more protons are pumped into the intermembrane space. **B1** more protons returning through ATP synthase means more ATP is made per gram; it also means more oxygen is needed, which is why lipid gives a respiratory quotient near 0.70. [3]
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- B5** **B1** the tube of glass beads contains nothing that respire, so any movement of fluid in it is caused by changes in room temperature or atmospheric pressure rather than by oxygen uptake. **B1** its reading is used to correct the reading from the experimental tube, so that a warm afternoon is not recorded as a burst of respiration. **B1** gas warming up to the temperature of the water bath expands, and that expansion would swamp the small volume change caused by the organisms, so the apparatus is equilibrated before readings begin. [3]
- B6** **B1** carbon dioxide is being released that the oxygen uptake cannot account for, so some of it must come from a reaction that does not consume oxygen. **B1** the yeast must therefore be respiring anaerobically alongside any aerobic respiration, releasing carbon dioxide when pyruvate is decarboxylated to ethanal. **B1** as the oxygen sealed into the flask is used up the quotient would rise further, and once oxygen uptake reaches zero the quotient becomes undefined rather than merely large. [3]