RESPIRATION

Topics for this weeks class:

Glycolysis
The Link Reaction
Krebs Cycle
Oxidative Phosphorylation
Anaerobic Respiration

Playlist of videos to take notes on before the web class:

AQA VIDEOS	OCR VIDEOS	EDEXCEL VIDEOS
Introduction To Respiration	Introduction To Respiration	Introduction To Respiration
Glycolysis	Mitochondria	Mitochondria
The Link Reaction	Glycolysis	Glycolysis
Krebs Cycle	The Link Reaction	The Link Reaction
Oxidative Phosphorylation	Krebs Cycle	Krebs Cycle
Anaerobic Respiration - Glycolysis	Oxidative Phosphorylation	Oxidative Phosphorylation
Respiratory Substrates	Anaerobic Respiration - Glycolysis	Chemiosmotic Theory
Mitochondria	Respiratory Substrates	Anaerobic Respiration - Glycolysis
	Respiratory Quotient	Lactate
		Respiratory Substrates

Q1.

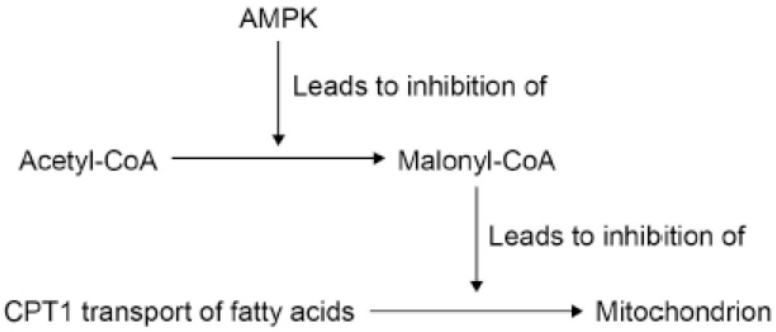
(a) Exercise causes an increase in heart rate.

Describe the role of receptors and of the nervous system in this process.

(4)

(b) AMP-activated protein kinase (AMPK) is an enzyme that regulates a number of cellular processes. Exercise leads to activation of AMPK.

The diagram shows one effect of activation of AMPK during exercise.



CPT1 is a channel protein that transports fatty acids into mitochondria.

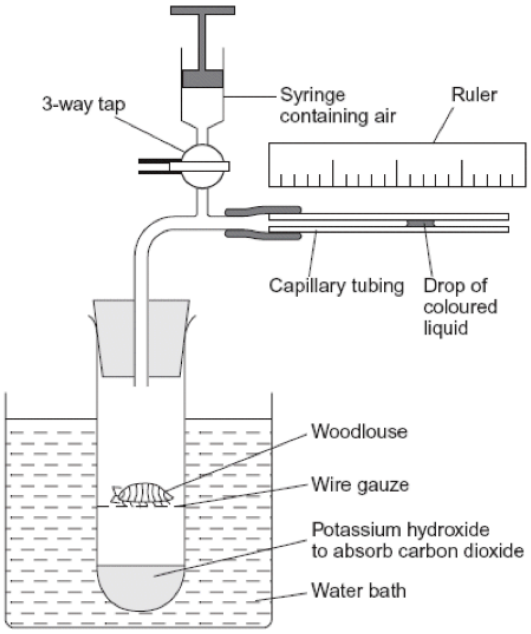
Using the diagram above, explain the benefit of activation of AMPK during exercise.

(3)

(Total 7 marks)

Q2.

(a) A student measured the rate of aerobic respiration of a woodlouse using the apparatus shown in the diagram.



(i) The student closed the tap. After thirty minutes the drop of coloured liquid had moved to the left. Explain why the drop of coloured liquid moved to the left.

_____

_____

_____

_____

_____

_____

(3)

(ii) What measurements should the student have taken to calculate the rate of aerobic respiration in mm^3 of oxygen g^{-1} h^{-1}?

_____

_____

_____

_____

_____

_____

(3)

(b) DNP inhibits respiration by preventing a proton gradient being maintained across membranes. When DNP was added to isolated mitochondria the following changes were observed

- less ATP was produced
- more heat was produced
- the uptake of oxygen remained constant.

Explain how DNP caused these changes.

_____

_____

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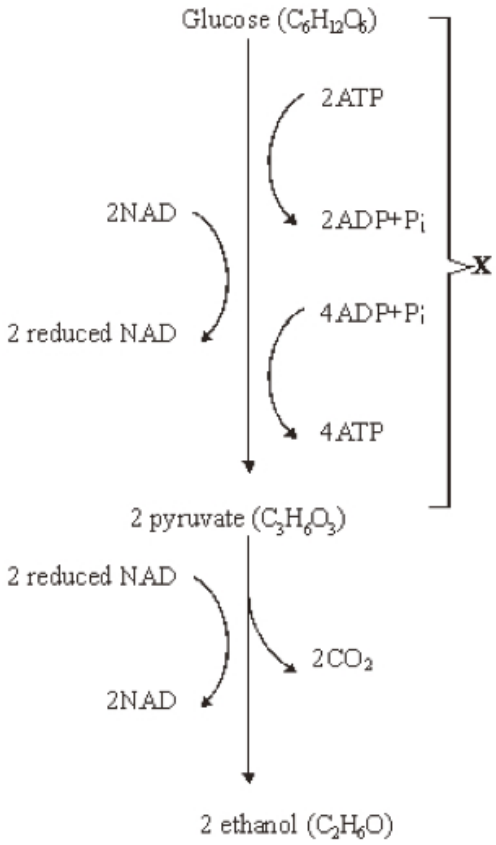
(3)

(Total 9 marks)

Q3.

(a) The main stages in anaerobic respiration in yeast are shown in the diagram.



(i) Name process **X**.

_____

(1)

(ii) Give **one** piece of evidence from the diagram which suggests that the conversion of pyruvate to ethanol involves reduction.

_____

_____

(1)

(iii) Explain why converting pyruvate to ethanol is important in allowing the continued production of ATP in anaerobic respiration.

_____

_____

_____

_____

(2)

(b) Give **two** ways in which anaerobic respiration of glucose in yeast is

(i) similar to anaerobic respiration of glucose in a muscle cell

1. _____

_____

2. _____

_____

(2)

(ii) different from anaerobic respiration of glucose in a muscle cell.

1. _____

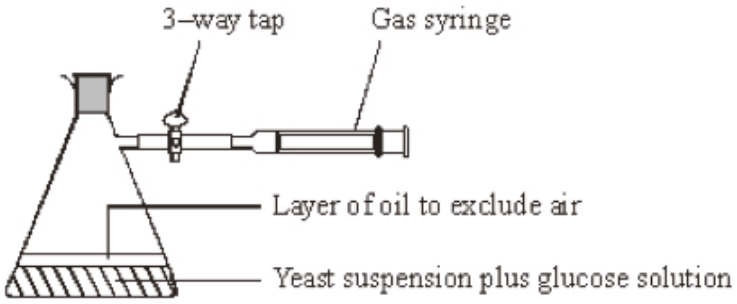
_____

2. _____

_____

(2)

(c) Some students investigated the effect of temperature on the rate of anaerobic respiration in yeast. The apparatus they used is shown in the diagram. The yeast suspension was mixed with glucose solution and the volume of gas collected in five minutes was recorded.



(i) Each student repeated the experiment and the results were pooled. Explain the advantages of collecting a large number of results.

_____

_____

_____

_____

(2)

(ii) At 30 °C, one student obtained the following results.

Volume of gas collected in 5 minutes / cm^3	Result 1	Result 2	Result 3
	38.3	27.6	29.4

Calculate the mean rate of gas production. Give your answer in $cm^3\ s^{-1}$.

Answer _____ $cm^3\ s^{-1}$

(2)

(iii) If aerobic respiration had been investigated rather than anaerobic respiration, how would you expect the volumes of gas collected at 30°C to differ from these results?

Explain your answer.

_____

_____

_____

_____

_____

_____

(3)

(Total 15 marks)

Q4.

(a) Pyruvate is formed in the breakdown of glucose during respiration. When there is sufficient oxygen, this pyruvate is fully broken down. Name **two** substances formed from the pyruvate.

1. _____

2. _____

(1)

(b) (i) If there is a shortage of oxygen in muscle cells during exercise, some pyruvate is converted into lactate. Explain why muscles become fatigued when insufficient oxygen is available.

_____

_____

_____

_____

(2)

(ii) Some of the lactate is oxidised to pyruvate by muscles when they are well-supplied with oxygen. Suggest an advantage of the lactate being oxidised in the muscles.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q5.

(a) Describe how acetylcoenzyme A is formed in the link reaction.

_____

_____

_____

_____

_____

(2)

(b) In the Krebs cycle, acetylcoenzyme A combines with four-carbon oxaloacetate to form six-carbon citrate. This reaction is catalysed by the enzyme citrate synthase.

(i) Oxaloacetate is the first substrate to bind with the enzyme citrate synthase. This induces a change in the enzyme, which enables the acetylcoenzyme A to bind.

Explain how oxaloacetate enables the acetylcoenzyme A to then bind to the enzyme.

_____

_____

_____

_____

_____

(2)

(ii) Another substance in the Krebs cycle is called succinyl coenzyme A. This substance has a very similar shape to acetylcoenzyme A.

Suggest how production of succinyl coenzyme A could control the rate of the reaction catalysed by citrate synthase.

_____

_____

_____

_____

_____

(2)

(c) In muscles, pyruvate is converted to lactate during anaerobic respiration.

(i) Explain why converting pyruvate to lactate allows the continued production of ATP during anaerobic respiration.

_____

_____

_____

_____

_____

(2)

(ii) In muscles, some of the lactate is converted back to pyruvate when they are well supplied with oxygen. Suggest **one** advantage of this.

_____

_____

_____

_____

(1)

(Total 9 marks)

Q6.

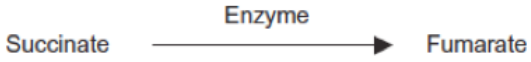
(a) The table contains statements about three stages of respiration.

Complete the table with a tick if the statement in the first column is true for each stage of respiration in an animal.

	Glycolysis	**Link reaction**	**Krebs cycle**
Occurs in mitochondria			
Carbon dioxide produced			
NAD is reduced			

(3)

(b) The following reaction occurs in the Krebs cycle.



A scientist investigated the effect of the enzyme inhibitor malonate on this reaction. The structure of malonate is very similar to the structure of succinate. The scientist added malonate and the respiratory substrate, pyruvate, to a suspension of isolated mitochondria. She also bubbled oxygen through the suspension.

(i) Explain why the scientist did not use glucose as the respiratory substrate for these isolated mitochondria.

_____

_____

_____

_____

(2)

(ii) Explain how malonate inhibits the formation of fumarate from succinate.

_____

_____

_____

_____

(2)

(iii) The scientist measured the uptake of oxygen by the mitochondria during the investigation. The uptake of oxygen decreased when malonate was added. Explain why.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q1.

(a) 1. Chemoreceptors detect rise in CO_2 / H_+ / acidity / carbonic acid / fall in pH

OR

Baro / pressure receptors detect rise in blood pressure

2. Send impulses to cardiac centre / medulla
3. More impulses to SAN
4. By sympathetic (nervous system for chemoreceptors / CO_2)

OR

By parasympathetic (nervous system for baro / pressure receptors / blood pressure)

1. Ignore: location of receptors.

1. Ignore: chemoreceptors detect oxygen.

2 and 3. Accept: action potentials.

2. Reject: 'messages', 'signals', 'an impulse' or an 'action potential'.

3. Ignore: messages', 'signals', 'an impulse' or an 'action potential' as emphasis here is on increase in frequency.

4

(b) 1. Less / no malonyl-CoA

2. (More) fatty acids transported / moved into mitochondria
3. Respiration / oxidation of fatty acids provides ATP

1. 'Inhibition of malonyl-CoA' on its own is not enough but accept production of malonyl-CoA is inhibited.

2. Accept: 'transport of fatty acids into mitochondria is not inhibited'.

2. Ignore: method of entry.

3. Accept: for respiration any stage of aerobic respiration e.g. Krebs (cycle), link (reaction) etc.

*3. Reject: production of energy, **but** accept production of energy in the form of ATP.*

3. Accept: acetyl CoA can enter Krebs cycle / mitochondria to provide ATP.

3

[7]

Q2.

(a) (i) 1. Oxygen taken up / used (by woodlouse)

2. Carbon dioxide (given out) is absorbed by solution / potassium hydroxide
3. Decrease / change in pressure

Reference to vacuum negates last marking point

Reject reference to pressure increasing inside tube

3

(ii) 1. Distance (drop moves) and time

2. Mass of woodlouse
3. Diameter / radius / bore of tubing / lumen / cross-sectional area

If answer refers to measuring volume using the syringe allow 2 max –

one mark for measuring volume

one mark for mass of woodlouse

3

(b) 1. Less / no proton / H^+ movement so less / no ATP produced

2. Heat released from electron transport / redox reactions / energy not used to produce ATP is released as heat
3. Oxygen used as final electron acceptor / combines with electrons (and protons)

3

[9]

Q3.

(a) (i) glycolysis

1

(ii) oxygen removed from pyruvate / reduced NAD is oxidised / donates hydrogen / donates electrons

1

(iii) allows NAD to be recycled / re-formed
so that glycolysis / described / candidates answer to (i) can proceed / so that (more) glucose can be converted to pyruvate / so that process X can continue

2

(b) (i) ATP formed / used
pyruvate formed / reduced
NAD / reduced NAD
glycolysis involved / two stage process

2 max

(ii) ethanol / alcohol formed by yeast, lactate (*allow lactic acid*)
by muscle cell CO_2 released by yeast but not by muscle cell
(note: need both parts of the comparison for the mark)

2

(c) (i) allows anomalies to be identified / increases reliability (of means / averages / results)
allows use of statistical test

2

(ii) = 31.8 / 31.76 / 31.77
(units not required)
÷ (5 × 60) = 0.106 / 0.11 / 0.1
(correct answer scores two marks, however derived.)
(correct mean volume (31.8 cm^3) however derived scores 1 mark)

2

(iii) Volume(s) less / no gas evolved
So (volume) CO_2 evolved = (volume of) O_2 taken in

3

[15]

Q4.

(a) CO_2, water, ATP, reduced NAD / FAD
(accept creatine phosphate)(any 2 - one tick)

1

(b) (i) build up / increased concentration of lactate lowers
pH / increases H^+ / increases acidity
enzymes / named protein inhibited(*not denatured)*

2

(ii) lactate / pyruvate is an energy source
muscles have increased / immediate energy or ATP supply
(accept lactate replenishes glycogen or glucose)
restores pH levels

2 max

[5]

Q5.

(a) 1. Oxidation of / hydrogen removed from pyruvate and carbon dioxide released
2. Addition of coenzyme A.
Accept: NAD reduced for oxidation

2

(b) (i) 1. Change (in shape) of active site / active site moulds around the substrate
Reject: reference to inhibitor
Accept: change in tertiary structure affecting active site
2. (Substrate / active site) now complementary.
Neutral: references to two active sites

2

(ii) 1. Is a competitive inhibitor / attaches to active site
Neutral: reference to inhibitor forming an enzyme-substrate complex
2. Reduces / prevents enzyme-substrate / E-S complex forming.
Accept: Reduces / prevents acetylcoenzyme A binding to enzyme / citrate synthase

2

(c) (i) 1. Regenerates / produces NAD / oxidises reduced NAD
2. (NAD used) in glycolysis.
Accept: description of glycolysis
Accept: glycolysis can continue / begin

2

(ii) (Pyruvate used) in aerobic respiration / (lactate / lactic acid) is toxic / harmful / causes cramp / (muscle) fatigue.
Accept: (pyruvate) can enter link reaction
Accept: reduces cramp / (muscle) fatigue
Neutral: 'reduces muscle aches'

1
[9]

Q6.

(a)

	Glycolysis	Link reaction	Krebs cycle
Occurs in mitochondria		√	√
Carbon dioxide produced		√	√
NAD is reduced	√	√	√

Mark horizontally

3

(b) (i) 1. Glucose is used / broken down during glycolysis / in cytoplasm

1. Accept: glucose to pyruvate or glucose not converted to pyruvate for one mark

2. Glucose cannot cross mitochondrial membrane(s) / pyruvate can cross mitochondrial membrane(s)

2

(ii) 1. Is a competitive inhibitor / attaches to active site

1 Accept: inhibitor / malonate attaches to active site to form an enzyme-substrate complex

2. Reduces / prevents enzyme-substrate / E-S complex forming

2 Accept: substrate / succinate cannot bind to enzyme

2 Accept mark point 2, but not mp1 in context of non-competitive inhibition

2

(iii) 1. Krebs cycle inhibited as NAD / Coenzyme / FAD not / less reduced

2. Hydrogens not passed to ETC therefore oxygen not used as (much as a) final / terminal (electron) acceptor

2

[9]