Week 32

A-Level Biology

Homework bundle for this week

本周作业合集

exercises.lol

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A-Level Biology Name: _____ Score: _____

1. Which is a use of energy in a cell?
   - ☐ active transport, movement, and building large molecules
   - ☐ lowering the temperature
   - ☐ removing all water
   - ☐ stopping all reactions
2. The respiratory quotient (RQ) is the ratio of CO_2 produced to:
   - ☐ oxygen used
   - ☐ water made
   - ☐ glucose used
   - ☐ ATP made
3. Glycolysis takes place in the cytoplasm, and needs no oxygen.

   ☐ True ☐ False
4. During the Krebs cycle, what is removed?
   - ☐ carbon dioxide (decarboxylation) and hydrogen (dehydrogenation, reducing NAD and FAD)
   - ☐ only oxygen
   - ☐ only water
   - ☐ whole glucose molecules
5. Why does fermentation matter when there is no oxygen?
   - ☐ it regenerates NAD so glycolysis can keep producing some ATP
   - ☐ it makes the Krebs cycle run faster
   - ☐ it produces oxygen
   - ☐ it stops glycolysis
6. ATP is re-made from ADP and a _____ group.

   _____
7. Which respiratory substrate releases the most energy per gram?
   - ☐ lipids
   - ☐ carbohydrates

☐ proteins

☐ they all release the same

8. Each turn of the Krebs cycle removes carbon dioxide and hydrogen, reducing NAD and FAD.

   ☐ True ☐ False

9. An organism produces 4 molecules of CO_2 and takes in 5 molecules of O_2. What is its RQ?

   _____

10. In mammals anaerobic respiration produces lactate, while in yeast it produces ethanol and carbon dioxide.

    ☐ True ☐ False

12. Energy and respiration

Answers · 答案

A-Level Biology

1. **active transport, movement, and building large molecules**

   Energy from respiration drives active transport, movement (e.g. muscle), and anabolic (building) reactions.

2. **oxygen used**

   RQ = CO_2 produced ÷ O_2 used.

3. **True**

   Glycolysis is in the cytoplasm and is anaerobic; the later stages (Krebs, oxidative phosphorylation) are in the mitochondria.

4. **carbon dioxide (decarboxylation) and hydrogen (dehydrogenation, reducing NAD and FAD)**

   Each turn removes CO_2 (decarboxylation) and hydrogen (dehydrogenation), reducing the coenzymes NAD and FAD.

5. **it regenerates NAD so glycolysis can keep producing some ATP**

   Without oxygen, NAD must be regenerated by fermentation so glycolysis can continue making ATP.

6. **phosphate**

   Respiration provides the energy to re-attach the phosphate to ADP.

7. **lipids**

   Lipids release the most energy per gram (most hydrogen); then proteins, then carbohydrates.

8. **True**

   The reduced NAD and FAD then carry the hydrogen to oxidative phosphorylation, where most ATP is made.

9. **0.8**

   RQ = CO_2 produced ÷ O_2 taken in = 4 ÷ 5 = 0.8.

10. **True**

    Same problem (no oxygen), two different products: lactate in mammals, ethanol + CO_2 in yeast.

A-LEVEL BIOLOGY • EXERCISE SHEET

12.1 Energy

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

KEY WORDS energy 能量 • respirometer 呼吸计 • respiratory quotient 呼吸商 • respiratory substrate 呼吸底物 • chemiosmosis 化学渗透

Objective

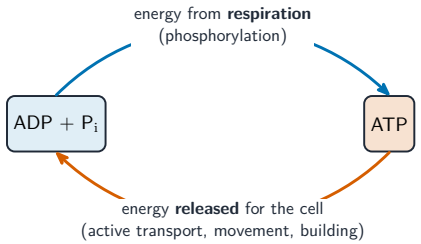
Build the skills to answer exam questions on **energy** — why cells need it, **ATP** as the energy currency, respiratory substrates, and the **respiratory quotient** 呼吸商 (RQ).

You must be able to:

- state why living organisms need energy and the features that suit ATP as the energy currency
- compare the energy values of carbohydrates, lipids and proteins
- calculate RQ values from respiration equations and use a **respirometer** 呼吸计

1 Worked examples

ATP — the energy currency



Respiration adds a phosphate to make ATP; the cell breaks it off to release energy

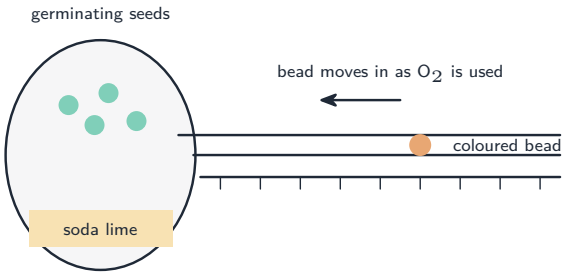
Cells need energy for **active transport** 主动运输, movement and **anabolic** 合成 reactions. ATP suits the job: it releases energy in small usable amounts, is quickly re-made, and is small and soluble. It is made by **phosphorylation** 磷酸化 (direct transfer) and **chemiosmosis** 化学渗透.

Respiratory quotient (RQ)

$$\text{RQ} = \frac{\text{molecules of } CO_2 \text{ produced}}{\text{molecules of } O_2 \text{ taken in}}$$

For glucose: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$, so $\text{RQ} = \frac{6}{6} = 1.0$. Carbohydrates give ≈ 1.0, lipids ≈ 0.7, proteins ≈ 0.9 (lipids release the most energy per gram).

The respirometer



Soda lime absorbs the CO_2, so the bead moves in by the volume of oxygen used

2 Practice

2.1 State **two** features of ATP that make it a good energy currency. [2]

2.2 State which respiratory substrate releases the most energy per gram. [1]

3 Exam-style questions

3.1 What is the RQ of a substrate that produces 8 molecules of CO_2 and uses 10 molecules of O_2? [1]

- **A** 0.6
- **B** 0.8
- **C** 1.0
- **D** 1.25

3.2 Why is the soda lime needed in a respirometer that measures oxygen uptake? [1]

- **A** to release oxygen
- **B** to absorb the carbon dioxide produced
- **C** to keep the seeds warm
- **D** to colour the liquid

3.3 A lipid respires according to: $2C_{51}H_{98}O_6 + 145O_2 \rightarrow 102CO_2 + 98H_2O$.

(a) Calculate the RQ for this lipid. Give your answer to 2 significant figures. [2]

(b) State what this RQ value tells you about the substrate being respired. [1]

3.4 In a respirometer, the coloured bead moves 45 mm in 15 minutes. The capillary tube has a cross-sectional area of 1.0 mm^2.

(a) Calculate the rate of oxygen uptake, in mm^3 per minute. [2]

(b) Explain why this apparatus measures oxygen uptake rather than the total gas change. [2]

3.5 A student measured the oxygen used and the carbon dioxide produced by germinating seeds in a respirometer.

	Oxygen used / cm^3 h^{-1}	**Carbon dioxide produced / cm^3 h^{-1}**
Seed batch A	12.0	12.0
Seed batch B	12.0	8.4

(a) Calculate the respiratory quotient for each batch, and state which respiratory substrate each is using. [4]

(b) Explain why the RQ differs between the two substrates. [2]

(c) Explain why cells use ATP as an energy currency rather than releasing energy directly from glucose. [4]

(d) State **two** variables that must be controlled in this experiment, and why each matters. [2]

Solutions

2.1 any two: releases energy in small usable amounts; quickly made and re-made; small and soluble (moves easily).

2.2 lipids.

3.1 B. RQ = 8/10 = 0.8.

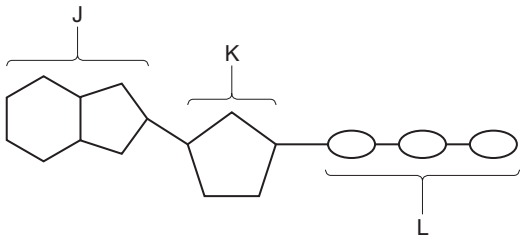
3.2 B. Soda lime absorbs the CO_2, so the gas volume falls only by the oxygen used.

3.3 (a) RQ = $\frac{102}{145} = 0.70$.
(b) it shows a lipid is being respired.

3.4 (a) volume = 45 mm × 1.0 mm^2 = 45 mm^3; rate = 45/15 = 3.0 mm^3 min^{-1}.
(b) the soda lime absorbs all the CO_2 released, so the only change in gas volume is the oxygen taken in.

3.5 (a) RQ = $\frac{\text{CO}_2 \text{ produced}}{\text{O}_2 \text{ used}}$; A = $\frac{12.0}{12.0} = 1.0$, so A is respiring **carbohydrate**; B = $\frac{8.4}{12.0} = 0.7$, so B is respiring **lipid**.
(b) A lipid molecule contains proportionally far less oxygen than a carbohydrate, so more oxygen must be taken from the air for each carbon dioxide released — giving a lower RQ.
(c) Glucose holds a large amount of energy, and releasing it all at once would waste most of it as heat and damage the cell; ATP releases a small, usable amount from one bond, so energy can be delivered in the size the reaction needs; it is soluble and moves easily within the cell; and it is quickly re-formed from ADP and phosphate, so it is recycled rather than stored.
(d) Temperature — it changes the rate of respiration and also the volume of the gas being measured; the mass or number of seeds, and their stage of germination, so the rates compared are per equivalent amount of tissue.

24 The diagram represents a molecule of ATP.



What are the components of ATP labelled J, K and L?

	J	K	L
A	adenine	deoxyribose	phosphates
B	adenosine	pentose	a phosphate group
C	adenosine	ribose	phosphorus
D	purine	pentose	phosphates

7 In aerobic respiration, most ATP is produced by oxidative phosphorylation.

(a) Outline the features of ATP that make it suitable as the universal energy currency.

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(b) Rotenone is a compound that affects oxidative phosphorylation.

Rotenone disrupts the first carrier in the electron transport chain by stopping the transfer of electrons from this carrier.

Suggest **and** explain how rotenone reduces the production of ATP **and** water in aerobic respiration.

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[Total: 9]

1 Organisms need a source of energy for many cellular processes. Respiration involves the release of energy from energy-rich molecules for the synthesis of ATP molecules. ATP is described as the energy currency of cells.

(a) Name **two** energy-rich molecules that enter the respiration pathway to synthesise ATP.

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..... [2]

(b) Fig. 1.1 shows a molecule of ATP.

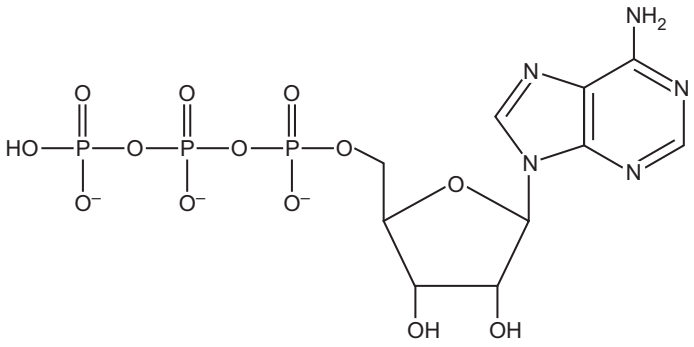

Fig. 1.1

Explain the features of ATP that make it suitable to be the universal energy currency of cells.

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..... [4]

(c) Identify the type of phosphorylation reaction to synthesise ATP that occurs during glycolysis and the Krebs cycle.

..... [1]

(d) **(i)** Pyruvate moves into the matrix of the mitochondrion only when a particular inorganic molecule is present.

Name the inorganic molecule that must be present in the cell for pyruvate to enter the matrix of the mitochondrion.

..... [1]

(ii) Explain how the presence of the inorganic molecule named in **(d)(i)** affects the ATP yield from respiration.

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..... [3]

[Total: 11]

A-LEVEL BIOLOGY • EXERCISE SHEET

12.2 Respiration

Name: _____ Class: _____ Date: _____ **Total: 17 marks**

KEY WORDS pyruvate 丙酮酸 • glycolysis 糖酵解 • aerobic 有氧 • oxidative phosphorylation 氧化磷酸化 • link reaction 连接反应

Objective

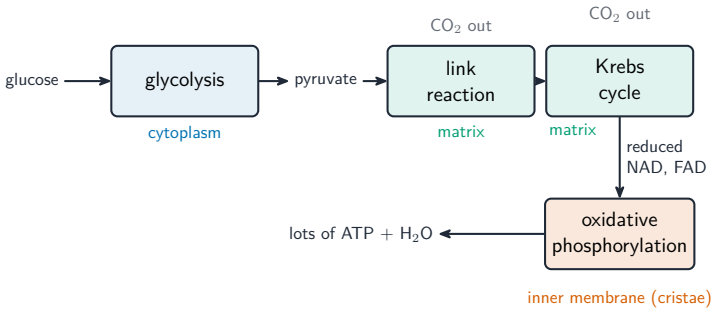
Build the skills to answer exam questions on **respiration** — the four stages of **aerobic** 有氧 respiration, the role of NAD and FAD, **oxidative phosphorylation** 氧化磷酸化, and **anaerobic** 无氧 respiration.

You must be able to:

- state where glycolysis, the link reaction, the Krebs cycle and oxidative phosphorylation occur
- outline each stage, including decarboxylation, dehydrogenation and chemiosmosis
- relate mitochondrial structure to function and describe anaerobic respiration

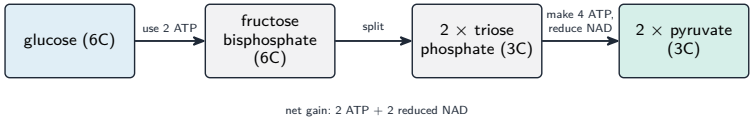
1 Worked examples

The four stages and where they happen



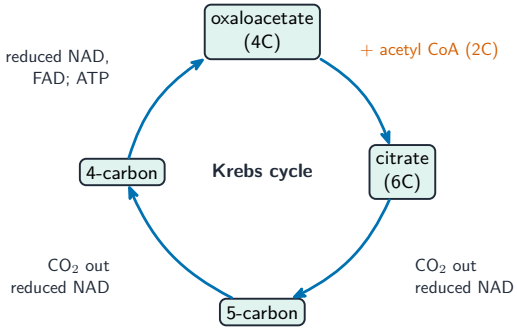
The four stages; reduced NAD and FAD carry hydrogen to the inner membrane where most ATP is made

Glycolysis



Glycolysis (cytoplasm) spends 2 ATP but makes 4 → net gain 2 ATP + reduced NAD; needs no oxygen

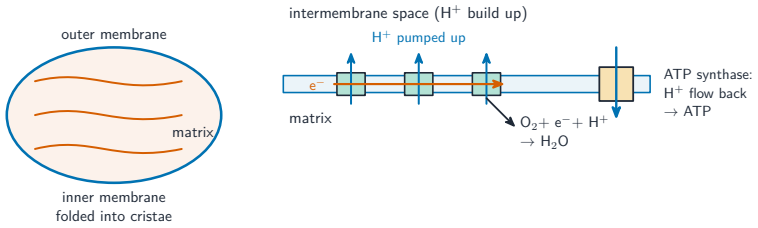
The link reaction and Krebs cycle



Each turn: decarboxylation releases CO_2; dehydrogenation reduces NAD and FAD

Link reaction (matrix): pyruvate (3C) loses CO_2 → acetyl (2C), carried by **coenzyme A** 辅酶 A; NAD is reduced. **Krebs cycle** (matrix): acetyl (2C) + oxaloacetate (4C) → citrate (6C), converted back with **decarboxylation** and **dehydrogenation**.

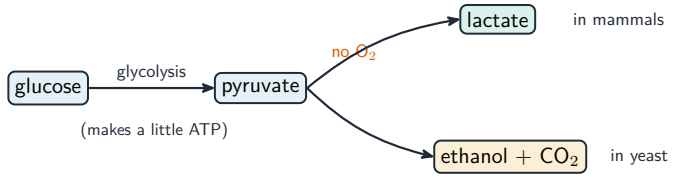
Oxidative phosphorylation



Electrons pump H^+ into the intermembrane space; they flow back through ATP synthase to make ATP (chemiosmosis)

Energetic electrons pass along the **electron transport chain** 电子传递链; the energy pumps protons across the inner membrane; protons flow back through **ATP synthase** to make ATP; **oxygen** is the final electron acceptor, forming water. **Cristae** 嵴 give a large surface for this.

■ Anaerobic respiration



this regenerates NAD so glycolysis can keep running (far less ATP than aerobic)

Without oxygen, pyruvate becomes lactate (mammals) or ethanol (yeast), regenerating NAD for glycolysis

2 Practice

2.1 State where in a eukaryotic cell each stage occurs: glycolysis; Krebs cycle; oxidative phosphorylation. [3]

2.2 State the net number of ATP molecules made directly in glycolysis. [1]

3 Exam-style questions

3.1 In which stage does oxygen act as the final electron acceptor? [1]

- **A** glycolysis
- **B** the link reaction
- **C** the Krebs cycle
- **D** oxidative phosphorylation

3.2 What is produced when pyruvate undergoes lactate fermentation in a muscle? [1]

- **A** ethanol and carbon dioxide
- **B** lactate
- **C** acetyl coenzyme A
- **D** citrate

3.3 (a) Describe what happens in the link reaction. [3]

(b) Explain how the folding of the inner mitochondrial membrane into cristae helps respiration. [2]

3.4 (a) Explain how ATP is made during oxidative phosphorylation, with reference to protons and ATP synthase. [4]

(b) Explain why anaerobic respiration releases far less energy than aerobic respiration. [2]

Solutions

2.1 glycolysis — cytoplasm; Krebs cycle — mitochondrial matrix; oxidative phosphorylation — inner mitochondrial membrane.

2.2 2 (a net gain of 2 ATP).

3.1 D. In oxidative phosphorylation oxygen is the final electron acceptor.

3.2 B. In mammals, anaerobic respiration converts pyruvate to lactate.

3.3 pyruvate enters the mitochondrial matrix; it loses a CO_2 (decarboxylation) and is oxidised to a 2C acetyl group, reducing NAD; the acetyl group joins coenzyme A to form acetyl coenzyme A.
(b) cristae give a large surface area for more electron carriers and ATP synthase, so more ATP is made.

3.4 (a) energetic electrons pass along the electron transport chain, releasing energy; this pumps protons across the inner membrane into the intermembrane space; the protons flow back into the matrix through ATP synthase; this flow provides energy to make ATP (chemiosmosis).
(b) anaerobic respiration uses only glycolysis, without the link reaction, Krebs cycle and oxidative phosphorylation that release most of the ATP.

1 Rice, *Oryza sativa*, is a crop plant that has adapted to grow in flooded fields.

Fig. 1.1 outlines the effects on rice plants of growing in flooded fields.

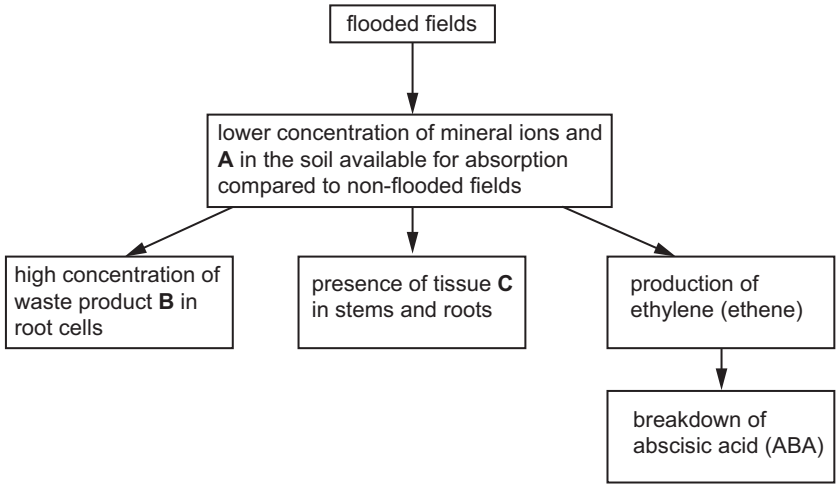


Fig. 1.1

(a) With reference to Fig. 1.1, name:

substance **A** .....

substance **B** .....

tissue **C** .....

[3]

(b) Describe how root cells respond to a high concentration of substance **B**.

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(c) Gibberellin is involved in the growth of stems in rice plants.

Fig. 1.2 shows the effect of gibberellin concentration on the length of stems in rice plants.

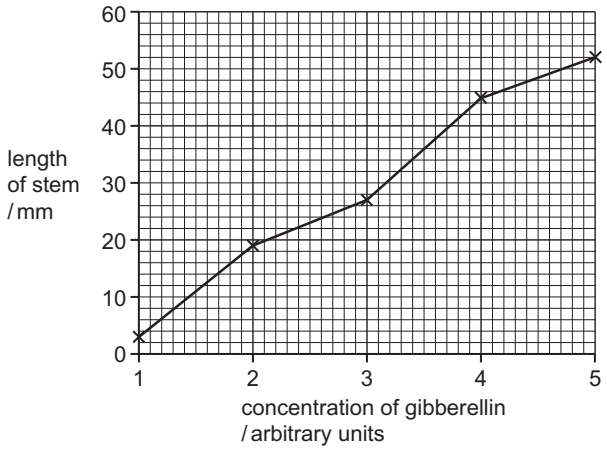

Fig. 1.2

(i) Describe the relationship shown in Fig. 1.2.

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..... [2]

(ii) ABA in rice plant cells inhibits the action of gibberellin.

With reference to Fig. 1.1 and Fig. 1.2, explain the importance of ethylene production for the growth of rice plants in flooded fields.

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.... [3]

[Total: 9]

9 **(a)** In aerobic conditions, pyruvate that has formed during glycolysis enters the mitochondrion and takes part in the link reaction.

Name the **two** coenzymes involved in the link reaction.

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[2]

(b) Enzymes play an important role in the functioning of the Krebs cycle.

The enzymes in the Krebs cycle can be affected by the presence of hydrogen peroxide. Hydrogen peroxide is a product of some of the reactions that occur within the mitochondrion.

An investigation was carried out to measure the effect of two different concentrations of hydrogen peroxide on an enzyme of the Krebs cycle. The activity of the enzyme was measured over 10 minutes when exposed to the two different concentrations of hydrogen peroxide.

The results are shown in Fig. 9.1.

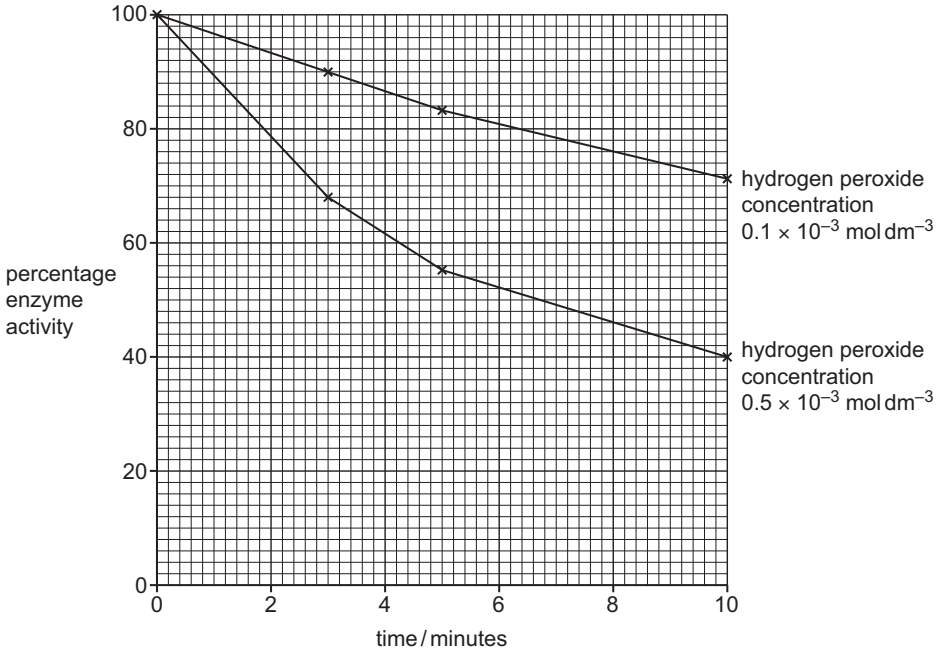

Fig. 9.1

Describe the effect shown in Fig. 9.1 of hydrogen peroxide concentration on the activity of the Krebs cycle enzyme.

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(c) Reduced NAD and reduced FAD are produced during the Krebs cycle. They carry hydrogen to the inner mitochondrial membrane where oxidative phosphorylation occurs.

The first two steps in oxidative phosphorylation are:

1. Hydrogen atoms split into protons and electrons.
2. Electrons move along the electron transport chain, releasing energy.

Outline the steps that occur to complete oxidative phosphorylation.

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(d) Fig. 9.2 shows the oxygen consumption of a person who is carrying out a fast-running exercise.

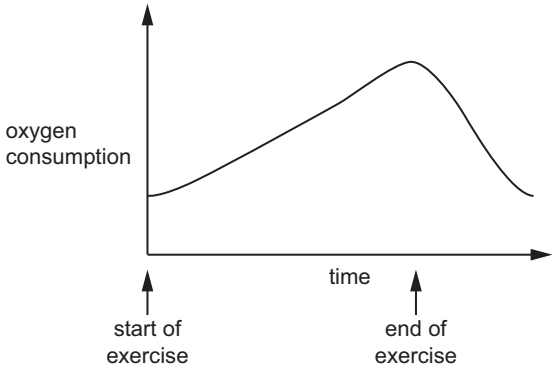

Fig. 9.2

Suggest why the oxygen consumption takes time to return to normal after exercise.

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[Total: 12]

1 Organisms need a source of energy for many cellular processes. Respiration involves the release of energy from energy-rich molecules for the synthesis of ATP molecules. ATP is described as the energy currency of cells.

(a) Name **two** energy-rich molecules that enter the respiration pathway to synthesise ATP.

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..... [2]

(b) Fig. 1.1 shows a molecule of ATP.

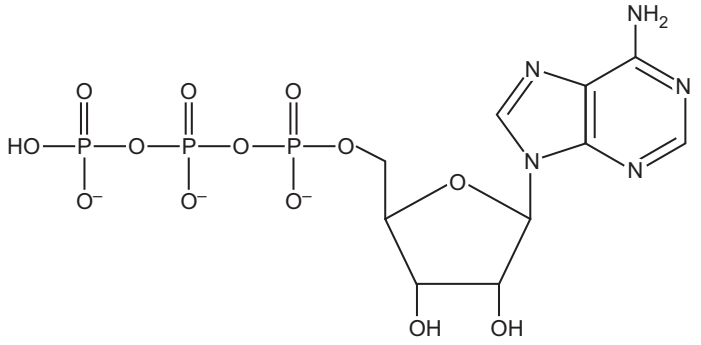

Fig. 1.1

Explain the features of ATP that make it suitable to be the universal energy currency of cells.

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(c) Identify the type of phosphorylation reaction to synthesise ATP that occurs during glycolysis and the Krebs cycle.

..... [1]

(d) **(i)** Pyruvate moves into the matrix of the mitochondrion only when a particular inorganic molecule is present.

Name the inorganic molecule that must be present in the cell for pyruvate to enter the matrix of the mitochondrion.

..... [1]

(ii) Explain how the presence of the inorganic molecule named in **(d)(i)** affects the ATP yield from respiration.

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..... [3]

[Total: 11]

2 A respirometer can be used to investigate how temperature affects the rate of respiration of woodlice.

Woodlice are small invertebrate animals. Fig. 2.1 shows a single woodlouse.

Fig. 2.1

Fig. 2.2 shows a simple respirometer.

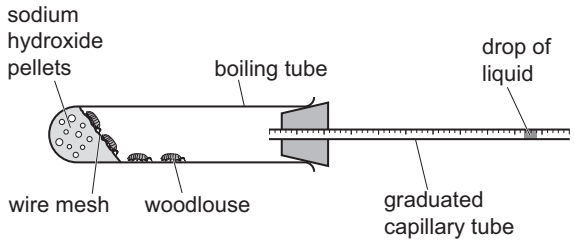

Fig. 2.2

(a) Explain how the experimental set-up in Fig. 2.2 allows the rate of respiration of woodlice to be determined.

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(b) A student determined the rate of respiration of woodlice at a temperature of 5 °C and at a temperature of 20 °C.

Predict **and** explain how the rate of respiration of woodlice differs at 5 °C compared to 20 °C.

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[Total: 5]