WJEC (Wales) Biology A-level

Unit 3.3 - Respiration

Flashcards

What is respiration?

What is respiration?

- A set of metabolic reactions that take place in organisms and break down respiratory substances, such as glucose, into smaller inorganic molecules, like water and carbon dioxide
- Linked to the synthesis of ATP

Why is respiration described as a catabolic process?

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Complex molecules (respiratory substrates) are broken down into smaller, simpler molecules.

Why do organisms need to respire?

Why do organisms need to respire?

- Produces chemical energy in ATP for a variety of processes include active transport, metabolic reactions and muscle contraction
- Releases heat energy for thermoregulation

Define aerobic respiration.

Define aerobic respiration.

A form of cellular respiration that takes place in the presence of oxygen and produces carbon dioxide, water and ATP. Overall:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

Name the four main stages of aerobic respiration and state where they occur.

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- **Glycolysis** - cytosol
- **Link reaction** - mitochondrial matrix
- **Krebs cycle** - mitochondrial matrix
- **Electron transport chain** - inner mitochondrial membrane

Outline the stages of glycolysis.

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1. Glucose (hexose sugar) phosphorylated to hexose bisphosphate by 2× ATP
2. Hexose bisphosphate splits into 2× **triose phosphate** (TP)
3. 2 molecules of TP oxidised to 2× **pyruvate**

Net gain of 2× reduced NAD (NADH) and 2× ATP per glucose.

Write an equation to summarise glycolysis.

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$$\text{Glucose} + 2\text{NAD} + 2\text{ADP} + 2\text{P}_i \rightarrow$$
$$2\text{ pyruvate} + 2\text{NADH} + 2\text{ATP} + \text{heat}$$

How does pyruvate from glycolysis enter the mitochondria?

How does pyruvate from glycolysis enter the mitochondria?

Via active transport

Outline the link reaction.

Outline the link reaction.

1. **Oxidative decarboxylation** and **dehydrogenation** of pyruvate to form **acetate**

   Net gain of CO_2 and 2× reduced NAD

2. Acetate combines with coenzyme A (CoA) to form **acetyl coenzyme A**

Write an equation to summarise the link reaction.

Write an equation to summarise the link reaction.

Pyruvate + NAD + CoA $\rightarrow$

acetyl CoA + reduced NAD + CO_2

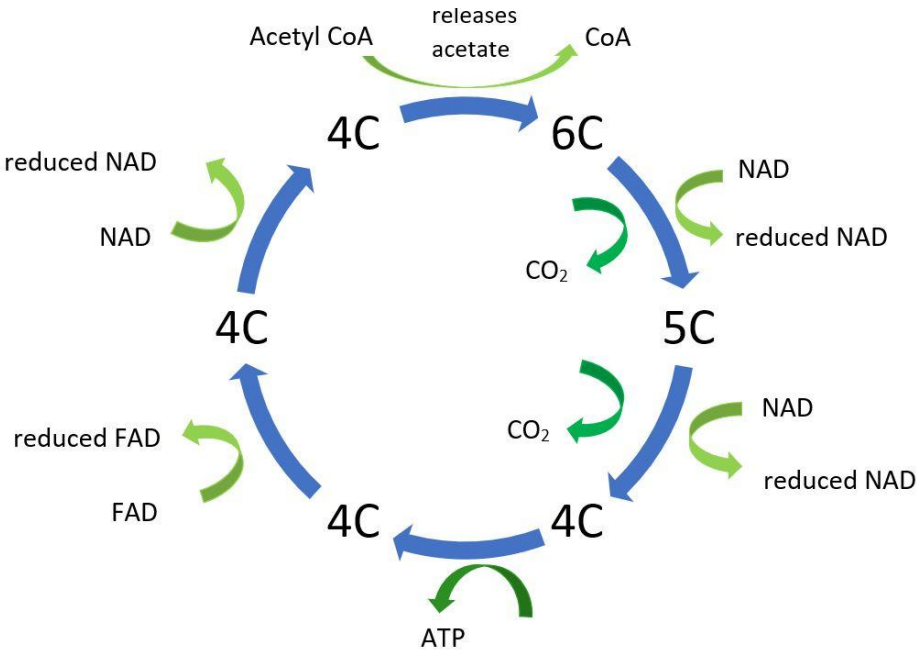
What is the Krebs cycle?

What is the Krebs cycle?

A series of oxidation-reduction reactions in the matrix of the mitochondria in which acetyl coenzyme A is oxidised generating reduced NAD, reduced FAD, ATP and carbon dioxide.

Outline the stages of the Krebs cycle.

Outline the stages of the Krebs cycle.



What is the function of the Krebs cycle?

What is the function of the Krebs cycle?

It is a means of releasing energy from carbon bonds to provide ATP, reduced NAD and reduced FAD (with the release of CO_2).

How many NAD and FAD does the complete oxidation of one glucose molecule yield?

How many reduced NAD and reduced FAD does the complete oxidation of one glucose molecule yield?

10 reduced NAD

2 reduced FAD

What is the electron transport chain?

What is the electron transport chain?

A series of electron carrier proteins that transfer electrons in a chain of oxidation-reduction reactions, releasing energy.

What happens in the electron transport chain?

What happens in the electron transport chain?

- Electrons released from reduced NAD and FAD undergo successive redox reactions
- The energy released is coupled to maintaining the proton gradient or is released as heat
- Oxygen acts as the final electron acceptor

Describe the role of reduced NAD and reduced FAD in the electron transport chain.

Describe the role of reduced NAD and reduced FAD in the electron transport chain.

They are a source of electrons and protons.

How does chemiosmosis produce ATP during aerobic respiration?

How does chemiosmosis produce ATP during aerobic respiration?

- Protons flow down their concentration gradient from the intermembrane space into the mitochondrial matrix via **ATP synthase**
- ATP synthase phosphorylates ADP to form ATP as protons flow through it

State the role of oxygen in the electron transport chain.

State the role of oxygen in the electron transport chain.

Final electron acceptor:

$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

How many ATP are produced per oxidised NAD in aerobic respiration?

How many ATP are produced per oxidised NAD in aerobic respiration?

3 ATP

How many ATP are produced per oxidised FAD in aerobic respiration?

How many ATP are produced per oxidised FAD in aerobic respiration?

2 ATP

Define anaerobic respiration.

Define anaerobic respiration.

A form of cellular respiration that takes place in the absence of oxygen. Less ATP is formed than in aerobic respiration.

State the product of anaerobic respiration in animals.

State the product of anaerobic respiration in animals.

Lactic acid

Outline anaerobic respiration in animals.

Outline anaerobic respiration in animals.

- Only glycolysis continues
- Reduced NAD (product of glycolysis) transfers the H to pyruvate, forming lactic acid

State the products of anaerobic respiration in plants and microorganisms.

State the products of anaerobic respiration in plants and microorganisms.

Ethanol and carbon dioxide.

Outline anaerobic respiration in plants and microorganisms.

Outline anaerobic respiration in plants and microorganisms.

- Only glycolysis continues
- Pyruvate is decarboxylated to form ethanal
- Ethanal is reduced to ethanol using reduced NAD, producing oxidised NAD for further glycolysis

Compare the yield of ATP in aerobic and anaerobic respiration.

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Aerobic - 30 to 32 ATP

Anaerobic - 2 ATP

Why is the maximum yield of ATP in aerobic respiration never achieved?

Why is the maximum yield of ATP in aerobic respiration never achieved?

- ATP lost due to leaky membranes
- Energy required to move pyruvate and ADP into the mitochondrial matrix

Name two types of molecules that can be used as alternative respiratory substrates.

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- (amino acids from) proteins
- (glycerol and fatty acids from) lipids

Explain how lipids are used in respiration.

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- Hydrolysed to glycerol and fatty acids
- Glycerol converted to a 3C sugar and enters glycolysis
- Fatty acids broken down into 2C acetate fragments which enter the Krebs cycle as acetyl coenzyme A

Explain how proteins are used in respiration.

Explain how proteins are used in respiration.

- Hydrolysed to amino acids
- Amino acids deaminated in the liver forming keto acids and ammonia
- Keto acids enter glycolysis and the Krebs cycle