Respiration Notes

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You have probably heard the word respiration many times before, maybe when you were learning about mitochondria or decomposing microorganisms for example. But what is it?

Respiration: an exothermic chemical reaction that occurs continuously in living cells. It releases energy from glucose so the cell can use it for metabolic processes.

There are two different forms of respiration, **aerobic** and **anaerobic**. Let's look at each in detail 😊

Aerobic Respiration

Aerobic respiration: the process of transferring energy from glucose in the presence of oxygen.

OXYGEN MUST BE PRESENT for aerobic respiration to take place 😊

The **word** equation:

Glucose + oxygen → carbon dioxide + water

The **balanced chemical** equation:

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

Mitochondria are the site of aerobic respiration within cells.

Anaerobic Respiration

Anaerobic respiration: the process of transferring energy from glucose in the absence of oxygen.

Anaerobic respiration occurs due to a **lack of oxygen** in a cell.

Note: Anaerobic respiration works differently in animal cells compared with plant and yeast cells. Let's look at animal cells first.

Animal cells: anaerobic respiration can occur in the muscles of animals (you have felt this before, it's a stitch, the pain you get in your side sometimes when you run) due to a lack of oxygen.

The **word** equation:

Glucose → Lactic acid

The **balanced chemical** equation:

$$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$$

Exam note: As the glucose is not fully oxidised (not fully burned) anaerobic respiration gives out a lot less energy than aerobic respiration.

In **plant and fungal cells (yeast)** anaerobic respiration produces ethanol and carbon dioxide.

The **word** equation:

Glucose → ethanol + carbon dioxide

Out of the two types of respiration, aerobic respiration releases the most energy as the glucose is fully oxidised. **But what do organisms need this energy for?**

Organisms need energy for:

1. **Muscle contraction (movement)** – they may need to move to look for food or to find shelter.
2. **Active transport** – moving ions against their concentration gradient from low concentration into an area of higher concentration.
3. **Synthesis reactions** – making larger molecules from smaller ones.
4. **Keeping warm** – to ensure their enzymes are working at or near their optimum temperature.

Uses of Anaerobic Respiration

1. **Fermentation –** yeast cells produce ethanol (alcohol) when they do anaerobic respiration.
   This ethanol can be collected and used to make alcoholic drinks.
   The equation for the fermentation reaction is:

$$C_6H_{12}O_6\ (aq) \rightarrow 2C_2H_5OH\ (aq) + 2CO_2\ (g)$$

We don't need to learn this equation. Just thought it might be helpful to show it for context 😊

2. **Bread making –** yeast cells also produce carbon dioxide gas when they do anaerobic respiration.
   This carbon dioxide is used to make bread rise. This makes the bread less compact.

Response to Exercise

When someone exercises their **breathing and heart rate increases.** Why do these increases take place?

1. **Breathing rate –** increases to bring plenty of oxygen to the respiring cells as well as removing carbon dioxide.
2. **Heart rate –** increases to ensure enough oxygenated blood is supplied to the contracting muscles and removing lactic acid to the liver.

During vigorous exercise lactic acid can build up. This build-up of lactic acid produces an **oxygen debt.**

Oxygen debt: is the quantity of oxygen required to break down lactic acid produced during anaerobic respiration.

Once the exercise is finished, lactic acid is taken to the liver via the blood stream. Here it can be:

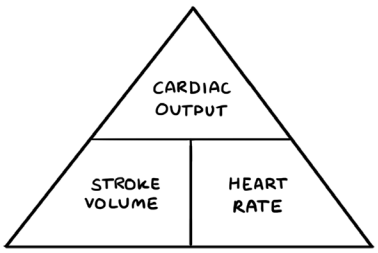
1. Changed to glucose, then to glycogen which is stored once again in the liver and muscles.
2. Oxidised to carbon dioxide and water which is exhaled through the lungs.

Cardiac Output

In the response to exercise, part of the topic of respiration, we could be asked to complete a calculation to determine the cardiac output of an individual. This is the same equation that we meet in the topic of the heart and circulation 😊

Cardiac output: the total volume of blood pumped by the heart in one minute. This is usually measured in cm^3/min or litres/min.

The equation for this calculation is:



Cardiac output = stroke volume × heart rate

Let's have a look at an example of calculating cardiac output.

Example 1: During a race, an athlete has a heart rate of 160 beats per minute and a stroke volume of 115 ml. Calculate the athlete's cardiac output. Give your answer in Litres per minute (L/min).

Step 1: **substitute the values from the question into the equation**.

Cardiac output = stroke volume × heart rate

Cardiac output = 115 × 160

Step 2: **solve to find the answer in millilitres (ml/min)**

Cardiac output = 18400 ml/min

Step 3: Convert the cardiac output into Litres by dividing by 1000.

Cardiac output = 18400 ÷ 1000 Cardiac output = 18.4 L/min