Edexcel GCSE Biology

Your notes

Respiration

Contents

* Respiration
* Practical: Investigating Respiration

Respiration

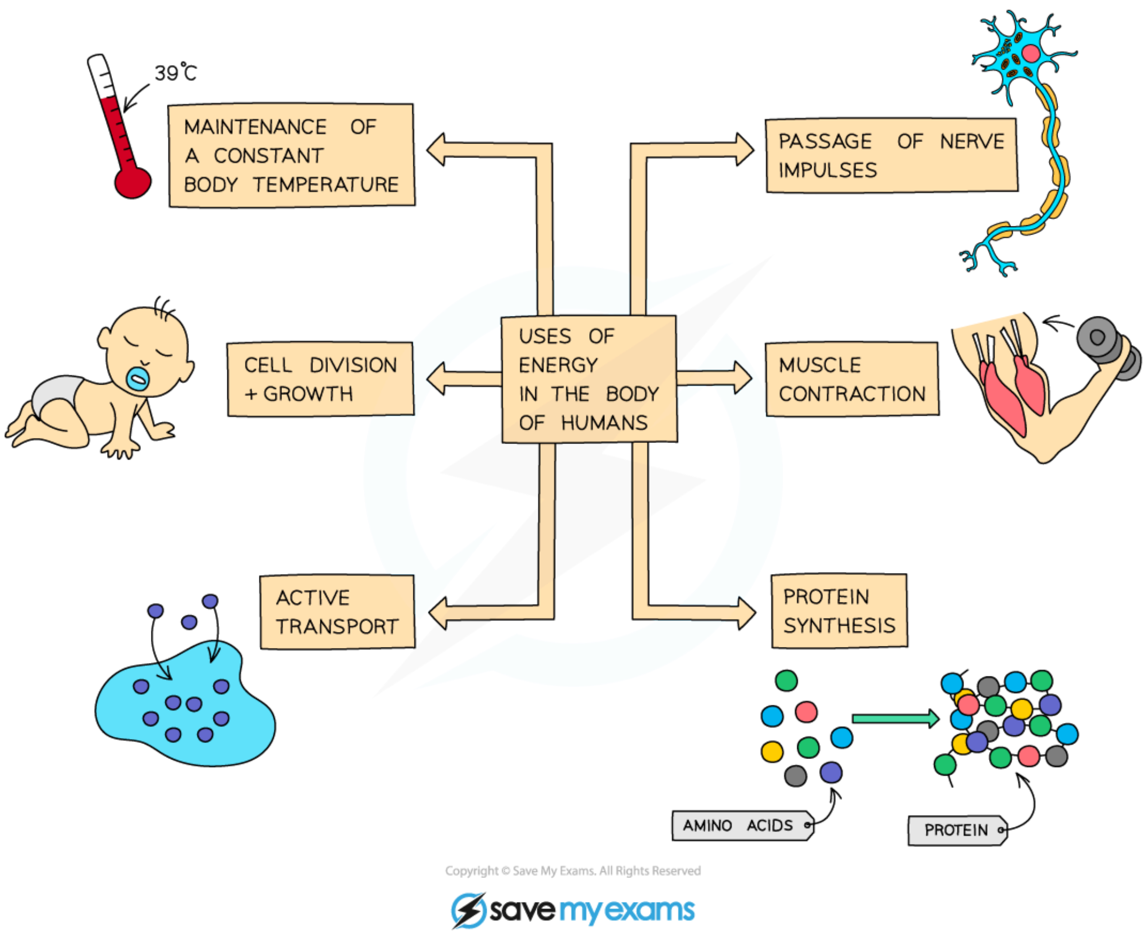
Your notes

Aerobic Respiration

Cellular respiration

- Cellular respiration is an **exothermic reaction** which is continuously occurring in living cells
- The chemical process of cellular respiration releases **energy** either in the **presence of oxygen (aerobic respiration),** or in the **absence of oxygen (anaerobic respiration)**
- The **energy transferred** supplies all the energy needed for **metabolic processes** to occur within cells and organisms as a whole
- Organisms need energy for:
  - **Chemical reactions** to build larger molecules from smaller molecules
  - **Muscle contraction** to allow movement
  - **Keeping warm** (to maintain a constant temperature suitable for enzyme activity)

Your notes

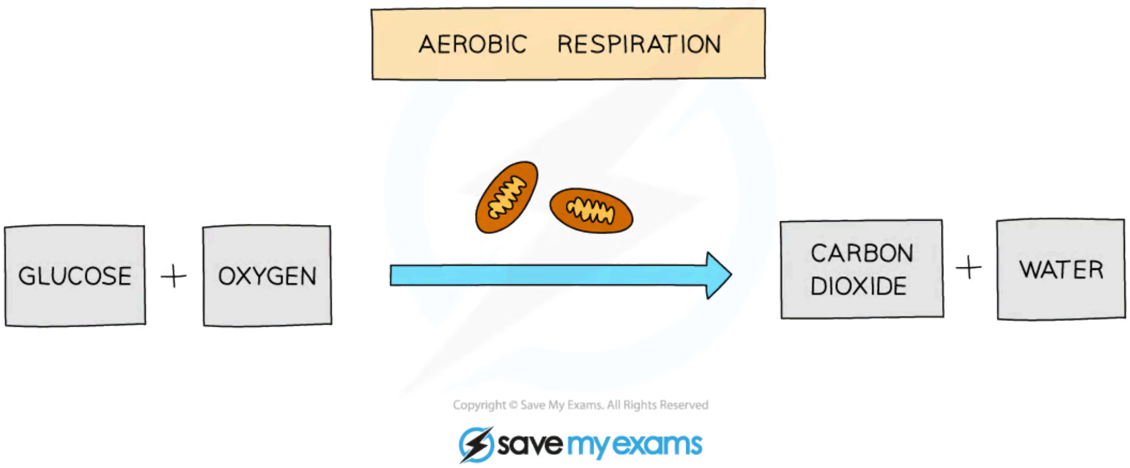


Uses of the energy released from respiration

Aerobic Respiration

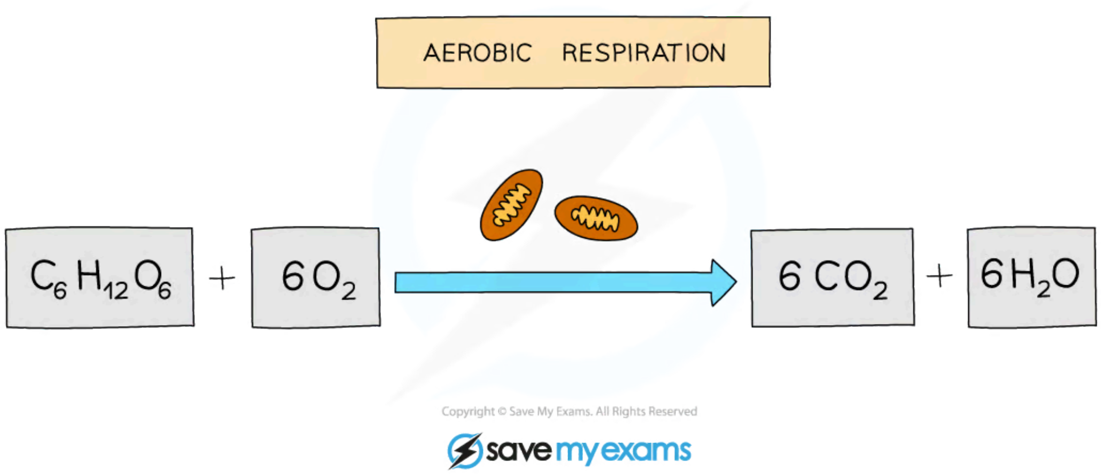
- **Aerobic** respiration requires **oxygen**
  - It is defined as **the chemical reaction in cells that uses oxygen to break down nutrient molecules to release energy**
- Aerobic respiration is the **complete breakdown of glucose** to release a relatively **large** amount of **energy** for use in cell processes and reactions
- **Carbon dioxide and water** are produced as waste products as well as releasing useful cellular energy

Your notes



Word equation for aerobic respiration

- This equation can also be shown as a **balanced symbol equation**
  - **One** molecule of glucose combines with **six** molecules of oxygen to produce **six** molecules of carbon dioxide and **six** molecules of water



The balanced symbol equation for aerobic respiration

Examiner Tips and Tricks

There are usually **3 marks given for the aerobic respiration chemical equation** in an exam:

- One for getting the correct **formula for glucose and oxygen**
- One for getting the correct **formula for carbon dioxide and water**
- One for **balancing the equation** correctly

So make sure you can do all three to gain maximum marks!

Your notes

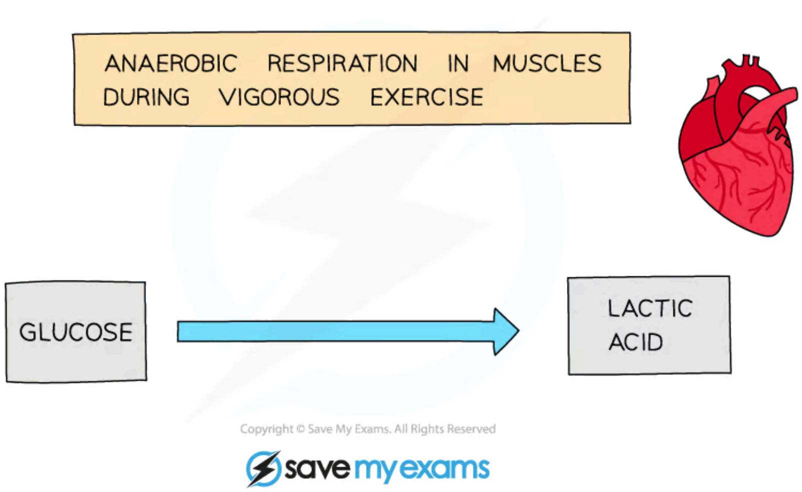
Anaerobic Respiration

- **Anaerobic** respiration does **not require oxygen**
  - It is defined as the chemical reaction in cells that breaks down nutrient molecules to release energy **without using oxygen**
- It involves the **incomplete breakdown of glucose** and so releases a relatively **small** amount of **energy** for use in cell processes
- Different breakdown products are formed depending on the type of organism that the anaerobic respiration is taking place in
- You need to know the equations for anaerobic respiration in **animals** and **plants (or fungi)**

Anaerobic respiration in animals

- Anaerobic respiration mainly takes place in muscle cells during vigorous exercise
- When we exercise at high intensities, our muscles have a **higher demand for energy**
- Our bodies can only deliver so much oxygen to our muscle cells for aerobic respiration
- When oxygen runs out, glucose is broken down without it, producing **lactic acid** instead
- Glucose has not been fully broken down meaning there is still energy stored within the bonds of lactic acid molecules
- **Anaerobic respiration releases less energy than aerobic respiration**

Your notes



Word equation for anaerobic respiration in animals

- This equation can also be shown as a balanced chemical equation
  - **One** molecule of glucose is broken down into **two** molecules of lactic acid

$$\text{GLUCOSE} \longrightarrow \text{LACTIC ACID}$$

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

The balanced chemical equation for anaerobic respiration in animals

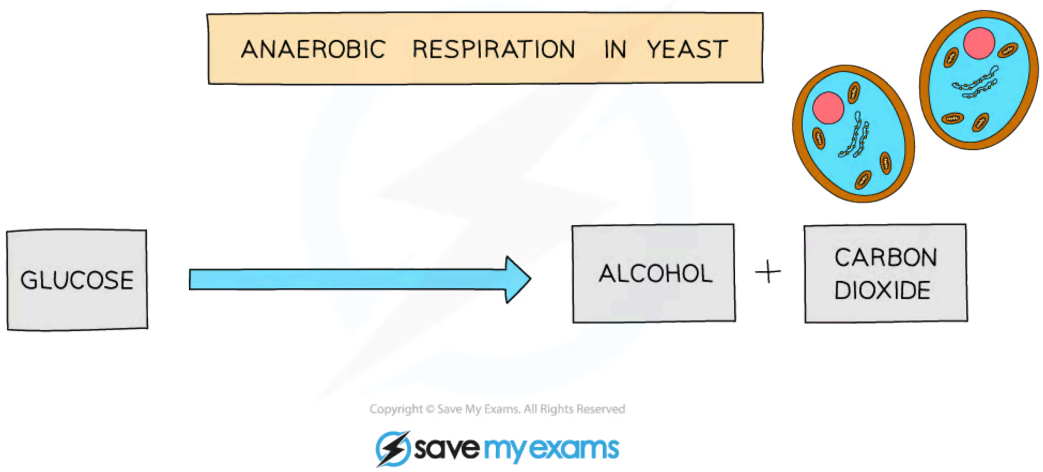
Lactic acid and oxygen debt

- **Lactic acid** builds up in muscle cells and **lowers the pH** of the muscle tissue (making the conditions more acidic)
  - Acidic conditions can **denature the enzymes in cells**
- Lactic acid will eventually be broken down using **oxygen** to produce **carbon dioxide** and **water** as waste products
- The amount of **oxygen required** to break down the **lactic acid** that has built up is referred to as the '**oxygen debt'**
- The process of breaking down the lactic acid is known as **'repaying the oxygen debt'**

Anaerobic respiration in plants and fungi

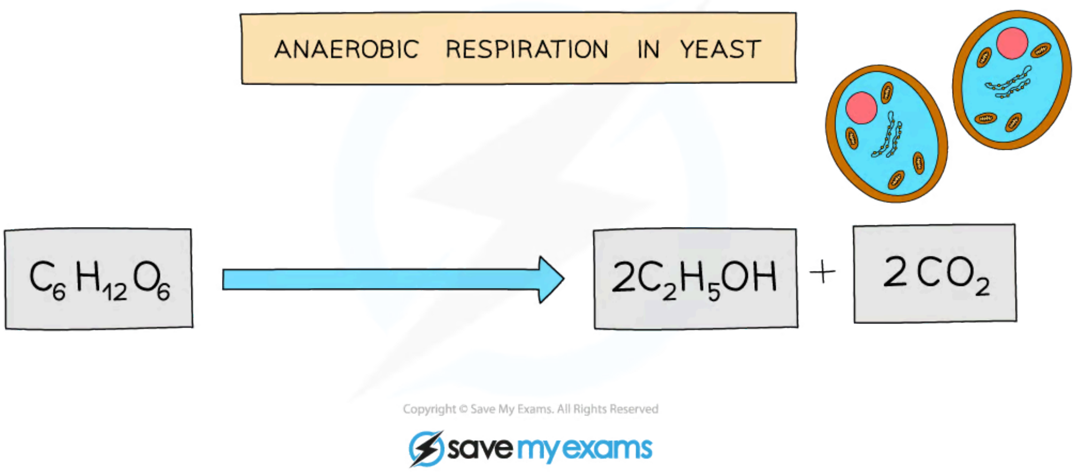
Your notes

- Plants and yeast can respire **without oxygen** as well, breaking down glucose in the absence of oxygen to produce **ethanol** and **carbon dioxide**
- Anaerobic respiration in yeast cells is called **fermentation**
- Fermentation is economically important in the manufacture of **bread** (where the carbon dioxide produced helps the dough to rise) and in **brewing** (where the ethanol produced makes beer)



Word equation for anaerobic respiration in plants and fungi

- This equation can also be shown as a **balanced chemical equation**
  - **One** molecule of glucose is broken down into **two** molecules of alcohol and **two** molecules of carbon dioxide



Balanced equation for anaerobic respiration in plants and yeast

Aerobic & Anaerobic Respiration

- You need to be able to compare the processes of aerobic and anaerobic respiration with regard to the need for oxygen, the products and the relative amounts of energy transferred

Comparing Aerobic & Anaerobic Respiration Table

	AEROBIC	ANAEROBIC
OXYGEN	NEEDED	NOT NEEDED
GLUCOSE BREAKDOWN	COMPLETE	INCOMPLETE
PRODUCTS	CARBON DIOXIDE AND WATER	ANIMAL CELLS: LACTIC ACID YEAST: CARBON DIOXIDE AND ETHANOL
ENERGY RELEASED	A LOT	A LITTLE

Practical: Investigating Respiration

Your notes

Practical: Investigating Respiration

- We can investigate the production of **carbon dioxide** and **heat** from **respiration** through experiments using germinating seeds or other living organisms such as woodlice

Practical investigation: demonstrating the production of carbon dioxide

Apparatus

- Boiling tubes
- Rubber bungs
- Hydrogen carbonate indicator solution
- Cotton wool
- Glass beads
- Germinating seeds
- Boiled/dead seeds

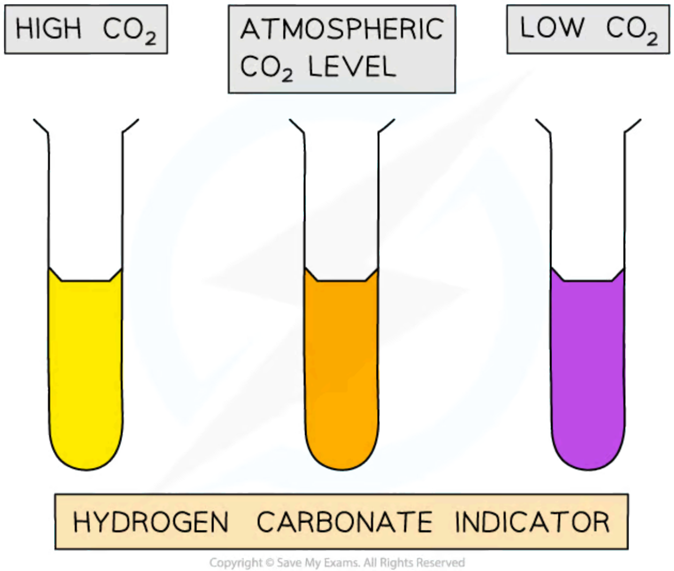
Method

- Measure out 10 cm^3 of **hydrogencarbonate indicator** into 3 boiling tubes
- Put in a layer of cotton wool
- Place 10 **germinating seeds** in **tube A**
- Place 10 **boiled/dead seeds** in **tube B**
- Place 10 **glass beads** in **tube C**
- Seal each tube with a rubber bung
- After **3 hours**, observe the **colour** of the indicator

Hydrogencarbonate indicator

- Hydrogencarbonate indicator is **orange in atmospheric CO_2 levels**
- In **high CO_2** levels the indicator absorbs the CO_2 and becomes **yellow**
- In **low CO_2** levels it loses CO_2 and becomes **purple**

Your notes

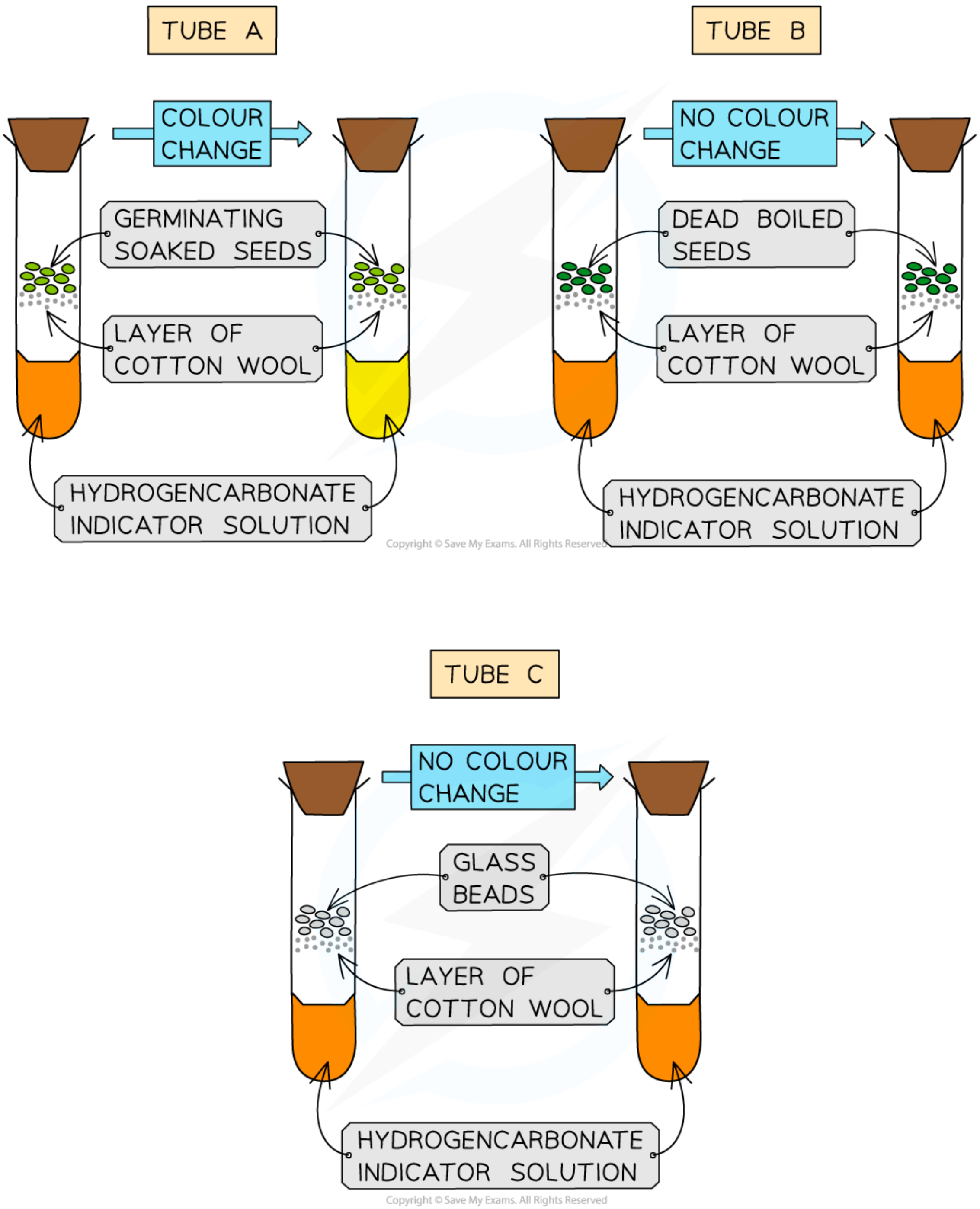


Colour results for hydrogen carbonate indicator

Results

- In this investigation, we would expect to note the following
  - **Tube A** should turn **yellow** as the seeds are **respiring** and producing **carbon dioxide**
  - **Tube B** should remain **orange** as the **dead seeds** produce **no carbon dioxide**
  - **Tube C** should remain **orange** as there is **no living material** in there

Your notes



Experiment to demonstrate the production of carbon dioxide by living material during respiration

Practical investigation: demonstrating the production of heat

Your notes

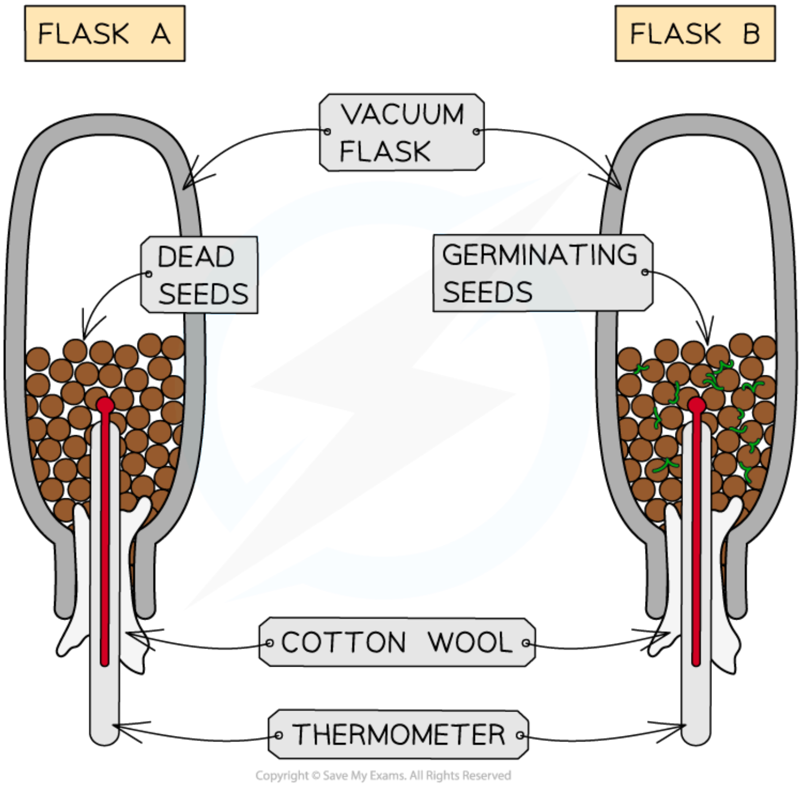
Apparatus

- Vacuum Flasks
- Thermometer
- Cotton wool
- Germinating seeds
- Dead/boiled seeds

Method

- Set up the flasks as shown in the diagram
  - **Flask A** with **dead seeds**
  - **Flask B** with **germinating seeds**
- Make sure the cotton wool is plugging the top of each flask
- Hold the thermometer in place with the cotton wool
- Invert the flask
- Record the **initial temperature**
- After **4 days**, record the **final temperature**

Your notes



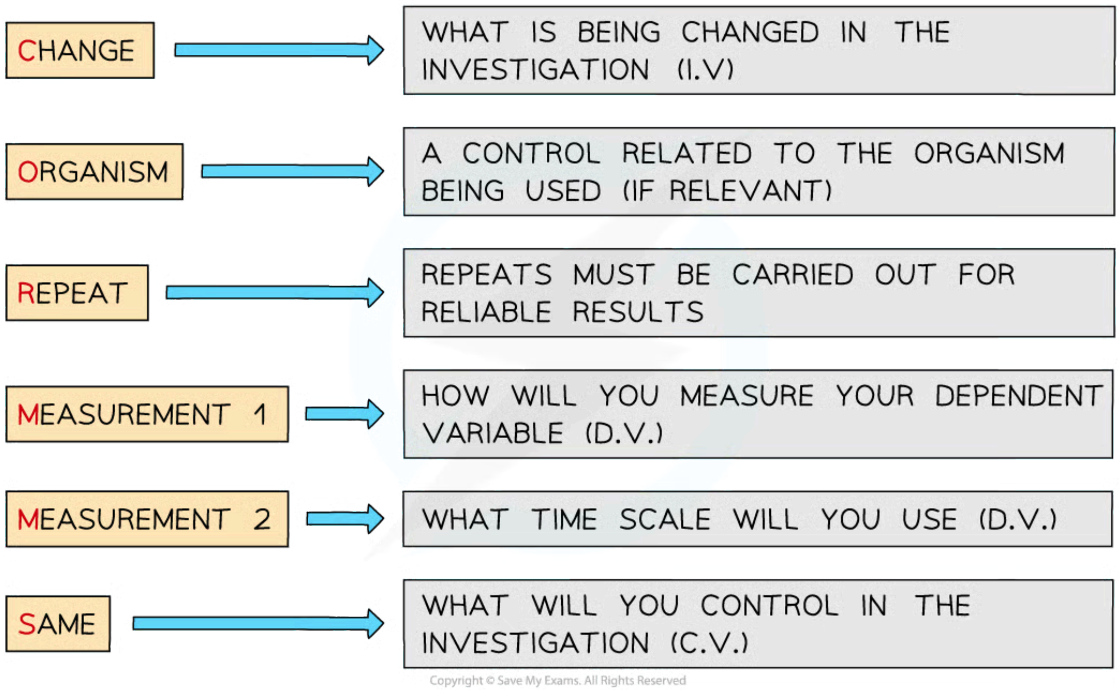
Experiment to demonstrate the production of heat by living material during respiration

Results

- The thermometer in the flask with the **germinating seeds** (**Flask B**) should show an **increase in temperature**
- **Flask A** should remain at **room temperature**
- This is because the seeds in flask B are **respiring** and producing **heat energy** in the process
- This shows that respiration is an **exothermic reaction**
- The seeds in **flask A** are **not respiring** because they are dead, so the temperature remains the same

Applying CORMS evaluation to practical work

- When working with practical investigations, remember to consider your CORMS evaluation



CORMS evaluation

- In the first investigation, your evaluation should look something like this:
  - **Change** - We will change the content of the boiling tube (germinating seeds, dead seeds or glass beads)
  - **Organisms** - The seeds used should all be of the same age, size and species
  - **Repeat** - We will repeat the investigation several times to ensure our results are reliable
  - **Measurement 1** - We will observe the change in the hydrogen carbonate indicator
  - **Measurement 2** - ...after 3 hours
  - **Same** - We will control the volume of hydrogen carbonate indicator, the number of seeds/beads, the temperature of the environment
- For the second investigation, your evaluation should look something like this:
  - **Change** - We will change the content of the flasks (germinating seeds or dead seeds)
  - **Organisms** - The seeds used should all be of the same age, size and species
  - **Repeat** - We will repeat the investigation several times to ensure our results are reliable

- **Measurement 1** - We will observe the change in the temperature on the thermometer
- **Measurement 2** - ...after 4 days
- **Same** - We will control the number of seeds, the starting temperature of the flasks, the material and size of the flasks

Your notes