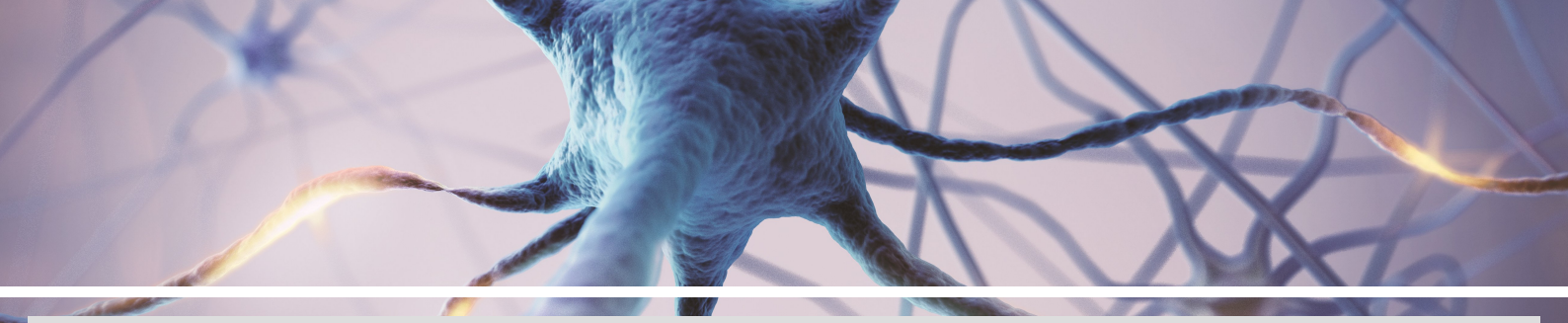

Explore the role of
our growing brain
when we exercise?

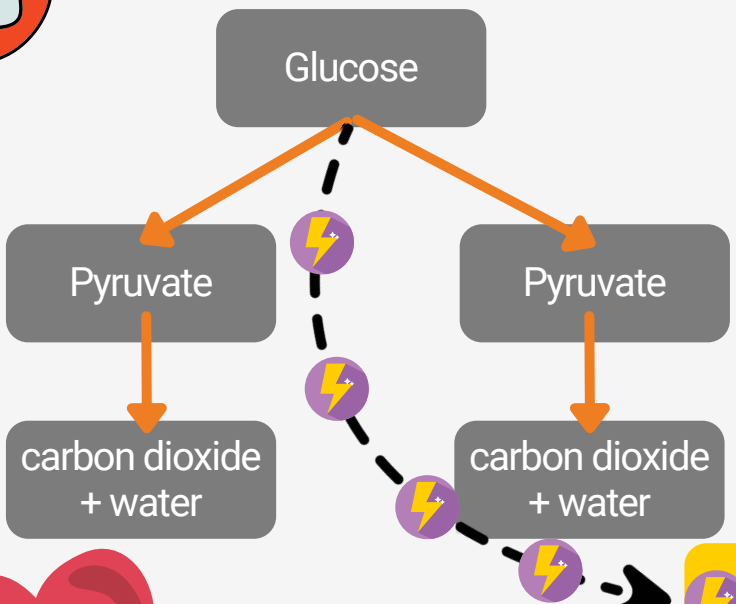


OUR GROWING BRAIN

The medulla in our brain influences the rate at which our heart beats. Let's put our medullas to the test in this experiment.

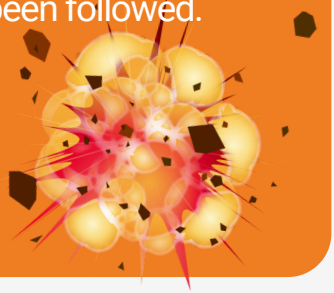
Aim: To investigate the effect of exercise on respiration rate.

Respiration is a cellular process that releases the chemical energy stored in glucose. It does this through a series of enzyme-controlled reactions. For complete breakdown of glucose, oxygen is required, leading to generation of a large number of ATP molecules. The energy transferred to ATP can be used for other cellular activities, such as muscle cell contraction.

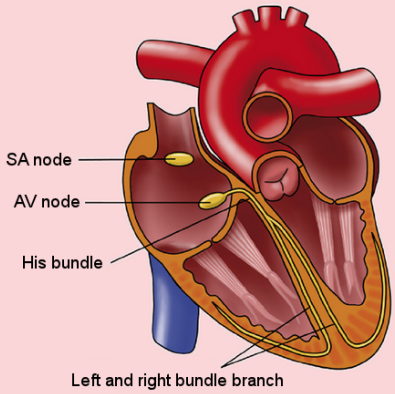


the chemical energy of glucose is transferred to form ATP

The **Screaming Jelly Baby** is a fun, visual demonstration of this energy transfer process. The protocol for this can be found here. For any class attempting this demonstration, ensure the risk assessment guidance has been followed.

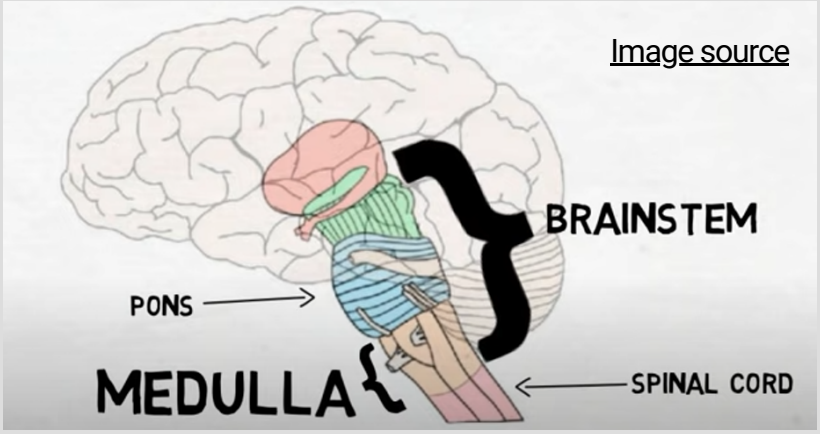


Exercise increases our demands for ATP, and therefore the rate of cellular respiration increases. This requires an increase in heart rate and breathing rate. While our resting heart rate is set by the sino-atrial node (SAN) within the heart itself, the medulla sends impulses to the SAN that causes either an increase or decrease in heart muscle contractions.



The conduction system delivers the electrical signal to the entire heart

Image source



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When we exercise, the medulla sends impulses through the sympathetic nervous system to increase the rate of heart muscle contractions. Ultimately this allows faster delivery of oxygen and removal of carbon dioxide from the circulatory system.

METHOD

Overview of Method

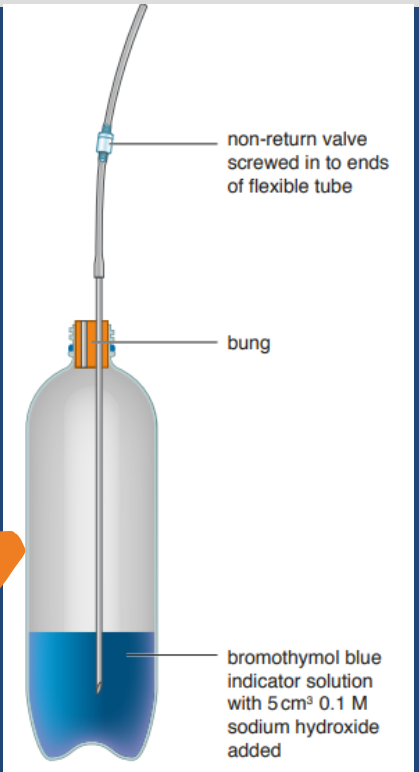
This protocol is adapted from the Wellcome Trust "In the Zone - I've Got the Power" resource pack. Using a respirometer containing bromothymol blue, you can measure how much carbon dioxide is in your breath before and after exercise.

MATERIALS

- 1 respirometer*
- bromothymol blue indicator
- 0.1M sodium hydroxide solution
- 500ml measuring cylinder
- filter funnel
- plastic pipettes
- stopclock
- safety goggles
- Exercise equipment

To make 1 respirometer:

- 2L plastic bottle
- bung to fit bottle
- piece of plastic tubing
- piece of flexible tubing
- one-way valve

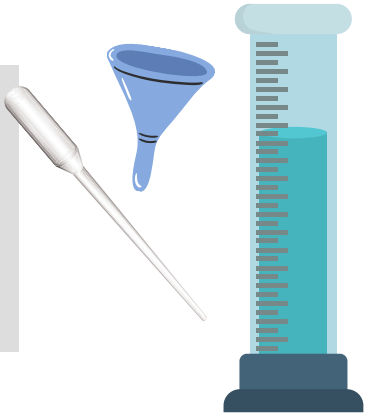


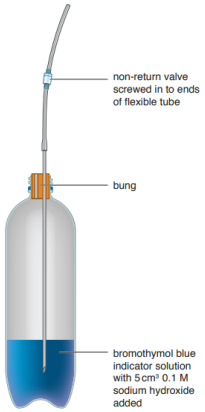
Health and Safety precautions

- The flexible plastic tubing must be disinfected or sterilised before and after each use.
- If anyone feels unwell during the activity, they should stop immediately.
- 0.1M sodium hydroxide is a skin irritant and hazardous to the eyes. During preparation of the indicator solution, goggles must be worn.
- Skin contact should be avoided with bromothymol blue - although this is low hazard.
- Students must only breathe out into the apparatus. The non-return valve must be fitted.

1

Add 500ml bromothymol blue to the 2L plastic bottle. Add 5ml 0.1M sodium hydrogen to the bottle. The alkaline conditions will turn the indicator blue in colour. A filter funnel will help to transfer the liquids. *Goggles must be worn throughout the preparation of this indicator solution.*





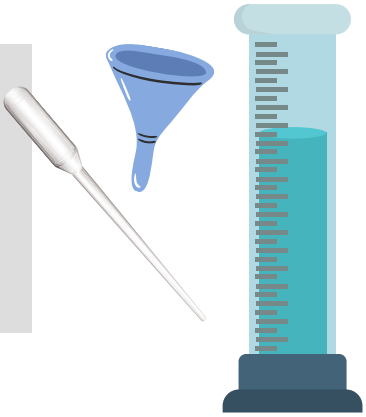
2

Insert the tubing into the plastic bottle to complete the respirometer. With pupils at rest, one in each group should breathe slow, deep breaths through the flexible tubing into the indicator solution. *Do not inhale through the straw.*
Count the number of breaths required to turn the solution green.

As you breathe through the tubing, carbon dioxide will enter the indicator solution. Since carbon dioxide is acidic, the indicator solution will turn from blue to green as it becomes neutrliased. It will take approximately 5ml of carbon dioxide to neutralise the indicator solution.

3

Pour the contents of the respirometer down the sink with copious volumes of water. Re-fill the respirometer with 500ml bromothymol blue indicator solution and 5ml 0.1M sodium hydroxide, taking the same safety precautions as before.



4

It's time to get active. Get outdoors for some circuits or try an online tutorial like this to get the heart pumping. Choose the duration of the exercise, e.g. 2 minutes. Then breathe out through the flexible tubing into the respirometer - the same slow, deep breaths as before. How many breaths did it take to turn the solution from blue to green?

5

Pour the solution down the sink with lots of water and set the respirometer apparatus to the side for disinfection. Wash your hands, clean down your desk and get ready to process your data.

RESULTS

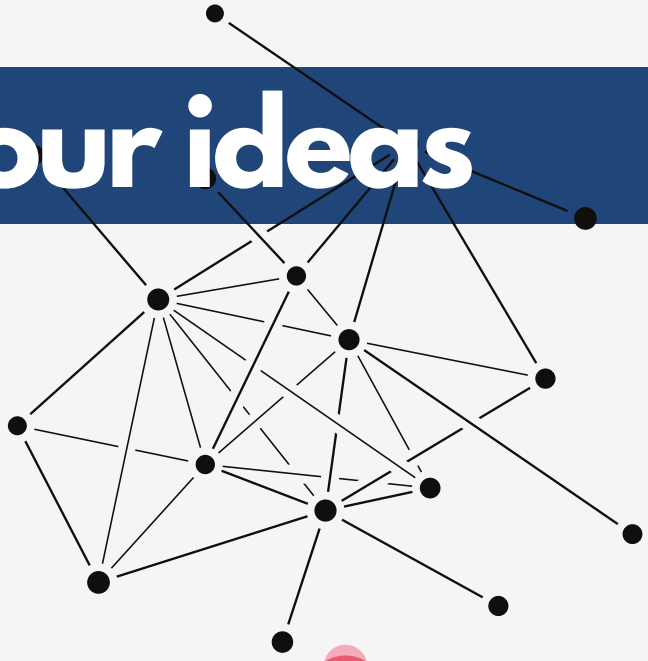
Construct a table and appropriate graph of your results.

Press the red button for a template to input your data.

What is the independent variable and dependent variable in this experiment?

Analyse your results and form a conclusion. What happened to the number of breaths required to neutralised the indicator solution **after** exercise? Remember it takes 5ml carbon dioxide to neutralise the solution.

Connecting your ideas



So how does your brain fit into this? Time to connect the dots - Make a flow chart to show how the following structures are all linked and explain how the brain controls the increased rate of carbon dioxide output during exercise.