Neurons

British Neuroscience Association

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Background

The aim of this session is to introduce students (aged 12-18) to neurons, the cells that make up the brain. Students will have the opportunity to discuss what they already know about the brain, gain an insight into how we can look at the brain and understand the different parts of neurons. This information sheet should be used in conjunction with the 'Secondary– Neurons PPT' PowerPoint presentation.

Introducing the Brain

(Slide 1) Title slide. **(2)** Start the session by asking the students to assign an activity to various pictures (cycling, playing piano or climbing stairs). Ask them what part of the body they think is responsible for carrying out these actions. Summarise by informing the students that the brain is the control centre for the body and incredibly important for everything we do. It makes us who we are!

(3) Ask the students what else they know about the brain and have a discussion. This is also a good opportunity for you to inform the students of some interesting brain facts, including:

- 'The human adult brain is just a bit heavier than a bag of sugar' (1.3kg).'
- 'The top of the brain looks similar to a walnut with a wrinkly part on top. If the brain's wrinkles were spread out, it would be about the size of 4 pieces of paper' (A4).
- 'The brain is a very hungry organ, takes up to 20-25% of your calories'.

(4-5) Inform the students about the anatomy of the brain. The brain is split in two sides called hemispheres. Each hemisphere controls functions on the other side of the body. So the left side will control motor functions of the right side of your body, and vice versa. For example, your left hemisphere moves your right arm and leg.

(6-7) Ask them how they think scientists study the brain. Take suggestions.

Explain some of them:

- **Microscopy** and different dyes which stain cells are used for visualization. They enable scientists to study the brain in more detail (structure and organization). Explain that microscopes work as a magnifying lens, but much more powerful. Some can magnify an object hundreds of times, or thousands.
- **Magnetic Resonance Imaging (MRI)** allows scientists to observe the different parts of the brain and shows what parts carry different functions. How does it work? When a part of the brain is activated, it 'glows' and can be observed.

(8) Inform the students that the brain is made up of different areas. Give examples (cortex, cerebellum, etc). Different areas with different functions work together, as different members of a football team.

Tip: Visual aids (e.g. model of the brain) may help you keep the attention of the students and boost your own confidence. If a screen is available, you could use a 3D brain model such as the one found at brainfacts.org/3d-brain.

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This activity has been supported by a grant from Roche Products Ltd

(8 continued) You may wish to ask questions to stimulate discussion such as 'Do you know what the brain is made up of?' Encourage the answer of 'cells' or 'neurons'.

Explain that the brain is made of particular types of cells, called neurons. Tell the students that there are billions of these in our brain.

(9-10) To give some sense of scale, you can inform students that although neurons differ in size, the axons of the biggest neurons are just thinner (3x thinner) than the width of a blonde human hair. (Other neurons are a lot thinner than that.) There are also around 86 billion neurons in an adult brain - more than 10X the number of people on earth.

Inform the students that because neurons are so small, we need to use microscopes to see them.

(11) Describe the different parts of the neuron: dendrites, cell body or soma, axon with myelin sheath, synapse. Neurons can come in many different shapes and have different jobs.

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(12) Explain that neurons talk to each other and create networks. Neurons communicate with electrical signals and send messages to one another. The axons work as electrical cables connecting different neurons. Ask how electrical cables are protected? ('plastic'). Explain that instead of plastic, neurons have a myelin sheath. Myelin works as the wire coating, protecting and insulating axons. The myelin coat makes the transmission of messages between neurons faster.

(13) When a neuron is excited by a stimulus, an electrical signal is generated, called an action potential, and it travels down the axon of the neuron, finally reaching the axon terminal. In the axon terminal, there are chemicals called neurotransmitters packaged into sacs called vesicles, which are released into the junction between neurons when the action potential reaches the axon terminal. The next neuron senses these chemicals, and also generates an action potential to send down its axon, allowing the transmission of the message from one neuron to another and so on in a network of neurons.

(14) Explain that the majority of our neurons are already present in our brain when we are born. However, new neurons can be created during our whole life. When we learn new things or by doing exercise, new neurons are generated from stem cells in a process termed **neurogenesis**.

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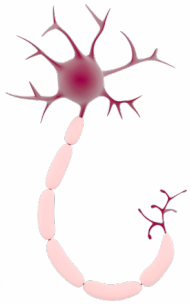
(15) Inform the students that neurons are very specialized cells but need help to do some functions, neurons are not the only cells in the brain!



So, other cells assist the neurons. These cells are called glial cells and there are different types :

- Astrocytes (support and feed neurons)
- Microglia (explorers that remove damaged cells and protect from infectious agents)
- Oligodendrocytes (create myelin to cover the axons).

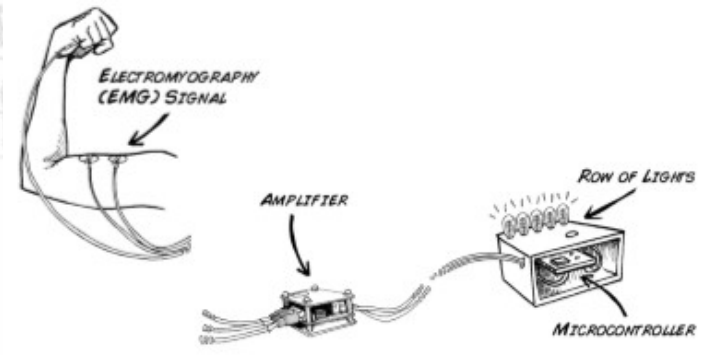
A good way to put into practice some of the concepts seen in the class is through engaging activities. Some suggestions for optional activities (require extra materials) are mentioned here.

A window to another world: A Microscopy lesson

1. Check if the school has light microscopes to use. Alternatively, a cheap and very entertaining option is the Foldscope (you can obtain it clicking here), where the students can learn how to make a microscope themselves.
2. Explain to the students why scientists need microscopes, all the components and how they works.
3. Show the students some tissue preparations or cell preparations (preferably of the brain). Explain how you obtain the sample and how you stain it.
4. Hands-on! Let the students use it!

We are electricity: How neurons control muscles

If you have access to an Electrical Muscle Stimulator (EMS) or a Transcutaneous Electrical Nerve Stimulation (TENS) device, you can do a demonstration to show how nerves are stimulated by electricity to control muscle movement. Alternatively, the Backyard Brains developed a simple version of an EMS, called the Muscle SpikerBox (https://backyardbrains.com/). Different experiments can be found here: https://backyardbrains.com/experiments/



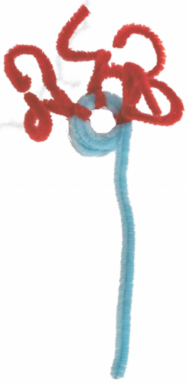
Depending on the age of the children you are doing the session with, you make like to make a pipe cleaner neuron (instructions below).

Also, if you have more time, you may like to get in touch with the Neural Knitworks group to ask for permission to use their patterns and host a mini-neural knitwork during your session (patterns include a simple but impressive neuron which doesn't require any knitting). See: https://www.scienceweek.net.au/neural-knitworks/

Making a pipe cleaner neuron Step-by-Step

1. Take one long pipe cleaner and roll half of it into a ball. This is the **cell body**. The other half sticking out is the **Axon**.

Messages travel from the cell body and along the axon.



2. Take short pieces of pipe cleaner and push them into the cell body, twisting them into the shape of **dendrites**.

The dendrites receive information from other neurons.

3. Take another short piece of pipe cleaner and wrap it around the end of the axon to create an **axon terminal**. This can be likened to the 'mouth' of the neuron and allows it to talk/pass on messages to other neurons.

4. To send the messages faster, neurons have a special coat (**myelin sheath**). Take another short piece of pipe cleaner and wrap it along the axon.

Encourage the students to 'connect' their neuron with another student's - axon terminal to dendrite - to demonstrate how a message is sent.