Module 1

CREATE

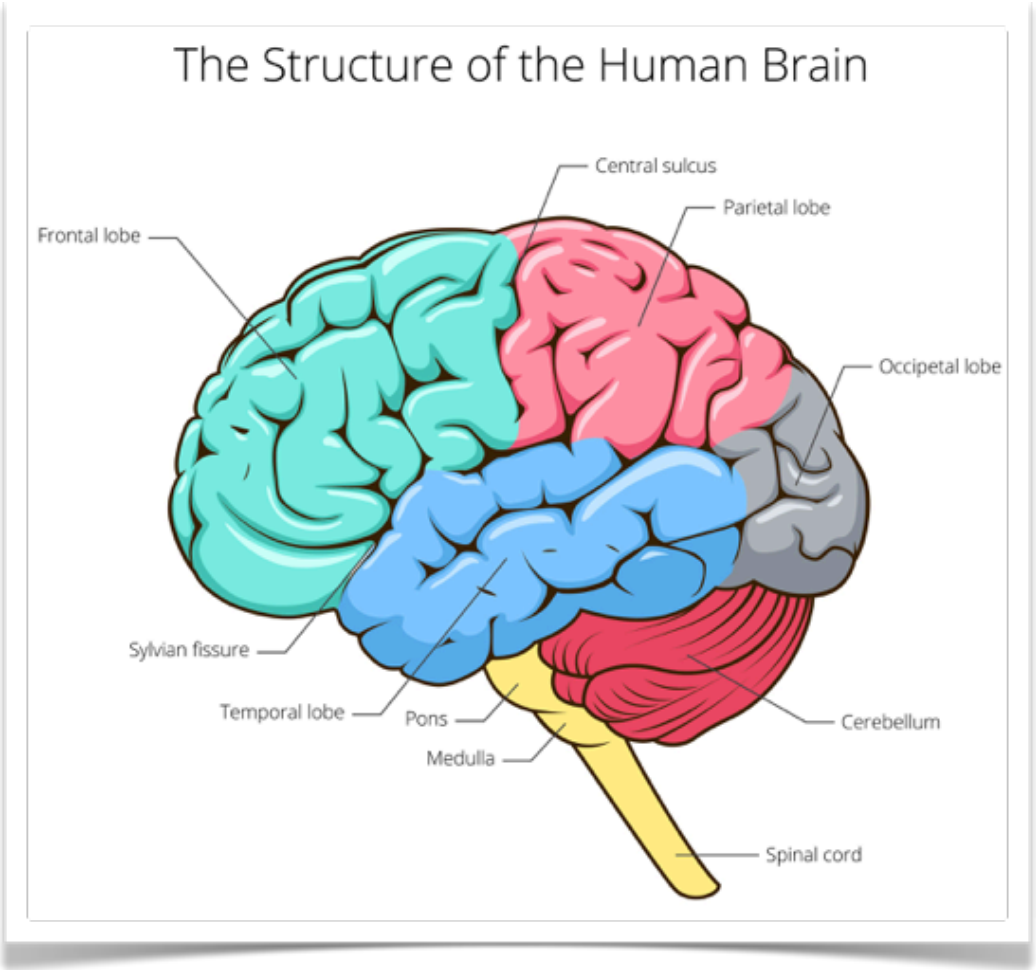
Getting the hardware sorted: How your brain works

Your cognition is your ability to think, learn and remember.

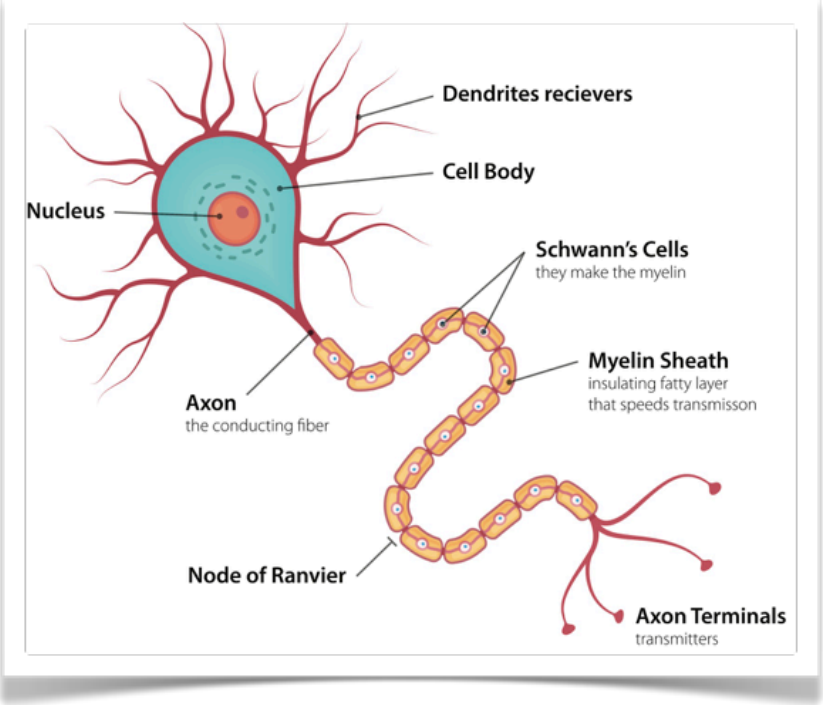
The human brain has been described as the most complex thing in the universe. To get the most out of your brain it helps to have an understanding of how your brain is put together.

It's been estimated the adult human brain comprises around 86 billion neurons, each being capable of forming connections with around 10,000 other neurons to form what are known as neural pathways. These pathways are used to transmit information in the form of electrical impulses so you can learn new skills, form memory, embed habits, make sense of and interact with the world around you.

Outside appearance of the human brain



Structure of a neuron



No two brains are share exactly the same neural architecture, not even identical twins because of the single most important concept to have come out of all the neuroscience; the idea that the brain is plastic, massively plastic.

Neuroplasticity is the term used to describe the brain's natural ability to form and strengthen synaptic connections between existing brain cells or neurons. This is a biological process that occurs across the lifespan meaning we are lifelong learners.

In addition to our neurons the brain contains a number of other highly specialised cells called glial cells. These are important for a number of specialist tasks primarily to support and maintain good neuronal health and function. Relatively little is known about them but it appears they have their own communication network and listen in to what your neurons are up to.

Our knowledge of how the brain works is still in its infancy.

Two previous ideas about the brain now shown to be completely wrong include:

1. The idea that the brain is hardwired incapable of change.
   Our understanding of the brain's plasticity has turned this former belief on its head. Your brain is constantly rewiring itself in response to changes in the environment. This is what has enables us as a species to not just survive but to thrive.

2. The idea that we are born with a finite number of brain cells and that once lost these can never be replaced.
   It's good to know this is wrong too. Your brain has two areas – the hippocampus and the olfactory bulbs used for learning and memory, and smell respectively that contain stem cells. Each day those stem cells produce approximately 700 new neurons, that, if conditions are suitable will survive, mature and become incorporated into your existing neural circuitry.

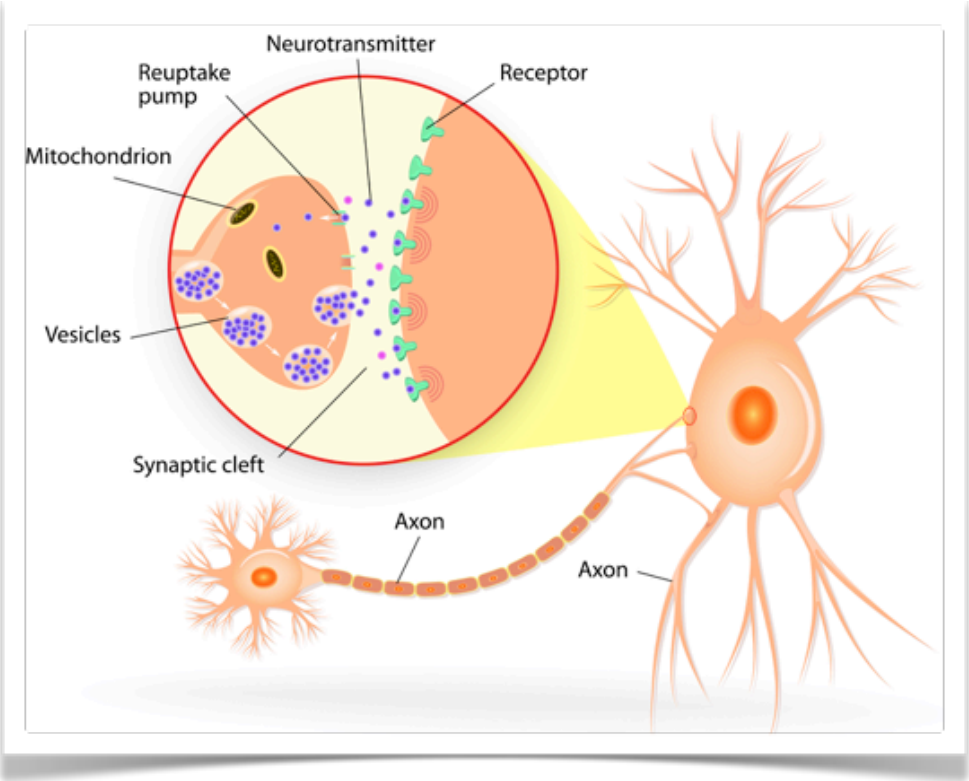
This process is called **neurogenesis**.

The Mighty Synapse

Perhaps one of the most extraordinary things about how neurons connect is that they don't physically touch and are separated by what is called the synaptic cleft. The way a neuron transmits its message is initially as an electrical impulse that passes along the axon towards the axon terminals. At the synapse where two neurons meet, the message changes into a chemical neurotransmitter that, when released from packages called vesicles float into the synaptic space to be then taken up by receptors on the receiving neuron.

If the message received is sufficiently big, it is then changed back into an electrical impulse to continue its journey.

Structure of a typical chemical synapse



Hebbs Law Introduced by Donald Hebb in 1949 his theory is that neurons that fire together, wire together.

Activating a single neuron on its own doesn't achieve very much. However, each neuron can connect synaptically to over 10,000 other neurons. So, imagine if you have a whole army of neurons simultaneously firing together sharing the same chemical message you've now got a tsunami of either an excitatory or inhibitory message that can have far greater impact.

Hebbs idea was that if two or more neurons are active at the same time this helps to strengthen the synapse. This is important because new synaptic connections are highly fragile and easily broken. Networking groups of neurons working together in this way facilitate the formation of memory that is more durable.

This is what makes the human brain so special - its level of connectivity. Having a big brain does not necessarily confer the greatest intelligence.

Beyond knowing your brain is plastic capable of forming new synapses throughout life, the best news is that you can harness this plasticity for your own cognitive advantage.

Your choice of conscious focus enables you to master or upskill certain brain functions such as your ability to pay attention, to learn how to play a musical instrument or to code.

The more you continue to use your brain in this way the more cognitive reserve you create, meaning you help to develop a stronger more resilient brain that will hopefully stay in good shape for as long as the rest of you does.

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How could harnessing your plasticity help you in your chosen career path? Write down your ideas where upskilling or learning a new skill could be useful for you

The dark side of plasticity

While having a plastic brain is a huge advantage, it also has a dark side. Every time a memory or thought pattern is rehearsed or remembered that corresponding neural pathway is strengthened.

However in the situation where anxiety or depression has developed, recurring or ruminative negative thoughts can become significantly entrenched and harder to overcome.
Like a gramophone record with a scratch on it, worries can get stuck in a mental groove that are difficult to shift.

Have you ever experienced an earworm?

Earworms are typically a piece of music or a song that you can't get out of your head. It plays over and over, even though you'd love it to stop! Negative thoughts can get stuck in our minds in exactly the same way.

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Have negative thoughts ever got stuck in your head?
What did you find useful to overcome them?

Neurotransmitters

The brain has a variety of neurotransmitters, complex chemical messengers that can be either excitatory or inhibitory.

Some of the better-known neurotransmitters include the monoamines such as dopamine, noradrenaline, histamine and serotonin. Dopamine and noradrenaline are the major excitatory neurotransmitters important for our reward circuitry and optimal brain performance respectively.

Acetyl choline is also a mostly excitatory neurotransmitter.

Neurotransmitters Others are amino acids including GABA, glutamic acid, aspartic acid and glycine. GABA is the brain's chief inhibitory neurotransmitter that along with serotonin work to quieten the brain down.

Please don't worry about all these names. What is important to know is how certain neurotransmitters play an important role in regulating many of our daily functions including movement, mood, cognition, appetite and sleep.

Over the course there will be references made about several neurotransmitters that will be mentioned only in relation to helping you to understand how they influence your thoughts and feelings.

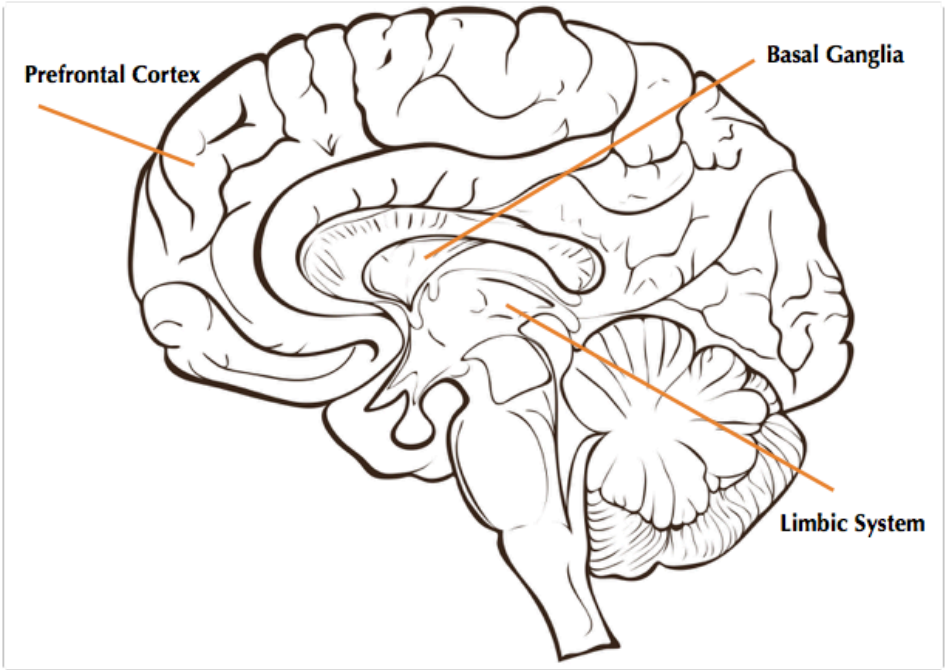
Let's keep it simple While complex, your brain has only three primary objectives

- TO KEEP YOU SAFE
- TO HELP YOU FIND REWARD
- TO ALWAYS CONSERVE MENTAL ENERG

You achieve this through the two operating systems that enable you to think either FAST or SLOW

But first let's take a quick drive around the different areas of the brain most relevant here.

- The Prefrontal Cortex: Your Executive Suite
- The Limbic System: The Chief Safety and Emotions Officer
- The Basal Ganglia: Your Seat of Habit



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The Prefrontal Cortex Your executive suite is concerned with conscious thought; planning, organising, deciding, regulating emotion, paying attention and your working memory. It's the last part of the brain to mature, a feat not completed until you are in your mid-twenties.

The Limbic System An older part of the brain in evolutionary terms, the limbic system is intricately involved in keeping you safe from predators and potential danger. It is involved in the subconscious generation of emotion and linked to the cerebral cortex and the brain stem.

The Basal Ganglia These are a group of structures located deep in the brain involved in facilitating movement and the formation and storage of our habits or automated behaviours.

The reason we run around on autopilot so much of the time is that it saves the brain a heap of energy. Conscious thought is hugely energy demanding so it makes perfect sense to conserve as much energy as possible for higher order thinking, such as paying focused attention, making decisions, assessing and analysing incoming information and determining when it's safe or appropriate to undertake certain tasks. That's why many of those thoughts or behaviours that are routine and commonly repeated become our automated patterns never being required to rise to the surface level of our consciousness.

While having access to our conscious thought is critically important for many of our harder thinking tasks and to guide us to undertake the appropriate activity at a certain time, scientists believe that our subconscious is responsible for 95-99% of all cognitive activity.

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What does that imply to how you think and operate on a daily basis?
Write down which activities you perform on autopilot each day?

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At work, when would it help to recognise when you are using conscious and focused thought versus being stuck on autopilot?

Now that you have completed your Lessons and workbook it is time to take the quiz and prepare for Module 2. Good luck!