



**NEUROSCIENCE**  
**A Career Guide for Students**



The brain is the most complex system in the known universe - many unanswered questions remain.



Understanding the brain is regarded by many as the final frontier of science.

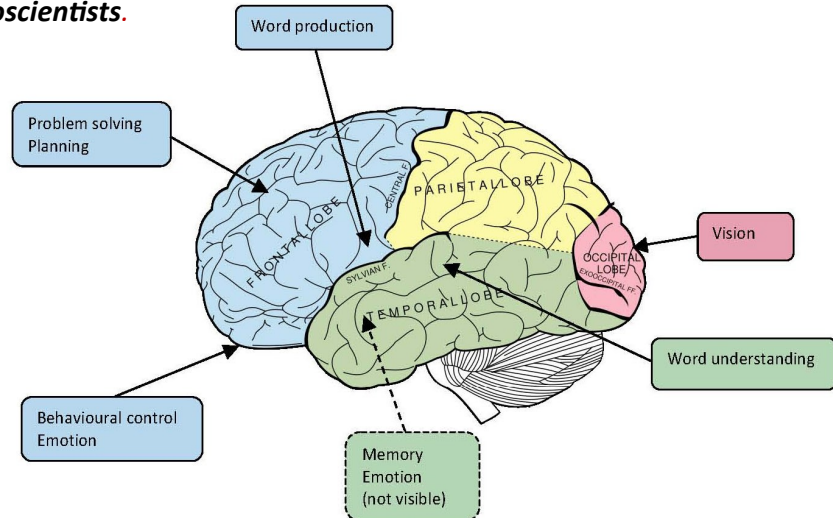


Neuroscientists work alongside scientists in many other fields including chemistry, computer science, engineering, linguistics and mathematics.

## The Brain

Weighing about 1.3 kg, the human brain consists of billions of neurons and glial cells arranged in an inter-connected network of circuits and subcircuits, with connectivity principally mediated through electrochemical transmission at its  $10^{14}$  synapses, which pass an electrical or chemical signal from one neurone to another. It is responsible for our thoughts, mood, emotions and intelligence, as well as our physical movement, breathing, heart rate and sleep. It makes us who we are..... but how? A group of people make it their mission to understand this.....

### Neuroscientists.



### What is Neuroscience ?

Neuroscience is the science of the nervous system, which includes the brain. It is the study of how the brain functions in health and disease. There are lots of types of Neuroscience, for example:

**Developmental Neuroscience:** how the nervous system grows and develops.

**Cognitive Neuroscience:** how the brain creates and controls thought, language, problem-solving, and memory.

**Molecular Neuroscience:** considers genes, proteins, and other molecules involved in the functioning of the nervous system.

**Cellular Neuroscience:** considers the cells of the nervous system: neurones and glia.

**Behavioural Neuroscience:** how different regions of the brain process the behaviour of animals and humans, including studying the effect of drugs on behaviour.

**Clinical Neuroscience:** how to treat and manage disorders of the brain and nervous system.

Many exciting discoveries have been made in Neuroscience research but there is so much more to reveal!

Some new techniques which Neuroscientists have developed include:

- ⇒ Tiny electrodes which can touch the surface of cells and can be used to stimulate the brain of a conscious patient or record its activity.
- ⇒ 'Switching on' cells using lasers which has already given researchers unparalleled control over brain circuits and may lead to treatments for conditions such as epilepsy, Parkinson's disease and blindness.
- ⇒ Silicon chips containing artificial brain circuits.
- ⇒ Reconstructing videos of memories from a part of the brain called the 'visual cortex'.
- ⇒ Deep brain stimulation to treat brain disorders such as Parkinson's disease.



*Neuroscience is global. You can work in other countries and work with colleagues around the globe.*



*We are 2-3 times smaller in body size than gorillas, but our brains are 2-3 times as big!*



*There are around 86 billion neurones per human brain, with each having anywhere between 1,000 and 10,000 connections (synapses) with other neurones. And you thought spaghetti junction was crazy!*

## **Why brain research is so important**

Disorders of the brain are all too frequent in our society. Depression, schizophrenia, stroke, drug addiction, head injury, Alzheimer's and Parkinson's disease are just a few examples.

We need to understand what happens in the brain in order to find new treatments. In the UK alone:

### **Mental Health**

- ⇒ Approximately 1 in 4 people in the UK will experience a mental health problem each year
- ⇒ In Britain, 10% of children and young people (aged 5-16 years) have a clinically diagnosable mental problem
- ⇒ Mixed anxiety and depression has been estimated to cause one fifth of days lost from work in Britain
- ⇒ By 2030, it is estimated that there will be approximately two million more adults in the UK with mental health problems than there were in 2013.

### **Dementia**

- ⇒ 850,000 people are estimated to be living with dementia in the UK
- ⇒ The total cost of dementia in the UK is £26.3 billion
- ⇒ It is estimated that 135 million people worldwide will have dementia by 2050

### **Traumatic brain injury**

- ⇒ Approximately 50–60 million new TBI cases are estimated to occur annually worldwide
- ⇒ TBI represents 30–40% of all injury-related deaths, and neurological injury is projected to remain the most important cause of disability from neurological disease until 2030.
- ⇒ It has been estimated that TBI costs the global economy approximately \$US400 billion annually

### **Brain tumours**

- ⇒ At least 16,000 people each year are diagnosed with a brain tumour
- ⇒ Less than 20% of brain tumour patients survive beyond five years of their diagnosis
- ⇒ More children and adults under 40 die of a brain tumour than from any other cancer

### **Spinal Cord Injury**

- ⇒ Around 1,000 people sustain a spinal cord injury each year in the UK and Ireland
- ⇒ There are currently no effective treatments for spinal cord injury

### **Stroke**

- ⇒ Stroke occurs approximately 152,000 times a year in the UK; that is one every 3 minutes 27 seconds
- ⇒ 1 in 4 strokes are fatal within a year
- ⇒ Stroke is the fourth single largest cause of death in the UK and second in the world



The brain of an adult human weighs around 3 pounds (1.3kg). Although it makes up just 2% of the body's weight, it uses around 25% of its energy.



The brain is separated from the bloodstream by a collection of specialized cells that make up the blood-brain barrier.



The human cerebral cortex has 16 billion neurons – the most of any brain – and this may explain the superior cognitive abilities of our species.

## What jobs to Neuroscientists do?

The following is a snapshot of different neuroscience-related careers.

### Research

Research Neuroscientists carry out experiments to understand more about the brain and nervous system, both in normal circumstances and in nervous system disorders. They often work in laboratories in universities and industry and communicate their experiments in peer-reviewed journals and local, national and international conferences.

### Clinical Sciences

Clinical scientists (or healthcare scientists) use their knowledge of science to help prevent, diagnose and treat illness. They research and develop the techniques and equipment used by medical staff with clinical trials. Clinical trials are conducted to establish the safety and efficacy of drug candidates.

### Biotechnology

Biotechnology is technology based on biology. Biotechnology harnesses cellular and biomolecular processes to develop technologies and products to help improve our lives and the health of our planet.

### Pharmaceutical Industry

Pharmaceutical companies discover, develop and market new medicines—translating neuroscience research into useful products. There are a number of different roles within the pharmaceutical industry, from research scientists to sales reps.

### Medical devices industry

The medical device manufacturing industry is a highly diversified industry that provides a range of products designed to diagnose and treat patients in healthcare systems worldwide. Medical devices range in nature and complexity from simple tongue depressors and bandages to complex programmable pacemakers, transcranial electrical or magnetic stimulation devices and sophisticated imaging systems.

### CRO Industry

A contract research organisation (CRO) provides support to the pharmaceutical, biotechnology, and medical device industries in the form of research services outsourced on a contract basis. A CRO may provide such services as biopharmaceutical development, biologic assay development, commercialisation, preclinical research, clinical research and clinical trials management. CROs also support foundations, research institutions, and universities, in addition to governmental organizations.

### Regulatory Affairs, Policy and Research Administration

Regulatory affairs officers and policy implementers ensure that scientists, companies and their products comply with current legislation and national and international requirements. For example, the regulatory requirements for the approval to market a new medicine, biomarker or medical device.

### Publishing and Media

Scientists publish their work in scientific journals. Often the people involved in the editing, publishing, and reviewing the papers are scientists themselves. Having a science background also opens doors to the media world: many of the science reporters you see on TV, or read about in the news, have a science degree.

- ⇒ **Neuroethics** - the social, legal and ethical consequences of advances in brain research.
- ⇒ **Neuroeconomics** – risk-taking and decision making that influence business and the economy.
- ⇒ **Neuroaesthetics** – creativity and the brain.
- ⇒ **Neurotechnology**- combining engineering and IT with Neuroscience.
- ⇒ **Neuroprosthetics** - the interface between humans and machines.





The human brain can process entire images that the eye sees in as little as 13 milliseconds – less than the blink of an eye!



The myelin sheath is a fatty layer that surrounds the axons of some neurons. It is the reason why action potentials (neuronal messages) can be sent at speeds up to 150 metres per second!



The human brain is protected by the skull (cranium), a protective casing made up of 22 bones that are joined together.

### How to get into Neuroscience

**Foundation programmes**  
A route to degree courses at specific universities and designed for students who lack traditional educational qualifications. See <http://fd.ucas.com/FoundationDegree/About.aspx>

**Complete 3 'A' levels / Scottish Advanced Highers / IB** usually including two sciences. Check specific institutional requirements at [www.bna.org.uk](http://www.bna.org.uk)

**Access to Higher Education Diploma**  
They aim to prepare you for study at degree level if you haven't got the grades that you need straight from school. See <http://www.accesstohe.ac.uk>

**Masters.**  
One or two years and includes lectures, tutorials, project work and exams. Check [www.bna.org.uk](http://www.bna.org.uk) for postgraduate opportunities.

**Neuroscience or related undergraduate degree.**  
Usually 3 or 4 years. For different degree options see [www.bna.org.uk](http://www.bna.org.uk)

**PhD/doctorate.**  
3 or 4 years and consists of your own research project under the supervision of an experience research academic. PhDs don't have any lectures or "taught" elements, but you will have to write a thesis and defend your work in a oral presentation (Viva).

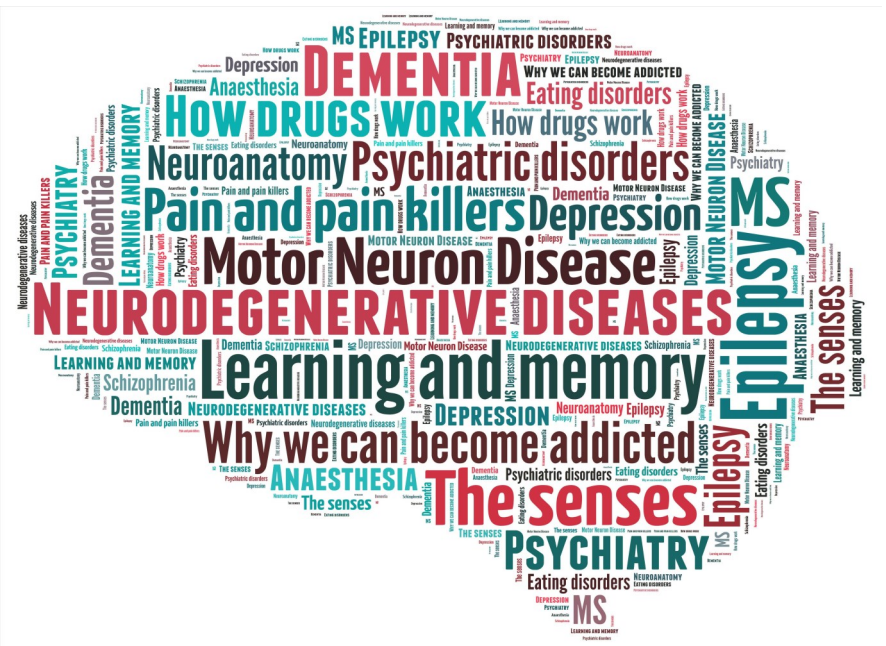
**Postgraduate study**

### Neuroscience degrees

There are many Neuroscience undergraduate degrees available at universities throughout the UK. You can study a straight Neuroscience course or a combined degree such as Neuroscience with Psychology. The qualification gained is usually a Bachelor of Science with Honours [BSc (Hons)] but can also take the form of a Bachelor of Arts [BA], Master of Science [MSc] or Master of Biology [MBiol]. Neuroscience and related degrees are usually 3 or 4 years full time and some include a placement in industry or academia. For a full list of Neuroscience undergraduate courses in the UK and Ireland please visit the 'Careers' section at [www.bna.org.uk](http://www.bna.org.uk).

**Important!** – Each university has different entry requirements so make sure you check the website of the university that you are interested in.

What you will be taught varies between universities, however most degrees will cover some of these topics.





The posterior hippocampus, an area important in spatial memory, is significantly larger in London taxi drivers – perhaps due to the mental workout of remembering and navigating the 25,000 streets.



The popular fact that we use only 10% of our brains is false. Brain scans clearly show that we use the majority of our brain most of the time, even when we're sleeping.



A nerve fibre bundle called the corpus callosum allows communication between the two cerebral hemispheres of the brain.

## Neuroscientists at work

### **Academia - Hugo Spiers**

My research team uses functional magnetic resonance imaging (fMRI), magnetoencephalography (MEG) and single neuron recording to record brain activity. We use virtual reality to transport our volunteers to different worlds to study how they react when confronted with challenges, such as escaping a labyrinth.

[www.ucl.ac.uk/spierslab](http://www.ucl.ac.uk/spierslab) or on Twitter @hugospiers



### **Media – Victoria Gill (Science reporter for BBC)**

I'm a science reporter for BBC News and primarily for the news website.

A love to writing, especially about what makes people 'tick', inspired me to set out on my post-graduate course and pursue a career in science writing and journalism. I now primarily make short films for the website.

Twitter @Vic\_Gill



### **PhD Student – Casmira Brazaitis (University of St Andrews)**

I am now in my second year of a four year PhD program at the University of St Andrews and my project is in drug discovery, where I am looking at a drug that can modulate one of the receptors in our nervous system. I am doing this using a number of techniques, including taking slices of brains and recording the electrical activity of the cells.



### **Undergraduate Student – Julie Smilie (University of Dundee)**

I'm in my final year of my Neuroscience degree at Dundee University. I started off doing a degree in biomedical sciences, however a Neuroscience module really sparked my interest in the brain and I knew that I wanted to study Neuroscience instead. I switched degrees in 3rd year and I'm now carrying out my 4th year project looking at the effects of cocaine on the brain.





Sleep is essential for consolidating the experiences that have taken place during the day into long-term memory.



Synaesthesia is a condition where stimulation of one sense evokes a perception of another. Individuals affected may 'taste' words, 'smell' sounds, or see numbers as colours.



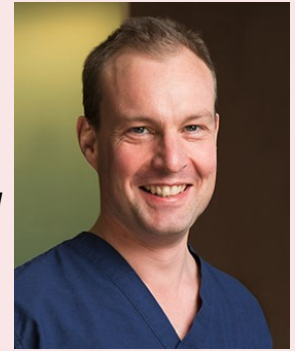
Forgetting is important in memory. It allows us to focus on the stuff that's going to help make decisions in the real world.

### **Edward McKintosh – Consultant Neurosurgeon**

*My weekly routine now consists of outpatient clinics and theatre sessions.*

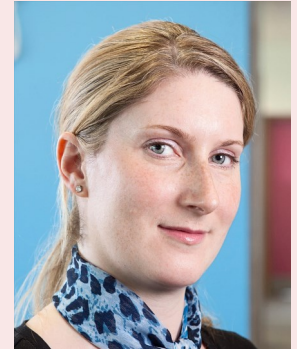
*I spend 50% of my time with brain tumour patients and the other 50% with a mixture of brain and spinal injured patients, and patients with degenerative spine conditions.*

<http://e-mck.net/>



### **Pharmaceutical research - Lisa Wells (Imanova)**

*My research involves the use of positron emission tomography (PET) and computerised tomography (CT) imaging techniques to measure changes in biological systems in the living brain. We use established and develop new imaging probes to help increase our understanding of progressive disease states such as Alzheimer's and Parkinson's disease.*



### **Useful links and resources**

- ⇒ British Neuroscience Association – [www.bna.org.uk](http://www.bna.org.uk)
- ⇒ Access to higher education diplomas - [www.accesstohe.ac.uk](http://www.accesstohe.ac.uk)
- ⇒ Foundation courses - <http://fd.ucas.com/FoundationDegree/About.aspx>
- ⇒ Universities and Colleges Admissions Service - [www.ucas.com](http://www.ucas.com)
- ⇒ PhD positions – [www.findaphd.com](http://www.findaphd.com)
- ⇒ Postgraduate and funding opportunities - <http://targetcourses.co.uk/>
- ⇒ Masters positions – [www.findamasters.com](http://www.findamasters.com)
- ⇒ Neuroscience resources - [www.bna.org.uk/schools](http://www.bna.org.uk/schools)
- ⇒ BrainFacts.org - [www.brainfacts.org/](http://www.brainfacts.org/)
- ⇒ Neuroscience, Science of the Brain - [www.bna.org.uk/about-neuroscience/written-resources](http://www.bna.org.uk/about-neuroscience/written-resources)



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Be part of the UK's largest and longest-running neuroscience community and help support vital neuroscience research

from just

**£1** per month

The British Neuroscience Association (BNA) has been supporting neuroscience and neuroscientists for over 50 years, ensuring that the UK has the strong base of basic discovery neuroscience which is absolutely critical for developing treatments for disorders such as motor neuron disease, dementia, pain, mental health disorders, stroke, autism and epilepsy.

## We welcome everyone interested in the brain and nervous system to join us.

Our membership includes people working in neuroscience or related fields at all stages of their career, from A-Level students to retired academics; and our Associate Membership is for people who don't necessarily work in neuroscience but who are still fascinated by the brain.

### Membership benefits include:

- Careers advice and opportunities
- Student prizes and travel bursaries
- Free membership of the international neuroscience organisations, FENS and IBRO
- Chances to meet leading neuroscientists
- Printed publication, the BNA Bulletin
- Sponsored abstracts for the Society for Neuroscience Annual Meeting

See full details at [bna.org.uk](http://bna.org.uk)

