BNA
British Neuroscience Association

NEUROSCIENCE
Unravelling the Mysteries of the Brain

www.bna.org.uk

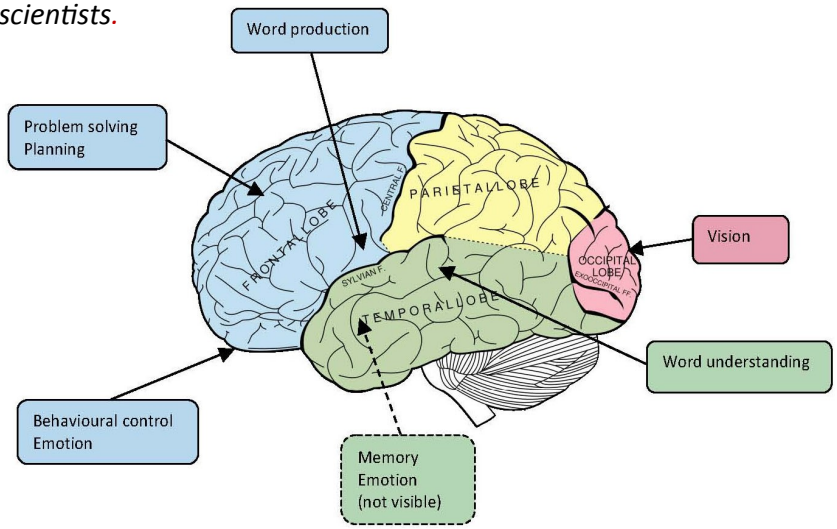
The brain is the most complex system in the known universe—many unanswered questions remain.

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 80 billion neurons and a trillion 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'.

⇒ Growing a tiny brain in a test tube used for modelling diseases and testing drugs.

⇒ 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.

Neurones develop at the rate of 250,000 per minute during early pregnancy!

There are around 80 billion neurones per human being, with each having anywhere between 1,000 and 10,000 connections called synapases 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

⇒ 1 in 4 people will experience some sort of mental health problem during their lives

⇒ About 10% of children have a mental health problem at any one time

⇒ 9/10 prisoners have a mental health problem

⇒ Mixed anxiety and depression is the most common mental disorder in Britain

⇒ About one in 100 people will have one episode of schizophrenia, and two thirds of these will go on to have further episodes

Dementia

⇒ There are currently 800,000 people with dementia in the UK (2013)

⇒ 80% of people living in care homes in the UK suffer from some form of dementia

⇒ It is estimated that 135 million people worldwide will have dementia by 2050

Traumatic brain injury

⇒ There are estimated to be 1 million people in the UK suffering with the long-term effects of traumatic brain injury

⇒ Every 90 seconds someone is admitted to hospital with traumatic brain injury

⇒ The total UK admissions to hospital for traumatic head injury in 2011-12 were 213,752

Brain tumours

⇒ 16,000 people each year are diagnosed with a brain tumour

⇒ 20% to 40% of all cancers eventually spread to the brain

⇒ 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

⇒ The cost to the nation is estimated at £1 billion per annum

⇒ There are currently no effective treatments for spinal cord injury

Stroke

⇒ Every year in the UK approximately 152,000 people experience impaired brain functioning resulting from reduced blood supply to the brain, which is known as a stroke

⇒ Stroke is a major health problem for the UK and is the third biggest killer each year with 11% of deaths attributed to stroke. It is the single largest cause of disability in the UK yet it has not traditionally had a high profile

⇒ One in five strokes are fatal. Stroke causes about 7% of deaths in men and 10% of deaths in women

Only 10% of our brain mass is neuronal cells. The remainder is glial cells, which provide support and protection for neurones, along with other important functions.

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

Learning to balance and co-ordinate your body is so complex the region of the brain devoted to this task contains as many cells as the rest of the brain put together.

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 simply 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 is over three times as big as the brain of other mammals that are of similar body size.

The largest part of the human brain is called the cerebrum. Other important parts include corpus callosum, cerebral cortex, thalamus, cerebellum, hypothalamus, hippocampus and brain stem.

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

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 for postgraduate opportunities.

Neuroscience or related undergraduate degree.
Usually 3 or 4 years. For different degree options see www.bna.org.uk

Postgraduate study

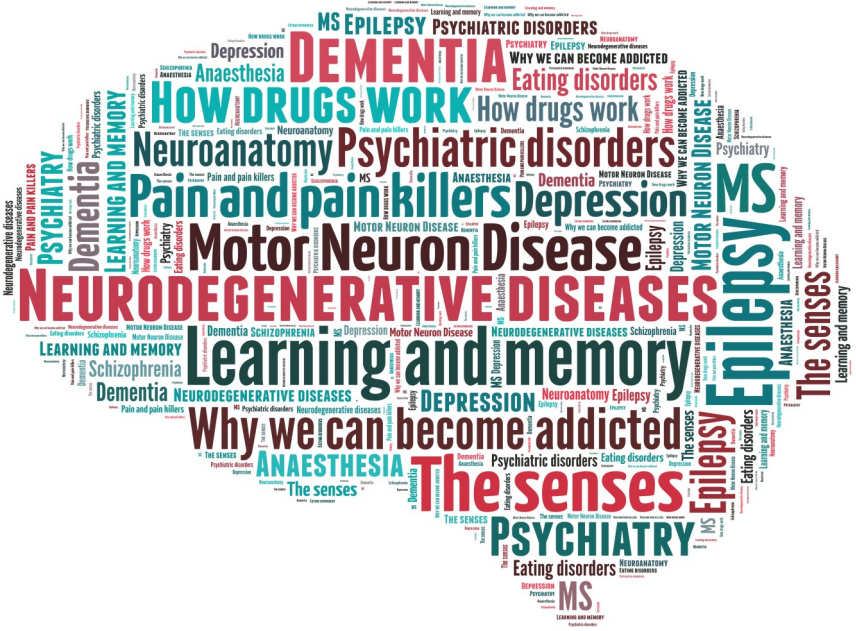
PhD/doctorate.
3 or 4 years and consists of your own research project under the supervision of an experience research academic. PhDs don't have any lectures or "taught" elements, but you will have to write a thesis of your work, usually around 100,000 words and an oral presentation.

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 'Education and Training' section at 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.



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 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.

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 20% of its energy.

The brain can stay alive for 4 to 6 minutes without oxygen. After that cells begin to die.

The energy used by the brain is enough to light a 25 watt bulb.

After age 30, the brain shrinks a quarter of a percent (0.25%) in mass each year.

More electrical impulses are generated in one day by a single human brain than by all the telephones in the world.

How much does a human brain think? 70,000 is the number of thoughts estimated that the human brain produces on an average day.

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

⇒ Access to higher education diplomas - www.accesstohe.ac.uk

⇒ Foundation courses - http://fd.ucas.com/FoundationDegree/About.aspx

⇒ Universities and Colleges Admissions Service - www.ucas.com

⇒ PhD positions – www.findaphd.com

⇒ Postgraduate and funding opportunities - http://targetcourses.co.uk/

⇒ Masters positions – www.findamasters.com

⇒ Neuroscience podcasts - www.thenakedscientists.com/HTML/podcasts/Neuroscience/

⇒ BrainFacts.org - www.brainfacts.org/

⇒ Neuroscience, Science of the Brain - www.bna.org.uk/about/science-of-the-brain.html

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The British Neuroscience Association (BNA) is the largest UK organisation representing all aspects of Neuroscience, from ion channels, to whole animal behaviour, to Neuroscience applications in the clinic. As well as promoting UK Neuroscience research nationally and internationally, we organise lectures, symposia, meetings, events and reports.

We also advise on issues in Neuroscience, engage with the public and media, and train Neuroscientists and Neuroscience-related professionals. The BNA has good connections with other organisations worldwide and our members range from academic to industrial Neuroscientists.

To find out more about what we do and the benefits of becoming a member from just £1 a month, visit:

www.bna.org.uk/join.html