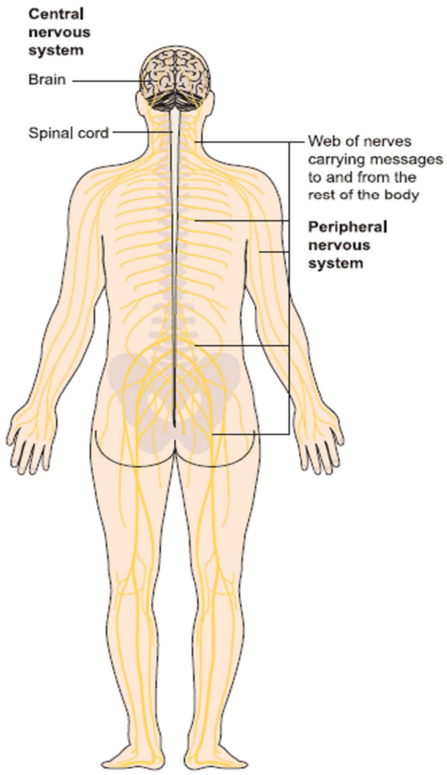
Module 1: The Brain and the Central Nervous System (CNS)

By the end of this unit, the learner will be able to:

- Describe the anatomy of the brain and the central nervous system
- Identify regions of the brain and their functions
- State which areas of the brain are associated with different activities
- Describe various ways in which the brain is protected.

In order to understand brain injuries, it is important to have a basic understanding of how the brain and nervous system works when it functions normally.

Overview of the Central Nervous System (CNS)



The central nervous system is made up of the brain, the spinal cord and nerves.

The brain controls everything our body does. It can be compared to a computer, as it makes sense of all the messages it receives from the spinal cord and the neurons. Our brain controls what we think, what we say, our emotions, memories, sensations, and body movements. It also allows us to interpret messages given by the nerves from other organs in the body, such as the desire to use the toilet. The brain therefore plays a part in everything we do, including interpreting images, sounds and smells.

The brain is made up of 100 billion nerve cells called neurons. Neurons are connected to the rest of the body via the spinal cord. The spinal cord hosts a network of nerves which lead from there to other parts of the body. The spinal cord can therefore be seen as part of the brain, together they make up the Central Nervous System (CNS).

How the Central Nervous System Works

The central nervous system can be seen as a hierarchy, with the brain sitting at the top. A nerve in the body will have to send a message to the spinal cord, which then sends the message up to the brain. The brain then processes the message and interprets what to do with the information, sending instructions to the muscles. For example, when the bladder is full, the bladder's nerves will tell the spinal cord, which then relays the message to the brain. The brain then decides if it is time to visit the toilet, and sends instructions via the nerves for the bladder muscle to release.

A Reference Guide to the Brain

The brain is made up of many parts, and it is important to understand the basic functions of the important parts. Damage in any area, even damage which is very small, can result in loss of function. When someone experiences brain damage, he or she also experiences impairment of skills. Knowing what part of the brain is damaged therefore, tells us what function that part of the brain performs. This means that when someone acquires a brain injury, how they are affected will depend on which part of the brain has been injured.

Scientists have used this knowledge to map the brain to psychological and physical functions. The brain is divided into three main parts: the stem, the cerebellum, and the cerebrum (also called the cerebral cortex).

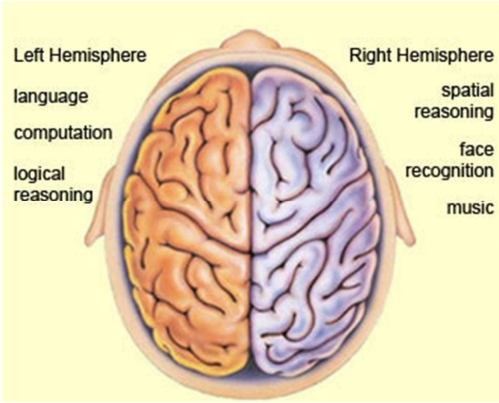
1. **The brain stem** is located at the top of the spinal cord, and it is this which keeps us alive as it controls consciousness and breathing. The stem is further divided into three sections: the **mid brain** allows the left and right hemispheres to communicate; the **pons** is a like a junction for all of the nerves; and the **medulla** controls our heart and lungs (cardiac and respiratory functions).

2. **The cerebellum** is at the back of the skull and allows us to balance and co-ordinate movement.

3. **The cerebrum (or cerebral cortex)** is the largest part of the brain and contains the two hemispheres, which are further divided into 4 lobes. The role of the cerebrum will now be looked at in more detail, as this part of the brain performs the very specific functions that make us individual.

A Tale of Two Halves

The cerebrum is divided into two halves which are joined in the middle. Both of these halves are referred to as "hemispheres". The left hemisphere controls the right-hand side of the body, and the right hemisphere controls the left-hand side of the body. This means that if a person has damage to the left side of the brain, he will have difficulties using the right hand side of his body. Similarly, one side of the brain is "dominant". For most of us, this is the left-hand side, and we are therefore right-handed. Left-handed people are right-brain dominant.



Each hemisphere of the cerebrum is divided into four lobes, called the **frontal**, **parietal**, **temporal**, and **occipital** lobes. Each of these lobes has its own physical and mental functions to perform, and damage to the brain in these regions would affect a person's ability to perform those functions.

The Frontal Lobes

As its name suggests, the frontal lobe is located at the front of each hemisphere of the brain. The frontal lobes are vital for each of our personalities, as emotion, problem solving, planning, reasoning, and control of movement is located there. The main job of the frontal lobes is to think things through and to decide how to use the information that the rest of the brain is taking in. The frontal lobes are used to perform tasks requiring intelligence and are important in performing several tasks:

- **Problem solving:** High-level and detailed thinking is possible because of the frontal lobes, which allow us to reason, make plans, make choices, plan courses of action, think through alternatives, and make judgments. Without the frontal lobes, it is possible to be intelligent, but the brain would not be able to process intelligent thinking.

- **Social interaction:** The frontal lobes allow us to access our memories and also to interact with others appropriately. The frontal lobes help us to interpret social cues, letting us know when to hold back in social situations and helping us to differentiate between what is socially acceptable and what is not. They allow us to understand empathetic behaviour, to know what other people are thinking, and to interpret their emotions.

- **Emotional control**: The left frontal lobe is used to control emotion. If this part of the brain is damaged, the person will display exaggerated emotional responses without inhibition. He or She will also have difficulty interpreting facial expression.

- **Movement**: Muscle control is located in another part of the brain, but the frontal lobes allow voluntary control of movement, such as the ability to walk, run, and throw or catch a ball.

The Temporal Lobes

The temporal lobes are located near the ears, and they are important for processing sensory information. The main functions are thought to be making sense of what we see and hear and also directing language.

As temporal lobes process sensory information, they play an important part in memory retrieval. If you smell a perfume that reminds you of your first date, this memory is triggered by the scent, which is processed in the temporal lobe.

The Parietal Lobes

The parietal lobes are located in the upper part of the back brain. They are involved in the appreciation of sensation. It is the parietal lobes which make us identify if we are hot or cold, or help us to decide if food smells good, has a nice texture, or tastes foul. The parietal lobes also play a part in our spatial awareness, allowing us to realize what is part of our body and what is not. For instance, they help us to gauge if there is enough space to park a car, if the road is long, or if a cat will fit through a

particular gap. Reading and mathematical ability have also been mapped to this region of the brain.

The Occipital Lobes

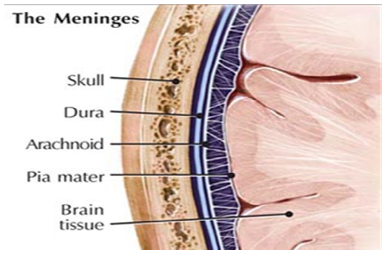
The occipital lobes are involved in vision. Namely, they deal with the information sent by the eyes. As you read this page, your occipital lobes are working by processing the sensory input from your eyes and linking it to your memories. For example, you can remember what different letters and words are, and correctly interpret their meaning. The occipital lobes therefore allow us to make inferences. For instance, we can always recognize a cat as a cat: whether this is a real animal, a photograph, or a basic line drawing, we are using our occipital lobes to process the visual stimulus and link it to information stored in our memory. People who have damaged occipital lobes could have serious problems with vision, even complete blindness, even if their visual system is perfect. This is called cortical blindness: the person's vision is fine, but the brain can not process visual information.

Protecting the Brain

The brain is the most vital organ in the body and must be protected from damage. Fortunately, there are 3 ways it is protected: by the cranium (**skull)**, by the **cerebrospinal fluid,** and by the **meninges**.

The cranium, more commonly referred to as the **skull,** is the bone in which the brain is housed. The job of the skull is to protect the brain from injuries caused by falls and accidents, as the hard bone takes the impact instead of the brain. Having a skull fracture is painful, but is certainly preferable to damaging the brain.

Cerebrospinal fluid surrounds the brain to stop it banging into the hard bones of the skull and getting damaged. The cerebrospinal fluid also "washes" the brain, helping it to remove waste substances by absorbing them into the bloodstream, where they are turned into urine by the kidneys.



The meninges is a protective layer of connective tissue covering and protecting the brain. It is a bit like fruit peel protecting the fruit. The meninges has 3 layers, called the dura mater, arachnoid and pia mater.

The brain is a very complicated and important organ. A healthy, undamaged brain works automatically and allows us to get on with our life. Once the brain is damaged, through illness or injury, simple everyday tasks can become a challenge to our dignity, independence and quality of life.

It is important that the brain receives fuel to keep it working effectively. This fuel is oxygen and glucose, which it receives via the blood; without these, it cannot function properly. The human body will work hard to make sure the brain is fuelled with oxygen and glucose. If needed, it will divert blood from other parts of the body to make sure that the brain is fuelled.

Module 2: What is ABI and what causes it?

This section will look at different kinds of brain injuries and there causes

By the end of this unit, the learner will be able to:

- Know what is meant by Acquired Brain Injury
- Explain the difference between a head injury and brain injury
- Define traumatic brain injury
- Be familiar with the terms used to describe traumatic brain injuries
- Identify the symptoms of post traumatic amnesia
- Explain the difference between traumatic and non-traumatic brain injury
- Name different types of non-traumatic brain injury
- Identify symptoms of anoxia.

Acquired Brain Injury (ABI) is a general term used to describe brain damage which occurs after birth. It is not possible to be born with an acquired brain injury as it is not genetical or congenital, although it is possible to acquire the injury during the process of being born. The injury occurs after birth and as a result of an event, either an accident or illness which causes injury and subsequent damage to the brain.

Traumatic brain injury refers to damage which occurs as a result of a physical trauma, usually an accident, assault, neuro-surgery or head injury. A non-traumatic brain injury occurs as a result of an illness, such as a stroke, tumour, infection, substance misuse or poisoning. Nearly everyone with a brain injury will find thinking and behaviour is affected by their injury, but otherwise, no two people with an acquired brain injury will be affected in the same way. Each will have their own story to tell and the problems they have will be as unique. There are many different ways in which brain injury can affect a person and these will be discussed further in module 5.

Traumatic Brain Injury (TBI)

A traumatic brain injury is caused by a trauma to the head, which initially comes from an outside force, such as an accident or blow to the head. Traumatic Brain Injury also includes after injuries that can follow as a result of this, such as pressure or swelling. A traumatic brain injury can be viewed as a chain of events.

1. Accident causing damage to the brain

2. The brain then acquires a secondary injury as result of this, for example, bleeding or swelling

3. A third injury can occur later.

The First Injury

The first injury comes from the outside force and can be one of three types: closed, open or crush.

Closed	No open cuts, no break in the skin. Head can be rocked back and forth, can twist or rock. Brain can knock onto the skull and nerve endings can be twisted, stretched, flooded, or become torn when the movement occurs. Very common in car accidents.	Most common
Open	Skull is opened and exposed. For example, bullet wound or stabbing injuries.	Uncommon
Crush	Head becomes crushed between 2 objects, such as car wheel and road. Usually damages the base of the skull and brain stem.	Least common

The Second Injury

As the initial injury occurs, there will be other things happening to the body and brain that can make the brain damage worse. For example, as a result of a car accident, the patient might lose a lot of blood; this can mean the brain is deprived of its essential oxygen and glucose supply and cause a further injury. In this example, the car accident causes the head to rock, which is the first injury, but the victim is also injured by broken glass and loses too much blood; the lack of oxygen to the head is the secondary injury.

The second injury can occur within minutes and hours of the first injury.

The Third Injury

The third injury can occur as a consequence of bleeding, swelling, bruising or blood clots forming any time after the initial brain injuries. These injuries can occur at any time, sometimes weeks after the initial injury. Examples of third injuries include:

- The brain could slowly leak blood, CSF or other bodily fluids; meaning there is more material inside the skull. As there is only a fixed amount of space inside the cranium and the bones are hard, the brain becomes squashed in its skull, causing it to swell and restrict essential blood flow. Intercranial pressure is the pressure within the skull, and the medical team will constantly monitor this to prevent further damage.
- Veins become damaged and leak blood, which forms clots, medically known as haematomas. The clot haematoma presses onto the brain, damaging it. Patients with minor head injuries will be monitored until the risk of clots forming, is over.

Module 1 – The Brain and the Central Nervous System (CNS)

Activity 1

Describe the function of the following parts of the brain and central nervous system:

a. Brain stem
b. Mid brain
c. Pons
d. Medulla
e. Cerebellum

a.

b.

c.

d.

e.

Activity 2
The cerebral cortex is divided into 2 halves, which in turn are divided in 4 lobes.
Outline the main functions of the four lobes below.

1. Frontal lobes
2. Occipital lobes
3. Parietal lobes
4. Temporal lobes

1.

2.

3.

4.

Activity 3

In the left hand column below are 10 activities you carry out on a regular basis. In the right hand column, write down the name of the lobe you mainly use to carry out this activity. The first one has been done for you.

Activity	Main responsible lobe
Thinking about what might happen next	Frontal
Smelling perfume that reminds us of a recent holiday	
Interpreting facial expression	
Making sense of what we see	
Realising that we are too hot	
Knowing it is not socially acceptable to make sexual remarks	
Deciding that we don't like curry from the local take away	
Realising we are too cold	
Controlling emotions	
Processing the visual information on this page	

Activity 4

Identify and explain three ways in which the body can protect the brain.

Now ask your Tutor/mentor to check this section and provide feedback. You should both sign below, when you agree that the results of your activities meet the required standard.

Tutor/mentor Signature: _____ Date: _____

Student Signature: _____ Date: _____