## 1. Details of Module and its structure

| Module Detail | |
|---|---|
| Subject Name | Psychology |
| Course Name | Psychology 01 (Class XI, Semester - 1) |
| Module Name/Title | Central Nervous System – Part 2 |
| Module Id | kepy_10302 |
| Pre-requisites | To understand the structure and function of the CNS |
| Objectives | After going through this lesson, the learners will be able to understand the following:<br>• CNS-Overview<br>• Brain Overview<br>• Hindbrain Overview<br>• Medulla Oblongata<br>• Pons<br>• Cerebellum<br>• Midbrain |
| Keywords | Brain, Hindbrain, Midbrain, Forebrain, Cerebellum, Medulla Oblongata, Pons, Hypothalamus, Thalamus, Limbic system, Reticular Activating System, Frontal Lobe, Occipital Lobe, Nystagmus, Parietal Lobe, Temporal Lobe, Spinal Cord, Associative Neurons |

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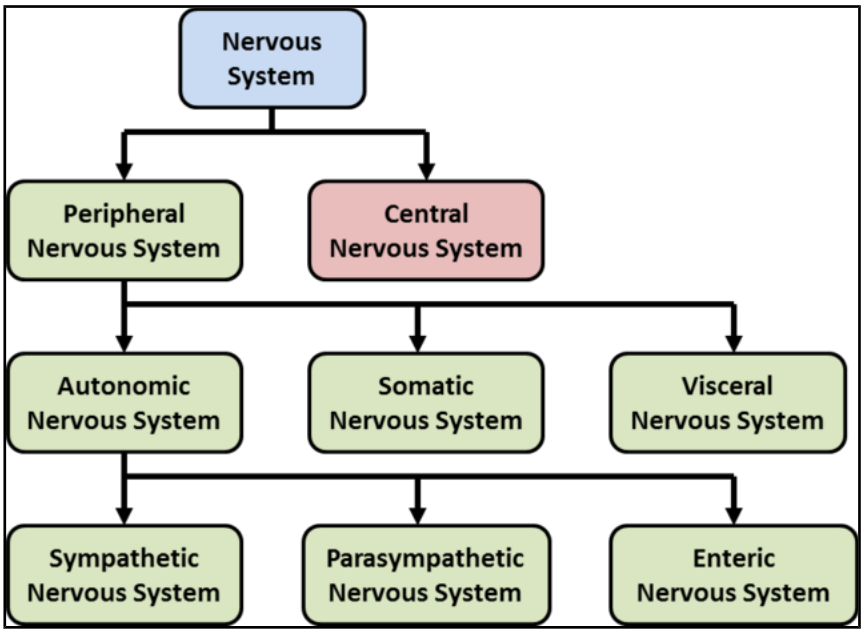
## Central Nervous System

### The Central Nervous System

The central nervous system (CNS) is the centre of all neural activity. It integrates all incoming sensory information, performs all kinds of cognitive activities, and issues motor commands to muscles and glands. The CNS comprises (a) brain and (b) spinal cord. You will now read about the functions of the major parts of the brain and for what behaviours is each part responsible.

**The Human Nervous System: An Overview**




Source:https://upload.wikimedia.org/wikipedia/commons/thumb/a/aa/Components_of_the_Nervous_System.png/640px-Components_of_the_Nervous_System.png

The growth of the human brain is rapid and massive, especially during the first two years. Two years after birth, the size of the brain and the proportion of its parts are basically those of an adult. The typical brain of a full-term infant weighs 350 grams (12 ounces) at birth, 1,000 grams at the end of the first year, about 1,300 grams at puberty, and about 1,500 grams at adulthood. This increase is attributable mainly to the growth of pre-existing neurons. The trebling of weight during the first year (a growth rate unique to humans) may be an adaptation that is essential to the survival of humans as a species with a large brain. Brain development in humans is thought to continue into the mid-20s, on average. From childhood into adulthood, processes such as synaptic pruning- the formation of new neural connections, and the strengthening of established connections shape brain development.In adulthood, as in early brain development, neurons that are not fired or used atrophy or die. In healthy adults, some 85,000 neurons in the neo cortex may be lost each day. By age 75, the weight of the brain is reduced from its maximum at maturity by about one-tenth and the flow of blood through the brain by almost one-fifth. A loss of neurons does not necessarily imply a comparable loss of function; however, some loss may be compensated for by the formation from viable neurons of new branches of nerve fibres and by the formation of new synapses.

**The Brain and Behaviour**

It is believed that the human brain has evolved over millions of years from the brains of lower animals, and this evolutionary process still continues. We can examine the levels of structures in the brain, from its earliest to the most recent form in the process of evolution. **The limbic system, brain stem and cerebellum are the oldest structures**, while **Cerebral Cortex is the latest development** in the course of evolution.

Pg?

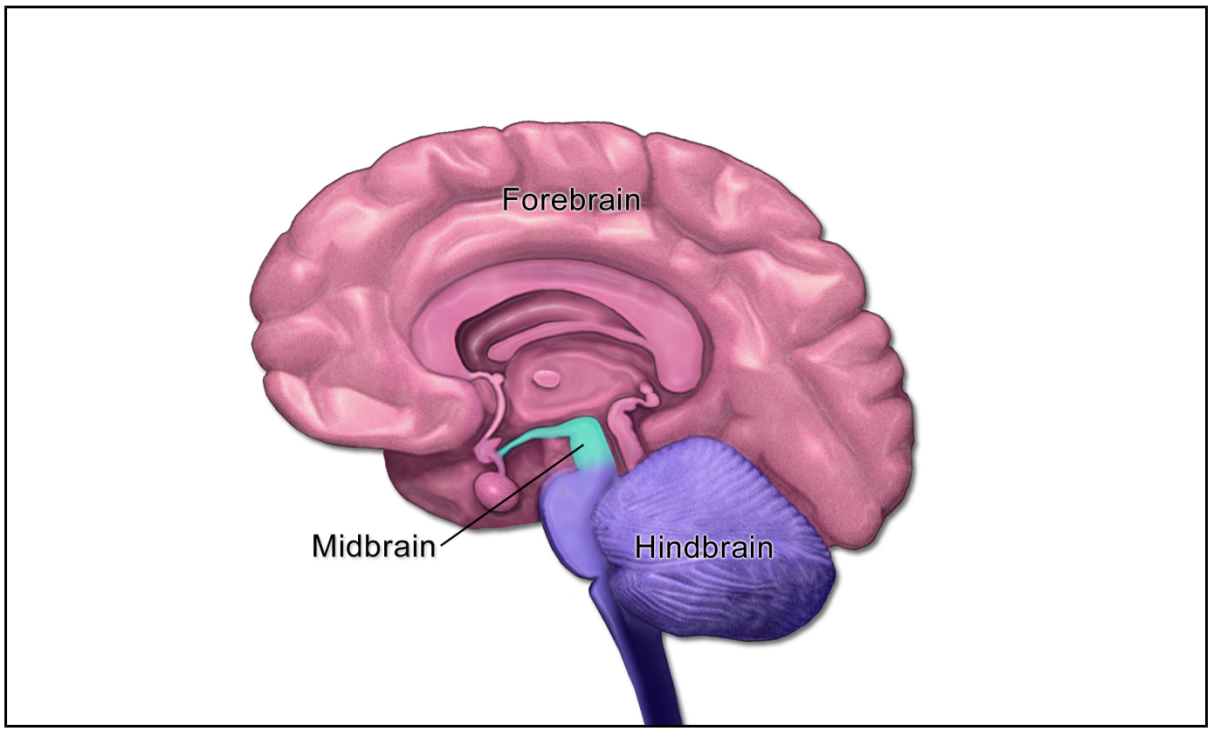
Image from NCERT Text book

An adult brain weighs about 1.36 kg and contains around 100 billion neurons. However, the most amazing thing about the brain is its ability to guide human behaviour and thought.

The brain is organised into structures and regions that perform specific functions.Brain scanning reveals that while some mental functions are distributed among different areas of the brain, many activities are localised also. For example, the occipital lobe of the brain is a specialised area for vision.

Sometimes, the same activity has different facets to it. Take a look!

Structure of the Brain For the convenience of study, the brain can be divided into three parts: Hindbrain, Midbrain and Forebrain. Here is a picture:



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**Hindbrain**

The hindbrain consists of Cerebellum and Pons Medulla Oblongata.

**Medulla oblongata**

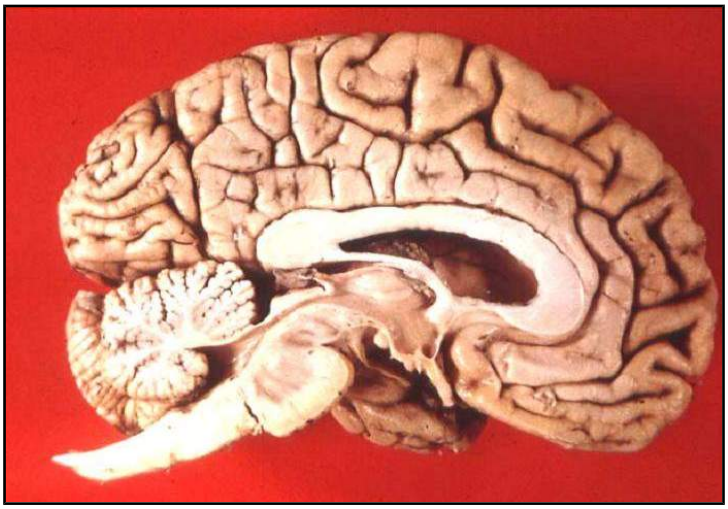
It is the lowest part of the brain that exists in continuation of the spinal cord

It contains neural centres, which regulate basic life supporting activities like **breathing, heart rate, and blood pressure**. This is why medulla is known as the **vital centre of the brain**.

It has some centres of **autonomic activities** also, such as breathing, digestion, heart and blood vessel function, swallowing, and sneezing.

It also relays nerve signals between the brain and the spinal cord,

Here is a picture of the medulla oblongata found in a real brain, marked for convenience:



Source:https://de.wikibooks.org/wiki/Neuroanatomie/_Druckversion#/media/File:Human_brain_midsagittal_cut.JPG

**Note : lable/modifiy the image**

**Injury to the Medulla Oblongata:**

This may result in a number of:

- Fatal damages in vital autonomic functions, such as breathing and heart rate.
- Sensory related problems. These include numbness, paralysis, difficulty swallowing, acid reflux, and lack of movement control.
- Damages caused by drugs and other chemical substances can impact the medulla's ability to function. E.g., An **opiate** overdose.

**Pons:**

**Location:**

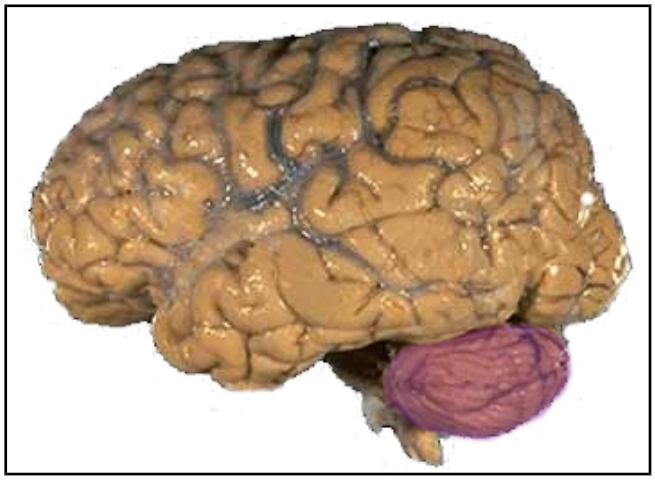
It is connected with medulla on one side and with the midbrain on the other.

**Function:**

- It is believed that pons is involved in sleep mechanism, particularly the sleep characterised by dreaming.
- It contains nuclei affecting respiratory movement.

**Cerebellum:**

The cerebellum is another name for “little brain”. Take a look at its location, size and hemispheres:



Source: https://simple.wikipedia.org/wiki/Cerebellum#/media/File:Cerebellum_NIH.png

Note : label the image for cerebellum

**Structure:** This highly developed part of the hindbrain can be easily recognised by its wrinkled surface.

**Function:**

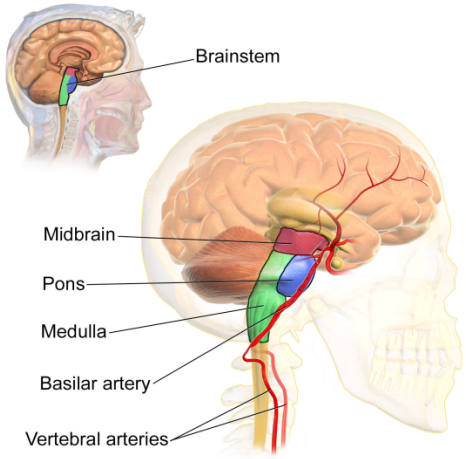
- It maintains and controls posture and equilibrium of the body.
- Its main function is coordination of muscular movements. Though the motor commands originate in the forebrain, the cerebellum receives and coordinates them to relay to the muscles.
- It also stores the memory of movement patterns so that we do not have to concentrate on how to walk, dance, or ride a bicycle.

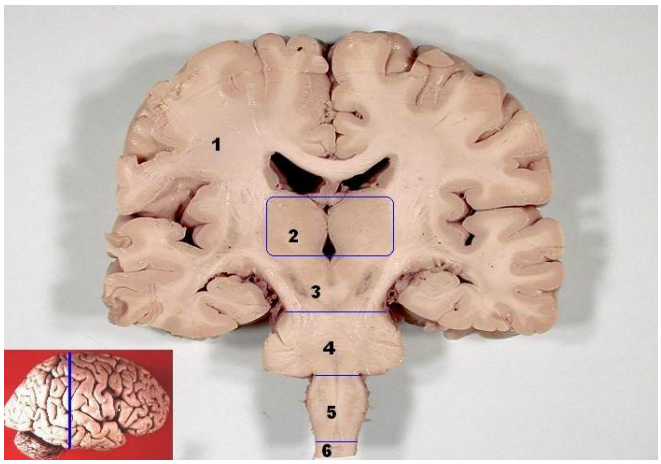
Damage to part or even all of the human cerebellum, on its own, does not lead to clear impairment of intellect, emotion, or vegetative functions (such as the control of the heart and breathing). But there is abundant evidence that typically, patients with cerebellar damage are unsteady on their feet, their hands shake as they try to point or lift objects; their eyes swing uncontrollably from side to side (nystagmus); and even their speech can be jerky. Extremely rarely, individuals are born with little or no cerebellum, and although some of its functions may be taken over by other parts of the brain, movements are permanently clumsy and poorly co-ordinated, suggesting that the learning of motor skills is impaired.

**Midbrain:**

The midbrain is relatively small in size and it connects the hindbrain with the forebrain.

Here's the midbrain's location and a close-up in a real brain (marked by arrows).




Source:https://upload.wikimedia.org/wikipedia/commons/e/e0/Blausen_0114_BrainstemAnatomy.png

Source:https://upload.wikimedia.org/wikipedia/commons/5/59/Human_brain_frontal_%28coronal%29_section_description_2.JPG

**Function:**

1. Dopamine produced here plays an important role in excitation, motivation and habituation of humans.
2. The midbrain helps to relay information for vision and hearing.
3. An important part of midbrain, known as Reticular Activating System (RAS), is responsible for our arousal. It makes us alert and active by regulating sensory inputs. It also helps us in selecting information from the environment.

It is  composed of several neuronal circuits connecting the brainstem to the cortex.

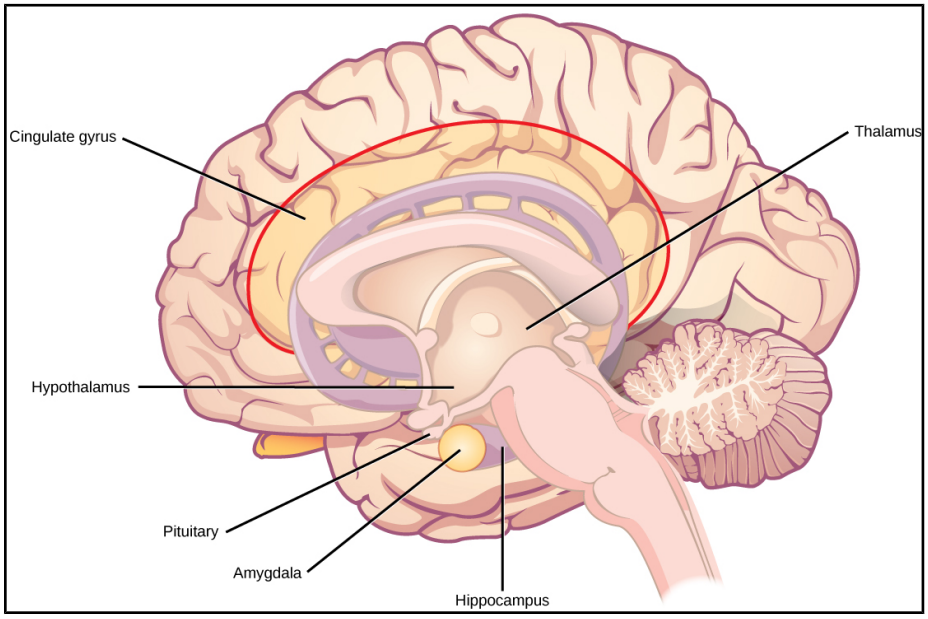
**Forebrain:**

It is considered to be the most important part of the brain because it performs all cognitive, emotional, and motor activities. We will discuss four major parts of the forebrain: hypothalamus, thalamus, limbic system, and cerebrum.

**Hypothalamus:**

The hypothalamus is one of the smallest structures in the brain, but plays a vital role in our behaviour.

It regulates physiological processes involved in emotional and motivational behaviour, such as eating, drinking, sleeping, temperature regulation, and sexual arousal. It also regulates and controls the internal environment of the body (e.g., heart rate, blood pressure, temperature) and regulates the secretion of hormones from various endocrine glands.



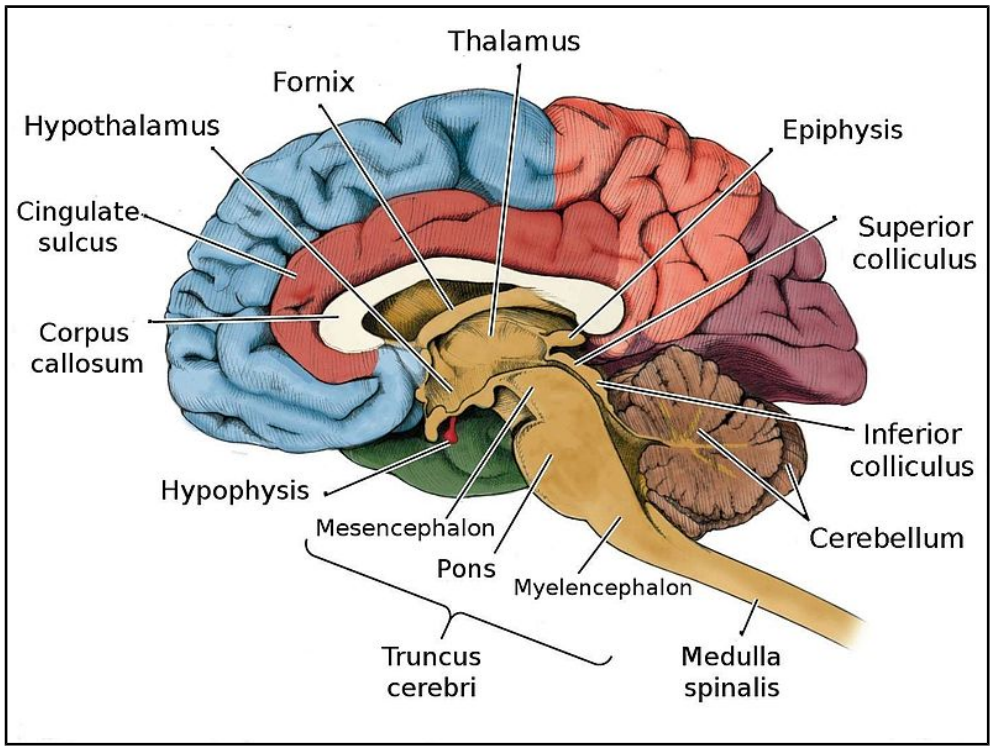

Source:https://upload.wikimedia.org/wikipedia/commons/4/48/Figure_35_03_06.jpg

One especially important role is that it activates the stress response, otherwise known as the ***fight or flight response***. It does this when it receives information from the amygdala to the effect that a threat is present. The hypothalamus not only directly activates the core of the adrenal gland, which sits above the kidney, to release adrenaline, but it also regulates the pituitary gland, which controls the release of the stress hormone cortisol. Because the hypothalamus also regulates the

relaxation response, by activating the parasympathetic system, it plays an important role in regulating whether or not stress response is activated. To the extent that one can maintain a relaxed state, the stress response will be prevented. This is why most therapies for stress and anxiety involve relaxation training.

**Thalamus:**

It consists of an egg-shaped cluster of neurons situated on the ventral (upper) side of the hypothalamus. It is like a relay station that recives all incoming sensory signals from sense organs and sends them to appropriate parts of the cortex for processing. It also recives all outgoing motor signls coming from the cortex and sends them to appropriate parts of the body.




Source:https://upload.wikimedia.org/wikipedia/commons/thumb/0/07/Brain_latino.jpg/1280px-Brain_latino.jpg

**Injury:**

If this part of the brain is damaged, all sensory information would not be processed and sensory confusion would result.

**The Limbic System:**

This system is composed of a group of structures that look like a border or a margin (or “limbus”) that form part of the old mammalian brain.

It helps in maintaining internal homeostasis by regulating body temperature, blood pressure, and blood sugar level. It has close links with the hypothalamus.

The limbic system comprises the Hippocampus and Amygdala.

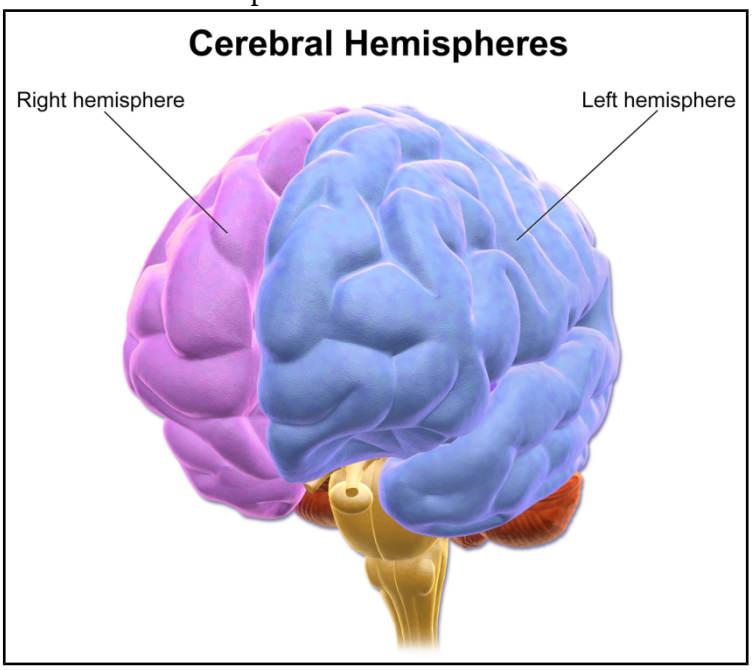
**Hippocampus:** The hippocampus primarily plays an important role in long-term memory.

**Amygdala:** The almond-shaped amygdala plays an important role in emotional behaviour.

**The Cerebrum:**

Also known as Cerebral Cortex, this part regulates all higher levels of cognitive functions, such as attention, perception, learning, memory, language behaviour, reasoning, and problem solving.

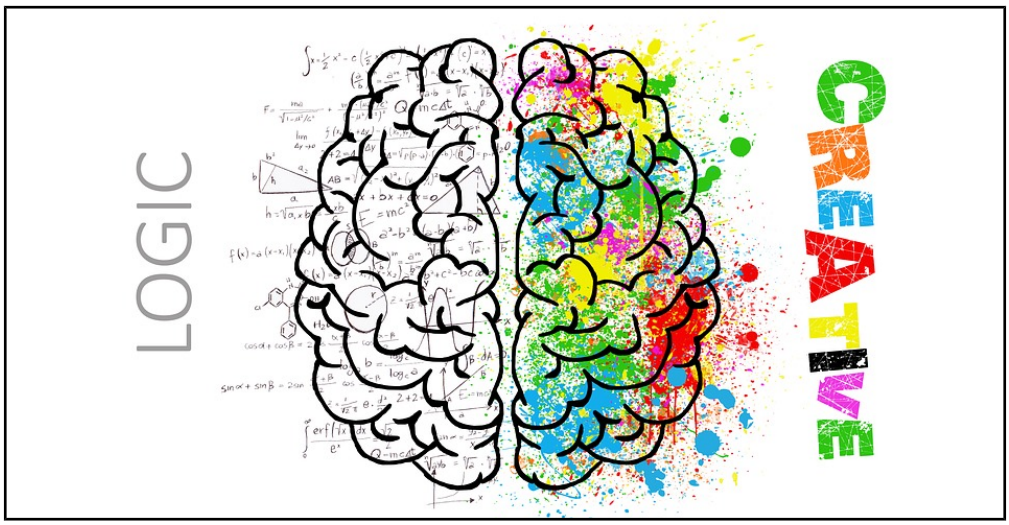
The cerebrum makes two-third of the total mass of the human brain. Its thickness varies from 1.5 mm to 4 mm, which covers the entire surface of the brain and contains neurons, neural nets, and bundles of axons. All these make it possible for us to perform organised actions and create images, symbols, associations, and memories. The cerebrum is divided into two symmetrical halves, called the Cerebral Hemispheres.




Source:https://upload.wikimedia.org/wikipedia/commons/0/01/Blausen_0215_CerebralHemispheres.png

Although the two hemispheres appear identical, functionally one hemisphere usually dominates the other. For example, the left hemisphere usually controls language behaviour. The right

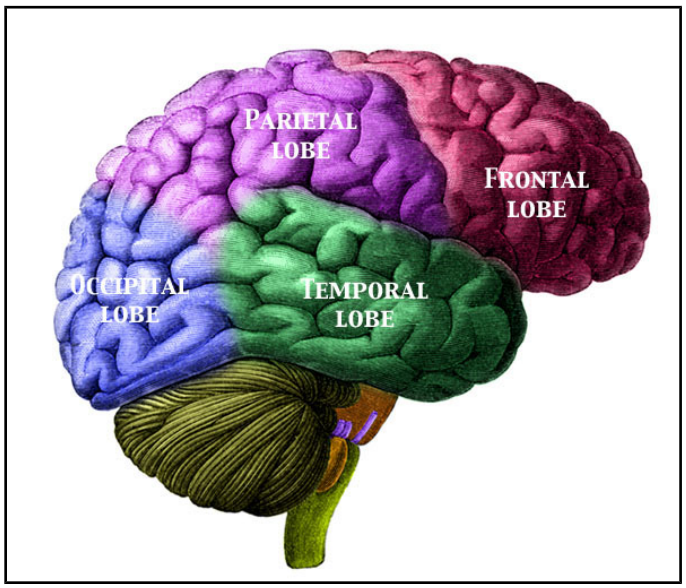
hemisphere is usually specialised to deal with images, spatial relationships, and pattern recognition. Theories that support that the left hemisphere is strictly for logic driven activities and the right hemisphere is entirely creativity driven are not entirely true.




Source: https://cdn.pixabay.com/photo/2017/02/13/08/54/brain-2062055_960_720.jpg

These two hemispheres are connected by a white bundle of myelinated fibers, called Corpus Callosum that carries messages back and forth between the hemispheres.

Cerebral cortex has also been divided into four lobes - Frontal lobe, Parietal lobe, Temporal lobe, and Occipital lobe.




Source:https://upload.wikimedia.org/wikipedia/commons/e/ed/BrainLobesLabelled.jpg

**The Frontal lobe** is mainly concerned with cognitive functions, such as attention, thinking, memory, learning, and reasoning, but it also exerts inhibitory effects on autonomic and emotional responses.

**Case Study: Phineas Gage**

On September 13, 1848, twenty-five year-old Phineas Gage was working with a blasting crew when he was in an accident that drove a tamping iron through his head. The rod entered through the left cheekbone, past his eye, and out the top of his head. He survived the trauma, but exhibited significant behavioral changes.

Source:https://upload.wikimedia.org/wikipedia/commons/0/00/Phineas_Gage_Cased_Daguerreotype_WilgusPhoto2008-12-19_Unretouched_Color.jpg

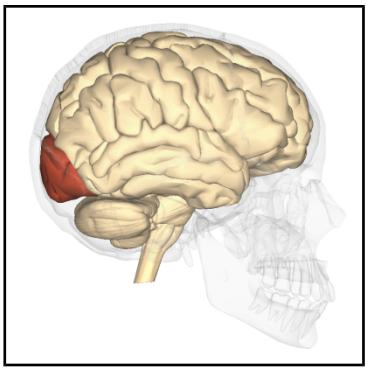
The frontal lobe takes time to develop fully, which is why children and young adults struggle with planning for the future.

**The Parietal lobe** is mainly concerned with cutaneous sensations and their coordination with visual and auditory sensations.

**The Temporal lobe** is primarily concerned with the processing of auditory information. Memory for symbolic sounds and words resides here.

The temporal lobe also contains the language area of the brain. Understanding of speech and written language depends on this lobe.

**The Occipital lobe** is mainly concerned with visual information. It is believed that interpretation of visual impulses, memory for visual stimuli and colour visual orientation is performed by this lobe. Here’s a look at things we know about the lobe... and things for you to wonder about!



Source:https://upload.wikimedia.org/wikipedia/commons/f/f8/Occipital_lobe_-_lateral_view.png

**Summarizing the parts of the brain**

**Spinal Cord**

The spinal cord is a long rope-like collection of nerve fibers, which run along the full length inside the spine. Its one end is connected with the medulla of the brain and another is free at the tail end. Its structure all along its length is similar.

Here's a look at its overall structure and function:

The butterfly shaped mass of grey matter present in the centre of the spinal cord contains **association neurons** (also called interneurons) and other cells. Surrounding the grey matter is the white matter of the spinal cord, which is composed of the ascending and descending neural tracts. These tracts (collections of nerve fibres) connect the brain with the rest of the body.

Here's a look at the cross section showing white matter, gray matter, sensory and motor neurons:

The spinal cord plays the role of a huge cable, which exchanges innumerable messages with the CNS. There are two main functions of the spinal cord.

- Firstly, it carries sensory impulses coming from the lower parts of the body to the brain; and motor impulses originating from the brain to all over the body.
- Secondly, it also performs some simple reflexes that do not involve the brain. Simple reflexes involve a sensory nerve, a motor nerve, and the association neurons of the grey matter of the spinal cord.