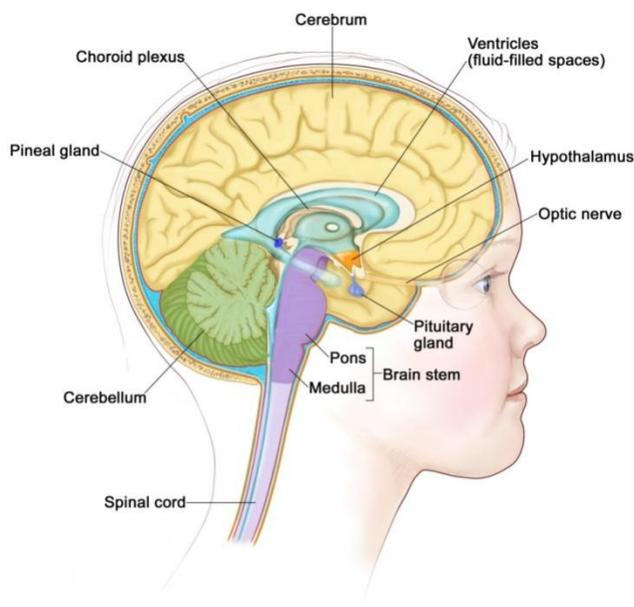


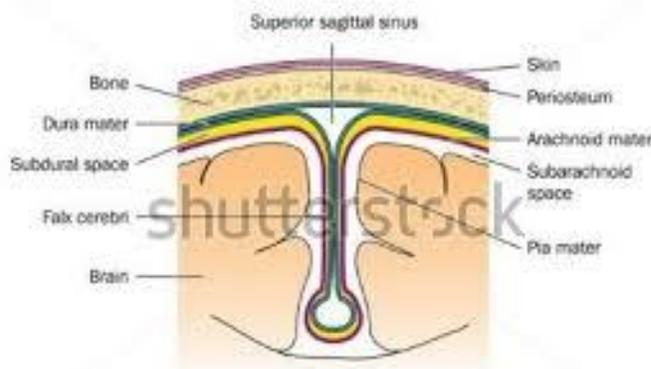
## Introduction to Nervous System

Human brain is the most important structure and the most complex organ of the body. Although all ancient civilizations and cultures have considered importance of Brain, very few accounts are available historically. In fourth century BC Indian medical maestros Shushruta and Charak have done surgeries on brain and written theses. The Egyptians are credited for first written accounts of anatomy of the brain, the meninges, and cerebrospinal fluid. The word “brain” appears on ancient papyrus like document ‘papyrus’ written by an Egyptian surgeon in around 1700 BC but based on year 3000 BC. This was then subsequently bought by an American Egyptologist Mr. Edwin Smith in 1862 from a dealer in Egypt. These were subsequently known as Edwin Smith Surgical Papyrus which is the first medical document in the history of mankind. This document mentions about cases of head injury probably due to falls during construction of monuments or buildings with the word “brain” appearing 7 times but with no mention of word “nerve”. Our understanding of brain has come a long way since then with “look into” brain imaging techniques such as magnetic resonance imaging (MRI) and positron emission tomography (PET). Numerous parts and functions of brain have been recognized but certain mysteries of mind still remain like why do we sleep? Or what is consciousness?

However still, human race is superior and special than other living creatures with extraordinary capabilities which are attributed to the brain’s unique anatomy and physiology of the human nervous system. The nervous system comprises of the brain, the spinal cord, and the emerging nerves with innervations of muscle fibers.

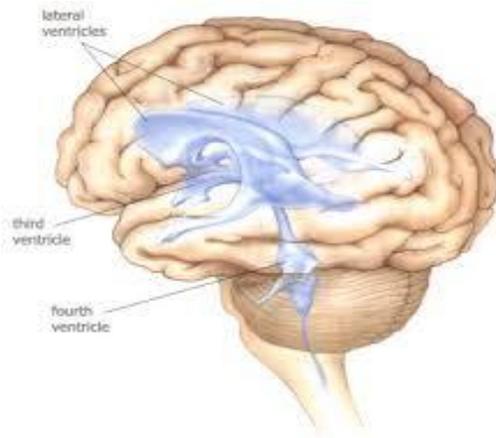


The brain rests securely inside the skull and is well protected by membranes called as Meninges that prevent friction between brain and skull. The sequence of meninges from outside to inside is ,thedura mater (literally the tough mother),arachnoid mater (spider like)and Pia mater(soft mother).



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The most evolved region of the brain, the neocortex, is responsible for exceptional mental powers with cognitive ability, logic, memory judgment, vocabulary, perception etc. The neocortex consists of outer layer of grey matter surrounding the deeper white matter of the cerebrum (with reversal of the arrangement in spinal cord).It consists of deep grooves(sulci) and wrinkles(gyri) in primates and many other mammals and accounts for 76% of the brain's volume. There are chambers inside the brain parenchyma known as Ventricles which are communicating network of cavities occupied with watery cerebrospinal fluid (CSF) and consists of two lateral networks, a third ventricle, the cerebral aqueduct and a fourth ventricle. The ventricles consist of choroid plexus that produce CSF that fills subarachnoid space other than the ventricular system and which is constantly reproduced and reabsorbed. The function of CSF is to prevent friction and to provide buoyancy to brain. Any infection or hemorrhage in brain can be conveniently diagnosed by examination of CSF extracted from spinal cord by a procedure called Lumbar Puncture.



The frontal lobe and the prefrontal cortex are the most advanced in humans even if compared to the intelligent primates like chimpanzees and orangutans. Interestingly a large size of head does not relate to increased intellectual functions and capabilities but the structure of brain does.

For the smooth functioning of the brain as many as 100 million neurons are provided along with 100 trillion synapses and one becomes highly adapted by frequent use of brain and taking up **challenging task**. The average weight of brain is 1200-1400 gms with a capacity of that can be compared to a storing of 90 million books each having 1000 pages, with generation of 30,000 thoughts a day. Although the brain weighs only 1 to 2% of total body weight it uses up approximately 25% of total O<sub>2</sub> intake of body weight and 70% of total glucose supply of the body. The lower group of chordate animals like urochordates, lancelets etc do not have developed organ like brain and don't feel qualitative pain.

The brain in fact, is extremely central to human survival and well-being so much so that death of brain is legally equivalent to death of a person.

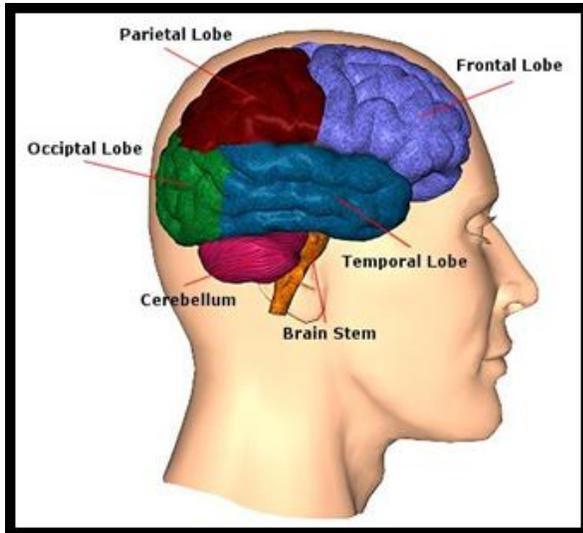
The brain can be divided into three parts-

### 1. The Cerebrum (large brain)

It occupies the larger portion of the skull. Being divided into two hemispheres, left and right, it is connected by corpus callosum, **which is a thick band of nerve fibers that allow communication between both hemispheres. The corpus callosum transfers motor, sensory and cognitive information between the brain hemispheres.** The cerebrum can be subdivided into four parts as:

- Frontal lobe ( The anterior part)
- Parietal lobes ( The lateral upper part)
- Temporal lobe ( The lateral lower part)
- Occipital lobe ( The posterior part)

The *frontal lobe* is responsible for the movements of the opposite limbs, language, the personality and behavior of an individual. The *parietal lobe* controls emotions and is connected with mathematical powers and is responsible for analyzing particular sensations from opposite side of body. The *temporal lobe* and limbic system are associated with memory, **auditory, visual, olfactory functions and others like emotional and social feelings**. *Occipital lobe* is associated with processing center in brain for vision and color recognition.



## 2. The Cerebellum (small brain)

It is located in the posterior region of the base of skull **just above the brain stem where spinal cord meets the brain** and is divided into two left and right parts and its primary function is to maintain equilibrium of the body. **It receives information from the sensory systems, the spinal cord and other parts of brain and then controls motor movements.**

3. The brain stem connects the two sides of the brain and consists of mid brain, pons and medulla oblongata that truncate into the spinal cord.

The right half of brain controls the motor and sensory function of the left half of body and vice versa. The left brain is involved in controlling the linguistic expressive ability, mathematical and logical ability. The right half is related to sensitivity, creativity, imagination, face recognition etc. The phenomena of right handedness in majority of people can be related to evolutionary role with newer researches mentioning about variant gene that determines handedness.

**Conventionally, the functions of the brain that are usually attributed to the psyche /mind are: thoughts, emotions, desires, behavior, attitude and ego.**

The fact that mind conventionally works in duality by changing its stand on issues and also is unstable by wondering about time, place and person makes it dynamic and complex in its functions.

The location of psyche (mind/ 'mana') in the brain is controversial and was thought to be present in each and every cell of the body. There were certain beliefs that the mind exists in either temporal lobe, limbic circuit or in the pineal gland of the brain but there is no proof of anatomical location for the mind/'mana'. It is rather a commonly applied descriptive term for the operation of brain.

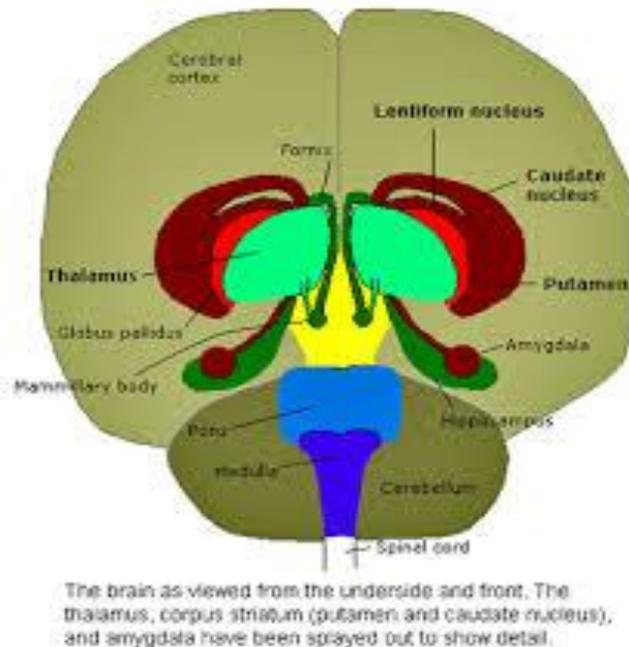
The location of psyche (mind/'mana') can be based on a secular model and is intimately connected with the body and is an extension that is not separate from body. It is related to the functioning of the brain associated with human personality and behavior that makes choices of human existence or living a way of life. **The secular model was developed by advanced researches by Sigmund Freud a psychologist, Karl Marx, a sociologist, and Jean-Paul Sartre, an existentialist philosopher.** The spiritualist people call conscious as the soul but there is still no perfect evidence and understanding. The current mental health disciplines of psychiatry, psychology, nursing and social work have implemented a model based on these secular trends known as bio-psycho-social model.

Based on this model, emotional problems and mental illness can be diagnosed and treated based on psychological, biological and social approach to the problem.

In current technological savvy world the mind can be simply related to software and brain as the hardware of a computer and can be labeled as an interface between brain and consciousness. Spiritualistic people label consciousness as the soul and but the science has its own limits and hence cannot understand the concept of 'soul'. The science mostly accepts the consciousness and does not accept the existence of soul, its rebirth and its function as spiritualists do.

The human brain consists of important cellular clusters namely the thalamus and the Basal ganglia and any alteration of chemicals in which may cause diseases like Parkinson's disease, Chorea, dystonia etc. which are explained in detailed in later chapters. Similarly, Hypothalamus is important center and a final control point of sympathetic and the parasympathetic nervous system that controls functions of involuntary muscles as well as physical processes like stress. This type of nervous system has autonomic control over heart, intestines, eyes, blood pressure, respiration etc. The pituitary gland is the master controller of all endocrine glands which is located in the brain and has amazing regulation over the entire hormonal system of the body. Presence of certain neurotransmitters like Dopamine, Noradrenalin, GABA, Serotonin, Acetylcholine, Endorphin and Enkephalin in the brain and the entire nervous system help in transmission of to and fro impulses that communicate through a series of receptors as discussed elsewhere. These neurotransmitters have been linked to specific emotions or functions. Dopamine is a molecule of reward as well as motor movement, Noradrenalin for drive,

GABA for peace and tranquility, Serotonin for mood and confidence, Acetylcholine for memory, Endorphin and Enkephalin for pleasure and happiness.



Twelve pair of nerves arises from either side of the brain that are termed as cranial nerves. They regulate extremely important functions like smell, sight, facial muscles and movements of the tongue.

- The 1<sup>st</sup> nerve is labeled as Olfactory nerve, which provides information to the brain about smell.
- 2<sup>nd</sup> nerve is called the Optic nerve. It provides information related to sight to the brain from its site of origin on the retina of the eye. Damage to this part of brain may result in disorders of vision with or without blindness.
- 3<sup>rd</sup>, 4<sup>th</sup>, and 6<sup>th</sup> nerves are called as Oculomotor, Trochlear and Abducens respectively. These nerves innervate muscles of the eye ball that help in movement of eyeball and may cause double vision if any of these nerves are affected.
- 5<sup>th</sup> nerve is called Trigeminal nerve, and any disorder of its function causes weakness of facial and jaw muscles or loss or improper interpretation of sensations on the face. The

painful sensation on this area is called Trigeminal neuralgia. There may be altered sensations of taste due to malfunction of this nerve.

- 7<sup>th</sup> nerve is called Facial nerve and if paralyzed, causes distortion of the face with improper closure of eye on that side of face. The most common disease is called Bell's Palsy.
- 8<sup>th</sup> nerve is called Vestibulocochlear nerve and its damage results in deafness or loss of body equilibrium which presents as vertigo or fainting.
- 9<sup>th</sup> and 10<sup>th</sup> nerves are Glossopharyngeal and vagus respectively and their main function is swallowing food, phonation and aiding function of laryngeal muscles. Vagus nerve also regulates many involuntary activities of the body and hence is a very important part of the Autonomic Nervous System.
- 11<sup>th</sup> nerve is called Accessory nerve and controls muscles of the neck whereas the 12<sup>th</sup> nerve is called Hypoglossal nerve that makes the muscles of the tongue function properly.

These 12 nerves originate from the brain at particular sites and reach appropriate destination. The nerves which carry sensations (sensory nerves) originate from sites like ears, eyes etc. that reach the brain whereas the nerves that carry impulses from brain to muscles (like muscles of eyeball, facial muscles) are called motor nerves.

Movements of the body are carried out by three systems chiefly, which is explained in detail in later chapters.

The brain's anatomy is not only unique but has other features that make the man exceptional amongst other living beings. There is a kind of electrical impulses that are emitted from the cells of the brain and are rhythmic and persistent that forms an electrical process. These impulses travel chemically across one nerve cell to the other through neurotransmitters and receptors forming amazing network and can transmit information from one part to another in 1000<sup>th</sup> fraction of a second. The electric impulses of the brain can be detected on an EEG (Electroencephalogram). The electric impulse generated by posterior part of brain during the alert state but with closed eyes is known as  $\alpha$  waves (Alpha) with frequencies of 8-13 Hz. Normally, the frontal cortex generates  $\beta$  waves (beta) rhythm measuring 14-40 Hz. The  $\theta$  (theta) activity can be detected in temporal regions measuring 4-7 Hz, which are more developed in children. The  $\delta$  (delta) activity in an adult is always considered abnormal and is linked usually with organic disorder of brain but can be normally noted in children when they are asleep.

The brain cells like any other cell of the body handle their own metabolism like any other biological process. As mentioned earlier, the human brain is endowed with distinct features of thinking, intelligence, ability to discriminate between good and bad, memory, creativity, etc. The brain is the seat where basic human emotions like care, anger, like/dislike and instinctive drives like hunger, sleep, fear, reproduction, self-preservation etc. are governed. Sensation of vision, taste, smell, touch and hearing are under command of the brain.

Moreover the gift of communication helps us to express our thoughts and ideas easily and explicitly. All these features of brain cannot be found anywhere on this earth, not even in the man-made super computers. The marvelous thing is that we ourselves can think about the features of brain and analyze it but the One who has created humans has discreetly left humans in dark about Him/ Her our creator, another limitation of science.

**These sections provide a broad framework of basic concept and terms necessary to understand fundamental process of functions of brain.**

In the past few decades, mental maladies are being recognized as problems of the brain and many therapeutic agents have emerged for their successful treatment. There are certain facts about brain like the person who we are is encoded in our brain and any major changes in thought ,mood and behavior of this brain results in mental illness. The key issue is not whether mental illness exists really in neural form but the nature of neural change that underlies the mental problems and the manner in which treatment should be undertaken.

**The following paragraphs try to explain the intricacies and function of brain in a little depth-**

The origin of certain neurological disturbances like epilepsy can be understood, by understanding neurons and their method of communication. The nervous system comprises as you know, of the brain,the spinal cord, the nerves emanating from their innervations of muscle fiber(i.e. peripheral nervous system). The brain is made up of unlimited complexities because even though a human brain weighs only 1200 to 1400 grams ,it contains about 100 billion neurons and 100 trillion synapses(meaning each neuron talks to several other neurons at any given point of time).Although that extraordinary number is of the same order of magnitude as the number of stars in the Milky Way, it alone cannot account for the complexity of the brain. A major part of the complexity arises from the rich diversity of nerve cells, or neurons, which the famous neuroanatomist Ramon Y Cajal described as “the mysterious butterflies of the soul”.

The basic building blocks of brain are Neurons or nerve cells. A neuron consists of three main parts – a cell body containing nucleus, dendrites which are specialized branches for receiving information from other neurons, and axons which are specialized branches for sending out information to other neurons. Neurons which are excited convey information to other neurons by generating electrical impulse called ‘action potential’. Here the signals propagate down the length of cell’s single axon and are converted to chemical signal. At synapses, the contact point which is between Dendrites of one neuron with axons of the other (usually), the impulse reaches the axon terminals of pre-synaptic neuron and induces release of “neurotransmitters” which are brain chemicals.

Neurotransmitters(NTs)

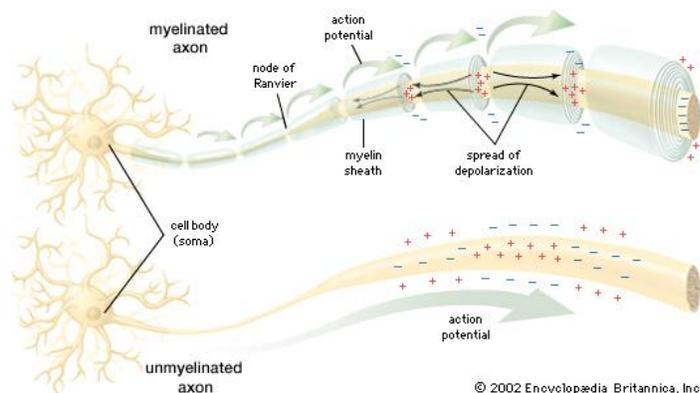
As mentioned earlier, neurotransmitters are brain chemicals, packed in small sac at the ends of axons which help in transmission of information from neuron to neuron. They diffuse across the synaptic gap (cleft), bind to their specific receptor located on the next neuron and cause opening of certain ion channels, which in turn, generates a new action potential in the next neuron. This is how a neuron communicates. The released Neurotransmitter determines the type

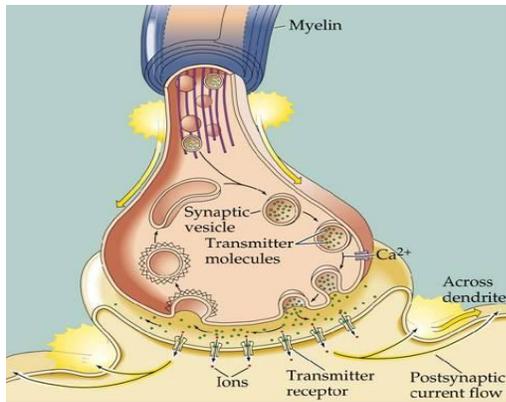
of ion – channels that will open up. Scientists have found a large variety of NTs that are found in an adult brain. But the predominantly important ones are:-

- Epinephrine
- Non- Epinephrine (NE)
- Dopamine
- Acetyl- Choline (ACh)
- Serotonin

NTs like ACh& epinephrine have an excitatory effect and NE & dopamine have an inhibitory effect, Excitatory in the sense, that the release of these NTs will “enhance” processing of certain information. While the inhibitory effect, would, of course mean that the release of those NTs will see significant decrease as altogether, inhibiting that process. The excess of/absence of neurotransmitter may undermine, to a big extent, the formation or regression of memories, the learning processes, alertness, pleasure and also in development of certain neurological and psychological disorders. Like, for instance, low levels of secretion of dopamine causes development of Parkinsonism(explained in detail in later chapters). Similarly depression is usually associated with reduced level of serotonin.

### The propagation of action potential



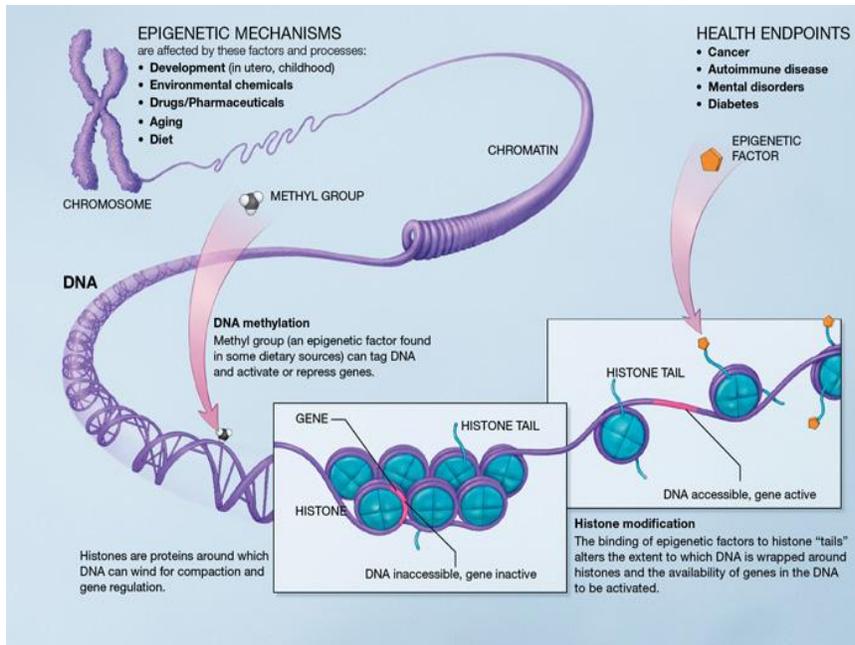


It is now a well-established fact that DNA (deoxyribonucleic acid) is the key to the transfer of hereditary information from parents to offspring. 'Genes' are the smallest segments of a piece of information located along the length of DNA.

Hence other than familial traits, certain genetic disorders are also inherited if they are expressed in previous member of the family. For example, epilepsy, a disorder in which the electrical discharge of the neurons shoot up to higher than normal levels seems to be having genetic origin, just like schizophrenia, anxiety and many others.

The genetic endowment of an individual determines predisposition to certain familiar traits along with the key role played by the environment, in the expression or non-expression of these genes. Alzheimer's disorder, a neurological age related condition in which the memory seems to fade, seems to be due to a genetic pattern. However vigorous exercises of the brain, activities that bolster the use of brain can appreciably delay the onset.

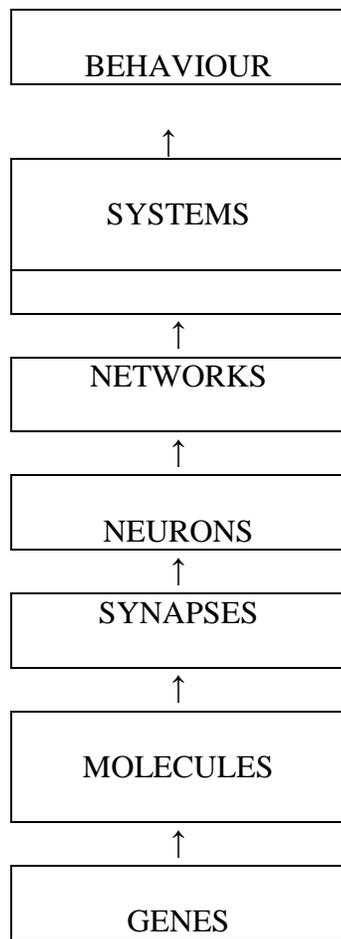
It's interesting to know the way in which genes can influence behavior with molecule and synapse playing an important role:



## Levels of Neural Organization

It is interesting to know the way in which genes can influence behavior, with molecule and synapses playing an important role.

BEHAVIOUR  
SYSTEMS  
NETWORKS  
NEURONS  
SYNAPSES  
MOLECULES  
GENES



Neuroscience has rapidly emerged as a frontier area of cutting - edge research due to major discoveries at all of these levels of investigation - starting from psychiatry at one end to molecular neurobiology and neurogenetics at the other. All these resources have become extremely useful in treatment of psychological and neurological disorders.

### **Man & Woman: Different Wiring?**

If confronted by a tough situation, the response of a man and that of a woman to face it differs visibly. But to say that the difference in gender causes difference in logic, thinking pattern, in other words, projection of the gender difference in brain, is controversial. Moreover that it is debatable because of the fact that this sexual identity and associated behavioral patterns are not well- defined or compartmentalized in the brain.

Previous studies have found behavioral differences between men and women. For example, women may have better verbal memory and social cognition, whereas men may have better motor and spatial skills, on average. Brain imaging studies have shown that women have a higher percentage of gray matter, the computational tissue of the brain, while men have a higher percentage of white matter, the connective cables of the brain. But few studies have shown that men's and women's brains are connected differently.

According to a study, the inferior parietal lobe of a male was found to be about 6% larger than a female. This area accounts for the spatial relationship, examining mathematical problems and estimating time and speed. Also the tendencies of appearance of certain disorders like dyslexia, autism, mental retardation may be seen higher in male than in female.

Estrogen levels in women, seems to be playing an important role in memory. Women deprived of estrogen experience memory lapses that disappear on administration of this hormone.

## **COMMON DISEASES :**

**After understanding the basics of the brain, we will now classify the common diseases of the brain and nervous system:**

1. Altered Consciousness-Loss of the cognitive state of the brain like coma, loss of Consciousness etc.
2. Epilepsy -excessive electrical stimulus
3. Stroke (i) Interruption in blood supply to the brain; Paralysis  
(ii) Rupture of Blood vessel in the brain; Hemorrhage ,bleeding
4. Brain Trauma- Injuries to the brain due to trauma like concussion, Contusion
5. Brain Tumor Meningioma, Gliomas
6. Infective diseases of the Meningitis-Abscess brain (Non-viral)
7. Viral diseases of the brain -Encephalitis, AIDS
8. Diseases of the White matter of the Brain - Demyelinating disease e.g. Multiple Sclerosis(MS)
9. Nutritional deficiency, Metabolic Encephalopathy hormonal or metabolic diseases
10. Congenital diseases - Phakoma, mental retardation, deformities of brain
11. Degenerative diseases of the brain –Parkinsonism, Alzheimer,dementia and other Degenerative disorders
12. Diseases of the spinal cord- Myelopathy
13. Neuropathy diseases- Neuropathies Acute inflammatory demyelinating polyneuropathy (AIDP), Leprosy of the nerves
14. Diseases of the muscles- Myopathy
15. Myasthenia Gravis etc.

The above mentioned diseases are known as neurological disorders that can be handled by a neurologist or an experienced physician.

Diseases of the psyche (mana) are called psychiatric disorders e.g. depression, anxiety, psychosis, neurosis, personality problem, psychosexual diseases etc. which have to be treated by a qualified psychiatrist. Normally in psychiatric diseases reports of certain investigations like CT

scan, E.E.G. and Lumbar Puncture have normal findings. Many a times there can be similar symptoms creating confusion for e.g, a change in the personality of a patient may either be due to depression or can be due to brain tumor of frontal or corpus callosum region. This can result in serious lapse in diagnosis. Therefore, in each psychiatric case a detailed history as well as a thorough examination of the nervous system is essential. If in doubt, it is always better to get a test or two (like MRI Brain or E.E.G) done, rather than label the patient a psychiatric case in haste. Fortunately, such errors are extremely rare.

At times head injuries in cases of road accidents, fall from a height, or injury due to objects may demand emergency treatment. In such cases it is essential that the patient is immediately shifted to a public or private hospital without wasting any time, and given emergency treatment by a neurosurgeon. Moreover all operations related to the brain as well as spinal cord require a neurosurgeon.

The various diseases of the brain are explained in detail, in the subsequent chapters. The above mentioned psychiatric disorders being out of context are not discussed in this book.

**Finally, a most important point** – It has been observed from experience that, though timely, correct diagnosis and proper medications are important for curing a patient, there are **other equally important factors** to bring a patient to a **state of total healing & health. This is known as holistic approach. In my experience, Healing is much more important than cure of the symptoms. It is much beyond a game of chemicals.** Unfortunately this concept has not been given enough importance in modern medicine.

It is important for the patient to have **faith** in his doctor and have **will power, a desire to live, a positive attitude** and a **disciplined and simple lifestyle**, for a quick and complete recovery. This apart, the **sympathy of the doctor** towards his patient, his **honest dedication** towards his profession as well as his **skill and high character** are vital. Also the caring attitude and kindness of nursing staff in the ward are equally important. The **care and warmth** offered by family members, friends and relatives, the **prayers**, the social atmosphere of the home are quite useful in healing process. Further accurate **information** about the disease also plays role of a road map and hence is important in restoration of the health of the patient.

#### **‘Must Know points’/ Take Home Point :**

- There is a network of 100 billion nerves in the human brain. Weight of the brain is 1200-1400 grams.... It is estimated that we underutilize our brain. According to some assumption, an average human utilizes only around 3-12 % of the brain. Some tips are given in chapter 10 to improve memory.
- There are three main parts of brain: Cerebrum (major brain), Cerebellum (minor brain) and brain stem. 12 nerves emanate from both sides of the brain.
- The basic building blocks of brain are Neurons or nerve cells consisting of axons and dendrites with neurotransmitters playing important role in carrying nerve impulses.
- Left side of brain regulates function of right side limbs whereas right side brain regulates function of left side of body.
- If there is cessation of circulation of blood and oxygen to the brain for more than 5 minutes, the person may die.
- Pituitary gland located in the lower part of the brain controls all the hormones of the body.

- Rhythmic electrical impulses are generated from neurons of the brain. These can be studied by a test called E.E.G.

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