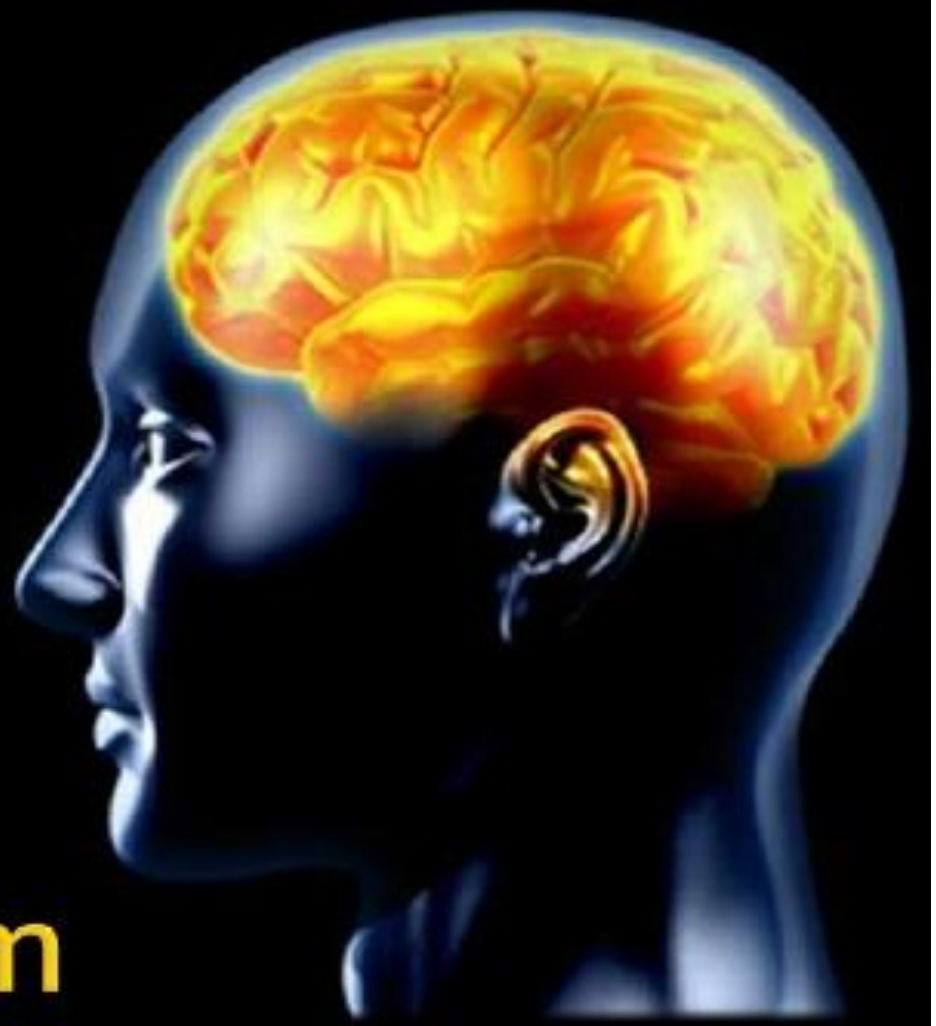
The Nervous System



An overview of brain development

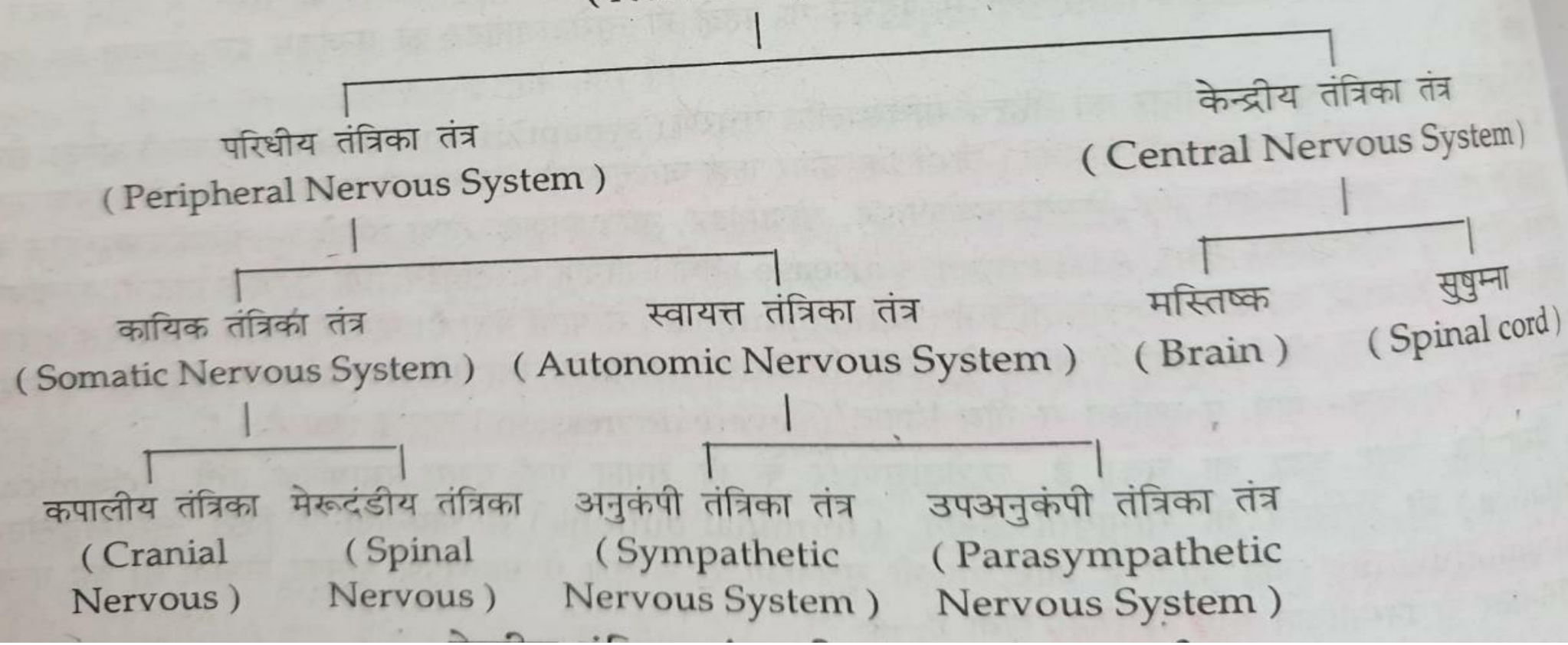
Development of the nervous system begins around the 18th day after conception.

Part of the ectoderm (outer layer) of the back of the embryo thickens and forms a plate.

The edges of this plate form ridges that curl toward each other along a longitudinal line, running rostral- caudal direction.

by the 21st day these ridges touch each other and fuse together, forming a tube- the neural tube that gives rise to the brain and spinal cord.

तालिका 2-B: तंत्रिका तंत्र का विभाजन (Division of Nervous System)



By the **28th day of development** the neural tube is closed, and its rostral end has developed three interconnected chambers. these chambers become ventricles, and the tissue that surrounds them becomes the three major parts of the brain: **the forebrain, the midbrain, the hindbrain.**(fig 3.5 a and 3.5 c)

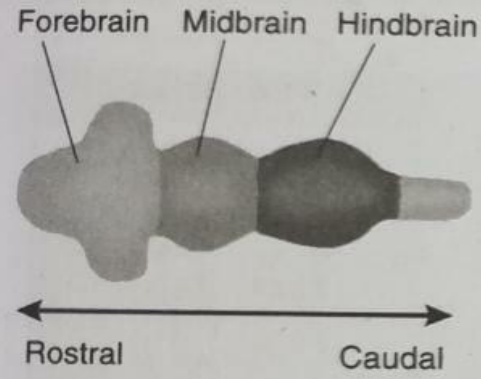
as development progresses, the **rostral chambers (the forebrain)** divides into three separate parts, which become the **two lateral ventricles** and the third ventricle.

the **region around the lateral ventricles become the telencephalon (end brain)**, and the **region around the third ventricle becomes the diencephalon (interbrain)**. (fig 3.5 b and 3.5 d)

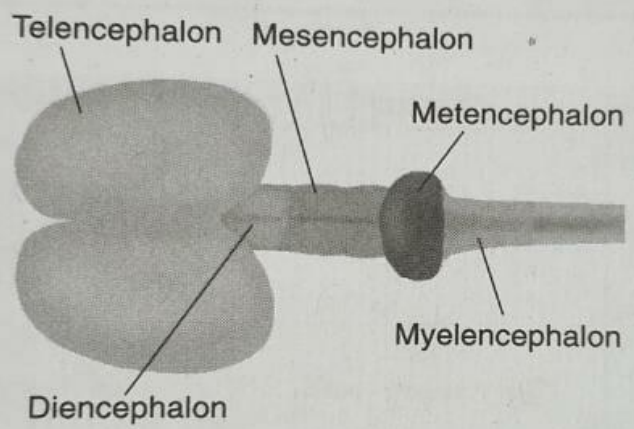
In its final form, the chamber inside the **midbrain (mesencephalon)** becomes narrow, forming the cerebral aqueduct, and two structures develop in the hindbrain: the **metencephalon (afterbrain)** and the myelencephalon **(marrowbrain)** (fig 3.5 e)

Figure 3.5

A schematic outline of brain development, showing its relation to the ventricles. (a) and (c) Early development. (b) and (d) Later in development. (e) A lateral view of the left side of a semitransparent human brain, showing the brain stem "ghosted in." The colors of all figures denote corresponding regions.



(a)



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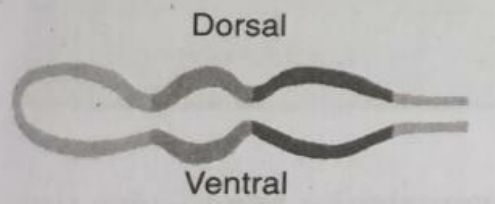
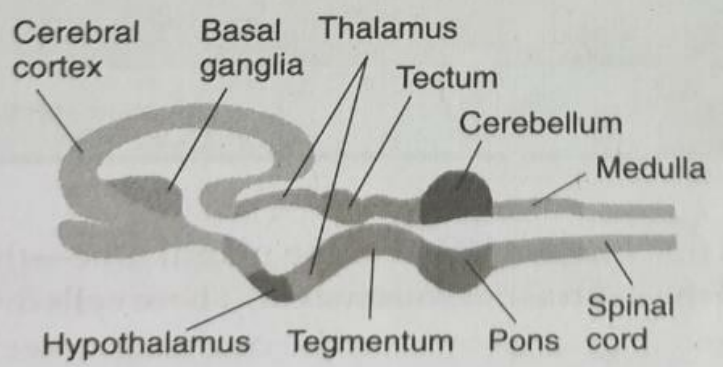
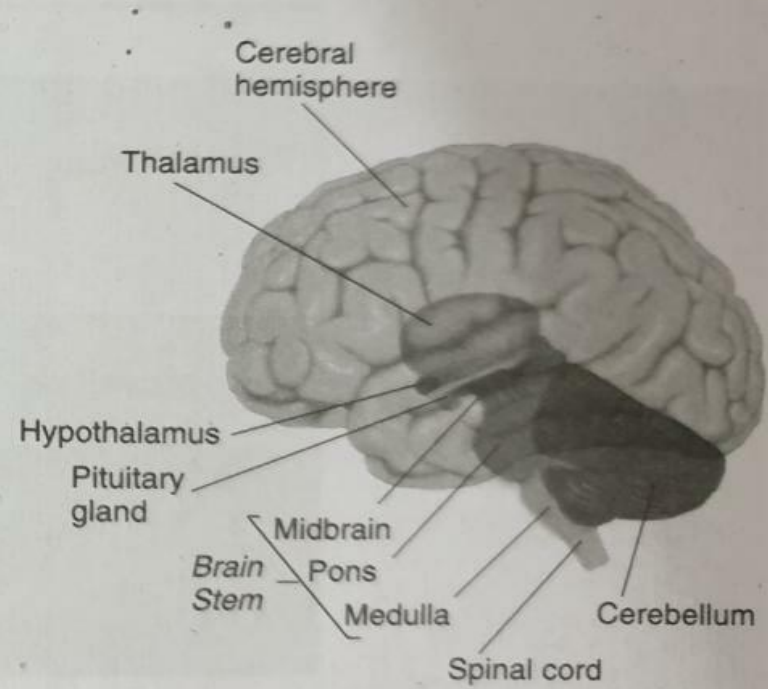


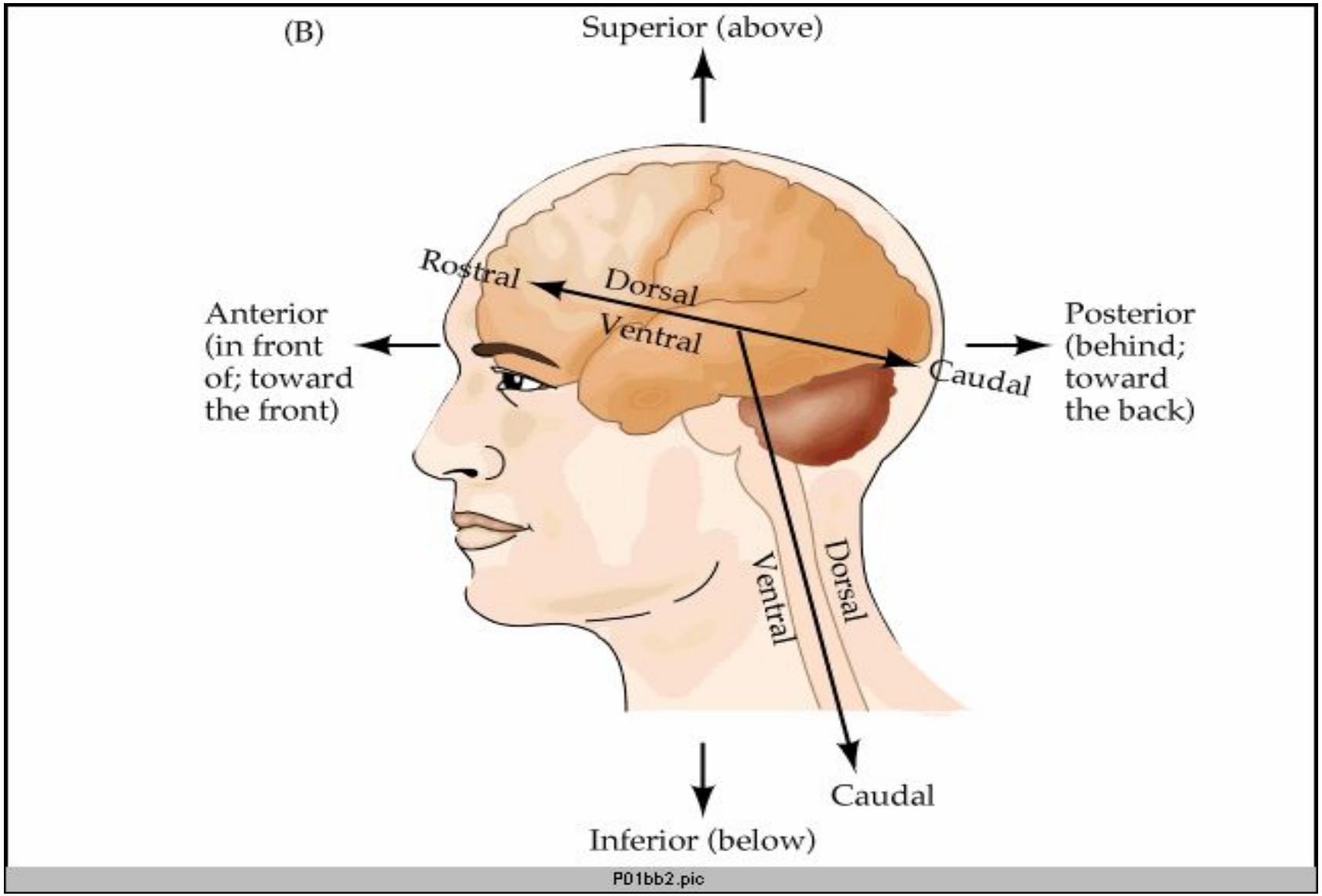
(c)



(d)



(e)


(B)
Superior (above)
Rostral
Dorsal
Ventral
Anterior
(in front
of; toward
the front)
Posterior
(behind;
toward
the back)
Caudal
Ventral
Dorsal
Caudal
Inferior (below)
P01bb2.pic

According to evolution

Central core- Midbrain and hindbrain- cerebellum, pons, medulla, midbrain, reticular formation. brain stem. thalamus, hypothalamus.

Limbic system-

Cerebral hemispheres- cerebrum- left and right hemispheres. part of forebrain.

Brain

Meninges- protective sheet

outer layer- Dura mater

inner layer- pia mater

between these layer- Arachnoid- membrane

In arachnoid membrane- Cerebrospinal fluid

Function of this fluid- shock absorber, mediator of nutrients between blood vessels and brain tissues.

naked eye- grey color and white color. white because of myelin sheath. grey because of cells.

Details of Brain Development

Brain development begins with a thin tube and ends with structure weighing approximately 1400 g and consisting of several hundreds of billions of cells.

the cells that line the inside of the neural tube- **the ventricular zone**- gives rise to the cells of the central nervous system.

Cortex means "**bark**". and the cerebral cortex. approx 3 mm thick, surrounds the cerebral hemispheres like the bark of a tree.

corrected for body size, the cerebral cortex is larger in humans than in any other species.

circuits of neurons in the cerebral cortex plays a **vital role in cognition and control of movement.**

The cerebral cortex develops from the inside out.

According to the position

Forebrain- Thalamus, hypothalamus, cerebrum

Midbrain

Hindbrain- medulla, pons, cerebellum, reticular formation

Last two are consider in brain stem.

According to the neuroscientist

Myelencephalon- spinal cord part, medulla oblongata- breathing, heart activities.

Metencephalon- pons and cerebellum- balance

Mesencephalon- Tectum and Tegmentum

Diencephalon- Thalamus and hypothalamus

Telencephalon- Highest division- forebrain- limbic system and cerebral cortex are part.

The Forebrain

- the forebrain surrounds the rostral end of the neural tube. its **two major components** are the **telencephalon and the diencephalon.**

TELENCEPHALON

- The **telencephalon includes most of the two symmetrical cerebral hemispheres that make up the cerebrum.**
- The cerebral hemispheres are covered by the **cerebral cortex** and contain the **limbic system** and the **basal ganglia.**
- these convolutions, consisting of **sulci (small grooves)**, **fissures (large grooves)**, and **gyri (bulges** between adjacent sulci or fissures), greatly enlarge the surface area of the cortex, compared with a smooth brain of the same size.
- The **cerebral cortex consists mostly of glia and cell bodies, dendrites, and interconnecting axons of neurons.**
- because **cells predominate**, the cerebral cortex has a grayish brown appearance, and it is called **gray matter.** millions of axons run beneath the cerebral cortex and connect its neurons with those located elsewhere in the brain. the **large concentration of myelin** around these axons gives this tissue an opaque white appearance- hence the term **white matter.**

Cerebrum

largest part of brain.

Longitudinal fissure- left and right hemispheres.

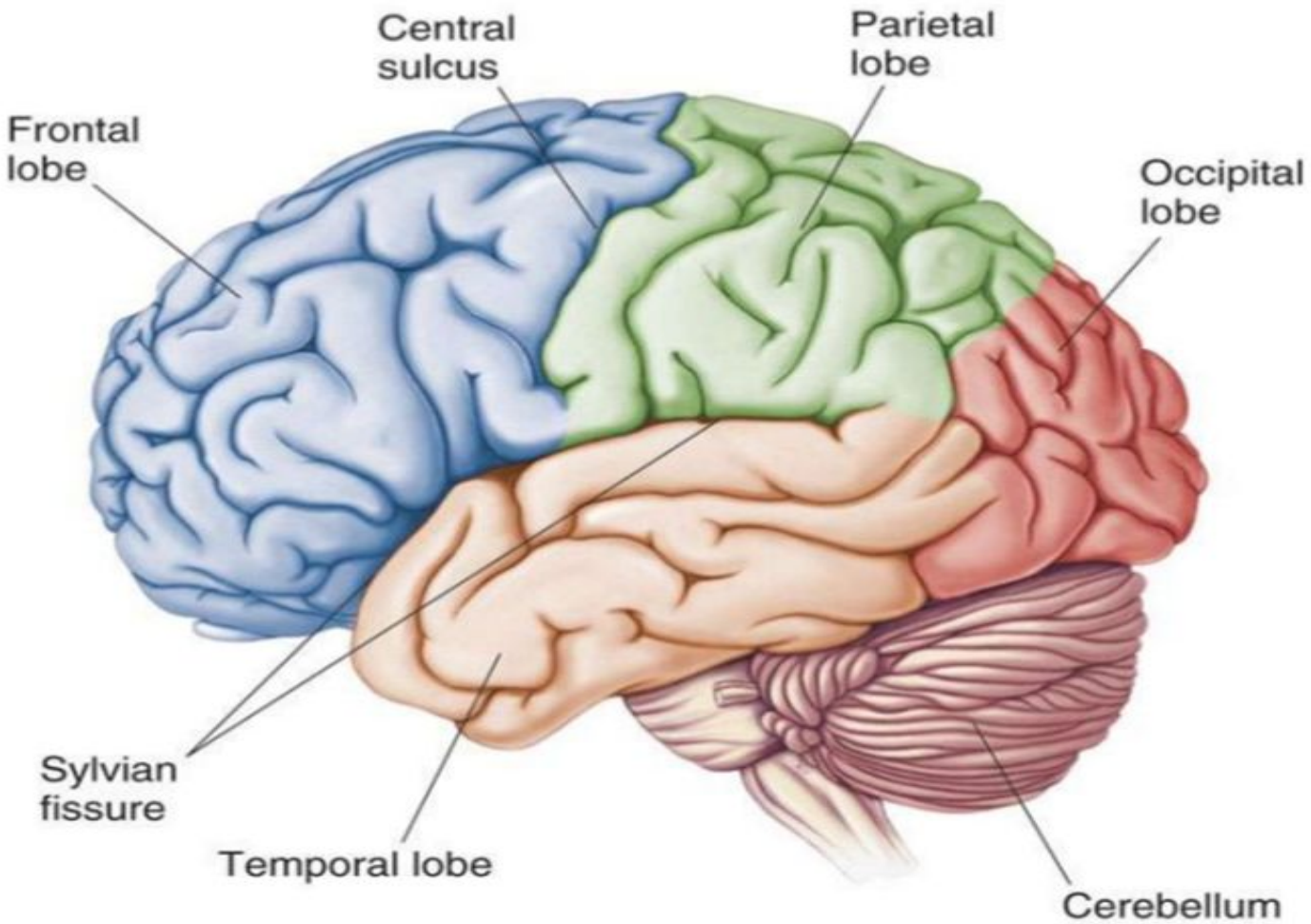
Broadman divided cortex in 44 different area on the base of differences in cellular architecture. For e.g. 17, 18, 19 are visual area.

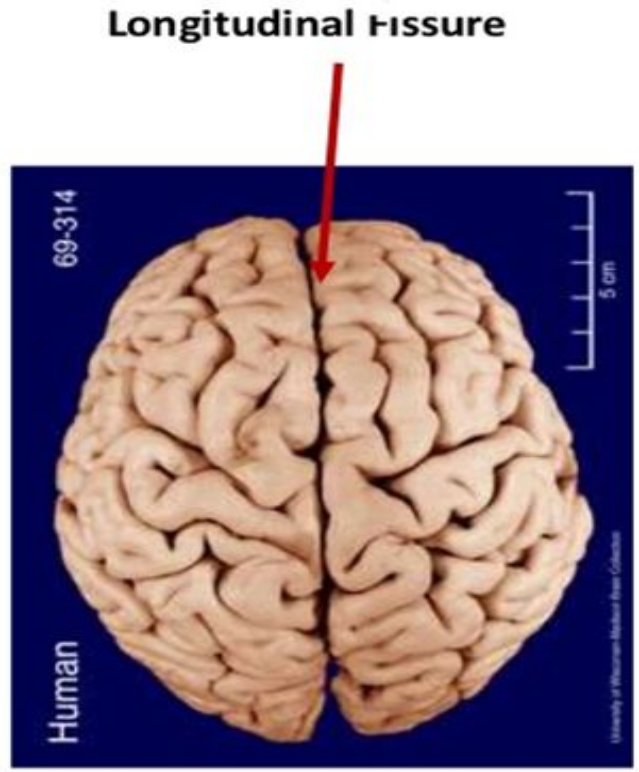
each hemispheres have two deep fissures that is **fissures of Ronaldo or central sulcus**, and **fissure of sylvius or lateral fissure.**

central sulcus and lateral fissure divide cerebrum in four lobes:

Frontal lobe- ahead of central sulcus and above lateral fissure. motor activities and higher thought processes, consist of motor cortex, Broca's area, frontal association area.

Lobes of the Brain



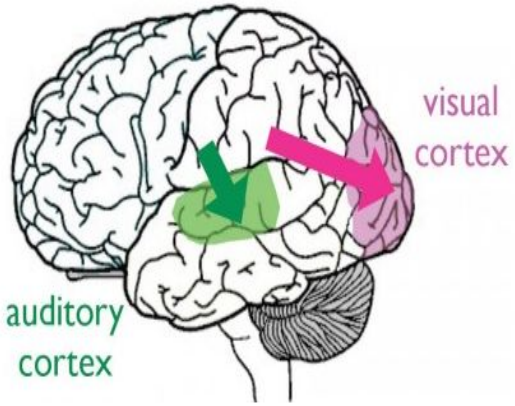


Parietal lobe- Back of central sulcus and above of lateral fissure. Main functions are bodily sensations and knowledge of direction.

Temporal lobe- below lateral fissure, auditory sensations. there is wernicke's area, temporal association area.

Occipital lobe- back part, visual sensation

Sensory Cortex



primary visual cortex & primary auditory cortex & Somatosensory Cortex

Different regions of the cerebral cortex perform different functions.

three regions receives information from the sensory organs.

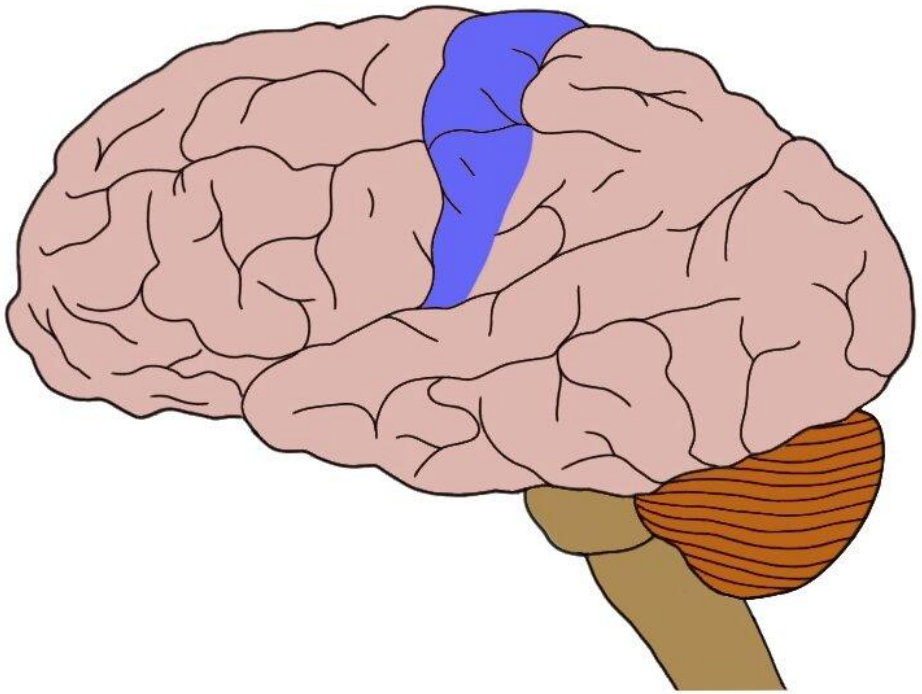
The **primary visual cortex**, which receives visual information, is located at the back of the brain, on the inner surfaces of the cerebral hemispheres.

with the exception of olfaction and gustation (taste), sensory information from the body or the environment is sent to primary sensory cortex of the contralateral hemisphere.

the primary somatosensory cortex of the left hemisphere learns what the right hand is holding, the left primary visual cortex learns what is happening toward the person's right.

The **primary auditory cortex**, which receives auditory information, is located on the upper surface of a primary somatosensory cortex, a vertical strip of cortex just caudal to the central sulcus, receives information from the body senses.

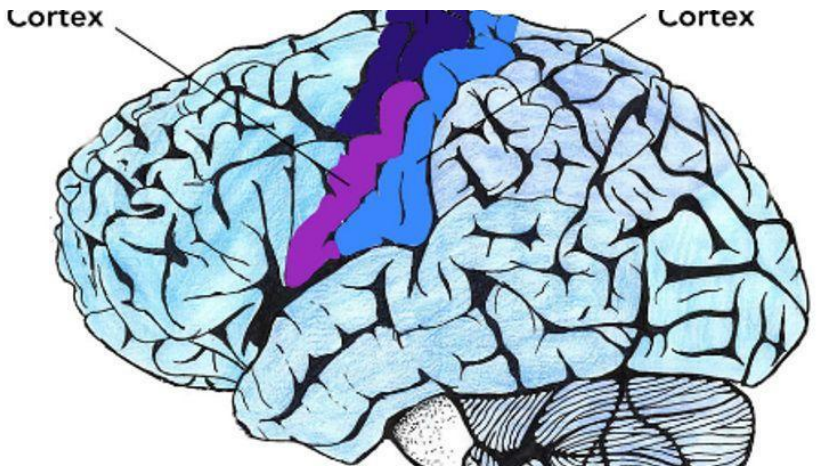
somatosensory area- skin sensations like touch, pain, temperature, pressure. it is situated in parietal lobe.



Motor Cortex

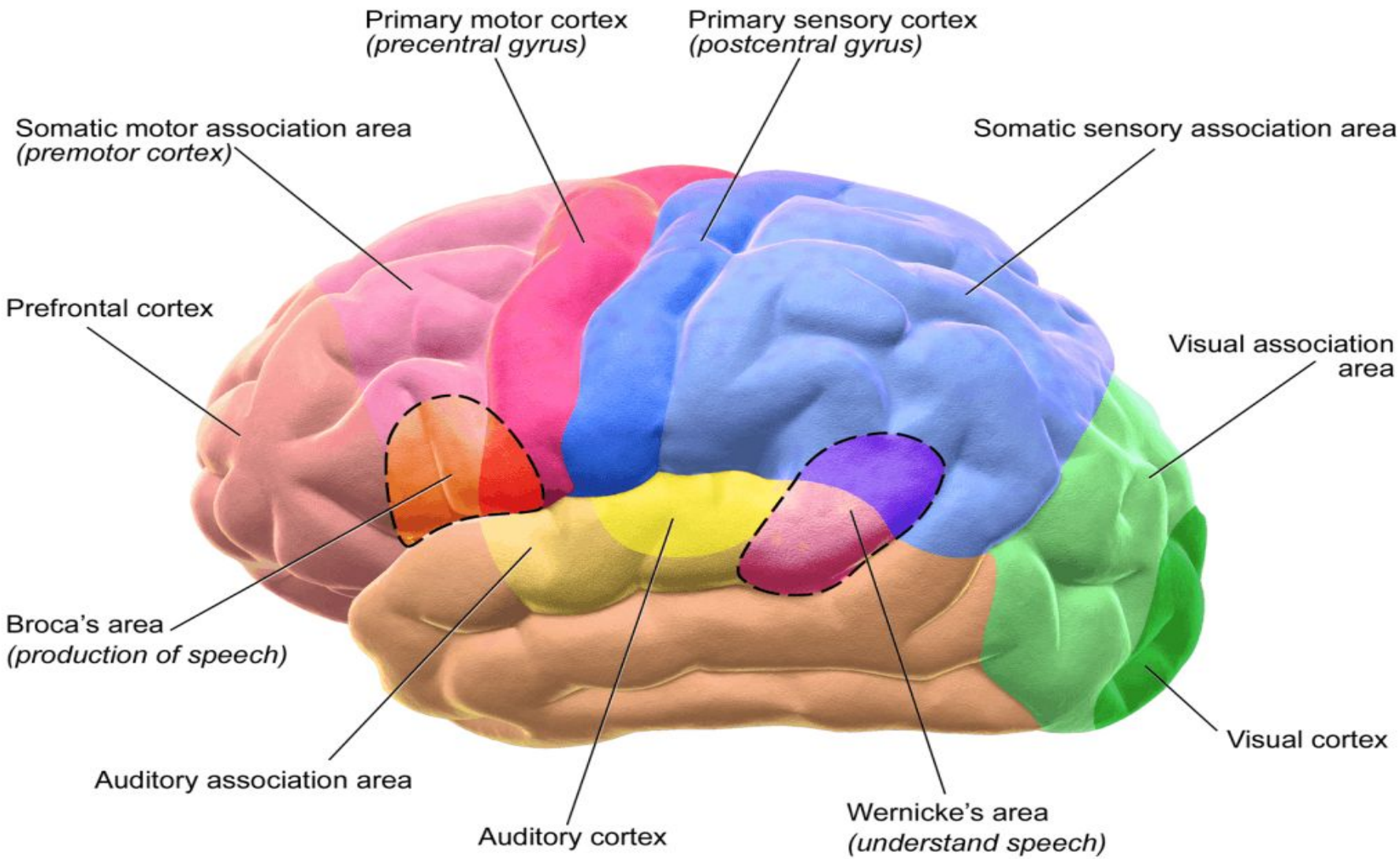
The region of the cerebral cortex that is most directly involved in the control of movement is the **primary motor cortex**, located just in front of the primary somatosensory cortex.

if a surgeon places an electrode on the surface of the primary motor cortex and stimulates the neurons there with a weak electrical current, the result will be movement of a particular part of the body. moving the electrode to a different spot will cause a different part of the body to move.

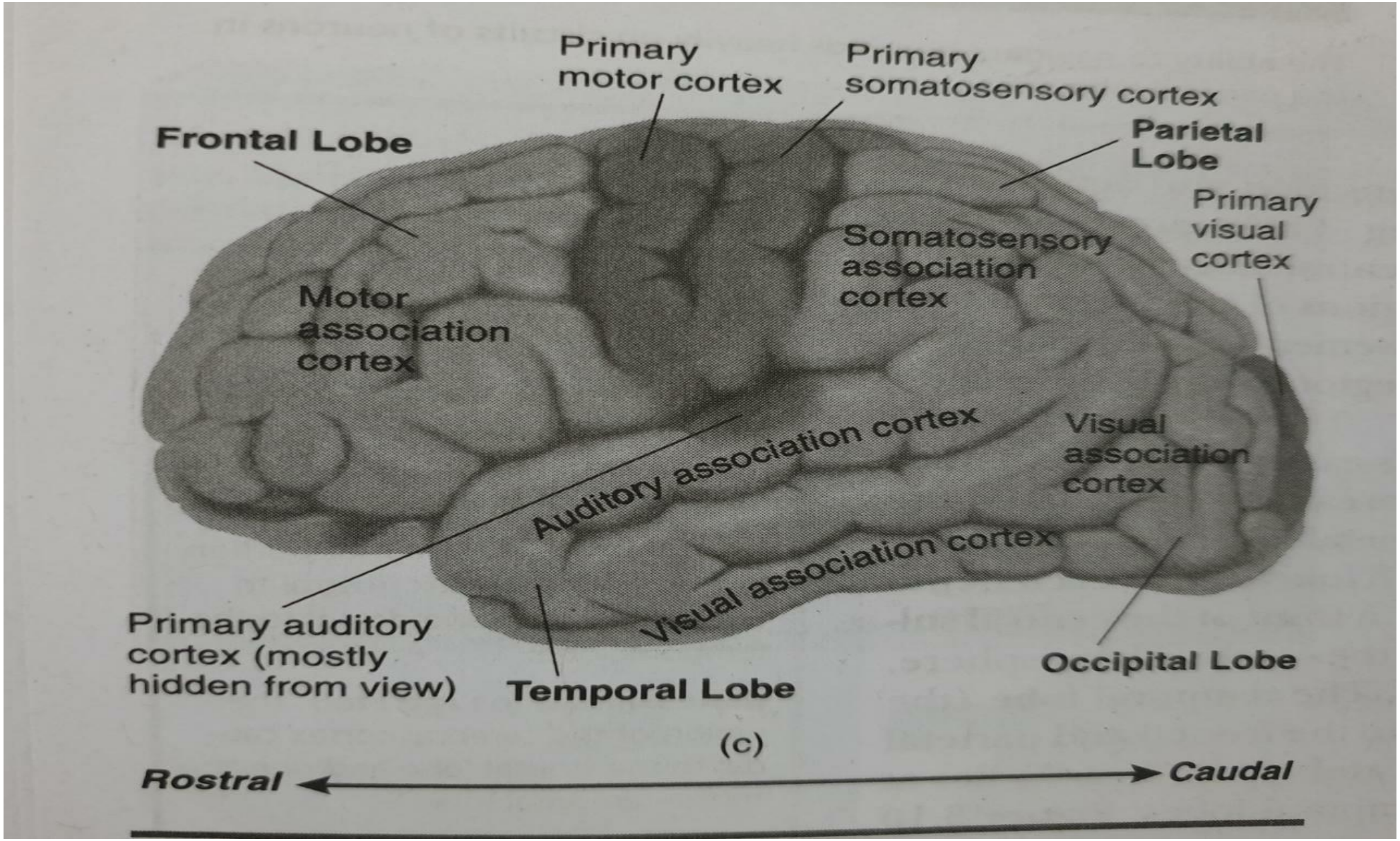


- The regions of the primary sensory and motor cortex occupy only a small part of the cerebral cortex.
- the rest of the cerebral cortex accomplishes what is done between sensation and action: perceiving, learning and remembering, planning and acting.
- these process take place in the **association areas** of the cerebral cortex
- each primary sensory area of the cerebral cortex sends information to adjacent regions, called the **sensory association cortex.**
- Circuits of neurons in the sensory association cortex analyze the information received from the primary sensory cortex; perception takes place there, and memories are stored there.

Motor and Sensory Regions of the Cerebral Cortex



- if people sustain **damage to the somatosensory association cortex**, their **deficits are related to somatosensation** and to the environment. for eg. they may have difficulty perceiving the shapes of objects that they can touch but not see, they may be unable to name parts of their bodies, or they may have trouble drawing maps or following them.
- **destruction of primary visual cortex** causes **blindness**. although people who sustain damage to the visual association cortex will not become blind, they may be **unable to recognize objects by sight**.
- people who sustain **damage to the auditory association cortex** may have **difficulty perceiving speech** or even **producing meaningful speech of their own**
- if who sustain **damage to regions of the association cortex** at the junction of the three posterior lobes, where the somatosensory, visual, and auditory functions overlap, may have **difficulty reading or writing.**


Primary motor cortex
Primary somatosensory cortex
Frontal Lobe
Parietal Lobe
Primary visual cortex
Somatosensory association cortex
Motor association cortex
Auditory association cortex
Visual association cortex
Visual association cortex
Primary auditory cortex (mostly hidden from view)
Temporal Lobe
Occipital Lobe
(c)
Rostral
Caudal

Hemispheres

- Although the two cerebral hemispheres cooperate with each other, they do not perform identical functions.
- some functions are **lateralized- located primarily on one side of the brain.**
- the **left hemispheres** participates in the **analysis of information**- the extraction of the elements that make up the whole of an experience. the serial functions that are performed by the left hemispheres include verbal activities, such as talking, understanding the speech of other people, reading and writing.
- the **right hemispheres** is specialized for **synthesis**; it is particularly good at putting isolated elements together to perceive things as a whole. for eg. ability to draw sketches, read maps.

Corpus Callosum

- the two cerebral hemispheres perform somewhat different functions, our perceptions and our memories are unified. this unity is accomplished by the corpus callosum, a large bundle of axons that connects ,corresponding parts of the association cortex of the left and right hemisphere.
- because of the corpus callosum, each region of the association cortex knows what is happening in the corresponding region of the opposite of the brain.

Midsagittal view of the brain

the brain and part of the spinal cord has been sliced down the middle, dividing it into two symmetrical halves.

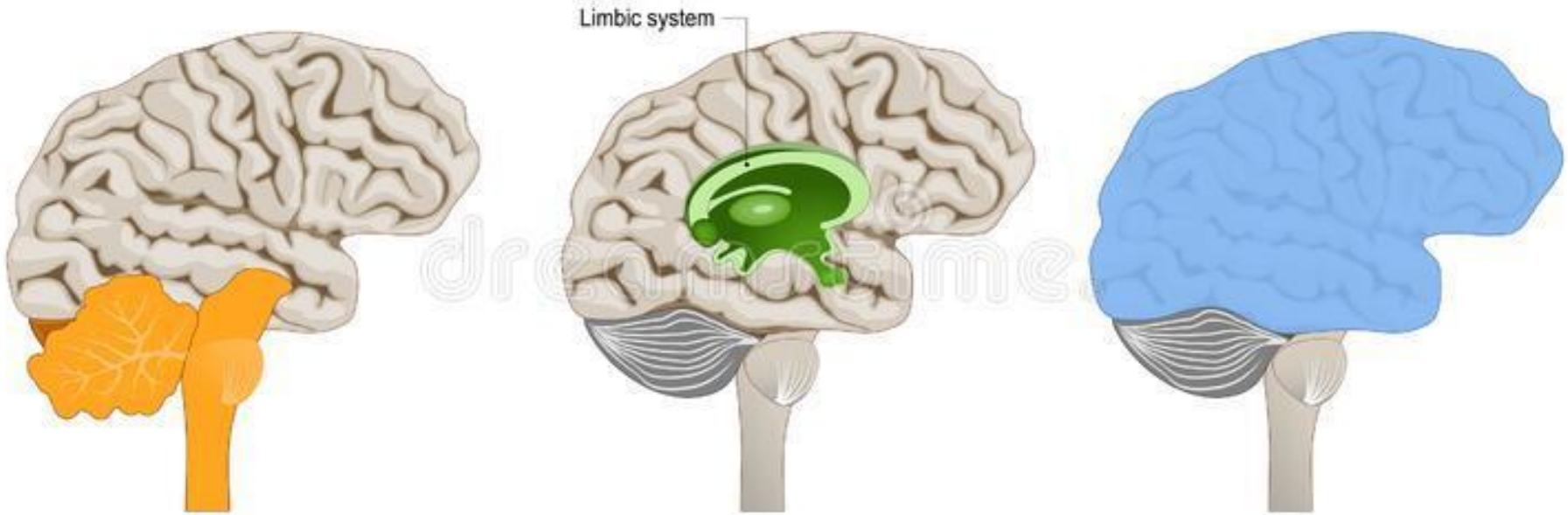
the left has been removed, so the inner surface of right can be seen.

the cerebral cortex that covers most of the surface of the cerebral hemispheres (including the frontal, parietal, occipital and temporal lobes) is called the **neocortex.**

Another form of cerebral cortex is the **limbic cortex**, is located around the medial edge of the cerebral hemispheres. (limbus means border)

the **cingulate gyrus**, an important region of the limbic cortex lying along the groove separating the cerebral hemispheres just above the corpus callosum.

The triune brain hypothesis



REPTILIAN COMPLEX

typical instinctual behavior, aggression, and dominance

PALEOMAMMALIAN COMPLEX

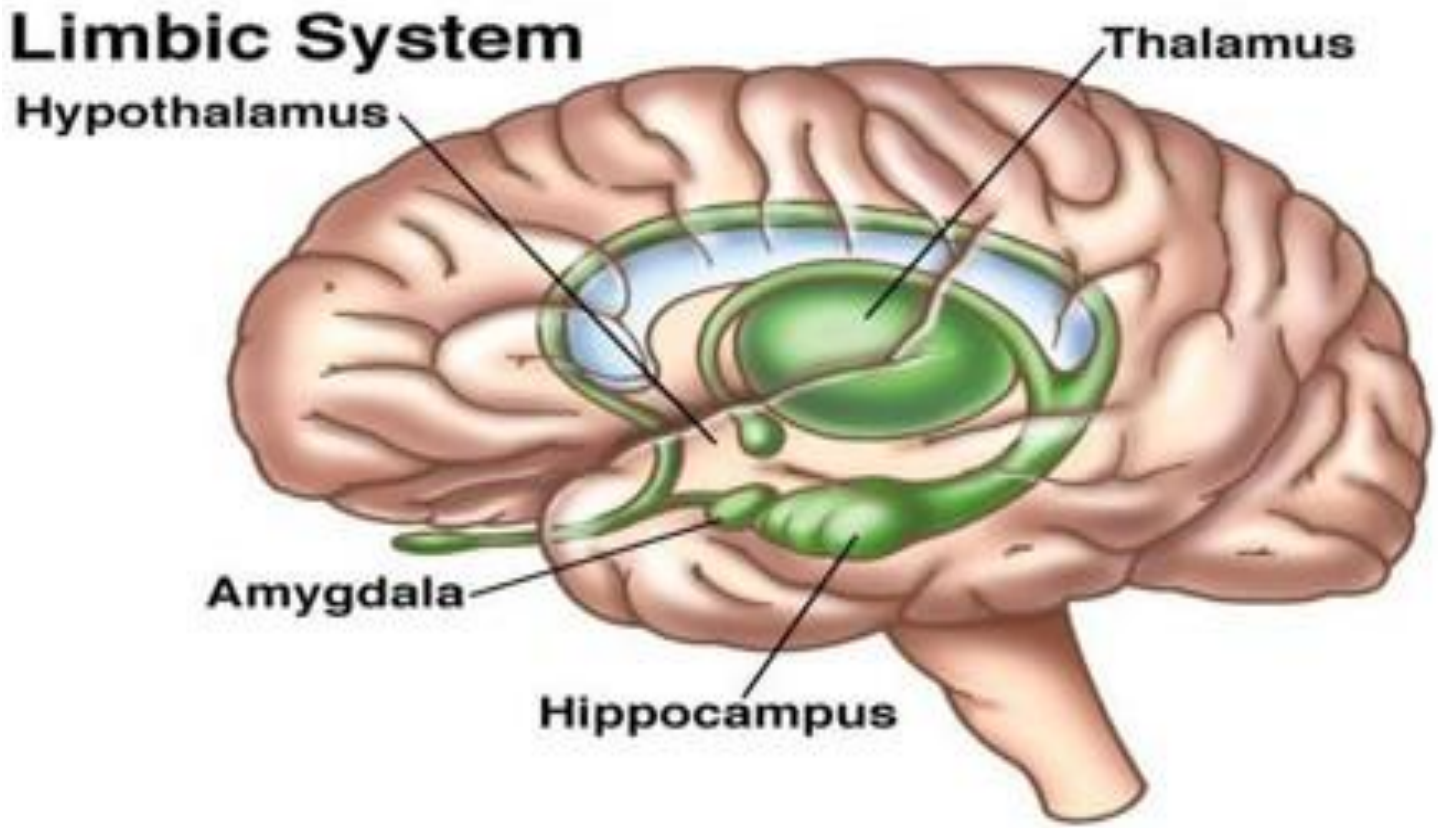
motivation and emotion, reproductive behavior, and parental behavior

NEOMAMMALIAN COMPLEX

ability for language, abstraction, planning, and perception

Limbic system

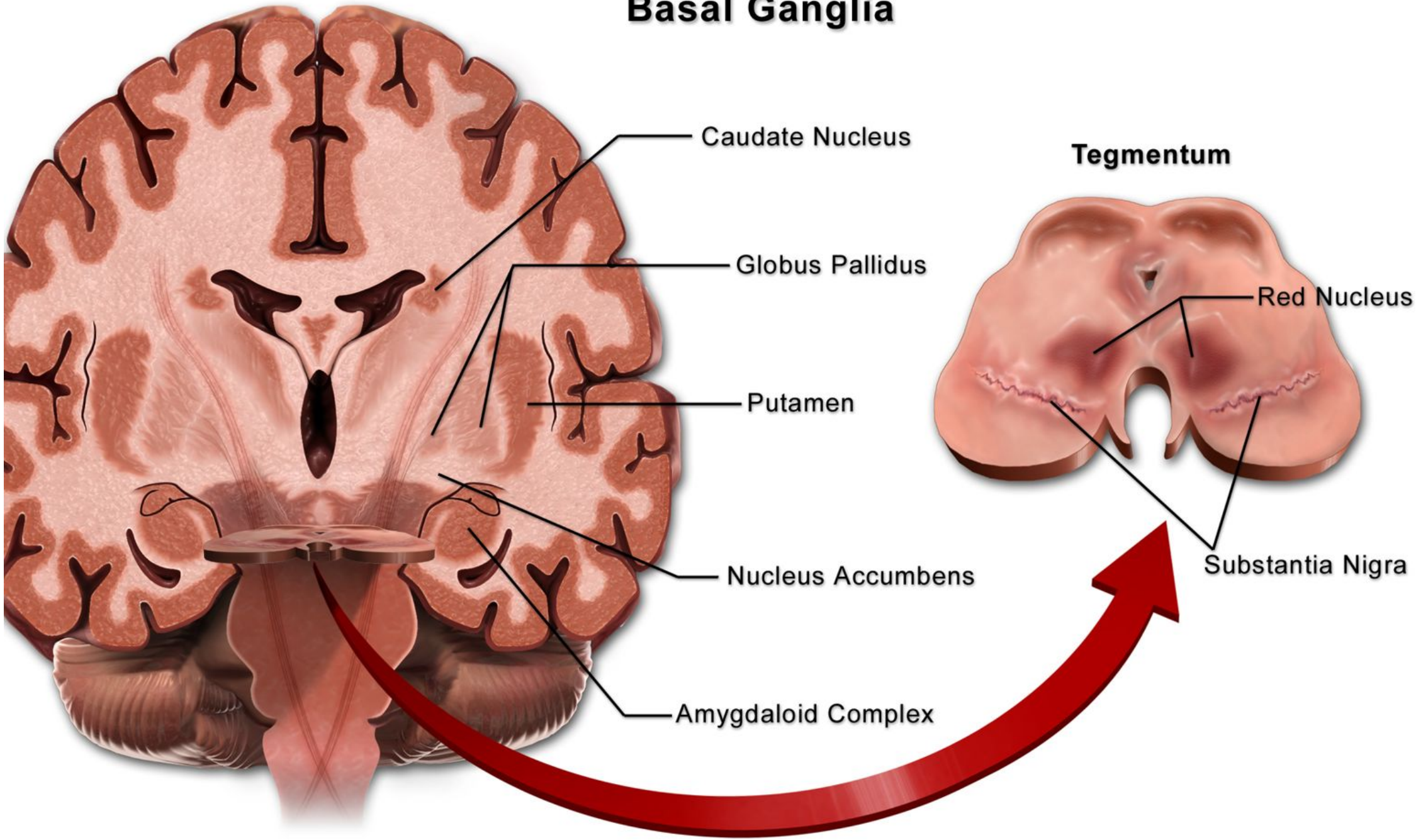
- A neuroanatomist, Papez (1973), suggested that a set of interconnected brain structures formed a circuit whose primary functions was motivation and emotion.
- A physiologist **MacLean (1949)**, exploded the system to include other structures and coined the term limbic system.
- the most important parts of the limbic system are the hippocampus (sea horse) and the amygdala (almond).
- the parts of the limbic system (notably the hippocampal formation and the region of limbic cortex that surrounds it) are involved in learning and memory.
- **the amygdala and some regions of limbic cortex are specifically involved in emotions: feelings and expression of emotions, emotional memories, and recognition of the signs of emotions in other people.**
- **olfactory bulb- smell brain**
- **septal area, amygdala, cingulate gyrus- conduction and control of emotional behavior**
- **Hippocampus- memory**


Limbic System
Thalamus
Hypothalamus
Amygdala
Hippocampus

Basal Ganglia

- The basal ganglia are a collection of subcortical nuclei in the forebrain that lie beneath the anterior portion of the lateral ventricles.
- the major parts of the basal ganglia are the **caudate nucleus**, the **putamen** and the **globus pallidus** (the nuclei with a tail, the shell, pale globe) and part of **amygdala.**
- the basal ganglia are involved in the **control of movement.**
- for eg. **Parkinson disease** is caused by degeneration of certain neurons located in the midbrain send axons to the caudate nucleus and the putamen.
- the symptoms of this disease are of weakness, tremors, rigidity of the limbs, poor balance, and difficulty in initiating movements.

Basal Ganglia



Diencephalon

The second major division of the forebrain, the diencephalon is situated between the telencephalon and the mesencephalon.

its two most important structures are the **thalamus and the hypothalamus.**

Thalamus- Greek word meaning bedroom. also called as relay station or switch board. The thalamus is a small structure within the brain located just above the brainstem between the cerebral cortex and the midbrain and has extensive nerve connections to both. the primary function of the thalamus is to relay motor and sensory signals to the cerebral cortex. it also regulates sleep, alertness and wakefulness. There are three nuclei in which one nuclei is sensory- which plays important role in sensory processes like visual, hearing, pain, temperature, touch, taste, smell etc.

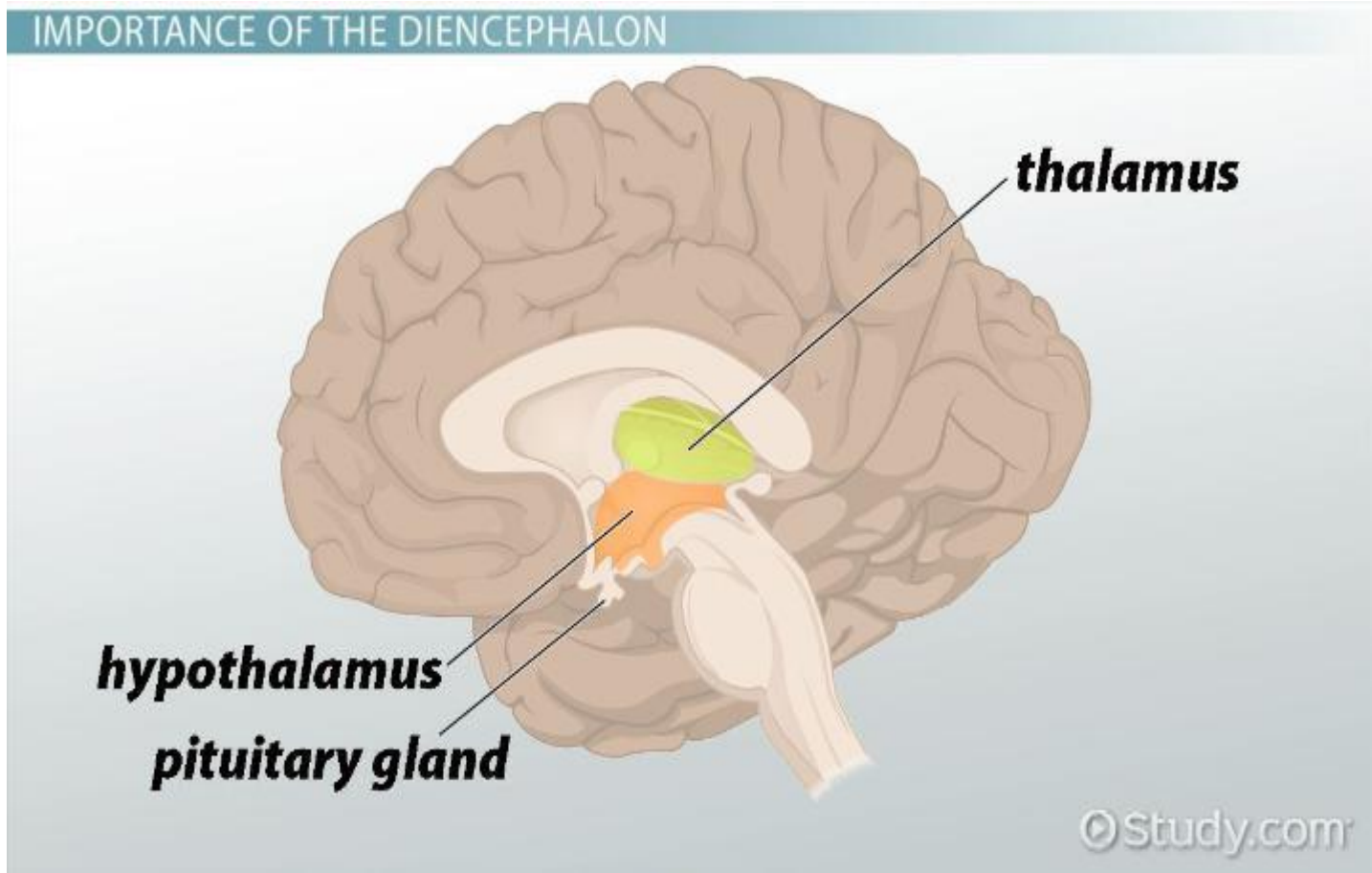
second typeof nuclei take impulse from cerebellum,brain storm, reticular formation

Third type of nuclei are association nuclei.

Hypothalamus- The hypothalamus is a small region of the brain. its located at the base of the brain, near the pituitary gland. it is considered very important by psychologists as it is related to motivation and emotion.

hypothalamus plays a crucial role in many important functions:

- regulating body temperature known as homeostasis
- maintaining daily physiological cycles
- controlling appetite
- managing of sexual behavior
- regulating emotional responses- hypothalamic theory by cannon and Bard.
- it also controls autonomic nervous system and endocrine activities. as hypothalamus is near pituitary gland and by controlling pituitary gland it controls all the endocrine glands.
- it is also related to survival like fighting, feeding, fleeing, mating.


IMPORTANCE OF THE DIENCEPHALON
thalamus
hypothalamus
pituitary gland
Study.com

Brain Stem: Hindbrain & Midbrain

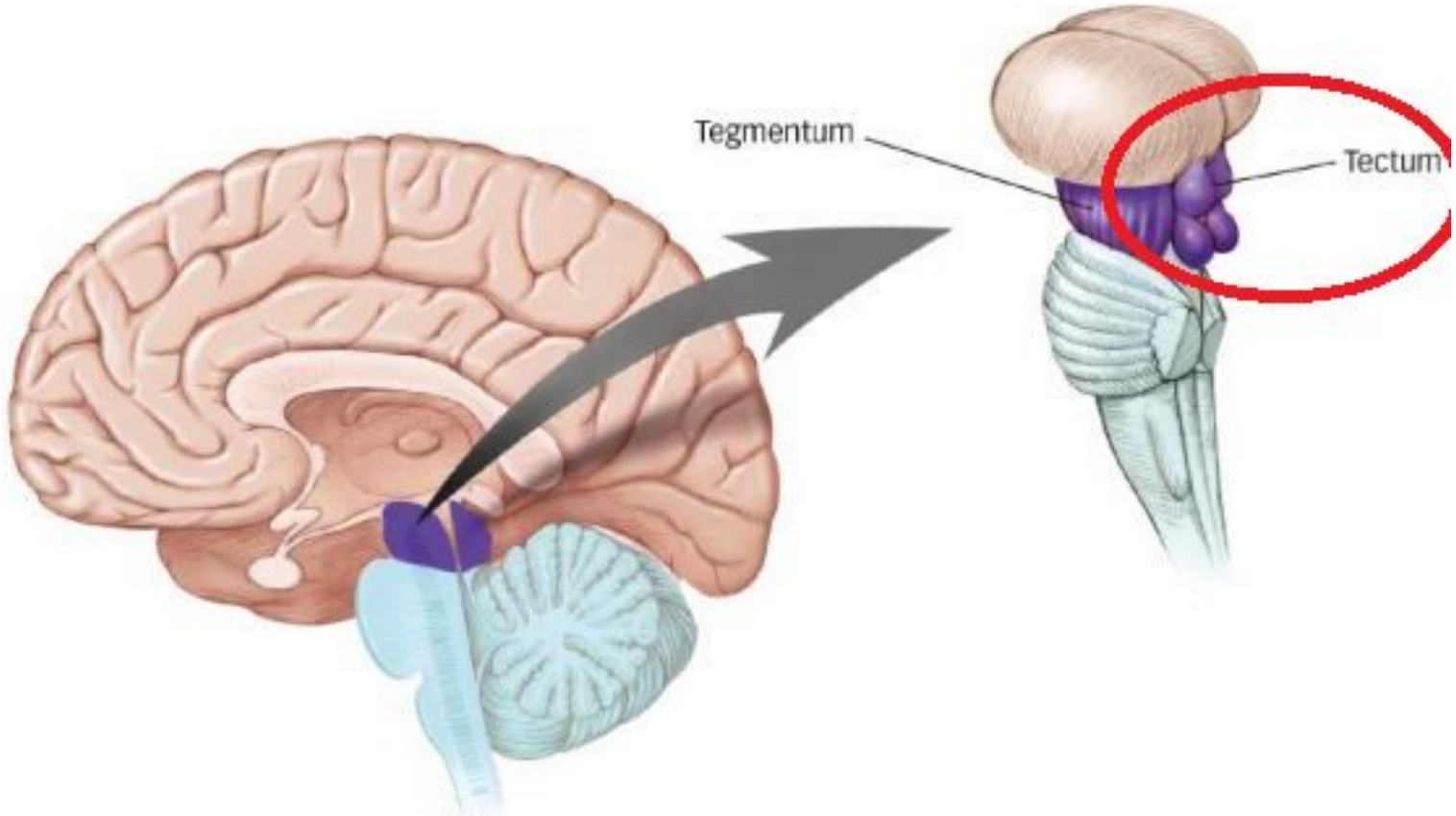
Medulla- lowest part of hindbrain which joins the main parts of spinal cord and brain. main functions are respiration, heart rate, blood pressure, activities of tongue.

Pons- it consists of different types of sensory and motor neurons. sense are received from head and face related to touch, pain, temperature. motor responses- muscular activities used in facial expression, movement of eyeball and jaw movement.

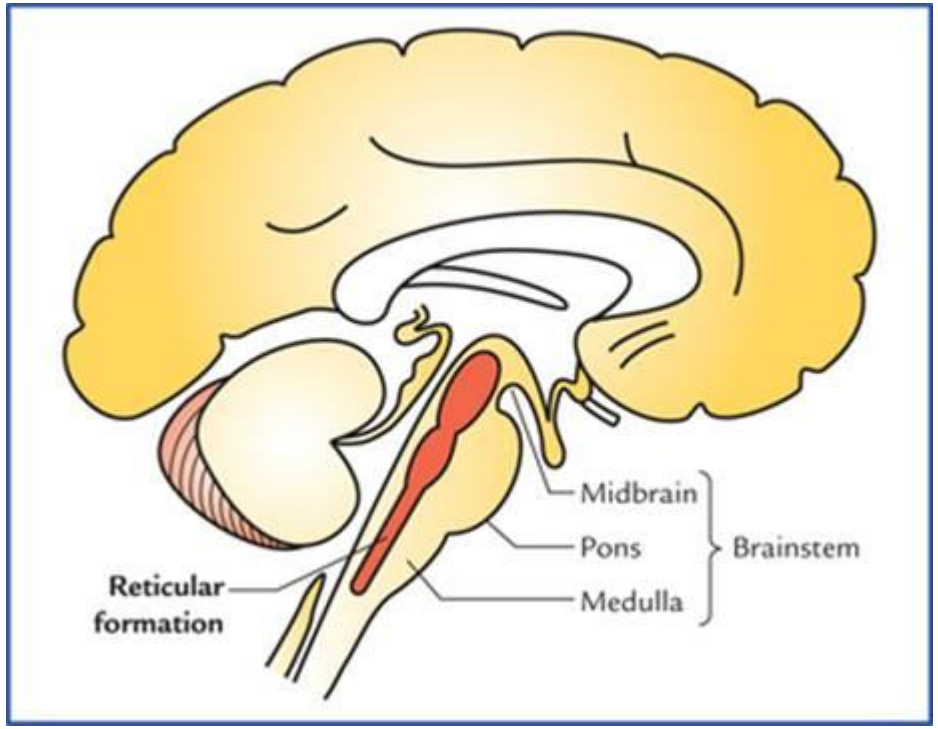
Cerebellum- balanced coordinated movements

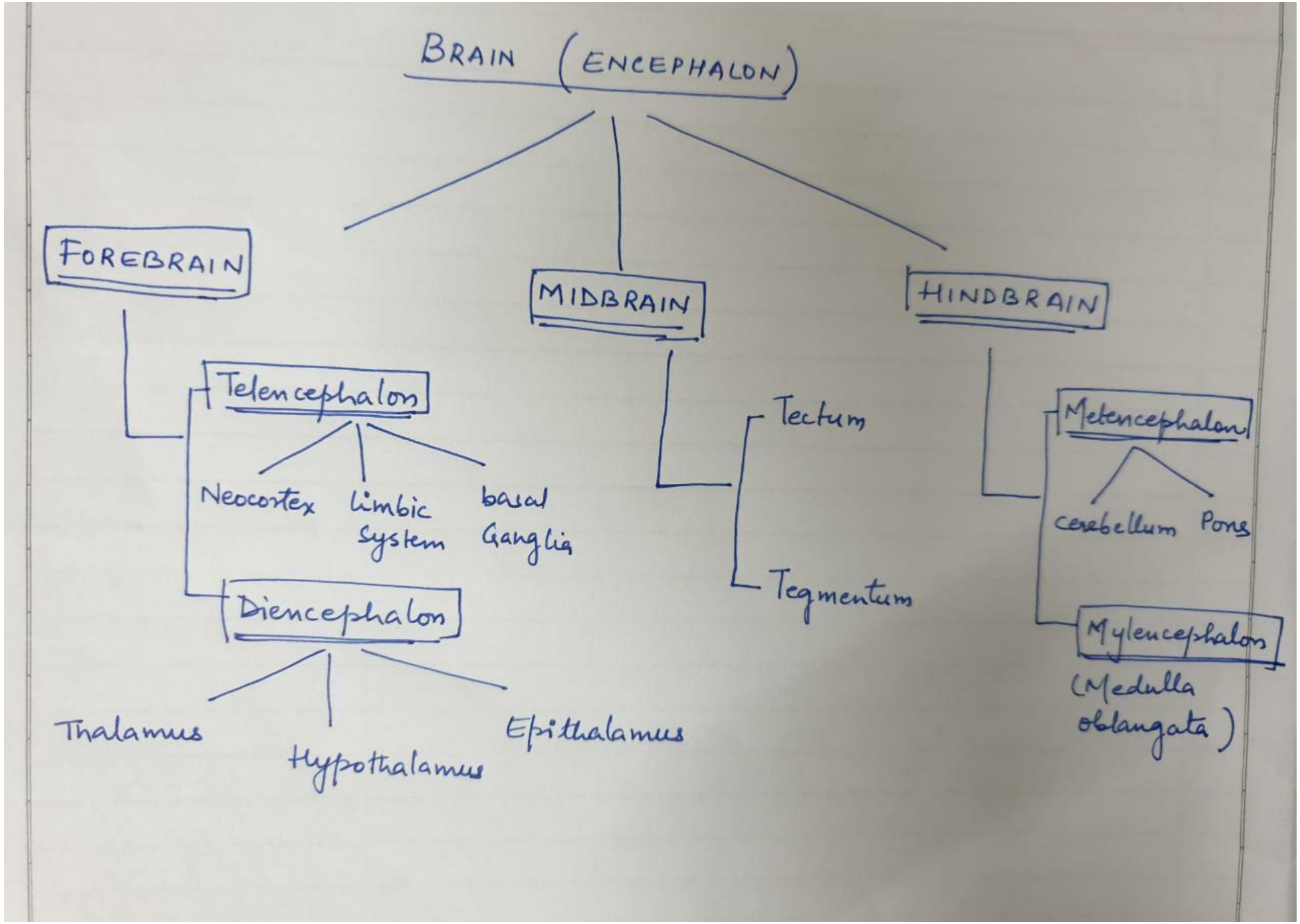
Midbrain (Mesencephalon)- it works as a bridge between forebrain and hindbrain.

- Tectum- sensory functions. Superior Colliculus- Visual centres
  Inferior Colliculus- auditory centres
- Tegmentum- movement of eye and ways of nerve impulse from upper to bottom


Tegmentum
Tectum

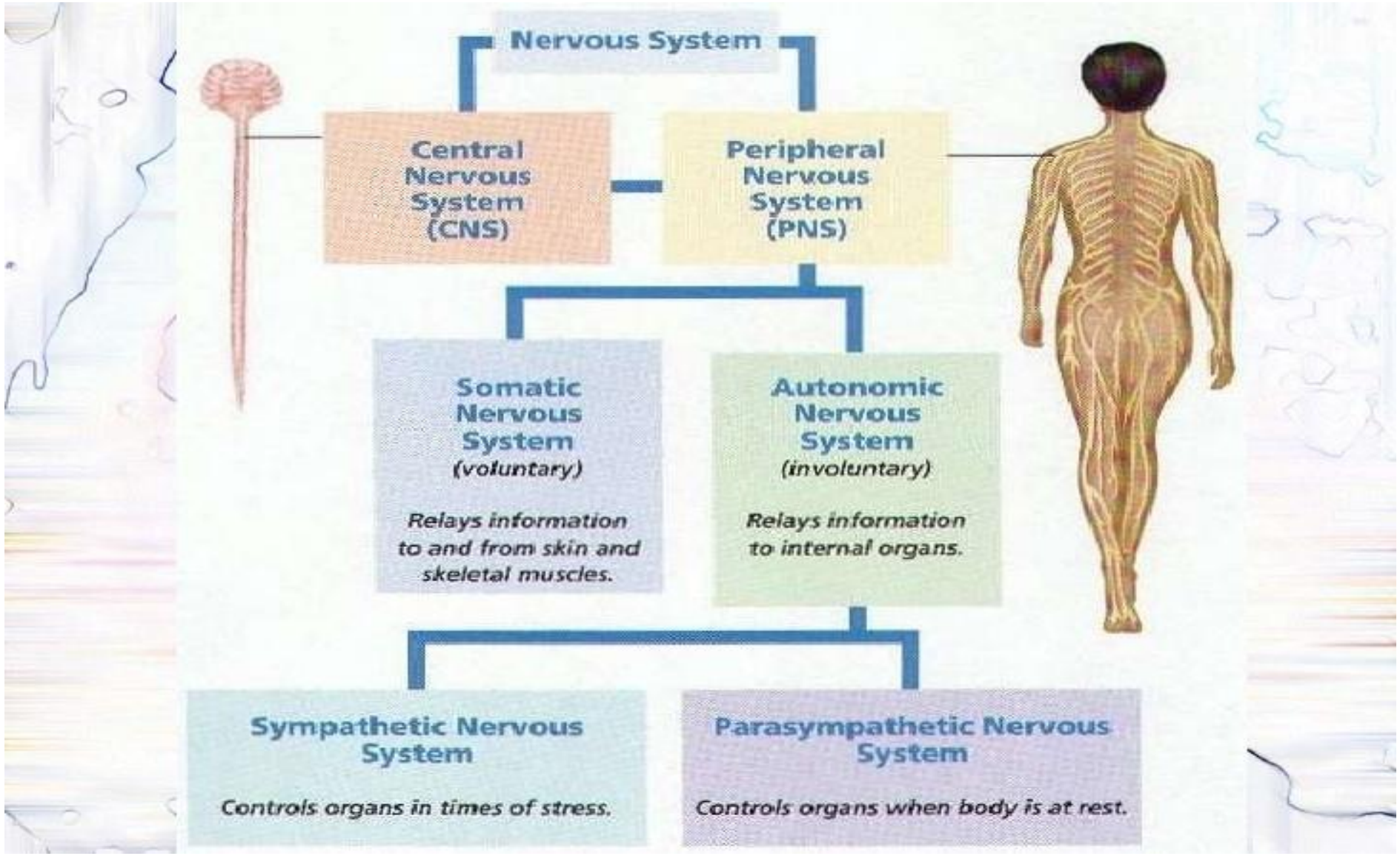
Reticular Formation- sleep, arousal, attention, stimulation. also known as reticular activating system. there are two subsystems- ascending reticular system and descending reticular system




BRAIN (ENCEPHALON)
FOREBRAIN
MIDBRAIN
HINDBRAIN
Telencephalon
Neocortex
Limbic System
basal Ganglia
Diencephalon
Thalamus
Hypothalamus
Epithalamus
Tectum
Tegmentum
Metencephalon
cerebellum
Pons
Myelencephalon
(Medulla oblangata)

Function of the Nervous System

- SENSORY FUNCTION: Nervous system uses its millions of sensory receptors to monitor changes occurring both inside and outside of the body. Those changes are called STIMULI, and the gathered information is called Sensory Input.
- INTEGRATIVE FUNCTION: The Nervous System process and interprets the sensory input ad makes decisions about what should be done at each moment—a process called Integration.
- MOTOR FUNCTION: The Nervous System then sends information to muscles, glands, and organs (effectors) so they can respond correctly, such as muscular contraction or glandular secretions.


Nervous System
Central Nervous System (CNS)
Peripheral Nervous System (PNS)
Somatic Nervous System (voluntary)
Relays information to and from skin and skeletal muscles.
Autonomic Nervous System (involuntary)
Relays information to internal organs.
Sympathetic Nervous System
Controls organs in times of stress.
Parasympathetic Nervous System
Controls organs when body is at rest.