

Introduction
to Physiology of the Nervous System

Dr. Taha Sadig Ahmed
Physiology Department , College of Medicine , King Saud University

Examples of Lesions Which Helped in Understanding Normal Function :

<u>Lesion /Abnormality in a neural structure</u>	<u>Associated change in normal function</u>	<u>Evidence-based conclusion</u>
<i>Injury to the facial nerve on one side</i>	Failure of muscles of the face on that side to contract	The Facial nerve is the cranial nerve responsible for facial movements and facial expression
<i>Stroke involving Broca's area</i>	Motor aphasia	Broca's area is essential for normal speech
<i>A large tumor in the cerebellum</i>	Dysmetria	The cerebellum is important for our ability to judge distance
<i>Cerebral hemorrhage involving the left cerebral hemisphere</i>	Paralysis of the right half of the body	The left cerebral hemisphere controls movements of right side of the body

Classification of the Nervous System

○ **1st Classification :**

- (A) Somatic (Voluntary) Nervous System .
- (B) Autonomic (Involuntary) Nervous System

○ **2nd Classification :**

- (A) Central Nervous System (CNS)
- (B) Peripheral Nervous System (PNS)

A) *Central Nervous System (CNS)*

- Consists of :

1) Brain

2) Spinal Cord

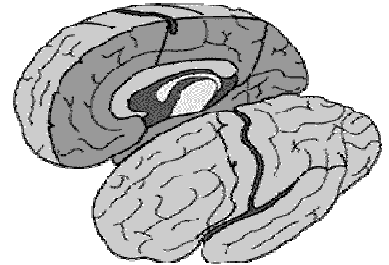
- ✓ They contain centers for analysis of incoming sensory inputs , their integration with previous stored information , and then , accordingly , issuing of the appropriate motor commands (responses)

1) Brain :

- The Brain consists of :

a) **Telencephalon** : which consists of: **1) Cerebrum** , **2) Basal Ganglia**

1)Cerebrum : It is comprises 2 cerebral hemispheres
Divided by Brodmann into 47 areas (called after him “
Brodmann’s areas ” .



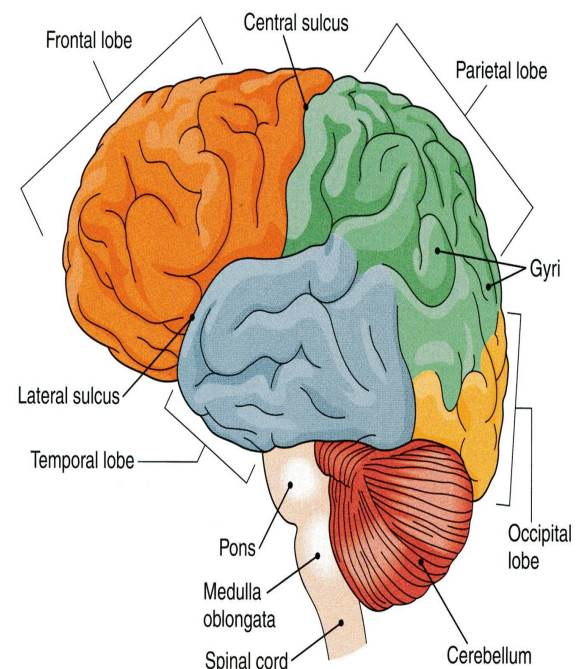
► The CEREBRAL HEMISPHERES:-

- ♦ they are the largest part of the brain
- ♦ they have ridges of tissue, called **gyri**
- ♦ the gyri are separated by grooves called **sulci or Fissures**
- ♦ Big fissures divide large regions of the brain into **lobes**
- ♦ Each hemisphere has four main lobes :

- **Frontal**
- **Parietal**
- **Temporal**
- **Occipital**

- Separated by the following sulci :

- **central sulcus** (of Rolando) separates the frontal and parietal lobes
- **lateral sulcus** (of Sylvius) separates the temporal from the frontal & parietal lobes
- **parieto-occipital sulcus**



Cerebral Dominance : The Dominant Hemisphere

- ♦ Each hemisphere receives sensations & controls movement on the opposite side of the body (Because fibers cross to the opposite side)
- ♦ One hemisphere usually has more influence than the other and is called the “ Dominant Hemisphere “ .
- ♦ About 90 % of people are right-handed, and consequently their Dominant Hemisphere
- ♦ is on the left side (their left cerebral hemisphere) .
- ♦ The remaining 10 % of people have their right cerebral hemisphere as the Dominant Hemisphere , and therefore they are left-handed.

Overview of Functions of Cerebral Lobes

- ♦ Frontal lobe : Largely responsible for initiation and execution of voluntary movement .Also contains Broca’s area of speech in the dominant hemisphere (i.e., in the left hemisphere in most people) .
- ♦ Parietal lobe : primarily responsible for perception of sensations (e.g.pain , touch , hotness , coldness) from the body surface (skin) .
- ♦ Occipital lobe: primarily responsible for visual perception .
- ♦ Temporal lobe : primarily responsible for hearing and also contains centers for memory .

Functional Anatomy of Cerebral Cortical lobes

- the **Somatosensory (General Sensory)** area is located in the Parietal Lobe posterior to the central sulcus (Rolandic Fissure)
- **visual sensations** are received in the Occipital Lobe
- **auditory sensations** are received in the Temporal Lobe close to the lateral sulcus (Sylvian Fissure).
- **olfactory sensations** are received deep inside the temporal lobe

2) Basal Ganglia

b) Diencephalon : consist of :

(1) Thalamus

(2) Hypothalamus

(3) Epithalamus and Subthalamus

c) Brainstem : consists of :

(1) Midbrain

(2) Pons

(3) Medulla

D) Cerebellum

2) spinal cord :

♦ The spinal cord is generally cylindrical in shape , From it emerge 31 pairs of **spinal nerves**:

- 8 cervical,
- 12 thoracic,
- 5 lumbar,
- 5 sacral and
- 1 coccygeal.

Functionns of the Spinal Cord and its Associated Spinal Nerves :

(1) Carrying sensory information from the receptors in the periphery to the sensory areas in the brain .

- This is done via ascending sensory tracts.

(2) Carrying of motor commands from the motor areas of the brain to the spinal centers.

- his is done via descending motor tracts .

- Then the spinal centers send messages through peripheral nerves to muscles in the periphery to carry out movement .

(3) Spinal Reflexes : Spinal centers serve to receive incoming sensory information , integrate it and respond to it by programmed spinal reflexes

- The Knee Jerk and Biceps Jerk are two examples of the pre-programmed spinal reflexes

(4) The Spinal cord also provides **autonomic innervation** for the viscera and the skin .

Physical Protection of the CNS

► The delicate CNS tissues are protected from external mechanical insults by :

(A) bony structures :

- (1) Skull : around the brain ,and
- (2) The spine (Vertebral Column) : around the spinal cord . It also offers it mechanical support .

(B) The meninges (coverings) of the CNS :

- 1) Dura Mater → the outermost covering (in contact with the skull)
- 2) Arachnoid Mater → the middle covering , &
- 3) Pia Mater → the innermost covering (in contact with the brain surface) .

B) Peripheral Nervous System (PNS)

♦ It transmits sensory inputs from the periphery to the CNS and motor commands from the CNS to the peripheral organs . It comprises :

- (i) **Cranial Nerves** (whose nuclei are present in the brain) , and
- (ii) **Spinal Nerves** (whose cell-bodies are present in the spinal cord) .

▪ The spinal nerves arise from the cord as dorsal and ventral roots .

♣ The **dorsal roots** contain **primary afferent neurons** running from *peripheral sensory receptors* to the spinal cord .

♣ The cell body of each of these neurons is located in **dorsal root ganglion (DRG)** . The DRG appears as a small enlargement on the dorsal root of the spinal nerve .

♣ The ventral roots carry efferent motor (somatic and/or autonomic motor) fibers .

♣ The cell bodies of somatic motor neurons are located in the anterior (ventral) horn of the spinal cord grey matter .

♣ The cell bodies of autonomic motor neurons in the thoracic segments of spinal cord are located in the lateral horn .

♣ 2 roots of the spinal nerve (dorsal and ventral roots) unite at or close to the intervertebral foramen , to form here onward the mixed spinal nerve (“mixed” means carrying both motor and sensory fibers) ..

Neural Tissues (Tissues of the NS)

♦ Consist of : (A) Neurons , and (B) Glia

(A) **The Neuron** :(the main functional unit of the NS)

► **Structure:** It is formed of :

- 1) *Cell body*: contains the nucleus and cell's organelles (e.g., mitochondria, endoplasmic reticulum , etc).
- 2) *Dendrites*: one or more branched processes .
- 3) *Axon (nerve fiber)*: Transmits nerve impulses (action potentials , APs) from the parent (mother) to another neuron , or to an effector organ (muscle or gland) .

(B) **Glia** : (neuroglial cells)

► These offer structural and metabolic support to neurons:

- 1) Cells that form myelin sheath →
 - (i) Oligodendrocytes around axons inside the CNS ,&
 - (ii) Schwann cells around axons of peripheral nerves .
- 2) Cells that line ventricular cavities and secrete CSF (Cerebrospinal Fluid) → Ependymal cells .
- 3) Cells that regulate neuronal environment and contribute to formation of the blood-brain barrier → Astrocytes .

د. أبو يسرا