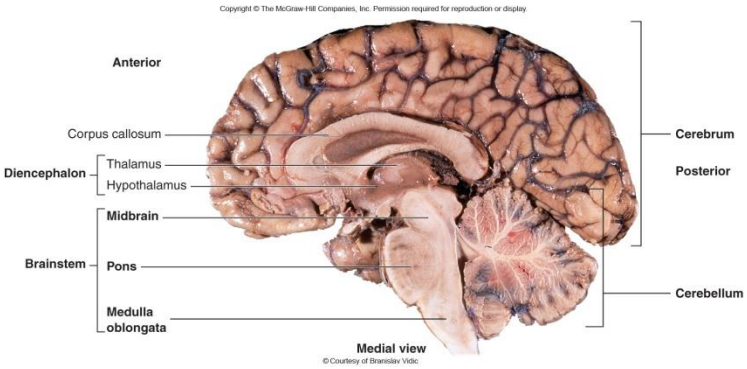
Unit 4 Lecture 12

THE BRAIN

Overview



Neurons within the nervous system link to form circuits with specific functions. In the brain, neural networks create affective and cognitive behaviors. Signaling within these pathways creates thinking, language, feeling, learning, and memory. The brain exhibits plasticity, the ability to change connections as result of experiences. The brain is the primary control center in the body. Homeostatic responses in many organ systems are designed to maintain brain function. The brain can create complex thoughts and emotions without external stimuli. Communication between the CNS and the PNS utilizes electrical and chemical signals.

The brain is the largest and most complex part of the nervous system. It contains nerve centers that are associated with sensations. The brain issues motor commands and carries on higher mental functions.

Brain development

During embryonic development, brain vesicles or cavities (prosencephalon, mesencephalon, and rhombencephalon) are formed from a neural tube, which serves as forerunners of various parts of the brain. The forebrain develops into the telencephalon and the diencephalons. The midbrain develops into the metencephalon and the myelencephalon.

Five resulting cavities remain as ventricles in the mature brain. Ultimately the telencephalon develops into the cerebrum. The diencephalon develops into the epithalamus, thalamus, subthalamus, and hypothalamus, the mesencephalon develops into the midbrain, the metencephalon becomes the pons and cerebellum, and the myelencephalon becomes the medulla oblongata.

VENTRICLES AND CEREBRAL SPINAL FLUID (CSF)

Ventricles are interconnected cavities within the cerebral hemisphere and brain stem and are filled with CSF. The choroid plexuses in the walls of the ventricles secrete CSF. CSF is reabsorbed into the blood through the arachnoid villi. About 500 cc of CSF are secreted daily of which about 140 cc are present at any one time. Most CSF is produced in the lateral ventricles. CSF functions in mechanical protection (floating shock absorber), in chemical protection by producing a stable ionic concentration, and in circulation for exchange of nutrients and wastes.

Hindbrain & Midbrain

Brain Stem

From an evolutionary viewpoint, the brain stem is the oldest and most primitive region of the brain. The brain stem extends from the base of the cerebrum to the spinal cord and consists of the midbrain, pons, and medulla oblongata. Eleven of the twelve pairs of cranial nerves originate along the brain stem. The midbrain contains reflex centers associated with eye and head movement. The pons transmits impulses between the cerebrum and other parts of the nervous system, and contains centers that help regulate the rate and depth of breathing. The medulla oblongata transmits all ascending and descending impulses, and contains several vital (heart rate, respiratory rate) and non-vital reflex centers. The reticular formation regulates muscle tone; helps maintain consciousness and awakening from sleep.

Cerebellum

The cerebellum consists of two cerebellar hemispheres connected by the vermis. A thin cortex surrounds the white matter of the cerebellum. The cerebellum functions primarily as a reflex center, coordinating skeletal muscle movements and maintaining equilibrium.

Forebrain

The diencephalon begins where the midbrain ends and surrounds the third ventricle. Found in the diencephalons are the epithalamus, thalamus, subthalamus, and hypothalamus. The thalamus contains nuclei that that serve as relay stations for all sensory impulses to the cerebral cortex, registers conscious recognition and temperature, and plays a role in cognition and awareness.

The hypothalamus regulates the autonomic nervous system, secretes a variety of regulating hormones, participates in expression of rage and aggression, controls body temperature, regulates food and fluid intake, and establishes a diurnal sleep pattern. Memory is established in phases and is stored in both hemispheres utilizing the limbic system, which is found in the central hemispheres, and the diencephalon. The limbic system also functions in emotional aspects of behavior. The pineal gland found in the epithalamus secrets melatonin which plays a role in sleep and setting of the body's biological clock.

Structure of the Cerebrum

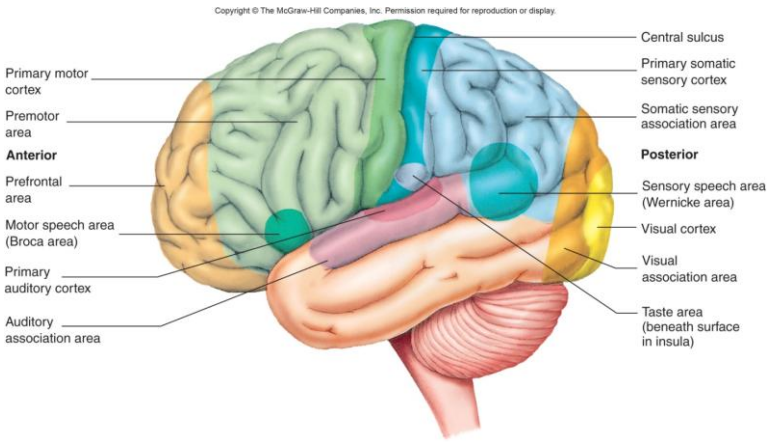
The cerebrum can be described as two lobes of cerebral hemisphere connected by the corpus callosum. Its surface is marked with ridges, grooves that increase the surface area. A sulcus is a shallow groove. Separating the hemispheres is a deep groove called a fissure. Covering the cerebral cortex is a thin layer of gray matter, mostly composed of the neuron cell bodies. White matter is myelinated and unmyelinated nerve fibers that interconnect neurons with the nervous system and communicate with other body parts. The lobes are named after the skull bones;

(frontal, parietal, temporal, and occipital, insula). Other gray matter found in the cerebrum is located in the basal nuclei and the limbic system. Basal nuclei are masses of gray matter located deep within the cerebral hemispheres. They relay motor impulses originating in the cerebral cortex, and aid in controlling motor activities. The limbic system acts as a link between higher cognitive functions such as reasoning and more primitive emotional responses such as fear. The major structures of the limbic system are the amygdala and cingulated gyrus, which are linked to memory and emotion, and the hippocampus which is associated with learning and memory. Memory is established in phases and is stored in both hemispheres.

Function of the cerebrum

The cerebrum carries out higher brain functions such as thought, reasoning, interpretation of sensory impulses, control of voluntary muscles and memory storage. The cerebral cortex has sensory areas that receive inputs and translate it into perception, motor areas that direct skeletal muscle movement, and association areas, regions that integrate information from multiple sensory and motor areas and that can direct voluntary behaviors. The primary motor regions are found near the **central sulcus** in the frontal lobe. Other areas include the motor speech area and special motor areas. Primary sensory areas are found in the occipital area (sight), temporal area (sound), frontal lobe (taste).

Association areas analyze and interpret sensory impulses and provide memory, reasoning, verbalizing, judgment, will, intelligence, personality traits, and emotions. One cerebral area dominates for certain intellectual functions. Left hemisphere is important for right-handed control, spoken and written language, numeric and scientific skills, and reasoning. Right hemisphere is more important for left-handed control, musical and artistic awareness, space and pattern perception, insight, imagination, and generating images of sight, sound, touch, taste and smell.



The diffuse modulating systems of the reticular formation influence attention, motivation, wakefulness, memory, motor control, mood, and metabolic homeostasis. The reticular activating system keeps the brain conscious or aware of self and the environment. Circadian rhythms are controlled by an internal clock in the suprachiasmatic nucleus. Sleep is an easily reversible state of inactivity with two phases: REM (rapid eye movement) sleep and slow-wave sleep (non-REM).

Emotional events influence physiological functions and are controlled in the limbic center of the brain. Motivation arises from voluntary signals that shape voluntary behaviors related to survival or emotions. Motivational drives create goal-oriented behaviors. Moods are long lasting emotional state. A number of mood disorders can be treated by altering neurotransmission in the brain.

Language is the most elaborate cognitive behavior. The integration of language in the human brain involves processing in Wernicke's area and Broca's area.

Basal nuclei (Basal Ganglia)

These are masses of gray matter located deep within the cerebral hemispheres. They relay motor impulses originating in the cerebral cortex, and aid in controlling motor activities.

Cranial Nerves

Twelve pair of cranial nerves connects the brain to various body parts. Some are mixed, some sensory, some are motor. Their names indicate either their distribution or their function. They can either be somatic or autonomic. Most are mixed with only the olfactory and optic as being strictly sensory.

(I) Olfactory, (II) Optic, (III) Oculomotor, (IV) Trochlear, (V) Trigeminal (Ophthalmic, Maxillary and Mandibular divisions, (VI) Abducens, (VII) Facial, (VIII) Vestibulocochlear, (IX) Glossopharyngeal, (X) Vagus, (XII) Accessory (Cranial and Spinal branches), (XII) Hypoglossal.

Why is this chapter important?

The chapter covers the brain and cranial nerves. You would want to know the anatomy of the brain and the specific functions of each of major parts. The function and circulation of Cerebral Spinal Fluid (CSF) is provided. You should be able to describe the sensory, motor, and association areas of the cerebral cortex and briefly describe brain waves. A number of cranial nerves and their functions will be covered.