Divisions of the Nervous System I

As discussed earlier, the nervous system is considered to have 2 major parts: the **central nervous system (CNS)** and the **peripheral nervous system (PNS)**. The CNS contains the centrally located brain and spinal column. It integrates the information it receives from all over the body. The PNS is comprised of individual neurons and groups of neurons called nerves.

The Central Nervous System

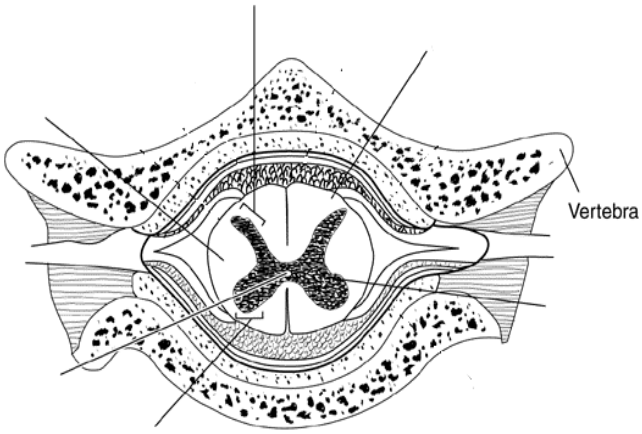
As previously discussed, the CNS is composed of the brain and the spinal chord. The CNS is protected by bone. The brain by the ***skull*** and the spinal cord by the ***vertebrae***. There are three ***meninges*** which wrap and protect the brain and spinal cord. Inside the meninges is found ***cerebrospinal fluid*** which cushions and protects the CNS. Cerebrospinal fluid is produced in the ***ventricles*** (interconnecting spaces) of the brain which also act as a reservoir for the liquid.

The Spinal Cord

The spinal chord lies along the midline of the body and has two main functions:

1. It is the center for many reflex actions.
2. It provides a means of communication between the brain and the spinal nerves which leave the spinal cord.

The following shows a cross section of the spinal cord and the associated vertebra.



The following parts will be referred to:

Gray Matter: butterfly shaped, made up of unmyelinated cell bodies and short fibers.

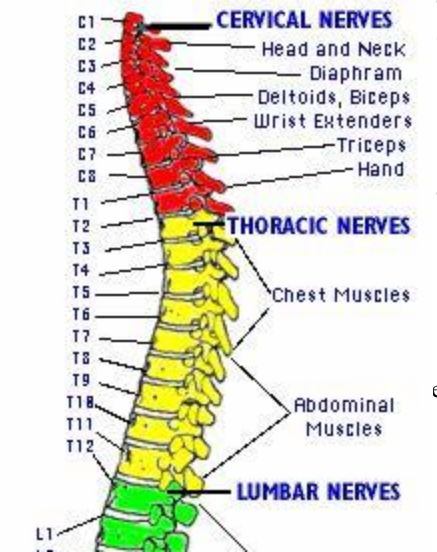
a) **Dorsal Horn** (posterior horn): axons of sensory neurons. Carry sensory information to the brain.

b) **Ventral Horn** (anterior horn): dendrites and cell bodies of motor neurons. Carry messages from the brain to the body.

White Matter: found in between the regions of grey matter, made up "tracts" of myelinated fibers of interneurons which connect the spinal cord to the brain. Left and right tracts crossover prior to entering the brain. Therefore, left side of the brain controls right side of the body and vice versa.

Central Canal: a canal filled with cerebrospinal fluid which is continuous with the ventricles of the brain.

Vertebra: bone which provides protection for the spinal chord.



The spinal cord extends from the brain down the back through the vertebrae. Thirty one pairs of spinal nerves originate in the spine and branch out to both sides of the body. The spinal chord has four regions:

1. **The Cervical Region**: corresponds to the neck. There are no nerves which emerge in this region. This facilitates the rotational motion of the neck. The nerves show in the diagram to the left ***originate*** in the region, but actually ***emerge*** from the thoracic region.
2. **The Thoracic Region**: corresponds to the

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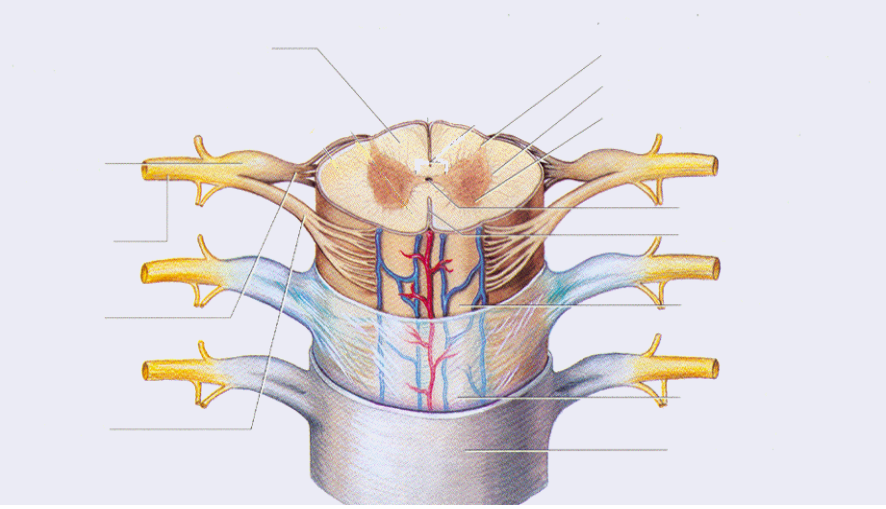
thoracic cavity.

3. **The Lumbar Region**: corresponds to the abdominal cavity.
4. **The Sacral Region**: corresponds to the tailbone area.

The nerves which emerge from these regions are a part of the PNS and will be discussed later.

There are a number of structures associated with the spinal cord which are a part of the PNS, but they will be described now.

a) Spinal Nerves: are also called mixed nerves because they contain both dendrites of sensory nerves and axons of motor nerves.
b) Dorsal roots: contain the axons of sensory neurons. Lead to the dorsal horn of the gray matter.



c) Dorsal-root ganglia (sing: ganglion): contain the cell bodies of the sensory neurons.
d) Ventral roots: contain the axons of the motor neurons.
e) Meninges: protect the spinal cord. There are three.

The Brain

The 1.4 kilograms of protein, fat and water that you carry around inside your skull is the most complex structure in the known universe and the only structure that can wonder about itself. It consists of about 35 billion neurons. It is the most active energy consumer of you body. Although it accounts for about 2% of your body weight, it consumes about 20% of the oxygen you use in a resting state. The brain never rests. Its rate of energy metabolism is relatively constant day and night (it increases slightly when you dream). If the oxygen supply to the brain is cut even for a few minutes, the brain will usually suffer enormous damage. Such damage can also result in death. Brain cells do not regenerate themselves as they are too specialized.

The Brain: Structures and Their Functions

Sagittal View of the Brain

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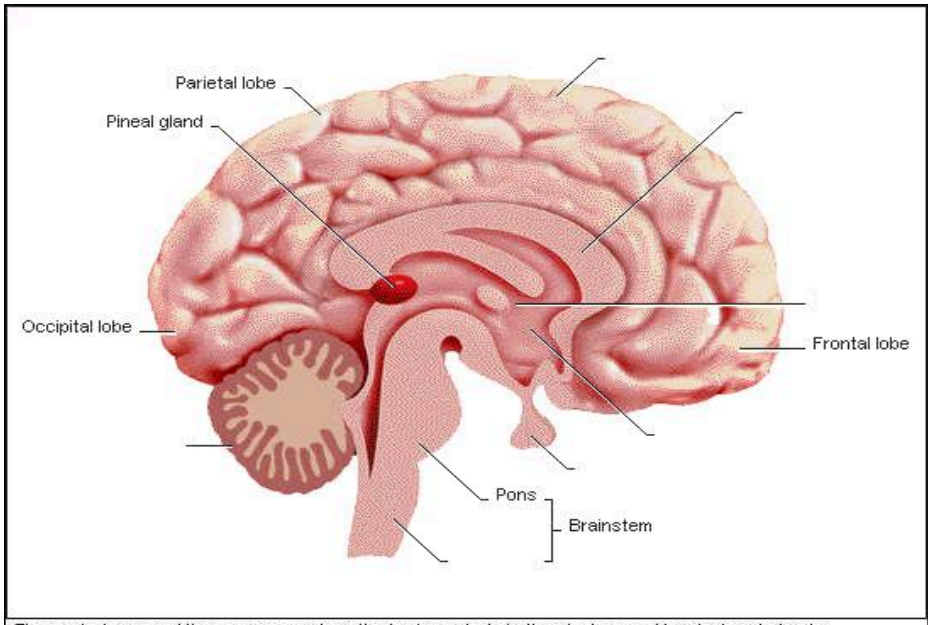
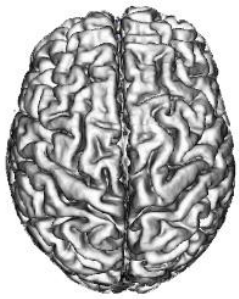


The central organ of the nervous system, the brain controls both voluntary and involuntary behavior.
Alexander and Turner Illustration

The Cerebrum



The largest part of the brain (shown in the top view to the left) is called the ***cerebrum*** and it is responsible for our consciousness. The highly wrinkled outer layer of the cerebrum is called the ***cerebral cortex*** and is divided into the ***right*** and ***left hemispheres*** by the ***central fissure***. At the base of this fissure is a tissue known as the ***corpus callosum***. If one were to consider a section cut down the fissure, through the corpus callosum and down into the spinal cord, the resulting section would be considered a sagittal view of the brain (see above). The cerebrum is the area of the brain responsible for conscious thought processes. It is divided into four ***lobes (the frontal, parietal, temporal and occipital)***, each of which has specific functions associated with them. The surface view on the following page shows the four lobes of the cerebrum as well as some other parts of the brain which will be discussed later.

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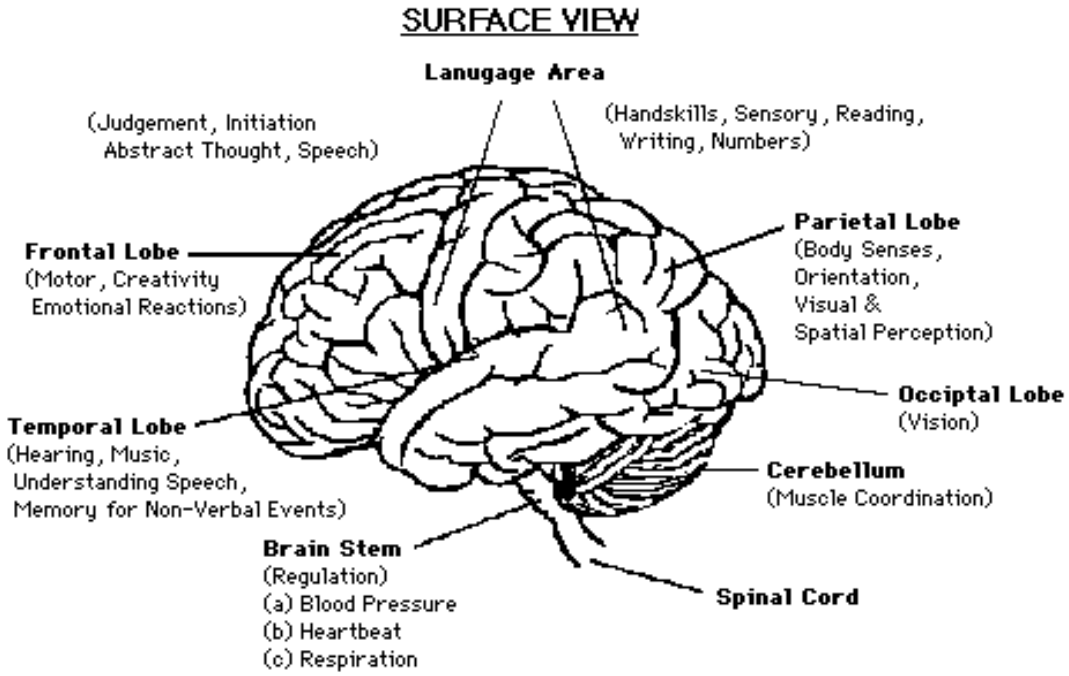
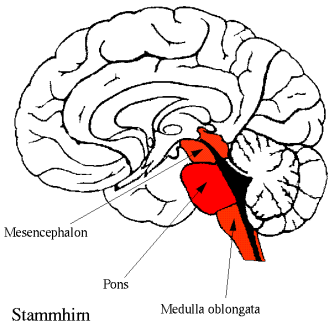


Each half of the cerebrum deals with the opposite side of the body. Sensations from the left side of the body go to the right side of the brain and vice versa. Commands to the muscles on the left side of the body are generated in the right hemisphere of the brain and vice versa.

The Cerebellum

The second largest part of the brain is located at the back of the skull, beneath the occipital lobe of the cerebrum. This portion of the brain co-ordinates voluntary muscle movements and helps the body maintain balance and posture. Commands to move muscles come from the cerebral cortex; however they are coordinated in the cerebellum.

Medulla Oblongata



The medulla oblongata is the bottom part of the brain stem. It plays a role in:

a. The digestive system: controls swallowing.
b. The circulatory system: controls blood pressure and heart rate.
c. The respiratory system: contains ***receptors*** which are sensitive to conditions in the blood (mostly too much CO_2 and H^+) which initiate inhalation.
d. This structure is located at the top of the spinal cord, so the responses mentioned above are involuntary and do not require conscious thought.

The Corpus Callosum

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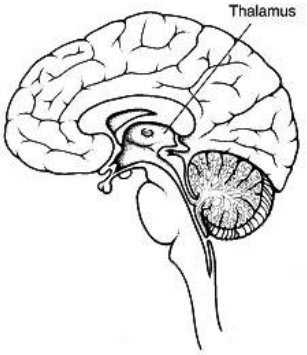
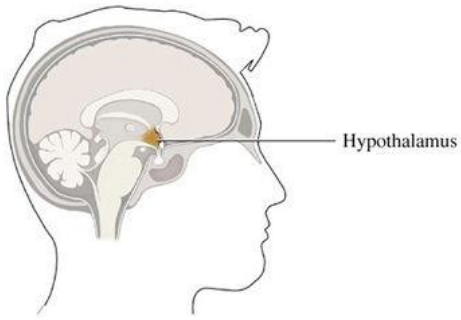
A "bridge" between the two hemispheres of the brain, the corpus callosum contains millions of nerve fibers. Through it, impulses are conducted from one side of the brain to the other allowing the activities of one side to coordinate with the other.

The Thalamus



Located within the walls of the ***ventricles*** (chambers) of the brain, below the ***corpus callosum***, is the region called the ***thalamus***. All impulses traveling up the spinal cord must pass through the thalamus. It receives all these sensory impulses (except for smell) and directs them to the appropriate region of the brain. It is referred to as the "relay station" or "sorting center" of the brain.

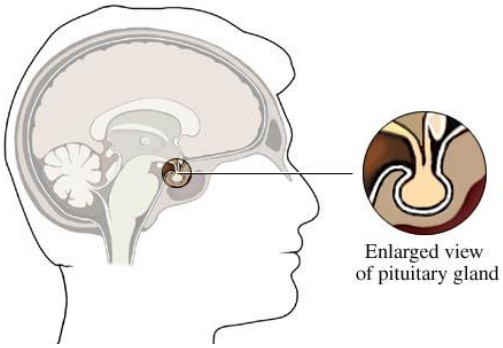
The Hypothalamus



Located immediately below the thalamus, this is the region of the brain responsible for maintaining ***homeostasis*** (the constant control of the internal environment). It contains centers for hunger, sleep, thirst, body temperature, water balance and blood pressure. It is constantly sampling the blood that passes through it and responding in one of two ways:

1. through the initiation of nerve impulses or,
2. by causing the release of hormones through its association with the ***pituitary gland***.

The Pituitary Gland



A bean sized structure which dangles from a slender stalk of tissue just beneath the hypothalamus, the pituitary gland is divided into two parts: the ***anterior and posterior lobes***. It secretes ***nine major hormones*** that regulate many body functions. It also controls the release of hormones by several other endocrine glands.

Neuroendocrine Control

(pages 346-351)

The hypothalamus and the pituitary gland function in conjunction with one another, thereby associating the body's nerve tissue with hormones. The mechanism by which hormones are released from the posterior and anterior lobes of the pituitary glands are quite different.

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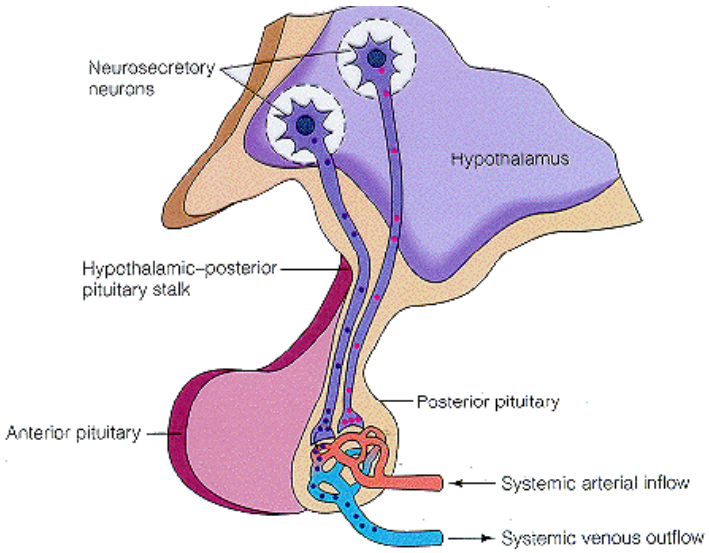
Secretions from the posterior pituitary gland.

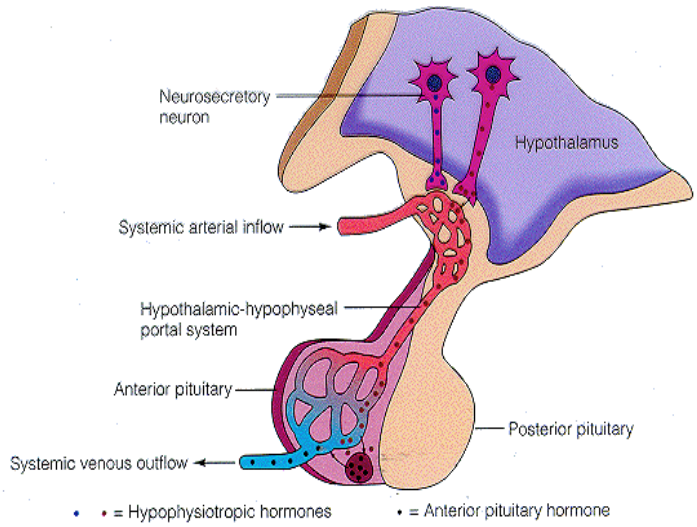
The posterior pituitary gland secretes:

1. Antidiuretic Hormone (ADH) which stimulates the kidneys to absorb more water and
2. Oxytocin stimulates uterine contraction during child birth and release of milk by mammary glands (no known function in males).



These hormones are actually ***PRODUCED*** in the hypothalamus, but released into the blood from the posterior pituitary. The hypothalamus contains special neurons called ***NEUROSECRETORY CELLS*** which produce the hormones. The hormones are carried down the axons of these special neurons to the posterior pituitary. Here they are stored in the axon terminals until release into the bloodstream. From here they enter the blood via capillary beds in the posterior pituitary and the circulatory system carries them to their specific ***TARGET ORGANS***.

<u>Secretions from the anterior pituitary gland.</u>



The anterior pituitary gland releases seven hormones which bring about many changes in the body. In the case where the hypothalamus detects that the effect of one of the hormones from the anterior pituitary is required, it releases a hormone-like substance called a ***RELEASING FACTOR*** (hypophysiotrophic hormones in the diagram) that travels through the very short blood vessels (a portal system) that connect the hypothalamus to the anterior pituitary. The effect of this is to cause the release of the required hormone