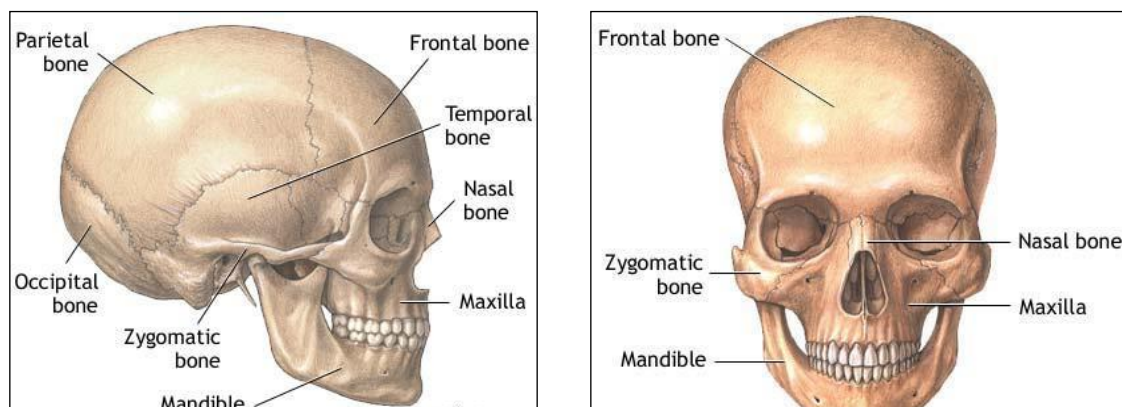


Basic Anatomy and Terminology of the Head and Brain

Scalp and Skull

The scalp is the skin and connective tissue overlying the top of the head. It starts at the level of the eyebrows in front, wraps around the sides of the head and continues to the back of the head. The scalp merges with the skin of the face and neck. Hair grows on the scalp.

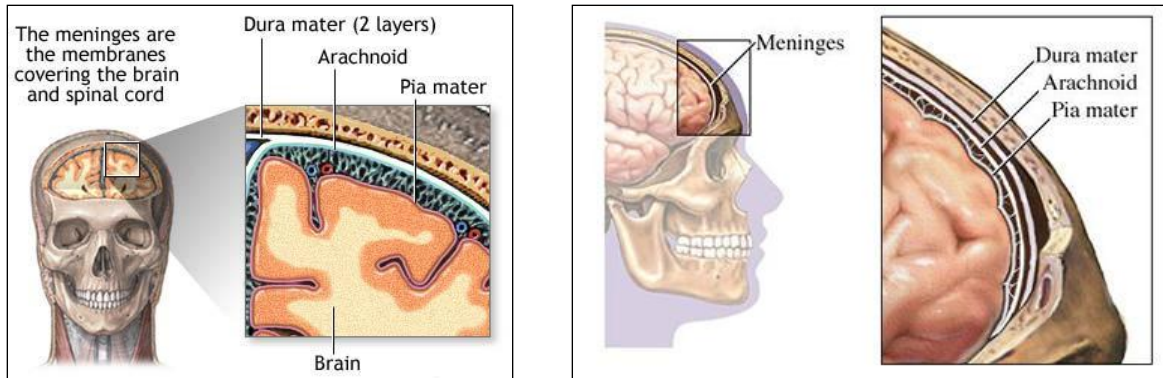
The skull, or cranium, refers to the bone that encases the brain. It is not only on the top, sides and back of the head, where it is readily felt, but is also inside the head, surrounding the brain on the brain's undersurface. The underneath part of the skull is known as the skull base. The skull base has openings through which arteries, veins and nerves pass, and contains the structures of the inner and middle ear, the orbits and the nasal sinuses.



The Skull

Meninges

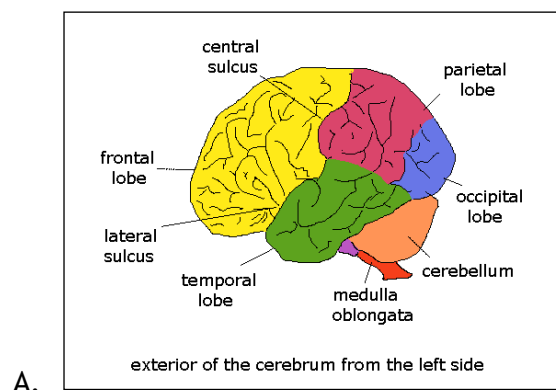
Inside the skull, three membranes surround the brain. Collectively these are called the meninges. The thickest and outer-most of these membranes is the dura mater or dura. The middle membrane, known as the arachnoid mater or arachnoid, envelops a fluid compartment called the subarachnoid space. This compartment contains cerebrospinal fluid (see below). The innermost meningeal layer is the pia mater or pia. This is a very thin, tough, transparent membrane which adheres directly to the surface of the brain.

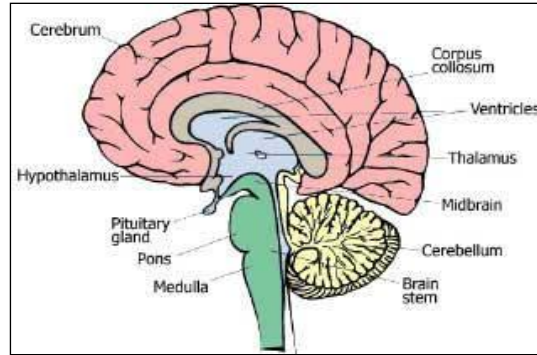


The Meninges

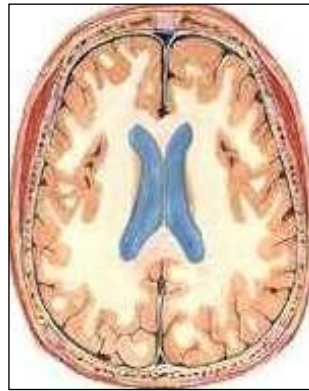
Cerebrum

The largest area of the brain is the cerebrum. It is the large, outer part of the brain, the part that you think of when you picture the brain. The cerebrum is divided into two halves or cerebral hemispheres. Each cerebral hemisphere controls the opposite side of the body. The surfaces of the cerebral hemispheres are convoluted. This means that the surfaces are folded in on themselves in many places. The convolutions allow for more surface area for the brain. The surface is called the cerebral cortex, or grey matter, and is composed of billions of interconnected nerve cells or neurons, each insulated by supporting cells called glial cells or glia. Beneath the surface there are sheets of nerve fiber tracts called the corona radiata or white matter. The white matter tracts connect the cells of the cerebral cortex with each other and all other parts of the brain. There is also a large band of white matter running between and connecting the two hemispheres known as the corpus callosum. Together the cortex and subcortical white matter (plus a group of cell nuclei under the white matter known as the basal ganglia - see below) comprise the cerebrum.





B.



C.

Brain Anatomy.

A. Left hemisphere surface.

B. Midline (sagittal) section between the cerebral hemispheres as seen from left side.

C. Cross section through the brain. Anterior is up.

Each cerebral hemisphere is divided into four lobes: the frontal, temporal, parietal and occipital lobes. The lateral fissure (or Sylvian fissure) separates the frontal and temporal lobes. The central sulcus (aka Rolandic fissure) separates the frontal and parietal lobes.

The primary motor (movement) areas are in the frontal lobes especially the precentral gyrus, also known as the motor strip or primary motor area. Control of behavior is largely found in the frontal lobes also.

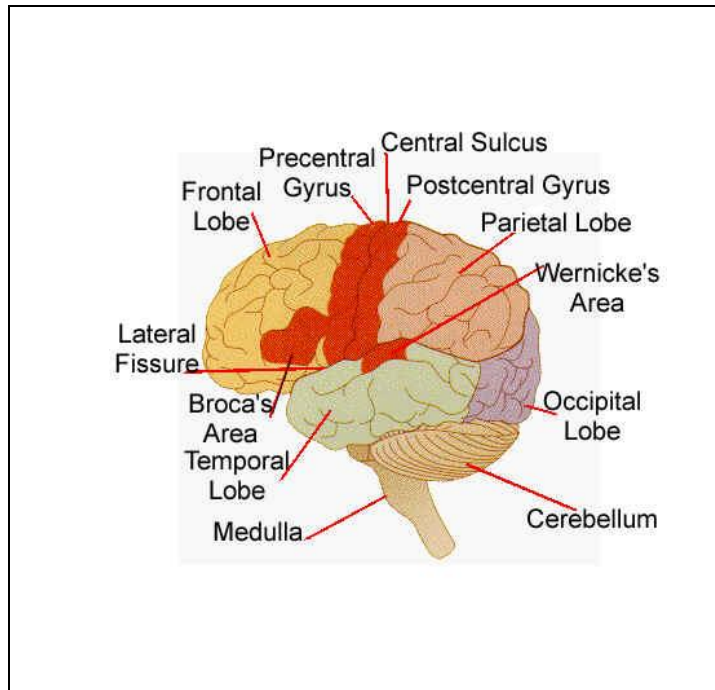
The parietal lobes have mostly to do with sensory perception, especially the postcentral gyrus, also known as the sensory strip or primary sensory area.

The temporal lobes have mainly to do with memory (especially short-term memory), emotional states and hearing.

Vision is the main role of the occipital lobes.

Thinking is shared throughout the hemispheres.

The primary speech and language areas (subserving reading, writing, understanding of speech, naming, repetition, fluency, etc.) are in the left frontal lobe (Broca's area) and temporal lobe (Wernicke's area). The left hemisphere also has areas for mathematics and calculations. Right hemisphere functions include understanding of three-dimensional space, and holistic types of understanding, such as comprehension of music, concepts and events.



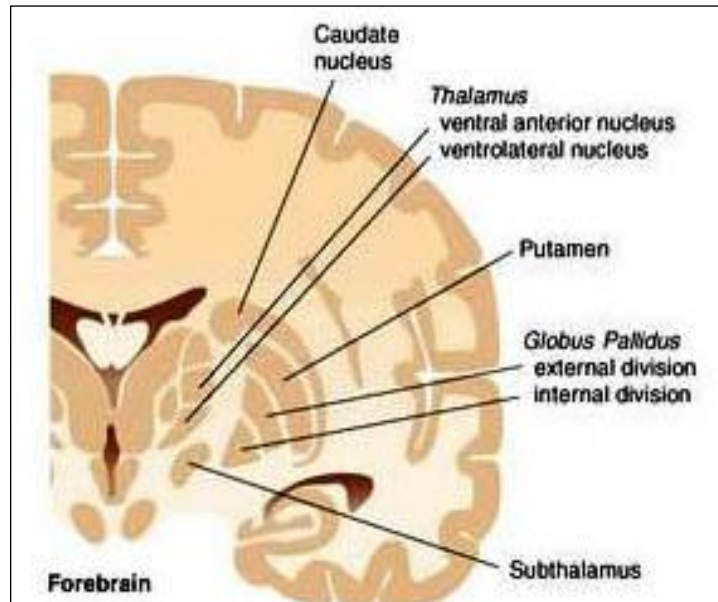
Anatomy and Functional Areas of the Left Cerebral Hemisphere

Basal Ganglia, Thalamus, Hypothalamus and Pituitary Gland

In the central or deep areas of the brain are groups of nerve cells called nuclei (one is a nucleus) which control various functions. The first are the basal ganglia, which are subdivided into the caudate nucleus, globus pallidus and putamen. The basal ganglia have connections with the cerebral cortex and nuclei of other parts of the brain, including the nuclei known as the subthalamic nuclei, red nuclei and substantia nigra. The basal ganglia and related nuclei are involved in the creation and smoothing of movement. They are implicated in Parkinson's disease, for example.

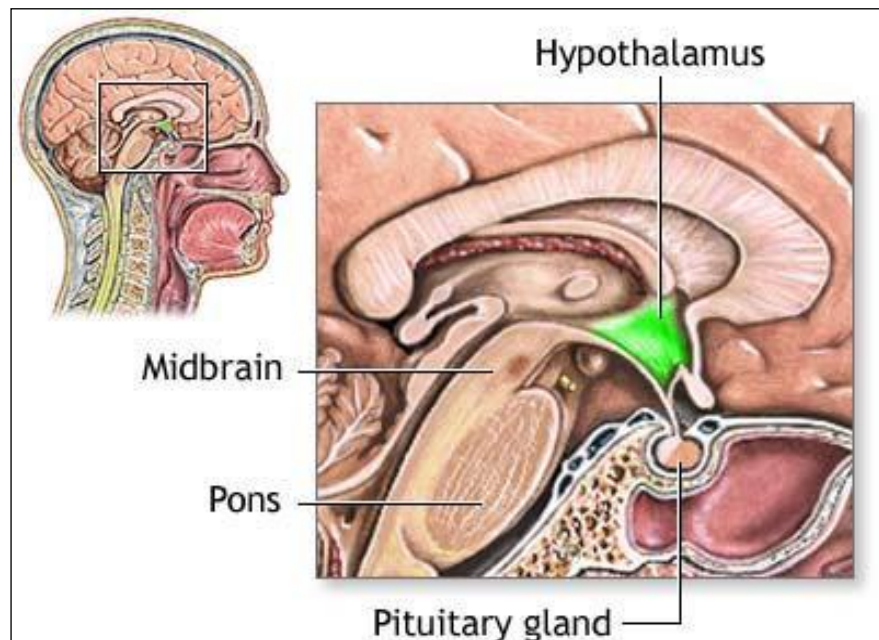
Behind and medial to the basal ganglia is an area of nuclei known as the thalamus. It is also divided into numerous sub-nuclei that have central roles in various different brain functions. The thalamus is involved in maintaining levels of consciousness, and controlling relays for vision, hearing, language and movement. Attached to the back of the thalamus is a small structure known as the pineal body (or gland). The pineal body has no apparent function in humans.

Below the thalamus is a grouping of nuclei called the hypothalamus. This small nuclear complex has numerous roles, with involvement in endocrine (hormone) function, hunger, thirst, satiation, temperature regulation, sweating, water balance, short-term memory, sexual function and emotion.



Basal Ganglia, Thalamus, and Hypothalamus

Attached to the base of the hypothalamus is the pituitary gland, a small but powerful structure that secretes many different hormones. These hormones affect many body functions including physical growth and maturation, pregnancy and lactation, energy level, sexual function, and water balance.

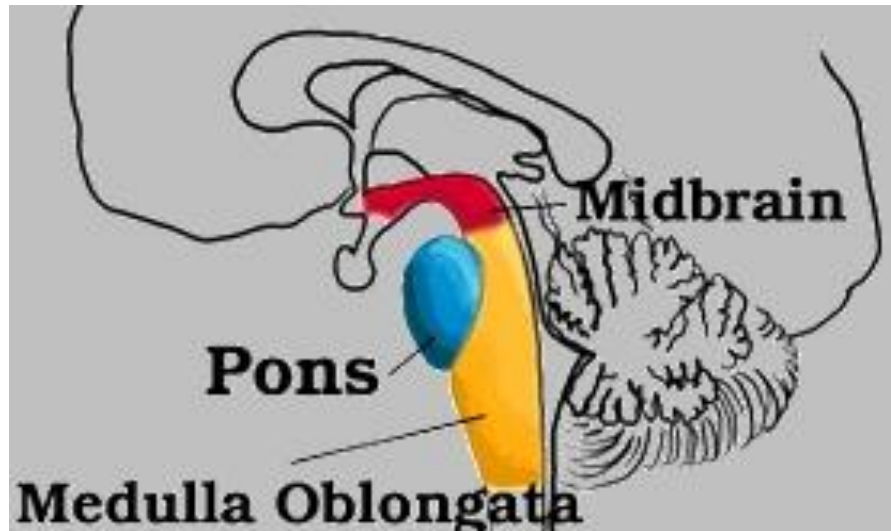


Hypothalamus and Pituitary Gland

Brainstem

Eventually, all brain activity passes down to (or up from) the bottom of the brain through an area known as the brainstem. The brainstem is a very “packed” area of the brain. Virtually all of the functions of the body have connections with, controls within or pathways through, the brainstem. These include vision, hearing, taste, and smell, sensation throughout the whole body, movement of every muscle of the body, and balance and coordination. In addition,

wakefulness/consciousness and sleep/unconsciousness is controlled in the brainstem. For this reason the brainstem is sometimes referred to as the “seat of the soul” and the “center of consciousness.” The brainstem is divided into three main parts, called the midbrain, pons and medulla oblongata, from top to bottom.

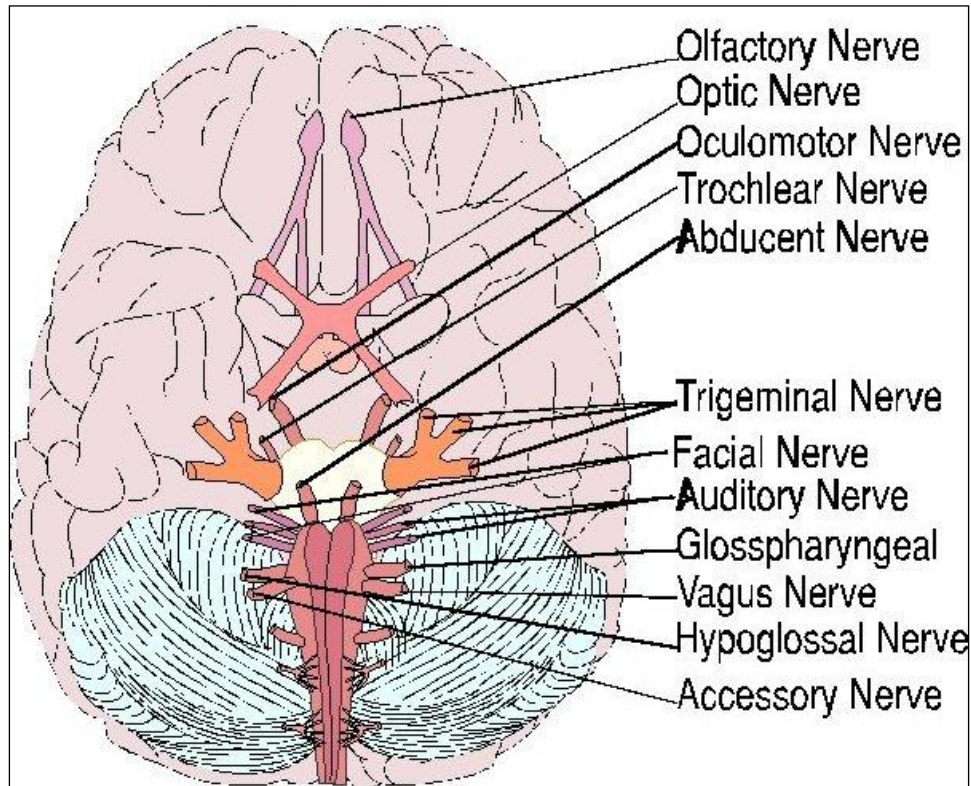


Brainstem

The Cranial Nerves

Exiting (and entering) the brainstem is also a series of nerves for the head and throat. These are the cranial nerves. There are 12 cranial nerves on each side. Their numbers, names and functions are as follows:

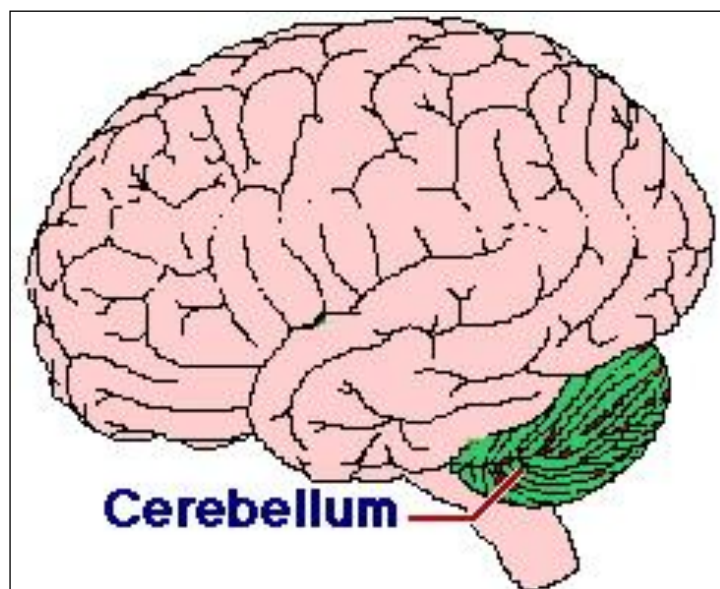
I. Optic nerve (vision)
II. Olfactory nerve (smell)
III. Oculomotor nerve (eye movements, focusing and pupil size)
IV. Trochlear nerve (eye movement)
V. Trigeminal nerve (sensation on the face and inside of mouth, muscles of chewing)
VI. Abducent nerve (eye movement)
VII. Facial nerve (movement of the facial muscles, taste)
VIII. Vestibulocochlear nerve (hearing and balance)
IX. Glossopharyngeal nerve (sensation and movement of throat, taste, salivation)
X. Vagus nerve (sensation and movements of swallowing, voice, stomach, intestines, heart rate)
XI. Spinal accessory nerve (head turning and shoulder shrug)
XII. Hypoglossal nerve (movement of the tongue)



The 12 Pairs of Cranial Nerves

Cerebellum

Attached to the back of the brainstem is a structure called the cerebellum. Like the cerebrum, the cerebellum has a convoluted grey mater cortex, subcortical white mater tracts, and deep nuclei. It is involved in the smoothing and coordination of movement. It has connections to and from many areas of the brain including the cerebral cortex, basal ganglia, thalamus, brainstem and spinal cord.

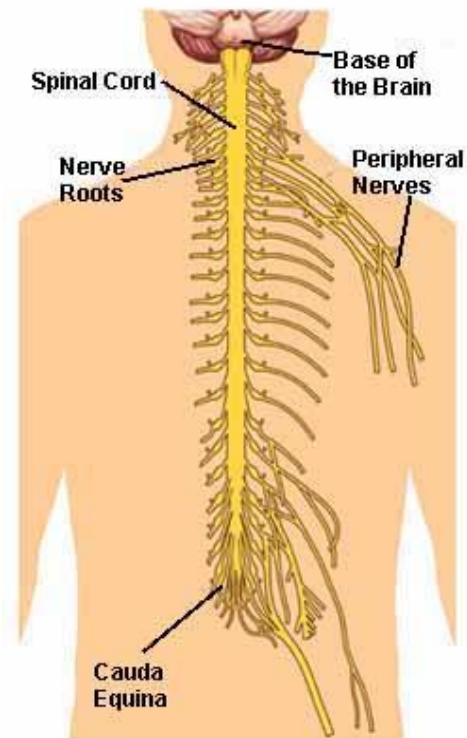


Spinal Cord

The bottom of the brainstem becomes an elongated nerve cord that runs down the central canal of the spine. This is called the spinal cord. The spinal cord carries all of the motor and sensory signals to and from the brain and all parts of the body below the head. It is an extension of the brain and as such is a part of the central nervous system or CNS (as opposed to the peripheral nervous system - the nerves outside of the spine and brain). The spinal cord has grey mater in its center, and white mater tracts along its outsides. As with all of the central nervous system, the nerve cells of the spinal cord cannot regenerate if lost or destroyed (the nerves of the peripheral nervous system can regenerate).

The spinal cord sends off (and receives) peripheral nerves to the body. One pair of motor nerves goes out and one pair of sensory nerves comes in at each vertebral segment/level. The front (anterior, ventral) half of the spinal cord is motor and the back (posterior, dorsal) half is sensory.

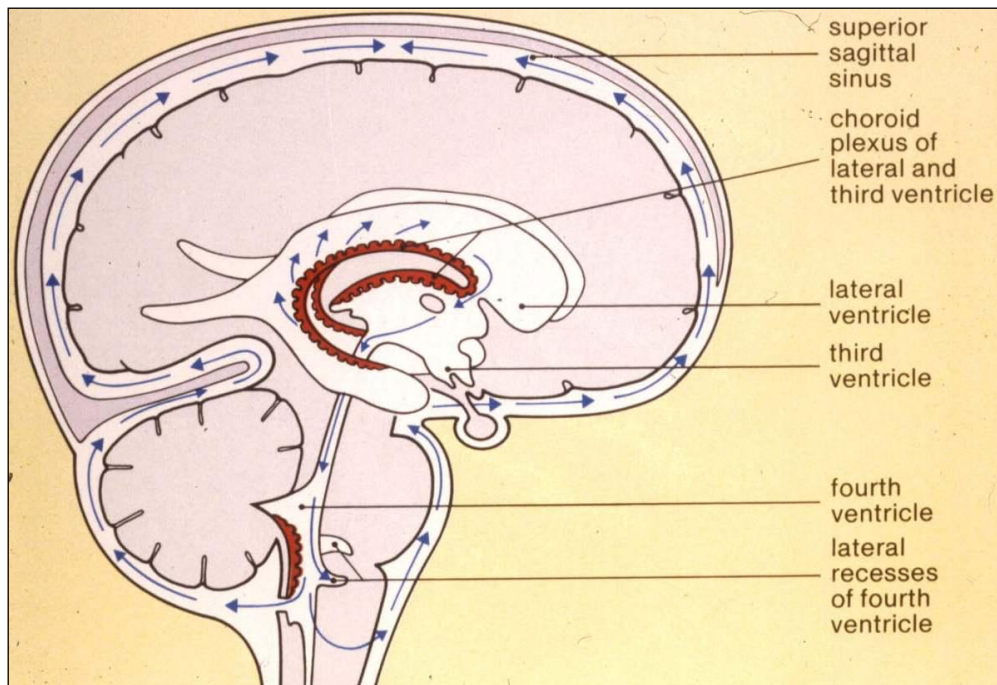
Spinal Cord and Nerve Structures



Spinal Cord, Nerve Roots and Peripheral Nerves

Ventricles, Choroid Plexus, Subarachnoid Space, and Cerebrospinal Fluid

In the center of the brain and around the brain and spinal cord is a fluid called cerebrospinal fluid or CSF. Within the brain it is found in chambers called ventricles. There are paired lateral ventricles in the cerebrum, a midline third ventricle in the thalamus/hypothalamus region, and a midline fourth ventricle in the brainstem/cerebellum region. The role of CSF is to provide buoyancy to the CNS (the brain and spinal cord actually 'float' inside the spine and head).

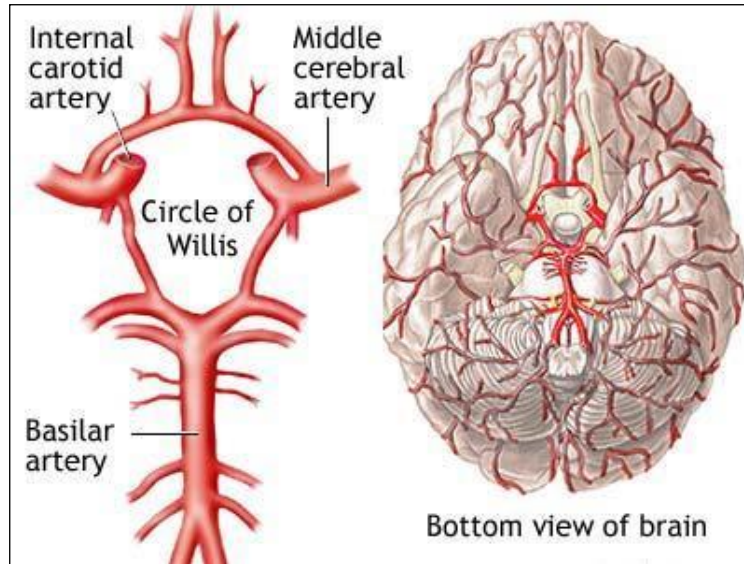


Ventricles and Subarachnoid Space

Cerebrospinal fluid is produced by structures in the ventricles called the choroid plexus. It flows slowly from inside the ventricles to the outside of the brain and spinal cord as follows: from the lateral ventricles, down into the third ventricle, into the fourth ventricle and then out into the space around the brain and spinal cord known as the subarachnoid space (see above). Once in the subarachnoid space, the CSF is absorbed back into the bloodstream via specialized structures called arachnoid granulations or villae. The arachnoid granulations project from the dural venous sinuses (see below) into the subarachnoid space along the top of the brain.

Arteries

The blood supply to the brain comes up the neck from the heart via two pairs of arteries. In the front of the neck are the carotid arteries and in the back of the neck are the vertebral arteries. The vertebral arteries meet inside the skull to form the basilar artery. The two carotid arteries and the basilar artery supply an arterial 'circle' called the circle of Willis, from which the arteries that supply the brain then take off. From the circle of Willis arise the paired anterior, middle and posterior cerebral arteries and their branches. These arteries then branch into smaller and smaller arteries which then penetrate the brain surface to supply it.



Arteries of the Brain

Veins and Venous Sinuses

Blood flows out from the brain by draining first into small veins that exit the brain, into larger and larger veins throughout the surfaces of the brain, and eventually into large veins within the dura called the dural venous sinuses. From the sinuses the blood flows into the jugular veins of the neck and back to the heart.