



Part I
Brain Anatomy
the basics

David M. Pagnanelli, M.D.



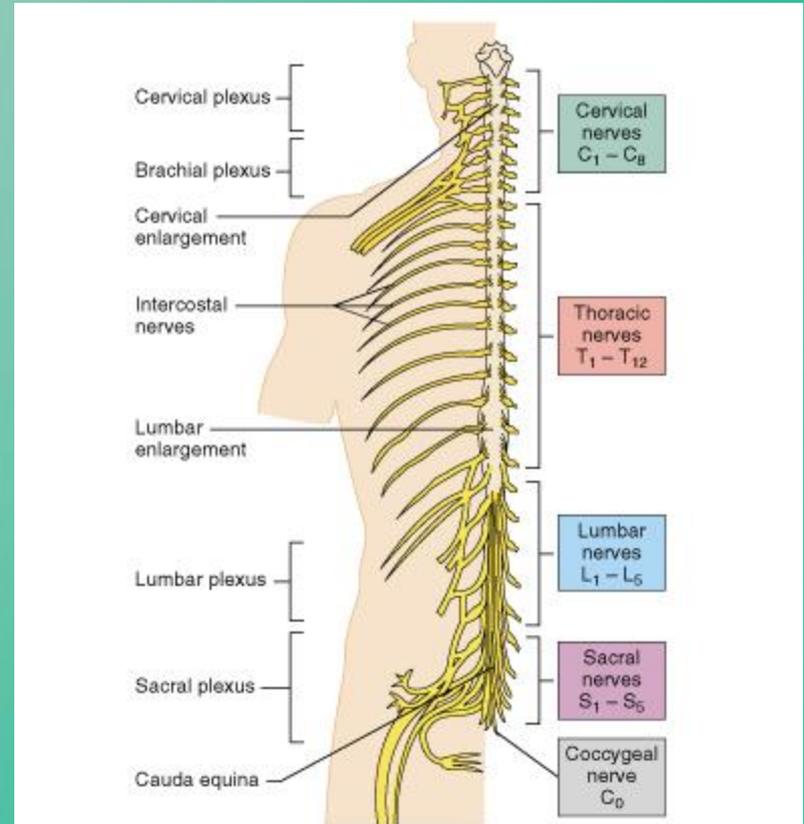
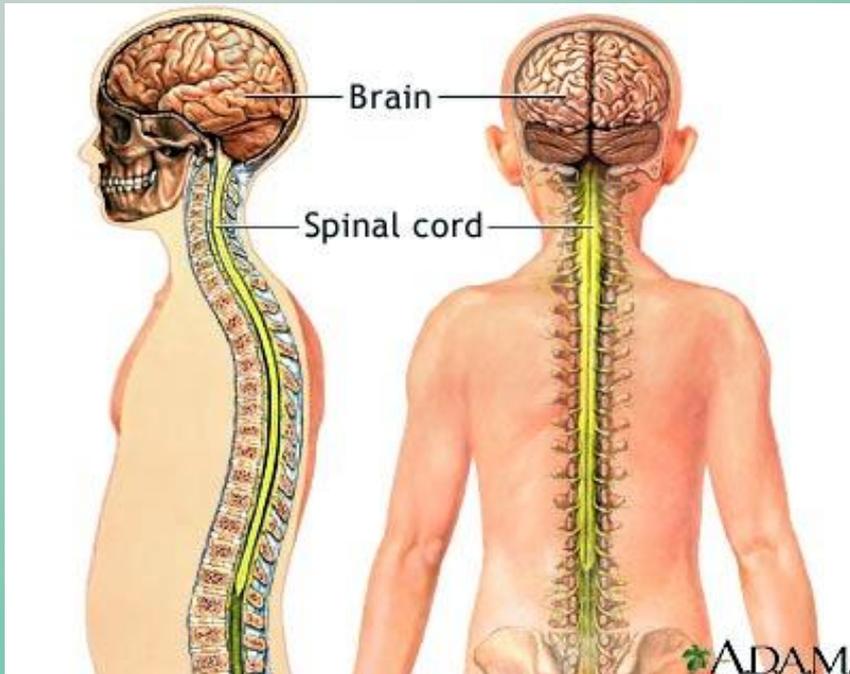
Introduction



The nervous system is divided into the;

central nervous system

peripheral nervous system



A component of the Peripheral Nervous System is the Autonomic Nervous System.





This session is directed at a *component* of the
Central Nervous System,

The Brain





3D visual





An Overview



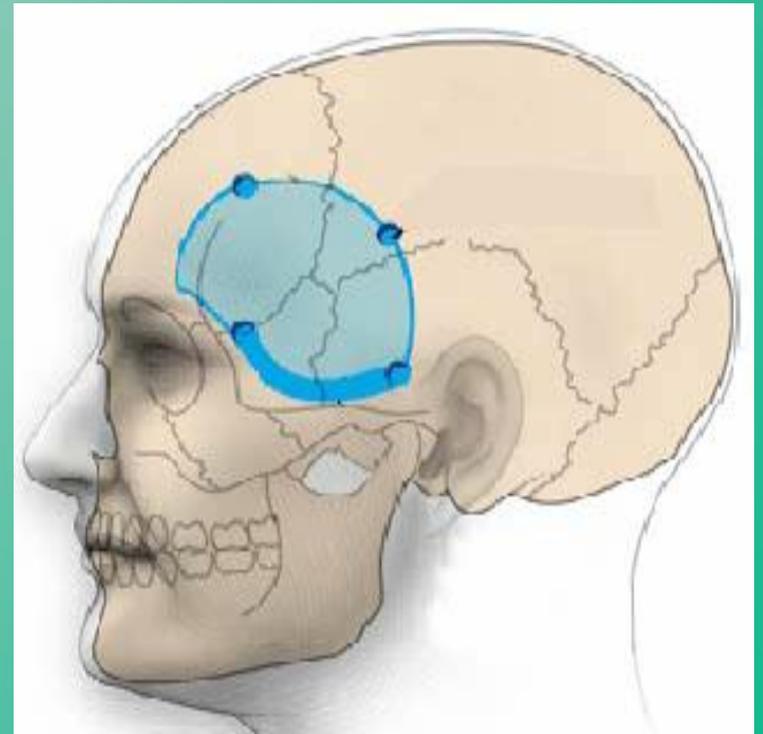
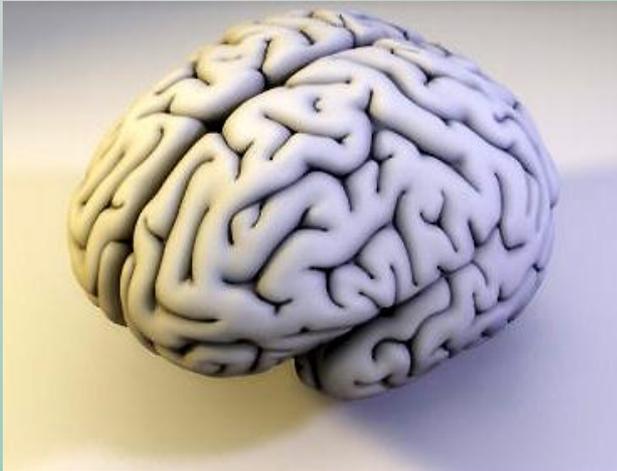
This side view of a human brain demonstrates the many crumpled convolutions of the brain surface. The dark blue streaks on the surface are veins. Looking at the top of the brain, you can see the space and fissure dividing the cerebrum into the right and left halves and the smaller cerebellum below it.

In a 150 pound human the brain accounts for only 2% of the body weight. In the liver, any given area performs the exact same function as another. In the brain, although similar in appearance, each area has a unique function



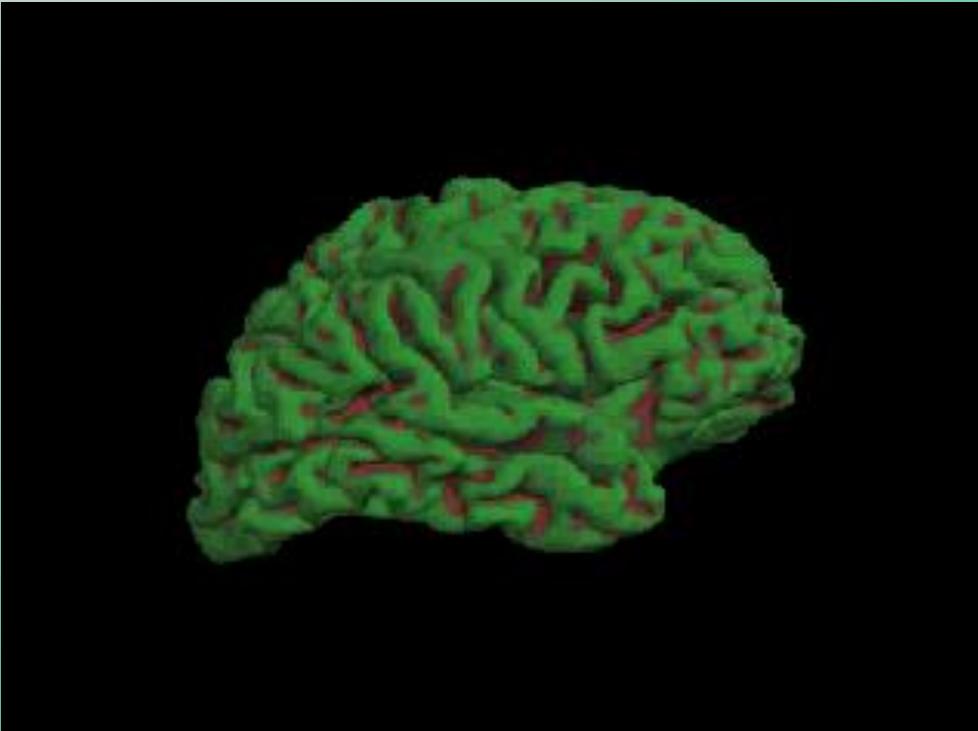


Thinking *inside* the box





Brain Surface Area



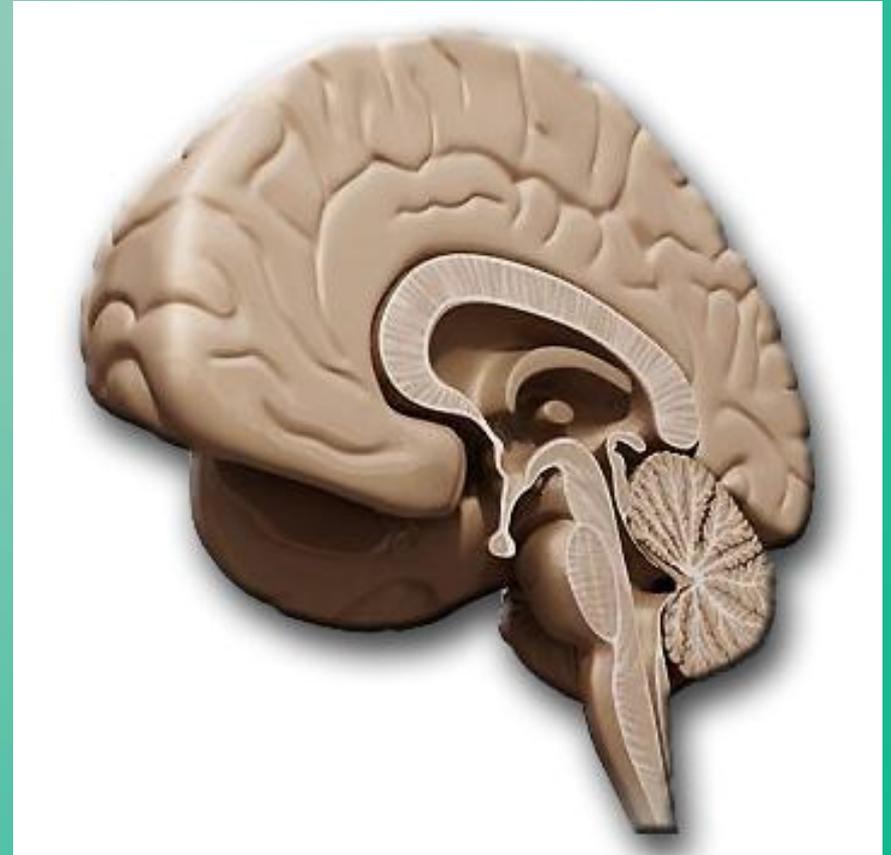
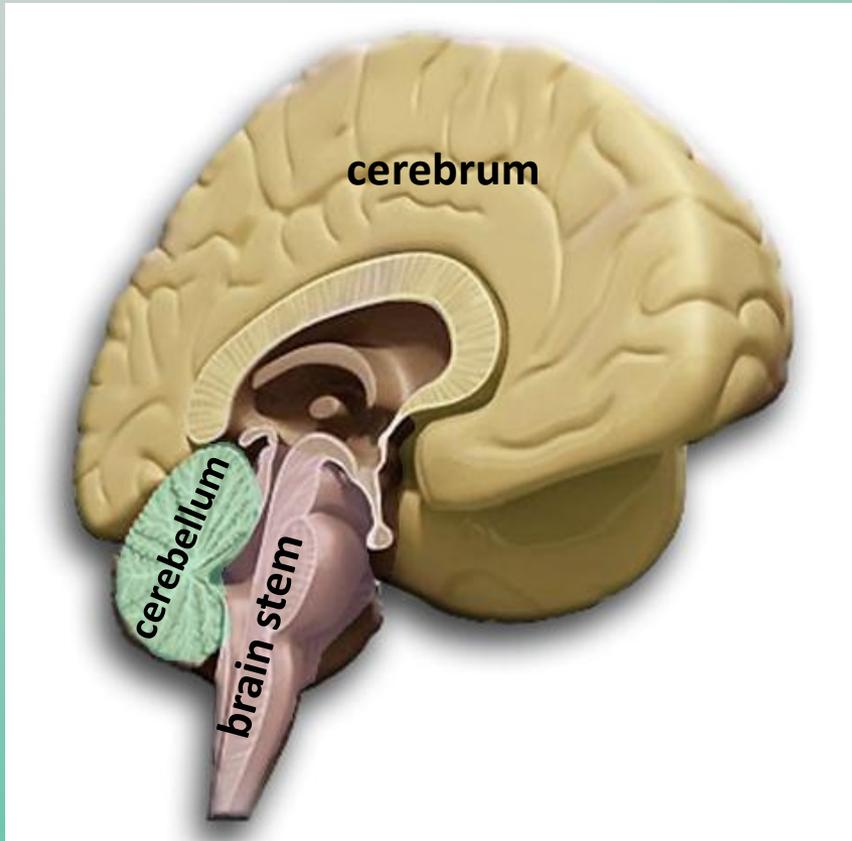
Total surface area of the cerebral cortex = 2,500 cm² (2.5 square feet).

In order to fit it in the skull, it is crumpled up.





The brain is divided into two halves or hemispheres. The large upper part is called the Cerebrum. The lower part is comprised of the Brain Stem and Cerebellum

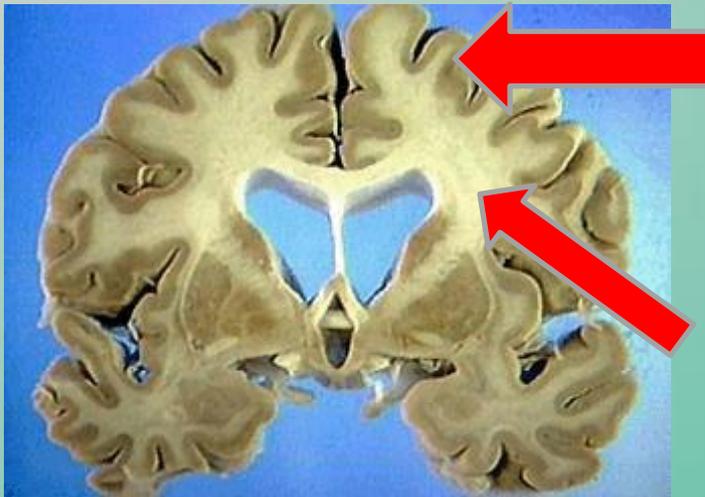


Although the two halves may look alike their functions are very different





The Cerebrum

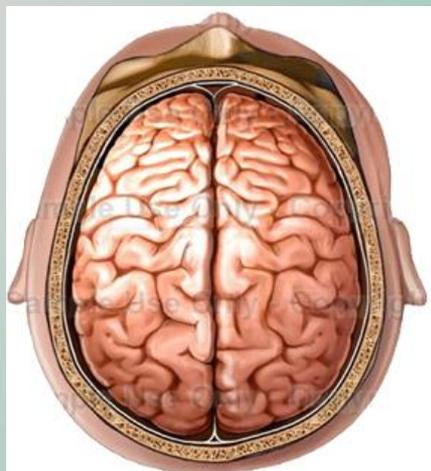


Grey matter is composed of cell bodies of the neurons

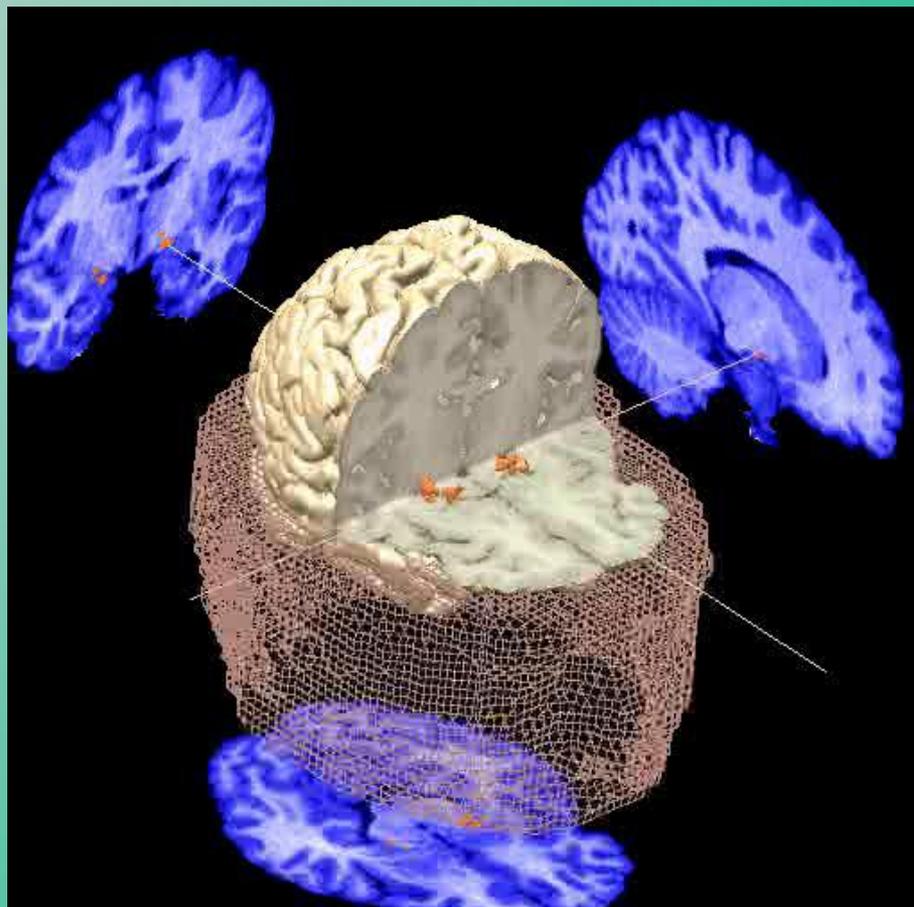
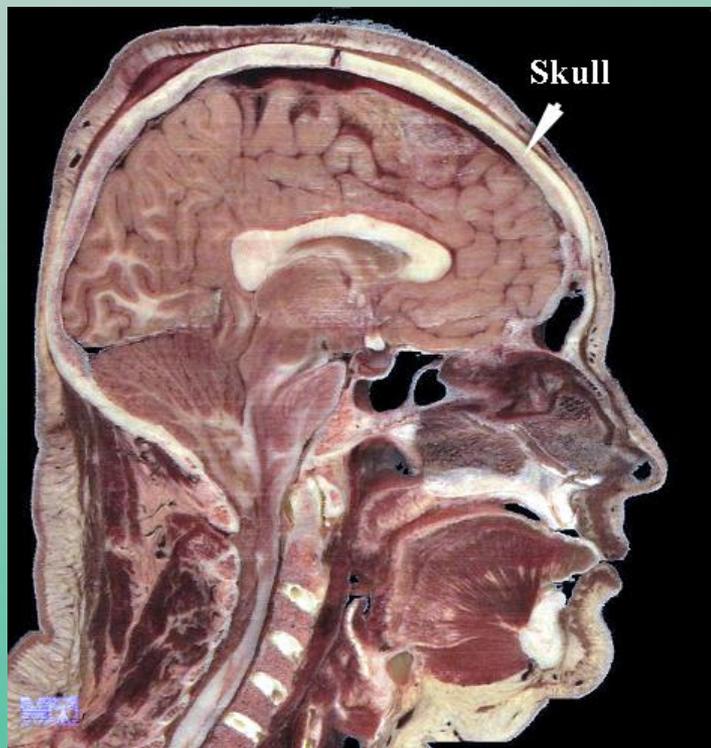
White matter is the axons and dendrites of the neurons – bundles of “cables” connecting regions of the brain and spinal cord.

Deep within the brain are large clusters of neuron cell bodies called nuclei or ganglia. They are also grey matter



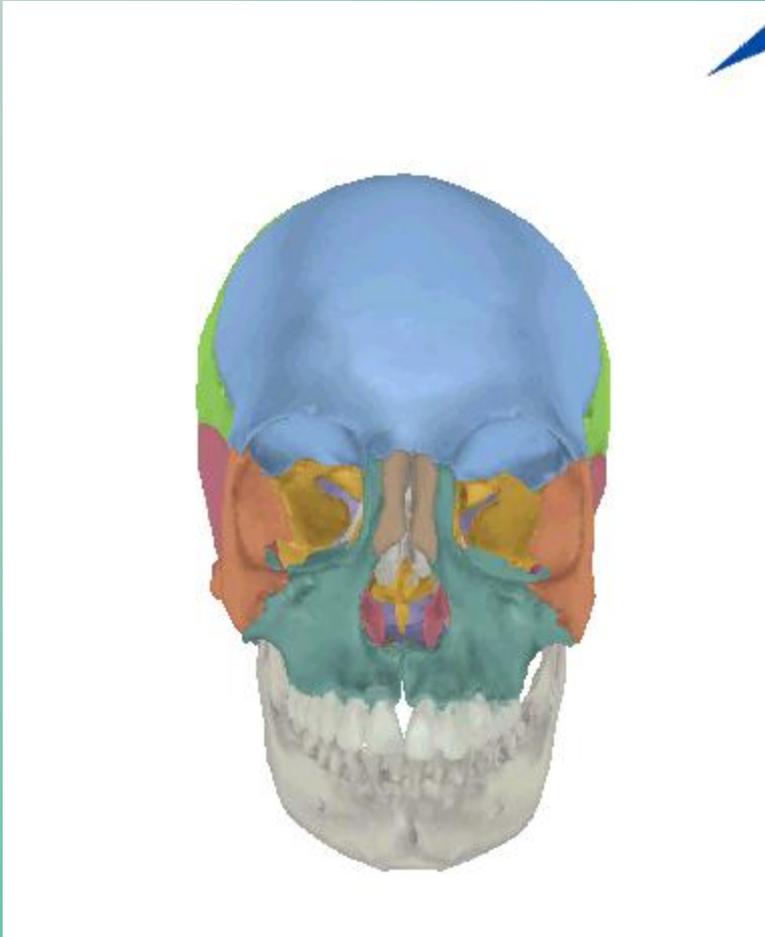
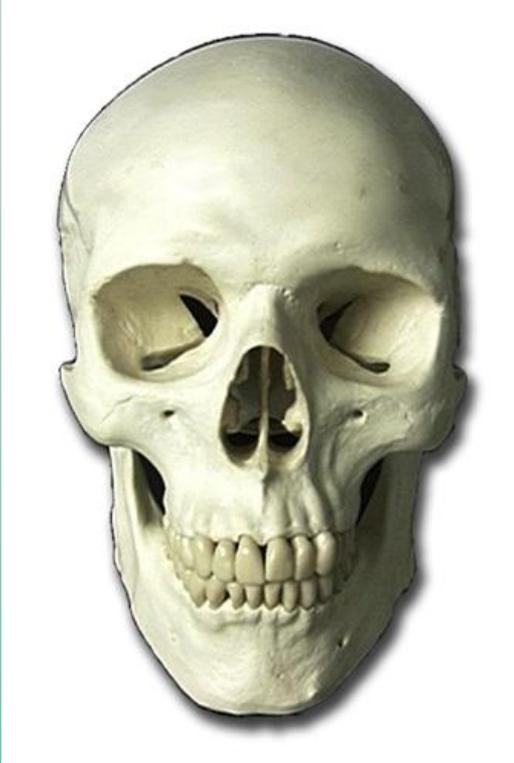


The brain is situated in a very rigid bony casing, the skull.



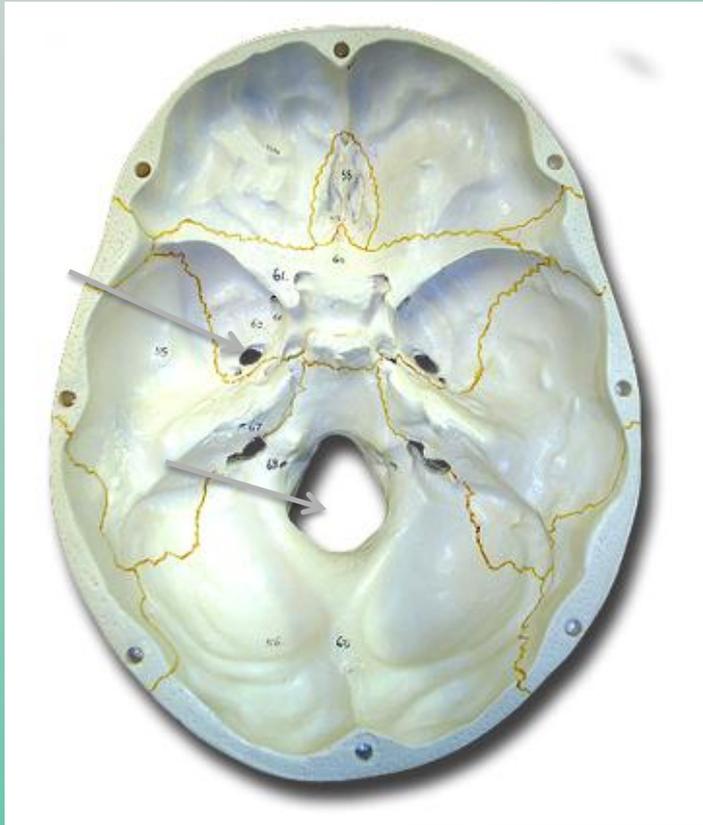


The Skull

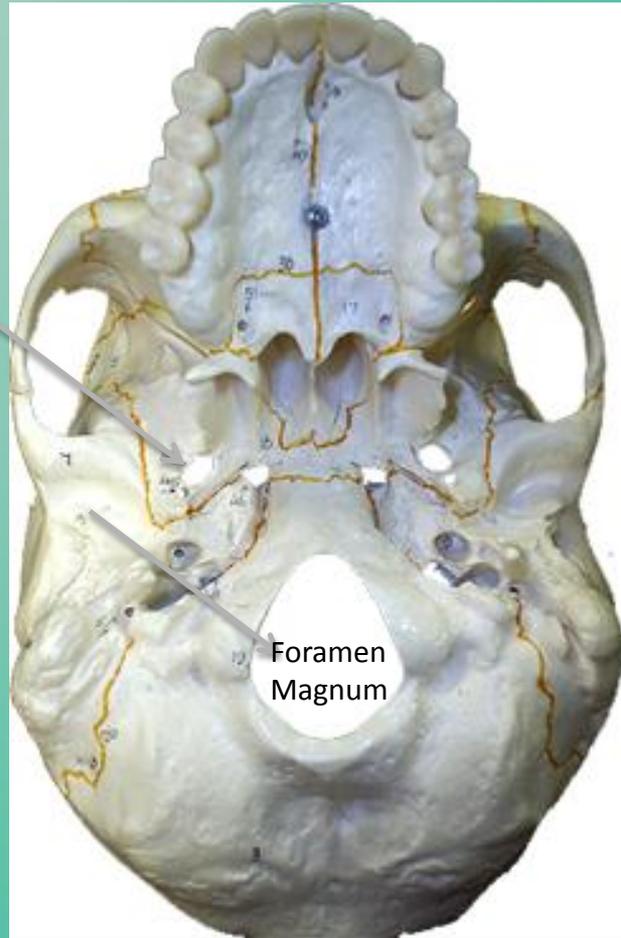




The Skull



Inside view

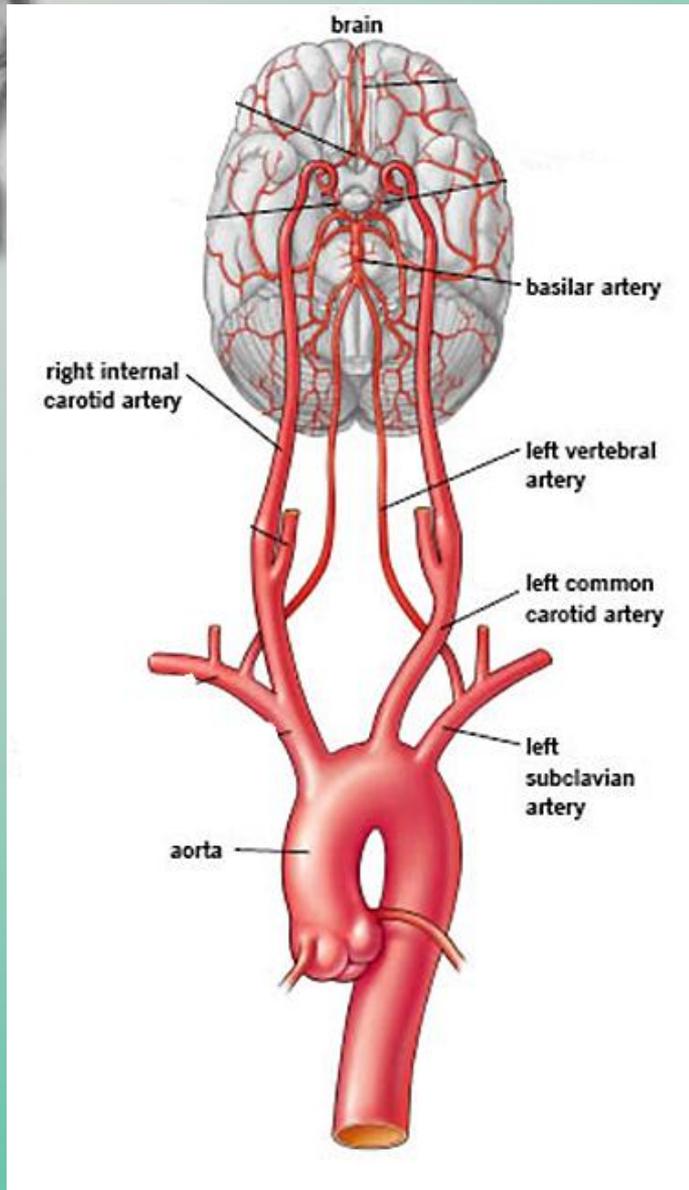


Under surface

The underside of the skull has several holes (foramen) for the passage of nerves and blood vessels.

The large hole (Foramen Magnum) is for passage of the spinal cord





Brain Circulation



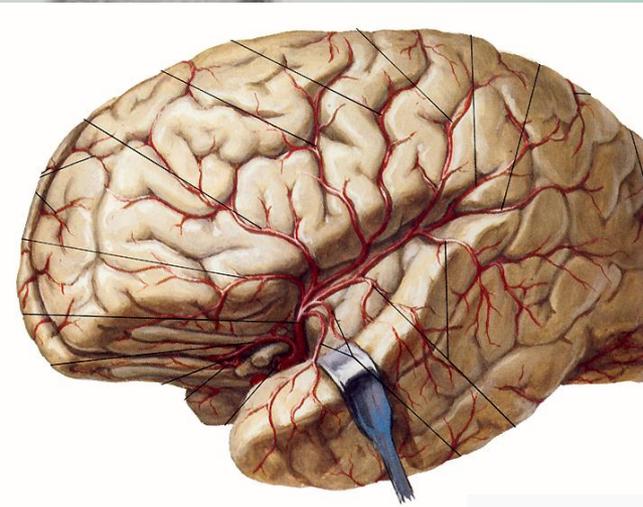
An example of the blood vessels in a human brain, with the brain tissue removed

Although the brain comprises only about 2% of the body weight it uses about 20% of the body's blood supply and consumes 15-20% of the oxygen

The human brain contains around 400 miles of blood vessels.

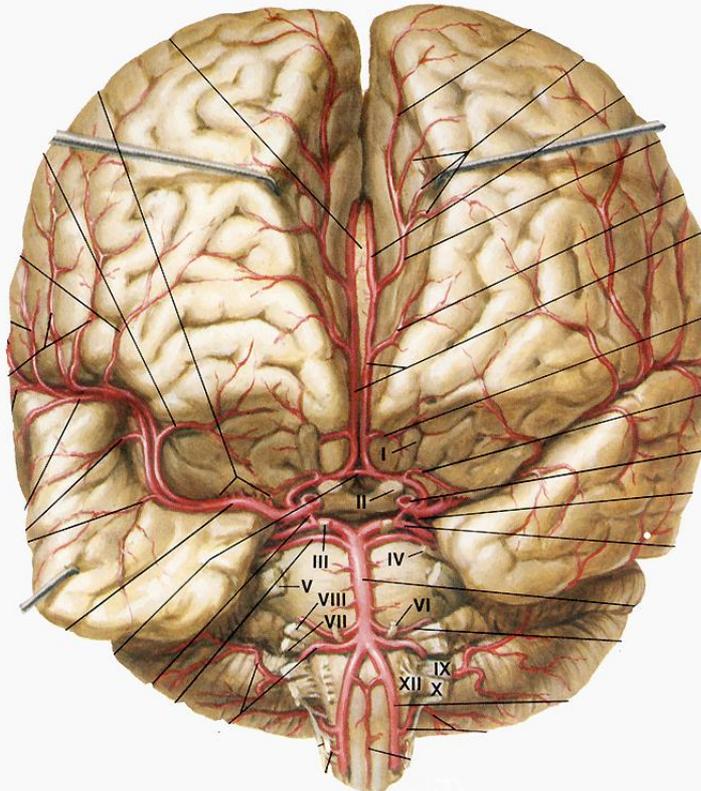


Brain Circulation



Each area of brain is almost totally dependent upon the specific artery supplying that areas blood.

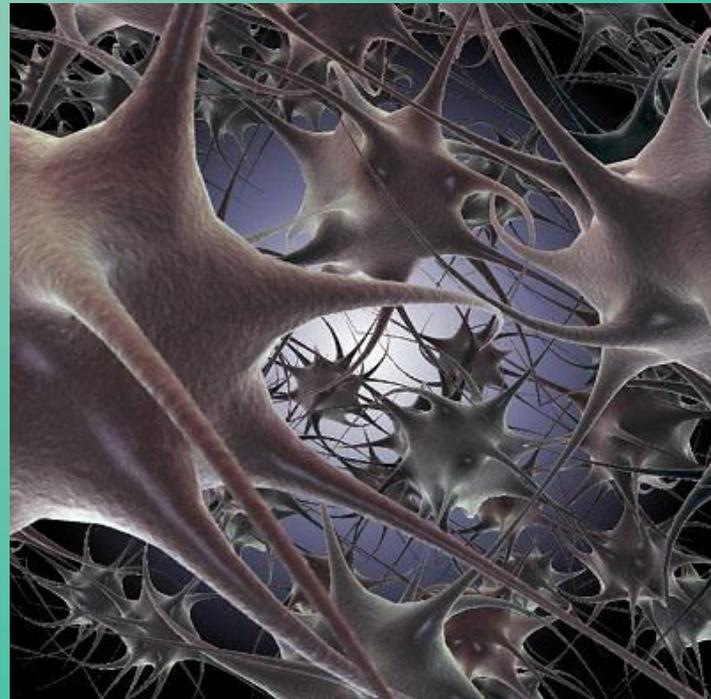
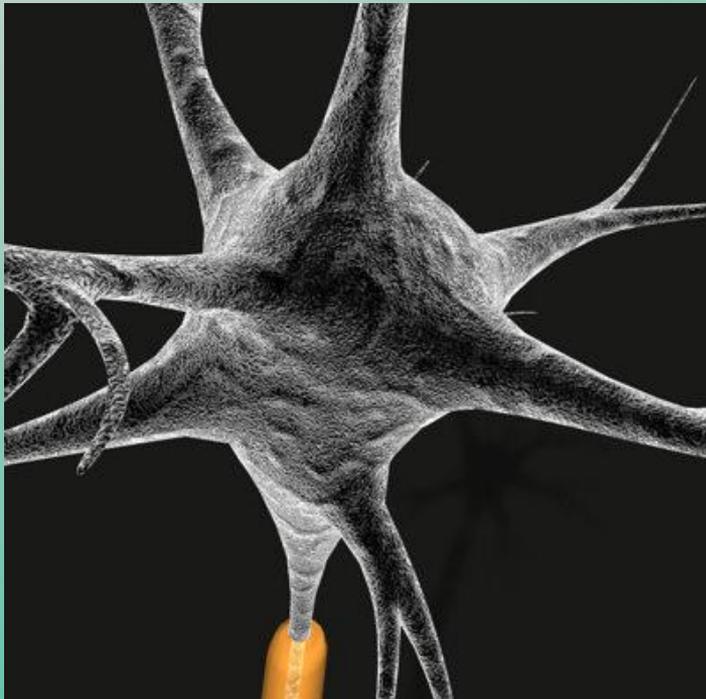
So when the artery is blocked, that area of brain dies.





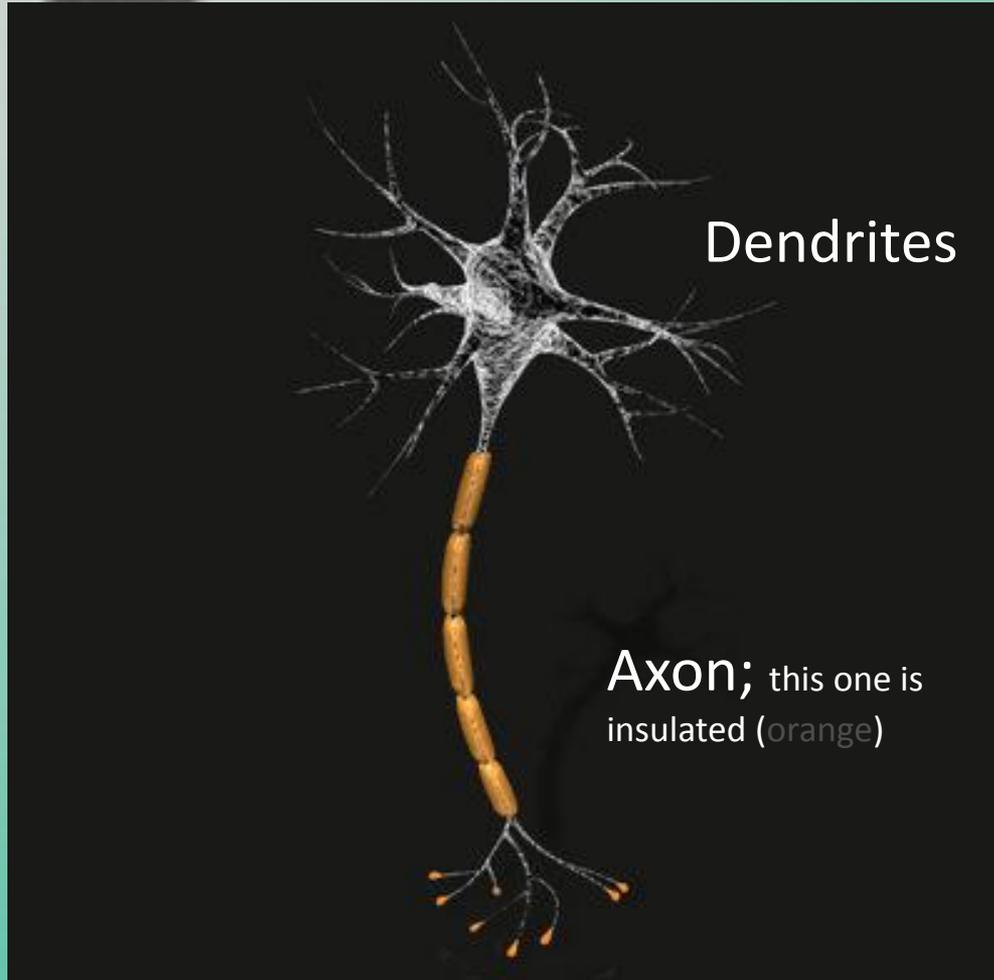
What is a brain made of?

Like all other organs of the body, the brain is made up of cells. These cells, like all others, have a nucleus, membranes, DNA, etc. The uniqueness in these cells is the long extensions of the cell membranes.





These cell extensions are specialized



A **neuron** is a nerve cell.

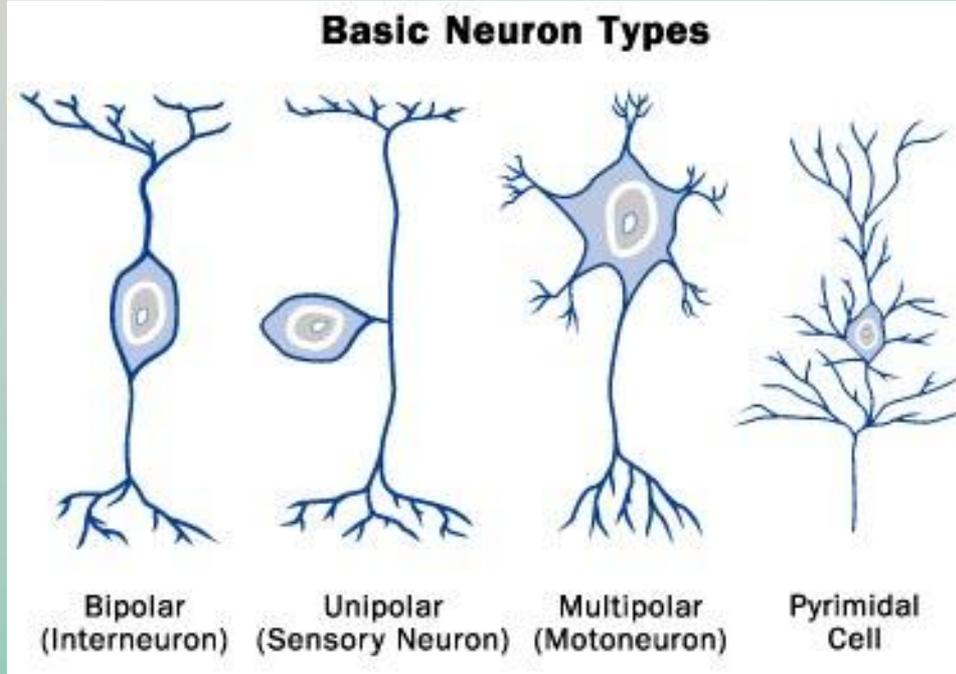
The brain is made up of approximately 100 billion neurons.

Neurons have specialized projections called **dendrites** and **axons**. Dendrites bring information to the cell body and axons take information away from the cell body.



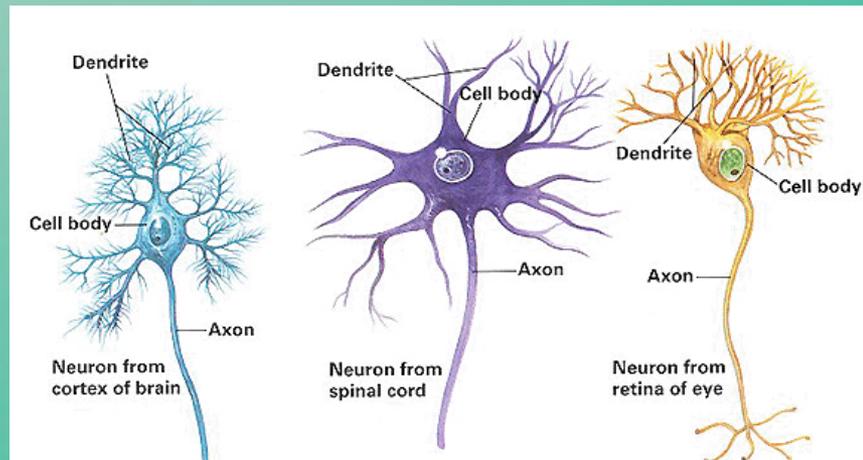


Neurons
come
in
many
shapes
and
sizes



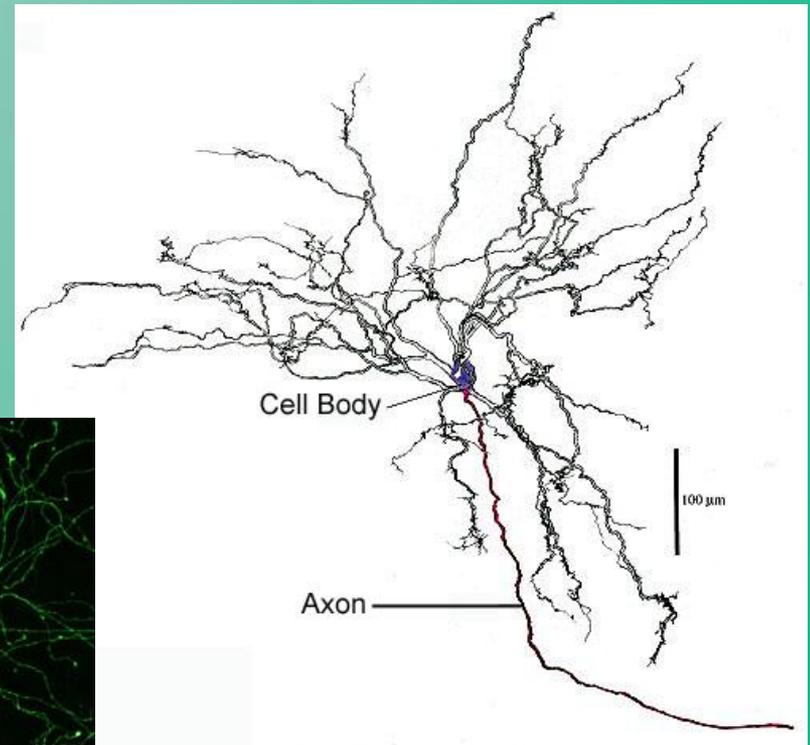
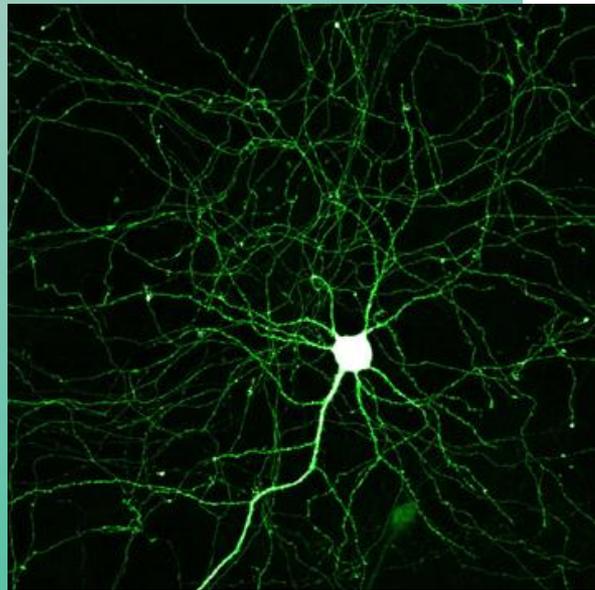
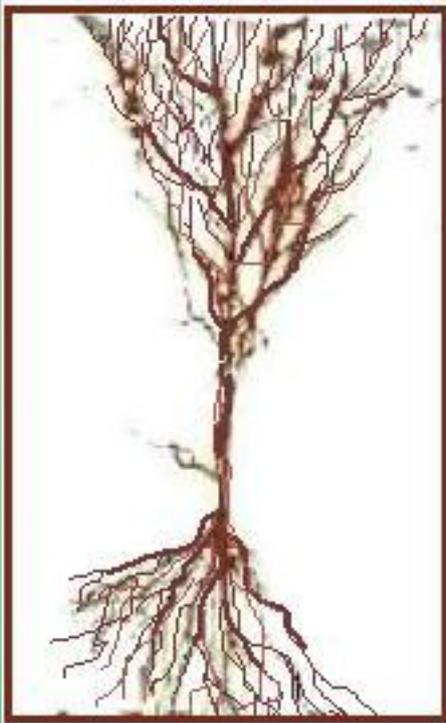
The axon of a motor neuron in the spinal cord that innervates a muscle in the foot can be about 3 feet in length.

Length of a Giraffe sensory axon, from toe to neck, is 15 feet.



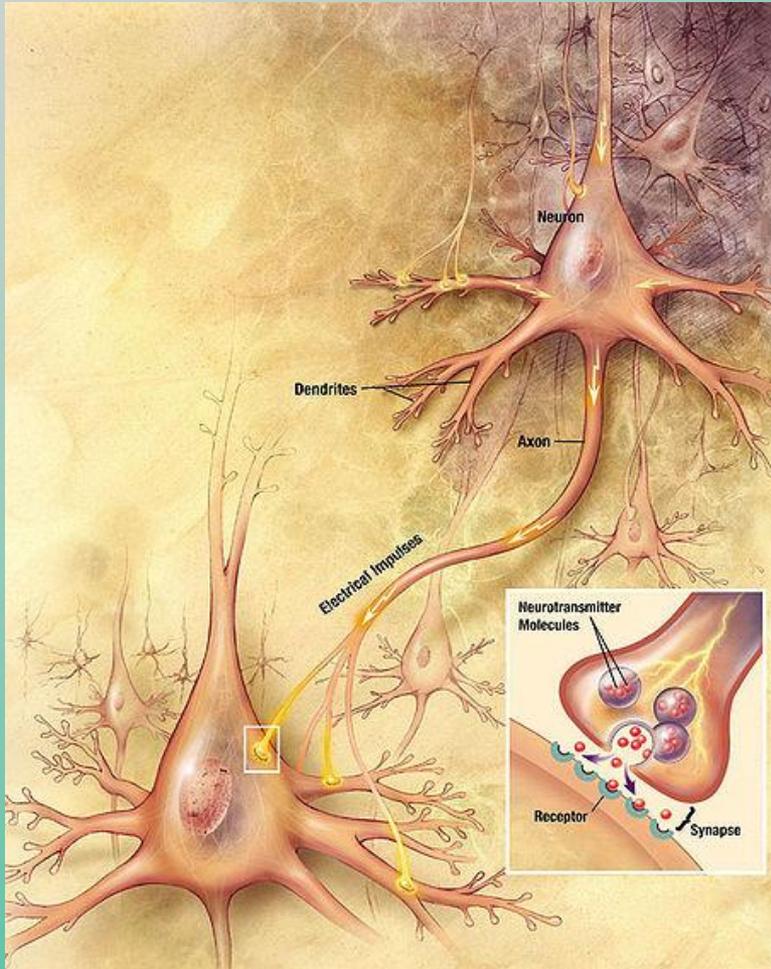


Neuron shapes can be very complex





Neuron Connections, The Synapse



Neurons communicate with each other through chemical connections called synapses

A single neuron can have between 1,000 and 10,000 synapses in contact with it.

Electrochemical impulses travel at different speeds within different types of neurons. Transmission can be as slow as 0.5 meters/sec or as fast as 120 meters/sec.

(equivalent to 268 miles/hour)



The Synapse

Although the neurons appear to be touching, they are separated by small gap called a **synapse**

Total number of synapses in cerebral cortex is about 60 trillion. This is equal to about a half-billion synapses per cubic millimeter.





Imagine, that in addition to each neuron, there are 50 times as many glial cells, and many blood vessels filling the space between them.

Unregistered MiniCapture





Other cells in the brain

The neurons make up less than 8% of the cells in the brain.

The majority of the remaining cells are called “Glia”, which means glue. There 10-50 times as many Glia cells as neurons.

There several types of glial cells;

Insulate the neurons (myelin)

Oligodendrocytes

Nourish and support the neurons

Astrocytes

Produce Spinal Fluid

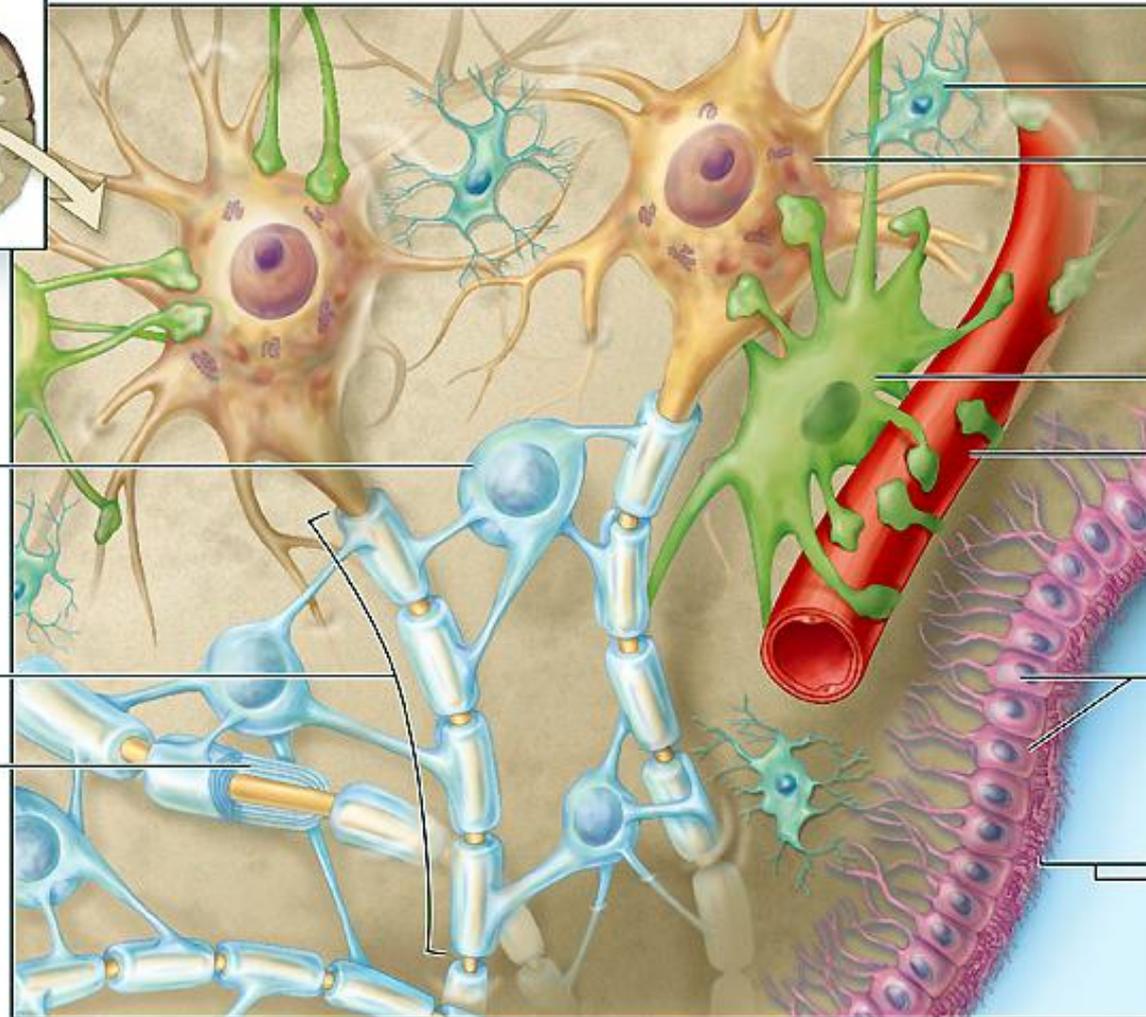
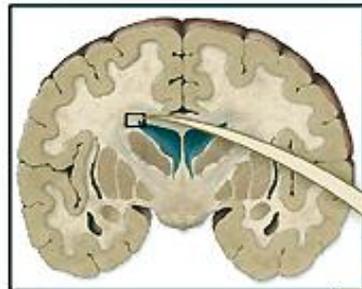
Ependymal Cells

Remove debris

Microglia



Glial Cells



Oligodendrocyte

Myelinated axon

Myelin sheath (cut)

Microglia

Neuron

Astrocyte

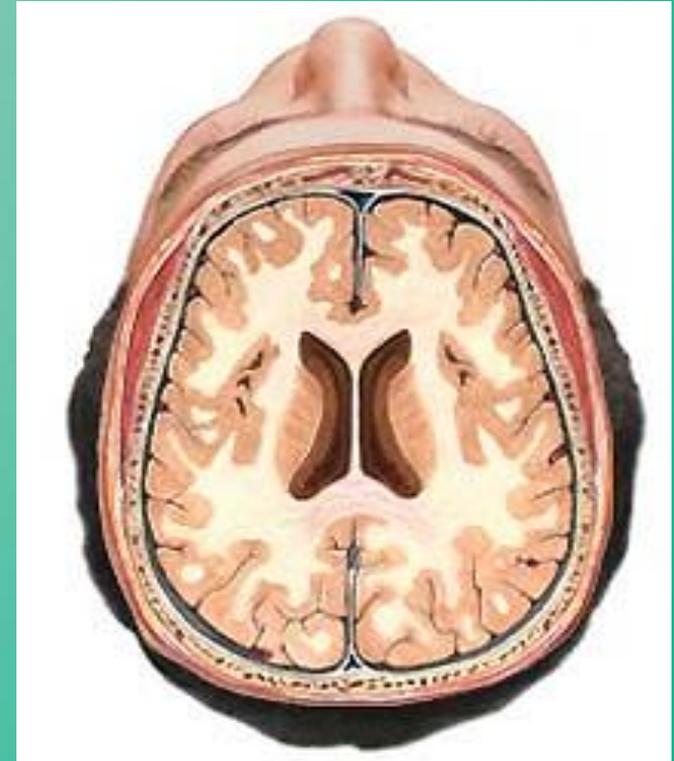
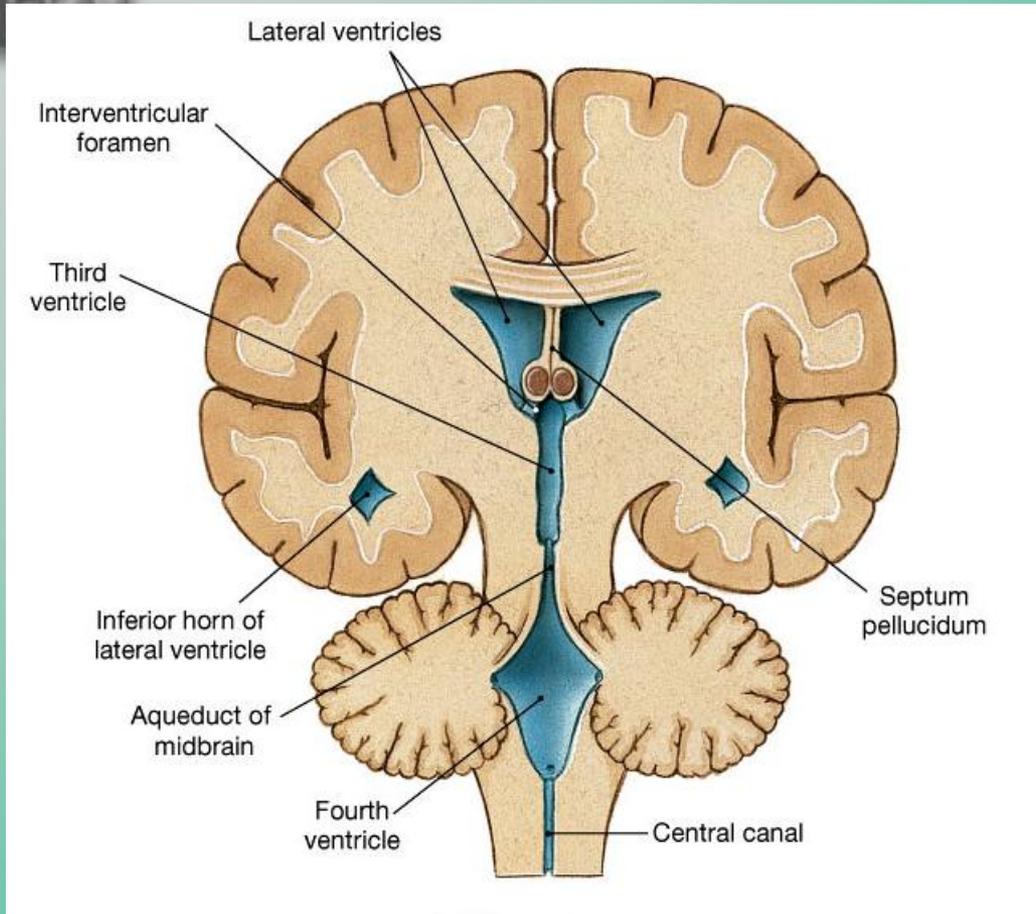
Capillary

Ependymal cells

ventricle of brain



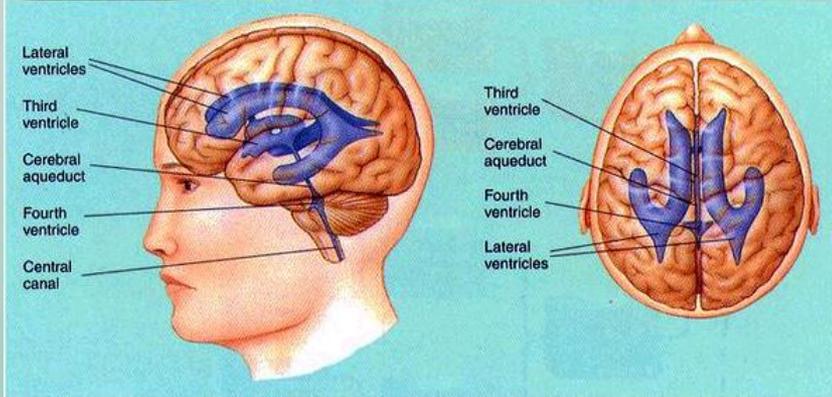
The Ventricles



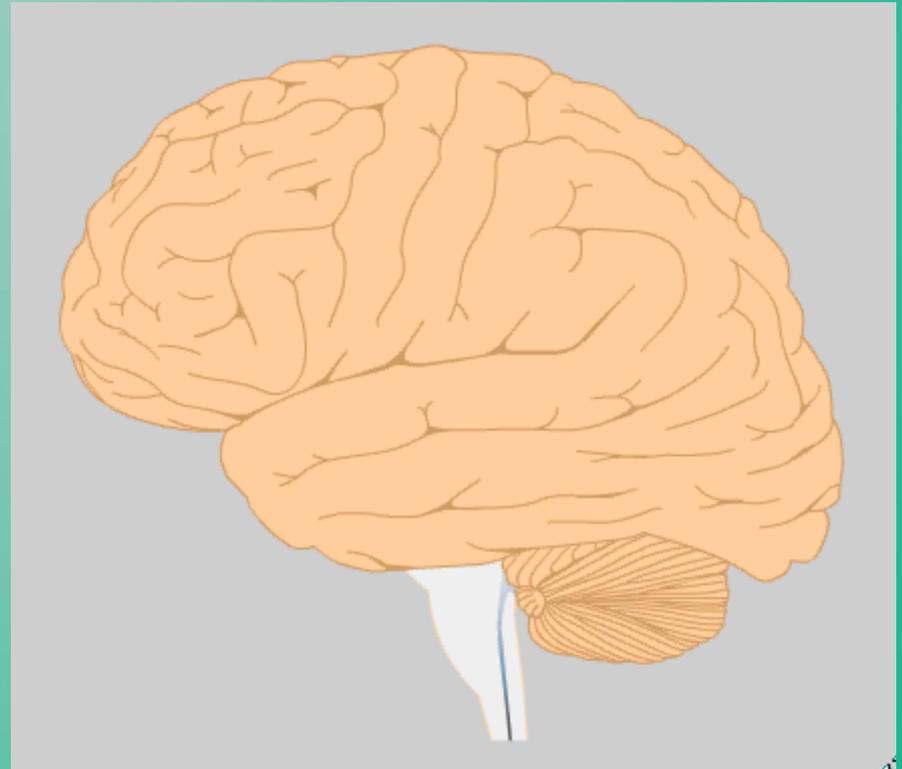
The **ventricles** are cavities in our brains, where most of the **cerebrospinal fluid (CSF)** is made.



The Ventricles



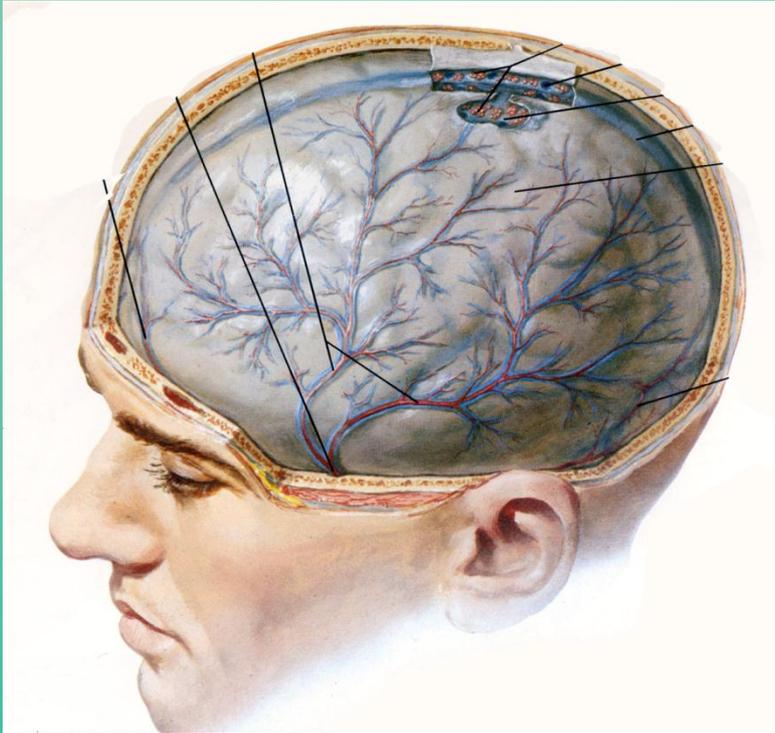
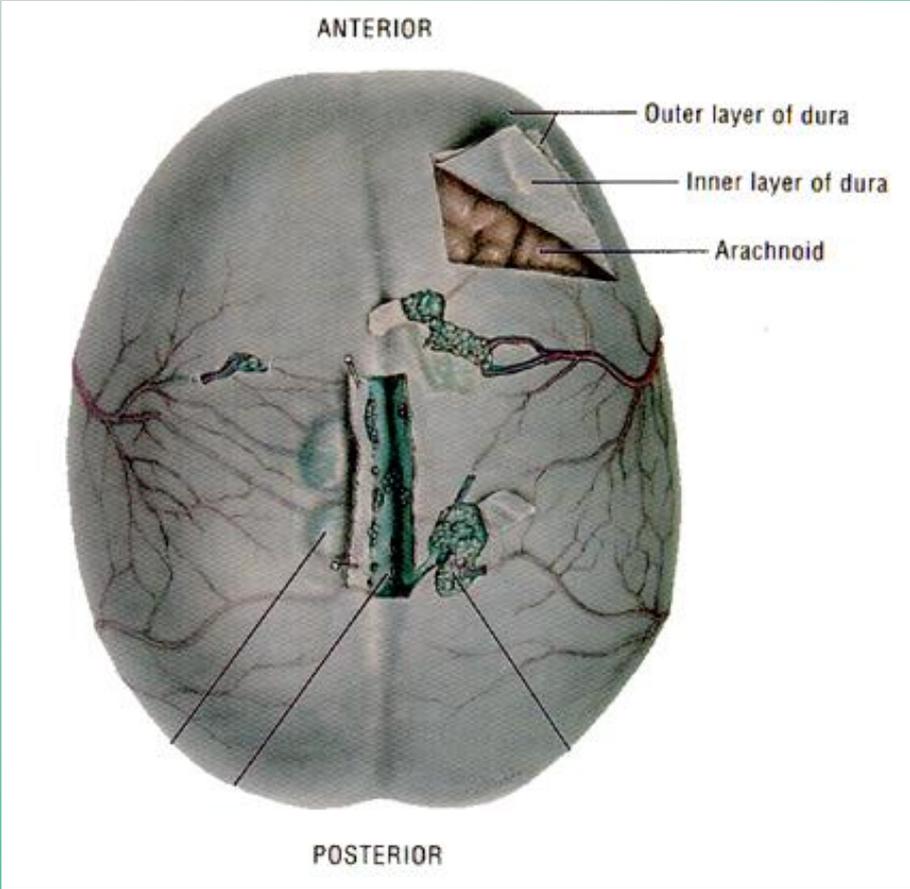
The animation illustrates a 3D view of the ventricles, as though a cast was made.





Coverings of the Brain

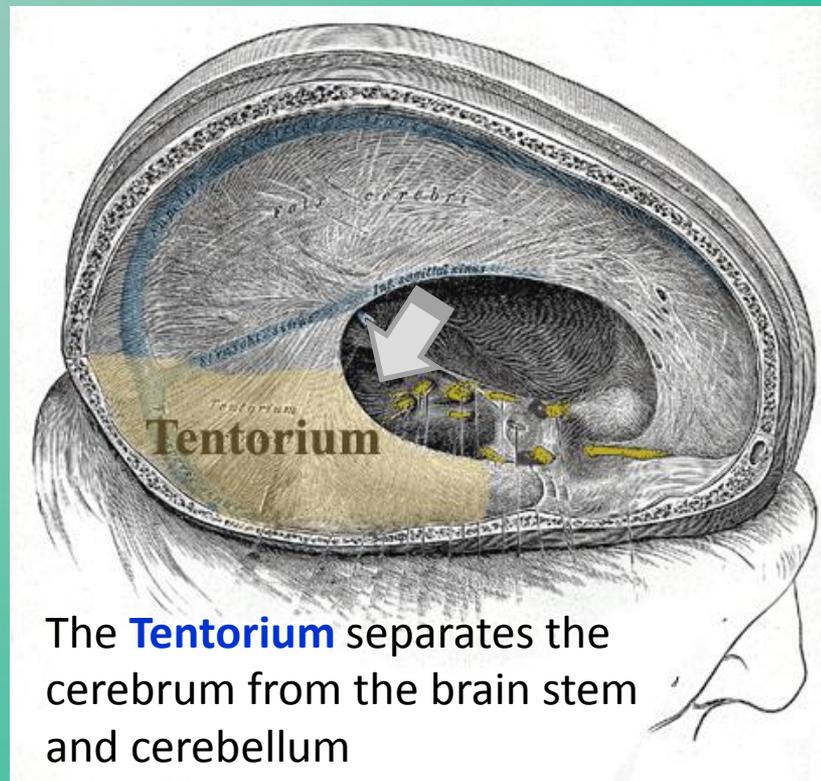
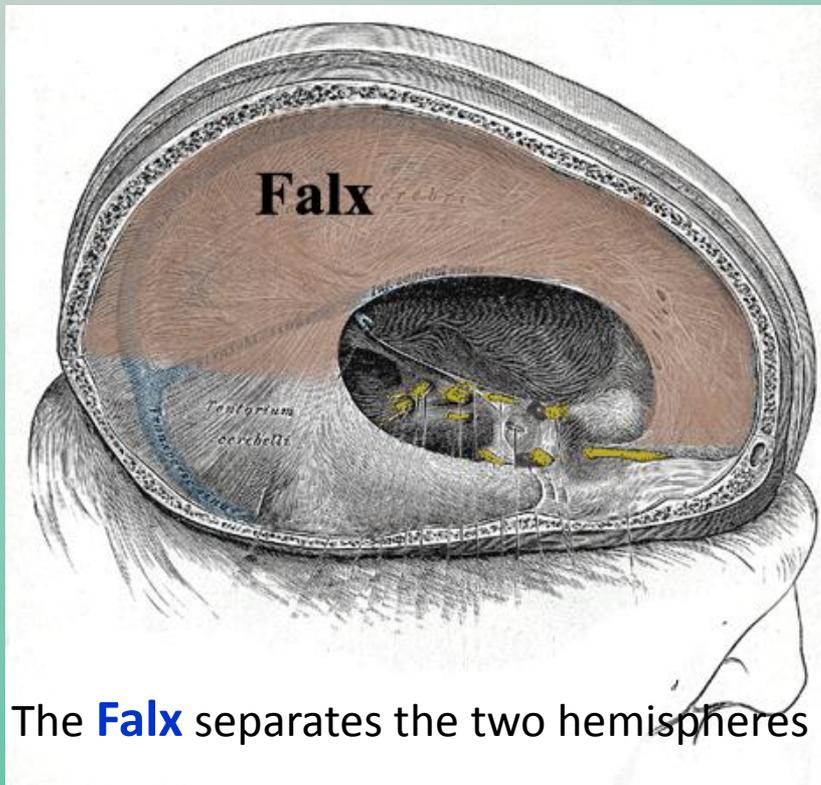
Dura



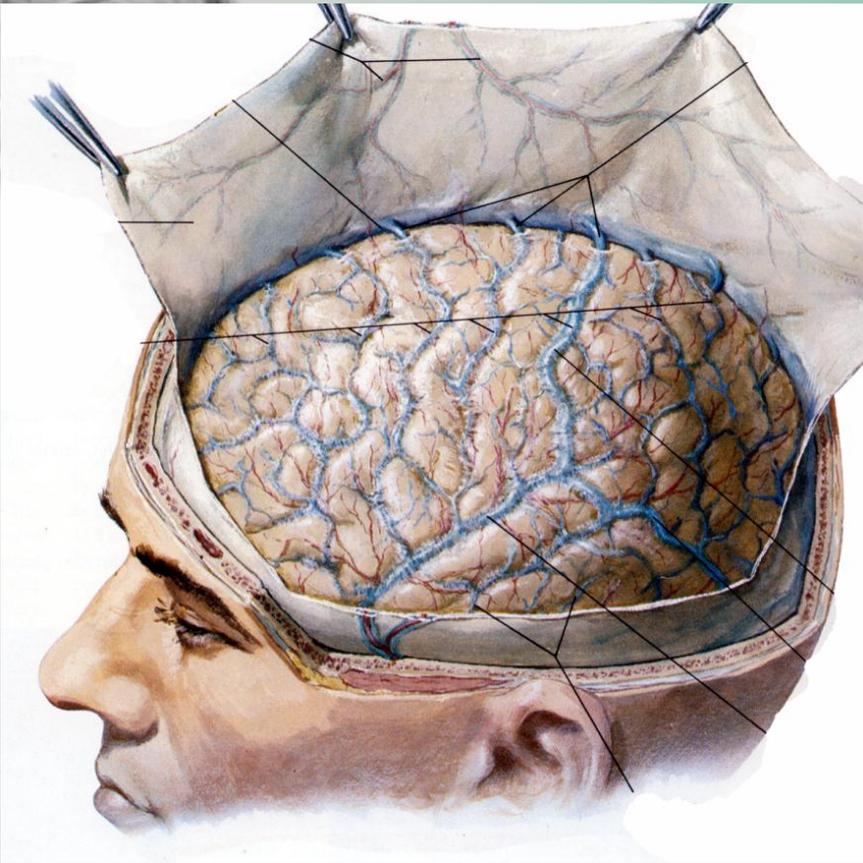


Dural Partitions

In a few regions, the dura creates large partitions, separating large parts of the brain



Arachnoid



The **Arachnoid** is like a sheet of cellophane that is draped over the brain. It does not dip into the valleys of the brain contour.

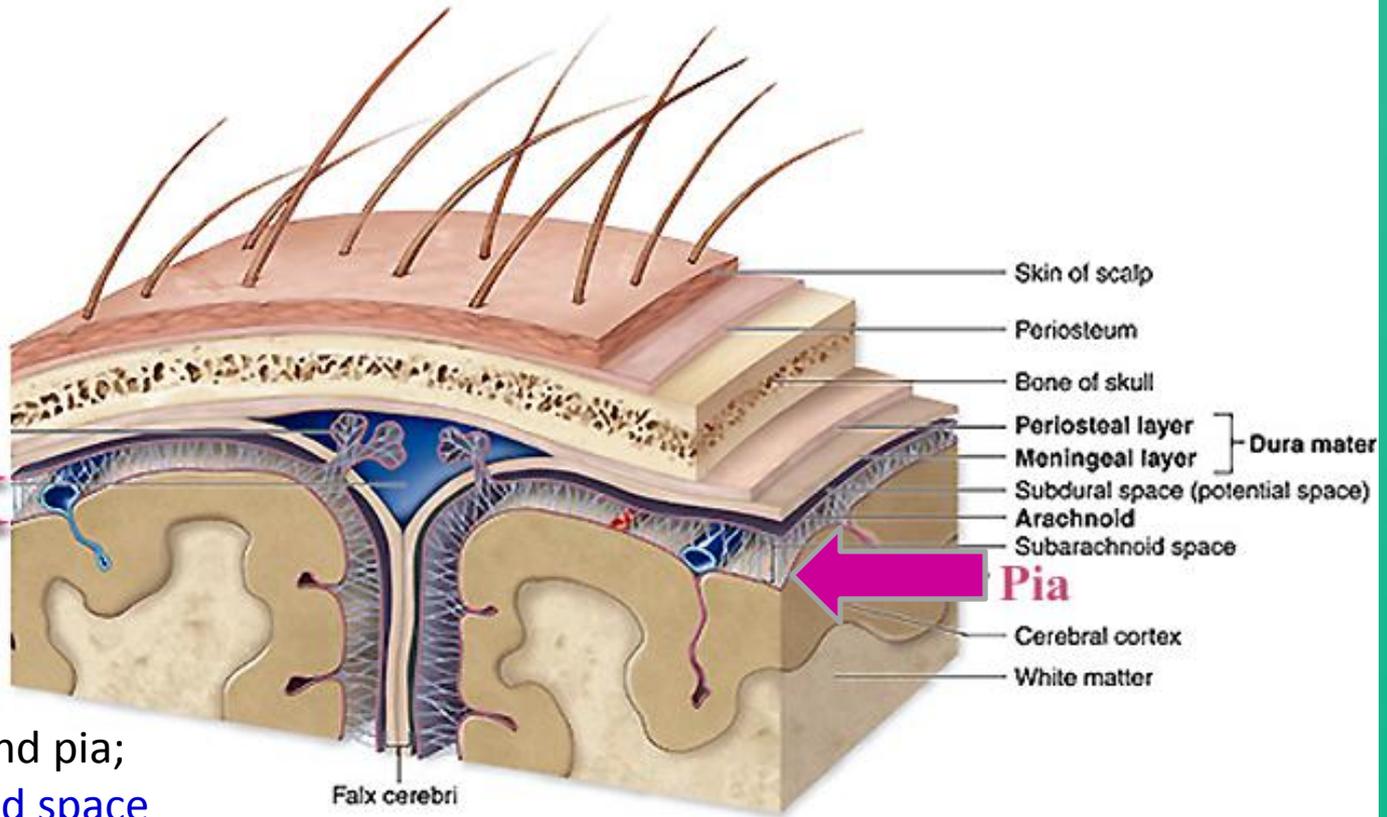
There is a space between the Arachnoid and the brain called the **subarachnoid space**. In this space is the spinal fluid and the blood vessels





Pia

The **Pia** is a single layer of cells that coat the brain surface, much like linoleum on a floor



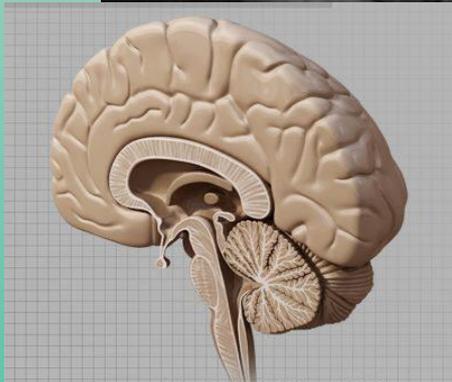
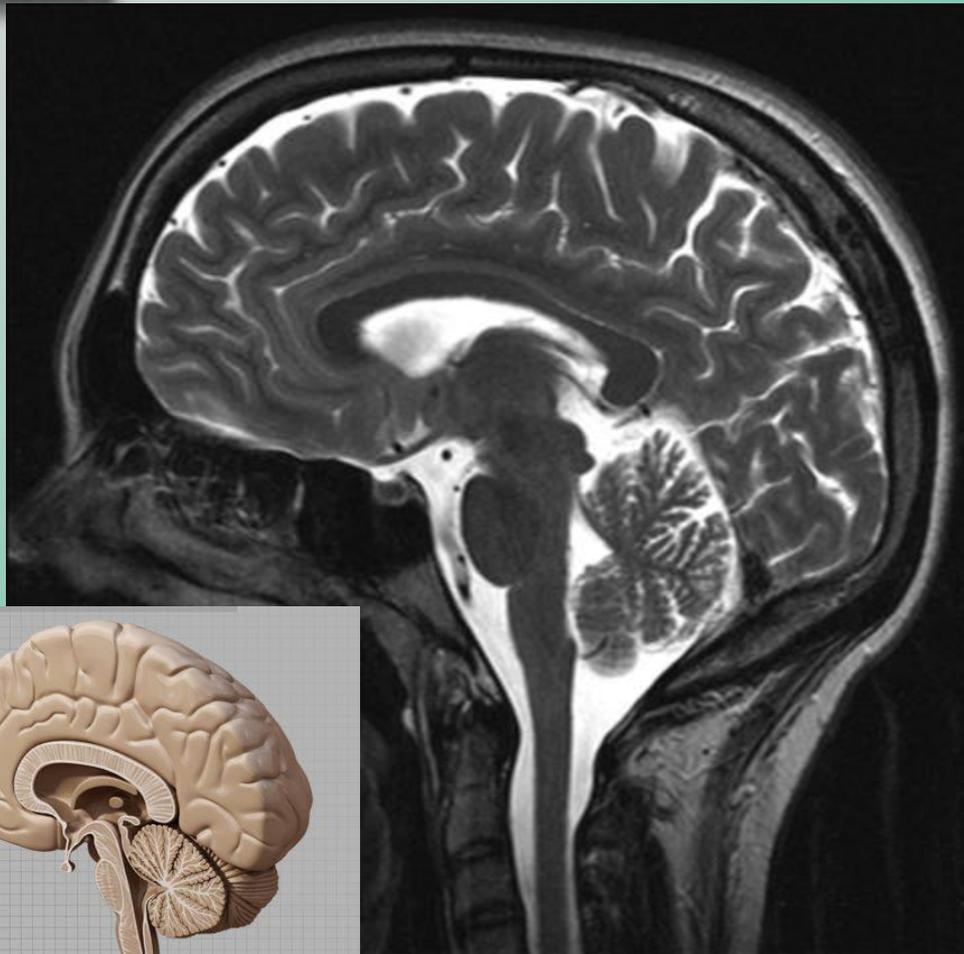
The arrows outline the space between the arachnoid and pia; the **subarachnoid space**





Cerebrospinal Fluid

CSF



CSF is **actively** secreted by the brain. CSF is constantly being made, circulates and is reabsorbed into the blood stream.

Total volume of cerebrospinal fluid = 125-150 ml

CSF is made at a rate of about 30cc per hour

The entire volume of cerebrospinal fluid turns over 3 to 4 times per day

The CSF resides in the subarachnoid space





For Brain Function
and
Basic Physiology
go to
Anatomy & Physiology
Part II

