13. Nervous System: Brain and Cranial Nerves

I. Protection and Support of the Brain

Cranial meninges
The cranial meninges are similar to the spinal meninges (Fig. 13.5). In fact, the cranial meninges are contiguous with the spinal meninges.

A. The pia mater is the innermost layer, and it is tightly associated with the surface of the brain.

B. The arachnoid mater is the middle layer. A subarachnoid space filled with CSF lies between the arachnoid and the pia mater. Note that the arachnoid is smooth, and it does not follow the folds of the cerebrum.

C. The dura mater is the outermost and toughest layer. There are two major differences between the dura of the brain and the dura of the cord: (1) The dura of the brain consists of two layers; the periosteal layer is attached directly to the inner surface of the skull and the meningeal layer is deep to the periosteal layer. In places, the two layers are fused together; in other places, dural sinuses lie between the two layers. (2) There is no epidural space associated with the brain.

Brain ventricles
The brain contains cavities, called ventricles (Fig. 13.7). Each cerebral hemisphere contains a large lateral ventricle. The third ventricle lies within the diencephalon. The fourth ventricle lies between the pons and the cerebellum.

The ventricles are connected to each other, and the fourth ventricle is continuous with the central canal of the spinal cord. Like the central canal of the spinal cord, the ventricles of the brain are filled with cerebrospinal fluid (CSF). The CSF circulates from the ventricles and central canal into the subarachnoid space of the surrounding meninges via openings at the fourth ventricle.

Cerebrospinal fluid
Cerebrospinal fluid forms a liquid cushion around the brain and spinal cord. CSF is also found in the ventricles of the brain and central canal of the spinal cord. It is similar in composition to blood plasma, but with less protein and different concentrations of various ions.

CSF is produced from blood in structures called the choroid plexuses (Fig. 13.8), which are located in each of the ventricles. The choroid plexuses contain specialized ependymal cells, which secrete the CSF, remove waste products from the CSF, and regulate its composition. Structures called the arachnoid villi absorb CSF back into the bloodstream. CSF is produced at a rate of about 500 ml per day, although the total volume of CSF at any one time is just 150 ml. Thus, there is rapid turnover of CSF. Hydrocephalus may result in infants that have problems with reabsorption of CSF.

Check out the following link for an animation on how CSF flows: https://www.youtube.com/watch?v=f90ZdNbiigQ&list=PLrKmnG19xn_jlEPmBtiyeEwzhAtZ_m8vb
Blood-brain barrier
Unlike capillaries in most other parts of the body, capillaries within the CNS are lined with epithelial cells that are tightly connected to prevent movement of materials between the blood and the interstitial spaces (Fig. 13.10). Astrocytes also wrap around capillaries to restrict movement between the blood and brain tissue. Together, the epithelial cells of the capillaries and the astrocytes form what is called the blood-brain barrier. Although lipid soluble molecules (e.g., oxygen, CO₂, lipids, and small alcohols) are able to diffuse freely between the CNS and the blood, movement of other molecules is restricted.