Lecture 2- Introduction to Anatomy of the Brain

Directional Terms

Dorsal: Back	Rostral: Upward
Ventral: Front	Caudal: Downward

Meningeal Coverings (Nolte 5th Ed. Pg 79)

The CNS is suspended within a membrane called **meninges**. This membrane is 3 layers thick and serves many functions. Within the meninges you find an aqueous fluid called **cerebrospinal fluid (CSF)**. This fluid adds buoyancy therefore protecting the brain against any effects from gravity etc.

The brain is covered by meninges, this in turn attaches to the skull therefore the brain has to move as the head does.

Meningeal Coverings (Nolte 5th Ed. Pg 80)

Summary: Three layers. Outermost – **Dura Mater**, Second Most – **Arachnoid**, Innermost – **Pia Mater**. The dura mater is the thickest layer and the rest are relatively thin in comparison. Note the similarity to these coverings to the coverings of the heart. The pia and arachnoid are continuous with each other, whilst the dura is the thick outer most covering (Good picture on Pg 80). Dura mater → attached to inner surface of skull, the arachnoid adheres to the inner portion of the dura mater, whilst the pia follows the intricate contours of the brain. See the diagram below:

Insert Picture here

The **sub-arachnoid space** contains the CSF that add buoyancy effects to the brain. Note that the meningeal coverings of the brain are unique and does differ to those of the spinal cord.

Functions of the dura mater (Nolte 5th Ed. Pg 81)

The main function of the dura mater is to provide a thick outer coating capable of protecting the brain physically. Mainly acts as a **physical barrier**. It is often described as containing two layers – **outer periosteal layer** (covers inner skull) and **inner meningeal dura** (just above arachnoid).

For the main part, no space actually exists on either side of the dura mater, but certain pathological conditions (eg: haemorrhage) can lead to fluid filled cavities located in these areas. Under normal circumstances, these potential spaces can occur above the dura mater (periosteal layer ↑) – called **epidural**, and the other space is called **subdural** (between meningeal layer of dura mater and arachnoid).

Dura venous sinus (Nolte 5th Ed. Pg 81)

For the most part, don't worry about the details here. Just understand that normally (generally speaking) the two layers of the dura mater are fused prominently. But there are exceptions where sinuses occur. These **sinuses** are where cerebral veins drain into. Fig 4-6 shows a good section.

Blood supply of the dura mater (Nolte 5th Ed. Pg 83)

Refer to the diagram below to under the arterial supply. The arterial supply derives from branches of arteries supplying the skull by travelling in the **periosteal layer** of the dura mater. The **middle meningeal artery** supplies most of the lateral part of cerebral dura. Anteriorly it is supplied by branches from the **ophthalmic artery,** posteriorly it is supplied by branches of the **occipital and vertebral arteries.**

Insert picture here.

Arachnoid (Nolte 5th Ed. Pg 86)

Note that the dura mater is probably one of the main structures that is sensitive to pain while physical sensation occurs. The brain, arachnoid, and pia mater are not at all sensitive to pain; hence some neurosurgical procedures can be done without anaesthesia.

The arachnoid is a thin **avascular** membrane composed of a few cell layers thick, and consist of interspersed **collagenous** bundles. There is an **"interface layer"** that intimately associated with the dura mater. The **arachnoid trabeculae** are projections that extend from the "interface layer" and continue onto the pia mater. The sub-arachnoid space is formed because the pia mater follows the intricate dips and engravings of the brain whilst the arachnoid fails to follow the same pattern. This allows CSF to be formed. Where large areas exist, this forms **cisterns**.

The arachnoid functions in **maintaining the strict environment** in which the CNS lives. If you inject a dye into the **middle meningeal arteries**, you find the dye in the dura mater and not into the arachnoid and sub-arachnoid space. Why? This is because the arachnoid cells in the "interface layer" have no collagen interspersed between them and are tightly bonded to each other by **tight junctions**.

Cerebral surface (Nolte 5th Ed. Pg 57)
This is just a little bit of terminology which helps in the understanding of the brain structures, and contours. Each groove between ridges is called **sulcus**. Each ridge within the convoluted area of the brain is called **gyrus**. When **sulci** become quite large, we call them **fissures**.

Major Subdivisions – Lateral View (Nolte 5th Ed. Pg 57, Netter Plate99/100)
The brain is conveniently divided into different lobes and each of these lobes have named gyri, sulci and fissure. The cerebrum is the main part of the brain, and it has right and left sides. The lateral view allows vision of the cerebrum, cerebellum, and brain stem. For orientation purpose, we use the central sulcus, parietooccipital sulcus, preoccipital sulcus, and cingulate sulcus as key landmarks (For good picture, refer to Pg 55). Each cerebral hemisphere is divided into 5 lobes. These are described below.

Frontal Lobe: The frontal lobe extends from the anterior tip of the brain to the central sulcus (purple section). On the lateral surface the lateral sulcus separates this lobe from the temporal lobe (blue section). On the medial surface it extends along the cingulate sulcus, and posteriorly it extends from the central sulcus to the cingulate sulcus (Pg 58 for good diagram). Note the locations of the precentral gyrus, superior, inferior, and middle frontal gyri.

Functions of the frontal lobe: Most of precentral gyrus is the primary motor cortex, involved in voluntary movements (contains cells that act as origin of descending motor pathways), remainder occupied by supplementary motor and premotor areas also functionally involved in voluntary movements. Broca's areas (inferior frontal gyrus – usually of left hemisphere) is involved in written and spoken language and the Prefrontal cortex (remainder of lobe) is attributed to personality, insight, and foresight.

Parietal Lobe: The parietal lobe is located posterior to the frontal lobe. Laterally it extends from the parietooccipital sulcus to the preoccipital notch at the bottom. Anteriorly it is bounded by the frontal lobe. Inferiorly it is bounded by the lateral sulcus and its imaginary extension to the parietooccipital sulcus. The parietal lobe is divided into three smaller areas namely: postcentral gyrus, inferior and superior lobules. The post central gyrus is located posterior to the central sulcus, and terminates at the post central sulcus. The inferior lobule contains the supramarginal gyrus, and the superior lobule is separated from the inferior lobule by the intraparietal sulcus. The lateral sulcus terminates at the supramarginal gyrus. The angular gyrus caps the superior temporal sulcus (running in the temporal lobe). Note: Caps is like a "dead end".

Functions of the Parietal Lobe: The postcentral gyrus is concerned with the processing of tactile and proprioceptive information. Most of the inferior parietal lobe of one hemisphere (usually the left) and some of the temporal lobe is involved with language comprehension (Wernecke's area). The remainder areas of the parietal lobe is involved with spatial orientation, and perception.

Temporal Lobe: Note that the temporal lobe is subdivided into three gyri namely: superior, inferior and middle. The superior gyri parallels the lateral sulcus, the inferior gyri continues

and reflects onto the inferior surface of the temporal lobe. The remaining inferior portion of the temporal lobe (i.e.: base of the lobe) is made up of the occipitotemporal gyrus, which is separated from the centrally placed limbic lobe by the collateral sulcus (i.e.: it is parallelling the lateral sulcus but on the inside portion of the brain). The gyri are separated by the superior and inferior temporal sulci.

Functions of the Temporal Lobe: Part of the superior gyri of the temporal lobe is the primary auditory complex; the Wernecke's area is the posterior portion of the superior temporal gyrus of one hemisphere (usually the left side) and is involved in comprehension of language. The inferior gyrus is particularly involved in processing of complex visual information (including most of the temporal lobe), whilst the medial parts are involved in learning and memory.

Occipital Lobe: The occipital lobe is seen most posterior on a lateral view. The cuneus is bounded by the calcarine sulcus and the parietooccipital sulcus and below this is the lingual gyrus.

Functions of the Occipital Lobe: The occipital lobe is mostly concerned with visual functions. The primary visual cortex is located within the walls of the calcarine sulcus. The remainder of the lobe is called visual association cortex, which concerns higher order processing of visual information. This extends into the temporal lobe as well.

Medial View – Midsagittal cut (Netter Plate 100)

Cerebrum

When the brain is cut in this plane, you see gray mater on the outer compound, and white matter on the inner compound. Note that this is different to the spinal cord, where we see gray mater on the inner aspect, and white mater on the outer aspect.

The corpus callosum is white matter, containing fibres interconnecting the two hemispheres. It is made up of the splenium (posterior notch), body, genus (anterior notch), and rostrum. The septum pellucidum is the membranous downward extension of the corpus callosum (Pg 69f of Nolte).

Limbic Lobe

The limbic lobe is located on the inner aspect of the brain, seen only when cut in a mid sagittal plane. It is mainly made up of the cingulate, and the parahippocampal gyri. The cingulate travels posteriorly superior to the corpus callosum, and travels inferiorly through the isthmus and becomes the parahippocampal gyri. The uncus is the hook formed by the parahippocampal gyrus as a result of the backward turn.

The limbic lobe and many of the structures comprise of the limbic system, which is important in emotional responses, drive related behaviour and memory.

Diencephalon ***(Netter Plate 100)***

This is located just below the fornix and only makes up only 2% of the weight; it forms four important structures namely: thalamus, hypothalamus, epithalamus, and subthalamus. The thalamus is just an ovoid nuclear mass of major importance in most functional systems. All the sensory information (except olfactory information) reaches the cortex via a synaptic stop at the thalamus. The epithalamus is alternatively named as the pineal gland (Picture Pg 63). The hypothalamus is separated from the thalamus by the hypothalamic sulcus, and inferiorly are the infundibular stalk and the mamillary bodies. The main function of the hypothalamus is the control of the visceral functions, but also involved in the limbic system.

*Cerebellum (****Nolte 5th Ed. Pg 66)***

The cerebellum consists of a vermis. This appears along the midline of the cerebellum and also laterally in the lateral hemisphere area. The anterior lobe is anterior to the primary fissure, and this plays a huge role in regulating leg movements. The flocculonodular lobe consists of a nodulus and a flocculus (as the name suggests). This lobe is involved in controlling eye movements and postural adjustments to gravity. The posterior lobe is anything

posterior to the primary fissure (except for the flocculonodular lobe), and plays a vital role in regulating voluntary movements.

Midbrain, Medulla, Pons (Nolte 5th Ed. Pg 264)
The medulla is the part of the brain stem closest to the spinal cord. Above this is the pons, and the mid brain is the most superior aspect (Good picture on Pg 265). The medulla itself is split into two areas, the open and closed areas. The open area corresponds to the area where the central canal opens up into the fourth ventricle. The closed portion corresponds to the part which contains the central canal continuous with that of the spinal cord. The obex is the V shaped portion representing the entrance to the fourth ventricle. The pyramids are the two structures lateral to the pyramidal decussation (Good picture on Pg 266). The olives are located just lateral to the pyramids.

The pons is the swelling continuous with the medulla oblangata (same as medulla). It contains the basal pons, and tegmentum (roof). Part of the fourth ventricle forms the roof of the pons. The mid brain includes the superior and inferior colliculi, the cerebral peduncles, and the cerebral aqueduct. The cerebral aqueduct leads to the fourth ventricle.

Note: The above information is just an overview, I am sure we will be dealing with these structures as we do more neuroscience.