Glossary of the terms you will encounter in dissection of the sheep brain: alphabetically arranged.

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More than you ever wanted to know about the structures you see in the sheep brain: a glossary. All of the structures defined and described here are seen in both the sheep and in humans. Whether this is reassuring or troublesome for you is another matter. The functional descriptions are all based on functions thought to apply to the human brain.

Note: In the process of writing the text for the structures described in this brief dictionary, I have liberally consulted various sources. In particular, I am fond of “fundamental neuroanatomy”, by Nauta and Feirtag. For the cranial nerves, most of the text comes verbatim from the excellent descriptions in: it goes without saying that the small print sections throughout this glossary are only for those who wish toknow more - not intended to be examination material.
http://www.meddean.luc.edu/lumen/MedEd/GrossAnatomy

Abducens Nerve

(L. ab, from + ducens, leading):
The sixth cranial nerve (VI), operates the later rectus muscle used for eye movements that are abductive - leading away from the nose. In humans, this nerve has between 3000 and 4000 fibers, but some higher numbers have been reported.
The abducens nerve originates from neuronal cell bodies located in the ventral pons. These cells give rise to axons that course ventrally and exit the brain at the junction of the pons and the pyramid of the medulla. The nerve of each side then travels anteriorly where it pierces the dura lateral to the dorsum sellae. The nerve continues forward and bends over the ridge of the petrous part of the temporal bone and enters the cavernous sinus. The nerve passes lateral to the carotid artery prior to entering superior orbital fissure. The abducens nerve passes through the common tendonous ring of the four rectus muscles and then enters the deep surface of the lateral rectus muscle.. The abducens nerve in humans is solely and somatomotor nerve.

Amygdala

(Gr. Almond), or amygdaloid body:
Set of nuclei that lie in the dorso-medial temporal lobe, immediately ventral to the olfactory cortex, the structure is one of the main functional components of the limbic system although it can be considered a part of basal ganglia on anatomical grounds. Various schemes of subdividing the amygdala exist. Suffice it to say that there are a number of distinct nuclei, of which the central nucleus is the major output nucleus. Very important structure for assigning emotional “value” to experiences and objects.

Anterior Commissure

A round bundle of nerve fibers that are situated anterior to the anterior columns of the fornix; they connect the right and left anterior temporal lobes as well as subcortical structures that are involved with olfaction. It is not clear whether the structure is involved with functions other than those that deal with olfaction. Claims are made that this structure is larger in human females than males, but there are uncertainties involving this finding when brain size is controlled for.

Anterior Thalamus

The anterior nucleus of the thalamus is an important relay station for fibers that come from the limbic system and project to the cingulate gyrus.
Please see also: thalamus

Anterior Lobe of Cerebellum

see cerebellum

Basal Ganglia

The term "basal ganglia" is rather vague and that has led to various confusing discussions as to what structures do and do not belong to the basal ganglia. Because "basal ganglia" refers to clumps of neurons at the base of the brain, there is really no binding anatomical definition and anything goes. So, we see as main components (few people argue about this) these structures, which belong to the telencephalon: **caudate nucleus, the globus pallidus and the putamen**. Then there is the nucleus accumbens septi (also: part of the ventral striatum), also a telencephalic structure, which is anatomically closely related to the caudate and putamen, but functionally more a transition structure that connects limbic structures with the caudate and putamen. Slightly more complicated is the position of the amygdala, still in the telencephalon, that is counted in by some and out by others.
But then we also hear that the substantia nigra and the subthalamic nucleus are considered components of the basic ganglia, and these structures are no longer in the telencephalon. The subthalamic nucleus is in the posterior (caudal) diencephalon and the substantia nigra is in the mesencephalon. The situation here is pretty similar to that of the limbic system which has functional components that stretch from the telencephalon to the mesencephalon. The point is that all of the above structures are grouped together because they appear to have rather intimate connections with each other. Earlier attempts of naming them came up with the term "extrapyramidal system", and threw in the red nucleus (nucleus ruber) and the cerebellum for good measure, but let us make to with the caudate, putamen, globus pallidus, subthalamic n and substantia nigra as the principal components of the system, with the nucleus accumbens, and parts of the amygdala as "interfaces" between these principal structures and the limbic system.

Here are terms you can often run across and you can see that they don't make us any wiser:
Lentiform nucleus (lenticular nucleus) composed of the putamen as outer portion and the inner part of the lobus pallidus.
corpus striatum - composed of lentiform nucleus and caudate nucleus
striatum - composed of caudate nucleus and putamen
neostriatum - caudate nucleus and putamen
paleostriatum - globus pallidus
archistriatum - amygdala (to make it more complicated, in birds, the term "archistriatum" has a much wider and more complex meaning than in mammals).

Caudate nucleus

please also see: basal ganglia
a large C-shaped mass of gray matter that is closely related to the lateral ventricle and lies lateral to the thalamus. The lateral surface of the nucleus is related to the internal capsule, which separates it from the lentiform nucleus. It is often descriptively divided into a ***head***, a ***body*** and a ***tail***. The ***head*** of the caudate nucleus is large and rounded and forms the lateral wall of the anterior horn of the lateral ventricle. The head is continuous inferiorly with the putamen of the lentiform nucleus. Just superior to this point of union, strands of gray matter pass through the internal capsule, giving the region its striated appearance. The ***body*** of the caudate nucleus is long and narrow and is continuous with the ***head*** in the region of the interventricular foramen. The body of the caudate nucleus forms part of the floor of the body of the lateral ventricle. The ***tail*** of the caudate nucleus is long and slender and is continuous with the ***body*** in the region of the posterior end of the thalamus. It follows the contour of the lateral ventricle and continues forward in the roof of the inferior horn of the lateral ventricle. It terminates anteriorly in the amygdaloid nucleus.
The caudate nucleus is separated from the putamen by the internal capsule. In terms of function, there is much to indicate that the caudate participates in higher order motor and even cognitive function. Among other things, the caudate nucleus is thought to be involved in the initiation and termination of movement within a meaningful context. It is also thought to allow us to form new associations between perceptions and actions, and to break links between well established stimulus-response chains in order to make different responses to the stimulus and the same response to different stimuli.
The caudate nucleus is critically implicated in Parkinson's disease, caused by an insufficient supply of dopaminergic fibers that stem from the substantia nigra.

Cerebellum

Next to the cerebral cortex, the most spectacular structure in the brain. The three-layered cerebellar cortex is very finely folded so that the folia (these are analogous to what we call gyri in the cerebral cortex) are quite narrow at the surface. There are two ways to divvy up the cerebellum anatomically. One way recognizes three lobes. Of these, the phylogenetically oldest, the flocculonodular lobe (intimately concerned with vestibular functions that are involve in maintaining posture) is dwarfed by the other two lobes, the anterior lobe and the posterior lobe.

The **anterior lobe** is also referred to as "spinocerebellum"; it receives input from the inferior cerebellar peduncle and contains maps of the body surface. Receives important input from Clark's column and the lateral cuneate nucleus. Cells in Clark's column give rise to the dorsal (posterior) spino-cerebellar tract, an important input element to the inferior cerebellar peduncle that carries information about proprioception. It also receives input from the ventral (anterior) spino-cerebellar tract.

The **posterior lobe** is separated anteriorly from the anterior lobe by the **primary fissure.** This is the largest lobe and it receives input from many sources, notably input from all regions of the cerebral cortex, via the **pons**. The role of the posterior lobe cannot be as simply characterized as the role of the anterior lobe because input and outputs are concerned with very "high-level" functions as well as with more basic functions, such as muscle tone adjustment.

If the cerebellum is cut along the midsagittal axis, a number of lobules can be recognized. These can be numbered in various ways, from I to X. The differences in numbering arise because some anatomists subdivide lobules whereas others do not. The basic lobules are (from the anterior ventral lobule to the last, folded under the posterior aspect (but they curl around toward each other so that the first is located quite closely to the last):

1 **lingula** 2 **central lobule** (often subdivided into ventral and dorsal lobules) 3 **culmen** (sometimes subdivided into dorsal and ventral culmen) 4 **declive** (often further subdivisions) 5 **folium vermis** 6 **tuber vermis** 7 **pyramis** 8 **uvula** (often further subdivisions) 9 **nodulus**

Input and output connections of the lobules are mostly related to the connections of the cerebellar lobes within which they are located, but there are many exceptions - for example, the **cuneocerebellar** tract which transmits proprioceptive information from the upper parts of the body, sends fibers mostly to some posterior lobules but also to the anterior cerebellum.

Another way of dividing up the cerebellum is by recognizing a medial/lateral set of divisions. The most medial part is the **vermis** (it is here where the cerebellar lobules are most clearly seen). Then, on each side of the vermis are the **intermediate** parts of the cerebellar cortex and, most laterally, the **lateral** cerebellum (often also referred to as **neocerebellar** cortex).

This last paragraph sums up the most useful way of subdividing the cerebellum if we want to describe cerebellar output to other parts of the brain. With exception of the flocculonodular lobe, which sends fibers quite directly to some vestibular structures, all cerebellar cortex sends its output axons to the deep cerebellar nuclei, and these send axons to other parts of the brain and spinal cord. Rough relations are: the vermis sends its output to the **fastigial nuclei**, the intermediate cortex sends its output to the **intermediate nuclei** (used as collective term for the small emboliform and globose nuclei; the term "nucleus interpositus" is also used) and the lateral cerebellar cortex sends its output to the **dentate nuclei**. Often, anatomists recognize subdivisions of the intermediate and dentate nuclei.

Cerebellar input: The information from elsewhere reaches the cerebellum via three so-called cerebellar peduncles, which are massive fiber tracts. The **middle cerebellar peduncle** is most easily described: the pontine nuclei which have received information from the entire cerebrum send their axons via the pontocerebellar tract (which forms the middle cerebellar peduncle) into the cerebellum - the most massive set of tracts in the brain. Indeed, the bulgy nature of the pons (which gives rise to its name = bridge) derives from the tremendous number of connections made in this region.

The **inferior cerebellar peduncles** carry information from a great number of tracts to the cerebellum, among these the dorsal spinocerebellar tract, the cuneocerebellar tract, the reticulocerebellar tract, the vestibulocerebellar tract, the perihypoglossocerebellar tract and the trigeminocerebellar tract. Most input that reaches the cerebellum via the inferior cerebellar peduncles synapses in the **inferior olivary nucleus**, and the so-called climbing fibers that reach the Purkinje cells in the cerebellar cortex all originate from here. Some anatomists distinguish the main portion of the **inferior cerebellar peduncle** as the **restiform body** which carries the main tracts in a compact portion of the inferior cerebellar peduncles. The restiform is easily recognized as a compact cylindrical part of the inferior cerebellar peduncles. In contrast, the **juxtarestiform body,** which carries a number of minor tracts, gives a more fragmented impression.
The **superior cerebellar peduncles** serve mainly as output avenues (see below) but, just to make things difficult they also carry some information into the cerebellum - from the ventral spinocerebellar tracts and the tectocerebellar tract. The principal output portion of the superior cerebellar peduncles is known as **brachium conjunctivum**, distinct from the input portions described above.

Cerebellar output: In humans, the dentate nuclei send most of their output to the ventrolateral nucleus of the thalamus from whence they reach the cerebral cortex, the intermediate nuclei send much of their output to the red nucleus (nucleus ruber) and the fastigial nuclei send to the vestibular nuclei and other regions of the brain stem. Most of the output travels in the brachium conjunctivum part of the superior cerebellar peduncle.

Function: multiple functions. Among other things: tunes the excitability in the proprioceptive system (and probably most other major systems in the brain) to optimal levels for given situations, is involved in providing exact timing to actions, is involved in coordinating movement of limbs across several joints, compares what you want to happen with what actually happens and corrects the mismatch to reduce errors, marshals resources to provide the optimal "effort" to get a job done just right. So, pretty important and involved in just about everything we do.

Cerebral Aqueduct

The cerebral aqueduct passes the cerebro-spinal fluid, which is generated in the lateral ventricles, to the fourth ventricle. The passage is relatively small and does get blocked under some conditions. The resulting increase of pressure in the 1, 2^{nd} and 3^{rd} ventricles leads to their expansion, and condition called hydrocephalus (literally "waterbrain") can result.

Cerebral Peduncles

Superior, middle, inferior: see cerebellum

Cerebrospinal fluid

A filtered version of blood that differs in some way from blood, by containing very few proteins, somewhat less glucose, similar concentrations of sodium but less potassium and calcium than blood, to name a few things.

Choroid plexus
A richly intertwined network of bloodvessels mostly in the lateral ventricles where the cerebrospinal fluid emerges from the blood into the ventricles after the cells have filtered out a great number of components of blood - such as the red blood cells that give blood its color.

Corpus Callosum
The principal fibre bundle through which the left and right hemispheres of the cerebral cortex in mammals communicate with each other. This is an enormous commissure, which in humans contains in the order of 200 to 350 of million axons. The majority of such fibers are quite small and relatively slow, with only a small proportion of large and fast fibers. The densest connections are between so-called homotypic areas - that is, functionally identical areas on the left and right side of the brain - that are in an approximate mirror location of each other. Fewer connections connect non-homotypic regions (example: where a connection would extend from the parietal cortex of one side to the temporal cortex of the other).
The shape and size of the corpus callosum varies widely across individuals. The anterior portion of the corpus callosum is known as the “**genu** of the corpus callosum” while most posterior portion is known as the “**splenium** of corpus callosum”. The portion in between is often referred to as the body of the corpus callosum. In many individuals there is a markedly thinner portion of the corpus callosum , known as the “**isthmus**” (literally = narrow portion of land).
Interruption of the corpus callosum will interfere with the exchange of information between brain halves.

Cingulate Gyrus
This is clearly seen in midsagittal sections of the brain, as a solid gyrus that lies right above the corpus callosum, and which extends from anterior to the genu of the corpus callosum to posterior of the splenium where continues as the isthmus of the cingulate gyrus which becomes continuous with the parahippocampal gyrus. It is clearly separated from the corpus callosum through the callosal sulcus, and anteriorly from the medial frontal gyrus by the cingulate sulcus. The structure of the cingulate cortex is not quite isocortex (the complex and highly evolved neocortex) and the more simply three-layered allocortex and is sometimes referred to as periallocortex or proisocortex - referring to a transitional form of cortical types. The principal input is from the parts of the thalamus associated with the limbic system (anterior thalamus, mediodorsal thalamus). The cingulate gyrus has been associated with a variety of functions, including the direction and supervision of attention, general emotional responses and addictive behavior. In a clinical context, the anterior cingulate gyrus has been associated with obsessive compulsive disorder (OCD).

Claustrum

A strip of grey matter lateral to the putamen, which has mostly cortical connections. A dorsal and a ventral claustrum are distinguished anatomically, and they may be functionally distinct; with the ventral portion being more aligned with amygdala function. Some classify this as part of the basal ganglia (these would be anatomists who also consider the amygdala as part of the basal ganglia. In terms of function the claustrum has been implicated in cross-modal function with strong evidence of involvement in vision. More recently, it has been claimed that the claustrum is involved in sexual responses in humans.

Fornix

Output element of the hippocampus. Most of the fibers in the fornix are axons of pyramidal neurons in the hippocampus, which project to the septal nuclei (which is below the septum pellucidum) and to the mammillary nuclei (in the hypothalamus) where they synapse. Anatomically, the fornix is formed as the fimbria of the hippocampus runs anteriorly, with the left and right fornix converging toward each other in the midline at the level of the septum. After this, the two fornices (fornix = arch) separate slightly as the fibers arch back toward the lateral hypothalamus. Where the two fornixes on each side are visually distinct and compact, they are referred to as columns of the fornix. Section of the fornix has been associated with problems in the regulation of memory formation (by influencing gene expression of genes that deal with CREB = cyclic AMP response expression binding protein).

Corona radiata

The corona radiata are formed by the millions of fibers that stream from the internal capsule toward their terminations in the cerebral cortex. Thus, these fibers that radiate upward and outward from the internal capsule are not a separate anatomical entity but are formed by fibers that have been packed in quite compactly when forming the internal capsule which in turn - and these fibers in turn are continuous with the fibers that form the cerebral peduncles.

External capsule

The external capsule delimits the outer part of the **lentiform nucleus** from the claustrum. The fibers that make up this capsule are mostly fibers that project from the neocortex to the putamen and thus are considered part of the traditional extrapyramidal fiber system.

Extreme capsule

Found as somewhat diffuse white fibers between the claustrum and the insula. The insula is the part of the neocortex you see laterally to the claustrum in your horizontal sections. The more dorsal part of the extreme capsule is formed by fibers that are part of the usual connection system for cortex areas but the more ventral part of the capsule is formed by fibers that connect the frontal to the temporal lobe. Collectively, these fibers are known as the **uncinate fasciculus**, part of the association fiber systems that interconnect parts of the cerebral cortex.

Facial Nerve (cranial nerve VII)

Arises in brainstem nuclei near the pons. Carries fibers that innervate glands (tear glands, salivary glands), some taste sensation from the tongue, sensation from the ear, innervation of a muscle that serves to dampen oscillations of the inner ear bones (tensor tympani acts on stapedius) and, most importantly, fibers that innervate muscles of expression in the face. The motor portion of the VII is important in speech because it operates, among other things, the lips which play an important role in shaping speech sounds (try to speak without moving your lips). This nerve has a bit of a tortuous route from the brainstem to the target areas in the face region and appears vulnerable to various kinds of infections and damage. This nerve has, in the order of about 10000 fibers.

The facial nerve is mixed nerve containing both sensory and motor components. The nerve emanates from the brain stem at the ventral part of the pontomedullary junction. The nerve enters the internal auditory meatus where the sensory part of the nerve forms the geniculate ganglion. In the internal auditory meatus is where the greater petrosal nerve branches from the facial nerve. The facial nerve continues in the facial canal where the chorda tympani branches from it the facial nerve leaves the skull via the styolomastoid foramen. The chorda tympani passes through the petrotympanic fissure before entering the infratemporal fossae. The main body of the facial nerve is somatomotor and supplies the muscles of facial expression. The somatomotor component originates from neurons in the facial motor nucleus located in the ventral pons. The visceral motor or autonomic (parasympathetic) part of the facial nerve is carried by the greater petrosal nerve. The greater petrosal nerve leaves the internal auditory meatus via the hiatus of the greater petrosal nerve which is found on the anterior surface of the petrous part of the temporal bone in the middle cranial fossa. The greater petrosal nerve passes forward across the foramen lacerum where it is joined by the deep petrosal nerve (sympathetic from superior cervical ganglion). Together these two nerves enter the pterygoid canal as the nerve of the pterygoid canal. The greater petrosal nerve exits the canal with the deep petrosal nerve and synapses in the pterygopalatine ganglion in the pterygopalatine fossa. The ganglion then gives of nerve branches which supply the lacrimal gland and the mucous secreting glands of the nasal and oral cavities. The other parasympathetic part of the facial nerve travel with the chorda tympani which joins the lingual nerve in the infratemporal fossa. They travel with lingual nerve prior to synapsing in the submandibular ganglion which is located in the lateral floor of the oral cavity. The submandibular ganglion originates nerve fibers that innervate the submandibular and sublingual glands. The visceral motor components of the facial nerve originate in the lacrimal or superior salivatory nucleus. The nerve fibers exit the brainstem via the nervus intermedius. (The nervus intermedius is so called because of its intermediate location between the eighth cranial nerve and the somatomotor part of the facial nerve just prior to entering the brain). There are two sensory (special and general) components of facial nerve both of which originate from cell bodies in the geniculate ganglion. The special sensory component carries information from the taste buds in the tongue and travel in the chorda tympani. The general sensory component conducts sensation from skin in the external auditory meatus, a small area behind the ear, and external surface of the tympanic membrane. These sensory components are connected with cells in the geniculate ganglion. Both the general and visceral sensory components travel into the brain with nervus intermedius part of the facial nerve. The general sensory component enters the brainstem and eventually synapses in the spinal part of trigeminal nucleus. The special sensory or taste fibers enter the brainstem and terminate in the gustatory nucleus which is a rostral part of the nucleus of the solitary tract.

Fimbria

Output element of the hippocampus. Fibers that emerge from the hippocampus after internal processing traverse the surface of the body of the hippocampus as a thin sheet of white fibers. The fibers collect in an output bundle known as the fimbria (fringe). The fimbria gains in size as it passes along the hippocampus as the two hippocampi approach the midline - much like a river gains size as smaller waterways enter it on its course. Ultimately, once there is no more input from the hippocampus, the fimbria forms the **fornix.**

Fourth ventricle

The cerebrospinal fluid is generated into the lateral ventricles, and flows into the IIIrd ventricle , via the cerebral aqueduct, into the fourth ventricle. This ventricle does not have much of a volume because it is snugly filled by tissue of the cerebellum. The CSF leaves the IVth ventricle via the foramina of Luschke and Magendie that form the vents into the subarachnoid membrane - from the space formed by the latter, the CSF is then reabsorbed into the veinous return system.

Frontal lobe

This is a complex business; for those who wish a good recent review: Luppino, G. & Rizzolatti, G. (2000). The organization of the frontal motor cortex. News in Physiological Sciences,15, 219-224)

Formally, the cortex anterior to the central fissure. The latter is quite clearly defined in humans.
In humans, we distinguish the **primary motor area** (Brodmann's area 4) and
the **premotor** area which can be subdivided into:
lateral premotor area = 6 and 44,
medial premotor area 6 = supplementary mc,
frontal eye field = area 8
supplementary eye field area = 8A

The areas 4 and 6 were also known as frontal agranular cortex because of the missing layer 4. In contrast, areas anterior to this do have a granular layer and are known as granular cortex. However, these days, subdivisions of all regions are more commonly used (mostly different systems from the Brodmann system are used but this forms a useful reference.

and the **prefrontal** area
dorsolateral = 9,46
inferior prefrontal = 11, 12, 13, 14 (orbitofrontal = 11, 13, 14)
medial frontal = 25, 32

The prefrontal lobe is not directly concerned with movement execution but the motor areas 4, 6, 8 and 9 are involved with the execution of movement in a direct or indirect manner.
Note that the functional maps overlap the historically established Brodmann's areas. Functional maps include the motor area, the premotor areas, the frontal eye fields and the motor speech areas that are adjacent to the face motor areas.

Frontal lobe function - involved in action generally; from the planning of action to suit circumstances (at all levels, social action, movement as such, mental effort) right down to the execution of the action plan. No wonder we speak of this as part of the brain that is involved in executive function.

Genu of Corpus Callosum

Anterior "knee" of the corpus callosum

Globus Pallidus

The "pale globe", another principal component of the basal ganglia. Found "at the bottom", in the lowest horizontal sections and characterized by its pale appearance. Has an outer and inner segment. The inner segment (GPi) is one of the principal outputs of the basal ganglia (by which I mean output to other brain structures, not to other basal ganglia structures - i.e., to the thalamus) while the outer segment (GPe - "e" for external) has strong reciprocal connections with the subthalamic nucleus. In primates but not necessarily in other mammals, the inner and outer segments are separated by the internal capsule.

Glossopharyngeal Nerve (IX) (Not seen in Plate 1)

This one we don't get to see in our sheep brains because it is generally lost in removal.
The motor component of this facial nerve is involved in the operation of the soft palate, and has some importance in swallowing and speaking. Sensory portions are involved in sensation from palate and pharynx. The motor portion of this nerve stems from the nucleus ambiguous in the brainstem which also gives rise to the motor portion of the Vagus nerve (X)

This cranial nerve exits the brain stem as a the most rostral of a series of nerve rootlets that protrude between the olive and inferior cerebellar peduncle. These nerve rootlets come together to form the ninth cranial nerve and leave the skull through the jugular foramen. The tympanic nerve is a branch that is occurs prior to exit the skull. The visceromotor or parasympathetic part of the ninth nerve originate in the inferior salivatory nucleus. Nerve fibers from this nucleus join the other components of the ninth nerve during their exit from the brain stem. They branch in the cranium as the tympanic nerve. The tympanic nerve exits the jugular foramen and passes by the inferior glossopharyngeal ganglion. It re-enters the skull through the inferior tympanic canaliculus and reaches the tympanic cavity where it forms a plexus in the middle ear cavity. The nerve travels from this plexus through a canal and out into the middle cranial fossa adjacent to the exit of the greater petrosal nerve. It is here the nerve becomes the lesser petrosal nerve. The lesser petrosal nerve exits the cranium via the foramen ovali and synapses in the otic ganglion. The otic ganglion provides nerve fibers that innervate and control the parotid gland, an important salivary gland. The branchial motor component supplies the stylopharyngeas muscle which elevates the pharynx during swallowing and talking. In the jugular foramen are two sensory ganglion connected to the ninth cranial nerve: the superior and inferior glossopharyngeal ganglia. General sensory components from the skin of the external ear, inner surface of the tympanic membrane, posterior one-third of the tongue and the upper pharynx join either the superior or inferior glossopharyngeal ganglia. The ganglia send central processes into the brain stem which terminate in the caudal part of the spinal trigeminal nucleus. Visceral sensory nerve fibers originate from the carotid body (oxygen tension measurement) and carotid sinus (blood pressure changes). The visceral sensory nerve components connect to the inferior glossopharngeal ganglion. The central process extend from the ganglion and enter the brain stem to terminate in the nucleus solitarius. Taste from the posterior one-third of the tongue travels via nerve fibers that enter the inferior glossopharyngeal ganglion. The central process that carry this special sense travel through the jugular foramen and enter the brain stem. They terminate in the rostral part of the nucleus solitarius (gustatory nucleus).

Habenula

Habenular nucleus (L. bridle rein, or strap): a small group of neurons situated just medial to the posterior surface of the thalamus. Afferent fibers are received from the amygdaloid nucleus in the temporal lobe through the stria medullaris thalami; other fibers pass from the hippocampal formation through the fornix. Some of the fibers of the stria medullaris thalami cross the

midline and reach the habenular nucleus of the opposite side; these latter fibers form the habenular commissure. Axons from the habenular nucleus pass to the interpeduncular nucleus in the roof of the interpeduncular fossa, the tectum of the midbrain, the thalamus, and the reticular formation of the midbrain. The habenular nucleus is believed to be a center for integration of olfactory, visceral, and somatic afferent pathways. The habenular nuclei, their projections, and the pineal gland make up the epithalamus.
Studies done on rats show that the medial habenular nucleus projects - among other places - to the interpeduncular nucleus while the lateral habenular nucleus projects to - among other places - the substantia nigra (pars compacta) as well as to hypothalamic destinations.

Hippocampus

This is a structure that is very nicely visible in your brain preparation. To describe it verbally is pretty pointless. If you look at your hippocampal dissection, you will note that you can move your probe at the anterior edge of the hippocampus once you have removed the overlying cortex. However, at the posterior edge, the hippocampus is continuous with the cortex, and this means that the cortex and the hippocampus are continuous at the posterior edge. This is where the cerebral cortex is in direct continuity with the hippocampus, via the region known as the "entorhinal cortex", which gives way to the subiculum, a connecting bridge into the hippocampus.

There are two ways in which the subiculum is connected to the hippocampus proper. First, fibers that originate from the 2^{nd} and 3^{rd} layer of the entorhinal cortex travel to the granule cells of the dentate gyrus, via the perforant path. This is an odd arrangement because where these fibers travel, there is actually no continuity between the dentate gyrus and the subiculum; the fibers perforate the outer edge of the subiculum, travel through a tiny gap and enter the dentate gyrus. This is the source of the major input to the hippocampus. Two parts of the perforant path can be recognized as lateral and medial paths - given their name from the source of origin in the lateral and medial entorhinal cortex.

It turns out that the subiculum is also the main recipient of hippocampal output; after processing in the hippocampus, the CA 1 cells of the Hippocampus send their output in a finely arranged topographic order to the subiculum and cells there send the information on to other areas in the entorhinal cortex.

The information that enters the dentate gyrus end up on granule cells in the dentate gyrus, and from these granule cells fibers output goes to CA 3 pyramidal cells via the so-called mossy fibers. The CA 3 cells in turn send axons to the CA 1 region either in the hippocampus in which they originate or to the corresponding region in the Hippocampus on the other side.

The other input/output system operates via the fimbria which carries fibers from the hippocampus towards the septum, hypothalamus, and mammillary bodies (mostly from CA 3 cells) and back into the hippocampus.

Finally, a comment on the relation between hippocampus, the amygdala and the **uncus**. At the bulbous thick beginning of the hippocampus, in the temporal lobe, the amygdala lies practically touching the hippocampus. This region represents a literal fusion of the ventral amygdala and the hippocampal gyrus, and the bump on the very medial surface at the anterior end of the temporal lobe that gives rise to this fusion is called the uncus ("hook" - any hook-shaped structure). The uncus contains both the mesocortex characteristic of the entorhinal cortex and the allocortex, characteristic of the hippocampal gyrus.

Function the hippocampusis involved in spatial function both in the narrow sense, such as in providing a spatial mapping of the environment through we navigate, and in humans in a broader sense, providing a "space" within which concepts are organized. Early degenerative changes in the hippocampus, as are seen in Alzheimer's disease are thought responsible for one of the earlier behavioral signs of the disease - having difficulties in finding your way and orienting yourself in the environment.

Hypoglossal nerve (XII)

The hypoglossal nerve, as the name indicates, can be found below the tongue. It is a somatomotor nerve that innervates all the intrinsic and all but one of the extrinsic muscles of the tongue. The exception is the palatoglossal muscle which is innervated by the vagus (X) nerve, and serves to elevate the dorsal part of the tongue and lower the soft palate. This nerve has an average of 6000 fibers, with quite a bit of interindividual variability.

The neuronal cell bodies that originate the hypoglossal nerve are found in the dorsal medulla of the brain stem in the hypoglossal nucleus. This nucleus gives rise to axons that exit as rootlets that emerge in the ventrolateral sulcus of the medulla between the olive and pyramid. The rootlets come together to form the hypoglossal nerve and exit the cranium via the hypoglossal canal. The nerve passes laterally and inferiorly between the internal carotid artery and internal jugular vein. The twelfth cranial nerve travels lateral to the bifurcation of the common carotid and loops anteriorly above the greater horn of the hyoid bone to run on the lateral surface of the hyoglossus muscle. It then travels above the edge of the mylohyoid muscle. The hypoglossal nerve then separates into branches that supply the intrinsic muscles and three of the four extrinsic muscles of the tongue.

The most important muscle of the tongue, the geniglossus is bilaterally arranged. The left geniglossus turns the tongue to the right and the right geniglossus turns it to the left. Thus, if the tongue turns to the left when the subject tries to stick out tongue straight, the left geniglossus is weak (right geniglossus turns it to left and left geniglossus cannot counteract).

Hypothalamus

A crucially important diencephalic region that lies at the bottom of the third ventricle. Anatomically, it is delimited as the region extending from the area just anterior to the optic chiasma to the mammillary bodies in the anterior-posterior axis. The mammillary bodies are considered by many to be part of the hypothalamus. A medial region is defined by nuclei on either side of the third ventricle (some of these "periventricular" hypothalalamic nuclei are capable of receiving hormonal signals that are carried in the cerebro-spinal fluid). A lateral region extends slightly beyond the area that is traversed by the fornix and mammillothalamic

tract; the former on its way to the mammillary bodies and the latter from the mammillary bodies to the anterior thalamus. Dorsally the region extends, roughly to the anterior commissure. The hypothalamus is connected to the pituitary gland via the infundibular stalk that emerges from a small bump, the tuber cinerum.
Functionally, the hypothalamus is involved in a huge array of biologically crucial functions, such as regulation of sexual/reproductive behavior, activity cycles/sleep, coordination of simple behavior patterns involved in feeding, drinking and fighting, attention to biologically relevant stimuli, translation of physiological need states into psychological states as well as in direct physiological functions concerned with respiration, circulation and digestion. Don't leave home without it !

Inferior Colliculus

Unlike the superior colliculus, this structure is an important relay station for auditory fibers that are on the way to the auditory cortex. Fibers from the Inferior colliculus ascend to the auditory cortex on both sides, meaning that fibers cross from left to right and vice versa. The Inferior colliculus together with the superior colliculus form the roof of the mesencephalon. As the name indicates, the inferior nucleus lies behind (caudal) to the Superior colliculus . Like the Superior colliculus , the Inferior colliculus has a commissure that connects the two colliculi. The function of the Inferior colliculus is not certain other than in broad outlines. It is clear that a large amount of integration of auditory stimuli from the two ears takes place here, tuning curves of the neurons in the Inferior colliculus have their specific signatures and it is likely that processing of the directionality (laterality) of auditory stimuli is partly determined here. In keeping with this idea, the Inferior colliculus is involved in orienting the head toward the source of a sound, both in regular functioning and in the auditory startle reflex.
For reason that are not entirely clear, the inferior colliculus has the highest rate of blood flow of any brain structure. Common sense would suggest that this structure would be very sensitive to interruptions of blood flow.

Intermediate zone of the cerebellum

Please see cerebellum

Insula

Cortex lateral to the claustrum in your horizontal sections. The insula is an extension of the cortex of the orbitofrontal cortex, which is the adult is completely covered by areas of the frontal lobe that have expanded greatly and contain, among other things, the cortex involved in speech production. The insula is visible only in the developing fetus and in newborns because the frontal lobe that later comes to cover the insula has not grown sufficiently to cover the entire area. .

Internal Capsule

This is formed by massive fiber bundles that represent not only the total output of the cortex to the brainstem and spinal cord, but also the fibers that stream from the thalamus toward the cortex. This fiber system is called "capsule" because it appears to encapsulate the thalamus. One way of visualizing this is the time-honored way of holding the hands together so that the wrists touch, and the hands are opened to cradle an inner open space. When the hands are held like this in front of you and the smaller fingers point away from you, you can imagine the wrists as the cerebral peduncles, the thumb region points to the flow of fibers from the occipital/parietal cortex, the position of the index fingers indicates fibers that travel from the parietal area and elsewhere in that region toward the pons, the middle finger is the region for fibers from the somatosensory regions, followed by the ring fingers that indicate the region of fibers in the internal capsule that come from the motor cortex and little fingers indicate fibers from the frontal cortex to the pons.

Lateral Geniculate Nucleus

The "knee-like" lateral bump on the lateral posterior aspect of the thalamus. In horizontal cuts in particular, you can see a massive white fiber bundle on the outside of the LGN, which is formed by the optic tract fibers that enter the LGN. This nucleus is arranged in layers that receive fibers from the ipsilateral eye (reminder: ipsi - means same side) eye and the contralateral eye. Layers 1, 4 and 6 receive input from the contralateral eye while 2, 3 and 5 receive fibers from the ipsilateral eye. Within each of the layer receiving input from a particular eye there is a further subdivision, so that layers 1 and 2 represent the magnocellular (large cells) layers of the LGN, and 3, 4, 5 and 6 represent the parvocellular (small cells) layers.
The layers are numbered from the medial to the lateral portion of the LGN.

Lateral Ventricle

It is in the lateral ventricles where the cerebrospinal fluid is generated via the choroid plexus. By convention, the left ventricles is numbers I, and the right II.

Lateral Olfactory Tract

Also lateral olfactory striae, travels to the region of the uncus, where it terminates in the primary olfactory cortex and in the hippocampal gyrus. Among other things, may be part of a system which is involved in the recognition of individuals on the basis of their odor.

Lateral Zone of the Cerebellum

Please see cerebellum

Mammillary Bodies

These lie posterior to the hypothalamic area at the bottom of the brain; part of the diencephalon. They first came to attention because the mammillary bodies often show softening and atrophy in individuals with Wernicke-Korsakoff disease. This disease is characterized by - among other things - memory problems, and it was thought that the mammillary bodies are involved in memory functions. The mamillary bodies receive input from the hippocampus via the fornix, and send output to the limbic portions of the frontal lobes via the **mammillothalamic tract** (also known as bundle of Vicq d' Azyr) that travels to the anterior thalamus (the "limbic" thalamus).

Massa Intermedia

In humans, the thalami of body sides connect in the middle via the tissue known as massa intermedia. Curiously, it is present not in all individuals, and there is a claim of a sex difference: with ca. 20 % of females and 30 % of males lacking this structure (some studies find even larger sex differences). Functional significance is unknown.

Medial geniculate body

The major relay nucleus for auditory information that ascends to the cortex via the thalamus. As in the case of the visual lateral geniculate body (LGB), fibers from the MGB ascend only to the ipsilateral side. That is, the left only sends to the left cortex, and the right MGB to the right cortex. However, because there is vigorous crossover of fibers in the auditory relays below the MGM, the fibers from the MGM to the cortex carry information from the ipsi- and contralateral ear which are kept nicely separate in cortical bands in the left and right auditory cortex. The fine anatomy of the MGB is not as well worked out as is the case for the LGB. In the human, both the LGN and the MGB are said to have a similar number of neurons. This means that in the LGB, the huge number of primary visual input fibers converges massively on a small number of LGB nuclei while there is divergence in the MGB because in this case, a relatively small number of auditory input fibers hits some 570 000 cells in each MGB, a number similar to cell numbers in the LGB.

Medial Olfactory Tract

Fibers end in the region of the **parolfactory** area (small region of cerebral cortex on the medial surface of the frontal lobe, formed by the junction of the straight gyrus with the cingulate gyrus, demarcated from the subcallosal gyrus by the posterior parolfactory sulcus) and in the region of the **anterior perforated substance** (this is a region of the basal forebrain, roughly lateral to the optic chiasma; "perforated" refers to the points where the striate arteries enter the brain) as well as in the vicinity of the septum. In addition, some of the fibers cross over into the opposite hemisphere in the anterior commissure. Possibly involved in pheromone detection and functions of the vomeronasal organ.

Occulomotor Nerve (III)

The oculomotor nerve originates from motor neurons in the oculomotor (somatomotor) and Edinger-Westphal (visceral motor) nuclei in the brainstem. Nerve cell bodies in this region give rise to axons that exit the ventral surface of the brainstem as the oculomotor nerve. The nerve passes through the two layers of the dura mater including the lateral wall of the cavernous sinus and then enters the superior orbital fissure to access the orbit. The somatomotor component of the nerve divides into a superior and inferior division. The superior division supplies the levator palpebrae superioris and superior rectus muscles. The inferior division supplies the medial rectus, inferior rectus and inferior oblique muscles. The visceromotor or parasympathetic component of the oculomotor nerve travels with inferior division. In the orbit the inferior division sends branches that enter the ciliary ganglion where they form functional contacts (synapses) with the ganglion cells. The ganglion cells send nerve fibers into the back of the eye where they travel to ultimately innervate the ciliary muscle and the constrictor pupillae muscle. In humans, this nerve has an average of about 30 000 fibers.

Olfactory Bulbs

Axons from the primary olfactory receptors penetrate the skull at the cribiform plate (small holes in the bone through which the axons pass give a “sieve-like” impression) and enter the olfactory bulbs. Here, the primary sensory processing of olfactory stimuli begins in the so-called glomeruli. The olfactory bulbs send their information directly into various cortical areas - the only sense that enters the cortex directly, without “switching” in the thalamic relay nuclei. The cortical areas receiving direct olfactory bulb output are : the **pyriform cortex**, the **olfactory tubercle** (in primates also described as the **perforated substance**), the **cortico-medial nuclei of the amygdala**, the **entorhinal cortex** (linked to the hippocampus) and, finally, to the **anterior olfactory nucleus**. The latter nucleus links the olfactory bulbs of each side via the anterior commissure. The olfactory bulbs and connected structures are not only involved in olfactory discrimination, but also to behaviors that are linked to olfactory stimuli. See: vomeronasal organ.

Olfactory Nerve (Not seen in Plate 1)

The olfactory nerve is actually a collection of sensory nerve rootlets that extend down from the olfactory bulb and pass through the many openings of the cribiform plate in the ethmoid bone. These specialized sensory receptive parts of the olfactory nerve are then located in the olfactory mucosa of the upper parts of the nasal cavity. During breathing air molecules attach to the olfactory mucosa and stimulate the olfactory receptors of cranial nerve I and electrical activity is transduced into the olfactory bulb. Olfactory bulb cells then transmit electrical activity to other parts of the central nervous system via the olfactory tract.

Olive

A bit confusing, because this terms simply refers to an olive-shaped bump lateral to the pyramidal tract, formed by the bulging **inferior olivary nucleus** (please see under cerebellum, inferior cerebellar peduncle) that lies underneath. Depending on the prominence of the inferior olivary nucleus, the olive is inconspicuous (as in the sheep) or quite colossal (as in humans). for clarification, the superior olivary nucleus has nothing to do with the cerebellum; it is a relay station of the auditory system.

Optic chiasma

see optic nerve

Optic Nerve

The optic nerve carries about 1 million fibers from each eye toward the lateral geniculate body. In humans, 50 % of the fibers - those which originate from the nasal part of the retina cross over to the contralateral side, while the 50 % that originate from the temporal retina remain ispilaterally. By convention, the optic nerve is that portion of the axons that come from the ganglion cells of the retina which reach the **optic chiasma** - where the crossing to the contralateral side occurs. Also by convention, the **optic tract** begins after the optic chiasma, where the axons stream towards the nucleus of the thalamus that carries visual information to the visual cortex. The fibers from the geniculate bodies that spread out to reach the visual cortex are collectively known as "**optic radiations**". In humans, the optic nerve has in the order of 1.2 million fibers.

Optic tract

See optic nerve

Periamygdaloid Cortex

That cortex in the temporal lobe in close proximity to the amygdala. This cortex sends projections to the lateral amygdaloid nucleus which in turn reciprocates to this region of cortex. The fibers involved carry information about olfactory stimuli and this is likely an important connection in terms of behavioral/emotional responses to specific olfactory substances.

Pineal Gland

Also known as epiphysis (note that the pituitary gland is also known as hypophysis) this gland is quite large in humans. As an interesting contrast, while the pituitary gland does not differ much in size between sheep and human brains, the pineal gland in humans can be as large as 1 cm across - much larger than in the sheep brain. This suggests an important role in humans. The gland produces melatonin, which is closely related to serotonin. Because serotonin in turn is related to, among other things, sleep and activity cycles it won't surprise you the that pineal gland receives input from the retina, and is thought to be involved in sleep-wake and activity cycles. The means by which retinal input reaches this gland is a bit tortuous - from the retina to the suprachiasmatic nucleus of the hypothalamus (known to be involved in "biological clocks"), and that region sends fibers to the cervical portion of the spinal cord from whence fibers ascend to reach the pituitary gland. In animals with seasonal reproductive cycles, this gland is important in initiating such cycles in response to changes in daylight duration. In humans, important in sleep cycles and becomes important in re-setting such cycles (shift work, airplane travel across time zones).

Pituitary Gland (Not seen in Plate 1)

Pea-sized gland that connects into the hypothalamic region immediately above, via the infundibulum. An anterior and a posterior portion is recognized. The anterior portion contains glandular cells that secrete six major hormones - all in response to hormonal factors that are generated in the hypothalamus. These are: Follicle stimulating hormone (FSH), luteinizing hormone (LH), prolactin (PRL), growth hormone (GH), adrenocorticotropic hormone (ACTH), and alpha melanocyte stimulating hormone (alpha MSH).
The posterior lobe secretes, principally, antidiuretic hormone (ADH) - also known as arginine vasopression and the structurally similar hormone oxytocin. The hypothalamus communicates with the cells in the anterior lobe of the pituitary gland via hormones that are transported in blood vessels whereas to connections between the hypothalamus and the posterior pituitary are formed by axons that descend from the former to the latter (thus also know as neuro-hypophysis; hypophysis is an alternate term for the pituitary gland).

Pons

The bulbous portion of the brain stem directly under the cerebellum, formed mostly by nuclei on which descending fibers on the way from the rest of the brain to the cerebellum synapse, and their ascending fibers that reach the cerebellum via the middle cerebellar peduncle.

Posterior Commissure

The pretectum, an area anterior to the superior colliculus, receives visual input and projects to the Edinger-Westphal nuclei on both sides of the brain. The fibers that cross from the pretectum to these nuclei, form a portion of the posterior commissure. Another portion of this commissure connect the opposite pretectal regions one each side. Only the latter fibers really form a commissure because the fibers connection the pretectum to the Edinger-Westphal nuclei form a decussation. These connections are involved, among other things, in the consensual pupillary reflex. This reflex is characterized by a pupillary changes in one eye after light changes in the other eye.

Pulvinar Nucleus of Thalamus

One of the association nuclei of the thalamus that interconnects various subcortical structures (superior colliculus) with cortical structures, most visual cortex. Please see thalamus.

Putamen

Together with the caudate nucleus forms the neostriatum, but separated from the latter (at least in primates) by the internal capsule. In many treatments, the two are considered very similar in function but it is likely that they are involved in somewhat different circuits. For example, the connections between the putamen and the supplementary motor area of the cortex (SMA) that ultimately involve the globus pallidus (internal segment) and the substantial nigra most likely are involved in the same kind of function as the connections between the frontal eye fields and the head of the caudate nucleus. The connections from the caudate also go to the globus pallidus (internal segment) and the substantial nigra, but to different parts. In the case of the putamen, the function appears to involves higher order activity of the somatic musculature while in the case of the caudate, the same sort of function is involved, but specific to vision and the higher order control of eye movement.

Pyramidal Tract

The fibers descending through the pyramidal system were the first of all motor fibers known to be involved in movement. The pyramids are made up of massive numbers of descending motor fibers and they derive their name from the shape of these tracts at the level of the medulla oblongata.

Pyramids are found in all mammals and they contain fibers that originate from the cortex and travel through the pyramids to the spinal cord (part of the CORTICOSPINAL pathways) as well as fibers of neurons that lie in the brainstem (part of the CORTICOBULBAR pathways, where “bulbar” refers to the medulla oblongata, the hindmost part of the brain before the spinal cord proper begins). In humans, there are some 1.000000 fibers in each of the pyramids. The vast majority of these fibers cross over from one side to the other. For example neurons that originate in the left brain half send their fibers to the right spinal cord after they have crossed at the pyramidal decussation. A small portion of fibers remains uncrossed and descends on the same side of the spinal cord as the cells of origin in the brain.

The vast majority of all fibers in the pyramids are quite small in diameter and therefore slow. Depending on the species, there also is a variable portion of small unmyelinated fibers that are even slower. It appears that fast conducting neurons (a rule of thumb labels fibers conducting faster than 20 m/sec as fast) are most active during large fast movements and these movements are little influenced by sensory feedback. In contrast, the slowly conducting neurons are active during both small and large amplitude movements and are strongly influenced by sensory feedback.

Septohypothalamic Tract

Originates from the septohypothalamic nucleus, an ill defined region at the anterior region of the hypothalamus and near the septal nuclei. A region that has a rich supply of hormone receptors appears to be involved in the regulation of hormones (e.g. thyrotropin releasing hormone) and is possibly involved in the initiation of specifies-specific behaviors that are linked to olfactory substances (pheromones). The region has been implicated in fear-motivated behavior.

Septum

This term general refers to a partition (the word comes from “sepes = hedge”). Your nose has a septum and so does your heart. Here, the term refers to a nuclear mass that lies medially anterior to the thalamus, and in close proximity to a number of olfactory structures and the hypothalamus. Often, referred to as "septal nuclei" and anatomically considered to be part of the diencephalon. This structure is an integral part of the limbic system; it receives input from the hippocampus via fibers from the fornix and it has strong reciprocal connections with the hypothalamus. Because of its diverse connections, no unitary function can be assigned but a rough distinction can be made between **medial septal** nuclei that appear to be involved in memory functions, and which send cholinergic input to the hippocampus, as well as being connected to structures that send cholinergic fibers to the cortex - and lateral septal nuclei that have many receptor sites for behavioral and physiologically important hormones (such as vasopression), and which may be involved in the regulation of biologically relevant emotional and motivational behaviors.

Septum Pellucidum

The thin membrane that divides the lateral cerebral ventricles I and II.

Spinal Accessory Nerve (XI)

The spinal accessory nerve originates from neuronal cell bodies located in the cervical spinal cord and caudal medulla. Most are located in the spinal cord and ascend through the foramen magnum and exit the cranium through the jugular foramen. They are branchiomotor in function and innervate the sternocleidomastoid and trapezius muscles in the neck and back. **You use this nerve to shrug your shoulders and move your head.**

The spinal accessory nerve originates from neuronal cell bodies located in the cervical spinal cord and caudal medulla. Most are located in the spinal cord and ascend through the foramen magnum and exit the cranium through the jugular foramen. They are branchiomotor in function and innervate the sternocleidomastoid and trapezius muscles in the neck and back. The cranial root of the accessory nerve originates from cells located in the caudal medulla. They are found in the nucleus ambiguus and leave the brainstem with the fibers of the vagus nerve. They join the spinal root to exit the jugular foramen. They rejoin the vagus nerve and distribute to the same targets as the vagus. Most consider the cranial part of the eleventh cranial nerve to be functionally part of the vagus nerve.

Splenium of Corpus Callosum

see corpus callosum

Stria Medullaris

A fiber tract that ends in the habenula. There are two components. The first comes from the thickened part of the septum, and the second arises in various structures in the base of the forebrain: the diagonal band of Broca, the ventral pallidum, the olfactory tubercle as well as a component from the lateral hypothalamus. This tract, running on the surface of the thalamus, broader towards the anterior thalamus and more tightly bundled as it reaches the habenula is likely involved in behavioral reactions to olfactory stimuli.

Subcallosal Fasciculus

Longitudinal bundle of fibers squeezed into the angle formed between the corpus callosum and the caudate nucleus, carries fibers from cortex to caudate nucleus.

Superior Colliculus

An important structure in the visual system which receives direct input from the eyes via a branch of the optic tract that bypasses the lateral geniculate body. This branch is most commonly known as the brachium of the superior colliculus (brachium = arm). The Superior colliculus also receives information from the primary visual cortex via the cortico-tectal system. The superior colliculus is a crucial structure in directing eye movement in space. It contains both topographical maps of the retina and motor maps that serve to direct the eye toward certain regions of the visual field. By and large it operates as an automatic “servo” unit - we are not aware of its inputs and outputs as it directs movements of the eyes toward regions of interest. This structure is also involved in automatic tracking movements of objects or visual stimuli. The Superior colliculus operates together with the frontal eye fields, the parietal cortex and parts of the basal ganglia (caudate nucleus, pars reticulata of the substantial nigra). During normal visual orienting behavior, the Superior colliculus is involved in coordinating the gaze direction with orienting movements of the head which harmonize with the direction of the eye movement (try to move your eyes strongly to one side without moving your head; the system does not like it !!!).

Thalamus

(Gr. an inner chamber): a large ovoid mass of gray matter that forms the major part of the diencephalon. It is a region of great functional importance and serves as a cell station to all the main sensory systems (except the olfactory pathway). The thalamus is situated on each side of the third ventricle. The anterior end of the thalamus is narrow and rounded, and forms the posterior boundary of the interventricular foramen. The posterior end is expanded to form the pulvinar nucleus, which overhangs the superior colliculus and the superior brachium. The lateral geniculate body forms a small elevation on the under aspect of the lateral portion of the pulvinar. The superior surface of the thalamus is covered medially by the tela choroidea and the fornix, and laterally it is covered by ependyma and forms part of the floor of the lateral ventricle; the lateral part is partially hidden by the choroid plexus of the lateral ventricle. The inferior surface is continuous with the tegmentum of the midbrain. The medial surface of the thalamus forms the superior part of the lateral wall of the third ventricle and is usually connected to the opposite thalamus by a band of gray matter, the interthalamic connection (interthalamic adhesion). The lateral surface of the thalamus is separated from the lentiform nucleus by the internal capsule.

There are Numerous ways of subdividing this large central cell mass of the diencephalon.

Limbic system nuclei

Anterior nuclei From mammillary body

<u>Specific Sensory relay nuclei</u>
Medial geniculate Ear
Lateral geniculate Eye
Ventral posterior (ventrobasal group) (somatosensory inputs)

Lateral vp - from dorsal column-medial leminiscal pathways and spinothalamic paths
Medial vp - sensory nuclei of the cranial nerve V
semi-lunar - from gustatory receptors and secondary trigeminal tracts, also known as arcuate nucleus, thalamic gustatory nucleus, semilunar nucleus of Flechsig; projects to the lower part of the postcentral gyrus of the cerebral cortex.

<u>Secondary relay nuclei</u>
Ventral anterior from globus pallidus
Ventral lateral mostly from dentate nucleus of cerebellum

<u>Association nuclei</u>
Lateral dorsal from cingulate gyrus, cortex
Lateral posterior from parietal lobe, cortex, superior colliculus
Medial dorsal nuclei From amygdala, olfactory areas, hypothalamus

Pulvinar from superior colliculus, temporal, from and to parietal occipital lobes
Medial dorsal nuclei From amygdala, olfactory areas, hypothalamus

<u>Intralaminar nuclei</u>
parafascicular (PFN), paracentral (PCN), central lateral (CLN), and centromedian (CMN)
associated with activation of cortex (consciousness loss if lesion in these nuclei), and also with pain perception.
Inputs from reticular system, spinothalamic tract, globus pallidus, cortex, other thalamic nuclei

Third Ventricle

Now you see it, now you don't. This ventricle is squished vertically, so that you see it only as a thin slit that separates the two brain halves above the massa intermedia of the thalamus, and below the slit extends right down to separate the two sides of the hypothalamus. The cerebrospinal fluid that is generated in the lateral ventricles circulates around the midline of the thalamus and hypothalamus and then collects just below the **tectum** (roof) of the mesencephalon to enter the cerebral aqueduct on the way to the fourth ventricle.

Trapezoid Body

Just at the caudal end of the pons, the trapezoid body represents the most important output from the cochlear nuclei to the auditory cortex. The trapezoid body is formed by crossing fibers that connect the left auditory cortex to the right ear and vice versa; on their way the fibers in the trapezoid body synapse in the superior olive, a major auditory relay nucleus.

Trigeminal Nerve (IV)

The trigeminal nerve is involved in conducting sensory information from the face region, including from the jaws and teeth and serves are motor nerve to the muscle that move that jaws during speech, sucking and chewing. The nerve is composed of the ophthalmic (V1, sensory), maxillary (V2, sensory) and mandibular (V3, motor and sensory) branches.

Altogether, the sensory portion of this nerve, with about 140 000 fibers, is far more massive than the motor portion that has about 8000 fibers.

The large sensory root and smaller motor root leave the brainstem at the midlateral surface of pons. The sensory root terminates in the largest of the cranial nerve nuclei which extends from the pons all the way down into the second cervical level of the spinal cord. The sensory root joins the trigeminal or semilunar ganglion between the layers of the dura mater in a depression on the floor of the middle crania fossa. This depression is the location of the so called Meckle's cave. The motor root originates from cells located in the masticator motor nucleus of trigeminal nerve located in the midpons of the brainstem. The motor root passes through the trigeminal ganglion and combines with the corresponding sensory root to become the mandibular nerve. It is distributed to the muscles of mastication, the mylohyoid muscle and the anterior belly of the digastric. The mandibular nerve also innervates the tensor veli palatini and tensor tympani muscles. The three sensory branches of the trigeminal nerve emanate from the ganglia to form the three branches of the trigeminal nerve. The ophthalmic and maxillary branches travel in the wall of the cavernous sinus just prior to leaving the cranium. The ophthalmic branch travels through the superior orbital fissure and passes through the orbit to reach the skin of the forehead and top of the head. The maxillary nerve enters the cranium through the foramen rotundum via the pterygopalatine fossa. Its sensory branches reach the pterygopalatine fossa via the inferior orbital fissure (face, cheek and upper teeth) and pterygopalatine canal (soft and hard palate, nasal cavity and pharynx). There are also meningeal sensory branches that enter the trigeminal ganglion within the
cranium. The sensory part of the mandibular nerve is composed of branches that carry general sensory information from the mucous membranes of the mouth and cheek, anterior two-thirds of the tongue, lower teeth, skin of the lower jaw, side of the head and scalp and meninges of the anterior and middle cranial fossae.

Trochlear Nerve (IV)

The trochlear nerve is purely a motor nerve and is the only cranial nerve to exit the brain dorsally. The trochlear nerve supplies one muscle: the superior oblique. The smallest of the nerves the operate the muscles of the eye, with an average of about 2700 fibers. The cell bodies that originate the fourth cranial nerve are located in ventral part of the brainstem in the trochlear nucleus. The trochlear nucleus gives rise to nerves that cross (decussate) to the other side of the brainstem just prior to exiting the brainstem. Thus, each superior oblique muscle is supplied by nerve fibers from the trochlear nucleus of the opposite side.

The trochlear nerve fibers curve forward and enter the dura mater at the angle between the free and attached border of the tentorium cerebelli. The nerve travels in the lateral wall of the cavernous sinus and then enters the orbit via the superior orbital fissure. The nerve travels medially and diagonally across the levator palpebrae superioris and superior rectus muscle to innervate the superior oblique muscle.

Vagus Nerve (X)

For us, the most important function is the innervation of the larynx for speech, minor importance for speech in movement of pharynx.

The vagus nerve is the longest of the cranial nerve. Its name is derived from Latin meaning "wandering". True to its name the vagus nerve wanders from the brain stem through organs in the neck, thorax and abdomen. The nerve exits the brain stem through rootlets in the medulla that are caudal to the rootlets for the ninth cranial nerve. The rootlets form the tenth cranial nerve and exit the cranium via the jugular foramen. Similar to the ninth cranial nerve there are two sensory ganglia associated with the vagus nerve. They are the superior and inferior vagal ganglia. The branchial motor component of the vagus nerve originates in the medulla in the nucleus ambiguus. The nucleus ambiguus contributes to the vagus nerve as three major branches which leave the nerve distal to the jugular foramen. The pharyngeal branch travels between the internal and external carotid arteries and enters the pharynx at the upper border of the middle constrictor muscle. It supplies the all the muscles of the pharynx and soft palate except the stylopharyngeas and tensor palati. These include the three constrictor muscles, levator veli palatini, salpingopharyngeus, palatopharyngeus and palatoglossal muscles. The superior laryngeal nerve branches distal to the pharyngeal branch and descends lateral to the pharynx. It divides into an internal and external branch. The internal branch is purely sensory and will be discussed later. The external branch travel to the cricothyroid muscle which it supplies. The third branch is the recurrent branch of the vagus nerve and it travels a different path on the left and right sides of the body. On the right side the recurrent branch leave the vagus anterior to the subclavian artery and wraps back around the artery to ascend posterior to it. The right recurrent branch ascends to a groove between the trachea and esophagus. The left recurrent branch leaves the vagus nerve on the aortic arch and loops posterior to the arch to ascend through the superior mediastinum. The left recurrent branch ascends along a groove between the esophagus and trachea. Both recurrent branches enter the larynx below the inferior constrictor and supply intrinsic muscles of larynx excluding the cricothyroid. The visceromotor or parasympathetic component of the vagus nerve originates from the dorsal motor nucleus of the vagus in the dorsal medulla. These cells give rise to axons that travel in the vagus nerve. The visceromotor part of the vagus innervates ganglionic neurons which are located in or adjacent to each target organ. The target organs in the head-neck include glands of the pharynx and larynx (via the pharyngeal and internal branches). In the thorax branches go to the lungs for bronchoconstriction, the esophagus for peristalsis and the heart for slowing of heart rate. In the abdomen branches enter the stomach, pancreas, small intestine, large intestine and colon for secretion and constriction of smooth muscle. The viscerosensory component of the vagus are derived from nerves that have receptors in the abdominal viscera, esophagus, heart and aortic arch, lungs, bronchia and trachea. Nerves in the abdomen and thorax join the left and right vagus nerves to ascend beside the left and right common carotid arteries. Sensation from the mucous membranes of the epiglottis, base of the tongue, aryepiglottic folds and the upper larynx travel via the internal laryngeal nerve. Sensation below the vocal folds of the larynx is carried by the recurrent laryngeal nerves. The cell bodies that give rise to the peripheral processes of the visceral sensory nerves of the vagus are located in the inferior vagal ganglion. The central process exits the ganglion and enters the brain stem to terminate in the nucleus solitarius. The general sensory components of the tenth cranial nerve conduct sensation from the larynx, pharynx, skin the external ear and external auditory canal, external surface of the tympanic membrane, and the meninges of the posterior cranial fossa. Sensation from the larynx travels via the recurrent laryngeal and internal branches of the vagus to reach the inferior vagal ganglion. Sensory nerve fibers from the skin and tympanic membrane travel with auricular branch of the vagus to reach the superior vagal ganglion. The central processes from both ganglia enter the medulla and terminate in the nucleus of the spinal trigeminal tract.

Vermis

Please see cerebellum

Vestibulo-cochlear (or Vestibulo-accoustic Nerve) VIII

The vestibulocochlear nerve is a sensory nerve that conducts two special senses: **hearing** (audition) and **balance** (vestibular).

The receptor cells for these special senses are located in the membranous labyrinth which is embedded in the petrous part of the temporal bone. There are two specialized organs in the bony labyrinth, the cochlea and the vestibular apparatus. The cochlear duct is the organ that is connected to the three bony ossicles which transduce sound waves into fluid movement in the cochlea. This ultimately causes movement of hair cells which activate the auditory part of the vestibulocochlear nerve. The vestibular apparatus is the organ that senses head position changes relative to gravity. Movement causes fluid vibration resulting in hair cell displacement that activates the vestibular part of the eighth nerve. The peripheral parts of the eighth nerve travel a short distance to nerve cell bodies at the base of the corresponding sense organs. From these peripheral sensory nerve cells the central part of the nerve then travels through the internal auditory meatus with the facial nerve. The eighth nerve enters the brain stem at the junction of the pons and medulla lateral to the facial nerve. The auditory component of the eighth nerve terminates in a sensory nucleus called the cochlear nucleus which is located at the junction of the pons and medulla. The vestibular part of the eight nerve ends in the vestibular nuclear complex located in the floor of the fourth ventricle.

Vomeronasal organ

Also known as Jacobson’s organ; olfactory structure that is specialized in the processing of pheromones = non-volatile olfactory substances that bear information about sex, receptive status and individual identity and other behaviorally relevant olfactory communicants.