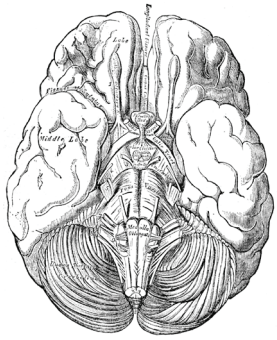
64: THE BRAIN (part 1)

The brain is the most complex object in the universe. There's no way we're going to learn enough about it in just two lessons. Please feel free to learn more about the brain using books, videos and websites. There's lots of good stuff out there!

From the top, the brain might remind you of a walnut. Both are kind of wrinkly and have two halves, or **hemispheres**. In general, the right hemisphere of the brain controls the left side of the body and the left hemisphere controls the right side of the body. The place where the optic nerves (from the eyes) cross over and go to the other side is clearly visible on the bottom of the brain. This is called the **optic chiasm** *(KIE-az-im)*. The crack between the lobes is called the **longitudinal fissure**. (Fissure just means "crack.") The rest of the cracks are called ***sulci*** (singular: ***sulcus***). The lumps and bumps are called **gyri** (singular: **gyrus**). The purpose behind all the wrinkles and bumps is to provide more surface area. Imagine a bath towel lying on a flat surface, then imagine the edges being pushed toward the middle creating many wrinkles and folds. The surface of the brain is called the cortex, and it gets bunched together like that imagined towel so it takes up less flat surface area.



This drawing by Andrea Vesalius in the 1500s shows the brain as seen from the bottom. You can clearly see the nerve chords from the eyes crossing over as they go to the opposite brain hemisphere.

From the side we can see that the brain has three distinct sections The top part, which we saw in the top view, is called the **cerebrum** *(sah-REE-brum)*. It's the part that does all the thinking. However, two other parts are equally important. That little lump under the back of the cerebrum is called the **cerebellum** *(sare-eh-BELL-um)*, which means "little brain." This little piece of the brain enables you to coordinate your movements. Without it you could not walk. It also allows you to remember motions like riding a bike, playing the piano, or tying your shoe. The long thin piece going downwards is called the **brain stem**. It looks like it would be the stem if the brain was a flower. The brain stem is where vital functions are controlled, such as breathing and heart rate.

The cerebrum has a notable lobe at the bottom called the ***t*emporal lobe**. It is located behind your ear. This lobe has many important functions including hearing, smell and speech. We'll learn more about it in the next lesson.

If we cut the brain in half lengthwise, making a **sagittal section** (cross section would be ear to ear), we can see most of the internal features. Some of the parts come in pairs, so we have to cheat just a bit. If we went straight down the middle, we'd miss both members of these pairs, so we'll just assume we went a little to one side in order to see one of these parts. We'll discuss each part number by number.

1) Olfactory bulb: There are two of these, one for each sinus. All the sensory neurons lining the inside of the nose connect to the olfactory bulb. (Olfaction is a fancy word for the sense of smell.) The signals travel from the bulb to a location in the temporal lobe where they are interpreted as odors.

2) Pituitary gland: We saw this in a previous lesson. It's tucked into its own little protective bone cavity. The pituitary, pea-sized as it is, has two parts, the anterior and posterior (front and back). The anterior part produces hormones that control many body parts including the thyroid, the adrenal glands (more on both of these in a future lesson), the growth of bones and muscles, reproductive organs in both males and females, and milk production in females. The back part controls the function of smooth muscles in the reproductive organs, plus it sends hormone signals to the kidneys telling them how much water to absorb. The pituitary is directly tied into the hypothalamus and receives signals from its neurons.

3) Hypothalamus: The hypothalamus is right underneath the thalamus. ("Hypo" means "under.") The most well-known functions of the hypothalamus are body temperature and appetite. Without your hypothalamus making you feel hungry you wouldn't know you needed to eat. The hypothalamus is also linked to the pituitary gland, as we saw in number 2. The neurons of the hypothalamus stimulate the cells of the pituitary. This means that the hypothalamus is part of the regulation of all the things that the pituitary does. Additionally, the hypothalamus plays a role in our sleep cycles and even some of our emotions.

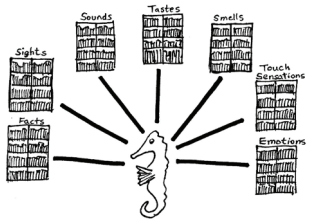
4) Thalamus: The this is often described as the "relay station" for all the incoming signals. It has a central location in the brain, which is just where it needs to be to sort out all the signal traffic that is coming in and going out. All the signals collected by your senses go to the thalamus before they go to the brain parts that will interpret them. The thalamus will decide how important each signal is and whether to relay it on to the upper brain. If you are concentrating on something very important, or watching something very exciting, the thalamus might decide you don't need to be bothered with the minor pain signals coming from your skin. Then, later, you'll notice that you injured yourself and think, "When did that happen?" There are limits, of course, and if the pain is great enough, the thalamus will let the signal go through no matter what you are doing.

5) Intermediate mass of thalamus: This is a connecting part and joins the left and right lobes of the thalamus. In this view we can't see the left and right lobes; we see only one. Most brain parts have a left and right section. (The pituitary is an exception.)

The next four parts form a group called the **limbic system**. This system is your emotional center. Even if you don't think you are a very emotional person, you still have a limbic system. The limbic system also plays a vital role in memory.

6) Fornix: This is a connecting arch that goes up and over the thalamus. (The word "fornix" means "arch.") It connects the mammillary bodies on the front end (anterior) to the hippocampus on the other side (posterior). As with most brain parts, there is a fornix on each side, but they touch in the middle so there can be some communication between left and right sides.

7) Mammillary body: The name of this brain part has nothing to do with its function. It was first discovered well over a hundred years ago, long before anyone had a clue what it did, so they just named it for what it looked like to them, and someone thought that the pair of them looked like mammary glands (i.e. breasts). Yeah, sorry. But they used the scientific name, "mammillary" so it didn't sound so bad. But this part has nothing to do with mammary glands. The clue to its function came from some people who had a nutritional disease that damaged this part specifically. The symptoms of the disease were memory problems. Therefore, it was concluded that the mammillary bodies must play a role in memory. Now the theory is that they act like a relay center, receiving signals from the hippocampus at the other end, and sending some of the signals into a central area of the thalamus. They play an important role in our sense of direction and our memory of places and spaces.



8) Hippocampus: This is at the posterior end of the fornix, and is definitely a huge player in memories. As with the fornix and the mammillary bodies, the name comes from its shape, not its function. Someone thought this part looked a bit like a seahorse, and "hippocampus" is Greek for either "seahorse" or "horse-like sea monster." (Or, maybe they were thinking of "kampe" which means "caterpillar.") Seahorse is actually a good image to use, because it is about the right size and shape.

The hippocampus is the part that transfers short term memories into long term storage. It also helps to retrieve memories when you want to remember them. It's a bit like a librarian who both puts books into storage and also goes and finds them when needed

9) Amygdala: *(ah-MIG-dah-la)* This is near the hippocampus. ("Amygdala" is Greek for "almond.") The amygdala seems to be involved with strong emotions, especially fear and anger. Brain technology now allows researchers to see which brain parts are working in different situations, and they've been able to watch the amygdala light up when certain pictures or ideas were shown or read to the subjects in the experiment. From this, and from dissection of rat brains (and a few human brains) they've been able to determine that this brain part is involved with negative emotions, that it is different in males and females, and that the two lobes of the amygdala are not identical. The left side can experience either happiness or sadness, and might be a key player in conditioned learning, where you receive either positive rewards or negative punishments. The right side is restricted to anger, fear and aggression and makes sure events that produce these emotions get recorded in the permanent memory. It's part of your survival system to make sure you don't repeat behaviors that led to negative consequences. You never forget traumatic events. (Which is also why this brain part is involved in post-traumatic stress syndrome.)

In early childhood, the amygdala seems to be responsible for the fear that babies experience when they see faces they don't recognize. The amygdala also senses people invading your "personal space." Malfunctions in the amygdala seem to play a role in anxiety disorders and alcoholism. In general, males tend to have larger amygdalas, and their amygdalas take longer to develop than they do in females. Males also tend to have the right side of the amygdala be larger than the left. This is one of the lesser known difference between males and females.

NOTE: A few other parts are sometimes listed as being part of the limbic system, because they are connected to it, such as the cingulate gyrus, or the thalamus.

10) Cingulate gyrus: *(SING-gu-late GIE-rus)* Basically, this part connects the cerebrum to the limbic system. However, it is not merely a connecting piece, but adds functions of it own. It connects all those emotional brain parts with the frontal lobe up in the cerebrum, which is the part where conscious decisions are made. The cingulate gyrus makes sure your frontal lobe is involved in any decisions that are very emotional. You might be so angry that you want to throw your friend out the window, but your frontal lobe says no, that would not be a good idea. The cingulate gyrus seems to be involved in positive things like the emotional bonding that happens between mothers and their babies. Also, it connects our language centers in the cerebrum to these emotional centers in the limbic system, making it possible for you talk about how you are feeling.

11) Corpus callosum: ("Corpus" means "body" and "callosum" means "thick.") This is the part that connects the left and right hemispheres. It is made of bundles of axons, so it looks white. People who have very severe forms of epilepsy sometimes have to have a cut made down through their corpus callosum, so that seizures cannot travel from one hemisphere to the other. This has allowed researchers to do very interesting experiments, testing what happens when the two hemispheres can't communicate. These people are surprisingly normal and if you met them you would not immediately suspect anything was wrong. The problems are only apparent during particular tasks, like asking the brain to name something they are seeing with only their left eye. (Since the right side of the brain controls the left eye, and the right brain usually doesn't have a speech center, the person will not be able to talk about what he/she is seeing.) The results of these tests have helped us learn a great deal about the different functions of the left and right sides of the cerebrum.

12) Mid-brain: This is a center for connections and reflexes. The connections from the cerebrum to the cerebellum go through this area. Also, the pathways that carry signals from the cerebrum to the muscles are found here. One part of the midbrain makes a neurotransmitter chemical called dopamine which is necessary for transmission of signals to muscles. If these cells stop producing dopamine, the result can be "Parkinson's disease." The midbrain also has our pupillary reflexes (adjustments for bright or dim light) and the automatic focusing feature of the lens. The midbrain also seems to play a role in maintaining consciousness (being awake and alert). Some people include the colliculi (16) as part of the midbrain.

13) Pons: ("Pons" means "bridge.") This looks like a lump at the top of the brain stem. It has a number of different functions, but the most well-known of these is the sleep cycle, sometimes called the "circadian *(sir-CADE-ee-an)* rhythm." Your pons will wake you up eventually, even if your alarm clock doesn't go off. The type of sleep that produces dreams seems to originate in the pons. Several very large nerves come out of the pons area, and connect to various parts of the face, eyes, and ears.

14) Medulla oblongata: This long (oblong) part is in charge of keeping us breathing and keeping our heart beating. Our breathing and heart rate keep going while we are asleep thanks to our medulla oblongata.

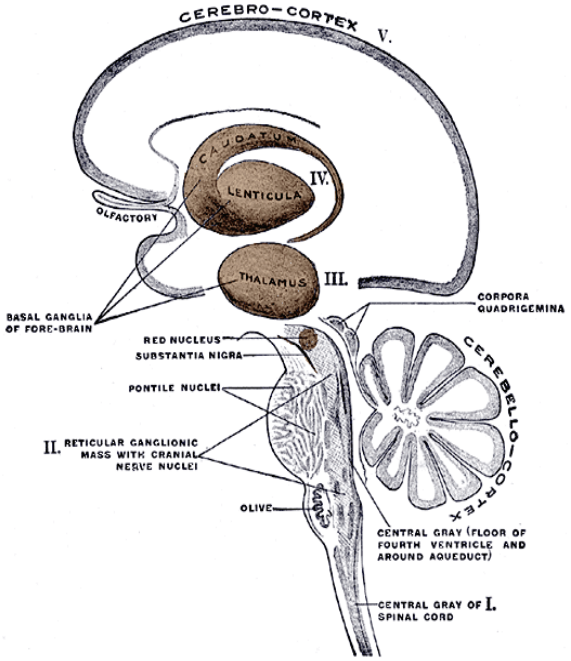
15) Pineal gland: This tiny part produces melatonin, a chemical involved in sleep. It is connected to the eyes and receives information about whether it is light or dark (day or night).

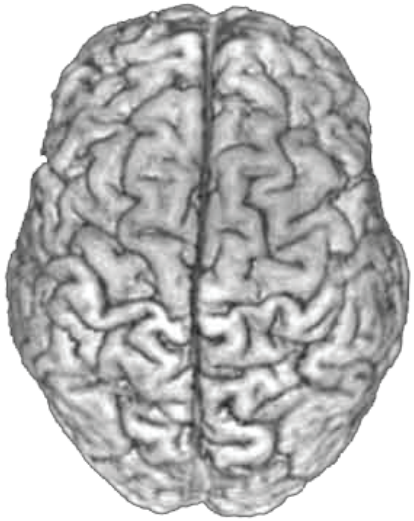
16) Colliculus: *(col-LICK-u-luss)* This area has two sections, the superior (upper) colliculus and the inferior (lower) colliculus. The superior part has important eye reflexes, such as being able to maintain our fix on an object while turning our head. The inferior part is connected to the ears and contains our startle reflex.

NOTE:

There's still one group of brain parts not included on this diagram. There are four places on the inside the cerebrum, kind of around the outside of the thalamus, where there are clusters of nerves, called ganglia. Since these clusters occur generally in the lower half, or underneath, the cerebrum, they are called the **basal ganglia**. They are harder to understand and harder to draw than the 16 brain parts in this lesson, and they are often not shown on brain anatomy diagrams for beginners.. This drawing is pretty full of brain parts already, so I thought it best not to include them.

The basal ganglia are coordinating areas that interconnect different parts of the brain. Some of the ganglia help to coordinate muscle movement. There are several neurological diseases that affect the basal ganglia, including Parkinson's disease and Tourette's syndrome. Both disorders involve muscles moving too much, out of the person's control. Tourette's syndrome also has a behavioral aspect, as people with Tourette's sometimes do things that are viewed as socially unacceptable, such as yelling or biting.





Top view of the cerebrum