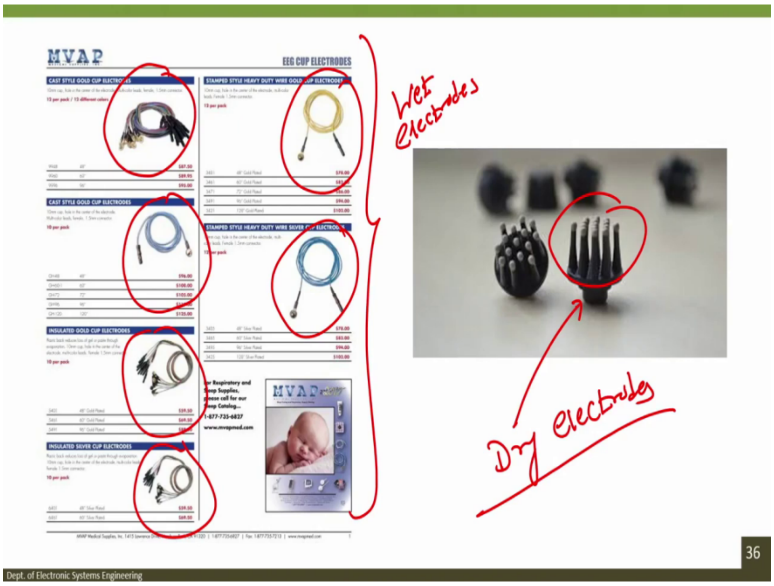
Introductory Neuroscience and Neuro-Instrumentation
Assistant Professor Hardik J. Pandya
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore
Introduction to EEG applications for Hearing Loss

(Refer Slide Time: 00:14)

Hi, welcome to this module. This is a short module, so I need to be focused more on the electrodes that are there for measuring or acquiring the EEG signals. So after this module, we will see the application of the micro fabrication for several devices, just as an example.

(Refer Slide Time: 00:43)



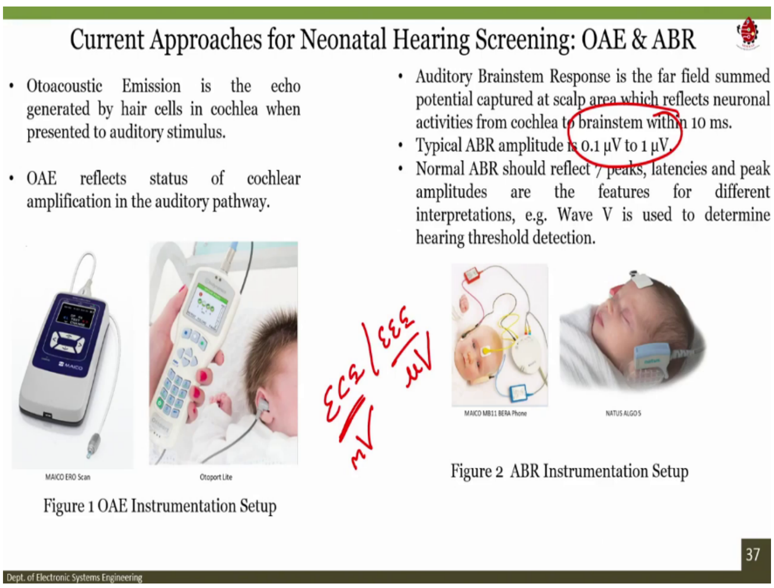
So if you see this slide, what you see here are the EEG cup electrodes from MVAP. This is a Medical Supplies Incorporation in California. And there are several kinds of electrodes that are used for capturing the EEG signal.

The first 1 is a cast style gold cup electrodes. We will show it to you how these electrodes looks like, we will bring it and show it you. There are stamped style heavy duty wire silver cup electrodes, which are generally used. And then there are stamped type heavy duty wire gold cup electrodes. Cast style gold cup electrodes.. We have insulated gold cup electrodes. Then we have insulated silver cup electrodes and so on and so forth.

These are the dry electrodes. So these are all wet electrodes. Wet electrodes require a gel to be used before you can place it or stick it on their scalp. This schematic shows dry electrodes. Dry electrodes do not require a gel for making a contact to the scalp.

Now, The importance of using the gel is to reduce the impedance. In this case, we can see there are spikes and thus, the chances of touching the scalp is higher without using any gel.

(Refer Slide Time: 2:40)



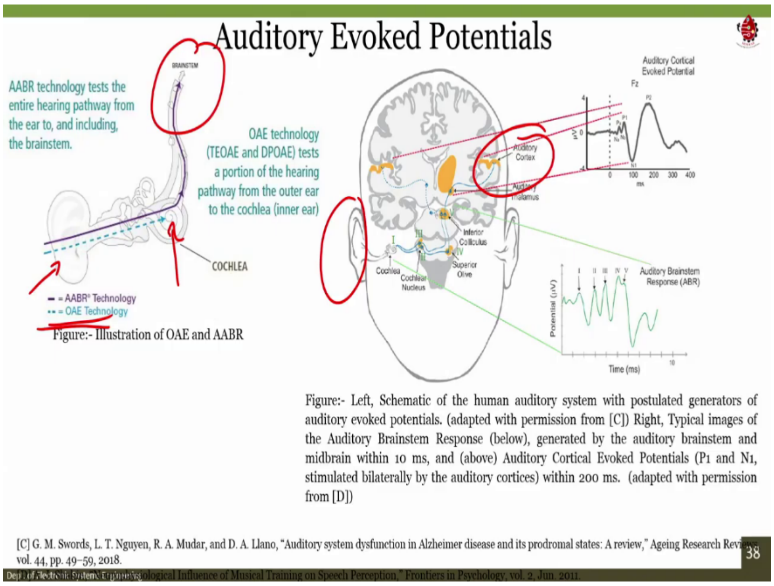
Now what are the applications of this kinds of EEG electrodes? One of the application is neonatal hearing screening. When the baby is born, to understand, whether the baby can hear it correctly or not, there are several techniques commercially available. one is called

Otoacoustic Emission, which is the echo generated by hair cells in cochlea when presented to the auditory stimulus. And OAE, which is a short form of otoacoustic remission reflects the status of cochlear amplification in the auditory pathway.

While another technique is called Auditory Brainstem Response or ABR is a far field summed potential captured at scalp areas, you can see here, which reflects neuronal activities from cochlea to brainstem within 10 microseconds.

So typically, when you talk about ECG versus EEG, we will be discussing this thing in detail, you will see that the voltage or amplitude of the signal in ECG is millivolt, amplitude of signals in EEG is microvolts. You can see here, typical ABR amplitude is 0.1 microvolts to 1 microvolt. And thus, your electronic module should be strong enough with a higher signal to noise ratio, so as the signals can be amplified and the noise can be filtered out.

(Refer Slide Time: 4:13)

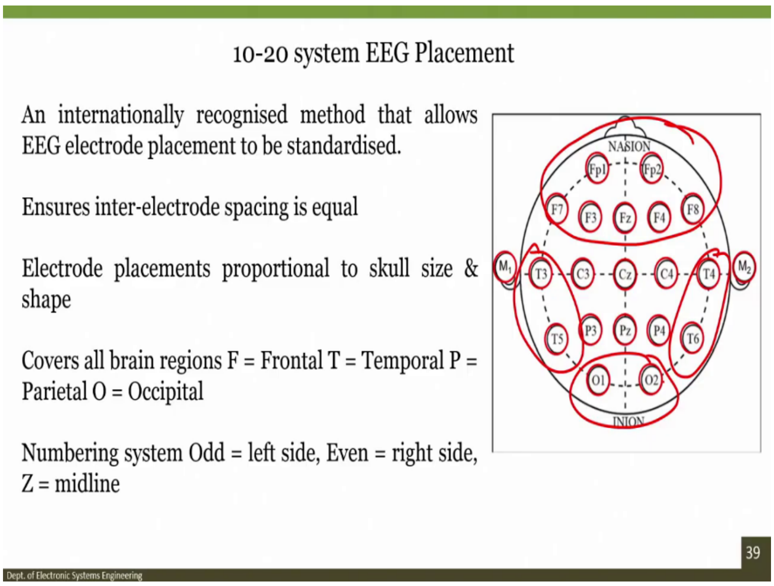


We were discussing about auditory evoked potentials. That means that the ABR technology test, entire hearing pathway from the ear to, and including the brainstem. So, if you start from the ear, it goes to the brainstem. And OAE test, a portion of the hearing pathway from outer ear to the inner cochlear. That means if you see here, the blue color line, OAE otoacoustic emission, starts from the outer ear to the cochlear, while ABR starts from the outer ear all the way to brainstem.

We are interested in not just to brainstem, but all the way to auditory cortex starting from here all the way to here. And how can we do that? What are the ways to do that? We will be discussing it.

This is an important area of research, where you can understand that how you can use these EEG electrodes to understand whether the hearing is correct or not, and also, to understand the cognitive-ability of the new born. So we will be discussing about several signals, including mismatched negativity, ABR, what are the positive picks, what are the negative picks, what is P300 positive pick at 300 milliseconds and so on and so forth in the modules.

(Refer Slide Time: 5:50)



However, this particular class is more on understanding just a general concept about the EEG and the fabrication techniques for the same. So when you talk about EEG placement, you see this is the way they use, which is called 10-20 system for placing the EEG electrodes. And then you can see that, the numbering system on the system is odd for the left side and is even for the right side.

What do we know odd for the left side? You see this side, if I show you this side is the left side and the remaining is the right side. So if you see the numbering 1, 7, 3, 3, 3, 1, 5, 3, 1, this all left side, that is why it is odd. It is just to help in understanding how to place electrodes and how to use the numbering system. While the right side, all the numbers are even 2, 4, 8, 4, 4, 2, 4, 6, 2.

While the regions, brain regions are divided or are noted in following ways, the F which is the, alphabet F is used for frontal area; alphabet T, so you can see here the frontal area like this. T is used for temporal, T, here. O is used for occipital.

So, the idea here is that, 10-20 system is an internationally recognized method. It ensures inter-electrode spacing is equal, because you can see that how it should be placed. Because 4 different skull size and shape, we need to make sure that the electrode placement is correct and it covers all the brain regions right from frontal, temporal, occipital.

So, before we go further into understanding how these electrodes work and how can we acquire the signals and what are different between ECG and EEG, and also before moving to ECG and EEG, we will see a lot of devices. Let us first understand what is the anatomy of the brain. That means, see, this is the scalp, This signal originating from the brain has to travel all the way down to the, all the way out to the scalp. So what if, how the signal travels? When you see the brain, that means, when you open the skull, how the brain looks like, what is the anatomy of brain? It is very important to understand the anatomy of brain and it is a very nice video that we have used and we have indicated in this particular module. So look at the video and we will discuss after that.

So let me play the video. (Video being played: 9:06 to 36:46)

Hi, engineers. So we have already covered the brain in another video. Our intention is in this video is just to be able to give you guys another view of the brain and some of the internal structures. So let us go ahead and dive right into this.

So, first off, if you remember from before, we had the central sulcus here on the side, and it is just this little like, this little groove right there, and you are running right there, this guy right there is actually called the central sulcus. So again, the central sulcus is this little light groove right here running all the way up right there.

And what is the purpose of it? The central sulcus separates the frontal lobe from the prior lobe. So if I come up this central sulcus one more time, if I go right in front of this sulcus to this gyrus right there, because there were a sulcus because it is like this little like divot and then a gyrus is this big fat lumpy thing right there.

This gyrus in front of the central sulcus is called the precentral gyrus. It is also where the primary motor cortex is. And if I fall, the central sulcus back up again and I go to this fat gyrus that is right behind it, that guy right there is called the postcentral gyrus and that is where the primary somatosensory cortex is.

And then if I were to go in front of the primary motor here, which is where the precentral gyrus is, I would hit like the premotor and then coming in front of that, it was called the prefrontal cortex and so on and so forth. There is even called the eyelids stuff like that.

But again, the basic important thing right here is the central sulcus, precentral gyrus, postcentral gyrus. The precentral gyrus is functionally called the primary motor cortex. The postcentral gyrus is functionally called the primary somatosensory cortex.

Then, if I were to continue to work my way back to see where else does the parietal lobe, where can, where does that terminate and where does it go into the another lobe? So if I come over here, I am going to take this brain and kind of like open it up here, turn it around. So if we look here, you will see another sulcus right there. That sulcus right there is actually called the parieto-occipital sulcus, and the parieto-occipital sulcus is what separates the parietal lobe from the occipital lobe. So back here is the occipital, I will give you guys another view here in a second, just let me repeat that one more time again.

This is the parieto-occipital sulcus and the parietal occipital sulcus is what separates the parietal lobe, which begins right after the central sulcus, all the way up to this sulcus and it separates the parietal lobe again from the occipital lobe.

So if we look back here, we have the occipital lobe back there, again and what separates occipital lobe from the parietal lobe is the parieto-occipital sulcus. So this is the occipital lobe.

In the occipital lobe, there is a specific cortex, it is actually called the primary visual cortex and that is where, the actual signal transduction that comes from our retina that portrays basically light. We can actually have the perception of that light in this area to be able to perceive what we see certain types of objects and shapes and colors and so on and so forth. So again, primary visual cortex is located within the occipital lobe.

And then, if I turn this to the right side or lateral side over here, we can see another sulcus and this sulcus is right here. So, let me move this rubber band guys, so you can see a little better. If I move that rubber band right there and I move my finger right on this, this whole pointer here, right through this area, right through that sulcus, that sulcus right there is called the lateral sulcus.

Now the lateral sulcus is the sulcus that separates the temporal lobe again from the parietal lobe and even a little bit from the frontal lobe, but there is lateral sulcus right down here and it separates the temporal lobe from the parietal lobe and even a little bit from the frontal lobe.

So again, what is this lobe right here then? I already said this is a temporal lobe. And the temporal lobe has a specific cortex in it, which is called the primary auditory cortex. And the primary auditory cortex is going to be where we take specifically sound and hearing from the cochlear in our inner ear and we bring it to this area to be able to perceive and put together different types of memories, to understand what we are hearing and be able to perceive that hearing. So that is where the primary auditory cortex is. Okay, that is the temporal.

There is another lobe, we cannot see and he is going to be deep to the temporal and that is called the insula.

So let us go ahead and show you two more other areas that are kind of important here. And what I am going to do is, turning on the left side of the frontal lobe, and it is called the Broca's area. So the Broca's area is just going to be this little area over here on the left side of the frontal lobe, it kind of controls the muscles of speech production. So being able to change the shape of our mouth and other types of muscles that are basically assisting within pronunciation and production of consonants and so on and so forth. But again, just controls the muscles with speech production.

There is another area back here, it is kind of an overlapping area right about here about, that is called the Wernicke's area, basically it just helps us to be able to understand what we are hearing and put those words together in a appropriate manner that when we speak it, it makes sense. So it does help with being able to play a role also in speech production, but also understanding speech. So that is the Wernicke's area.

Now what I am going to do is, we are going to going to kind of take this guy here and turn it forward here, so I can show you another structure. This whole thing up here is the cerebrum, and the cerebrum is actually derived from what is called the telencephalon, that its scientific name.

Now what I am going to do is, I am going to kind of separate this two server hemispheres right there. And what happens is there is a fissure that runs right between these two, right between these two and that is called the longitudinal fissure, called the longitudinal fissure.

Why I mentioned that is there is, what is called dural sinuses, that are veins that run through this area and we have to protect them. So there is these things called dural septa, which are just like little central partitions of dura mater that dip down into this longitudinal fissure and protect the dural sinuses. And that dural septa is that comes in here in the longitudinal fissure is called the falx, so falx cerebra. And again, it is right here in the longitudinal fissure.

Now I am going to go and turn this guy around, so we can tell you guys about another one. So I am going to come back here back where the occipital lobe was. And if you remember, this was the occipital lobe. Well how do we know? We know where the parietal lobe ends. You remember it starts at the central sulcus and then it ends at the parietal occipital sulcus and that is where the occipital lobe begins to the parieto-occipital sulcus. Where does it end? It ends right back here, where there is this little space in here, right between the occipital lobe and the cerebellum right there. So in between here is what is called the transverse fissure and the transverse fissure is important because there is another dural septa that actually dips in that area, and that right there is called the tentorium cerebelli, tentorium cerebelli and it is just a dural matter partitioner septa, the dips in that area.

Now, we are going to and do, is we are going to go ahead deeper into the structures of the cerebrum and take a look at that. Now I am going to show some other structures underneath the cerebrum. So deep in the cerebrum, I just want to show you guys, if you see all this white right here, this is all white matter. And what my white matter is, is it is just myelinated axons. So it is myelinated axons and myelinated axons just means it has this thing called myelin, which is made up of fat and proteins, helps with basically nerve conduction, the speed of nerve conduction. But anyway, myelinated axons right here is going to be the white matter.

All this pink stuff around the edges or the outsides of it, this is all part of what is called a cerebral cortex and that is made of gray matter. And gray matter is actually unmyelinated cell body. So there is no myelin around the cell bodies. So unmyelinated cell bodies is our gray matter, which makes up the cerebral cortex. And as you can think of that, like as the thinking tissue. So that is the part where they are the biomechanical centers and they basically, they are the ones that control a lot of the thinking or conscious thought. This white matter, you could think about it as like transmission tissue. It is basically responsible for being able to transmit impulses to and from certain areas. So that again that shows you the cerebral cortex and I guess shows the white matter right there.

Now we are going to do is we are going to take a look at some other structures, which is in the diencephalon and the ventricles. I guess, I have the left cerebral hemisphere right now. What I am going to do is I am going to take this top piece off so we can take a deeper look at some structures inside here. So if we take a look in here, we are kind of in the lateral ventricle and the ventricles are just basically cavities within the actual brain and also within the brainstem and it contains what is called cerebral spinal fluid. And we will talk about that more in the neurophysiology stuff.

But if you look right here sitting in the bottom of the lateral ventricle down here, this is actually if you remember from the other video, it is called the hippocampus. And the hippocampus is a limbic nuclei, so it plays a role with memory and emotions and so on and so forth. So it does play a very, very important role within basically memory. If you look here, that is 190 and if I come up here and I follow these white fibers like 186, if I follow it all the way from here all the way back, and then I come back up this way, so again all way up here following this guy, and all the way back this way, these fibers are very important. They are called association fibers.

And association fibers are what allow for the movement of impulses to go from front, from the, in front of the cerebrum room to the back of the cerebrum or vice versa. So again, these are association fibers, and this is the hippocampus, and then this whole cavity right here. So like, for example, this inferior horn, this is the posterior horn, and then we will see the anterior horn in a second, that is all the lateral ventricle. And again, you can see the white matter and then you can see the gray matter out there.

So the last structure here is going to be number 206 and this is actually called the internal capsule. And the internal capsule is specific fiber, it is called a projection fiber. And projection fibers are important for being able to bring sensory information up to the cerebral cortex. So they bring information up. But they do, they can allow for information to go down also. So they just basically offer movement to go up and down. So association is back and forth. So back and front, and projection is up and down. And we will look at another one in a second called the commissural fibers.

Now, we are going to let him turn around and look at some other structures guys. So I just turned it around guys. So again, we are looking here at kind of like the other view, it was on the backside and now we are looking over here on the front side. So if you look right here, there is a nuclei here, it is a basal nuclei. And basal nuclei just started pouring for being able to dampen or smooth out certain motor movements. He is 1 of them, he is called the caudate nucleus. So it is a caudate nucleus right there.

But this whole, remember I told you, there was another anterior horn that lateral ventricle. So there is a little cavity here and this whole cavity here is the lateral ventricle. And if you look right here, this structure right there is actually called the, it is a choroid plexus, because there is a choroid plexus, which is basically made up of ependymal cells and pia mater and you are also going to have your capillaries in there and it is what helps to be able to make the cerebral spinal fluid and circulated. So again, this is going to be the lateral ventricle.

This cavity here imagine like bathing this nucleus here, imagine a bathing this caudate nucleus. And once this whole cavity filled with cerebral spinal fluid and that is made by this thing called the choroid plexus. And then you can see this fiber right there. There is another white matter fiber and this is actually called the fornix. And the fornix is a white fiber that actually it is a tract, which is a bundle of axons in the central nervous system that connects multiple limbic nuclei together. So again, this structure right here, all the way from all the way from here, this is called the fornix and the fornix is basically what helps to be able to connect multiple limbic nuclei together.

So again, last time, lateral ventricle, caudate nucleus, choroid plexus of the lateral ventricle and the fornix. So now we are going to go ahead and look at some of these other structures in the diencephalon.

So this side here is the corpus callosum and the corpus callosum number 145, this is actually going to be made up of what is called commissural fibers. And commissural fibersis again myelinated axons that allow for transmission of impulses from left cerebral hemisphere to right or from right cerebral hemisphere to left cerebral hemisphere. So it is very important for that connection.

It is also an area that is commonly damaged during concussions and it is actually been found that women have more commissural fibers than men do, which allows for them to be able to have a little bit better at multi-tasking and stuff like that, and it also plays a role in epilepsy and stuff like that, but we are not going to get into that again.

If you look here there is a membrane, 146, so the stem membrane here is called the septum pellucidum and underneath is septum pellucidum is that lateral ventricle that I was showing you guys before. So underneath this septum pellucidum is the lateral ventricle. So it is just a thin membrane that is separates the two lateral ventricles, because again, we have a lateral ventricle on this one cerebral hemisphere, let us say the right one and we will also have a lateral ventricle in the left cerebral hemisphere. And the structure separating them, this membrane is the septum pellucidum. If you guys look at the ventricle model we have, you will also see a better way of looking at that also.

Let us come back here again. 148 here, this is the fornix and again, that was that fiber track that connects a lot of limbic nuclear together. If I imagine I draw a whole circle, I said a whole circle all the way around here, you imagine like an egg, an egg is kind of like oval shape. So this whole thing right here is the thalamus. So this whole egg structure here, the whole bunch of nuclei is the thalamus. And the thalamus is actually the relay station for a lot of sensory information going up into the stream because he has tons of nuclei that regulate that activity.

And if you look there that little brown structure right there, that is called the intermediate mass and it basically is like an interthalamic adhesion between the thalamus because you would have a thalamus and your right hemisphere, you have a thalamus in your left hemisphere, so you have two of them.

If you actually imagine here, imagine this being an eye, like a bird's eye. So if you can imagine, you can imagine the bird's eye, which is kind of like the widely eyes like the thalamus and then the pupil right there is where the intermediate mass is. And if you imagine the bird's beak, this right there a birds beak because is actually the hypothalamus. Look and kind of say, look at like a bird's eye and a bird beak. And again, the bird's eyes made up at the thalamus and then immediate mass and the bird's beak is hypothalamus.

If you look back here, you have what is called the pineal gland, which is a part of the epi thalamus, they are also going to notice this little like the hypothalamus has this little stock here on this side that connects to the pituitary gland, that would sit right underneath the optic chiasma. Actually this is, if you look at 170 there, that is 1 where the optic nerves cross, that is actually called the optic chiasma. So for example, this is the right cerebellum this should be the right optic nerve here and it is getting ready, so its fibers will cross over to the left side. So that is kind of like the optic chiasma there.

And then this part right there is the infundibulum. Then if you look right there, that little like blue ball there, that right there is called the mammillary bodies. And the mammillary bodies are also important because they play a role within certain types of olfactory pathways. So they play a role in smell. That is the mammillary bodies in their limbic nuclear. So they play a role also rather play a role in recollective memory, stuff like that.

If you come over here, we are going to see some other structures. And now we are getting ready, start moving into the brainstem. So as we get ready to move over here, let us actually hit our brainstem. So if you look right here, all this part right here, this is all called the midbrain and they also call it the mesencephalon, so it is derived from mesencephalon. All this right here is our ponds. This is all our ponds and the ponds, and this right here is the cerebellum, they were actually derived from what is called the metencephalon.

And then if we look here all the way over here, this is the medulla oblongata. Medulla oblongata what the others call them myelencephalon. So again, I had it one more time, mesencephalon and then you got your metencephalon, which is made up of ponds and the cerebellum and then you have your myelencephalon, which is the medulla oblongata.

Another thing here is, I mentioned that all this area right here is the diencephalon. Diencephalon is mainly made up of 3 things, which we said the thalamus, hypothalamus and then technically the epithalamus, which consists of the pineal gland. There is this little cavity right here and also contains cerebral spinal fluid. And this is called the third ventricle.

So this is the third ventricle would be a cabbie right in this vicinity right here. So it actually gets drained from the lateral ventricle. So here is our third ventricle. The third ventricle drain some of that actual fluid from the lateral ventricle. Then there is another little tube right here, running right here through the midbrain. So if you see a little tube right there, that is actually called the cerebral aqueduct.

So cerebral aqueduct trains the third ventricle and the third ventricle trains the lateral ventricle via what is called the intervention of the foramen. So again, third ventricle here and then cerebral aqueduct here. Then the cerebral aqueduct moves into what is called the 4th ventricle. And then from the 4th ventricle cerebral spinal fluid can go two ways, it can go down through the central canal, it eventually go through central canal spinal cord, or it can go out through these two little holes called the foramen Luschka and the foramen Magendie or you can say foramen Magendie is median aperture and the foramen Luschka is the lateral apertures.

Now, if we look here in the back of the midbrain, we see these two little like balls there. This top one right there is called the superior colliculi. And basically what he helps you to do is being able to move, take a reflexive movement of your head in response to some type of visual stimulus.

So for example, if I see Kate often walking by, my head is going to move with response to that visual stimulus. And then down here is the inferior colliculi. The inferior colliculi actually controls reflexive head movements, response to auditory stimulus.

So for example, if Kate Upton's boyfriend yelled at me, hey, what you are doing, looking at her? My head would move that way too. So that is an example of that right there. So superior colliculi, inferior colliculi there.

And so if I look here, guys, there is another structure I want to show you, it is 182 right there. That structure right there is called the cerebral peduncles. So it is like the stalk and again, these are projection fibers actually. So if you remember the cerebral peduncles, these are projection fibers, they are right around the midbrain and they carry sensory information up into the cerebrum. So again, that is the cerebral peduncles right there.

So, if you look here, I have 183 right there. This is the pyramids, this is the pyramids of the medulla oblongata and that is where the descending motor fibers actually decussate or crossed right there. So the pyramids is due to the Decussation or just crossing of the descending motor pathways.

I guess if we look over here on the side of the medulla oblongata, like on this side of it, it is all this pink gummy stuff. That is all the olives, and the olives are, they're actually broken up into two nuclei. You get your superior olivary nuclei, inferior olivary nuclei. In the superior, basically they play a role in, basically the auditory pathways and the inferior olivary nuclei play a role with an appropriate reception, cerebellar motor function and learning and stuff like that. So I guess, again all this play role in probate reception, and they play a role in basically in hearing also. So that is your olives.

Now we are going to basically go over the cerebellum now. So, if you look here, you can see all of this like tree, like structure right there, all this white light, tree-like looking thing. All those white matter here is called the arbor vitae. And the arbor vitae are just basically the white matter of the cerebellum. Arbor vitae stands for like a tree of life. So again, all this white matter here is the arbor vitae.

And the outer gray matter on the actual edges where you will find like your purkinje cells and certain stuff like that. Like all the outer side is the gray matter of the cerebellar cortex. And again, that is just unmyelinated cell bodies.

Again, if you look here in the back of the cerebellum here, if you see all these little, like little divots there, it is actually called folia. So the folia basically like the folds of the cerebellum. So all these little lines right there that you see forming these little folds that is called the folia.

If you look right here, right in between the actual cerebellum, there is actually this little warm like structure between them, it is actually called the vermis. And in between the vermis, there is like an actual dural septa, like I said before, that actually runs in between there. And that dural septa is called the falx cerebelli, falx cerebelli.

Again, so this structure right there between the two cerebellum is the actual firmness and the dural septa that goes between the two is called the falx cerebelli. All right, so that pretty much covers the cerebellum.

Now what we are going to do is we are going to go into the cranial nerves. So if we look right here, we are going to see cranial nerve one, that is the olfactory nerve. And again, remember that the olfactory nerve originates in the nasal cavity through the olfactory epithelium, and that actually picks up certain types of sensations, like smells for odor and sense in different types of chemicals and carries that up through the cribriform plate of the ethmoid bone, and then all up into a specifically happen to this olfactory bulb here, where there is glomeruli line mitral cell. So these are sensory nerve.

Then right here, you are going to notice two optic nerves right there. So there is your left optic nerve, there is your right optic nerve and then the point at which cross is called the optic chiasma. And so the optic nerve basically picks up sensations of vision. So he picks up the vision stimulus and then takes that into the actual cerebrum, very specifically to that primary visual cortex.

Then if we go, we are going to have to go in and separate this guy, so we can look at some other structures here. So we can look at the midbrain a little bit deeper. I guess, so if we look here, we can see cranial nerve 3, it actually comes out in between the interpeduncular fossa or right there at the midbrain. And that is called the oculomotor nerve, cranial nerve 3.

The oculomotor nerve actually runs through, the superior orbital fissure and supplies a lot of the extraocular eye muscles. I also did not mention the whole that the optic nerve runs through, but you could imagine it is the optic canal. So again, optic motor nerve runs through these superior orbital fissure and supplies a lot of extraocular eye muscles.

Then if we come down here, we can see the sort of like, you see sort of white thing right there, guys, the little like white piece of thing popping down there, that is called the trochlear nerve. So that is called trochlear nerve or cranial nerve 4. And the cranial nerve 4 or the trochlear nerves actually runs also through the superior orbital fissure and supplies the, its called the superior oblique muscle, which is another extraocular eye muscles. So he plays a role in motor functioning.

So here is the trochlear nerve again and so that is cranial nerve 4. And then if you look down here, we have these two nerves because they are paired guys. So we are going to see the trigeminal nerve here, which is cranial nerve 5 and you will see the trigeminal nerve here, which is again, cranial nerve 5. So the trigeminal nerve is a really big one and it actually splits into 3 branches, and it actually runs through 3 holes. It can run through the superior orbital fissure, it can run through the foramen ovale and the foramen tandem. And the trigeminal nerve supplies, the muscles of mastication and he also supplies certain areas of the skin of the face to pick up sensation. So he plays a role in muscle action, which is mastication. Chewing, and he also picks up sensations on the face.

Interestingly, this is actually, if this has what is called neuralgia, trigeminal neuralgia, where there is some certain type of nerve pain, this can cause one of the most severe nerve pains actually known to man, it is actually called trigeminal neuralgia and it is extremely, extremely painful, I would actually call it the suicide disease.

Then if we come down here to this structure right there, and that structure right there, these are actually your cranial nerve 6 or the abducens nerve and he also runs through the superior orbital fissure and he supplies the lateral rectus. And again, that is another extraocular eye muscles.

Then if we move out laterally over here, we are going to have these 2 guys, you see this 1 right there and this one over here, that is actually called the facial nerve. So that is cranial nerve 7. So this one right there and this one right there. And the facial nerve has 5 branches, but he can run through the stylomastoid foramen and he also can run through the internal acoustic meatus. But basically he supplies the muscles of facial expression, a lot of glands within the like the lacrimal gland and nasal glands and stuff like that. So he plays a role in both. He actually plays, and he also picks up sensations again from the face as well. So he is actually a motor nerve and a sensory nerve. Okay, so that is the facial nerve.

Then if we go over here to the edge, these one, that one right there over there, and this one right there on that edge, that is actually called the vestibulocochlear nerve. And the vestibular cochlear nerve, and the vestibulocochlear nerve he runs through the internal acoustic meatus and he basically carries dynamic and static equilibrium and just a general sound and hearing. And that is that guy.

Then if we come down here, there is this little chunk right there, which is the same chunk right there. That is called the glossopharyngeal nerve, which is cranial nerve 9. And he also, he actually runs through the jugular foramen and he supplies to the tongue, he supplies certain muscles of the pharynx. He also can act as a, he can pick up sensations from the baroreceptors. So he plays a lot of roles in different sensory and motor functions as well.

Below him is the vegas nerve. So this one right there, that is cranial nerve 10. So again, vagus nerve right there and right there. He is the main parasympathetic nerve. He carries about 90% of the parasympathetic flow. And he also runs through the jugular foramen. He supplies many, many different organs from the heart to the lungs, to the GI tract, to the urogenital tract, so on and so forth. So again, that is your vagus nerve.

So if you look down here guys, you will see this nerve right here and over here, its cranial nerve 11, which is called the accessory nerve. Now the accessory nerve has 2 parts, 1 that is on the cervical part of the spinal cord and one on this medulla here, that is the medullary branch. And what happens is the cervical branch of the accessory nerve comes up through the foramen magnum and merges with this branch off the medulla. And as a collection, they run through the jugular foramen and they go on supply the trapezius muscle and the sternocleidomastoid, which are, again, there is somatic muscles or skeletal muscle. All right, so that is the accessory nerve, he is mainly a motor nerve.

And then the last one right here is this guy right there, which is the same as this guy right there. That is cranial nerve 12, which is the hypoglossal nerve. And the hypoglossal nerve runs through what is called the hypoglossal canal and supply some of the extrinsic muscles of the tongue. So he is mainly a motor nerve.

All right, I guess that pretty much covers all the cranial nerves. I hope this video helped guys and see you engineers.

So you have seen the video. And what you see is how, when you see the brain, you cannot really identify what is the difference. But when you look at the anatomy, we kind of know that what are the regions required for motor cortex, what are the region that are used for your visual stimulus, what are the regions that can be helped, which helps in understanding the hearing of the things.

The idea is, that these electrical signals travels on entire brain, on entire brain surface. But at some point of time, or in some cases, the electrical signal starts misfiring, I am putting in very easy terms.

So if that happens, then it is kind of epilepsy and we talk about epilepsy and how can we record those signals from the brain, there a device that will fabricate? So let us, let us see that, the other devices that we can fabricate with micro fabrication and then we will take care of how to, what is the difference between ECG and EEG followed by the experiments related to the, understanding the EEG signal, acquiring the EEG signal. And also, understanding how we can use the METLAB, to solve or to process this signals further.

So till then you take care, I will see you in the next module. Bye.