Animal Physiology
Prof. Mainak Das
Department of Biological Sciences & Bioengineering & Design Programme
Indian Institute of Technology, Kanpur

Lecture – 27
Anatomy of Hippocampus

Welcome back to the lecture series on Animal Physiology. So, in the last class which was the first lecture of the sixth week we talked about the spatial and temporal summation and I concluded the class with overall layout of what all by link in the light of this action potential, temporal summation, rule of neurotransmitters all that stuff.

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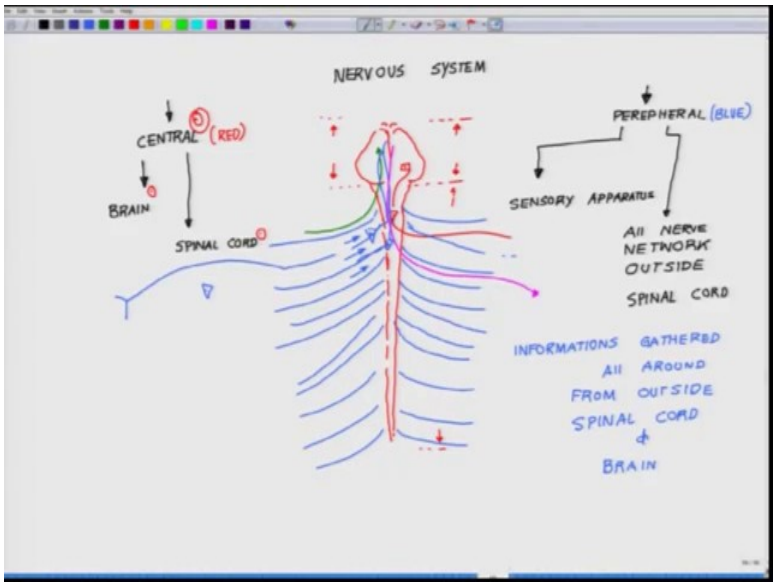

So, before I proceed lets revisit the anatomical aspects. So, if you remember this is what I have covered with you people central nervous system brain and the spinal cord and peripheral nervous system all nerve network outside this spinal cord information gathered all from outsides spinal cord and from outside and sent to this spinal cord and brain this I have already shown you.

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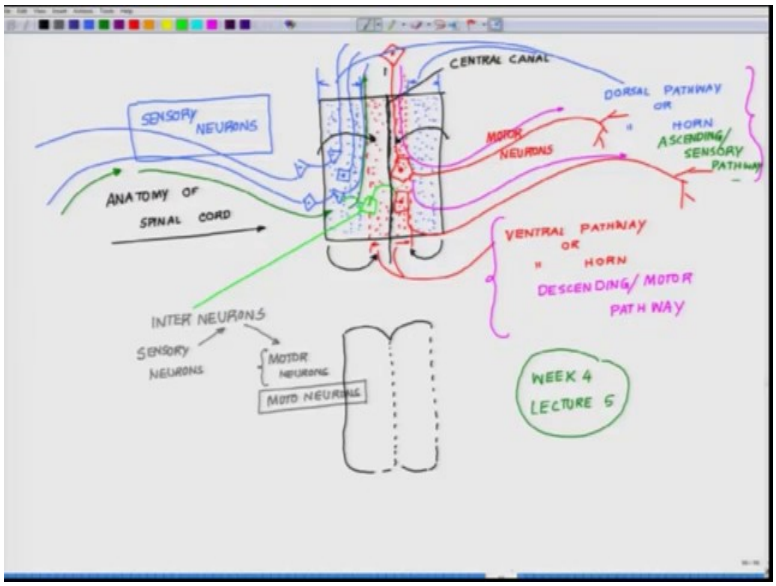

Then I have told you about the motor neuron pathway, dorsal pathway, the ventral pathway, the descending pathway and all the system. So, part of the anatomy, I have already covered.

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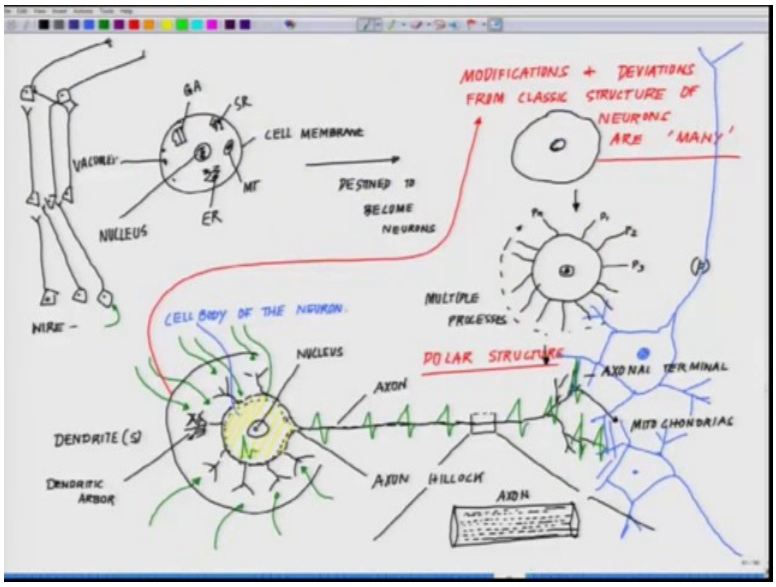

Now, what I will do is from here I will move on to with this brief background.

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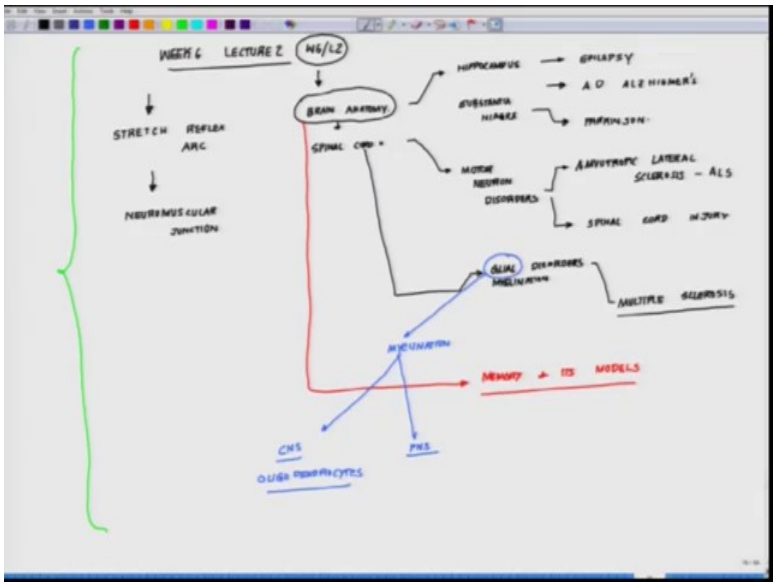

I will move on to the, let me just put it down; this is week-6 lecture-2 - W-6 L-2. Now, let me move on to the anatomy of the brain. What the brain anatomy really looks like because of detail I have dealt with you. Let us start with it. Let us go ahead with the brain anatomy first. So, I have already talked to you about the descending pathway and the ascending pathway. Ascending pathway is all the information's from all the peripherals which are reaching to the brain. So, though it works first of all try to visualize this picture and something like this is the location, this is the main stadium, and all the roads are kind of you know coming towards it. So, you are going to see a game or something. So, it is something like this, this is central hub, which is receiving all the signals.

Now, once you get inside the stadium, you have a specific ticket number, it is not that everybody sits randomly. So, you have a seat number, based on that you go and you know cover the whole stadium. So, there are crowd flocking from the all directions, but they have specific number, they have specific gate numbers through which you enter, exactly brain is like that. You just replace the stadium with the brain and all those gates around the stadium as with the nerves, which are coming there. So, there are nerves which are reaching to the brain. And then all those chairs or seats in the stadium are designated spot for every nerve to reach. So, this is where that kind x, y, z information will be processed.

What I mean by x, y, z information say for example, there is visual information coming. So, we will be process in the visual cortex. So, there is a region of the brain which is called visual cortex. So, it is exactly the same corollary as the chairs in a stadium with a designated number. So, you should follow that and sit in that specific seat. Similarly, if it is a auditory information, then it will go to the auditory cortex. If it is a test related information, there is a place gustatory that is why it will go. So, similarly there are several locations within the brain where the information goes.

But much earlier than that well, let us put it like this. Once they reach their spot, they are being processed and through the descending pathway messages are being send back this is how we have to react. But then the system has to match it with its some other reference. If you are seeing something for the first time then that is the first reference point, but then you try to match it. Suppose, you see a dinosaur tomorrow, so you have to match it this is I have read about there are dinosaur you know you will start correlating or you see a face you will try to correlate to do with some face. So, you already have some reference or you may not have any reference of something that is possibly happen when a child grows up, but then you have a matching reference. So, this is it and that part is called learning. So, first let us try to understand the anatomy and the seat where most of this information believed to be store.

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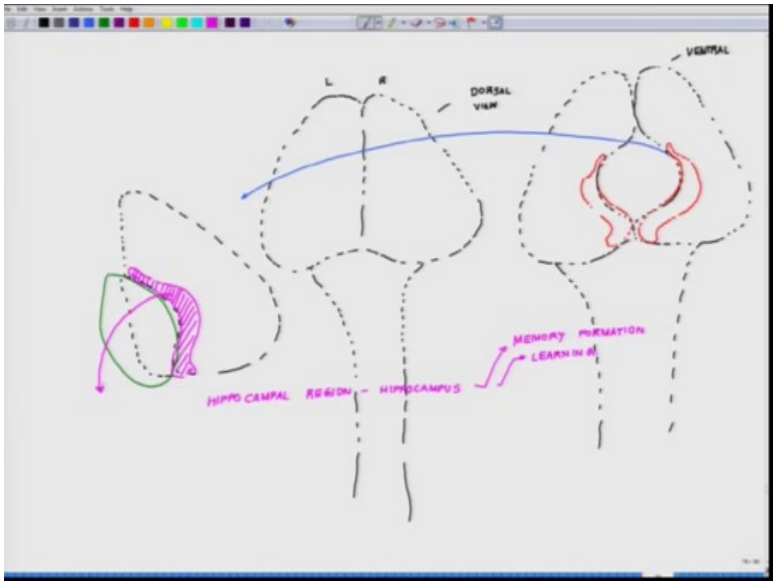

So, if you see the brain from the top the top view of the brain it is something like this. So, it is two-hemisphere, this is how the brain looks like. This is the brain stem, which is going down, I have already talked to you. You have the descending pathway, you have the ascending pathway and all that stuff. Now, this is your dorsal view, then there is a ventral view. If you just flip it down, the brain looks like something like this. This is the ventral view of the brain. Now, you have two-hemisphere - left and the right with several references you get.

Now, out here somewhere out here you cannot see it, it is slightly deeply folded inside, there is a structure like this. And this structure is deeply embedded you can only figure out this structure if you have somewhere other from the ventral side if you can you know cut the two hemisphere separately. So, you have say for example, hemisphere like this, and you are looking it from the ventral side, it will look something like this.

Now, if you could scoop out this part of the tissue, you can scoop out this part of the tissue and then the lower part this is where this particular system will be sitting this is where it is sitting fairly deeply placed inside. And this particular structure which is very similar to a sea horse to the Greeks is called hippocampal region or in short you call it hippocampus. This is one area, which is deeply involved believe to be again believe to be deeply involved in memory formation, learning. Now, how do we know that this area is involved in it? So, this will bring us to the previous class when I talked to you about epilepsy. So, out here in the hippocampus if you place the hippocampus, so I am showing you like this right, if I place it like this tissue will look something like this now.

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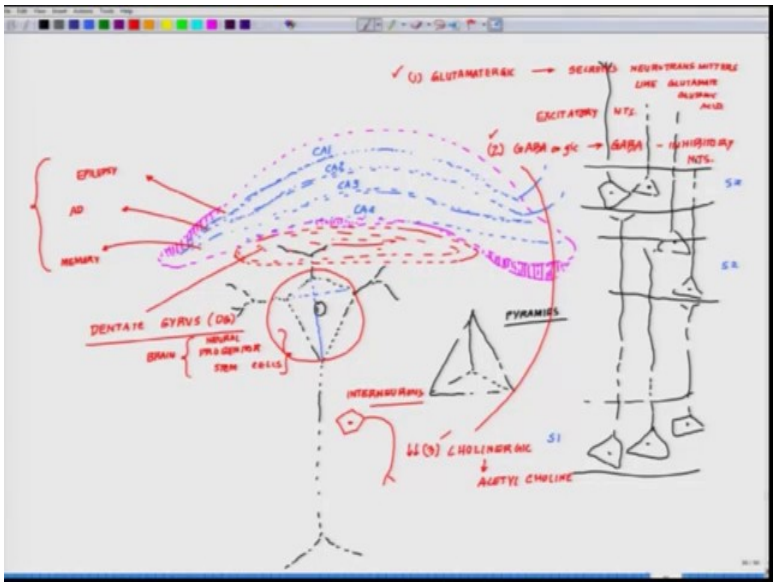

Something like this. So, I am just follow it once again. So, here is the tissue, I just if this is how the tissue looks like, it showing like this, I am just place it like this. So, how it will look like, it will look like a curve structures on it. So, on the surface if you look at it from the top, it will look like half-moon kind of shape. So, this is exactly what I am trying to draw in the next something like half-moon with stretch extended likewise. And if you have accessed to very good microscope, you will see this is layer in this structure and this is three-dimensional structure mind it so, this structure is kind of you know something like this it is a very, very three-dimensional structures. So, do not expect that this will come out as a thin film or something. It is fairly good you know three-dimensional assembly.

So, now if you have really good microscope to look in look through it, you will see something very interesting. It will almost look like that there are kind of very distinct lines scrolling through out here. As if there are roods (Refer Time: 12:33) there something like this. But then you really need a good microscope to see through them something like this. Now, if you go even further into it layer by layer assembly of it, if you kind of you know make slices, so for example, you have this is a structure and you start making slices like this then you will observe the neurons which are present there have a very typical shape. Most of them are something as a geometry like this with the dendritic network.

So, the shape is very similar to if I just reverse the shape, very similar to the pyramids. And based on this shape, these neurons are called pyramidal neurons; it is purely based on the shape of the cell body. So, if you look at the shape something like this, so hippocampal region significant population consist of this large cell body of pyramidal neurons, which kind of are the most dominant neuron types there. And the way they are arrange is very interesting. If you look at it, if you look at further into this circuit what I was trying to tell you it will look like something like this. You know there are layers as I am just showing cell body on the bottom something like this. If you see pictures, they will look like this.

As if just imagine on your door, there are lot of frill or some kind of you know ribbons which are line there. Since all of you have seen in the doors, you put those kind of very nice stuff like you know decorations stuff where they are hanging like this and in the air they move or wind shines coming. So, it something like this and it is a very interesting array at different level. So, there is different level at which they are present. So, this is one level, this is another level, this is the another level. Now, try to correlate it with one of the previous slides, where I drew that they are located at different part of this space, this is space one, this is space two, this is space three. So, there are different levels. So, they have different lamina laminated just like you know you have seen table-chairs where you have the laminations or something being done it is just like lamina there are different layers where they are arranged.

So, if you look at the circuit, look at these lines dot line, you will see almost these are laminated. So, there are different levels and there are specific way this circuit is functioning. These are communication links which is all over this place. And based on that from where these are coming or arriving, they have different name called CA 1, CA 2, CA 3, CA 4 likewise. So, they have different names like. Underneath is this area, I have talked more about it. So, this area there very small out here the neurons which are present. Do not have this kind of unique morphology, do not have, they are different. And this area is called dentate gyrus, in short you see the green map they will considered as they will write it as DG dentate gyrus area.

This is one area where there are lot of [FL] kind of seat for lot of brain progenitor neurons, neural progenitor or neural stem cells. But whether these stem cells helps in the brain repair or what are their roles is still not clear to us. We really cannot say with

certainty, but definitely dentate gyrus is on area where there it is kind of we can call it a hotspot where there is tremendous amount of interest to understand what this dentate gyrus, stem cells, a progenitor cells which are present somewhere rather they could help in the repair or you know or somewhere other are they playing a significant role in the brain functioning or not. We really do not know this part.

Now coming back to where this whole discussion started. After giving this anatomy, now I will move on to talk about what happens. So, there are three aspects what will be dealing out here. One we will talk about epilepsy with respect to this structure. Next, we will talk about AD Alzheimer's and third we will talk about memory all these three things will be dealing with this structure that is why this anatomy I am spending significant time to explain this anatomy and the significance of this anatomy

Now, the neurons which are present here, this is one aspect of the anatomy which I told you. Most of these neurons which are present in the hippocampal region has certain unique neurotransmitter types. So, they are mostly either glutamatergic, when I say glutamatergic it means these neuron secrets neurotransmitters like glutamate or glutamic acid which is a excitatory neurotransmitter NTS. I am just putting where neurotansmitters NTS. This is a glutamatergic or they are gabaergic, they secrete gaba g aminobutyric acid this is inhibitory neurotransmitter inhibitory NTS. There is a third population which is a very controversial population some say they are there some say they are not there, but at least from my own personal research account and studies, I can see with reasonable degree of certainty. There is a small population which is present here is cholinergic it means they secrete acetyl choline.

So, apart from the pyramidal neurons there is another large number of neurons which are not like pyramidal neurons, but they are much more smaller, they are call interneurons which are present in the hippocampal region in large numbers. So, a pyramidal neurons a inter neurons, they may have a neurotransmitter signature like either glutamatergic, gabaergic or a small, small population which is cholinergic.

So, I will closing here for this class. And in the next class, we will move on to explore that how this neurotransmitter profiles influences in the aspects of epilepsy or alzheimers disease and memory.

Thanks a lot, thanks for your patience.