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

Lecture - 20
Structure & Circuit of Neurons

Welcome back to the lecture series in Animal Physiology.

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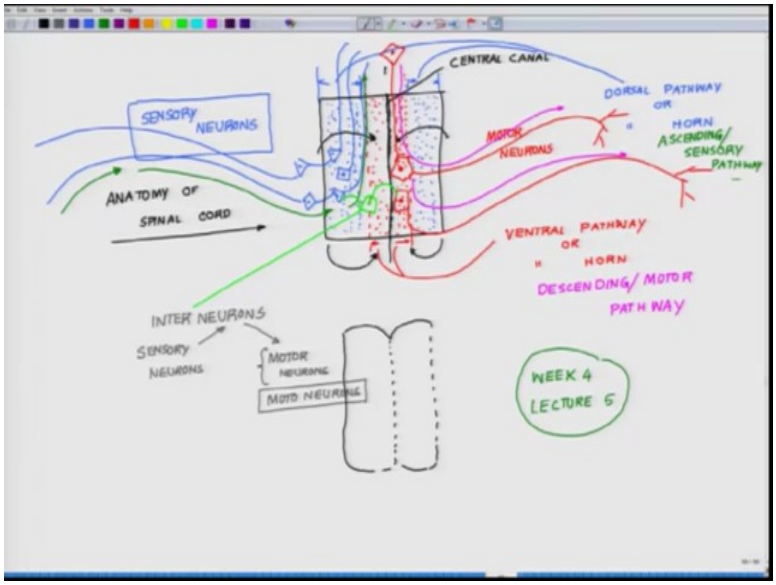

We are in to week 4: lecture 5 week 4. So, let us start with lecture 5 the last lecture of fourth week. So, we talked about now introduced few terminologies. So, that demands that way again revise them we talked about dorsal pathway ventral pathway dorsal means sensory pathway which are bringing the information from all the peripherals or all different parts of the body internal or external to the central processing unit which is the spinal cord or the brain depending on the what kind of information is being relayed. If it is a very sophisticated information visual information that from here it will directly go to the brain by the spinal cord. Similarly if it is coming from ear exactly the same way through auditory nerves and there are specific nerves involved which has different names given according to their processing or depending on their anatomic location.

Now, having said this there are certain information's I told you which are getting processed in the spinal cord itself; that means, the sensory signal which is reaching the spinal cord has to be conveyed to the motor neurons which are sitting there. So, that is done by a class of neurons which are sitting and I will put them in neurons which are conveying the message of the sensory neurons cross talks with the motor neuron in the spinal cord via inter neurons, and just for your knowledge sake sometime people write motor neurons as m o t o n u u r o n s. So, do not get confused these are different technologies which are being used. So, there is something which is missing here if you look at this picture carefully you just see the motor neuron sitting here, but these motor neurons are fed information from the brain from the very higher centres of the brain, and they travel like this.

So, motor neurons itself are classified as two categories of motor neurons, we will come later while we talk about diseases like Parkinson's and other women related disorders where this problem can be seen very clearly, there are higher motor neurons there are lower motor neurons.

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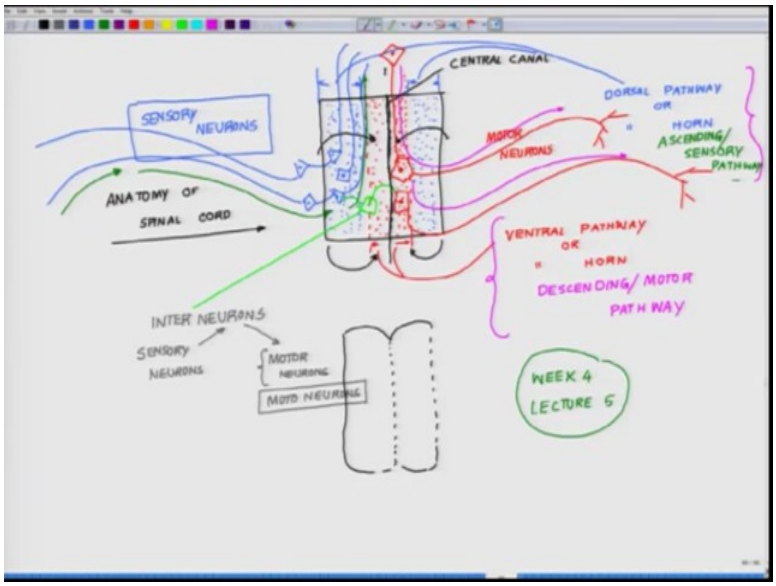

When you talk about higher motor neurons we talk about I told you the higher structure or higher level of processing. So, motor neurons which are sitting out here, they convey

the signal out here this is how the circuit goes. Whereas sensory neurons are again of that kind some of them sitting they sit here, they have their target out here and from here either they directly go to the brain or sometime they convey the message out here and these one's carries the message to the brain.

In between we will talk a lot about another set of neurons which are kind of sub type of it which is called sympathetic and parasympathetic, but I will not confuse you at this stage you will come later into. So, out here the information is going like this, and out here on the other side ventral side the information is moving out from this. Interestingly if you look at a motor neuron part of it is called is well extended away the spinal cord all the way into your muscles, and that has it is own anatomical I should say anatomical modification we will come later in to it.

For the time being appreciate these terminologies; dorsal pathway, dorsal horn ascending pathway and sensory pathway these are all falls under the same category where as ventral pathway ventral horn descending or motor part pathway, they all fall under the same line. Having said this now we will move on to explain the basic anatomy of the neuron which we have not done yet you all have seen as of.

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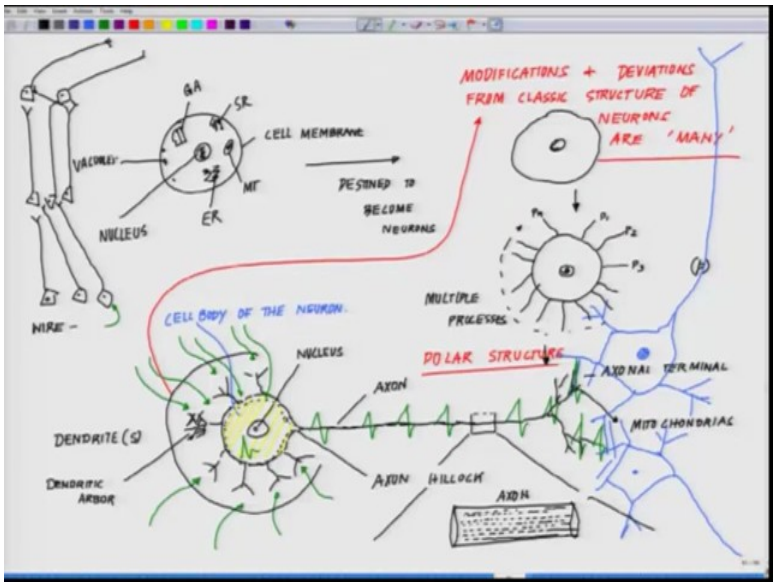

Now, I have drawn cells like this cell membrane with a series of organelle inside it, mitochondria endoplasmic reticulum and just put empty ER sarcoplasmic reticulum GA Golgi apparatus here you have the nucleus and there are series of lipid bodies called vacuoles in likewise oxysomes vacuoles likewise.

So, now when we talk about neurons some of these cells which are destined to become neurons, they follow a different course and the way these cells grow is very interesting suppose this cell is destined to become neuron this is a nuclear, they first of all send out lot of processes around them like this. This is how the development occurs multiple processes multiple processes. Now among this multiple processes some interesting reason which till this date is not very clear one of these processes dominates over others; that means, say for example, the multiple hand multiple processes which are coming out like this, but imagine all these my fingers are those multiple processes, but one of them decides to grow longer and the rest will not grow.

So, in other word they develop some form of polarity there is a polarization of one process which grows up what we do not know is given this situation if I number them like you know a P 1 P 2 as process one process two process three all the way if I move I will have P n. So, for each one of these processes if I measure the probability each one of them have equal probability to grow either together or become the longer, but how one of them one chosen one becomes the process and rest remain smaller one we do not know and this is one of the central problem of nervous system, who and how and what determine the polarization of the neuron there are lot of studies happening across the world for last possibly 25 to 30 years, but still to tell with absolute certainty is a real challenge. There are several very elegant studies very complex studies, surface chemistry related studies, but as of now we really do not know this answer to this question, but for the time being let us see what happened after this.

So, one of the processes out here becomes longer like this, where as the rest of them they form networks like this, but will not grow any further and they form complex networks and eventually at a point this structure kind of stops stop to grow. So, it is a continuous structure like this. So, this is the classic anatomy of a neuron, but that does not essentially means all that neurons are like that, but before I get into those complex stuff

these small processes which did not grow further, they all are termed as dendrite individually dendrites. And this whole network what the form out here the arborization is called dendritic arbour. Here you have the nucleus and the process which is a chosen one is called axon, and this is the axonal terminal this is from where the axon originated is called axon hillock, and if you kind of take a 3D view of this this is like a tube like this.

This axon and you almost cease a lot of proteins which are lead almost like rail roads and what is the significance of it? Once we talk about Alzheimer's and Parkinson and all those other neurodegenerative diseases we will talk about it, as if they are lying together.

At this fag end out here if you look at the axonal terminal, you will see lot of mitochondria's have migrated all the way from the cell bodies. So, this part nucleus and the surrounding structure, this constitute let me just shade it for your convenience in yellow. So, this is the cell body of the neuron, now this is the classic architecture of a neuron, there are n number of variations into it there are neurons who have very few dendritic arbours, there are neurons which do not have an axon there are neurons where dendritic tree is more prominent then the axon, there are neurons where the dendritic arbour is so specialised that it is just amazing to look at that the way it pick up signals external signals.

At this stage of course, I will just highlight that here the modification or deviation, modification and deviations from classic structure of neuron or many and on depending on context, context wise I will request you to remember this week for last class that is the fifth lecture of the week 4, depending on the contact we will time and again time and again time and again we will pick up those modifications because this is very very important you understand it.

Now it is a polar structure now in this polar structure as I told you there are information processing which happens. So, most of the information again at this stage we are not talking about how the information processing takes place, which most likely would I will be starting in the next class, but at this stage you have to understand the basic anatomy before you understand the physiology how the information processing happens. Now the way it works is you saw this whole dendritic arbour right this dendritic arbour picks of

the information. In other word all the information's are being picked up by this dendritic arbour the one I am showing the green are imagine these are the information's, these information's we will come later do not worry about it what does that mean. These information's through electrical processing is being conveyed through these axon to the next neuron.

So, the next neuron starts here where another neuron sitting whose dendritic arbour is out here it is going to the next neuron or even there is another neuron imagine sitting. So, in other word what you observe is as if you have to draw it. So, you are seeing something very interesting that. So, it seems like there it forms a wire, but unlike when we talk about electrical wires we talk about continuous wire, but here the where is not continuous it is at discontinuous wire, neuron convey this to the next convey to the third convey to the fourth. So, as a matter of fact now look at your own body if there is a neuronal terminal here identic terminal, it picks other information somewhere said body is sitting there it conveys the information all the way it is travelling and this is all the electrical impulses which are travelling all the way to the brain through break points through check points, it is never a continuous thing.

So, it means some way or other at different level first of all a any information what we get say for example, we get information of light, we get information of pressure, we get information of touch, we get a information of vibration, we get a thermal information the step one of information processing what I mentioned you remember out here the information processing.

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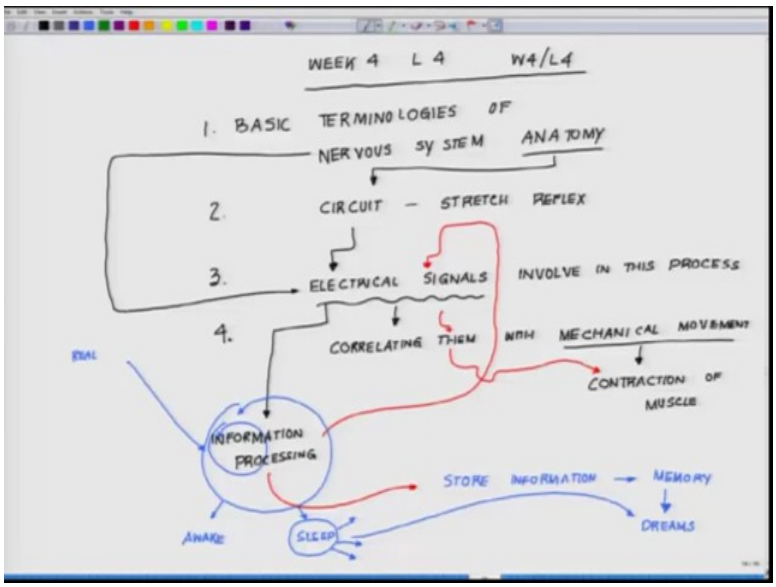

So that what we talked in week 4 lecture 4; so information processing could be divided into distinct mode.

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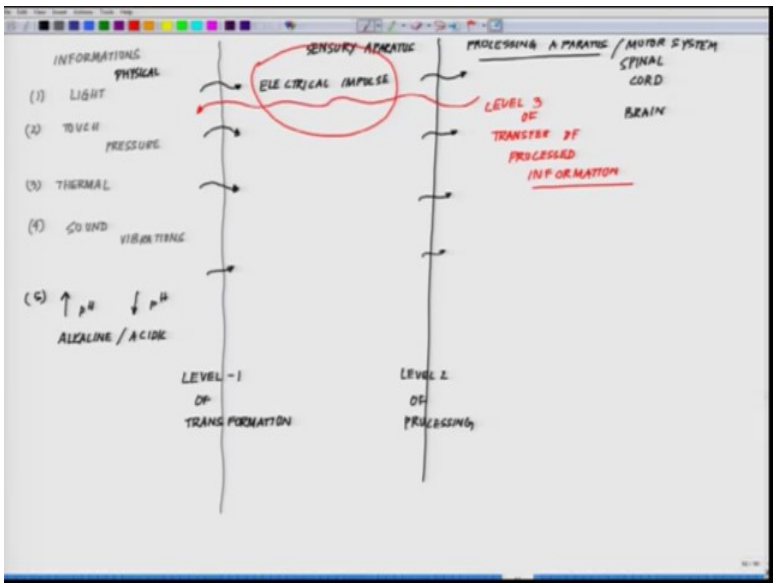

Say for example, you have let us put all the information first information's. Say information of light you have to usually you have to see touch which is of course, under

pressure sensors, you have thermal what is the temperature, you have sound which is vibrations, all these information the first thing what has to happen is that. Now, you have a sensory apparatus right all these modalities first of all has to be translated into an electrical signal, the first information translation.

Information so all these are all the physical forces with their physical nature and even including say high p H or low p H acidic or alkaline, alkaline or slash acidic. All these information has to be translated into electrical impulse. So, inform in the form of signal transduction or signal processing this is what we call them as transformation single transformation level one of transformation.

First level of transformation, these electrical signals are then move to the processing apparatus. The processing as I mentioned you could at the spinal cord which is the lower level of processing or at the level of the brain right these electrical impulses have to travel to the processing unit. There is a in between of course, while this electrical impulse is transmitted to the processing next level of apparatus this is level two of processing, because from one system it is moving to the next system. So, this is a sensory system this is pretty much is the motor system. Based on that these processed information I am just changing the colour for your understanding sake is brought back which is for the execution at that specific point level three of transfer of processed information. So, if you look at it very carefully at different level, there are different intensity of information processing of electrical information.

So, that brings us to a point to understand how these electrical information's are being generated in the structures, and that brings us to under very interesting point which I have highlighted cells can be classified into two categories, excitable cells and non-excitable cells right. So, excitable cells are the ones which could translate any information into electrical impulse, which essentially a muscle can do and by autorhythmicity a cardiac system can do it smooth muscles, can do it as well as the neurons and some of the neuroendocrine cells in our body.

So, coming back where I was: our next goal will be to understand this green part what you see all these information's these information's, how these information's are being

translated into electrical impulse, and that will bring us to the world of ion channels, voltage gated ion channels, like in gated ion channels, g protein couple receptors and a series of proteins which are all line all setting out here.

So, with this background I wish to again remind you people that do not forget that we have started this journey with stretch reflex arc. We will come back to that once I kind of give you an idea how the electrical information's are getting transported. So, then it will be very easy for you people to correlate the circuits, but the reason to introduce you through that circuit is those are very interesting zones where two different systems cross talk with each other. And understanding those cross talk or at least having the philosophical understanding of those kind of crosstalk are essential to you know appreciate the whole system in it is complete totality, instead of you know getting in crossed into one specific aspect of it. So, I will close in here.

Thank you.