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

**Lecture - 35**
**Glial cells**

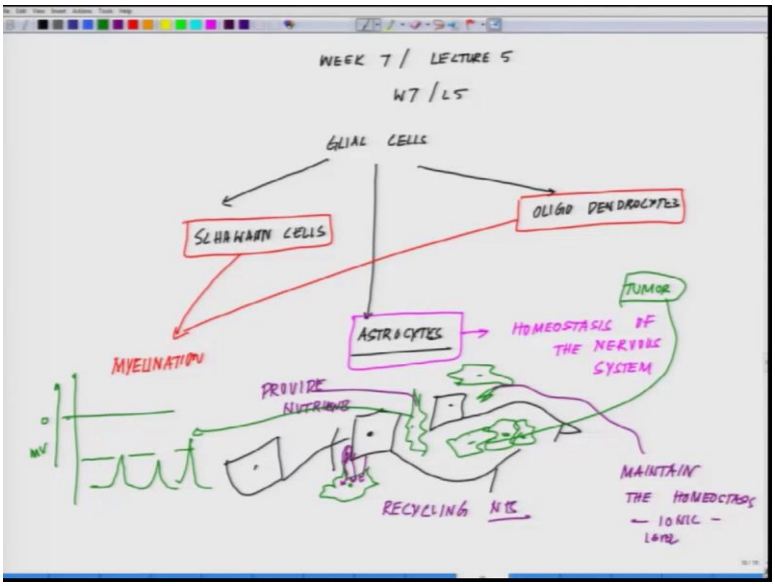
Welcome back to the lecture series in Animal Physiology. We are into the week 7, and today we will be starting the 5th lecture of this week.

So, in this week if you look carefully we have talked about Alzheimer's- degenerative disease of the brain, we talked about Parkinson- another degenerative disease of the brain which leads to movement disorder concrete to Alzheimer's where it leads to problems of self losing memory about your own self and the surrounding. Then we talked about our degenerative disease affecting the ventral on motor neuron ALS amyotrophic lateral sclerosis.

We kind of talked about the similarities and dissimilarities. Followed by that we moved on to the spinal cord injury, and we talked about the development of sirens and how that prevents the further regenerative ability is being compromised, and preventing further the axon to you know guide through that injured site.

Today we will talk about the other cell type the Glial Cells.

(Refer Slide Time: 01:52)



So, let us get back on the board today it is week 7 lecture 5: w 7 L 5. So, we will be talking about Glial Cells. So, glial cells could be classified into two categories broadly, and we will talk about those which concern such the most: one is the Schwann cells and other one is the Oligodendrocytes, whereas the third one is astrocytes. So, these two the Schwann cells, one which I am putting red boxes these ones are involved in myelination, whereas astrocytes on the country is involved in homeostasis of the nervous system.

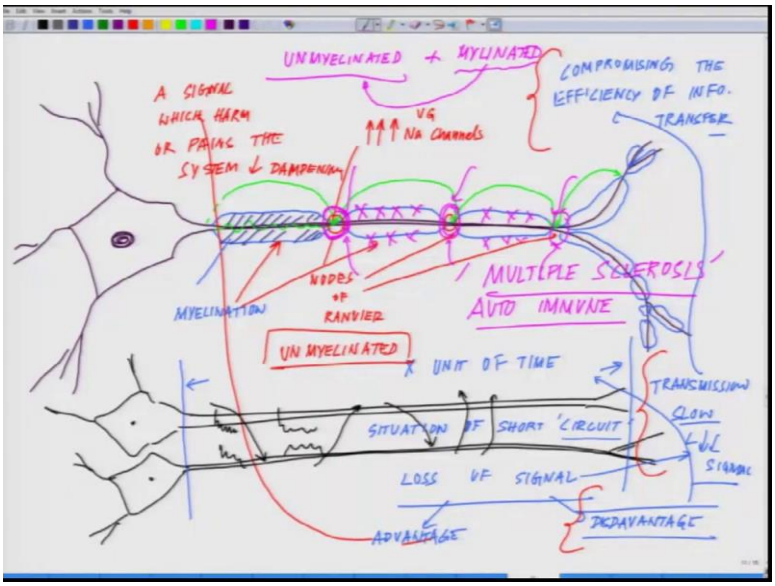
What does that mean? That means say for example, let us take an take an hypothetical situation inside the brain there are synapsing bodies and there are lot of neurotransmitters which are getting released. So, the oligodendrocytes, now I will put them in the green they are sitting like this. They are numerous far more as compared to the neuronal cells. Their number is far more higher. They are the ones to ensures that hyper excitability due to neurotransmitter being accumulated in this synapse is being prevented. They are the one who have seen recycling the neurotransmitter. They are the ones which.

So, recycling NTs neurotransmitters they are the ones which provide nutrients and they maintain the homeostasis in terms of ionic level around the neurons. Many time because of their pathologies these cells kind of divide uncontrolled manner and they could lead to form tumours. These cells are electrically active, they shoot certain electrical currents, but they do not shoot an action potential and their membrane voltage could never overshoot the 0.

So, if this is the 0 and this is an millivolt I am talking about and these cells are sitting minacity they will shoot something like this, you will see them. But, just in around you know minus 60 minus 30 minus 40, but they will never overshoot the zeroes if this is the zero line.

So, strictly speaking if I say that they are not electrically active that will be wrong they are indeed electrically active, but do not shoot action potential. The difference between them in the neurons is these cells do divide and their uncontrolled division may lead to tumour in the brain. Second, they help in recycling of the neurotransmitters provide nutrients and maintain the homeostasis or the ionic balances.

(Refer Slide Time: 06:47)




Now, comes about the other two the Schwann cells and oligodendrocytes and the concept of myelination. So whenever we draw a classic neurons the picture is something like this. Something like this, with the cell body and nucleus sitting here. And on this you observe something like this. Both sides something like this, there is small gaps are there we will talk about those gaps something like this, further this, further this, and this continues like this.

Now, this in a textbook you will see it is written as myelination and this part what you see it is called Nodes of Ranvier- Nodes of Ranvier this one, this one, this one, likewise. and Nodes of Ranvier have very high population of voltage gated sodium channels. And the action potential kind of as a salutatory mode it looks like it is jumping like this.

Now, action potential could have travelled all along like this, if there would not have been and it actually travels like that, but the thing is that: say for example, this green cover or sorry the blue cover would not have been there say for example, I draw something like this one and action potential, so this is one axon say for example, of one neuron and there is another neuron side by side moving, because these are nerve nets and nerve tubes which are moving and if these are close by. There are no covering so the excitability which is happening here will affect the excitability here, excitability happening here will affect the excitability here and not only that, in that process there will be information which will be lost like this.

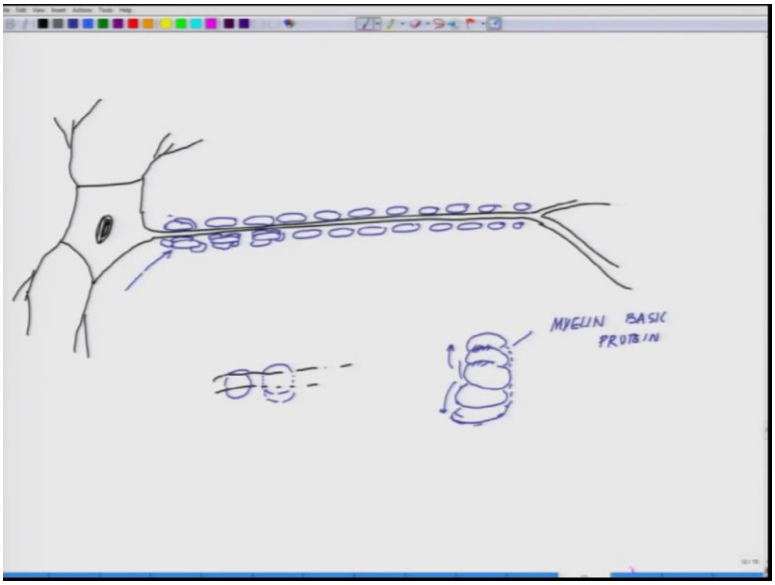
In other word you can call this as a situation of short circuit and that way the information which from here say for example to reach here need say x unit of time will now take or may not even reach from here to here because of loss of signal. It has its advantage and it has its disadvantage. In terms of the disadvantage is your transmission, slow loss of signal, no loss of signal, and compromising the efficiency of info transfer.

So, there are these disadvantages, some time advantages are also there. A signal which harms or pains the system needs to be dampened. So, this is the classic situation where loss of signal or dampening of the signal could come very handy. As a matter of fact in the case of pain which is very excruciating pain you want to signal to get lost, you do not want to brain to kind of get bog down by that heavy excruciating signal of pain.

There is a fundamental difference between those neurons which carry the pain signal as compared to the neurons which are conveying other kind of signals. The one which are carrying the pain signal are unmyelinated neurons. They do not have any such cover just like this. Contrite wait you have these myelinated neurons out here which cannot afford any kind of these disadvantages they cannot afford it.

So, myelination process by which there are categories of cell which are termed as Schwann cells and oligodendrocyte, which forms an insulation on top of these axon. Now how they do form? So, myelin is a protein which is secreted by these cells.

(Refer Slide Time: 13:34)



So, the way it works is very interesting, when the axon is forming mother's womb. For example, this is the axon of a neuron. Now the Schwann cells, I will first talk about the Schwann cells then I will tell you about the myelination with a oligodendrocytes. These are the dendritic trees, here you have the nucleus setting. So, the way it works is the Schwann cells is started to migrate at the site of myelination. They are all goes there and they started to align themselves like this all along, both sides they are coming say for example like this.

Then there is a second level of process which occurs, these cells divide they started to divide this. And interestingly some of these cells post division kind of goes underneath the axon. Say for example, if this is the axon these cells will go almost underneath. So, some of the cells will be underneath it. And some of the cells will be top and they started to climb on top each other.

So, say for example, these cells they started to claim like this. And through this climbing motion on both sides along this rods, say for example if this is the axon. So, these are the glial cells. So, the eventually form a kind of a coating like this, something like this all around it. And then these cells slowly lose their individual identity and they merge. So, these individual cells eventually merge and they secrete a protein which is myelin basic protein. These protein along with this cellular structure forms what I drew in the previous slide what we call as the myelin sheath. It is a very controlled process.

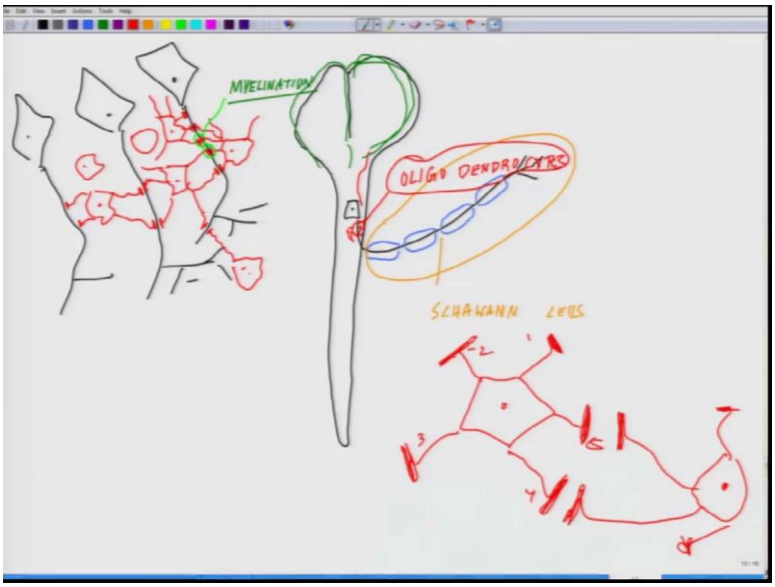
What we do not know absolutely no clue how they decide that where they have to have these Nodes of Ranvier. Who decides, how they decides, it is still a mysterious thing. But they do divide in a most beautiful controlled way by virtue of with they create this kind of very interesting pockets, where the insulation is not present. And that is the place where the external excitability kind of accesses the axon.

So, this is the rule of the Schwann cells. But, several unfortunate individuals in their case because of certain autoimmune situation these Schwann cells started to die. And that they die then of course, in nature there are situations where there are neuronal pathways which are unmyelinated. So, we have two categories of pathways which are unmyelinated and myelinated. So, this has been already decided. But imagine because of a disease situation these myelinated become unmyelinated, because these Schwann cells is started to die out.

This is a situation what happens in multiple sclerosis. Where insulation of the myelinated neuron is being compromised, which leads to severe problem. Partly genetic and there are many things which we do not know about it, but that is one issue which effect the patient heavily. There are different kinds of antibodies which are there again that auto name in disorder there people use. So, but still it is a very very compromised lifestyle.

The Schwann cells are present outside the central nervous system. So, the myelination of the neuron; say for example, now let me again redraw the spinal cord and the brain so whenever we draw it drew it like this.

(Refer Slide Time: 19:05)




Now, the neurons are setting here right and they are sending out the processes. So, all the myelinations which are happening they are happening outside, and this is the myelination of the Schwann cell myelination, but as soon as this neuron enters inside the spinal cord and goes to the brain and wherever the myelination pattern changes. Same neuron is myelinated out here by another set of myelinating cells, but they myelinate in a different way those are called the other cell type called Oligodendrocytes.

So, a neuron whose part of the body or part of the axon which is inside this spinal cord and part which is outside this spinal cord will be myelinated differently. The one which is outside, says that is the location out here you will be myelinated by Schwann cells. Whereas, the one which are inside the spinal cord will be myelinated by the

oligodendrocyte, but oligodendrocyte myelination is very different; oligodendrocyte does not follow the paradigm followed by the Schwann cells.

The way oligodendrocyte myelinate is very interesting. Say for example, this is inside the brain somewhere or spinal cord these are the processes I am talking about cell body sitting there and you know. So, the way this myelination happens is something very interesting.

So, here you have numerous oligodendrocytes, and these oligos are like this. There are thousands of oligos in an around. These oligos send out this processes like this. (Refer Time: 21:17) or you know processes so they form something like this. So, this is where oligodendrocyte forms. So, one oligodendrocyte can myelinate 10 or 12 or even more neurons at one point of time. Why nature has done it probably to save space unlike because been as; so you see the same oligodendrocyte it is myelinating here this myelinating here, it can even if you go down the plane it can myelinate something else. So, these are the zones of myelination.

So, so oligomyelination is entirely a different kind of pattern unlike the Schwann cells myelination. So, what I was telling about the space. So, here you know always have a space limitations you really cannot increase the size of the brain or you cannot really spread. So, out here possibly nature has design this in such a way that a single oligo can. So, it is something like this say for example, if this is one oligo siting there. So, oligo will be forming like, it is almost like you have seen that Spiderman this thing something like this. Even if you look at it at one point this oligo just in one plane code myelinate 1 2 3 4 5; so there is a another oligo say siting out here will be myelinating that axon or another one coming like this axon.

So, it is a very interesting network of oligos which are doing this job in your brain. So, this brings us the full circle of talking about the different types of Schwann cells. And I will request you please go through standard textbooks which are there, but the cracks of the matter are what I have taught you. That you have Schwann cells, you have oligos, you have microglial, but the microglial originals I have mentioned are mostly from the immune cells origin. If the neurons of different types this suffer from different kind of neurodegenerative disorders, whereas there are brain tumours caused due to the glial

cells. There are degenerative disorders of the glial cells because a certain mutations or autoimmune aspects which leads to multiple sclerosis.

So, that kind of brings us a fruit circle about the different cell types constituting our system. Next what we will do is, we will talk about the special sensors which will be including eyes, ears, tongue, skin and we will talk little bit about stress reflects at the end and neuromuscular junction. So with this, I will conclude this week.

Thanks a lot, and please do read.