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

Lecture - 38
Neuro Muscular Junction

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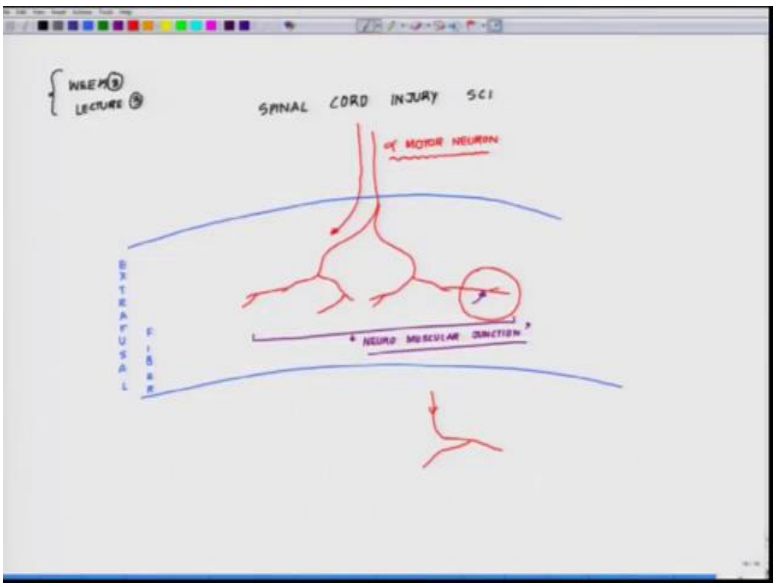

So, welcome back to the lecture series on animal physiology. So, today we are into the third lecture we are into week 8 lecture 3. This is what we where we are. So, at the neuro muscular junction if you look at it, how the neuro muscular junction really looks like ok.

So, we have already talked about the signal originating from the muscle spindle, going to the spinal cord they are bifurcating of the signal bifurcation of the signal into the alpha and the gamma motor neuron. And gamma neuron motor neuron is coming back and synapsing on the muscle spindle. Whereas, the alpha are synapsing on the extrafusal muscle to bring back their length. So now, this is where this is the back drop of the story.

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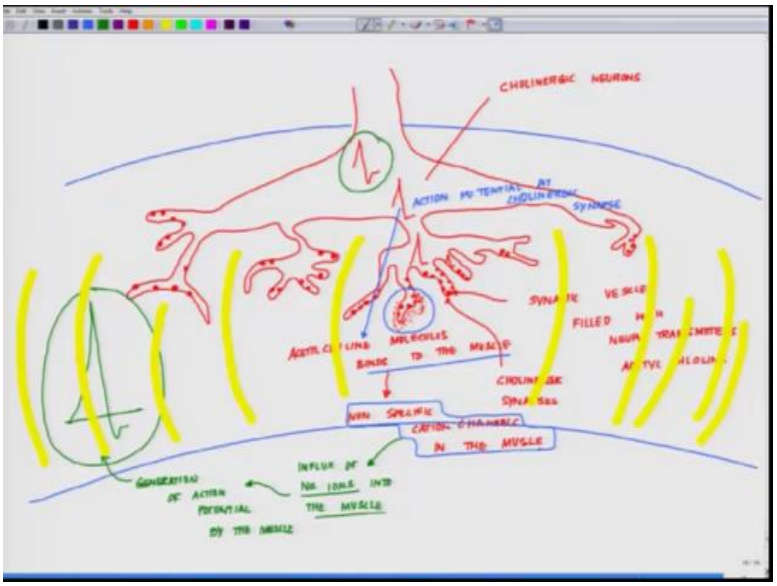

So now let us see what is happening at this site. At this site if you blow it up you will observe neuronal terminal is something like this. It fingers like projection all over the place like this in a microscopic detail. This is which was observed by the scientist very early, something like this. And these were all the very early electron microscopic picture during 1950s and 60s likewise. This is one of the synapse which has been explored by neuro scientist very extensively. We know whole lot more about these synapses than any other synapse. So, this is where it is sitting ok.

Now, if you see this terminals very carefully you will observe something very interesting with they have these kind of buttons like structures. And there is a huge amount of mitochondria which are located in this locations ok. So now, this is how it is physically if you have a very good quality biological EM electron microscope, this is what you are going to see.

Now, suppose a signal arrives here and train of action potential arrives here. As the train of action potential arrives here, these neurons, these ends of these this neuron what these you see these are synaptic vesicle. These synaptic vesicles are filled with neurotransmitters. And most of these neurotransmitters in the mammalian systems are in acetyl choline. Because these synapses are governed by acetyl choline these are also called cholinergic neurons and cholinergic synapses, cholinergic neurons or cholinergic synapsis ok.

Now, at the cholinergic synapses when the electrical signal reaches here, these neurotransmitters are you know secreted at this synaptic space. This is the synaptic space, and if you wanted to see it will be more like I think this is the good enough. These acetyl choline molecules goes and binds to the muscle. These acetyl choline binds to write it down acetyl choline molecules binds to the muscle. That opens up nonspecific cation channels in the muscle. So, just if you go back little bit back backward. So, there is an action potential, action potential at cholinergic synapse. These acetyl choline molecules then are secreted at the cholinergic synapse. They bind to the muscle; nonspecific cation channels are open in the muscle, fair enough?

Now, at this spot where nonspecific cation channels are open in the muscle, there is a influx of influx of sodium ions into the muscle. This influx of sodium ions into the muscle leads to the generation of action potential by the muscle. And in that process muscle generates it is own single action potential. So, there is an action potential which is coming from neuron and there is an action potential which is generated by the muscle. And there is a role to that, how that action potential which is generated by the muscle is transmitted.

So, what you see that there is a wave pulse, one second, on the muscle there is an electrical activity which is spreading out now. What we even talked about is something else. End of the day the muscle has to perform a electrical function, not only an electrical function or mechanical action, how this mechanical action happens?

So, know having gone this part you have to realise one very interesting aspect, before I get into to that accept. Muscle is a 3 dimensional structure if you look at a muscle something like this.

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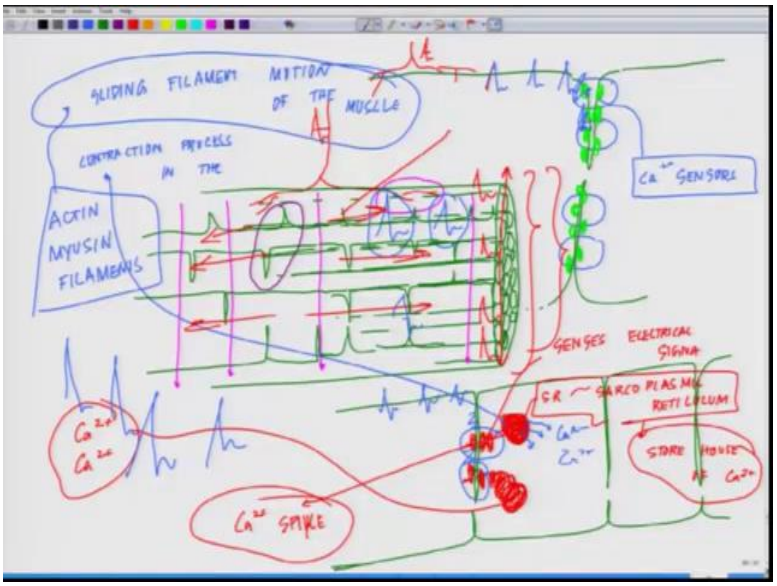

It is a structure which is like this, like this. Now your synapses are happening? At the upper surfaces. So, the synapses are happening here? So, electrical signals coming like this, an electrical signal generated by this muscle.

Now, think of a situation before I get into the details of it. How the electrical signal will travel all the way into this? Or how the contraction can happen all along this thing? Because your connection is happening exclusively out here, so how it is getting transmitted. So, that is where comes the significance of the action potential which is generated by the muscle. And second thing if you look at the skeletal muscle structure, this structure is very, very unique. If you look at the structure you will see something like this. This is from one side I am showing you if I show it from the other side it will be it will be something like this. As if they are you must have seen (Refer Time: 12:03) as if the structure is gorge like this, both sides. Why this structure has been made like this? When I do this cylindrical structure I did not show from I am showing (Refer Time: 12:21) I am adding up to that.

So, these tubes are something like this, something like this. Why this structure has to be like that even in the first place? Something like this. Now this structure has to be like that, because it has certain very interesting advantages what we are going to talk about now. Now say for example, let us take this situation. So, let us take a simplistic view of it. So, here you have the synaptic zone. So, action potential generated by this. Muscle

generates it is own action potential which is shown in blue. These action potential travels like this. Now out here there are some very unique features, I have come to this unique features which will sum up the whole story.

There you have a lot of calcium sensors or calcium ion sensors. What are the calcium ion sensors?

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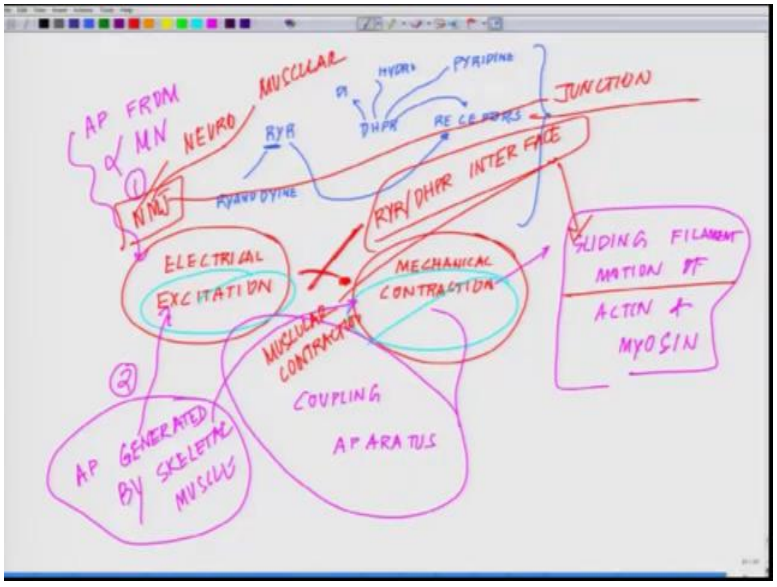

So, there are something called one of the key one calcium ion sensors is called RYR DHPR receptors. Talk soon about the locations of this. Let me give you the full form RY stands for ryanodine, r stands for receptor. D stands for di hydro. P stands for pyridine, r stands for receptors. So, you have these very 2 interesting receptors or calcium sensors and calcium channels (Refer Time: 14:57) we call them because these are very controversial current till this date.

Ryanodine receptor and DHPR receptors and they remain in close proximately like this. Something like this. Now what happens is very interesting, let me go back. So, most of this now I will use a different colour code for you to understand this part. So, most of this DHPR I will take it slightly brighter colour. And I had apyridine receptors are sitting like this. This bright green colours you are seeing this is how they are sitting. Now this is where they are sitting, now when the electrical signal comes. So, electrical signal can gorge inside these places, because it is a gorge like structure you could see.

So, the electrical signal comes here like this in the muscle it spreads out here. Out here it encompasses these so now I am showing in red the DHPR and ryanodine receptors. So, what happens these receptors senses electrical signal, and part of this the hydro pyridine and ryanodine which is still not very clear is attached to organal within these called SR or sarcoplasmic reticulum.

Sarcoplasmic reticulum is a store house of calcium. Sarcoplasmic reticulum is the house of calcium which is sitting there, like this. So, this is the store house of calcium. Now when the electrical signal comes here these electrical signal makes this sarcoplasmic reticulum sensitive to it. They become getting sensitize because of this adaptor kind of molecules which are the calcium sensors switch are ryanodine and DHPR receptors. These ryanodine and DHPR receptors let us the sarcoplasmic reticulum to give out the calcium. This calcium now initiate what we talked about is contraction process in the actin myosin filaments.

So, that whole movement on the actin myosin filament is executed by the calcium which is secreted at that spot. So, this leads to what we call as sliding filament motion of the muscle. Remember when we talked about muscle we talked about this sliding filament motion of the muscle where this sliding happens. And this calcium spike comes from here; this is the calcium spike which is coming.

So, it is a very interesting process how these electrical signals are transmitted at the 3 dimension back and forth, and which leads to the mechanical motion of this muscle. So, this whole process is called excitation contraction coupling apparatus. Because there is an excitation which is electrical excitation, which I told you what it is leading to an contraction, which is the mechanical contraction electrical excitation lay into mechanical contraction.

So, excitation contraction next thing what we know is coupling of these 2 and this whole process is called excitation contraction coupling apparatus, which contraction is because of sliding filament motion of actin and myosin filaments. Whereas, electrical excitation comes at 2 level, one is an action potentials from alpha motor neuron, second level is if this is the first one second one is action potential generated by skeletal muscle. And this action potential generated by the skeletal muscle leads to a muscular contraction governed by sliding filament motion of actin and myosin.

So, this whole thing is very wonderfully coordinated at different points, to the first electrical stimulus which is happening at NMJ or neuro muscular junction. The first one, second this muscular contraction is happening at this zone is happening of course, from the muscle, but this transform translation is taking at RYR DHPR interface. So, we see at different level these information transfers are being governed. So, that is what we needed to talk about the neuro muscular junction and the stress reflex circuit. Now from here we will shift the gear, and we well move towards the special senses. So, I will close in here.

And Thank for your patience listening.