Animal Physiology
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Lecture - 37
Stretch Reflex Art Circuit – II

Welcome back to the lecture series in animal physiology. So, we are into the eighth week and we are starting the lecture 2 of the 8th week.

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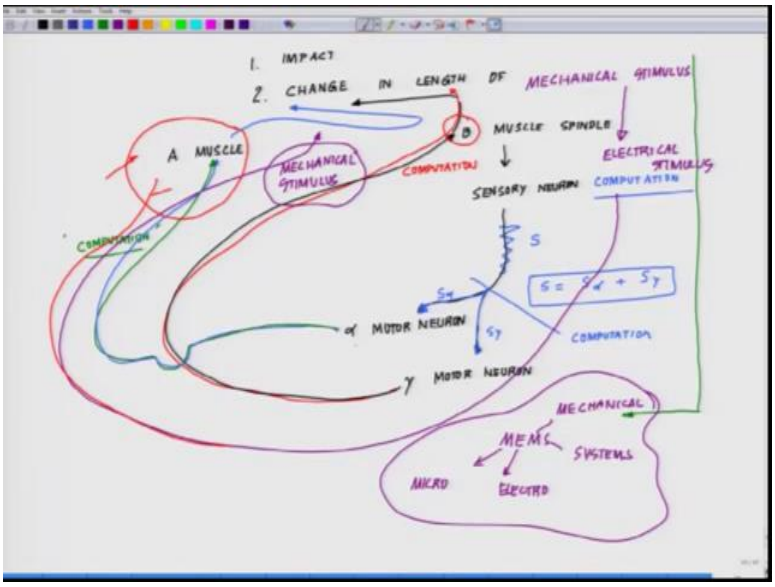

So, let me just put it down there week 8 and we are into lecture 2 fine. So, if you remember when we ended the last class I told you that these muscles spindles which are there, they are a specialized group of muscle. So, if you guys remember now when the muscle differentiates.

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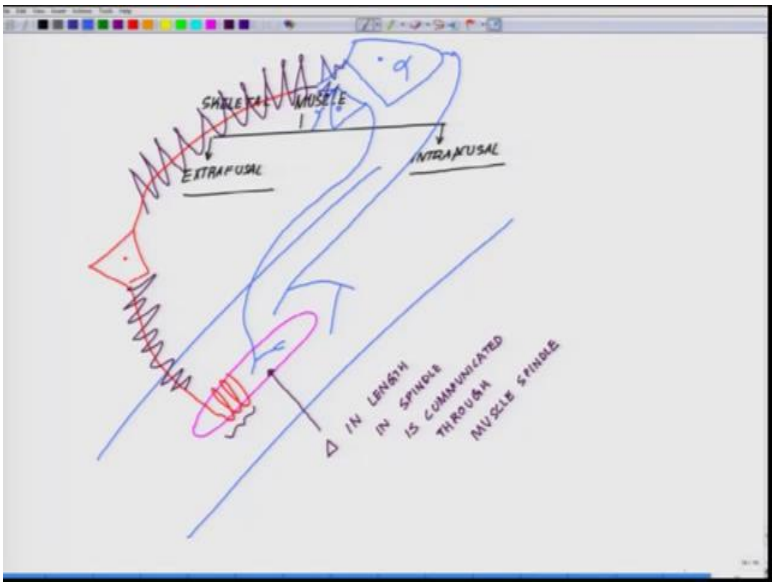

Muscle differentiate into two different forms of skeletal muscle specifically in the two different forms of. So, let me just put it in case you missed out on it.

Skeletal muscle differentiate between two population one will be called Extrafusal the other one is called the Intrafusal. So, the extrafusal forms the larger chunk of it. So, now, what we do not know that who decides that which small. So, intrafusal is a very small population of muscle whereas, extrafusal is a very large chunk which decides or whose fate is determined as to be the skeletal muscle.

So, now what we do not know what decides which part will become extrafusal and which part will become intrafusal this part is still a mystery for the development of biologist we really do not have an answer to this question. But what we know for sure is that this huge chunk in blue what you see this forms the extrafusal, this is the extrafusal muscle or extrafusal (Refer Time: 02:31) tube, extradural (Refer Time: 02:32) fibers where this muscle spindle is intrafusal fiber.

Interestingly intrafusal fibers are the ones which acts as sensors, they have some very unique electrical properties unlike the extrafusal fibers their electrical properties are different they behave differently. So, now, coming back we were talking about the circuit. So, the muscle spindle. So, there are at two level the change in length is happening. I have mentioned the change in length in muscle which essentially means

extrafusal muscle and change in length in the muscle spindle which essentially means in the intrafusal muscle.

Now, once the muscle length muscle gets a hit the muscle spindle length changes and a signal at the level of muscle spindle. So, where to kind of you know. So, if this is your muscle spindle which we are representing as pink and if this is the extrafusal muscle what we have, and if the sensory neuron rapping is shown in red on the muscle spindle and this is the sensory neuron which is carrying the signal to the spinal cord.

So, out here at this juncture if you look at this very carefully at this rapping. So, the change in length in this spindle change delta stands for change in length in spindle is communicated through muscle spindle. So, there is a train of stimulus which travels along like this. Now at this synaptic site of the motor neuron here say for example, it is synapsing with the motor neuron. So, motor neuron axon the large motor neuron axon fix up the signal. So, the blue is showing the motor neuron. So, here the signal split into two parts which I have not mention now I am mentioning you. There are two forms of motor neuron which fix up the signal from the sensory neuron this is specifically true for the stretch reflex there are situation where you do not need two motor neuron, but in stretch reflex there are two motor neurons.

One is called the alpha the other one is called the gamma. Now the signal coming here and now signals splitting up or synapsing on to two different motor neuron like this and like this now this gamma motor neuron which is sitting out here brings the signal back to the muscle spindle whereas, alpha brings the signal to the muscle itself. I told you that there are change in length at two different levels right. So, the first change in length if you look at it is in the extrafusal muscle, second change in length in the extrafusal muscle which is the sensor.

So, now if you complete the circuit what is happening? So, this is the signal which just follow my pen. So, here is the signal which went all the way there signal get split up into two different neurons one is alpha the large one, one is a small one which is the gamma motor neuron. So, the gamma motor neuron brings the signal telling this spindle to regain its size whereas, the alpha comes to the surrounding in extrafusal muscle and arcs gets to change in lengths.

So, any delta L change here or any delta small l change here. So, this one is taken care by gamma this one is take care by alpha. So, in this simplest of the simply circuit if you want to mathematically explain it how many events are happening. So, now, what we will do we will enumerate all the events. So, that we this concept gets into your mind.

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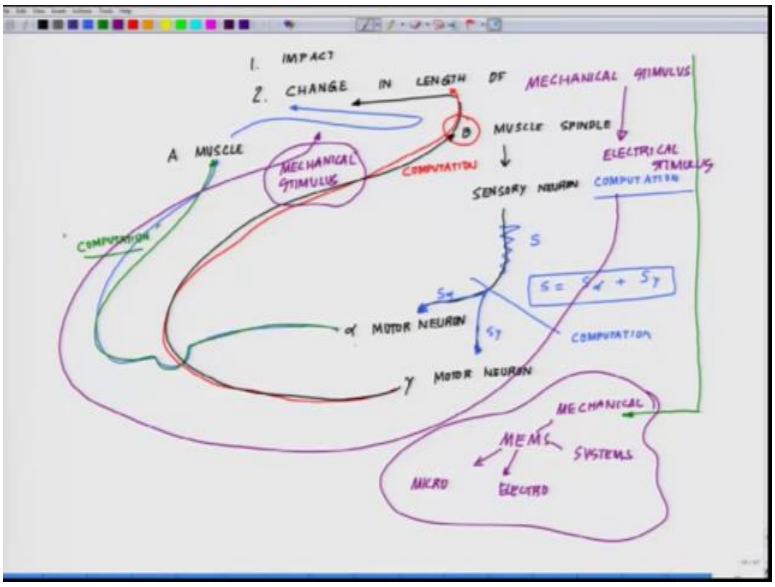

Step one impact; step two change in length of a muscle b muscle spindle. Now muscle spindle synapse on sensory neuron, sensory neuron carries the message to the motor neuron now motor neuron out here rather carries the message to two different motor neurons in this case, one is alpha one is gamma now this gamma motor neuron brings its message telling the muscle spindle to regain its change in length or rather back whereas, the alpha motor neuron tells the muscle to change it lengths to its origin.

What till this date is the most mysterious thing is that when there is a change in length happening in the muscle spindle the way it coats the signal out here, how this neuron knows, what signal has to be given to the motor alpha motor neuron and what signal has to be given to the gamma motor neuron, how that whole split of signal is taking place if this signal I denoted by s then part of the signal which is coming to alpha will be s alpha and the part of the s gamma.

So, theoretically speaking signal total s is equal to s gamma s alpha plus s gamma. So, how this thing this kind of calculation neuron makes is a mysterious to us we have no

idea about it. So, these are some of the futuristic challenge to understand how the signal is being transmitted, we really absolutely no clue about this part of the circuit.

So, apparently at level different level of computation is major is out here, first level of computation those who are interested in neural computation, computation neuro science they can really look into these problems and second level of computation of course, is the first and second level of computation is here. Now whatever the electrical signal which is coated out here which is travelling along the gamma exactly knows how much length changes happen in the muscle spindle this is the third level of computation. There is the fourth level of computation which is happening out here how much length has to be you know brought back with ground state.

So, if you look at it mathematically you can really breakup this problem into a very very complex and interesting problem those of you who are interested into mathematics, and you are observing something very interesting this is the part I wanted to highlight now. There is a mechanical stimulus which is the impact these mechanical stimulus is transformed into a that electrically stimulus.

These electrical stimulus that again computed back through multiple channels and again this electrical stimulus is translated into a mechanical stimulus, where there is length change recalibration or restructuring of the length is happening. So, what you essentially see is mechanical signal to electrical signal to mechanical signal. So, in a week when we talked about in modern mechanical engineering the concept of MEMS, which stands for micro electro mechanical systems you are essentially seeing or micro electro mechanical systems in this form.

So, biology through the evolutionary ride has done all such different level of transformations of translating light signal to electrical signal, pressure waves into electrical signal, mechanical stretch and straight strain into electrical signal and again transforming an electrical signal to a mechanical signal. So, in a way what I wanted to highlight here for you to has to think ponder over its just not an information I am giving you ponder over it that the amount of I should say the amount of flexibility or the amount of modularity or modifiability or transformation ability of signals, within the biological system is unfathomable.

Like it is amazing to see as we will be rolling through it this week and partly the next week how the light signals are getting transformed into electrical signal. How in the ear the pressure waves are translated into electrical signals out here, how you have two different kind of sensor species sitting there one is the muscle spindle and other one is the extrafusal muscle, their length changes and how they are recalibrated back where their regional lengths. So, mechanical to electrical to further mechanical, these are some of the very amazing feet what nature has developed over billions of years of evolution.

So, having can read this stretch reflex circuit now I wanted to highlight this fragment of the circuit which is out here where exclusively I will be dealing with this extrafusal muscle and its connectivity with the motor neuron. Why this is important is in the very last week we talked about spinal cord injuries right if you remember we talked about SCI.

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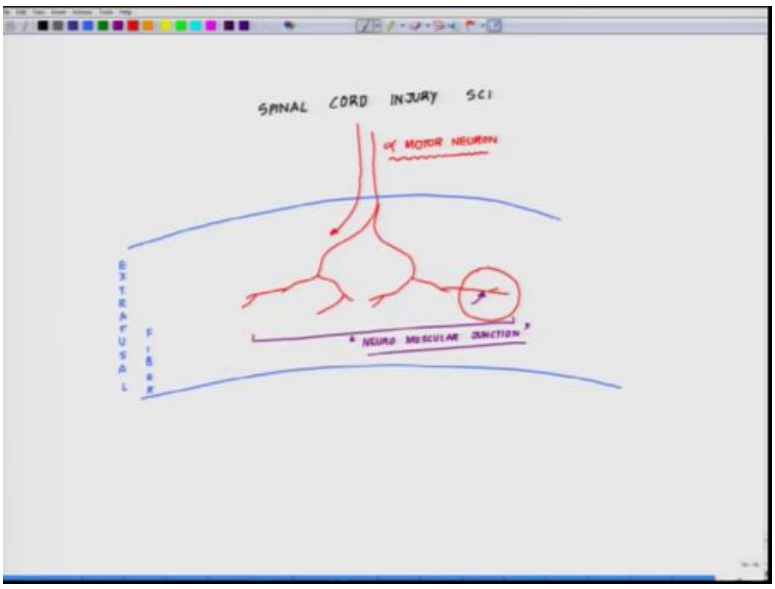

In a spinal cord injury we talked about the neurons which takes the maximum hit are the motor neurons. So, it is the motor neuron which is synapsing on the extrafusal fiber. So, if a motor neuron takes a hit. So, automatically this signal or electrical stimulus which it is supposed to sends to the effector muscle will not happen. Now how the signal in a normal situation is transmitted from the motor neuron or the axonal terminal of the motor neuron to the muscle, today we are going to discuss that part ok.

So, if you look at that synapse out here. So, this synapse what we will be dealing with. This synapse looks which is and by the way this is one of the very very oldest or the very first synapse which was elucidated into final details by mankind. So, let us draw that synapse in a. So, otherwise it will looks like this right. So, here it is. So, what we will be dealing today is this is the alpha motor neuron. So, the signal is coming like this and one second alpha motor neuron this is extrafusal fiber and this part is called the Neuro muscular junction this particular part where muscle is being in close contact with the alpha motor neuron fine.

Now, some form of signal transfer takes place between this alpha motor neuron and the muscle and how that happens, that is what we are going to now deal with. So, what I will do in this class I will close in here in the next class we will talk about the detailed architecture of this spot and how this is being regulated.

Thank you.