Animal Physiology
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Lecture - 36
Stretch Reflex Arc Circuit – I

Welcome back to the lecture series in animal physiology. So, today we are starting the eighth week and if you remember in the last class of the 7th week we talked about the different form of myelination where we talked about the Schwann cell myelination and the oligodendrocyte myelination. Where the Schwann cell myelination was predominant in the peripheral nervous system whereas, oligodendrocyte myelination was is predominant in the central nervous system.

So, in a way if you think of a neuron coming out from the central nervous system an hitting on to the peripheral tissue then part of the neuron which is inside the spinal cord will be myelinated by the oligodendrocytes and part of the neuron say for example, axon which is coming out will be myelinated by the Schwann cells.

Similarly, suppose the neuron from the periphery is sending a signal to the central nervous system. So, if it is a continuous single neuron, then part of the signal from the peripheral side or sorry the part of the axon which is reaching up to the spinal cord will be myelinated by the Schwann cells and part of the axon which is entering inside the spinal cord will be myelinated by the oligodendrocytes.

And I have discussed that possibly the reason why nature design it in such a way because of the space minimization optimization because within the spinal cord you have a fairly limited space and whatever or whatsoever you have you have to accommodate within that limited frame work of space to you know execute the function ok.

So, today what we will do in couple of classes we will revisit some of the very early circuits what we talked about the stretch reflex circuit and the neuromuscular junction and in that process we will talk about the part of the excitation contraction coupling apparatus what we have not talked yet ok.

So, if you remember when we talked about the stretch reflex circuit. So, reflex circuits are the smallest of all the circuits neural circuits in our body. So, there is a sensation on

any peripheral side of our body peripheral part of the body, that sensation along a sensory neuron travel to this spinal cord, add this spinal cord the signal is transmitted to the lower motor neuron which are the ventral horn neurons, directly or via neuron and in that process the signal is being processed within the motor neuron and signal is relayed back to the effector.

So, essentially if you look at it the signal passes from the sensor which senses the signal moves on to the sensor neuron. So, the first level of information transfer from sensor neuron have message moves or the information transfer takes place to the ventral horn motor neuron, third ventral horn motor neuron brings back it to the effector tissue which is the fourth level of transmission.

So, essentially there are 4 information transfer I will diagrammatically show it that will make more sense. Over at times there may be two more additional transfer oh sorry one more additional transfer in a way, signal received in the ventral horn by the interneuron and the interneuron passes the signal to the ventral horn motor neuron. So, there is in between a connector right.

So, these are the possible ways by which a signal can travel in a reflex circuit and based on this connectivity they are termed as monosynaptic reflexes and polysynaptic reflexes. So, let us start little draw it that will make more sense what I am talking about. So, we are. So, we are into week 8 into lecture 1.

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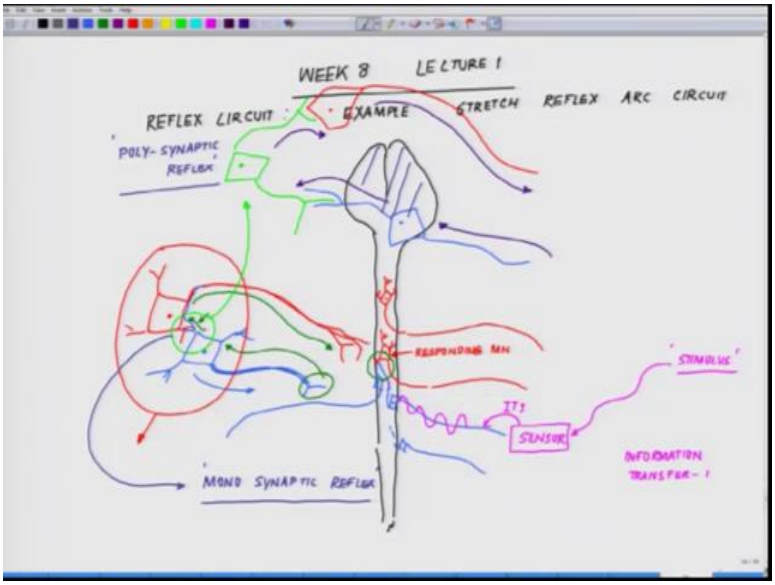

So, we are talking about the reflex circuit and in particular the example what we will be taking about will be simplest of all call stretch reflex arch circuit which is simplest of all reflex circuits. So, if this is the brain and this is the spinal cord we are talking about. So, you have your motor neuron or the ventral horn neuron sitting at the centre like this, you have dorsal root neuron sitting in the dorsal horn like this ok.

Now, possibilities when we talk about or say for example, a dorsal horn neuron sitting on this side one second, I just made a small mistake or a dorsal horn neuron may be just sitting somewhere just outside like this ok.

So, now you have a sensor element which is sitting here sensor element senses some external stimulus here is an stimulus. So, by the way I may receive this stimulus this stimulus can be from inside the body also from the outside also it does not essentially means where I am showing it outside that it is only coming from the outside environment.

So, within the surface within the peripheral surface somewhere here some inside somewhere you have the sensor sitting there sensor senses the signal. So, it has a sensor element and we will further elaborate this while we will be talking about eyes, ears, nose and several other sensory systems what we have or rather special sensors.

So, this sensory input transfer the first set of electrical information. So, this is the first information transfer IT1 IT stands for information transfer IT1, from here the information travels all along the sensor neuron here there are possibilities. So, at this time what could happen signal is directly transmitted to the motor neuron. So, if this is the responding motor neuron, we have this one responding m n stands for motor neuron right.

So, the responding motor neuron is directly synapsing upon. So, if I have to blow up this location it will be something like this. So, you have in blue you have the sensory neuron this and encloses proximity in the ventral horn siting the motor neuron cell body with its axon like this, and here is your or with its dendrites siting like that and here is the major axon. So, here is the signal, here comes the signal here the signal is transmitted, here the signal is brought back ok.

So, information transfer one and one more thing I want to tell you here you what you are seeing. So, there are sensory neurons where this process what you are thinking as an axon those are not axon those are dendritic processes, and there are several sensory neurons was dendrites are fairly long or for your simplicity sake you can even have this dendrite the one which is drawn. So, long you can have this dendrite or this processes this process you can really shift this neuron out here cell body. So, that you do not get confused you can keep it slightly in a close proximity to the ventral horn right.

So, the signal process signal moves like this comes your synapse here. So, which is your information transfer 2 out here what you see, and then this processor brings back the process signal through its axon to its target tissue out here. So, the involvement out here is between 2 major neuron directly, and that is out here. This is the only involvement what is happening.

Now, there is a possibility that the involvement out here could be executed by another neuron which is sitting in between like this and that additional neuron. So, one end of this additional neuron is synapsing with the motor neuron, the other end is synapsing with the axon of the sensory neuron like this

So, the flow of information is like this. So, if it is interfaced by another neuron which is an interneuron this connectivity is termed as polysynaptic reflex whereas, in the second case or in the first case where it is in direct contact this is called monosynaptic reflex. These are the 2 possibilities a polysynaptic reflex and monosynaptic and you can further make it complex that you may have two interneuron processing that are several possibilities which may emerge out of the situation. So, these are some of the very simplistic reflex circuits reflex circuits what we have.

Now, the time taken is exceptionally small in such circuits, the reason for reflex circuits to take. So, less time is the fact that these circuits are your survival strategies you really do not have any room for the higher centres so, this part of the brain to think over such thing because you have to act very fast.

So, now in the light of this we will talk about the next representative circuit which is which I was mentioning as the stretch reflex arch circuit.

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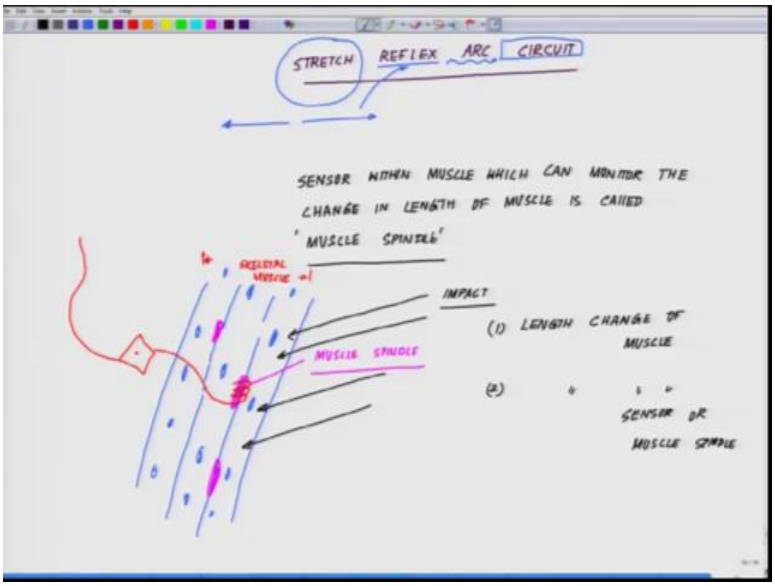

So, before I draw the circuit the basic architecture of the circuit is same as I have already shown you, but what this circuit exactly does. So, say for example, hypothetically think of a situation this is our muscle out here it gets a hit it gets a hit or it gets a hit at joints or somewhere. So, the muscle length changes or muscle get distorted. So, essentially what you see is the muscle get distorted. So, there is a change in the length of the muscle.

But you do not even realize that much before you realize the phonate the muscle regains its original length. So, what essentially happen what you see is that the muscle got a hit it is stretches and even before any of your realization muscle gets back to its original position.

So, in terms of a physical process the muscle length changes and it or starched out and it came back to its original position as if there is a reflex action which is happening. Now what is the title what I was telling you I what I was writing if you see the title or I said stretch means there is some form of an stretch which is happening and that is stretch leading to a reflects and this is in the form of a circuit a stretch reflex arch circuit, this is what the circuit is all about.

So, in order for a stretch reflex arch circuit to happen, if we logically break down the problem then we need a muscle length sensor something which changes the change in length in muscle and such sensors which is the ability to sense the change in length of a muscle are called muscle spindle. The term which is used is the sensor within muscle

which can monitor the change in length of muscle is called muscle spindle step one ever muscle spindle.

Now, this muscle spindle what is the real structure this muscle spindle has to be innervated by a sensory neuron. Now whenever we hit upon a muscle there is muscle not only changes its length this spindle too changes its length. So, if you see a muscle like this. So, it will be like this here is the muscle remember we talked about all these myotubes myofibrils and all those things. So, you have the muscle with multinucleated myotubes myofibrils and everything which is present there within these muscles. So, in this case we are talking about this skeletal muscle skeletal muscle and within this skeletal muscle we have this structure called muscle spindles, and these muscle spindles are innervated by sensor by the dendrites of the sensory neurons something like this ok.

So, once a muscle take an impact this is the impact what muscle is taking, this impact changes two different length. The first length, length change of muscle and length change of sensor or muscle spindle. So, try to kind of imagine the situation muscle in this case the whole muscle is your effector where the effect is happening. So, there is the change in which is and on the muscle there are muscle sensors.

So, here I will take a pause because I will take a pause because I will have to take you back to one of the earlier classes when we talked about how this muscle spindle is formed and then from there will follow up how this whole circuit kind of force. So, I will closing here very next class well start from here that how this change in muscles integrated into the complete circuit.

Thank you.