Neuroscience of Human Movement
Department of Multidisciplinary
Indian Institute of Technology, Madras

Lecture - 08
Action Potential - Part 3

So, welcome to this class on neuroscience of human movement, this is a part 3 of our discussion an action potentials.

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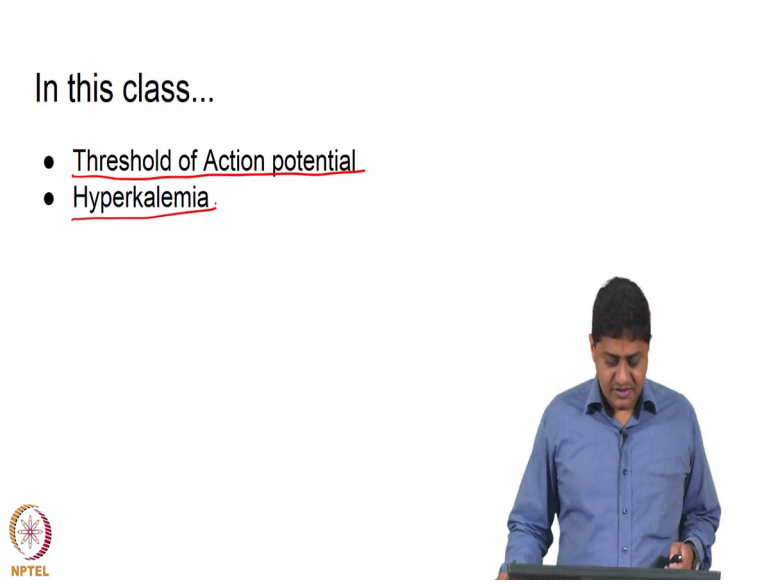

So, in today's class we will be discussing the relationship of the resting membrane potential with the threshold of action potential, if that is varied artificially due to some condition what could happen to the system. And so, more specifically we will discuss the case of hyperkalemia.

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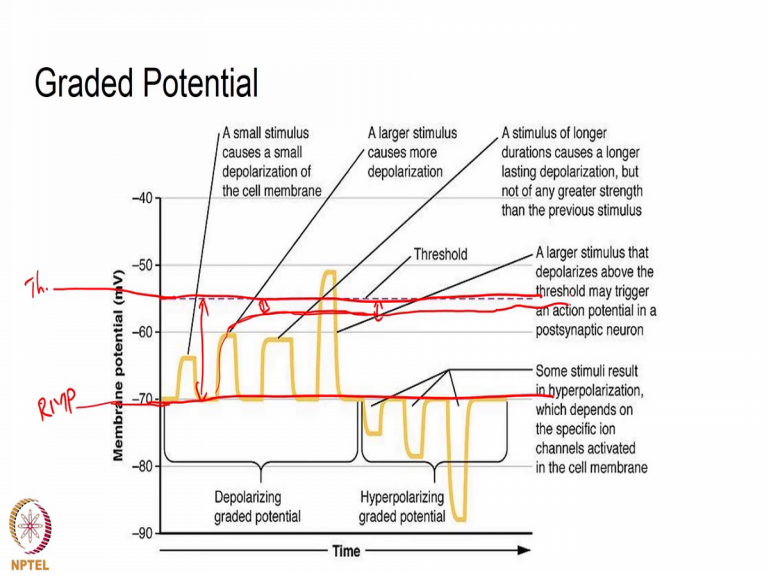

So, we saw earlier that if the threshold is here say for example. The closer to the threshold you take the membrane potential say for example, here then I add one more stimulus here so that the threshold if reach, then that will (Refer Time: 01:00) action potential seminar this is something that we have seen. However, one more thing to be noted is the resting membrane potential is approximately here say for example, that is the resting membrane potential that is the threshold.

Suppose, I maintaining the resting membrane potential or the membrane potential further away from the resting membrane potential, but very close to the threshold something like that. You would think that it is easier to cause an action potential, but you would because you would only need a stimulus of that amplitude and not that amplitude. You would not need a largest stimulus to cause and action potential a relatively small stimulus is sufficient (Refer Time: 02:04) not you think that that is an advantage unfortunately.

If the a membrane potential is held at a value closed to the threshold for a relatively long period, something happens that is non-intuitive. Important to note is that this is biology and here several exceptions exists for every rule that they speak about which is why we say in biology exception is the rule. So, let us consider what happens in the case of the situation, when the membrane potential is held at value very close to the threshold what happens in that state.

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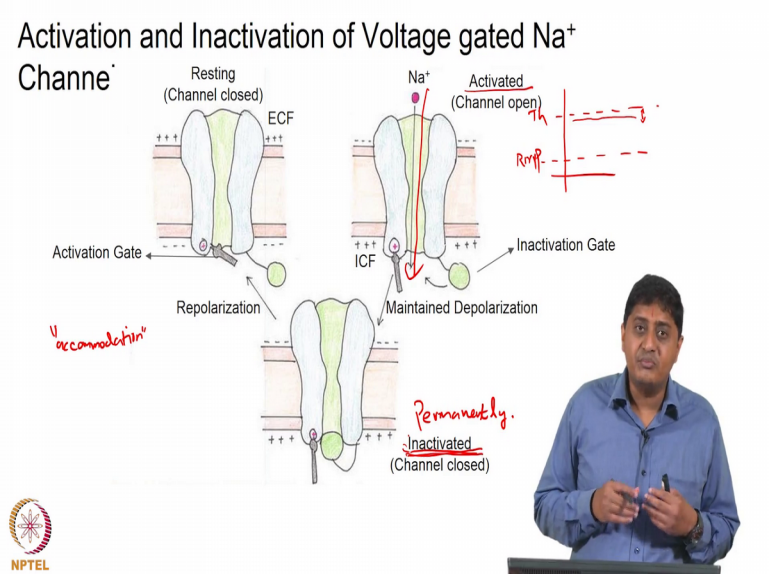

These are the case of the voltage gated sodium channel it will open when the threshold is reached right. So, that is only a very small amount very small amplitude, that needs to be crossed if you already maintain the membrane potential close to threshold right.

So, once again that is threshold, and this is the resting membrane potential. And for whatever reason we will see the reason later for whatever reason the membrane potential is held very close to this value. If that happens you would need only a small amplitude stimulus to take the membrane to threshold and then an action potential will be cause. Once threshold is cause the voltage gated sodium channel we will get activated and basically the activation gate we will open and a larger sodium will enter inside. But, if you maintain the membrane potential way about the resting membrane potential and close to the threshold what happens is, some form of accommodation happens, some form of response long term response happens that takes the membrane or that takes the voltage gated sodium channel to a permanently inactivated state.

Now, let us remember what this could happen let us discuss, what this could cause what this could cause is no more action potentials can be produced. Let us remember that if the activation gate is closed and the inactivation gate is open regardless of which period I am regardless of the membrane potential. If even if I am and relative refractory period a largest stimulus can take the membrane to threshold and cause one more action potential this is what we signed the previous class. But if the in activation gate is closed regardless

of what the strength of the stimulus is, I cannot take the membrane to threshold and cause one more action potential, because the membrane is in its absolute refractory period right. That absolute refractory period is the period during which the voltage gated sodium channel is inactivated. So, maintaining the membrane potential closed to threshold causes permanent deactivation. So, permanent deactivation of the voltage gated sodium channel causes a situation where it is impossible to cause one more action potential.

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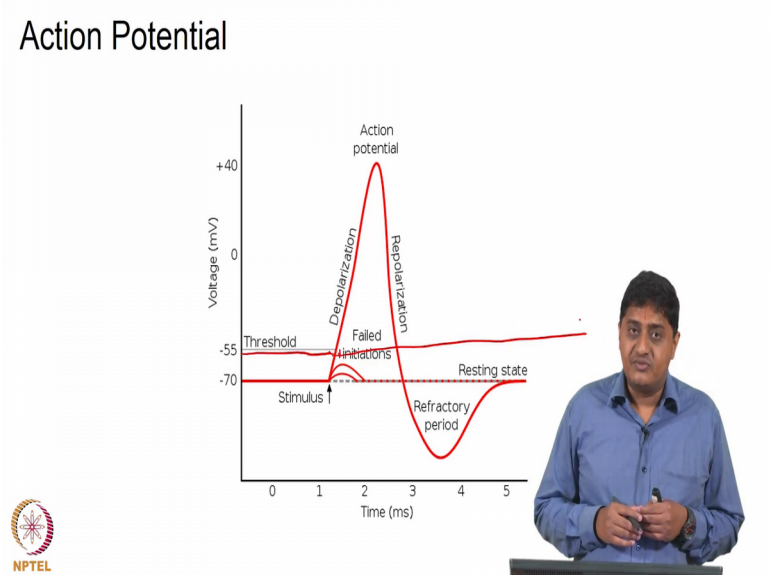

So, this is what happens in the case of hyperkalemia. So, I am maintaining it at this level say for example, and this even after that even after producing our a stimulus will not cause an action potential, I will continue to maintain at this value will never be able to cause an action potential. Because, the membrane or that part of the membrane is in a situations similar to absolute refractive period right.

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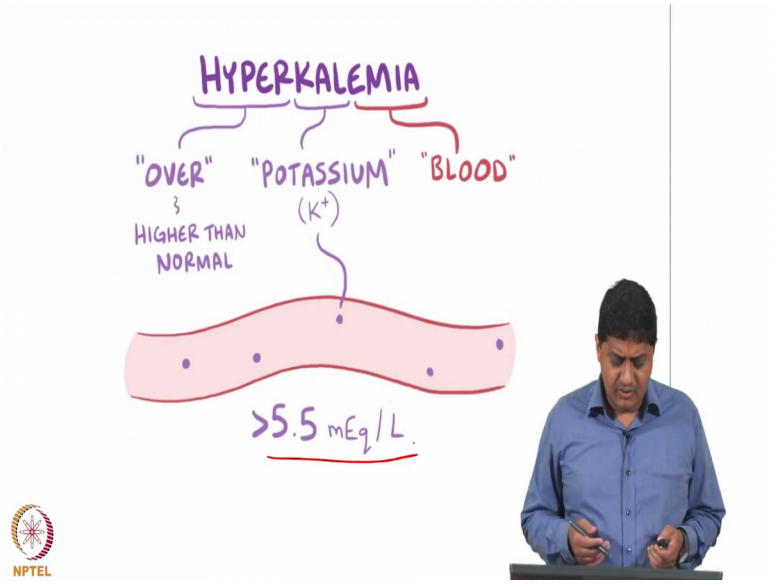

This is what happens in hyperkalemia in general what is hypokalemia what does this do.

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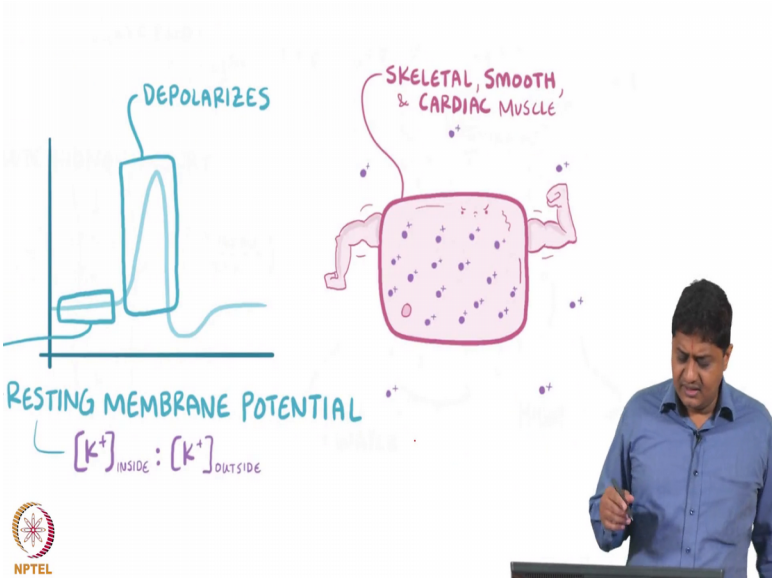

Once again in the general case in the regular case what happens is. So, this is resting membrane potential, at resting membrane potential there is suppose there is a stimulus and this is what happened. So, this is a healthy person and then basically this causes action potential in skeletal muscles, smooth muscle and cardiac muscle etcetera so, relatively healthy function normal function. Now, suppose the membrane potential is

taken upward say for example, here. Now this can also cause say an action potential you keep taking it upward with it like that.

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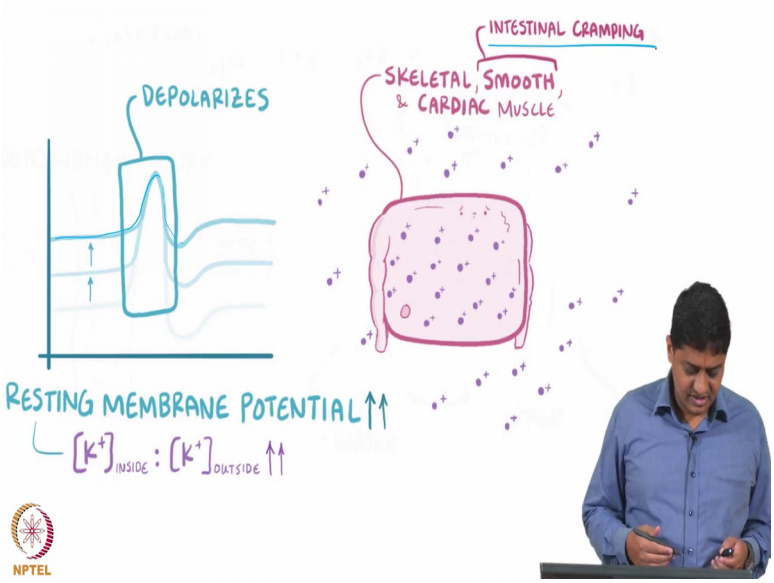

After sometime what happens is there is permanent deactivation of the voltage gated sodium channel, that no more action potential can be caused. Because of this reason the muscles will become flaccid you will not be able to produce force with the muscle. So, that we cause a several problems including intestinal cramping and weakness of muscles and so many other such situation.

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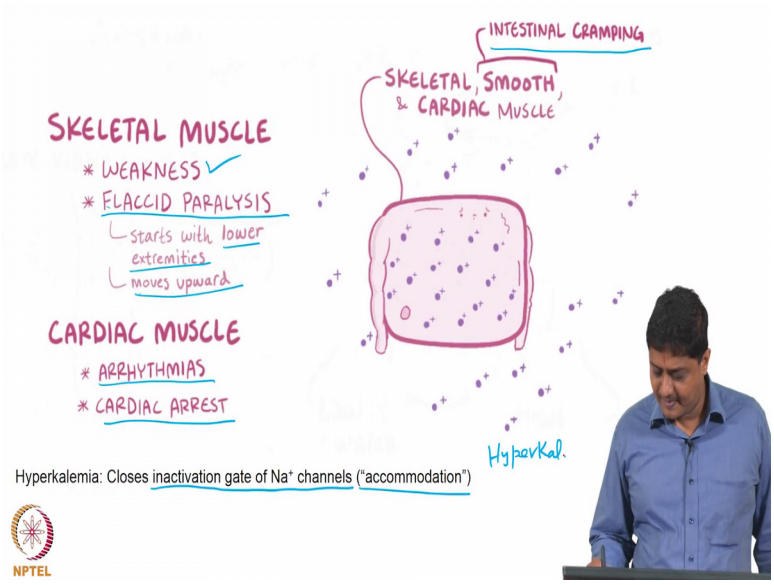

So, basically in the skeletal muscle it causes weakness and flaccid paralysis or it starts with the lower extremities. So, our a form of ascending paralysis so, it is start with lower extremities and then raises up right ascending paralysis and then moves towards.

And in the cardiac muscle which is all which is special type of muscle, it could cause arrhythmias can even cause cardiac arrest. And in the smooth muscles of the (Refer Time: 07:36) intestinal system it could cause intestinal cramping. So, essentially this is caused due to the closer of the inactivation gate of the voltage gated sodium channel due to accommodation and this causes weakness and paralysis.

So, a higher amount of potassium in the extracellular matrix causes this situation such called as hypokalemia there is special case ok. So, with this we come to the end of this lecture we will discuss other topic in future classes.

Thank you very much.