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

Lecture – 59
Cerebellum Part - 8

So, welcome to this class on Neuroscience of Human Movement, this is part 8 of our discussion on Cerebellum.

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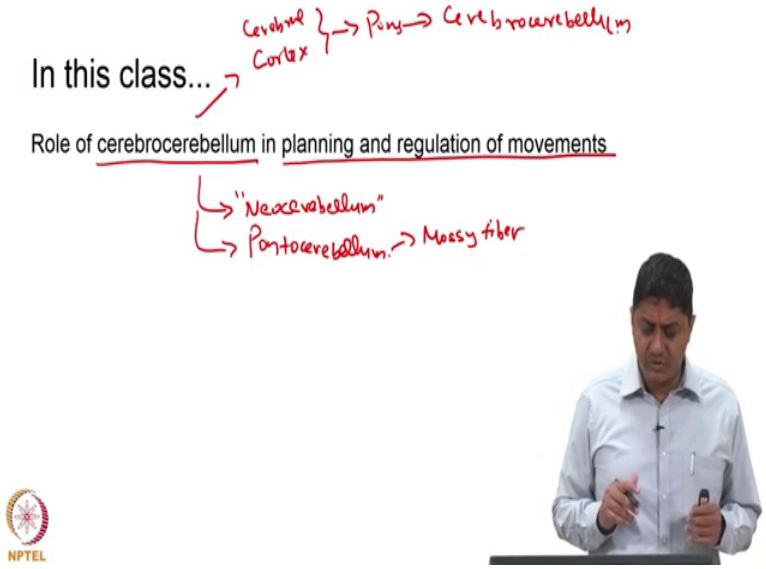

So, in this class we will introduce and start the discussion on cerebrocerebellum, and how cerebrocerebrum plays a crucial role in planning and regulation of movements. So, cerebrocerebellum is the later cerebellum are is considered to be evolutionarily advanced the cerebellum, which is the reason this is also called as neocerebellum. We have discussed this in a previous class that cerebrocerebellum is the newest addition evolutionary.

So, this is called as the neocerebellum. And since it receives inputs from the pons mainly from the pons it is called as ponto cerebellum. So, the inputs it receives from the pons are the mossy fibers is it not? Mossy fiber input from pons. Where does pons received it is input from? Obviously, it is receiving inputs. So, this is be because cerebral cortex cerebral cortex 2 pons to cerebrocerebellum.

So, the pons are those areas of pons that project to the cerebrocerebellum receive inputs from cerebral cortex, ok. For a long time, it is believed that, cerebro cerebellum and cerebellum in general is a motor organ of the brain. In other words, it is main function is to plan regulate and modulate moments.

Whereas, now this view is being challenged that it also has other functions other than motor functions it also performs cognitive and other functions. This view is now gaining traction, but this is a relatively new view and evidences just getting built up to support this notion. For now, in this course we are interested in movements and movement related active and movement related functions. So, we will restrict our discussion to movement related functions of the cerebrocerebellum.

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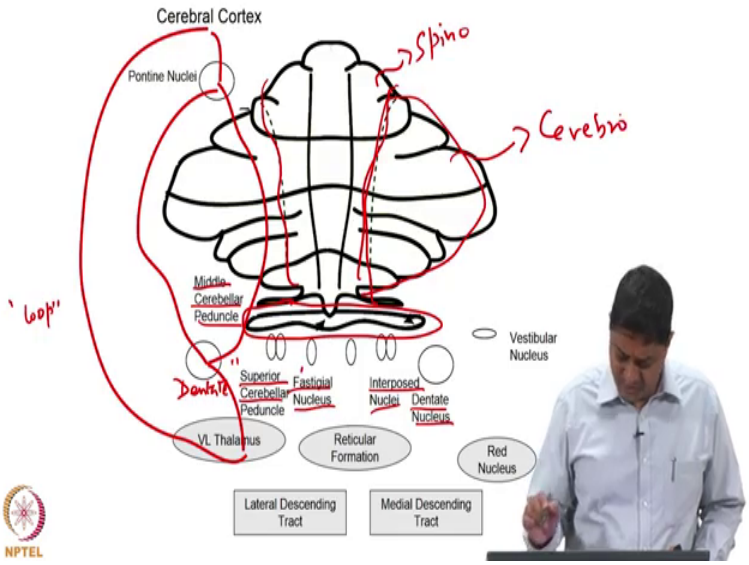

So, once again we go back to the outline picture of the cerebellum, and here we discusses cerebrocerebellum.

So, pontine nuclei or pons receives inputs from cerebral cortex. And from there is a projection to the dented nucleus so, it is big. So, that must be dentate nucleus, it is shown here that is the dentate nucleus. We are showing the peak we are illustrating only one set, but this is happening on both sides of the cerebellum. So, of course, these are interpose nuclei and that is the fastigial nucleus. These a are the output nuclei of the cerebellum or the deep cerebral nuclei.

There shown outside the cerebellum for illustration purposes, but there actually embedded here, there actually embedded within the cerebellum ok. There shown outside for convenience for illustration purpose. So, the pontine nuclei project first one on the one hand project directly to the dented nucleus, but the dented nucleus also receives input from the cerebral cortex. What is this input? This is the purkinje cell input is it not this is the purkinje cell input, and there is comparison then happens at this point. We have seen this during our discussion we have seen this during our discussion of the cerebral microcircuit etcetera.

So, the dented nucleus compare so, input it receives from the mossy fibers and also they inputs inter receives from the purkinje cells. This comparison also of course, there are other comparisons that happen within the cerebral cortex, but this is one of the many comparisons that happened.

So, the dented nucleus this is input from the pont pontine nucleus and also from the cerebral cortex or the purkinje cell input from the cerebral cortex. From there it projects so this input is coming via the middle cerebral peduncle. And from there the dented nucleus, it projects to the ventrolateral thalamus and from the ventrolateral thalamus back to the cerebral cortex right.

So, this is one of 2 important outputs; one is to projecting back to the cerebral cortex via the ventrolateral thalamus, the other one we will discuss in a bit ok. So, to review this just briefly. So, pons receives input from the cerebral cortex, from the pontine nuclei there is projection back to the there is projection to the dented nucleus, and via the cerebral cortex to the dented nucleolus where there is a comparison that is happening from the dented nucleus to the ventrolateral thalamus.

And from the ventrolateral thalamus back to the cerebral cortex. Thus, forming one loop right, this is forming one loop. And node the output the output from the dented nucleus is through the superior peduncle ok is through the superior peduncle. The input is through the middle cerebral peduncle.

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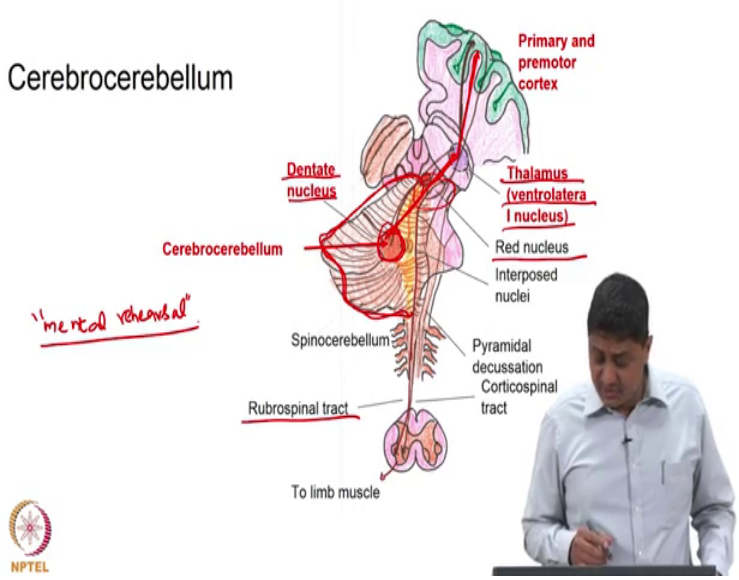

And actually the other output in the other output so, one output is through the dented nucleus. So, that is the cerebrocerebellum. It is basically the most lateral parts the cerebellum, the more medial parts are called as the vermis and the parable malaria or the intermediate zone, these constitute the spinocerebellum which we discussed in the previous class..

And the flocculonodular lobe constitutes the or that is the flocculonodular lobe, that constitutes the vestibulo cerebellum, we have seen these things previously. So, that area the more medial region constitutes the spinocerebellum. Now more lateral region which is that contributes the cerebrocerebellum ok.

So, once again that constitutes the cerebrocerebellum, and that is the deep cerebellum nucleolus which is the dented nucleolus right. So, the dented nucleolus from there are at least 2 projections, one is to the ventrolateral thalamus which is here shown here. And the other is to the red nucleus, right. So, from the red nucleus there is projection of course, to the spinal card via the rubrospinal tract, we have seen this. And from the cortex are there from the ventrolateral thalamus it reaches to the primary and pre motor area.

And from the cortex there is corticospinal tract, we have seen this. Now it is believed that the red nucleus also receives input from the pre motor and the primary motor cortex. So, that is that region right.

So, it receives input from the dented nucleus and the primary and pre motor cortex. And since these regions receives input on 2 different aspects. One is a planned movement and the other is the controlled command. It is believed that, there is and the mental rehearsal of movements that is happening.

I want to do this. How am I going to do this? Type of mental rehearsal of movements is happening in this the current loop that involves the red nucleus primary motor cortex pre motor cortex, and mainly the promoter cortex or the association cortex and the dented nucleus. So, the dented nucleus since one form of input the promoter cortex since other form of input, this comparison or this mental rehearsal is probably due to the activity that happens in the red nucleus.

So, this is an interesting intrigue in hypothesis concerning the function of red nucleus or the projections red nucleus receives from the dented nucleus on the primary motor cortex and the pre motor cortex areas, right. Also it is to be noted that red nucleolus projects to inferior olive in another recurrent circuit.

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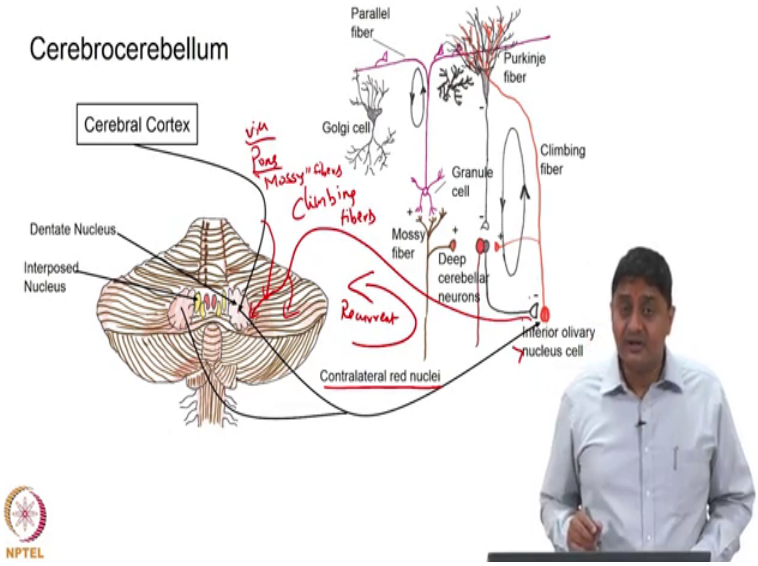

So, what happens is at the cerebral cortex projects to the cerebral cortex via the pons, cerebral cortex and to deep cerebral nucleus. So, there are 2 and then from here to there. So, there are 2 comparisons, right there are 2 projections. One projects directly to the to the deep cerebral nucleus, the other one projects to the cerebral cortex which then projects back via the purkinje neurons right. So, that happens, and this projection is and

then from the dented nucleolus from the output nucleus, from the dented nucleus there is projection to actually to the inferior olive how via the contralateral red nucleolus right.

So, then this inferior olive neurons send information back to the deep nucleus and to the cortex as climbing fibers. Whereas, these cells are these fibers that originate from pons are of course, mossy fibers, is it not? So, this continues this constitutes one recurrent loop. So, from the deep nucleus through to the inferior olive nucleus via the red nucleus via the contralateral red nucleus from the inferior olive back to the cerebellum, as a climbing fiber. So, this constitutes another of the recurrent loops.

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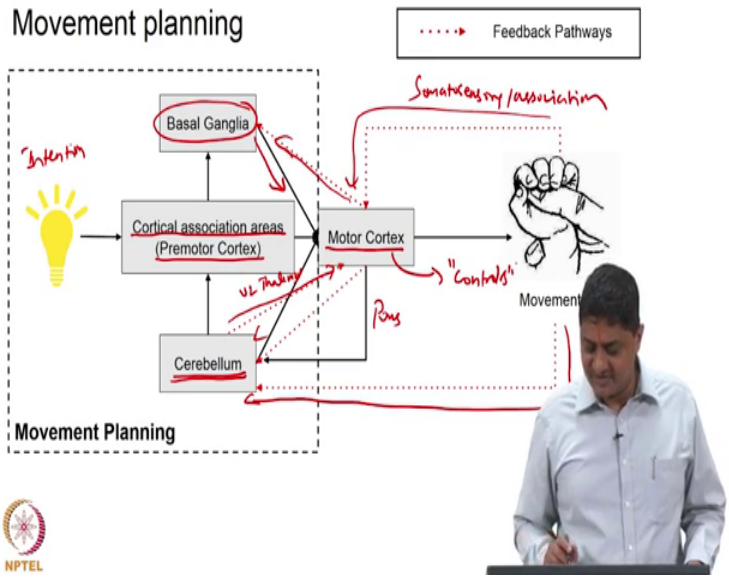

So, to discuss or to summarize. So, there is an idea, there is an intention to make a movement. So, that is probably happening in the prefrontal frontal areas, and that is a communicated to the association or the motor association areas. So, the pre motor cortex, supplementary there are multiple numbers of the way; we discuss the details in the previous classes.

There are many of this, and then that is communicated to the motor cortex. But it turns out when the movement is happening it is receiving feedback or cerebellum is receiving one from a feedback, the motor cortex is receiving feedback via the somato sensory cortex and association cortexes, Right.

Also note that basal ganglia participates in movement modulation, and motor cortex also controls inputs to the basal ganglia. Cerebellum projects back to the motor cortex via the VL thalamus, motor cortex also sends it is inputs to the cerebellum via the pons. So, there are so, this is via the pons.

So, there are multiple loops, multiple feedback circuits that are received. So, there is a feedback about the movement via the somatosensory association cortex. There is also feedback that is sense by the cerebellum, which then sends appropriate corrective commands to the motor cortex or the brain stem regions right. So, in this cerebellum also forms a crucial element of the movement modulation and movement regulation system.

The other element obviously, that participates in the movement modulation are regulation system is basal ganglia; that forms the discussion for some of the future classes, but we are not done with cerebellum yet. And of course, motor cortex controls movements we have seen, how it controls moments in the previous classes.

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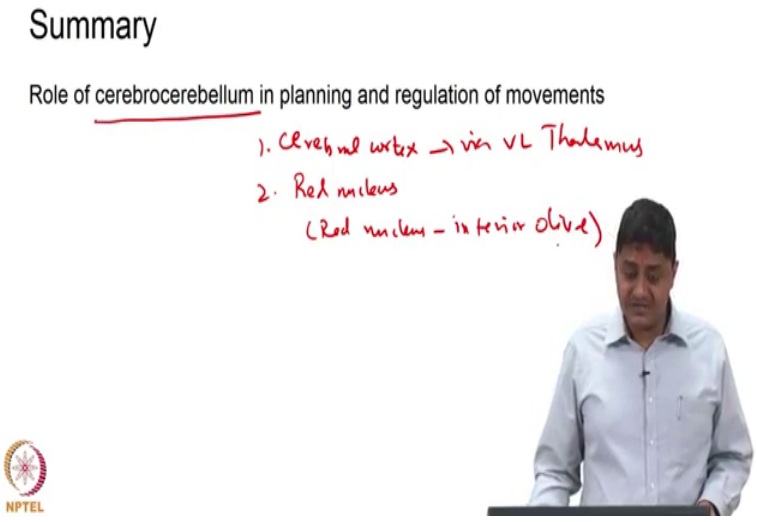

So, with this we come to the end of this lecture. So, in this class we discuss the role of cerebrocerebellum in a planning and regulation of movements. We discussed in particular. There are 2 loops; one is to the cerebral cortex via the ventrolateral thalamus, through dentate nucleus and to the red nucleus are the recurrent loop involving red nucleus and inferior olive. We will continue our discussion on we will continue our discussion on cerebrocerebellum in the next class.

So, thank you very much for your attention.