Basics of Mental Health & Clinical Psychiatry
Doctor Arijita Banerjee
Doctor B. C. Roy Multi-Specialty Medical Research Centre
Indian Institute of Technology, Kharagpur
Lecture 02
Cerebellum

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So, our next topic is cerebellum, which is a very vital topic to understand because all our movements, the regulation of movements, the coordination of our movements, they all depend on cerebellum as well as basal ganglia. Basal Ganglia will study some in some other lecture. So, today we will study cerebellum.

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So, the concepts we will cover under this topic is the functional anatomy of cerebellum, the Homunculus, the Internal circuitry, the connections, inputs and outputs, and the functions of cerebellum and what are its applied aspects.

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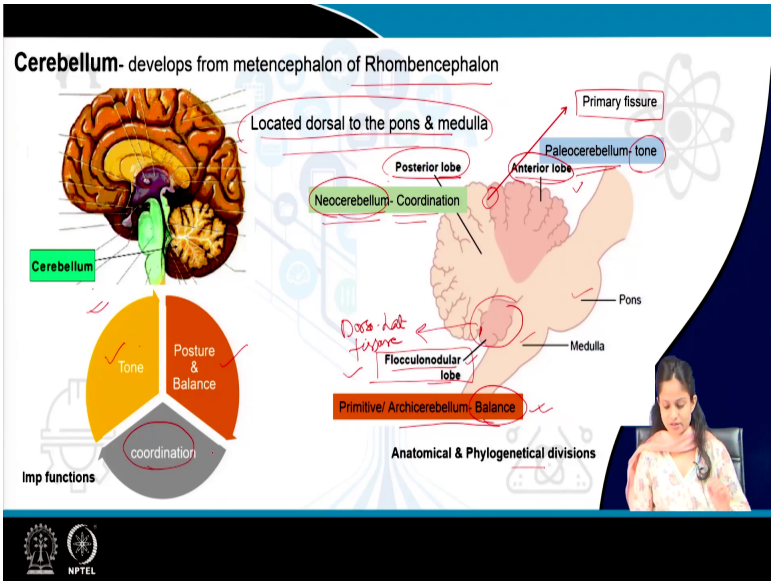

So, cerebellum, now, this structure of cerebellum, this is given, when we have taken the literal view, literal view means this portion view we are taking. So, when this lateral view of cerebellum, you can see this is the cerebellum, this is the cortex, this is the cingulate gyrus. Now

cerebellum develops from Rhombencephalon, even if you do not remember metencephalon, you just remember, it develops from the Rhombencephalon because it forms the hindbrain. So, cerebellum is located dorsal to the pons and medulla, this is pons, this is medulla. So, that it is located dorsal to the pons and medulla.

Now, if any of you been asked the questions the what is the main function of cerebellum, even if you do not remember any functions or, many functions of cerebellum, but you should remember at least 3 major functions of cerebellum. The first function is posture and balance, how it maintains our posture, how it maintains our balance, like for example, I am sitting straight, I am not swaying here and there. So, that is posture and balance, then tone of the muscle, then my muscles are not rigid, my muscles are not flaccid. So, there is maintenance of tone of our muscles, there is maintenance of posture and balance by the cerebellum.

And very important function is coordination of the movements like when I am speaking, my hands are also moving, so it is coordinating when I am speaking on my hands are not moving here and there. So, that is incoordination of the movements. So, how this is occurring, how I am maintaining my posture and speaking to you with coordination of my movements, so, that is done by cerebellum.

So, now, we will see this lateral view of the cerebellum, cerebellum has been classified anatomically, functionally, and phylogenetically. Phylogenetical divisions of cerebellum means obviously, my cerebellum or human cerebellum will be different from that of a fish cerebellum, because the brain structures because we are all evolved, but still fish should have certain posture of a certain portion of cerebellum which is still present or exists in our cerebellum in human cerebellum.

So, so that is known as the phylogenetical divisions of cerebellum. So, we classify cerebellum, this is pons, this is medulla as I told you it is located dorsal to the pons and medulla. So, this is classified mainly into 3 lobes. This is the anterior lobe, this is the posterior lobe and this is the flocculus or the flocculonodular lobe.

Now anterior lobe and posterior lobe is mainly divided by a primary fissure and posterior lobe and flocculonodular lobe, this is also there is a fissure, this is known as posterior lateral fissure or

dorso lateral fissure. Now out of this 3 lobes, that is anterior lobe, posterior lobe and flocculonodular lobe, which is the most primitive lobe that means which lobe is present in fish also, the most primitive lobe obviously one which is very small, that is flocculonodular lobe. This lobe is present in fish also.

So, this flocculonodular lobe is the primitive lobe, it is also known as archicerebellum. Then we come to the next lobe, when it is further more evolved that is the anterior lobe that is known as paleocerebellum, then with further evolution, we have got the posterior lobe that is the neocerebellum. So, you can just from the name you can understand archi refers to something which is very old. So, primitive lobe that is archicerebellum that is flocculonodular lobe, then you have the paleocerebellum that is anterior lobe and neocerebellum anything which is new. So, that is posterior lobe. So, we have got 3 lobes.

Now, what are the functions of these 3 lobes, we know the 3 major functions of cerebellum that is mentioned maintenance of posture and balance, tone and coordination. So, this primitive lobe coming to this primitive lobe, the flocculonodular lobe, should be doing some primitive function. So, that is maintenance of posture and balance. So, posture and balance is also maintained in fish, birds, other than human beings. So, flocculonodular lobe is mainly responsible for the balance.

Now coming to the anterior lobe, this is mainly responsible for the tone and coming to the neocerebellum that is the posterior lobe that is since its neocerebellum, so, it is mainly more evolved and so, it is responsible for the coordination of our movements. So, if we see this, 3 functions, if you just could revise posture and balance is maintained by the flocculus or the flocculonodular lobe, tone of the muscles are maintained by the paleocerebellum or anterior lobe and coordination is mainly maintained by the new cerebellum or the posterior lobe.

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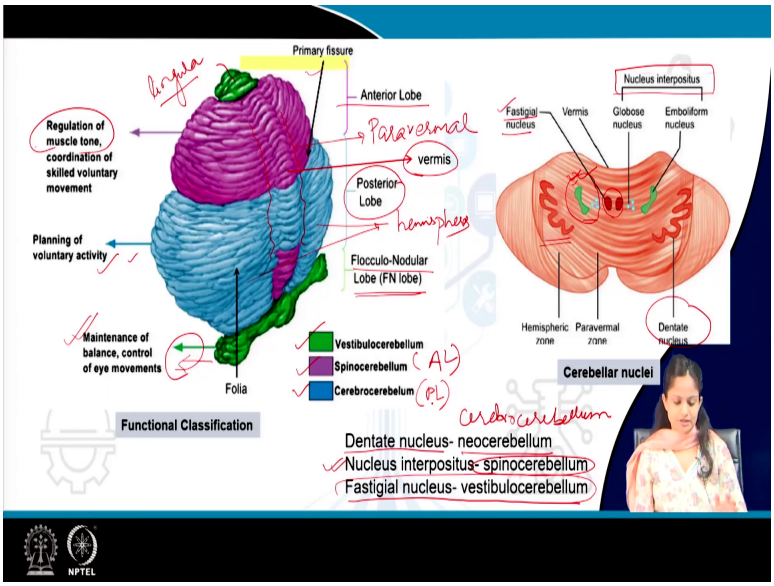

With this, we will move on to the next part of our lecture that is the cerebellum functional classification. Now, this is the structure if we see cerebellum from the back, previous slide, we have shown the cerebellum from the side, this is when you look cerebellum from the back, it is present in the hindbrain. So, when you look cerebellum from the back, you can see these are the 2 hemispheres of the cerebellum, the central portion is known as Vermis obviously, anything lateral, to the central portions, this and this, these are the 2 cerebellar hemispheres, these are the 2 cerebellar hemispheres.

So, central portion is the Vermis anything which is literal to the Vermis is para vermal area. So, if this is vermis, this portion, and this portion just adjacent to the vermis, is known as para vermal area, this para because it just lies adjacent to the vermis. So, that is para vermal area, the rest, this is the anterior lobe, which is divided from the posterior lobe by primary fissure, then the bigger one is the posterior lobe. And you can see this green color this is the flocculonodular lobe or the flocculus, this portion is known as Lingula. This is also a part of archicerebellum or primitive cerebellum.

So, we have we mainly should concentrate on the 3 lobes that is anterior to posterior lobe and the flocculonodular lobe and the Vermis that is the central portion of the cerebellum and the adjacent portion of the cerebellum that is para vermal area and the lateral portions of this Vermis that is 2

cerebral cerebellar hemispheres. Now as I told you, this flocculonodular lobe, is mainly responsible for maintenance of balance and eye movements.

See, when I am moving my head in both directions, my eyes are also moving it is not that I am moving my head and my eyes are fixed to one place. So, with the movement of the head and neck your eyes also move. So, this is done by this flocculonodular lobe. Then anterior lobe is mainly responsible for the regulation of muscle tone has been already said and planning of the voluntary activity, whatever activity we plan and execute that is mainly done by the posterior lobe or the neocerebellum.

So, again, very easy to remember. This green color is the archicerebellum or the oldest prime primitive cerebellum, mainly responsible for the balance, posture and balance and eye movements. Then we have the anterior cerebellar that is the paleocerebellum, which is mainly responsible for the regulation of muscle tone. And then we have the newest or the neocerebellum that is mainly responsible for the, that is the posterior lobe mainly responsible for the voluntary activity coordination.

Now how we will link this with of cerebellar nuclei, there are various cerebellar deep cerebellar nuclei. So, what nuclei are present in the cerebellar we will see in the center we can see the small nuclei, this is known as fastigial nucleus. You can see this, since there are 2 hemispheres, so we will have obviously pair of nuclei. So, in the center nuclei, the center which is close to the Vermis we have fastigial nuclei. Fastigial as the name suggests Fastigial and it is related to primitive functions.

Then we have 2 sets of nuclei, that is Globose nucleus, globossus and nucleus Emboliformus. These 2 sets of nuclei are collectively called as nucleus interpositus. And then we have the very evolved nuclei, that is dentate nucleus, the bigger nucleus the largest nucleus is the dentate nucleus. So, we have the 3 nuclei one is in pair, the first one which lies very central to the Vermis in the midline that is fastigial nucleus.

Then laterally we have nucleus interpositus, then laterally we have dentate nucleus. So, the more things are in center, we have primitive functions, the more things go laterally, we have newly evolved functions, the same with that of the structure of the cerebellum see the vermis, para

vermal and the lateral area of the cerebellar hemispheres they are concerned with the voluntary activity.

And the central portions, they are mainly concerned with the posture and tone. Then the same is that with the nucleus also. So, this fastigial nucleus is mainly responsible for the posture and balance. So, this fastigial nuclei is responsible for this vestibulo cerebellum that means it should have connections with vestibulo cerebellum. Vestibulo cerebellum is nothing but archicerebellum or the flocculonodular lobe of the cerebellum, vestibulo means balance, maintaining equilibrium. So, vestibulo cerebellum is connected with this fastigial nucleus, because vestibular apparatus is present in our ear, we have utricle, succulus, semicircular canals, those are the apparatus which are concerned with maintaining balance and equilibrium.

If those apparatus are destroyed, we will not be having balance and equilibrium maintained. So, this vestibular apparatus at present in ear, so, this is related to this fastigial nucleus of this cerebellum. Then we have nucleus interpositus, this group of nucleus just lateral to the fastigial nucleus. This is mainly related with the spinocerebellum, spinocerebellum means spino means, spinal cord, spinal cord means, the spinal cord is mainly responsible for the reflexes or the tone of the muscles or the posture of the muscles because every tracks whether tracks are moving up or whether tracks are moving down, they go through via spinal cord.

So, this spinal cord is related to the nucleus interpositus that is for the maintenance of tone and posture. Now, coming to the most evolved nucleus that is dentate nucleus, which is related to the neocerebellum, Dentate Nucleus related to the neocerebellum or this is also known as Cerebro cerebellum. Why it is cerebro cerebellum, because this cerebellum has got direct connection with the cerebral cortex, cortex is which is the main content referring all the functions of our body the control is on the hands of cerebral cortex. So, cerebro cerebellum, spinocerebellum, and vestibulo cerebellum these are the functional classifications.

Previous slide I told you the anatomical classification that is anterior lobe, posterior lobe and the flocculonodular lobe. Then I told you the actual the phylogenetical classifications, that is archicerebellum, paleocerebellum and the neocerebellum. Then I told you the functional classification that is vestibulo cerebellum, this is nothing but the flocculonodular lobe, spinocerebellum, this is nothing but anterior lobe and cerebro cerebellam this is nothing but the

posterior lobe. The classifications are evolved and several types of classifications are done since because for the help, various connections are there, these connections are very important from a clinicians point of view.

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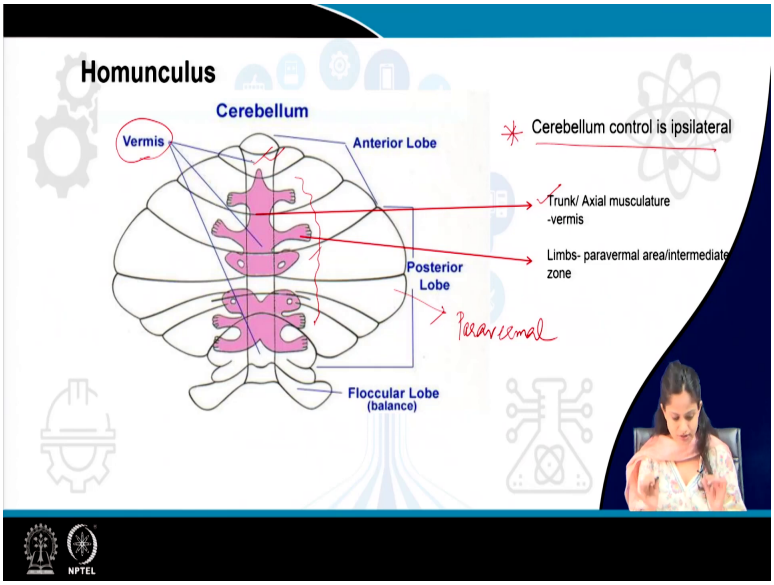

So, with this, we will move on to the Homunculus. Homunculus means how our body, the whole body is represented in the cerebellum, it is represented in a miniature form in the cerebral cortex also, it is represented in a miniature form in our cerebellum, also the cerebellum knows where our hands are, where our feet is, where is my neck, where is my face very nicely even our cerebral cortex knows, but it cannot be present as a whole, it is present in a miniature form that is known as homunculus in the cerebellum.

The first thing you have to remember the very important difference between cerebrum and cerebellum is cerebellum control is ipsilateral, ipsilateral control means, it is just the opposite of cerebral cortex or the cerebrum, cerebellum control is ipsilateral means if my left side of the cerebellum is damaged, so I will be having problems on my left side. But if my left side of the cerebral cortex is damaged, I will have problem on the right side that is contralateral, so, that does not happen in cerebellum.

Cerebellum means the side which gets damaged only that side gets affected. So, this is the cerebellum control, this is very important, you should remember. Now, this area I told you, this is

Vermis, this lateral to the Vermis area I told you, this is para vermal region, this is para vermal region just adjacent to the vermis is para vermal region, you can see a miniature form of human being is represented in the cerebellum you can see that trunk portion, trunk means the middle of the head portions, the shoulder portion, the hip portion, the pelvis portion is present in the vermis, and the limbs are present that his hand and feet are present in the para vermal region.

So, why this is important because if the Vermis is affected, so, the trunk will get affected the axial musculature will get affected with sparing the limbs, but if the para vermal region is getting affected due to any reason, so, the limbs will get affected, but the trunk and the axial musculature will get spared, axial musculature means the shoulder the hips and the pelvis.

So, as you can see, this is the somatotropic representation of the homunculus representation, middle portion of the cerebellum is the Vermis which consists of the trunk and axial musculature and the para vermal region consists of the limbs both of upper limbs and lower limbs. And another important thing is cerebellum control is ipsilateral.

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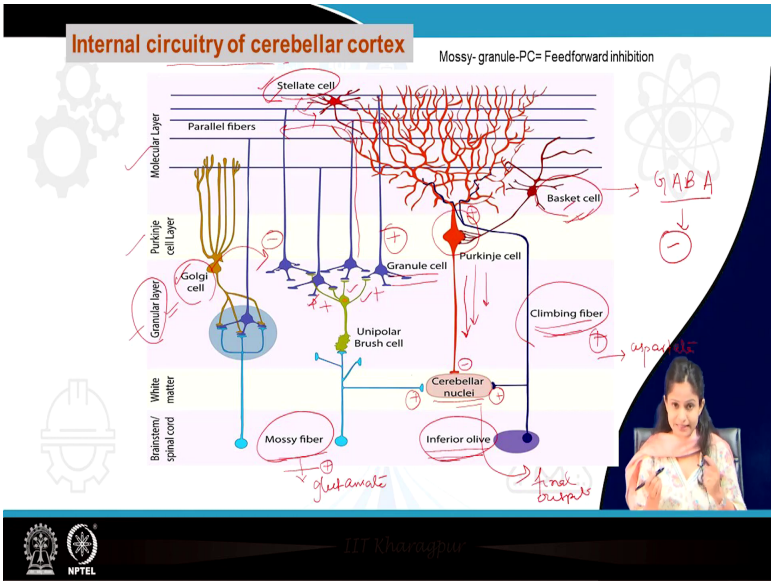

With this we will move on to the very complex yet interesting part of our lecture that is internal circuitry of cerebellar cortex. Internal circuitry of cerebellar cortex why it is important. Now, a very minute example I am giving I am sitting over here, I am not reacting or I am my emotions

are not exaggerated, neither my emotions are not very slow. This is maintained by cerebellum, cerebellum always checks, whether our mind motions are within the normal range.

For example, if I asked you to close an eyes and point this 2 fingers towards each other, see, even after even if I am closing my eyes and I am pointing this fingers to towards each other, initially, there is a bit difference, you know, there will be some difference in pointing the this 2 fingers but finally, you could be able to match this correction within a second is done by cerebellum, how it is done, it is done with the help of the cerebellar circuits.

So, what cerebellar circuits will talk? The cerebellar cortex mainly consists of we are talking about the histology part, 3 layers, this is molecular layer, Purkinje cell layer and the granular layer, the 3 layers very important molecular layer, Purkinje cell layer, granular layer. 3 layers consists of 3 different types of cells. Now, before that, there are 2 types of fibers, which move up to the cortex, I mean, which will take the information to the cortex. So, information is taken up to the cerebellar cortex, there is some processing is done with the help of the circuitry mechanism.

And then a final plan is taken as output with the help of this cerebellar nuclei the deep cerebellar nuclei which I told depends on which function we are talking about whether it is best fastigial, dentate or interpositors. So, if the fibers are coming from inferior olivary nucleus, those fibers are known as climbing fibers, if the fibers are coming from anywhere else except the inferior olivary nucleus, those are known as mossy fibers, any tracks except the oliver cerebellar track, those fibers are mossy fibers and when you should remember which fiber is coming from inferior olivary nucleus, these fibers are known as climbing fibers.

Now, this climbing fibers secretes excitatory neurotransmitter in our CNS that is aspartate and this mossy fiber secretes another excitatory neurotransmitter that is glutamate, in our central nervous system, there are various excitatory neurotransmitters that means, which will excite the system. So, they are aspartate glutamate, then we have inhibitory neurotransmitter there is only one that is GABA, GABA aminobutyric acid, this inhibits the system. So, for time being we should remember climbing fibers secrets aspartate, which are stimulatory and mossy fibers also secrete glutamate which are also stimulatory.

So, mossy fibers when climb, when going up will give a connection to cerebellar nuclei. That means, it will stimulate the cerebellar nuclei. Climbing fibers also while moving up, it will say hi to this cerebellar nuclei that means, it is stimulating then climbing fibers will reach up in the Purkinje cell layer there is a special star type of cell known as Purkinje cell.

This Purkinje cell will be innervated by this climbing fibers, this climbing fibers will stimulate this Purkinje cell. Why it will stimulate? Because it is secreting excitatory neurotransmitter. So, this climbing fiber will stimulate this Purkinje cell and this Purkinje cell is giving axon or the output to this cerebellar nuclei, which is inhibitory.

Now Purkinje cell after getting stimulated, they are sending the signal to the cerebellar nuclei which will be the final output from the cerebellar. So, this is the final output. So, which is inhibitory, because Purkinje cell after being stimulated it secretes GABA. So, this Purkinje cell will inhibit the cerebellar nuclei.

So, see how very nicely it is oriented already climbing fiber while going up it is stimulating the cerebellar nuclei, mossy fibers are stimulating the cerebellar nuclei, but in turn again climbing fibers are going up and stimulating the Purkinje fiber at the same time, which is also inhibiting the cerebellar nuclei, so, that there is no over actions been done by our body system.

So, this is one. Now, coming to this mossy fiber, mossy fibers, they cannot climb very high. So, what they will do, they will climb up to the layer of granular cell, there we have granule cells, it will connect send it dendrites to various granule cells, it will connect with various granule cells make connections and mossy fibers will stimulate the granule cells because it also secretes glutamate. So, it will stimulate the granule cells, this granule cells will go up and create parallel fibers as you can see, these are creating parallel fibers it is bifurcating and while bifurcating, they will stimulate number of Purkinje cells in between.

So, very important thing is climbing fibers is having one to one reaction, one to one attachment with Purkinje cell, one climbing fiber, one Purkinje cell, but here in mossy fibers, this is very clever, they are stimulating number of granule cells and this number of granule cells are getting climbing up and they are bifurcating into parallel fibers and in between they are stimulating number of Purkinje cells, millions of Purkinje cells. So, indirectly one mossy fiber is stimulating

number of Purkinje cells. So, when the Purkinje cells will get stimulated, this granule cells is also excitatory that means it will also secrete glutamate.

So, when this will stimulate the Purkinje cell what will happen, the output will be same that is inhibition of cerebellar nuclei and finally, there will be inhibitory output. Now, in between there is some minor role which is played by Golgi cell, and the stellate cells and the basket cells. Now, this Golgi cells what they will do, they secrete inhibitory neurotransmitter, this mossy cells is going up into the granular layer, this mossy cells will stimulate the Golgi cell, now Golgi cell will in turn inhibit the granular cell, this Golgi cell again inhibits the granule cell. So, what mossy cell is doing? Mossy cell is stimulating granule cell.

On the other hand mossy cell is against stimulating Golgi cell, which is giving inhibitory output to the granule cell. So, that there is any at any level, there is no over reaction or over firing is done, then at the level of stellate cells, and the basket cells, which are present on the molecular layer, these are also inhibitory cells, that means, they secretes inhibitory neurotransmitters, what will happen, this basket cells and stellate cells, they will also inhibit the other Purkinje cells. So, what happens when the central Purkinje cell is acting, so, this basket cells and stellate cells will inhibit or do lateral inhibition of the other Purkinja cells.

So, the central portion is getting activated and the other cells are not getting much activated to make something more prominent, to central portion becomes more prominent, you have to inhibit the lateral portion. So, that is done by the basket cells and stellate cells. So, this internal circuitry mechanism is mainly important for controlling the fine movements of our body with the help of cerebellum.

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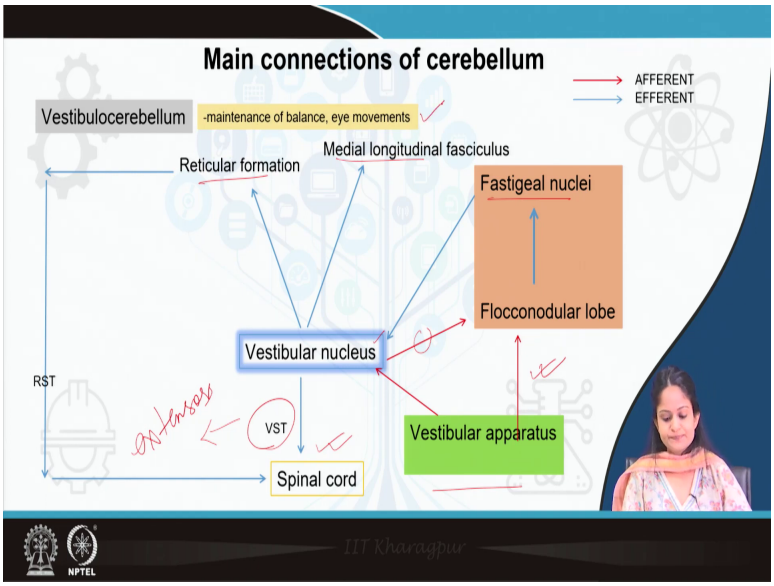

So, having said the internal circuitry of cerebellum, so, now we will see what are the main connections of cerebellum. So, first we will discuss the vestibulocerebellum. So, in vestibulocerebellum, the main afference which we get is from the vestibular apparatus vestibular apparatus, which are present in the cochlea, utricle, saccules and the semicircular canals.

So, this constitute the vestibular apparatus, from vestibular apparatus either directly the afference can move to the cerebellum, mainly the flocculonodular lobe or the flocculus or it can move to the vestibular nucleus and from there to the inferior cerebellar peduncle it can go to the flocculonodular lobe of the cerebellum.

Now, in this flocculonodular lobe of the cerebellum there will be internal circuitry mechanism which had been already discussed, then the output will be through the fastigeal nuclei. The output will be mainly from the fastigeal nuclei to the vestibular nucleus. So, after this vestibular nucleus will give rise to main to efference, up and down. Up it will go to the reticular formation and medial longitudinal fasciculus.

Medial longitudinal fasciculus is mainly playing a role for the eye movements with the help of ocular motor nerve and reticular formation is mainly responsible for the reticular spinal tract and down vestibular nucleus is sending the vestibular spinal tract to the spinal cord for example, if I have to stand, then my standing posture is maintained by the anti-gravity muscles. So, this

vestibular spinal tract usually maintains the extensors or the anti-gravity muscle tone. So, in this way, the vestibulocerebellum maintains the balance, posture and eye movements.

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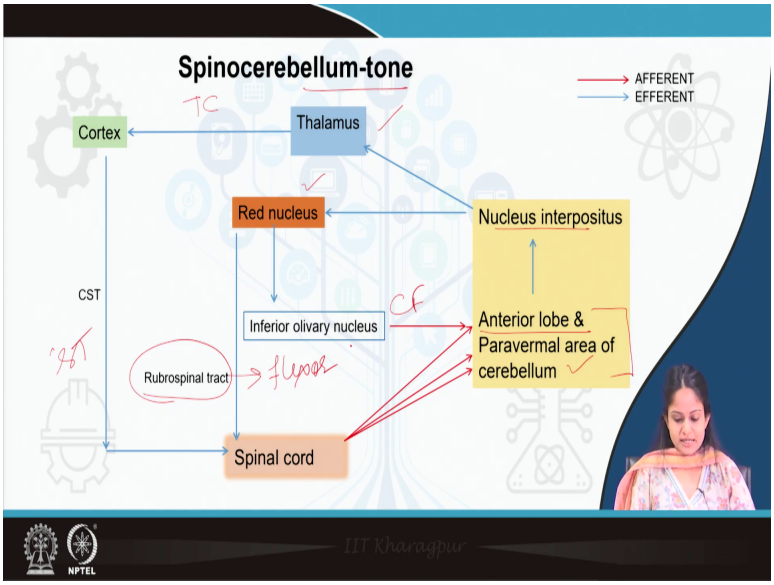

Coming to the spinocerebellum, spinocerebellum mainly maintains the tone. So, how it will maintain the word spinocerebellum means the afferent should come from the spinal cord towards the cerebellum. So, from the spinal cord, we get so many spinocerebellar tracts, like dorso spino cerebellar tracts, ventro spino cerebellar tracts, cuneo spino cerebellar tracts, and also we get inputs from the inferior olivary nucleus with the help of climbing fibers were to the anterior lobe of the cerebellum, which constitutes mainly which is mainly responsible for the tone.

So, this in the anterior lobe of the cerebellum there will be internal circuitry mechanism and the main output will be from the nucleus interpositus, that is globossus and emboliformis, from the nucleus interpositus, the main output will be or the efference will be to the thalamus and red nucleus.

Now from red nucleus it will further reach to spinal cord with the help of Rubrospinal tract from thalamus via thalamocortical fibers it will reach the cortex, from cortex it will reach the spinal cord with the help of corticospinal tract, so this is corticospinal tract. Now, this Rubrospinal tract is mainly responsible for maintaining the tone of the flexor muscles. So, in this way spinocerebellum maintenance the tone.

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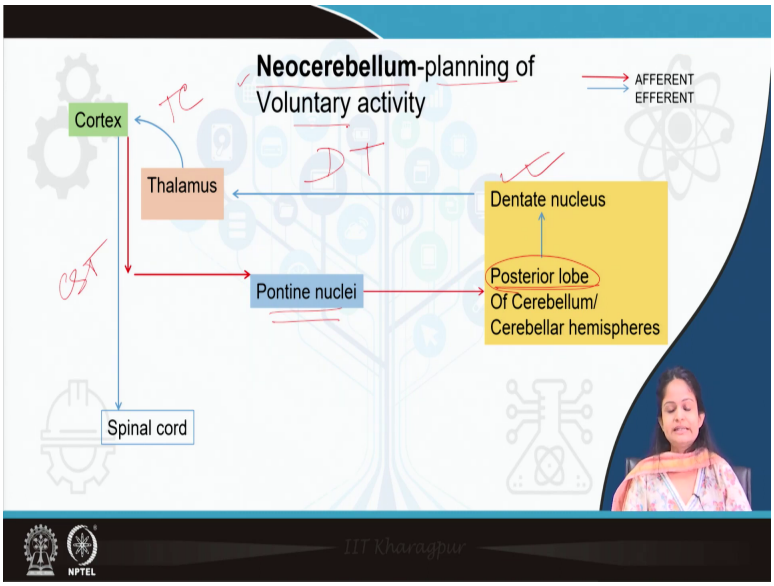

Now next we move on to the neocerebellum. Neocerebellum is mainly responsible for planning and coordination of the voluntary activities. When I talk about neocerebellum, this neo means it should come from the cortex. Now, cortex does not give direct input to the cerebellum, it gives input via pods or pontine nuclei. So, from the pontine nuclei, pontocerebellar tracks, we will move to the posterior cerebral posterior lobe of the cerebellum, which is the main lobe for the voluntary activity and the output will be from the dentate nucleus, the most evolved nucleus.

So, from the dentate nucleus, the main output or the efference will be to the dentato thalamic fibers, this is the denteto thalamic fibers, which will then move to the cortex by the thalamo cortical fibers and from cortex again to the spinal cord, that is cortico spinal tracts. So, in this way, the neocerebellum maintains planning of voluntary activity. So, all these tracks are mainly responsible for the functions of cerebellum to work in a coordinated fashion.

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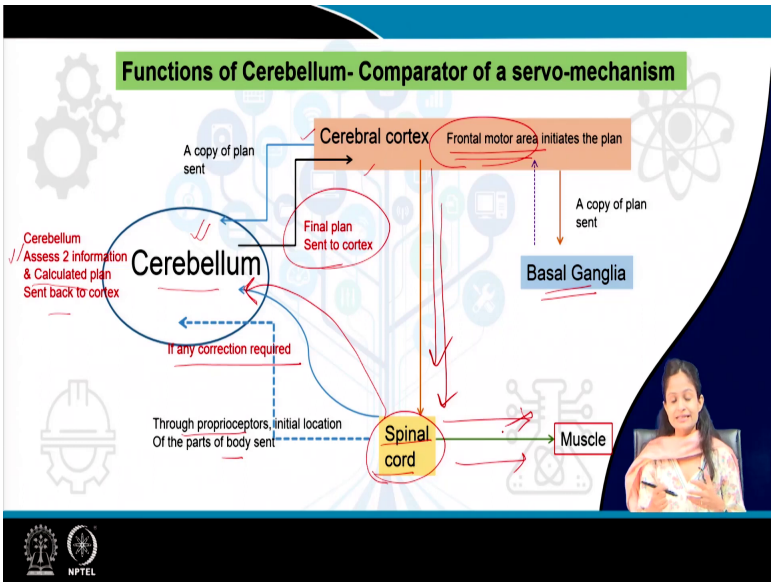

This neocerebellum and spinocerebellum connections are very important for the comparator or servo mechanism for carrying out any voluntary activities, how does voluntary activities is carried out for example, I want to drink a glass of water. So, to drink a glass of water first my idea should come that is the prefrontal area that okay now I have to drink a glass of water. So, suppose glass of water is there. So, what I will do, I will take the hand and I will take my hand and take the glass, I will take the glass towards my mouth and then I will drink.

Now, this seems to be a very voluntary action, but the programming of this action like when how much my arm should move, what is the position of my arm, where the glass is located the calculation the distance between my arm and the glass and where my mouth is located, this programming is all done with the help of cerebellum and basal ganglia in connection with the cerebral cortex.

So, basal what happens whenever an idea is generated in the pre frontal area, that idea idea is sent to the frontal motor area, frontal motor area that I told you already lies in the in the motor executive area. So, this frontal motor area of the cerebral cortex will send a plan copy to basal ganglia now, basal ganglia will have a will concern a will check the plan copy and revert back to the cerebral cortex that will study later, it will also send a plan copy to cerebellum to check it this is the idea this is the plan we are going to do to check it is okay or not.

Now cerebellum will receive a plan copy from cerebral cortex, cerebellum will also receive something from the spinal cord what it will receive. Now if I am giving the idea of drinking water this idea and the plan to the cerebellum, cerebellum should know where my initial position of my hand is, this they will know from the proprioceptors. Proprioceptors means the joints ligaments, tendons, Golgi tendon, organs, these are all the receptors present from which from where it will receive the informations and this cerebral will receive the informations from the spinal cord to check where my initial position is.

Now, it has received the plan from the cortex, it has received the initial position where it is, now it will calculate it will assess the information and calculate the plan and sent back to the cerebral cortex. So, this is the calculated plan you can initiate it. Now cerebral cortex will send this final plan to the spinal cord. Again there is very important, even before the action of spinal cord before spinal cord sets its action towards the muscle.

What will happen, it will send another copy of the plan to the cerebellum. Cerebellum is a very important portion of our body which also anticipates what action will be do. Suppose if I am moving my hand cerebellum will calculate well whether my hand is reaching the proper distance or not. If it is not it will correct instantaneously. So, this plan will also be moved to the cerebellum and if there any correction required again the cerebellum will correct it and it will move to the cerebral cortex and final plan we will be executed from spinal cord to the muscle.

Now, this planning and coordination is all done by the internal circuitry mechanisms with so many cells in the cerebral cortex and with the help of so many connections, input and output connections are in the cerebellum. Now, whenever there is a problem in this coordination, we see many symptoms arising.

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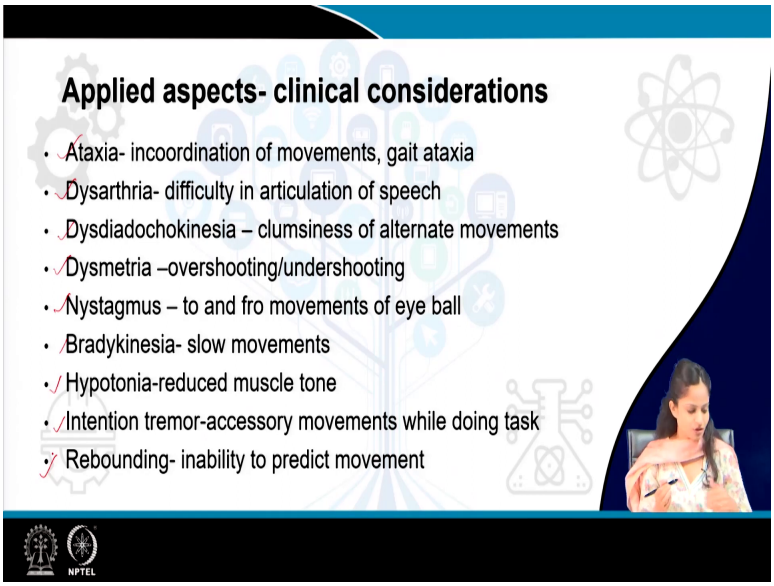

For example, Ataxia, ataxia means incoordination of the movements, gait ataxia, the person is walking in a straight line, he is not able to walk, he will sway either on the right side or the left side because there is no balance and equilibrium. So, these are the defects I am talking about whenever the cerebellum gets destroyed. Dysarthria means difficulty in articulation of the speech. I know what I am supposed to say, but I am not able to speak because of the difficulty in articulation.

Dysdiadochokinesia is the clumsiness of the alternate movements. I cannot do alternate movements, I cannot do supination I cannot do pronation there will be haphazard. Then Dysmetria, Dysmetria is overshooting or undershooting, that means I will not be able to move this 2 fingers together. Nystagmus, since the maintenance of eye movements is maintained by cerebellum. So, there will be to and fro movements of the eyeball. Bradykinesia is slow movements, very slow movements because of the destruction of the cerebellum.

Hypotonia muscle tone is maintained so reduced muscle tone. Intention tremors, whenever the person is trying to do something or perform any task there will be tremors. Why? Because the person does not know what where to reach and what to act because that coordination is not happening because of the destruction of the cerebellum.

So, there will be intention of the tremor intention tremors if you ask the person to tie the shoe, or to ask the person to button the shirt, there will be intention tremors. Then Rebounding inability to predict the movement. If I tell you to step forward, you do not know how much to step forward. So, that has rebounded inability to predict the movement these all occurs because of the defect in the cerebellum as also there is impaired in the learning.

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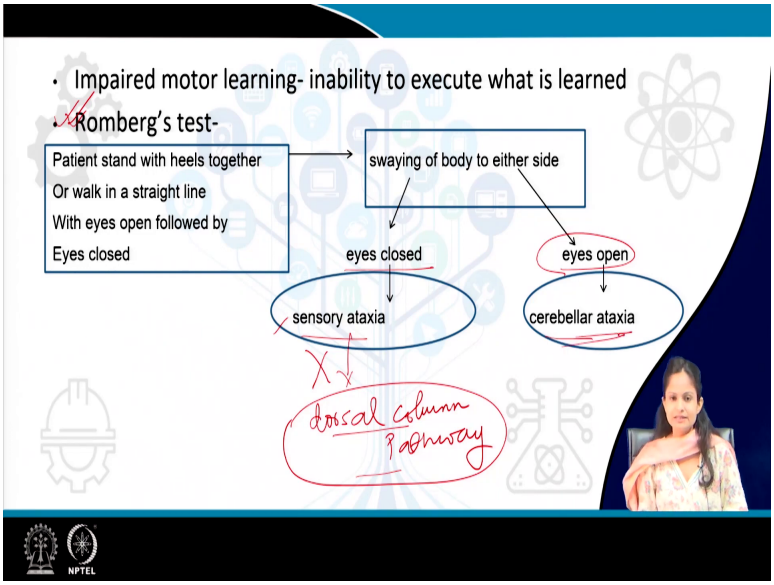

A very important test is done that is Romberg's test, which is very important at the undergraduate level to check whether a person is having cerebellar ataxia or sensory ataxia. Now sensory ataxia is mainly when there is a disruption of the dorsal column pathway. Whenever this tract gets destroyed, and this tract carries sensations like pain, touch discrimination, these are 2 point discrimination, proprioception these are all the senses, general senses, these this pathway carry to the somatosensory cortex area.

So, when this part gets destroyed, there is sensory ataxia and whenever cerebellum gets destroyed, there will be cerebellar ataxia. So, how to differentiate them, between these 2, you will ask the person to walk in a straight line or to stand still by the feet or the heels together, once you will ask the person to open the eyes and stand and second that will be followed by eyes closed that means with eyes open, I will stand straight or I will walk in a straight line, then I will repeat that same with eyes closed.

Now, what will happen if the person is having if the person is swaying either on the right side or the left side that means there is ataxia, if this is happening on the eyes open that means whether eyes are open or closed, if it is happening and the eyes open, that is cerebellar ataxia. If the eyes are closed, then the person is swaying then the person is having difficulty in walking or standing, then that is sensory ataxia.

Now, why, because when the eyes are open, at least that person is getting the visual cues, there is light there is object. So, with that cues, the person knows okay, I have to stand still or I have to walk straight, but when I am closing the eyes, that visual cues are getting obliterated. So, that is sensory ataxia. But even if my eyes are open, then also I am not able to stand straight or I am swaying here and there, then the major equilibrium body that is the cerebellum that is destroyed. So, that results in cerebellar ataxia. This is a very important Romberg test which is done and asked in various examinations.

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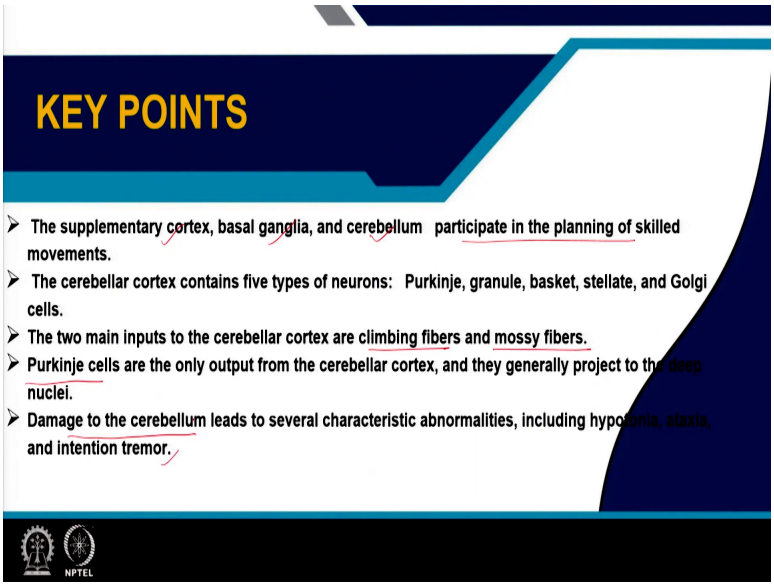

So, the supplementary cortex, basal ganglia, cerebellum, they take part in the planning of the skilled movements. The cerebellar cortex had got 3 layers and various types of cells Purkinje granule basket cells. The 2 major inputs of the cerebellum is via climbing fibers and Mossy fibers. And the major output is via Purkinje cells, which is inhibitory and damage to the cerebellum leads to various abnormalities which I have already discussed mainly hypertonia, ataxia and intention tremors.

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With this I conclude my lecture. Thank you.