Basics of Mental Health & Clinical Psychiatry
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Lecture 10
Reticular Formation

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Good morning everyone. So today we will start our topic Reticular Formation. Now, the concepts will cover location reticular nuclei, the various pathways and the function of reticular formation.

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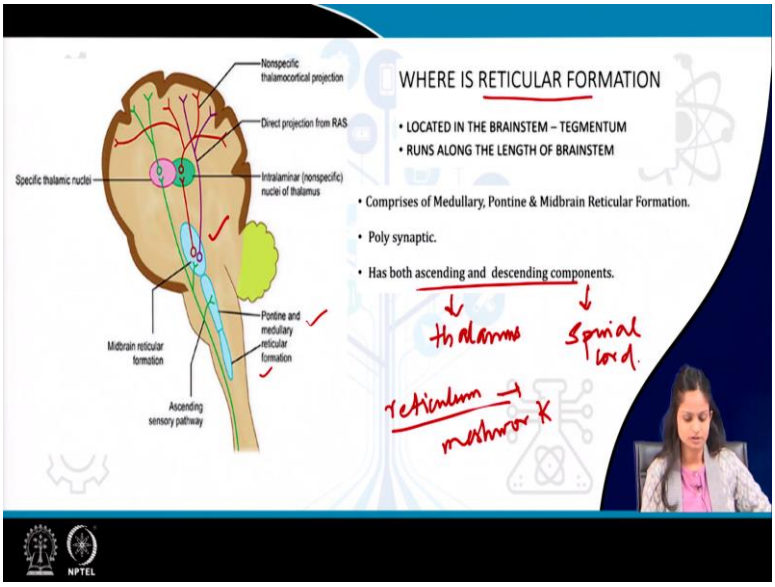

Now, reticular formation comes from the word reticulum. Reticulum means the meshwork it is a meshwork of various nerve cells and fibers. So, reti culum, reticulum means a meshwork. So, there are various nerve cells and fibers which run along the brainstem region we can see over here that it is the reticular formation is located in the brainstem basically.

So, as per the locations we have different components of reticular formations like midbrain reticular formation, pontine and medullary reticular formation, this is a very phylogenetically old system which is poorly developed but it is poly synaptic and it has got various roles in various functions in our body and it has got both ascending and descending components, ascending tracts and descending tracts. Now, ascending components means one it will go up, ascending will rise up to the thalamus while descending it will descend down to the spinal cord. So, this is all about the location of the reticular formation it runs along the length of the brainstem.

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Now, reticular nuclei we have three main group of reticular nuclei, one is the median column then the medial column and lateral column. Median column means it is n it is not the medial it is n median column consists of mainly the raphe nuclei. Raphe nuclei is mainly concerned with the release of serotonin level which has already been discussed in the signups chapter. And it plays a very important role in arousal, attention and analgesic system that was in the plain pathway. So that is a role played by serotonergic pathways from the Raphe nuclei.

Then the medial column consists of magnocellular cells means gigantic, large cells sized cells, which mainly consist of control of the eye movements, then the behavioral reflects brainstem reflects and swallowing mechanisms. And the lateral column consists of the parvocellular cells, which are the small cells. So, the median column consists of the magnocellular cells, which are large sized cells. And lateral column consists of the parvocellular cells, which are small size cells. And this is mainly responsible for the control of respiration blood pressure and visceral functions.

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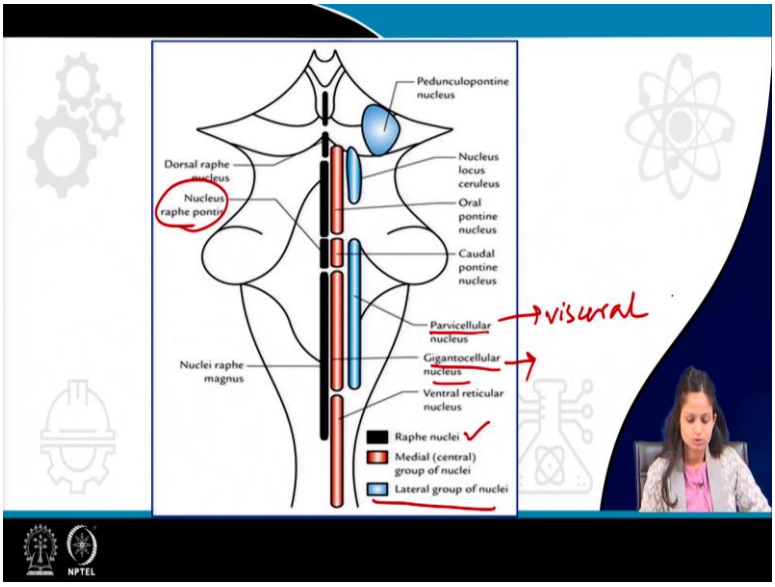

So, this is a pictorial diagram which is shown we can see the three groups of nuclei the black one is the raphe nuclei. This is the raphe nuclei which secretes the serotonin neurotransmitter and mainly responsible for arousal state as well as the analgesic system. The medial group of nuclei, which consists of the magnocellular cells, this is mainly responsible for the eye movements as well as the swallowing reflexes and the lateral group of nuclei, which mainly consists of the parvocellular cell nucleus or the cells that is mainly responsible for the visceral functions. So, these are the three group of nuclei which run along the brainstem.

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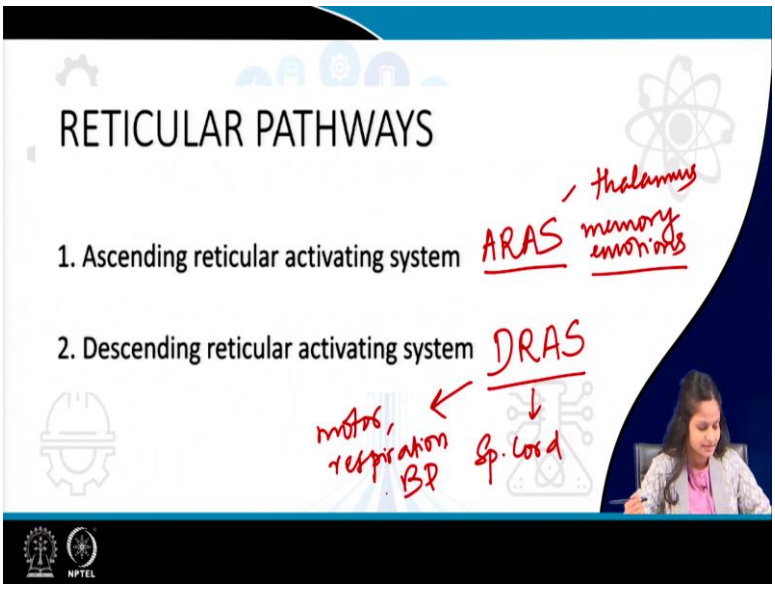

Reticular pathways are two types, Ascending Reticular Activating System pathway, in short, we call it as ARAS, and Descending Reticular Activating System in short, we call it as

DRAS. Ascending reticular system mainly which will ascend up that is to thalamus and descending, it will descend down to the spinal cord.

Now, since this reticular system in ascending reticular activating system, the pathways are moving to the thalamus. So, whatever functions which is involved with memory, learning, emotions are all sensory functions these are all related by ascending reticular activating system, but at the same time descending reticular activating system is mainly controlling the motor functions as we know it is wheeling the pathway to the spinal cord. So, the motor functions and the structures are already present in the medulla that is the respiration center Cardiovascular Center. So, respiration control and our blood pressure regulation. These are all done by the descending reticular activating system.

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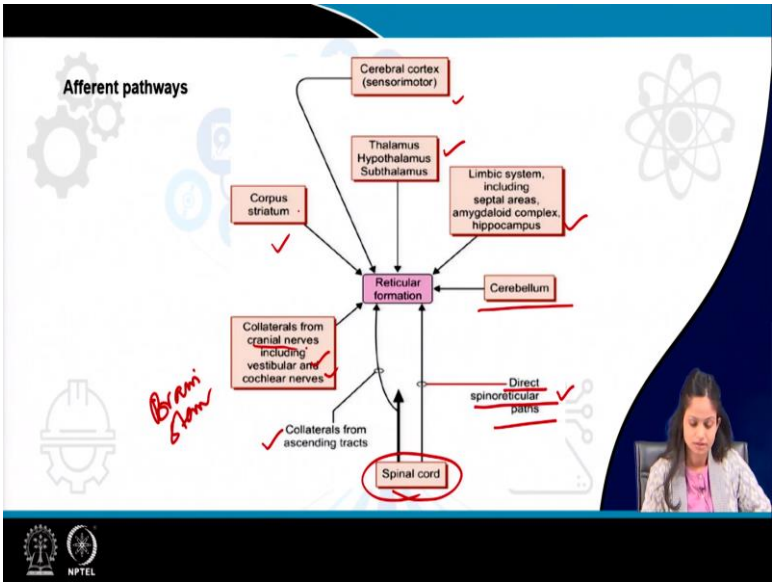

With this we will move on what are the afferent pathways that means, what are the inputs the reticular pathway, so, the reticular formation they receive the first and foremost the afferent reticular formation receives from the spinal cord direct they receive the information from the spinoreticular, since it is coming from spinal cord and ending in the reticular formation to its spinoreticular tract. So, the spinoreticular pathways also receives information from the other collaterals from a sending tracts then it receives information from the brainstem nuclei.

Brainstem nuclei mainly consists of the nuclei of the cranial nerves. So, the collaterals from the cranial nerves including the vestibular and the cochlear nerves reticular formation they received the informations besides the receive information from cerebellum, the limbic system, the tactile reticular fibers they received from the tectum thalamus hypothalamus,

cerebral cortex, sensory motor cortex from every regions of the cortex and corpus striatum. So, these are the afferent received by the reticular formations.

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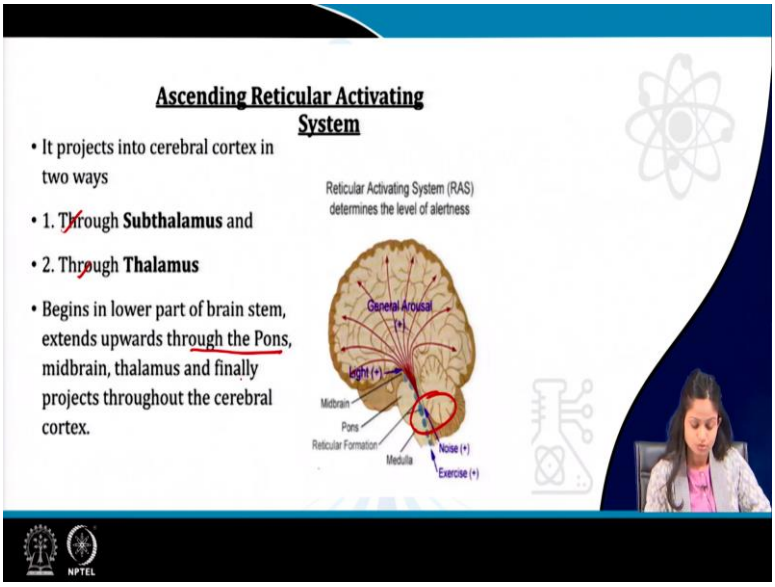

Now, ascending reticular activating system already I told you it projects into the cerebral cortex through subthalamus or thalamus. It begins in the lower part of the brainstem and it extends to the pons then midbrain, then thalamus and finally projects into the throughout the cerebral cortex.

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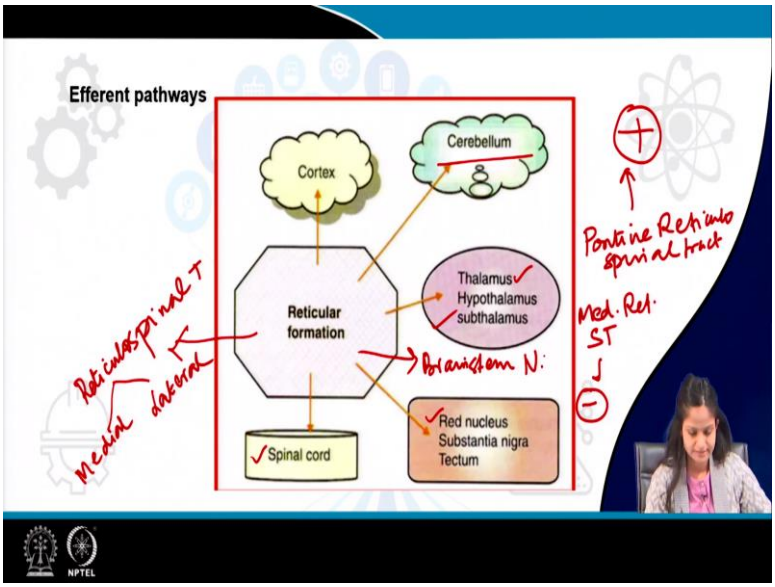

Now, efferent pathways that means till now we have discussed what are the inputs of the reticular formation. Now, we will see what the outputs of the reticular formation. Output of

the reticular formation is mainly, the reticular formation sends output to the spinal cord, it sends its output to the spinal cord in the form of reticular spinal tract. Reticular spinal tract reticular formation and spinal cord so reticular spinal tract. Now, this reticular spinal tract is again divided into medial reticular spinal tract or lateral reticular spinal tract.

Now, this can also be divided into in terms of whether it is coming from pons or whether it is coming from medulla. If the tracts is coming from the pons, so it is pontine reticular spinal tract if it is coming from medulla, then it is medullary reticular spinal tract. Now, what is the main important thing to be remembered is pontine reticular spinal tract is facilitatory in nature and medullary reticular spinal tract is inhibitory in nature it is both the tracts are antagonistic in actions because they provide reciprocal innovations. So, this is the main output of the reticular formation to the spinal cord. And it this helps you maintain the posture and the tone of the body and the muscles.

Further it gives another other output to thalamus, hypothalamus and subthalamus then from there to the cortex, then, it gives information to the cerebellum, then to the red nucleus midbrain, that is substantia nigra and tectum. So, cerebellum, cortex, thalamus, hypothalamus and the spinal cord and also it gives information out to the brainstem nuclei, it receives the information from them. So, obviously they gave out the information also to the brainstem nuclei through cotico reticular bulbar fibers. So, these are the main app efferent pathways.

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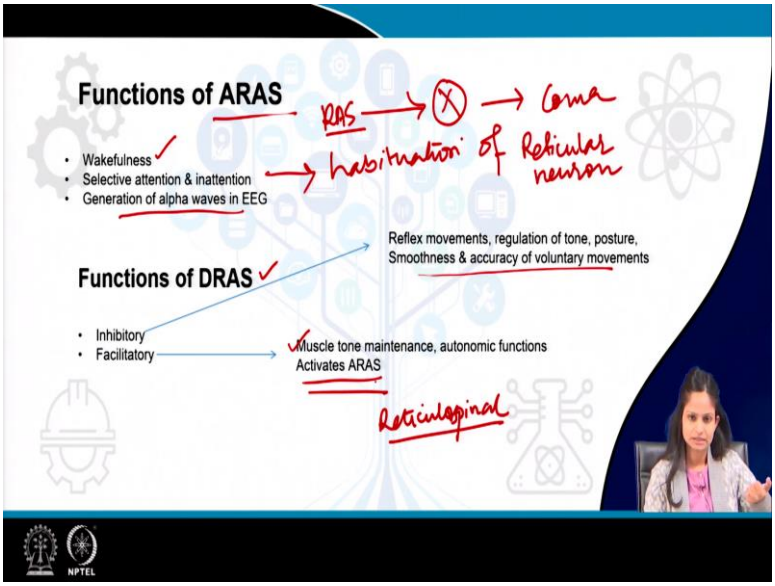

So, coming to the functions of ascending reticular activating system. So, the main functions of a sending reticular activating system is wakefulness. Now, if reticular activating system is

stimulated, or it is active, the person will be awake, if this reticular activating system is inactive or destroyed, the person will go into coma. So, this you have to remember, then there is selective attention and inactive inattention to selective attention and inattention behavior is mainly responsible because of the habituation of reticular neuron.

Now, there are various properties of neurons and synapses, one of the properties is habituation with the help of which either you give attention to a stimulus or you ignore a stimulus. So, selective attention and inattention is mainly because of the habituation of the reticular neuron, then there are a generation of alpha waves in EEG.

Now, two things like how a person is kept awake or how reticular activating system inactivation will induce sleep and how there are generation of alpha waves in electroencephalograph study. This we will discuss in the physiology of sleep as well as in the electrical activity of brain in late further chapters.

Now, what are the functions of descending reticular activating system as I told you descending reticular activating system, it has got mainly two tracts, I mean two important tracts that is the reticular spinal tract for the control of the tone and posture of a body. So, that is again inhibitory as well as faciliatory in nature. So, this we are talking about reticular spinal tract so, reticular spinal tract which is both facilitatory and inhibitory nature.

Now, the inhibitory reticular spinal tract they mainly is important for the reflex movements regulation of tone and posture smoothness and accuracy of voluntary movements. Whereas the facilitatory reticular spinal tract or facilitatory descending reticular activating system they mainly cause maintenance of the muscle tone as well as the autonomic functions autonomic functions is irrespective of the reticular spinal tract, the other reticular, he other difference from the reticular formations and they also activates the ascending reticular activating system.

So, the first one is the functions of ascending reticular activating system is wakefulness, selective attention and inattention generation of the alpha waves and electroencephalography and functions of descending reticular activating system is either inhibitory or facilitatory. Inhibitory will maintain the reflects movements or regulation of tone posture and smoothness and accuracy of the voluntary movements and faciliatory will actually activate the ascending reticular system and maintain the muscle tone and the autonomic functions.

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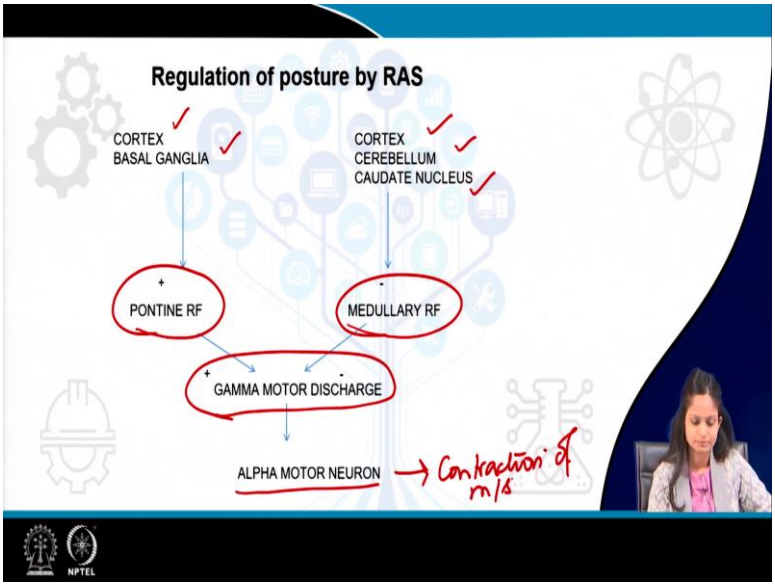

Now, regulation of posture how it is done by reticular activating system as I told you, the pontine reticular fibers and medullary reticular fibers are antagonistic in nature. The pontine reticular fibers are stimulatory. The medullary reticular fibers are inhibitory. The pontine reticular fibers and medullary reticular fibers have the control from higher centers that is cortex and other centers like cortex basal ganglia, they cause respiratory effect on the content reticular fibers, cortex cerebellum, caudate nucleus they cause effect on the day keep a check on the medullary reticular fibers.

Now, pontine reticular fibers and medullary reticular fibers they based on their inhibitory as well as faciliatory actions they will cause action on the gamma motor discharge gamma motor discharge, this is mainly of the they supply the antigravity muscles. So, based on the inhibitory and the facility three role of this pontine and medullary reticular formation gamma motor discharge will act.

For example, if there is a facilitatory gamma motor discharge will occur more inhibitory gamma motor discharge will occur less based on that gamma motor discharge sends signals to the alpha motor neuron and this alpha motor neurons present on the anterior horn cells of spinal cord will finally cause either contraction or relaxation of the muscle. So, in this way, the posture and the tone is maintained by the reticular activating system. In details we will since the sleep physiology and electrical activity of the brain will further study how these are maintained. So, we will talk a bit details about the regulation of tone.

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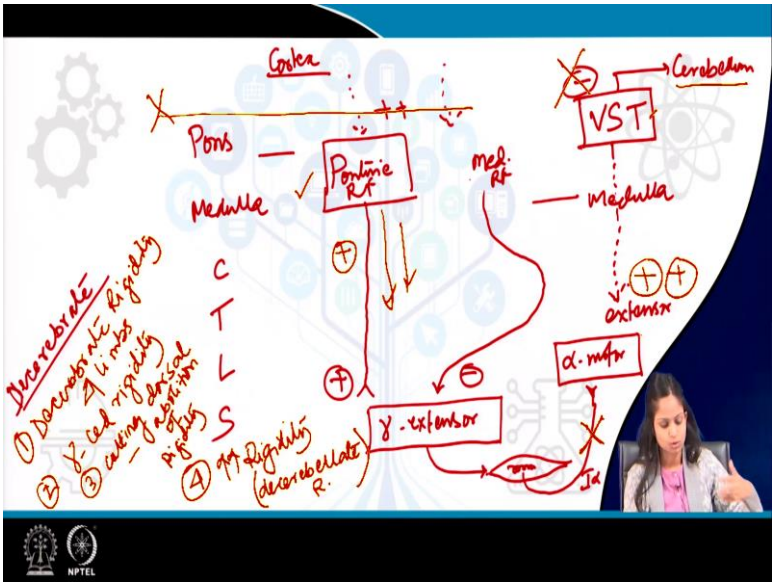

Now, as I told you, there is a pontine reticular fibers and medullary reticular fibers. So, these pontine reticular fibers is coming from the level of pons, this medullary reticular fibers is coming from the level of medulla. Then we have this is medulla then we have cervical, thoracic, lumbar and sacral vertebrae. So, above we have cortex which keeps a check on all of this tract. So, these pontine reticular fibers this will traverse along his course and give innervation to the gamma motor neuron this is gamma motor neuron mainly gamma motor neuron of the extensor.

Now, the for maintenance of the tone and posture of our body, our antigravity muscles are very important, like I am standing if I stand, the tone and the posture of my antigravity muscles are necessary, which will help me to stand otherwise I will fall so, which is maintained by the gamma extensor and the alpha extensors.

So, the alpha extensors is supplied by the pontine reticular fibers, which is I told you stimulatory in action and it is uncrossed fibers it does not cross anywhere and also pontine reticular fibers is already capped at a check by cortex that means, cortex will try to inhibit the spawn time reticular fibers, because pontine reticular fibers is always tonically active.

Tonically active means that always the neurons are firing. So, it is always tonically active the signals are always traversing. So, it has to be in a check or kept check by cortex higher centers. On the other hand, the medullary reticular fibers they travel to other parts of the body that means they are the crossed fibers and they supply the alpha gamma extensors. So, medullary fibers are the uncrossed fibers, which are inhibitory in nature supplying the gamma

extensors and they are not tonically active, it is the pontine reticular fibers which are tonically active.

Now, alpha sorry, gamma extensors, what will it will it usually supplies the muscle spindle, our muscle spindle receptors, the end of the muscle spindles. Now, whenever there will be stretch on the muscle spindles the center of the muscle spindles will get stretched and the information will be carried by one a one alpha neurons to the alpha motor neurons that I told you already alpha motor neurons this alpha motor neurons is again this is all extensor muscles.

So, gamma extensors are stimulated, that will cause stretch of the muscle spindle whenever there will be stretch of the muscle spindle. The alpha motor extensor muscles will also get activated with the help of one a neurons or one alpha neurons and that will cause contraction of the muscles. Now, this alpha motor extensors is again kept a check by with the help of vestibular spinal tract, if you could remember this vestibular spinal tract, this is a tract which is kept under the influence of cerebellum.

Now, what does cerebellum do? Cerebellum, the major output of the cerebellum is inhibitory. So, cerebellum will cause the vestibular spinal tract to remain inhibited. So that there is no unnecessary contraction going on in the extensors. So, cerebellum will inhibit this vestibular spinal tract. So, whenever this vestibular spinal tract will remain inhibited, so there will be less alpha motor extensor activity.

So, this is the normal phenomenon of variety reticular spinal tract or reticular formations by which the tone and posture is maintained in our body. So pontine reticular fibers when they are actually tonically active, but cortex keeps a check on a it after this pontine reticular fibers or medullary reticular fibers, they traverse the our body and ends at the level of spinal cord at the level of gamma extensors gamma extensors either they will stimulate or inhibit.

Now, whenever there will be stimulatory effect there will be stretching of the muscle spindle from the muscle spindle through one alpha activity the alpha motor extensors will get stimulated and there will be contraction of the muscles. Now, what happens there is a condition known as decerebrate rigidity.

Now, decerebrate rigidity now, what happens if I got suppose the experimental it has done if I cut above the level of pons, suppose, I am cutting at the level of pons, so, when I am cutting out the level of pons, the influence of the cortex is gone on the pontine reticular fibers. So,

what will happen the pontine reticular fibers I told you it is always tonically active. So, the inhibition has gone the pontine reticular fibers will constantly fire there will be stimulatory effect.

So, what will happen when it will constantly fire at the same time medullary reticular fiber is also there which is inhibitory nature, but since pontine reticular fibers is tonically active, the dominant action will be of content reticular fibers, so, this gamma extensors will also get active. So, whenever this gamma extensors will get active, this will send signals to the alpha motor neurons and hence alpha motor neurons will also be very much active.

So, what will happen in this case the this is supplying the extensor muscles. So, the all the extensor muscles of our body have the upper limbs and the lower limbs will go into extensor stage the or the it will be rigidity, our muscles will go into rigidity or the extensor compartment or the muscles will go into rigidity.

So, our arms our hands and legs will be all extended. So, if there is a cut or if there is a distraction above the level of pons there occurs decerebrate rigidity in decerebrate rigidity what happens all the four limbs go into extensor rigidity. So, that is known as decerebrate rigidity. So, if I the main most important point is decerebrate rigidity.

So, in decerebrate rigidity what happens there is a rigidity of the four limbs, all the four limbs, both hands and legs. The second point is to be remembered, if the question is asked which fibers are responsible for this obviously, it is pontine pontoreticular fibers, because, of these fibers only tonically active fibers, so, the inhibition is gone. That is why the alpha, the gamma extensors and as well as the alpha motor extensors are active and it is going decerebrate rigidity. So, this is pontine reticular fibers.

The second point is which extensors or which group of neurons it is activating whether it is alpha and gamma, it is mainly because of the gamma. So, this is known as gamma led rigidity, it is not alpha led, it is gamma rigid rigidity because, it is the pontine reticular fibers are not acting on the alpha motor neurons directly it is actually acting on the gamma extensors mainly another important thing is we can see this one alpha fibers are supplying the alpha motor neurons.

So, if I cut this one alpha fibers, so, obviously, the rigidity will vanish because from the gamma extensors the signal is going to one alpha and then it is moving to the alpha motor neurons. So, if I cut this dorsal root or these dorsal nerves which is supplying the alpha motor

neurons, so, obviously the signal there will be interruption in the signals so, that that time alpha motor extensors will get released from its rigidity. So, abolition of rigidity is done by cutting the dorsal root. So, cutting dorsal root will cause decrease or abolishing of rigidity.

And, lastly, as I told you, you this it has got a very important influence of cerebellum. What cerebellum is doing? The cerebellum is actually inhibiting this pathway, the whole pathway by keeping a check on the vestibular spinal tract. Now, if I remove the cerebellum also what will happen? The cerebellum is actually inhibiting this vestibular spinal tract, this inhibition will go now, when this inhibition will go this vestibular spinal tract will become active and it also supplies the alpha motor extensors.

So, this alpha motor extensors will again get activated, more and more activated. So, what will happen the rigidity will increase. So, the last point is on cutting the cerebellum or on removing the cerebellum, we get increased rigidity, the rigidity will continue and it will get increased this is also known as decerebellate rigidity, because we are removing the cerebellum. So, this is all about the regulation of tone and posture by the reticular formation which is very important, how decerebrate rigidity is done when there is a distraction above the level of pons and because of the over activation of the pontine reticular fibers.

So, pontine reticular fibers is facilitatory nature you have to remember, medullar reticular fibers is inhibitory in nature, both supply the gamma extensors, which in return supply the alpha motor extensors and finally maintaining the stone tone of the antigravity muscles. Whenever there will be inhibition whenever there will be removal of the inhibition of the pontine reticular fibers which is actually tonically active, there will be decerebrate rigidity, because of the over activation of this pointe reticular fibers over activation of the gamma extensors giving rise to gamma rigidity.

And whenever if, if we if I want to abolish this rigidity, I have to cut to the dorsal root I have to cut the dorsal root or the dorsal nerves which is supplying the alpha motor extensors. And if I remove the cerebellum, the rigidity will further increase because cerebellum also has a negative influence or inhibitory influence on the vestibular spinal tract.

This vestibular spinal tract also supplies the alpha extensor muscles. So, the vestibular spinal tract will get removed of it of the inhibition of the cerebellum and against stimulate more alpha motor activity and hence more rigidity of our extensor muscles. All the four limbs will

be like this, it would not, you will be not able to flex the limbs it will be so rigid both the upper limbs and the lower limbs.

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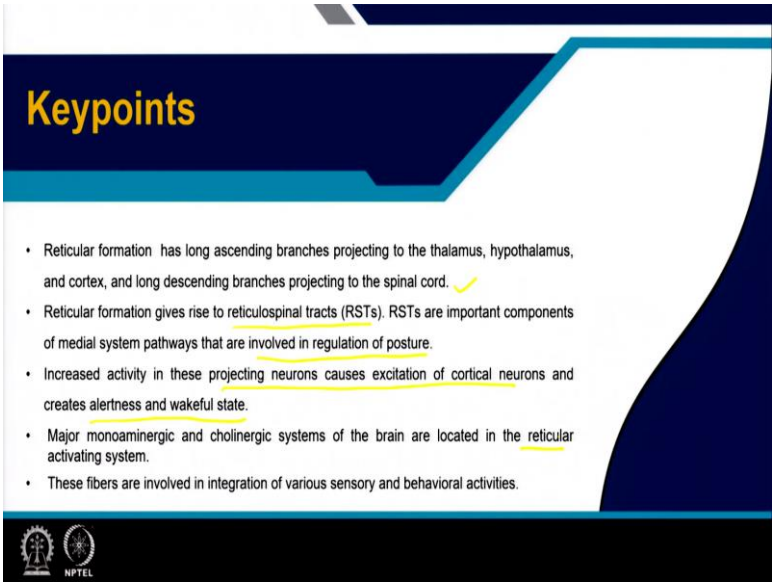

So, this is all about your reticular formation. Reticular formation has got long ascending branches and long descending branches because it has to travel a long path above to the thalamus and hypothalamus level and cortex level and lower to the spinal cord level. Reticular formation gives rise to reticular spinal tract these are very much important components which are involved in the regulation of posture. Increased activity in this projecting neurons cause excitation of the cortical neurons and create alertness and wakeful state.

As I told you, if there is an activation of reticular activating system, the person will go into coma and the various monoaminergic and cholinergic systems of the brain are located in the reticular activating system besides the raphe nucleus which secretes the serotonin which is very important in integration of various sensory and behavioral activities. So, this much you have to remember in reticular formation with this I conclude today's chapter. Thank you.