Introduction to Brain and Behaviour

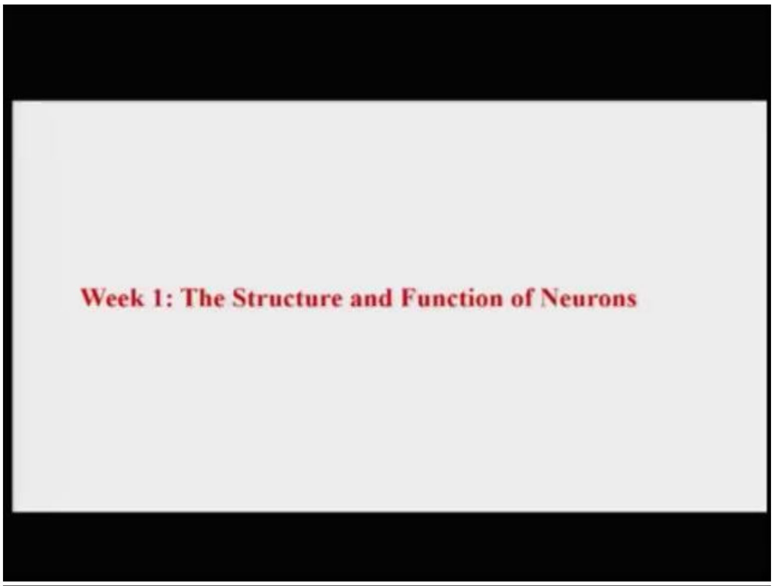
Professor Ark Verma
Department of Humanities and Social Sciences
Indian Institute of Technology, Kanpur

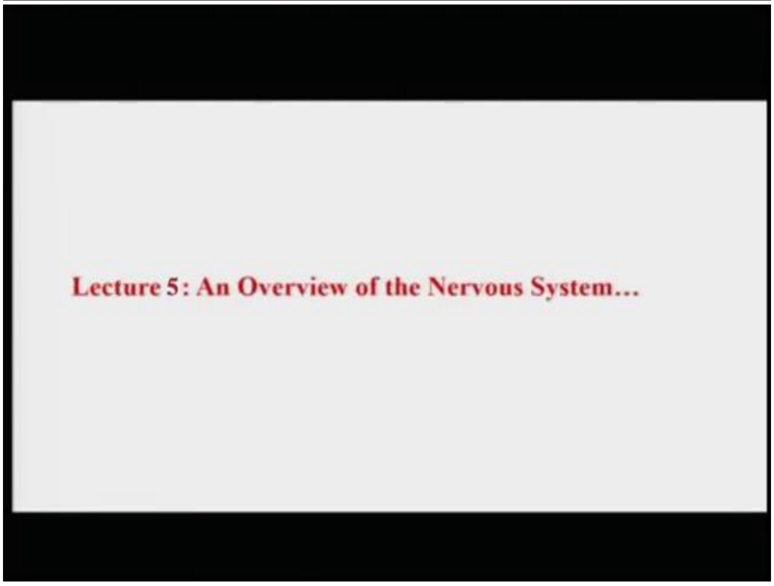
Lecture 05

An Overview of the Nervous System

Hello and welcome to the course introduction to Brain and Behaviour. I am Ark Verma. I am a assistant professor of psychology in the Indian Institute of Technology Kanpur. I work in the department of humanities and social sciences and also the program for cognitive sciences in the institute.

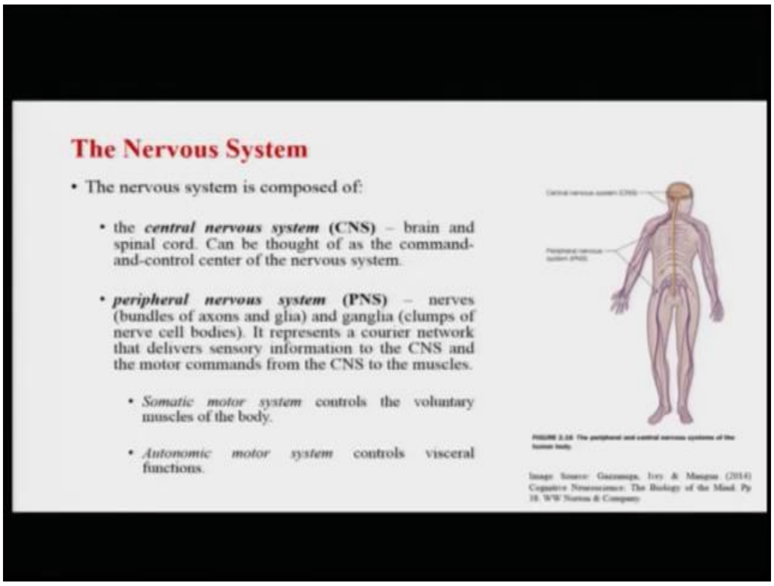
(Refer Slide Time: 00:30)





This is the first week we are talking about the structure as a function of the of neurons and the nervous system broadly. In today's lecture, I will try to give you overview of the nervous system this is actually the fifth lecture.

(Refer Slide Time: 00:42)



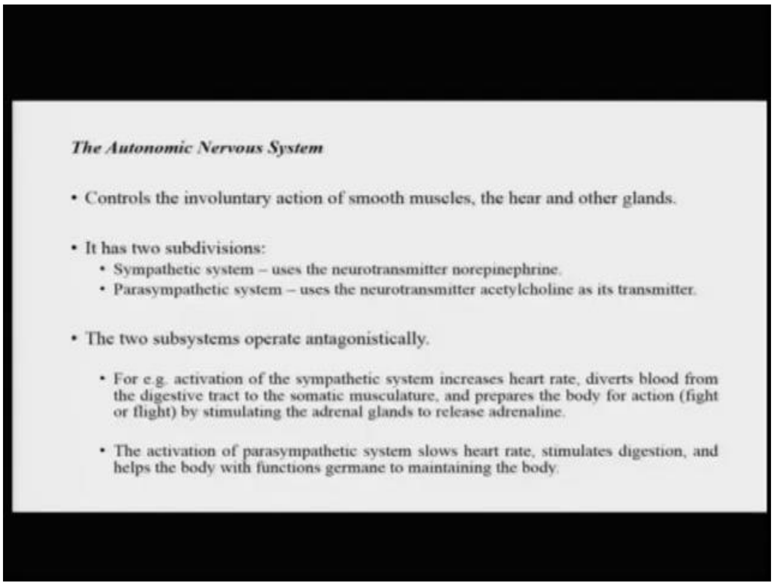
Now, looking at the nervous system, it is primarily can be conceived of in two parts. First is the central nervous system, which basically contains mainly the brain and the spinal cord. You can see that here, so the brain and the spinal cord here, this is basically refer to as the central nervous system. And this central nervous system can you can think of this as the main command and control center of the entire nervous system in some sense of the entire body. So, this is where all the computations that we perform basically take place.

Then you can see that this, the central nervous system has these branching's of which basically extend to other parts of the body the entire body. This system of connections through nerves and ganglia is called the peripheral nervous system, because this basically represents what is called, or what can be called a sort of courier network that delivers sensory information from the central nervous system to other parts of the body, and also the motor commands from the central nervous system to other parts of the body.

Say for example, again going back to the old example, if you are touching something very hot, the brain processes it and it will need to release a motor command for your hand to kind of move itself rubbing on the thing. One way it could be happening through just kind of reflexes, the other way it could be happening through sort of a decision kind of a process.

So, this is a very very important system, it basically makes use of two kinds of nerves. One is the nerves in the somatic motor system, which controls the voluntary muscles of the body, things that you move by choice sort of. And then there is the autonomic motor system which controls whistle functions like sneezing, coughing, breathing, and some of these other things which are autonomous and they do not really require some guy different decision making process to intervene.

(Refer Slide Time: 02:58)



Now, let us go into a little bit more detail into the autonomic nervous system first. Now, the autonomic nervous system basically, it controls the involuntary action of smooth muscles. Say for example, the ones in the heart and the other kind of glands and the autonomic nervous system basically can be seen as divided into two kinds of systems. Yeah, so the autonomic nervous system basically can be seen to have two kinds of subdivisions, one is the part of the sympathetic system.

Now, this sympathetic system, basically what it does is it uses the neurotransmitter norepinephrine, and basically mainly plays a role in preparing the body for, you know, a fight or flight kind of action. It basically operates by increasing the heart rate, diverting the blood from the digestive tract to the somatic musculature, and preparing the body for actions.

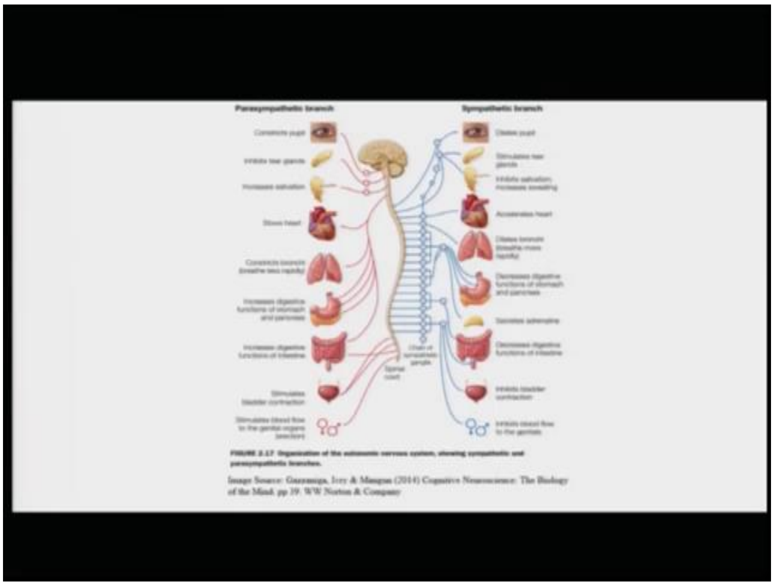
So, it is something that will kind of say for example, if you are in a slightly heightened emotional state, if you are, let us say very angry or very happy or very aroused, or you are preparing yourself for some kind of a you know, competitive physical activity, this is the system that will prepare your body for this kind of a thing.

The other system is the parasympathetic system and the parasympathetic system basically uses the neurotransmitter acetylcholine as its main agent. Now, the parasympathetic system acts almost opposite how the sympathetic system acts. It basically works for cooling the body down, it basically works for bringing the body from an excited state to a slightly calmer state to a slightly more sedate state.

So, what it does, is using the neurotransmitter acetylcholine, it basically tries to slow down your heart rate, it tries to stimulate digestion so that more energy can be sort of, you know generated and it also helps the body, you know, with functions which are germane to maintaining the body.

Say for example, processes of healing. Suppose, you have now you know, you are coming off some very strenuous physical activity like maybe, you know a 5 kilometre run or something like that. So, basically what the parasympathetic nervous system would do, is that it would sort of restore the body to its normal its more relaxed and safe state. So, that is basically the job of the parasympathetic nervous system.

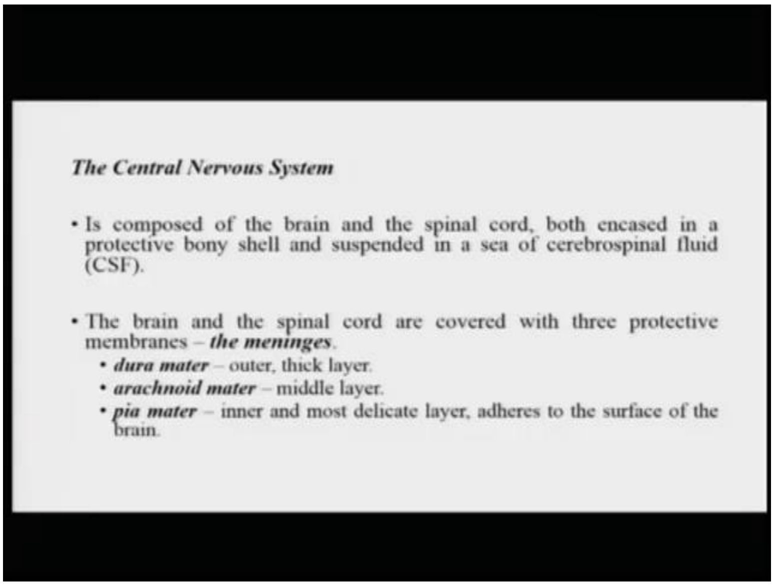
(Refer Slide Time: 05:17)



And this is where you can visualize them, the parasympathetic and the sympathetic branch. Here you can see that how the two kinds of systems act on these different organs, so you can see for example, while the sympathetic branch will dilate the pupils so that more light can enter the eyes and better visibility is achieved. The parasympathetic branch will constitute the pupil restricting the flow of light and sort of leading you towards sedation.

Similarly, the sympathetic nervous system will stimulate the tear glands whereas this parasympathetic system would, you know, inhibit the tear glands and so on. All of these are basically two sort of a set of functions, which work almost like yin and yang for the body. One is typically making the body ready for action and the other is basically restoring the body from tiredness and from harm that might have come across in that heavy exercise or action phase.

(Refer Slide Time: 06:20)

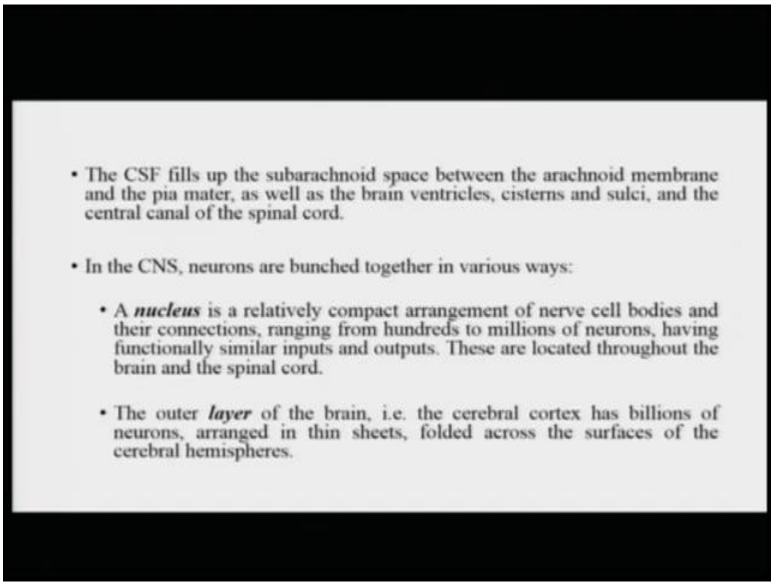


Let us focus our attention now, to the central nervous system. Now, the central nervous system, as I said, is composed of mainly the brain and the spinal cord. And both this organs are encased in a productive bony shell, you know, that the brain is covered in the skull and the spinal cord is also covered in this bony covering, and they are both suspended into in a sea of cerebrospinal fluid which is just, you know, some kind of fluid, which is basically helping the brain to be suspended and to not really, you know, every time we are running.

Say for example, if there were no cerebral spinal fluid, your brain would get injured by just you know, rocking against the walls of the inner walls of the scar, but because of the cerebral spinal fluid that is not there. And it sort of saves the brain from a lot of jerks and head, you know, rapid head movements and so on.

That said, the brain in the spinal cord are covered with three kinds of protective membranes, which are collectively called the meninges. The outer and the thick most layer is called the dura mater. The middle layer is called the arachnoid mater. And the inner most and the most delicate layer is called a pia meter, which basically is something that is adhering to the surface of the brain.

(Refer Slide Time: 07:44)



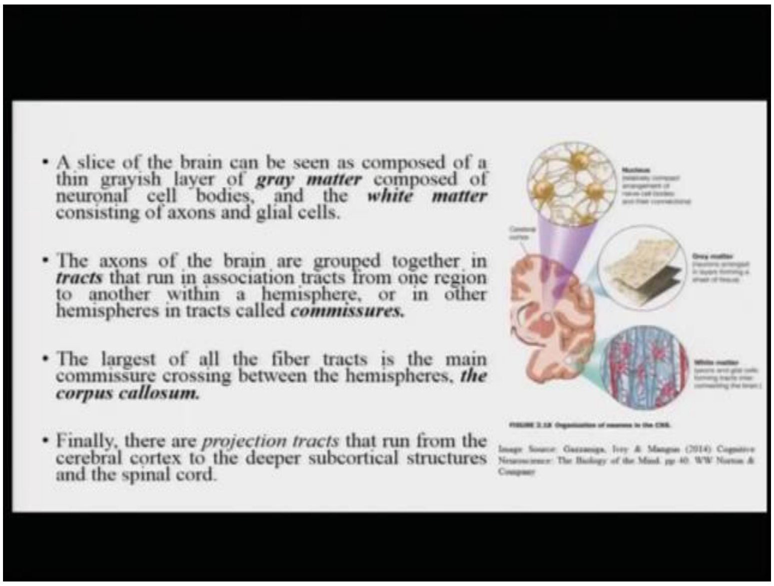
Now, this cerebral spinal fluid that I was talking about, it basically fills up the subarachnoid space, which mean the arachnoid membrane between the second layer and the last layer, which is your pia meter. As well as it is fill in the brain ventricle, cisterns and sulci, which are the gaps in the brain we will see that in more detail moving further and also it is filled up in the central canal where the spinal cord is housed. So, this is said.

Now, in this central nervous system neurons are bunched together or can be organized in various kind of ways, one of the ways is via nuclei. So, a nucleus is basically it can be said to be a relatively compact arrangement of nerve cell bodies and their connections, ranging from very few, just hundreds of neurons to millions of neurons at once, having basically functionally similar kind of inputs and similar kinds of outputs, they are looking at it throughout the brain and the spinal cord.

Now, the outer layer of the brain, basically so the outer part so one of the ways is being ranged into nucleus, the other is being ranged into in the form of a layer. So, this outer layer of the neurons is basically what forms your cerebral cortex, which contains billions and billions of neurons, and they are arranged in thin sheets, laterally and they are folded across the cerebral hemispheres.

You will see that the when we talk about such (())(09:11) we will see, there are these processes, there are these structures called the sulci and gyri, which is basically just sheets of these neuronal arrangements which are folded in forms of just like say for example, some kind of fondant icing on the cake.

(Refer Slide Time: 09:25)



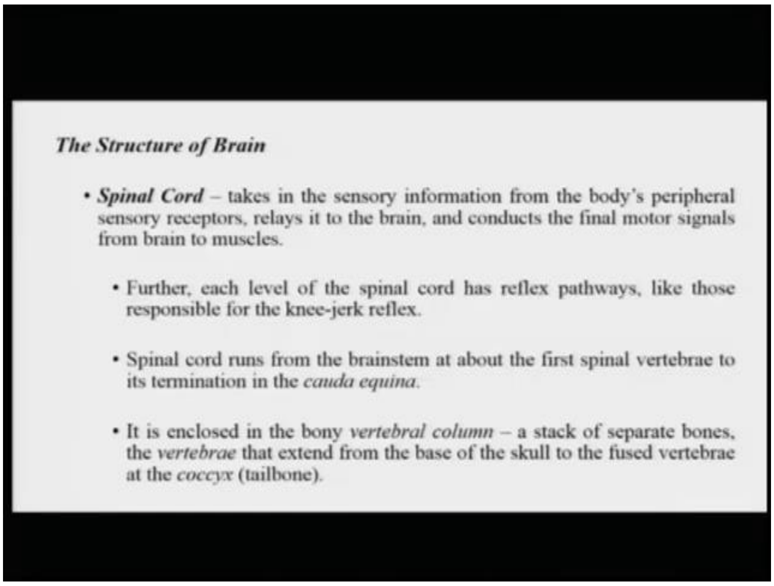
Now, if you take, you know slice of the brain, if you just cut it across the way it is been demonstrated here, you will see that the brain is composed of two kinds of matter or two kinds of matter are visible. First is the grey matter, the grey matter is composed of the cell bodies of neurons. And then there is this white matter, which is composed of axons and glial cells. So, axons is where basically, the communication is happening whereas the cell bodies are in the slightly upper grey matter portion.

The axons of the neurons in the brain are grouped together to form tracks that run in association from one region to another, sometimes within a hemisphere and sometimes they cross the hemisphere and move towards the other hemisphere through what are called commissures, we will see all of these things in a lot of detail going further.

Now, the largest of these fiber tracts that you can see basically connects the two hemispheres together. So, this is the right hemisphere and left hemisphere, there are these bunch of fibers that are connecting the two hemisphere, this is basically through a lot of these axon fiber tracts and this structure is called the corpus callosum, so basically callosum fibers.

Finally, and there are these projection tracts that run from the cerebral cortex to deeper subcortical structures and in the spinal cord. So, these projection tracts from the axons can actually learn run deeper into the brain and also they can kind of extend themselves through the spinal cord. And we have talked about the central nerves system and we have sort of begun talking about it, there are two major parts in this central nervous system, we will talk about the brain. But before we get to the brain, we can talk a little bit about the spinal cord as well.

(Refer Slide Time: 11:10)



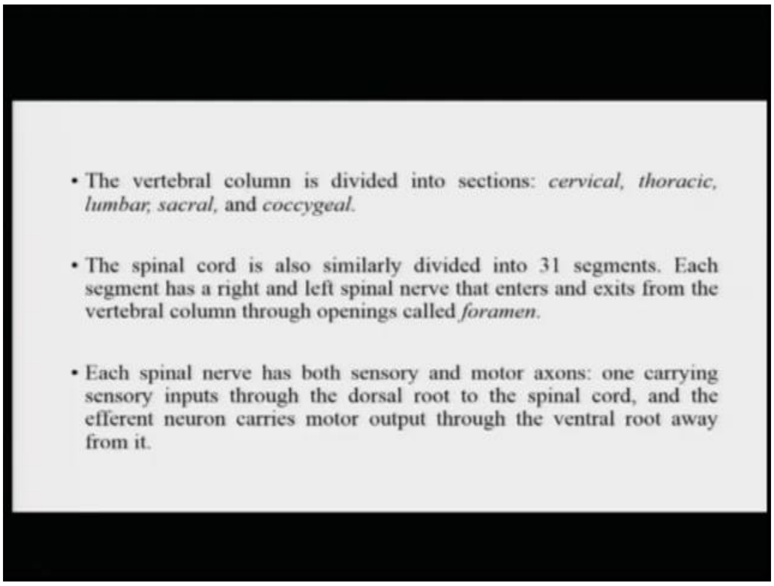
Now, the spinal cord is that cord that extends from the brainstem down towards the tailbone. It basically the main task is that it takes the sensory information from the body's peripheral sensor receptors, so your arms and limbs, and it basically relays it to the brain, so from here to the spinal cord to upwards in the brain, and it basically also does a very important job of connecting the final motor signals from the brain to the muscles.

So, so, for example, if the brain signals that you have to pick up this glass, this signal probably originated in the brain through the brainstem went to the spinal cord and then reach these efferent nerves so that I could just lift this glass. Further, each level of the spinal cord has these different kinds of pathways, which are also referred to as the reflex pathways.

Now, these reflex pathways as I was mentioning earlier, reflex pathways are very rapid, quick pathways that are responsible for involuntary but rapid actions. Say for example, the knee jerk reflex, if you are tapping somebody on the knee with the hammer, and if you hit the right spot, the person will create what is called a knee jerk response, which is basically in response to being hit at the right spot and the leg will flex in a further direction very quickly, so this is basically referred to as the knee jerk reflex.

The spinal cord basically runs from the brain stem from at about the first spinal vertebrae at the top, and it terminates at the lower structure called the cauda equina and it is enclosed in this bony vertebral column. Bony vertebral column, which is basically a stack of separate bones that are just their whole job is to protect this spinal cord, which extend from the base of the skull to the tailbone or the coccyx.

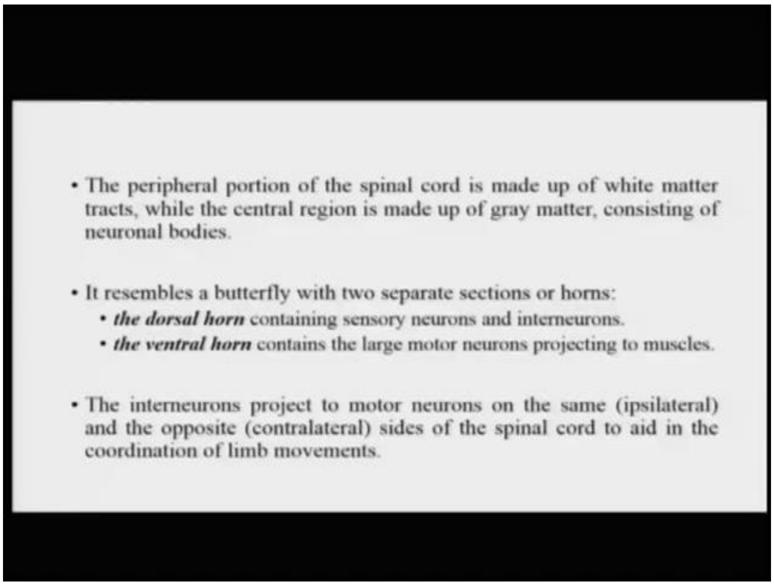
(Refer Slide Time: 13:07)



This vertical vertebral column can be divided into sections such as the cervical, thoracic lumbar, sacral, coccygeal and this is basically also the spinal cord is divided into 31 segment, each segment has a right and the left spinal nerve that enters and exits the vertebral column through openings called foramen. So, basically the spinal cord is receiving these inputs from both the left and the right part of the body and these nerves are entering the vertebral column through these openings called the foramen.

Each spinal nerve has both sensory and motor axons. Sensory inputs are basically carried through the dorsal route to the spinal cord. And the efferent neuron carries the motor output through the ventral root away from the spinal cord. So, the action part basically is through these motor axons, which are connecting which are basically going from the spinal cord to the efferent nerves. And the sensory part is basically from these peripheral nerves and converging towards the spinal cord, so that the signal can be communicated to the brain and upwards.

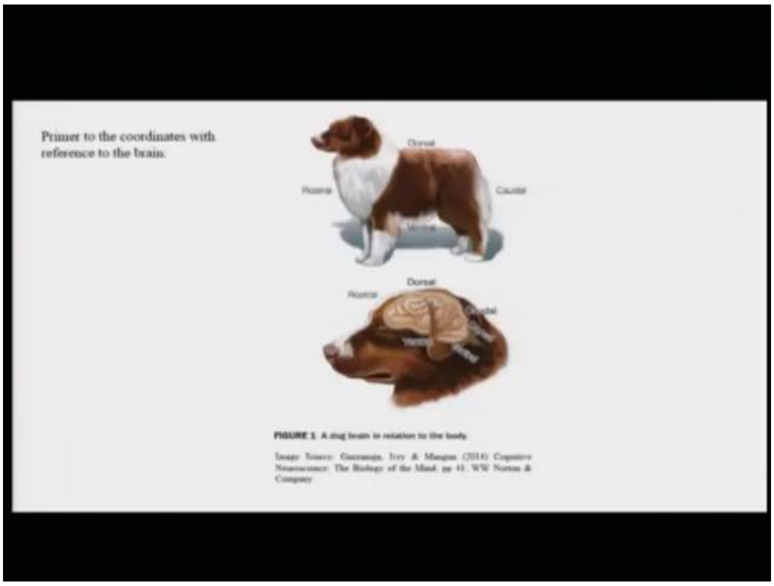
(Refer Slide Time: 14:19)



Now, the peripheral portion, the back portion, of the spinal cord is made up of white matter tracts, axons. While the central region is made up of grey matter consisting of neuronal bodies. So, we were talking about, how the spinal cord and how this entire system is created? It resembles, structure resembling, a butterfly with two separate sections. One is called a dorsal horn and the one is called the ventral horn. The dorsal horn contains sensory neurons and interneurons, whereas the ventral horn contains large motor neurons projecting to muscles.

The interneurons basically, they project to motor neurons on the same side and also on the opposite side of the spinal cord to aid in the coordination of limb movements. And we go further, we are talking more about the motor functions and so on we discover that the left side of the body is controlled by the right part of the brain, the right side of the body is controlled by the left part of the brain and basically this is achieved through these interneurons which are projecting both towards the ipsilateral and the contralateral side from the spinal cord, basically controlling the movements.

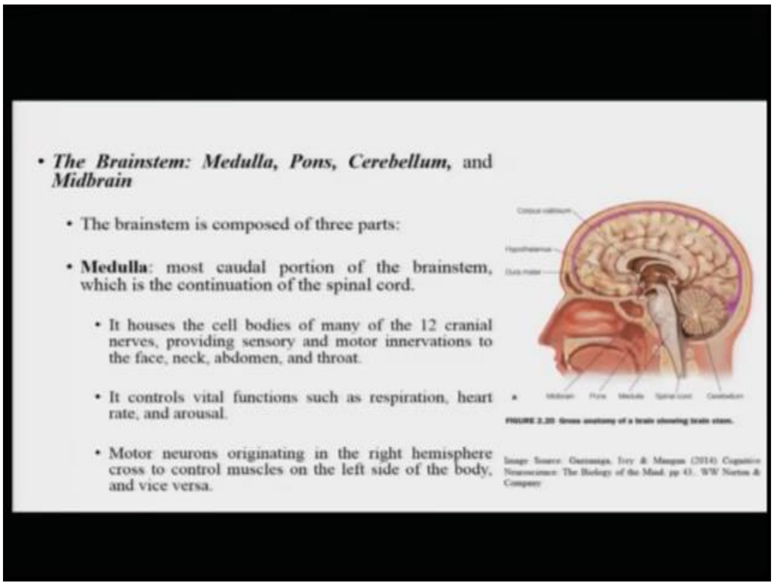
(Refer Slide Time: 15:23)



Now, before I move further, this is a very good demonstration from Gazania’s book, wherein we can talk about some kind of geospatial coordinates of the brain. Whenever I am talking about dorsal I basically means the top portion of the brain, this is the dorsal portion let us say of the dog's body. Caudal basically means the posterior portion here at the back, rostral means the front bottom portion and ventral means the lower portion, so dorsal, ventral, rostral and caudal.

So, this is something that will basically help you to sort of locate when I am talking about these specific areas of the brain and when I am mentioning these terms like dorsal, prefrontal cortex or ventral prefrontal cortex and so on. So, just sort of remember this you can come back to this slide again and again, whenever there is a confusion in terms of which locations I have been talking about.

(Refer Slide Time: 16:20)

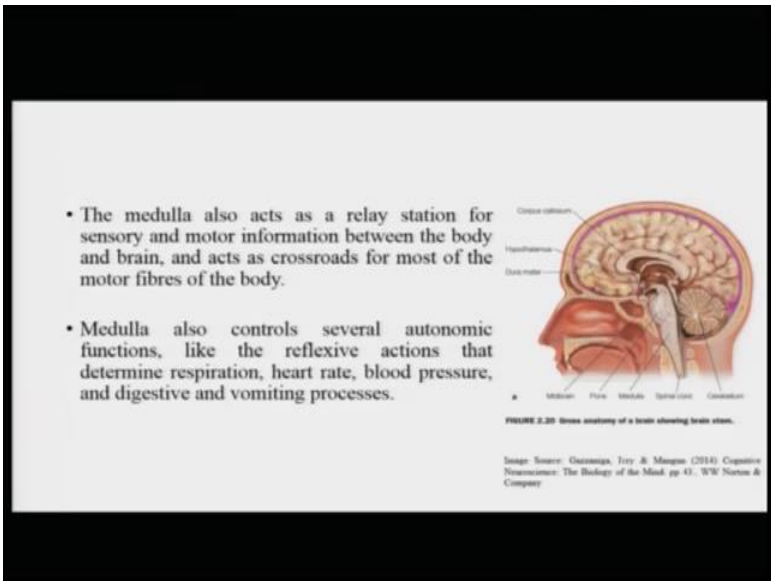


Now, let us move further. Let us from the spinal cord, let us enter to the brainstem, you can see here that this is the spinal cord then this structure here up till here actually is basically referred to as the brainstem. And the brainstem basically consists of three main parts, basically the medulla, the pons, and the cerebellum, we will we will talk about these three areas in in some detail.

Now, the medulla is the most chordal portion, you can see it is the chordal any backwards portion of the brain stem, which is sort of a continuation of the spinal cord itself. Now, it basically houses the cell bodies of many of the 12 cranial nerves, the nerves in the skull. They are providing sensory and motor innervations to the face, neck, abdomen, and the throat.

So, this is a very, very important region, as regards the movement of the face, neck, abdomen and the throat. Also, the medulla controls vital functions such as respiration, heart rate, and physiological arousal. Now, the motor neurons that originate in the right hemisphere cross, basically to control muscles on the left side of the body, and the motor neurons that originated in the left hemisphere cross, basically at this point to control the muscles on the right side of the body as I was just mentioning.

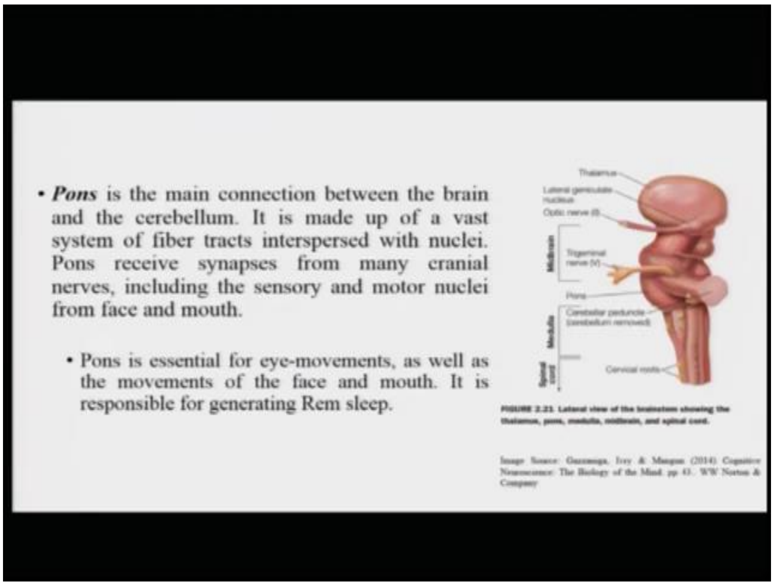
(Refer Slide Time: 17:49)



The medulla also acts as a relay station for all kinds of sensory and motor information between the body and the brain. So, here we are talking about all these sensations coming from different parts of the body to the spinal cord, aggregating at the top of the brainstem in the medulla, and then from the medulla being communicated to different parts of the brain, and then the signal will come back also and will basically be dissipated in the same manner.

So, in that sense the medulla acts as crossroads for most of the motor fibers of the body. Also, the medulla controls several autonomic functions, involuntary functions, such as the reflexive actions that determine respiration, heart rate, blood pressure, digestive and vomiting processes, coughing, sneezing, those kind of things.

(Refer Slide Time: 18:41)

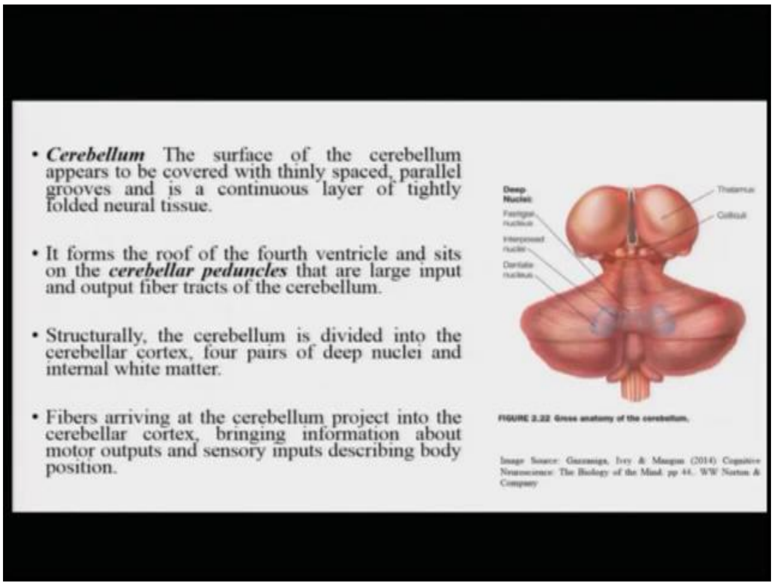


Now, the other important structure in this brainstem is this structure called Pons. You can see it here this is where the pons are located. The pons basically is the main connection between the brain and the cerebellum, so we will talk about this cerebellum at the back but between the brain and the cerebellum. And it is basically made up of a system of mass system of fiber tracts, which are interspersed with these specific nuclei, when I was talking about nuclei is this bundle of, you know cell bodies coming out, you know, couple slides ago.

Now, these pons basically they receive synapses from many cranial nerves in the skull region, including the sensory and the motor nuclei from face and mouth. So, this is also a region, which is very very important for facial movement. Now, pons are also essential for eye movements, as well as the movements of the face one as was just saying.

And basically it is also supposed to be responsible for generation of rapid eye movement, sleep, if you remember, sleep has to two kinds of cycles, non-rapid eye movement, non-REM sleep and REM sleep. We will talk about this maybe at a later point.

(Refer Slide Time: 19:53)

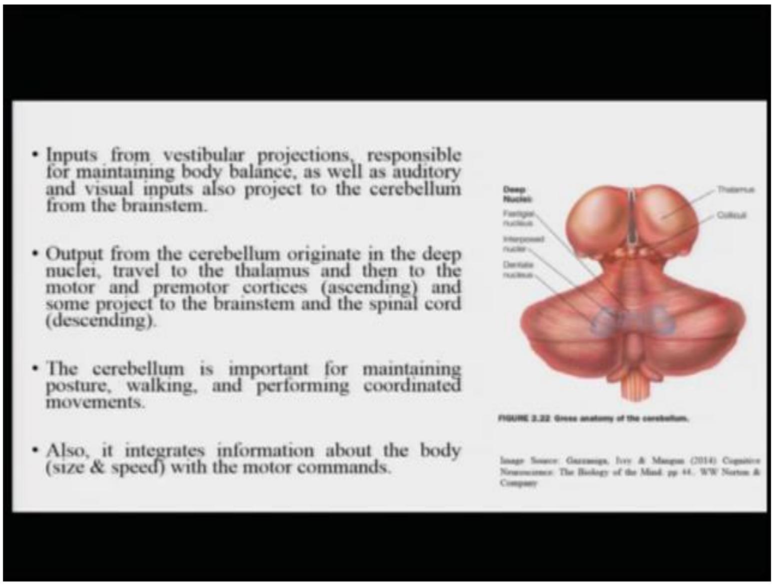


Now, the final thing that we can talk about or one of the other things that we can talk about is the cerebellum. The cerebellum is this surface is at the back of the brain, it is also called a smaller brain, you know, colloquial sense. The surface of the cerebellum appears basically to be constructed of these thinly spaced parallel grooves, which basically form a very continuous layer of tightly folded neural tissue. So, you can see that this is basically tightly folded, you know, layers of tissue that you can see here.

It basically forms the roof of the fourth ventricle and sits on what are called the cerebral preduncles that are large and basically have large input and output fiber tracts in the cerebellum. What I will do also, is as it was mentioned in the last lecture, I will put some anatomy videos in the in the links when these lectures are uploaded, and you can kind of go through these anatomical videos, and where you will actually see these areas visualized in a more animated form, so that they make a little bit more sense to you then these 2d pictures.

Now, structurally the cerebellum is divided into the cerebral cortex, and four pairs of deep nuclei and also internal white matter. Now, fibers basically arriving at the cerebellum basically project into the cerebral cortex, bringing in information about the motor output and sensory inputs. And we sort of also described body position, say for example, orientation of the body is the size of the body, the movement of the movement of the body and so on.

(Refer Slide Time: 21:34)

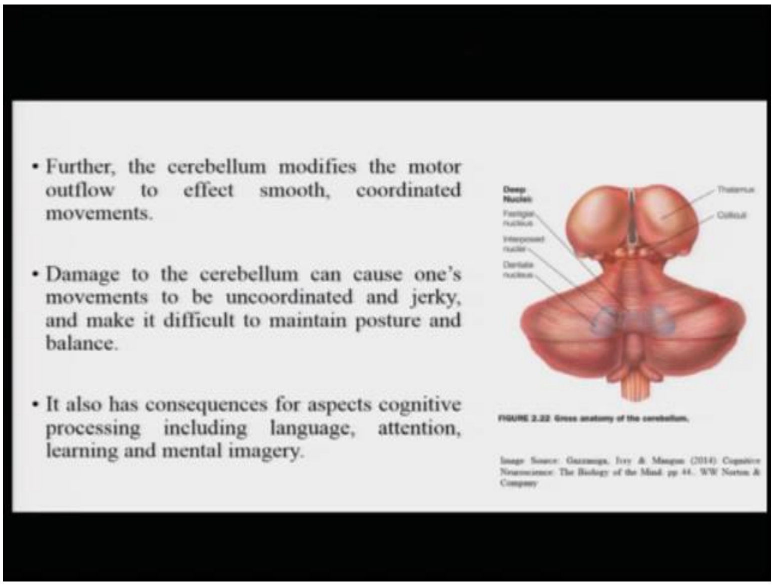


The inputs from the vestibular projections there, which are responsible for maintaining body balance, as well as auditory and visual inputs also project to the cerebellum, from the brainstem. Also, output from the cerebellum, basically outputs from the cerebellum originate in these deep nuclei which you can see in the finger here. And basically, then they move from these nuclei to the motor and premotor cortices, in case of ascending going upwards. And some of them which come down to the brainstem and the spinal cord which are descending projections.

The cerebellum is very, very important for maintaining posture for walking and for performing coordinated movements. Say for example, tapping the piano or say for example playing you know an instrument like the tabla or something like that, so these are fine movements writing all of these are grossly controlled and handled by the cerebellum.

Also an important contribution of the cerebellum is that it integrates information about the body, you know size and speed and orientation and so on with the motor command. Say for example, if I throw a ball towards and you have to catch it, basically the movement will be based partly on the on the inputs that are received at the cerebellum, which sort of will keep informed you about your current body position and how it has to be changed in order to you know, accomplish a particular task.

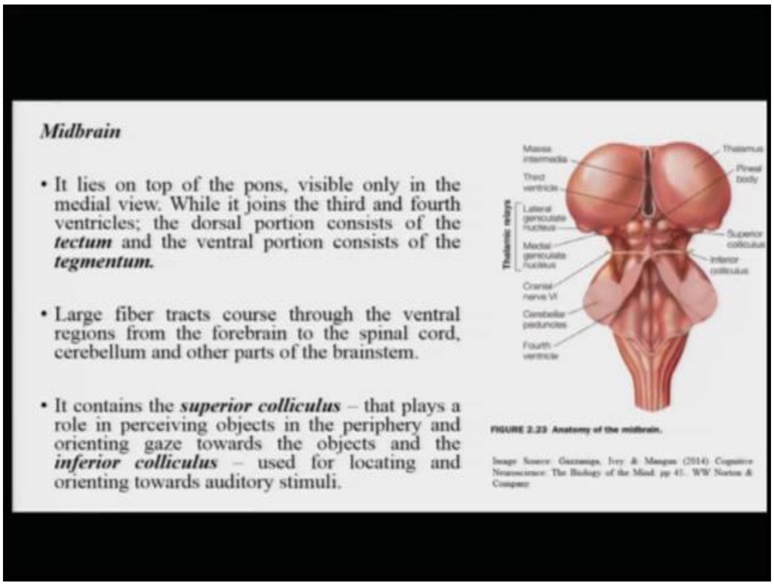
(Refer Slide Time: 23:03)



Further, the cerebellum modifies the motor outflow to effect smooth coordinated movements, the ones that I have been talking about. And if the cerebellum is damaged, basically it can lead to severe consequences as far as motor actions or movements are concerned, your moments would become uncoordinated, there will be no smoothness in them and they will become jerky and it will also become very difficult to maintain posture and balance and walk straight and to maintain an upright posture and so on.

People symptoms might resemble the people who have disease called Parkinson's disease who have, you know, jerky and uncoordinated movements. Now also, the damage to cerebellum can have significant consequences, for other kinds of cognitive processes like language, attention, learning, and mental imagery. So, this is this is more about the cerebellum that I wanted to say.

(Refer Slide Time: 23:59)

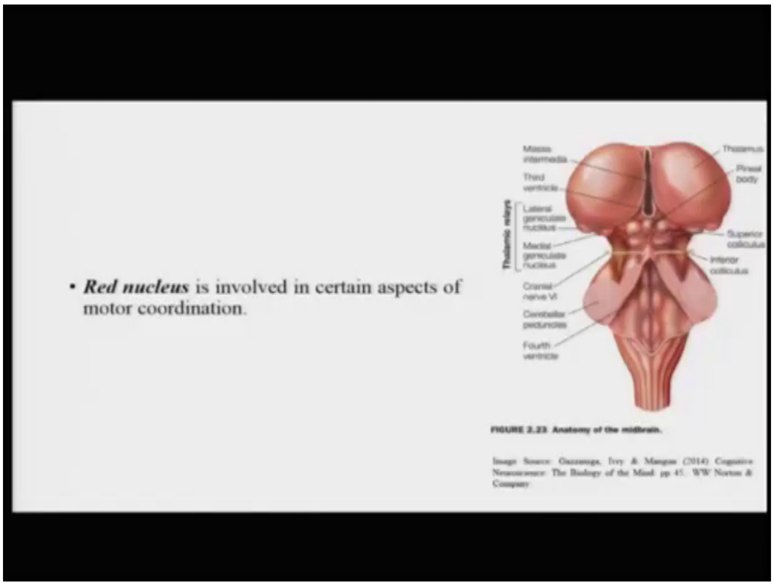


We can talk we can move further into the midbrain, this is how the midbrain sort of looks. The midbrain basically is resting on top of the pons, this is the inside this is the inside of the brainstem. It joins the third and the fourth ventricle. The dorsal portion, the top portion is basically referred to as the tectum as the bottom portion is referred to as the tegmentum. I do not really have to, you know, exactly remember each and every of these things, but just sort of remember when some of these things will be referred to in later chapters.

Now, large fiber tracts basically goes through the ventral regions from the forebrain, from front of the brain to the spinal cord, cerebellum and other parts of the brainstem. So, this is basically sort of a realization of that kind of thing. And it basically contains two kinds of two sets of nuclei, you can see here at the top there are these two nuclei called the superior colliculus and then there are these two just at the bottom of bottom which are called inferior colliculus.

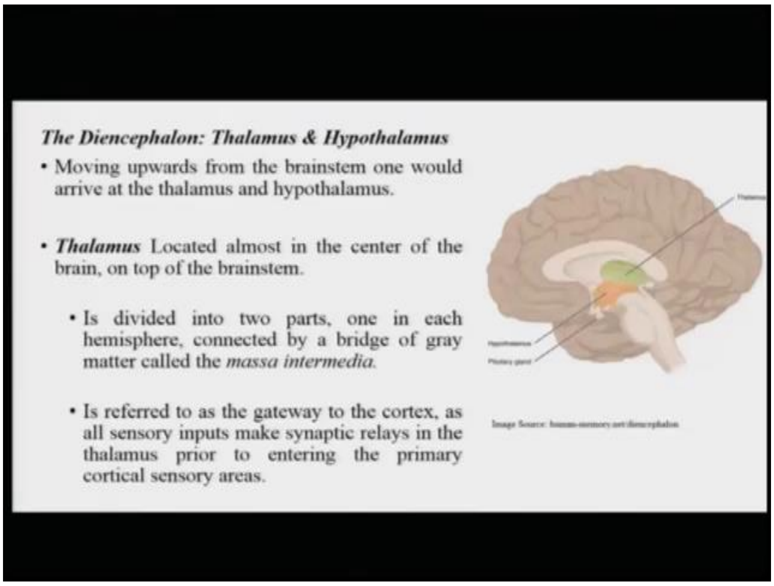
So, the superior colliculus basically play a role in perceiving objects in the periphery somewhere if something is situated in my peripheral vein and it basically helps me orient my gates towards that object. And then there is this inferior colliculi, which basically used for orienting towards auditory, suppose I am talking to you, and somebody at the back somewhere, calls my name, the inferior colliculus will help me orient my hearing towards that particular source of sound.

(Refer Slide Time: 25:37)



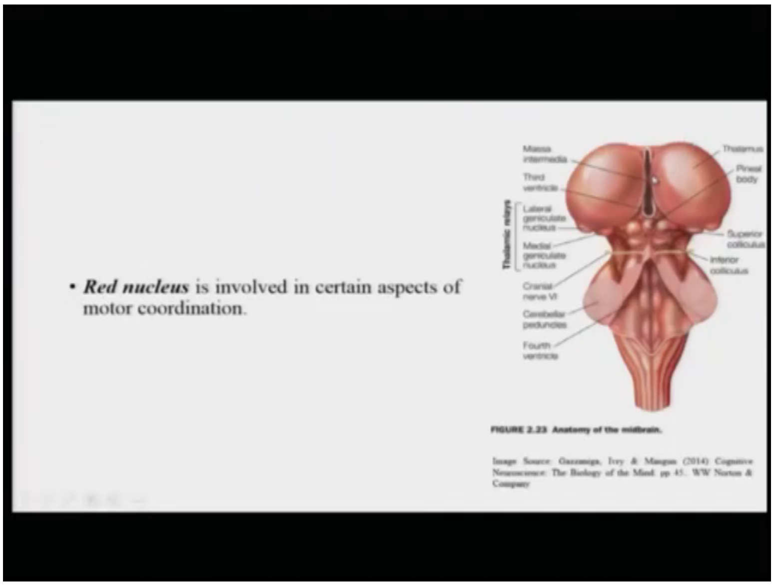
Finally, there is this Red nucleus. I do not think we are have seen that in the figure here, but there is also the set of nuclei called the red nuclei, which are also involved in aspects of motor coordination.

(Refer Slide Time: 25:48)



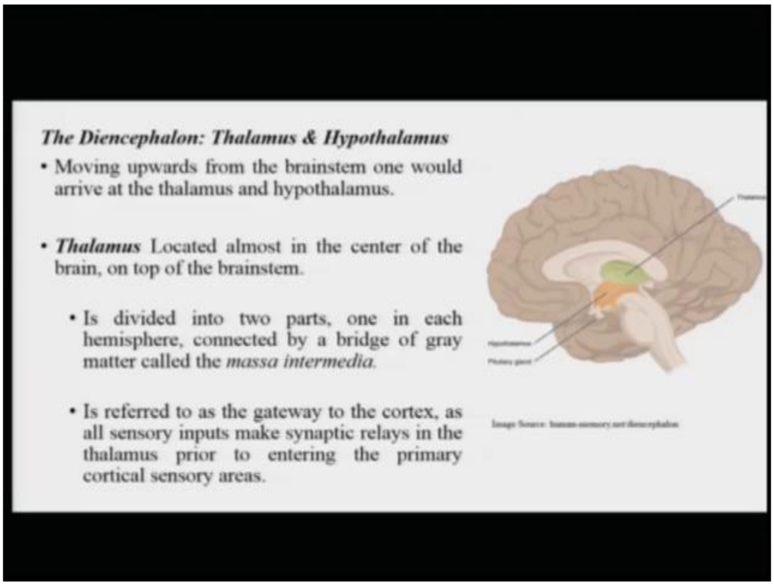
Finally, we can move slightly more upwards, slightly more internal from the midbrain from the brainstem, midbrain and upwards we can talk about the Diencephalon which contains the thalamus and the hypothalamus, also the pituitary gland. So, let us talk about the thalamus and the hypothalamus. Now, thalamus is located as you can see, almost in the center inside of the brain almost inside of the brain in the center. And basically it is connected by a bridge of grey matter called the Massa intermediate.

(Refer Slide Time: 26:20)



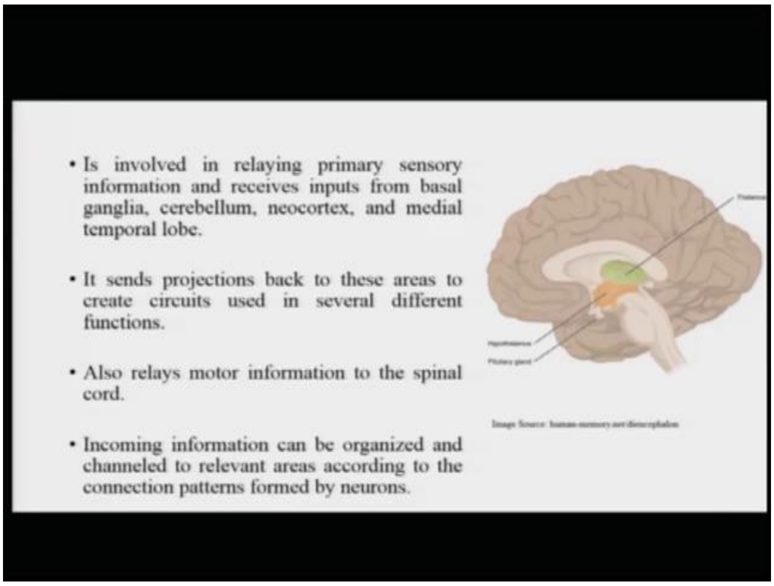
You can see the master intermediate here somewhere. Inside this you will find the thalamus.

(Refer Slide Time: 26:27)



So it was an intermedia, the thalamus is referred to as the gateway to the cortex. Everything that is coming from this peripheral nervous system to the spinal cord to the brainstem, through the medulla, etc. are projected to the thalamus and from the thalamus basically all the projections go to all the other parts of the cerebral cortex or the brain. So, it is referred to as the gateway to the cortex as all sensory inputs makes synaptic relays in the thalamus prior to entering the primary cortical sensitive areas.

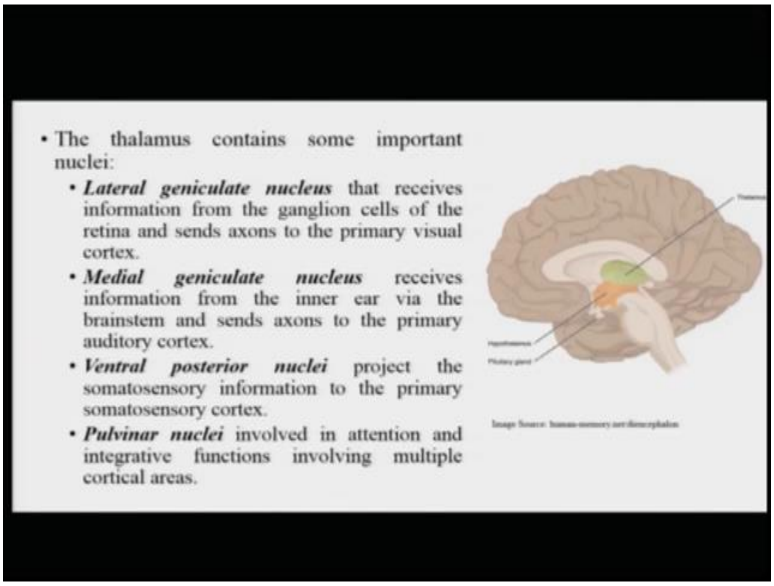
(Refer Slide Time: 26:58)



The thalamus is involved in relaying primary sensory information and it basically receives input from basal ganglia, cerebral cerebellum neocortex and the medial temporal lobe. It is basically gaining all of this primary sensory information relaying it to the other parts of the brain. It sends projections back to these areas also to create certain you know circuits, which are used in several kinds of functions. The thalamus also relays motor information to the spinal cord, so this kind of forms this kind of a loop.

Now, incoming information can be organized and channeled to relevant areas, according to the connection pattern formed by the neurons. So, incoming information that is coming to the thalamus from various parts of the nervous system from the peripheral nerves, through the spinal cord and coming, you know to the thalamus basically has to be has to be always in a particular manner and channeled to relevant areas as the need, you know, as per the need, as per the priority.

(Refer Slide Time: 28:01)

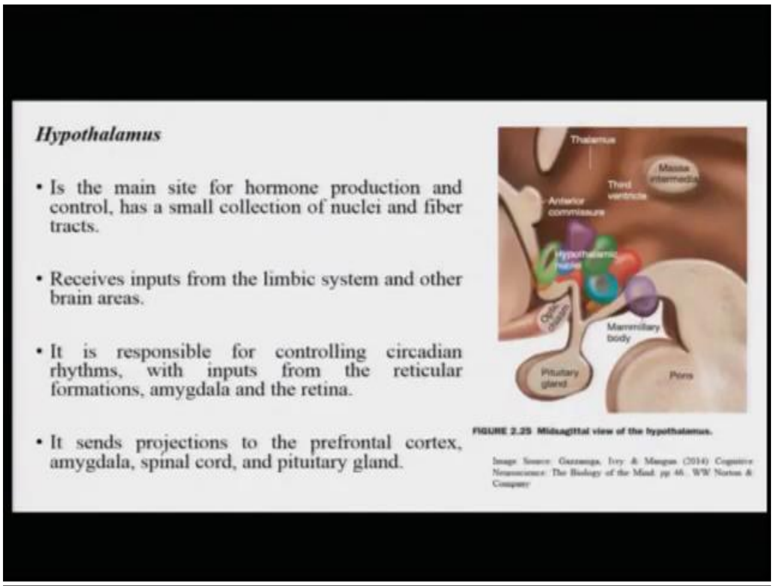


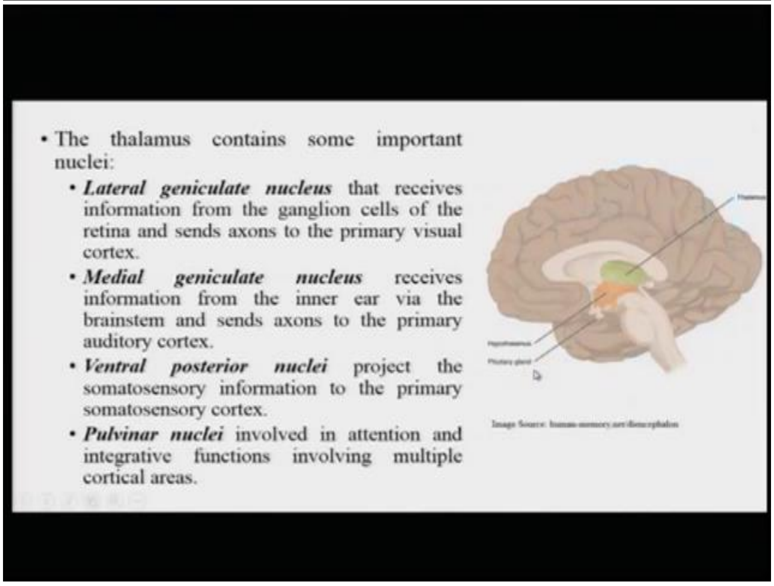
Now, the thalamus contains three or some important set of nuclei. One of them is the lateral geniculate nuclei or lateral geniculate nucleus. Now, the lateral geniculate nucleus basically receives information from the ganglion cells of the retina from the back of the eyes, and it basically sends axons to the primary visual cortex, so through the thalamus it sends these connections to the primary visual cortex.

Then there is the medial geniculate nuclei, the medial geniculate nucleus basically receives information from the inner ear and sends axons of the primary auditory cortex and you have the ventral posterior at the back and the bottom. Ventral posterior nuclei that project the somatosensory all kinds of touch related tactile information to the primary somatosensory cortex.

And finally, there is the pulvinar nuclei which are basically involved in orienting attention and integrating, you know integrated functions that involve multiple kind of cortical areas. These are the set of nuclei that very important in the thalamus.

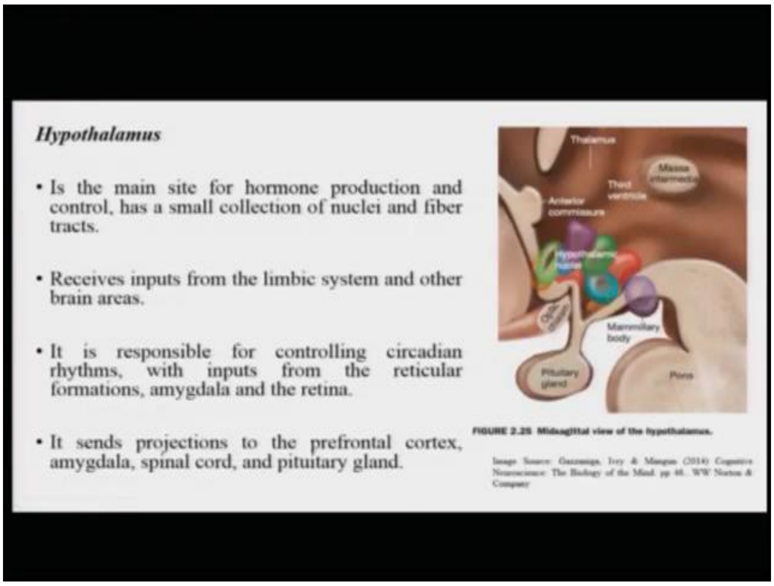
(Refer Slide Time: 29:00)





We can talk a little bit about the hypothalamus as well. Hypothalamus is just this region. under the thalamus you can see if this were the thalamus this region here under the thalamus. You can see here under the thalamus is the hypothalamus.

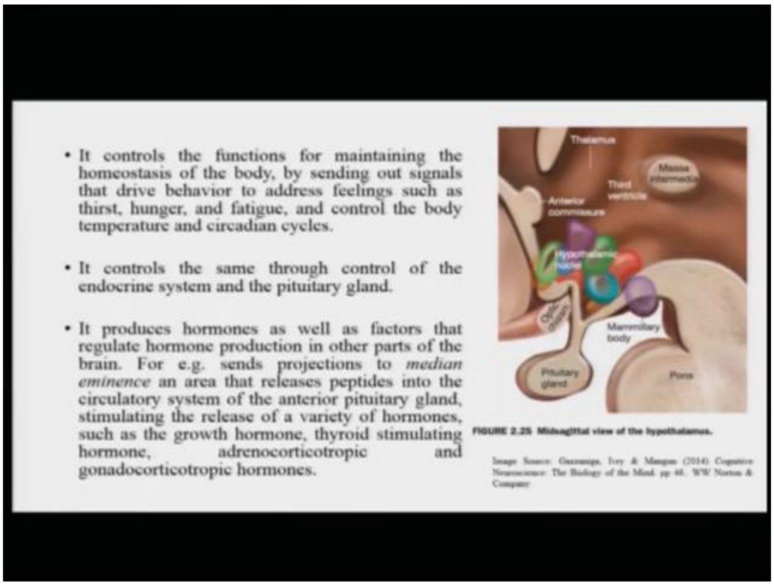
(Refer Slide Time: 29:14)



It is very important site for hormone production and control. It has also a small collection of nuclei and fiber tracts as you can see. Now, they basically the hypothalamus receives input from the limbic system and other kinds of brain areas. It is responsible for controlling the body's circadian rhythms, which basically does, you know, by getting input from the reticular formations, amygdala and the retina.

Some of these regions I am mentioning here, you will see the figures and use of them again and again as we go through the different chapters. Now, basically the hypothalamus sends projections to the prefrontal cortex, the amygdala, the spinal cord and the pituitary gland. So, these are the three regions where the hypothalamus mainly projects.

(Refer Slide Time: 30:03)

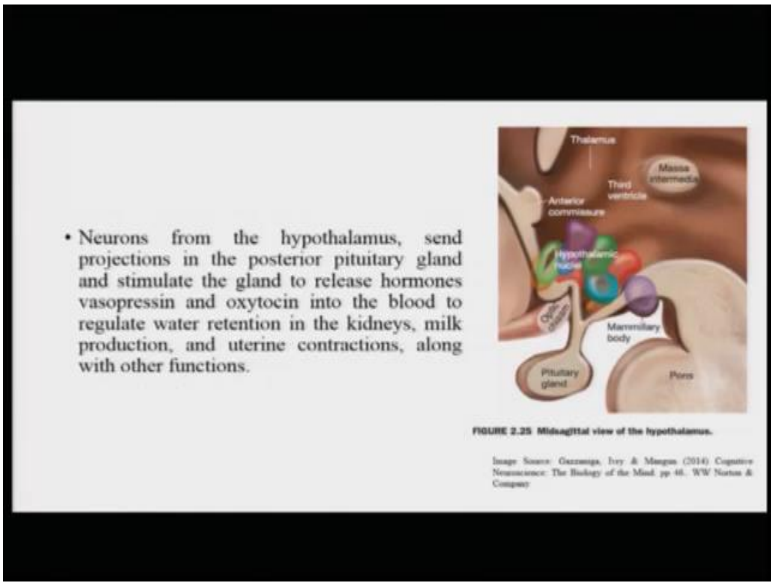


It controls the functions for maintaining the homeostasis of the body, maintaining the normal equilibrium of the body by sending out signals that drive behaviour to sort of address whenever a need, or whenever some kind of emergency arises in the body. Say for example, if you are thirsty, hungry, feeling too hot, too cold, too excited or you know, unrested, and nobody needs some kind of sleep, so all of those basic housekeeping things or you know, something that maintains the equilibrium of the body is handled by the hypothalamus is a very, very important region.

It controls these things through via controlling the endocrine system, the system that generates these neurons, these are hormones sorry and the pituitary gland. So, also what the hypothalamus sort of does, is it produces the hormones itself but it also produces factors that might, you know control or manipulate the rate of production of hormones in different areas.

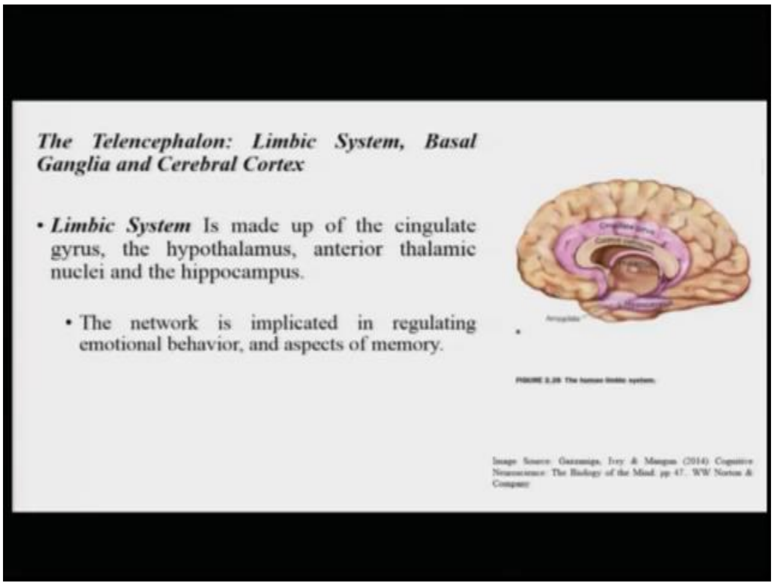
So, one example is that, say for example, the hypothalamus sends production sends projections to region called the medium and eminence and an area where it releases peptides into the circulatory system of the anterior pituitary gland, the front portion of the pituitary gland, where basically it can eventually control the generation of thyroid simulation hormone, the adrenocorticotropic and the gonadocorticotropic hormones, which have different kinds of functions, we will talk about them when the need arises.

(Refer Slide Time: 31:35)



Now, neurons from the hypothalamus send projections in the posterior pituitary gland as well. And they can stimulate the gland to release and the gland to release hormones like them like vasopressin and oxytocin, oxytocin, vasopressin and oxytocin in the blood basically to regulate water retention in the kidneys, milk production in a lactating females and uterine contractions and so on. So, in in that sense, it kind of takes care of some of the very, very important, you know, functions of the body.

(Refer Slide Time: 32:11)

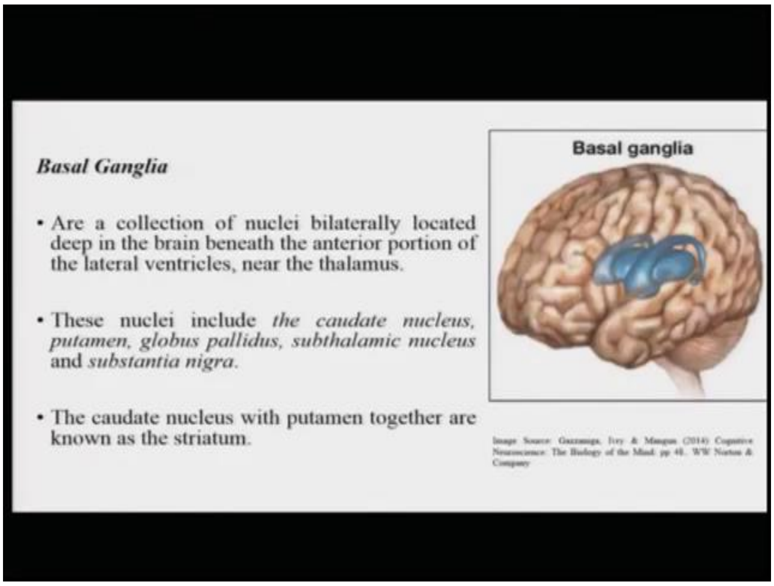


Finally, we can talk about the telencephalon. So, we are kind of moving upwards from the spinal cord to the brainstem to the midbrain to the Diencephalon, which has a thalamus and hypothalamus. And now moving slightly more further up, wherein we come across three kinds of systems, the limbic system, the basal ganglia, and the cerebral cortex.

Is made up of these three very, very important regions, the cingulate gyrus, you can see here, the hypothalamus, which is just below the thalamus, the anterior thalamus nuclei, some of the nuclei that we have mentioned, and the hippocampus, which is this region here. Now, this is a very, very important network, and we will talk about the detailed implications of what this network does in one of the later chapters.

But this is just to give you a brief hint, this to give you a briefing hint is basically implicated in regulating emotional behaviour and regulating behaviour with respect to you know, responses like fear, judgement of emotions etc and certain aspects of memory also. So, this one has to remember.

(Refer Slide Time: 33:16)

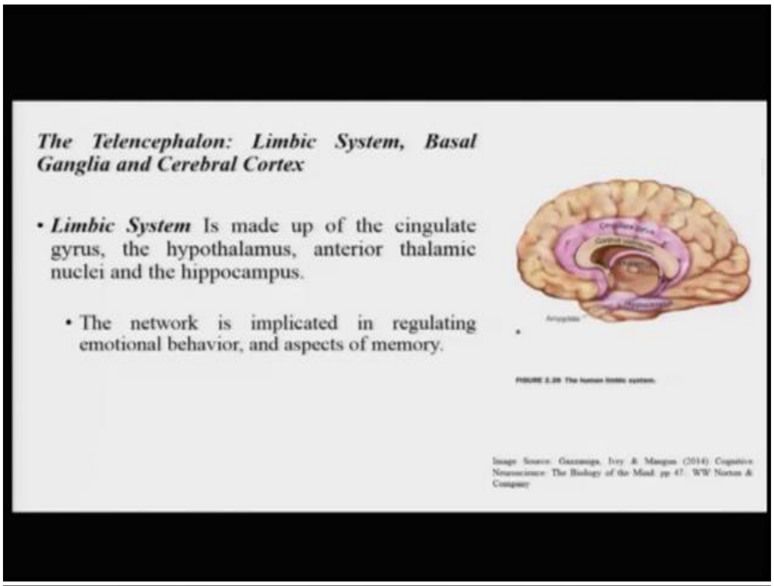


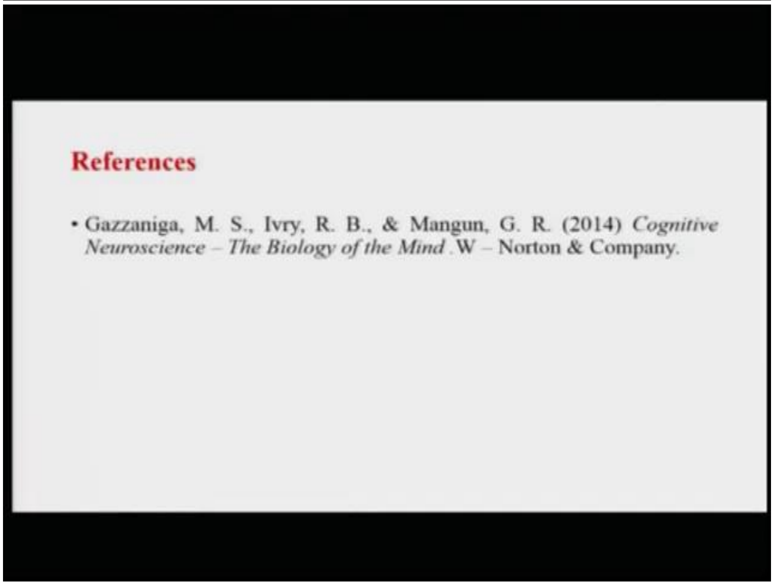
Then we can talk a little bit about the basal ganglia, the basal ganglia are collection of nuclei bilaterally located and both hemispheres deep in the brain beneath the anterior portion of the lateral ventricles, near the thalamus. So, basically this around here under the thalamus. Is basically the basal ganglia include different kinds of nuclear like the caudate nuclei, putamen, globus pallidus, subthalamic nuclei and substantia nigra, we will talk about some of their functions, maybe at a later time.

Now, the caudate nucleus with the putamen together are referred to as the striatum and striatum basically, what it does? is it receives projections from the thalamus. As they basal ganglia receives input from the sensory and the motor areas. Now, these nuclei, which we have just mentioned, as part of the basal ganglia are involved in very important brain functions like action selection, action gating, motor preparation, timing, coordination, fatigue, and things like task switching. So, these are some of the very important functions of these regions of the brain.

And finally, the basal ganglia also play a very important part in what is called reward based learning and goal oriented behaviour. So, basically behaviours that lead to pleasurable reward based outcomes. These are the reasons that process some of the outcomes and may lead to us learning those behaviours better and so on.

(Refer Slide Time: 34:49)





So, we sort of covered two portions of the telencephalon, which are the limbic system and the basal ganglia. I will talk about the cerebral cortex in the next lecture. Thank you.