Basics of Mental Health & Clinical Psychiatry

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Lecture 01
Introduction to Neuroanatomy

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Hello, everyone. So today, we will start our first topic of basics of Mental Health and Clinical psychiatry, that is introduction to neuro anatomy, that is lecture number 1.

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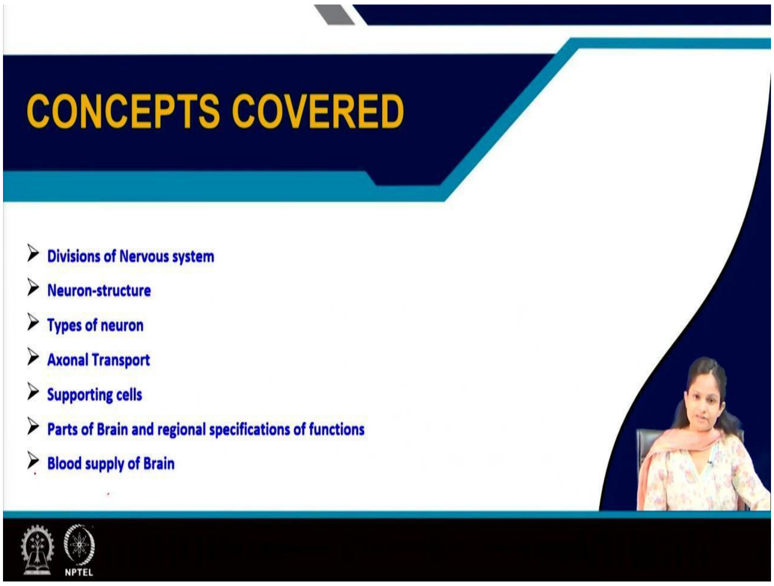

So, neuroscience is very important with regard to the clinical psychiatry. So we have to know the basics of neuroscience. So, what are the concepts we shall cover in this today's topic, we will see. We will cover divisions of nervous system; the types, the structural, the functional unit of nervous system, that is neuron; what are the types of neuron; how there is a transport of impulse, that is axonal transport; what are the supporting cells of the brain and what are the functional divisions or regional specifications of the various parts of the brain and finally, what is the blood supply to the brain.

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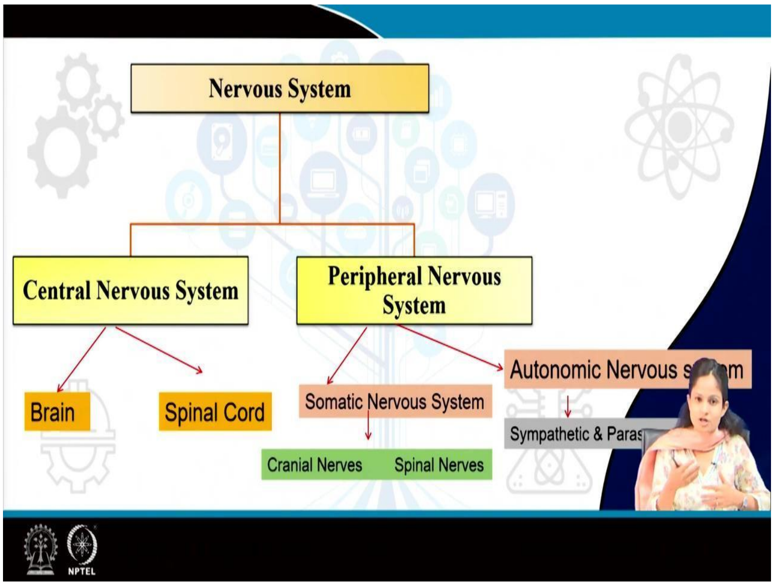

Now, coming on to nervous system, overall as you can see, the nervous system is divided into mainly 2 parts, that is central nervous system and peripheral nervous system. Central Nervous System is what? The main thing in our body, which controls the whole systems of our body. It receives the information not only from our body, but it collects and receives the information from our surrounding area through our body system and also it processes those information and sense back to the effectors.

Now, central nervous system has got brain and spinal cord. Now brain is the main seat of cognition and spinal cord is mainly responsible for the postural reflexes. Now, peripheral nervous system consists of 2 part that is somatic nervous system, and autonomic nervous system. Peripheral Nervous System is what? which receives the information from the peripherals. So somatic nervous system consists of cranial nerves and spinal nerves. What is somatic nervous system? Whatever voluntary activities we do, for example, I am talking, I am sitting, you are standing, you are running.

So whatever voluntary activities we are supposed to do that is mainly governed by the somatic nervous system via cranial nerves, that is head and neck movements and spinal nerves, that is the movement of our limbs, upper limbs and lower limbs. Now, autonomic nervous system, whatever actions which are done in our body involuntary, means we are not aware of, like we are breathing, our heart rate is being regulated, our blood pressure is being maintained.

So these are the involuntary activity which goes on in our body. So, that is mainly governed by the autonomic nervous system which has got 2 divisions, sympathetic divisions and parasympathetic divisions. Sympathetic divisions is mainly for the actions when the body is under stress, any stress. So it is physical stress, emotional stress, psychological stress, and parasympathetic division is mainly when the body is under rest.

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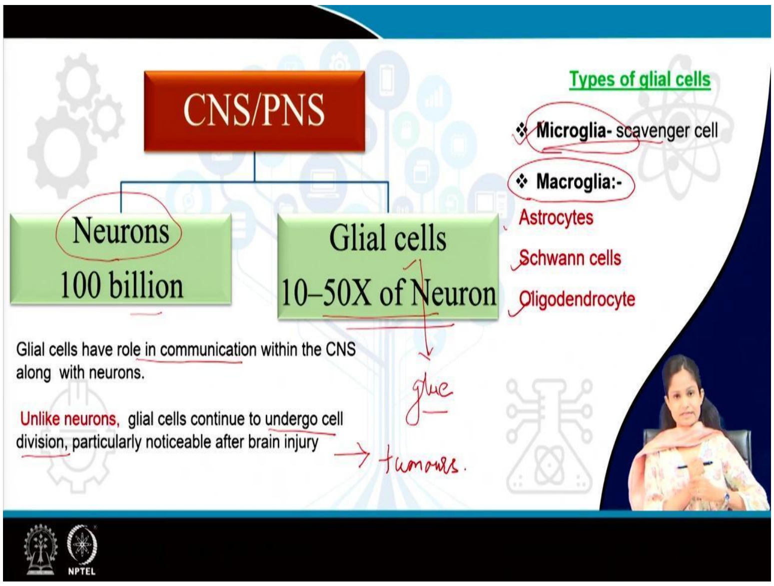

So next, whether its central nervous system or peripheral nervous system, the structural and functional unit of central nervous system is neuron. There are many, many neurons, 100 billion neurons are present in the central nervous system. And also there are supporting cells of the brains other than the neurons, which are 10 to 50 times more than that of the neuron. So those are named as glial cells, the glial cells, usually this glial word is derived from glue.

It is a Greek word which is derived from glue, which means it plays a very important role in communication with the neurons in the central nervous system. Now, unlike neurons, we know neurons do not divide. From your 11th, 12th biological knowledge, you must be knowing that neurons do not regenerate or divide, but glial cells in the central nervous system, which are the supporting cells, they have this ability to undergo cell division, particularly when there is a cell injury.

Now when this glial cells go unwanted or unacceptable cell division, this results in various pathology, mainly the tumors of glial cells. So this is very important or applied aspect of the glial cells. Now what are what are the types of glial cells we will see. Broadly, glial cells is divided into micro glial cells and macro glial cells. The micro glial cells, what you have to remember is only they are the scavenger cells. The micro glial cells are the scavenger cells, they act just like other tissue macrophages.

Now, what do these tissue macrophages do? They remove the debris or the inflammatory byproducts from the surrounding area of the cells. So this is the same function which is done by this microglial cells. What function do this macro glial cells do? Now macro glial cells have different functions based on which type of cells you are talking about. There are astrocytes, there are Schwann cells, there are oligodendrocytes.

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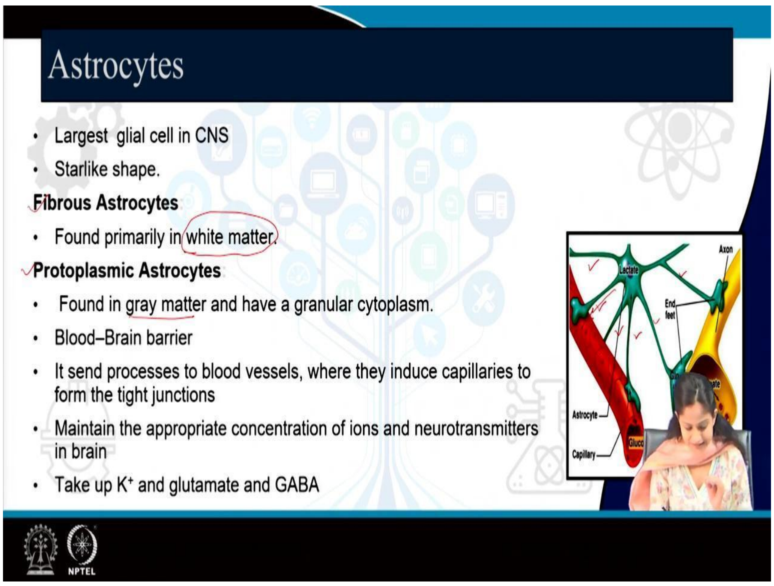

Now, astrocytes are the star shaped cells, these are the largest cells in the central nervous system. As you can see in the diagram, it has various food processes. These food processes are nothing but the starlike processes of the astrocytes. Now, if these astrocytes are found in white matter, they are called as fibrous astrocytes. If these astrocytes are found in gray matter, they are known as protoplasmic astrocytes. So 2 types of astrocytes we see. It is found in white matter, it is fibrous astrocytes; if it is found in grey matter, it is protoplasmic astrocytes.

Now, the main function of this astrocytes are, as you can see, they send this foot processes to this blood vessels, any blood vessels or any blood capillaries, they send this foot processes, they form tight junctions, they induce the capillaries to form tight junctions and these tight junctions play a very important role in forming the blood brain barrier in our central nervous system. So, other functions of this astrocytes are, they maintain the appropriate concentrations of the ions and neurotransmitter in the brain, they take various ions, mainly the potassium ions, the glutamate and the GABA.

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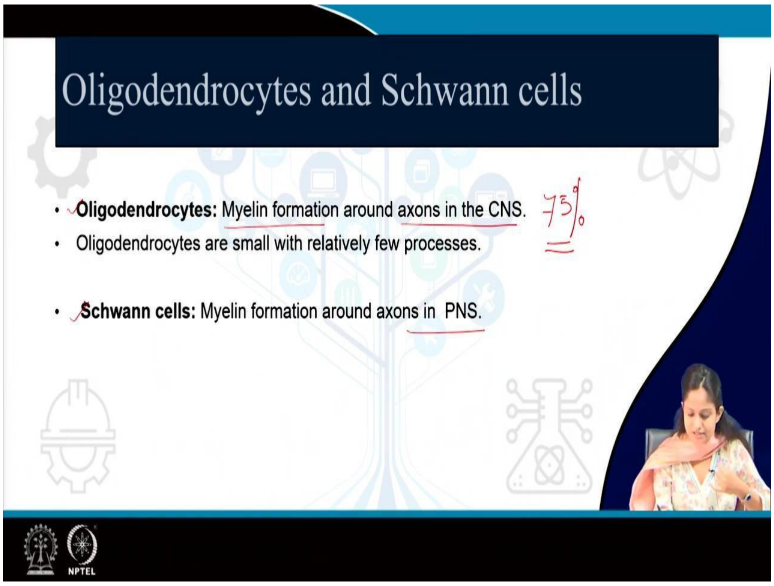

Now, what is the function of oligodendrocytes? Oligodendrocytes is very important function. They form the myelin sheath, around the axons in the central nervous system. Now, oligodendrocytes cater to around 75 percent of the glial cells in our central nervous system, the most abundant, a very important MCQ also multiple choice question asked in various entrance examinations, what is the most abundant glial cells present in the central nervous system? So it is oligodendrocytes.

The largest glial cell is astrocyte. So, oligodendrocytes are very small, and they have relatively few processes, not like astrocytes, but they form myelin formation around axons in the CNS - central nervous system. The same myelin formation, if it occurs in the peripheral nervous system that is done by Schwann cells. So astrocytes, oligodendrocytes, and Schwann cells. Astrocytes, mainly important for the formation of the tight junctions, that is blood brain barrier; oligodendrocytes, they form the myelin sheath around the central nervous system axons and Schwann cells, they form the myelin sheath around the axons of the peripheral nervous system.

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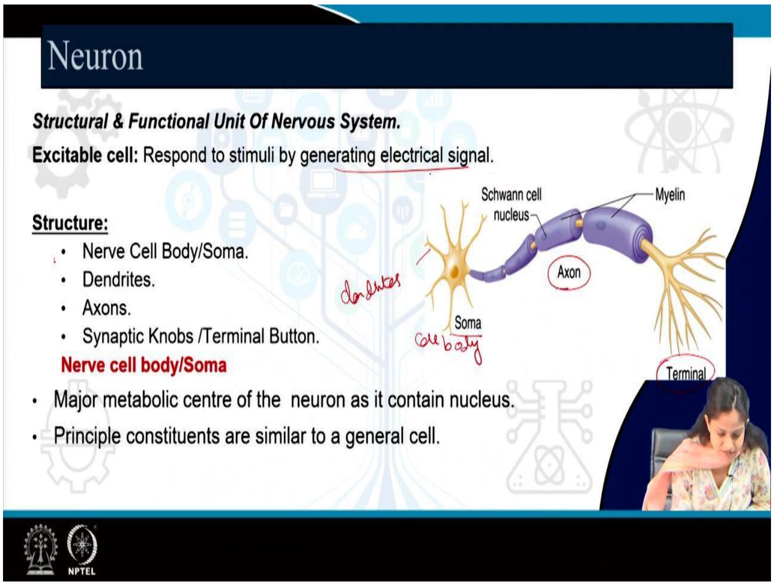

Now, coming to the structural and the functional unit of central nervous system or the nervous system that is neuron. Now, you must have read in biology that is neuron is an excitable cell. Excitability is the property means whenever it responds to a stimulus. So, it bears generating electrical signal. So, main structure of neuron if you see, it possess a cell body, that is Soma, then the soma contains various dendrites, these are the dendrites. Then it consists of the axon, this is the axon, which is again played by the myelin sheath and this myelin sheath is formed by the schwann cell nucleus, that means this neuron I am talking of peripheral nervous system.

And this axon later on terminates into synaptic knob or terminal buttons. So nerve cell body, Soma, dendrites, axons, and synaptic knobs or terminal button. Now this nerve cell body is a very important structure in the neuron because it forms the main metabolic center; it contains the nucleus like that of other cell. It has got ribosomes, it has got Golgi bodies, it has got nucleus.

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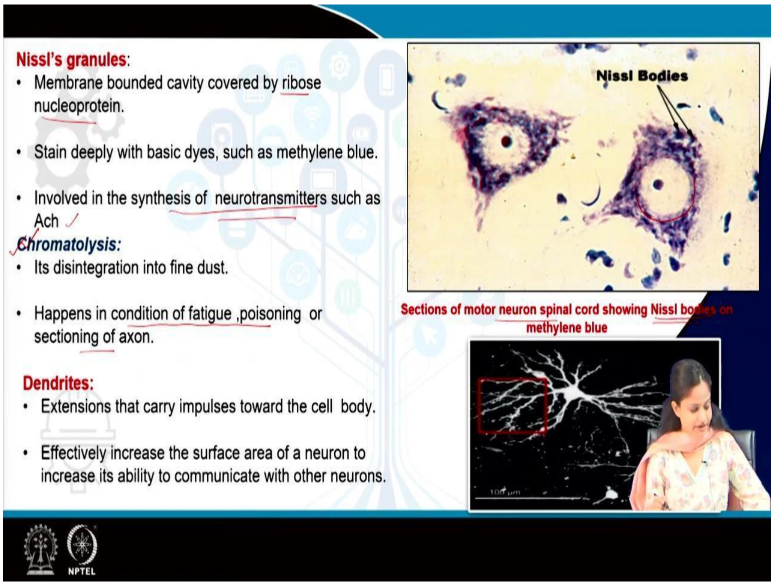

Now we will see what does this ribosomes play a role? As you can see, this is the section of a motor neuron spinal cord which is showing Nissl bodies which are stained by a basic dye that is methylene blue. You can see, this is a membrane covered area and these are the Nissl bodies. These Nissl bodies are nothing, but they are covered by the RNA protein, that is ribonucleoprotein which are stained by a basic dye, that is methylene blue. The role of these Nissl bodies are very important because they are involved in the synthesis of neurotransmitters, neurotransmitters like acetylcholine.

Now, when this Nissl bodies get disintegrated into fine dust, this happens whenever there is an injury to the axon. Whenever there is fatigue sectioning of the nerve, or poisoning of the nerve, nerve gets injured. Any portion of the nerve gets injured, what will happen? This Nissl bodies gets disintegrated into fine dust, this process is known as Chromatolysis. Now, coming to the dendrites, as you can see the dendrites, they carry the impulses towards the cell body, dendrites will carry the impulses towards the cell body; then from the cell body the impulse will go, travel towards the axon to the terminal buttons.

So, this dendrites are more in number. This helps in communication and this helps in increasing the surface area, they effectively increase the surface area of a neuron to increase its ability to communicate with other neurons.

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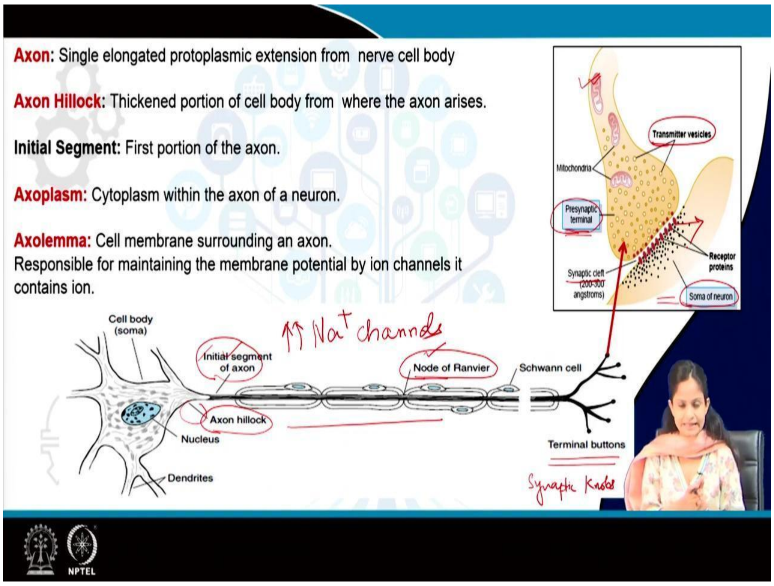

As I told you, this is the axon, this is covered by the myelin sheath. The thickened portion from where this axon arises is known as axon hillock. Now, the first segment is initial segment of the axon. Then we have axoplasm, obviously, the cytoplasm of the axon within the axon of a neuron and the membrane which covers this axon is the axo lemma. This axo lemma is very important because it maintains the resting membrane potential of the neuron.

Now, this nodes of Ranvier what you see over here, these are present in between 2 Schwann cells. So, this is non myelinated area, this nodes of Ranvier and initial segment of axon, they contain highest number of sodium channels. As you know that the cell membrane is very important for maintaining resting membrane potential, that means, when the cell is at rest what the charge they are bearing inside the membrane and outside the membrane if you just, it just like a voltmeter if you add and you just measure the potential difference when the cell is at rest, from inside the membrane and outside the membrane, that is resting membrane potential.

Now, whenever there is any action, when you stimulate that cell, there will be some influx and efflux of the various ions. So, what you have to remember is the initial segment of the axon and the nodes of Ranvier, they contain highest number of sodium channels. Now, as I told you, this axon terminates into terminal buttons or these are also known as synaptic knobs. So, this is a very magnified or amplified version of synaptic knob terminal is shown.

Now, this neuron is the, this is the part of the neuron, this is the pre synaptic terminal. That means from where impulse is coming. This portion is the post synaptic terminal which will receive the impulse. Now, from where impulse is coming, that means it is the part of the axon; the portion which will receive the impulse, that is the part of the nerve cell body or Soma. So, pre synaptic terminal is the axon path. Post synaptic terminal is the soma. In between this pre synaptic terminal and post synaptic terminal, there is a cleft or gap, that is known as synaptic cleft.

Why this is very important? Because whatever impulse conduction occurs, the basis of impulse conductions, the transmission of impulse, that is mainly present in this synaptic cleft. There are various transmitted vesicles which are present inside the pre synaptic terminal. The neurotransmitters get released from these vesicles and these are the receptor which are present on the post synaptic terminal. Because post synaptic terminal is the receiving end, so, the receptors are always present on the post synaptic terminal membrane.

So, the receptors whenever the neurotransmitters will bind to the receptors, there will be influx of positive ions or cations and hence there will be conduction of the impulse.

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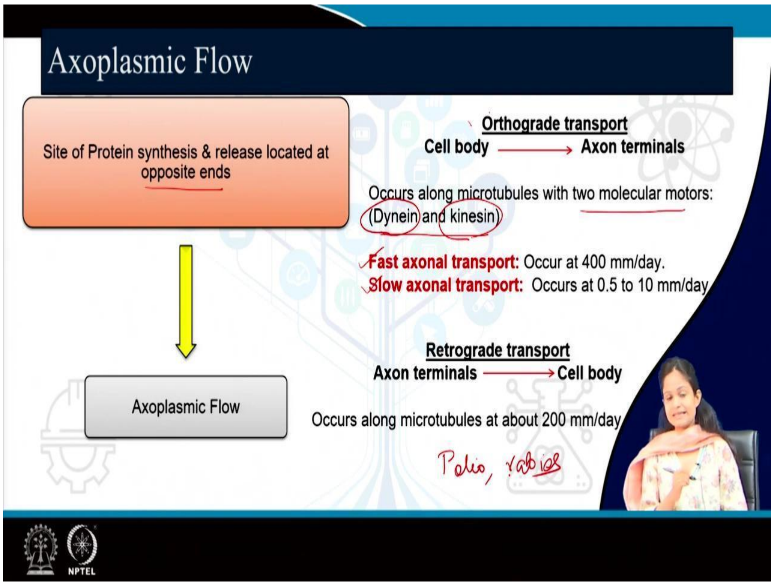

So, axo plasmic flow, what does it mean? Axo plasmic flow is wherever the site of synthesis of protein, that is neurotransmitter synthesis occurs and it release occurs in the opposite ends, the neurotransmitters is synthesized with the help of nasal granules, where it is present in the cell body or Soma.

And this neurotransmitter is released from where? From the axon terminals. So, these are occurring at the opposite ends, this is known as Axo plasmic flow. Now, there are 2 types of extra plasmic flow, you should remember orthograde transport and retrograde transport. Orthograde transport means when the impulse is getting transmitted from cell body to axon terminals, which is very normal, the impulse is getting transmitted from the soma to the axon terminals.

Now, this transmission occurs with the help of 2 moleculer motors, like dynein and kinesin. Molecular motors are nothing but like a vehicle which is transmitting people from one place to another. So, in that way, the molecular motors you have to remember 2 names, dynein and kinesin. This, dynein and kinesin play a very important role in the orthograde transport. There can be fast axonal transport, there can be slow axonal transport. Retrograde transport is just the reverse of orthograde transport, that means, the impulse is getting transmitted from axon to cell body.

Now, this usually occurs whenever there is any viral infection. You must be aware of polio virus, then rabies virus, this virus gets transmitted retrogradely, that means from axon terminals to the cell body. So, these are the 2 types of transport.

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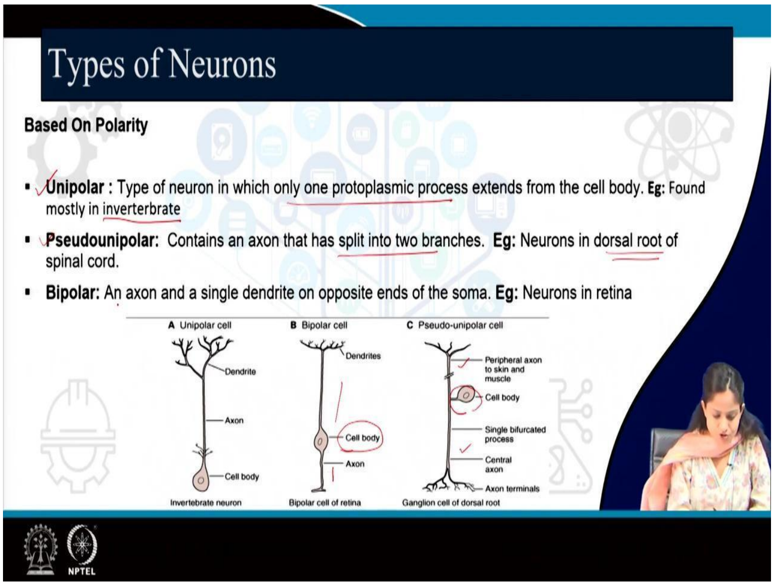

Now, based on polarity we have different types of neuron. The first is uni polar, which if you do not remember also, there is no problem because these are mainly found in vertebrate animals which have only one protoplasmic process which extends from the cell body. The pseudo unipolar neuron, this is present in the dorsal root ganglion of the spinal cord usually. Pseudo unipolar neuron is there is a cell body which contains an axon and then it is split into 2 branches. You can see there is an upper branch and there is a lower branch.

So, this is pseudo unipolar neuron, it is present in the dorsal root of spinal cord, dorsal root ganglion. Now, bipolar neuron are present in the retinal cells, what does bipolar neuron is having? You can see there is a cell body. Then, above there are dendrites. Below, there are axon. So, an axon and a single dendrite on opposite sides of the neuron constitutes a bipolar neuron, it is mainly present in the retinal cells

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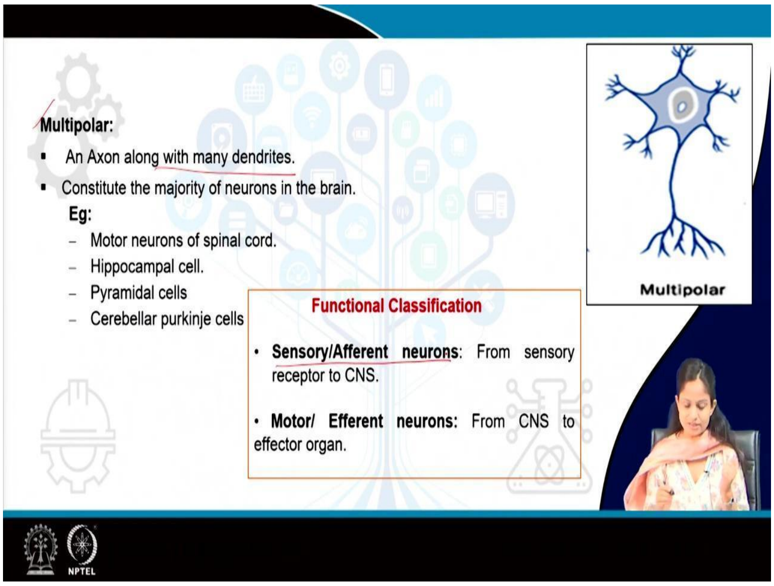

And rest wherever you talk in our body about the neurons, they are multipolar neurons. That means, a neuron which is having cell body and an axon, which is having various many dendrites. You take any examples, motor neurons, hippocampal cells, pyramidal cells, whatever neurons, they are multipolar neurons. Now, this classification is based on the polarity. The functional classification means which impulse they are taking, whether they are taking towards the central nervous system or away from the central nervous system.

So, sensory or afferent neurons from sensory receptors, receptors are present in the peripheries, they are taking the impulse towards our brain. Central nervous system in short, I am denoting as brain. Even though impulse is taken from the receptors to the brain, they are afferent neurons or sensory neurons. When the impulse is taken from the brain towards the effectors, so that is a motor neuron, that means from the brain towards the periphery. They are the afferent neurons.

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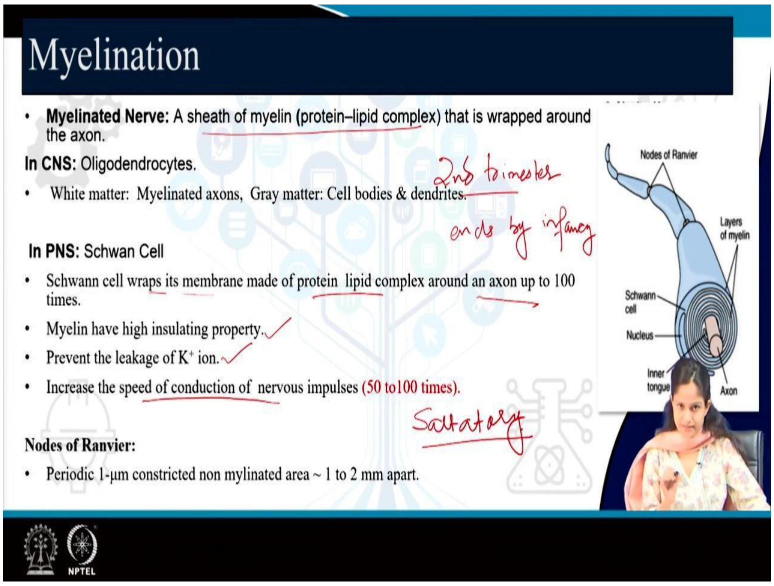

Now, myelination I told you that is mainly done by the schwann cells in the peripheral nervous system. Now this myelination, you can see, this is a sheet of protein lipid complex, this sheet of protein lipid complex starts at the usually the beginning of second trimester or myelination starts by second trimester, in utero, and it gets completed, ends usually by infancy. So in CNS as I told you, these are the oligodendrocytes, which usually constitute this myelination and peripheral nervous system, it is mainly the schwann cells.

Now what are the characteristics of this myelination? Now there is a neuron, the axon is there. Now it is just like wrapping a bandage. Whenever you wrap a bandage, you wrap it multiple times. So the same way myelination occurs. The myelination, the schwann cell wraps its membrane made of protein lipid complex that is myelin sheath around the axon up to 100 times. Now, this myelin sheath has got very high insulating property, it prevents the leakage of potassium ions and it increases the speed of conduction.

As I told you, in between 2 Schwann cells, you have nodes of Ranvier. So, when the nodes of Ranvier contains highest number of sodium channels, so whenever there will be more sodium channels obviously the impulse will get transmitted at a very high speed. So whenever there is myelination, the speed of conduction increases to 50 to 100 times and this conduction is known as saltatory conduction. This is specifically present in the myelinated nerve. So myelinated nerves have highest conduction speed.

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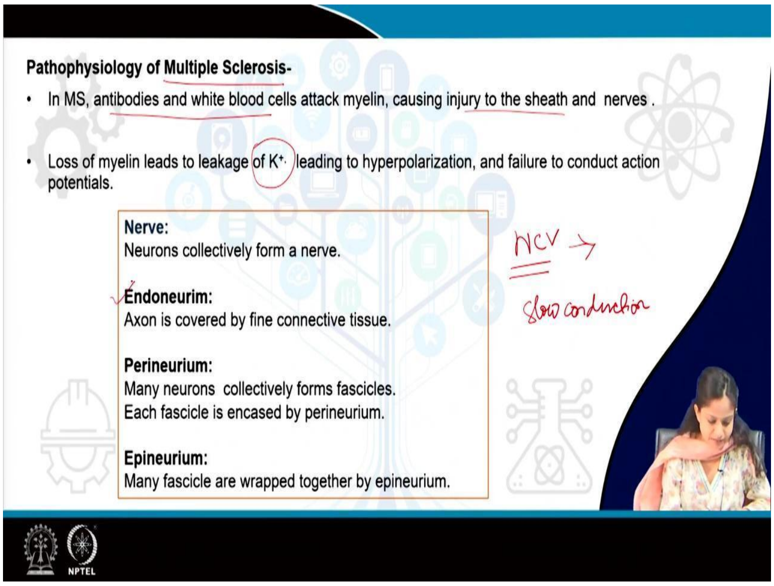

Now if this myelination is defective, what will happen? So, what happens in case of multiple sclerosis? In multiple sclerosis, is an auto immune demyelinating disease in our body. Autoimmune disease means when our body attacks our own cells. So, the antibodies and the white blood cells, they attack the myelin sheath. So, when they will attack the myelin sheath of our own body, they will cause destruction to the injury to the sheaths and the nerves. So, obviously, the functions of the myelin sheath will get hampered.

So, there will be loss of or the leakage of potassium ions leading to hyperpolarization of the neuron and hence there will be less conduction. These patients usually complain of muscle fatigue, slow conduction, not able to do work properly. And in case of nerve conduction studies, NCV nerve conduction study, this is the electrophysiological study, we see slow conduction, the conduction velocity is decreased highly.

So, this we talk about neurons. So, what is a nerve? When many neurons get collected, they call as nerve. It has got the innermost layer endoneurium, then the perineurium, then the epineurium, the 3 layers are present in a nerve.

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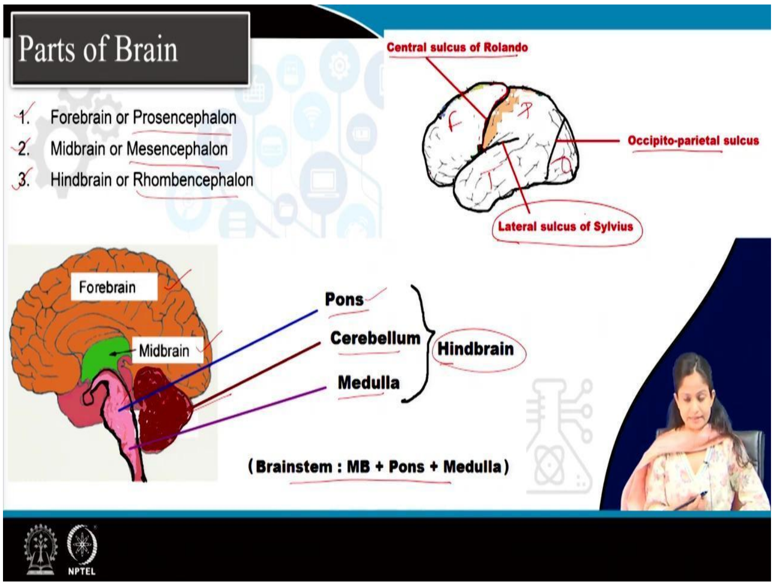

Now coming to the various parts of brain. So, brain various parts like forebrain, midbrain, hindbrain, these are all derived from how they are developed from a neural tube in embryonic neural tube from the embryogenesis. So, forebrain is also known as prosencephalon. This is further divided into diencephalon and telencephalon; midbrain, mesencephalon. And hind brain rhombencephalon. So in this picture, you can see mainly this portion, the cortex, the corpus callosum and the cortex and the basal ganglia, the thalamus, these are all present in the forebrain.

This is the midbrain. This is the pons. Then this is the cerebellum and this is the medulla. Pons, cerebellum, medulla constitutes the hindbrain. Brainstem, if we call, then it is medulla pons and midbrain brainstem is the medulla pons and midbrain. Now in the cortex, cerebral cortex, anyway, we will go details of the cerebral cortex in our further lectures. But just for a brief introduction, cerebral cortex plays a very important role in the cognition.

So you have to remember the 3 sulci. So this 3 sulcus is very important - central sulcus of Rolando, this is central sulcus of Rolando which separates or divides the frontal lobe from the parietal lobe. This is the lateral sulcus of Sylvius. This divides the parietal lobe from the temporal lobe and this is the occipito-parietal sulcus, this is mainly dividing the occipital lobe and the parietal lobe.

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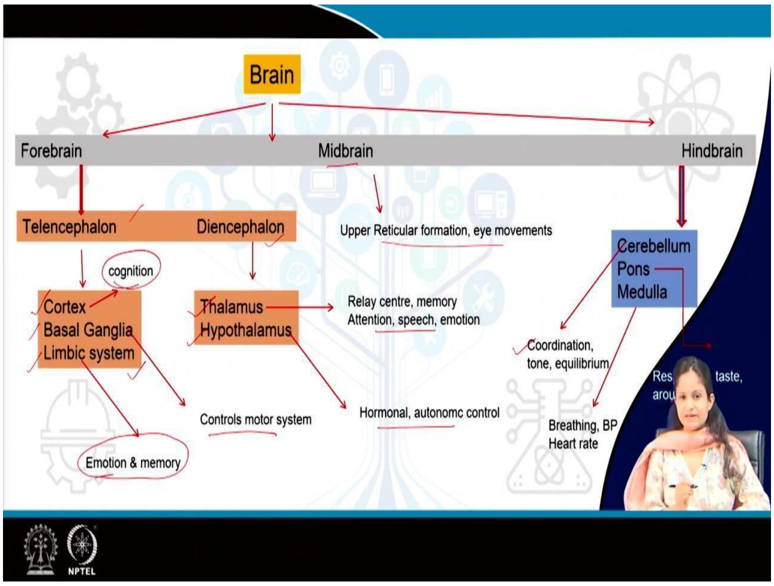

So, these are the important lobes which has got various functions. Before that, we will go into the various parts of brain with various functions. Now forebrain is divided into telencephalon and diencephalon. Telencephalon gives rise to, you do not have to remember all the structures but what is important is the functions of this structures is important. You do not have to, even if you do not remember the derivations. So cortex, basal ganglia limbic system, cortex is mainly responsible for cognition.

The planning of the movements, how something is learned, how something is executed - you get an idea, then you think of executing it, that is mainly done by a cerebral cortex. Basal Ganglia mainly controls the motor system. Basal ganglia and cerebellum, these 2 structures mainly constitutes the motor system. Then the limbic system, this is emotion and memory. Then diencephalon consists of thalamus and hypothalamus. Thalamus is mainly the relay center for memory, attention and speech. Hypothalamus has got hormonal control and autonomic control, that is the involuntary activities. Midbrain, you have to remember the upper reticular formations for arousal state and eye movements.

Cerebellum, as I told you, cerebellum is mainly responsible for the toned posture and equilibrium, pons mainly for respiration, taste and medulla is very vital for our breathing, blood pressure regulation and heart rate.

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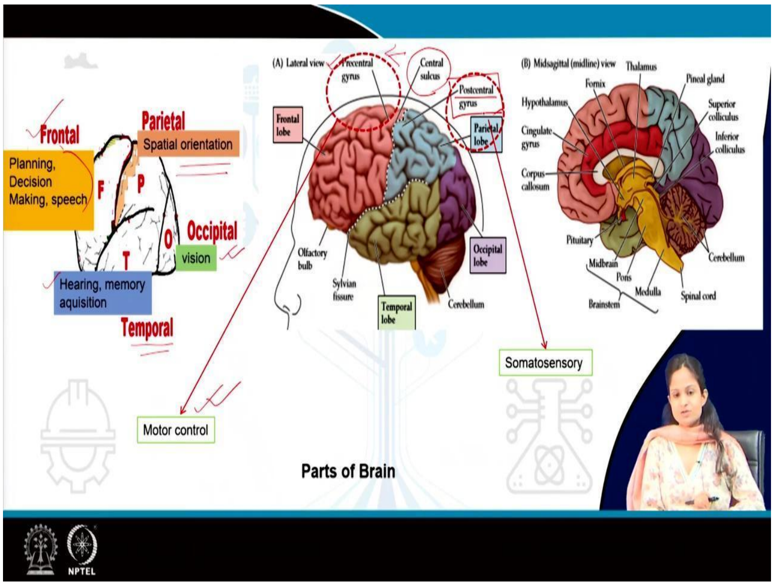

Now, in this parts of brain, the already lobes I have told you, what is the function of each lobes is important. Frontal Lobe is mainly important for planning, decision making and speech. Parietal Lobe is mainly important for spatial orientation. Spatial orientation means when you are walking in a road suppose, you have to have that 3d dimensions of the road. So that is spatial orientation.

Occipital lobe is mainly responsible for vision. Temporal Lobe is mainly responsible for audition or hearing and memory formation. So, in these parts of brain the most important part is the central sulcus. Now, in front of the central sulcus, we have pre central gyrus, this precentral gyrus is present in the frontal lobe, this is the main seat of motor control. Whatever motor activities we do, that is mainly responsible for this precentral gyrus and lateral to this or behind this central sulcus we have post central gyrus.

This is the main seat of somatosensory cortex. That means it receives all the informations from our body or the from the peripheries. So these 2, you have to remember.

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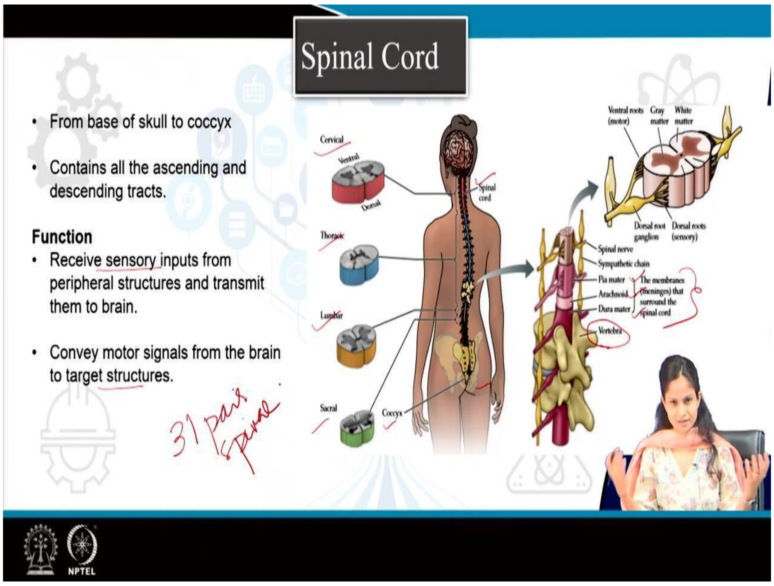

Now, this coming to the spinal cord, spinal cord extends from the base of the skull to the coccyx. So it contains all the ascending tracks in the descending track. So its functions are mainly receiving the sensory inputs from the peripheral structures and transmitting to the brain and then again conveying them from the motor pathway. So the motor signals to the target structures. The spinal cord is surrounded by the vertebra, again it contains of 3 layers. These are the meningeal layers, that is pia mater, arachnoid matter and dura mater.

Now this spinal cord, there are various levels of spinal cord which you must be knowing, you have read in your biology classes, there are cervical divisions, thoracic divisions, lumbar division, sacral divisions, coccyx division. So, totally there are 31 pairs of spinal nerves which are generating which are emanating from this divisions from each level. So these spinal nerves are mainly responsible for the hands and limbs and truncal movements.

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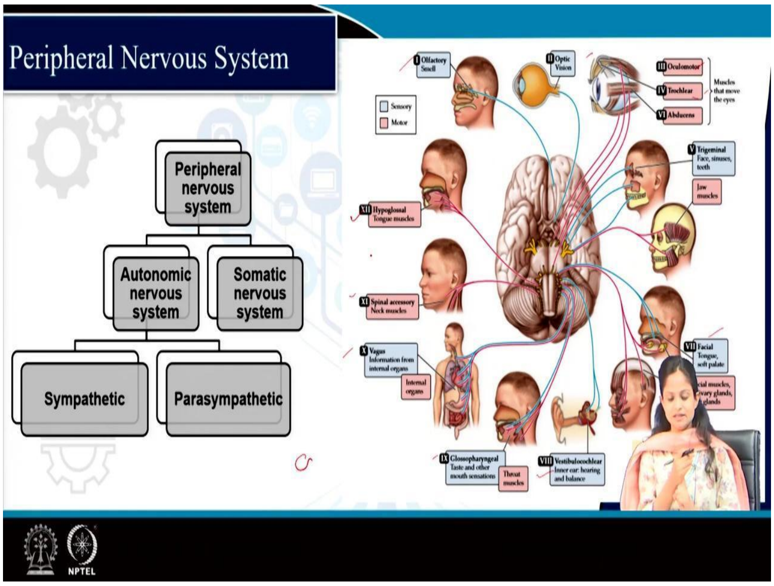

Now, the peripheral nervous system also has got very important rolling movement of the neck, head, eye. So this is mainly done by the cranial nerves. So these are the cranial nerves. So in cranial nerves, what happens? You have 12 pairs of cranial nerves. You can see, Olfactory, optic, oculomotor, trochlear, abducens, trigeminal, facial, Vestibulocochlear or auditory, glossopharyngeal, vagus, spinal accessory and hypoglossal.

So there are 12 pairs of cranial nerves mainly responsible for the head and neck movements and the eye movements. What you have to remember is pure sensory cranial nerves are olfactory, optic and Vestibulocochlear, that is 1, 2 and 8 cranial nerves, they are very important.

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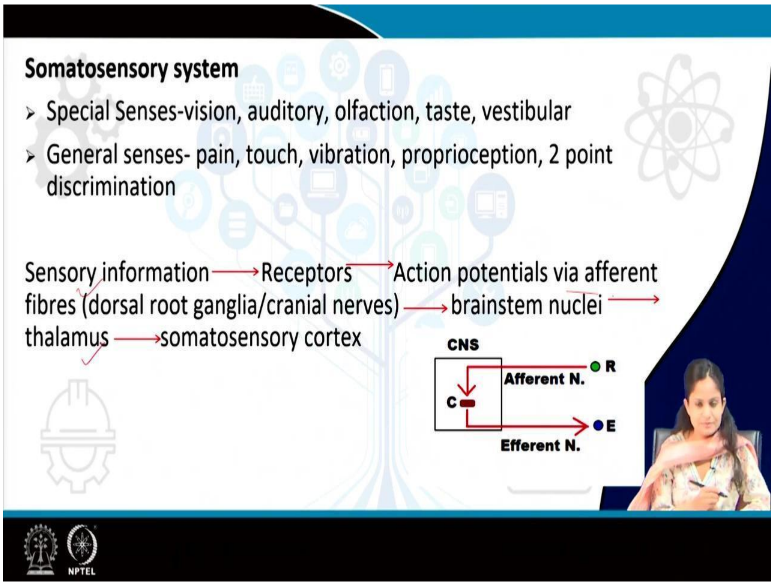

Now whatever sensations we have, we have got general sensations like pain, touch sensations, discriminatory sensations, balance sensations, equilibrium; we have special senses like taste, smell, vision, audition, whatever sensory information we receive, they are received at the level of receptors.

Now from receptors, they travel via efferent fibers to the dorsal root ganglion, which I had already discussed in the spinal cord. From there, they move on to the brainstem nuclei, then thalamus and finally the somatosensory cortex that is the post central gyrus. So this is the main pathway which you should remember, this is a general pathway.

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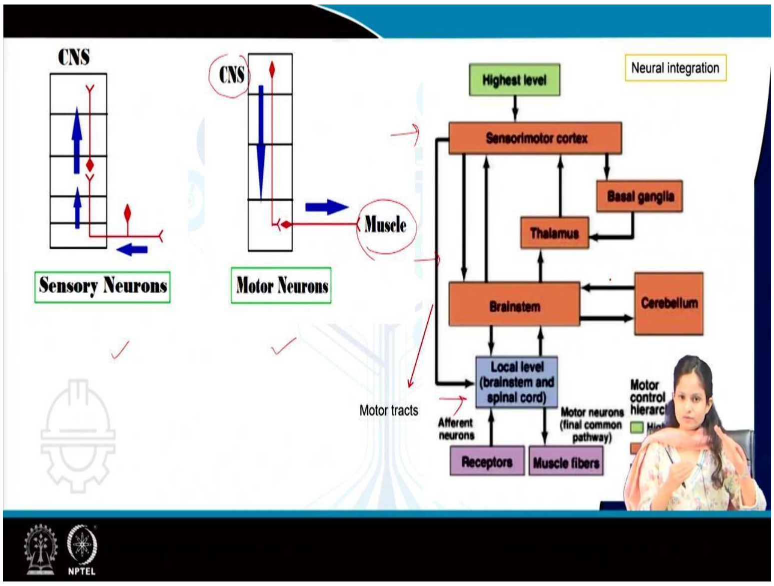

And this is a sensory neural pathway, there is afferent pathway and this is the efferent pathway, that means the motor neurons, the motor pathway, they travel the neck travel the information from CNS to the effectors, how the information is traveled from the brain to the effectors. So, this motor control is done mainly at 3 levels - one at the level of spinal cord, the other at the level of brainstem and the third at the level of cortical level, the highest level is the cortical level.

So, as you can see, whatever informations are been carried out whatever sensory information we are receiving, that is mainly then under the control of our cerebral or sensory motor cortex. Sensory motor cortex will decide when to act and when not to act.

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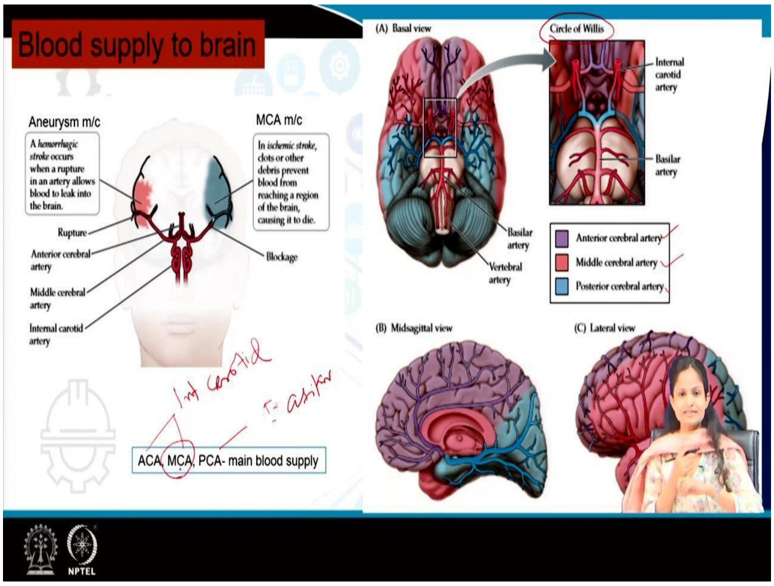

So, this is the motor neuron pathway. I am coming to the last part of our lecture that is the blood supply to brain. For blood supply to brain you should remember the 3 main arteries - anterior cerebral artery, middle cerebral artery and posterior cerebral artery. This anterior cerebral artery and middle cerebral artery they are the derivatives of internal carotid artery and posterior cerebral artery, this is the derivative of the basilar artery.

So, this 3 arteries they form a circle of Willis in the brain. These 3 arteries they form circle of Willis in the brain, there we have anterior cerebral artery, middle cerebral artery, posterior cerebral artery with their minor branches like anterior communicating artery and the posterior communicating artery which finally completes the circle of Willis. So, they are the major source of supply of blood to the brain.

Now, why this is important, because there are 2 types of stroke we get. The one is hemorrhagic stroke, the other is ischemic stroke. Hemorrhagic stroke means whenever there is a rupture of blood vessel in our brain, that mainly happens because of hypertension, the most common cause is hypertension. But whatever be the cause, whenever there is a rupture of artery in our brain that causes diffuse loss of blood inside our brain and surrounding tissues.

So that causes hemorrhagic stroke and the most important artery that is posterior communicating artery is responsible for this aneurysm. Then we have ischemic stroke. Ischemic stroke means whenever any artery gets blocked, due to any reason it is getting blocked. So the blood is not able to move or travel to a specific region. So the brain or that particular tissue of the brain dies.

So that is ischemic stroke. So ischemic stroke, the main artery which gets involved is middle cerebral artery over here. So in case of aneurysm or hemorrhagic stroke, it is a posterior communicating artery. In case of ischemic stroke, it is the middle cerebral artery.

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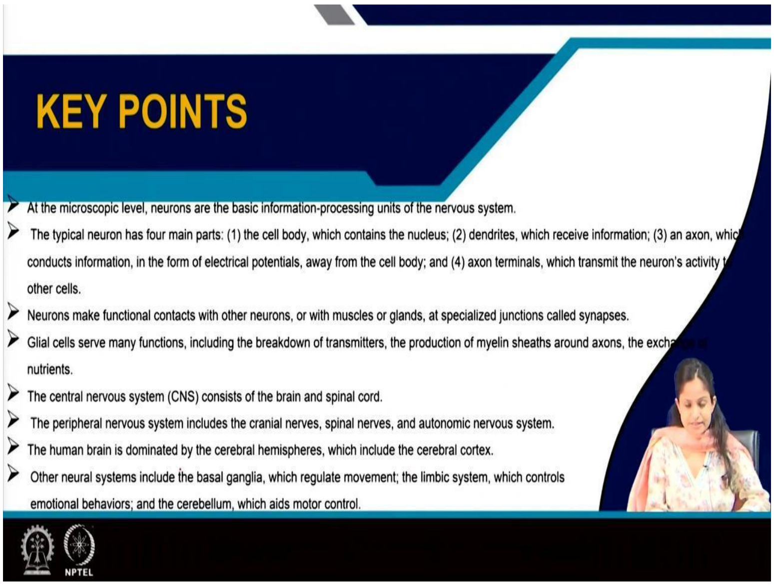

So with this, I would like to discuss the few key points that you should remember. The neurons are the basic processing units of the nervous system. The various parts of neurons with the cell body, Soma, dendrites, axon, and the terminal buttons are important. And the glial cells, they form the supportive cells of the brain. There are 3 types of glial cells, how myelin sheath is formed, by which cells and the peripheral nervous system which consists of cranial nerves, spinal nerves and autonomic nervous system.

The human brain action is mainly dominated by cerebral cortex and the movements of our body is mainly regulated by cerebral cortex, basal ganglia, cerebellum along with the limbic system and spinal cord.

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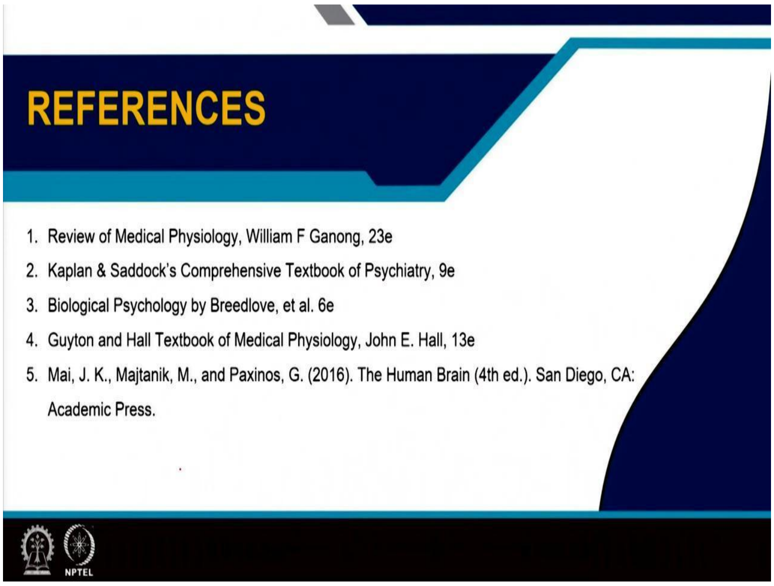

So these are the references of my slide. Today's lecture. I would like to thank you all for hearing this lecture. Thank you.