Basics of Biology
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Lecture – 43
Nervous System Part – 1

Hello everyone, this is Dr. Vishal Trivedi from Department of Bioscience and Bioengineering IIT Guwahati and what we were discussing? We were discussing about the different properties of the living organism and in this context, what we have discussed? We have discussed about the classification of the living organisms, we have discussed about the evolutions and we have also discussed about the different aspects of the living organisms.

So, in this context, in this particular series of modules, we were discussing about the physiology of the living organisms and in that so far what we have discussed? We have discussed about the digestions and then subsequent to that we have discussed about the circulatory system, and then we have also discussed about the muscular system. So, in the previous module, we have also discussed about the circulatory system as well as muscular system.

And in the today's lecture, we are going to start discussing about the nervous system. So, nervous system is the system which actually controls the different types of activities. So, far what we have discussed, we have discussed about the digestion, circulation, muscular even in the subsequent to that, we are also going to discuss about the endocrine system as well as the excretory system, but in that all these different types of activities has to be done under the coordination to each other and these coordination is always been maintained by the nervous system.

Because nervous system is going to respond to the different types of stimuli or the different types of responses from the different sources and that is how they are actually going to act on. So, the nervous system as the name suggests is going to, is a organ system which is actually going to respond to the different types of responses.

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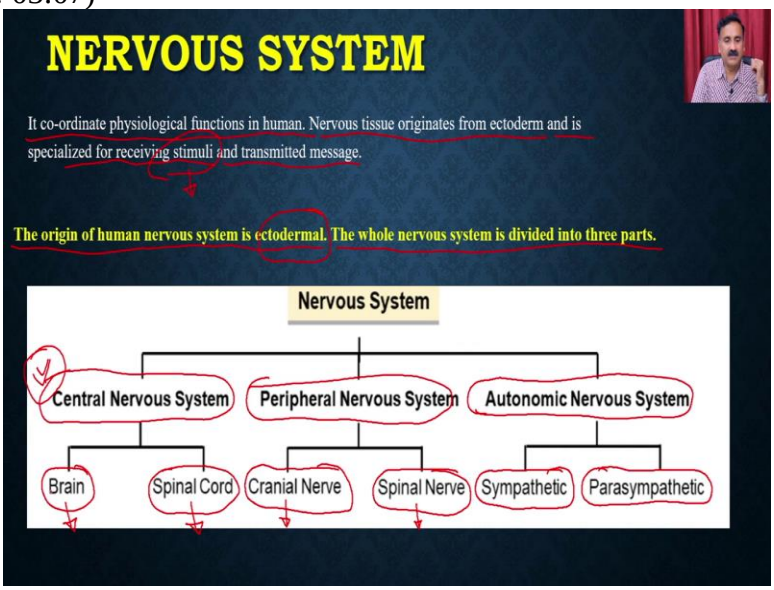

So, the nervous system is what is the physiological function is that it coordinates the physiological function in the humans. Which means, it is actually going to control the different types of activities, it is going to coordinate when there will be a secretion of the gastric juices, when there will be a secretion of the different types of hormones, when there will be a secretion of the sweat, when there will be a secretion of the different types of other signaling molecules so that the person is going to be respond accordingly.

So, the nervous system is originated from the ectoderm and it is a specialized for receiving the stimuli and the it is going to transmit the message. So, depending on the stimuli, it is actually going to transmit to the message to the particular organ. For example, if there will be a stimuli that there will be a danger. So, then that is actually going to transmit to the hormonal systems, it is going to transmit to the muscular system.

So, if there will be a danger, what you are going to do is you are going to secrete the different types of hormones. And then, in addition to that, you are also going to activate the particular type of muscular system like for example, if you have to run then the muscular muscles of the legs are going to be activated and that is how they are, you are going to start running.

In other conditions, if there is a danger signal, but that danger signal is can be managed, then it is actually going to secrete a particular type of hormone and then you are going to use your hands or other kinds of defense mechanisms to overcome that particular type of danger. So, the origin of the human nervous system is ectodermal. Which means it is actually going to be generated

from the ectodermises you know that we have the three germ layers ectoderms, endodermis and the mesoderm.

The whole nervous system can be divided into the three parts. So, the nervous system what is there in the human body can be controlled or can be divided into the three parts depending on the its functions. So, the nervous system can be divided into three parts, you can have the central nervous system, you can have the peripheral nervous system and then you can also have the automatic nervous system.

And the function of these three components are very well defined. Central nervous system is going to be comprised of the brain and the spinal cord, and they are actually going to respond to some of the executory functions. So, they are actually going to respond to the stimuli and accordingly they are going to give the functions, they are going to give the instructions to the particular organ or the organ system and that is how they are going to function.

So, in this central nervous system, you are going to have the two organs, one is called as the brain, the other one is called as the spinal cord. Then both of these organs are going to communicate to the different parts of the body through the, because they have to respond to the stimuli and then they also have to send the message. So, that is a part of the peripheral nervous system and the peripheral nervous system you are going to have the different types of nerves, you can have the cranial nerves or you can have the spinal nerves.

So, the cranial nerves are going to be the nerves which are originated from the brain, whereas the spinal nerves are the nerves which are going to be originated from the spinal cord. So, the function of these cranial nerves or the spinal nerves are going to be that they are actually going to carry the message from the particular organ present in the central nervous system to the peripheral nervous system.

And that is how it is actually going to give you the, give the message to the muscular system or it is going to give the message to the different types of glands and it is going to give the message to the other organs so that they are actually going to work. And then we have the autonomic nervous systems. So, autonomic nervous system is going to function without any voluntary action. So, it is going to be an involuntary reaction.

So, it is going to control all the involuntary actions. So, autonomic nervous system is going to have the two components, one is called as a sympathetic nervous system and the other one is called as a parasympathetic nervous system. We are going to discuss more in detail about all these three components of the nervous system.

So, in the central nervous system, you have the two organs brain and the spinal cord, in the peripheral nervous system you are going to have the different types of nerves and in the autonomic nervous system, we have the sympathetic nervous system or the parasympathetic nervous system. So, we will start with the central nervous system and first we are going to discuss about the organs. So, we have the brain and we have the spinal cord.

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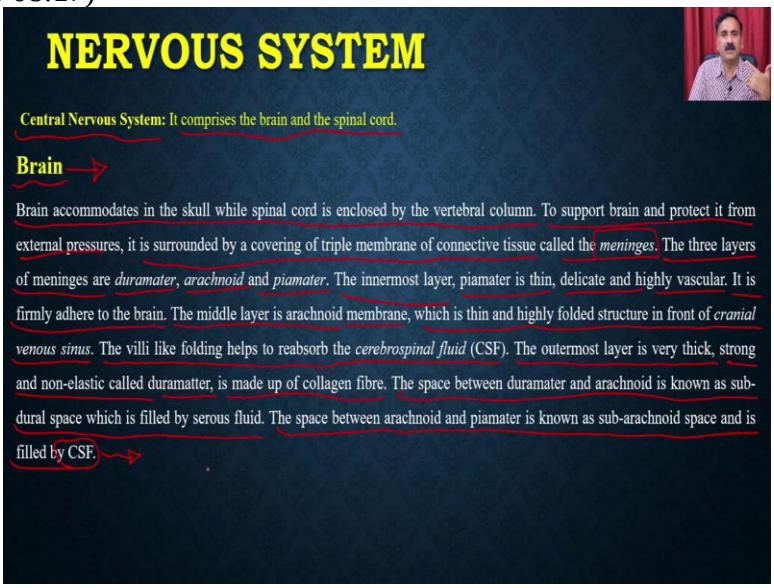

So, central nervous system, central nervous system it is comprises the brain and the spinal cord. So, let us start with the brain. So, brain is actually the main organ what is responsible for making the decision in the particular human body and brain is very delicate you know that the brain is present inside the skull and it is very delicate and it is very jelly like a tissue. So, the brain accommodates in the skull, while spinal cord is enclosed by the vertebral column.

To support the brain and protect it from the external pressures. It is surrounded by the covering of the triple membrane of the connective tissue called the meningitis and I am sure you might have heard about the different types of diseases in which the these connective tissues which are called as meningitis are actually going to be damaged or they are actually going to be get the inflammation and that is how it actually causes the disease which is called as meningitis.

And meningitis is a life threatening conditions where it is actually going to cause the damage or to the inflammation within this triple membrane. And that is how it is actually going to compromise the protection of the particular brain and that is how the meningitis is a really, really serious conditions. The three layers of the meningitis are duramater, arachnoids and the piamater ammeter.

So, all these three membranes are important or three are actually the sheets which are important for protecting the brain. The innermost layer, or the piamater is thin, delicate and highly muscular which means it is going to have the very high supply of the blood. It is formally adhere to the brain. The middle layer is called as the arachnoid membrane, which is thin and highly folded structure in front of the cranial venous sinus.

The villi like folds help to reabsorb the central cerebral spinal fluid, cerebral spinal fluid is the fluid which is present inside the brain and it circulates throughout the brain. And we discussed about the CSF. The outermost layer is very thick, strong, and the non-elastic which is called as duramatter and it is made up off of the collagen fiber. So, the outermost layer is thick, it is strong because it is made up of the collagen fiber.

The middle layer is having the different types of folds like villi like folds, and its job is to reabsorb the secreted or reabsorb the cerebral spinal fluid, whereas the inner layer is a thin piamater and that is going to be having the inner sticking to the brain. The space between the duramater and arachnoid is known as the subdural space which is filled by the Cirrus fluid. The space between the arachnoid and the piamater is known as a subarachnoid space and it is filled by the CSF or the cerebral spinal fluid.

And the cerebral spinal fluid is going to be a way so that your brain is going to communicate. Now brain is a very very complex organ and brain is anatomically can be divided into three main parts, it can be divided into like the forebrain, midbrain and the hindbrains.

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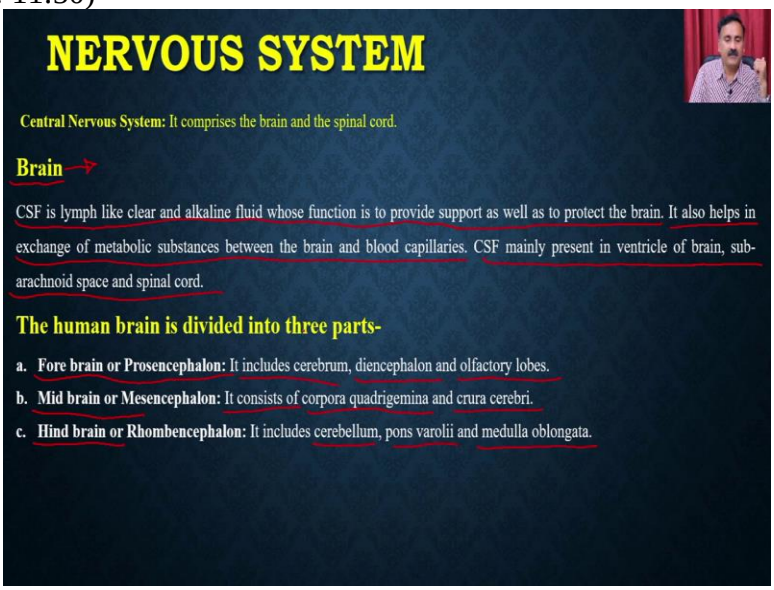

So, brain is going to have the very very complicated and the brain that is why the brain is being present inside a skull like a hard metal and then it is also being covered by the membrane and within the membrane, they have the fluid which is going to be called as the CSF. So, CSF is a lymph like clear and alkaline fluid whose function is to provide support as well as to protect the brain.

It is also helps in the exchange of metabolic substances between the blood and the blood cavalry. So, CSF is actually going to be served as a medium through which the blood is, through which the nutrients are actually going to be exchanged between the brain and the surrounding blood. CSF mainly present in the ventricle of the brain and the sub arachnoid space and the spinal cord. And according to the anatomy, the human brain can be divided into three parts, it can be fore brain or the Prosencephalon.

It includes the cerebrum, diencephalon and the olfactory lobes. And you have the mid brain it consists of the carproa quadrigemina and crura cerebri. And then you have the hind brain and it includes the cerebellum, Pons varolii and medulla oblongata. So, let us discuss about the anatomy of the brain. So, let us start with the forebrain.

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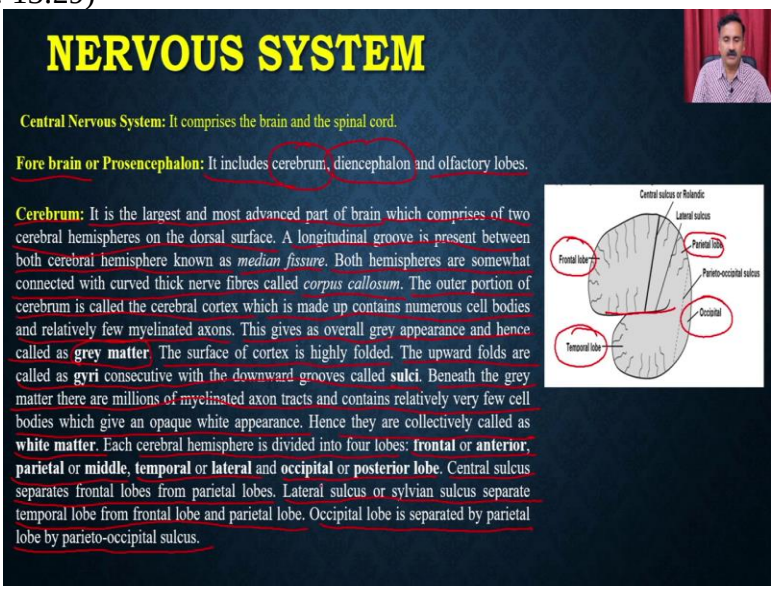

So, forebrains, it includes the cerebrum, diencephalon and the olfactory lobes. So, cerebrum, this is what you see is the cerebrum. It is the largest and the most advanced part of the brain which comprises of the two cerebral hemispheres on the dorsal side. So, what you see here is the two two lobes.

One is called as the frontal lobe the other one is called as a temporal lobe. A longitudinal groove is present between the both cerebral hemisphere known as the median, median fisheries, both hemispheres are somewhat connected with a curved thick nerve fiber which is called as the corpus callosum. So, this is what is the corpus callosum.

The outer portion of the cerebrum is called as the cerebral cortex, which is made up of numerous cell bodies and relatively few myelinated axon. This gives as the grow overall gray appearances and hence it is called as the gray matter. So, cerebellum is actually having a cerebral cortex and that cerebral cortex is also called as the gray matter. The surface of the cortex is highly folded, the upward folds are called as the gyri consecutively with the downwards grooves are called as a sulci.

Beneath the gray matters there are millions of myelinated exon tracks and contains relatively very few cell bodies, which gives an opaque white appearance hence they are collectively called as the white matter. Each cerebral hemisphere is divided into the four lobes. You have the frontal or the interior lobe. So, you have the frontal lobes. Then you have the parietal or the middle lobe. So, this is the parietal or the middle lobe.

Then you have the temporal or the lateral lobes, and this is the temporal at the lateral lobes and then we have the occipital or the posterior lobe. So, this is the occipital or the posterior lobe, a central or sulcus separate the frontal lobe and the frontal or the parietal lobes. This is the central sulcus which is actually going to separate the frontal lobes as well as the parietal lobes, whereas the lateral sulcus or the Sylvian sulcus, separate the temporal lobe from the frontal lobe and the parietal lobe. And the occipital lobe is separated by the parietal lobe by the parietal occipital sulcus. So, these are the this is the anatomy of the cerebrum.

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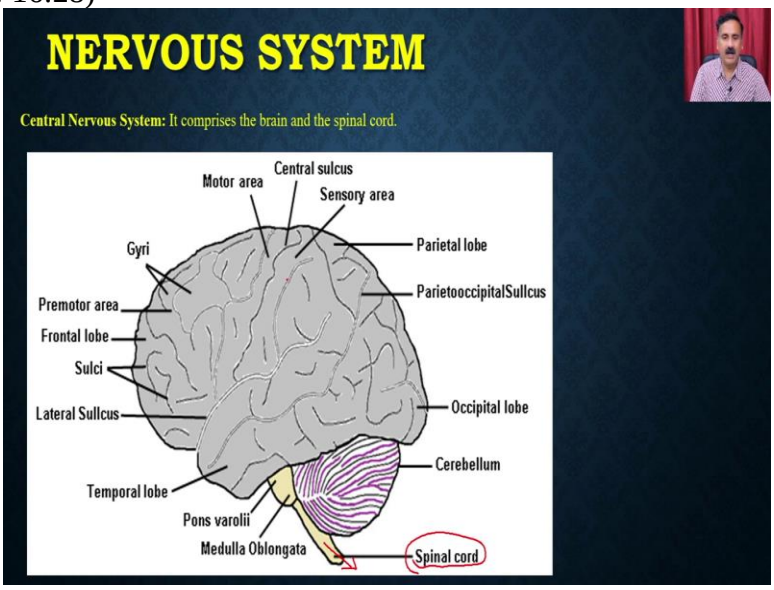

And this is what you see as a brain. So, in this brain, you have the different types of organs, you have the different portions you have the forebrains, mid brain and the hind brain. And in the hindbrain, you have the cerebellum, medulla oblongata, and the pons varolii and the cell this medulla oblongata is only getting extended and that is how it is actually going to form the spinal cord. So, this is what you see here is the structure of the complete brain and how the three different parts of the brain are actually going to be reorganized.

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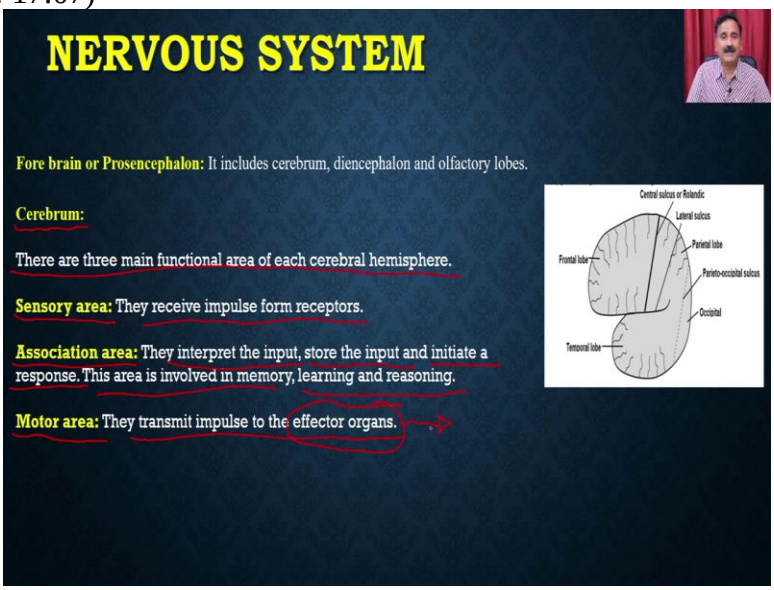

Now, let us go to the second part of the forebrain. So, cerebrum, cerebrum is there are three main functions of the each cerebral hemispheres you have the sensory area, so they receive the impulse from the receptor, then you have the association area they interpret the input, store the input and initiates a response this is the area which is involved into the memory learning and as well as the reasoning part.

So, this is very, very important because it actually helps or this is actually be important in terms of memorizing the stuff then you can actually be able to process that information and then you can be able to come out with the outcomes and then you can actually be based on those outcomes, you can actually be able to take the decisions.

Then we have the motor areas, so they transmit the impulse to the different effector functions. So, this is a very important function which is actually going to so the motor area is actually going to coordinate the activities of the different types of organs.

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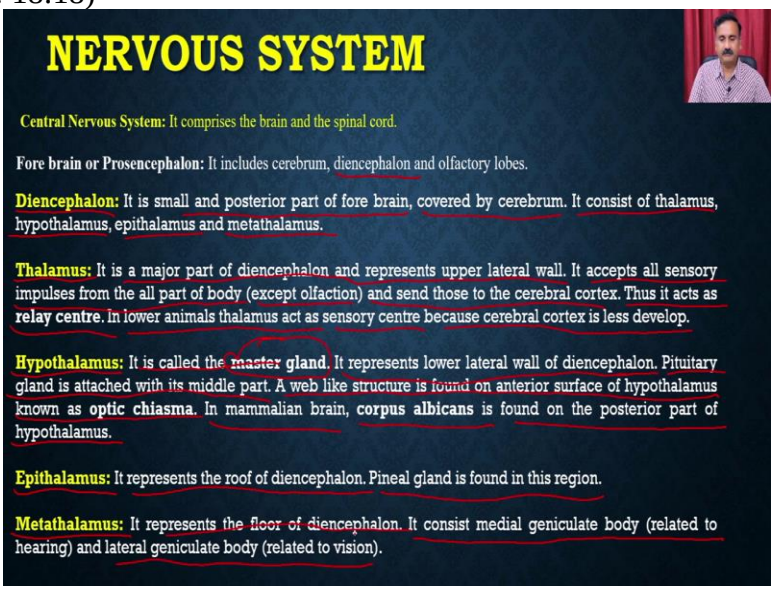

Then we have the second component which is called as diencephalon. So, it is a small and the posterior part of the forebrain covered by the cerebrum. It consists of the thalamus, hypothalamus, epithalamus and the metathalamus. So, thalamus it is the major part of the diencephalon, and represents upper lateral wall it accepts all in sensory impulse from the all part of the body except the olfaction and send those to the cerebral cortex which means it is going to send it to the gray matter, does it act as a relay center.

So, in lower animals, the thalamus act as a sensory center whereas, because the central cortex is cerebral cortex is less developed. Then we have the hypothalamus so it is called as the master gland of the human body, and it represents the lower lateral wall of the diecenphalon. Is pituitary gland is attached with this middle part of web like structure is found on the interior surface of the hypothalamus known as the optic chiasma.

In mammalian brain corpus albicans is found on the posterior part of the hypothalamus and hypothalamus is a very, very important part of the forebrain which is going to take part in different types of the activities. Then we have the epithalamus it represents the roof of the diencephanol and Pineal gland is found in this particular region, so it is going to secrete the different types of hormones.

Then we have the metathalamus it represents the floor of the diencephalon and it consists medial geniculate body and it relate geniculate body. So, the metathalamass is actually related to vision.

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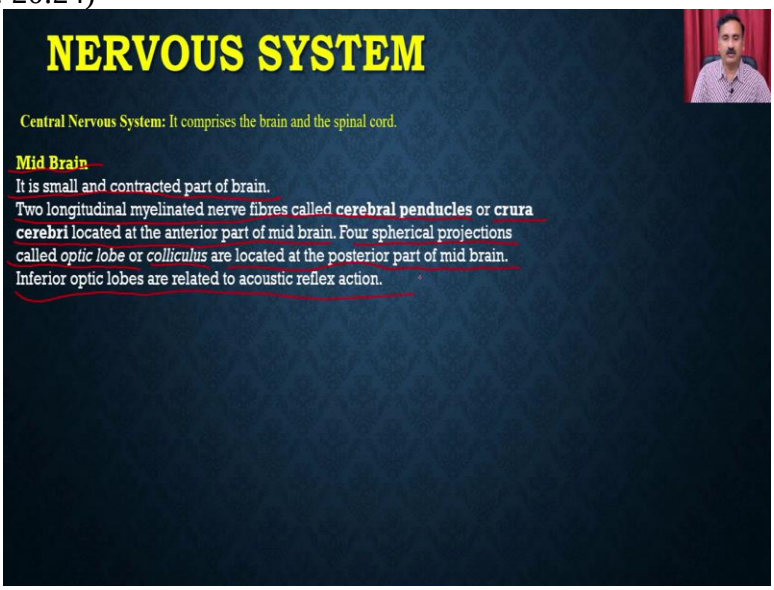

Then we have the midbrain, so midbrain, it is the small and the contracted portion part of the brain. There are two longitudinal myelinated nerve fibers called as the cerebral pediculus or crura Cerebri located at the interior part of the midbrain. Four spherical projections called optic lobe or colliculus are located at the posterior part of the midbrain and the inferior optic lobes are related to the acoustic reflex actions.

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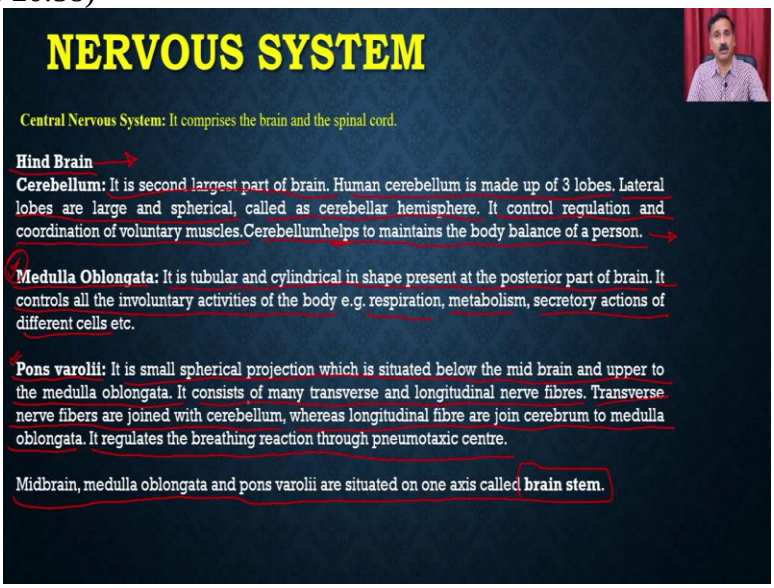

And then we have the hind brains, a hind a brain is also very, very useful area where you have the cerebellum, medulla oblongata, and the Pons Varolli and all these parts or the regions are actually going to participate very actively into different types of activities. So, it is the second

largest part of the brain cerebellum. Human cerebellum is made up of the three lobes you have the lateral lobes.

Lateral lobes are large and spherical called as the cerebellar hemisphere it controls and regulations and coordination of the voluntary muscles and then we have the cerebral cerebellum helps to maintain the body balance of a person so it is actually going to function in terms of controlling the balance of that particular individual. And then we have the medulla oblongata, it is the tubular and the cylindrical in shape present at the posterior part of the brain.

It controls all the involuntarily activities of the body for example, respiration, metabolism secretory activity of the different types of cells. So, medulla oblongata is a very important part of the brain which actually controls the involuntary activities of the body. So, it is actually going to be a part of the even the automatic nervous system as well. Then we have the Pons varolli. So, it is the small spherical projection which is situated below the midbrain and it is upper to the medulla oblongata.

It consists of the many transfers and longitudinal nerve fibers, the transferred nerve fibers are joined with the cerebellum, whereas the longitudinal fibers are joined cerebellum to the medulla oblogata it regulates the breathing reactions to the new pneurmotaxic center. So, it is Pons varolii is actually going to participate in to the breathing reactions. Midbrain medulla oblongata and Pauls Varolii are situated on the one axis which is called as the brainstem.

So, all these different parts of the central nervous system is actually going to have the different types of nerves and that those nerves are actually going to control the different parts of the activities or different parts, different activities. Apart from that the brain itself has the different regions and all different regions are actually going to control the different types of activities in the human body.

For example, just now, you have seen that the medulla oblongata is actually going to control the involuntarily activities like the respiration, metabolism and secretory activities. Similarly, the Pons varolii is actually going to control the breeding the actions and so on. So, let us see what are the different activities are going to be controlled by the brain.

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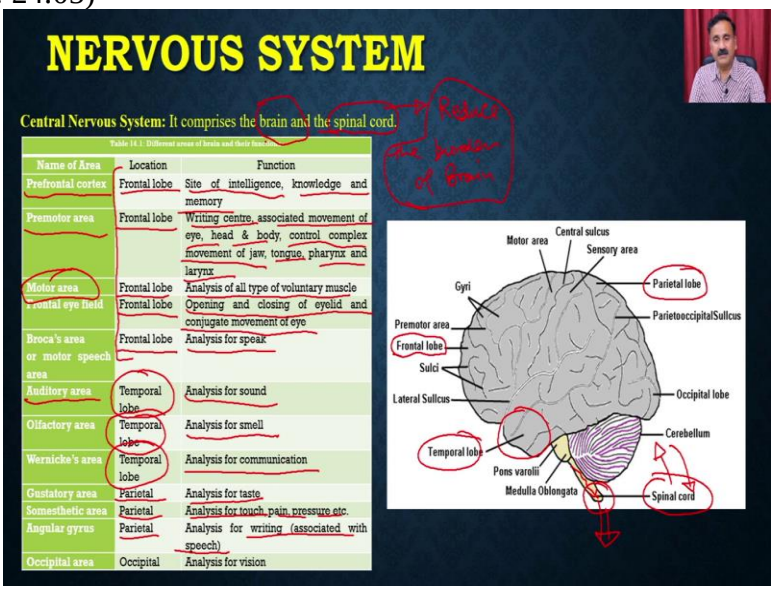

So, these are the different regions which are actually been part so and they are actually going to have the different types of functions. So, what you see here is I have shown the different types of functions interior brains, middle brain and the hind brain. So, in the radial like the prefrontal cortex you have the frontal lobes and the frontal lobe is actually going to be present here and that is the site of the intelligence, knowledge and the memory.

So, if there is a frontal lobes and so frontal lobe is then we have the premotor areas. So, frontal lobe is actually going to help the person to writing centers associated movement of the eye, head and the body and the control, complex movement of jaw, tongue, pharynx and the larynx, then the frontal lobes which is going to be having connected to the motor neurons is also going to be a part of the analysis of the all types of voluntary muscles.

Then we have the frontal lobes which is going to be controlled the opening and closing of the eyelids and the conjugate movement of the eye. Then we also have the frontal lobes, which are going to be part of this area. And they are also going to have the analysis of the speak. So, which means what you are going to speak, what you, how you are going to speak all that is going to be controlled by the frontal lobe.

So, frontal lobe is mostly been a part of the intelligent area. So, it is part of your intelligence, which is actually going to control the different types of activities like how you are going to acquire the knowledge, how you are going to memorize the stuffs and all that.

Then we have the auditory areas. So, in the auditory area, we have the temporal lobes. So, in the temporal lobes, which is actually going to be used for the analysis for the sound, then the temporal lobe is also going to be used for the analysis for the smell, and the temporal lobe is also going to be used for analysis for the communications. So, this is the temporal lobe this is the temporal lobe what you see and that is actually going to have the controlling mechanisms for the sound, smells and communications.

And then we have the parietal area or in the parietal area you have that is the analysis for the taste, touch, pain, pressure, and for the writing like which is means if you are also going to be associated with the association. So, the parietal area is this, so you are going to have the parietal area, and that is also going to function as the in different types of activities like taste, touch, and all that.

And then we have the occipital area, occipital area, there will be analysis of the vision. So, it is going to control the vision. Now, so, this is all about the anatomy of the brain and the different components of the brain like the forebrain, midbrain and hind brain and how the what are the different parts are present in these particular different region of the brain and how these different regions are actually controlling the different types of activities of the brain.

Now, let us let us move on to the next component and the next component is a spinal cord because you see that the medulla oblongata is actually going to be extended into the spinal cord. So, spinal cord after these it is actually going to run into the vertebral column and the spinal cord is actually going to do the exactly the same function as the brain except that it is actually requiring the training. So, spinal cord is initially will actually going to receive the training from the brain and then once it got the training, then it is actually going to be control the all the activities.

So, spinal cord is the activity from the spinal cords are mostly requiring the pre training sessions for example, there are the involuntarily activities which are actually going to be controlled by the spinal cord. So, so, the main purpose of having a spinal cord into the nervous system is that it actually reduces the load of the brain. So, that all the, for all type of decision the signal should not go to the brain.

So, signal will first go to the spinal cord and then if the that signal is can be decided that signal can be processed simply by the spinal cord, there is no decision making required because like for example, eating food, for example. So, if eating food is a, does not require the decision from the brain but for the taste and all other kinds of activities, you require the decision from the brain like what you will eat that you are going to decide from the brain but how you are going to eat, how you are going to do the ingestion and digestion and all that that is going to be controlled by the spinal cord.

So, the purpose of having a spinal cord is that it is going to reduce the burden of the brain. Because if you reduce the burden of the brain, it is actually going to take care of the all different it can actually be able to be, it can be more efficient in terms of the taking the decision for the other kinds of activities where analytical skills are required and all that.

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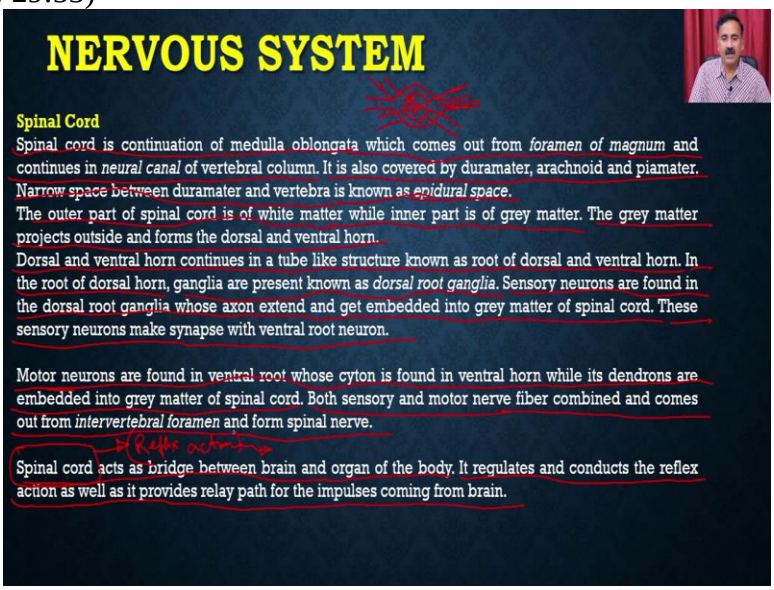

So, let us discuss about the spinal cord and spinal cord is the continuation of the medulla oblognata which comes out From the foramen of Magnum, and it continues in the neural canal of the vertebral column. So, this is the brain, this is the area what you see here is the brain and on the backside you are going to have the extension of the medulla oblognata. So, spinal cord is actually an extension of the hindbrain.

And then it is actually going to go into the vertebral column. So, our vertebral column is actually going to have the hole so you have the vertebral column like this, and the vertebral column in the center you are going to have the nerve fibers and these nerve fibers are going to run throughout

the vertebral era. And that is how they are actually going to take out these the nerves from this vertebral and this spinal cord.

And that is how they are actually going to control the different parts of the body. It is also covered by the duramater, arachnoids and the piamater. Narrow space between the duramater and vertebra is known as the epidural space. The outermost part of the spinal cord is of a white matter while the inner part is made up of the gray matter. The gray matter projects outside and forms the dorsal and the ventral horn.

The dorsal and the ventral horn continue in a tube like structure known as the root of dorsal and the ventral horn. In the root of the dorsal horn the ganglia are present known as the dorsal root ganglia, whereas the sensory neurons are found in the dorsal root ganglia whose exon exist and get embedded into the gray matter of the spinal cord. These sensory neurons make synapses with the ventral root neurons.

Motor neurons are found in the ventral route whose cyton is found into the ventral horn while it is dendrons are embedded into the gray matter of the spinal cord. Both the sensory as well as the motor nerve fibers combined and comes out from the intervertebral foramen and form the spinal cord. Spinal cord act as a bridge between the brain and the organ of the body this is what I was trying to explain that spinal cord is actually a bridge between the brain and other parts of the organ other organs what are present in the body.

So, before the decision can be made by the brain the if there is, there is a training to the spinal cord it actually can help to take the decision it regulates and conduct the reflex action as well as it provides a relay path for the impulses coming from the brain. So, main area where the spinal cord is going to act is actually the reflex action which means if you do this I will do this. So, reflex action means a type of instant actions. So, the reflex action could be of different types.

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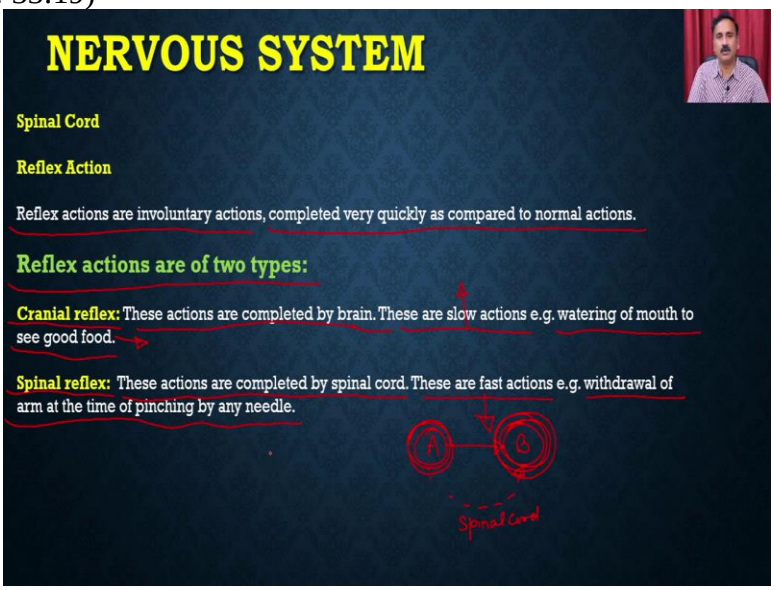

Reflex actions are the involuntarily action completed very quickly as compared to the normal action. So, reflex action means instant action. So, if you do this, I will do this like kind of thing. And reflex action can be of two different types it can be cranial reflexes or it can be a spinal reflexes. Cranial reflexes, these actions are completed by the brain, they these are the slow actions. So, cranial reflexes are the reflexes which are actually going to be controlled by the brain and they are slow action.

So, you see that a brain if the message will go to the brain the brain is going to take time because it has to process the information and then it will actually going to take the decision and that is why they are going to be slow. For example, the watering of mouth to see the good food so when you see a good food for example, when you see any of your favorite sweet whenever you see any of your favorite food, it actually you started watering on the mouth.

And that happens because there is a cranial reflex. Then we have the spinal reflex these actions are completed by the spinal cord, these are the fast action why they are fast action because there is a set rule that if A is happen, you are going to do B and that A to B is already been processed into the spinal cord. So, there will be a complete training through which the brain has actually trained the spinal cord that if you have the A situation, you are going to do the B action.

So, if there is no decision power, there is no decision what you are going to take right that A to B is actually already been preprogrammed into the spinal cord by the brain. And that is why these actions are fast. For example, the withdrawal of the arm at the time of pinching by any needle,

for example, when you put your hand into the flame, instantly without even thinking whether there is a, I should remove my hand or so on that you always withdraw your hands.

Similarly, if you touch to any sharp edges, you always remove your hands. So, with this, I would like to conclude today's lecture in our subsequent lecture, we are also going to discuss about the some more aspects related to the nervous system. Thank you.