Human Physiology
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Week - 11
Lecture - 01

Welcome, everyone, to another new class of Human Physiology. This week, we will discuss our nervous system, and we will examine various components of our nervous system, their functions, and how the nervous system and neurons work. So, let us stay with it. What different concepts will be covered in today's class? So, today first we will kind of go through the basics of the nervous system, and we will also discuss the functions of different components of the nervous system; in general, we will also see the structural organization and types of the nervous system. So, to start with, what is the nervous system? The nervous system is a combination of networks that primarily controls our overall communication in the body. It is a very complex and highly organized procedure that is responsible for coordinating different types of actions, along with transmitting signals to different body parts.

So, for example, if we experience any heat or pain, we process it in terms of visual observation, along with all of these different senses, which all kind of process via our nervous system. It is important to also highlight that the nervous system consists of different specialized types of cells. The most important and primary component of the nervous system, the unit cells, is called a neuron. Apart from neuronal cells, there are other types of supporting cells; these are called glial cells.

So, mostly if you check in terms of the nervous system, these neurons and glial cells together compose and constitute the processes of this nervous system. And then a bunch of neurons together form the nerve cell. So, basically, like a nervous system mainly in the peripheral nervous system, we will also observe the nerves. If nerves are also responsible for rapid reflexes and action. Overall, the nervous system is very important for our complex life processes, and without it, we will not be able to process all the signals and perform different actions.

What is the different function of the nervous system? So, as you can see, the nervous system has a very important role in terms of sensory input, which receives different types of information from external and internal environments through different sensory receptors. For example, touch, sound, taste, smell, etc. The nervous system also has a very important role in terms of integration. It helps in processing and interpreting the sensory input received by the spinal cord and the brain. This also involves analyzing different information, making crucial decisions, and planning.

So, the nervous system also has a very crucial role in terms of motor output, right? So, basically, once our brain and spinal cord receive signals from various sensory sources, our brain processes those signals and sends out the motor signals or motor output to our skeletal muscles, including different glands. Apart from that, the nervous system also has a very crucial role in regulating different body functions to create physiological homeostasis. This can be like maintaining heart rate; this can be like maintaining blood pressure or breathing rate. Apart from all these functions, our nervous system overall also plays some higher and complex functions. It can involve complex cognitive functions including thinking, memory, learning, language processing, emotions, and consciousness.

So, if you look at the overall structural organization of the nervous system, you see that our nervous system is generally classified into two components. One is the central nervous system, which is called the CNS, and what is the important role of the CNS? In short, the central nervous system processes, integrates, stores information, and issues orders to muscles and organs. So, basically it receives different types of sensory signals, and other signals process those signals and send out the task-related signals to different skeletal muscles and organs. Then we have the second classification or category of our nervous system, which is the peripheral nervous system, or PNS. And basically, this PNS, or peripheral nervous system, is connected across the peripheral parts of our body, including limbs, hands, and legs, and it transmits different information from the CNS to the different parts of our body.

So, if you see, the CNS is composed of mainly two important parts: one is the brain and the second is the spinal cord. And as you know, the brain is the most important and chief component of our whole nervous system; it has different roles that we will discuss one by one. Apart from that spinal cord, there is a bridge gap between the brain and the peripheral nerve. Then in terms of the peripheral nervous system, it has two different classifications: one is the sensory division and the second is the motor division. The sensory division has an important role in terms of processing different sensory applications, mainly collecting all the information from the environment and sending it to our CNS via the PNS.

And then the motor division has two components again. You can see that one is the somatic nervous system, which mostly controls our skeletal muscles, and the second is the autonomic nervous system, which is important. It mostly regulates glands, blood vessels, internal organs, etc. And in the autonomous nervous system, it is mostly called involuntary, right? So, the autonomous nervous system is also called involuntary, whereas the somatic nervous system can be called voluntary. So, the involuntary action of this autonomous nervous system is again classified into two components: one is the sympathetic nervous system, and the second is the parasympathetic nervous system.

So, in terms of the sympathetic nervous system, it mobilizes our body and prepares our body for action and energy output. So, basically, whenever there is a condition of stress, the sympathetic nervous system prepares our body to perform certain tasks. In terms of the parasympathetic nervous system, it conserves energy and relaxes the body. So, it maintains a quiet state. So, as you can see, the nervous system is quite complex, and different components, different circuits, and different organizations are there to perform certain tasks.

So, let us see one by one in a little bit of detail. So, as you see in terms of the central nervous system, it is mostly like we have our brain and spinal cord. So, this is like the two important components: the brain and spinal cord, and as we said, apart from the brain and spinal cord, there are different types of cranial nerves and spinal nerves; these are spread across our peripheral body parts towards the corners, like the hands and limbs, and these are part of the PNS or the peripheral nervous system. So, the central nervous system mostly consists of the brain and spinal cord, and the peripheral nervous system consists of different nerves and various neuronal tissues, including ganglia and nerves. Now, in terms of the central nervous system, the most important component or organ is the brain.

As you know, the brain is the most complex organ in the human body, and it is highly responsible for various functions, including processing, thought processes, memory, emotions, language processing, and voluntary movement. There are some major regions or compartments

in the brain. In the next class, we will have a detailed discussion about the brain, where we will discuss every component of it, but this is a preliminary introduction to the brain. So, let us see what the different regions of the brain are. So, in the brain we have a major component, which is the cerebrum, one of the largest components of the brain; you can see this is the whole part of the cerebrum.

And this is the largest part responsible for different types of higher-level functions. It has distinct components; for example, the frontal area, parietal area, temporal area, and occipital area. So, in the next class, we will see the exact position of those lobes and what their functions are. Then we also have another component in the brain, which is the second largest part, the cerebellum. Cerebellum coordinates different voluntary movements, including very important ones such as posture, balance, and motor learning.

Then we have another component, which is the brain stem, right? So, this area is called the brain stem. It connects the cerebrum, the cerebellum, and the spinal cord. So, the brain stem has a very important role to play because it connects the larger cerebellum to the spinal cord. So, in this way, it also controls different important functions, for example, heart rate, breathing, and sleep-wake cycles. So, as you can see, this is the three most important components of the brain: cerebrum, cerebellum, and the brain stem.

Apart from that, there is another component, which is the diencephalon. It includes mostly two components: one is the thalamus. which relays the sensory information and then another important component, which is the hypothalamus. It has a very important crucial role as an endocrine gland, if you remember. So, you know, like all the different roles we have already discussed in previous weeks, what are the different roles of the hypothalamus? Apart from its different endocrine roles, it also helps in maintaining the body's temperature regulation.

Then the second most important component of the CNS is the spinal cord, as you can see. So, from the brain, which is like a long cylindrical structure that extends right from the brainstem down to the vertebral column. So, the primary pathway for communication acts like a connection between the brain and the different parts of the peripheral nervous system, and from the spinal cord, various peripheral nerves are located and extend to different parts of the body. So, the spinal cord is also highly responsible for different quick responses, such as reflexes, for example, rapid involuntary responses to any stimuli. It is protected by different structures like meninges and vertebrae, as well as bone structure.

You remember how we thoroughly discussed the bones and joints, right? Apart from the cranial part, we covered how the spinal cord arises and the different components of the spinal cord, as well as the structure of everything during our bone discussion. This is organized into different types of segments, for example, each giving rise to the spinal nerve. So, as I said, the spinal cord is highly responsible for the rapid and quick reflexes in response to different types of stimuli. So, let us see in this image how a certain action can bypass the signal processing to the brain and can actually get processed inside the spinal cord for a rapid action. So, you can see in this case that if we touch something like a hot object or there is a burn or heat sensation, the afferent signal will eventually process through various nerves and go to our spinal cord, and eventually the efferent signals will occur without further going to the brain.

So, there would not be any further processing towards the brain. So, the efferent signals will immediately come out from the spinal cord and send the signals to our skeletal muscles and the muscle cells in order to create an immediate reflex. So, this is another way that quick reflexes

can actually be processed inside the spinal cord, avoiding or bypassing the processing time inside our brain. So, this is a very rapid kind of action that you can see. Then, after the CNS, we have the next component, which is the peripheral nervous system.

As we said, the peripheral nervous system is the house for different peripheral nerves that come out from the spinal cord, and basically, it integrates all peripheral parts of the body. So that different signals can come, sensory signals and other types of signals from the environment can travel through those peripheral nerves to the spinal cord and the brain, and eventually, once the sensory signals are processed, the motor signals can be sent via the brain and spinal cord back to our skeletal muscles and the organs for further processing. The peripheral nervous system is divided mainly into two components, as we said; the first one is the sensory or afferent division, which carries different sensory information from the receptors in the body to the central nervous system. And the second important component is the motor or efferent division; it carries all the commands after the initial signal processing in the brain and spinal cord, sending the signal back to different skeletal muscles and glands. So, in terms of the sensory division, as you can see, it transmits different impulses from the sensory receptors towards the CNS.

So, if you see all the environmental responses, it transmits towards the sensory. Mostly, the sensory signals it transmits towards the CNS, right? And once those sensory signals are processed, those processed signals eventually come out from the brain and the spinal cord, and in terms of motor expression, the motor signals go to different parts of the organ or the muscle. So, the sensory receptors are highly specialized to detect various types of stimuli, for example, touch, temperature, pain, light, sound, smell, taste, etc. Sensory neurons can carry this information along the sensory pathway to the brain and spinal cord. And as we said, in terms of the motor or the efferent division, it transmits signals from the brain or spinal cord to our skeletal muscles.

So, if it transmits the voluntary-like movements towards the skeletal muscle, which is called the somatic nervous system. So, basically, the somatic nervous system controls all our voluntary movements via the skeletal muscles. The autonomous nervous system, which is also another important component of the motor or efferent division, mostly controls the involuntary actions of the smooth muscles, different cardiac muscles, and the glands. So, if you look at it in terms of the somatic nervous system, as we said, it controls the voluntary functions of skeletal muscle movement. So, basically, in this way, it acts as a communication tool to create a communication pathway.

To act as a direct communication line between the brain and our skeletal muscles. So, basically, without the somatic part of the nervous system, the signals will not be able to pass to our legs or hands for skeletal muscle movement. Acetylcholine is a very important neurotransmitter, as it plays a crucial role in different types of neuromuscular junctions, where the signal from the motor neuron is transmitted to the muscle fiber, triggering the contraction needed for movement. So, acetylcholine is a very important and crucial neurotransmitter present in our body, and basically this molecule passes from one neuron to another neuron, one nerve to another nerve in order to carry those signals from the brain to the skeletal muscle, eventually triggering those skeletal muscles for contraction. The autonomous nervous system regulates, as I said, involuntary functions and also controls oral physiological homeostasis.

This can be divided into different components, mostly the two components: one is the sympathetic nervous system, which controls the excited state. So, whenever our body is under stress and needs to perform a certain action, the sympathetic nervous system comes into play.

So, in this way, the sympathetic nervous system mostly plays a crucial role in the fight or flight responses. Some of the functions can be like playing in terms of increased heart rate, dilated pupils, slow digestion, etc. In terms of the parasympathetic nervous system, it acts exactly in the opposite way.

So, basically it relaxes the body and tries to conserve different types of energy. Apart from the sympathetic and parasympathetic nervous systems, there is one more, called the enteric nervous system, which can be considered a third branch of the ANS and works in the digestive walls to regulate the digestion process. So, briefly, as you can see, the sympathetic nervous system, which is also called the fight or flight system, acts in a different way whenever our body is under stress; it prepares the body for action. So, as you can see, the sympathetic nervous system plays an important role in mobilizing energy. So, it basically prepares the body for stress or physical activity and helps to increase the metabolic process.

The sympathetic nervous system also stimulates the cardiovascular and respiratory functions, increasing the heartbeat, blood pressure, and breathing rate. It also activates the epinephrine or the adrenal gland, which has several roles, as you know, such as increasing blood pressure, heartbeat, and breathing rate. The sympathetic nervous system also helps in dilating the pupil, which enhances visual dimensions. It also reduces gastrointestinal motility and secretion to prioritize energy use elsewhere. It is highly dominated by neurotransmitters, mainly adrenaline and norepinephrine, which it primarily utilizes for transmitting different types of responses to the signal.

In terms of the parasympathetic nervous system, as it is almost exactly the opposite, it prepares the body for relaxation and conserving energy. It also helps in terms of enhancing digestion and absorption. It also promotes various restorative functions; for example, it supports salivation, lacrimation, urination, and defecation. It also helps in constricting the pupil and the bronchioles. It is also highly dominated by neurotransmitters, and here, acetylcholine is one of the important neurotransmitters that are being used.

So, to kind of conclude, as you can see, the sympathetic system prepares our body mostly for whenever it is under stress. So, basically, you can see that it dilates the pupil, it basically increases the heart rate, and it increases bronchial activity to increase the breathing rate, right? It increases sweating; it also kind of increases the rate of glycogen to glucose production. It helps in terms of decreasing digestive activity, right? Also, it stimulates like vaginal contractions, right? Also, it really relaxes the bladder in terms of urination. And the parasympathetic activity can actually help in terms of contracting the pupil.

It slows down the heartbeat. As you can see, it also constricts the like airways in the bronchial tubules. It stimulates bile release; it constricts the blood vessels to slow down blood flow. It also stimulates or increases digestive activity; further, it can relax the uterus and also increase urinary output. So, basically, the sympathetic parasystem can reduce urinary output, and in the case of the parasympathetic system, it can increase the output. So, in case in this case parasympathetic can increase the blood flow right.

In this case, the parasympathetic system can reduce breathing. In this case, the parasympathetic system can reduce blood flow, reduce breathing, reduce heartbeat, reduce vision dimension, and in the case of the sympathetic system, it can increase vision dimension, increase heartbeat, increase breathing, increase sweat, and eventually also increase blood flow. So, I hope you could understand the basic differences between the sympathetic and parasympathetic systems,

and in general, I also hope you liked and understood our overall nervous system. So, do you know that the human nervous system contains approximately 86 billion neurons? Can you imagine that these neurons are like unit cells of our brain? And basically, they are interconnected with a very complex network and a bunch of neurons, which kind of create coils or threads; they are also called nerves. So, imagine you are walking down a street when a dog starts barking aggressively and running towards you.

Which branch of the nervous system is immediately activated in this scenario? Can you kind of answer this? Also, what are the primary neurotransmitters and hormones involved in triggering the physiological changes associated with this response? So, hopefully, you enjoyed this class on human physiology and the nervous system. If you have any questions, please drop us your questions by email; also, you can ask questions directly during the live sessions. Hopefully, you are enjoying the classes on human physiology. We will meet with you again very soon with another new class on human physiology. Thank you again for attending today.