

Nervous System

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There are two major subdivisions of the nervous system: the Central Nervous System (CNS) and the Peripheral Nervous System (PNS). The CNS consists of the brain and the spinal cord. Whereas the PNS consists of the nerves outside the CNS. These nerves bring sensory information to the CNS and transmit commands (i.e. motor information) from the CNS to the body. The PNS has three components, the Autonomic Nervous System (ANS), somatic nervous system (spinal nerves), and the cranial nerves.

The ANS is a regulatory system that controls the smooth muscles, internal organs, and the viscera. The ANS is comprised of neurons that receive information and send commands to the heart, gastrointestinal system, and the respiratory system. It is also associated with emotion regulation, and controls activity that is involuntary and is mostly automatic. The ANS is comprised of two subdivisions, the sympathetic nervous system, and the parasympathetic nervous system.

The sympathetic division is responsible for the fight or flight response. As the sympathetic division increases in activity, there are multiple physiological responses. The responses include: increased breathing and heart rate, dilation of the bronchi, secretion of adrenaline, decreased digestive activity and flow of saliva, and dilation of the pupils. The parasympathetic division on the other hand, is responsible for resting and digesting. The resulting physiological responses are the opposite of what occurs during increased activation of the sympathetic nervous system. These two systems are constantly interacting and are both

always active. However, physiological responses are determined by the proportion of which system is more active at a given time.

The somatic nervous system is another component of the PNS. This system transmits messages from some sensory organs to the CNS and from the CNS to the muscles. The output of the somatic system is mostly voluntary and can be controlled. The somatic nervous system is also known as the spinal nerves. There are 31 pairs of spinal nerves that each have a right and a left component. Each spinal nerve is a fusion of a dorsal root and a ventral root. The dorsal roots bring sensory information from the body to the CNS, via the spinal cord, while the ventral roots take motor information from the CNS to the muscles.

The PNS also includes 12 pairs of cranial nerves that are connected to the brain and serve the sensory and motor systems of the face, and most of the head. The cranial nerves each have a right and left component. Some cranial nerves have purely sensory functions, while others have purely motor functions. Additionally, some cranial nerves have both sensory and motor functions. See the additional readings for more information on the different cranial nerves and their functions.

The CNS is comprised of the spinal cord and the brain. The spinal cord is an organ of the CNS that is within the spinal column and protected by vertebrae. The primary function of the spinal cord is to collect sensory information to send to the brain, and to send motor information from the brain to the muscles. The spinal cord has 31 segments that correspond to the spinal nerves, and consists of gray and white matter. The gray matter is comprised of neurons and is the internal portion of the spinal cord. The white matter is comprised of axons, and is the external portion of the spinal cord. The dorsal portion of the white matter has tracts that bring afferent

information from the periphery to the brain, while the ventral portion of the white matter has tracts that bring efferent information from the brain to the periphery.

The brain is also part of the CNS, and is divided into three areas: hindbrain, midbrain, and forebrain. The hindbrain contains the pons, cerebellum, and the medulla oblongata. The midbrain includes the superior and inferior colliculus, and substantia nigra. The forebrain is made up of the following structures: cerebral cortex, basal ganglia, limbic system, hippocampus, thalamus, and hypothalamus.

The cerebral cortex of the brain is divided into four main lobes: occipital, temporal, parietal, and frontal. The occipital lobes contain the primary visual cortex and visual association areas. This lobe is important for the integration and interpretation of visual information. The temporal lobes contain the primary auditory cortex, which is important for the interpretation of sounds. The temporal lobes are also responsible for understanding language. This lobe also is important for memory, and plays a role in perception of movement and facial recognition. The parietal lobes analyze spatial and visuospatial information. The parietal lobes also contain the primary and secondary somatosensory areas. Reading, writing, and mathematical association areas are also contained in the parietal lobes. Lastly, the frontal lobes contain the primary and secondary motor areas. The frontal lobes also contain the prefrontal cortex, which is what separates humans from other animals. The prefrontal cortex is responsible for higher order aspects of cognitive and emotional function. More information on the nervous system can be found in the additional readings.

Further reading:

Chandler, C. (2016). *Psychobiology*. Wiley & Sons.

Hua, J. Y., & Smith, S. J. (2004). Neural activity and the dynamics of central nervous system development. *Nature neuroscience*, 7(4), 327.

Sanes, D. H., Reh, T. A., & Harris, W. A. (2011). *Development of the nervous system*. Academic Press.