Appendix 33 - The Body's Nervous Systems

Central Nervous System

The fundamental core of our being, thinking, moving, emotional responses, involuntary processes such as digestion, respiration, egestion, and much more are controlled by the CNS. It comprises a computer and a data super-highway called the brain and spinal cord, respectively. All data conduction and processing take place using these two components. The central nervous system is so named because it integrates the received information and coordinates and influences the activity of all parts of the body.[3] The CNS is contained within the skull and dorsal body cavity within the spine which extends from the head down to the pelvic cavity. The brain is contained in the cranial cavity and the spinal cord in the spinal canal. In vertebrates, the skull provides a shield as a protection to the brain, and the vertebrae serves as a flexible protection for the spinal cord.[4] The PNS (Peripheral Nervous System) is everything else. The peripheral nervous system is so named because it is on the periphery—meaning beyond the brain and spinal cord. There are exceptions. In actuality, some elements of the peripheral nervous system exist within the cranial or vertebral cavities.[5]

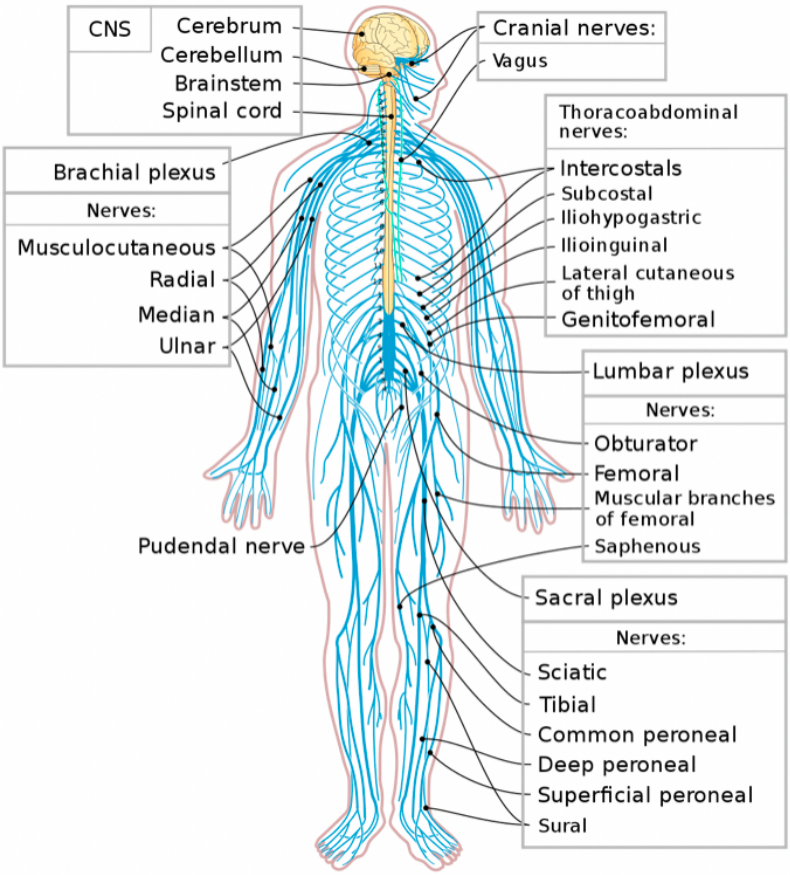

Figure 1, CNS and Major Nerves

Peripheral Nervous System

The PNS contains all the nerves lying outside the CNS and is subdivided into sensory-somatic nervous system, which transmits sensory information from the skin, muscles, and sensory organs to the CNS and sends motor commands from the CNS to the muscles, and the autonomic nervous system, which controls bodily functions without conscious control. The ANS (autonomic nervous system) is divided into parasympathetic and sympathetic nervous systems.[6]

Autonomic Nervous System

The ANS – The autonomic nervous system is divided into two parts, the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). The autonomic nervous system supports internal organs, including the blood vessels, stomach, intestine, liver, kidneys, bladder, genitals, lungs, pupils, heart, and sweat, salivary, and digestive glands.

The autonomic nervous system controls involuntary internal body processes such as:

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[3] Maton, Anthea; Jean Hopkins; Charles William McLaughlin; Susan Johnson; Maryanna Quon Warner; David LaHart; Jill D. Wright (1993). *Human Biology and Health*. Englewood Cliffs, New Jersey, USA: Prentice Hall. pp. 132–144. ISBN 0-13-981176-1.

[4] Ibid.

[5] Wikipedia, CC BY-SA 3.0, https://en.wikipedia.org/wiki/Central_nervous_system_disease, 28-Apr-2010, accessed 27-Jun-2019

[6] By Mysid (original by Tristanb) - Vectorized in CorelDraw by Mysid on an existing image at en-wiki by Tristanb., CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php

- Blood pressure
- Heart and breathing rates
- Body temperature
- Digestion
- Metabolism (thus affecting body weight)
- The balance of water and electrolytes (i.e., sodium and calcium)
- The production of body fluids (saliva, sweat, and tears)
- Urination
- Defecation
- Sexual response

Sympathetic Nervous System

The sympathetic nervous system promotes a fight-or-flight response, corresponds with arousal and energy generation, and inhibits digestion. For example, consider your experience of when surprised a vicious animal appeared or the threat of an impending accident when driving. An immediate dump of adrenaline floods into your bloodstream to cause any or all of the following:

- Diverts blood flow away from the GI (gastro-intestinal) tract and skin via vasoconstriction
- Blood flow to skeletal muscles and the lungs is enhanced (by as much as 1200% in the case of skeletal muscles)
- Dilates bronchioles of the lung through circulating epinephrine, which allows for greater alveolar oxygen exchange
- Increases heart rate and the contractility of cardiac cells (myocytes), thereby providing a mechanism for enhanced blood flow to skeletal muscles
- Dilates pupils and relaxes the ciliary muscle to the lens, allowing more light to enter the eye and enhances far vision
- Provides vasodilation for the coronary vessels of the heart
- Constricts all the intestinal sphincters and the urinary sphincter

In the context of chronic pain, how does the sympathetic nervous system change the pain response?

The SNS (sympathetic nervous system) and pain interact on many levels of the central nervous system. In healthy individuals, activation of the SNS in the brain normally suppresses pain through descending inhibition of nociceptive transmission in the spinal cord. Some data suggests that the SNS might control peripheral inflammation and nociceptive activation. It is noteworthy, that slight changes in pathophysiology can influence the effect of SNS on pain, and vice versa. In this process, we see an increase in inflammation or nociceptive activation; spinal descending inhibition normally seen in healthy individuals is reversed to spinal facilitation. The awareness of these changes can bring about anxiety, which exacerbates and intensifies pain perception, leading to expected negative changes in pain behavior, causing depression and other biopsychosocial struggles for the patient and their family.[7]

Parasympathetic Nervous System

The parasympathetic nervous system is said to promote a "rest and digest" response, promotes calming of the nerves return to regular function, and enhancing digestion. Functions of nerves within the parasympathetic nervous system include:

- Dilating blood vessels leading to the GI (gastrointestinal) tract, increasing the blood flow.
- Reducing the bronchiolar diameter when the demand for oxygen has reduced
- Dedicated cardiac branches of the vagus and thoracic spinal accessory regulate the heart (myocardium)

[7] Schlereth T, Birklein F, The sympathetic nervous system and pain, Neuromolecular Med., 2007; 10(3):141-7, DOI: 10.1007/s12017-007-8018-6

- Constriction of the pupil and contraction of the ciliary muscles, provide for nearer vision
- Stimulating salivary gland secretion, controls digestion of food and, indirectly, the absorption of nutrients

Sensory-Somatic Nervous System

Motor neurons transmit messages about desired movement from the CNS to the muscles to make them contract. Without the sensory-somatic nervous system, an animal could not process any information about its environment (what it sees, feels, hears, and so on) and could not control motor movements. Unlike the autonomic nervous system, which has two synapses between the CNS and the target organ, sensory and motor neurons have only one synapse—one ending of the neuron is at the organ and the other directly contacts a CNS neuron.

The sensory somatic nervous system encompasses cranial and spinal nerves and contains both sensory and motor neurons. Sensory neurons transmit sensory information from the skin, skeletal muscle, and sensory organs to the CNS. Without the sensory somatic nervous system, we could not process any information about our environment (seeing, hearing, tasting and smelling) and could not control motor movements enabling and controlling movement.