Anatomy and Physiology

Nervous System

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The Autonomic Nervous System

The peripheral nervous system consists of the **somatic nervous system (SNS)** and the **autonomic nervous system (ANS).**

- The SNS consists of motor neurons that stimulate skeletal muscles.
- The ANS consists of motor neurons that control smooth muscles, cardiac muscles, and glands. The ANS monitors visceral organs and blood vessels with sensory neurons, which provide input information for the CNS.
- The ANS is further divided into the sympathetic nervous system and the parasympathetic nervous system.
- Both of these systems can stimulate and inhibit effectors. However, the two systems work in opposition—where one system stimulates an organ, the other inhibits.

The sympathetic nervous system

The sympathetic nervous system prepares the body for situations requiring alertness or strength, or situations that arouse fear, anger, excitement, or embarrassment ("fight-or-flight" situations).

In these kinds of situations, the sympathetic nervous system stimulates cardiac muscles to increase the heart rate, causes dilation of the bronchioles of the lungs (increasing oxygen intake), and causes dilation of blood vessels that supply the heart and skeletal muscles (increasing blood supply). The adrenal medulla is stimulated to release epinephrine (adrenalin) and norepinephrine (noradrenalin), which in turn increases the metabolic rate of cells and stimulates the liver to release glucose into the blood. Sweat glands are stimulated to produce sweat. In addition, the sympathetic nervous system reduces the activity of various "tranquil" body functions, such as digestion and kidney functioning.

Parasympathetic Nervous System

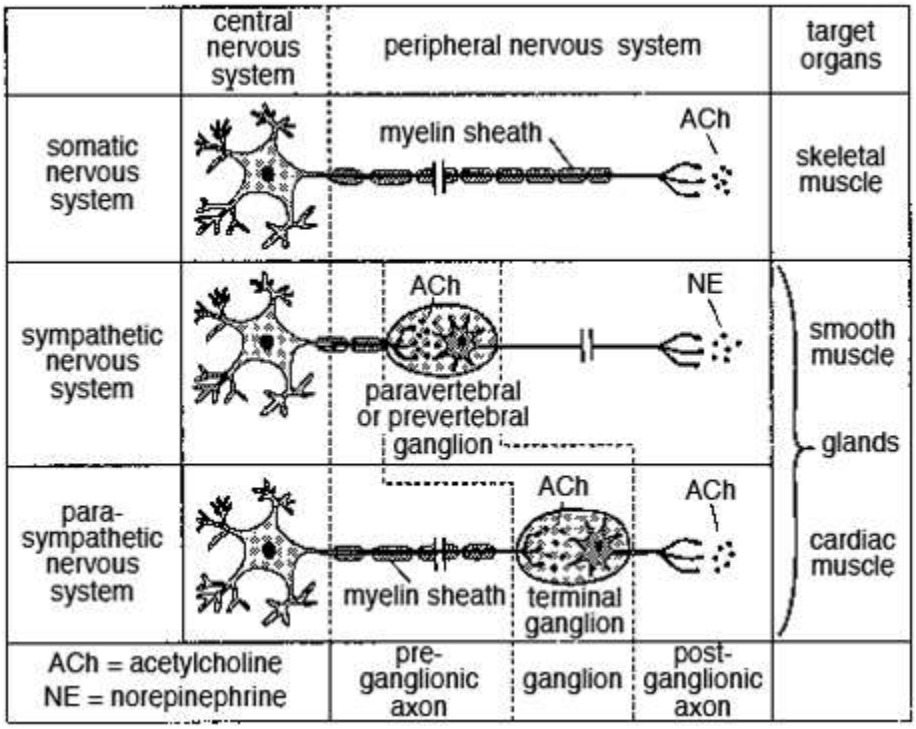
The parasympathetic nervous system is active during periods of digestion and rest. It stimulates the production of digestive enzymes and stimulates the processes of digestion, urination, and defecation. It reduces blood pressure and heart and respiratory rates and conserves energy through relaxation and rest.

In the SNS, a single motor neuron connects the CNS to its target skeletal muscle. In the ANS, the connection between the CNS and its effector consists of two neurons—the preganglionic neuron and the postganglionic neuron. The synapse between these two neurons lies outside the CNS, in an autonomic ganglion. The axon (preganglionic axon) of a preganglionic neuron enters the ganglion and forms a synapse with the dendrites of the postganglionic neuron. The axon of the postganglionic neuron emerges from the ganglion and travels to the target organ (see Figure 1). There are three kinds of autonomic ganglia:

The sympathetic trunk, or chain, contains sympathetic ganglia called paravertebral ganglia. There are two trunks, one on either side of the vertebral column along its entire length. Each trunk consists of ganglia connected by fibers, like a string of beads.

The prevertebral (collateral) ganglia also consist of sympathetic ganglia. Preganglionic sympathetic fibers that pass through the sympathetic trunk (without forming a synapse with a postganglionic neuron) synapse here. Prevertebral ganglia lie near the large abdominal arteries, which the preganglionic fibers target.

Terminal (intramural) ganglia receive parasympathetic fibers. These ganglia occur near or within the target organ of the respective postganglionic fiber.



The target organs of the different nervous systems.

A comparison of the sympathetic and parasympathetic pathways follows:

Sympathetic nervous system. Cell bodies of the preganglionic neurons occur in the lateral horns of gray matter of the 12 thoracic and first 2 lumbar segments of the spinal cord. (For this reason, the sympathetic system is also called the thoracolumbar division.) Preganglionic fibers leave the spinal cord within spinal nerves through the ventral roots (together with the PNS motor neurons). The preganglionic fibers then branch away from the nerve through white rami (white rami communicantes) that connect with the sympathetic trunk. White rami are white because they contain myelinated fibers. A preganglionic fiber that enters the trunk may synapse in the first ganglion it enters, travel up or down the trunk to synapse with another ganglion, or pass through the trunk and synapse outside the trunk. Postganglionic fibers that originate in ganglia within the sympathetic trunk leave the trunk through gray rami (gray rami communicantes) and return to the spinal nerve, which is followed until it reaches its target organ. Gray rami are gray because they contain unmyelinated fibers.

Parasympathetic nervous system. Cell bodies of the preganglionic neurons occur in the gray matter of sacral segments S_{2}–S_{4} and in the brainstem (with motor neurons of their associated cranial nerves III, VII, IX, and X). (For this reason, the parasympathetic system is also called the craniosacral division, and the fibers arising from this division are called the cranial outflow or the sacral outflow, depending on their origin.) Preganglionic fibers of the cranial outflow accompany the PNS motor neurons of cranial nerves and have terminal ganglia that lie near the target organ. Preganglionic fibers of the sacral outflow accompany the PNS motor neurons of spinal nerves. These nerves emerge through the ventral roots of the spinal cord and have terminal ganglia that lie near the target organ.