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Lecture title: # Subdivisions of the Autonomic Nervous System

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Summary:

The Autonomic Nervous System Has Two Subdivisions That Originate in the Central Nervous System and One That Does Not

The ANS is divided into two major subdivisions based on the respective CNS origin of their preganglionic neurons and on their synaptic transmitters at the target organ. These two subdivisions are the sympathetic nervous system and the parasympathetic nervous system. The enteric nervous system can be considered a third subdivision of the peripheral ANS. It is an extensive network of interconnected sensory, motor and interneurons within the gut (gastrointestinal tract) wall that can control gut function independently of the CNS. However, these neurons can also be influenced by the CNS through input from the sympathetic and parasympathetic subdivisions.

The Sympathetic Nervous System Originates from the Thoracolumbar Spinal Cord

1- The sympathetic nervous system generally has short preganglionic and long postganglionic axons.

2- The preganglionic axons of the sympathetic nervous system leave the spinal cord by way of the ventral roots of the first thoracic through the third or fourth lumbar spinal nerves. For this reason, the sympathetic nervous system is often called the thoracolumbar system.

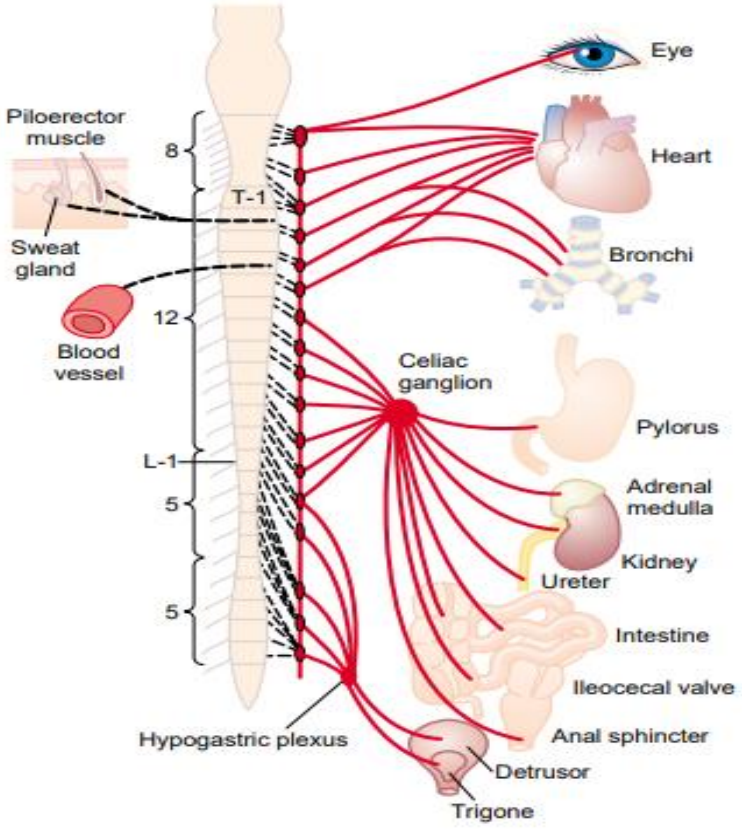
3- The preganglionic axons pass through the ventral root and then a communicating branch (white ramus) to enter the paravertebral sympathetic ganglion chain (also called the sympathetic trunk), where most synapse with a postganglionic neuron.

4- The ganglion chain actually extends from cervical to sacral regions and some of the thoracolumbar preganglionic neurons extend their axons rostrally or caudally within the chain to reach these cervical and sacral ganglia.

5- A large complement of postganglionic axons from each of the chain ganglia enter nearby spinal nerves, through a different communicating ramus (gray ramus), and travel to the body wall or extremities to control blood vessels, sweat glands, or hair erector muscles.

6- Another complement of these postganglionic neurons, mainly from thoracic or cervical chain ganglia, does not enter spinal nerves but forms separate nerves that travel respectively to thoracic viscera (e.g., heart, bronchi) or to organs and glands of the head (e.g., eye, lacrimal gland).

7- Some of the thoracolumbar preganglionic axons simply pass through the sympathetic chain ganglia without synapsing there. These axons form splanchnic nerves that synapse with postganglionic neurons in prevertebral ganglia, usually named for neighboring blood vessels (e.g., celiac, mesenteric). Postganglionic neurons of the prevertebral ganglia innervate abdominal and pelvic visceral organs. Some of the aforementioned splanchnic nerve fibers bypass the prevertebral ganglia and continue all the way to the adrenal medulla, where they synapse with rudimentary postganglionic neurons that make up the adrenal medullary secretory cells. These vestigial postganglionic neurons secrete their transmitter substance directly into the circulating blood. The transmitter substance, acting as a true hormone, is carried by the blood to all tissues of the body.



The Parasympathetic Nervous System Arises from the Brainstem and Sacral Spinal Cord

1- The parasympathetic nervous system generally has long preganglionic and short postganglionic axons.

2- Preganglionic axons of the parasympathetic system leave the CNS by way of cranial nerves III (oculomotor), VII (facial), IX (glossopharyngeal), and X (vagus) and through several sacral spinal nerves. For this reason, it is called the craniosacral system.

3- The parasympathetic preganglionic axons leaving through cranial nerves III, VII, and IX synapse in well defined ganglia outside the skull (e.g., otic, submandibular).

4- The parasympathetic postganglionic neurons project to smooth muscle and glandular targets in the head (e.g., ciliary muscle, parotid gland).

5- Preganglionic axons leaving through cranial nerve X travel all the way to the body cavity to synapse in more diffuse parasympathetic ganglia located close to, or within, thoracic and abdominal viscera (see Figure 13-3, B, bottom).

6- The short postganglionic neurons control the smooth muscle, cardiac muscle, and glandular cells of these organs.

7- Parasympathetic preganglionic axons leaving through sacral spinal nerves depart to form pelvic nerves that synapse in diffuse parasympathetic ganglia residing close to, or within, pelvic viscera (e.g. rectum, bladder).

8- The short postganglionic neurons control these organs, as well as erectile tissue of the genitals.

9- Most viscera receive both sympathetic and parasympathetic innervation. Although the parasympathetic system originates in brainstem and sacral regions, it

can provide parasympathetic innervation to organs in the thoracic and lumbar parts of the body, as just noted, by way of the vagus nerve (cranial nerve X).

10- The sympathetic thoracolumbar system can influence organs in cranial and sacral regions by way of preganglionic sympathetic axons that travel to sympathetic postganglionic neurons in cervical and sacral regions of the sympathetic ganglion chain.

11- Although blood vessels in all parts of the body receive sympathetic innervation, which most commonly produces vasoconstriction, most do not receive parasympathetic innervation (except those in glands and the external genitals).

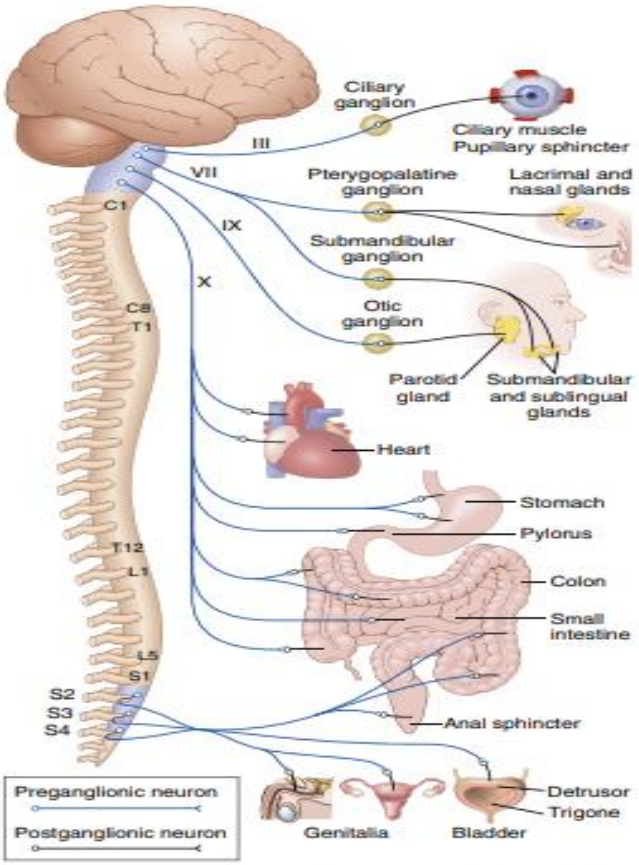


Figure 61-3. The parasympathetic nervous system. The *blue lines* represent preganglionic fibers and the *black lines* show postganglionic fibers.