22.2A: Enteric Nervous System

The enteric nervous system (ENS) is a subdivision of the autonomic nervous system (ANS) that directly controls the gastrointestinal system.

Learning Objectives

- Describe the structure and function of the enteric nervous system (ENS)

Key Points

- The enteric nervous system (ENS), which is embedded in the lining of the gastrointestinal system, can operate independently of the brain and the spinal cord.
- The ENS consists of two plexuses, the submucosal and the myenteric. The myenteric plexus increases the tone of the gut and the velocity and intensity of contractions. The submucosal plexus is involved with local conditions and controls local secretion, absorption, and muscle movements.
- While described as a second brain, the enteric nervous system normally communicates with the central nervous system (CNS) through the parasympathetic (via the vagus nerve) and sympathetic (via the prevertebral ganglia) nervous systems, but can still function when the vagus nerve is severed.
- The ENS includes efferent neurons, afferent neurons, and interneurons, all of which make the ENS capable of carrying reflexes and acting as an integrating center in the absence of CNS input.
- The ENS contains support cells, which are similar to the astroglia of the brain, and a diffusion barrier around the capillaries surrounding the ganglia, which is similar to the blood–brain barrier of cerebral blood vessels.
Key Terms

- **enteric nervous system**: A subdivision of the peripheral nervous system that directly controls the gastrointestinal system.

EXAMPLES

The second brain of the enteric nervous system is the reason we get butterflies in our stomach or need to use the restroom more frequently when we are nervous and/or under stress.

The gastrointestinal (GI) system has its own nervous system, the enteric nervous system (ENS). Neurogastroenterology is the study of the enteric nervous system, a subdivision of the autonomic nervous system (ANS) that directly controls the gastrointestinal system. The ENS is capable of autonomous functions such as the coordination of reflexes.

Although it receives considerable innervation from the autonomic nervous system, it can and does operate independently of the brain and the spinal cord. The ENS consists of some 100 million neurons, one-thousandth of the number of neurons in the brain, and about one-tenth the number of neurons in the spinal cord. The enteric nervous system is embedded in the lining of the gastrointestinal system.

Ganglia of the ENS

The neurons of the ENS are collected into two types of ganglia:

1. The myenteric (Auerbach’s) plexus, located between the inner and outer layers of the muscularis externa
2. The submucosal (Meissner’s) plexus, located in the submucosa

The Myenteric Plexus

The myenteric plexus is mainly organized as a longitudinal chains of neurons. When stimulated, this plexus increases the tone of the gut as well as the velocity and intensity of its contractions. This plexus is concerned with motility throughout the whole gut. Inhibition of the myenteric system helps to relax the sphincters—the muscular rings that control the flow of digested food or food waste.

The Submucosal Plexus

The submucosal plexus is more involved with local conditions and controls local secretion and absorption, as well as local muscle movements. The mucosa and epithelial tissue associated with the submucosal plexus have sensory nerve endings that feed signals to both layers of the enteric plexus. These tissues also send information back to the sympathetic pre-vertebral ganglia, the spinal cord, and the brain stem.
Neural control of the gut: An illustration of neural control of the gut wall by the autonomic nervous system and the enteric nervous system.

Function and Structure of the ENS

The enteric nervous system has been described as a second brain. There are several reasons for this. For instance, the enteric nervous system can operate autonomously. It normally communicates with the central nervous system (CNS) through the parasympathetic (e.g., via the vagus nerve) and sympathetic (e.g., via the prevertebral ganglia) nervous systems. However, vertebrate studies show that when the vagus nerve is severed, the enteric nervous system continues to function.

In vertebrates, the enteric nervous system includes efferent neurons, afferent neurons, and interneurons, all of which make the enteric nervous system capable of carrying reflexes and acting as an integrating center in the absence of CNS input. For instance, the sensory neurons report mechanical and chemical conditions, while the motor neurons control peristalsis and the churning of intestinal contents through the intestinal muscles. Other neurons control the secretion of enzymes.

The enteric nervous system also makes use of more than 30 neurotransmitters, most of which are identical to the ones found in the CNS, such as acetylcholine, dopamine, and serotonin. More than 90% of the body’s serotonin is in the gut, as well as about 50% of the body’s dopamine, which is currently being studied to further our understanding of its utility in the brain.

The enteric nervous system has the capacity to alter its response depending on factors such as bulk and nutrient composition. In addition, the ENS contains support cells that are similar to the astroglia of the brain, as well as a diffusion barrier around the capillaries that surround the ganglia, which is similar to the blood–brain barrier of the cerebral blood vessels.
Regulation of ENS Function

The parasympathetic nervous system is able to stimulate the enteric nerves in order to increase enteric function. The parasympathetic enteric neurons function in defecation and provide a rich nerve supply to the sigmoid colon, the rectum, and the anus.

Conversely, stimulation of the enteric nerves by the sympathetic nervous system will inhibit enteric function and capabilities. Neurotransmitter secretion and direct inhibition of the enteric plexuses cause this stall in function. If the gut tract is irritated or distended, afferent nerves will send signals to the medulla of the brain for further processing.