The Autonomic Nervous System and Higher Order Functions

Objectives
• Describe the structures and functions of the sympathetic and parasympathetic divisions of the ANS.
• Describe the mechanisms of neurotransmitter release in the sympathetic and parasympathetic divisions.
• Describe the effects of sympathetic and parasympathetic neurotransmitters on target organs and tissues.
• Describe the hierarchy of interacting levels of control in the ANS.

An Overview of the ANS

ANS - autonomous
• Coordinates cardiovascular, respiratory, digestive, urinary, and reproductive functions
• Preganglionic neurons in the CNS send axons to synapse on ganglionic neurons in autonomic ganglia outside the CNS
• Dual innervation = organs that receive input from both systems

Divisions of the ANS
• Sympathetic division (thoracolumbar, “fight or flight”)
  • Thoracic and lumbar segments
• Parasympathetic division (craniosacral, “rest and repose”)
  • Preganglionic fibers leaving the brain and sacral segments

The Sympathetic Division

Sympathetic division anatomy
• Preganglionic neurons between segments T₁ and L₂
• Ganglionic neurons in ganglia near vertebral column
• Specialized neurons in adrenal glands

Sympathetic ganglia
• Sympathetic chain ganglia (paravertebral ganglia)
• Collateral ganglia (prevertebral ganglia)

Organization and anatomy of the sympathetic division
• Segments T₁-L₂, ventral roots give rise to myelinated white ramus
• Leads to sympathetic chain ganglia
Abdominopelvic viscera

- Celiac ganglion
  - Innervates stomach, liver, gall bladder, pancreas, spleen
- Superior mesenteric ganglion
  - Innervates small intestine and initial portion of large intestine
- Inferior mesenteric ganglion
  - Innervates kidney, urinary bladder, sex organs, and final portion of large intestine

Sympathetic activation

- In crises, the entire sympathetic division responds
  - Sympathetic activation
  - Affects include increased alertness, energy and euphoria, increased cardiovascular and respiratory activities, elevation in muscle tone, mobilization of energy resources

Neurotransmitters and sympathetic function

- Stimulation of sympathetic division has two distinct results
  - Release of ACh or NE at specific locations
  - Secretion of E and NE into general circulation
- Most postganglionic fibers are adrenergic, a few are cholinergic or nitroxidergic

The Parasympathetic Division

- Preganglionic neurons in the brainstem and sacral segments of spinal cord
- Ganglionic neurons in peripheral ganglia located within or near target organs

Organization and anatomy of the parasympathetic division

- Preganglionic fibers leave the brain as cranial nerves III, VI, IX, X
- Sacral neurons form the pelvic nerves

Parasympathetic activation

- Effects produced by the parasympathetic division
  - Relaxation
  - Food processing
  - Energy absorption

Neurotransmitters and parasympathetic functions

- All parasympathetic fibers release ACh
- Short-lived response as ACH is broken down by AChE and tissue cholinesterase
- Postsynaptic membranes have two kinds of receptors
  - Muscarinic
  - Nicotinic