

The Autonomic Nervous System Outline

- 14.1 The ANS differs from the somatic nervous system in that it can stimulate or inhibit its effectors (pp. 528–529, Figs. 14.1–14.2)
 - A. The effectors of the somatic nervous system are skeletal muscles, while the ANS innervates cardiac and smooth muscle and glands. (p. 528; Figs. 14.1–14.2)
 - B. Efferent Pathways and Ganglia (pp. 528–529; Fig. 14.2)
 - 1. In the somatic nervous system, the cell bodies of the neurons are in the spinal cord and their axons extend to the skeletal muscles they innervate.
 - 2. The ANS consists of a two-neuron chain in which the cell body of the first neuron, the preganglionic neuron, resides in the spinal cord, and synapses with a second neuron, the postganglionic neuron, reside within an autonomic ganglion outside the CNS.
 - C. Neurotransmitter Effects (p. 529)
 - 1. The neurotransmitter released by the somatic motor neurons is acetylcholine, which always has an excitatory effect; the neurotransmitters released by the ANS are epinephrine and acetylcholine, and both may have either an excitatory or an inhibitory effect.
 - D. Higher brain centers regulate and coordinate the somatic and autonomic nervous systems, so that there is cooperation between skeletal muscle and visceral organ functions. (p. 529)
- 14.2 The ANS consists of the parasympathetic and sympathetic divisions (pp. 530–531; Fig. 14.3; Table 14.1)
 - A. Both divisions usually serve the same visceral organs, but cause opposite effects. (p. 530; Fig. 14.3)
 - B. The parasympathetic division, the “rest and digest” system, keeps body energy use as low as possible, and directs digestion, and elimination of feces and urine. (p. 530; Fig. 14.3)
 - C. The sympathetic division, the “fight or flight” system, enables the body to cope with potential threats to homeostasis, by promoting adjustments in the cardiovascular and respiratory systems, sweat production, pupil dilation, and glucose release from the liver, while inhibiting nonessential tasks, such as gastrointestinal motility. (pp. 530–531; Fig. 14.3)
 - D. Sympathetic and parasympathetic divisions differ in the site of origin, relative lengths of fibers, and location of ganglia. (p. 531, Fig. 14.3; Table 14.1)
- 14.3 Long preganglionic parasympathetic fibers originate in the craniosacral CNS (pp. 534–435; Fig. 14.4)
 - A. Preganglionic axons extend from the CNS nearly all the way to the structures to be innervated, where they synapse with postganglionic neurons in the terminal ganglia (p. 532, Fig. 14.3)
 - B. Cranial Part of Parasympathetic Division (pp. 532–533; Fig. 14.4)
 - 1. The cranial outflow consists of preganglionic fibers that run in the oculomotor, facial, glossopharyngeal, and vagus cranial nerves.
 - C. Sacral Part of Parasympathetic Division (p. 533; Fig. 14.4)

1. The distal half of the large intestine and the pelvic organs are served by the sacral part, which arises from neurons located in the lateral gray matter of spinal cord segments S_2 – S_4 .
- 14.4 Short preganglionic sympathetic fibers originate in the thoracolumbar CNS (p. 534–537; Figs. 14.5–14.7; Tables 14.1–14.2)
- A. In addition to innervating visceral organs in internal body cavities, sympathetic neurons exclusively innervate superficial structures, such as sweat glands, arrector pili muscles, and vascular smooth muscle. (pp. 533–534)
 - B. Sympathetic preganglionic neurons exit the spinal cord via the ventral root, and enter sympathetic trunk ganglia, along each side of the vertebral column. (p. 534; Fig. 14.5)
 1. All sympathetic ganglia are close to the spinal cord, and have long postganglionic fibers.
 - C. Some sympathetic fibers of the thoracic splanchnic nerves terminate by synapsing with the hormone-producing medullary cells of the adrenal cortex. (p. 537)
- 14.5 Visceral reflex arcs have the same five components as somatic reflex arcs (pp. 537–538; Fig. 14.8)
- A. Visceral reflex arcs differ from somatic motor reflex arcs, in that they have two consecutive neurons in their motor components, and afferent fibers are visceral sensory neurons. (pp. 537–538; Fig. 14.8)
 1. The visceral sensory neurons are the first link in autonomic reflexes, sending information concerning chemical changes, stretch, and irritation of the viscera.
- 14.6 Acetylcholine and norepinephrine are the major ANS neurotransmitters (pp. 538–540; Fig. 14.8; Tables 14.3–14.4)
- A. Cholinergic Receptors (pp. 539–540; Tables 14.3–14.4)
 1. Nicotinic cholinergic receptors are found on all postganglionic neurons, hormone-producing cells of the adrenal medulla, and skeletal muscle cells at the neuromuscular junction, bind acetylcholine, and are always excitatory.
 2. Muscarinic receptors occur on all parasympathetic target organs, and a few sympathetic targets, such as eccrine sweat glands, bind acetylcholine, and may be excitatory or inhibitory.
 - B. Adrenergic Receptors (p. 540; Tables 14.3–14.4)
 1. There are two classes of adrenergic receptors, α and β , that bind norepinephrine, and produce either excitatory or inhibitory responses.
- 14.7 The parasympathetic and sympathetic divisions usually produce opposite effects (pp. 540–543; Table 14.5)
- A. Most visceral organs receive dual innervation by both ANS divisions, allowing for a dynamic antagonism to exist between the divisions and precise control of visceral activity. (p. 540; Table 14.5)
 - B. Sympathetic and Parasympathetic Tone (p. 540; Table 14.5)
 1. Sympathetic tone throughout the vascular system allows the firing rate of sympathetic neurons to control the diameter of blood vessels, regulating systemic blood pressure.

- 2. Parasympathetic tone is usually dominant in the heart, digestive system, and urinary tracts, maintaining normal homeostatic levels of function unless overridden by the sympathetic system during stress.
 - C. Sympathetic and parasympathetic divisions show a cooperative effect in the genitalia during sexual excitement and release. (p. 540; Table 14.5)
 - D. Unique Roles of the Sympathetic Division (pp. 541–542; Table 14.5)
 - 1. The sympathetic system has a unique role in control of thermoregulatory responses, release of renin from the kidneys, and metabolic rate.
- 14.8 The hypothalamus oversees ANS activity (pp. 542–543; Fig. 14.9)
- A. The brain stem appears to exert the most direct influence over autonomic functions. (pp. 542–543; Fig. 14.9)
 - B. The hypothalamus is the main integration center for the autonomic nervous system. (p. 543; Fig. 14.9)
 - C. Cortical or voluntary control of the autonomic nervous system may be possible. (p. 543; Fig. 14.9)
 - D. Biofeedback training may enable a person to alter some involuntary functions. (p. 543)
- 14.9 Most ANS disorders involve abnormalities in smooth muscle control (p. 543)
- A. Hypertension, or high blood pressure, may result from an overactive sympathetic vasoconstrictor response due to continuous high levels of stress. (p. 543)
 - B. Raynaud's disease is characterized by intermittent attacks causing the skin of the fingers and the toes to become pale, then cyanotic and painful. (p. 543)
 - C. Autonomic dysreflexia is a life-threatening condition involving uncontrolled activation of both somatic and autonomic motor neurons. (p. 543)
- Developmental Aspects of the ANS (p. 543)
- A. Embryonic and fetal development of the autonomic nervous system. (p. 543)
 - 1. ANS preganglionic neurons and somatic motor neurons derive from the embryonic neural tube.
 - 2. ANS structures found in the PNS (postganglionic neurons, adrenal medulla, and all autonomic ganglia) derive from the neural crest.
 - 3. Nerve growth factor is a protein secreted by target cells of the postganglionic axons that directs the growth of axons toward their targets.
 - B. In youth, ANS dysfunction is usually due to injury to the spinal cord or autonomic nerves. (p. 543)
 - C. In old age, the efficiency of the ANS begins to decline, partly due to structural changes of some preganglionic axon terminals. (p. 543)
 - 1. Typical changes include constipation, dry eyes and frequent eye infections, and orthostatic hypotension.