Chapter 15 - The Autonomic Nervous System and Visceral Reflexes

Student Objectives:

- Compare and contrast structural and functional differences found in health and disease
- Apply critical thinking skills in various anatomical and physiological situations
- List the divisions of the ANS and give the functions of each
- Compare the organization of the ANS with that of the somatic nervous system
- Describe the structures of the sympathetic division of the autonomic nervous system
- Describe the functions of the sympathetic division of the autonomic nervous system
- Trace the pathway from the CNS to the effector organ for both the sympathetic and parasympathetic motor divisions of the ANS
- Describe the structures of the parasympathetic division of the autonomic nervous system
- Describe the functions of the parasympathetic division of the autonomic nervous system
- Discuss the neurotransmitters and their receptors found in the autonomic nervous system
- List the divisions of the ANS and give the functions of each
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- Describe the structures of the parasympathetic division of the autonomic nervous system
- Describe the functions of the parasympathetic division of the autonomic nervous system
- Discuss the neurotransmitters and their receptors found in the autonomic nervous system
- Compare the neurotransmitters found in the autonomic nervous system to those found in the somatic nervous system
- Compare the neurotransmitters found in the sympathetic division of the autonomic nervous system to those found in the parasympathetic division of the autonomic nervous system
- Describe the effects of sympathetic neurotransmitters on target organs and tissues
- Describe the effects of parasympathetic neurotransmitters on target organs and tissues
- Explain how the adrenal gland functions as an organ of the ANS
- Discuss the relationship between the two divisions of the autonomic nervous system and the significance of dual innervation
- Explain the importance of autonomic tone
- Discuss how the autonomic nervous system is controlled
- Explain the significance of visceral reflexes

Terms for review:

- Recall the definitions of the following terms
  Effector
  ESPS
  ISPS
  Anatomy of neurons (dendrites, cell bodies, axons)
  Myelination
  Classification of axons (type A, B, C fibers)
  Ganglia
  Plexus
  Reflex

Terms:

- Define the following terms
  Autonomic nervous system
  Somatic nervous system
  Dual innervation
  Autonomic plexus
  Autonomic ganglia
  Divergence
  Mass activation
  Agonist
  Antagonist
  Autonomic tone

I. Overview
   A. Somatic nervous system
   B. Autonomic nervous system
   C. Differences between somatic and autonomic nervous systems
II. Anatomy of the autonomic nervous system

A. Overview
   1. Sensory neurons (afferent pathway)
   2. Motor neurons (efferent pathway)
      a. sympathetic division
      b. parasympathetic division
   3. effector organs

B. autonomic motor neurons
   1. preganglionic neurons
      a. myelinated
   2. autonomic ganglia
   3. postganglionic neurons
      a. unmyelinated

C. autonomic plexuses
   1. cardiac plexus
   2. pulmonary plexus
   3. celiac (solar) plexus
   4. superior mesenteric plexus
   5. inferior mesenteric plexus
   6. hypogastric plexus
   7. renal plexus

D. sympathetic division
   1. structures
      a. preganglionic cell bodies (in spinal cord)
      b. rami communicantes
         i. white rami communicantes
         ii. gray rami communicantes
      c. post ganglionic cell bodies
         i. sympathetic chain (trunk)
         ii. prevertebral ganglia (collateral ganglia)
            • celiac ganglia
            • superior mesenteric ganglia
            • inferior mesenteric ganglia
         iii. splanchnic nerves
   2. circuitry of sympathetic division
      a. divergence
      b. mass activation
      c. adrenal gland
   3. organs innervated by the sympathetic division
      a. structures innervated by each spinal nerve
      b. thoracic and cranial plexuses
      c. splanchnic nerves

E. parasympathetic division
   1. structures
      a. preganglionic bodies
         i. brain stem
         ii. spinal cord
      b. post ganglionic cell bodies
         i. terminal ganglia
   2. organs innervated by parasympathetic division
      a. cranial nerves
i. oculomotor nerve
ii. facial nerve
iii. glossopharyngeal
iv. vagus

b. spinal nerves: sacral nerves

F. ganglia for both divisions
   1. autonomic relay stations
   2. integrating centers

III. Autonomic responses overall
   A. Sympathetic division ties the entire system together to function as a whole
   B. Parasympathetic division acts relatively independent

IV. Neurotransmitters
   A. Cholinergic neurons
      1. neurotransmitters
         a. acetylcholine (ACh)
      2. receptors
         a. nicotinic receptors
         b. muscarinic receptors
   B. Adrenergic neurons
      1. neurotransmitters
         a. acetylcholine (ACh)
         b. norepinephrine (NE)
      2. receptors
         a. alpha 1 receptors
         b. alpha 2 receptors
         c. beta 1 receptors
         d. beta 2 receptors
         e. beta 3 receptors
      3. synaptic enzymes
         a. monoamine oxidase (MAO)
         b. catechol-o-methyltransferase (COMT)
   C. adrenal medulla
      1. neurotransmitters
         a. NE
         b. Epinephrine (EP, Epi)
         c. Others: DA, peptides
      2. receptors
         a. nicotinic receptors via blood stream
   D. somatic nervous system
      1. ACh at neuromuscular junction (NMJ)
      2. nicotinic receptors

V. physiology of ANS
   A. physiological effects
      1. effector organs: smooth muscle, cardiac muscle, glands
      2. dual innervation
      3. autonomic tone
         a. dual innervation
         b. only sympathetic innervation
   B. sympathetic responses
      1. fight or flight
   C. parasympathetic responses
      1. rest and digest
D. autonomic reflexes (visceral reflexes)
   1. components of reflex arc
      a. sensory receptor
      b. sensory neuron
      c. integrating center
      d. pre and post ganglionic motor neurons
      e. visceral effectors

E. control
   1. hypothalamus
      a. input: emotions and visceral sensory information
      b. output: brainstem and spinal cord

Clinical Applications:
Peripheral neuropathy
Megacolon
Hirschsprung disease
Chagas disease
Horner syndrome
Raynaud disease