

Medical Neuroscience | Tutorial Notes

Visceral Motor System—Hypothalamus

MAP TO NEUROSCIENCE CORE CONCEPTS¹

- NCC1. The brain is the body's most complex organ.
- NCC3. Genetically determined circuits are the foundation of the nervous system.

LEARNING OBJECTIVES

After study of the assigned learning materials, the student will:

1. Describe the organization of the hypothalamus and identify several functions associated with key hypothalamic nuclei.

TUTORIAL OUTLINE

- I. Central control of visceral motor system
 - A. several structures in the forebrain and have an important role in the regulation of homeostasis/allostasis; these include the **amygdala**, orbital and medial parts of the **prefrontal cortex**, **insular cortex**, and the **hypothalamus** (see [Figure 21.5²](#) & [21.7](#)); together they constitute a *central autonomic network*
 - B. *hypothalamus* ([Box 21A](#))
 1. comprises a large number of distinct nuclei that subserve a broad range of integrative functions
 2. overview of connections (see [Figure 21.7](#))
 - a. the hypothalamus is highly interconnected with the limbic forebrain, especially the amygdala, parts of the hippocampal formation and orbital-medial divisions of the prefrontal cortex
 - b. major outflow is directed toward integrative centers in the brainstem; most importantly, the periaqueductal gray (midbrain) and the reticular formation (pons and medulla)
 4. overview of function
 - a. hypothalamus regulates five basic functions:
 - i. controls blood pressure and electrolyte balance

¹ Visit [BrainFacts.org](https://www.brainfacts.org) for Neuroscience Core Concepts (©2012 Society for Neuroscience) that offer fundamental principles about the brain and nervous system, the most complex living structure known in the universe.

² Figure references to Purves et al., *Neuroscience*, 5th Ed., Sinauer Assoc., Inc., 2012. [[click here](#)]

- ii. regulates body temperature
 - iii. controls energy metabolism
 - iv. regulates reproductive activity
 - v. controls emergency responses
 - b. basic mechanisms of regulation:
 - i. receives sensory and contextual information
 - ii. compares sensory feedback with biologic set-points
 - iii. activates visceral motor, endocrine and somatic motor systems to restore homeostasis or respond to crisis conditions (promote allostasis)
- 3. the nuclei of the hypothalamus are diverse anatomically and functionally (see **Box 21A** for an account of several interesting examples of hypothalamic nuclei and their functions)
 - a. periventricular zone
 - i. arcuate and periventricular nuclei:
 - scattered cells that secrete releasing or inhibiting factors into the portal circulation
 - these factors modulate the production of hormones in the anterior pituitary
 - b. medial zone
 - i. paraventricular & supraoptic nuclei:
 - send axons into posterior pituitary where they secrete oxytocin and vasopressin (anti-diuretic hormone) into the systemic circulation
 - paraventricular nucleus sends axons that descend to visceral motor control centers in the brainstem (reticular formation, periaqueductal gray) and spinal cord (intermediolateral cell column)
 - ii. medial preoptic nucleus: sexual behavior, sexuality (sexual identity/orientation) and other motivational states
 - iii. **suprachiasmatic nucleus**: receives retinal input and entrains circadian rhythms to cycles of light and dark
 - iv. dorsomedial & ventromedial nuclei: receive heavy input from amygdala and orbital-medial prefrontal cerebral cortex
 - reproductive & parenting behavior
 - feeding behavior (target of leptin: hormone that provides feedback regulation of food intake)
 - water balance & thermoregulation

- c. lateral zone
 - I. loose collection of cells (not really nuclei) that can be considered a rostral extension of the reticular formation of the midbrain tegmentum
 - II. involved in feeding behaviors, arousal and attention
 - III. contains major efferent fiber bundle for hypothalamic control of brainstem and spinal cord centers

STUDY QUESTIONS

- Q1. Which of the following statements DOES NOT characterize a function of hypothalamic nuclei?
- A. Hypothalamic nuclei are involved in the regulation of visceral motor preganglionic neurons in the brainstem and spinal cord.
 - B. Hypothalamic nuclei are involved in the regulation of the secretion of hormones in the anterior pituitary gland.
 - C. Hypothalamic nuclei are involved in the regulation of the secretion of hormones in the posterior pituitary gland.
 - D. Hypothalamic nuclei are involved in the regulation of circadian rhythms.
 - E. Hypothalamic nuclei are involved in the relay of sensory information from second order neurons in the spinal cord and brainstem to primary sensory areas in the cerebral cortex.
 - F. Hypothalamic nuclei are involved in the expression of sexual behavior and sexual orientation.
- Q2. Suppose you are examining a patient who presents with left-sided **Horner's syndrome**. You recall learning about this condition in Medical Neuroscience, and you remember that damage of descending projections from the hypothalamus to the sympathetic preganglionic neurons in the intermediolateral cell column may be involved. What would you expect to see upon physical examination?
- A. The left pupil is larger than the right pupil.
 - B. The left side of the face feels cold to the touch, relative to the right side of the face.
 - C. The patient will be hyperventilating.
 - D. The patient's heart will be racing (in tachycardia).
 - E. The right pupil is larger than the left pupil.
 - F. The left side of the face is noticeably sweaty, but the right side is dry.
 - G. The left globe (eyeball) seems to be protruding outward from a normal neutral position in the orbit.