

# Medical Neuroscience | Tutorial Notes

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## Neurobiology of Addiction

### MAP TO NEUROSCIENCE CORE CONCEPTS<sup>1</sup>

- NCC1. The brain is the body's most complex organ.
- NCC3. Genetically determined circuits are the foundation of the nervous system.
- NCC4. Life experiences change the nervous system.

### LEARNING OBJECTIVES

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

1. Discuss the brain's reward system.
2. Discuss involvement of limbic forebrain circuitry in mediating addictive behavior.

### TUTORIAL OUTLINE

- I. Brief review of basal ganglia structure and function
  - A. **basal ganglia**
    1. collection of nuclei located deep in the anterior telencephalon that are intimately related to the functions of the cerebral cortex
      - a. receive widespread inputs from the cerebral cortex
      - b. after several steps of processing, basal ganglia output is directed to the thalamus, which in turn projects back to the cerebral cortex
      - c. thus, the overall function of the basal ganglia is to *modulate thalamo-cortical activity*
    2. there are multiple parallel processing "streams" through the basal ganglia (see **Box 18D<sup>2</sup>**); three important streams are:
      - a. dorsal motor stream (motor loop)
      - b. dorsal cognitive ("executive") stream (prefrontal loop)
      - c. ventral limbic ("emotional") stream (limbic loop)
  - B. general sense of basal ganglia function:
    1. processes executive commands for the **initiation** of appropriate behavior and the **suppression** of inappropriate behavior

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<sup>1</sup> 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.

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

2. for the ventral limbic stream, activation of the direct pathway facilitates the processing and/or prediction of reward

## II. Addiction

- A. mediated by “reward” circuitry of the ventral limbic stream in the basal ganglia, which receives input from the amygdala, hippocampus and orbital-medial prefrontal cortex (see [Figure 29.10](#))
  1. output is directed toward orbital-medial prefrontal cortex (among other limbic regions) where valence (rewards and punishers) and emotion are integrated
  2. dopamine amplifies the output of the ventral limbic stream by facilitating activation of the direct pathway and suppressing activation of the indirect pathway
  3. dopamine signals the presence and/or prediction of rewarding conditions (see [Figure 29.12](#))
- B. addiction leads to an *increase* in reward-associated release of dopamine in the ventral striatum (nucleus accumbens) (see [Figure 29.11](#))
- C. but addiction also may lead to a *decrease* in the release of dopamine in response to non-addictive (normal) rewarding experiences
- D. because of “B” & “C” above, addicts become increasingly oriented toward obtaining the rewarding experience that has become the object of the addiction

## STUDY QUESTION

Based on current evidence from studies of animal models of addiction, what do you expect to happen in the brain of a person who is addicted to cocaine when this person enters a room that happens to have drug paraphernalia on a table in plain site?

- A. There is likely a burst of action potentials generated in ventral tegmental area neurons when the objects on the table are recognized as pertaining to cocaine consumption.
- B. There is likely a suppression of action potentials in ventral tegmental area neurons when the objects on the table are recognized as pertaining to cocaine consumption.
- C. There is likely a burst of action potentials generated in nucleus accumbens neurons that contribute to the indirect pathway when the objects on the table are recognized as pertaining to cocaine consumption.
- D. There is likely a burst of action potentials generated in ventral pallidum neurons when the objects on the table are recognized as pertaining to cocaine consumption.
- E. There is likely a suppression of action potentials in mediodorsal thalamic neurons when the objects on the table are recognized as pertaining to cocaine consumption.