

The Neuroscience of Addiction

Companion Lesson X-STEM Video "[Teens and Drug Addiction](#)" by Dr. Nora Volkow

Grade Band: Middle School - High School		Topic: Neuroscience
Brief Lesson Description: Students will explore the connection between drug addiction and the role of dopamine in the brain.		
Performance Expectation(s): MS-LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or long-term changes. HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.		
Specific Learning Outcomes: Students will be able to: -identify the role of dopamine in the brain and explain how it is affected by various drugs -analyze research on at least one specific drug of their choice, summarizing its effects on dopamine levels and discuss the resulting short-term and long-term impacts on behavior and health.		
Narrative / Background Information Understanding the impact of drug addiction on the brain, particularly the role of dopamine, is crucial for middle and high school students as they navigate a formative period in their lives where they may encounter substances and peer pressure. This knowledge empowers them to make informed decisions about their health and well-being, fostering critical thinking about the consequences of drug use. This lesson expects that students should have a foundational understanding of basic neuroscience, particularly the structure of the brain and the function of neurotransmitters. They should be familiar with the concept of addiction. Additionally, students should possess research skills to gather information from reliable sources, as well as critical thinking skills to engage in discussions about addiction's social implications.		
Science & Engineering Practices: Obtaining, Evaluating and Communicating Information Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias for each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8) Planning and Carrying Out Investigations Plan and conduct an investigation individually or collaboratively to produce data to serve as the basis for evidence and in the design: decide on types, how much and accuracy of data needed to produce reliable measurements and consider limitations on the precision of data (e.g., number of trials, cost, risk, time) and refine the design accordingly. (HS-LS1-3) Connections to Nature of Science Scientific Investigations Use a Variety of Methods Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)	Disciplinary Core Ideas: LS1.A: Structure and Function Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS-1-3) LS1.D: Information Processing Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical) transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (MS-LS1-8)	Crosscutting Concepts: Cause and Effect Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8) Stability and Change Feedback (negative or positive) can stabilize or destabilize a system (HS-LS1-3)

Possible Preconceptions/Misconceptions:

High school students may hold several misconceptions about drug addiction and the role of dopamine that can hinder their understanding of the topic. They might view dopamine solely as a "feel-good" chemical, overlooking its complex functions in motivation and behavior. Many may believe that addiction is simply a matter of willpower, not recognizing the biological and psychological factors involved. Students may also overgeneralize the effects of different drugs, failing to appreciate the unique ways each substance interacts with dopamine and the brain. Additionally, misconceptions about the stigma surrounding addiction can lead to a lack of empathy, as students may see individuals struggling with addiction as lacking moral character rather than understanding addiction as a complex health issue. They might underestimate the risks associated with legal substances and mistakenly believe recovery is impossible once addiction develops, highlighting the need for comprehensive education on these topics.

LESSON PLAN – 5-E Model**ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:**

Start the lesson by asking students to create a concept map of what they know about drugs and addiction. Next, show students the video "[What Causes Addiction and Why it is So Hard to Treat](#)". Following the video, have students discuss the following prompts as a class:

What do you think happens in the brain when someone uses drugs?

Why is dopamine often referred to as the "feel-good" neurotransmitter?

Set the following goal for the remainder of the lesson: **Students will understand the basic function of dopamine and its role in the context of drug addiction.**

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

Divide students into small groups. Assign each group one of the following drug groups: Depressants, Opioids, Stimulants, Hallucinogens, Cannabinoids, Alcohol, Analgesics, Barbiturates, Psychedelics, etc.

Ask each group to research the following information about the drugs:

1. How the drug group affects dopamine levels
2. The short term effects on the brain and behavior
3. The long term effects on the brain and behavior

Have each group present their findings to the class. Create a class list of the effects of drugs on the brain and behavior.

EXPLAIN:

Show the Video "[Teens and Drug Addiction](#)". As students watch the video, they should take notes about how the brain is affected by drugs and the mechanism of dopamine that causes addiction.

Following the video, discuss the following prompts:

1. *"How does dopamine function as a neurotransmitter in the brain, and what are some specific ways it influences our emotions and decision-making? Can you think of examples from your own life where you felt motivated or rewarded?"*
2. *"Discuss the different ways various drugs interact with dopamine levels in the brain. How do these interactions lead to both short-term pleasurable effects and potential long-term consequences for mental and physical health?"*
3. *"What are some common societal perceptions of addiction, and how might these perceptions impact individuals seeking help? How can understanding the biological basis of addiction, particularly the role of dopamine, help reduce stigma and promote empathy for those struggling with substance use?"*

ELABORATE: Applications and Extensions:

Present students with a [case study of an individual struggling with addiction](#). Ask students to individually read the case study and respond to the prompts.

Groups students in small groups to discuss their answers to the prompts. After the small group discussions, ask each group to share to their class their biggest take away from this lesson.

EVALUATE:**Formative Monitoring (Questioning / Discussion):**

Questions in bold, italics can be used to check student understanding throughout the lesson. Additionally, student presentations in the explore section and case study handouts in the elaborate section can be used to monitor student progress.

Summative Assessment (Quiz / Project / Report):

Provide each student with a copy of "[Written Reflection on Dopamine and Addiction.](#)" Review the expectations and grading rubric prior to giving students time to write their reflection.

Elaborate Further / Reflect: Enrichment:

Have students integrate their new learning about dopamine and addiction with their research on various groups by creating a Public Service Campaign to teach others about this important topic. Public Service Campaigns could include commercials, tik tok videos, posters, letters to the editor, or other student generated ideas.

SOCIAL EMOTIONAL LEARNING ACTIVITY**CASEL Competency Addressed: Self-Awareness and Self-Management**

Objective: Students will deepen their understanding of dopamine's role in behavior and addiction by tracking their own activities and reflecting on the impacts of rewards in their daily lives. Students will create a "Dopamine Diary" for one week, documenting activities that result in feelings of pleasure or reward, and reflecting on how these activities influence their mood and behaviors.

1. **Diary Setup:** Provide students with a copy of the [Dopamine Diary](#).
2. **Daily Entries:** For one week, students will log at least three activities each day that bring them pleasure or satisfaction. Examples may include:
 - a. Exercise (sports, walking, etc.)
 - b. Social interactions (hanging out with friends, family time)
 - c. Hobbies (playing video games, reading, or crafting)
 - d. Consumption of media (watching a movie, listening to music)
 - e. Eating favorite foods
3. **Reflection Questions:** At the end of the week, students will respond to the following prompts in a reflection section of their diary:
 - a. *Which activities brought you the most pleasure? Why do you think that is?*
 - b. *Did you notice any patterns in your mood related to specific activities?*
 - c. *How do you think dopamine is involved in your feelings during these activities?*
 - d. *Reflect on how this exercise relates to what you learned about drug addiction and its effects on dopamine.*
4. **Class Discussion:** After completing the diary, hold a class discussion where students can share their findings and experiences. Encourage them to discuss the role of natural rewards in their lives versus the artificial rewards that drugs provide.

Materials Required for This Lesson/Activity

Quantity	Description
1 per class	Computer with Projector and Internet Access
1 per group	Computer with Internet Access for Research
1 per student	Copies of Handouts as described in lesson



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