THE TEEN BRAIN
Curriculum for High School Teachers

Module 6
Drugs in the Brain
How do drugs affect the brain?
What is the impact of drug use on the teen brain?

Center for Neuroscience & Society, University of Pennsylvania
The Franklin Institute
Acknowledgments
The Franklin Institute
Julia Skolnik, M.S.Ed.
Jayatri Das, Ph.D.

Center for Neuroscience & Society
Laurel E. Ecke, Ph.D.
Martha J. Farah, Ph.D.

Teachers
Maria Fitzgerald
David Jones
Helen B. Murray
Karen S. O’Hara
Robert H. Rineer
Khaing Win

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OVERVIEW

Module 6 allows students to explore how drugs influence normal neurotransmission in the brain, and can become habit-forming. Students transfer what they are learning about drug use to what they have already learned about the developing teen brain, drawing conclusions about the added danger in using and abusing drugs during this sensitive phase of brain development.

This module invites students to explore the questions:

* How do drugs affect the brain?
* What is the impact of drug use on the teen brain?

While exploring this idea, students will:

- Understand and demonstrate neurotransmission when under the influence of drugs.
- Describe the dangerous impacts of drugs on the teen brain, using evidence.

The [PowerPoint slides](#) that accompany this module are meant to help guide the lesson, transitioning between activities and providing relevant information when necessary. Frequently engage students in discussion by asking questions, eliciting their prior knowledge, experience, and ideas. Examples of probing and reflective questions are embedded throughout the curriculum guide, to scaffold meaningful and relevant experiences for students.

**Time Frame:** 2 hours

**Activities:**

- Simulation of how drugs affect neurotransmission in the brain
- Discussion about drug abuse in teens
- Drug Abuse Activity

**Preparation:**

- Load [PowerPoint slides](#) onto computer/tablet.
- Preview the [Mouse Party website](#) used in the Drug Abuse Activity.
- Make copies of [Drug Abuse Activity](#) worksheets.
- Ensure Internet access for students to do independent research.

**Materials Needed:**

**Exploration 1: Simulation of How Drugs Affect Neurotransmission**

- Computer/tablet with PowerPoint slides

**Exploration 2: Discussion about Drug Abuse in Teens**

- Computer/tablet with PowerPoint slides

**Exploration 3: Drug Abuse Activity**

- Computers, laptops, or tablets for students to do independent research
- Drug Abuse Activity worksheets
Journal Reflection

- Journal books for each student
- Extra pens/pencils

Review (15 mins)
Driving Question: How does a signal transfer from one neuron to the next?

1. Review neurotransmission:
   a. Neurotransmission is a chemical release from one neuron to another that transfers the signal from one neuron to the next.
   b. Packages of chemicals are contained in “vesicles.”
   c. When the electrical signal/action potential reaches the axon terminal, the vesicle releases the chemicals called neurotransmitters, which are received by receptors on the next neuron.

2. Review steps of neurotransmission using the dopamine simulation. Invite students to describe each of the steps, referencing how they acted it out in the Neurotransmission Game in the previous session.
   a. Action potential travels down axon to the axon terminal where the vesicles are.
   b. Vesicles release neurotransmitter (e.g. dopamine).
   c. Dopamine is released into the synapse and binds to a receptor on the next neuron.
   d. This releases a messenger, which carries the signal forward in the next cell.
   e. The neurotransmitter (dopamine) is released back into the synapse.
   f. The transporter on the first neuron takes the neurotransmitter back into that cell, and re-enters the vesicle.
   g. As more and more neurotransmitters are released, more action potential/signal builds in the second neuron and when it has enough energy it releases the signal down the next axon to fire to the next neuron.

Drug Simulations (25 mins)
Driving Question: How do drugs affect the brain?

1. Explain that there are two types of drugs that can impact the brain:
   a. Drugs to treat diseases, which correct existing imbalances in the brain to be normal levels
   b. Drugs of abuse, which create an imbalance in the brain to be abnormal levels, to create altered state of mind

2. Highlight two examples:
   a. Prozac is used to treat depression. Depression is associated with lower levels of the neurotransmitter serotonin being released in the brain. Ask students to make a prediction: What do you predict Prozac does to help with this problem?
      i. To correct for that imbalance, Prozac helps increase the amount of serotonin in the synapse by blocking it from getting back into the original neuron.
   b. Cocaine is a drug of abuse that involves dopamine, the chemical that is associated with feeling good. Ask students to make a prediction: How do you predict cocaine affects levels of dopamine in the brain?
      i. Cocaine also blocks the transporter like Prozac, which prevents dopamine from going back into the first neuron. It stays in the synapse and binds to the receptors repeatedly, firing an artificial “high” of feeling good.
      ii. Ask students to predict:
         1. What do you think happens to the dopamine receptors over time after dopamine continues to bind over and over again?
         2. Do you think there are long-term effects of drug use?
iii. Looking at effects of cocaine slide, analyze the results of what happens to the number of iv. dopamine receptors in a person's brain who is addicted to cocaine versus a normal brain.

c. Ecstasy – These images are from a study in monkeys to show how much serotonin is in their brains after taking ecstasy. The “control” is normal monkey brain with no drug, shows a lot of serotonin, which is an important neurotransmitter in the brain to regulate mood.

i. Another group of monkeys were given ecstasy twice a day for four days—only half a week of taking the drug. Ask students to notice: Two weeks after that, what do you notice about the amount of serotonin present in the monkey’s brain? Is that surprising to you? Why or why not? Allow students to share their thoughts.

ii. Ask students to predict: How do you think the monkeys felt in this “withdrawal period” from ecstasy even after only having had it for a short time?

iii. Seven years later, the image on the right shows how much serotonin these monkeys regained. Ask students to predict: What do you notice about this? How does it compare to the monkeys who never took ecstasy at all?”

d. Methamphetamine (meth) – The red in this image shows where 5% of brain matter dies. The greatest loss is in areas of emotion, reward centers, and memory. Scientists call this a “forest fire of brain damage.” The tissue is actually destroyed.

i. Ask students to reflect: Is this surprising to you? Why or why not?

3. Ask students to discuss: Do you think drugs affect teen brains differently than adult brains? Why or why not? Take time to elicit students’ experiences and ideas, to foster deep thinking about these questions. Due to sensitivity of their experiences or those of their family and friends, create a safe and receptive space for students to share this information.

a. Discuss that since teen brains are still developing, and are in the “pruning” phase of trying to figure out which habits and pathways in the brain should be solidified for adulthood, chances of addiction to drugs and permanent changes based on drug use can be much more likely in teens than adults.

b. Ask students to reflect: What does this make you think about drug use during teen years?

Short Break (10 mins)

Drug Abuse Activity (60 minutes)

Driving Questions: What are the effects of different drugs on the brain? Why are these dangerous for teens?

1. Introduce the Drug Abuse Activity – students will work in pairs and identify a drug they are interested in learning more about. They can use “Mouse Party” and other credible websites to gather information about the drug. They should use the activity handout to organize the type of information they collect, to inform a video, flyer, or PowerPoint presentation that they present about their drug to the group.

2. While it’s important that students research a drug they’re particularly interested, attempt to have diversity among the groups to represent different drugs.

3. Have students present their final products to one another, teaching them about the way that drug works in the brain, the effect it has on behavior and mood, and why it is dangerous for teens.

Journal Reflection (10 mins)

Driving Questions: What are you thinking about after today’s session?

1. Encourage students to think about what they did and learned today. Ask them to consider and write about:
   a. What does that make you think?
   b. Where do you feel confused?
   c. What are you still curious to learn more about?