National Institute on Drug Abuse (NIDA)

Brain Power: Grades 6-9

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https://www.drugabuse.gov

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An Introduction to the Brain and Nervous System (Module 1)

You can also download this entire module in PDF format by clicking the following link: Module 1 (PDF, 796KB)

Summary

This introductory module of the *Brain Power! Challenge* Program is designed to help students learn about the parts of the brain, the functions of these parts, and how the brain communicates with the rest of the body. The process of neurotransmission is described in detail. This module provides a key foundation for the next five modules, which will discuss the impact of specific drugs on the body and the brain.

Students will refer to the information covered in this introductory module throughout the entire *Brain Power!* curriculum. If the students did not participate in the *Brain Power!* The NIDA Junior Scientists Program for grades K - 5, the information in this module may need to be covered in greater depth.

Learning Objectives

At the end of this module:

- Students can name the main parts of the brain: the cerebral cortex, hypothalamus, cerebellum, brain stem, and limbic system.
- Students can identify the lobes of the cerebral cortex: frontal, parietal, occipital, and temporal.
- Students can explain the functions of the major brain parts.
- Students can identify the components of a neuron: cell body, dendrites, and axon.

- Students can explain the process of neurotransmission.

Relationship to the National Science Education Standards

The lesson in module 1 aligns with two standards in the NSES: systems, order, and organization; and structure and function in living systems. The chart below shows how the activity aligns with these standards.

Unifying Concepts and Processes	**How the Lesson is Aligned**
Systems, order and organization	The students develop an understanding of what drugs are and how they are used so that they can learn how to make decisions that affect their health.

Life Science	**How the Lesson is Aligned**
Structure and function in living systems	Students will learn how neurons in the brain work together to communicate through a process called neurotransmission.

Background

Major Parts of the Brain

Cerebral Cortex

The cerebral cortex is the largest part of the human brain, making up more than 75 percent of this organ. The cerebral cortex is also the most highly developed part of the brain. It controls thinking, perception, and understanding language.

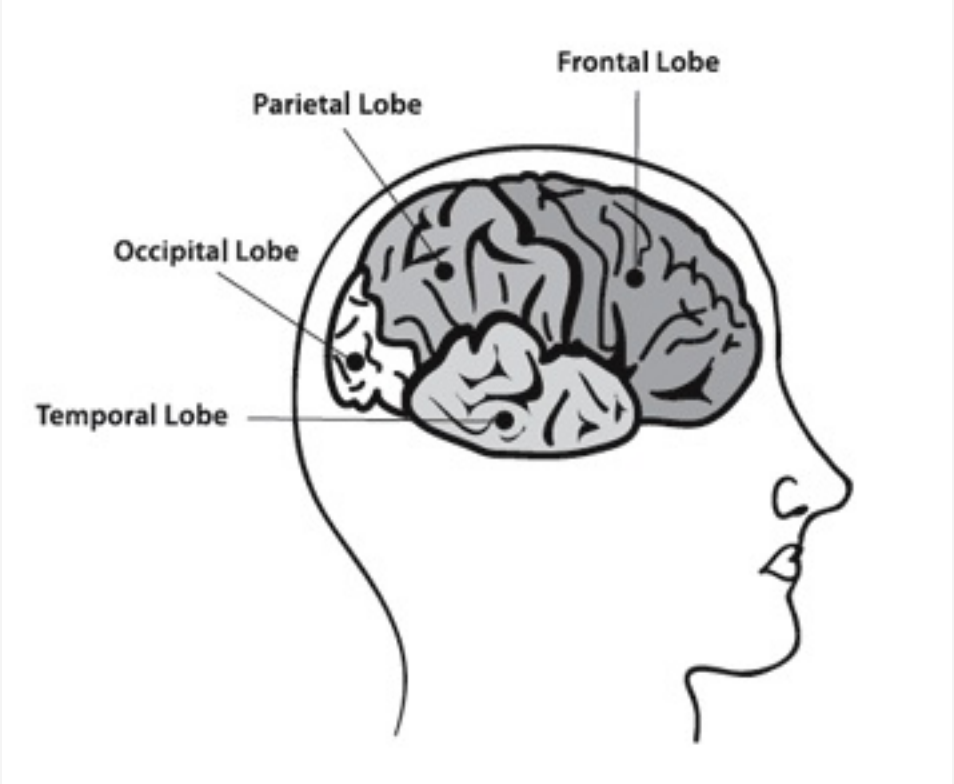
The cerebral cortex is divided into two hemispheres - the right hemisphere and the left hemisphere.

- The right hemisphere controls the left side of the body and is largely responsible for artistic expression and for understanding relationships in space - tasks such as reading a map.
- The left hemisphere controls the right side of the body. It is largely responsible for mathematical ability, problem solving, and comparing information needed to make decisions. It is also the brain's language center.

The two hemispheres communicate with one another through a bundle of fibers called the corpus callosum. The corpus callosum is the bridge between the two hemispheres.

The cortex is specialized. Four specific areas of the cortex, called lobes, are responsible for different tasks:

- The *frontal lobe* is responsible for initiating and coordinating motor movements and higher cognitive skills, such as problem solving and thinking.
- The *parietal lobe* processes sensory information from the whole body - for example, information
  about pain, touch, and pressure.
- The *occipital lobe* processes visual information coming into the brain.
- The *temporal lobe* is in charge of making sense of the auditory information from the environment.



Hypothalamus

The *hypothalamus* is situated deep inside the center of the brain. The hypothalamus links the nervous system to the endocrine system by producing and releasing hormones. The endocrine system is made up of glands that regulate, coordinate, and control hormones. The hypothalamus regulates body temperature, hunger, and thirst.

Cerebellum

The *cerebellum* is located at the back of the head near the spine. It controls posture, movement, and the sense of balance. Playing ball, picking up objects, and playing musical instruments are among the activities that fall under the control of the cerebellum.

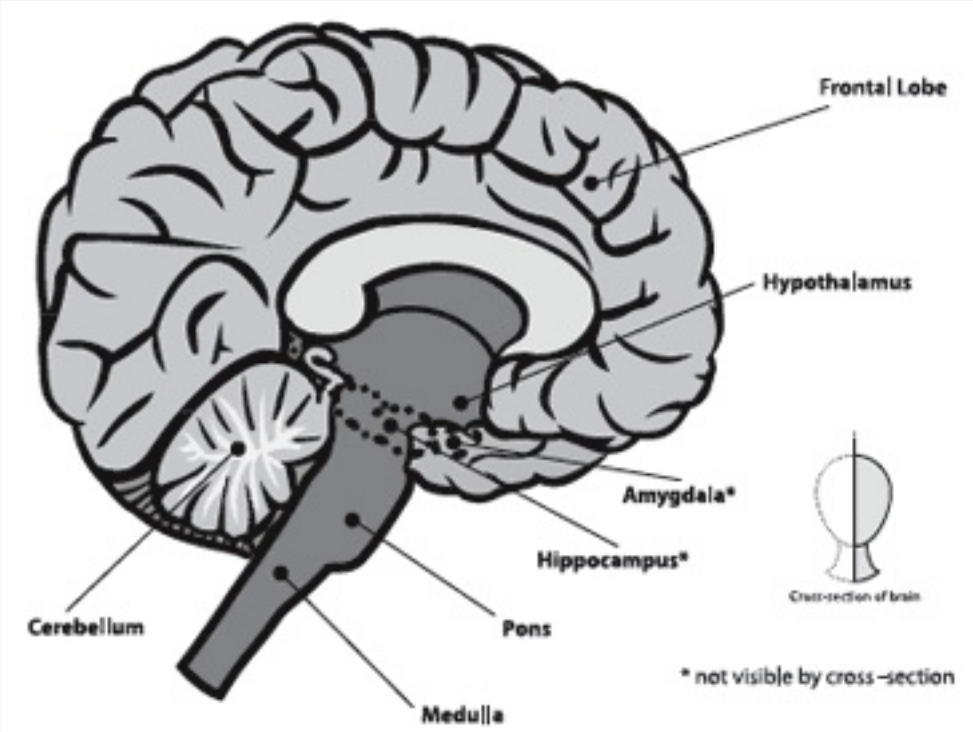
Brain Stem

The *brain stem*, the most primitive part of the brain, connects the brain to the

spinal cord. It is located near the cerebellum. The two main parts of the brain stem are the *pons* and the *medulla*. The pons contains nerve fibers that connect the cerebral cortex with the cerebellum and the spinal cord. The pons controls sleep, awakening, and dream onset. The medulla controls heart rate, respiration, and blood pressure. The brain stem also controls simple reflexes, such as coughing and sneezing.

Limbic System

The *limbic system* is located deep inside the brain. It has many parts, but two of the most important are the *hippocampus* and the *amygdala*. The hippocampus is mainly responsible for learning and memory. The amygdala plays an important role in emotional behavior. The limbic system is greatly affected by substances such as nicotine, alcohol, and illegal drugs.

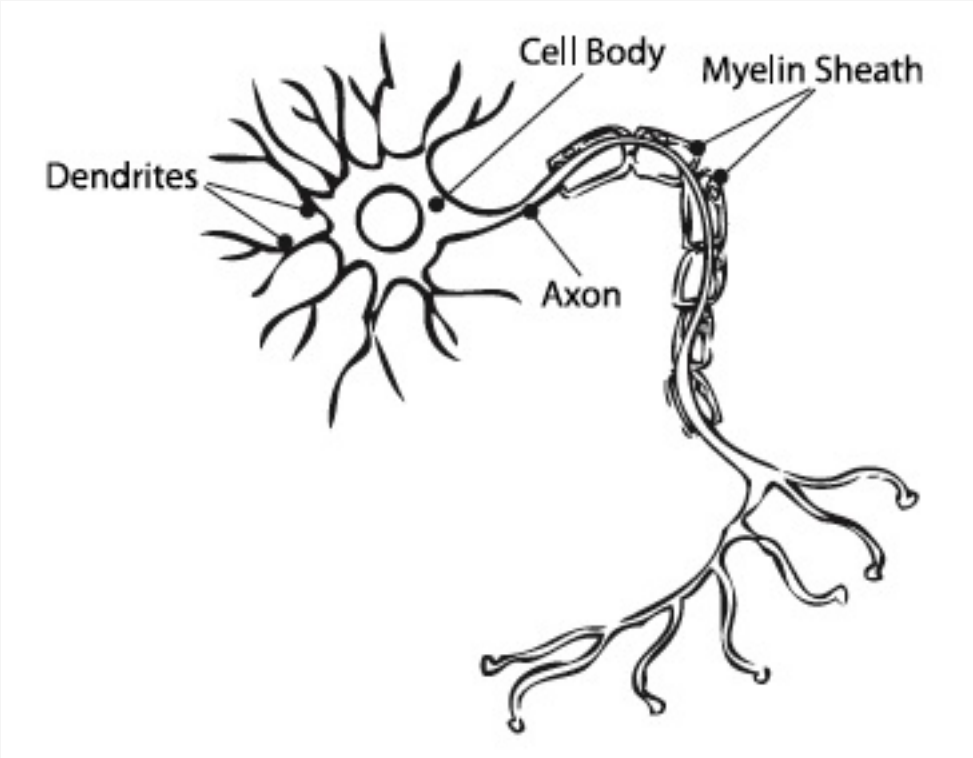


Neurons

Information is constantly exchanged between the brain and other parts of the body by both electrical and chemical impulses. Cells called neurons are responsible for carrying this information. All of the major brain parts discussed

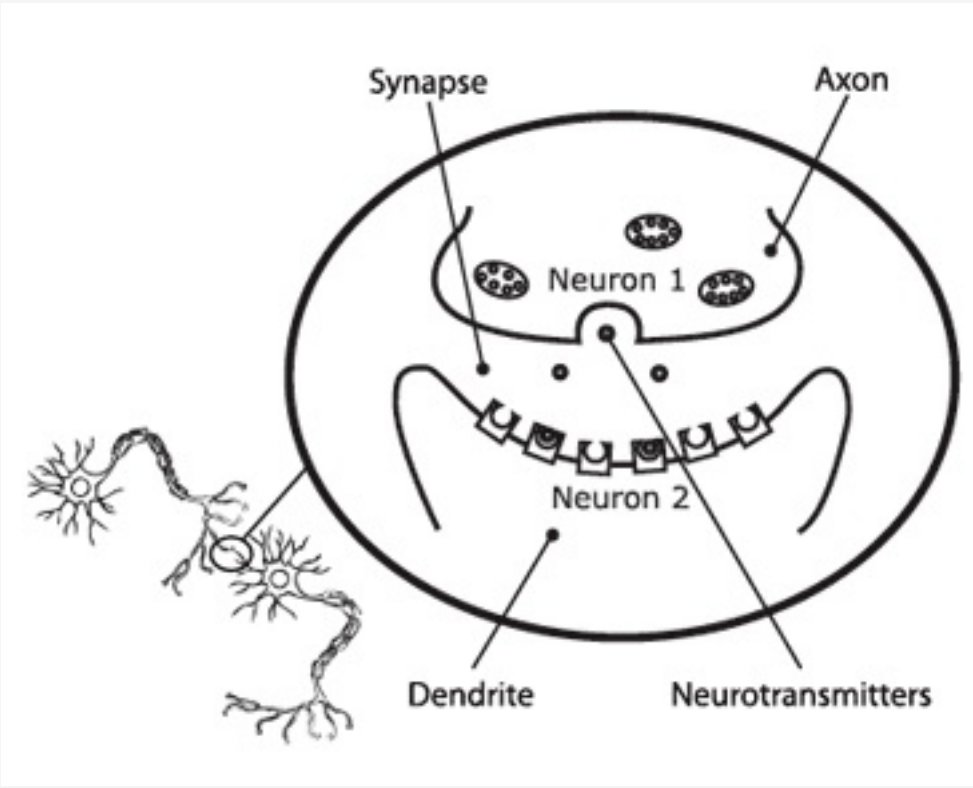
above are composed of neurons - almost 100 billion neurons total!

A neuron has three main parts. The *cell body* directs all the neuron's activities. *Dendrites*, short branches that extend out from the cell body, receive messages from other neurons and pass them on to the cell body. An *axon* is a long fiber that transmits messages from the cell body to the dendrites of other neurons or to other tissues in the body, such as muscles. A protective covering, called the *myelin sheath*, covers the axons of many neurons. Myelin insulates the axons and helps messages from nerve signals travel faster, farther, and more efficiently.



Neurotransmission

The exchange of information between the axon of one neuron and the dendrites of another neuron is called neurotransmission. Neurotransmission takes place through the release of chemicals into the space between the axon of the first neuron and the dendrites of the second neuron. These chemicals are called neurotransmitters. The space between the axon and the dendrite is called a *synapse*.



When neurons communicate, an electrical impulse traveling down the axon causes neurotransmitters to be released from the end of the axon into the synapse. The neurotransmitters cross the synapse and bind to special molecules, called receptors, on the dendrite of the second neuron. Receptors are found on the dendrites and cell bodies of all neurons. The receptors convert the information into chemical or electrical signals which are then transmitted to the cell body and eventually to the axon. The axon then carries the signal to another neuron or to body tissues such as muscles.

Once a neurotransmitter binds to a receptor, a series of events follow. First, the message carried by the neurotransmitter is passed on to the receiving neuron. Second, the neurotransmitter is inactivated. It is either broken down by an enzyme or reabsorbed by the axon from which it was released. Other molecules, called transporter molecules, complete this reabsorption process. These molecules are located in the cell membranes of the axon that releases the neurotransmitters. They pick up specific neurotransmitters from the synapse and carry them back across the cell membrane and into the axon, where they are recycled for use at a later time. Note that this process is true for most neurotransmitters, but not for all of them.

The human body produces many different types of neurotransmitters. Each neurotransmitter has a specific role to play in the functioning of the brain. A neurotransmitter binds to a receptor in much the same way that a key fits into a lock; a specific neurotransmitter will bind only to its corresponding receptor.

Neurotransmitter messages can be generalized as either excitatory or inhibitory messages. An excitatory neurotransmitter is one that increases the activity of neurons, and an inhibitory neurotransmitter decreases the activity of neurons. Over the course of these modules, several specific neurotransmitters will be discussed, including acetylcholine, GABA, and dopamine.

Neurotransmitter	Brain Function
Acetylcholine (excitatory)	Plays an important role in the function of the hippocampus, which is in charge of learning and memory.
GABA (inhibitory)	A neurotransmitter in the cerebral cortex, which controls thinking, perceiving, and understanding language.
Dopamine (excitatory)	Plays an important role in reinforcing rewarding behaviors.

Preparation/Introduction

Preparation

- Read the Background section of this module for more information about the brain and neurotransmission.
- Provide students with the Module 1 magazine *The Brain and Nervous System* for background knowledge.
- Determine which activities you want the class to complete.
- Arrange for computer lab time or prepare the classroom computer for

students' Internet and CD-ROM use.

- Photocopy and pass out the Brain Parts Fact Sheet and the Neurotransmission Fact Sheet for students to complete during the lecture.
- Prepare transparencies and photocopies for the lesson.

Introduction

Time: 15 - 20 minutes

Supplies: Transparencies of diagrams if needed

Handouts: Module 1 magazine (PDF, 10.4MB)

Brain Parts Fact Sheet (PDF, 668KB)
(Page 6 in the pdf)

Reading: Begin by giving students adequate time to read the student magazine. Have students pay particular attention to the following sections: Background, Stats and Facts, and Science in the Spotlight.

Discussion: After students have read the magazine, facilitate a discussion about the brain using the following questions. If necessary, review this information with your students, using the diagrams provided.

The Parts of the Brain

- What does the brain do?
- What are the four lobes of the brain?
- What are the functions of the right and left hemispheres?
- What does the limbic system control?

- What are three functions of the brain stem?

Neurotransmission

- What are the three main parts of a neuron?
- Approximately how many neurons are in the brain?
- What are the steps of neurotransmission?
- What are the definitions of neurotransmitters, synapse, and receptors?

Activities

Activity 1: Brain Messages

Time: 45 minutes

Supplies: One large piece of butcher-block paper per group

Markers/crayons/pencils

Handouts: Neurotransmission Fact Sheet (PDF, 668KB)

This is the first activity in a series of six. These activities are all part of the Brain Power! Challenge competition. Before you begin, go over the competition details that are found on page vii of this guide.

Part 1

- Give each group the Neurotransmission Fact Sheet. Make sure students understand the role of the brain and neurons in transmitting messages throughout the body.

- Give each group a large sheet of butcher-block paper, pencils, and markers. Tell each group to draw the steps involved in neurotransmission. Students should be able to describe the parts of a neuron, how information exchange takes place, and how information is sent throughout the body. They should include a short written explanation of how the process works.

Part 2

- Have groups take turns showing the steps of neurotransmission. Encourage students to ask questions in a discussion format in between the presentations.
- Based on the clarity, information, and creativity in the groups' presentations, you will give each group a score from 0-10. These scores need to be recorded on the Group Scorecard, as each Challenge activity for the *Brain Power!* modules involves a similar scoring system. At the end of all the modules, the team with the most points wins the *Brain Power!* Challenge competition.

Activity 2: Scavenger Hunt

Time: 45 minutes

Supplies: Timer, if needed

Pen or pencil

Handouts: Neurotransmission Scavenger Hunt (PDF, 668KB)
(Page 4 in the pdf)

In this activity, students will learn about neurotransmission by using the Internet. Have students work together in groups to complete an Internet scavenger hunt.

Ideas for making this activity more suitable for a bigger class: If there are not

enough computers for all groups, send groups one at a time while the rest of the class completes other activities. Use a timer to record each group's completion time.

Students should try to find the answers as quickly as possible. You can use the provided Scavenger Hunt handout or develop one of your own. The following Web site contains all the information students need to complete the scavenger hunt:

Prior to this activity, add the Internet resource listed below to the computer's Internet "Favorites" drop-down menu.
faculty.washington.edu/chudler/neurok.html

Room 1(Online Version)*

Includes games and materials to supplement the information presented in the module. ***The room labeled "1"*** contains the following activities and specific information pertaining to this module:

- *Learning Objectives:* these are presented at the beginning of each CD-ROM module
- *Parts of the Brain:* a short film about brain parts
- *Cerebral Cortex:* a short film about the cerebral cortex
- *Hemisphere Quiz:* a personal quiz students can take to determine their own "dominant hemisphere"
- *Harry Human Superguy:* an interactive quiz and cartoon about brain parts and functions
- *NT 101:* An Introduction to Neurotransmission: this activity details the process of neurotransmission step-by-step
- *Module Quiz:* this quiz is the final part of the module, intended to assess students' learning

* *Adobe Flash player required to view.*

Extensions

1. Divide the students into pairs and give each a copy of the Brain Parts Fact Sheet. Assign each pair a part of the brain and have them draw their own original cartoon character or superhero that represents this brain part. For example, students assigned the occipital lobe might draw a character with very large eyes, and students assigned the cerebellum might draw their character playing football or dancing ballet. After drawing the cartoon, each pair should think of a fun name for their character and then introduce him or her to the class.
2. Have students develop timelines charting the major findings and breakthroughs in brain research. Divide the students into small groups and have each group focus on a specific timeframe (e.g., 0 - 1700 AD, 1700 - 1900, 1900 - present). Encourage students to highlight key milestones on their timelines. The following Web site is a good starting point: http://faculty.washington.edu/chudler/hist.html
3. Have students create a plan for a board game to show the process of neurotransmission. Make sure they cover all the major parts of the process. You can present the activity with the following framework to build motivation.

> The object of the game is for the neurotransmitter to reach the receptors across the synapse. What kind of obstacles would the neurotransmitter face in your game? What pieces would the neuron need to collect before it can send the message? What would the board look like?

Have students create a visual presentation for their games. In this activity, you are the president of a board game company looking to make and sell the best neurotransmission game. Judge the presentations based on creativity and scientific accuracy.

Assessment

As students complete the activities in the module, observe whether they have mastered the following:

1. Do students know the main parts of the brain and the major functions of each part?
2. Do students know the main parts of a neuron? Can they explain the function of the neurotransmitters?
3. Can students explain neurotransmission? Do they have a clear understanding that this is the process through which messages are sent throughout the brain and body?
4. Do students understand the importance of the brain and its many functions?
5. Did students participate in the class activities and discussion? Did they engage in the topics?

Resources

Resources for Teachers

National Institute on Drug Abuse (NIDA)
301-443-1124
This Web site contains information about drug abuse as well as sections designed specifically for parents, teachers, and students.

NIDA DrugPubs Research Dissemination Center
877-NIDA-NIH (877-643-2644; TTY/TDD: 240-645-0228)
Order our materials free of charge in English or Spanish.

The Amazing Brain. Ornstein, R., & Thompson, R. F.
Boston: Houghton Mifflin Company, 1991.
This uniquely illustrated, comprehensive presentation of the numerous and

complex functions of the brain is an ideal source for health educators and older students.

Brain Basics: Know Your Brain
Provides an excellent overview of the architecture and functions of the brain.

Resources for Students

Neuroscience for Kids
Useful for both adults and children, this Web site contains information on the brain and neurotransmission, activities, experiments, pictures, and other resources.

The Physical Brain. Byrnie, F.
Woodbridge, CT: Blackbirch Press, Inc., 2001.
This book, part of *The Amazing Brain* series, uses a variety of illustrations and pictures to describe the development, functions, and specializations of the brain. The book also contains an overview of neurotransmission.

The Great Brain Book: An Inside Look at the Inside of Your Head. Newquist, H.P.
New York: Scholastic Reference, 2005.
The Great Brain Book uses medical illustrations, cartoon illustrations, and interesting photographs to tell the complete story of the brain, from the history of the brain to the future of brain science.

Legal Doesn't Mean Harmless (Module 2)

You can also download this entire module in PDF format by clicking the following link: Module 2 (PDF, 764KB)

Summary

This module focuses on how two drugs, nicotine and alcohol, change the functioning of the brain and body. Both drugs are widely used in the community, and for adults, using them is legal. Nonetheless, both alcohol and nicotine can have a strong impact on the functioning of the brain. Each can cause a number of negative effects on the body and brain, ranging from mild symptoms to addiction.

The goal of this module is to help students understand that, although nicotine and alcohol are legal for adults, they are not harmless substances. Students will learn about how nicotine and alcohol change or disrupt the process of neurotransmission. Students will explore information on the short- and long-term effects of these two drugs, and also learn why these drugs are illegal for children and teens.

Through the media, students are exposed to a great deal of information about alcohol and tobacco, much of which is misleading or scientifically inaccurate. This module will provide information on what researchers have learned about how nicotine and alcohol change the brain, and the resulting implications for safety and health.

Learning Objectives

At the end of this module:

- Students can explain how nicotine disrupts neurotransmission.

- Students can explain how alcohol use may harm the brain and the body.
- Students understand how alcohol can intensify the effect of other drugs.
- Students can define addiction and understand its basis in the brain.
- Students draw conclusions about why our society regulates the use of nicotine and alcohol for young people.

Relationship to the National Science Education Standards

This lesson aligns with three standards in the NSES: risks and benefits; personal health; and structure and function in living systems. The chart below shows how the activity aligns with these standards.

Science in Personal & Social Perspectives	**How the Lesson is Aligned**
Risks and benefits Personal health	Students learn about the short- and long-term effects of nicotine and alcohol. These drugs can change how the body and brain function and can lead to addiction. Students can use this information in making decisions that affect their own health.

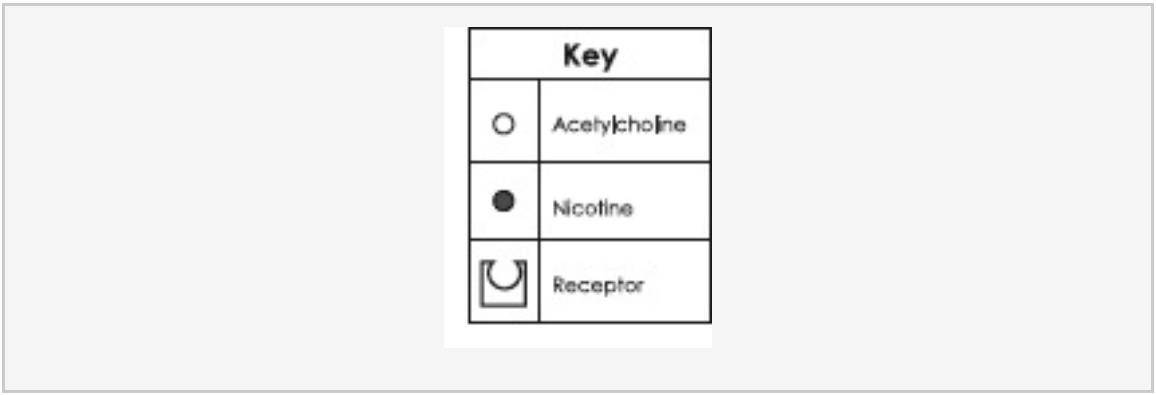
Life Science	**How the Lesson is Aligned**
Structure and function in living systems	Students will learn how nicotine and alcohol act in specific parts of the brain to alter the functioning of neurons. They will learn that these drugs ultimately affect the entire brain and body.

Background

Nicotine

Nicotine is a stimulant drug found in cigarettes, cigars, pipe tobacco, and smokeless tobacco. Nicotine is highly addictive; in fact, it is as addictive as heroin and cocaine. Nicotine reaches the brain within 8 seconds of inhalation. Its effects on the body include increased heart rate and blood pressure, increased alertness, and reduced appetite.

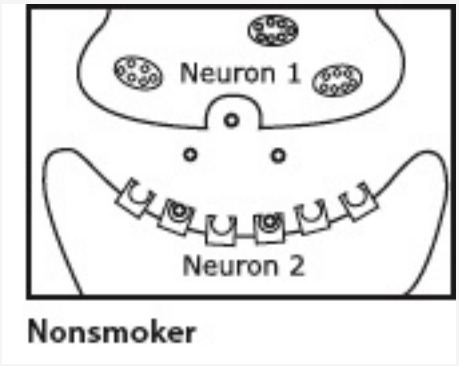
Although nicotine is an addictive substance, it is actually the tobacco in nicotine products that can cause deadly cancers. Smoking and chewing tobacco can cause cancer of the lungs, throat, and mouth.



Nicotine and Neurotransmitters

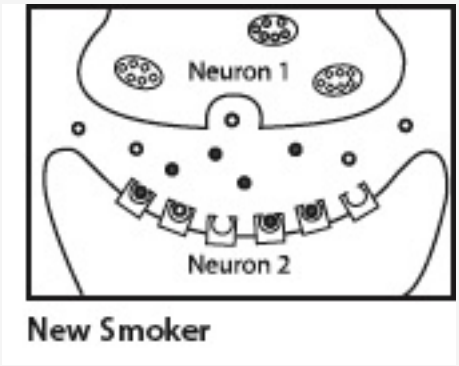
Nicotine disrupts the normal relationship between the neurotransmitter acetylcholine and the receptors acetylcholine binds to. These changes in the brain, detailed here with diagrams, can lead to addiction.

Normal acetylcholine and receptors



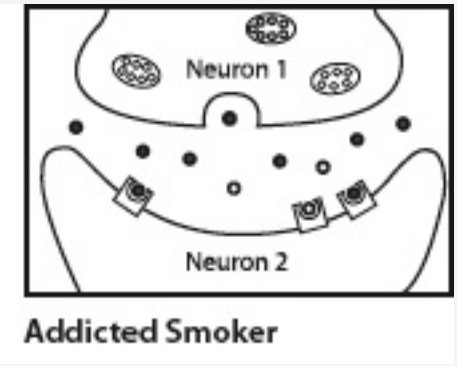
Nicotine affects the neurotransmitter acetylcholine and its receptor. This receptor is located in many brain structures and body organs. It carries messages related to respiration, heart rate, memory, alertness, and muscle movement.

Too many chemicals in the synapse



Because nicotine is shaped similarly to acetylcholine, it can fit in the same receptors and act just like acetylcholine. After repeated use of nicotine, there is more activity at the acetylcholine receptors than usual because the receptors are being activated by both acetylcholine and nicotine.

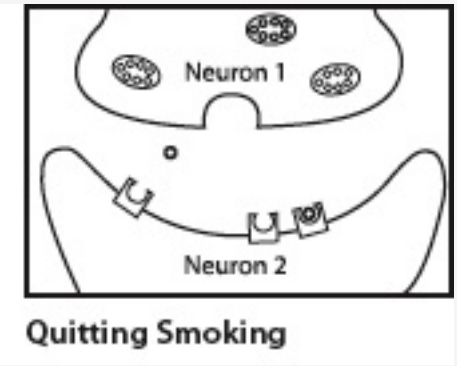
Less acetylcholine and fewer receptors



Addicted Smoker

This change in balance causes the brain to “think” there is too much acetylcholine and react by reducing the number of receptors and releasing less acetylcholine into the synapse. The brain now needs nicotine to maintain normal functioning.

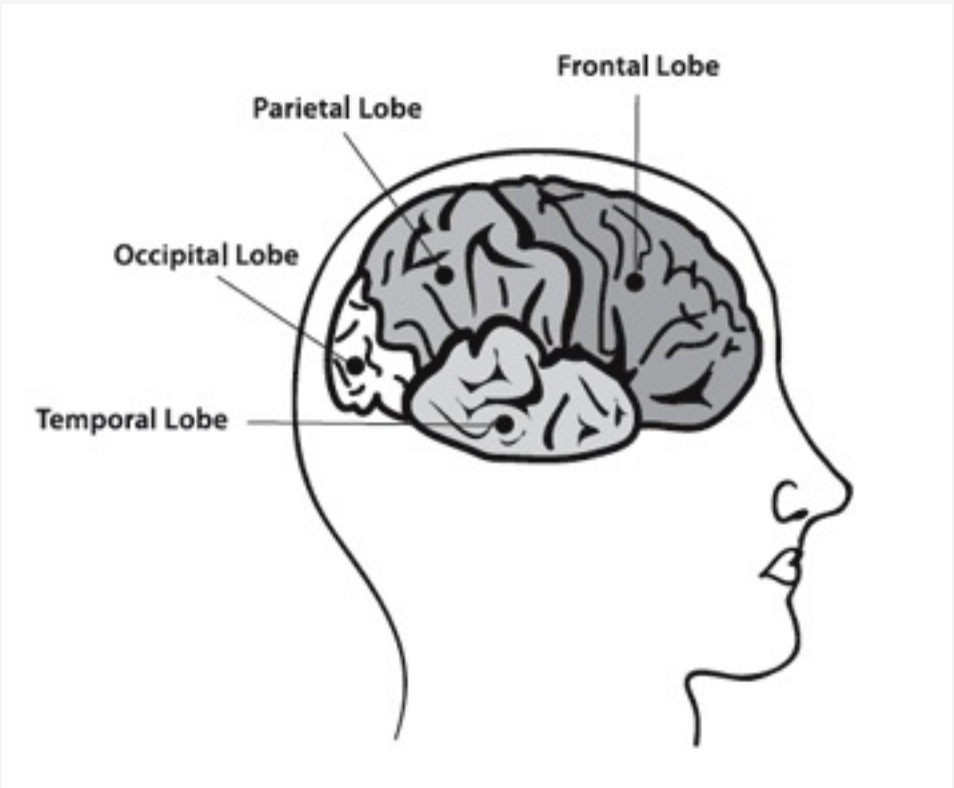
Not enough acetylcholine and receptors



Quitting Smoking

These changes in the brain cause a nicotine user to feel abnormal when not using nicotine. In order to feel normal, the user has to keep his or her body supplied with nicotine. This is addiction. If the person stops using nicotine, the number of receptors and their sensitivity to acetylcholine will eventually be reestablished, but only after some time.

Nicotine also activates the reward circuits that are part of the limbic system, producing a pleasurable feeling, as well as causing a surge of the neurotransmitter dopamine in these circuits, which prods the person to want to repeat behaviors that caused pleasure before. This effect on dopamine is part of what makes many drugs like nicotine so addictive.



Nicotine use also causes a decrease in an enzyme that is responsible for breaking down dopamine. The decrease in this enzyme results in higher-than-normal dopamine levels. Because of these effects on dopamine, smokers have powerfully learned to associate the good feelings from smoking not only with cigarettes themselves but also with things that remind them of cigarettes (cues).

Withdrawal from Nicotine and Nicotine Replacement Therapy

Withdrawal symptoms are the uncomfortable feelings a drug user experiences after he or she has stopped taking a drug. A person who is trying to stop using nicotine may be shaky, have sleeping problems, experience increased appetite, and feel uncomfortable, irritable, and less alert. These unpleasant symptoms can prevent many smokers from quitting.

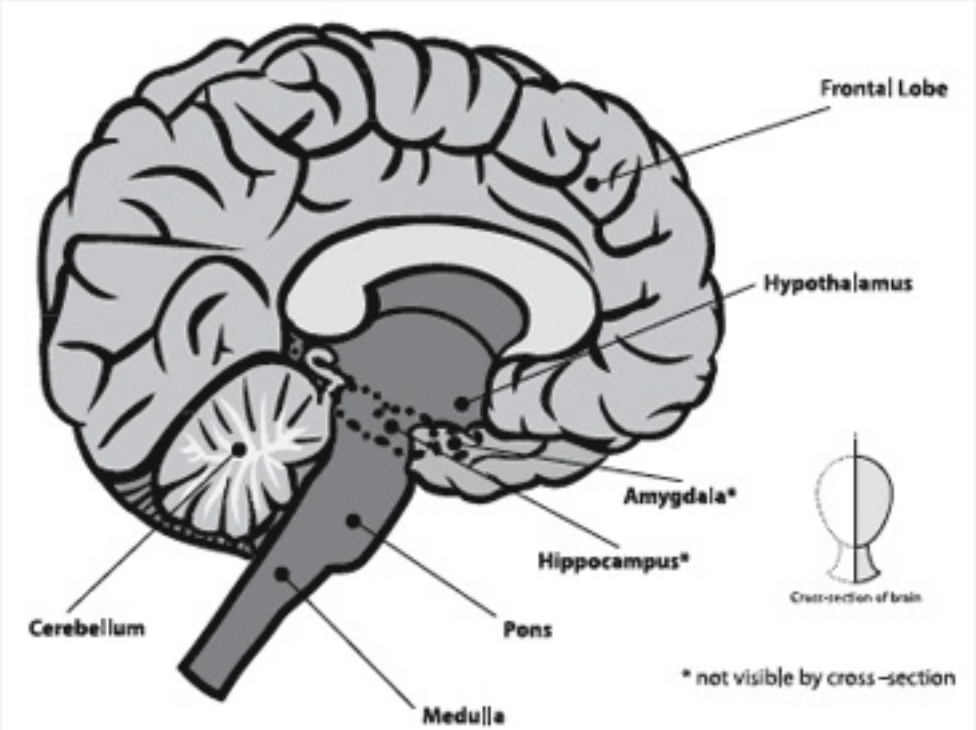
Nicotine replacement therapy, like the nicotine patch and gum, has helped many smokers quit. These products gradually reduce the amount of nicotine in the brain so that the smoker does not experience the negative effects of a sudden drop in nicotine levels. After the brain has adjusted to nicotine reduction or loss, the withdrawal symptoms can diminish or go away.

Alcohol

Alcohol is found in beer, wine, and hard liquors such as gin, vodka, and whiskey. It affects many areas of the brain and can cause memory loss, impaired motor coordination, impaired thinking and problem solving, changes in emotional behavior, and even death.

Alcohol and Brain Structures

Alcohol affects the *frontal lobe* region of the brain, causing thinking and problem-solving difficulties. Motor-coordination problems are caused by alcohol's effects on the *cerebellum*. Alcohol can cause memory loss by damaging the *hippocampus*. In large doses, alcohol can cause a person's heart to stop beating through its effects on the *medulla oblongata* and the *pons*.



Alcohol and Neurotransmitters

Alcohol has specific effects on certain receptors and neurotransmitters in the brain. Researchers have found that alcohol affects gamma amino butyric acid

(GABA) receptors and GABA, which is the neurotransmitter that binds to them. GABA is an inhibitory neurotransmitter; in other words, it decreases the activity of neurons. More GABA may cause decreased attention, memory alterations, mood changes, and drowsiness.

> Alcohol interrupts the normal functioning of other neurotransmitters, and can prevent the neurotransmission that would normally inhibit some types of behavior. For many, this effect causes increased social behaviors (decreased inhibition). Also, like many other drugs of abuse, alcohol increases dopamine release, which reinforces the alcohol drinking behavior.

Alcohol Withdrawal

After long-term use of alcohol, the brain may try to compensate for the inhibitory neurotransmission by increasing excitatory neurotransmission. This increases the activity of other neurons. When alcohol use is stopped, the excitatory neurotransmission is still active, which causes withdrawal symptoms like shaking, sweating, nausea, and anxiety.

Long-Term Damage to the Body

Wernicke-Korsakoff's disorder is a disease associated with long-term alcoholism. Because alcohol damages the brain, people with this condition cannot form new memories. They also have difficulties with muscle coordination and movement.

Long-term abuse of alcohol can also cause a potentially fatal liver disease called cirrhosis. The liver's job is to remove poisons, germs, and bacteria from the blood and to help the body function normally. Because alcohol is a poison to the body, the liver works to remove all alcohol that is ingested. When alcohol is repeatedly and excessively used, the liver becomes damaged and this damage can lead to cirrhosis.

Alcohol and Other Drugs

People who abuse alcohol often abuse other drugs as well. In fact, 45 percent of patients being treated for alcohol abuse report abuse of other drugs. Alcohol and certain drugs work in the same areas of the brain. Combining drugs with alcohol can greatly intensify their effects, which can be very dangerous to the brain and body.

Alcohol and Children

Research shows that the younger a person is when he or she begins to drink, the more likely he or she is to develop alcohol problems and alcohol dependence. Drinking at a younger age is also associated with a higher risk of alcohol-related traffic crashes, injuries, fatalities, and violence. In 1984, the United States increased the legal drinking age from 18 to 21 years of age. This change reduced youth drinking and alcohol-related incidents.

> Children should never drink alcohol. Alcohol is very dangerous for young people. The brain continues to develop until people are in their early twenties. Research shows that introducing alcohol during this developmental stage can harm the growing system and affect learning and memory, and increase risk of addiction.

Health Benefits of Moderate Drinking for Adults

Research shows that *moderate* consumption of alcohol has some benefits for adults. For example, moderate alcohol use seems to lower the risk of stroke and heart disease. This may be because alcohol helps keep blood vessels unclogged. “Moderate drinking” is defined as one or two drinks per day for men and one drink a day for women and people over the age of 65. Women and elderly persons of both sexes have lower levels of water, and they absorb alcohol differently than younger men do; thus, a smaller amount of alcohol has stronger effects.

Preparation/Introduction

Preparation

- Read the Background section of this module for more information about the effects of nicotine and alcohol on the brain and body.
- Provide students with the Module 2 magazine Legal Doesn't Mean Harmless for background knowledge.
- Determine which activities you want the class to complete.
- Arrange for computer lab time or prepare the classroom computer for students' Internet and CD-ROM use.
- Photocopy and pass out the "Nicotine and the Brain" and the "Alcohol and the Brain" worksheets for students to complete during the lecture.
- Prepare transparencies and photocopies for the lesson.
- Cut out puzzle pieces for Activity 1.

Introduction

Before giving students time to review the magazine, begin with the following activity. Working as a class or in small groups, ask students to generate a list of all the drugs and medicines they can think of in 2 minutes. Then review students' lists and circle all the drugs that are legal.* Ask students to share examples from their lists. Provide these important definitions:

- A drug is any substance that changes the way the body or brain functions.
- Some drugs are legal for adults but illegal for children and teens. Other drugs, such as cocaine, are illegal for everyone.
- The most widely used legal drugs for adults are alcohol and nicotine, which is found in tobacco.

Tell students that the goal of this lesson is to learn about how nicotine and

alcohol change the brain. Legal doesn't always mean harmless!

* Drugs you buy over the counter and drugs prescribed by a doctor are also legal and should be safe and effective when taken according to the directions. However, they are illegal when used by someone else or not as prescribed. They will be covered in Module 3, Drugs in the Cupboard.

Time: 15 - 20 minutes

Supplies: Transparencies of diagrams, if needed

Handouts: Module 2 magazine (PDF, 2MB)

Reading: Give students adequate time to read the student magazine. Have students pay particular attention to the following sections: Background, Stats and Facts, and Science in the Spotlight.

Discussion: After students have read the magazine, facilitate a discussion about nicotine and alcohol by using the following questions. If necessary, review this information with your students using the diagrams provided.

Nicotine and Alcohol

- What changes in the brain cause nicotine withdrawal symptoms?
- How does alcohol affect learning and memory?
- What are possible consequences from drinking a lot of alcohol in a short period of time?
- How does alcohol affect thinking, planning, and decision-making?

Activities

Activity 1: Piece It Together

Time: 15 minutes

Supplies: Photocopies of Puzzle Pieces (cut out prior to activity)

Module 2 magazine (PDF, 2MB)

Handouts: Puzzle pieces, Nicotine and the Brain worksheet, and Alcohol and the Brain worksheet (PDF, 668KB)
(See Table of Contents for correct pages)

Tell students that this is the second activity of their competition. The first group to complete the task wins five points. Students should use the “Nicotine and the Brain” and “Alcohol and the Brain” handouts from the lecture and the magazine content to help them complete this activity.

1. Divide the class into their Brain Power! Challenge groups and tell the groups to move next to each other around a desk. (If the class is large, it might be better to work on the floor.)
2. Give each student a copy of the Puzzle Pieces handout. The definitions should be cut apart so each one is on a different piece of paper. The puzzle pieces are designed so that the definitions are gray and the words are white.
3. The puzzle pieces include words and definitions from the module. Students will need to arrange the pieces so that the correct definition is next to each word.
4. The team that completes this task correctly in the shortest time wins. Record the winning group’s points on the Group Scorecard.

Ideas for making this activity more suitable for a bigger class: Each member of the team could complete the puzzle individually, and the team with the most correct puzzles in the predetermined amount of time could win the five points.

Activity 2: Underage Drinking and the Media

Time: 45 minutes

Supplies: Timer, if needed

Pen or pencil

Handouts: Media Report Card (PDF, 885KB)

Popular television shows and movies often depict underage drinking. It is important for teens to think critically about the media's portrayal of alcohol use and recognize both the accuracies and inaccuracies.

Divide the class into groups of 4 to 6 students. Give students about 10 minutes to list television shows and movies that portray underage drinking using the Media Report Card and assign each example an accuracy grade. Students should justify each grade in the comments section of the Media Report Card. Have each group present its two highest and lowest graded examples and explain the reasoning behind each grade assignment.

Tell students to ask the following questions as they determine grades for each television show and movie:

- How often is underage drinking depicted?
- What is the tone of the scene(s) in which underage drinking is depicted? For example, is the scene comic, designed to elicit laughs? Or does it take underage drinking more seriously?

- Are the consequences of underage drinking shown?
- How are the effects of alcohol on the brain and body depicted?

Room 2 (Online Version)*

Includes games and materials to supplement the information presented in the module. ***The room labeled "2"*** contains the following activities and specific information pertaining to this module:

- *Learning Objectives*: these are presented at the beginning of each CD-ROM module
- *Meet Acetylcholine*: an introduction to the acetylcholine neurotransmitter, and how nicotine uses the same receptors
- *Nicotine Knockout*: a game in which players must stop nicotine from getting to the receptors
- *Chalkboard Facts*: this is a listing of facts about how alcohol affects a developing brain
- *Inter-lobe Loop*: an interactive quiz where students "travel" through the brain and answer questions about how alcohol affects different brain parts
- *Module Quiz*: this quiz is the final part of the module, intended to assess students' learning

**Adobe Flash* player required to view.*

Extensions

1. The *Brain Power!* magazine provides a timeline of some of the major events in the history of alcohol. Develop a similar timeline for tobacco. The timeline should trace people's growing understanding of the impact of tobacco on public health in the United States, from the founding of the colonies to the present day. What are some current topics in the news related to tobacco, smoking, and nicotine?

2. The *Brain Power!* magazine includes a cartoon that illustrates how nicotine affects neurotransmitters in the brain. Have students develop a cartoon that shows the effects of alcohol on the brain.
3. Lead the class in completing the following experiment to demonstrate the harmful effects of nicotine and alcohol.

Materials

- 4 household plants of the same kind
- Alcohol
- Paper and pencil
- Marker
- Coffee
- Ruler
- Water
- 2 clear plastic cups
- Cigarettes

Never let children handle alcohol or tobacco products.

Conducting the experiment:

What would happen if plants drank alcohol or coffee, or smoked cigarettes? Have students think about how the items will be used in this experiment and record their observations on how the plants look. If you have a camera, take pictures of the plants before you begin the experiment.

Predict

Write down student predictions about how each plant will react over the course of 3 weeks if each is fed with one of the following substances: water, coffee,

tobacco water, or alcohol.

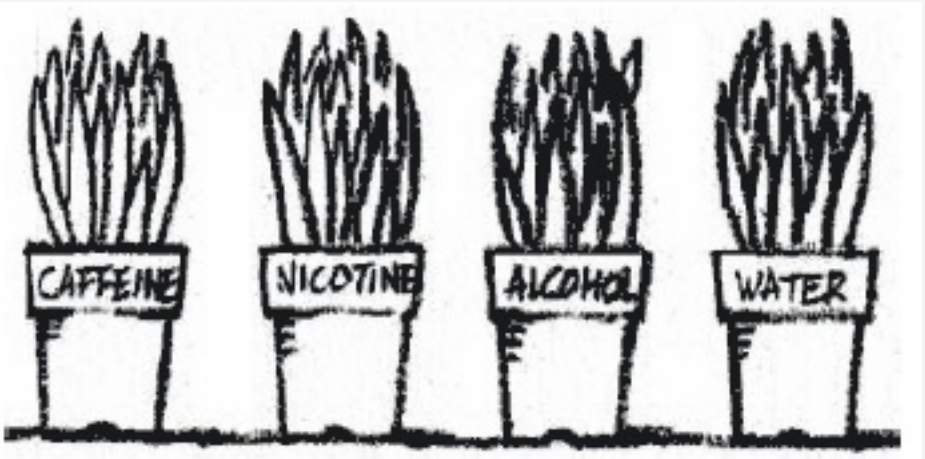


Figure 1

Experiment

1. Label each plant with the substance with which it will be fed (Figure 1).


Figure 2

2. With a ruler, measure 1 inch from the bottom of the clear plastic cups and draw a line. To feed the plants, fill the cups only to the line so that each plant receives the same amount of food (Figure 2). Only teachers should handle the alcohol and tobacco.
3. Label one of the cups “Tobacco.” This cup will be used for the tobacco water only.
4. Every 3 days for 3 weeks, do the following:

a. The night before, fill the tobacco cup to the line with water; remove the paper from one cigarette, and put the tobacco in the cup. Let it soak overnight.

b. The next day, place the plants on a table.

c. Measure each plant at its highest point (the tallest leaf) with a ruler. Record each plant's height and appearance (color, overall health, and number and health of its leaves).

d. Have students record their observations, and draw a picture of each plant.

e. Gather the tobacco water, fresh water, coffee, and alcohol. Make sure they are at room temperature.

f. Pour the tobacco water in the plant labeled tobacco.

g. Pour one of the other substances (water, coffee, or alcohol) into the other plastic cup to the line.

h. Pour the substance into the plant labeled for that substance.

i. Rinse the cup between each feeding.

j. Repeat steps g, h, and i until each plant has been fed.

k. Keep the plants in a sunny area between feedings.

Conclude

At the end of 3 weeks, examine and measure each plant. Have students record their observations. Compare the measurements and drawings of each plant from the first day with the measurements and appearance of each plant after 3 weeks of feedings and have students record the differences. If you took pictures of the plants prior to the experiment, compare the pictures to the way the plants look now.

Questions for Students

What effect did each substance have on the plant? What happened? Did some

of the plants grow more than others? Did any of the plants die? What conclusions can you draw from the appearance of the plants? Discuss the results of the experiment. If these substances hurt, or maybe even killed, the plants, what would happen if a person used nicotine, alcohol, or caffeine?

As students complete the activities in the module, observe whether they have mastered the following:

1. Can students describe the effects of nicotine on the brain? Can they explain how these changes often result in addiction?
2. Can students describe the effects of alcohol in the brain? Can they explain how these changes may result in addiction?
3. Can students list withdrawal symptoms of nicotine and alcohol? Do they understand the connection between these symptoms and how the brain changes as a result of the use of these substances?
4. Can students provide a scientific justification for the laws against the use of nicotine and alcohol by young people?
5. Did students participate in class activities and discussion? Did they engage in the topic?

Assessment

As students complete the activities in the module, observe whether they have mastered the following:

1. Can students describe the effects of nicotine on the brain? Can they explain how these changes often result in addiction?

2. Can students describe the effects of alcohol in the brain? Can they explain how these changes may result in addiction?

3. Can students list withdrawal symptoms of nicotine and alcohol? Do they

understand the connection between these symptoms and how the brain changes as a result of the use of these substances?

4. Can students provide a scientific justification for the laws against the use of nicotine and alcohol by young people?

5. Did students participate in class activities and discussion? Did they engage in the topic?

Resources

Resources for Teachers

National Institute on Drug Abuse (NIDA)
301-443-1124
This Web site contains information about drug abuse as well as sections designed specifically for parents, teachers, and students.

Mind Over Matter
Designed for teens, this site includes information about how different drugs, including nicotine, affect the brain. Also available for free by calling 1-800-729-6686.

NIDA DrugPubs Research Dissemination Center
877-NIDA-NIH (877-643-2644; TTY/TDD: 240-645-0228)
Order our materials free of charge in English or Spanish.

National Institute on Alcohol Abuse and Alcoholism
A useful tool for educators, this site details the latest research, and provides information, publications, and news releases on alcohol use and abuse.

Buzzed: The Straight Facts About the Most Used and Abused Drugs from Alcohol to Ecstasy. Kuhn, C., Swartzwelder, S. and Wilson, W.
New York: W. W. Norton & Company, 2003. A highly informative, detailed

review of widely abused drugs.

Resources for Students

Above the Influence
Designed for teens, this site covers the risks and consequences of various drugs and provides news, advice, and real-life stories.

Mind Over Matter
Designed for teens, this site includes information about how different drugs, including nicotine, affect the brain. Also available for free by calling 1-800-729-6686.

NIDA for Teens
Designed for teens, this site provides information on several drugs, including nicotine, as well as quizzes and real-life stories.

Too Smart to Start
Covers a wide range of alcohol-related issues and contains advice columns, word games, and an interactive tool that explains alcohol's effects on different parts of the body.

The Cool Spot
This NIAAA Web site, created for middle school students, covers a variety of peer pressure issues and discusses the myths and facts of alcohol.

Alcohol. Wagner, H.L.
Part of the *"Drugs: The Straight Facts*" series. Philadelphia, PA: Chelsea House Publishers, 2003. Contains a thorough discussion of alcohol-related issues, including history, health effects, usage trends, and alcoholism.

Nicotine. Wagner, H.L.
Part of the "*Drugs: The Straight Facts*" series. Philadelphia, PA: Chelsea House Publishers, 2003. Contains a thorough discussion of nicotine and smoking, including history, health effects, usage trends, and addiction.

The U.S. Government does not endorse or favor any specific commercial product or company. Trade, proprietary, or company names appearing in this publication are used only because they are considered essential in the context of the studies described here.

Drugs in the Cupboard (Module 3)

You can also download this entire module in PDF format by clicking the following link: Module 3 (PDF, 600KB)

Summary

This module explains how prescription drugs and some household products can damage the brain and body when used improperly. Household products are called inhalants when they are abused. These drugs are particularly prone to misuse because they are often found in the home and are easily accessible. Prescription drugs and inhalants are not dangerous when they are used as intended. However, they can lead to serious side effects, even death, when used inappropriately.

Learning Objectives

At the end of this module:

- At the end of this module:
- Students can explain the effects of prescription drugs.
- Students can explain how prescription drugs affect the functioning of the brain and body when not used properly.
- Students understand how inhalants can change the brain.
- Students understand why it is important to use medication as instructed.

Relationship to the National Science Education Standards

This lesson aligns with three standards in the NSES: risks and benefits; personal health; and structure and function in living systems. The chart below

shows how the activity aligns with these standards.

Science in Personal & Social Perspectives	How the Lesson is Aligned
Risks and benefits Personal health	Students learn about the short- and long-term effects of abusing prescription drugs and inhalants. These drugs can change how the body and brain function and can lead to addiction. Students can use this information in making decisions that affect their own health.

Life Science	How the Lesson is Aligned
Structure and function in living systems	Students will learn how prescription drugs and inhalants act in specific parts of the brain to alter the functioning of neurons. They will learn that these drugs ultimately affect the entire brain and body.

Background

Prescription Drugs

Drugs prescribed by a physician can relieve pain and control the symptoms of many disorders and diseases. People who use prescription drugs as directed by a doctor (at the prescribed dose and for the recommended length of time) are at very low risk for addiction or other negative side effects. However, intentional misuse of prescription drugs can be dangerous. Three commonly misused prescription drugs are opioids, central nervous system (CNS) depressants, and CNS stimulants.

The Internet makes prescription drugs more easily accessible for misuse. E-mail inboxes are often full of spam e-mails offering the sale of prescription drugs without a prescription. When discussing these drugs with your students, bring up the topic of dangerous and misleading spam e-mails, and how it is important to respect prescription drugs.

Effects of Prescription Drugs on the Brain and Body

Opioids

Opioids, such as morphine, codeine, oxycodone (Oxycontin), and hydrocodone (Vicodin), are prescribed for pain relief. Used correctly, opioids are helpful for people suffering from chronic pain or pain from surgery. These drugs act by attaching to opioid receptors in the brain and spinal cord, and blocking the transmission of pain messages to the brain. Opioids also cause initial feelings of pleasure by acting on the reward system in the brain. Side effects of opioids include drowsiness and constipation.

CNS Depressants

CNS depressants include barbiturates and benzodiazepines (e.g., diazepam [Valium], alprazolam [Xanax], and lorazepam). These medications are prescribed to treat anxiety, tension, and sleep disorders. They slow brain function by increasing the activity of the neurotransmitter GABA. GABA decreases brain activity and causes feelings of drowsiness and calmness, which is helpful in people with anxiety or sleep disorders.

CNS Stimulants

CNS stimulants, such as dextroamphetamine (Dexedrine) and methylphenidate (Ritalin), are prescribed for attention-deficit hyperactivity disorder (ADHD), narcolepsy (a sleeping disorder), and depression that has not responded to other treatments. Stimulants copy the activity of the neurotransmitters dopamine and norepinephrine by stimulating their specific receptors. This results in increased alertness, attention, and energy. Stimulants also result in increased

feelings of pleasure, higher blood pressure and heart rate, and increased blood glucose levels.

Scientists propose that there is less dopamine transmission in the brains of persons with ADHD when compared to other individuals. Because stimulants correct this shortfall, individuals with ADHD better able to pay attention and concentrate their focus on a task. It is premature to draw solid conclusions, but studies so far have not shown a difference in later substance use in young people with ADHD treated with prescription stimulants compared with those who didn't receive such treatment. This suggests that treatment with ADHD medication does not positively or negatively affect a person's risk of developing problem use. Individuals who misuse Ritalin often do so by taking more than prescribed, taking pills not prescribed for them, or by crushing and then snorting the tablets. This causes wakefulness and euphoria. The increased dopamine transmission caused by ingesting Ritalin reinforces the behavior of taking the drug, putting a user at risk of addiction.

	Drug Effects
Opioids	
Morphine, Codeine, Oxycodone, Hydrocodone	Attach to opioid receptors in the brain and body to block transmission of pain messages.
CNS Depressants	
Barbiturates and Benzodiazepines	Slow brain function by increasing the activity of the neurotransmitter GABA, which decreases brain activity and causes feelings of drowsiness and calmness. These drugs also decrease heart rate and blood pressure.
CNS Stimulants	
Dextroamphetamine and Methylphenidate	Activate dopamine and norepinephrine receptors, which results in increased alertness, attention, and energy. Stimulants also cause higher blood pressure and heart rate.

Prescription Drugs in Combination with Other Drugs

In order to be safe and healthy, patients taking prescription drugs must comply with the medication guidelines set by their doctor. It is important to know how much medicine to take, how long to take it, and what else can have an impact on its effects on the body. Possible interactions with other drugs, vitamins, certain activities, or environmental factors such as sun exposure need to be thoroughly understood by the patient for the prescribed medication. Prescription medications should never be shared.

Misusing prescription drugs can have very negative consequences. At large doses, opioids can be fatal because they can cause heart and breathing rates to slow down or stop. High doses of stimulants can cause an irregular heartbeat, seriously high body temperatures, and the potential for heart attacks and death. Taking stimulants in combination with over-the-counter cold

medications can cause abnormalities in blood pressure and heart rhythm. Taking opioids and CNS depressants in combination with other drugs, such as alcohol or antihistamines, can cause severe respiratory problems and death.

Prescription Drug Withdrawal

Long-term misuse of prescription drugs may cause addiction and produce withdrawal symptoms if the drug is discontinued. The withdrawal symptoms from prescription drug misuse vary, depending on the particular drug being used. The withdrawal symptoms that result from opioid misuse include restlessness, insomnia, vomiting, muscle and bone pain, diarrhea, and cold flashes with goosebumps.

Withdrawal from CNS depressants may cause the brain's activity to rebound and race out of control, resulting in seizures and other harmful consequences. The withdrawal symptoms of CNS stimulants include depression, fatigue, insomnia, loss of appetite, and craving for more stimulants.

Inhalants

Inhalants are a class of chemicals that have many useful purposes in households but were never meant to enter the body. They are intentionally misused by sniffing or inhaling. They can be sprayed directly into the nose or mouth, inhaled from substances dropped into a bag ("bagging"), inhaled from a soaked rag ("huffing"), or inhaled from a balloon. Inhalants enter the bloodstream directly through the lungs and rapidly travel to the brain. Users experience an immediate "head rush" or high.

Many inhalants are commonly found in the home. They can be classified into four categories: volatile solvents, aerosols, gases, and nitrites.

The student materials for this module do not mention specific household products. This was intentional. Young people are often highly curious about these easily accessible drugs. To guard against such curiosity, we recommend you avoid mentioning specific products in your discussion. They are listed in the following chart for your information only.

Volatile solvents: Paint thinners and removers, dry-cleaning fluids, degreasers, gasoline, glues, correction fluids, felt-tip marker fluids.

Aerosols: Sprays containing propellants and solvents, including spray paints, deodorants and hair sprays, vegetable oil sprays for cooking, fabric protector sprays, whipped cream.

Gases: Household gases and medical anesthetics: ether, chloroform, halothane, nitrous oxide (laughing gas).

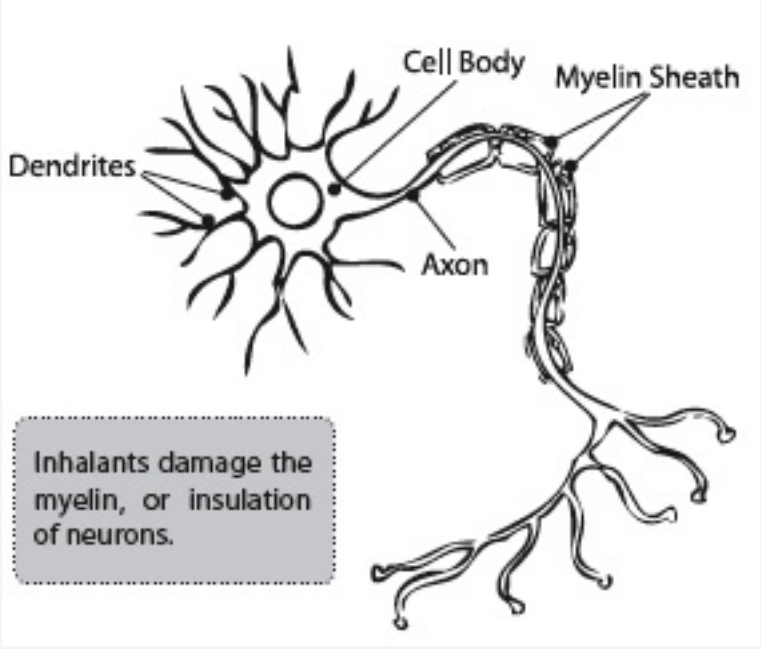
Nitrates: Cyclohexyl nitrite, isoamyl (amyl) nitrite, isobutyl (butyl) nitrite; sold under the name of “poppers,” or found in certain room deodorizing sprays.

Inhalant use can damage areas of the brain involved in cognitive functions and produce symptoms ranging from mild impairment to dementia. Inhalant use can also damage brain areas responsible for movement and vision.

Permanent hearing loss and irreversible damage to nerves throughout the body can occur from using inhalants. Inhalants can cause hepatitis, liver failure, and muscle weakness. They also interfere with the production of red blood cells, which can result in a life-threatening condition known as aplastic anemia. A condition called “sudden sniffing death” may occur when inhaled fumes replace oxygen in the lungs and brain and cause suffocation. Finally, inhalants can interfere with heart rhythm, leading to a heart attack. This can occur from a single session of repeated inhalant use.

Effects of Inhalants on the Brain

Scientists are investigating the exact way in which inhalants slow and stop the activities of neurons. Some inhalants also damage the structure of the brain, particularly the myelin, or insulation, that covers the axons. Because myelin helps messages travel through the neurons, this damage can be very serious. The parts of the brain most affected by inhalants are the cerebral cortex, cerebellum, hippocampus, and brain stem. Because of the damage to the cerebellum, heavy users of inhalants often show signs of decreased coordination, moving slowly and clumsily.



The frontal cortex of the brain, important for solving problems, and the hippocampus, a part of the brain involved in memory, are also affected by inhalant use. Researchers think that inhalants deprive the brain of oxygen. This causes the death of nerve cells and a decrease in nerve cell activity. Thinking, memory, and the ability to learn are all negatively affected.

Many inhalants activate the brain's reward system, causing brief euphoria and stimulating the release of dopamine. This is thought to be responsible for making the user want to continue using inhalants.

Long-Term Inhalant Use

People who use inhalants over a long period of time feel a strong urge to continue using them. Effects of long-term use include weight loss, muscle weakness, disorientation, inattentiveness, lack of coordination, irritability, and depression.

Preparation/Introduction

Preparation

- Read the Background section of this module for more information about the effects of prescription drugs and inhalants on the brain and body.
- Provide students with the Module 3 magazine Drugs in the Cupboard for background knowledge.
- Determine which activities you want the class to complete.
- Arrange for computer lab time or prepare the classroom computer for students' Internet and CD-ROM use.
- Photocopy and pass out the Prescription Drugs, Inhalants, and the Brain Fact Sheet for students to complete during the lecture.
- Prepare transparencies and photocopies for the lesson.
- Gather colored paper for Activity 1.

Introduction

Time: 15 - 20 minutes

Handouts: Module 3 magazine (PDF, 4.3MB)

Reading: Begin by giving students adequate time to read the student magazine. Have students pay particular attention to the following sections: Background, Stats and Facts, and Science in the Spotlight.

Discussion: After students have read the magazine, facilitate a discussion about the brain using the following questions. If necessary, review this information with your students using the diagrams provided.

Prescription Drugs and Inhalants

- Who should take prescription drugs? When?
- What are the three classes of prescription drugs?
- Should a person use a prescription drug that has been prescribed for someone else?
- How does inhalant use injure the brain and body?
- What is the name of the insulation around neurons that is damaged by inhalants?

Activities

Activity 1: Choose a Color

Time: 20 minutes

Supplies: Each student needs a piece of red, orange, blue, and green paper

Markers

Tell students that this is the third activity of their competition. The group that does the best job will earn five points. Remind students of which groups they are in. Give each student four different colored pieces of paper: one for opioids, one for CNS depressants, one for stimulants, and one for inhalants. Students should label each accordingly. Read each of the statements below. Pause after reading each statement and tell the students to pick the colored paper (drug)

that the statement describes and to hold it up. Create your own set of paper to hold up the correct answer(s) for students to see after they have made their own selection(s).

Red = Opioids
Orange = Depressants
Blue = Stimulants
Green = Inhalants

Warn students that sometimes they may have to hold up more than one colored piece of paper. Tell the students that if they hold up a paper with the wrong color, they will be out of the game. The game will continue until only one student is left or until all the statements have been read. If only one student is left, that student's team earns five points. If several students are left, each student earns one point for his or her team. When the game is over, record the winning group's points on the Group Scorecard.

1. These drugs should only be used when directed by a doctor.
   Answer: Red, Orange, Blue (opioids, CNS depressants, stimulants)
2. People should never use these drugs for anything other than their intended purposes.
   Answer: All colors (all four groups of drugs)
3. These drugs can cause addiction if used inappropriately.
   Answer: Red, Orange, Blue (opioids, CNS depressants, stimulants)
4. These drugs can cause death if used inappropriately.
   Answer: All colors (all four groups of drugs)
5. This group of drugs is prescribed to relieve severe pain.
   Answer: Red (opioids)
6. When one of these drugs is inhaled, it can cause sudden sniffing death.
   Answer: Green (inhalants)
7. These drugs are prescribed to patients with attention-deficit hyperactivity disorder (ADHD).
   Answer: Blue (stimulants)

8. When used inappropriately, this group of drugs can cause seizures.
   Answer: Blue (stimulants)

9. When used appropriately, this group of drugs causes calmness and helps with sleep and anxiety problems by increasing the release of the neurotransmitter GABA.
   Answer: Orange (CNS depressants)

10. When used appropriately, this group of drugs causes alertness by copying the activity of the neurotransmitters dopamine and norepinephrine.
    Answer: Blue (stimulants)

11. This type of prescription drug affects the neurotransmitter dopamine.
    Answer: Blue, Red (stimulants, opioids)

12. This group of drugs can deprive the brain of oxygen and decrease coordination.
    Answer: Green (inhalants)

13. When abused, these drugs can cause heart and breathing problems.
    Answer: All colors (all four groups of drugs)

Activity 2: Public Service Announcement

Time: 40 minutes

Supplies: Module 3 magazine (PDF, 4.3MB)

Pen or pencil

Paper

Handouts: Prescription Drugs, Inhalants, and the Brain Fact Sheet (PDF, 668KB)
(page 14 in the pdf)

Public Service Announcements, or PSAs, are run on TV and radio to inform the

community about safety and health information. Tell the students that they will be planning, writing, and performing their own PSA for the class. Divide students into groups of 4–6, and assign each group either “prescription drugs” or “inhalants” as their topic.

Give the students about 15 minutes to look through the student magazine, their notes, and other sources to gather information concerning their assigned topic. Inform the groups that all PSAs must educate the audience on the effects these drugs have on the brain and body, and other science-based facts. Allow them another 15 minutes to plan and write their PSA; then have all groups perform their PSA. To make sure that all students in each group are actively engaged in the planning, writing, and performing of tasks, you can assign roles such as writer, director, actors, and scientific researchers.

> Keep the students on track by emphasizing key lecture points about the science behind drug use from the background section.

Wrap up the activity with a discussion and assessment of the strengths of each group’s PSA.

Room 3 (Online Version)*

Includes games and materials to supplement the information presented in the module. ***The room labeled “3”*** contains the following activities and specific information pertaining to this module:

- *Learning Objectives*: these are presented at the beginning of each CD-ROM module
- *Pill Poppers*: an activity where students must match drug effects to the correct class of prescription drugs: depressants, stimulants, and opioids
- *Synapse Sweep*: a game in which players must act quickly to get rid of the drugs in the synapse while avoiding the neurotransmitters

- *Myelin Sleuth*: an activity where students figure out which neuron on a microscope slide is from an inhalant abuser and which is the healthy brain cell
- *Module Quiz*: this quiz is the final part of the module, intended to assess students' learning

* *Adobe Flash player required to view.*

Extensions

1. Have students do research on ADHD using the student magazine, the Internet, and other magazines. Tell them to develop an outline summarizing ADHD: what it is, the symptoms, how common it is in children, behaviors associated with the disorder, and treatment. This will give students a better understanding of the disorder, as well as why many children take medication to treat ADHD.

Useful Web sites:

- www.chadd.org/
- www.nimh.nih.gov/health/publications/attention-deficit-hyperactivity-disorder/complete-index.shtml

2. Distribute drawing paper and drawing supplies to students. Tell them that they are going to be making a brochure for younger students (elementary age) to explain the dangers of prescription drug and inhalant abuse. Encourage students to remember what they knew about these issues or drugs when they were younger, and help them brainstorm ideas for how to present the information to the younger audience.

Assessment

As students complete the activities in the module, observe whether they have mastered the following:

1. Do students realize the importance of taking prescription medications only under a doctor's guidance? Do they understand the effects that prescription drugs can have on the brain and body when taken improperly?
2. Do students understand the various types of prescription medications and why they are prescribed? Do they understand the possible consequences of Ritalin use for someone who doesn't have ADHD?
3. Can students explain the consequences of prescription drug use in combination with other drugs, such as alcohol, antihistamines, or other over-the-counter medications?
4. Can students list some withdrawal symptoms of inhalants? Do they understand the connection between these symptoms and how the brain changes from the use of inhalants?
5. Do students understand the short- and long-term effects of inhalants on the brain and body? Do they realize the impact of these symptoms on brain functioning?

Resources

Resources for Teachers

National Institute on Drug Abuse (NIDA)
301-443-1124
This Web site contains information about drug abuse as well as sections designed specifically for parents, teachers, and students.

Mind Over Matter Teacher's Guide
This printable/downloadable teacher's guide accompanies NIDA's Mind Over Matter series. The series is designed to educate teens about the biological

effects of drug abuse on the body and brain.

NIDA DrugPubs Research Dissemination Center
877-NIDA-NIH (877-643-2644; TTY/TDD: 240-645-0228)
Order our materials free of charge in English or Spanish.

Buzzed: The Straight Facts About the Most Used and Abused Drugs from Alcohol to Ecstasy. Kuhn, C., Swartzwelder, S., and Wilson, W. New York: W. W. Norton & Company, 2003. A highly informative, detailed review of widely abused drugs.

Resources for Students

Mind Over Matter
Designed for teens, this site includes information about how different drugs, including inhalants and opioids, affect the brain. Also available for free by calling 1-800-729-6686.

Above the Influence
Designed for teens, this site covers the risks and consequences of various drugs and provides news, advice, and real-life stories.

Ritalin and Other Methylphenidate-Containing Drugs. Ferreiro, C. Philadelphia, PA: Chelsea House Publishers, 2003. Part of the "Drugs: The Straight Facts" series. The book provides a thorough discussion of Ritalin and ADHD, with facts about abuse.

Inhalants. Lobo, I.A. Philadelphia, PA: Chelsea House Publishers, 2004. Part of the "Drugs: The Straight Facts" series. Provides useful information about the different types of inhalants, how they act on the brain and body, usage trends, and health effects.

Prescription Pain Relievers. Foster, O.M. Philadelphia, PA: Chelsea House Publishers, 2005. Part of the "Drugs: The Straight Facts" series. Contains a thorough discussion of prescription pain relievers, including how they act in the

brain, health effects, and usage trends. This book helps students understand the connection between these prescription pain relievers and how the brain changes as a result of the use of these substances.

Weeding Out the Grass (Module 4)

You can also download this entire module in PDF format by clicking the following link: Module 4 (PDF, 640KB)

Summary

Marijuana is the most commonly abused illegal drug in the United States. Nearly half of all high school students have used marijuana. Many children and adolescents, and even adults, think of it as a harmless drug, especially when compared to heroin, cocaine, and even cigarettes.

But marijuana is hardly harmless. Today's marijuana is 10 to 15 times stronger than it was in the 1960s. Recent research is showing that this drug has a strong physical impact on the brain and body. Because their brains are still developing, it is particularly important for young people to understand the effects of marijuana. This module is designed to teach students about the serious effects of marijuana.

Learning Objectives

At the end of this module:

- Students can explain the short- and long-term effects of marijuana use and the seriousness of these effects.
- Students understand how THC, the active ingredient in marijuana, disrupts neurotransmission.
- Students can explain how marijuana can adversely affect the hippocampus and other parts of the brain.

Relationship to the National Science Education Standards

This lesson aligns with three standards in the NSES: risks and benefits; personal health; and structure and function in living systems. The chart below shows how the activity aligns with these standards.

Science in Personal & Social Perspectives	**How the Lesson is Aligned**
Risks and benefits Personal health	Students learn the short- and long-term effects of using marijuana. Students can use this information to influence decisions that affect their own health.

Life Science	**How the Lesson is Aligned**
Structure and function in living systems	Students will learn how marijuana acts in the brain and how marijuana can ultimately affect the brain and body.

Background

Marijuana

Marijuana comes from the dried leaves and flowers of the cannabis plant. It can be smoked, cooked into baked goods, or brewed into tea. It contains more than 400 chemicals. Smoking marijuana, like smoking tobacco, can have negative effects on the lungs.

Marijuana also has potentially dangerous short-term effects that can last more than 4 hours. In low to medium doses, marijuana can cause relaxation, reduced coordination, reduced blood pressure, sleepiness, attention problems, and an altered sense of time and space. In high doses, marijuana can cause

hallucinations, delusions, memory problems, and disorientation.

> Slang terms for marijuana include pot, herb, weed, grass, chronic, ganja, and hash.

Marijuana and Neurotransmitters

Tetrahydrocannabinol (THC) is the active ingredient in marijuana that causes changes in the brain. THC activates specific receptors, known as cannabinoid receptors, which are located in the limbic system, cerebral cortex, and cerebellum. In student materials, cannabinoid receptors are referred to more simply as THC receptors. Because these receptors are located in many areas of the brain, the effects are widespread. In the healthy brain, cannabinoid receptors are activated by a neurotransmitter called anandamide. Anandamide is known to have a pain-relieving effect and may also play a role in numerous other brain activities. THC has many of the same effects as anandamide and can bind to the same receptors. But when THC activates the receptors, it interferes with the normal functioning of these areas of the brain.

Since the discovery of anandamide, scientists have discovered other similar neurotransmitters that also act on the receptor where THC binds. They are still investigating the function of both anandamide and these other neurotransmitters.

Like other drugs, marijuana also boosts the neurotransmitter dopamine (indirectly) in the brain's reward circuits, which reinforces the behavior of taking the drug.

Effects of Marijuana

While someone is using marijuana, activity in the hippocampus is reduced, causing problems with short-term memory. Animal studies of long-term marijuana use have shown damage in this area. Research with people has found that chronic use of marijuana can cause permanent memory and

cognitive problems, especially at young ages. Specifically, one study found that young people who used marijuana before the age of 17 had significantly lower verbal IQs, or the ability to think with words and process verbal information, than both people who began using the drug at an older age and people who never used it at all. These studies show that marijuana can be particularly harmful when it is used by young people when the brain is still developing.

Short-term effects of marijuana use include distorted perception, due to the drug's interference with the brain's ability to process sensory information. Information about touch, sight, sounds, and time are distorted because of marijuana's effects on the cerebral cortex. Short term marijuana use can also interfere with the normal functioning of the cerebellum. This can cause problems with balance, posture, and the coordination of movement.

Long-term use of the drug can also lead to a series of attitude and personality changes, known as "amotivational syndrome." This syndrome is characterized by a diminished ability to carry out long-term plans, a sense of apathy, decreased attention to appearance and behavior, and decreased ability to concentrate for long periods of time. These changes can also include poor performance in school.

Marijuana Withdrawal

New research is showing that long-term marijuana use may lead to addiction. When the drug is no longer available, the user may develop an uncontrollable desire for the drug and withdrawal symptoms including decreased appetite, weight loss, disruption in sleep, increased irritability, restlessness, and anger.

Medical Uses of THC

There are some medicines that contain THC. They are used for treating nausea and vomiting associated with chemotherapy for cancer treatment, and for improving appetite which is one of the complications of AIDS.

Although THC can be very helpful to people suffering from cancer, and AIDS, it continues to have negative side effects. Scientists are studying the drug so that

they can develop a therapeutic drug that is free of THC's negative consequences. Another chemical related to THC, nabilone, has been approved by the U.S. Food and Drug Administration for treating nausea associated with cancer treatment. Research in this important area continues.

Preparation/Introduction

Preparation

Preparation

- Read the Background section of this module for more information about the effects of marijuana on the brain and body.
- Provide students with the Module 4 magazine Weeding Out the Grass for background knowledge.
- Determine which activities you want the class to complete.
- Photocopy and pass out the Marijuana Fact Sheet for students to complete during the lecture.
- Arrange for computer lab time or prepare the classroom computer for students' Internet and CD-ROM use.
- Pass out copies of the Marijuana Survey a few days ahead of time. Give each student 2 - 3 copies and instruct them to have some friends fill them out anonymously. Tell them not to look at the papers in respect of their friends' privacy. Collect the surveys prior to the class period you plan to teach this lesson and tally up the responses.

Introduction

Time: 15 - 20 minutes

Handouts: Module 4 magazine (PDF, 6.8MB)

Begin by announcing the results of the survey, and see if the class is surprised. Tell them they are going to learn more about the drug in today's class.

Reading: Give students adequate time to read the student magazine. Have students pay particular attention to the following sections: Background, Stats and Facts, and Science in the Spotlight.

Discussion: After students have read the magazine, facilitate a discussion about marijuana using the following questions.

Marijuana:

- What is marijuana? Where does it come from?
- What effects does marijuana have on a person?
- How does marijuana affect neurotransmission?
- Can an individual become addicted to marijuana?

At the end of the discussion, ask the class whether they feel their friends have an accurate view of marijuana. Help them understand how common opinions can contradict science.

Activities

Activity 1: Marijuana Bingo

Time: 30 minutes

Supplies: Bingo cards and sheet (PDF, 37KB)

Markers

Tell students that this is the fourth activity of their competition. The group who gets a bingo first earns 5 competition points. Instruct the students to sit with their *Brain Power!* Challenge groups; however, explain to them that, for this activity, they will participate individually and each play their own card. Only one person in the group is required to get a bingo for the team to earn the 5 points.

1. Pass out a bingo card to each student. Using the word bank at the bottom of the card, instruct students to write a word in each of the spaces on the card. Each word should only be used once.
2. Using the teacher bingo sheet, read each definition in order always announcing the number first because this is how the students will mark their cards. For example: Number 1—The active chemical in marijuana. At this time, instruct students to find the answer on their cards and mark with a "1." Continue reading the definitions in order, reminding students to mark the answer with the definition's number, until someone yells, "Bingo". Inform the students that they need to get 5 in a row—diagonally, across, or up and down. Other bingo patterns can be substituted if you choose to do so.
3. Use the teacher bingo sheet to check for correct answers. Marked words should correspond with definition numbers. If the player gets all answers correct, that team earns 5 points. If any of the answers are wrong, the game continues until someone wins.
4. Record the team points on the Group Scorecard.

Activity 2: Poster Presentation

Time: 45 minutes, or adequate research and presentation time (may want to allow more time for poster preparation)

Supplies: CD-ROM

Module 4 magazine (PDF, 6.8MB)

Computer for research

Poster board

Handouts: Marijuana Fact Sheet and Survey (PDF, 668KB) (Pages 18-21 in the pdf)

In the 1960s, some people thought that marijuana was a "safe" drug. However, new research presents a different picture of this drug. During this activity, students have an opportunity to find out for themselves the latest research on the effects of marijuana on the body and brain.

Divide the class into groups of three or four students. Ask each group to imagine that it has been asked to present the latest research on marijuana at a National medical conference. Have students use the Fact Sheet, CD-ROM, student magazine, and the Web sites listed on the next page to:

1. Study current research about marijuana.
2. Create a scientific poster presenting findings from the research. The poster should include statistics about marijuana use, results of recent research, charts and graphs providing important information, and any other relevant findings.
3. Have each group present its findings to the class.
4. After all groups have presented, brainstorm as a class different ways of educating the general public about the latest marijuana research.

Prior to activity, add these sites to the classroom computer's "Favorites" drop-down menu:

- www.drugabuse.gov/drugs-abuse/marijuana
- www.abovetheinfluence.com/drugs/marijuana/#facts
- http://teens.drugabuse.gov/educators/curricula-and-lesson-plans/mind-over-matter/mom-teachers-guide/marijuana
- https://www.whitehouse.gov/ondcp/key-issues/marijuana/

Room 4 (Online Version)*

Includes games and materials to supplement the information presented in the module. ***The room labeled "4"*** contains the following activities and specific information pertaining to this module:

- *Learning Objectives*: these are presented at the beginning of each CD-ROM module
- *Using Animals in Research*: a short lesson on the ethical use of animals and research, and why this use is scientifically important
- *Rat Trap*: a fun game where players scramble to capture rats and return them to their cages
- *Receptor Search*: students learn where THC receptors are located in the brain, through an interactive game
- *Experiment: Marijuana and Memory*: students will conduct a full experiment to learn the effects marijuana has on memory
- *Module Quiz*: this quiz is the final part of the module, intended to assess students' learning

* *Adobe Flash player required to view.*

Extensions

1. Have students develop a public relations campaign against marijuana use. Refer them to www.abovetheinfluence.com as an example. They can develop posters to put around the school as well as announcements to be delivered over the PA system. If the school has a TV station, students could develop a short announcement to be broadcast on the school's news program. Have students set a timeframe that the campaign will run and a goal for its outcome.
2. Have students develop a PowerPoint® presentation on the effects of marijuana on the body and the brain. The presentation could include illustrations of the brain, charts and graphs, and relevant statistics.
3. Have students keep a "log" of when and where they see mention of marijuana in popular media. Ask them to cut out or copy newspaper magazine articles, and keep a record of when they notice references to the drug on television. Ask them to think about the differences between how the drug is represented, and what science can tell us about the effects of drugs on the brain and body.

Assessment

As students complete the activities in the module, observe whether they have mastered the following:

1. Can students explain the effects of marijuana on the brain and how these effects can change the brain?
2. Do students understand the scientific basis for the laws making marijuana use illegal?
3. Do students understand how marijuana affects neurotransmission?
4. Did students participate in the class activities and discussion? Did they engage in the topics?

Resources

Resources for Teachers

National Institute on Drug Abuse (NIDA)
301-443-1124
This Web site contains information about drug abuse as well as sections designed specifically for parents, teachers, and students.

NIDA DrugPubs Research Dissemination Center
877-NIDA-NIH (877-643-2644; TTY/TDD: 240-645-0228)
Order our materials free of charge in English or Spanish.

Mind Over Matter Teacher's Guide
This printable/downloadable teacher's guide accompanies NIDA's Mind Over Matter series. The series is designed to educate teens about the biological effects of drug abuse on the body and brain. Also available for free by calling 1-800-729-6686.

Buzzed: The Straight Facts About the Most Used and Abused Drugs from Alcohol to Ecstasy. Kuhn, C., Swartzwelder, S., and Wilson, W. New York: W. W. Norton & Company, 2003. A highly informative, detailed review of widely abused drugs.

Resources for Students

NIDA for Teens
Designed for teens, this site provides information on several drugs, including marijuana, as well as quizzes and real-life stories.

Mind Over Matter
Designed for teens, this site includes information about how different drugs, including marijuana, affect the
brain. Also available for free by calling 1-800-729-6686.

Above the Influence
Designed for teens, this site covers the risks and consequences of various

drugs and provides news, advice, and real-life stories.

Marijuana. Mehling, R. Philadelphia, PA: Chelsea House Publishers, 2003. Part of the “Drugs: The Straight Facts” series. Contains a thorough discussion of marijuana, including how it acts in the brain, history, health effects, usage trends, and relevant laws.

Drugs on the Street (Module 5)

You can also download this entire module in PDF format by clicking the following link: Module 5 (PDF, 520KB)

Summary

This module discusses two illegal drugs: heroin and cocaine. Many people consider cocaine and heroin to be hard-core “street” drugs, but increasingly, younger people in all kinds of communities across the country are using these dangerous drugs. Heroin and cocaine both have a huge impact on the health of the brain and the body. Use of these drugs changes the brain. Both are illegal and highly addictive. Sometimes these drugs are used in combination.

Through the content of the magazine and CD-ROM, students will learn how heroin and cocaine affect the brain and body. They will also explore information on the short- and long-term effects of these drugs, including addiction.

Learning Objectives

At the end of this module:

- Students can explain how heroin and cocaine use affects the brain and body.
- Students can explain how heroin and cocaine use affects normal neurotransmission.
- Students understand how heroin and cocaine can change the brain and cause addiction.

Relationship to the National Science Education Standards

The lesson in module 1 aligns with two standards in the NSES: systems, order, and organization; and structure and function in living systems. The chart below shows how the activity aligns with these standards.

Science in Personal & Social Perspectives	**How the Lesson is Aligned**
Risks and benefits Personal health	Students learn the short- and long-term affects of using cocaine and heroin. These drugs can change how the body and brain function and can lead to addiction. Students can use this information to influence decisions that affect their own health.

Life Science	**How the Lesson is Aligned**
Structure and function in living systems	Students will learn how neurotransmission is effected by cocaine and heroin and how these drugs ultimately affect the entire brain and body.

Background

Heroin

Heroin belongs to a class of drugs called opioids, which also includes the painkillers codeine and morphine. Heroin comes from a natural substance extracted from the seedpod of the Asian poppy plant. It usually appears as a white or brown powder.

Slang terms for heroin include smack, H, skag, and junk. Other names refer to types of heroin produced in a specific geographical area, such as Mexican black tar.

Heroin is usually injected, sniffed, snorted, or smoked. Injection of the drug provides the greatest intensity and most rapid onset of symptoms. Almost immediately upon injection, the user is relieved of physical pain and discomfort and experiences pleasurable feelings. This false sense of well-being plays a part in the addiction to heroin. The drug “rush” is accompanied by a flushing of the skin.

Less pleasant aftereffects of heroin use include a dry mouth and heavy feeling in the limbs, which may be accompanied by nausea, vomiting, and severe itching. People who use heroin are generally drowsy for several hours after using heroin and their mental functioning becomes clouded as the central nervous system, heart, and breathing slow down. In the case of overdose, this decrease in functioning can cause death.

Heroin and Neurotransmitters

The brain naturally contains receptors for opioids that are involved in breathing, perception of pain, emotion, and reward. When a person abuses heroin, the drug travels quickly to the brain and activates these receptors. Heroin also interacts with the reward system to produce an intense, short-lived rush; it also produces a surge of the neurotransmitter dopamine, which nudges the brain to want to repeat the behavior. Long-term use of heroin can decrease the reward system’s sensitivity to the drug. This is addiction. The receptors that are sensitive to heroin are located in several parts of the brain, including the cerebral cortex and brain stem.

Long-term Effects, Addiction, and Withdrawal

Long-term effects of heroin use include addiction, infection of the heart lining and valves, and liver disease. For those users who inject the drug, there is a

high risk of infectious diseases, including HIV/AIDS, collapsed lungs, and hepatitis B and C. Lung complications, including various types of pneumonia, may result from the overall poor health of the person using heroin as well as from heroin's effects on respiration. Death by overdose is not uncommon.

When addicted users stop taking the drug, they go through a severe withdrawal. Symptoms of withdrawal include restlessness, muscle and bone pain, inability to sleep, diarrhea, vomiting, cold flashes with goose bumps ("cold turkey"), and involuntary leg movements. A person who is going through withdrawal craves the drug and will do just about anything to get it.

Cocaine

Cocaine is a very addictive stimulant that is made from the leaves of the coca plant. It comes in two forms: powder and crystal ("crack"). Cocaine can be snorted, injected, or smoked. Immediately after use, cocaine produces feelings of happiness, increased energy, and alertness. This "high" is followed by feelings of depression, edginess, and a craving for more of the drug. People who use cocaine often don't eat or sleep regularly and may feel paranoid, angry, hostile, and anxious. Cocaine use can cause an increase in heart rate, muscle spasms, and convulsions. Breathing becomes faster. Users may sweat and have dilated pupils. Long-term health risks of cocaine use include damage to the nasal tissue, seizures, stroke, heart attack, and sudden death from overdose.

> Slang terms for cocaine include blow, coke, flake, nose candy, powder, rock, snow, and white.

Cocaine and Neurotransmission

Cocaine acts in several brain circuits that use dopamine, by preventing dopamine's recycling, resulting in a buildup of dopamine in the synapse. The excess dopamine continues to stimulate the neighboring neuron; in brain circuits controlling movement, this produces hyperactivity; in reward circuits, it

strongly reinforces the association between the drug and pleasure, inducing the person to keep taking the drug.

When cocaine is no longer taken, dopamine levels return to their normal lower concentration. Because there are now fewer dopamine receptors available, the dopamine is unable to fully activate nerve cells. At this point, a person is addicted to cocaine and experiences intense craving and withdrawal. Damage to the neurons and the process of neurotransmission can lead to many problems, including problems with memory and a disruption in the rate of learning. Cocaine is very addictive; withdrawal is very hard.

Long-term Effects, Addiction, and Withdrawal

People who use cocaine eventually are unable to achieve the same effects from the drug as they did from their first experience. This is because they have developed a tolerance to the drug. At this point, they must repeatedly increase their doses in an attempt to obtain those initial effects again. When cocaine use is stopped, the person may feel a strong craving for more cocaine, accompanied by feelings of depression, anxiety, irritability, and paranoia.

Preparation/Introduction

Preparation

- Read the Background section of this module for more information about the effects of heroin and cocaine on the brain and body.
- Provide students with the Module 5 magazine Drugs on the Street for background knowledge.
- Determine which activities you want the class to complete.
- Arrange for computer lab time or prepare the classroom computer for students' Internet and CD-ROM use.
- Photocopy and pass out the Heroin and Cocaine Fact Sheet for students to complete during the lecture.

- Prepare transparencies and photocopies for the lesson.

Introduction

Time: 20 - 25 minutes

Handouts: Module 5 magazine (PDF, 7MB)

Heroin and Cocaine Fact Sheet (PDF, 668KB)
(Page 22 in the pdf)

Reading: Begin by giving students adequate time to read the student magazine. Have students pay particular attention to the following sections: Background, Stats and Facts, and Science in the Spotlight.

Discussion: After students have read the magazine, ask the students what they know about heroin and cocaine. Record all thoughts on the chalkboard. Tell them that the goal of this lesson is to learn about cocaine and heroin. Facilitate a discussion about the brain, heroin, and cocaine using the following questions.

Heroin

- How is heroin used?
- What are the receptors in the brain that heroin binds to?
- What neurotransmitter is most affected by heroin use?
- How does the brain change as a result of heroin use?
- What happens in the brain that causes heroin addiction?

Cocaine

- How is cocaine used?

- What are some of the effects of cocaine on the central nervous system?
- What neurotransmitter is affected by cocaine?
- How does the brain change as a result of cocaine use?
- What are the long-term effects of cocaine use?

Activities

Activity 1: Targeting the Central Nervous System

Time: 30 minutes

Supplies: Pencil and paper

Handouts: Module 5 magazine (PDF, 7MB)

Tell students that this is the fifth activity of their competition and the group that has the most number of complete base words will earn five points. Remind students which groups they are in. Have students sit with their groups.

1. Have the students review the magazine for this module. They should focus on how heroin and cocaine affect the central nervous system.
2. Have each group identify a vocabulary word used in this module. This word will be their “base word” for an acronym. Then have students come up with supporting words beginning with each letter in the base word. The words must directly relate to the base word. For example, if the base word is “COCAINE,” the supporting words could be Crack, Overdose, Craving, Anxiety, Insomnia, Nasal damage, and Edginess.

Point out that heroin depresses the central nervous system, while cocaine stimulates it. Both are extremely addictive.

3. For each supporting word, students should write a sentence that describes its relationship with the base word (e.g., “Nasal damage is an effect of snorting cocaine.”). Give the students 10 - 15 minutes to complete their words. Tell them they will get one point for each supporting word they can come up with.

You can either give students base words to complete or have them come up with the base words on their own. If the group is more advanced, have them complete several words. Students can use any word that pertains to something they’ve learned in the module, or even the curriculum so far.

4. After each group has completed the word or set of words, have studentsshare them with the class.
5. Record the winning group’s points on the Group Scorecard.

Activity 2: Talk It Out

Time: 45 minutes

Supplies: Poster board for each group

Markers

Computer for research

Over the last 30 years, scientists have developed a large body of research documenting how cocaine and heroin affect the central nervous system and

other body systems. Often this material is written in such a way that young people have a difficult time understanding it. Nonetheless, it is important that students have access to this information. During this activity, students will work together to interpret some recent research and put it into a format that their peers can understand.

1. Create six groups of students. Assign each group a topic according to the following chart:

	Heroin	**Cocaine**
Addiction	Group 1	Group 4
Brain/Nervous System	Group 2	Group 5
Body	Group 3	Group 6

2. Ask each group to use the Web sites listed below or other related sites to deepen their understanding of the topic assigned to them.

   Prior to the activity, add these sites to the classroom computer's "Favorites" drop-down menu:

   - NIDA InfoFacts: Cocaine
   - NIDA InfoFacts: Heroin
   - NIDA Research Reports: Cocaine
   - NIDA Research Reports: Heroin
   - www.whitehouse.gov/ondcp

3. Have each group put its information into a poster that is simple and easy to understand that they will present to the class.

> If poster board is unavailable, have students create a brochure instead.

4. After each group has completed a poster, have them present their poster to the class. Ask follow-up questions to reinforce important information.

Room 5 (Online Version)*

Includes games and materials to supplement the information presented in the module. ***The room labeled "5"*** contains the following activities and specific information pertaining to this module:

- *Learning Objectives*: these are presented at the beginning of each CD-ROM module
- *Experiment*: Heroin and Addiction: students will conduct an experiment to observe the addictive properties of heroin
- *Rat Chow-lenge*: a fun game where players must jump over moving rat food cans to straighten the shelves in a supply closet
- *NT 210: Cocaine in the Brain*: this animated learning tool details how cocaine disrupts normal neurotransmission
- *Cycle of Addiction*: an informative poster where students will learn about the stages of addiction
- *Module Quiz*: this quiz is the final part of the module, intended to assess students' learning

* *Adobe Flash player required to view.*

Extensions

1. Have students write a short paragraph on how addiction to heroin or cocaine changes the brain. You can assist them with this by reading through the teacher's guide content. Then, have each student uniquely illustrate the concepts in a comic-book style. They can create neuron characters, neurotransmitter superheroes (dopamine), and villains (heroin or cocaine).
2. Explain to the students that "Letters to the Editor" pages in local newspapers

are an excellent way for people to get messages out about issues they care about. Have students write their own letter to an editor as a Brain Power! drug expert about the importance of drug education in the schools.

Assessment

As students complete the activities in the module, observe whether they have mastered the following:

1. Can students explain the effects of heroin on the brain? Can they explain how these changes can result in addiction?
2. Can students explain the effects of cocaine in the brain? Can they explain how these changes can result in addiction?
3. Do students understand the connection between withdrawal symptoms and how the brain changes from the use of heroin and cocaine?
4. Do students understand the differences between the effects of each of these drugs on the body?
5. Did students participate in class activities and discussion? Did they engage in the topics?

Resources

Resources for Teachers

National Institute on Drug Abuse (NIDA)
301-443-1124
This Web site contains information about drug abuse as well as sections designed specifically for parents, teachers, and students.

NIDA DrugPubs Research Dissemination Center
877-NIDA-NIH (877-643-2644; TTY/TDD: 240-645-0228)
Order our materials free of charge in English or Spanish.

Mind Over Matter Teacher's Guide
This printable/downloadable teacher's guide accompanies NIDA's Mind Over Matter series. The series is designed to educate teens about the biological effects of drug abuse on the body and brain. Also available for free by calling 1-800-729-6686.

Buzzed: The Straight Facts About the Most Used and Abused Drugs from Alcohol to Ecstasy. Kuhn, C., Swartzwelder, S., and Wilson, W. New York: W. W. Norton & Company, 2003. A highly informative, detailed review of widely abused drugs.

Resources for Students

Mind Over Matter
Designed for teens, this site includes information about how different drugs, including marijuana, affect the brain. Also available for free by calling 1-800-729-6686.

Above the Influence
Designed for teens, this site covers the risks and consequences of various drugs and provides news, advice, and real-life stories.

Heroin. Ferreiro, C. Philadelphia, PA: Chelsea House Publishers, 2003. Part of the "Drugs: The Straight Facts" series. Contains a thorough discussion of heroin, including history, effects, addiction, and related laws.

Cocaine. Wagner, H.L. Philadelphia, PA: Chelsea House Publishers, 2003. Part of the "Drugs: The Straight Facts" series. Contains a thorough discussion of cocaine, including history, effects, addiction, and the "business" of cocaine.

Drugs in the News (Module 6)

You can also download this entire module in PDF format by clicking the following link: Module 6 (PDF, 454KB)

Summary

The dangers of drug use make headlines all over the world: from methamphetamine labs in rural homes to “club drugs” being used in parties and bars to world-class athletes abusing steroids. The goal of this module is to help students identify and understand different messages about drugs that are present in the media, and to increase their knowledge about the possible dangers, harmful effects, and consequences of all types of substance use.

This module will focus on illegal drugs that have made recent headlines:

- *Steroids*: Performance-enhancing drugs that are injected or taken orally by athletes to increase strength and endurance.
- *Methamphetamine*: Stimulants that are synthetically created, often in small home-based labs.
- *GHB, Rohypnol, Ketamine, MDMA*: These are some of the more popular “club drugs,” or drugs that can cause feelings of disorientation and memory loss.

Students will learn about the effect that each drug has on the brain and body, and how use of these drugs affects individuals and our society as a whole.

Learning Objectives

At the end of this module:

- Students can explain the effects that methamphetamine, steroids, and many

common “club drugs” can have on the brain and body.

- Students understand the relationship between the effects of these drugs on the brain and body and addiction.
- Students understand the dangers of these drugs and are aware of their presence in our society.
- Students can identify and critically analyze media information about methamphetamine, steroids, and “club drugs.”

Relationship to the National Science Education Standards

This lesson aligns with three standards in the NSES: risks and benefits; personal and community health; and structure and function in living systems. The chart below shows how the activity aligns with these standards.

Science in Personal & Social Perspectives	**How the Lesson is Aligned**
Risks and benefits	Students learn about the risks associated with several drugs prevalent in our society. Students can use this information to assess the risks and benefits that affect their own health.
Personal and community health	Students learn about the impact that drugs have on society and how the media can influence attitudes about drugs. Students will become more critical consumers of information and use their knowledge to make better decisions.

Life Science	How the Lesson is Aligned
Structure and function in living systems	Students will learn how neurotransmission is affected by different drugs and how these drugs ultimately affect the entire brain and body.

Background

Steroids

Anabolic steroids are artificial versions of testosterone, a hormone that all individuals have naturally in their bodies. Anabolic steroids, the most frequently misused of all steroids, are taken orally or injected to enhance athletic performance, increase stamina, and improve physical appearance. Anabolic means “muscle-building.” Steroids are often taken in cycles of weeks or months rather than continuously.

This is called “cycling.” “Stacking” refers to the use of several different types of steroids successively; this practice is thought to maximize their benefits while minimizing negative effects. Users think this will have a greater effect, but there is no scientific evidence for this.

> Slang terms for steroids include Arnolds, gym candy, pumpers, stackers, weight trainers, and juice.

Effects of Steroids on the Body

Steroids have very dangerous side effects, including damage to the liver and kidneys as well as risk of high blood pressure and heart problems. In some cases, steroid use has led to death. Although steroids are effective in building lean muscle, strength, and endurance, no studies have documented that they enhance athletic performance.

While anabolic steroids can make some people look stronger on the outside, the immune system—the body's defense against germs and diseases—is significantly weakened. Aggression and other psychiatric side effects may also result from misuse of anabolic steroids. Although users may report feeling good while on anabolic steroids, extreme mood swings can occur, with the potential for violence (this is often referred to as "roid rage"). Users may also suffer from paranoid jealousy, irritability, delusions, impaired judgment, and depression.

In addition, steroid use can impact sexual development (cessation of menstruation in girls, shrinking of the testicles and impotence in boys), and cause severe acne, loss of scalp hair, and hair growth on the body and face. Liver cancer and heart disease are among other serious side effects of steroid use that can occur in both males and females of all ages. Steroids can permanently stop the bones from growing, meaning that a teenage steroid user will not grow to full adult height. Although more boys than girls misuse steroids, these drugs are equally dangerous for both genders. People who inject anabolic steroids put themselves at higher risk of contracting HIV/AIDS or hepatitis, a disease that seriously damages the liver.

Steroids and Neurotransmission

After a person takes steroids, the drugs are distributed to many regions of the brain, including the hypothalamus. Testosterone is naturally produced in the hypothalamus, which controls appetite, blood pressure, moods, and reproductive ability. Steroids alter the normal functioning of the hypothalamus, resulting in changes in the amount of testosterone that is sent throughout the body. Because testosterone plays a role in many body functions, this can result in the many effects seen with steroid misuse.

Steroids can also disrupt the functioning of neurons in the limbic system, the part of the brain responsible for emotional regulation. This disruption can lead to aggressive behavior, mood swings, violent behavior, impairment of judgment, and even psychotic symptoms like personality changes or paranoia.

Methamphetamine

Methamphetamine is an illegal stimulant that speeds up the brain's functioning. It can be smoked, snorted, injected, or taken orally. Methamphetamine is produced as pills, powders, or chunky crystals. The crystal form, nicknamed "crystal meth," looks like small fragments of glass or shiny, blue-white rocks. When swallowed or snorted, methamphetamine gives the user an intense high. Injections cause the person to feel a quick high called a "rush" or "flash" that lasts an especially long time.

> Slang terms for methamphetamine include speed, uppers, meth, crystal meth, ice, and crank.

Methamphetamine and neurotransmition

Methamphetamine acts by altering levels of the neurotransmitters dopamine and norepinephrine in synapses in various brain regions. Because methamphetamine has a similar chemical structure to dopamine and norepinephrine, it can be picked up by neurons that normally recycle these neurotransmitters. It can also enter neurons by passing directly across the cell membrane. Once methamphetamine enters a neuron, it causes the neuron to release large amounts of both dopamine and norepinephrine into the synapse. Norepinephrine most likely causes the alertness seen with methamphetamine use. High concentrations of dopamine in the brain's reward circuits strongly reinforce use of the drug (making the user want to repeat the experience).

Effects of Methamphetamine on the Brain and Body

Methamphetamine can cause addiction, stroke, violent behavior, nervousness, confusion, paranoia, auditory hallucinations, mood disturbances, and delusions. Some of these effects may be long-lasting. Research has also shown that even several years after methamphetamine use has stopped, users may still have a reduction in their ability to transport dopamine from the synapse back into the neuron, indicating that there can be long-term impairment following the drug use. The damage to the dopamine system from methamphetamine is similar to the damage seen in Parkinson's disease, where it occurs naturally.

Methamphetamine Withdrawal

Although methamphetamine is a highly addictive drug, no acute symptoms are evident at the time of methamphetamine withdrawal. Withdrawal symptoms can often take 30 to 90 days to occur, and can include depression, cravings, lack of energy, and even suicidal thoughts. New research suggests that brain abnormalities similar to those seen in people with depression and anxiety disorders can occur when a person stops using methamphetamine. Methamphetamine use has a very high relapse rate; more than 90 percent of individuals in treatment return to drug use.

The Impact of Methamphetamine on Communities

Dramatic increases in the production and use of methamphetamine have led to broad media coverage of this drug. Methamphetamine is made illegally with fairly inexpensive and readily available ingredients, such as drain cleaner, battery acid, and antifreeze. As a result, a majority of the methamphetamine produced in the United States is made in home labs. Methamphetamine is highly addictive, creating a high demand for the drug and the labs that supply it. These labs are a major problem for the community. Methamphetamine labs have the potential to contaminate drinking water, soil, and air. In addition, methamphetamine use often increases crime and violent acts, such as domestic violence or child abuse, in affected individuals and communities.

See the “Science in the Spotlight” article in the Module 6 magazine for more on the impact of methamphetamine on society.

GHB, Rohypnol, MDMA, AND Ketamine (“Club Drugs”)

Four club drugs are GHB (gamma hydroxybutyric acid), flunitrazepam (Rohypnol), MDMA (3-4 methylenedioxymethamphetamine), and ketamine. These drugs are called club drugs because of their association with use in party situations (note: methamphetamine is also considered a club drug).

GHB has three forms: a colorless, odorless liquid, a white powder, and a pill. Rohypnol is a pill that dissolves in liquids.

Some forms of Rohypnol are undetectable in liquids, while newer Rohypnol pills cause color changes in the liquid. MDMA, often known as ecstasy, comes in a tablet or capsule form. Ketamine is a white powder.

GHB is also known as "Georgia home boy". Rhypnol is also known as "roofies". Slang terms for MDMA include "ecstasy", "XTC", "e", "x", and "adam". Ketamine is sometimes refered to as "special K".

GHB and Rohypnol are also known as "date rape drugs" because of their effect on memory and their use in sexual assault situations. Student materials do not offer this terminology. Determine whether your students are ready for this level of discussion before presenting this terminology to them, if you decide to at all.

GHB can cause memory loss, relaxation, drowsiness, dizziness, nausea, difficulty seeing, unconsciousness, seizures, breathing problems, tremors, sweating, vomiting, decreased heart rate, a dreamlike feeling, coma, and possible death.

Rohypnol can cause memory loss, lower blood pressure, sleepiness, muscle relaxation or loss of muscle control, a drunk feeling, nausea, slurred speech, difficulty with motor movements, loss of consciousness, confusion, problems seeing, dizziness, and stomach problems.

MDMA can cause increases in heart rate and blood pressure, muscle tension, involuntary teeth clenching, nausea, blurred vision, faintness, and chills or sweating. In high doses, MDMA can lead to a sharp increase in body temperature (hyperthermia) that results in liver, kidney, and cardiovascular system failure.

Ketamine can cause hallucinations, lost sense of identity and time, distorted

perceptions of sight and sound, feeling out of control, impaired motor function, problems breathing, convulsions, vomiting, out-of-body experiences, a dreamlike feeling, numbness, loss of coordination, aggressive or violent behavior, and slurred speech.

GHB, Rohypnol, MDMA, and Ketamine in the Brain

GHB and Rohypnol affect the neurotransmitter GABA (gamma amino butyric acid). Normally, GABA inhibits the ability of neurons to send messages to neighboring neurons; in other words, it stops or slows the communication between neurons. When a person uses GHB or Rohypnol, the drugs enhance the effects of GABA, further decreasing communication between neurons. This decreased communication, or depressant effect, causes drowsiness and confusion, and can have even more serious effects such as sleep, coma, or death.

MDMA causes an increase in activity associated with the neurotransmitters serotonin, dopamine, and norepinephrine. It does this by preventing the reuptake of the neurotransmitters. MDMA can also cause the reuptake sites to work in reverse, so they release even more serotonin into the synapse. Serotonin plays an important role in the regulation of mood, sleep, pain, emotion, and appetite. The excess serotonin found in synapses as a result of MDMA use likely causes the euphoric effects of the drug. Because the drug depletes large amounts of this important neurotransmitter, it also contributes to the negative aftereffects that users often experience days after use.

Ketamine disrupts the functioning of receptors for the neurotransmitter glutamate, known as NMDA (N-methyl-D-aspartate) receptors. This can cause the stupor observed in a person who has used ketamine as well as problems with learning, memory, awareness, and judgment. Ketamine can also disrupt the actions of the neurotransmitter dopamine.

Preparation/Introduction

Preparation

- Read the Background section of this module for more information about drugs in the news.
- Provide students with the Module 6 magazine Drugs in the News for background knowledge.
- Determine which activities you want the class to complete.
- Arrange for computer lab time or prepare the classroom computer for students' Internet and CD-ROM use.
- Photocopy and pass out the Drugs in the News Fact Sheet for students to complete during the lecture.
- Prepare transparencies and photocopies for the lesson.

Introduction

Time: 15 - 20 minutes

Handouts: Module 6 magazine (PDF, 12.8MB)

Drugs in the News Fact Sheet (PDF, 668KB)
(Page 25 in the pdf)

Before giving students time to review the magazine, begin with the following activity. Lead a discussion about drugs in the news and other media outlets. Ask students what they've read and seen in the media about substance use and addiction. Specifically mention the drugs included in this module and see whether students are familiar with these three substances. List students' responses on the chalkboard.

Reading: Give students adequate time to read the student magazine. Have them pay particular attention to the following sections: Background, Stats and Facts, and Science in the Spotlight.

Discussion: In small groups, have students discuss the information using the following questions. Then, bring the groups together and discuss as a class. Review the effects of the drugs, how the drugs are used, how the drugs act in the brain, and why these drugs appear so often in the media.

> *Tell students that one goal of this lesson is to help them learn how individuals, families, and the community are affected by drugs of abuse. A second goal is to give students the skills to critically analyze how the media covers information about drugs of abuse.*

Drugs in the News

- Why are these drugs illegal?
- What parts of the brain are affected by steroids? Methamphetamine? Other club drugs?
- What are the risks to an individual who may use these drugs?
- What is the impact of these drugs on communities?
- Why do these drugs appear so often in the media?
- Is the media coverage of drugs balanced? Have students seen both positive and negative information presented when drugs are discussed?
- How does the information they have read in the media compare to the information in the fact sheet

Activities

Activity 1: Brain Messages

Time: 45 minutes

Supplies: One large piece of butcher-block paper per group

Markers/crayons/pencils

Handouts: Media Chart (PDF, 668KB)
(Page 29 in the pdf)

After presenting the information on the fact sheet, announce the sixth and final activity of the competition. Remind students which groups they are in. Have students sit with their groups.

In this activity, students will earn points for their groups by monitoring the media—newspapers, TV, and magazines—for information about legal and illegal drugs that have been covered by the Brain Power! curriculum. Encourage students to bring in information they find about drugs in the news to share with the rest of the class. Award points for both the amount and the quality of the information the groups find. Develop your own plan for awarding points, or use this one:

- One point per article (or description of TV commercial or show) that discusses drug use.
- Two points if the article discusses the impact of the drug on the brain and body.
- Three points per article if the student can identify an imbalance in the presentation of the information, as in a media piece that lacks scientific background or presents false or sensational information.

Use the Media Chart provided to track the teams' progress as they gather this information and present it to their classmates. Run the competition for a few days or a week. Encourage conversation about the topics that the students present to support the integration of all the information covered in the *Brain*

Power! curriculum. Do students realize that accurate information can support healthy decision-making? Are they aware of the role of the media in disseminating this information?

Record group points on the Group Scorecard.

Activity 2: Scavenger Hunt

Time: 45 minutes

Supplies: Computer for research

Pen or pencil

Handouts: Ripple Effects (PDF, 668KB)
(Page 27 in the pdf)

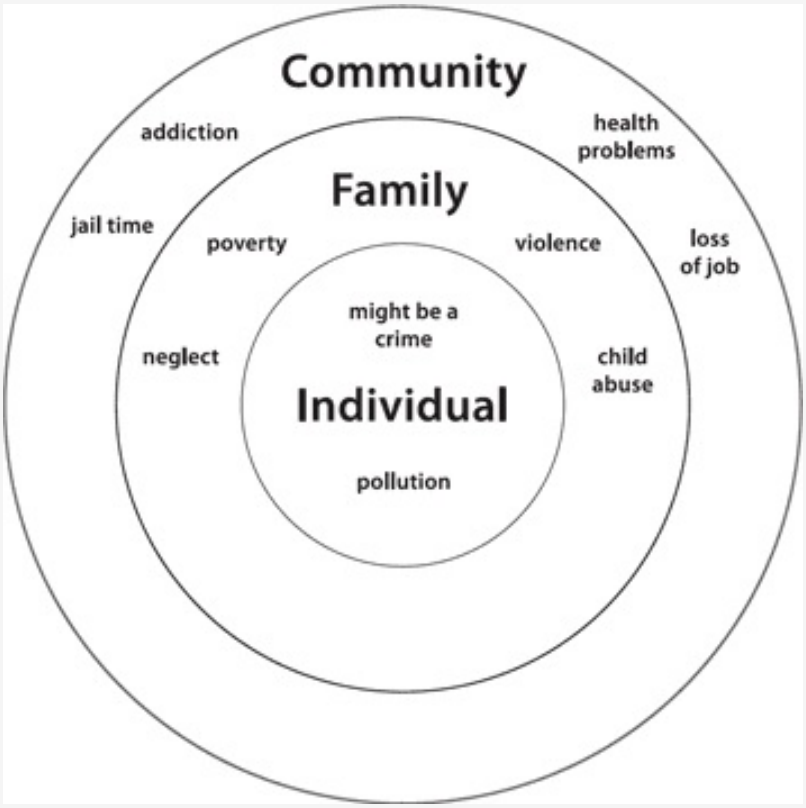
Methamphetamine use, like the use of other drugs, impacts both individuals and society. For this final activity, students will explore how methamphetamine use has a ripple effect throughout society.

Using the Web sites provided as a starting point, have students research the prevalence of methamphetamine and the consequences of its production, distribution, and use. Have students complete the diagram on the Ripple Effects handout, listing ways in which methamphetamine affects multiple layers of society—from individuals to families to communities. Students should use information from the Web sites below and others to justify their responses. Then, have students brainstorm ways to prevent or improve the problems on each tier. The image below represents the Ripple Effect.

Prior to the activity, add these sites to the classroom computer's "Favorites" drop-down menu. If need be, the activity can be spread across a few day's time by having one group at a time access the computer for research time while the

rest of the class completes other work.

- http://teens.drugabuse.gov/educators/curricula-and-lesson-plans/mind-over-matter/methamphetamine
- www.intheknowzone.com/meth/community.htm



Example: for the individual, responses may include addiction, health problems, loss of job, and jail time; for the family, responses could include violence, poverty, child abuse, and neglect; for the community, responses might be crime and pollution.

Room 6 (Online Version)*

Includes games and materials to supplement the information presented in the module. ***The room labeled "6"*** contains the following activities and specific information pertaining to this module:

- *Learning Objectives*: these are presented at the beginning of each CD-ROM module

- *Brain Scan Files*: in this activity, students view brain scan images to see the damaging effects of various drugs on the brain
- *Methamphetamine and Sports News Daily Article*: inspired by news headlines, the articles discuss the broad impact of methamphetamine and steroid use
- *Memory Game*: students match vocabulary words from the module in this memory-based game
- *Beat the Clock*: in this game, students race to select the terms that correctly relate to the drugs discussed in the module
- *Module Quiz*: this quiz is the final part of the module, intended to assess students' learning

**Adobe Flash* player required to view.*

Extensions

1. Some professional athletes have ruined their reputations and careers when routine drug testing revealed that they had been using anabolic steroids. Have students decide if they support (pro) or disagree with (con) routine drug tests for athletes. Have each side (pro and con) present their main points to the class. Make sure students emphasize the brain and body effects of the drug and how this information should be considered in the debate.
2. Have each student access the data from the Monitoring the Future national survey online. Ask students to record at least one teen drug fact obtained from the site; observe what information students were able to pull from the text and charts that are at a higher reading level.

Assessment

As students complete the activities in the module, observe whether they have mastered the following:

1. Can students explain the effects of methamphetamine in the brain? Can they explain how these changes can result in addiction?
2. Can students explain the effects of steroids in the brain? Can they explain the dramatic effects the drug can have on the body?
3. Can students list the serious effects of MDMA abuse?
4. Can students list the types of date rape drugs and their effects on the brain and body? Do they realize the prevalence of these drugs in society?
5. Do students recognize the prevalence of information on drugs in the news? Can students articulate why drug abuse is such an important topic for the media?
6. Have students become more critical consumers of information about drugs of abuse? Are they able to recognize inaccuracy or imbalance in news coverage, if present?

Resources

Resources for Teachers

National Institute on Drug Abuse (NIDA)
301-443-1124
This Web site contains information about drug abuse as well as sections designed specifically for parents, teachers, and students.

Mind Over Matter Teacher's Guide
This printable/downloadable teacher's guide accompanies NIDA's Mind Over Matter series. The series is designed to educate teens about the biological effects of drug abuse on the body and brain.

NIDA DrugPubs Research Dissemination Center
877-NIDA-NIH (877-643-2644; TTY/TDD: 240-645-0228)
Order our materials free of charge in English or Spanish.

Resources for Students

Mind Over Matter
Designed for teens, this site includes information about how different drugs, including methamphetamine and steroids, affect the brain. The site also includes a teacher's guide. Also available for free by calling 1-800-729-6686.

NIDA for Teens
Designed for teens, this site provides information on several drugs, including steroids, as well as quizzes and real-life stories.

Above the Influence
Designed for teens, this site covers the risks and consequences of various drugs and provides news, advice, and real-life stories.

Date Rape Drugs. Kehner, G.B. Philadelphia, PA: Chelsea House Publishers, 2004. Part of the "Drugs: The Straight Facts" series. Discusses the history, effects, usage trends, and other information about GHB, Rohypnol, and ketamine.

Body Enhancement Products. Santella, T.M. Philadelphia, PA: Chelsea House Publishers, 2005. Part of the "Drugs: The Straight Facts" series. Discusses the health risks of steroids and other body enhancement products.

Materials/Contact

Contact Information

For questions regarding *NIDA's Science Education Program and Materials*, email NIDA Info.

Handouts

Module 1: An Introduction to the Brain and Nervous System

- Module 1 Magazine (PDF, 10.4MB)
- Module 1 Handouts (PDF, 129KB)
- Module 1 Handouts (Spanish, PDF, 89KB)
- Student/Teacher Worksheets (PDF, 668KB) (Pages 2-7)
- Parent Guide (PDF, 330KB)
- Parent Guide (Spanish, PDF, 1.55MB)

Module 2: Legal Doesn't Mean Harmless

- Module 2 Magazine (PDF, 2MB)
- Module 2 Handouts (PDF, 97KB)
- Student/Teacher Worksheets (PDF, 668KB) (Pages 8-13)
- Parent Guide (PDF, 330KB)
- Parent Guide (Spanish, PDF, 1.55MB)

Module 3: Drugs in the Cupboard

- Module 3 Magazine (PDF, 4.3MB)
- Student/Teacher Worksheets (PDF, 668KB) (Pages 14,15)
- Parent Guide (PDF, 92KB)
- Parent Guide (Spanish, PDF, 62KB)

Module 4: Weeding Out the Grass

- Module 4 Magazine (PDF, 6.8MB)
- Student/Teacher Worksheets (PDF, 668KB) (Pages 16-22)
- Parent Guide (PDF, 70KB)
- Parent Guide (Spanish, PDF, 65KB)

Module 5: Drugs on the Street

- Module 5 Magazine (PDF, 7MB)
- Student/Teacher Worksheets (PDF, 668KB) (Pages 22,23)
- Parent Guide (PDF, 120KB)
- Parent Guide (Spanish, PDF, 119KB)

Module 6: Drugs in the News

- Module 6 Magazine (PDF, 12.8MB)
- Student/Teacher Worksheets (PDF, 668KB) (Pages 24-30)
- Parent Guide (PDF, 91KB)
- Parent Guide (Spanish, PDF, 105KB)

T-shirts, Stickers, and Buttons

How do I make a T-shirt?

Download PDF (2MB)

1. Ask children to have their parents find a plain white t-shirt or other cotton item that they can use for the iron-on.
2. Pick up iron-on ink-jet transfer paper at your local craft or office supply store. Choose opaque transfer paper for dark-colored items and transparent transfer paper for light-colored items. Transparent transfer paper may help avoid white outlines around artwork. Always read the instructions that come with the transfer paper.
3. Download the free artwork.
4. Use an inkjet printer to print the downloaded artwork onto the transfer paper. The artwork comes as a two-page PDF document. Page one is a flipped, mirror image (backwards) of the design. Page two is a regular (straightforward) non-flipped image.

5. Use an ordinary iron to transfer the design onto the item. Use caution, the iron will be very hot.

How do I print the stickers?

Download

1. Pick up some blank white labels paper at your local craft or office supply store.
2. Download the free artwork.
3. Place the downloaded artwork onto your labels and resize the art to fit your label.
4. Use an ink-jet printer to print your downloaded design onto the labels. Be sure to read the instructions that come with the labels.

Online Activities

Activities can be used as an enriching, learning tool to reinforce information covered in the lesson. We recommend that these activities be used after the lesson is completed, either immediately after or as time allows in the classroom schedule.


Come help Jordan find...
The Keys to
Brain Power!
1 2 3
4 5 6
Teacher's Lockbox
PLAY INTRO
NEW GAME
CREDITS
CLOSE