

### 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.

### 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.

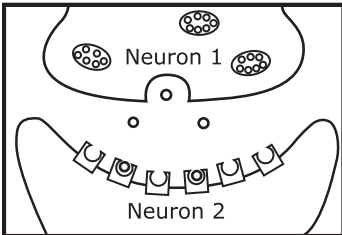
Although nicotine is an addictive substance, it is actually the tobacco in nicotine products that can cause deadly cancers. Smoking and chewing tobacco can cause cancer of the lungs, throat, and mouth.

## 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.

Key	
○	Acetylcholine
●	Nicotine
⌋	Receptor

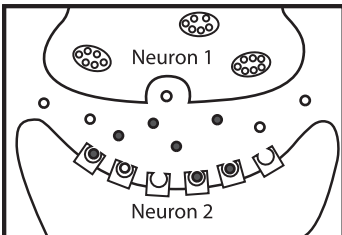
### Normal acetylcholine and receptors



Nonsmoker

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.

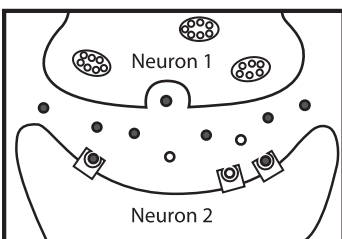
### Too many chemicals in the synapse



New Smoker

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.

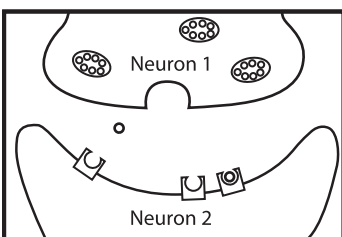
### Less acetylcholine and fewer receptors



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

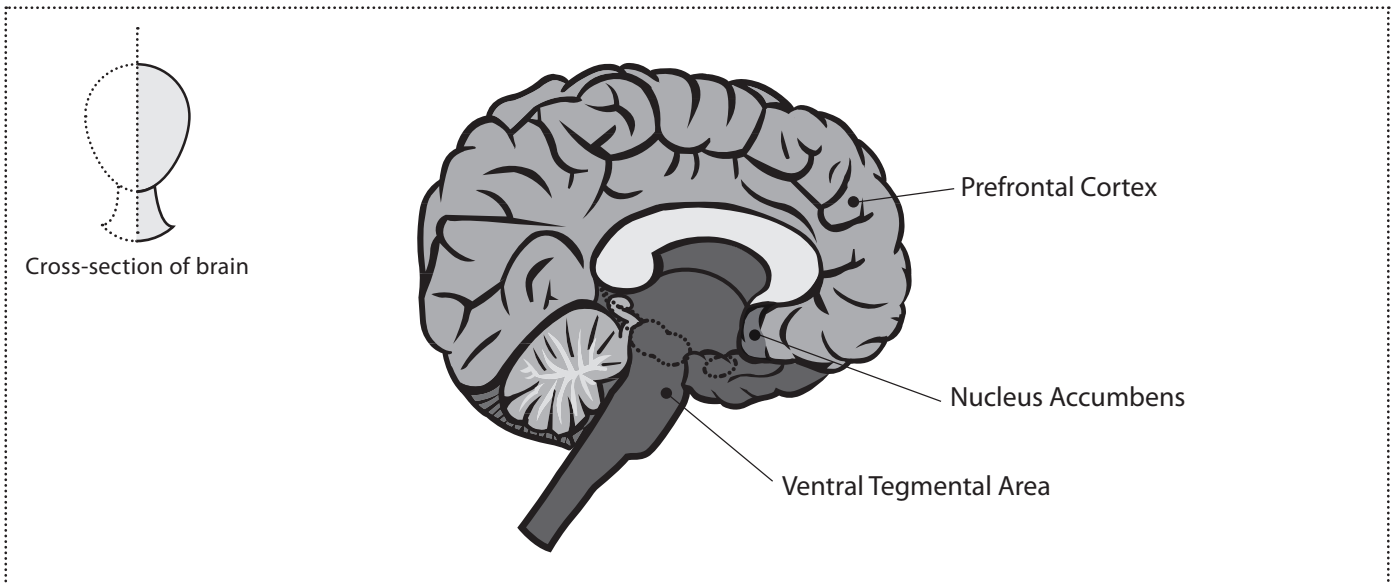


Quitting Smoking

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 causes an increase in the release of dopamine from neurons located in the limbic system. Dopamine is a neurotransmitter responsible for carrying messages about pleasurable feelings. The result is stimulation of the “reward system” in the brain, which causes feelings of pleasure.

The reward system is a circuit in the brain that carries messages about pleasure. These messages move from the dopamine-containing neurons located in the **ventral tegmental area (VTA)**, to a structure in the limbic system called the **nucleus accumbens**, and then to the **prefrontal cortex**. Activation of this system causes feelings of pleasure.



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. Smokers may continue to smoke to maintain these high dopamine levels and the good feelings associated with the drug.

### 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.

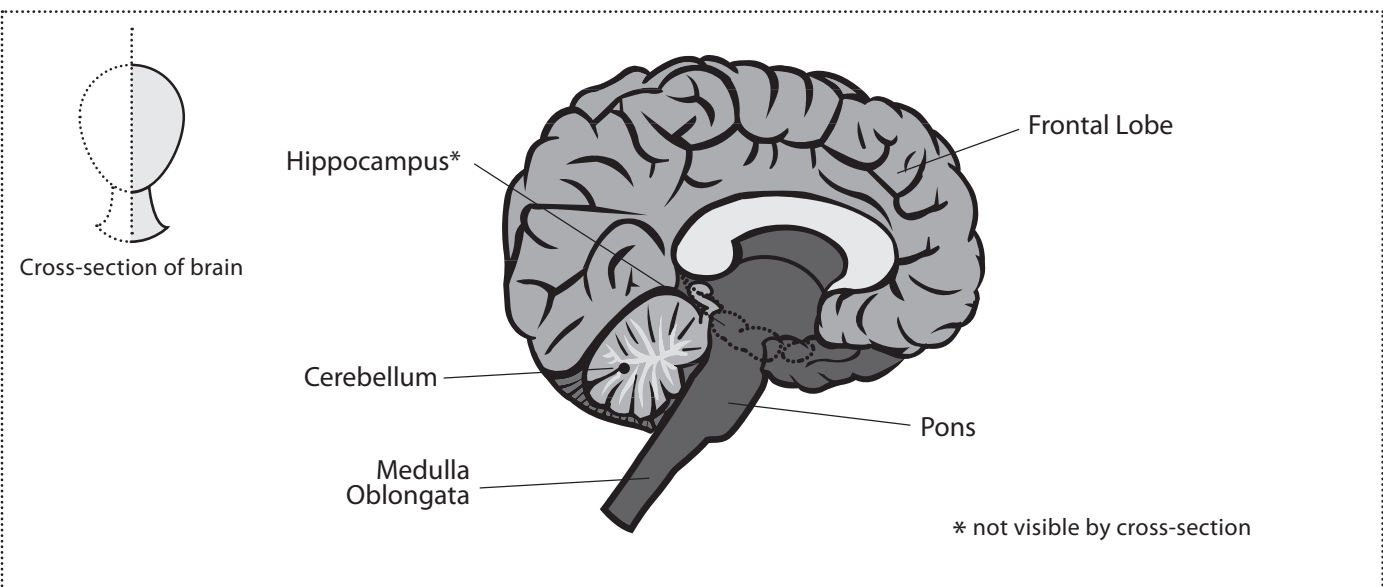
Nicotine replacement therapy, like the nicotine patch and gum, has helped many smokers quit. These products gradually reduce the amount of nicotine in the brain so that the smoker does not experience the negative effects of a sudden drop in nicotine levels. After the brain has adjusted to nicotine reduction 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 increases the activity of inhibitory neurotransmitters like GABA. When the number of inhibitory neurotransmitters in the brain is increased, brain activities slow down.

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 is responsible for the pleasurable aspects of drinking.

## 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**

- 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*.



**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.

**Time:**

15–20 minutes



**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.

**Supplies:**

Transparencies of diagrams if needed

**Handouts:**

Module 2 magazine

### 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, see #2)

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.

Module 2 magazine

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.

**Handouts:**

Puzzle pieces

Nicotine and the Brain handout

Alcohol and the Brain handout

**Introduction**



**Activity 2: Underage Drinking and the Media**

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?

**Time:**

40 minutes

**Supplies:**

Pen or pencil

**Handouts:**

Media Report Card






The CD-ROM 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

## 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?



The following Web site provides a tobacco history timeline and is a good starting point:  
[www.cnn.com/US/9705/tobacco/history](http://www.cnn.com/US/9705/tobacco/history)

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.

### Key to Icons



Art



Science



History



Business



Social Studies



English



Math

**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.

**Experiment:**

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

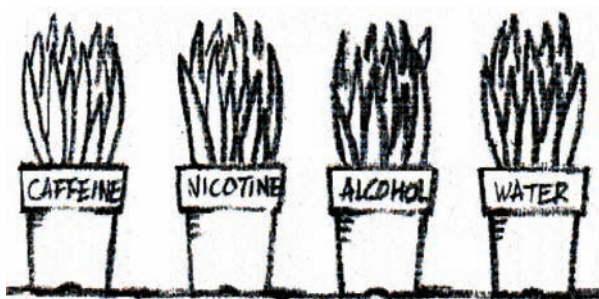


Figure 1

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.



Figure 2

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?

## RESOURCES FOR TEACHERS

### **National Institute on Drug Abuse (NIDA)**

**[www.drugabuse.gov](http://www.drugabuse.gov), 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**

**<http://teens.drugabuse.gov/mom>**

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.

### **National Clearinghouse for Alcohol and Drug Information (NCADI)**

**<http://ncadi.samhsa.gov>, 1-800-729-6686**

NCADI is the world's largest resource for information and materials concerning substance abuse. Many free publications are available here.

### **National Institute on Alcohol Abuse and Alcoholism**

**[www.niaaa.nih.gov](http://www.niaaa.nih.gov)**

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

### Mind Over Matter

<http://teens.drugabuse.gov/mom>

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

<http://teens.drugabuse.gov>

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

### Free Vibe

[www.freevibe.com](http://www.freevibe.com)

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

### Too Smart to Start

[www.toosmarttostart.samhsa.gov](http://www.toosmarttostart.samhsa.gov)

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

[www.thecoolspot.gov](http://www.thecoolspot.gov)

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.

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