DRUG ABUSE ADDICTION AND THE ADOLESCENT BRAIN
A Curriculum Supplement for Middle School Life Science

Funded through a Science Education Drug Abuse Partnership Award from the National Institute on Drug Abuse (NIDA)
Drug Abuse, Addiction, and the Adolescent Brain

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Drug Abuse, Addiction, and the Adolescent Brain

Contents

Introduction to Drug Abuse, Addiction, and the Adolescent Brain .............................. 7
  ■ What Are the Objectives of the Module? ................................................................. 7
  ■ Why Teach the Module? ......................................................................................... 8
  ■ What’s In It for the Teacher? .................................................................................. 9
  ■ Reaching a Broader Audience.............................................................................. 9

Implementing the Module .......................................................................................... 11
  ■ What Are the Goals of the Module? ..................................................................... 11
  ■ What Are the Science Concepts, and How Are They Connected? ...................... 12
  ■ How Does the Module Correlate with the National Science Education Standards? ... 13
  ■ How Does the BSCS 5E Instructional Model Promote Active, Collaborative, Inquiry-Based Learning? .......................................................... 15
  ■ How Does the Module Support Ongoing Assessment? ........................................ 18
  ■ How Can Controversial Topics Be Handled in the Classroom? ............................ 18

Using the Lessons ....................................................................................................... 21
  ■ The Student Lessons .............................................................................................. 21
    ○ Format of the Lessons
    ○ Timeline for Teaching the Module
  ■ Presenting the Video to Adult Audiences ............................................................. 23

Student Lessons ........................................................................................................ 25
  ■ Lesson 1 .................................................................................................................. 27
    ○ Defining Drug Abuse and Addiction
  ■ Lesson 2 .................................................................................................................. 35
    ○ Drug Addiction Is a Brain Disease
  ■ Lesson 3 .................................................................................................................. 41
    ○ The Adolescent Brain and Drugs
  ■ Lesson 4 .................................................................................................................. 49
    ○ Treating Drug Abuse and Addiction

continued on next page
Additional Resources ................................................................. 113

Image Credits ........................................................................... 117

Masters ..................................................................................... 119
Adolescence is a period of change in many aspects of a person’s life. During adolescence, young people are changing physically, increasing their cognitive abilities, and becoming more aware of the world around them. One of the situations that many young people face at some point involves drug use. Some of the information that adolescents receive about drugs may be confusing or even contradictory. On the one hand, they may hear messages about “just say no” or see celebrities doing public service announcements on television about the dangers of drugs. On the other hand, they may see friends or acquaintances use drugs without obvious harmful effects. They also see actors in movies using drugs, especially alcohol or nicotine, in somewhat glamorous portrayals. None of these sources provides evidence to explain how drugs affect the body from a scientific point of view. Adolescents, like adults, need accurate information to separate fact from myth and misconception when it comes to drugs of abuse.

What Are the Objectives of the Module?

Students have probably had some form of drug education before they reach middle school. Many existing programs use a strategy of helping students learn to avoid or “say no” to drugs. *Drug Abuse, Addiction, and the Adolescent Brain* seeks to present adolescents with a new way to think about drug abuse and addiction. This module focuses on the science that explains the effects that drugs have on the brain and, by extension, a person’s thoughts, feelings, and behaviors. Learning the biological basis for how drugs exert their effects should help replace the common misconception that people who have drug- or substance-abuse problems are morally weak or “deserving” of the problem.
Another feature of this module is its focus on helping students understand why adolescence is a unique time period in life with respect to drug use. Adolescents may be more susceptible to the effects of drugs and may have difficulty making good decisions when it comes to drug use. Scientists now know that adolescence is a time of significant brain development—especially in areas of the brain that are involved in decision making and being able to predict the consequences of actions. The immaturity of these brain regions helps explain why adolescents may make poor or impulsive decisions. Scientists are also finding that drug use during adolescence may affect the development of the brain, in ways that may have long-lasting effects.

Many misconceptions circulate about drug abuse and addiction. Because of its focus on the biological effects of drugs on the brain, this module will help students know what is true and what is not.

This module also helps students refine their understanding of science and biology. During adolescence, students are developing the skills that better enable them to relate the structure of the body to the way the body functions. *Drug Abuse, Addiction, and the Adolescent Brain* directly ties the structure of the nervous system to its function in the body. The module furthers students’ understanding by helping them understand how normal functioning is changed by drugs of abuse.

Students also gain skills related to evidence—why it is important to have evidence, what conclusions can be drawn, and what constitutes good evidence. The activities in *Drug Abuse, Addiction, and the Adolescent Brain* ask students to identify and analyze the data and evidence that support major concepts related to how drugs exert their effects on the functioning of the brain.

**Why Teach the Module?**

Science teachers are constantly challenged to find ways of making material meaningful to middle school students. At this age, students want to see the relevance of topics to their lives. Because this module focuses on the adolescent period, students see a direct link to their own life. This real-life context grabs their attention. Students see that learning the science underlying drug abuse and addiction is more than just another topic to memorize for biology class. They can apply the information to decisions about their own lives.
What’s In It for the Teacher?

*Drug Abuse, Addiction, and the Adolescent Brain* meets many of the criteria used to assess teachers and their programs:

- The module is *standards based* and meets science content, teaching, and assessment standards as expressed in the *National Science Education Standards*.1
- The module includes a video as an integral part of the instructional materials. The video presents interviews with several of the nation’s leading experts on the neurobiology of drug use, adolescent brain development, and treatment. It also includes interviews with individuals who are recovering from drug dependence. Animations make the biology topics easier to understand.
- It is an *integrated* module, drawing most heavily from the subjects of science, health, math, and the language arts. Students practice and develop their skills in identifying and communicating major concepts related to drug abuse and drug addiction.
- Students practice and develop their *critical-thinking skills*. The lessons ask students to examine evidence, synthesize information, and form explanations.
- The module includes built-in *assessment* tools, indicated by an assessment icon in the lessons.

Reaching a Broader Audience

Adolescents aren’t the only ones who have a lack of knowledge about drugs of abuse. Many adults also have misconceptions about this area of science. The stereotypical view remains common that addicts are morally weak “losers” living on the street, who could quit if they just tried hard enough. The stigma associated with drug abuse can make it uncomfortable for some people to discuss. The video in this module has the potential to help diverse audiences improve their understanding that drug abuse and addiction are issues of biology. Because many teachers, school administrators, school counselors, and coaches deal with adolescents who may be abusing drugs, helping these school professionals increase their knowledge about drug abuse and addiction may enable them to help students more effectively.

Also, many parents are uncomfortable discussing drugs of abuse with their children. The video presentation may provide them with factual information that can be the starting point for discussions between parents and children—especially if the students have completed the module in class.

*Drug Abuse, Addiction, and the Adolescent Brain* includes a facilitation guide for using the video with adult audiences. This facilitation guide provides a plan for showing the video and guiding discussion among adult participants. It also includes a brochure that summarizes the key points of the video and can be distributed to adults. This brochure is provided in both English and Spanish.
The five lessons in this module are designed to be taught in sequence for approximately five to eight class periods, as a replacement for part of the standard curriculum in middle school biology. The following pages offer general suggestions about using these materials in the classroom; you will find specific suggestions in the procedures provided for each lesson.

What Are the Goals of the Module?

*Drug Abuse, Addiction, and the Adolescent Brain* is designed to help students develop the following major understandings and skills associated with scientific literacy:

- To understand that drugs of abuse change the way a person’s brain functions to cause changes in thoughts, feelings, and behaviors
- To develop an appreciation of how developmental changes that occur during adolescence make the effects of drug use during this time different from use in adulthood
- To recognize that drug addiction is a treatable, chronic brain disease
- To practice summarizing scientific information and communicating that information to others
- To practice identifying major concepts and the evidence that supports them
- To experience the process of scientific inquiry and develop an enhanced understanding of the nature and methods of science
- To appreciate the role of science in society and the relationship between basic science and human health
What Are the Science Concepts, and How Are They Connected?

The lessons presented in this module form a conceptual whole that will provide students with a fundamental knowledge of drug abuse, drug addiction, and the effects of drugs on brain function. Students begin by considering their prior knowledge of drug abuse and addiction. They learn that abuse and addiction are medical conditions that are diagnosed by specific criteria (Lesson 1, Defining Drug Abuse and Addiction). Students then learn that drug use changes how the brain functions. Specifically, drugs change the way neurons relay messages to each other. Because of this change in brain function, addiction is viewed as a disease (Lesson 2, Drug Addiction Is a Brain Disease). Students then extend their understanding when they learn that drug use during adolescence may have consequences that are different from drug use in adults because the adolescent brain is still developing (Lesson 3, The Adolescent Brain and Drugs). Students can then consider how treatment for the disease of drug addiction compares with that for other chronic diseases (Lesson 4, Treating Drug Abuse and Addiction). Finally, students integrate their knowledge and share information with others (Lesson 5, What Should Others Know?). The Conceptual Flow of the Lessons chart (Table 1) illustrates the sequence of major concepts addressed by the five lessons.

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Learning Focus*</th>
<th>Major Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson 1, Defining Drug Abuse and Addiction</td>
<td>Engage-Explore</td>
<td>“Drug abuse” and “drug addiction” are terms that people often attribute different meanings to. For medical purposes, they are defined by specific criteria. Other experts define drug abuse and addiction using other terms. Drug abuse is any use of an illegal drug or the inappropriate use of a legal substance to produce pleasure, alleviate stress, or escape reality. Drug addiction is the continued compulsive use of drugs despite negative consequences.</td>
</tr>
<tr>
<td>Lesson 2, Drug Addiction Is a Brain Disease</td>
<td>Explore-Explain</td>
<td>Drugs change the way neurons in the brain communicate. Addiction is a disease because drugs affect the way the brain functions. Changes in brain function caused by addiction negatively impact a person’s thoughts, feelings, and actions.</td>
</tr>
<tr>
<td>Lesson 3, The Adolescent Brain and Drugs</td>
<td>Explore-Explain</td>
<td>The brain undergoes specific developmental changes during adolescence. Because some parts of the brain are immature, adolescents are more likely to make impulsive decisions about many things, including drug use. Drug use may also influence the development of certain areas of the brain.</td>
</tr>
<tr>
<td>Lesson 4, Treating Drug Abuse and Addiction</td>
<td>Elaborate</td>
<td>Drug abuse and addiction, like other chronic diseases, can be treated effectively. The stigma associated with drug abuse and addiction and the frequency of relapse or recurrence often keep people from seeking treatment.</td>
</tr>
<tr>
<td>Lesson 5, What Should Others Know?</td>
<td>Evaluate</td>
<td>Learning the science about how drugs affect a person’s brain function can help dispel misconceptions. The ability to evaluate scientific and health-related information is an important skill for students that they can apply throughout their lives.</td>
</tr>
</tbody>
</table>

*See How Does the BSCS SE Instructional Model Promote Active, Collaborative, Inquiry-Based Learning? on page 15.
How Does the Module Correlate with the National Science Education Standards?

*Drug Abuse, Addiction, and the Adolescent Brain* supports teachers in their efforts to reform science education in the spirit of the National Research Council’s *National Science Education Standards* (NSES). The content of the module is explicitly standards based. The Content Standards: Grades 5–8 chart (Table 2) lists the specific content standards this module addresses.

<table>
<thead>
<tr>
<th>Standard A: As a result of activities in grades 5–8, all students should develop</th>
<th>Correlation to <em>Drug Abuse, Addiction, and the Adolescent Brain</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Abilities necessary to do scientific inquiry</td>
<td></td>
</tr>
<tr>
<td>Develop descriptions, explanations, predictions, and models using evidence.</td>
<td>Lessons 1, 2, 3, and 4</td>
</tr>
<tr>
<td>Think critically and logically to make the relationships between evidence and explanations.</td>
<td>Lessons 1, 2, 3, 4, and 5</td>
</tr>
<tr>
<td>Recognize and analyze alternative explanations and predictions.</td>
<td>Lessons 1 and 3</td>
</tr>
<tr>
<td>Communicate scientific procedures and explanations.</td>
<td>Lessons 2 and 3, and 4</td>
</tr>
<tr>
<td>Understandings about scientific inquiry</td>
<td></td>
</tr>
<tr>
<td>Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.</td>
<td>Lessons 2 and 3</td>
</tr>
<tr>
<td>Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.</td>
<td>Lessons 1, 2, and 3</td>
</tr>
<tr>
<td>Science advances through legitimate skepticism. Asking questions and querying other scientists’ explanations is part of scientific inquiry. Scientists evaluate the explanations proposed by other scientists by examining evidence, comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations.</td>
<td>Lessons 2, 3, 4, and 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard C: As a result of their activities in grades 5–8, all students should develop understanding of</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure and function in living systems</td>
<td></td>
</tr>
<tr>
<td>Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells, organs, tissues, organ systems, whole organisms, and ecosystems.</td>
<td>Lessons 2 and 3</td>
</tr>
<tr>
<td>Specialized cells perform specialized functions in multicellular organisms. ... Each type of cell, tissue, and organ has a distinct structure and set of functions that serve the organism as a whole.</td>
<td>Lesson 2</td>
</tr>
</tbody>
</table>
### Table 2. Content Standards: Grades 5–8 (Continued)

<table>
<thead>
<tr>
<th>Regulation and behavior</th>
<th>Lessons 1, 2, 3, and 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavior is one kind of response an organism can make to an internal or environmental stimulus. A behavioral response requires coordination and communication at many levels, including cells, organ systems, and whole organisms. Behavioral response is a set of actions determined in part by heredity and in part from experience.</td>
<td>Lessons 1, 2, 3, and 4</td>
</tr>
</tbody>
</table>

**Standard F:** As a result of activities in grades 5–8, all students should develop understanding of

- **Personal health**
  - The use of tobacco increases the risk of illness. Lessons 1, 2, 3, and 4
  - Alcohol and other drugs are often abused substances. Such drugs change how the body functions and can lead to addiction. Lessons 1, 2, 3, 4, and 5

- **Risks and benefits**
  - Individuals can use a systematic approach to thinking critically about risks and benefits. Lessons 1, 3, and 4
  - Important personal and social decisions are made based on perceptions of benefits and risks. Lessons 1, 2, 3, 4, and 5


### Teaching Standards

The suggested teaching strategies in all the lessons support teachers as they work to meet the teaching standards outlined in the *National Science Education Standards*. The module helps teachers of science plan an inquiry-based science program by providing short-term objectives for students. It also includes planning tools, such as the *Conceptual Flow of the Lessons* chart and the *Suggested Timeline* for teaching the module. Teachers can use this module to update their curriculum in response to their students’ interest in this topic. The focus on active, collaborative, and inquiry-based learning helps teachers support the development of students’ understanding and nurture a community of science learners.

The structure of the lessons in this module enables teachers to guide and facilitate learning. All the lessons encourage discourse among students and challenge them to accept and share responsibility for their learning. The use of the BSCS 5E Instructional Model, combined with active, collaborative learning, allows teachers to respond effectively to the diversity of student backgrounds and learning styles. The module is fully annotated, with suggestions for
how teachers can encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.

**Assessment Standards**

Teachers can engage in ongoing assessment of their teaching and of student learning by using the variety of assessment components embedded within the module’s structure. The assessment tasks are authentic: they are similar in form to tasks in which students will engage in their lives outside the classroom or in which scientists participate. Annotations guide teachers to these opportunities for assessment and provide answers to questions that can help teachers analyze student feedback.

**How Does the BSCS 5E Instructional Model Promote Active, Collaborative, Inquiry-Based Learning?**

Because learning does not occur through a process of passive absorption, the lessons in this module promote active learning: students are involved in more than listening and reading. Through collaborative work, they are developing skills, analyzing and evaluating evidence, experiencing and discussing, comparing interpretations of evidence, and talking to their peers about their own understanding. Many students find they can learn better when they work with others in a collaborative environment than they can when they work alone in a competitive environment. When this active, collaborative learning is directed toward inquiry science, students succeed in making their own discoveries. They ask questions, observe, analyze, explain, draw conclusions, and ask new questions. These inquiry experiences include both those that involve students in direct experimentation and those in which students develop explanations through critical and logical thinking.

This view of students as active thinkers who construct their own understanding out of interactions with phenomena, the environment, and other individuals is based on the
theory of constructivism. A constructivist view of learning recognizes that students need time to
■ express their current thinking;
■ interact with objects, organisms, substances, and equipment to develop a range of experiences on which to base their thinking;
■ reflect on their thinking by writing and expressing themselves and comparing what they think with what others think; and
■ make connections between their learning experiences and the real world.

This module provides a built-in structure for creating a constructivist classroom: the BSCS 5E Instructional Model. This model sequences the learning experiences so students have the opportunity to construct their understanding of a concept over time. The model takes students through five phases of learning that are easily described using five words that begin with the letter E: Engage, Explore, Explain, Elaborate, and Evaluate. The following paragraphs illustrate how the 5Es are implemented across the lessons in this module.

**Engage**

Students come to learning situations with prior knowledge. This knowledge may or may not be congruent with the concepts presented in this module. The Engage lesson provides the opportunity for teachers to find out what students already know or what they think they know about the topic and concepts to be developed.

The Engage lesson in this module, Lesson 1, *Defining Drug Abuse and Addiction*, is designed to
■ pique students’ curiosity and generate interest,
■ draw out students’ prior knowledge about drug abuse and drug addiction,
■ encourage students to compare their ideas with the ideas of others, and
■ allow teachers to assess what students do or do not understand about the stated outcomes of the lesson.

**Explore**

In the Explore phase of the module, parts of Lesson 1, *Defining Drug Abuse and Addiction*, Lesson 2, *Drug Addiction Is a Brain Disease*, and Lesson 3, *The Adolescent Brain and Drugs*, students explore how drugs act on the brain and why the effects of drugs may be different during adolescence than at other times of life. The lessons provide a common foundation for students within which they can compare what they think.

During the Explore phase of the lessons, students
■ analyze a series of case studies to determine if the individuals in the cases have problems with drug abuse or addiction;
■ use their skills of observation, logic, and deduction to gain an understanding of addiction as a brain disease;
acquire a common set of experiences with their classmates so they can compare results and ideas; and

- observe, describe, record, compare, and share their ideas and experiences.

**Explain**

The Explain components of Lesson 2, *Drug Addiction Is a Brain Disease*, and Lesson 3, *The Adolescent Brain and Drugs*, provide opportunities for students to connect their previous experiences and to begin to make conceptual sense of the main ideas of the module. This phase also allows for the introduction of formal language, scientific terms, and content information that might make students’ previous experiences easier to describe and explain.

In the Explain lessons in this module, students

- explain concepts and ideas about the effects of drugs on the brain,
- incorporate the correct scientific terminology into their explanations,
- add new information about the development of the brain to their understanding of the effects of drug use,
- listen to and compare other’s explanations of their results with their own, and
- become involved in student-to-student discourse in which they explain their thinking to others and debate their ideas.

**Elaborate**

In Elaborate lessons, students apply or extend the concepts in new situations and relate their previous experiences to new ones.

In the Elaborate lesson in this module, Lesson 4, *Treating Drug Abuse and Addiction*, students

- consider factors that affect whether a person seeks treatment,
- compare treatment for addiction with treatment for other chronic diseases,
- draw reasonable conclusions from evidence and data, and
- communicate their understanding to others.

**Evaluate**

The Evaluate lesson is the final phase of the instructional model, but it provides only a “snapshot” of what the students understand and how far they have come from where they began. In reality, the evaluation of students’ conceptual understanding and ability to use skills begins with the Engage lesson and continues throughout each phase of the model, as described in the following section. Combined with the students’ written work and performance of tasks throughout the module, however, the Evaluate lesson can serve as a summative assessment of what students know and can do.

The Evaluate lesson in this module, Lesson 5, *What Should Others Know?* provides opportunities for students to

- demonstrate what they understand about the function of the brain and the effects of drugs on that function,
integrate information from the previous lessons to form a deeper understanding of drug abuse and addiction as biological disorders,

assess their own progress by comparing their current understanding with their prior knowledge, and

apply their knowledge to situations in the real world.

To review the relationship of the BSCS 5E Instructional Model to the concepts presented in the module, see the Conceptual Flow of the Lessons chart on page 12.

How Does the Module Support Ongoing Assessment?

Because teachers will use this module in a variety of ways and at a variety of points in their curriculum, the most appropriate mechanism for assessing student learning is one that occurs informally at various points within the five lessons, rather than something that happens more formally and only once at the end of the module. Accordingly, specific assessment components are integrated within the lessons in the module. These embedded assessment opportunities include one or more of the following strategies:

- Performance-based activities (for example, participating in discussions of how drugs affect brain function or constructing brochures)
- Oral presentations to the class (for example, explaining an analysis of data)
- Written assignments (for example, answering questions or writing summaries)

These strategies allow the teacher to assess a variety of aspects of the learning process, such as students’ prior knowledge and current understanding, problem-solving and critical-thinking skills, level of understanding of new information, communication skills, and ability to synthesize ideas and apply understanding to a new situation. An assessment icon and an annotation that describes the aspect of learning that teachers can assess appear in the margin beside the step in which each embedded assessment occurs.

How Can Controversial Topics Be Handled in the Classroom?

Teachers sometimes feel that the discussion of values is inappropriate in the science classroom or that it detracts from the learning of “real” science. The lessons in this module, however, are based upon the conviction that there is much to be gained by involving students in analyzing
issues of science, technology, and society. Society expects all citizens to participate in the
democratic process, and our educational system must provide opportunities for students to learn
to deal with contentious issues with civility, objectivity, and fairness. Likewise, students need to
learn that science intersects with life in many ways.

Drug abuse and addiction are topics that can elicit strong feelings. In addition, some students
may have personal or family experiences that involve drug abuse. These experiences may lead to
some discomfort. Although this curriculum module is focused on the science that underlies drug
abuse and addiction, some discussions may extend into values and ethics. As students encounter
issues about which they feel strongly, some controversies might arise during discussions. How
much dissension develops will depend on many factors, such as how similar the students are
with respect to socioeconomic status, perspectives, value systems, and religious preferences. In
addition, the language and attitude of the teacher factor into the flow of ideas and the quality of
exchange among the students.

The following guidelines may help teachers facilitate discussions that balance factual
information with feelings:

■ Remain neutral. Neutrality may be the single, most-important characteristic of a successful
discussion facilitator.
■ Encourage students to discover as much information about the issue as possible.
■ Keep the discussion relevant and moving forward by questioning or posing appropriate
problems or hypothetical situations. Encourage everyone to contribute, but do not force
reluctant students into the discussion.
■ Emphasize that everyone must be open to hearing and considering diverse views.
■ Use unbiased questioning to help the students critically examine all views presented.
■ Allow for the discussion of all feelings and opinions.
■ Avoid seeking consensus on all issues. The multifaceted issues that the students discuss
result in the presentation of divergent views, and students should learn that this is
acceptable.
■ Acknowledge all contributions in the same evenhanded manner. If a student seems
to be saying something for its shock value, see whether other students recognize the
inappropriate comment and invite them to respond.
■ Create a sense of freedom in the classroom. Remind students, however, that freedom
implies the responsibility to exercise that freedom in ways that generate positive results
for all.
■ Insist upon a nonhostile environment in the classroom. Remind students to respond to
ideas instead of to the individuals presenting those ideas.
■ Respect silence. Reflective discussions often are slow. If the teacher breaks the silence,
students may allow the teacher to dominate the discussion.
■ At the end of the discussion, ask the students to summarize the points that they and
their classmates have made. Respect students regardless of their opinions about any
controversial issue.
The Student Lessons

*Drug Abuse, Addiction, and the Adolescent Brain* consists of five classroom lessons. These lessons are a means to provide information to your students on neurobiology, drug abuse, and drug addiction. To review the concepts in detail, refer to the *Conceptual Flow of the Lessons* chart on page 12.

**Format of the Lessons**

As you scan the lessons, you will find that each contains several major features.

*At a Glance* gives the teacher a convenient overview of the lesson:

- The *Overview* provides a short summary of student activities.
- The *Major Concepts* section lists the central ideas that the lesson is designed to convey.
- *Learning Objectives* lists two to four specific understandings or abilities students should have after completing the lesson.

*Teacher Background* lists the sections of *Information about Drugs and the Brain* (pages 65–102) that are most closely linked to the content of the lesson. The background information provides the science content that underlies the key concepts of the lessons. The information provided is *not* intended to form the basis of lectures to students. It is also *not* designed to be a direct resource for students. Instead, it is designed to enhance your understanding of the content so that you can more accurately facilitate class discussions, answer student questions, and provide additional examples.

*In Advance* provides instructions for collecting and preparing the materials required to complete the activities in the lesson:

- *Materials* lists all the materials other than photocopies needed for the lesson.
- *Photocopies* lists the paper copies or transparencies that need to be made from masters.
- *Preparation* outlines the things you need to do to be ready to teach the lesson.
Procedure outlines the steps for the lesson. It provides implementation suggestions and answers to questions.

Within the procedures, annotations provide additional commentary:

- Observations from the Field Test includes suggestions for teaching strategies, class management, and module implementation, based on observations and comments from the field-test teachers.
- Notes give information about issues that may need further clarification or emphasis.
- Assessment Opportunity marks times when you can assess student progress. An icon with an annotation suggest strategies for assessment.

The masters required for each lesson are located in a separate section at the end of the module.

**Timeline for Teaching the Module**

The suggested timeline provides a guideline for completing the five lessons in this module. This module requires five to eight 45-minute class periods. The difference reflects the practice of individual teachers. Some classes spend more time on questions and discussion that require additional time. The timeline assumes you will teach the lessons on consecutive days. If several days separate the lessons, you may need to spend more time reviewing the previous lesson so that students can make connections between the previous lesson and the current lesson.

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 weeks ahead</td>
<td>Reserve DVD player and projection system.</td>
</tr>
<tr>
<td></td>
<td>Check DVD performance.</td>
</tr>
<tr>
<td></td>
<td>Schedule time for presenting the video to parents; reserve a room and equipment.</td>
</tr>
<tr>
<td>1 week ahead</td>
<td>Prepare photocopies.</td>
</tr>
<tr>
<td></td>
<td>Read through the lessons and background information.</td>
</tr>
<tr>
<td></td>
<td>Preview the video to familiarize yourself with the content.</td>
</tr>
<tr>
<td></td>
<td>Copy the brochure for parents, include the date and time of the presentation, and send it home with students.</td>
</tr>
<tr>
<td>Days 1–2</td>
<td>Lesson 1, Defining Drug Abuse and Addiction</td>
</tr>
<tr>
<td>Days 3–4</td>
<td>Lesson 2, Drug Addiction Is a Brain Disease</td>
</tr>
<tr>
<td>Day 5</td>
<td>Lesson 3, The Adolescent Brain and Drugs</td>
</tr>
<tr>
<td>Day 6</td>
<td>Lesson 4, Treating Drug Abuse and Addiction</td>
</tr>
<tr>
<td>Days 7–8</td>
<td>Lesson 5, What Should Others Know?</td>
</tr>
</tbody>
</table>
Presenting the Video to Adult Audiences

The Facilitation Guide for Adult Audiences, page 59, provides a plan for presenting the video to parents and guardians. If possible, schedule a parent night around the same time that students are working on this module. By having the parents see the same video that the students will see, parents may feel more comfortable discussing the topics of drug abuse and addiction with their children. You can inform parents of the time and place for the presentation by sending the brochure (located at the end of the masters) home with the students. The facilitation guide also provides additional ideas for using the video with other adult audiences.
STUDENT LESSONS
At a Glance

Overview
Students begin the lesson by expressing their current ideas related to the terms “drug abuse” and “drug addiction.” They then watch a segment of the video that presents information about the criteria for drug abuse and addiction and how those criteria manifest themselves in people’s lives. Students complete the lesson by working in teams to analyze case studies to apply what they have learned in the video.

Major Concepts
“Drug abuse” and “drug addiction” are terms that people often attribute different meanings to. For medical purposes, they are defined by specific criteria. Other experts define drug abuse and addiction using other terms. Drug abuse is any use of an illegal drug or the inappropriate use of a legal substance to produce pleasure, alleviate stress, or escape reality. Drug addiction is the continued compulsive use of drugs despite negative consequences.

Learning Objectives
After completing this lesson, students will be able to
- define drug abuse and drug addiction,
- distinguish between drug abuse and drug addiction, and
- explain how specific situations meet criteria for drug abuse or drug addiction.
Teacher Background

The following sections of Information about Drugs and the Brain are most relevant to this lesson:

- Adolescent Drug Use and Attitudes
- Defining Drug Abuse and Addiction
- Other Body Systems Affected by Drug Use

In Advance

Materials

Drug Abuse, Addiction, and the Adolescent Brain DVD
DVD player and projection system
Chart paper (2–4 pieces)
Markers for chart paper
Masking tape for hanging chart papers

Photocopies

<table>
<thead>
<tr>
<th>Master</th>
<th>Number of Copies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master 1.1, Is It Abuse or Addiction?</td>
<td>1 copy per student</td>
</tr>
<tr>
<td>Master 1.2, Is There a Problem?</td>
<td>Approximately 4 copies depending on class size*</td>
</tr>
</tbody>
</table>

*Students will work in teams of three to four students for this part of the lesson. Each team will analyze one of seven case studies. Each student in the team will need a copy of the team’s case.

Preparation

- Watch Segment 1 of the video, Defining Abuse and Addiction, to familiarize yourself with the content.
- Prepare copies of masters.
- Cut Master 1.2, Is There a Problem?, at the dotted lines to separate the different case studies.

Procedure

1. Write the following phrases on the board: “drug abuse” and “drug addiction.” Tell students they have two minutes to write a definition or a description of what these terms mean to them.

Students may write definitions for these terms or simply describe what mental pictures these phrases evoke. Encourage them to write down the thoughts that first come to their minds as initial responses—not what they may have learned in previous classes. Students will come to this curriculum from different perspectives. It is important for students to have the opportunity to bring to mind what they know or believe about the topic.
2. Ask students to share what they have written. Record students’ ideas on a piece of chart paper. After several students have shared their thoughts, ask them to identify areas in which their ideas are similar to and different from those of other students in the class.

At this stage, accept all reasonable answers from students. The purpose of this step is to draw out students’ prior conceptions. Do not judge the accuracy of the responses at this time. Keep the discussion moving fairly quickly. You don’t need to get every idea that students have, but you and the students will likely see some discrepancies. The discrepancies will show that not everyone views drug abuse and addiction in the same way, thus illustrating that there is a need for common terminology.

Observations from the Field Test: Steps 1 and 2 are intended to give you an idea of what knowledge students have at the beginning of this module. Students in the field test varied greatly in their understanding about drug abuse and drug addiction. Some students were able to define the terms fairly accurately, while others revealed incorrect preconceptions, stereotypes, or confusion about the terms. Even if students already have an appropriate definition for these terms, it can be helpful for students to see that there are different preconceptions about drug abuse and addiction. Most of the material in this module will likely be new to them because it focuses on the science of how drugs affect the brain.

Some students also used terms related to drug abuse and addiction, such as tolerance, cravings, and withdrawal, but it was clear that they didn’t really understand the meaning of these terms. You may want to ask them what they mean if they use these terms. Don’t correct misconceptions at this point (they will be covered as part of the lessons in this module), but you can use the information to gauge the depth of students’ understanding.

Note: Save the chart paper with the students’ responses. You will use this again in Lesson 5, What Should Others Know? It may be helpful for students to save their own papers on which they initially wrote about their understanding of drug abuse and addiction.
3. Refer again to some discrepancies on the list generated in Step 2. Explain to students that people have different knowledge and feelings about the topics of drug abuse and addiction (as revealed in their lists). Ask students, “If people have different ideas about what drug abuse and drug addiction are, how do you know if someone has a problem with drug abuse or addiction?”

Many people, adults and adolescents, have some knowledge about drug abuse and addiction. The discrepancies indicate that some information would be inaccurate. Drug abuse and addiction are topics about which many people have misperceptions that are then passed on to other people.

The conflicting information about drug abuse and addiction revealed in the class list may lead students to think that drug abuse and drug addiction have either vague or inconsistent definitions. The question should encourage students to think about how definitions of drug abuse and addiction apply to real situations. The question should also provide a transition to watching the first segment of the video, which presents the definitions and criteria for drug abuse and addiction.

You may also want to explain to students that they will be doing a project at the end of the module. Give them a brief description of the final project—a brochure or poster that will present the main scientific ideas of how drugs affect the brain. By giving a brief description now, you can help students recognize that they will need to know and use the information they learn during this and the following lessons.

4. Inform students that during the next several days they will be learning the science of how drugs cause changes in the brain. Explain that they will now watch a video on drug abuse and addiction. Show Segment 1 of the video, Defining Abuse and Addiction.

Segment 1 is about 9 minutes long. This segment provides information about how scientists and doctors define drug abuse and addiction. Drug abuse and drug addiction are not just conditions to which the saying “you’ll know if you see it” applies. There are specific criteria to define each. This information is important because it serves as a common foundation for all students for the remainder of the module.

Tell students that they do not need to take notes during the video—it is better if they concentrate on what the speakers are saying. Master 1.1, Is It Abuse or Addiction?, which they will receive a copy of in Step 5, provides the same definitions and criteria for abuse and addiction that they will hear in the video.

5. Ask students to form teams of three or four. Give each student one copy of Master 1.1, Is It Abuse or Addiction?, and one of the case studies from Master 1.2, Is There a Problem? Explain that teams should read their case studies and decide whether the individual in the case study has a problem with drug abuse or addiction. Point out to students that Master 1.1 provides the same criteria presented in the video.
Give each team a different case study, but each member of the team gets the same case. These cases are similar in format to the types of case studies that doctors analyze to learn about health conditions and diseases. If helpful, you can tell students that they are playing the role of doctors who are learning more about drug abuse and addiction. If you have more than seven teams, different teams can work with the same case. If you do not have seven teams, you can choose not to use all the case studies, have smaller teams, or have teams analyze more than one case study.

Emphasize to students that they need to use the criteria on Master 1.1 to make their decisions. It isn’t appropriate for students to make decisions about abuse or addiction based on their guesses or previous ideas about drugs—they should be basing their decisions on the information in the case study and the criteria provided. It is good if students compare the information from the video and Master 1.1 to what they thought previously, but for the decision-making task, they need to apply the scientific criteria.

6. **After students have time to work through the case studies, have teams present their decisions. Each team should explain why they made the decisions they did.**

Each student can play a role in the team’s presentation to the class. Team members can decide who will

- read or describe the case study to the class,
- explain why the case study would or would not represent drug abuse (according to both definitions or the criteria),
- explain why the case study would or would not represent drug addiction (according to both definitions or the criteria), and
- describe how the case study is related to something they saw in the video.

The case studies give the students an opportunity to work with the definitions for abuse and addiction. Students may have difficulty understanding why the medical criteria are somewhat different from the alternate definitions. You may want to help students with this by explaining that the medical criteria help doctors decide if the person needs treatment. There may be cases of people using drugs once or twice in ways that don’t require medical treatment because the drugs haven’t caused them problems yet and they aren’t continuing their drug use. You may also want students to look for similar ideas in both definitions.

Table 1.1 (pages 32–33) outlines the appropriate responses and reasons for the different case studies. The table also points out some misconceptions that may influence students’ thinking and suggests follow-up questions if you think students are holding onto preconceptions. The point for this activity is to help students connect the medical criteria and signs of abuse and addiction to situations that happen in real life. There may be different interpretations of some of the cases based on the information provided. Students may reach different conclusions, but they should be able to support their conclusions with specific pieces of information.

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**Assessment Opportunity:** In this activity, students apply the information that they have learned from the video and from the handout. Listen to the students’ presentations to determine if they apply the criteria correctly and understand the terms.
### Table 1.1
**Analysis of Case Studies**

<table>
<thead>
<tr>
<th>Case</th>
<th>Drug</th>
<th>Abuse or Addiction?</th>
<th>Criteria Used</th>
<th>Relevant Signs</th>
<th>Common Misconceptions</th>
<th>Potential Follow-Up Questions to Assess Misconceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cough syrup</td>
<td>Abuse</td>
<td>Abuse according to both definitions</td>
<td>Grades falling&lt;br&gt;Stealing&lt;br&gt;Taking cough syrup to feel pleasure</td>
<td>Some students may not think that over-the-counter or prescription medications are a problem for abuse or addiction. This is false.</td>
<td>Is cough syrup a drug?&lt;br&gt;Can prescription drugs be abused? Explain according to the definitions.</td>
</tr>
<tr>
<td>2</td>
<td>Inhalants (paint thinner)</td>
<td>Abuse</td>
<td>Abuse by Definition 2 only</td>
<td>No obvious impact after using inhalants one time&lt;br&gt;Inappropriate use of legal substance</td>
<td>Inhalants are not always seen as dangerous or addictive, but even a single use can result in serious health problems or even death. Inhalants cause damage to several body systems, especially with repeated use.</td>
<td>If this does not qualify as abuse using the medical criteria, does that mean inhalants are OK?</td>
</tr>
<tr>
<td>3</td>
<td>Marijuana</td>
<td>Addiction</td>
<td>Addiction by both definitions</td>
<td>Using marijuana more often&lt;br&gt;Problems dealing with friends&lt;br&gt;Trouble trying to stop&lt;br&gt;Withdrawal symptoms&lt;br&gt;Starting to use again&lt;br&gt;Stealing money</td>
<td>Many people do not believe marijuana is addictive. Recent research, however, supports that it is.</td>
<td>How many people think marijuana can be addictive?</td>
</tr>
<tr>
<td>4</td>
<td>Ecstasy (MDMA)</td>
<td>Abuse</td>
<td>Abuse by Definition 2 only</td>
<td>Using a drug one time with no obvious impact of the drug&lt;br&gt;Use of illegal substance&lt;br&gt;Trying ecstasy for pleasurable feelings</td>
<td>Using a drug of any kind can be dangerous even with a single use. However, there is a difference between danger or risk of harm and a medical condition (abuse or addiction) that would require treatment.</td>
<td>Even if using a drug one time doesn't fit the medical signs for abuse, does that mean that it is safe?</td>
</tr>
<tr>
<td>5</td>
<td>Cocaine</td>
<td>Addiction</td>
<td>Addiction according to both definitions</td>
<td>Using by herself&lt;br&gt;Spending less time with friends&lt;br&gt;Taking more of the drug&lt;br&gt;Spending more time trying to get the drug&lt;br&gt;Promises to quit&lt;br&gt;Compulsive need for the drug</td>
<td>Some students may not feel that this case study fits addiction, because they have a stereotype of an addict as someone whose life is seriously disrupted or totally nonfunctional in society.</td>
<td>Is it possible that people can hide their addiction?</td>
</tr>
<tr>
<td></td>
<td>Alcohol</td>
<td>Addiction</td>
<td>Addiction by both definitions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>drinking more</td>
<td>problems at school</td>
<td>compulsive need for alcohol even though he knows it is causing problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Some students may not feel that alcohol is a drug because it is legal to possess or drink (over the age of 21). It is, in our culture, an illegal drug for people under the age of 21.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is alcohol a drug?</td>
<td>Based on the information you have, can someone who is over age 21 abuse alcohol? Explain. (Definition 2 for abuse suggests the answer is yes if the person uses alcohol to ease stress, produce pleasure, or avoid reality.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Would using cigarettes be drug abuse?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Prescription</th>
<th>Abuse</th>
<th>Abuse by both definitions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pain medication</td>
<td>continuing to use</td>
<td>continuing to use</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Many people feel that prescription medications are not a problem because they are prescribed by a physician. However, these medications can be abused if they are used for a purpose different from that for which they were prescribed or by someone else.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Why would using another person’s prescription medication be potentially dangerous?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Note: These case studies may suggest to students that using drugs once or twice might be OK because the drugs may not cause serious enough problems. However, where appropriate, point out that any use of drugs can, depending on the circumstances, cause serious health problems or even death.

7. After student teams have discussed the case studies, ask them if the alternate definitions of abuse and addiction would be acceptable to use for the remainder of the lessons in this module. Ask them to explain their ideas of why these definitions would or would not be acceptable to use.

The alternate definitions should be acceptable for use during the remainder of this module. Perhaps the main thing to emphasize is that drug abuse is the use of substances for inappropriate reasons (escaping reality, alleviating stress, or producing pleasure) and addiction (dependence) is characterized by a compulsion or preoccupation with drugs. At the point of addiction, a person has really lost control over his or her drug use.

8. Write the definitions for drug abuse and drug addiction on pieces of chart paper. Keep these posted during the remainder of the module for students’ reference.

   **Drug abuse** is any use of an illegal drug or the inappropriate use of a legal substance to produce pleasure, reduce stress, or escape reality (or all three).

   **Drug addiction** is the continuing compulsive use of drugs in spite of negative health, legal, or social consequences.

Keeping these definitions posted will likely help keep students focused on the accepted definitions as opposed to their previous ideas or incorrect information.

9. Ask students to look again at the descriptions of drug abuse and addiction that the class put together at the beginning of this lesson (Step 2). Ask students if any changes to these lists should be made to reflect the information from this lesson.

This task does not need to be exhaustive. The main thing is for students to recognize that there were probably some ideas at the beginning that need to be revised in light of new information.

10. Ask students to save the handouts from this lesson for use in Lesson 5.
At a Glance

Overview
Students reveal preconceptions about drug addiction by expressing an opinion about whether drug addiction is a disease. After considering what the word “disease” means, students watch a segment of the video to learn why scientists consider addiction to be a brain disease. Students complete the lesson by writing a few statements to summarize the evidence presented in the video that supports addiction as a brain disease.

Major Concepts
Drugs change the way neurons in the brain communicate. Addiction is a disease because drugs affect the way the brain functions. Changes in brain function caused by addiction negatively impact a person’s thoughts, feelings, and actions.

Learning Objectives
After completing this lesson, students will be able to
- recognize that drugs change the way neurons in the brain communicate,
- list at least three pieces of evidence that support scientists classification of addiction as a brain disease, and
- explain why the reward center is important in the brain’s response to drugs.
Teacher Background

The following sections of *Information about Drugs and the Brain* are most relevant to this lesson:

- Basic Brain Anatomy and Specialization
- The Brain’s Reward System and Drugs
- The Cells of the Brain
- Neurons Use Electrical and Chemical Signals to Transmit Information
- Different Neurons Use Different Neurotransmitters
- Drugs Disrupt Neurotransmission
- Imaging the Brain

In Advance

**Materials**

*Drug Abuse, Addiction, and the Adolescent Brain* DVD
DVD player and projection system
Overhead projector
Transparency pens

**Photocopies**

<table>
<thead>
<tr>
<th>Master</th>
<th>Number of Copies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master 2.1, <em>Addiction</em></td>
<td>1 transparency</td>
</tr>
<tr>
<td>Master 2.2, <em>Definition of Disease</em></td>
<td>1 transparency</td>
</tr>
<tr>
<td>Master 2.3, <em>What Is the Evidence?</em></td>
<td>1 copy per student</td>
</tr>
</tbody>
</table>

**Preparation**

- Preview Segment 2 of the video, *Drugs Change the Brain*, to familiarize yourself with the content.
- Prepare copies of masters.

**Procedure**

1. Point out the definitions of drug abuse and addiction that you posted on chart paper during Lesson 1, *Defining Drug Abuse and Addiction*. Ask students to recall whether abuse and addiction have any consequences for a person.

   Students should remember that both abuse and addiction have consequences. At the very least, when people abuse drugs, their thoughts and usually their behaviors are
changed. Addiction causes more significant changes in a person’s thoughts, emotions, and actions. Emphasize the loss of control over or compulsion with drug use that characterizes addiction.

2. Display a transparency of Master 2.1, Addiction. Quickly poll the class to see who agrees with and who disagrees with the statement on the master. Write the number of students who take each position on the transparency.

The number of students who take each position isn’t important. This quick poll will give you an idea of whether students view addiction as a biological condition, and it calls for students to assess their current understanding.

3. Ask for volunteers to share their reasons why they either agree with or disagree with the statement.

Students’ responses will vary. Accept all answers that have a logical explanation. It isn’t necessary to reach consensus.

4. Explain to students that scientists and experts in drug abuse and addiction view this as a true statement. Ask students to propose what questions these experts would need to answer in order to reach the conclusion that addiction is a brain disease.

Students should draw on their understanding of science to state that experts would need evidence to support their conclusion. Information that they would need to know would include:

- What do drugs do to the body and the brain?
- How do drugs affect a person?
- What is a disease?

Students may come up with other questions. Accept ones that are appropriate and challenge students to explain further if their ideas seem to be offtrack. If necessary, you can start the discussion by prompting with one of the questions.

If students don’t raise the question “What is a disease?” you should propose that this question is an important one to ask.

5. Focus the class’s attention on the question of disease. Explain to students that they need to have a definition of disease before they can answer the question about whether addiction is a disease. Have students work with a partner to develop a brief definition of what a disease is. Allow about three minutes for students to share their ideas with a partner.

Students do not need to worry about developing a formal definition or writing their thoughts in complete sentences. It is more important at this time to focus on the specific components that would need to be incorporated in a definition.
6. Display a transparency of Master 2.2, *Definition of Disease.* Read the definition aloud to the class and ask them if their ideas for disease match this definition.

Students should be able to see a direct correlation between the definition they developed and this definition of disease. You don’t need to cover this exhaustively, but students should reinforce the three main points in the definition. A disease is a health condition

- that affects a specific part or parts of the body,
- in which the body does not function in normal range, and
- interferes with an individual’s life.

**Note:** For the purposes of this module, you can explain to students that there are many synonyms for the word “disease,” including “sickness,” “illness,” “syndrome,” and “disorder.” Acknowledge that there may be subtle distinctions among these words for physicians, but for this module, all of them are basically equivalent in meaning.

If students question a characteristic listed as part of the definition for disease, the following paragraphs may help you respond to their thoughts and help them move from specific examples to a broader definition of disease. Students may have trouble distinguishing between symptoms of a specific disease and disease as a concept. For example, a student might suggest that a person has a fever or elevated body temperature. Other students may suggest that a cough is part of a disease. These are symptoms of some diseases but not all. Symptoms are usually tied to a part of the body. For example, someone who is coughing (symptom) because of pneumonia (disease) has problems with the lungs primarily (body part). Someone who has strep throat has problems mainly with the functioning of the throat. Although many body parts can be involved in many diseases, it is usually possible to identify the part or parts of the body that are affected when someone has a disease. In a disease, a part (or parts) of the body is not working normally.

Students may not express the idea of usual or normal ranges of function. Body temperature is an example of an attribute that normally fluctuates within a narrow range. A normal body temperature is considered 98.6 degrees Fahrenheit (°F), but the temperature of a healthy person may vary several tenths of a degree (for example, from 98.3°F to 99.1°F) throughout the day. This person’s temperature would still be considered normal. A temperature of 101°F, however, would be considered abnormally high because it is outside the normal range.

Diseases have an impact on a person’s life in ways that range from a minimal impact to a severe disruption of normal activity. Students will likely explain that an illness prevents a person from engaging for a day or two in his or her usual activities, such as going to school or playing sports. An illness may just have minor effects such as a lack of energy or an annoying headache. More serious effects on a person’s life due to disease might include needing to take medicine for an extended period of time or being in the hospital. Other ways that an illness can interfere with a person’s life include changing a person’s mood or feelings, changing the way a person interacts with friends or family members, or changing a person’s eating habits. There are a very large number of ways that a disease can interfere with a person’s life. Some of those ways are more obvious and direct than others.
Many students may think that all diseases are caused by an infectious agent, such as a bacterium or a virus. Others may think that illness applies only to long-term and potentially fatal health problems. Disease can refer to a broad range of health problems, from minor diseases such as colds to a short-term health problem such as a headache to a long-term, more-serious condition such as diabetes.

Students should keep the definition from the transparency in mind as they watch the video (Step 8).

7. **Explain to students that they will now view another video segment.** Their task while watching the video is to identify pieces of evidence that either support or refute the idea that addiction is a brain disease. Give each student a copy of Master 2.3, *What Is the Evidence?* Go over the handout with students. Explain how they should use Part 1 on the handout to write short notes that will help them remember what they have seen.

Students should make brief notes during the video, but not try to record all the information. Also, it isn’t necessary for students to remember the names of specific brain locations such as nucleus accumbens or ventral tegmental area. These are included for more information, but just remembering “reward system” is sufficient.

Although students will only write in Part 1 while watching the video, point out Part 2 and explain that, after the video is over, students will use the notes they wrote in Part 1 to write complete sentences to summarize the main points of the video.

8. **Show Segment 2 of the video, Drugs Change the Brain.**

Segment 2 is about 14 minutes long. In this segment, students will learn how neurons transmit information and how drugs alter this communication. They will also learn how these drug-induced changes in brain function cause changes in thoughts, feelings, and behaviors.

Observations from the Field Test: The science content in Segment 2 of the video is fairly advanced for most middle school life science classes. Some students may feel that it is too complicated for them. Help students understand that they do not need to learn all the terminology and details. Instead, they need to think about the material from the perspective of “What is the ‘big idea’ for this part of the video? Does it support the idea that drug addiction is a brain disease? Why or why not?” After previewing the video, you may want to go over an example with students before they watch the video. Students will see an animation showing how neurons communicate. They do not need to learn all the terminology or even remember all the steps in the process. However, they should think about why it was included in the video.

9. **After watching the video, have students complete Part 2 of Master 2.3.**

In this part of the handout, students should write a few sentences summarizing the evidence from the video. This task will help students add detail to their brief notes. Students can work individually to write their summary statements or they can work in teams of two to three students to complete the task. It may be helpful to set a time limit of about five minutes to help students focus on the task.

If you think it would be helpful, go over a couple examples of summary statements before students begin writing their own. Example 1 identifies a type of evidence but does not
provide much information about why positron emission tomography (PET) images support the idea that addiction is a brain disease. Explain that a sentence that begins like Example 2 would be a stronger summary because it not only indicates the type of evidence (PET images) but also includes a description of what the PET images showed:

- Example 1: PET images are one type of evidence that scientists use to look at the effect of drugs.
- Example 2: The PET images in the video support that addiction is a brain disease because they show that drugs . . . [finish sentence by describing the effect on the brain shown in the PET images].

10. Ask for volunteers to each share one piece of evidence to support the idea that addiction is a brain disease. Continue having students share their ideas while they have evidence to contribute. Ask students if anything presented in the video refutes the idea that addiction is a disease.

Students should be able to state why the piece of evidence relates to addiction being a disease. Students may add information that they recall from the first segment of the video, if that helps. The focus of the discussion should be that drugs change the way that certain parts of the brain work—drugs change the signaling that occurs between neurons. You may need to help them separate basic information from the information that supports why addiction is a brain disease.

The following is some of the evidence that students may cite:

- Drugs change the communication between neurons to increase dopamine release.
- Drugs stimulate specific parts of the brain (the reward center).
- Drugs affect a person's thoughts, behaviors, and emotions.
- PET imaging shows that different parts of the brain are active when someone takes drugs.
- The effects of drugs on the brain may be seen in PET images a long time after the last time drugs were used.
- Microarray analysis shows that different genes in the brain are active at different times during withdrawal.

Depending on your students' prior experiences and science background, some of the terms may be challenging for them. It isn't really necessary for students to understand PET imaging or microarray analysis; they can simply say that these tests show that there are differences apparently caused by drugs. Most middle school students will have basic knowledge of what a gene is. If not, you can simply define gene as a set of instructions inside the cells that instruct the cell what to do.

11. Ask students to save their copies of Master 2.3. They may want to refer to them during Lesson 5, What Should Others Know?

Lesson 5 is the Evaluate lesson where students will be asked to summarize what they have learned. The notes they take at this stage may be helpful to them at that time.
At a Glance

**Overview**

Students begin the lesson by analyzing data from animal experiments to recognize that the response to drugs may be influenced by the age at which drug use begins. They then watch another segment of the video to find out more about how drugs affect the adolescent brain in unique ways. Students summarize the major ideas from the video.

**Major Concepts**

The brain undergoes specific developmental changes during adolescence. Because some parts of the brain are immature, adolescents are more likely to make impulsive decisions about many things, including drug use. Drug use may also influence the development of certain areas of the brain.

**Learning Objectives**

After completing this lesson, students will be able to

- draw conclusions from scientific data about the relationship between exposure to drugs and age in an animal model,
- name two types of changes to the brain that occur during adolescence,
- describe how adolescents are different from adults in their response to drugs, and
- explain that adolescents are more vulnerable to drug abuse because certain parts of the brain are not fully developed during this time in life.
Teacher Background

The following sections of Information about Drugs and the Brain are most relevant to this lesson:

- Genetic, Behavioral, and Environmental Influences on Drug Addiction
- Biological Differences between Adolescent and Adult Brains
- Regions of the Brain Develop at Different Times
- Developmental Changes in the Adolescent Brain
- The Effects of Drugs on the Maturation of the Adolescent Brain

In Advance

Materials

Drug Abuse, Addiction, and the Adolescent Brain DVD
DVD player and projection system
Overhead projector
Transparency pens (optional)

Photocopies

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<tr>
<td>Master 3.5, The Adolescent Brain and Drugs</td>
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Preparation

- Watch Segment 3 of the video, The Adolescent Brain and Drugs, to familiarize yourself with the content.
- Prepare copies of masters.

Procedure

1. Introduce students to the idea that scientists can learn a great deal about the effects of drugs by using animals. Tell students that they will be analyzing data from scientific studies that used rats as model organisms. Display a transparency of Master 3.1, Learning from Animal Models. Review the information with students to prepare them for the data analysis.
The data that students will analyze is from self-administration experiments. In these experiments, the rats go through a training period during which they learn that pressing a lever in the cage gives them a pellet of food. During this period, the rats also receive a dose of nicotine along with the food when they press the lever. Later, after the training period is over, the rats receive only the nicotine when they press the lever. During the training period, the rats have learned that pressing the lever results in a rewarding feeling from the drug. This rewarding feeling explains why the rats will continue to press the lever.

To make sure the rats in the experiment are treated appropriately, there are limits to the number of nicotine doses that the rats can get. This prevents the rats from overdosing. If students are concerned about the use of animals in scientific research, inform them that scientists must follow strict rules and protocols when they use the animals. For specific information about the regulations for use of animals in research, see the appendix.

2. Divide the class into teams of three students. Give a copy of Master 3.2, Analyzing Scientific Data: Experiment 1, to each student in half the groups. Give each student in the other groups a copy of Master 3.3, Analyzing Scientific Data: Experiment 2. Ask students to work with their team members to examine their graphs and answer the questions that follow.

As students work, circulate around the room to answer any questions students may have. Allow approximately 5–10 minutes for this analysis.

Note: If time permits, have all teams analyze both graphs.

3. Hold a class discussion in which groups present their graph to the rest of the class and explain it to the other teams.

As the teams explain their graphs, display a transparency of the corresponding graph so all students can see the data. Because multiple teams will analyze each graph, ask other teams to share their interpretations, too. If teams interpret the graphs differently, work through the data on the graph to resolve discrepancies.

Sample Answers to Items on Master 3.2, Analyzing Scientific Data: Experiment 1

1. What is the difference between the two groups of rats in this experiment?

The difference between the groups is the age at which they were trained and the data were collected. The adolescent-group rats were adolescents both at the time of training and when the scientists collected the experimental data.
2. What is the question that the scientists are trying to answer using these two groups?

Scientists are trying to answer the question, “Does the age at which rats are first exposed to nicotine have an effect on their desire to keep using nicotine?”

3. What is the average number of self-administered doses in the adolescent group?

The average number of doses in the adolescent group is 10.4. (Students should recognize that the group contains more than 1 rat, so the data are averaged for all individuals in the group. In actuality, there were 13 rats in the adolescent group.)

4. What is the average number of self-administered doses in the adult group?

The average number of doses in the adult group is 7.5. (The adult group consisted of seven rats.)

5. What conclusion can you make from these data?

Rats that were first given nicotine as adolescents self-administer more doses of nicotine than do rats that were first given nicotine as adults. The age at which rats are first exposed to nicotine influences their behavior toward nicotine.

Sample Answers to Items on Master 3.3, Analyzing Scientific Data: Experiment 2

1. What is the difference between the two groups of rats in this experiment?

The difference between the groups is the age when the rats were first exposed to nicotine. The adolescent rats were trained and first given nicotine as adolescents and then became adults before scientists collected the data shown here. The rats in the adult group were adults when they were trained and when first given nicotine. They were older adults when the scientists collected the data shown in the graph.
2. What is the question that the scientists are trying to answer using these two groups?

The question scientists are trying to answer is, “Does the age at which rats are first exposed to nicotine influence the desire to use nicotine later in life?” Another way to ask the question is, “Do rats that are first given nicotine as adolescents have a different response to nicotine as adults than do rats that don’t get nicotine until they are adults?”

3. What is the average number of self-administered doses in the adolescent group?

The average number of self-administered doses by rats in the adolescent group is 10.1. (The adolescent group consisted of six rats.)

4. What is the average number of self-administered doses in the adult group?

The average number of self-administered doses in the adult group is 5.1. (The adult group consisted of 10 rats.)

5. What conclusion can you make from these data?

Rats that were first given nicotine as adolescents self-administer more nicotine as adults than do rats that were not given nicotine until they were adults. The age at which rats are first exposed to nicotine can influence their behavior toward nicotine in a long-lasting way.

4. Display a transparency of Master 3.4, Drawing Conclusions from the Data. Read the introductory statements and then ask students to identify the statements that are best supported by the experimental data that they analyzed.

This is an opportunity for students to draw conclusions that are supported by scientific evidence. Statements 2 and 4 are best supported by the data:

2. Using drugs during adolescence can affect a person’s response to drugs later in life.

4. The response of an adolescent to drugs may be different from that of an adult.

Statement 1 is contradictory to the evidence in the data from both Experiments 1 and 2. Although Statements 3 and 5 may be true (at least to some degree), the data in the graphs do not address these issues. Statement 6 also is unsupported by the data.

If your students are accustomed to drawing conclusions from data, you may wish to have them state conclusions independently before you display Master 3.4.

5. Now that students recognize that scientific evidence supports the idea that there is a biological basis for an organism’s response to drugs, inform them that they will be watching another segment of the video to learn more about what is known about how human adolescents may be different from adult humans in their behaviors and responses to drugs.

If students have learned about the use of animals as models as part of their previous science training, they should understand that scientists can learn a great deal about how the human body functions by using appropriate animal models. Despite their value, however, it is important for scientists to also learn from studies that use humans when ethically appropriate. Even though animal models can provide valuable insight, there are...
often limitations. Scientists use what they have learned from animal models to further their investigations to learn about humans.

6. Give each student a copy of Master 3.5, *The Adolescent Brain and Drugs*. Inform students that their task while watching the video is to determine the main points that the video segment is trying to convey. In other words, students are to identify the “big ideas” presented in this video segment. Briefly review the master with students.

   Part 1 of the master provides space for students to write brief notes as they watch the video. Students do not need to write complete sentences. This part of the master is simply to help them jot down some ideas that they will use after the video is complete. Students will complete Part 2 of the master in Step 8.

7. Show Segment 3 of the video, *The Adolescent Brain and Drugs*, to the class.

   This segment is approximately 12 minutes long. If students wish, view specific segments again if it is helpful.

8. After students have watched the video, have them spend a few minutes completing Part 2 of Master 3.5. In this part, students should write a summary of the major messages contained in this segment of the video.

   Students should write two to four sentences that they believe are the big ideas of this segment of the video. You may wish to remind students that they will be able to refer to their work on this master when they do their final project.

**Observations from the Field Test:** In some classrooms, students found writing statements that summarized the video content challenging. As in Lesson 2, *Drug Addiction Is a Brain Disease*, this lesson asks students to write summary statements. Depending on how students fared in Lesson 2, you may wish to spend a few minutes going over examples of summary statements to help students improve their ability for the current lesson. The following sentences are based on content from Lesson 2:

   - Example 1: The big idea is drug addiction.
   - Example 2: Drugs change the way the brain works.
   - Example 3: Drug addiction is a brain disease because drugs change the way the cells in the brain function.

   Obviously, Example 1 is not very informative and does not provide any explanation related to the information in the video. Example 2 is better—it does accurately summarize a major idea from the video. However, it doesn’t provide any examples or supporting information. Example 3 is the most informative because it includes a summary statement and a rationale to support it.

9. Ask students to share their statements with the class. Record their statements on the board or an overhead transparency. After the statements have been recorded for the class to see, work with the class to review the statements for accuracy, clarity, and their effectiveness at capturing the big ideas presented in the video. Ask the class to work together to improve the statements that are not as informative or accurate as they could be.
This activity asks students to practice their critical-thinking skills and their ability to summarize information. It is also an opportunity for students to practice skills related to cooperative learning. Students should provide constructive critiques and make positive suggestions to improve the summary statements. For example, the statement, “Drugs may have different effects on adolescents than on adults because the adolescent brain is still developing,” has a bigger grain size than the statement, “Alcohol affects adolescents differently than adults.” Both statements are correct, but one represents a more complete idea and is more informative than the other.

10. **Instruct the students to save their copies of Master 3.5 for reference during Lesson 5, What Should Others Know?**

**Assessment Opportunity:** Listen to students’ reasons for suggesting specific changes to statements. This will enable you to assess their understanding of the content presented in the video.
At a Glance

Overview
Students begin this lesson by discussing their current knowledge about treatment for drug abuse and addiction. They then watch a segment of the video to learn more about treatment, relapse, and the stigma that can keep people who have a drug abuse or addiction problem from seeking help.

Major Concepts
Drug abuse and addiction, like other chronic diseases, can be treated effectively. The stigma associated with drug abuse and addiction and the frequency of relapse or recurrence often keep people from seeking treatment.

Learning Objectives
After completing this lesson, students will be able to
- name two possible components of effective treatment,
- describe how stigma may influence whether a person seeks treatment,
- explain how treatment for drug addiction is similar to treatment for other chronic diseases, and
- describe how relapse is a normal part of the disease of addiction.
Teacher Background

The following sections of Information about Drugs and the Brain are most relevant to this lesson:

- Drug Abuse, Addiction, and Stigma
- Treatment for Addiction
- Cravings
- Relapse
- Medications for Treating Drug Addiction
- The Effectiveness of Treatment for Addiction
- Treatment for Adolescents Who Have Problems with Drug Abuse and Addiction

In Advance

Materials

Drug Abuse, Addiction, and the Adolescent Brain DVD
- DVD player and projection system
- Overhead projector (optional)
- Overhead transparency (optional)
- Transparency pens (optional)

Photocopies

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<td>Master 4.1, Treating Drug Abuse and Addiction</td>
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Preparation

- Watch Segment 4 of the video, Treating Drug Abuse and Addiction, to familiarize yourself with the content.
- Prepare copies of masters.

Procedure

1. Begin this lesson by asking students to think about what they know or think about the treatment for drug addiction. Ask for volunteers to share their ideas with the class. List the students’ ideas on the board or an overhead transparency.

At this stage, accept all reasonable answers. Many students will have some ideas about treating addiction based on things they hear in the popular media. Some of this information is correct, and other information is probably not correct. Save the list of responses for later in this lesson.
Preconceptions about treatment may include the following:

- Treatment doesn’t work because celebrities (or other people) keep going back to rehab.
- Treatment isn’t necessary because people could just stop if they wanted to.
- People can take medicine to treat addiction.
- Treatment is just people talking about their drug use.
- Only morally weak people are addicts, so they can’t be helped.

These are examples of preconceptions that are incorrect or partially correct. Hopefully, some of the incorrect ideas (if students have them) are already diminishing after the first three lessons.

2. **Give each student a copy of Master 4.1, *Treating Drug Abuse and Addiction*. Briefly review how students should use Part 1 of the master to jot down notes as they watch the video.**

This master is similar to the previous one in that it provides a place for students to write a few words or phrases while they watch the video. The purpose is not for students to write statements from the video in word-for-word form, but rather to write key words or phrases that will help them remember important ideas for use in Part 2.

3. **Show Segment 4 of the video, *Treating Drug Abuse and Addiction*.**

This video segment is approximately 14 minutes long. Before you begin the video, you may want to introduce students to the word “chronic,” which is used in the video. Chronic describes a health condition as something that is long lasting, not something that goes away quickly like a cold.

4. **After the video is finished, allow a few minutes for students to write their summary paragraphs in Part 2 on Master 4.1.**

Students should write organized paragraphs using complete sentences. The first paragraph should include enough specific information to capture and support the main ideas presented in the video.

The second paragraph should connect the information in the video with a previous idea that students had about treatment. Students can relate the video to their own previous idea or to one from the class list developed at the beginning of the lesson. It doesn’t matter whether the previous idea was correct or incorrect. The paragraph that students write should explain how information in the video either supports the earlier idea or corrects a misconception.

5. **Ask for volunteers to read their paragraphs to the class. Lead a class discussion about how information in the video relates to the ideas about treatments that were listed in Step 1.**

This discussion can reinforce that a normal part of science is revising ideas and explanations on the basis of new information. For example, the fact that most treatments for addiction have concentrated only on what works for adults—not adolescents—is
probably new to students. They can now add this aspect of treatment to their understanding. (This lack of information about differences between adolescents and adults is now affecting how scientists are moving forward in their research and influencing the questions they are investigating.)

6. Instruct students to save their copies of Master 4.1 for reference during Lesson 5, *What Should Others Know?*
At a Glance

Overview

In this lesson, students review the ideas about drug abuse and addiction that they shared during Lesson 1, *Defining Drug Abuse and Addiction*, to assess if their understanding has changed. Students then prepare a project about the science of drug abuse or drug addiction, using the information they learned during the previous lessons.

Major Concepts

Learning the science about how drugs affect a person’s brain function can help dispel misconceptions. The ability to evaluate scientific and health-related information is an important skill for students that they can apply throughout their lives.

Learning Objectives

After completing this lesson, students will be able to

- synthesize what they have learned about the science of drug abuse and addiction from the previous lessons,
- consider how their scientific knowledge compares with common misconceptions about drug abuse and addiction,
- communicate their new understanding to others, and
- evaluate information about drug abuse and addiction that other students have compiled for accuracy and relevance.
Teacher Background

Because this is an Evaluate lesson, students will be synthesizing what they have learned in the previous lessons. Because they will not be learning new content, there is no new background information presented here. Refer to Information about Drugs and the Brain for more information.

In Advance

Materials

- Overhead projector
- Art supplies (chart paper, typing paper, construction paper, markers, glue sticks, scissors)
- Computers with slide-presentation software (See Preparation)

Photocopies

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<tr>
<td>Master 5.2, Project Scoring Sheet</td>
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Preparation

- Decide which formats (brochures, posters, computer presentations) will be acceptable for student projects. Projects can be completed on paper with art supplies, or students can use a computer with slide presentation software. The decision about project format will influence which supplies you will need to gather and prepare. When deciding on acceptable formats, remember that students will need to view the projects during the critique phase. If computer presentations are an option, the student “reviewers” will need to have either access to the onscreen presentation or printouts of the presentation.
- Locate the list of ideas about drug abuse and addiction that the class created at the beginning of Lesson 1.

Procedure

1. Post the list of ideas about drug abuse and addiction that students developed at the beginning of Lesson 1. Ask students whether they think all the items on their original list are correct on the basis of the science they now know about drug abuse and addiction. Place a checkmark beside any item that they now think may be incorrect.

   Students may have additional ideas or thoughts they wrote before the class discussion in Lesson 1 (that didn’t get added to the class list). Ask students to refer to their own papers if you want to expand the list.
2. Write the word “misconception” on the board. Ask students if they know what the word means. If students have difficulty with the word, provide the following definition:

**misconception:** An incorrect explanation or understanding.

Students don’t need to have an exact definition. If their own definition is correct, accept their wording. Make sure the entire class is using the same definition.

3. Ask the students, “Do the marked items on the list represent misconceptions about drug abuse and addiction?”

The marked items probably do represent misconceptions about drug abuse and addiction. There may be some that are partially correct, but if the overall meaning is not accurate, the statement would be incorrect.

For example, a common misconception about drug addiction is that everyone who is addicted to drugs will have withdrawal symptoms. Many people believe this is true because some people who are addicted experience withdrawal symptoms. But this statement is incorrect because withdrawal symptoms are just one of the seven signs of drug addiction. Recall from Lesson 1 that addiction is any three of the seven signs—a person who is addicted to a drug may have three of the other signs and not experience withdrawal.

4. Ask students if they can think of where misconceptions might come from or how people come to know information that is incorrect.

This is an opportunity for students to recognize that perhaps they should not believe everything they hear. Students may think of things that they have heard on television, from other people, or even from music videos. People sometimes pass on information when they aren’t sure it is correct. Other times, people may pass on information that is not complete. A possible example related to drug use is the statement, “Drinking alcohol every day is good for you.” There is some scientific evidence that certain types of wine may help prevent heart disease. However, this only applies to certain types of wine that a person drinks in limited amounts. Drinking alcohol, even moderately, increases the risk of accidents, and there are some people who should not drink wine at all. People may not intend to give inaccurate information, but sometimes after being repeated several times, the accuracy is sacrificed.

5. Ask, “Is it important to get accurate information about drug abuse and addiction out to people?” “Would it be important to tell others the correct information about drug abuse and addiction?”

Students should recognize that having the correct information is important. If students don’t respond this way, reinforce that other people probably have the same misconceptions about drug abuse and addiction that they had themselves before starting this module.

6. Explain to students that they will be putting together a project to inform other people about the science of drug abuse and addiction. Tell students the types of projects that will be acceptable. Explain that the emphasis needs to be on the science of drug abuse and addiction.
You can decide what limits you want to put on the type of product the students produce. For example, if you feel it is easier for all students to make posters, limit their choice to that format.

7. **Display a copy of Master 5.1, *Rubric for Evaluating the Projects*, on the overhead projector.** If students have not used rubrics before, explain that a rubric is a guide that will be used to evaluate their final product. Inform students that knowing what is on the rubric should help them know what to pay attention to while creating their projects.

   A rubric has specific criteria that will be used to judge the final project. By knowing ahead of time the criteria that will be used for judging or evaluating the final product, students can take responsibility for their work.

   Explain to students that they will use information they have learned from the previous lessons to construct their projects. This is not an assignment where students do additional research. Rather, it is their opportunity to demonstrate what they have learned from the activities and the video.

8. **Review with students each of the categories on the rubric.** Point out the different point values that apply to each category and the criteria that justify each score. As you review each category and set of criteria, explain to students what each of the criteria means.

   Point out to students that the rubric is divided into two parts—one for content and one for appearance. The point range is different for each of these two parts to reflect the idea that the science content (including accuracy and a clear message) is the higher priority for the project but that creating a product with a pleasing appearance is also important to encourage others to read it.

   Also, as you review each of the criteria, you may want to discuss certain points that may be more challenging for students. You may want to confirm that students understand what is meant by main message and supporting facts. The main message is the big idea or “take-home” message that the project is trying to convey. In a sense, it is a summary statement. Supporting facts are specific pieces of information that serve as evidence for the main message. Students must include appropriate and correct supporting facts to earn a better score for the project. You can also demonstrate how to use the rubric to assign scores. For example, one criterion in the content category asks students to consider the accuracy of information presented in the project. In each column, bullets give guidance that students can use to determine whether a score of 5, 3, or 1 is most appropriate.

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**Observations from the Field Test:** Some students seemed to feel that “filling up the page” with information made the brochure better. This is not a criterion on the rubric. The purposes of this activity are for students to synthesize and summarize the important concepts that they have learned in the previous lessons. Students demonstrate their understanding by identifying a main message and including supporting facts that explain the message. Students do not need to include every piece of information from the four previous lessons.
9. **Spend a few minutes brainstorming with the students about topics that may be appropriate for the main message.** Students should understand that the topic they choose should focus on the science of drug abuse or addiction.

Keep this discussion focused and short. The purpose of the discussion is to give students a starting point for thinking about ideas for their projects. You don’t want to brainstorm at the level of individual facts, but rather at the categories of information that might be important to include. Encourage students to use a sentence to express their ideas for the project instead of using a simple phrase. By using a complete sentence, the idea becomes more informative. An example is provided:

Uninformative topic phrase: Drug abuse and addiction

More informative main message: Drug addiction is different from drug abuse.

More examples are provided in the table in Step 10 to help students refine their ideas after they have had a chance to begin planning their projects.

10. **Allow students to begin working on their projects.** Students should begin by deciding on a message that will be the focus of their projects. Inform students that they can refer to any of the masters that they completed in Lessons 1–4 for ideas.

Students can either work independently or in a small group. Ask students not to put their names or identifying information on the project. You can assign them a code so you know who created each project.

You may want to have students spend a few minutes developing a basic idea or outline that you review before they add all the detail and supporting evidence. When you review the outline for the students’ projects, assess whether the ideas are appropriate for the main message. The table lists ideas that are too broad, vague, or off topic to use for a main message or big idea; it also lists modifications of those topics that would be appropriate. Notice that the more-appropriate topics are statements—not just nouns or phrases. To help students go from the broad or vague topic to a more refined and appropriate statement, ask them what it is about drug abuse or addiction, for example, that they think is important for people to know. If they focus on specific facts, prompt them to think about why a fact is important or interesting, as a way to help them verbalize the bigger idea.

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<thead>
<tr>
<th>Topics That Are Too Broad or Vague</th>
<th>More-Appropriate Topics for the Project</th>
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<tbody>
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<td>Drug abuse and addiction</td>
<td>Drug abuse and addiction have specific definitions and signs.</td>
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<td>Drugs and the brain</td>
<td>Drugs change the way the brain works. or Addiction is a brain disease.</td>
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<td>Making the right choice about drugs</td>
<td>Drug use may affect adolescents differently from adults.</td>
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<td>Information about a variety of specific drugs (e.g., everything about</td>
<td>Drugs change the biology of the brain to influence a person’s thoughts,</td>
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<td>cocaine—or another drug)</td>
<td>feelings, and actions.</td>
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<tr>
<td>Treatment for drug addiction</td>
<td>Drug addiction can be treated effectively.</td>
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11. As students work on their projects, circulate among the teams to monitor their progress.

As you circulate among teams, ask questions that may help students stay focused. If you notice problems on a project, ask students how the information on the project fulfills the criteria on the scoring rubric. You may also ask students to explain what the main message is and how the supporting facts relate to that main message. It may be helpful to ask students to recall a specific activity or segment of the video that discussed the points they are making. Through discussion, you can assess the accuracy of their ideas and determine if they are interpreting the information correctly.

12. After students have finished their projects, explain that an important part of science is something called peer review. Students are going to model peer review by reviewing each other’s final projects.

A person’s peer is someone who is equal in rank or status. In this case, other students in the class are peers. Peer review in science is when the scientist’s work is reviewed by another scientist who has an understanding of the scientific topic. The purpose of peer review is to make the scientist’s project or paper better. A review should not only identify problems but suggest ways to improve the work.

13. Give each student a copy of Master 5.1, Rubric for Evaluating the Projects, and a copy of Master 5.2, Project Scoring Sheet. Briefly review the information on the scoring sheet. Make sure students understand how to use the rubric and scoring sheet together.

Assign each student a project to evaluate.

The evaluation is the primary reason for not having students’ names on the individual projects. The assignment of an identifying code to each project enables you to identify who worked on each project, but minimizes the tendency of some students to assign inappropriate scores during the critique simply because of who worked on that project. Obviously, students should not review their own work. It is probably best if students work individually on the critique. In that way, you can assess each individual’s understanding.

Emphasize for students that they will need to make specific suggestions or corrections during their evaluation. If they identify a fact as incorrect, they should explain why it is wrong and suggest how to make it correct. If they score a project low on a specific criterion, they should explain why they thought it was a problem.

Note: Even with the use of codes, students are likely to know who worked on a given project. If you have more than one class section, students can evaluate projects done by students in another class. However, even if students do figure out who the authors of a project are, this task should help students practice skills of cooperative learning. Remind students, if necessary, that the critique is to be based on the information in the project, and that their task is to point out problems and make appropriate suggestions that would improve the clarity of the message or the accuracy of the facts.
To improve the health and well-being of humans and other animals, scientists must do experiments. Sometimes, research is best advanced by using a variety of animal species. Animals used for research must be treated humanely. Scientists who use animals are required to abide by strict federal policies that govern the use and care of vertebrate animals in research. The Public Health Service (PHS), part of the United States Department of Health and Human Services, has established a policy that dictates specific requirements for animal care and use in research. This policy conforms to the Health Research Extension Act of 1985 (Public Law 99-158) and applies to all research, research training, biological testing, and other activities that involve animals.

Whenever scientists use vertebrate animals for research, they must adhere to the following principles for their use and care.

- The transportation, care, and use of animals should be in accordance with the Animal Welfare Act (7 U.S.C. 2131 et. seq.) and other applicable Federal laws, guidelines, and policies.
- Procedures involving animals should be designed and performed with proper consideration of their relevance to human or animal health, the advancement of knowledge, or the good of society.
- The animals selected for a procedure should be of an appropriate species and quality. Experiments need to be designed to use the minimum number of animals to obtain valid results. Methods such as mathematical models, computer simulation, and in vitro biological systems should be used if appropriate.
- Procedures should minimize discomfort, distress, and pain to the animals.
- Procedures with animals that may cause more than momentary or slight pain or distress should be performed with appropriate sedation, analgesia, or anesthesia.
- Animals that would otherwise suffer severe or chronic pain or distress that cannot be relieved should be painlessly euthanized.
- The living conditions of animals should be appropriate for their species, and contribute to their comfort and health. The housing, feeding, and care of all animals used for biomedical purposes must be directed by a veterinarian or other trained, experienced scientist.
■ Investigators and other personnel shall be appropriately qualified and experienced for conducting procedures on living animals.
■ Exceptions to any of these principles must be reviewed and approved by an appropriate committee prior to the procedure.
■ An Institutional Animal Care and Use Committee (IACUC) oversees all animal use in each institution where animal research is conducted. The IACUC must give approval for the research plan and species to be used. IACUCs include both scientists and nonscientists from the institution and other outside groups. Nonscientists are often representatives of humane organizations.

For more information about the use of animals in research, refer to the following Web sites:
■ The Office of Laboratory Animal Welfare: http://grants.nih.gov/grants/olaw/olaw.htm
■ The National Academies, The Guide for the Care and Use of Laboratory Animals: http://www.nap.edu/readingroom/books/labrats/
Definitions for the following terms were adapted from a variety of sources. Specific sources are listed in the reference section.

**addiction:** A chronic brain disorder characterized by the continued, uncontrollable, compulsive use of drugs in spite of negative health, legal, or social consequences. Addiction is characterized by relapses during recovery. Medically, drug addiction (dependence) requires a person to have any three of seven specific signs during a one-year period. (See *Defining Drug Abuse and Addiction* in *Information about Drugs and the Brain* for more details.)

**alcohol:** A psychoactively complex drug in beverages such as beer, wine, and whiskey. Alcohol is a depressant drug with potential for abuse and addiction.

**amphetamine:** Stimulant drugs whose effects are very similar to cocaine.

**axon:** The fiber-like extension of a neuron by which the cell carries information to target cells.

**axon endings (or axon terminals):** The structure at the end of an axon that produces and releases chemicals (neurotransmitters) to transmit the neuron’s message across the synapse.

**brainstem:** The major route by which the forebrain sends information to, and receives information from, the spinal cord and peripheral nerves.

**caffeine:** A mild stimulant found in coffee and kola nuts. Caffeine is the most widely used drug in the world.

**cannabis:** The botanical name for the plant from which marijuana comes.

**cell body:** The central structure of a neuron, which contains the cell nucleus. The cell body contains the molecular machinery that regulates the activity of the neuron. The cell body is sometimes called the soma.

**central nervous system:** The brain and spinal cord.

**cerebellum:** A portion of the brain that helps regulate posture, balance, and coordination.

**cerebral cortex:** The outer layer of the cerebral hemispheres that controls conscious experience, including perception, emotion, thought, and planning.

**cerebral hemispheres:** The two specialized halves of the brain. The left hemisphere is specialized for speech, writing, language, and calculation; the right hemisphere is specialized for spatial abilities, face recognition in vision, and some aspects of music perception and production.

**cerebrum:** The upper part of the brain consisting of the right and left hemispheres.
**chronic:** Refers to a disease or condition that persists over a long period of time.

**cocaine:** A highly addictive drug derived from the coca plant that produces profound feelings of pleasure.

**craving:** An intense desire or hunger for drugs. It is caused by drug-induced changes that arise from a need of the brain to maintain a state of homeostasis that includes the presence of the drug.

**dendrite:** The specialized branches that extend from a neuron’s cell body and function to receive messages from other neurons.

**diencephalon:** The region of the brain which includes the thalamus and hypothalamus.

**dopamine:** The neurotransmitter that produces feelings of pleasure when released by the brain reward system.

**drug:** A chemical compound or substance that can alter the structure and function of the body. Psychoactive drugs affect the function of the brain, and some of these may be illegal to use and possess.

**drug abuse:** Any use of illegal drugs or the inappropriate use of legal substances. The repeated use of drugs to produce pleasure, to reduce stress, or to alter or escape reality (or all three). For a medical diagnosis of drug abuse, a person experiences one or more of four key signs during a one-year period. (See Defining Drug Abuse and Addiction in Information about Drugs and the Brain for more details.)

**drug addiction:** See addiction.

**ecstasy (MDMA):** A chemically modified amphetamine that has hallucinogenic as well as stimulant properties.

**forebrain:** The largest division of the brain, which includes the cerebral cortex and basal ganglia. It is credited with the highest intellectual functions.

**frontal lobe:** One of the four divisions of each cerebral hemisphere. The frontal lobe is important for controlling movement and associating the functions of other cortical areas.

**glial cells (glia):** Brain cells that support neurons by performing a variety of functions in the brain. Scientists are learning more about additional roles that glia fulfill in the nervous system.

**heroin:** The potent, widely abused opiate that produces addiction. It consists of two morphine molecules linked together chemically.

**hippocampus:** A brain structure that is involved in emotions, motivation, learning, and memory.

**hypothalamus:** The part of the brain that controls many bodily functions, including feeding, drinking, and the release of many hormones.

**inhalant:** Any drug administered by breathing in its vapors. Inhalants commonly are organic solvents, such as glue and paint thinner, or anesthetic gases, such as ether and nitrous oxide.

**limbic system:** A set of brain structures that generates our feelings, emotions, and motivations. It is also important in learning and memory.

**magnetic resonance imaging (MRI):** An imaging technique that uses magnetic fields to take pictures of the structure of the brain.

**marijuana:** A drug, usually smoked but can be eaten, that is made from the leaves of the cannabis plant. The main psychoactive ingredient is THC.

**medication:** A drug that is used to treat an illness or disease according to established medical guidelines.

**methadone:** A synthetic opiate used to treat cancer pain and heroin addiction.
methamphetamine: A commonly abused, potent stimulant drug that is part of a larger family of amphetamines.

morphine: The most potent natural opiate compound produced by the opium poppy. Morphine is a very effective medicine for treating pain.

myelin: Fatty material that surrounds and insulates axons of some neurons. Formed by the membranes of a specific type of glial cell.

neuron (nerve cell): A unique type of cell found in the brain and body that is specialized to process and transmit information.

neurotransmitter: A chemical produced by neurons to carry messages to other neurons.

neurotransmission: The process that occurs when a neuron releases neurotransmitters to communicate with another neuron across the synapse.

nicotine: The addictive drug in tobacco. Nicotine activates a specific type of acetylcholine receptor.

nucleus accumbens: A part of the brain reward system, located in the limbic system, that processes information related to motivation and reward. Virtually all drugs of abuse act on the nucleus accumbens to reinforce drug taking.

occipital lobe: The lobe of the cerebral cortex at the back of the head that includes the visual cortex.

opioids: Any of the psychoactive drugs that originate from the opium poppy or that have a chemical structure like the drugs derived from opium. Some opioids (such as opium, codeine, and morphine) are derived from the plant, while others were first synthesized by chemists.

parietal lobe: One of the four subdivisions of the cerebral cortex; it is involved in sensory processes, attention, and language.

phencyclidine (PCP): Originally developed as an anesthetic, PCP may act as a hallucinogen, stimulant, or sedative.

positron: A positively charged particle having the same mass and spin as, but opposite charge of, and electron.

positron emission tomography (PET): An imaging technique for measuring brain function in living subjects by detecting the location and concentration of small amounts of radioactive chemicals.

postsynaptic neuron: A neuron that receives messages from other neurons.

prefrontal cortex: The portion of the cerebral cortex at the front of the brain. It is involved with planning, decision-making, and controlling impulses and emotions.

presynaptic neuron: A neuron that releases neurotransmitters into synapses to send messages to other neurons.

psychoactive drug: A drug that changes the way the brain works.

psychosocial therapy: Therapy that uses a combination of individual psychotherapy and group (social) therapy approaches to rehabilitate or provide the interpersonal and intrapersonal skills an addict needs to live without drugs.

receptor: A large molecule that recognizes specific chemicals (normally neurotransmitters, hormones, and similar endogenous substances) and transmits the message carried by the chemical into the cell on which the receptor resides.

relapse: In drug abuse, relapse is the resumption of drug use after trying to stop taking drugs. Relapse is a common occurrence in many chronic disorders, including addiction, that require behavioral adjustments to treat effectively.
**reuptake**: The process by which neurotransmitters are removed from the synapse by being “pumped” through transporters back into the axon endings that first released them.

**reward**: The process that reinforces behavior. It is mediated at least in part by the release of dopamine into the nucleus accumbens. Human subjects report that reward is associated with feelings of pleasure.

**reward system (or reward center)**: A brain circuit that, when activated, reinforces behaviors. The circuit includes the dopamine-containing neurons of the ventral tegmental area (VTA), the nucleus accumbens, and part of the prefrontal cortex. The activation of this circuit causes feelings of pleasure.

**rush**: Intense feelings of euphoria a drug produces when it is first consumed.

**serotonin**: A neurotransmitter that regulates many functions, including mood, appetite, and sensory perception.

**stigma**: a negative image about something that isn’t always based on fact.

**synapse**: The site where presynaptic and postsynaptic neurons communicate with each other.

**synaptic pruning**: The elimination of weak or redundant connections between neurons.

**synaptic space (or synaptic cleft)**: The intercellular space between the presynaptic and postsynaptic neurons.

**temporal lobe**: One of the four major subdivisions of each hemisphere of the cerebral cortex. It functions in auditory perception, speech, and visual perceptions.

**thalamus**: Located deep within the brain, the thalamus is the key relay station for sensory information flowing into the brain, filtering out important messages from the mass of signals entering the brain.

**tolerance**: A physiological change resulting from repeated drug use when the user either does not feel as intense a high from the same amount of drug or the user must take larger amounts of the drug to get the same effect initially felt from a smaller dose.

**transporter proteins**: Large proteins that carry neurotransmitter molecules back into the axon terminals that released them. Sometimes called reuptake pumps.

**ventral tegmental area (VTA)**: The group of dopamine-containing neurons that make up a key part of the brain reward system. These neurons extend axons to the nucleus accumbens and the prefrontal cortex.

**vesicle**: A membranous sac within an axon ending that stores and releases neurotransmitter.

**withdrawal**: Physical symptoms in the body and brain that occur when a person who is physically dependent stops using the drug or the need to take drugs to avoid physical symptoms.


The following resources may provide additional background information for you or your students about drugs of abuse, addiction, and neurobiology.

Resources on the World Wide Web

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

http://www.nida.nih.gov/

NIDA is the world’s leading supporter of research on the health aspects of drug abuse and addiction. This site provides current and authoritative information about the latest research on drugs and addiction. One of the adolescent-centered components of the NIDA Web site is *NIDA for Teens* (http://teens.drugabuse.gov), where students in grades 5–9 can find more age-appropriate information about the biology underlying drug abuse.

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

http://ncadi.samhsa.gov/

NCADI is part of the U.S. Department of Health and Human Services and functions as the information service for the Center for Substance Abuse Prevention. NCADI is the world’s largest resource for current information and materials concerning substance abuse. At this site, you may obtain information about alcohol and other drugs.
Office of National Drug Control Policy
http://www.whitehousedrugpolicy.gov/

The purpose of the Office of National Drug Control Policy (ONDCP) is to establish policies, priorities, and objectives for the nation’s drug control program. The National Drug Control Strategy is available on this Web site. This site also provides information about specific drugs (including statistics on their use), treatment, research, and enforcement.

National Institute on Alcohol Abuse and Alcoholism (NIAAA)
http://www.niaaa.nih.gov/

NIAAA is the institute within the National Institutes of Health that provides leadership in the national effort to reduce alcohol-related problems. The NIAAA Web site provides a wide range of information related to alcohol use and abuse.

Society for Neuroscience
http://www.sfn.org/

The Society for Neuroscience is the world’s largest organization of scientists and physicians dedicated to understanding the brain, spinal cord, and peripheral nervous system. This site provides a wide variety of information on topics related to the function of the brain and nervous system. The site also provides an opportunity to submit a specific question that may be answered by a neuroscientist.

Partnership for a Drug-Free America
http://www.drugfree.org/

The Partnership for a Drug-Free America’s Web site includes information about specific drugs and their effects.

United States National Library of Medicine
http://www.nlm.nih.gov/

The U.S. National Library of Medicine is the world’s largest medical library. This site provides extensive online information about health issues. This includes access to Medline and MedlinePlus to search for the information about specific health topics.
Office of Science Education
http://science.education.nih.gov/

This address takes you directly to the home page of the National Institutes of Health’s Office of Science Education. This site provides access to a variety of resources for teachers and students, including NIH publications on drug abuse and brain function.

The Dana Foundation
http://www.dana.org/

The Dana Foundation is a private philanthropic foundation with principal interests in health and education. Its Web site provides information for the public on the latest research findings about the brain and brain disorders. The Web site also provides access to its publications.

The Reconstructors
http://reconstructors.rice.edu/

This Web game enables students to learn more about the history of opioids, their use in pain management, and the neuroscience underlying their actions. The activities incorporate aspects of chemistry, neuroscience, medicine, public policy, and history.

Books and Video


Image Credits

Lesson 1:
- Person in Shadow Holding Cigarette Dreamstime/Allein
- Person in Shadow Holding an Alcoholic Drink iStockphoto/Knud Nielsen

Teacher Background:
- Teenagers Playing Basketball Dreamstime/Lorraine Swanson
- Teenager on Bike iStockphoto
- Teenagers Shopping PhotoDisc
- Physician with Patient EyeWire
- Human Brain with Words of Functions Dreamstime/Sebastian Kaulitzki
- Teenagers Walking in Hallway Comstock
- Brain showing the reward system National Institute on Drug Abuse, The Brain & the Actions of Cocaine, Opiates, and Marijuana (Teaching Packet)
- Neurons Dreamstime/Monica Wisniewska
- PET Imaging Equipment Corbis
- Teen Talking on Cell Phone While Driving Dreamstime/David Smith
- Teen Drinking and Driving Dreamstime/Vladimir Mucibabic
- Teenagers Walking on Railroad Tracks PhotoDisc
- Human Brain Dreamstime/Sgame
- Teenager with Therapist PhotoDisc
- Ice Cubes in a Glass Dreamstime/Csaba Peterdi

Facilitation Guide:
- Adults in a Discussion Group Dreamstime/Kirill Zdorov

Video:
- Microarray Analysis of Cocaine Withdrawal J.R. Walker and D. W. Self
Refer to the Photocopies section in each lesson for more information about the number of copies required for each master.

**Lesson 1, Defining Drug Abuse and Addiction**
Master 1.1, Is It Abuse or Addiction? ................................................................. student copies
Master 1.2, Is There a Problem? ................................................................. team copies

**Lesson 2, Drug Addiction Is a Brain Disease**
Master 2.1, Addiction ................................................................. transparency
Master 2.2, Definition of Disease ................................................................. transparency
Master 2.3, What Is the Evidence? ................................................................. student copies

**Lesson 3, The Adolescent Brain and Drugs**
Master 3.1, Learning from Animal Models ........................................................ transparency
Master 3.2, Analyzing Scientific Data: Experiment 1 ..................................... transparency, student copies
Master 3.3, Analyzing Scientific Data: Experiment 2 ..................................... transparency, student copies
Master 3.4, Drawing Conclusions from the Data ................................................ transparency
Master 3.5, The Adolescent Brain and Drugs ................................................ student copies

**Lesson 4, Treating Drug Abuse and Addiction**
Master 4.1, Treating Drug Abuse and Addiction ............................................ student copies

**Lesson 5, What Should Others Know?**
Master 5.1, Rubric for Evaluating the Projects ............................................. transparency, student copies
Master 5.2, Project Scoring Sheet ................................................................. student copies

**Adult Facilitation**
*Drug Abuse, Addiction, and the Adolescent Brain* brochure ................................. participant copies
*Drug Abuse, Addiction, and the Adolescent Brain* brochure (Spanish version) .... participant copies
Read your case study and use the following information to decide whether the person has a problem with drug abuse or drug addiction. Analyze the case study using both definitions.

## Drug Abuse (Substance Abuse)

### Definition 1: The Medical Definition of Drug Abuse

To be diagnosed with a **drug abuse** problem as a medical condition, the person would answer yes to at least one of the following four questions about his or her drug use during a **one-year** time period. Which signs does the person in your case study show?

<table>
<thead>
<tr>
<th>Key Sign</th>
<th>Sign of Drug Abuse</th>
<th>Is This Sign Present?</th>
<th>Evidence from Case Study Related to This Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Is the drug use causing the person to have problems at school, work, or home?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Is drug use causing the person to do things that are risky or dangerous?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Is the person having problems with the law because of drug use?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Is the person having trouble dealing with other people, including family and friends because of drug use?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

Does the person in the case study fit Definition 1 for drug abuse? Explain your answer.
Definition 2: Alternate Definition of Drug Abuse

Drug abuse is any use of illegal drugs or the inappropriate use of legal substances to produce pleasure, ease stress, or escape reality (or all three).

Does the person in the case study fit Definition 2 for drug abuse? Explain your answer.

Can you think of things presented in the video that helped you reach your decision or that discussed similar issues?

(Continued)
Drug Addiction (Drug Dependence; Substance Dependence)

**Definition 1: The Medical Definition of Drug Addiction**

To be diagnosed with drug addiction, a person would show any three (or more) of the following seven signs during a one-year period. Which signs does the person in the case study show?

<table>
<thead>
<tr>
<th>Key Sign</th>
<th>Sign of Drug Addiction</th>
<th>Is This Sign Present?</th>
<th>Evidence from Case Study Related to This Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tolerance (either needing larger amounts of the drug to get the high or rush or having a less intense response to the same amount of the drug)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Withdrawal (experiencing physical symptoms when stopping use of the drug or needing to take the drug to avoid having physical symptoms)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Using larger amounts of drugs for a longer time</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Repeatedly trying to cut down or stop using the drug</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Spending most of the time trying to get more of the drug</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Spending less time in social, fun, school, or work activities</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>Continuing to use drugs even though the user knows that drugs are causing problems in life</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Does the person in the case study fit Definition 1 for drug addiction? Explain your answer.
Is It Abuse or Addiction?

**Definition 2: Alternate Definition for Drug Addiction**

Drug addiction is the continuing, compulsive use of drugs in spite of negative health, legal, or social consequences.

Does the person in the case study fit Definition 2 for drug addiction? Explain your answer.

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Can you think of things presented in the video that helped you reach your decision or that discussed similar issues?

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________________________________________________________________________
Case 1
A 12-year-old girl is having trouble in school. She used to get mostly Bs on her report card, but now she has trouble even getting Cs. She hangs out after school with her friends. A couple of months ago, she and her friends started taking cough syrup that they bought at the drugstore. They liked the way the cough syrup makes them feel, so they kept doing it every few days. The cough syrup got expensive, so they tried taking it from the store. The store security cameras caught them, and the police charged them with shoplifting. After getting caught, all of them quit using the cough syrup.

Case 2
A 10-year-old boy and his friends are at home one day. While messing around, they find a can of paint thinner in the garage. They decide to huff it to see how it makes them feel. After they used it, the boy felt stimulated at first. Then he felt very relaxed. His friends started to worry when they noticed that he was having trouble talking clearly and was very sleepy. One of the friends felt sick to his stomach.

Case 3
A 15-year-old girl smokes marijuana. When she started smoking marijuana, she only did it at parties about once every month or two. Then she started smoking it more often. For the last six months, she has been smoking about two or three times a week. She is mad at some of her friends because they don’t like being around her when she is high. Her parents even found out that she had stolen money out of her mom’s purse. When she tried to stop smoking the marijuana, she had trouble sleeping, was anxious about everything, and got mad at people easily. She doesn’t like those feelings, so she started smoking again.

Case 4
A 14-year-old boy tried ecstasy with his friends about a year ago. He thought it would make him feel cool because he knows some older kids who have used it. He didn’t like it very much, so he never tried it again.
Is There a Problem?

Case 5
A 16-year-old girl uses cocaine almost every day. She started using the drug at parties with her friends. Now, she mostly uses by herself. Her friends don’t want to be around her anymore. She is also taking more of the drug at a time because that is the only way she can get the same high that she got when she first started taking the drug. Because of this need for more of the drug, she is always wondering where she will get the next fix. Her parents found out that she uses cocaine and were mad. She and her parents argue several times a week about her drug use. She promised her parents that she will stop using cocaine, but every time she tries to quit, she ends up using again. When she hasn’t taken the drug for a while, all she thinks about is when she will take it next. When she wants it really badly, she can’t help herself from taking it again.

Case 6
A 15-year-old boy drinks alcohol several times a week. He started by drinking beer when he was 12, but now he would rather drink hard liquor because he can feel its effects faster. He is missing school about one day each week because he wakes up with headaches or not feeling well. Even when he is at school, he has trouble paying attention on the days after he has been drinking. When his friends try to talk to him about how much he is drinking, he promises to cut down or quit. He knows that his drinking is causing his problems at school. His boss may fire him because he has missed work several times. But so far, he can’t seem to quit. He’s actually drinking more at a time than he was before. When things get stressful, the only thing he wants is a drink—and he just can’t seem to stop himself.

Case 7
A 13-year-old fell off her bike and sprained her ankle. The doctor told her to keep it wrapped in an elastic bandage. The doctor also explained to her and her parents that she could take an over-the-counter medicine to help keep the swelling down. One afternoon, the girl found a prescription pain medicine that her father sometimes takes for severe back pain. She decided to try it. Even after her ankle got better, she took her father’s prescription medicine because she liked the way it made her feel. For a couple of months, she used it once or twice a week. She didn’t think her parents knew she was taking the pills, but one night she heard them talking about how they couldn’t explain why there were only a few pills left in the bottle.
Addiction is a brain disease.

Number of Students:  

True  False
A disease is a problem in which some part or parts of the body do not function normally in a way that interferes with a person’s life.
What Is the Evidence?

Part 1
Your task while watching the video is to identify the evidence that supports the view that addiction is a brain disease. Use the space below to write some notes as you watch the video. You do not need to write complete sentences. Just write words or short phrases that will help you remember the ideas.

__________________________________________________________________________

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Part 2
After watching the video, write a few sentences to summarize what you learned from the video. Your sentences should focus on the evidence that supports addiction as a brain disease. Your sentences should also describe how that evidence supports addiction as a brain disease.

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Scientists often use animals to study things that would not be appropriate to study in humans. They also use animals to do studies that help them get preliminary information that will guide later studies in humans.

In the experiments that you will analyze, the scientists used rats as a model system. In these experiments, scientists wanted to study the effects of nicotine. First, the scientists trained the rats to press a lever in the cage. At first, the rats got a pellet of food and a dose of nicotine when they pressed the lever. During this training period, the rats learned that pressing a lever gave them a reward (food and nicotine). Later, when the scientists were doing the experiments, the rats got only a dose of nicotine when they pressed the lever. The rats could continue to press the lever to get another dose of nicotine. The number of times a rat presses the lever during the experimental phase indicates how rewarding the nicotine is to the rat. This type of experiment is called a self-administration experiment because the rat’s behavior determines how many doses of nicotine it gets.
The following graph shows the average number of times the rats pressed the lever to get a dose of nicotine. Use the information in the graph to answer the questions that follow.

1. What is the difference between the two groups of rats in this experiment?

2. What is the question that the scientists are trying to answer using these two groups?

3. What is the average number of self-administered doses in the adolescent group?

4. What is the average number of self-administered doses in the adult group?

5. What conclusion can you make from these data?
The following graph shows the average number of times the rats pressed the lever to get a dose of nicotine. Use the information in the graph to answer the questions that follow.

1. What is the difference between the two groups of rats in this experiment?

2. What is the question that the scientists are trying to answer using these two groups?

3. What is the average number of self-administered doses in the adolescent group?

4. What is the average number of self-administered doses in the adult group?

5. What conclusion can you make from these data?
If the response of humans to drugs is similar to that of the rats, which of these statements would you predict to be correct?

1. The effect of drugs on an adolescent is not different than on an adult.

2. Using drugs during adolescence can affect a person’s response to drugs later in life.

3. Using nicotine as an adolescent is harmful because nicotine can cause health problems later in life.

4. The response of an adolescent to drugs may be different from that of an adult.

5. Using nicotine as an adolescent can lead to the use of other drugs.

6. Scientists cannot predict anything about the effects of drugs on humans from studying rats.
The Adolescent Brain and Drugs

Part 1
While you watch the video, write notes about the big ideas of the video. Write words or phrases that will help you remember the big ideas. You do not need to write complete sentences in this part.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Part 2
After watching the video, write two to four sentences that state the big ideas of the video.

1. ______________________________________________________________________

________________________________________________________________________

2. ______________________________________________________________________

________________________________________________________________________

3. ______________________________________________________________________

________________________________________________________________________

4. ______________________________________________________________________

________________________________________________________________________
Part 1
While you watch the video, write notes about the big ideas of the video. Write words or phrases that will help you remember big ideas. You do not need to write complete sentences.

Part 2
After you watch the video, write two paragraphs about treatment for drug addiction. The first paragraph should summarize the big ideas presented, including examples that support the big ideas. The second paragraph should focus on how information in this part of the video compares with an idea you had about treatment before watching the video. (Use additional paper to write your paragraph.)
# Rubric for Evaluating the Projects

<table>
<thead>
<tr>
<th>Content</th>
<th>Excellent (5 Points)</th>
<th>Good, but Could Be Improved (3 Points)</th>
<th>Needs a Lot of Improvement (1 Point)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The project has one clear idea or message.</td>
<td>- The main message of the project is very clear.</td>
<td>- The main message of the project is somewhat clear.</td>
<td>- The main message of the project is not clear at all.</td>
</tr>
<tr>
<td></td>
<td>- The project focuses on a single idea.</td>
<td>- The project’s theme is all right, but it includes more than one main idea.</td>
<td>- The ideas are not focused on a single theme. The project includes too many different ideas.</td>
</tr>
<tr>
<td></td>
<td>- The message and supporting facts relate to the information in the lessons.</td>
<td>- Some of the facts are not related to the information in the lessons.</td>
<td>- The idea is not related to the information in the lessons.</td>
</tr>
<tr>
<td>The project’s message is important for people to know.</td>
<td>- The main message is very important for people to understand.</td>
<td>- The main message is somewhat important for people to understand, but not the most important thing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- There are no spelling or grammar errors in the project.</td>
<td>- The project only includes one fact that supports the main message.</td>
<td>- The project does not include facts to support the main message.</td>
</tr>
<tr>
<td></td>
<td>- The facts that support the message are accurate.</td>
<td>- Some important facts that would support the message are missing.</td>
<td>- Most of facts that support the message are not accurate (are wrong).</td>
</tr>
<tr>
<td>The project includes accurate information.</td>
<td>- The main message of the project is supported by two or more facts.</td>
<td>- Some of the facts are not accurate (are wrong).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The facts that support the message are accurate.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appearancen</td>
<td><strong>Excellent (3 Points)</strong></td>
<td>Good, but Could Be Improved (2 Points)</td>
<td>Needs a Lot of Improvement (1 Point)</td>
</tr>
<tr>
<td>The project is well written.</td>
<td>- There are no spelling or grammar errors in the project.</td>
<td>- There are only a few spelling or grammar errors in the project.</td>
<td>- There are many spelling and grammar errors in the project.</td>
</tr>
<tr>
<td>The project looks nice.</td>
<td>- The project uses art and color nicely.</td>
<td>- The project’s use of art and color could be improved.</td>
<td>- The project does not use art or color well.</td>
</tr>
<tr>
<td></td>
<td>- The project is very neat.</td>
<td>- The project is a little sloppy.</td>
<td>- The project is very sloppy.</td>
</tr>
</tbody>
</table>
Using the information on the rubric, assign a score for each category. Then give a specific reason (or reasons) to explain the score you gave. If a statement is wrong, indicate what it should say to be correct. If something important is missing, describe what should be added and why. The reasons you give and the corrections you make are more important than the score you assign.

The ID code for the project I am evaluating is ________________.

<table>
<thead>
<tr>
<th>Content Category</th>
<th>Score (Circle number.)</th>
<th>Reason for Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>The project has one clear idea or message.</td>
<td>5 3 1</td>
<td></td>
</tr>
<tr>
<td>The project’s message is important for people to know.</td>
<td>5 3 1</td>
<td></td>
</tr>
<tr>
<td>The project includes accurate information.</td>
<td>5 3 1</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>The project looks nice.</td>
<td>3 2 1</td>
<td></td>
</tr>
</tbody>
</table>

Total Score

(Add the circled numbers to get the total score.)

1. What is the best thing about this project?

2. What suggestions do you have for improving this project?
“It’s very clear, after decades of brain research, that addiction is a biological disease that results from changes in the brain. It’s not a mystery.”

Drug Abuse, Addiction, and the Adolescent Brain is designed for middle school science classes. Features of the module include:

- Five classroom lessons that focus on the science of how drugs affect the brain.
- An integrated video with:
  - interviews by
    - leading scientists in the area of drug abuse research
    - treatment experts
    - recovering drug addicts
  - animations illustrating the effects of drugs
- A facilitation guide for presenting the video to adult audiences.

U.S. Department of Health and Human Services
NATIONAL INSTITUTES OF HEALTH
NIDA NATIONAL INSTITUTE ON DRUG ABUSE