Understanding Alcohol: Investigations into Biology and Behavior

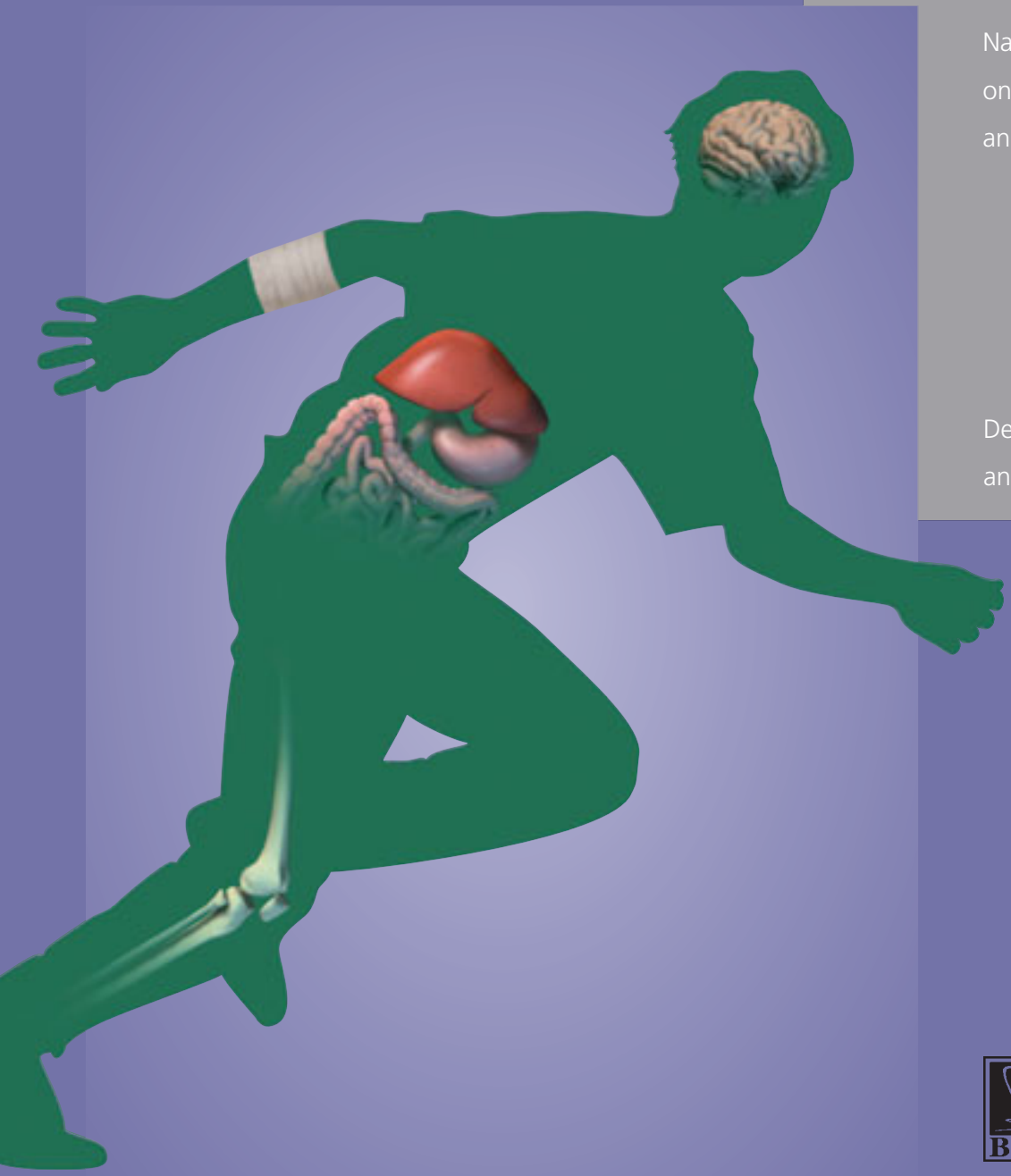
NIH Curriculum Supplement Series

Grades 7-8

National Institutes of Health

National Institute on Alcohol Abuse and Alcoholism

Department of Health and Human Services



BSCS

Understanding Alcohol: Investigations into Biology and Behavior

under a contract from the
National Institutes of Health

National Institute on Alcohol Abuse and Alcoholism

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Contents

Foreword

This curriculum supplement, from *The NIH Curriculum Supplement Series,* brings cutting-edge medical science and basic research discoveries from the laboratories of the National Institutes of Health (NIH) into classrooms. As the largest medical research institution in the United States, NIH plays a vital role in the health of all Americans and seeks to foster interest in research, science, and medicine-related careers for future generations. The NIH Office of Science Education (OSE) is dedicated to promoting science education and scientific literacy.

We designed this curriculum supplement to complement existing life science curricula at both the state and local levels and to be consistent with *National Science Education Standards*. It was developed and tested by a team composed of teachers from across the country, scientists, medical experts, other professionals with relevant subject-area expertise from institutes and medical schools across the country, representatives from the NIH National Institute on Alcohol Abuse and Alcoholism (NIAAA), and curriculum-design experts from Biological Sciences Curriculum Study (BSCS), SAIC, and Edge Interactive. The authors incorporated real scientific data and actual case studies into classroom activities. A three-year development process included geographically dispersed field tests by teachers and students.

The structure of this module enables teachers to effectively facilitate learning and stimulate student interest by applying scientific concepts to real-life scenarios. Design elements include a conceptual flow of lessons based on BSCS's 5E Instructional Model of Learning, multisubject integration emphasizing cutting-edge science content, and built-in assessment tools. Activities promote active and collaborative learning and are inquiry-based to help students develop problem-solving strategies and critical thinking.

Each curriculum supplement comes with a complete set of materials for both teachers and students including printed materials, extensive background and resource information, and a Web site with interactive activities. These supplements are distributed at no cost to teachers across the United States. All materials may be copied for classroom use but may not be sold. We welcome feedback from our users. For a complete list of curriculum supplements, updates, availability, and ordering information, or to submit feedback, please visit our Web site at *http://science.education.nih.gov* or write to

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We appreciate the valuable contributions of the talented staff at BSCS, SAIC, and Edge Interactive. We are also grateful to the NIH scientists, advisors, and all other participating professionals for their work and dedication. Finally, we thank the teachers and students who participated in focus groups and field tests to ensure that these supplements are both engaging and effective. I hope you find our series a valuable addition to your classroom and wish you a productive school year.

Bruce A. Fuchs, Ph.D.
Director
Office of Science Education
National Institutes of Health

1 In 1996, the National Academy of Sciences released the *National Science Education Standards*, which outlines what all citizens should understand about science by the time they graduate from high school. The *Standards* encourages teachers to select major science concepts that empower students to use information to solve problems rather than stressing memorization of unrelated information.

About the National Institutes of Health

Founded in 1887, the National Institutes of Health (NIH) today is the federal focal point for medical research in the United States. Composed of separate institutes and centers, NIH is one of eight health agencies of the Public Health Service within the U.S. Department of Health and Human Services. The NIH mission is to uncover new knowledge about the prevention, detection, diagnosis, and treatment of disease and disability, from the rarest genetic disorder to the common cold. It does this through

- *Research.* Enhancing research outcomes across the medical research continuum by supporting research in NIH's own intramural laboratories as well as the research of nonfederal scientists working in universities, medical schools, hospitals, and research institutions throughout the country and abroad; communicating scientific results; promoting the efficient transfer of new drugs and other technologies; and providing effective research leadership and administration.
- *Research Training and Career Development Program.* Supporting research training and outreach designed to ensure a continuing supply of well-trained scientists.
- *Research Facilities Program.* Modernizing and improving intramural and extramural research facilities to ensure that the nation's scientists have adequate facilities in which to conduct their work.

Science education efforts by NIH and its institutes and centers are critical in ensuring the continued supply of well-trained basic research and clinical investigators, as well as the myriad professionals in the many allied disciplines who support the research enterprise. These efforts also help educate people about the scientific results so that they can make informed decisions about their own health as well as the health of the public.

This curriculum supplement is one such science education effort, done through the partnership of the NIH National Institute on Alcohol Abuse and Alcoholism, the NIH Office of Science Education, and Biological Sciences Curriculum Study (BSCS).

About the National Institute on Alcohol Abuse and Alcoholism

The National Institute on Alcohol Abuse and Alcoholism (NIAAA) supports and conducts biomedical and behavioral research on the causes, consequences, treatment, and prevention of alcoholism and alcohol-related problems. NIAAA also provides leadership in the national effort to reduce the severe and often fatal consequences of these problems by

- conducting and supporting research directed at determining the cause of alcoholism, discovering how alcohol damages the organs of the body, and developing prevention and treatment strategies for application in the nation's healthcare system;
- supporting and conducting research across a wide range of scientific areas including genetics, neuroscience, medical consequences, medication development, prevention, and treatment through the award of grants and within the NIAAA intramural research program;
- conducting policy studies that have broad implications for alcohol-problem prevention, treatment, and rehabilitation activities;
- conducting epidemiological studies such as national and community surveys to assess risks for and magnitude of alcohol-related problems among various population groups;
- collaborating with other research institutes and federal programs relevant to alcohol abuse and alcoholism and providing coordination for federal alcohol-abuse and alcoholism activities;
- maintaining continuing relationships with institutions and professional associations; international, national, state, and local officials; and voluntary agencies and organizations engaged in alcohol-related work; and
- disseminating research findings to healthcare providers, researchers, policymakers, and the public.

Introduction to *Understanding Alcohol: Investigations into Biology and Behavior*

"Although alcohol is sometimes referred to as a 'gateway drug' for youth because its use often precedes the use of other illicit substances, this terminology is counterproductive; youth drinking requires significant attention, not because of what it leads to, but because of the extensive human and economic impact of alcohol use by this vulnerable population."[43]
—Dr. Enoch Gordis, former Director of the National Institute on Alcohol Abuse and Alcoholism

Despite the legal drinking age of 21, alcohol consumption by underage individuals is not rare. A recent survey showed that 26 percent of eighth graders reported consuming alcohol within the month prior to the survey, and 16 percent reported binge drinking during the two weeks before the survey.[42] The effects of adolescent drinking involve both health- and safety-related problems, including auto crashes, domestic violence, and suicide. Alcohol abuse among teenagers may also be related to behavioral problems linked to impulsiveness and sensation seeking. Youth-alcohol-use data indicate that the earlier an individual begins drinking, the greater is his or her risk of developing alcohol-use disorders in the future.[26]

What Are the Objectives of the Module?

Understanding Alcohol: Investigations into Biology and Behavior has four objectives. The first is to help students understand how alcohol consumption affects the functioning of the body. By focusing on the scientific issues that explain how the body reacts to alcohol, the module seeks to help students make informed decisions about the use of alcohol in their lives.

The second objective is to use the topic of alcohol as a way to understand important scientific concepts. The activities in this module incorporate concepts such as concentration and solubility (miscibility), as well as build important skills in observation, critical thinking, experimental design, and data analysis.

The third objective is to convey to students the purpose of scientific research. Scientific research changes the way we understand the world around us and gives us the foundation for improving our choices about our personal health and the health of the public. In this module, students see that science provides evidence that can be used to support ways of understanding and treating human disease. Because the mission of NIAAA includes increasing the public's understanding about the causes, consequences, treatment, and prevention of alcoholism and alcohol-related problems, the Institute believes that education provides one context in which it can fulfill its mission.

We have designed the lessons in this module to encourage students to think about the relationships among knowledge, choice, behavior, and enhanced human health in this way:

Knowledge (what is known and not known) + Choice = Power

Power + Behavior = Enhanced Human Health

The final objective is to encourage students to think in terms of these relationships now and as they grow older.

Why Teach the Module?

Middle school life science classes offer an ideal setting for integrating many areas of student interest. In this module, students participate in activities that integrate inquiry science, environmental studies, human health, history, decision-making concepts, and mathematics. The real-life context of the module's classroom lessons is engaging for students, and the knowledge gained by participating in the module can be applied immediately to students' lives.

"It [the module] could be easily done by my special-ed students, as well as keeping the interest of the gifted students." – Field-Test Teacher

"I thought that the lessons were very informative, and it is all information that everyone needs to know about." – Field-Test Student

What's in It for the Teacher?

Understanding Alcohol meets many of the criteria by which teachers and their programs are assessed.

- The module is **standards based** and meets science content, teaching, and assessment standards as expressed in the *National Science Education Standards*. It pays particular attention to the standards that describe what students should know and be able to do with respect to **scientific inquiry**.
- As described above, it is an **integrated** module, drawing most heavily from the subjects of science, history, mathematics, and health.
- The module has a Web-based **technology component** that includes videos and interactive simulations.
- Finally, the module includes built-in **assessment** tools, which are noted in each of the lessons with an assessment icon.

In addition, the module provides a means for **professional development**. Teachers can engage in new and different teaching practices like those described in this module without completely overhauling their entire yearlong program. In *Designing Professional Development for Teachers of Science and Mathematics*,[33] Susan Loucks-Horsley et al. write that supplemental modules such as *Understanding Alcohol: Investigations into Biology and Behavior* can "offer a window through which teachers can get a glimpse of what new teaching strategies look like in action." By experiencing a short-term unit like this one, teachers can "change how they think about teaching and embrace new approaches that stimulate students to problem solve, reason, investigate, and construct their own meaning for the content." The use of a supplemental unit like this module can encourage reflection and discussion and stimulate teachers to improve their practices by focusing on student learning through inquiry.

The following table correlates topics often included in the middle school curriculum with the major concepts presented in this module. This information is presented to help teachers make decisions about incorporating this material into the curriculum.

Correlation of *Understanding Alcohol* to Common Middle School Topics

Topic	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Chemical composition of matter		✔				
Individual variation and susceptibility			✔	✔	✔	
Human health and medicine	✔				✔	✔
Risk assessment and management					✔	✔
Scientific methods		✔	✔		✔	
Relationship among science, technology, and society	✔			✔	✔	✔

Implementing the Module

The six lessons in this module are designed to be taught in sequence for one to two weeks (as a supplement to the standard curriculum). 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?

Understanding Alcohol: Investigations into Biology and Behavior is designed to help students develop the following major goals associated with scientific literacy:

- to understand a set of basic scientific principles related to the use and abuse of alcohol and its effects on human health;
- to experience the process of scientific inquiry and develop an enhanced understanding of the nature and methods of science; and
- to recognize 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?

We have organized the lessons to form a conceptual whole that moves students from thinking about what they already know, or think they know, about alcohol (*Alcohol: Separating Fact from Fiction*), to investigating how much alcohol is in different types of alcoholic beverages and how the alcohol is distributed in the body (*A Drink Is a Drink, but People Are Different*). Students next use simulations to investigate how alcohol affects movement of mice at different doses, at different times after consumption, and in different genetic strains (*Responding to Alcohol: What's Important?*). Students then discover that alcohol use spans a continuum from no use, to use, to abuse, to alcoholism, and that how an individual's drinking is categorized depends on a variety of factors including personal choice (*Alcohol Use, Abuse, and Alcoholism*). Students focus their understanding of how alcohol affects a person's functioning by considering how drinking alcohol impairs cognitive and motor skills. The amount of alcohol, the pattern of drinking, and the individual's gender and body type influence how high the blood alcohol concentration is and how long it takes for it to decrease (*Alcohol and Driving: When to Say No*). Through consideration of how alcohol affects mental and physical abilities, students begin to consider how alcohol could affect them if they choose to drink. Finally, students synthesize the information they have learned to decide whether the use of alcohol should be restricted for all public activities and not just driving (*Using Alcohol: Setting Limits*). The tables on pages 8 and 9 illustrate the science content and conceptual flow of the six lessons.

How Does the Module Correlate to the *National Science Education Standards?*

Understanding Alcohol: Investigations into Biology and Behavior supports teachers in their efforts to reform science education in the spirit of the National Research Council's 1996 *National Science Education Standards (NSES)*. The content of the module is explicitly standards based: Each time a standard is addressed in a lesson, an icon appears in the margin and the applicable standard is identified. The Content Standards: Grades 5–8 chart on pages 6 and 7 lists the specific content standards that this module addresses.

Content Standards: Grades 5–8

Standard A: As a result of activities in grades 5–8, all students should develop	**Correlation to *Understanding Alcohol: Investigations into Biology and Behavior***
Abilities necessary to do scientific inquiry	
• Identify questions and concepts that guide scientific investigations.	Lessons 1, 2, 3, 6
• Design and conduct a scientific investigation.	Lesson 3
• Use appropriate tools and techniques to gather, analyze, and interpret data.	Lesson 3
• Develop descriptions, explanations, predictions, and models using evidence.	Lessons 1, 2, 3, 4, 5
• Think critically and logically to make the relationships between evidence and explanations.	Lessons 1, 2, 3, 5, 6
• Recognize and analyze alternative explanations and predictions.	Lessons 1, 2, 3, 4, 6
• Communicate scientific procedures and explanations.	Lessons 1, 2, 3, 4, 5, 6
• Use mathematics in all aspects of scientific inquiry.	Lessons 2, 3, 4, 5
Understandings about scientific inquiry	
• Different kinds of questions suggest different kinds of scientific investigations. Some involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects; and some involve making models.	Lessons 2, 3, 4, 5
• Mathematics is important in all aspects of scientific inquiry.	Lessons 2, 3, 4, 5
Standard C: As a result of their activities in grades 5–8, all students should develop understanding of	
Structure and function in living systems	
• 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.	Lessons 2, 5
• Specialized cells perform specialized functions in multicellular organisms. Groups of specialized cells cooperate to form a tissue, such as muscle. Different tissues are in turn grouped together to form larger functional units, called organs. Each type of cell, tissue, and organ has a distinct structure and set of functions that serve the organism as a whole.	Lessons 2, 5
• The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control, coordination, and protection from disease. These systems interact with one another.	Lessons 2, 3, 5

• Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection from other organisms.	Lessons 4, 6
Reproduction and heredity	
• The characteristics of an organism can be described in terms of a combination of traits. Some are inherited and others result from interactions with the environment.	Lessons 3, 4, 5, 6
Regulation and behavior	
• Behavior is one kind of response an organism can make to an internal or environmental stimulus.	Lessons 1, 3, 4, 5, 6
Standard F: As a result of their activities in grades 5–8, all students should develop understanding of	
Personal health	
• The potential for accidents and the existence of hazards impose the need for injury prevention. Safe living involves the development and use of safety precautions and the recognition of risk in personal decisions.	Lessons 1, 5, 6
• 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, 5, 6
Risks and benefits	
• Risk analysis considers the type of hazard and estimates the number of people who might be exposed and the number likely to suffer consequences. The results are used to determine the options for reducing or eliminating risks.	Lessons 4, 5, 6
• Students should understand the risks associated with natural hazards (fires, floods, tornadoes, hurricanes, earthquakes, and volcanic eruptions), chemical hazards (pollutants in air, water, soil, and food), biological hazards (pollen, viruses, bacteria, and parasites), social hazards (occupational safety and transportation), and personal hazards (smoking, dieting, and drinking).	Lessons 1, 4, 5, 6
• Important personal and social decisions are made based on perceptions of benefits and risks.	Lessons 4, 5, 6
Standard G: As a result of activities in grades 5–8, all students should develop understanding of	
Science as a human endeavor	
• Science requires different abilities, depending on such factors as the field of study and type of inquiry. Science is very much a human endeavor, and the work of science relies on basic human qualities, such as reasoning, insight, energy, skills, and creativity, as well as on scientific habits of minds, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.	Lessons 1, 2, 3, 6

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 in the lessons helps teachers support the development of student 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 activities encourage and support student inquiry, promote discourse among students, and challenge students to accept and share responsibility for their learning. The use of the 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 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 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. They are developing skills, analyzing and evaluating evidence, experiencing and discussing, and talking to their peers about their own understandings. Students work collaboratively with others to solve problems

Science Content and the Lessons

Lesson	Science Content
Lesson 1	Distinguishing between observation and inference.
Lesson 2	Concentration and miscibility. Relating body type to an individual's response to alcohol.
Lesson 3	Use of animal models. Effects of dose, time after ingestion, and genetic background on individual response to alcohol.
Lesson 4	Factors influencing alcohol use and abuse. Interactions of genetics and the environment.
Lesson 5	Calculation of blood alcohol concentrations (BACs). Effects of metabolism, gender, and body size and type.
Lesson 6	Relating BAC levels to impairments. Assessing risks and costs of alcohol use to the individual and to society.

Conceptual Flow of the Lessons

Lesson	Learning Focus	Major Concept
Lesson 1 *Alcohol: Separating Fact from Fiction*	Engage*: In this lesson, students express prior knowledge and become engaged in the study of alcohol, its use and abuse, and alcoholism.	Students receive mixed messages about alcohol use. They are warned of its dangers, yet it is portrayed as part of a desirable lifestyle in movies, media, and advertisements.
Lesson 2 *A Drink Is a Drink, but People Are Different*	Explore: In this lesson, students explore the alcohol content of various types of alcoholic beverages and how alcohol distributes in the human body. The Explore phase gives students a common set of experiences upon which to begin building conceptual understanding.	The total amount of alcohol in a typical serving of beer, wine, or hard liquor is about the same. Alcohol distributes throughout the water-containing portions of the body. The brain has a high water content, and alcohol exerts many of its effects here.
Lesson 3 *Responding to Alcohol: What's Important?*	Explore/Explain: Students analyze simulations of the effects of alcohol on mouse activity levels. Students express their understanding of the simulations in their own words and by using graphs.	The greater the dose of alcohol, the greater the effect on behavior. Alcohol is metabolized by the body. Its effects decrease with increasing time after consumption. Individuals within a population differ in their response to alcohol. Such differences are partly due to genetics.
Lesson 4 *Alcohol Use, Abuse, and Alcoholism*	Explain/Elaborate: Students continue to investigate how and why humans use alcohol. They broaden their conceptual understanding and apply what they have learned in a new context.	Alcohol use ranges along a continuum from abstinence to use, to abuse, to alcoholism. Where an individual falls along this continuum depends on genetic and environmental factors. Personal choice plays a key role in an individual's decision to use alcohol.
Lesson 5 *Alcohol and Driving: When to Say No*	Explain/Elaborate: Students refine their understanding of how alcohol affects human behavior and begin to consider how alcohol could affect their own lives.	Drinking alcohol impairs the functions of the mind and body. The extent of impairment depends upon the amount of alcohol in the blood. This in turn depends upon many factors including the drinker's body weight, gender, and amount and pattern of drinking.
Lesson 6 *Using Alcohol: Setting Limits*	Elaborate/Evaluate: In this lesson, students apply what they have learned in previous lessons to a new situation to demonstrate their understanding of concepts.	The effects of drinking alcohol are dose dependent. People who drink and have blood alcohol concentrations below the legal limit for driving may still be impaired. Public policies aimed at alcohol must balance many factors.

*See How Does the 5E Instructional Model Promote Active, Collaborative, Inquiry-Based Learning?, on page 8.

and plan investigations. Many students find they learn better when they work with others in a collaborative environment than when they work alone in a competitive environment. When all 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 5E Instructional Model. This model sequences the learning experiences so that 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, *Alcohol: Separating Fact from Fiction,* is designed to

- pique students' curiosity and generate interest,
- determine students' current understanding about alcohol and its use,
- invite students to raise their own questions about alcohol use and its effects on human health,
- encourage students to compare their ideas with the ideas of others, and
- enable 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 2, *A Drink Is a Drink, but People Are Different*, and Lesson 3, *Responding to Alcohol: What's Important?*, students explore what an alcoholic drink really is, where alcohol goes in the body, and how it affects the activity level of mice. These lessons provide a common set of experiences within which students can compare what they think about what they are observing and experiencing.

During the Explore lessons in this module, Lesson 2, *A Drink Is a Drink, but People Are Different*, and Lesson 3, *Responding to Alcohol: What's Important?*, students

- interact with materials, ideas, classroom demonstrations, and simulations;
- consider different ways to solve a problem or answer a question;
- acquire a common set of experiences with their classmates so they can compare results and ideas;
- observe, describe, record, compare, and share their ideas and experiences; and
- express their developing understanding of the effects of alcohol on behavior using graphs and by answering questions.

Explain

The Explain lesson provides opportunities for students to connect their previous experiences and begin to make conceptual sense of the main

ideas of the module. This stage also allows for the introduction of formal language, scientific terms, and information that might make students' previous experiences easier to describe and explain.

In the Explain lessons in this module, Lesson 3, *Responding to Alcohol: What's Important?*, and Lesson 4, *Alcohol Use, Abuse, and Alcoholism*, students

- explain concepts and ideas about the mouse simulations and the dice modeling activity in their own words;
- listen to and compare others' explanations of their results with their own;
- become involved in student-to-student discourse in which they explain their thinking to others and debate their ideas;
- revise their ideas;
- record their ideas and current understanding;
- use labels, terminology, and formal language; and
- compare their current thinking with what they previously thought.

Elaborate

In Elaborate lessons, students apply or extend the concepts in new situations and relate their previous experiences to new ones. In the Elaborate lessons in this module, part of Lesson 4, *Alcohol Use, Abuse, and Alcoholism;* Lesson 5, *Alcohol and Driving: When to Say No;* and Lesson 6, *Using Alcohol: Setting Limits*, students

- make conceptual connections between new and former experiences, particularly with respect to the decision to use alcohol, its effects, and the consequences of its use;
- connect ideas, solve problems, and apply their understanding in a new situation;
- use scientific terms and descriptions;
- draw reasonable conclusions from evidence and data;
- add depth to their understanding of concepts and processes; and
- communicate their understanding to others.

Evaluate

The Evaluate lesson is the final stage of the instructional model, but it only provides 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 stage of the model. 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 6, *Using Alcohol: Setting Limits,* provides an opportunity for students to

- demonstrate what they understand about alcohol and how well they can apply their knowledge to solve a problem;
- share their current thinking with others;
- assess their own progress by comparing their current understanding with their prior knowledge; and
- ask questions that take them deeper into a concept.

To review the relationship of the 5E Instructional Model to the concepts presented in the module, see the chart Conceptual Flow of the Lessons, on page 9.

When a teacher uses the 5E Instructional Model, he or she engages in practices that are very different from those of a traditional teacher. In response, students also participate in their learning in ways that are different from those seen in a traditional classroom. The following charts, What the Teacher Does and What the Students Do, outline these differences.

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 throughout the six lessons, rather than something that happens more formally just once at the end of the module. Accordingly, integrated within the six lessons in the module are specific assessment components. These "embedded" assessment opportunities include one or more of the following strategies:

What the Teacher Does

Stage	That is *consistent* with the 5E Instructional Model	That is *inconsistent* with the 5E Instructional Model
Engage	• Piques students' curiosity and generates interest • Determines students' current understanding (prior knowledge) of a concept or idea • Invites students to express what they think • Invites students to raise their own questions	• Introduces vocabulary • Explains concepts • Provides definitions and answers • Provides closure • Discourages students' ideas and questions
Explore	• Encourages student-to-student interaction • Observes and listens to the students as they interact • Asks probing questions to help students make sense of their experiences • Provides time for students to puzzle through problems	• Provides answers • Proceeds too rapidly for students to make sense of their experiences • Provides closure • Tells students that they are wrong • Gives information and facts that solve the problem • Leads students step-by-step to a solution
Explain	• Encourages students to use their common experiences and data from the Engage and Explore lessons to develop explanations • Asks questions that help students express understanding and explanations • Requests justification (evidence) for students' explanations • Provides time for students to compare their ideas with those of others and perhaps to revise their thinking • Introduces terminology and alternative explanations after students express their ideas	• Neglects to solicit students' explanations • Ignores data and information students gathered from previous lessons • Dismisses students' ideas • Accepts explanations that are not supported by evidence • Introduces unrelated concepts or skills
Elaborate	• Focuses students' attention on conceptual connections between new and former experiences • Encourages students to use what they have learned to explain a new event or idea • Reinforces students' use of scientific terms and descriptions previously introduced • Asks questions that help students draw reasonable conclusions from evidence and data	• Neglects to help students connect new and former experiences • Provides definitive answers • Tells students that they are wrong • Leads students step-by-step to a solution
Evaluate	• Observes and records as students demonstrate their understanding of concept(s) and performance of skills • Provides time for students to compare their ideas with those of others and perhaps to revise their thinking • Interviews students as a means of assessing their developing understanding • Encourages students to assess their own progress	• Tests vocabulary words, terms, and isolated facts • Introduces new ideas or concepts • Creates ambiguity • Promotes open-ended discussion unrelated to the concept or skill

What the Students Do

Stage	That is *consistent* with the 5E Instructional Model	That is *inconsistent* with the 5E Instructional Model
Engage	• Become interested in and curious about the concept/topic • Express current understanding of a concept or idea • Raise questions such as, What do I already know about this? What do I want to know about this? How could I find out?	• Ask for the "right" answer • Offer the "right" answer • Insist on answers or explanations • Seek closure
Explore	• "Mess around" with materials and ideas • Conduct investigations in which they observe, describe, and record data • Try different ways to solve a problem or answer a question • Acquire a common set of experiences so they can compare results and ideas • Compare their ideas with those of others	• Let others do the thinking and exploring (passive involvement) • Work quietly with little or no interaction with others (only appropriate when exploring ideas or feelings) • Stop with one solution • Demand or seek closure
Explain	• Explain concepts and ideas in their own words • Base their explanations on evidence acquired during previous investigations • Record their ideas and current understanding • Reflect on and perhaps revise their ideas • Express their ideas using appropriate scientific language • Compare their ideas with what scientists know and understand	• Propose explanations from "thin air" with no relationship to previous experiences • Bring up irrelevant experiences and examples • Accept explanations without justification • Ignore or dismiss other plausible explanations • Propose explanations without evidence to support their ideas
Elaborate	• Make conceptual connections between new and former experiences • Use what they have learned to explain a new object, event, organism, or idea • Use scientific terms and descriptions • Draw reasonable conclusions from evidence and data • Communicate their understanding to others • Demonstrate what they understand about the concept(s) and how well they can implement a skill	• Ignore previous information or evidence • Draw conclusions from "thin air" • Use terminology inappropriately and without understanding
Evaluate	• Compare their current thinking with that of others and perhaps revise their ideas • Assess their own progress by comparing their current understanding with their prior knowledge • Ask new questions that take them deeper into a concept or topic area	• Disregard evidence or previously accepted explanations in drawing conclusions • Offer only yes-or-no answers or memorized definitions or explanations as answers • Fail to express satisfactory explanations in their own words • Introduce new, irrelevant topics

- performance-based activities (for example, developing graphs or participating in a discussion of risk assessment);
- oral presentations to the class (for example, presenting experimental results); and
- written assignments (for example, answering questions or writing about demonstrations).

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, 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 teachers can assess appear in the margin beside the step in which each embedded assessment occurs.

How Can Teachers Promote Safety in the Science Classroom?

Even simple science demonstrations and investigations can be hazardous unless teachers and students know and follow safety precautions. Teachers are responsible for providing students with active instruction concerning their conduct and safety in the classroom; posting rules in a classroom is not enough. They also need to provide adequate supervision and advance warning if there are dangers involved in the science investigation. By maintaining equipment in proper working order, teachers ensure a safe environment for students.

The following are important ways to implement and maintain a safety program.

- Provide eye protection for students, teachers, and visitors. Require that everyone participating wear regulation goggles in any situation where there might be splashes, spills, or spattering. Teachers should always wear goggles in such situations.
- Know and follow the state and district safety rules and policies. Be sure to fully explain to the students the safety rules they should use in the classroom.
- At the beginning of the school year, establish consequences for students who behave in an unsafe manner. Make these consequences clear to students.
- Do not overlook any violation of a safety practice, no matter how minor. If a rule is broken, take steps to ensure that the infraction will not occur a second time.
- Set a good example by observing all safety practices. This includes wearing eye protection during all investigations when eye protection is required for the students.
- Know and follow waste-disposal regulations.
- Be aware of students who have allergies or other medical conditions that might limit their ability to participate in activities. Consult with the school nurse or school administrator.
- Anticipate potential problems. When planning teacher demonstrations or student investigations, identify potential hazards and safety concerns. Be aware of what might go wrong and what can be done to prevent the worst-case scenario. Before each activity, verbally alert students to the potential hazards and distribute specific safety instructions.
- Supervise students at all times during a hands-on activity.
- Provide sufficient time for students to set up the equipment, perform the investigation, and properly clean up and store the materials after use.
- Never assume that students know or remember safety rules or practices from their previous science classes.

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.

In this module, students have a variety of opportunities to discuss, interpret, and evaluate basic science and health issues, some in the light of values and ethics. As students encounter issues about which they feel strongly, some discussions might become controversial. How much controversy 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 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 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 in-stead of to the individuals presenting those ideas.
- Respect silence. Reflective discussions are often slow. If a teacher breaks the silence, students may allow the teacher to dominate the discussion.
- At the end of the discussion, ask students to summarize the points that they and their classmates have made. Respect students regardless of their opinion about any controversial issue.

Using the Student Lessons

The heart of this module is the set of six classroom lessons that follow. These lessons are the vehicles that we hope will carry to your students important concepts related to alcohol use and its effects on mind and body. To review the concepts in detail, refer to the chart Conceptual Flow of the Lessons, on page 9.

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 summary of the lesson.

- The **Overview** provides a short summary of student activities.
- The **Major Concepts** section states the central idea(s) the lesson is designed to convey.
- **Objectives** lists specific understandings or abilities students should have after completing the lesson.
- **Teacher Background** specifies which sections of the *Information about Alcohol* reading relate directly to the student lesson. This reading material provides the teacher with the science content that underlies the key concepts covered in the lesson. The information provided is *not* intended to form the basis of lectures to students. Instead, it enhances the teacher's understanding of the content so that he or she 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.

- **Web-Based Activities** tells the teacher which of the lesson's activities use the *Understanding Alcohol* Web site as the basis for instruction.
- **Photocopies** lists the paper copies or transparencies that need to be made from masters, which follow the student lesson.
- **Materials** lists all the materials other than photocopies needed for each of the activities in the lesson.
- **Preparation** outlines the things the teacher needs to do to be ready to teach each of the activities in the lesson.

Procedure outlines the steps in each activity in the lesson. It provides implementation suggestions and answers to questions.

Within the procedures, annotations provide additional commentary.

- **Tip from the field test** includes actual field-test teachers' suggestions for teaching strategies, class management, and module implementation.
- **Assessment** provides you with strategies for assessing student progress throughout the module and is identified by an assessment icon (see page 18).
- **Icons** identify specific annotations:

identifies teaching strategies that address specific science content standards as defined by the *National Science Education Standards*.

identifies when to use the World Wide Web site as part of the teaching strategies. Instructions tell you how to access the appropriate site. Information about using the Web site can be found in *Using the Web Site* (see page 19). A print-based alternative to Web activities is provided in case a computer with Internet access is not available.

identifies a print-based alternative to a Web-based activity to be used when computers are not available.

identifies when assessment is embedded in the module's structure. An annotation suggests strategies for assessment.

Lesson Organizer provides a brief summary of the lesson. It outlines procedural steps for each activity and includes icons that denote where in each activity masters, transparencies, and the Web site are used. The lesson organizer is intended to be a memory aid for you to use only after you become familiar with the detailed procedures for the activities. It can be a handy resource during lesson preparation as well as during classroom instruction.

The **Masters** required to teach the activities are located at the end of each lesson.

Timeline for the Module

The timeline (below) outlines the optimal plan for completing the six lessons in this module. The plan assumes you will teach the lessons on consecutive days. If your class requires more time for completing the procedures, discussing issues raised in this module, or completing activities on the Web site, adjust your timeline accordingly.

Suggested Timeline

Timeline	Activity
3 weeks ahead	Reserve computers Check performance of Web site
1 week ahead	Copy masters Make transparencies Gather materials
Day 1 Monday	**Lesson 1** Activity 1: *What's Up with This Mouse?* Activity 2: *Alcohol—Separating Fact from Fiction*
Day 2 Tuesday	**Lesson 2** Activity 1: *What Is a Drink?* Activity 2: *Where Does Alcohol Go in the Body?*
Day 3 Wednesday	**Lesson 3** Activity 1: *Gathering Data* Activity 2: *Data Analysis and Discussion*
Day 4 Thursday	**Lesson 4** Activity 1: *To Drink or Not to Drink?* Activity 2: *Modeling Alcohol Use and Abuse*
Day 5 Friday	Activity 3: *Modeling Alcohol Abuse and Alcoholism* Activity 4: *Applying the Model*
Day 6 Monday	**Lesson 5** Activity 1: *Patterns of Drinking* Activity 2: *Alcohol and Driving Behavior*
Day 7 Tuesday	**Lesson 6** Activity 1: *Alcohol—Risks and Consequences* Activity 2: *How Much Have You Learned about Alcohol?*

Using the Web Site

The *Understanding Alcohol: Investigations into Biology and Behavior* Web site is a tool, like an overhead projector or a textbook, that can help you organize the use of the module, engage student interest in learning, and orchestrate and individualize instruction. The Web site features videos, animations, and simulations that enhance two of the module's lessons.

Hardware/Software Requirements

The Web site can be accessed from Apple Macintosh and IBM-compatible personal computers. Links to download the Macromedia Flash and QuickTime Player plug-ins are provided on the Web site main page. The minimum hardware and software requirements to use the Web site are listed in the table below.

To access the Web site, type the following URL into your browser: *http://science.education.nih.gov/supplements/alcohol/teacher*.

Getting the Most out of the Web Site

Before you use this Web site, or any other piece of instructional software in your classroom, it may be valuable to identify some of the benefits you

Minimum Hardware/Software Requirements for Using the Web Site

CPU/Processor (PC Intel, Mac)	Pentium 333 MHz, Power PC or faster
Operating system (DOS/Windows, Mac OS)	Windows 95/98/2000 or Mac OS 7
System memory (RAM)	64 MB or more
Screen display	800 x 600, 16 bit (65K colors)
Browser	Microsoft Internet Explorer 5.5 or Netscape Communicator 4.75 and higher
Browser settings	JavaScript enabled
Free hard drive space	10 MB
Connection speed	56 kbps
Plug-ins	Macromedia Flash Player (version 6 and higher) and QuickTime Player (version 5 and higher)
Audio	Sound card with speakers

expect it to provide. Well-designed instructional multimedia software can

- motivate students by helping them enjoy learning and want to learn more because it enlivens content that students otherwise might find uninteresting;
- offer unique instructional capabilities that allow students to explore topics in greater depth and in ways that are closer to actual field experience than print-based resources can offer;
- provide teachers with support for experimenting with new instructional approaches that allow students to work independently or in small teams and that give teachers increased credibility among today's technology-literate students; and
- increase teacher productivity by helping them with assessment, record keeping, and classroom planning and management.

The ideal use of the Web site requires one computer for each student team. However, if you have only one computer available, you can still use the Web site (for example, by using a suitable device for projecting the screen image, or by rotating student teams through the computer station). If you do not have the facilities for using the Web site with your students, you can use the print-based alternatives provided for those lessons.

Collaborative Groups

Many of the activities in the lessons are designed to be completed by teams of students working together. Although individual students working alone can complete these activities, this strategy will not stimulate the types of student-student interactions that are one of the goals of active, collaborative, inquiry-based learning. Therefore, we recommend that you organize collaborative teams of two to four students each, depending on the number of computers available. Students in groups larger than this will have difficulty organizing the student-computer interactions equitably, which can lead to one or two students' assuming the primary responsibility for the computer-based work. Although this type of arrangement can be efficient, it means that some students do not get the opportunity to experience the in-depth discovery and analysis that the Web site was designed to stimulate.

We recommend that you keep your students in the same collaborative teams for all the activities in the lessons. This will allow each team to develop a shared experience with the Web site and with the ideas and issues that the activities present. A shared experience will also enhance your students' perceptions of the lessons as a conceptual whole.

If your student-to-computer ratio is greater than four students to one computer, then you will need to change the way you teach the module from the instructions in the lessons. For example, if you have only one computer available, you may want students to complete the Web-based work across an extended time period. You can do this in several ways. The most practical way is to use your computer as a center along with several other centers at which students complete other activities. In this approach, students rotate through the computer center, eventually completing the Web-based work that you have assigned.

A second way to structure the lessons if you only have one computer available is to use a projection system to display the computer monitor onto a screen for the whole class to view. Giving selected students in the class the opportunity to manipulate the Web activities in response to suggestions from the class can give students some of the same type of autonomy in their learning that they would gain from working in small teams.

Web Activities for Students with Disabilities

The Office of Science Education (OSE) is committed to providing access to the Curriculum Supplement Series for individuals with disabilities, including members of the public and federal employees. To meet this commitment, we will comply with the requirements of Section 508 of the Rehabilitation Act. Section 508 requires that individuals with disabilities who are members of the public seeking these materials will have access to and use of information and data that are comparable to those provided to members of the pub-

lic who are not individuals with disabilities. The online versions of this series have been prepared to comply with Section 508.

If you use assistive technology (such as a Braille reader or a screen reader) and the format of any material on our Web sites interferes with your ability to access the information, please use the following points of contact for assistance. To enable us to respond in a manner most helpful to you, please indicate the nature of your accessibility problem, the format in which you would prefer to receive the material, the Web address of the requested material, and your contact information.

Contact us at

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Understanding Alcohol: Investigations into Biology and Behavior 508-Compliant Web Activities

Lesson, activity	For students with hearing impairment	For students with sight impairment
Lesson 1, Activity 1: *What's Up With This Mouse?*	No special considerations are required.	With a screen reader, students are presented with two buttons, "mouse 1" and "mouse 2." Each button will play a video with descriptive narration.
Lesson 3, Activity 1: *Gathering Data,* Study 1—Effect of Alcohol Dose on Mouse Activity; Study 2—Effect of Time on Alcohol Response; Study 3—Effect of Genetics on Alcohol Response	Students may click on the closed-captioning icon to view the captioning for the activity's introduction.  The closed-captioning icon is located in the top left corner of the animation. The text appears at the bottom of the animation. The individual studies do not have captioning.	Using a screen reader, students are able to navigate to each study. Within each study, a sound effect is heard each time a mouse crosses a grid line. Students must count the number of sound effects to arrive at the number of grid lines crossed by the mouse. Supervision is recommended.
Lesson 5, Activity 2: *Alcohol and Driving Behavior*	No special considerations are required.	With a screen reader, students are presented with two buttons, "Simulation A" and "Simulation B." Each button will play a video with descriptive narration. The narration describes the major activities that occur during each simulation. After hearing each description, students will be able to easily determine which driver is under the influence of alcohol. Be sure to have students relate each of the intoxicated driver's actions to the specific effects of alcohol on the body.

Information about Alcohol

Figure 1. Alcohol has been part of societies for thousands of years, as shown by this representation of the ancient Greek god of grape growing and wines, Bacchus.

1 Introduction

Alcohol has been used for centuries in social, medical, cultural, and religious settings. Most Americans believe alcohol can be used responsibly by adults for social and religious purposes. However, alcohol can also be used to excess resulting in health, social, legal, and other problems. Students may receive conflicting messages about alcohol from the news media, school, their friends, and their parents. On the one hand, they hear that moderate alcohol use is acceptable, and in some instances may actually be good for your health; on the other hand, they are told that alcohol is a drug that requires abstinence until age 21. In addition, advertisements and media images often present alcohol as a means to success and an enjoyable life. These conflicting messages, combined with misunderstandings and misinformation, do not help students make responsible decisions about alcohol use.

Statistics indicate that many adolescents begin consuming alcohol at an early age. In 1997, 26 percent of eighth graders, 40 percent of 10th graders, and 51 percent of 12th graders reported consuming alcohol within the month prior to the survey.[43] In addition, 16 percent of eighth graders reported **binge drinking** within the two weeks leading up to the survey. The effects of adolescent drinking involve both health- and safety-related problems, including auto crashes, domestic violence, and suicide. Alcohol abuse among teenagers may also be related to behavioral problems linked to impulsiveness and sensation seeking.[55] Youth alcohol-use data indicate that the earlier an individual begins drinking, the greater his or her risk of developing alcohol-use problems in the future. Individuals who begin drinking before age 15 are four times more likely to develop alcohol dependence during their lifetimes than are those who begin drinking at age 21.[24, 25]

The earlier an individual begins drinking, the greater his or her risk of developing alcohol-related problems in the future.

Dr. Enoch Gordis, former Director of the National Institute on Alcohol Abuse and Alcoholism (NIAAA), has written, "Although alcohol is sometimes referred to as a 'gateway drug' for youth because its use often precedes the use of other illicit substances, this terminology is counterproductive; youth drinking requires significant attention, not because of what it leads to, but because of the extensive human and economic impact of alcohol use by this vulnerable population."[43]

The purpose of this supplement is to present students with the opportunity to learn about the science underlying the effects of alcohol on human biology and behavior through a series of inquiry-based classroom lessons. Young people are natural scientists. They have a curiosity about the world around them and about themselves as individuals. Since they have little in the way of life experiences, many young people tend to view themselves as nearly invincible. Consequently, when adults caution them against engaging in risky behaviors such as drinking alcohol, some don't listen. They feel that such warnings aren't for them and apply only to those less grown up than themselves.

The aim of this supplement is to give students the opportunity to construct their own understanding about alcohol and its attendant risks. In addition, the inquiry-based lessons are designed to help students hone their critical-thinking skills. With enhanced understanding and skills, they will be better prepared to make informed decisions about real-life situations involving alcohol use.

2 Alcohol Use, Abuse, and Alcoholism: Definitions

In any discussion of alcohol use, it is crucial to begin with a clear understanding of terms. For the purposes of this module, we define alcohol use by adults as the consumption of alcohol for social or religious purposes without demonstrating the characteristics of alcohol abuse or alcoholism (see Tables 1 and 2). **Alcohol abuse** is defined as the continued use of alcohol despite the development of social, legal, or health problems. It is important to note that any alcohol use by underage youth is considered to be alcohol abuse.

Table 1. Characteristics of Alcohol Abuse[55]

failing to fulfill major work, school, or home responsibilities
drinking in situations that are potentially dangerous, such as driving a car or operating heavy machinery
experiencing repeated alcohol-related legal problems, such as being arrested for driving while intoxicated
exhibiting continued drinking despite having relationship problems that are caused or made worse by drinking

Table 2. Characteristics of Alcoholism[55]

craving (a strong need or compulsion to drink)
impaired control over drinking
use and abuse of alcohol despite adverse consequences
failure to acknowledge the problem
tolerance or need for increasing amounts of alcohol to feel intoxicated
physical dependence or the occurrence of withdrawal symptoms when alcohol use is discontinued

Any alcohol use by underage youth is considered to be alcohol abuse.

In contrast, **alcoholism**, also known as alcohol dependence syndrome or alcohol addiction, is a **chronic** disease involving a strong need to drink, the inability to stop drinking, the occurrence of withdrawal symptoms, and tolerance (see Table 2). Alcoholism is often progressive.

Alcohol abuse is not equivalent to alcoholism. A person who abuses alcohol may drink excessive amounts but does not experience an alcoholic individual's intense cravings or severe **withdrawal symptoms** (**physical dependence**) when drinking stops. Susceptibility factors that contribute to alcoholism are genetic, environmental, and **psychosocial**. Thus, while not all people who abuse alcohol become alcoholics, those with genetic susceptibility factors who place themselves in environments that encourage drinking put themselves at risk for developing alcoholism.

The definitions of alcohol abuse and alcoholism described above do not directly apply to youth drinking. As previously noted, any alcohol drinking by underage youth is considered to be alcohol abuse. Youth who abuse alcohol typically do so by drinking often,[43] or engaging in binge drinking, which is commonly defined as drinking five or more drinks in a row. Such drinking patterns put youth at increased risk for developing alcoholism later in life. Research suggests that separate criteria may be needed to distinguish between alcohol abuse and alcoholism in youth as compared with adults.[34, 43] Table 3 lists some of the risk factors associated with youth drinking.

Table 3. Risk Factors for Youth Drinking[55]

genetic factors (based on animal and human twin studies)
childhood behaviors such as impulsiveness, aggressiveness, and antisocial behavior
psychiatric disorders such as attention deficit hyperactivity disorder and depression
family environments with favorable attitudes about drinking and lack of support
acceptance of drinking by peers
child abuse and trauma

3 Misconceptions about Alcohol Use, Abuse, and Alcoholism

Generally, textbooks for middle school students present little, if any, scientific information on how alcohol affects cell function and animal behavior. If the subject is covered at all, it is likely done in a health class, or possibly in a driver's education class. Much of what students know, or think they know, comes through family, peers, the media, and personal experimentation. Very often this information is characterized by errors, half-truths, and folk wisdom. Students need to understand the changes that occur in their minds and bodies when they drink alcohol. They also need to understand that if they choose to drink, there can be both short-term (**acute**) and long-term (**chronic**) consequences, even with moderate levels of drinking. The materials contained in this curriculum supplement, *Understanding Alcohol: Investigations into Biology and Behavior*, should at least help correct the following misconceptions.

Even moderate levels of alcohol use can lead to both short-term and long-term consequences.

Misconception 1: Alcohol is a stimulant.
Alcohol has been falsely thought of as a stimulant because its initial effects on some people include feelings of **euphoria** and lowered **inhibitions**. Alcohol is classified correctly as a **depressant** because it later causes sedation and drowsiness.[30] In high concentrations, alcohol can induce unconsciousness, coma, and even death.

Misconception 2: Alcohol abuse and alcoholism are problems only for the individual drinker.
Alcohol abuse and alcoholism are social problems that touch many more lives than that of the individual drinker. Alcohol abuse is a contributing factor to many other social problems including auto crashes, domestic violence, and child abuse or neglect. In addition to the personal costs, alcoholism also has a severe economic impact on the country due to lost productivity, healthcare treatment, and costs attendant to administering the criminal justice system.

Misconception 3: People with alcoholism are morally weak individuals lacking will power.
Alcoholism involves more than just drinking too much. It is known to be a complex disease that involves a variety of factors including genetic, environmental, social, and behavioral components. The physical dependence of alcoholics on drinking defines alcoholism as a disease that must be diagnosed, and as separate from alcohol abuse (see *2 Alcohol Use, Abuse and Alcoholism: Definitions*). In alcoholic individuals, the brain is affected by alcohol and promotes its continued use through both positive and negative reinforcements. Most notably, the severe physical withdrawal symptoms that result from stopping drinking serve as a strong biological force that can maintain drinking behavior.

Alcoholism is a complex disease that involves a variety of factors including genetic, environmental, social, and behavioral components.

Misconception 4: Children cannot be alcoholics.
Alcohol is the most used and abused drug among young people. A recent national poll reports that one in four eighth graders drank alcohol in the past month, and 18 percent of eighth graders got drunk at least once in the past year.[46] Research using animal models suggests that the developing brain of the adolescent responds differently to alcohol than does the adult brain.[31, 59] Children who abuse alcohol may develop alcoholism, though the criteria for making the diagnosis may be different from those used to diagnose adults.[34]

Misconception 5: Small amounts of alcohol won't impair bodily or mental functions.
Half of the states in the United States have set the legal limit for **blood alcohol concentration (BAC)** at 0.08 percent for motor vehicle operation. (BAC is usually expressed without "percent.") This does not mean, however, that an individual is unimpaired at lower BACs. A BAC of 0.02–0.04 can impair memory and judgment.[51] The effects of alcohol on an individual vary depending on the person's weight, nutritional state, gender, exposure to other drugs, and other factors. Any amount of alcohol taken during pregnancy is considered risky.

Misconception 6: Alcohol's effects are only temporary.
The adult body can process approximately one drink per hour. A drink, according to the National Institute on Alcohol Abuse and Alcoholism (NIAAA), is one 12-ounce bottle of wine cooler or beer, one 5-ounce glass of wine, or 1.5 ounces of 80-proof distilled liquor.[42] A significant portion of the societal costs of alcohol use (for example, falls, automobile crashes, and violence) is due to acute effects. Alcohol users and abusers, as well as alcoholics, can suffer injuries related to the acute effects of alcohol. Although the acute effects of alcohol last only a short time, chronic long-term effects can develop and persist. Adolescents and adults who drink excessive amounts of alcohol may be causing chronic alterations to their brains. A recent study provides evidence that heavy drinking among teenagers can impair brain function.[7] It is not yet known if these effects are reversible.

Figure 2. A drink can be one 12-ounce beer, one 5-ounce glass of wine, or 1.5 ounces of 80-proof distilled liquor.

Misconception 7: Alcohol is good for your health.
Recent reports have indicated that moderate drinking (defined as one drink per day for women and two drinks per day for men) may lessen the risk for cardiovascular disease.[44] These observations, however, do not give carte blanche for drinking alcohol. In considering such findings, it is important to weigh the benefits versus the risks. Although moderate drinking is associated with decreased risk for heart disease, it is also associated with increased risk of accidents. Drinking five or more drinks per day leads to increased risks for stroke and cancer. In addition, pregnant women, people using certain medications, and those diagnosed with alcoholism or other medical problems should refrain from drinking entirely.

Misconception 8: Alcoholism can be cured by behavioral programs such as Alcoholics Anonymous.
Alcoholism, at present, has no known cure. However, as with other chronic diseases, such as dia-

betes or heart disease, alcoholism can be controlled effectively using behavioral therapies, with or without pharmacological therapies. For such treatments to be effective, however, the patient must be willing to make significant and permanent lifestyle changes. People being treated for alcoholism often experience one or more episodes of **relapse.** An important aspect of behavioral therapy is to help patients deal with such relapses and motivate them to continue their efforts to remain sober.

Figure 3. Behavioral therapy helps patients deal with relapse and motivates them to continue with their efforts to remain sober.

Misconception 9: The public knows enough about the effects of alcohol use; further research is not necessary.

It is true that we do know many of the behavioral effects of alcohol consumption, such as memory and **motor function** impairment. Nonetheless, we do not know how alcohol creates its addictive actions. Research continues to provide insight into how alcohol acts on all cells of the body and affects their functions. New scientific approaches help scientists understand more about the biological and behavioral effects of alcohol. One approach uses knockout mice (mice with a specific **gene** deleted) to identify genes that **predispose** a person to alcoholism. New imaging techniques enable scientists to see alcohol's effects in the living brain. In addition, various sociological studies are helping us better understand the social effects of alcohol consumption. The results of these studies, "from cell to society," yield essential knowledge that is a prerequisite for more-effective ways to prevent and treat this disease.

4 Animals as Research Models

Much of the research into the effects of alcohol on humans uses animals. Scientists use animals when the use of humans is either impractical or unethical. For example, when scientists investigate fetal alcohol syndrome, they cannot give alcohol to pregnant women but they can give alcohol to pregnant animals.

Scientific research with animals has contributed to many important advances in scientific and medical knowledge. When using animal models, scientists first must choose an animal appropriate to their research. Scientists studying genetics often use fruit flies (*Drosophila melanogaster*) because they have a short generation time. However, fruit flies are not a good model to use when investigating aspects of mammalian physiology. In such cases, a mouse or rat is preferred.

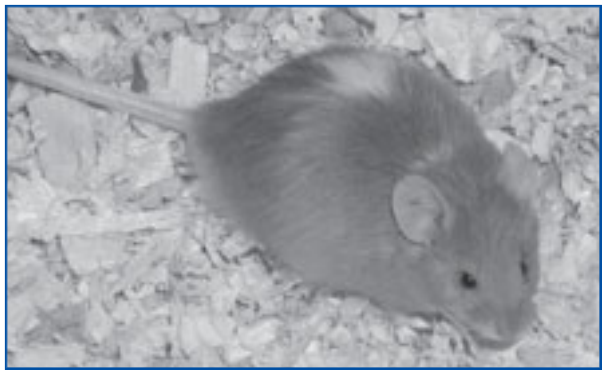

Figure 4. Mice are a useful model for studying the effects of alcohol.

Animal models do have their drawbacks. Some animals are difficult or expensive to maintain. Consequently, many scientists try to develop nonanimal models using cell cultures or computer simulations. Unfortunately, such models usually fail to duplicate the complexity of the animal or human body. Medical and scientific research will continue to depend on animal models for the

foreseeable future (see The Use of Animals in Scientific Research below).

5 Alcohol: Pharmacokinetics

Because of its legal status and prevalence in society, alcohol should be considered apart from other drugs. The term *drug* is not always easy to define. In a medical context, a **drug** may be defined as any substance used in the diagnosis, prevention, treatment, or cure of a disease. In an abuse context, a **drug** may be described as any substance that alters consciousness and may be habit forming. According to these definitions, alcohol is classified as a drug in the context of abuse.

Alcohol is classified as a drug in the context of abuse.

The alcohol contained in alcoholic beverages is called **ethanol**. Ethanol is a small molecule having a 2-carbon (C) backbone with 5 attached hydrogens (H) and a hydroxyl (OH) group at one end. This terminal hydroxyl group is characteristic of an alcohol (Figure 5). Ethanol is formed by a natural conversion process called **fermentation** where yeast, a fungus, converts sugar into alcohol and carbon dioxide. The natural sugars found in fruit, berries, and malted grains are fermented to

The Use of Animals in Scientific Research

Scientists who use animals as research subjects must abide by federal policies. Public Health Service policy 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. The principles for using and caring for vertebrate animals in research and testing include

- The transportation, care, and use of animals should be in accordance with the Animal Welfare Act and other applicable federal laws, guidelines, and policies.
- Procedures involving animals should be designed with consideration of their relevance to human or animal health, the advancement of knowledge, or the good of society.
- The animals selected should be of an appropriate species and quality and the minimum number required to obtain valid results. Methods such as mathematical models, computer simulations, and in vitro biological systems should be considered.
- Procedures should minimize discomfort, distress, and pain to the animals.
- Procedures that may cause more than momentary or slight pain should be performed with appropriate sedation, analgesia, or anesthesia.
- Animals that would suffer severe or chronic pain or distress that cannot be relieved should be painlessly killed.
- The living conditions of animals should be appropriate for the species. The housing, feeding, and care of animals must be directed by a veterinarian or a trained, experienced scientist.
- Investigators who work with animals must be appropriately qualified and trained 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 scientists and nonscientists from outside the institution. Nonscientists are often representatives of humane organizations.

produce beer and wine. Liquors, however, are produced through the process of **distillation**.

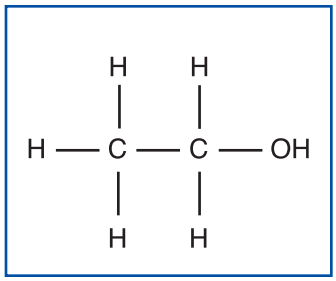

Figure 5. Chemical structure of ethanol.

5.1 Absorption and distribution of alcohol in the body. When an alcohol-containing drink is consumed, the alcohol is quickly absorbed in the blood by **diffusion** and is then transported to the tissues and throughout the water-containing portions of the body as part of the process of distribution. About 20 percent of the alcohol is absorbed through the stomach, and about 80 percent is absorbed through the upper portion of the small intestine.[6,28]

5.2 Measurement of blood alcohol concentration (BAC). **Metabolism** refers to the process by which the body breaks down food to extract energy from it. With respect to alcohol, metabolism refers to the transformation of ethanol to acetaldehyde and other products. The primary site of alcohol metabolism is the liver. Only a tiny fraction (less than 10 percent) of the alcohol consumed is not metabolized and is excreted from the body in breath, sweat, and urine.[6] This process of metabolism and excretion is known as elimination. The concentration of alcohol in breath and urine mirrors the concentration of alcohol in blood. This means that alcohol in breath can be detected, measured, and used to calculate a person's **blood alcohol concentration (BAC)**. The BAC calculation is the standard means of determining the extent of a person's alcohol impairment.

BAC, although expressed as a percentage when a unit of measure is shown, is actually a weight-per-volume measurement: grams of ethanol per 100 milliliters, or deciliter, of blood. The calculation of an individual's BAC depends partially on the total amount of water in the body. For example, males average 58 percent of their total body weight as water, while females average 49 percent.[38] Other factors important to calculating BAC are the amount of alcohol consumed and the burnoff, or rate at which the alcohol is metabolized.

The concentration of alcohol in the breath and urine mirrors the concentration of alcohol in the blood. This means that alcohol in breath can be detected, measured, and used to calculate a person's blood alcohol concentration (BAC).

In a practical sense, the only factor influencing the BAC calculation likely to be known with great precision is the amount of alcohol consumed. The total body water and burnoff are themselves influenced by several factors. Total body water is a function not only of a person's gender, but also of his or her weight and body type. Alcohol metabolism (burnoff) also varies among people. Heavy drinkers, for example, can have elevated rates of alcohol metabolism due to higher-than-normal concentrations of alcohol-metabolizing enzymes. Higher levels of these enzymes increase the burnoff. The average metabolism for a moderate drinker results in a decline in BAC of about 0.017 per hour, while a heavy drinker may have a decrease of 0.020 per hour. The range of metabolism rate per hour is from above 0.040 to below 0.010.[38] For more detailed descriptions of BAC effects on the brain and body, see *6.1 Alcohol and the brain* and *6.2 Alcohol and body systems,* as well as Table 4, on page 38.

5.3 Factors affecting alcohol absorption and elimination. Humans vary widely in their ability to absorb and eliminate alcohol. This section describes some of the most important factors that influence how quickly alcohol is absorbed into the blood.

Food. Absorption of alcohol is faster when the stomach is empty; the empty stomach allows rapid passage of the alcohol into the small intestine,

where absorption is most efficient. This means that the apparent sobering effect of eating prior to alcohol consumption is due to a delay in stomach emptying. A recent study showed that people who drank alcohol after a meal that included protein, fat, and carbohydrates absorbed alcohol nearly three times more slowly than when they drank alcohol on an empty stomach (see Figure 6). The rate of alcohol absorption depends not only on the presence or absence of food, but also on the type of food present. Foods with a higher fat content require more time to leave the stomach; consequently, eating fatty foods will allow alcohol absorption to take place over a longer time.

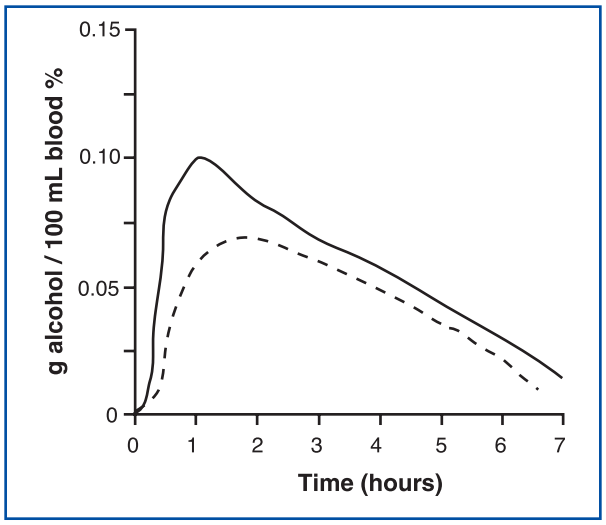

Figure 6. The effect of food on blood alcohol concentration. The graph shows BAC after a person drank alcohol following an overnight fast (solid line) and immediately after breakfast (dotted line).

Although alcohol's effects are delayed by the presence of food in the stomach, they are not prevented. Individuals may drink too much alcohol in a short time, believing that it isn't having an effect. Only after the delay in the absorption and elimination of the alcohol is the impact of their drinking felt, perhaps with disastrous consequences.

Body weight and build. Greater body weight provides a greater volume in which alcohol can be distributed. This means a larger person will be less affected by a given amount of alcohol than a smaller person would be. Alcohol is more **soluble** in water than in fat. This means that tissues rich in water, like muscle, take up more alcohol than do tissues rich in fat. A leaner person with a greater muscle mass (and less fat) provides a larger volume for alcohol to be distributed in compared with a person who weighs the same but has a higher percentage of body fat. In summary, if you compare two people of equal size but who differ in amount of body fat, the effects of alcohol will be different in them. The person with low body fat will be affected less than the person with a higher level of body fat.

Gender. Females, on average, have a smaller body mass and a higher proportion of body fat than do males. These characteristics mean that, on average, females have a lower proportion of total body water in which to distribute alcohol. Females also may have a lower activity of the alcohol-metabolizing enzyme **alcohol dehydrogenase (ADH)** in the stomach; therefore, more of the ingested alcohol reaches the blood. These factors mean that females generally exhibit higher BACs than do males after consuming the same amount of alcohol and are more vulnerable to alcohol's effects. Females are also more susceptible than males to alcoholic liver disease, heart muscle damage, and brain damage.[45]

5.4 Alcohol metabolism. The primary place where alcohol is metabolized is the liver. Liver cells contain ADH, which converts alcohol to **acetaldehyde**. Other enzymes in turn convert the acetaldehyde to carbon dioxide and water, which are excreted from the body. If the rate of alcohol consumption exceeds the rate at which the alcohol can be metabolized, then the concentration of alcohol in the blood rises and the individual may become intoxicated.

The effects of absorption, distribution, and elimination combine to produce a characteristic blood alcohol curve (Figure 8). Immediately after a person drinks alcohol, the BAC rises sharply during the **absorption phase** to a maximum that depends on the amount consumed. Typically, the greatest

Figure 7. Alcohol's effects are influenced by gender, body weight, and body type.

alcohol concentration is reached 45–90 minutes after drinking. BAC then slowly declines due to diffusion of alcohol into the body tissues as part of the **distribution phase**. Finally, BAC falls more quickly during the **elimination phase**. Alcohol is removed from the body through the normal routes of excretion as part of this process. During periods of high BAC, about 5 percent of the alcohol is excreted in breath and another 5 percent in urine, with negligible amounts excreted in sweat and feces.

The shape of the blood alcohol curve is influenced by many factors including such variables as body size, gender, build, amount and type of beverage ingested, duration of drinking, fatigue, and the presence and type of food. These variables are also major determinants of the timing and peak of the blood alcohol curve.

6 Alcohol: Biological Effects

Upon consumption, alcohol is distributed throughout the water-containing portions of the body, affecting primarily those organs having a high water content. One of these is the liver, which is the organ that metabolizes alcohol. Another is the brain, the organ that is the seat of cognition and behavior.

6.1 Alcohol and the brain. The brain is composed of billions of nerve cells called **neurons.** A typical neuron has three important parts (Figure 9). The **cell body** is responsible for directing all of the neuron's activities. The **dendrites** are a cluster of

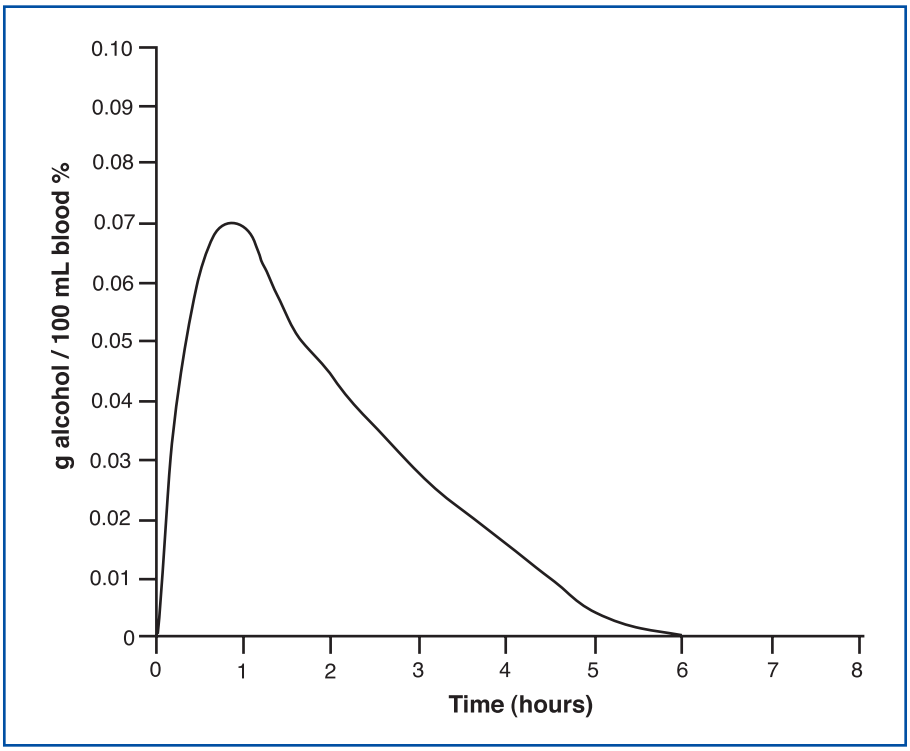

Figure 8. Blood alcohol concentration over time.

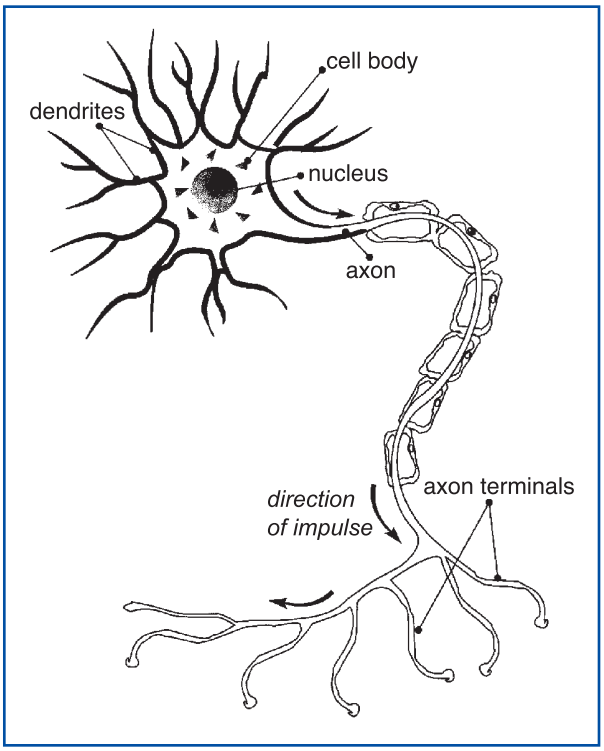

Figure 9. A typical neuron.

small fibers that receive chemical messages from other neurons. The **axon** is a single, long fiber that transmits messages from the cell body to other neurons or other cells of the body, such as muscle cells.

Although the axon of a neuron is extremely close to the dendrites of an adjoining neuron, they do not touch. The tiny amount of space between the neurons is called the **synapse**. The process by which neurons transmit messages to each other is known as **neurotransmission**. A message is an electrical impulse in the cell body that moves down the axon toward the synapse. At the synapse, it triggers the release of molecules called **neurotransmitters**, which diffuse across the synapse and bind to receptor molecules located in the cell membranes of the adjoining neuron's dendrites. The binding of the neurotransmitter either stimulates or inhibits the electrical impulse in the receiving neuron (see Figure 10).

There are many types of neurotransmitters in the brain, each with a specific function. The binding

of a neurotransmitter to its receptor is specific—that is, a neurotransmitter fits its own receptor much like a key fits only the appropriate lock. Once a neurotransmitter has passed on its message, it is either broken down by an enzyme or reabsorbed by the same neuron that released it.

For many years, scientists thought that alcohol altered the function of neurons in the brain by interacting with fat molecules in the cell membranes. More recently, it has become apparent that alcohol interacts with proteins found in the cell membranes, particularly those involved in neurotransmission. Like other drugs of **addiction**, alcohol acts via the brain's **reward pathway** in the **limbic system** (see "Reward pathway or pleasure circuit," on page 34). However, alcohol is unlike other drugs in that it interacts with multiple systems in the brain, sometimes stimulating and at other times inhibiting neurotransmission.

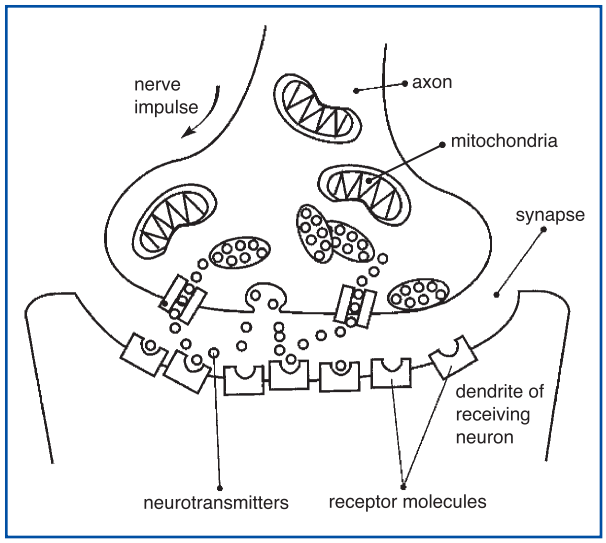

Figure 10. *Neurotransmission across a synapse.*

After drinking a sufficient amount of alcohol, many individuals experience a pleasurable state of mind. This pleasurable sensation leads some individuals to seek repeated exposure to alcohol. If drinking is excessive, it can lead to confusion, loss of coordination, sedation, coma, and even death. Long-term exposure to alcohol can lead to tolerance of its effects and eventually to physical dependence. The term "tolerance" refers to a decrease in brain sensitivity to alcohol following long-term exposure (see 2 *Alcohol Use, Abuse, and Alcoholism*: *Definitions,* on page 24, and "Tolerance," on page 34). If alcohol-dependent individuals stop drinking, they experience withdrawal symptoms, which may include tremors, anxiety, sweating, **hallucinations**, and seizures. The site of action of all these effects is the brain.

The physiological and behavioral changes associated with intoxication reflect the effects of alcohol on various parts of the brain.

Intoxication. The physiological and behavioral changes associated with intoxication reflect the effects of alcohol on various parts of the brain. For example, the loss of coordination observed in intoxicated individuals may result from the effects of alcohol on a portion of the brain called the **cerebellum**, which functions in the control of movement (see Figure 11). Alcohol-induced memory lapses may result from impairment of the **hippocampus**, a part of the brain that helps store new memories. Drinking can be sufficiently excessive that death results from suppression of the **brainstem** activity that controls breathing and circulation.

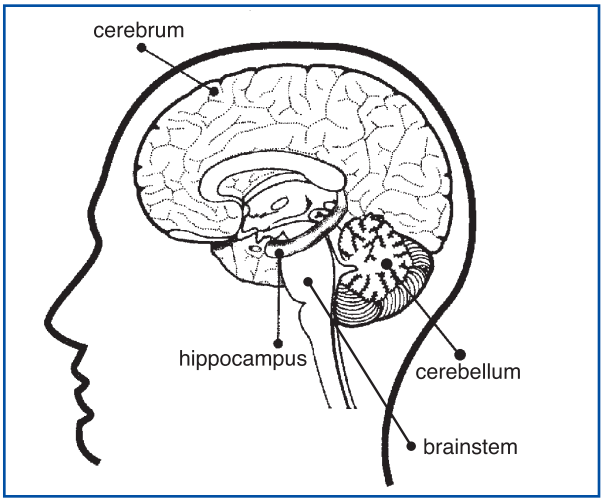

Figure 11. *Regions of the brain affected by alcohol.*

Reinforcement. The properties of alcohol that can cause continued drinking, such as its pleasurable and anxiety-reducing effects, are the very ones that contribute to chronic alcohol abuse and alcoholism. This is known as **reinforcement**. Scientists are currently exploring the brain chemistry involved in reinforcement. Research suggests that specific brain regions, such as the **hypothalamus** (which is involved in hunger, thirst, and emotions), as well as the amygdala, nucleus accumbens, and prefrontal cortex, play a role in reinforcement. Specific neurotransmitters are also implicated in alcohol's reinforcing effects.

Tolerance. **Tolerance** refers to the body's ability to adapt to chronic alcohol use. With continued use, the brain becomes less sensitive to alcohol. This means that higher BACs are needed to produce intoxication. Both alcohol abusers and alcoholics can display tolerance. BACs that can render nonabusers unconscious can leave abusers and alcoholics appearing nearly sober.

When alcoholic individuals stop drinking, they may experience severe alcohol cravings, short-term memory loss, disruption of cognitive and motor function, reduced perceptual abilities, and emotional and personality changes.

Chronic alcohol use leads to increased concentrations of the liver enzymes that metabolize alcohol. This allows the liver to break down alcohol more efficiently; therefore, the individual must consume more alcohol to reach a given BAC. There also is a behavioral component to tolerance. Subjected to chronic, excessive alcohol exposure, an individual learns to function under the influence of alcohol. For example, **functional tolerance** can reduce the impairment that would ordinarily accompany the performance of a task. Individuals may be able to drive home successfully after drinking because the route is familiar and nothing unexpected happens. However, if they encounter a detour or another car unexpectedly darts in front of them, they will be at the same risk for a crash as a driver with the same BAC who is unfamiliar with the route. The increased amounts of alcohol consumed by a person experiencing tolerance can severely damage the body's physiological systems despite their apparent normalcy.

Physical dependence and withdrawal. When alcohol use is stopped, withdrawal symptoms include severe alcohol cravings as well as physical and psychological problems. The biochemical changes associated with withdrawal lead to short-term memory loss, disruption of cognitive and motor function, reduced perceptual abilities, and emotional and personality changes.[3] Another consequence of withdrawal is delirium tremens (sometimes referred to as the DTs). **Delirium tremens** is characterized by severe agitation and hallucinations. The DTs can begin within a couple of days after alcohol consumption has stopped and can last for a week or more. The mechanisms behind tolerance and physical dependence involve relationships among nerve cell membranes, neurotransmitters and their receptors, and the reward pathway. All of these are areas of active research.

Reward pathway or pleasure circuit. The reward pathway is a powerful biological force. Strong motivations such as eating, drinking, and sex can activate neurons that produce and regulate feelings of pleasure. The reward pathway consists of a network of neurons found in the middle of the brain (see Figure 12). When activated by a positive experience, a group of neurons near the top of the brainstem (called the **ventral tegmental area**) releases the neurotransmitter **dopamine**. This message is relayed to a structure called the **nucleus accumbens** (part of the emotional limbic system) and to a related part of the **prefrontal cortex**, resulting in a pleasurable sensation.

The reward pathway can also be activated by a negative experience. Animal studies have shown that concentrations in the brain of a neurotransmitter associated with stress rise sharply during withdrawal from alcohol. The animal is motivated to seek the reward (alcohol) to avoid the pain of

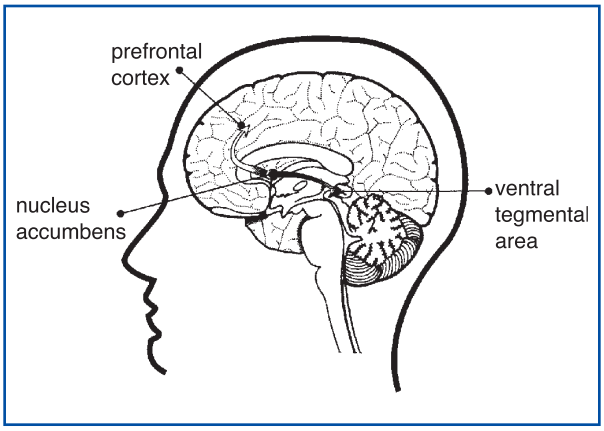

Figure 12. The reward pathway.

withdrawal. A similar process propagates the human cycle of alcohol addiction: individuals are motivated to continue consuming alcohol to avoid the discomfort of withdrawal, even though this behavior maintains addiction.

6.2 Alcohol and body systems. Once consumed, alcohol enters the bloodstream and becomes distributed throughout the body. Although heavy drinking is most commonly associated with liver damage, it can also affect the digestive, cardiovascular, immune, and endocrine systems.

The liver. Excessive drinking can harm nearly every organ in the body; however, it is most commonly associated with liver damage. The liver is especially sensitive to the effects of alcohol because it receives blood directly from the intestines, the major site of alcohol absorption. The liver is the primary site of alcohol metabolism, yet a number of the byproducts of this metabolism are toxic to the liver itself. Accumulation of these byproducts leads to alcohol-induced liver damage, which can take the form of either **inflammation** (**alcoholic hepatitis**) or liver scarring (**fibrosis** or **cirrhosis**). Often both types of damage exist within the same person. Alcohol abuse is the leading cause of liver-related deaths in the United States. It is estimated that over 2 million people suffer from some form of alcoholic liver disease.[17]

The mechanisms by which alcohol damages the liver are complex and incompletely understood. We do know that when liver cells metabolize alcohol, they use oxygen. Byproducts of this metabolism are highly reactive compounds called **free radicals**. Free radicals react with proteins, lipids, and DNA to cause cell damage or even cell death. Furthermore, drinking alcohol can cause the bacteria lining the gut to release **endotoxin** (a component of bacterial outer cell membranes). Endotoxin in turn activates certain liver cells to a higher metabolic state, which generates more free radicals and leads to cell damage.

The liver is the primary site of alcohol metabolism, yet a number of the byproducts of this metabolism are toxic to the liver itself.

The digestive system. Excessive drinking has been shown to cause chronic inflammation of the **esophagus**, which can lead to **esophageal cancer**. During swallowing, the esophagus contracts and relaxes to help food reach the stomach. By inhibiting this contraction, alcohol allows acidic stomach juices to back up into the lower esophagus. The presence of stomach acids in the esophagus can lead to inflammation, ranging from mild to severe. Long-term exposure to stomach acid can cause the cells lining the esophagus to progress toward esophageal cancer. Heavy alcohol use has also been linked to **pancreatitis** (inflammation of the pancreas) and cancers in various other body parts, including the mouth, throat, breast, colon, and rectum.

Although drinking alcohol is not specifically associated with increased risk for stomach cancer, it may be involved in **gastritis** (inflammation of the stomach). A bacterium called *Helicobacter pylori* (*H. pylori*) has been shown to cause gastritis and stomach ulcers; heavy drinkers have higher rates of gastritis and *H. pylori* infection than do light drinkers. Since gastritis among alcoholics is not reduced by stopping drinking, but rather by treatment with antibiotics, it may be the bacterial infection rather than the alcohol that causes gastritis.

However, heavy alcohol use may increase susceptibility to gastritis. Scientists currently are investigating whether the higher rate of gastritis among heavy drinkers is due to alcohol or to *H. pylori* infection.

The cardiovascular system. At high concentrations, alcohol can interfere with the pumping action of the heart. Its effects can be acute or chronic. Alcohol exerts its effects through a variety of mechanisms, including interfering with the **sodium-potassium pump** (which is needed to move an electrical impulse through the heart) and disturbing the heart's response to certain **hormones**. The short-term effects of alcohol disturb the electrical events that control the contraction of the heart muscle and interfere with the rhythm of the heartbeat. These effects are thought to be major reasons for sudden death among alcoholics.

At high concentrations, alcohol can interfere with the pumping action of the heart.

Long-term effects of heavy drinking may involve interfering with the action of the energy-producing parts of the heart cell called mitochondria. Studies of alcohol-fed hamsters have shown that after 14 weeks' of high BACs, the heart loses some of its ability to beat properly. This effect was accompanied by a lower-than-normal energy output from the mitochondria.[54] When hamsters, which have life spans of approximately three years, were given longer exposures to high BACs, they were able to bring the energy output of their mitochondria back to normal, but their hearts still didn't beat as well as they normally do. This study suggests that the body's adaptive response to long-term alcohol use is unable to fully restore normal heart function.

Hypertension (high blood pressure), strongly associated with drinking more than four drinks per day, can be another result of long-term alcohol use. Several mechanisms have been proposed to explain the relationship between drinking and hypertension. One proposed mechanisim involves changes in the levels of various hormones and neurotransmitters that regulate cardiac function. Another proposed mechanism states that alcohol interferes with the ability of muscles in the **arteries** to contract. Alcohol-induced hypertension is not permanent, and among heavy drinkers, it disappears within two or three weeks after drinking stops. The long-term presence of alcohol-induced hypertension in alcoholics may play a role in the association between drinking and the risk of stroke.

Coronary artery disease is the leading cause of death in Western societies, accounting for about 25 percent of all deaths. Despite the clear association between heavy drinking and heart disease, moderate drinking is correlated with reduced risk for coronary artery disease.[44] Scientists currently are attempting to establish whether the protection comes from the alcohol or the lifestyles of moderate drinkers. For example, a number of studies suggest that drinking moderate levels of wine produces the most protection against coronary heart disease. The reason for this is not clear. Wine drinkers are also associated with leading healthier lifestyles than are people who prefer to drink beer or liquor. This protective effect of moderate alcohol drinking must be weighed against its increased accident risk. These benefits are also offset at higher drinking levels due to increased risks of other types of disease and traumas.

The immune system. It is well documented that people who drink heavily suffer more infectious diseases than do people who only drink moderately. For example, various studies have found that drug and alcohol abusers are infected by the bacterium that causes **tuberculosis** at a rate that is 15 to 200 times greater than that of nonabusers. Today, we know that alcohol abuse can alter the distribution and function of immune cells called **lymphocytes** by interfering with molecules called **cytokines** that help orchestrate lymphocyte activities. Alcohol can increase cytokine production in liver cells, which leads to the scar formation and impaired blood flow associated with cirrhosis. In

turn, abnormal cytokine concentrations can lead to a poorly regulated immune system that is less capable of fighting off infections.

Alcohol's effects on the immune system can be even more severe. If alcohol damages the immune system to a level where it fails to accurately distinguish self from nonself, the immune system attacks the body. This can result in, or worsen, alcohol-induced organ damage such as alcohol liver disease. Regrettably, children born with **fetal alcohol syndrome** (**FAS**) must cope with the effects of alcohol on their immune systems throughout their lives (see *10.4 Drinking and pregnancy* and Table 4). FAS results from alcohol consumption by pregnant women. Prenatal exposure to alcohol can disrupt the normal formation of the fetal immune system, leading to increased frequencies of infection and an increased risk of organ damage, among other adverse, lifelong effects.

The endocrine system. Long-term alcohol use can also disrupt the function of the endocrine system and affect the balance of the hormones **insulin** and **glucagon**, which regulate blood glucose concentrations. Drinking alcohol can alter the release of **reproductive hormones**, **growth hormone**, and **testosterone**. Alcohol-induced changes in hormone concentrations are associated with sexual dysfunction in both men and women. Alcoholics also face increased risk of osteoporosis. The disruption of certain hormones, such as parathyroid hormone, vitamin D–related hormones, and calcitonin, may lead to a calcium deficiency.

7 Alcohol: Behavioral Effects

The brain is the origin of all human behavior, so it is not surprising that exposure to alcohol leads to changes in behavior. As discussed in *6.1 Alcohol and the brain,* the human brain has a high water content. Consequently, it is very sensitive to the effects of alcohol consumption. Alcohol induces several behavioral changes because it affects various areas of the brain. For example, the cerebellum (movement), the hippocampus (memory), the ventral tegmental area (reward), and even the brainstem (breathing) are all affected by drinking alcohol.

The short-term behavioral effects of alcohol follow the typical dose-response relationship characteristic of a drug; that is, the greater the dose, the greater the effect [see *5.2 Measurement of blood alcohol concentration (BAC)*]. Table 4 shows that increased blood alcohol concentrations lead to changes in personality as well as loss of control over physical functions. An early (and nearly universal) effect of alcohol on personality is the loss of inhibition. Other effects experienced at lower BACs (0.01–0.05) include a sense of well being and lowered alertness. These BAC values also impair thought, judgment, coordination, and concentration in most individuals.

The short-term behavioral effects of alcohol follow the typical dose-response relationship characteristic of a drug; that is, the greater the dose, the greater the effect.

It is easier to predict the physical effects of alcohol than the behavioral ones, especially at BACs in the range of 0.06–0.20. Personality influences behavioral responses. Loss of inhibition combined with additional drinking leads some individuals to become increasingly boisterous while others become withdrawn. Still others become angry and aggressive. Not surprisingly, inappropriate expression of anger and aggression can lead to abusive behavior and violence (see *10.5 Drinking and violence*). Excessive drinking may also cause some individuals to experience severe emotional swings and even trigger severe depression. At BACs of 0.21–0.29, loss of muscle control leads most individuals to experience **stupor** and impaired sensations. Since BACs over 0.30 affect breathing and heart rate, all individuals experiencing this BAC are at risk for unconsciousness, coma, and even death.

Though the behavioral effects of alcohol are unpredictable and vary from one individual to another, a number of factors are known to influence alcohol's

Table 4. Progressive Effects of Alcohol

Blood Alcohol Concentration	Changes in Feelings and Personality	Brain Regions Affected	Impaired Activities (continuum)
0.01 – 0.05	Relaxation Sense of well being Loss of inhibition	Cerebral cortex	Alertness Judgment Coordination
0.06 – 0.10	Pleasure Numbing of feelings Nausea, Sleepiness Emotional arousal	Cerebral cortex + forebrain	(especially fine motor skills) Visual tracking Reasoning and
0.11 – 0.20	Mood swings Anger Sadness Mania	Cerebral cortex + forebrain + cerebellum	depth perception Inappropriate social behavior (e.g. obnoxiousness)
0.21 – 0.30	Aggression Reduced sensations Depression Stupor	Cerebral cortex + forebrain + cerebellum + brain stem	Slurred speech Lack of balance Loss of temperature regulation
0.31 – 0.40	Unconsciousness Death possible Coma	Entire brain	Loss of bladder control Difficulty breathing
0.41 and greater	Death		Slowed heart rate

Source: Advisory committee and NIAAA scientists.

effects on behavior. One important factor that influences both personality and susceptibility to alcohol abuse is genetics (see *8.2 Alcoholism and genetics*, on page 39). Genetic influences work at both the individual and the population levels. For example, certain genetic variations that exist more often in Chinese and Japanese populations lead to an increased sensitivity to alcohol's effects, which in turn leads to a decreased susceptibility to alcoholism. An individual possessing these genetic variations experiences facial flushing, an elevated heart rate, and a burning sensation in the stomach upon consumption of alcohol. These negative consequences generally deter further alcohol consumption. In other populations, different genetic variations lead to an increased susceptibility to alcoholism. In still other populations, genetics has not been shown to influence an individual's drinking behavior. It is important to remember that an individual cannot control his or her genetic makeup, but being aware of it can help a person decide whether the choice to drink alcohol would be risky.

Drinkers expect to feel and behave in certain ways when drinking. Expectations about drinking can begin at an early age, even before drinking begins.

There are, of course, nongenetic factors that influence drinking behavior. The term **expectancy** refers to what a person expects will happen in a given drinking situation. Research has shown that drinkers expect to feel and behave in certain ways when drinking. Expectations about drinking can begin at an early age, even before drinking begins.[48] Students who engage in binge drinking during high school are more likely to do so in college.[57] Young people are also influenced by their perceptions of how much they think their friends drink. Studies have shown that college students

tend to think their friends drink more than they actually do.[40] This belief can cause them to increase their level of drinking in an effort to "fit in." Other social factors that promote increased alcohol consumption are drinking in groups and serving oneself.[20, 21]

8 Alcoholism

8.1 Signs of a problem. There is no simple test to identify someone with a drinking problem. However, clinicians often use a short series of questions as a screening tool. Honest answers to the following four questions can help individuals decide whether a problem may exist. To make the questions easier to remember, they have been written in such a way that the first letter of a key word in each question spells **CAGE**.[41]

1. Have you ever felt that you should **c**ut down on your drinking?
2. Have people **a**nnoyed you by criticizing your drinking?
3. Have you ever felt bad or **g**uilty about your drinking?
4. Have you ever had a drink first thing in the morning to steady your nerves or to get rid of a hangover (**e**ye opener)?

A "yes" answer to one of these questions may suggest that a drinking problem exists, while more than one "yes" response is highly indicative of a problem. Even if a person answers "no" to all four questions, an alcohol problem can still exist. If the screening procedure suggests that an alcohol-abuse or alcohol-dependence problem may exist, then that individual should be further evaluated by a qualified healthcare provider.

Most people who use alcohol do so without problems. However, about 17 percent of alcohol users either abuse it or are dependent on it.

The criteria used by healthcare providers to diagnose alcohol abuse and alcoholism continue to be refined. Prior to the 1970s, subjective judgments and clinical experience were used to diagnose alcoholism. More recently, the diagnostic criteria have relied more on data and research. Today, researchers and clinicians in the United States rely on the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* published by the American Psychiatric Association.[1] The *DSM* recognizes separate criteria for the diagnosis of alcohol dependence (alcoholism) and alcohol abuse.

8.2 Alcoholism and genetics. Most people who use alcohol do so without problems. However, about 17 percent of current regular drinkers either abuse it or are dependent on it. Regular drinkers are defined as those who have consumed 12 or more drinks in the past year. An individual's susceptibility to alcoholism is influenced by many factors. Scientists believe that, among other factors, there is a genetic basis for alcoholism because children or siblings of alcoholics are at much greater risk for developing the disease.

It is important to keep in mind that members of the same family share both genes and a common environment. To distinguish between the effects of nature versus nurture, scientists have conducted twin and adoption studies. Identical twins have the same set of genes. In contrast, fraternal twins, like nontwin siblings, share an average of half their genes. Thus, both types of twins share environmental influences to a similar degree, but they differ in the amount of genetic information they share. If a trait shows greater similarity among identical twins compared with fraternal twins, then genes contribute to that trait.

Children who are adopted at an early age provide an opportunity to separate genetic from environmental effects. The assumption is that any similarities for a trait between biological parents and their adopted-away offspring are due to genetics. Conversely, similarities between adoptive parents and their adopted children reflect shared environmental influences. Twin and adoption studies indicate that there are strong genetic influences on alcoholism. It is important to stress, however, that many individuals who are **genetically predisposed** to become an alcoholic do not do so. Genetic influence speaks to an individual's risk,

not their destiny. The environment, including the social setting of the individual, is a very important factor. The individual must engage in the behavior of drinking before the genetic predisposition can set the stage for alcoholism to develop.

The genetic influence on alcoholism is described as being **polygenic**, meaning that there is more than one gene influencing the trait. Scientific research has identified regions on many **chromosomes** (1, 2, 3, 4, 7, 11, 15, and 16) that may predispose an individual to alcoholism.[16, 18, 32, 50] In addition, other regions on chromosome 4 may help protect an individual from alcoholism. One such region is near the location of the genes for the ADH enzyme (see "The cardiovascular system," on page 36). This is especially interesting because certain **alleles**, or versions of the ADH gene, have been shown to reduce the risk for alcoholism in Chinese and Japanese populations. Individuals having the *ADH2* and *ADH3* alleles produce enzymes that metabolize alcohol to acetaldehyde at a high rate. The accumulation of toxic acetaldehyde can cause facial flushing, an elevated heart rate, and a burning sensation in the stomach. These negative effects of alcohol consumption are responsible for the reduced rates of alcoholism among people with these **genotypes**.

8.3 Alcoholism treatments. Although it is a chronic disease, alcoholism can be treated successfully. Any successful physiological treatment for alcoholism must also include a psychological component. Similar to other chronic diseases, such as heart disease or diabetes, relapse is common during the course of alcoholism. Thus, successful treatment is defined in terms of recovery, not cure. Research continues to develop both pharmacological and psychosocial (behavioral) therapies for alcoholism.[54]

Any successful physiological treatment for alcoholism must also include a psychological component.

Pharmacological treatment has for many years included the use of disulfiram (Antabuse), which affects the metabolism of alcohol in the liver. A person who drinks alcohol while taking disulfiram will experience severe discomfort and illness or, in extreme cases, even death. The expectation of illness deters the ingestion of alcohol. Often, however, alcohol abusers do not take the medication, or take it but continue to drink despite the consequences. Moreover, disulfiram treats only the effects, but not the causes, of the disease. This reduces its effectiveness unless used in conjunction with other behavioral therapies.

Figure 13. *Disulfiram is a drug approved by the Food and Drug Administration to treat alcoholism.*

More recently, the drug **naltrexone** has been approved as a pharmacological agent to help a person maintain **sobriety**.[58] **Endorphins** are among the hormones believed to be involved in alcohol craving. Naltrexone blocks the receptors for endorphins, thus helping reduce the desire for alcohol. Although clinical trials of naltrexone have been promising, the drug must be taken consistently to be effective. This drug should be used in conjunction with psychosocial therapies. Research is now under way to identify other medications that can be used alone, or in combination with other medications, to treat alcoholism.

Individual-initiated (or "self-help") therapies have traditionally been the backbone of alcohol recovery. The first such program, Alcoholics Anonymous (AA), describes itself as a "worldwide fellowship of men and women who help each other to stay sober." There are formal treatment programs, which include standard behavioral psychology interventions, relapse prevention, and family intervention, all of which can help some patients.

9 Alcohol and Youth

Alcohol abuse and alcoholism affect not just individuals, but whole families. Children become aware of alcohol at an early age. By about five or six years of age, most children can identify alcoholic beverages by smell alone.[48] Interviews with eight- and nine-year-old children living in New Zealand revealed that one-third of them were aware of alcohol-related problems in their own environments.[11] Most acquired their knowledge about alcohol from siblings. However, one-third cited television as their information source.

By about five or six years of age, most children can identify alcoholic beverages by smell alone.

The prevalence of alcoholism in the United States is such that 76 million Americans, or about 43 percent of the adult population, have been exposed to alcoholism in their families.[36] There are thought to be more than 28 million children of alcoholic parents in the United States, with over 11 million of them under the age of 18.[37] Children who live in a home with an alcoholic parent are four times more likely than children of nonalcoholic parents to develop alcoholism themselves.[36] Children of alcoholic parents are harmed in many other ways as well (see Table 5).

The interaction of genetic and environmental factors influences the probability that a young person will abuse alcohol. Children of alcoholic parents generally begin drinking at an earlier age than children of nonalcoholic parents.[12] Children who are restless and easily distracted at age 3 are twice as likely as their more focused counterparts to be diagnosed as alcoholic by age 21.[10]

Table 5. Effects of Alcoholism on Children[37]

Children of alcoholics are more likely than children of nonalcoholic parents to

- suffer child abuse
- exhibit symptoms of depression and anxiety
- experience physical and mental health problems
- have difficulties in school
- display behavior problems
- experience higher healthcare costs

The interaction of genetic and environmental factors influences the probability that a young person will abuse alcohol.

Parental drinking patterns and access to alcohol are associated with adolescents starting and continuing drinking.[26] Conversely, children who are warned about the negative consequences of drinking are less likely to begin.[2] Also, factors such as lack of parental support, monitoring, and communication contribute to alcohol abuse by adolescents. Children who are rejected or mistreated are much more likely to develop problems with alcohol.

Many adolescents develop positive expectations about alcohol use, which factor into their decision about whether to begin drinking. These attitudes are influenced by positive depictions of alcohol use in movies, on television, and in advertisements. Our society has an ambivalent attitude toward alcohol consumption, sometimes restricting it and at other times promoting it. For example, television networks in the United States show advertisements for beer and wine but not for distilled liquor. This voluntary ban on television advertising of hard liquor could end. The positive messages about drinking do not escape the notice of our youngest citizens. A recent study examining 50 children's animated films for examples of tobacco and alcohol use found that 25 of the films (50 percent) depicted alcohol use. Furthermore, the characters drinking alcohol were as likely to be "good" characters as "bad" ones.[22]

As children grow older, their drinking or abstinence is influenced more by their peers and less by their parents. College students have been found to pattern their drinking after the amounts they *perceive* their peers to drink, not what their peers actually consume.[4, 5, 49] These students consistently overestimated the amount of alcohol

consumed by their peers. This bias promotes heavier drinking habits. These studies also show that college students are less prone to heavy drinking after the spring term than the fall term. Presumably, they have experienced some of the negative consequences of alcohol abuse and temper their enthusiasm for drinking. Young people are also prone to model their drinking patterns after people they admire, such as athletes, actors, and musicians.[29]

Ultimately, each individual must decide whether to use alcohol or not. Students who understand the changes alcohol causes in their bodies and how these changes affect their health and behavior can make informed decisions about drinking. Providing that understanding is the first of the four objectives mentioned in the introduction to this curriculum supplement (see page 1).

10 Consequences of Alcohol Abuse and Alcoholism

10.1 The costs to society. Approximately two-thirds of American adults drink alcohol at least once during the course of a year. Most people drink responsibly, but approximately 13.8 million Americans have problems related to either alcohol abuse or alcoholism.[23] The risk for developing alcohol-related problems is higher among those who begin drinking when they are young. Research shows that biological (genetic) and psychosocial factors combine with environmental factors, such as the availability of alcohol, to increase the risk for developing drinking problems.[55]

Biological (genetic) and psychosocial factors combine with environmental factors, such as the availability of alcohol, to increase the risk for developing drinking problems.

Alcohol abuse and alcoholism have a large economic impact on our society. In 1998, alcohol abuse and alcoholism cost an estimated $185 billion in lost productivity, illness, premature death, and healthcare expenditures. For 1995, these costs were estimated to be over $166 billion, and in 1992, they were $148 billion.[47] A large portion of these costs is borne, in various ways, by nonabusers (see Figure 14).[56] While 45 percent of the costs of alcohol abuse fall on the abusers themselves and their families, 38 percent falls on government (in the form of lost or reduced tax revenue). Additional costs to nonabusers include, but are not limited to, the economic costs of the criminal justice system and higher insurance premiums, as well as the social costs of alcohol-related crimes and trauma. Some examples of the social costs of alcohol abuse and alcoholism are discussed in greater detail later.

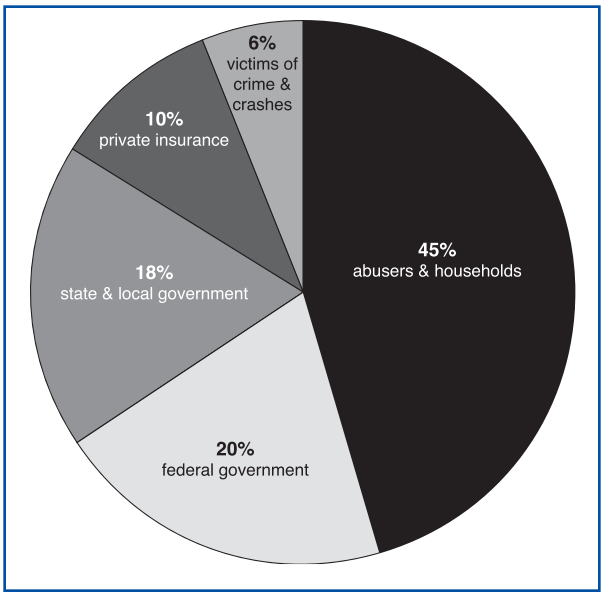

Figure 14. Distribution of the cost of alcohol abuse in the United States in 1998.

10.2 Drinking and driving. Although the proportion of crash fatalities attributable to drinking is declining, the problem is still serious, claiming about 15,000 lives annually in the United States. All states have laws stipulating driver BAC limits. Half the states have already established 0.08 as their *per se* level (meaning no other evidence of intoxication is required), while the other half currently have a limit of 0.10. Alcohol poses a more serious risk for younger drivers. They have less experience with driving and alcohol and consequently exhibit higher crash rates. Recognizing

this fact, all states have laws aimed specifically at preventing underage drinking and driving. Important among these are the minimum legal drinking age of 21 and zero-tolerance laws for underage drinking and driving. In addition, some states have enacted graduated driver licensing (GDL) systems. These systems often feature a three-phase process where 16- and 17-year-old drivers first are required to be supervised at all times by an older driver. The second stage allows them to drive unsupervised during daytime hours. The third stage imposes few restrictions. Recent reports indicate that GDL programs are successful. Crashes involving 16-year-old drivers declined 25 percent in Michigan and 27 percent in North Carolina following implementation of GDL programs.[19, 52]

Some driving skills are more impaired than others for a given BAC. The brain must control eye movement, briefly focusing on objects and tracking them. Low to moderate BACs (0.03–0.05) can interfere with the ability to track objects. Steering depends upon eye-to-hand reactions together with eye movements. Studies show that people have significant trouble steering a car with BACs beginning at 0.02.[42] Alcohol also interferes with the brain's information-processing ability. Another important aspect of driving is the ability of the driver to divide his or her attention. A driver must keep the car in its proper lane while at the same time paying attention to the local environment. Alcohol causes people to favor one activity over the other. Typically, alcohol-impaired drivers pay more attention to steering their car than they do to their local surroundings.

Some statistics about alcohol and driving compiled by the U.S. Department of Transportation include the following[39]:

- Alcohol was involved in 39 percent of fatal crashes and in 7 percent of all crashes in 1997.
- About 3 in every 10 Americans will be involved in an alcohol-related crash at some time in their lives.
- In 1997, the age group of drivers with the highest rates for fatal crashes while intoxicated was 21–24 years old (26.3 percent), followed by ages 25–34 (23.8 percent) and 35–44 (22.1 percent).

Figure 15. The Breathalyzer is used by law enforcement personnel to measure BACs.

- Relatively few problem drinkers (about 7 percent of all drivers) account for over 66 percent of all alcohol-related fatal crashes.
- One-third of all pedestrians 16 years of age or older killed in traffic crashes in 1997 were intoxicated.
- In 1997, an estimated 846 lives were saved by minimum-drinking-age laws.

10.3 Drinking and risky behavior. The perception of risk, risk taking, acting on impulse, and sensation-seeking behaviors are all affected by alcohol use. Among males, higher levels of drinking lead to increased risk-taking behaviors.[14] One study revealed that among a group of adults who came to the emergency room for alcohol-related injuries, three-fourths admitted to not using seat belts.[8] Adolescents who drink are more likely to report that they engage in risky behaviors such as swimming alone or taking someone else's medication.[60]

The perception of risk, risk taking, acting on impulse, and sensation-seeking behaviors are all affected by alcohol use.

The association between alcohol use and risky behavior applies to sexual behaviors, as well. The consequences of such behaviors can include rape,

transmission of diseases, unwanted pregnancies, and birth defects. Surveys of young people show an association between alcohol use and engaging in risky sexual behaviors.[53] Among boys, 17 percent said that they were less likely to use condoms when having sex after drinking. Alcohol use also correlates with increased risk of forced sexual activity. In one study of Massachusetts teenagers, 44 percent said they were more likely to engage in sexual intercourse if they had been drinking.[53]

Sometimes risky behavior associated with drinking may be inadvertent. For example, mixing alcohol with some medicines can produce serious and even fatal consequences. Anyone taking prescription and/or over-the-counter medications should carefully read the labels and check with a pharmacist, physician, or other health professional to be aware of possible adverse reactions if the drug is mixed with alcohol.

10.4 Drinking and pregnancy. Pregnant women who drink expose their unborn children to alcohol through the **placenta**. That exposure can lead to **fetal alcohol syndrome (FAS)**, which is characterized by a variety of developmental problems, some of which can be severe (see Table 6, below, and *The immune system,* on pages 36–37). FAS is estimated to be the most common preventable cause of mental retardation in children. Although not completely understood, the severity of the signs and symptoms seems to be related to the amount, frequency, and timing of alcohol consumption by the mother during pregnancy.

Diagnosis of FAS has been greatly improved by discoveries in alcohol research. Still, because there is no simple laboratory test to detect FAS, it is difficult to estimate its incidence with great accuracy. Complicating this situation are studies that indicate that some physicians are reluctant to make the diagnosis even when it does exist. Presumably, they don't want the child burdened with the stigma associated with FAS, and they recognize that the disorder has limited treatment options. Nevertheless, early and accurate diagnosis and referrals of these children and their parents/caregivers for appropriate medical, social, and educational services is effective.

Table 6. Characteristics of Fetal Alcohol Syndrome

growth deficiency either before or after birth
distinctive abnormal facial features
central nervous system disorders, including: • cognitive deficits • developmental delays • behavioral impairments • structural abnormalities

On the basis of a study in Washington State, it has been estimated that the minimum rate of FAS in the general population is 3.1 per 1,000 live births, or 0.31 percent.[15] Among heavy drinkers, the rate is 4.3 percent, which translates to more than 2,000 cases per year in the United States.[54] The incidence of FAS varies among different racial and ethnic groups. For example, data from the Centers for Disease Control and Prevention indicate that the incidence of FAS is seven times greater among African Americans than European Americans. Some Native American groups have a 30-fold greater incidence of FAS than the general population.[13] Since some populations are disproportionately affected by FAS, it is important that researchers, healthcare providers, and educators from these populations be involved in obtaining knowledge about and treatments for this serious disorder.

An additional unestimated number of children are born each year who were exposed to alcohol *in utero* but do not have the full syndrome. Their condition is termed **fetal alcohol effects** (**FAE**). They show one or more birth abnormalities associated with alcohol exposure. These may be either physical or neurodevelopmental.

The deficits associated with FAS are lifelong. Although the distinctive facial features of FAS become less apparent after puberty, the intellectual impairments remain, and emotional, behavioral, and social problems often get worse. In one study, adolescents and adults with FAS were found to have arithmetic skills at the second- to fourth-grade levels.[54] Children with FAS are often

described as hyperactive with short attention spans. They display a number of behavioral problems including poor judgment, failure to consider the consequences of their actions, and failure to appropriately respond to social cues.

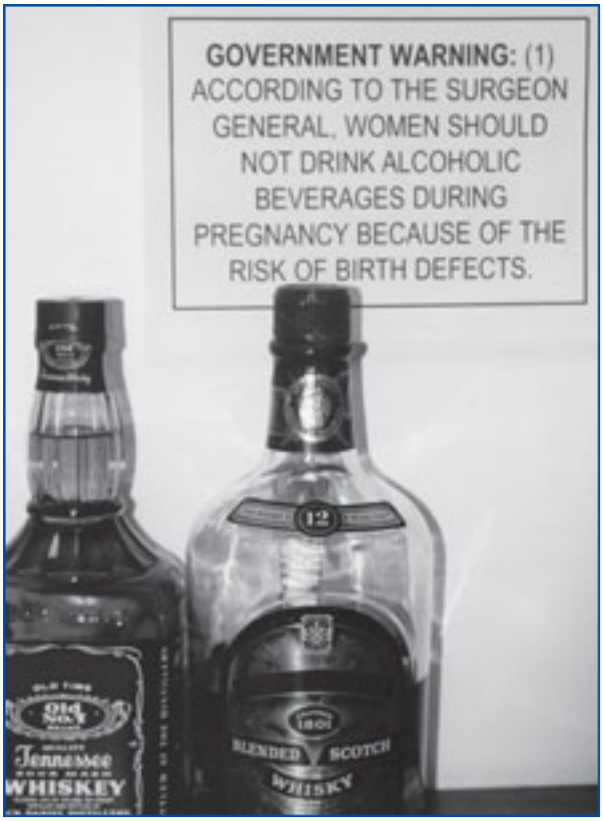

Figure 16. *Pregnant women should not drink alcohol.*

The timing of alcohol exposure during pregnancy is critical to the development of FAS and FAE. By using animal studies to explore the relationship between alcohol exposure and FAS, researchers are able to control not only the timing and dose of alcohol during pregnancy, but also the genetic background and environment of the test animals. A high BAC can destroy nerve cells in the developing rat brain.[27] The timing of this nerve-destroying alcohol exposure in rats corresponds to the brain growth spurt in humans, called **synaptogenesis**, when brain cells form most of their interconnections. In humans, synaptogenesis lasts from about the sixth month of pregnancy to a child's second birthday. In rats, this period occurs for a short period after the pup is born. The scientists exposed newborn rat pups to a BAC of 0.20 (about twice the BAC defined as legally intoxicated in humans). This high BAC was maintained for four hours or longer. A one-time exposure of four hours was sufficient to cause brain cells to die off at a rate nearly 30 times greater than normal.[27] Although it is difficult to translate these results from rats to humans, the uncertainties involved led the authors to advise expectant mothers to avoid alcohol entirely during their pregnancies.

A high BAC can destroy nerve cells in the developing rat brain.

10.5 Drinking and violence. It has long been observed that there is an association between alcohol use and aggressive or violent behavior. Clearly, violence occurs in the absence of alcohol, and drinking alcohol alone is not sufficient to cause violence. However, numerous studies have found that alcohol is involved with about half of perpetrators of violence and their victims. This relationship holds across cultures and for various types of violence. In the United States, alcohol use is a significant factor in[47]

- 68 percent of manslaughter cases
- 62 percent of assault offenders
- 54 percent of murders
- 48 percent of robberies
- 44 percent of burgerlies

The mechanism by which alcohol contributes to aggressive behaviors is not completely understood. Alcohol may interfere with the brain's mechanisms for restraining impulsive behaviors. Individuals who are intoxicated may misread social cues, overreact to situations, and not be able to accurately anticipate the consequences of their actions. In addition, alcohol consumption can lead to increased vulnerability in potential victims. Intoxicated people are often less able to defend themselves against a violent attack than are people who are sober. For example, a survey of students in

grades 8 and 10 across the United States showed that alcohol use correlates significantly to risky behavior and victimization. This association was strongest among eighth-grade males.[61]

Individuals who are intoxicated may misread social cues, overreact to situations, and not be able to accurately anticipate the consequences of their actions.

One experimental approach to studying the relationship of alcohol to aggressive behavior is to have a test subject administer an electric shock to an unseen "opponent" as part of a competitive task, such as one involving learning and reaction time. Unknown to the test subject, a computer plays the role of the opponent. The test subject performs the task while sober and after alcohol consumption. Such studies show that test subjects administer stronger electric shocks with increasing alcohol consumption. These same studies also reveal that test subjects do not display aggressive behavior unless they feel threatened or provoked.[8] Once again, these results show that alcohol alone is associated with, but not sufficient to account for, aggressive behavior.

The relationship between alcohol and violence is complex. Alcohol seems to influence aggressive behaviors in some individuals but not others, and only in certain social or cultural situations. Although our knowledge of the causes of violence is limited, research suggests that some violence may be treatable through behavioral therapies. Studies also show that successful alcoholism treatments have the added benefit of reducing violent behaviors.

Glossary

absorption phase: The time immediately after consumption when blood alcohol concentration rises sharply.

acetaldehyde: One of the first products of the body's metabolism of alcohol. Acetaldehyde is then converted to carbon dioxide and water, which are excreted from the body.

acute: Short-term.

addiction: A state that involves a physical or psychological dependency on a drug or alcohol.

alcohol: The intoxicating chemical in drinks such as beer, wine, and distilled liquors. Alcohol is a colorless, volatile liquid with the chemical formula C_2H_5OH, also called ethanol or ethyl alcohol. It is a central nervous system depressant.

alcohol abuse: The continued use of alcohol despite the development of social, legal, or health problems.

alcohol addiction, alcohol dependence, or alcoholism: A chronic disease characterized by a strong craving for alcohol, a constant or periodic reliance on use of alcohol despite adverse consequences, the inability to limit drinking, physical illness when drinking is stopped, and the need for increasing amounts of alcohol to feel its effects.

alcohol dehydrogenase (ADH): An enzyme found in the liver and stomach that helps break down alcohol into substances that can be excreted from the body. Specifically, ADH converts alcohol into acetaldehyde, which is then converted to carbon dioxide and water.

alcoholic hepatitis: Liver disease caused by chronic ingestion of alcohol.

alleles: Different variations of the same gene.

arteries: Thick-walled blood vessels that carry blood away from the heart.

axon: Extensions of nerve cells that carry the nerve impulses away from the nerve cell body.

binge drinking: A pattern of heavy drinking that occurs during an extended period of time set aside for drinking. Has been described as 5/4 binge drinking: five or more drinks in a row on a single occasion for a man or four or more drinks for a woman.

blood alcohol concentration (BAC): The amount of alcohol in the blood expressed as a percent: grams of ethanol per 100 milliliters (deciliter) of blood.

brainstem: The part of the brain that connects the spinal cord with other parts of the brain.

CAGE: Refers to a questionnaire developed by Dr. John Ewing to screen for alcohol abuse and alcoholism. The name comes from the first letters of key words in the questionnaire: **C**ut down on drinking, **A**nnoyed by people criticizing your drinking, **G**uilty about drinking, and drinking as an **E**ye opener.

cardiovascular system: The organ system that includes the blood, the heart, and blood vessels.

cerebellum: The region of the brain involved with coordination of muscles and maintaining balance and posture.

chromosomes: Rod-like, gene-bearing structures found in the cell nucleus. They are composed of DNA and protein. Humans have 46 chromosomes.

chronic: Long-term; refers to diseases or habits that last a long time, recur, or are difficult to cure.

cirrhosis: Hardening of connective tissue in the liver; fibrosis.

cognitive: Relating mental awareness and judgment.

coronary artery disease: A condition in which cholesterol and fat in the blood build up in clumps known as plaque on the inside walls of arteries. This build-up can restrict the flow of blood and thus of oxygen to the heart. Oxygen starvation of the heart muscle can lead to a heart attack.

cytokines: A class of molecules that help regulate the activities of the immune system.

delirium tremens (DTs): A serious alcohol-withdrawal syndrome observed in persons who stop drinking alcohol following continuous and heavy consumption. It involves profound confusion, hallucinations, and severe nervous system overactivity, typically beginning between 48 and 96 hours after the last drink.

dendrite: A cluster of small fibers that receive chemical messages from neighboring neurons and transmit them to the cell body.

depressant: A substance that causes sedation and drowsiness. Alcohol is a central nervous system depressant.

diffusion: The passive movement of a substance from a region where it is more concentrated to a region where it is less concentrated. For example, blood alcohol concentration decreases as alcohol diffuses from the blood into body tissues.

distillation: A process that uses heat to purify or separate a fraction of a complex substance. Various components of the mixture are collected as gases condense to liquids. Liquors are produced through distillation.

distribution phase: The process by which ethanol spreads from the blood to all tissues and fluids in proportion to their relative water content.

dopamine: A chemical messenger (neurotransmitter) that regulates brain processes such as those that control movements, emotions, pleasure, and pain.

drug: In a medical context, any substance used in the diagnosis, prevention, treatment, or cure of a disease. In an abuse context, any substance that alters consciousness and may be habit forming.

elimination phase: The combined processes of metabolism and excretion that decrease blood alcohol concentration.

endorphins: A class of protein hormones produced in the brain that have pain-relieving properties.

endotoxin: A bacterial toxin composed of protein, lipid, and polysaccharides.

enzyme: A class of proteins that speed up chemical reactions in the body.

esophageal cancer: Cancer of the esophagus (throat).

esophagus: The part of the digestive system that receives food. This is the tube leading from the mouth to the stomach.

ethanol: See alcohol.

ethyl alcohol: See alcohol.

euphoria: A feeling of well being.

excretion: The loss of ethanol from the body through urine, sweat, breath, and other routes of exit.

fermentation: An anaerobic process (not requiring oxygen) in which organisms convert sugars into alcohol and carbon dioxide. This process does not occur in animals but is used extensively by yeast (single-celled fungi). Humans exploit this phenomenon to make bread (the gas bubbles expand the dough) as well as wine and beer (for the alcohol produced).

fetal alcohol effects (FAE): A pattern of mental and physical birth abnormalities associated with children whose mothers abused alcohol during

pregnancy. The symptoms are less severe than those in fetal alcohol syndrome.

fetal alcohol syndrome (FAS): A pattern of mental and physical birth abnormalities found in some children of mothers who drank excessively during pregnancy.

fibrosis: A condition within a tissue or an organ that is characterized by an increase in fibrous tissue.

free radicals: Short-lived, highly reactive molecules that have one or more unpaired electrons.

functional tolerance: A state in which a chronic alcohol abuser learns to function under the influence of alcohol. The impairment normally associated with performing a familiar task is reduced, but the ability to perform unfamiliar tasks remains impaired.

gastritis: An inflammation of the stomach lining.

gene: The functional and physical unit of heredity. Genes are segments of DNA found along a chromosome. They typically encode information used to produce a specific protein.

genetically predisposed: Having variations in genes that increase the probability of displaying a given trait.

genotype: The genetic makeup of an individual. The expression of genotype as visible traits is called the phenotype.

glucagon: A pancreatic hormone that increases the concentration of blood sugar. Its effect is opposite to that of insulin.

growth hormones: Hormones that affect growth of the body, for example, by stimulating cell division and bone growth.

hallucination: The experience of sights and sounds that are not actually present.

hippocampus: A part of the brain that is responsible for learning and spatial relations.

hormone: A chemical released into the bloodstream that stimulates or inhibits an action in another body tissue.

hypertension: A condition of abnormally high blood pressure.

hypothalamus: A small area of the brain that is responsible for regulating the release of some hormones and maintaining body temperature.

impairment: Diminished ability, such as when alcohol decreases motor function or interferes with thinking.

inflammation: The body's response to tissue damage characterized by redness, swelling, heat, and pain.

inhibition: As related to behavior, restraint on instinctive impulses.

insulin: A hormone produced in the pancreas that lowers the blood sugar level. Its effect is opposite to that of glucagon.

intoxication: The condition of being drunk. An abnormal state that is essentially alcohol poisoning. It is characterized by slurred speech and a loss of coordination.

limbic system: The areas of the brain involved with emotions and memory.

lymphocytes: The white blood cells, the T cells, and B cells of the immune system.

metabolism: All the chemical reactions that enable the body to function. Nutrients and materials are broken down into stored energy or into usable compounds. The biological transformation of ethanol to acetaldehyde and other products.

mitochondria: The cellular organelles that function as energy factories in the cell. Mitochondria produce ATP (the energy currency of our bodies).

motor function: The ability to use and control muscles and movements. Alcohol and drugs interfere with the neuronal messages from our brain to muscles resulting in impaired motor function.

naltrexone: A drug that has been effective in the recovery from alcoholism. It blocks receptors for endorphins, thereby reducing alcohol cravings. Use of the drug in combination with psychosocial therapy improves the effectiveness of treatment.

neurons: One of two principal classes of cells in the nervous system, composed of three parts: the cell body, dendrites, and axons. Neurons receive and conduct electrical impulses.

neurotransmission: The process by which neurons transmit messages to other neurons, muscle cells, or gland cells.

neurotransmitter: A chemical substance that transmits a nerve impulse across a synapse.

nucleus accumbens: The part of the brain related to the limbic system that controls emotions.

pancreatitis: An acute or chronic inflammation of the pancreas associated with alcoholism and marked by severe abdominal pain, nausea, and fever.

pharmacokinetics: The study of the absorption, distribution, and elimination of alcohol and other drugs.

physical dependence: A condition in which the presence of a drug or alcohol is required to maintain normal functioning of the central nervous system. (See *withdrawal symptoms*.) Physical dependence is caused by changes in the relationships among nerve cell membranes, neurotransmitters and their receptors, and the reward pathway.

placenta: A membranous organ that develops during pregnancy. It lines the uterine wall, partially envelopes the fetus, and is attached to the umbilical cord. The placenta exchanges nutrients, wastes, and gases between maternal and fetal blood. Substances ingested by the mother during pregnancy pass through the placenta to the fetus.

polygenic: A trait, such as alcoholism, whose expression is influenced by more than one gene.

predispose: To make susceptible, such as to certain health problems or to alcohol dependency. For example, the presence of certain gene combinations or environmental conditions can predispose an individual to develop alcoholism.

prefrontal cortex: The part of the frontal lobe of the brain that relates to pleasure.

psychosocial: Involving both social and psychological behavior.

reinforcement: The positive effects of alcohol, such as its euphoric and anxiety-reducing effects, that help promote continued drinking. Specific neurotransmitters and regions of the brain are implicated in alcohol's reinforcing effects.

relapse: To fall back or revert to an earlier state; to regress after partial recovery. In the context of alcohol abuse and alcoholism, relapse means to start drinking again after giving up alcohol.

reproductive hormones: Hormones that influence development of secondary sexual traits and the production of or maturation of the sperm and the egg. These include testosterone, leutinizing hormone (LH), follicle stimulating hormone (FSH), estrogen, and progesterone.

reward pathway: A specialized network of neurons in the brain that produce and regulate pleasure associated with eating, drinking, and sex. These neurons use dopamine as a neurotransmitter. Alcohol activates the reward pathway. Alcohol abusers and alcoholics use alcohol to avoid the pain (lack of pleasure) associated with withdrawal.

sobriety: The condition of refraining from drinking alcohol.

sodium-potassium pump: Proteins embedded in the cell membrane that actively move potassium ions into the cell and, at the same time, move sodium ions out.

soluble: Capable of being dissolved in a solvent such as water or another liquid.

stimulant: A substance such as caffeine, nicotine, or amphetamines that temporarily arouses or accelerates physiological activity in the brain.

stupor: A state of impaired consciousness accompanied by diminished responsiveness to external stimuli and surroundings.

synapse: The tiny space between two nerve cells or between a nerve cell and a muscle or gland cell.

synaptogenesis: The time frame from about the sixth month of pregnancy to a child's second birthday when the brain experiences a growth spurt and brain cells form most of their interconnections.

testosterone: A sex hormone responsible for secondary sex characteristics. Present in both males and females but at lower concentrations in females.

tolerance: The body's ability to adapt to chronic alcohol or substance use. Higher BACs are needed to produce intoxication in alcohol abusers and alcoholics. Chronic alcohol use leads to increased levels of liver enzymes that metabolize alcohol. Since they allow the liver to more efficiently break down alcohol, the individual must consume a larger dose to reach a given BAC. This increased level of alcohol can severely damage the body's physiological systems, despite the apparent "normalcy" displayed by the individual.

tuberculosis: A communicable disease caused by a bacterium that causes lesions of the lung, bone, and other body parts. Drug and alcohol abusers are infected at a rate 15–200 times greater than that of nonabusers.

ventral tegmental area: Component of the reward pathway in the brain; located near the top of the brainstem.

withdrawal symptoms: Severe alcohol cravings as well as physical and psychological problems caused by the withdrawal from excessive, chronic alcohol consumption. The biochemical changes lead to short-term memory loss, disruption of cognitive and motor function, reduced perceptual abilities, and emotional and personality changes that include acts of aggression.

zero-tolerance laws: Laws that exist in all states and the District of Columbia making it illegal for anyone under the age of 21 to drive a car after drinking *any* alcohol.

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Lesson 1
Engage

Alcohol: Separating Fact from Fiction

Figure 1.1. When it comes to alcohol, it's not always easy to separate fact from fiction.

At a Glance

Overview

For teachers with Web access, the first lesson of the module begins by having students watch two short video clips of mouse activity. Students then record their observations of the behavior of the mice. Students come to realize that the differences in behavior are due to the effects of alcohol intoxication. Students are then confronted with a series of statements about alcohol and asked whether they agree or disagree with each statement. This activity helps you assess students' prior knowledge of the topic while helping students clarify their own understanding.

Major Concepts

Students receive mixed messages about alcohol consumption. On the one hand, they observe that society considers drinking alcohol socially acceptable. Movies, media, and advertisements often portray the use of alcohol as part of a desirable lifestyle. Simultaneously, however, students are warned that alcohol is dangerous and should be avoided. This situation leaves many adolescents with incomplete understanding and misconceptions about alcohol use and its effects.

Objectives

During this lesson, students will

- obtain a clearer understanding of their knowledge about alcohol;
- recognize that their attitudes, beliefs, and knowledge about alcohol may be different from those of their peers;

- identify areas where their understanding of alcohol is incomplete or even wrong; and
- gain experience with scientific methods, such as observation and inference.

Teacher Background

Consult the following sections in Information about Alcohol:
1 Introduction (pages 23–24)
2 Alcohol Use, Abuse, and Alcoholism: Definitions (pages 24–25)
3 Misconceptions about Alcohol Use, Abuse, and Alcoholism (pages 25–27)
7 Alcohol: Behavioral Effects (pages 37–39)

In Advance

Web-Based Activities

Activity	Web Version?
1	Yes
2	No

Photocopies

Activity 1	no photocopies needed
Activity 2	Master 1.1, *Alcohol: Is This Right?* (Make 1 copy for each student and prepare an overhead transparency.)

Materials

Activity 1	computers with an Internet connection[a]
Activity 2	no materials needed (except photocopies)

[a] Ideally, videos are presented to the class using a single computer whose monitor is projected to the class. Alternatively, students view the videos on computers individually or in small groups.

Preparation

Check with your computer lab personnel to determine which type of Internet connection you will be using. For Activity 1, you need to know whether you will use a modem, an ISDN line, or a T1 connection.

Activity 1: *What's Up with This Mouse?*

Teacher note
This activity is for classes with access to the Internet. The activity is designed to be conducted by students *before* they are told they will be participating in a module about alcohol. Students are asked to carefully observe the behavior of two mice and record their observations. One mouse has been given a dose of alcohol sufficient to render it intoxicated, while the other mouse has not been given alcohol. The students' observations are discussed in this activity and referred to again in Lesson 3, *Responding to Alcohol: What's Important?*

It is not essential that the students are unaware that they will be participating in a module about alcohol for this activity to be useful. During field testing of this module, even when students knew that one mouse had been given an intoxicating dose of alcohol, they could not always identify which mouse was intoxicated. Regardless of whether the class knows that alcohol is the topic under investigation, the discussion of which aspects of mouse behavior are caused by alcohol and their relevance to humans who consume alcohol is a useful one.

1. Log onto the Web site *http://science.education.nih.gov/supplement/alcohol/student* and click on "Lesson 1—Alcohol: Separating Fact from Fiction." Select the type of Internet connection you are using (56k modem, ISDN, or T1) and click to play a mouse video.

2. Explain to the class that they will view two short video clips of mice. Ask the students to observe the behavior of each mouse and record their observations on a sheet of paper. If some students are aware that the module is about alcohol, do not reveal which video clip shows the mouse that has been given alcohol.

3. Discuss the difference between an observation and an inference. Ask students:

   - What is an observation?

     Answers may vary. An observation relates to what a person can actually see. It involves the noting and recording of facts.

   - What is an inference?

Figure 1.2. Alcohol has many effects on mouse behavior.

An inference is a conclusion that follows logically from available evidence but is not a direct result of that evidence. This means that people may make different inferences from the same evidence.

- **If I say that the mouse is white, is that an observation or an inference?**

  This statement is an observation because you can see that the mouse is white.

- **If I say that the mouse is happy, is that an observation or an inference?**

  This statement is an inference because the mouse cannot tell you that it is happy, and it cannot display a behavior that indicates only happiness.

- **If I say that the mouse is drinking water, is that an observation or an inference?**

  If you see a mouse drinking water, then the statement is an observation. You can infer that, because the mouse is drinking water, it is thirsty.

Content Standard A: Develop descriptions, explanations, predictions, and models using evidence.

- **Why is it important for scientists to distinguish between observations and inferences?**

  Observations provide the facts that all scientists can agree on, while inferences are subject to individual interpretation.

4. **Ask students to take out a piece of paper and label it as follows:**

Mouse 1	
Observations	Inferences
Mouse 2	
Observations	Inferences

5. **Click on "mouse 1" to play the first video clip. Ask the class to observe carefully and record the behavior of the mouse.**

   Do not mention anything about the mouse or why you are asking them to observe it. This first clip shows the mouse that has not been given alcohol being placed on the center of a table. The mouse is nervous and tentatively explores its environment. It cautiously moves short distances in a circular pattern around the spot upon which it was placed. It occasionally rears up and sniffs the air. Replay the video if necessary.

6. **Invite students to share their observations and inferences about the behavior of the mouse. Ask students if they agree or disagree with the statements.**

   Students report various descriptions of the mouse's behavior. Some of the words and phrases provided by the field-test students are listed in the following table.

Mouse 1	
Observations	Inferences
sniffing	confused
moving slowly	hungry
moving in circles	tired
moving head up and down	afraid
rising on back legs	drunk

7. **Click on "mouse 2" to play the second video clip. Again, ask the class to observe carefully and record the behavior of the mouse. As before, do not mention anything about the mouse.**

   This second clip features the mouse that is intoxicated with alcohol. It has lost its sense of inhibition and immediately runs off the edge of the table. Each time the mouse is repositioned and released, it again recklessly runs off the table's edge. Replay the video if necessary.

8. **Invite students to share their observations and inferences about the behavior of the mouse. Ask students if they agree or disagree with the statements.**

   Once again, student descriptions of the mouse's behavior will vary. Some of the words and phrases provided by the field-test students are listed in the following table.

Mouse 2	
Observations	Inferences
running	scared
moves in a straight line	alert
doesn't sniff	not hungry
falls off table	not cautious
stays low on table	drunk

9. **Point out that the behavior of the second mouse was clearly different from the first mouse. Ask students to suggest reasons that could account for the differences in behavior.**

   Their answers will vary but may include sickness (either hereditary or infectious); exposure to drugs, alcohol, or chemicals; and age. Accept all responses that could reasonably account for the differences in behavior. List the responses on the board.

10. **Explain that, in fact, the second mouse was intoxicated with alcohol. Ask the class how the behavior of the intoxicated mouse is similar to that of intoxicated humans.**

    Answers will vary. Make sure that students appreciate that alcohol causes the mouse to lose its normal cautious nature in a manner similar to that in which humans lose their inhibitions after drinking alcoholic beverages.

Content Standard A: Recognize and analyze alternative explanations and predictions.

Activity 2: *Alcohol—Separating Fact from Fiction*

Teacher note
The purpose of this activity is to assess students' prior knowledge about alcohol. Explain to the class that the handout they are about to receive is not a test or a quiz and it will not be graded. At the conclusion of the entire module (all six lessons), the class will receive another copy of the handout and again will have an opportunity to react to the statements. This enables you and the class to see how attitudes and beliefs change as a consequence of the module.

1. **Explain to the class that they will now participate in a discussion to see what they know (or think they know) about alcohol.**

2. **Pass out a copy of Master 1.1, *Alcohol: Is This Right?*, to each student.**

Assessment: Listening to students' explanations gives you another opportunity to assess whether they understand the difference between observations and inferences.

3. **Instruct students to write their names on the handout. Ask them to circle whether they agree or disagree with each of the numbered statements.**

   Students may ask you to clarify some statements. It is not necessary to define terms at this point. The idea is to provoke students into assessing what they currently know or think they know about alcohol. Through the lessons of this module, students will become more familiar with terms associated with alcohol. Remind students that this is not a test.

4. **After students have had an opportunity to respond to each of the statements, collect their handouts and save them until the conclusion of the module.**

5. **Show the class a transparency of Master 1.1, *Alcohol: Is this Right?* Read each statement aloud and ask them to raise their hands if they agree with it.**

   At this time, do not judge the students' responses or provide them with additional information.

6. **Invite students to share their views about each statement with the class. Allow several students to respond to each statement.**

   As students discuss their beliefs about alcohol, they may bring up issues related to their family life. Such circumstances require sensitivity on your part. If other students make judgmental or inappropriate comments, be sure to reinforce the idea of being respectful of others' experiences. If necessary, talk to affected students individually to determine whether they have issues that might require professional help. Also, refer to *How Can Controversial Topics Be Handled in the Classroom?*, on page 14.

7. **Ask students how they learned about alcohol. Use the following questions to guide the discussion.**

   - **Where did you get your information about alcohol?**

     Students will list a variety of sources that may include parents, siblings, friends, television, movies, magazines, songs, and observations of people.

   - **How do you know if your information is accurate?**

Assessment:
The discussion of students' responses to the statements on Master 1.1 provides you with an assessment of their current understanding about alcohol.

Content Standard A:
Different kinds of questions suggest different kinds of scientific investigations.

Figure 1.3. Students learn about alcohol from different sources including teachers, parents, and friends.

Responses will vary. Information from another person depends on the level of trust they have with that person. Students may regard information from doctors or news reports to be more accurate than that from movies or friends.

- **How would a scientist learn about alcohol?**

  Students may respond that scientists conduct research, sometimes using animal models, to learn about alcohol. This may involve making hypotheses, recording observations, gathering data, making inferences, and reaching conclusions based upon evidence. Scientists also review the work of other scientists who have investigated the topic.

  This is an opportunity to reinforce the idea that gathering and analyzing data are critical to scientific investigations.

8. **Inform students that they will think about these statements again at the end of the module.**

Lesson 1 Organizer

Activity 1: *What's Up with This Mouse?*

What the Teacher Does	Procedure Reference
Log onto Web site and click on "Lesson 1—Alcohol: Separating Fact from Fiction." Select the type of Internet connection you are using. Select a mouse video clip.	Page 59 Step 1
Instruct the class to pay close attention as you play each of the mouse videos and to record their observations of each mouse's behavior.	Page 59 Step 2
Discuss the difference between an observation and an inference.	Pages 59–60 Step 3
Replay the video clip of mouse 1 and invite the class to share their observations and inferences.	Pages 60–61 Steps 4–6
Replay the video clip of mouse 2 and invite the class to share their observations and inferences.	Pages 61–62 Steps 7 and 8
Ask the class to account for differences in behavior between the two mice.	Page 62 Step 9
Discuss how the behavior of the intoxicated mouse relates to that of intoxicated humans.	Page 62 Step 10

= Involves using the Internet.

= Involves copying a master.

= Involves using a transparency.

Activity 2: *Alcohol—Separating Fact from Fiction*

What the Teacher Does	Procedure Reference
Explain to the class that they will discuss what they know (or think they know) about alcohol.	Page 62 Step 1
Have the class indicate whether they agree or disagree with a series of statements about alcohol on Master 1.1, *Alcohol: Is This Right?*	Pages 62–63 Steps 2 and 3 
Collect their responses and save them until the end of the module.	Page 63 Step 4
Using a transparency of Master 1.1, read each statement and ask students to indicate whether or not they agree with it. • Allow several students to share their views about each statement.	Page 63 Steps 5 and 6 
Discuss with the class how they learned about alcohol. • Where did they get their information? • How do they know if the information is accurate? • How would a scientist learn about alcohol?	Pages 63–64 Step 7
Explain that you will return to these statements about alcohol at the conclusion of the module.	Page 64 Step 8

Alcohol: Is This Right?

Name _____ Date _____

Please circle whether you agree or disagree with each statement.

1. Alcohol is a stimulant.
   Agree Disagree

2. Caffeine will sober you up.
   Agree Disagree

3. Food will keep you from becoming intoxicated.
   Agree Disagree

4. Drinking beer is safer than drinking wine or hard liquor such as vodka or whiskey.
   Agree Disagree

5. Alcohol-related car crashes are all caused by drunk drivers.
   Agree Disagree

6. Alcoholism is a disease.
   Agree Disagree

7. Alcohol abuse and alcoholism affect only the abuser.
   Agree Disagree

8. Alcohol abuse or alcoholism will never be my problem.
   Agree Disagree

9. Nothing can be done about alcohol abuse or alcoholism.
   Agree Disagree

10. It is a good idea to drink alcohol to prevent heart disease.
    Agree Disagree

11. Drinking a large amount of alcohol occasionally is less harmful than drinking a smaller amount every day.
    Agree Disagree

12. Drinking alcohol makes you feel more confident.
    Agree Disagree

Lesson 2
Explore

A Drink Is a Drink, but People Are Different

Figure 2.1. Different people respond differently to drinking alcohol.

At a Glance

Overview

Students investigate what is meant by a *drink* in reference to an alcoholic beverage. Demonstrations using food coloring and water illustrate that various types of alcoholic drinks contain the same amount of alcohol although the total volume of liquid is different. Simulated alcoholic drinks are then diluted into a mixture of oil and water that represents the fat- and water-containing portions of the body. This demonstrates how alcohol is distributed within the body.

Major Concepts

The concentration of alcohol in beer is lower than that in wine or hard liquor. However, the total amount of alcohol in a typical serving of beer (12 ounces), wine (5 ounces), and hard liquor (1.5 ounces) is the same. Because alcohol is *miscible,* or able to mix, with water, it distributes throughout the water-containing portions of the body. The brain has a high water content, and alcohol exerts many of its effects there.

Objectives

After completing this lesson, students will

- be able to explain that *concentration* is a measure of the amount of a substance in comparison with the total amount of the solution;
- understand that various alcoholic drinks contain the same amount of alcohol even though the serving size may be different;
- explain that alcohol is miscible with water but not with fat;
- be able to describe that alcohol distributes throughout the water-containing portions of the body;
- recognize that body size and type influence an individual's response to alcohol; and
- recognize the brain as an important site of alcohol's actions.

Teacher Background

Consult the following sections in Information about Alcohol:
5 Alcohol: Pharmacokinetics (pages 28–31)
6 Alcohol: Biological Effects (pages 31–37)

In Advance

Web-Based Activities

Activity	Web Version?
1	No
2	No

Photocopies

Activity 1	Master 2.1, *What Is a Drink?* (Make one copy per student and prepare a transparency.)
Activity 2	Master 2.2, *Tracing Alcohol's Path through the Body* (Prepare a transparency.)

Materials

Activity 1	For the class: 4 identical 1-gallon containers, such as clear plastic milk bottles [a, b] 1 measuring cup, marked in ounces 1 clear shot glass, or other clear cup that holds 1.5 ounces 1 clear wine glass, or other clear cup that holds 5 ounces 1 clear beer mug, or other clear cup that holds 12 ounces water

Activity 1	red food coloring (0.3-ounce bottle)[c] 1 stirring rod 1 piece of white poster board to use as a backdrop for the demonstration
Activity 2	For the class: 2 clear containers (drinking glasses) that hold at least 8 ounces of liquid [d, e] 2 containers that hold at least 2 ounces of liquid 2 ounces of rubbing alcohol (isopropyl alcohol) water mineral oil (8 ounces)[f] red food coloring (0.3-ounce bottle)[c]

[a] Large beakers (2,000 mL) or clear, 2-liter soda bottles may be good choices if larger containers are not available.

[b] Ideally, all of the containers will be transparent to help the class see the color intensities of the simulated alcoholic beverages.

[c] Other colors of food coloring may be used. Be sure to select a color that will show up well in the demonstration. Yellow may not be a good choice.

[d] The 8-ounce containers should be tall and slender (such as a drinking glass) as opposed to short and stout. This helps students visualize the water and oil phases.

[e] If you are doing this demonstration in front of a large class, you may wish to adapt it for your situation. If you use the volumes of water, mineral oil, and food-coloring solution listed, you may wish to walk around the room with the containers so that students can see them well. Alternatively, you may scale up the volumes of each liquid and use larger containers. Visually, this may be more effective, but it necessitates additional materials.

[f] If you are doing the demonstration for multiple classes, you can separate the mineral oil from the water and reuse it, but that requires additional preparation time.

Preparation

ACTIVITY 1

Fill four 1-gallon containers about three-quarters full of water. Prepare diluted red-food-coloring solution by adding 1 teaspoon of the food coloring to one of the gallon containers that has been filled about three-quarters full with water. Mix.

Prepare the simulated shot of hard liquor by adding 1.5 ounces of the diluted red-food-coloring solution to the shot glass or small cup (1.5 ounces total).

Prepare the simulated glass of wine by adding 1.5 ounces of the diluted red-food-coloring solution to the wine glass or a medium cup containing 3.5 ounces of water (5 ounces total).

Prepare the simulated mug of beer by adding 1.5 ounces of the diluted red-food-coloring solution to the beer mug or large cup containing 10.5 ounces of water (12 ounces total).

Teacher note
Practice this demonstration before attempting it in front of a class to ensure that the differences in color are obvious. Notice that each of the three simulated beverages contains the same amount of food coloring ("alcohol"). The "shot" should be noticeably darker than the "wine," which should be noticeably darker than the "beer." If the three drinks do not have noticeably different color intensities, then you may have to change the amount of food coloring that you add when you make the diluted food-coloring solution.

ACTIVITY 2
Teacher note
To reduce the amount of materials needed, this activity is described as a teacher demonstration. You can perform the dilutions yourself or have student volunteers assist. If you prefer, you can divide the class into small groups and have them each perform the activity.

Place 2 ounces of rubbing alcohol into a container and add three drops of red food coloring. Mix to give the solution a uniform color. Divide the red rubbing-alcohol solution equally between the two smaller containers.

To simulate different body types, pour 6 ounces of water into one drinking glass (or other transparent container), and pour 4 ounces of water into the other drinking glass.

Slowly and carefully pour 2 ounces of mineral oil down the side of the drinking glass that contains 6 ounces of water. Being less dense than water, the mineral oil will form a layer on top of the water.

Slowly and carefully pour 4 ounces of mineral oil down the side of the drinking glass that contains 4 ounces of water.

Teacher note
Save some diluted food coloring and the beer mug (or a clear glass) to use during Lesson 4.

Procedure

Teacher note
You may notice that this lesson uses units of ounces and gallons instead of metric units. This is because alcoholic beverages in the United States are typically described using ounces and this system is more familiar to students.

Activity 1: What Is a Drink?

1. **Introduce the activity by asking students to name different kinds of alcoholic beverages. List the different beverages on the board.**

Students will name a variety of alcoholic beverages, including specific varieties of beers, wines, and hard liquors.

2. **On the board, write the three categories of alcoholic beverages: beer, wine, and hard liquor. Invite students to suggest into which category each beverage should be placed.**

   Students likely will have heard the term hard liquor, but they may not understand what it means. At this stage, simply tell students that it refers to the way the alcoholic beverages are produced.

3. **Invite students to consider the differences among the alcoholic beverages they named. Why can alcoholic beverages be placed in different categories? Are they all the same in terms of amount of alcohol? Do they cause different effects?**

   Allow students to express their views. Some students will have misconceptions about the different types of alcoholic beverages. For example, some students will say that the effects of alcohol depend only on the amount, or total volume, of a drink (of any type) that a person consumes. Other students will volunteer that hard liquor contains more alcohol per unit of volume than does beer or wine. Students will revisit this question after the demonstration.

4. **Explain to the class that you are going to conduct a demonstration to investigate the amount of alcohol in the three different types of drinks.**

5. **Place the three simulated alcoholic beverages—the beer, wine, and hard liquor—on the table in front of the class. Explain that the liquid is actually water with red food coloring. The red food coloring represents the alcohol in each drink. Ask students to share their observations about the three drinks.**

Figure 2.2. All three of these drinks contain the same amount of alcohol.

Content Standard A: Think critically and logically to make the relationships between evidence and explanations.

Content Standard B: A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.

Students will mention that the beverages have different volumes of liquid, and that the red color varies in shade among the different drinks. The liquid in the shot glass has the deepest red color, and the liquid in the beer glass has the lightest red color. Do not explain at this point that each drink has the same amount of "alcohol."

6. **Place the three 1-gallon containers, each about three-quarters full of water, in view of the class. Explain that each container represents the water in a human body. Point out that the three containers hold equal amounts of water. Ask students to predict what will happen if you pour the "drinks" into the containers. Will the three containers look different from each other after you add the different "drinks" to them, or will they look the same?**

7. **Pour the simulated shot of hard liquor into the first gallon container and mix to allow the food coloring to quickly distribute throughout the water. Ask the class to observe what is happening.**

8. **Pour the simulated glass of wine into the second gallon container and mix to allow the food coloring to quickly distribute throughout the water.**

9. **Pour the simulated mug of beer into the third gallon container and mix.**

10. **Invite students to share their observations of the colors in the three containers. Do the different containers look the same or do they look different from each other? Which contains the most alcohol?**

    Because each glass contains 1.5 ounces of the diluted red-food-coloring solution, the shade of red in each should be about the same. (Since the simulated drinks have different volumes, the final volumes in the gallon containers will be slightly different.) If the gallon containers are not clear enough for the class to see the colors of the solutions, then pour equal quantities of the solutions into separate clear beakers or drinking glasses, so that students can accurately compare the tints of the three solutions.

    Before proceeding, make sure that the class understands that the red food coloring represents alcohol in the drink and that its spread throughout the water simulates the distribution of alcohol throughout a person's bloodstream.

11. **Ask the class to consider which container has the most alcohol in it. Introduce the term *concentration* to students. *Concentration* is a measure of the amount of a substance in comparison to the total**

Figure 2.3. Each type of alcoholic drink produces the same alcohol concentration in the blood.

amount of solution. (In this discussion, we will restrict the definition of concentration to liquids.) Which container has the highest concentration of alcohol?

Since the color intensity is an indicator of concentration, students should report that the containers have equal concentrations of food coloring (alcohol).

12. **Ask students to consider the three types of drinks poured into the containers. If the concentration of food coloring (alcohol) in each large container is the same, what can they say about the amount of alcohol that was added to each container?**

    Students should respond that if the final concentrations are equal, then the total amount of alcohol added to each container is the same because the volumes in the containers are about the same.

13. **Ask the class which alcoholic beverage, the beer, the wine, or the hard liquor, has the lowest *concentration* of alcohol. Which has the highest?**

    Without using actual alcohol concentrations, make sure that the class understands that beer has the lowest concentration, wine an intermediate concentration, and hard liquor the highest.

14. **(Optional) If students have difficulty understanding the concept of concentrations in different volumes of liquid, you may wish to demonstrate the mixing of the simulated alcoholic beverages. Add 1.5 ounces of the diluted red food coloring solution to a beer mug, a wine glass, and a shot glass. Then add water to the beer mug (10.5 ounces) and wine glass (3.5 ounces) to show the typical servings. These will be identical to the simulated drinks that you used for the first demonstration.**

Having students see that the different glasses contain the same amount of "alcohol" even though the final volume of liquid is different should help eliminate confusion.

15. **Ask the class to think about how the same amount of alcohol affects different people, for example, a small person and a large person. Guide the discussion with questions like the following:**
    - **Would the concentration of alcohol in the blood of each person be the same?**
    - **Which person would have a higher concentration of alcohol in the blood?**
    - **Why does the same amount of alcohol have a greater effect on a smaller person than a larger one?**

Assessment:
Listening to students' responses to these questions will help you assess their understanding of concentration.

Alcohol distributes throughout a person's bloodstream. A smaller person has a lesser volume of blood compared with a larger one. This means that a given amount of alcohol will lead to a greater blood alcohol concentration in the smaller person than the larger one.

Content Standard A:
Use mathematics in all aspects of scientific inquiry.

16. **Pass out a copy of Master 2.1, *What Is a Drink?*, to each student. Explain that the table on their handout lists the serving size and percentage of alcohol for each type of drink. Instruct students to calculate the amount of alcohol in each of the three types of alcoholic beverage and to write their answers in the appropriate spaces on the handout.**

17. **After students complete Master 2.1, ask them to draw conclusions about the amount of alcohol in an alcoholic beverage.**

Type of drink	Volume of serving (in ounces)	Concentration of alcohol expressed as a percent	Concentration of alcohol expressed as a percent in decimal form	Total amount of alchol (in ounces)
Beer	12	5	0.05	0.6
Wine	5	12	0.12	0.6
Hard liquor	1.5	40	0.40	0.6

Answers to questions on Master 2.1, *What Is a Drink?*, follow:

Students should recognize that typical servings of beer, wine, and hard liquor contain about the same amounts of alcohol. It is not the type of drink but rather the amount of alcohol consumed that determines the extent to which an individual is affected by drinking.

Question 1. Which contains more alcohol, a 12-ounce bottle of beer that is 5 percent alcohol or 1 ounce of whiskey that is 50 percent alcohol? Show your calculations.

The serving of beer contains more alcohol than does the serving of whiskey.

Beer: 12 ounces x 0.05 (that is, 5% alcohol) = 0.6 ounces alcohol
Whiskey: 1 ounce x 0.50 (that is, 50% alcohol) = 0.5 ounces alcohol

Question 2. Based on your calculations, is it safer for a person to drink beer than it is to drink whiskey?

The higher alcohol content of the beer in Question 1 demonstrates that it is not safer to drink beer than it is to drink hard liquor. Rather, the alcohol content and volume consumed determine the effects of the alcoholic beverage on an individual.

Working through this question enables students to respond correctly to Statement 4 on Master 1.1, *Alcohol: Is This Right?*: "Drinking beer is safer than drinking wine or hard liquor such as vodka or whiskey."

Teacher note
Students may raise questions about a "shot," or 1.5 ounces, being the typical serving size for hard liquor. Students are likely to have seen mixed drinks containing hard liquor that are much larger than 1.5 ounces. Remind students that these drinks often have other liquids, such as water, juice, or soft drinks, mixed in with the alcohol. You may remind students that a 12-ounce beer contains the same number of ounces of alcohol (0.6 ounces; see the table above), and the rest is primarily water.

Teacher note
In the classroom, you may encounter questions about how the percentage of alcohol in a drink relates to the concept of proof. In the United States, *proof* is a measure equivalent to twice the percentage of alcohol by volume; that is, an 80-proof liquor is 40 percent alcohol by volume.

18. **Ask students to summarize what they have learned from the activity by asking them to identify the factors that determine the amount of alcohol contained in an alcoholic beverage.**

    Students should respond that the percentage of alcohol in the drink and the serving size determine the amount of alcohol contained in an alcoholic beverage.

Assessment:
To evaluate the students' understanding of concentration, assign a few problems to solve, such as, How many 12-ounce beers containing 5 percent alcohol does it take to equal the amount of alcohol contained in a 30-ounce bottle of wine that contains 12 percent alcohol? (Answer: Six bottles of beer.)

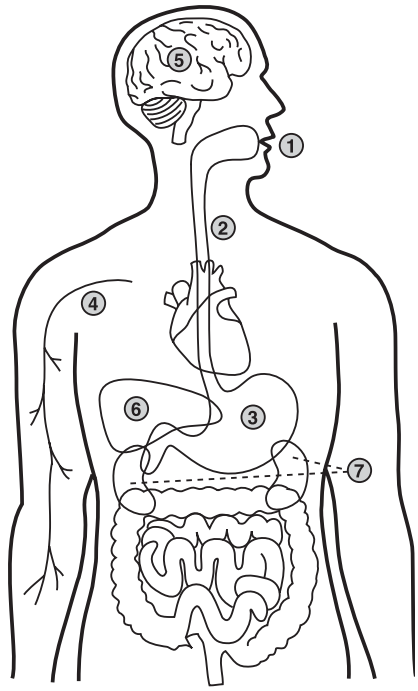
Activity 2: *Where Does Alcohol Go in the Body?*

1. **Introduce this part of the lesson by asking, "What happens to the alcohol after a person takes a drink? Where does it go?" As students name parts of the body, ask them to put their responses in the proper sequence, tracing the path that alcohol takes as it passes through the body.**

   You may want to prompt students by saying that alcohol enters through the mouth. Then ask, "Where does alcohol go next?"

2. **To help students visualize how alcohol is distributed throughout the body, display the transparency of Master 2.2, *Tracing Alcohol's Path through the Body*.**

   Alcohol is normally taken into the body through the mouth. After it is swallowed, it passes down the throat (esophagus). Help the students appreciate that when alcohol is consumed, it is first absorbed by the stomach and small intestine, then incorporated into the bloodstream. Students may continue by saying that alcohol goes to the liver, where it is metabolized (or broken down). After alcohol is metabolized, it passes through the kidneys, which process it for excretion in the urine. Be sure that students trace the path as depicted in Figure 2.4 below.



1. Alcohol enters the mouth.
2. Alcohol travels down the throat to the stomach.
3. Alcohol is absorbed into the blood by the stomach and small intestine.
4. Alcohol travels through the blood to the water-containing organs of the body.
5. Alcohol affects many brain functions.
6. Alcohol is metabolized in the liver.
7. Alcohol is excreted from the body after processing by the kidneys.

Figure 2.4. Tracing alcohol's path through the body.

3. **Now that students have traced the path of alcohol as it moves through the body, ask them to consider whether the alcohol distributes evenly through the body or whether it stays in only certain types of body tissues. Explain to the class that you will conduct a demonstration to investigate this question.**

4. **Place the two containers with different ratios of oil and water in full view of the class. As with the previous demonstration, explain that each container represents a human body. Inform students that each container has oil and water in it. Ask what differences they observe in the two containers. Which layer is the oil? Which layer is the water?**

   Students should note that the liquids form two layers and that the layers differ in size. The total volume of liquid (oil + water) is the same in each container. The oil is the top layer, and the water is the bottom layer.

Tip from the field test: Students can relate the two containers to people with different body types—one a lean athlete with a lower amount of body fat and the other a couch potato with a higher amount of body fat. However, be sure to reinforce the idea that you are comparing two people of the same weight.

5. **Ask the class why the water and oil form two separate layers. Explain that water is *immiscible*, or does not mix, with oil. If a liquid mixes with another liquid, it is *miscible* with the other liquid.**

   Other examples of immiscible liquids that students may think of include oil spills in the ocean where the oil floats on the surface and oil-and-vinegar salad dressings that separate into layers when the bottle is not shaken. An example of miscible liquids that students would be familiar with would be lemon juice and water (lemonade).

Figure 2.5. Bottles containing oil and water can simulate people with different body types.

Content Standard A:
Think critically and logically to make the relationships between evidence and explanations.

Content Standard B:
A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.

Assessment:
To reinforce the concept of miscibility, provide the students with a short list of everyday liquids and ask them which liquids will mix with which other liquids.

6. **Ask the class to predict what will happen if you pour alcohol into the containers. List the predictions on the board.**

   Again, responses will vary. Some will respond that alcohol will mix evenly throughout the solutions, while others will predict that alcohol will mix with either the oil or the water.

7. **Quickly pour 1 ounce of the red-colored alcohol solution into one of the containers. Use a stirring rod to gently mix the solution. Ask students what happened to the alcohol.**

   The alcohol mixes with the lower water layer. Bubbles will appear in the oil layer as the alcohol passes through it. Some red color might be seen in the bubbles, but it should be obvious that the alcohol is preferentially mixing with the water layer.

8. **Pour the second 1 ounce of red-colored alcohol solution into the second container. Gently mix with the stirring rod. Again, ask students what happened to the alcohol.**

   As with the first container, students should notice that the alcohol mixes with the water but not the oil.

9. **Ask the class to compare the two containers. Are there differences that they can see? Is alcohol miscible with oil or water?**

   Students should note that the red color is more concentrated in the glass containing the smaller amount of water (4 ounces) and more mineral oil than in the glass containing more water (6 ounces) and less mineral oil. As before, the total amount of liquid in each container is equal. Alcohol is miscible with water and not with oil.

10. **Ask the class to relate their observations to people who drink alcoholic beverages.**

    - **Can you tell how alcohol will affect a person by his or her appearance alone?**

    It is not possible to tell just by appearance how people will be affected by alcohol. As you recall from the demonstrations, alcohol mixes with water and not with oil; this is true in the body as well. Two people of the same size may have different amounts of body fat. The leaner person's body contains more water than the body of the person with the higher body-fat level. Therefore, the concentration of alcohol (in the water-containing portions of the body) would be higher in the person with more body fat (same amount of alcohol in

a lower total volume). This means that the higher-body-fat person would be more affected by a given dose of alcohol than a lean person of the same size. Because females, on average, have more body fat than males, they tend to feel the effects of alcohol more readily than do men. In summary, because body-fat content cannot be determined by appearance alone, it is not possible to predict the effects of alcohol on an individual solely by visual examination.

- **If two individuals have the same amount of body fat but one individual is larger than the other, who would be more affected by drinking a beer?**

  A number of factors, including body size, account for human variation in response to alcohol. A larger body size means a greater blood volume for alcohol distribution as compared with a smaller body size with an equal body fat content. Thus, in general, a larger person will be less influenced by a given alcohol dose than a smaller person will.

- **Because the brain is sensitive to the effects of alcohol, what can you conclude about the composition of the brain?**

  Since the brain is affected by alcohol, it must contain a significant amount of water into which the alcohol can mix.

Teacher note
These questions may bring up some sensitive issues for students. The effects of alcohol on the body are more complex than body size and amount of body fat. Although females are usually smaller than males and have higher levels of body fat, a comparison strictly on the basis of gender is not accurate. Other factors also influence how alcohol affects a person. For example, females, in general, are more sensitive to the effects of alcohol than males are because of differences in distribution.

Lesson 2 Organizer

Activity 1: *What Is a Drink?*

What the Teacher Does	Procedure Reference
Ask the class to name different kinds of alcoholic beverages and list them on the board.	Pages 72–73 Step 1
Have the class categorize each beverage as beer, wine, or hard liquor.	Page 73 Step 2
Invite students to consider differences between the different types of drinks.	Page 73 Step 3
Show the class three simulated alcoholic beverages and ask the students to share their observations about them.	Pages 73–74 Steps 4 and 5
Show the class three containers of water that each represent a human body. • Ask the class to predict what will happen when the simulated drinks are poured into the containers.	Page 74 Step 6
Pour each of the simulated drinks into a separate container and ask the class, • Do they look the same or different from each other? • Which container has the most "alcohol" in it?	Page 74 Steps 7–10
Introduce the concept of concentration and ask the class, • Which container has the highest concentration of alcohol?	Pages 74–76 Steps 11–14

M = Involves copying a master. T = Involves using a transparency.

• How do the amounts of alcohol added to each container compare? • Which simulated drink has the highest (and lowest) alcohol concentration?	Pages 74–76 Steps 11–14 (continued)
Have the class consider how the same amount of alcohol affects a smaller person compared with a larger person. • Would the concentration of alcohol in the blood be the same for each person? • Which person would have the higher concentration of alcohol in their blood? • Why does the same amount of alcohol have a greater effect on the smaller person?	Page 76 Step 15
Have the students calculate the amount of alcohol in each type of drink using Master 2.1, *What Is a Drink?* Ask them to draw conclusions about how different drinks compare with each other.	Pages 76–77 Steps 16 and 17 M T
Ask the class to identify factors that determine the amount of alcohol in an alcoholic beverage.	Page 77 Step 18

Activity 2: *Where Does Alcohol Go in the Body?*

What the Teacher Does	Procedure Reference
Discuss where alcohol goes once it enters the body. • Help students visualize the pathway of alcohol through the body using Master 2.2, *Tracing Alcohol's Path through the Body*. • Ask students if alcohol distributes evenly throughout the different body tissues.	Pages 78–79 Steps 1–3 T

Show the class two containers with mixtures of oil and water. • Explain that each container represents a human body. • Discuss the concept of miscible liquids.	Page 79 Steps 4 and 5
Ask the class to predict what will happen when a simulated alcoholic drink is poured into each container.	Page 80 Step 6
Pour the simulated drinks into each container. Ask the class, • Are there differences between the two containers? • Is alcohol miscible with oil or water?	Page 80 Steps 7–9
Have the class relate their observations to people drinking alcohol. • Can appearance alone tell you how alcohol will affect a person? • Why do people show variation in response to the same amount of alcohol? • Since the brain is sensitive to the effects of alcohol, what can you conclude about its composition?	Pages 80–81 Step 10

What Is a Drink?

Name _____ Date _____

Calculate the total amount of alcohol in a typical serving of the following alcoholic drinks.

Type of drink	Volume of serving (in ounces)	Concentration of alcohol expressed as a percent	Concentration of alcohol expressed as a percent in decimal form	Total amount of alcohol (in ounces)
Beer	12	5	0.05	
Wine	5	12	0.12	
Hard liquor	1.5	40	0.40	

The amount of alcohol in a drink can be calculated by multiplying the volume of the drink by the percentage of alcohol it contains. Remember to express percentage of alcohol in its decimal form before doing the multiplication. For example, 5% = 0.05 when expressed as a decimal.

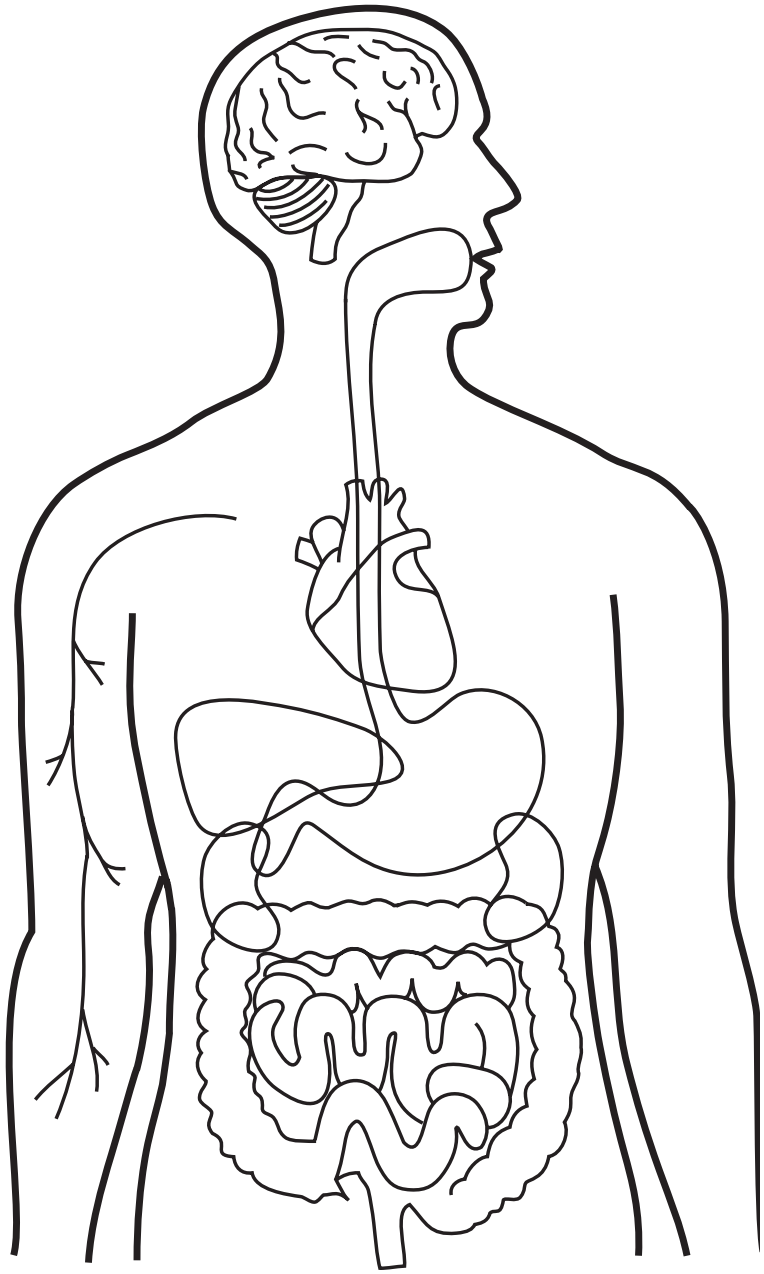
Volume of Serving	x	Percentage of Alcohol (in decimal form)	=	Total Amount of Alcohol in Serving

Answer the following questions.

1. Which contains more alcohol, a 12-ounce bottle of beer that is 5 percent alcohol or 1 ounce of whiskey that is 50 percent alcohol? Show your calculations.

2. Based on your calculations, is it safer for a person to drink beer than it is to drink whiskey?

Tracing Alcohol's Path through the Body



Lesson 3
Explore/
Explain

Responding to Alcohol: What's Important?

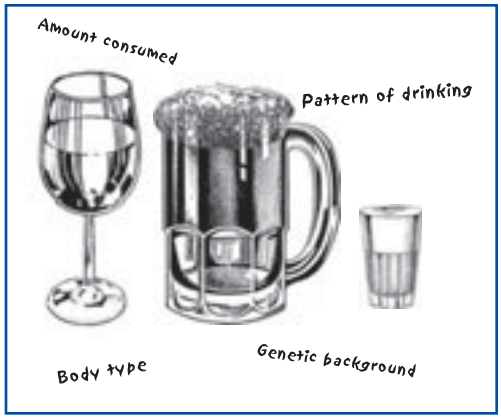


Figure 3.1. A variety of factors influences an organism's response to alcohol.

At a Glance

Overview

In Lesson 3, students explore the effects of alcohol on the motor activity (movement) of mice by analyzing data from three experiments. In the first experiment, students investigate the effect of alcohol dose on mouse activity. In the second experiment, students track the effect of increasing time after alcohol consumption on mouse activity. In the third experiment, aimed at understanding the role of genetics in alcohol response, students compare the effects of alcohol dose on activity using two different strains of mice. Students make measurements, then graph and interpret their data. In each experiment, students are asked to draw conclusions about the animal's response to alcohol.

Major Concepts

Alcohol produces a variety of effects on animal behavior including their movement. Alcohol exhibits a typical dose-response relationship: the greater the amount of alcohol consumed (dose), the greater the effect on behavior (response). Individuals within a population differ in their response to alcohol; some individuals are more sensitive to its effects than others. These differences in alcohol response have a genetic contribution. Since alcohol is metabolized at a constant rate by the body, the acute effects of alcohol decrease with increasing time after consumption.

Objectives

During this lesson, students will

- understand that the effect of alcohol is dose dependent;
- realize that alcohol can both stimulate and inhibit motor behaviors;
- explore individual variation in response to alcohol;
- recognize that genotype is one factor responsible for variation in response to alcohol;
- explain how the effects of alcohol on behavior change over time;
- explain the use of experimental controls; and
- recognize the usefulness of animal models in biology.

Teacher Background

Consult the following sections in Information about Alcohol:

5 Alcohol: Pharmacokinetics (page 28)
5.1 Absorption and distribution of alcohol in the body (page 29)
5.2 Measurement of blood alcohol concentration (BAC) (page 29)
5.3 Factors affecting alcohol absorption and elimination (pages 29–30)
5.4 Alcohol metabolism (pages 30–31)
6.1 Alcohol and the brain (pages 31–35)
6.2 Alcohol and body systems (pages 35–37)
7 Alcohol: Behavioral Effects (page 37)
8.2 Alcoholism and genetics (pages 39–40)
10.1 The costs to society (page 42)
10.3 Drinking and risky behavior (pages 43–44)
10.5 Drinking and violence (pages 45–46)

In Advance

Web-Based Activities

Activity	Web Version?
1	Yes
2	No

Photocopies

Activity 1	Master 3.1, Study 1—*Effect of Alcohol Dose on Mouse Movement* (Make 1 copy per student.) Master 3.2, Study 1—*Mouse Movement Data* (Make 1 copy per student.)[a] Master 3.3, Study 1—*Worksheet and Graph Template* (Make 1 copy per student and prepare an overhead transparency.) Master 3.4, Study 2—*Effect of Time on Alcohol Response* (Make 1 copy per student.)

Activity 1	Master 3.5, Study 2a—*Control Mouse Movement Data* (Make 1 copy per student.)[a] Master 3.6, Study 2b—*Experimental Mouse Movement Data* (Make 1 copy per student.)[a] Master 3.7, Study 2—*Worksheet and Graph Template* (Make 1 copy per student and prepare an overhead transparency.) Master 3.8, Study 3—*Effect of Genetics on Alcohol Response* (Make 1 copy per student.) Master 3.9, Study 3a—*Mouse Movement Data* (Make 1 copy per student.)[a] Master 3.10, Study 3b—*Mouse Movement Data* (Make 1 copy per student.)[a] Master 3.11, Study 3—*Worksheet and Graph Template* (Make 1 copy per student and prepare an overhead transparency.)
Activity 2	no photocopies needed

[a] Only needed for print-based version.

Materials

Activity 1	computers with Internet connection and a sound card
Activity 2	no materials needed except Masters 3.3, 3.7, and 3.11 from Activity 1

Teacher note
If multiple computers are not available, project images from a single computer for the class.

Preparation

If necessary, check with your computer lab personnel to determine which type of Internet connection your school uses. For Activity 1, you need to know whether you will use a modem, an ISDN line, or a T1 connection.

No preparations needed (except for photocopying).
Make sure that the Internet connections are working and that the sound is functioning.

Procedure

Teacher note
The alcohol doses used in these experiments are described in units of grams of alcohol per kilogram of body weight. Students may ask how these doses compare with human consumption. The lowest dose of 1.5 grams of alcohol per kilogram of body weight corresponds to the amount of alcohol needed to cause an average-sized person to just reach the legal limit of

intoxication. The doses of 2.0 and 3.0 grams of alcohol per kilogram of body weight correspond to higher levels of intoxication.

Teacher note
If possible, we recommend using the Web-based versions of the activities in this lesson. Instructions are provided first for the Web version of the activity and then for the print-based version.

Activity 1: *Gathering Data*

For classes using the *Web-based version* of this lesson:

Study 1—Effect of Alcohol Dose on Mouse Activity

Content Standard C: Behavior is one kind of response an organism can make to an internal or external environmental stimulus.

1. Log onto the Web site *http://science.education.nih.gov/supplement/alcohol/student* and click on "Lesson 1—Alcohol: Separating Fact from Fiction." Select the type of Internet connection you are using (56k modem, ISDN, or T1) and click to play a mouse video.

2. Introduce the activity by having the class review the two short video clips of the mice used during Lesson 1. Remind students which type of Internet connection your school uses. Ask students to recall their conclusions about the effects of alcohol on mouse behavior, especially with regard to the loss of inhibition.

3. Explain to students that they will be analyzing data from three experiments that investigate the effects of alcohol on the movement of mice. They will begin by investigating the effects of alcohol dose on motor activity (movement) in mice.

4. Instruct students to click on the "Student Activities" link to return to the "Web Portion of Student Activities" page.

5. Give each student a copy of Master 3.1, *Study 1—Effect of Alcohol Dose on Mouse Movement*, and Master 3.3, *Study 1—Worksheet and Graph Template.*

6. Instruct students to read Master 3.1, *Study 1—Effect of Alcohol Dose on Mouse Movement.* Be sure they understand how the experiment was performed and answer any questions.

7. Next, instruct students to click on the link to Lesson 3—*Responding to Alcohol: What's Important?* They should click on the "Start" button to listen to the introduction.

Students will hear a brief introduction to the activity and be taken into the virtual laboratory.

8. **Instruct students to click on the link to *Study 1—Effect of Dose*.**

   Students will read instructions asking them to select a mouse and count the number of grid lines it crosses. This number should be recorded in their data table on Master 3.3. This process is repeated for the three remaining mice.

Study 2—Effect of Time on Response to Alcohol

Teacher note
The experimental mice in this study were given alcohol at a dose of 3 grams alcohol/kg body weight.

1. **Give each student 1 copy of both Master 3.4, *Study 2—Effect of Time on Alcohol Response*, and Master 3.7, *Study 2—Worksheet and Graph Template*.**

2. **Instruct students to read Master 3.4, *Study 2—Effect of Time on Alcohol Response*. Be sure they understand how the experiment was performed and answer any questions.**

3. **Instruct students to click on the "Back" button and then on the link for *Study 2a—Effect of Time*.**

   Students will read instructions asking them to select the control mouse and count the number of grid lines it crosses for each time interval. These numbers should be recorded in their data table on Master 3.7.

4. **After collecting data on the fourth mouse, students should click on the "Back" button. Next, they click on the link for *Study 2b—Effect of Time*.**

5. **Students repeat the data collection procedure in Step 3 for the experimental mice.**

Study 3—Effect of Genetics on Response to Alcohol

1. **Explain to students that the different colors of the two mouse strains used in this study reflect genetic differences. Ask students what sort of genetic differences might exist between the two strains that could account for different responses to alcohol.**

Students' responses may be very general: differences in the brain or differences in the way the animals metabolize the alcohol may be suggested. Accept all reasonable answers and explain that it is time to investigate. Discussion of genetic variation can occur after this study and during Lessons 4 and 5.

2. Give each student 1 copy of both Master 3.8, *Study 3—Effect of Genetics on Alcohol Response*, and Master 3.11, *Study 3—Worksheet and Graph Template*.

3. Instruct students to read Master 3.8, *Study 3—Effect of Genetics on Alcohol Response*. Be sure that they understand how the experiment was performed and answer any questions.

4. Instruct students to click on the "Back" button and then on the link for *Study 3a—Effect of Genetics*.

Students will read instructions asking them to select a mouse and count the number of grid lines it crosses. This number should be recorded in their data table on Master 3.11. This process is repeated for the three remaining mice of that genetic strain.

Content Standard C: Behavior is one kind of response an organism can make to an internal or external environmental stimulus.

5. After collecting data on the fourth mouse, students should click on the "Back" button. Next they click on the link for *Study 3b—Effect of Genetics* to access the experiment with mice using a different genetic strain.

6. Students repeat the data-collection procedure in Step 4 for mice of the second strain.

Alternate version of Activity 1 for classes without access to the Internet:

Study 1—Effect of Alcohol Dose on Mouse Activity

1. Explain that students will be analyzing data from three experiments to investigate the effects of alcohol on the movement of mice. They will begin by investigating the effects of alcohol dose on motor activity (movement) in mice.

2. Give each student 1 copy of Master 3.1, *Study 1—Effect of Alcohol Dose on Mouse Movement,* Master 3.2, *Study 1—Mouse Movement Data*, and Master 3.3, *Study 1—Worksheet and Graph Template*.

- Master 3.1 describes how the experiment was performed.
- Master 3.2 contains the experimental data.
- Master 3.3 contains a worksheet and graph template.

3. **Instruct students to read Master 3.1, *Study 1—Effect of Alcohol Dose on Mouse Movement*. Be sure they understand how the experiment was performed and answer any questions.**

4. **Next, instruct students to count the number of grid lines crossed by each mouse on Master 3.2 and record the numbers in the appropriate spaces on their data table on Master 3.3.**

Study 2—Effect of Time on Response to Alcohol

Teacher note
The experimental mice in this study were given alcohol at a dose of 3 grams alcohol/kg body weight.

1. **Give each student 1 copy of Master 3.4, *Study 2—Effect of Time on Alcohol Response*, Master 3.5, *Study 2a—Control Mouse Movement Data*, Master 3.6, *Study 2b—Experimental Mouse Movement Data*, and Master 3.7, *Study 2—Worksheet and Graph Template.***

   - Master 3.4 describes how the experiment was performed.
   - Masters 3.5 and 3.6 contain the experimental data.
   - Master 3.7 contains a worksheet and graph template.

2. **Instruct students to read Master 3.4, Study 2—*Effect of Time on Alcohol Response*. Be sure they understand how the experiment was performed and answer any questions.**

3. **Instruct the students to count the number of grid lines crossed by each mouse on Masters 3.5 and 3.6 and record the numbers in their data table on Master 3.7.**

Study 3—Effect of Genetics on Response to Alcohol

1. **Explain to students that this study uses two mouse strains with different genetic backgrounds. Ask students what sort of genetic differences might exist between the two strains that could account for differing responses to alcohol.**

   Students' responses may be very general: differences in the brain or differences in the way the animals metabolize the alcohol may be suggested. Accept all reasonable answers and explain that it is time

to investigate. Discussion of genetic variation can occur after this study and during Lessons 4 and 5.

2. Give each student 1 copy of Master 3.8, *Study 3—Effect of Genetics on Alcohol Response*, Master 3.9, *Study 3a—Mouse Movement Data*, Master 3.10, *Study 3b—Mouse Movement Data*, and Master 3.11, *Study 3—Worksheet and Graph Template*.

   - Master 3.8 describes how the experiment was performed.
   - Masters 3.9 and 3.10 contain the experimental data.
   - Master 3.11 contains a worksheet and graph template.

3. Instruct students to read Master 3.8, *Study 3—Effect of Genetics on Alcohol Response*. Be sure that they understand how the experiment was performed and answer any questions.

4. Instruct students to count the number of grid lines crossed by each mouse on Masters 3.9 and 3.10 and record the numbers in their data table on Master 3.11.

Content Standard A: Think critically and logically to make the relationships between evidence and explanations.

Activity 2: *Data Analysis and Discussion*

Study 1—Effect of Alcohol Dose on Mouse Activity

1. Students should use their data and the graph template on Master 3.3, *Study 1—Worksheet and Graph Template*, to create a plot of movement (number of grid lines crossed) versus alcohol dose. After students plot their data, instruct them to connect the data points with lines.

   If you prefer, have students graph their data in histogram form.

2. Students' data for Study 1 should be as follows:

Dose of alcohol (g alcohol/kg body weight)	Number of grid lines crossed
0.0	10
1.5	16
2.0	20
3.0	4

3. Ask the class how the movement of mice varies with increasing doses of alcohol.

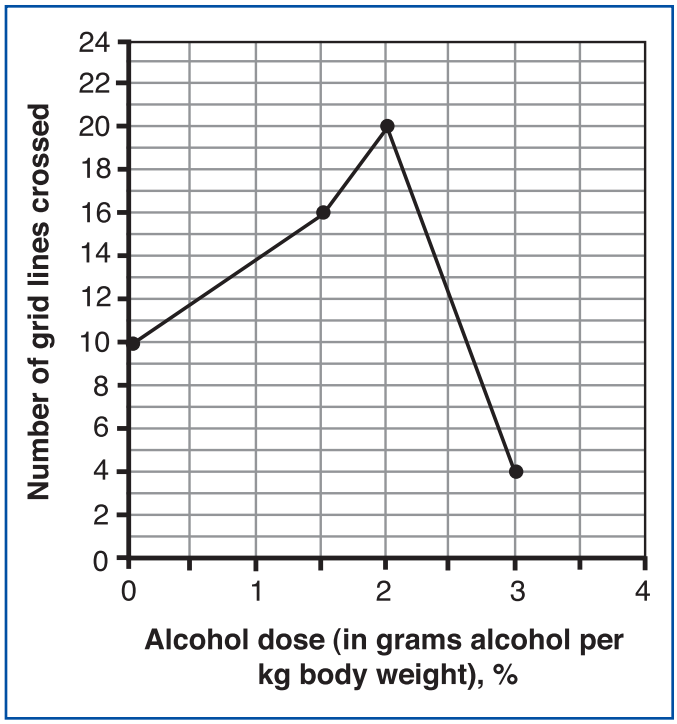


Figure 3.2. Data for Study 1—Effect of Alcohol Dose on Mouse Movement.

Students should explain that mouse movement (number of grid lines crossed) increases as the dose of alcohol increases from 0 to 1.5 g/kg and again from 1.5 g/kg to 2.0 g/kg. Movement then decreases from 2.0 g/kg to 3.0 g/kg. Students should note that alcohol affects the movement of mice and that this effect depends on the dose of the alcohol.

4. **Ask the class why the study included a mouse that was not given any alcohol.**

   The mouse that was not given alcohol is called a control mouse. Mice given alcohol are called the experimental mice. In order to reach a conclusion about the effect of alcohol on mouse movement, it is necessary to compare mice that were given alcohol with those that were not. Ideally, the control mouse should be just like the experimental mice except for the variable being tested (alcohol).

Study 2—Effect of Time on Response to Alcohol

1. **Students should use their data and the graph template on Master 3.7 to create a plot of movement (grid lines crossed) versus time after alcohol consumption. After plotting their data, instruct them to connect the data points with lines.**

NSES

Content Standard A: Design and conduct a scientific investigation.

If you prefer, have students graph their data in histogram form. Data for the control and experimental mice should be plotted on the same graph.

2. Students' data for Study 2 should be as follows:

Control mouse		Experimental mouse	
Time	**Number of grid lines crossed**	**Time**	**Number of grid lines crossed**
0 to 1 min.	6	0 to 1 min.	12
5 to 6 min.	8	5 to 6 min.	10
10 to 11 min.	8	10 to 11 min.	6
15 to 16 min.	10	15 to 16 min.	2

3. Ask the class to describe the effect of alcohol on mouse activity over time.

Compared with the control mouse, the mouse given alcohol was initially more active, but then as time passed, its activity slowed, while that of the control mouse increased.

4. Ask students if they collected data on the mouse given alcohol for hours instead of minutes, what would happen?

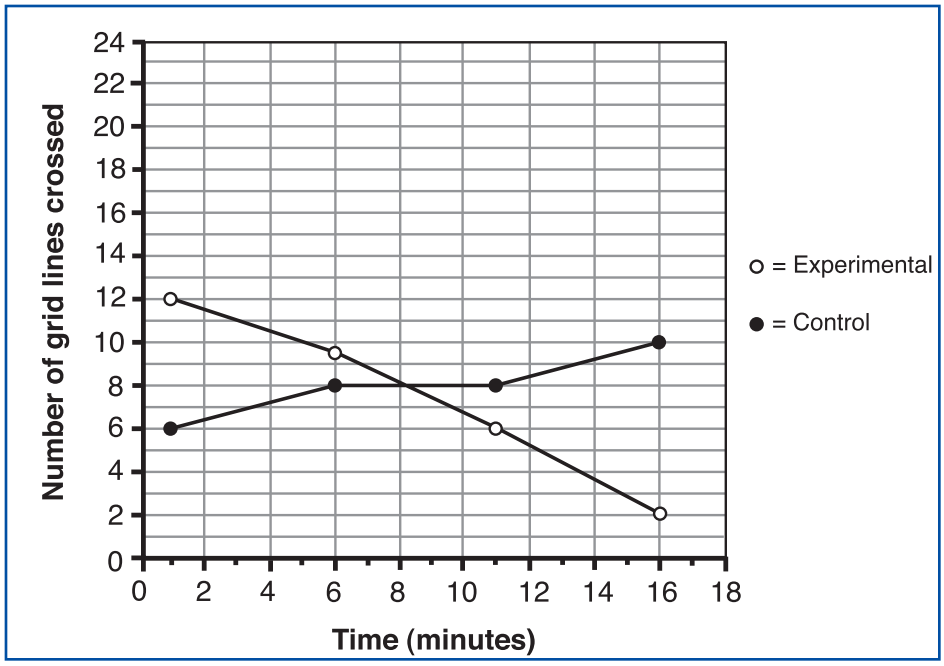


Figure 3.3. Data for Study 2—Effect of Time on Response to Alcohol.

This question may be difficult for students to answer. The movement of the mouse would slow to its lowest level and remain there for a while; then, the rate of movement would slowly increase up to the level of the control mouse. This is because the alcohol is being metabolized, and the blood alcohol concentration slowly decreases back to zero. When the BAC of the experimental mouse reaches zero, the mouse given alcohol and the control mouse would be expected to behave similarly.

5. **Why does the movement of the control mouse change over time?**

   This is an opportunity to discuss the nature of science. As mice become familiar with their environment, they tend to be less cautious. Since control mouse activity increases over time, this mouse is becoming familiar with its test surroundings.

Study 3—Effect of Genetics on Response to Alcohol

1. **Students should use their data and the graph template on Master 3.11 to create a plot of movement (number of grid lines crossed) versus alcohol dose. After plotting their data, instruct students to connect the data points for each mouse.**

   If you prefer, have the students graph their data in histogram form. Data for the two different mouse strains should be plotted on the same graph.

2. Students' data for Study 3 should be as follows:

Study 3a mice		Study 3b mice	
Alcohol dose (g alcohol/kg body weight)	**Number of grid lines crossed**	**Alcohol dose (g alcohol/kg body weight)**	**Number of grid lines crossed**
0.0	10	0.0	12
1.5	10	1.5	14
2.0	6	2.0	20
3.0	1	3.0	6

3. **Ask the class whether the mice in Study 3a behaved like the mice in Study 3b.**

   In some ways the mice in Study 3a did behave like the mice in Study 3b. Initially, they both were fairly active. They responded differently, however, to the higher doses of alcohol. The mice in

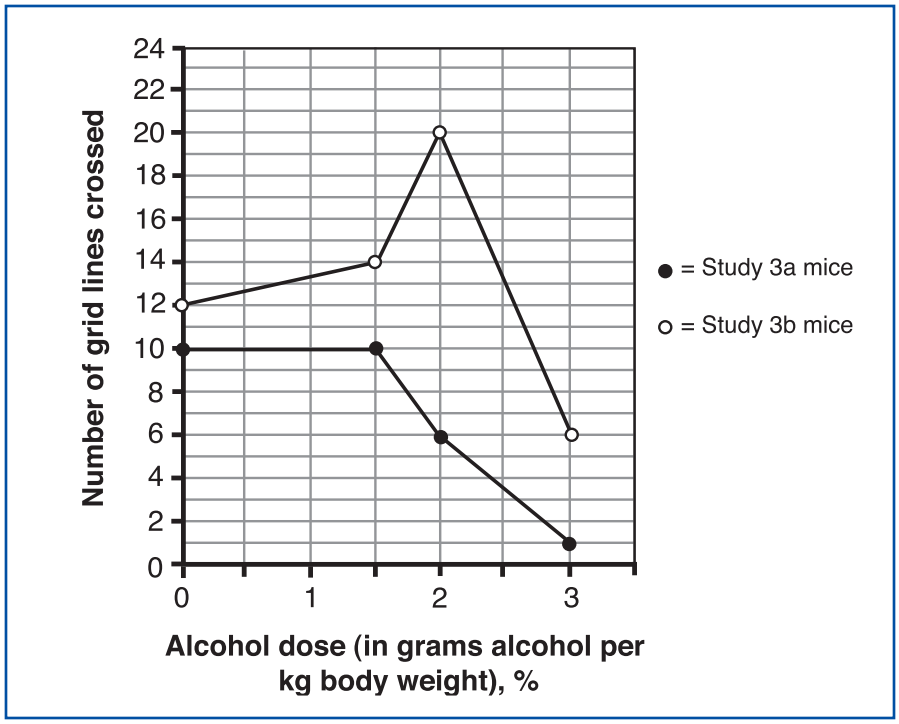


Figure 3.4. Data for Study 3—Effect of Genetics on Response to Alcohol.

Study 3a rapidly slowed down their movement as the dose increased from 1.5 to 3.0 g alcohol/kg body weight. In contrast, the mice in Study 3b first increased, then decreased their movement as the alcohol dose went from 1.5 to 3.0 g alcohol/kg body weight.

4. **Does this experiment suggest that genes play a role in an animal's response to alcohol? Why or why not?**

   The Study 3a and Study 3b mice show different responses to alcohol. The experimental environments for the two strains of mice were the same. The two mouse strains were handled identically in Study 3a and Study 3b. However, the two mouse strains have some genes that are different from each other. This genetic difference between the two mouse strains is the experimental variable. Consequently, the experiment suggests that genes play a role in response to alcohol.

5. **Ask the class to summarize what they have learned about alcohol's effects on behavior from these three studies.**

   Students should mention that the effects of alcohol depend on the dose, the time after the alcohol was consumed, and the genetic background of the individual.

6. **Ask the class why scientists would use mice to investigate the effects of alcohol.**

Student responses will vary. Be sure to bring out the idea that scientists use animals in experiments when using humans is either impractical or unethical. Data obtained from mice have relevance because the mice have similar genes and biochemistry to humans. It is important to keep in mind the limitations of such studies, however. Humans have greater cognitive abilities than mice and can more readily alter their behaviors.

7. **On the basis of data from these three studies, can you make any inferences about the effects of alcohol on humans?**

   These studies allow students to make inferences about how alcohol might affect humans. For example, students may comment that at the lowest dose of alcohol, the mice became more active, then, as the dose was increased, less active. They may propose that something similar happens to people and comment that some people who have a few drinks at a party become more outgoing and talkative, but if they drink to excess, they can become very quiet and may even pass out.

   Students should also reflect on individual variation in response to alcohol. Results of the study using mice of different strains suggest that different people may respond to the same dose of alcohol differently. This is true. Alcohol affects some people more profoundly than others. Some of the variation in response to alcohol is due to genetics (see Information about Alcohol, *8.2 Alcoholism and genetics*).

8. **Conclude the lesson by reminding the class of the statement from the survey in Lesson 1, which declared that alcohol is a stimulant. At that time, students either agreed or disagreed with the statement. Ask the class to use what they learned in this lesson now to respond to that statement.**

   This likely will be a difficult concept for students. Based on the studies explored in this lesson, students may believe that alcohol initially acts as a stimulant. In fact, alcohol is always a depressant. It appears to be a stimulant because it initially depresses that part of the brain that controls inhibitions. See "Misconception 1: Alcohol is a stimulant," on page 25.

Assessment:
Ask students to define scientific controls as related to the design of experiments. Instruct them to describe how the concept of controls was used in each of the three mouse studies in this lesson.

Assessment:
Before the class discussion, you may want to have students write a short summary of what they learned from the mouse experiments. This gives students an opportunity to organize their thoughts. Listening to the discussion and reading their summaries will help you evaluate their understanding of the experiments.

Lesson 3 Organizer: Web Version

Activity 1: *Gathering Data*
Study 1—Effect of Alcohol Dose on Mouse Activity

What the Teacher Does	Procedure Reference
Have students log onto the Web site, click on "Lesson 1—Alcohol: Separating Fact from Fiction." Select the type of Internet connection you are using. Have students click on a mouse video. Have them recall their conclusions about the effects of alcohol on mouse behavior.	Page 90 Steps 1 and 2
Explain to the class that they will analyze data from three experiments that investigate the effects of alcohol on the movement of mice.	Page 90 Step 3
Instruct students to return to the Web site's main page by clicking on "Student Activities."	Page 90 Step 4
Pass out to each student a copy of Master 3.1, *Study 1—Effect of Alcohol Dose on Mouse Movement,* and Master 3.3, *Study 1—Worksheet and Graph Template.*	Page 90 Step 5
Have students read Master 3.1, *Study 1—Effect of Alcohol Dose on Mouse Movement.*	Page 90 Step 6
Instruct students to click on "Lesson 3—Responding to Alcohol: What's Important?," then on the "Start" button to listen to the introduction, and then on "*Study 1—Effect of Dose*." • Allow students to collect data on the effect of alcohol dose.	Pages 90–91 Steps 7 and 8
Study 2—Effect of Time on Response to Alcohol	
Pass out to each student a copy of Master 3.4, *Study 2—Effect of Time on Alcohol Response,* and Master 3.7, *Study 2—Worksheet and Graph Template.*	Page 91 Step 1

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Have students read Master 3.4, *Study 2—Effect of Time on Alcohol Response.*	Page 91 Step 2
Instruct students to click on the "Back" button and then on the link for *Study 2a—Effect of Time.* Have students collect data for the control mouse (mouse 2a).	Page 91 Step 3
Instruct students to click on the "Back" button and then on the link to *Study 2b—Effect of Time.* Have students collect data for the experimental mouse (mouse 2b).	Page 91 Steps 4 and 5
Study 3—Effect of Genetics on Response to Alcohol	
Explain the use of two different mouse strains and ask students to suggest how genetics may influence a mouse's response to alcohol.	Pages 91–92 Step 1
Pass out to each student a copy of Master 3.8, *Study 3—Effect of Genetics on Alcohol Response,* and Master 3.11, *Study 3—Worksheet and Graph Template.*	Page 92 Step 2 
Have students read Master 3.8, *Study 3—Effect of Genetics on Alcohol Response.*	Page 92 Step 3
Instruct students to click on the "Back" button and then on the link for *Study 3a—Effect of Genetics.* Have students collect data for the first mouse strain.	Page 92 Step 4
Instruct students to click on the "Back" button and then on the link to *Study 3b—Effect of Genetics.* Have students collect data from the second mouse strain.	Page 92 Steps 5 and 6
Activity 2: *Data Analysis and Discussion* ***Study 1—Effect of Alcohol Dose on Mouse Activity***	
What the Teacher Does	**Procedure Reference**
Students create a graph of movement (grid lines crossed) versus alcohol dose on Master 3.3.	Page 94 Steps 1 and 2 

Ask students, • How does the movement of mice vary with increasing doses of alcohol? • Why did the study include a mouse that was not given any alcohol?	Pages 94–95 Steps 3 and 4
Study 2—Effect of Time on Response to Alcohol	
Students create a graph of movement (grid lines crossed) versus time after alcohol consumption on Master 3.7.	Pages 95–96 Steps 1 and 2 
Ask students, • How would you describe the effect of alcohol on mouse activity over time? • What would happen if you collected data in this study over hours rather than minutes? • Why does the movement of the control mouse change over time?	Pages 96–97 Steps 3–5
Study 3—Effect of Genetics on Response to Alcohol	
Students create a graph of movement (grid lines crossed) versus alcohol dose on Master 3.11.	Page 97 Steps 1 and 2 
Ask students, • Did the mice in Study 3a behave like the mice in Study 3b? • Does this study suggest whether genes play a role in the animal's response to alcohol? • Summarize what you learned about alcohol's effects on behavior. • Why do scientists use mice to investigate the effects of alcohol? • On the basis of these studies, can you make inferences about the effects of alcohol on humans? • Use what you learned here to respond to the statement that alcohol is a stimulant.	Pages 97–99 Steps 3–8

Lesson 3 Organizer: Print Version

Activity 1: *Gathering Data* *Study 1—Effect of Alcohol Dose on Mouse Activity*	
What the Teacher Does	**Procedure Reference**
Explain to the class that they will analyze data from three experiments that investigate the effects of alcohol on the movement of mice.	Page 92 Step 1
Give each student 1 copy of Master 3.1, *Study 1—Effect of Alcohol Dose on Mouse Movement,* Master 3.2, *Study 1—Mouse Movement Data,* and Master 3.3, *Study 1—Worksheet and Graph Template.*	Pages 92–93 Step 2
Instruct students to read Master 3.1, *Study 1—Effect of Alcohol Dose on Mouse Movement.*	Page 93 Step 3
Instruct students to count the number of grid lines crossed by each mouse on Master 3.2, *Study 1—Mouse Movement Data* and record their data on Master 3.3, *Study 1—Worksheet and Graph Template.*	Page 93 Step 4
Study 2—Effect of Time on Response to Alcohol	
Give each student 1 copy of Master 3.4, *Study 2—Effect of Time on Alcohol Response,* Master 3.5, *Study 2a—Control Mouse Movement Data,* Master 3.6, *Study 2b—Experimental Mouse Movement Data,* and Master 3.7, *Study 2—Worksheet and Graph Template.*	Page 93 Step 1
Have students read Master 3.4, *Study 2—Effect of Time on Alcohol Response.*	Page 93 Step 2

= Involves copying a master.

Instruct students to count the number of grid lines crossed by each mouse on Masters 3.5 and 3.6 and record their data on Master 3.7	Page 93 Step 3
Study 3—Effect of Genetics on Response to Alcohol	
Explain the use of two different mouse strains and ask students to suggest how genetics may influence a mouse's response to alcohol.	Pages 93–94 Step 1
Give each student 1 copy of Master 3.8, *Study 3—Effect of Genetics on Alcohol Response,* Master 3.9, *Study 3a—Mouse Movement Data,* Master 3.10, *Study 3b—Mouse Movement Data,* and Master 3.11, *Study 3—Worksheet and Graph Template.*	Page 94 Step 2 
Have students read Master 3.8, *Study 3—Effect of Genetics on Alcohol Response.*	Page 94 Step 3
Instruct students to count the number of grid lines crossed by each mouse on Masters 3.9 and 3.10 and record their data on Master 3.11.	Page 94 Step 4
Activity 2: Data Analysis and Discussion ***Study 1—Effect of Alcohol Dose on Mouse Activity***	
What the Teacher Does	**Procedure Reference**
Students create a graph of movement (grid lines crossed) versus alcohol dose on Master 3.3.	Page 94 Steps 1 and 2 
Ask students, • How does the movement of mice vary with increasing doses of alcohol? • Why did the study include a mouse that was not given any alcohol?	Pages 94–95 Steps 3 and 4

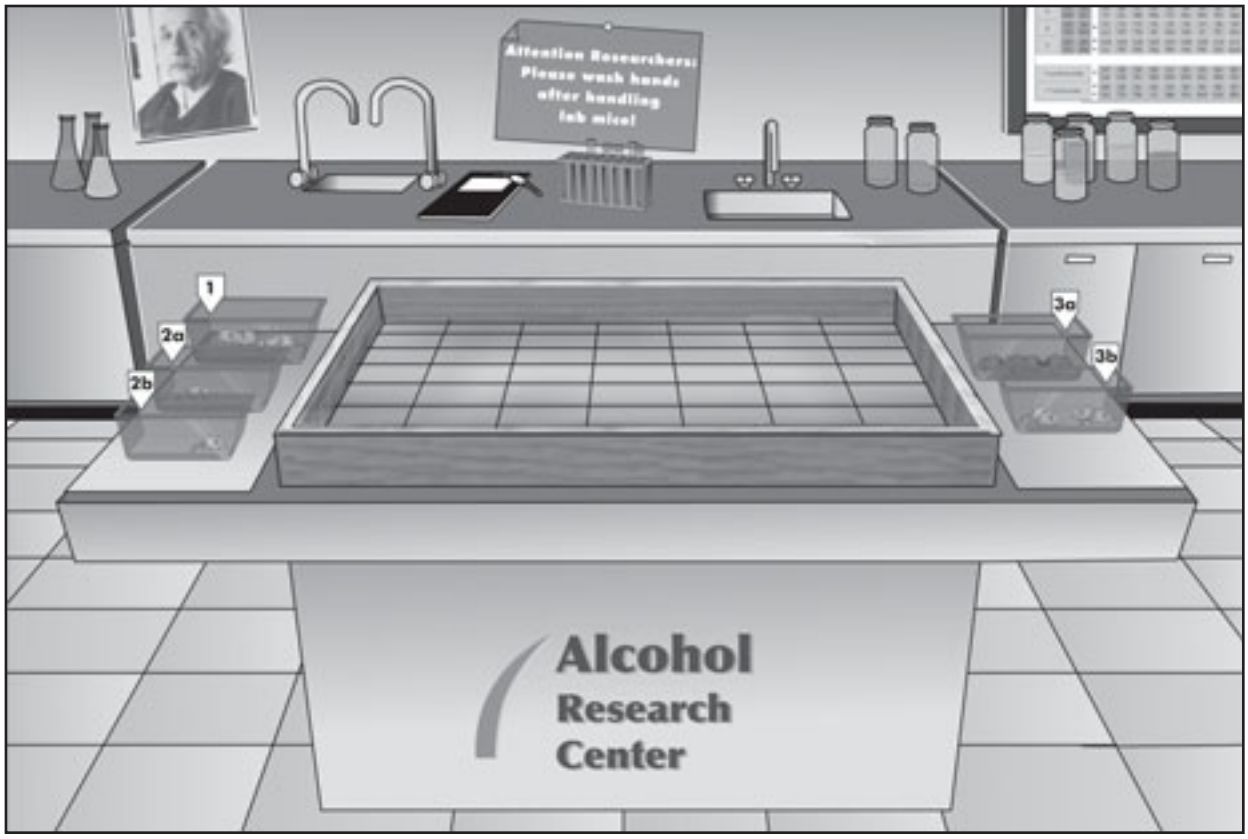
Study 2–Effect of Time on Response to Alcohol

Students create a graph of movement (grid lines crossed) versus time after alcohol consumption on Master 3.7.	Pages 95–96 Steps 1 and 2 
Ask students, • How would you describe the effect of alcohol on mouse activity over time? • What would happen if you collected data in this study over hours rather than minutes? • Why does the movement of the control mouse change over time?	Pages 96–97 Steps 3–5

Study 3–Effect of Genetics on Response to Alcohol

Students create a graph of movement (grid lines crossed) versus alcohol dose on Master 3.11.	Page 97 Steps 1 and 2 
Ask students, • Did the mice in Study 3a behave like the mice in Study 3b? • Does this study suggest whether genes play a role in the animal's response to alcohol? • Summarize what you learned about alcohol's effects on behavior. • Why do scientists use mice to investigate the effects of alcohol? • On the basis of these studies, can you make inferences about the effects of alcohol on humans? • Use what you learned here to respond to the statement that alcohol is a stimulant.	Pages 97–99 Steps 3–8

Study 1—Effect of Alcohol Dose on Mouse Movement

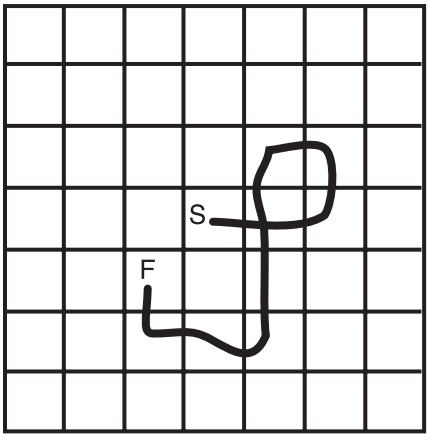


This study investigates the effect of different levels of alcohol consumption on the activity (movement) of mice. The experiment begins by placing a control mouse that has not been exposed to alcohol on the center square (labeled "S" for start) of a grid pattern. This is time zero. The mouse is observed for one minute. The movement of the mouse during this minute is shown by a line on the grid pattern.

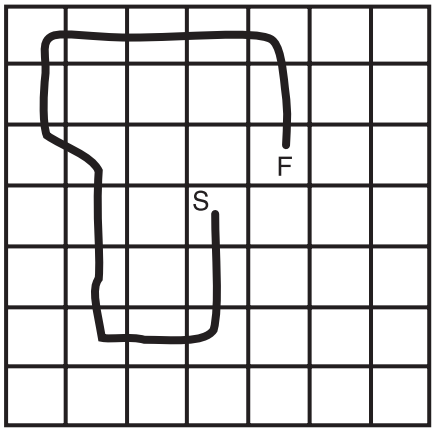
To collect your data, count the number of grid lines crossed by the mouse during the one minute of observation and record that number in the space provided on Master 3.3, *Study 1—Worksheet and Graph Template*. Repeat this process for the remaining three mice that have been given alcohol to levels of 1.5, 2.0, and 3.0 grams of alcohol per kilogram of body weight, respectively. In each case, the activity patterns for these mice were obtained 10 minutes after the mice had been given the alcohol.

Study 1—Mouse Movement Data

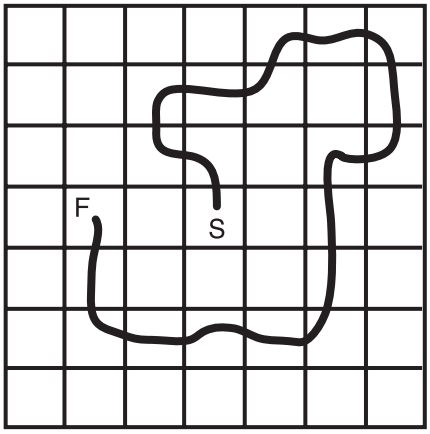
Count the number of grid lines crossed by each mouse and record those numbers on Master 3.3, *Study 1—Worksheet and Graph Template*. Note that "S" indicates "start" and "F" indicates "finish."



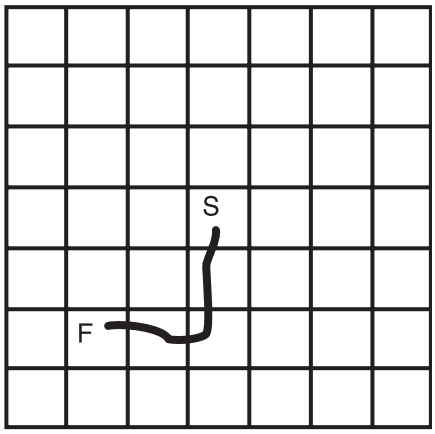
no alcohol



1.5 g alcohol/kg body weight



2.0 g alcohol/kg body weight

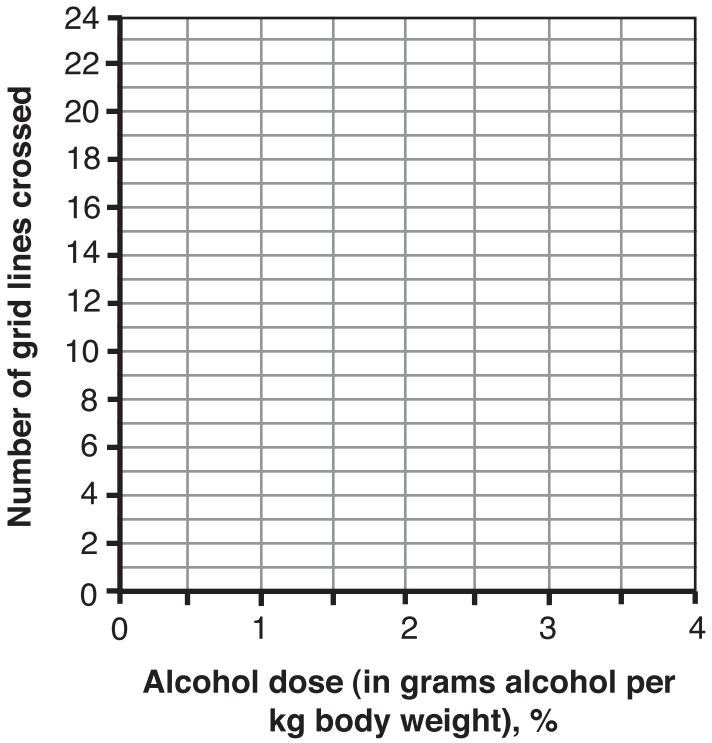


3.0 g alcohol/kg body weight

Study 1—Worksheet and Graph Template

Name _____ Date _____

Dose	Number of grid lines crossed
No alcohol	
1.5 g alcohol/kg body weight	
2.0 g alcohol/kg body weight	
3.0 g alcohol/kg body weight	



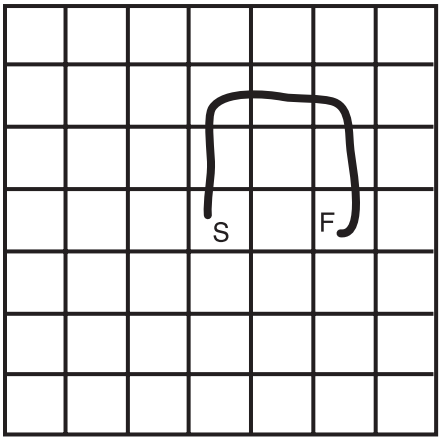
Study 2—Effect of Time on Alcohol Response

This study investigates the effect of time on the response of mice to alcohol consumption. The activity (movement) of a control mouse (unexposed to alcohol) is compared with that of a mouse that has been given alcohol to a level of 3 grams of alcohol per kilogram of body weight. Ten minutes after the alcohol is given, the mice are placed on the center square (labeled "S" for "start") of a grid pattern. This is time zero. Each mouse is observed for one-minute intervals (from 0 to 1 minute, 5 to 6 minutes, 10 to 11 minutes, and 15 to 16 minutes). The movement of each mouse during these intervals is shown by a line on the grid pattern.

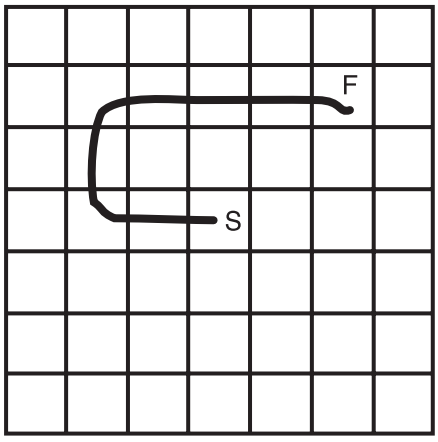
To collect your data, count the number of lines crossed by the control mouse during each one minute of observation and record those numbers in the spaces provided on Master 3.7, *Study 2—Worksheet and Graph Template*. Repeat this process for the experimental mouse that was given alcohol.

Study 2a—Control-Mouse Movement Data

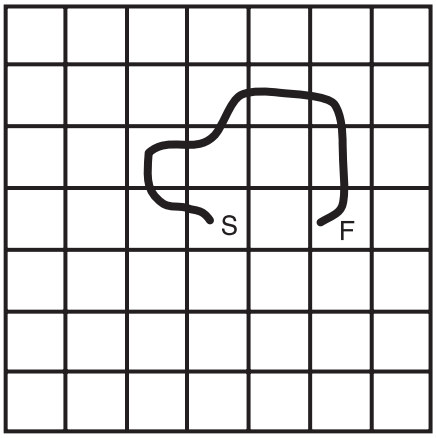
Count the number of grid lines crossed by each mouse and record those numbers on Master 3.7, *Study 2—Worksheet and Graph Template*. Note that "S" indicates "start" and "F" indicates "finish."



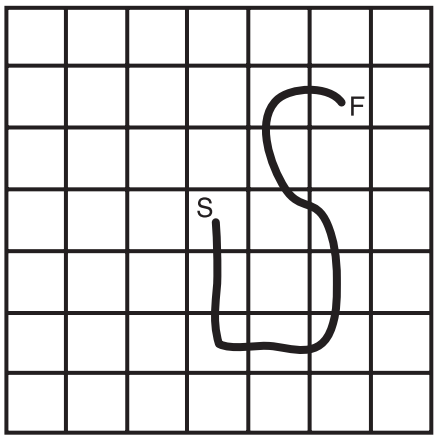
0 to 1 minute



5 to 6 minutes



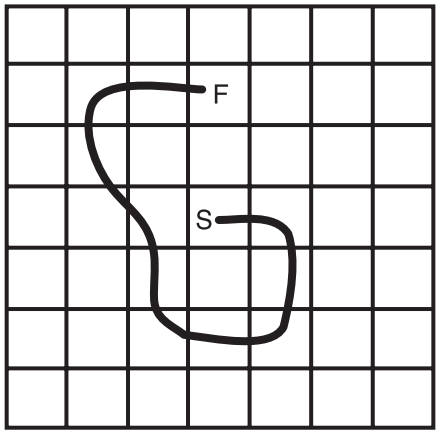
10 to 11 minutes



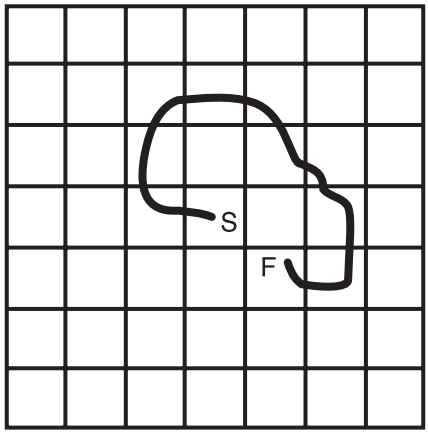
15 to 16 minutes

Study 2b—Experimental-Mouse Movement Data

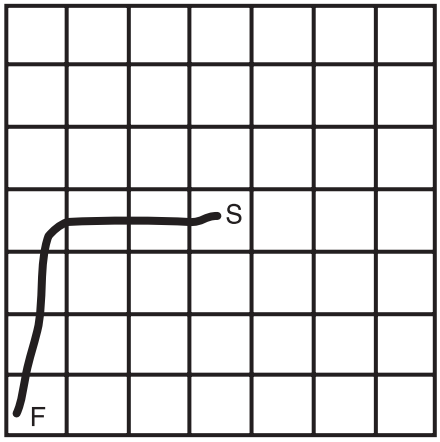
Count the number of grid lines crossed by each mouse and record those numbers on Master 3.7, *Study 2—Worksheet and Graph Template*. Note that "S" indicates "start" and "F" indicates "finish."



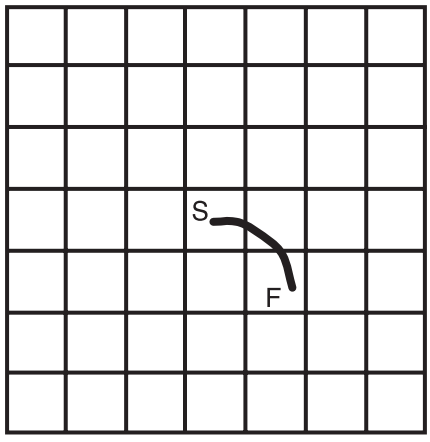
0 to 1 minute



5 to 6 minutes



10 to 11 minutes

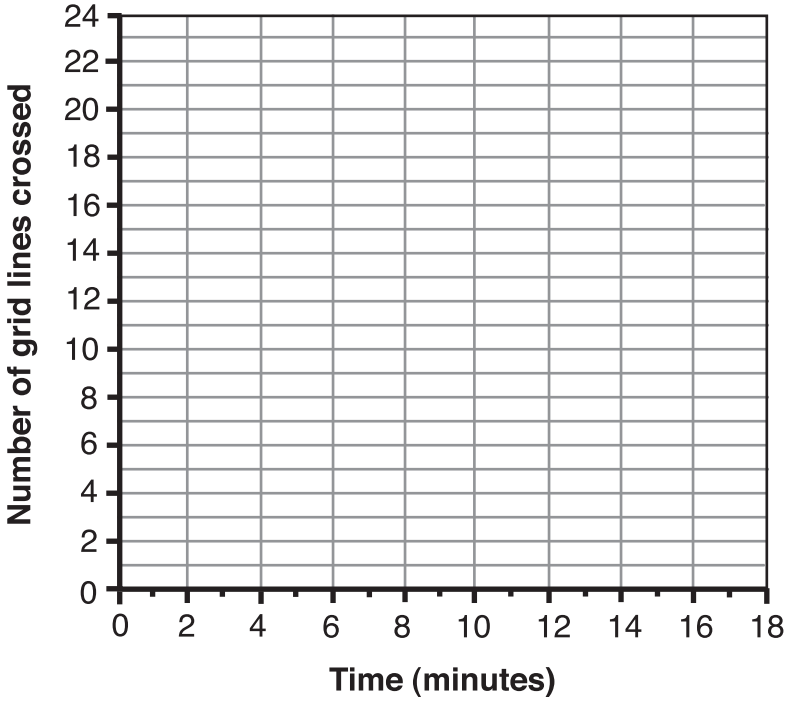


15 to 16 minutes

Study 2—Worksheet and Graph Template

Name _____ Date _____

Time intervals for control mouse	Number of grid lines crossed	Time intervals for experimental mouse	Number of grid lines crossed
0 to 1 min.		0 to 1 min.	
5 to 6 min.		5 to 6 min.	
10 to 11 min.		10 to 11 min.	
15 to 16 min.		15 to 16 min.	



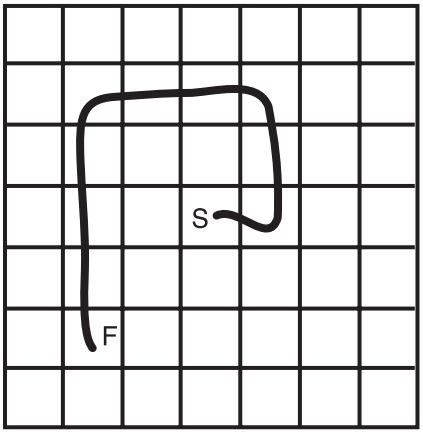
Study 3—Effect of Genetics on Alcohol Response

This study investigates the effect of genotype (genes) on the response of mice to alcohol consumption. Two strains of mice that have genetic differences are compared for their responses to alcohol. As in Study 1, a control mouse that has not been exposed to alcohol is placed on the center square (labeled "S" for "start") of a grid pattern. This is time zero. The mouse is observed for one minute. The movement of the mouse during this minute is depicted by a line on the grid pattern.

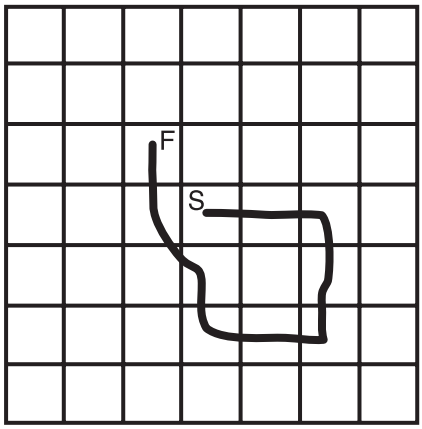
To collect your data, count the number of lines crossed by the mouse during the one minute of observation and record that number in the space provided on Master 3.11, *Study 3—Worksheet and Graph Template*. For the remaining three mice that have been given alcohol to levels of 1.5, 2.0, and 3.0 grams of alcohol per kilogram of body weight, respectively, repeat this process. These activity patterns were obtained 10 minutes after the mice had been given the alcohol. Be sure to collect data for both strains of mice (Studies 3a and 3b).

Study 3a—Mouse Movement Data

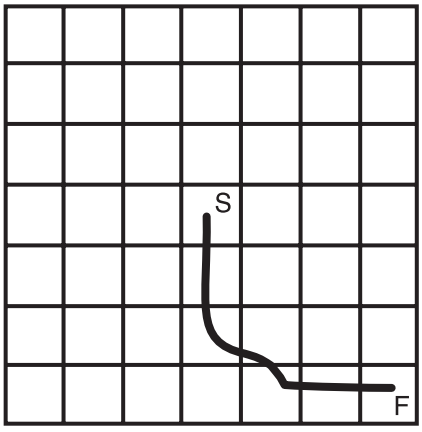
Count the number of grid lines crossed by each mouse and record those numbers on Master 3.11, *Study 3—Worksheet and Graph Template*. Note that "S" indicates "start" and "F" indicates "finish."



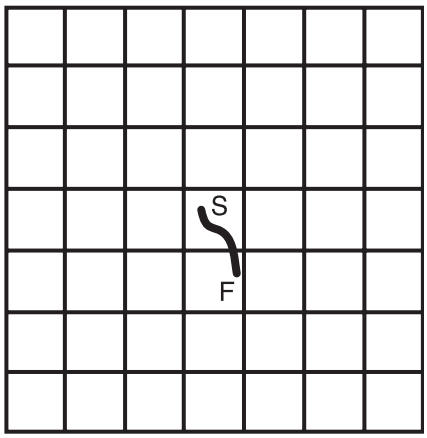
no alcohol



1.5 g alcohol/kg body weight



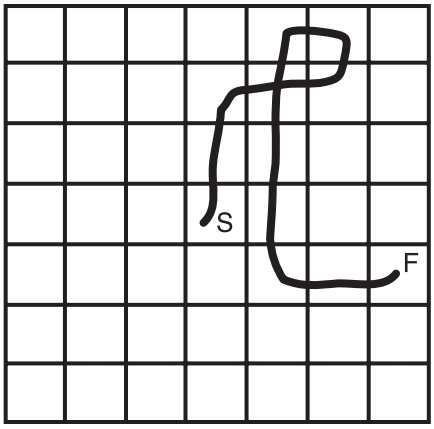
2.0 g alcohol/kg body weight



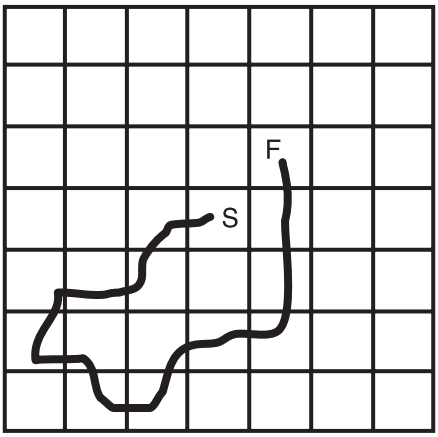
3.0 g alcohol/kg body weight

Study 3b—Mouse Movement Data

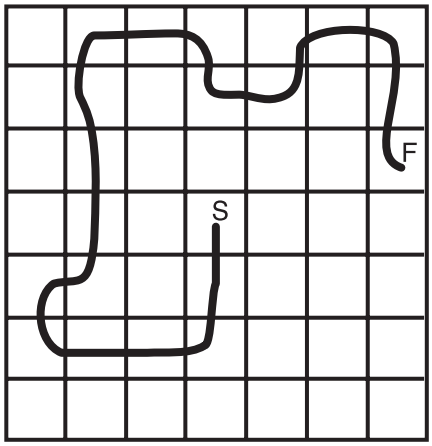
Count the number of grid lines crossed by each mouse and record those numbers on Master 3.11, *Study 3—Worksheet and Graph Template*. Note that "S" indicates "start" and "F" indicates "finish."



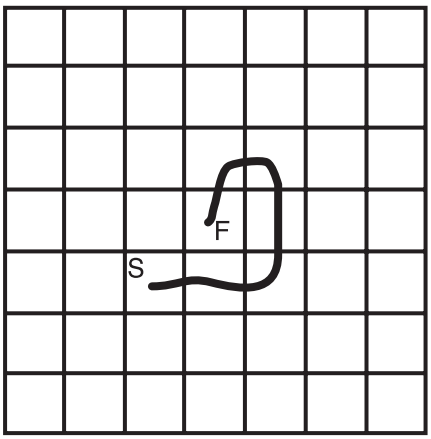
no alcohol



1.5 g alcohol/kg body weight



2.0 g alcohol/kg body weight

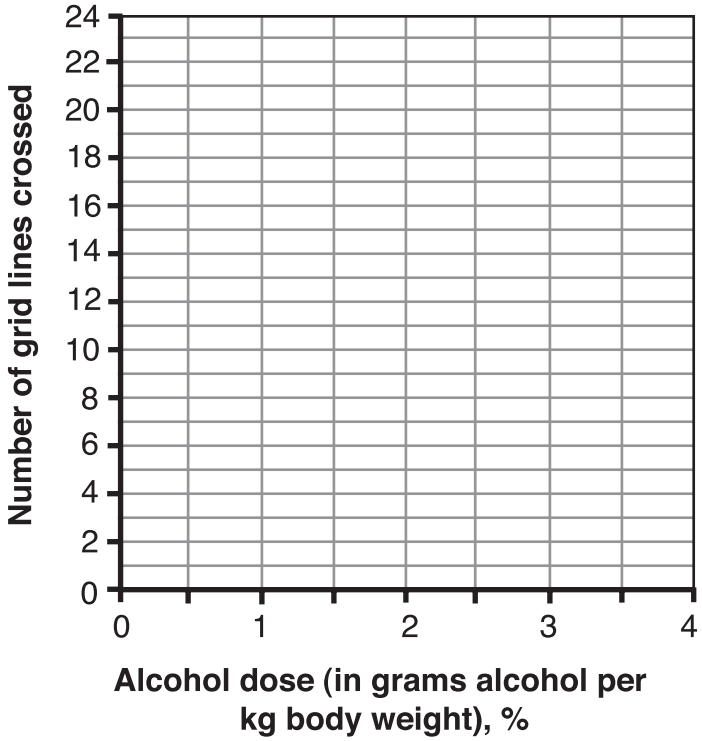


3.0 g alcohol/kg body weight

Study 3—Worksheet and Graph Template

Name _____ Date _____

Study 3a mice dose	Number of grid lines crossed	Study 3b mice dose	Number of grid lines crossed
No alcohol		No alcohol	
1.5 g alcohol/kg body weight		1.5 g alcohol/kg body weight	
2.0 g alcohol/kg body weight		2.0 g alcohol/kg body weight	
3.0 g alcohol/kg body weight		3.0 g alcohol/kg body weight	



Lesson 4
Explain/
Elaborate

Alcohol Use, Abuse, and Alcoholism

Figure 4.1. Some adults choose to drink alcoholic beverages while others choose to drink nonalcoholic beverages.

At a Glance

Overview

In Lesson 4, students roll dice to model factors that lead some individuals to use alcohol and others to abstain from it. As part of the modeling activities, students examine influences that contribute to, or help prevent, alcohol use, alcohol abuse, and alcoholism. Students also explore the frequencies of alcohol use, abuse, and alcoholism in the population.

Major Concepts

Alcohol consumption ranges along a continuum from no use to alcoholism. Many factors including the environment and genetics determine where an individual's alcohol use falls on this continuum. Personal choice plays a key role in the decision to use or abstain from alcohol.

Objectives

After completing this lesson, students will

- be able to identify factors that influence alcohol use;
- be able to distinguish among alcohol use, abuse, and alcoholism;
- recognize that everyone who chooses to consume alcohol does not necessarily develop a drinking problem;
- recognize that everyone who abuses alcohol does not necessarily become an alcoholic; and
- be able to explain that alcoholism is a complex disease influenced by genetic and environmental factors, as well as by personal choice.

Teacher Background

Consult the following sections in Information about Alcohol:

8.1 Signs of a problem (page 39)
8.2 Alcoholism and genetics (pages 39–40)
8.3 Alcoholism treatments (page 40)
10.1 The costs to society (page 42)

In Advance

Web-Based Activities

Activity	Web Version?
1	No
2	No
3	No
4	No

Photocopies

Activity 1	Master 4.1, *Environmental Factors Influencing Alcohol Use and Nonuse* (Make 1 copy per student.) Master 4.2, *Score Sheet for Modeling Alcohol Use* (Prepare an overhead transparency.) Master 4.3, *Results for Modeling Alcohol Use* (Prepare an overhead transparency.)
Activity 2	Master 4.4, *Modeling Genetic Influence* (Prepare an overhead transparency.) Master 4.5, *Factors Influencing Alcohol Use and Abuse* (Make 1 copy per student.) Master 4.6, *Results for Modeling Alcohol Abuse* (Prepare an overhead transparency.)
Activity 3	Master 4.7, *Factors Influencing Alcohol Abuse and Alcoholism* (Make 1 copy per student.) Master 4.8, *Score Sheet for Modeling Alcoholism* (Prepare an overhead transparency.) Master 4.9, *Results for Modeling Alcoholism* (Prepare an overhead transparency.)
Activity 4	Master 4.10, *When Is Alcohol Use a Problem?* (Prepare an overhead transparency.)

Materials

Activity 1	For the class: 1 beer mug or a clear drinking glass (used in Lesson 2)[a] water red food coloring[b] dice[c]
Activity 2	dice[c]
Activity 3	dice[c]
Activity 4	no materials needed

[a] In Activity 1, you will use a simulated beer, similar to that used in Lesson 2.

[b] If you have saved the diluted-food-coloring solution prepared in Lesson 2, use that to prepare the simulated beer. Otherwise, use a few drops of concentrated food coloring in water.

[c] You can decrease the number of dice needed if you have each group share 1 die. This may take slightly more class time than giving each student his or her own die.

Preparation

To prepare the simulated beer, fill the beer mug with water, add a couple of drops of food coloring, and mix.

Activity 1: *To Drink or Not to Drink?*

Procedure

1. **Ask the class to recall what they learned from the mouse simulations in Lesson 3 about which factors influence the response to alcohol.**

   Students should recall that the amount of alcohol, the time after consumption, and individual variation (genetic differences) all affect how a mouse (or a person) responds to alcohol.

2. **Remind the students that those simulations looked at what happened *after* alcohol was taken into the body. Hold up the simulated alcoholic beverage (see Preparation) for the class to see. Remind students that this represents a beer (an alcoholic drink). Ask students to consider what things might influence a person's decision to drink or not to drink the beer. Write their answers on the board.**

NSES

Content Standard F: Students should develop an understanding of populations, resources, and environments.

3. **Sort their answers into five categories:**
   - **availability,**
   - **family environment,**
   - **peer pressure,**
   - **media pressure, and**
   - **legal restrictions.**

   Explain that these five categories influence a person's decision to drink or not to drink alcohol.

   The items in these five categories account for most of the environmental factors that influence a person's decision to drink or not to drink. Other types of factors, including genetics, will be examined in Activities 2 and 3. Of course the effects of environment and genetics are not separated in time as discussed here; they interact with each other. When students are given an opportunity to discuss how the model represents, or fails to represent, reality, this fact can be brought out.

4. **Inform students that they will be exploring these environmental factors and their contributions to the decision whether or not to use alcohol. In the activity, students will roll dice to model fictitious individuals' decisions about drinking alcohol. Emphasize to students that they are going to model the behavior of *fictitious* individuals. The results of this activity do not reflect on their behavior or that of their classmates, family, or other acquaintances.**

   This activity models behavior. As a model, it has limitations. It is important to realize that students should not draw conclusions about the behavior of a friend or family member based on this activity. See *How Can Controversial Topics Be Handled in the Classroom?*, on page 14.

5. **Give each student a die and a copy of Master 4.1, *Environmental Factors Influencing Alcohol Use and Nonuse.***

Figure 4.2. Rolling dice can be used to model aspects of human behavior.

6. **Explain to the class that they will roll the die 5 times for each individual and record the number of each roll in the spaces provided on Master 4.1. After the first roll, the student records the number in the space provided under the "Availability" factor on their handout. The results of rolls two through five are recorded on the handout in the spaces provided under "Family environment," "Peer pressure," "Media pressure," and "Legal restriction," respectively.**

   For a class of 30 students, we suggest that each student model two fictitious individuals, thus providing data for 60 total individuals. For classes with fewer than 30 students, adjust the number of individuals each student models appropriately. The larger the data pool, the more closely the data will approximate the known distribution.

   Students will need these scores when they do Activity 2. Students should keep Master 4.1 handy.

7. **Display a transparency of Master 4.2, *Score Sheet for Modeling Alcohol Use*. Ask students to record a score for each category based on the die rolls they recorded. Each student should then add the values for the five factors to obtain a total score for each modeled individual.**

8. **Next, display the overhead transparency of Master 4.3, *Results for Modeling Alcohol Use*. Summarize the results of the activity by constructing a histogram of the total scores for the entire class. Remember that each student will have data for two fictitious individuals.**

   If you want to make this graphing exercise more interactive, you may draw a graph template on the chalkboard and have students add their own data to it. Students should place an X above the range

Figure 4.3. Sample histogram of class data for modeling alcohol use.

Content Standard A: Use mathematics in all aspects of scientific inquiry.

corresponding to their calculated alcohol-use score. As more students add their Xs to the same score, they place their X above the preceding one, building up a histogram.

9. **Ask students to interpret the graph. Guide the discussion with questions like the following:**

   - **How are the scores distributed on the graph?**

     Even though class results will vary, the data should reflect a bell-shaped curve with scores ranging from a low of 0 to a high of 45.

     If the data from a particular class do not yield a bell-shaped curve, this is an opportunity to discuss another limitation of the model. The class may benefit from a discussion of sample size in experiments or of probability.

Tip from the field test: If you do this activity with several classes, you may wish to collect the data from all classes and generate a single histogram. This should result in a graph that more closely resembles that of alcohol use in a population.

   - **What do the low scores represent?**

     A fictitious individual with a score of 15 or less represents someone who doesn't drink. It might help for students to refer to the transparency of Master 4.2, *Score Sheet for Modeling Alcohol Use*, when answering the next question.

   - **What factors are responsible for some individuals having scores of 15 or less?**

     No alcohol was available.
     Little or no use of alcohol among peers.
     Little exposure to or influence from the media.
     Family and/or religious values discourage alcohol use.
     Respect for laws that prohibit alcohol consumption by minors.

   - **Do you think this distribution accurately models the actual alcohol use in a population?**

     Students may suggest a number of reasons why this model fails to depict alcohol use in the population accurately. For example, the model includes only five variables to account for alcohol use and only describes two or three variations for each factor. Some students may suggest that genes may contribute to alcohol use. You may point out there is evidence for a genetic influence on alcohol abuse and

alcoholism. This will be taken into account in the next two activities. However, there is no evidence that the decision to first consume alcohol has a genetic component.

10. **Continue to display the graph on Master 4.3, *Results for Modeling Alcohol Use*, on the overhead projector. Ask students to refer to the completed graph to answer the following questions.**

    - **How many individuals have scores of 15 or less and, consequently, chose not to drink alcoholic beverages?**

      Answers will vary depending on the data generated by the class.

    - **According to the Surgeon General, about 33 percent of the population report that they do not drink alcoholic beverages. Keeping this in mind, how many fictitious individuals would you expect not to drink?**

      If the class models a total of 60 individuals, 33 percent of that group, or 20 individuals, would not consume alcohol. You can easily revise that number based on the total sample size that your class generates.

    - **On the basis of your class's data, is the number of individuals who choose to drink higher or lower than the predicted number?**

      The scoring for this model was designed so that approximately 33 percent of the scores would be 15 or lower. This correlates to the statistics for the population. In some classes, however, the number of fictitious individuals whose scores are 15 or less may be higher or lower than the predicted 33 percent who choose not to drink alcohol.

      If your class's results differ significantly from the predicted number, you can use this as an opportunity to discuss this limitation of this model. Discuss the effect of sample size and reliance on probability.

Tip from the field test: As the class proceeds through Activity 3, fewer individuals will be modeled at each stage to help students understand that fewer people are alcoholic than abuse alcohol and that there are fewer abusers of alcohol than alcohol users. You may find it helpful to write a chart on the board to summarize the number of fictitious individuals who fall into each of the following categories:

- Total number of modeled individuals: _____
- Number of alcohol users: _____
- Number of alcohol abusers: _____
- Number of alcoholics: _____

Activity 2: *Modeling Alcohol Use and Abuse*

1. **Ask students to recall what they learned in Lesson 3 about genetics and alcohol. What conclusions did they draw about the two different mice and why they responded differently to alcohol? Is it reasonable to suggest that humans, too, might vary in their response to alcohol?**

   Students should recall that Study 3 demonstrated that different strains of mice react differently to alcohol. These differences are largely attributable to differences in the genetic makeup of the two different mice strains. Students should predict (and are likely to have previous knowledge) that different individuals will respond differently to alcohol and that these differences, like those in the mice, may be affected by different genes.

2. **Remind students that the die-rolling activity they just completed models a person's decision whether to drink or not to drink alcohol. Tell the students that they will now be doing an activity that models whether a person who drinks alcohol will simply *use* alcohol appropriately or be more likely to *abuse* alcohol. Define alcohol abuse for students.**

   Alcohol abuse is characterized by consumption of excessive amounts of alcohol and is associated with social problems, but the individual does not experience intense cravings for or withdrawal from alcohol as with alcoholism.

3. **Ask students to consider the question, Can someone who chooses not to drink alcohol abuse alcohol? On the basis of their responses, guide students to the conclusion that a person who does not consume alcohol cannot abuse alcohol.**

   Students should realize that someone who does not drink alcohol will *not* be an abuser. Abuse of alcohol requires drinking alcohol. Therefore, nondrinkers will not participate in this activity.

NSES

Content Standard F: Students should develop an understanding of personal health.

4. **Inform students that they will again use dice to model the behavior of the same fictitious individuals that they did in Activity 1. Display a transparency of Master 4.4, *Modeling Genetic Influence*, and give each student 1 die and 1 copy of Master 4.5, *Factors Influencing Alcohol Use and Abuse*.**

5. **Explain to students that if the individual or individuals whose behavior they modeled in Activity 1 belonged to the group of nondrinkers (those individuals with scores of 15 or less), they will not**

roll the die for that individual. Ask students to roll the die according to the directions on Master 4.4, *Modeling Genetic Influence*, to obtain a score for the genetic influence for each of their modeled individuals.

6. **Instruct students to record the genetic influence factor for each individual in the appropriate space on Master 4.5, *Factors Influencing Alcohol Use and Abuse*. Also instruct them to transfer their scores from Activity 1 (recorded on Master 4.1) to the appropriate spaces on Master 4.5 (environmental factors) and add them to the genetic influence factor to obtain a final score for this activity.**

Teacher note
If each student has modeled the behavior of two fictitious individuals in Activity 1, each student likely will have at least one individual who belonged in the category of choosing to drink alcohol (individuals with scores over 15). If, by chance, neither of the two individuals that a student modeled falls into this category, ask the student to partner with another student and watch the activity.

7. **Display the overhead transparency of Master 4.6, *Results for Modeling Alcohol Abuse*. Use the students' final scores to construct a histogram of the data for the entire class.**

   As before, you may choose to have students add their own data to a graph. Again, you may wish to draw a graph template on the chalkboard and have students place an X above the range corresponding to their calculated alcohol score. As more students add their Xs to the same score, they place their X above the preceding one, building up a histogram.

   Because only individuals who chose to drink alcohol in Activity 1 are included in this modeling exercise, students will have different

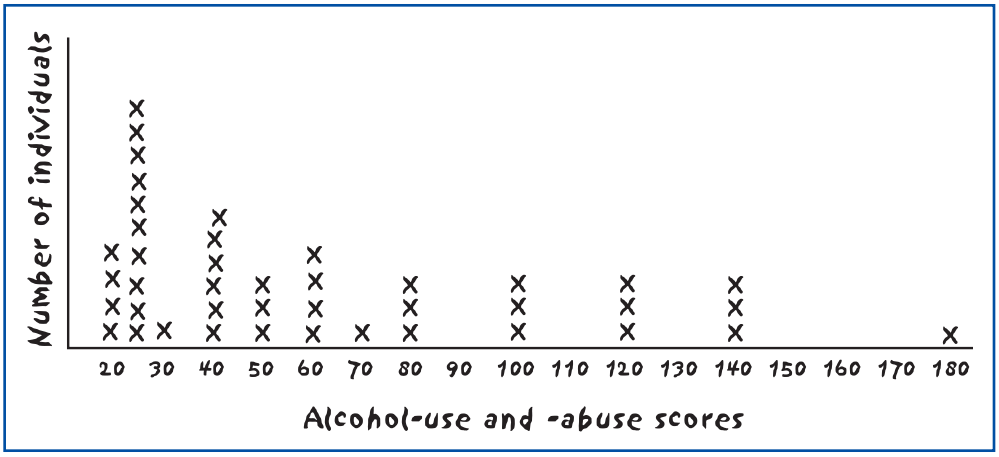


Figure 4.4. Sample histogram of class data for modeling alcohol use and abuse.

Content Standard A:
Use mathematics in all aspects of scientific inquiry.

amounts of data to contribute to this graph. Some students will have data for one fictitious individual, other students will have data for two fictitious individuals, and some students may not be collecting data during this activity.

8. **Ask the students to interpret the completed graph on the transparency. You may use the following questions to lead the discussion.**

- **How are the scores distributed on the graph?**

  Scores will range from a low of 20 to a high of 180. Since low scores from Activity 1 have been eliminated, we expect scores for this activity to cluster closer to the low of 20 than to the high of 180.

- **If lower scores represent alcohol use and higher scores represent alcohol abuse, what factors contribute to alcohol abuse?**

  Students should mention the environmental factors associated with alcohol use from Activity 1, as well as the genetic factors modeled here.

  The term "environmental factors," as used in this model, refers to factors that are not physiological; they are cultural or social influences. As indicated in Activity 1, environmental factors that contribute to alcohol abuse include
  - alcohol easily available,
  - alcohol use or abuse by most or all of the individual's peers,
  - family's view of alcohol use was positive or not discouraged,
  - failure to obey legal restrictions against use by minors, and
  - effective media advertisements portraying alcohol use in a positive light.

  Genetic factors could include having combinations of genes that influence your susceptibility or reaction to alcohol.

- **Explain that each roll of the die in this activity corresponds to having a version (allele) of a gene that either has no effect on alcohol use or promotes its use. In this simple model, we used two rolls of the die, simulating the contributions of just two genes.**

  In this model:
  a. genetic influence factor of 1 = having both alleles of no effect
  b. genetic influence factor of 2 = having one allele of no effect and one allele that promotes alcohol use
  c. genetic influence factor of 4 = having both alleles that promote alcohol use

Alcohol abuse and alcoholism certainly involve the contributions from more than one gene. The exact number of genes that influence alcoholism is not known.

- **In this activity, individuals who have scores of 120 or higher are considered to be alcohol abusers. By this measure, how many of the modeled individuals did abuse alcohol?**

  Results for your class will vary, but the graph should show approximately 10–15 percent of the original population with scores above 120.

- **If, in the population, 10–15 percent of alcohol users go on to abuse alcohol, how many modeled individuals would you expect to be alcohol abusers?**

  The answer depends on how many individuals were modeled. For example, if the class modeled 50 individuals, then you would expect between 5 and 8 scores to be above 120 and therefore represent alcohol abusers.

- **Do the results of the modeling activity accurately reflect the statistics for the population?**

  The scoring in this activity should yield results that are similar to the population statistics. However, results from individual classes will vary. This usually can be attributed to a small sample size. As before, if you do this activity in several classes, you might wish to pool the data.

- **How does this model accurately reflect the behavior of alcohol use and abuse? How is it inaccurate?**

  The model is accurate in that it leads to about one-third of the population abstaining from alcohol use and 10 percent of users abusing alcohol. It also accurately reflects most of the important factors that influence alcohol use. The model is inaccurate in that it does not take into account interactions among the various factors. For example, it is not the case that environmental factors play a role only in the decision to use alcohol and not in the decision to abuse it. The genetic influence on alcohol use is also oversimplified. The model fails to stress the role that personal choice plays in an individual's alcohol consumption.

Activity 3: *Modeling Alcohol Abuse and Alcoholism*

1. **Remind students that the die-rolling activity they just completed models a person's use or abuse of alcohol. Explain that they will now complete an activity that models whether a person who abuses alcohol will go on to become an alcoholic individual.**

   Alcoholism is a disease characterized by physical dependence on alcohol. When alcohol use is discontinued, withdrawal symptoms occur. People who are alcoholic exhibit tolerance, meaning they need increasing amounts of alcohol to feel intoxicated. They feel a strong need or compulsion to drink and continue despite adverse consequences.

Content Standard F: Students should develop an understanding of personal health.

2. **Invite students to consider factors they think might influence whether a person continues to abuse alcohol or goes on to suffer from alcoholism. List their responses on the board.**

   Students will likely name a variety of things. Try to focus their responses on the
   - presence or absence of a support system,
   - ability to control their drinking,
   - relative craving for alcohol,
   - sensitivity of the brain to alcohol, and
   - genetic risk.

   The genetic risk factor refers to genes that place an individual at increased risk for becoming addicted to alcohol.

3. **Remind the class that only individuals who were designated as alcohol abusers with a score of 120 or higher in Activity 2 will be used in this activity. Display the transparency of the completed graph from Master 4.6, *Results for Modeling Alcohol Abuse*, and ask students to recall how many modeled individuals abused alcohol.**

4. **Draw one stick figure on the board to represent each fictitious individual who was an alcohol abuser (a score of 120 or higher) from Activity 2. Assign a number to each fictitious individual. Explain to students that these drawings represent the alcohol abusers from Activity 2.**

5. **Explain that the procedure for this activity will be a little different from that of the previous activities because of the small number of fictitious individuals whose behavior is being modeled. Assign students numbers that correspond to each of the numbered stick figures. Each student should be assigned two numbers. For example, one student may be assigned numbers 1 and 2, another student**

assigned numbers 3 and 4, and so forth. Have students write the numbers for their assigned fictitious individuals on their copy of Master 4.7.

This strategy will allow all students to be involved in the activity even though the number of fictitious individuals is low. Several students will record data for the same fictitious individuals.

6. Give each student one copy of Master 4.7, *Factors Influencing Alcohol Abuse and Alcoholism.*

7. Complete the die rolling as a class. For each fictitious individual, the die needs to be rolled 5 times. After the first roll, students record the number in the space provided under "Support system" on their handout. Likewise, they record the results of rolls 2 through 5 under "Loss of control," "Craving for alcohol," "Brain sensitivity to alcohol," and "Genetic addictive factors." Have students take turns performing a single die roll.

8. Display a transparency of Master 4.8, *Score Sheet for Modeling Alcoholism*. Instruct students to assign a score for each of the five categories (for each individual) based on the die roll and the values listed on Master 4.7, *Factors Influencing Alcohol Abuse and Alcoholism*. Instruct students to add the five scores for each individual to obtain a total score.

   Scores will range from 0 to 90 in this activity.

9. Display a transparency of Master 4.9, *Results for Modeling Alcoholism*. As before, construct a histogram of the results.

   Because the number of individuals being modeled in this activity is low, the histogram bars will not be very high.

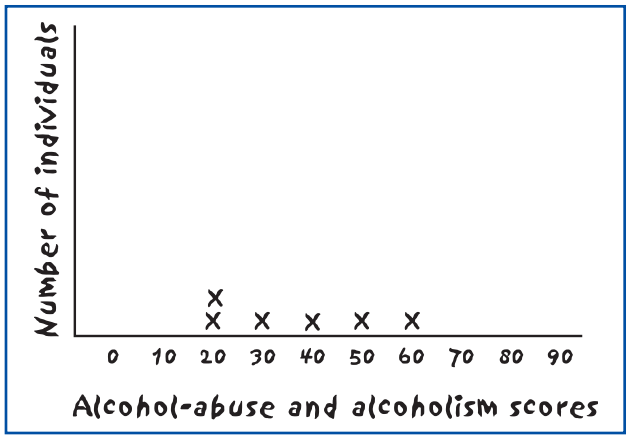


Figure 4.5. Sample histogram of class data for modeling alcohol abuse and alcoholism.

Content Standard A: Use mathematics in all aspects of scientific inquiry.

10. **Hold a class discussion to analyze the graph and interpret the results of the activity. Lead the discussion with the following questions.**

- **If in our society, one-half of alcohol abusers go on to become alcoholic, how many of the fictitious individuals would you expect to become alcoholic?**

  If one-half of alcohol abusers go on to become alcoholic, you can calculate the predicted number by multiplying the number of individuals modeled in Activity 3 by 50 percent (0.50).

- **If a score of 45 or higher indicates the individual has progressed from an alcohol abuser to an alcoholic, how many of the fictitious individuals have progressed to being alcoholic?**

  Answers will vary. The possible scores for Activity 3 range from 0 to 90. Approximately half of the fictitious individuals modeled will fall into this category.

- **Do the data from this activity accurately reflect the statistics from the population?**

  The data will vary considerably from class to class. The data collected in some classes may show no individuals who are alcoholic. Other classes may have data in which more than the predicted number of fictitious individuals are alcoholic.

  If the data vary greatly from the predicted, you may find this to be an opportunity to discuss sample size and the limitations of a model such as this. If you are collecting and pooling data from several classes, you can discuss how larger sample sizes are more likely to match results from a large population of individuals.

- **How does the number of individuals classified as alcoholic in this activity compare with the number of alcohol abusers? to alcohol users? to the general population?**

  Students should respond that the number of individuals classified as alcoholic is smaller than the number of individuals classified as alcohol abusers and is much smaller than the number of individuals in the initial population modeled in Activity 1.

  This is a good opportunity to remind the class that not everyone who chooses to consume alcohol will develop a drinking problem, and not everyone who abuses alcohol will necessarily become an alcoholic.

- **What factors are responsible for the individuals with the highest risk for alcoholism? (Display the transparency of Master 4.8, *Score Sheet for Modeling Alcoholism*, to help students respond to this question.)**

  In addition to those factors discussed in Activity 2, students may add the following:
  - a lack of a support system, or the unwillingness of the individual to use such a system;
  - loss of control that leads to heavy drinking;
  - a craving for alcohol;
  - a brain with a low sensitivity to alcohol that doesn't set up blocks to alcohol consumption; and
  - a genetic predisposition toward alcohol addiction.

- **How does personal choice influence alcohol use, alcohol abuse, and alcoholism?**

  Students will list a number of factors and ways in which personal choice is important. Some of these responses may include the following:

  Availability—Even if alcohol is readily available, an individual can still choose not to use it.
  Peer pressure—An individual chooses his/her friends, and even when peers consume alcohol, the individual can still choose to be different.
  Media pressure—Despite the tendency of TV, movies, advertisements, and music to portray alcohol use in a favorable light, an individual can choose to place these influences in perspective and resist their messages.
  Family environment—Families may have positive or negative beliefs about alcohol use. Likewise, religious views may prohibit alcohol use or tolerate it in moderation. These views can be followed or resisted.
  Legal restrictions—Minors considering alcohol use can choose to obey or disobey laws that restrict their access to alcohol.
  Support system—If individuals realize that they are abusing alcohol, then they can turn to family or friends for support. If a personal support system is absent, then individuals can seek professional guidance and counseling. Such a decision can help prevent alcohol abuse from progressing to alcoholism.

Teacher note
It is important to discuss the issue of personal choice so that students will not think that the influences modeled in this lesson constitute any individual's predetermined fate.

- **What factors might influence alcohol use, alcohol abuse, and alcoholism but do not involve personal choice?**

  Genetic factors that influence alcohol metabolism, brain sensitivity to alcohol, and risk for alcohol addiction are not under personal control.

Activity 4: *Applying the Model*

1. **Inform students that since they have completed the modeling activities to examine the range of alcohol use, alcohol abuse, and alcoholism in a small group of fictitious individuals, they will now explore how this range applies to the U.S. population. Tell students that there are approximately 200 million people between the ages of 13 and 65 in the United States.**

   These calculations can be done either by students individually or as a class.

Content Standard A: Use mathematics in all aspects of scientific inquiry.

- **If 33 percent of the population does not use alcohol, how many individuals do not use alcohol?**

  200 million x 0.33 = 66 million people do not use alcohol

- **If 67 percent of the population uses alcohol, how many individuals use alcohol?**

  200 million x 0.67 = 134 million people use alcohol

- **If 10 percent of alcohol users will become alcohol abusers, how many individuals are alcohol abusers?**

  134 million x 0.10 = 13.4 million people abuse alcohol

- **If 50 percent of alcohol abusers will become alcoholic, how many individuals are alcoholics?**

  13.4 million x 0.50 = 6.7 million alcoholics

2. **Display the transparency of Master 4.10, *When Is Alcohol Use a Problem?* Read over the transparency with the students. Explain that these simple questions *screen* for possible alcohol abuse or alcoholism. If a potential problem is identified, such an individual should see a doctor who has the training to more accurately diagnose the individual for alcoholism. Remind students that individuals diagnosed with alcoholism have options for achieving and maintaining a full recovery. Furthermore, all individuals, even those susceptible to alcoholism, have the option of choosing not to start drinking alcohol.**

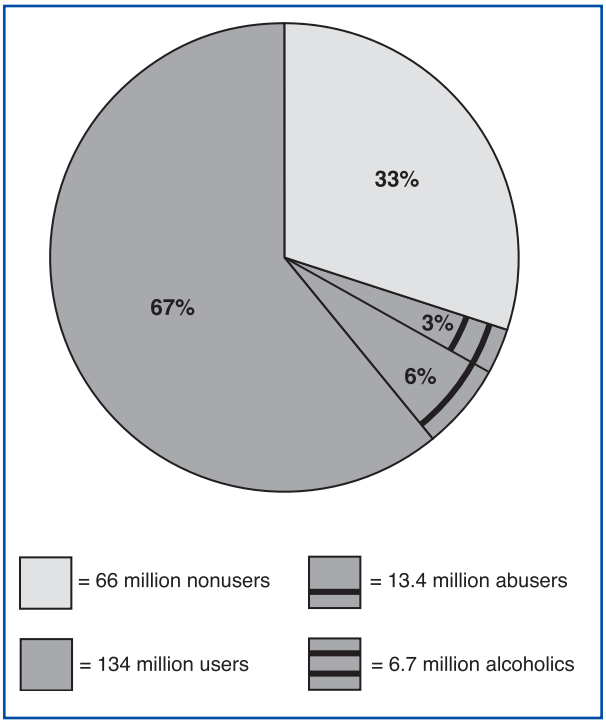


Figure 4.6. Distribution of alcohol nonusers, users, abusers, and alcoholics among Americans aged 13 to 65.

There is no simple test to identify someone with a drinking problem. However, honest answers to the four questions shown on Master 4.10 can help an individual decide whether a problem is likely to exist. To make the questions easier to remember, they have been written in such a way that the first letter of a key word in each question spells "CAGE."

1. Have you ever felt that you should **C**ut down on your drinking?
2. Have people **A**nnoyed you by criticizing your drinking?
3. Have you ever felt bad or **G**uilty about your drinking?
4. Have you ever had a drink first thing in the morning to steady your nerves or to get rid of a hangover (**E**ye opener)?

Source: National Institute on Alcohol Abuse and Alcoholism 1996. *Alcoholism: getting the facts*. Bethesda, MD: NIAAA.

A "yes" answer to one of these questions may suggest that a drinking problem exists, while more than one "yes" response is highly indicative of a problem. Even if a person answers "no" to these four questions, an alcohol problem can still exist.

If not brought up by the class, mention that molecular modeling also has many uses.

Assessment:
To evaluate students' understanding of modeling, ask them to provide other examples of scientific models and to explain what types of information scientists can get from these examples. Students will likely mention models of the weather and of ecosystems. Students may also mention that scientists use animals as models to learn about humans. They may refer to the studies they analyzed in Lesson 3.

Lesson 4 Organizer

Activity 1: *To Drink or Not to Drink*

What the Teacher Does	Procedure Reference
Have students reflect on the simulations of mice behavior in response to alcohol.	Page 119 Step 1
Ask the class what factors influence an individual's decision whether to drink alcohol. Sort their answers into the following categories: • Availability • Family environment • Peer pressure • Media pressure • Legal restrictions	Pages 119–120 Steps 2 and 3
Explain that students will roll dice to model whether fictitious individuals will drink alcohol.	Page 120 Step 4
Pass out to each student one die and a copy of Master 4.1, *Environmental Factors Influencing Alcohol Use and Nonuse.*	Page 120 Step 5 
Have students complete their rolls and record data for each of their modeled individuals. • Have students assign scores using Master 4.2, *Score Sheet for Modeling Alcohol Use.*	Page 121 Steps 6 and 7 
Summarize the results by constructing a histogram using data from the entire class on Master 4.3, *Results for Modeling Alcohol Use.*	Pages 121–122 Step 8 

 = Involves copying a master.

 = Involves using a transparency.

Have students interpret the graph. Ask, • How are the scores distributed? • What do low scores represent? • What factors contribute to low scores? • Does this distribution accurately model alcohol use in a population? • How many individuals have scores of 15 or less? • According to the Surgeon General, about 33 percent of the population report that they do not drink alcohol. Predict how many individuals in this activity would not drink alcohol. • Is this number higher or lower than expected?	Pages 122–123 Steps 9 and 10

Activity 2: *Modeling Alcohol Use and Abuse*

What the Teacher Does	Procedure Reference
Ask the class to recall their conclusions from Lesson 3 about how different mice respond to alcohol.	Page 124 Steps 1–3
Explain that students now will roll dice to model alcohol use and abuse in their fictitious individuals. Display a transparency of Master 4.4, *Modeling Genetic Influence,* and give each student a copy of Master 4.5, *Factors Influencing Alcohol Use and Abuse.*	Page 124 Step 4 
Have students complete their rolls, record data on Master 4.5, and compute scores for each modeled individual.	Pages 124–125 Steps 5 and 6
Summarize results of the activity by constructing a histogram using data from the entire class on Master 4.6, *Results for Modeling Alcohol Abuse.*	Pages 125–126 Step 7 

Have students interpret the graph. Ask, • How are the scores distributed? • What factors contribute to alcohol abuse? (Explain that this activity assumes that only two genes contribute to alcohol use.) • If individuals with scores of 120 or higher are considered to abuse alcohol, then how many modeled individuals are abusers? • If in the population, 10–15 percent of alcohol users go on to abuse alcohol, then how many modeled individuals would you expect to be alcohol abusers? • Is the number of modeled alcohol abusers higher or lower than expected? • How does the model accurately reflect the behavior of alcohol use and abuse? How is it inaccurate?	Pages 126–127 Step 8

Activity 3: *Modeling Alcohol Abuse and Alcoholism*

What the Teacher Does	Procedure Reference
Explain that the class will now model whether an alcohol abuser will go on to become an alcoholic individual.	Page 128 Step 1
Challenge the class to list reasons that might influence whether an alcohol abuser will develop alcoholism.	Page 128 Step 2
Explain that individuals with scores of 120 or higher in the previous activity are alcohol abusers and will be modeled in this activity. Display the transparency of the completed graph from Master 4.6.	Page 128 Step 3 
Assign each student two of the alcohol abusers to model, and explain the procedure.	Pages 128–129 Steps 4 and 5
Pass out to each student a copy of Master 4.7, *Factors Influencing Alcohol Abuse and Alcoholism.*	Page 129 Step 6 

Have students complete their rolls, record data, and compute scores for each modeled individual based on Master 4.8, *Score Sheet for Modeling Alcoholism.*	Page 129 Steps 7 and 8
Summarize results of the activity by constructing a histogram using data from the entire class on Master 4.9, *Results for Modeling Alcoholism.*	Page 129 Step 9
Have students interpret the graph. Ask, • If one-half of alcohol abusers go on to become alcoholic, then how many of the modeled individuals would be expected to become alcoholic? • If a score of 45 or higher indicates that an individual becomes alcoholic, then how many of the modeled individuals became alcoholic? • Do the data from this activity reflect the statistics from the population? • How does the number of individuals classified as alcoholic in this activity compare to the number of alcohol abusers? To alcohol users? To the general population? • What factors contribute to high risk for alcoholism? • How does personal choice influence alcohol use, alcohol abuse, and alcoholism? • What factors might influence alcohol use, alcohol abuse, and alcoholism but do not involve personal choice?	Pages 130–132 Step 10

Activity 4: *Applying the Model*

What the Teacher Does	Procedure Reference
Have the class apply the statistics for alcohol use, alcohol abuse, and alcoholism from the model to the U.S. population.	Page 132 Step 1
Have the class read Master 4.10, *When Is Alcohol Use a Problem?* • Discuss choice as it applies to drinking alcohol and the options available to those with drinking problems.	Pages 132–133 Step 2

Environmental Factors Influencing Alcohol Use and Nonuse

Name _____ Date _____

FICTITIOUS INDIVIDUAL #1

Availability factor	Die roll _____	Score _____
Family environment factor	Die roll _____	Score _____
Peer pressure factor	Die roll _____	Score _____
Media pressure factor	Die roll _____	Score _____
Legal restriction factor	Die roll _____	Score _____

Add scores together for **total score** _____

FICTITIOUS INDIVIDUAL #2

Availability factor	Die roll _____	Score _____
Family environment factor	Die roll _____	Score _____
Peer pressure factor	Die roll _____	Score _____
Media pressure factor	Die roll _____	Score _____
Legal restriction factor	Die roll _____	Score _____

Add scores together for **total score** _____

Score Sheet for Modeling Alcohol Use

AVAILABILITY FACTOR

Number on die	Score	Effect
Even	0	Alcohol not available
Odd	5	Alcohol available

FAMILY ENVIRONMENT FACTOR

Number on die	Score	Effect
Even	0	Alcohol use discouraged
Odd	10	Alcohol use not discouraged

PEER PRESSURE FACTOR

Number on die	Score	Effect
1 or 2	0	Peers don't use alcohol
3 or 4	5	Some peers use alcohol
5 or 6	10	Most peers use alcohol

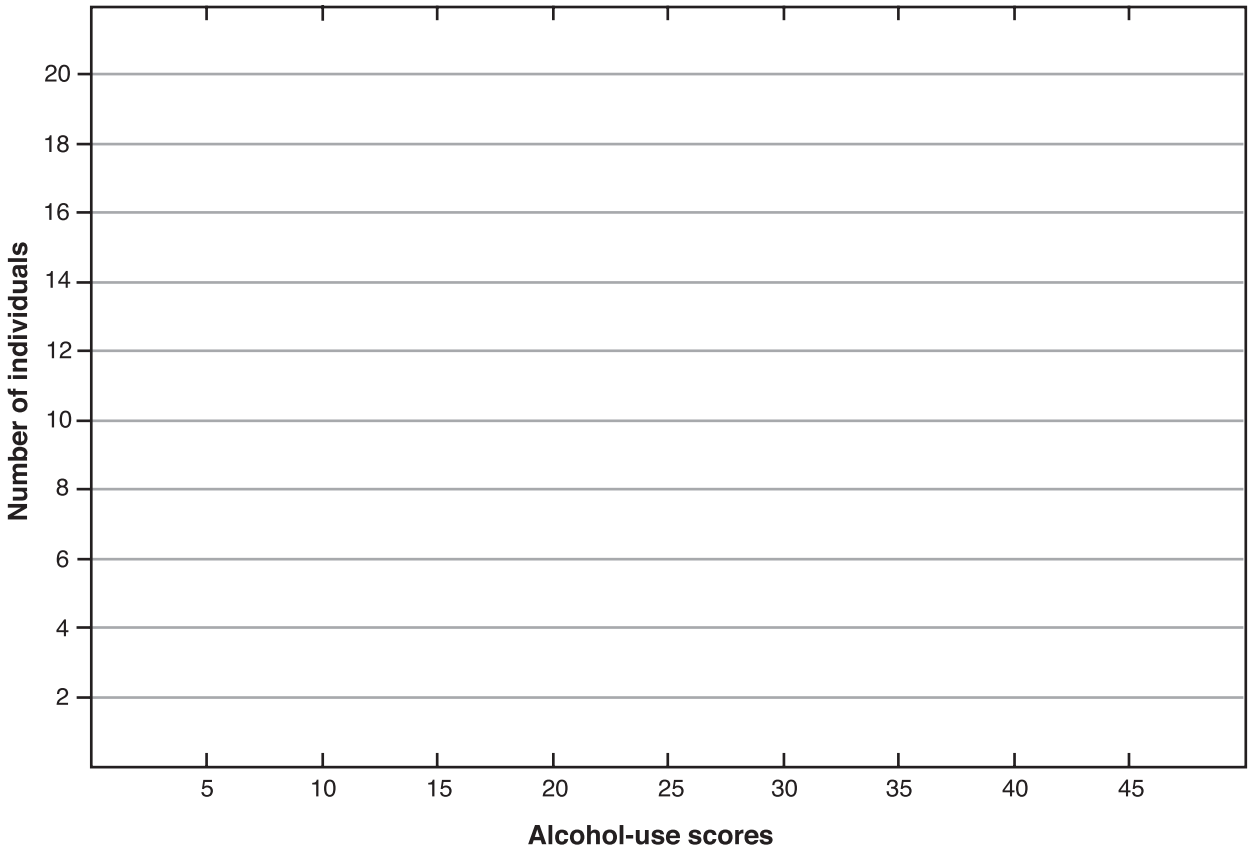
MEDIA PRESSURE FACTOR

Number on die	Score	Effect
1 or 2	0	Little influence to use alcohol
3 or 4	5	Moderate influence to use alcohol
5 or 6	10	Strong influence to use alcohol

LEGAL RESTRICTION FACTOR

Number on die	Score	Effect
Even	0	Choose to obey laws
Odd	10	Choose to disobey laws

Results for Modeling Alcohol Use



Modeling Genetic Influence

To model the genetic influence for an individual, follow the instructions below. This information is summarized in the accompanying table.

1. Roll the die. If an odd number turns up, then the genetic influence factor is 1. Do not roll again. If an even number turns up, then assign a value of 2 and roll again.

2. Roll the die a second time. If an odd number turns up, then assign a value of 1 and multiply the values of the two rolls to obtain the genetic influence factor:

   2 (first roll) x 1 (second roll) = 2 = genetic influence factor

   If an even number turns up, then assign a value of 2 and multiply the values of the two rolls to obtain the genetic influence factor:

   2 (first roll) x 2 (second roll) = 4 = genetic influence factor

Roll of die	Number on die	Outcome
First roll	Odd	Genetic influence factor = 1
First roll	Even	Roll again
Second roll	Odd	Genetic influence factor = 2
Second roll	Even	Genetic influence factor = 4

3. Record genetic influence factor on Master 4.5, *Factors Influencing Alcohol Use and Abuse*.

Factors Influencing Alcohol Use and Abuse

Name _____ Date _____

FICTITIOUS INDIVIDUAL #1

Environmental factors (total score from Master 4.1): _____

Genetic influence factor _____

Multiply environmental factors times genetic influence factor to get total score:

Environmental factors x genetic influence factor = _____ total score

FICTITIOUS INDIVIDUAL #2

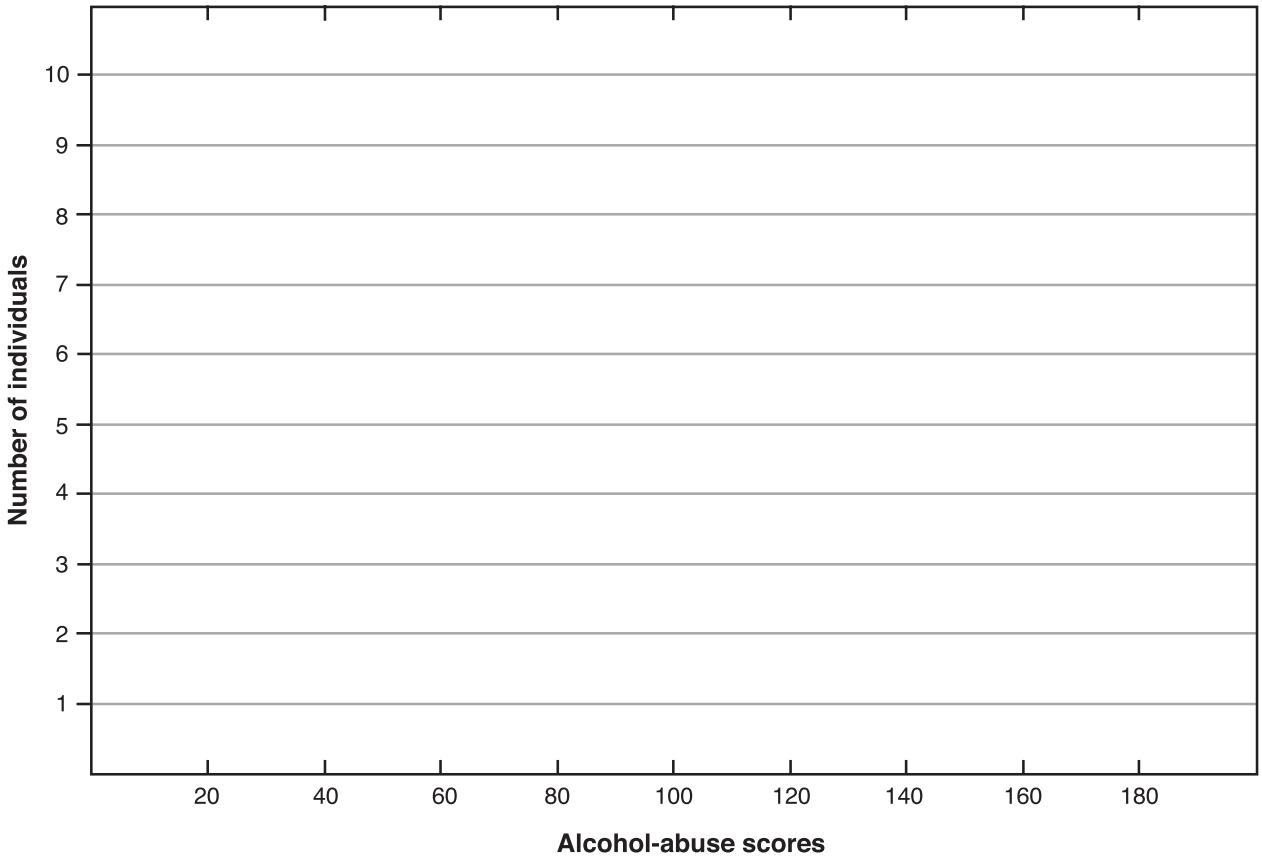
Environmental factors (total score from Master 4.1): _____

Genetic influence factor _____

Multiply environmental factors times genetic influence factor to get total score:

Environmental factors x genetic influence factor = _____ total score

Results for Modeling Alcohol Abuse



Factors Influencing Alcohol Abuse and Alcoholism

Name _____ Date _____

FICTITIOUS INDIVIDUAL # ___

Support system	Die roll _____	Score _____
Loss of control	Die roll _____	Score _____
Craving for alcohol	Die roll_____	Score _____
Brain sensitivity to alcohol	Die roll _____	Score _____
Genetic addictive factors	Die roll _____	Score _____

Add together for **total score** _____

FICTITIOUS INDIVIDUAL # ___

Support system	Die roll _____	Score _____
Loss of control	Die roll _____	Score _____
Craving for alcohol	Die roll_____	Score _____
Brain sensitivity to alcohol	Die roll _____	Score _____
Genetic addictive factors	Die roll _____	Score _____

Add together for **total score** _____

Score Sheet for Modeling Alcoholism

SUPPORT SYSTEM

Number on die	Score	Effect
1 or 2	0	Has been counseled for abuse
3 or 4	20	No abusers among family and peers
5 or 6	40	Associates with abusers

LOSS OF CONTROL

Number on die	Score	Effect
Even	0	Can control drinking
Odd	10	Cannot control drinking

CRAVING FOR ALCOHOL

Number on die	Score	Effect
Even	0	No craving for alcohol
Odd	10	Craving for alcohol

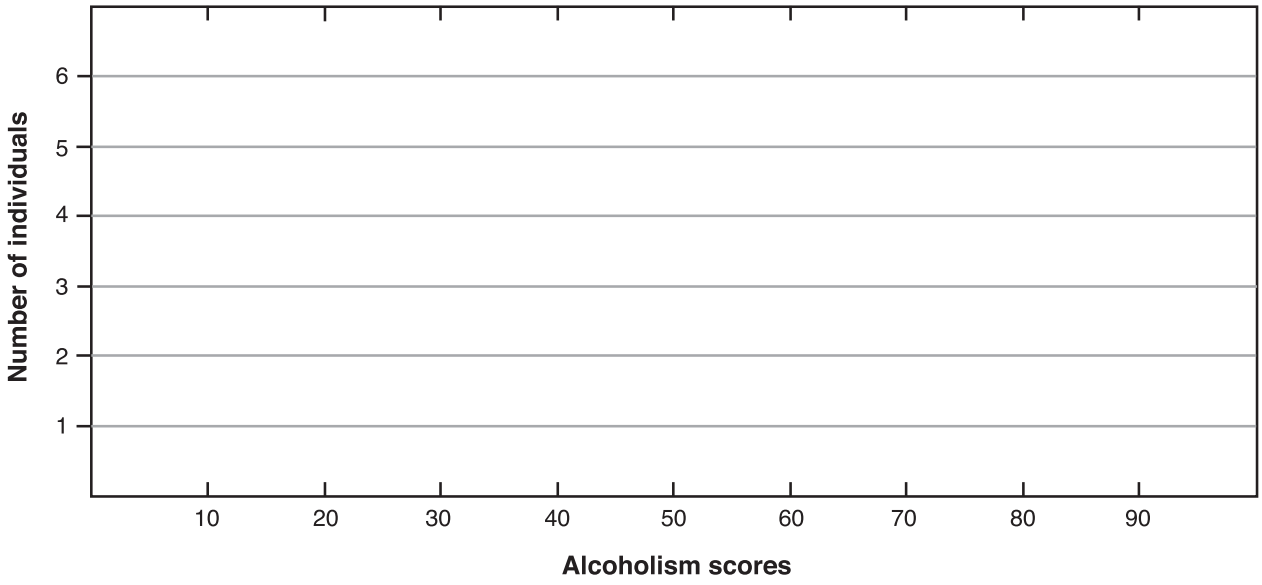
BRAIN SENSITIVITY TO ALCOHOL

Number on die	Score	Effect
Even	0	High sensitivity to alcohol
Odd	10	Low sensitivity to alcohol

GENETIC ADDICTIVE FACTORS

Number on die	Score	Effect
Even	0	No genetic addictive factors present
Odd	20	Genetic addictive factors present

Results for Modeling Alcoholism



When Is Alcohol Use a Problem?

Honest answers to the following four questions can help identify a potential drinking problem. A "yes" answer to one of the questions may suggest that a drinking problem exists, while more than one "yes" answer suggests that a drinking problem likely exists. The questions are written in such a way that the first letter of a key word in each question spells "CAGE."

1. Have you ever felt that you should **C**ut down on your drinking?

2. Have people **A**nnoyed you by criticizing your drinking?

3. Have you ever felt bad or **G**uilty about your drinking?

4. Have you ever had a drink first thing in the morning to steady your nerves or to get rid of a hangover (**E**ye opener)?

Source: National Institute on Alcohol Abuse and Alcoholism. 1996. *Alcoholism: getting the facts*. Bethesda, MD: NIAAA.

Lesson 5
Elaborate

Alcohol and Driving: When to Say No

Figure 5.1. Police administer sobriety tests to help keep drivers under the influence of alcohol off the road.

At a Glance

Overview

Students investigate how drinking alcoholic beverages affects the blood alcohol concentration (BAC). They then explore how gender, body weight, metabolism, and drinking patterns change BAC. Finally, students watch driving simulations in a Web-based activity and consider how mental and physical functions are impaired by drinking alcohol.

Major Concepts

Alcohol impairs the functions of the mind and body. These impairments depend on the amount of alcohol in the blood, as measured by the blood alcohol concentration. Factors that influence the BAC include the number of drinks and the time period over which they are consumed, as well as the drinker's gender and body weight. The body breaks down, or metabolizes, alcohol at a relatively constant rate, regardless of the rate at which it is consumed.

Objectives

After completing this lesson, students will

- be able to explain how the number of drinks, the pattern of drinking, the individual's gender, and the individual's body weight influence the BAC;
- understand that metabolism breaks down alcohol at a constant rate, regardless of the rate at which it is consumed; and
- be able to correlate different blood alcohol concentrations with impairments in body function.

Teacher Background

Consult the following sections in Information about Alcohol:

5 Alcohol: Pharmacokinetics (page 28)
- *5.1 Absorption and distribution of alcohol in the body* (page 29)
- *5.2 Measurement of blood alcohol concentration (BAC)* (page 29)
- *5.3 Factors affecting alcohol absorption and elimination* (pages 29–30)
- *5.4 Alcohol metabolism* (pages 30–31)

6 Alcohol: Biological Effects (page 31)
- *6.1 Alcohol and the brain* (pages 31–35)
- *6.2 Alcohol and body systems* (pages 35–37)

10.2 Drinking and driving (pages 42–43)

In Advance

Web-Based Activities

Activity	Web Version?
1	No
2	Yes

Photocopies

Activity 1	Master 5.1, *Blood Alcohol Concentration Tables* (Make 1 copy per student and prepare an overhead transparency.) Master 5.2, *Drinking Patterns for Party Guests* (Make 1 copy per student team.) Master 5.3, *Blood Alcohol Concentration Graph Template* (Make 1 copy per student team and prepare an overhead transparency.)
Activity 2	Master 5.4, *Progressive Effects of Alcohol* (Make 1 copy per student team and prepare an overhead transparency.)

Materials

Activity 1	colored pencils
Activity 2	computers with Internet access and sound card

Preparation

Gather supplies needed for the activities.
Arrange for access to computers.
Test the Internet connection and set up the appropriate bookmark to *http://science.education.nih.gov/supplements/alcohol/student*.
Students will need copies of Master 5.1, *Blood Alcohol Concentration Tables*, and Master 5.4, *Progressive Effects of Alcohol*, during Lesson 6.

Activity 1: *Patterns of Drinking*

Procedure

1. **Introduce the activity by creating a scenario for students. If two individuals attend a party and drink the same amount of alcohol, will they be affected in the same way? Ask students to share the reasons for their responses.**

   Students will respond that not all people react the same way to drinking the same amount of alcohol. Continue the discussion by asking the class to name factors that influence the extent to which a person is affected by drinking an alcoholic beverage. Accept all reasonable responses and list them on the board. Make sure that drinking pattern (whether the alcohol is consumed all at once or spread out over a long period of time) is mentioned.

2. **Inform students that they will investigate how drinking affects people differently. First, they need to recall some information from previous lessons. Review with the students what happens to alcohol after it has been consumed and what factors help determine an individual's response to alcohol.**

   As they learned in Lesson 2, students should mention that the alcohol is carried throughout the body and is quickly absorbed from the stomach and small intestine into the bloodstream. If necessary, remind the class that alcohol distributes throughout the water-containing parts of the body and that the brain is especially sensitive to its effects. Students should recall from Lesson 3 that the amount of alcohol consumed, the time after consumption, and the genetic background of the individual are important factors in determining an individual's response to drinking alcohol.

Assessment:
The discussion in Steps 1 and 2 provides an opportunity to evaluate what students recall from earlier lessons in the module. For example, do they recall that a 12-ounce beer contains the same amount of alcohol as 5 ounces of wine and 1.5 ounces of hard liquor? Do they understand that alcohol is absorbed into the bloodstream and is distributed throughout the body? Can students explain that an individual's response to alcohol depends on factors such as the amount of alcohol consumed, the time after consumption, and individual genetic variation?

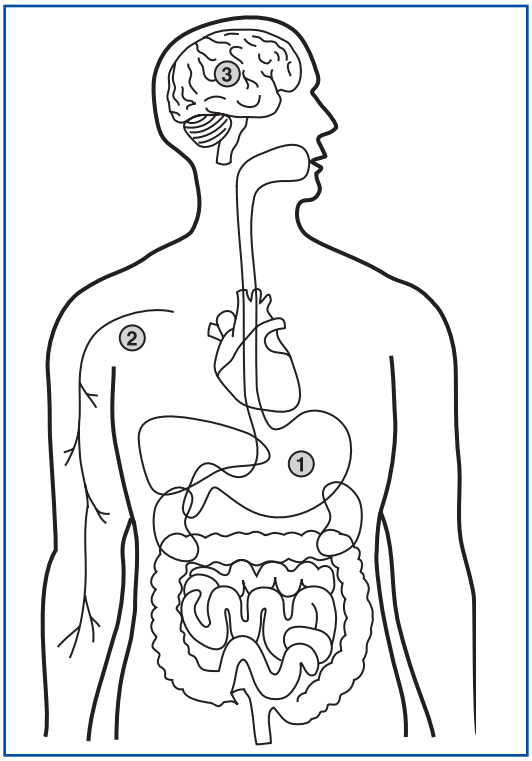


Figure 5.2. Once consumed, alcohol is absorbed through the stomach (1) and small intestine and enters the bloodstream (2), which distributes the alcohol to other parts of the body, including the brain (3).

3. Give each student a copy of Master 5.1, *Blood Alcohol Concentration Tables*. Explain that the concentration of alcohol in the blood is expressed as weight of alcohol in a specific volume of blood. In the United States, the measure is *grams of alcohol per 100 milliliters of blood*, and it is reported as a *percent*. For example, 0.05 grams of alcohol in 100 milliliters of blood corresponds to a blood alcohol concentration (BAC) of 0.05 percent. Help students understand how to read the BAC tables by providing an example using the transparency of Master 5.1, such as what would the BAC be for a 120-pound female who consumes two alcoholic drinks in an hour?

   If students look at the column for 120 pounds (third column from the left in the table for women at the top of Master 5.1) and read down to the row for 2 drinks, the BAC would be 0.08 percent.

Blood Alcohol Concentration Table: For Women

	Body weight in pounds							
Drinks per hour	100	120	140	160	180	200	220	240
1	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02
2	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04
3	0.14	0.11	0.10	0.09	0.08	0.07	0.06	0.06

4. **Ask the class what happens to a person's BAC after it reaches the value listed in the table. After you establish that the BAC gradually declines, ask the class why this occurs.**

   Make sure the discussion brings out the fact that the BAC declines slowly as the body breaks down the alcohol.

5. **After you are sure that the students understand how to read the tables in Master 5.1, divide the class into teams of three students. Continue to set the stage for the activity by explaining that students will be analyzing BACs for fictitious individuals who attend a party where alcoholic beverages are being served. The task for the students is to determine each individual's BAC and decide whether the individual can legally drive home.**

6. **Ask the class how they will determine whether the individuals are sober enough to drive a car legally.**

   Students may respond that the BAC measurement is used to determine whether a person is driving while intoxicated. Students also may respond that certain behavioral changes, such as stumbling, loss of coordination, and so forth, would indicate when a person should not drive.

7. **Pass out to each student team a copy of Master 5.2, *Drinking Patterns for Party Guests*. Explain that the master consists of three pages with data for two different party guests on each page. Each team member should take one page and analyze the data for those two individuals. Explain that they are to use the Blood Alcohol Concentration Tables (Master 5.1) to determine the BAC for each hour that the guest attends the party.**

   It is a good idea to work through the following example to acquaint the students with the process.

   A. During the first hour of the party, a 120-pound female drinks 2 drinks. She has not had any alcohol to drink before the party started, so her BAC at the start of the hour is 0.00.

   B. From the table on Master 5.1, 2 drinks would give her a BAC of 0.08.

   C. Adding 0.08 to 0.00 equals 0.08, which would be recorded in the fifth row of the chart [BAC (start + table)].

D. Next, subtract 0.02 from 0.08 to account for the body breaking down some of the alcohol.

E. This means that at the end of the hour the BAC is 0.06. Record this value both as the BAC at the end of hour 1 and also as the BAC at the start of hour 2.

F. The female drinks 1 drink during the second hour. Again referring to the BAC table, this means that 0.04 is added to her existing 0.06 BAC, yielding 0.10.

Content Standard A: Mathematics is important in all aspects of scientific inquiry.

G. Subtracting 0.02 for breakdown during the second hour leaves her with a BAC of 0.08. This process is repeated to obtain the BACs for the next two hours.

This guest is a 120-pound female:

Hour	1	2
Number of drinks	2	1
BAC at start of hour	*A.* 0.00	*E.* 0.06
BAC from table	*B.* 0.08	0.04
BAC (start + table)	*C.* 0.08	*F.* 0.10
Alcohol processed	*D.* –0.02	–0.02
BAC at end of hour	*E.* 0.06	*G.* 0.08

8. **While the students are calculating their party guest's BACs, pass out to each team a copy of Master 5.3, *Blood Alcohol Concentration Graph Template*. Ask students to graph their results for each individual for the four-hour duration of the party on the same graph. Students can use a different colored pencil for each individual's data. Each team member should graph the data that he or she analyzed.**

Teacher note

For this activity, students should assume that the legal BAC limit is 0.08 percent. We selected this value because many states have set this as the legal standard. However, if the legal BAC limit in your state is different (0.10 percent, for example), you may use this value instead. This may change the conclusions made for the different individuals portrayed in the activity.

9. After the teams have finished analyzing and graphing their data, ask them to share their results with the class. Display a transparency of Master 5.3, *Blood Alcohol Concentration Graph Template*, and have different students plot the data for the six different party guests.

   The completed charts and graphs for the six party guests are shown below.

Content Standard A: Communicate scientific procedures and explanations.

Guest 1 is a 120-pound female:

Hour	1	2	3	4
Number of drinks	2	1	1	0
BAC at start of hour	0.00	0.06	0.08	0.10
BAC from table	0.08	0.04	0.04	0.00
BAC (start + table)	0.08	0.10	0.12	0.10
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour	0.06	0.08	0.10	0.08

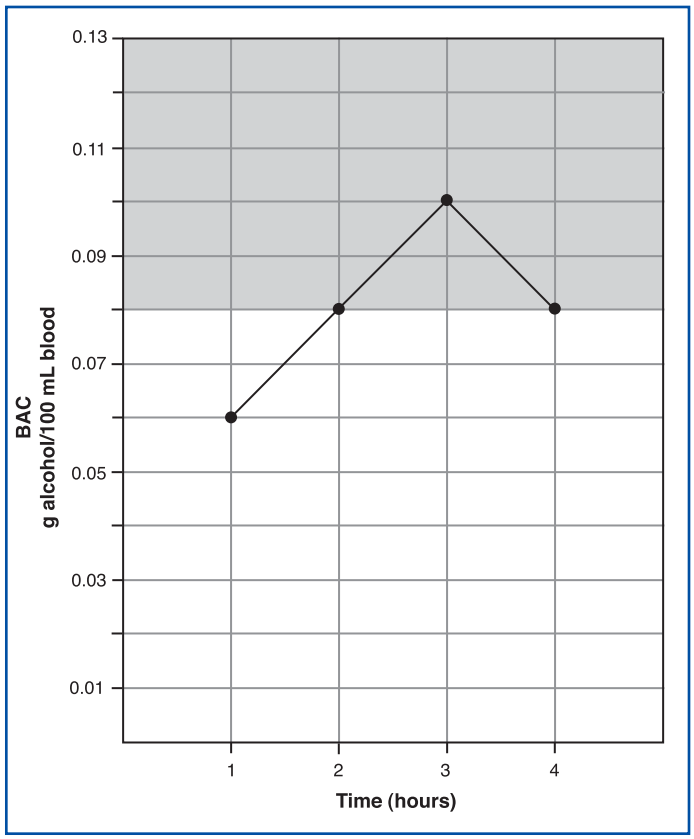


Figure 5.3. BAC over time for Guest 1.

Guest 2 is a 180-pound male:

Hour	1	2	3	4
Number of drinks	2	2	1	0
BAC at start of hour	0.00	0.02	0.04	0.04
BAC from table	0.04	0.04	0.02	0.00
BAC (start + table)	0.04	0.06	0.06	0.04
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour	0.02	0.04	0.04	0.02

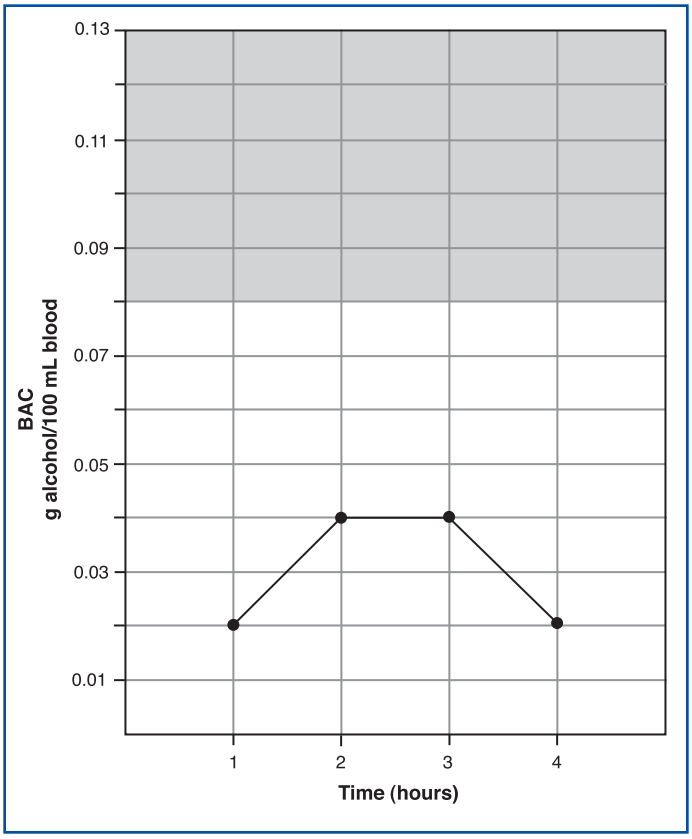


Figure 5.4. BAC over time for Guest 2.

Guest 3 is a 160-pound female:

Hour	1	2	3	4
Number of drinks	3	2	0	0
BAC at start of hour	0.00	0.07	0.11	0.09
BAC from table	0.09	0.06	0.00	0.00
BAC (start + table)	0.09	0.13	0.11	0.09
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour	0.07	0.11	0.09	0.07

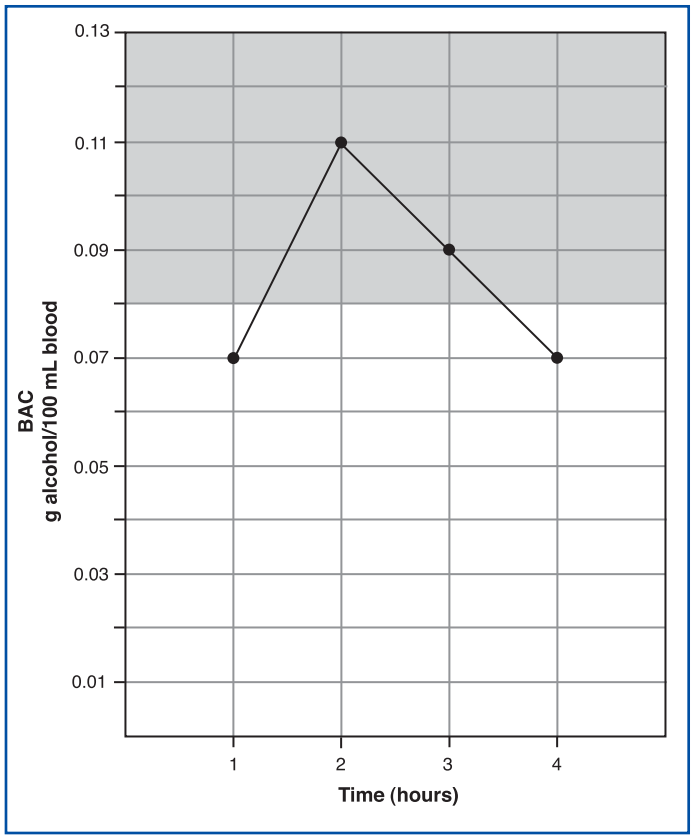


Figure 5.5. BAC over time for Guest 3.

Guest 4 is a 160-pound male:

Hour	1	2	3	4
Number of drinks	0	0	3	2
BAC at start of hour	0.00	0.00	0.00	0.05
BAC from table	0.00	0.00	0.07	0.05
BAC (start + table)	0.00	0.00	0.07	0.10
Alcohol broken down	0.00	0.00	–0.02	–0.02
BAC at end of hour	0.00	0.00	0.05	0.08

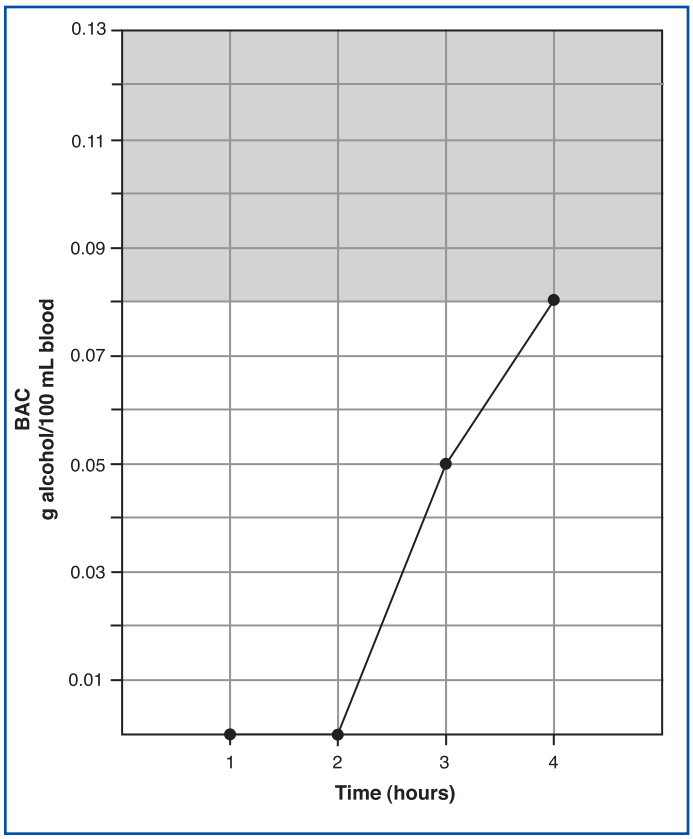


Figure 5.6. BAC over time for Guest 4.

Guest 5 is a 140-pound male:

Hour	1	2	3	4
Number of drinks	3	2	1	0
BAC at start of hour	0.00	0.06	0.09	0.10
BAC from table	0.08	0.05	0.03	0.00
BAC (start + table)	0.08	0.11	0.12	0.10
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour	0.06	0.09	0.10	0.08

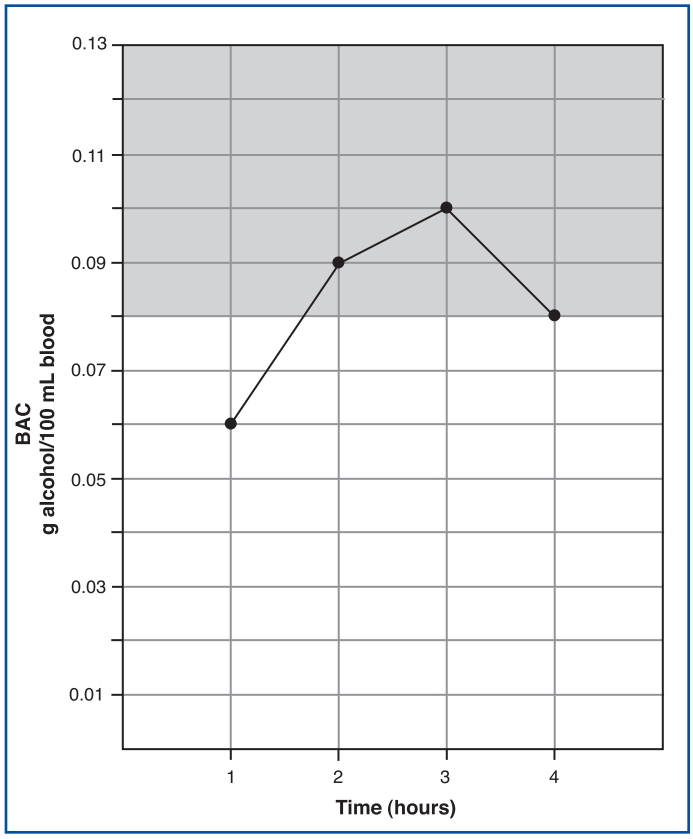


Figure 5.7. BAC over time for Guest 5.

Guest 6 is a 220-pound male:

Hour	1	2	3	4
Number of drinks	3	2	1	0
BAC at start of hour	0.00	0.03	0.04	0.04
BAC from table	0.05	0.03	0.02	0.00
BAC (start + table)	0.05	0.06	0.06	0.04
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour	0.03	0.04	0.04	0.02

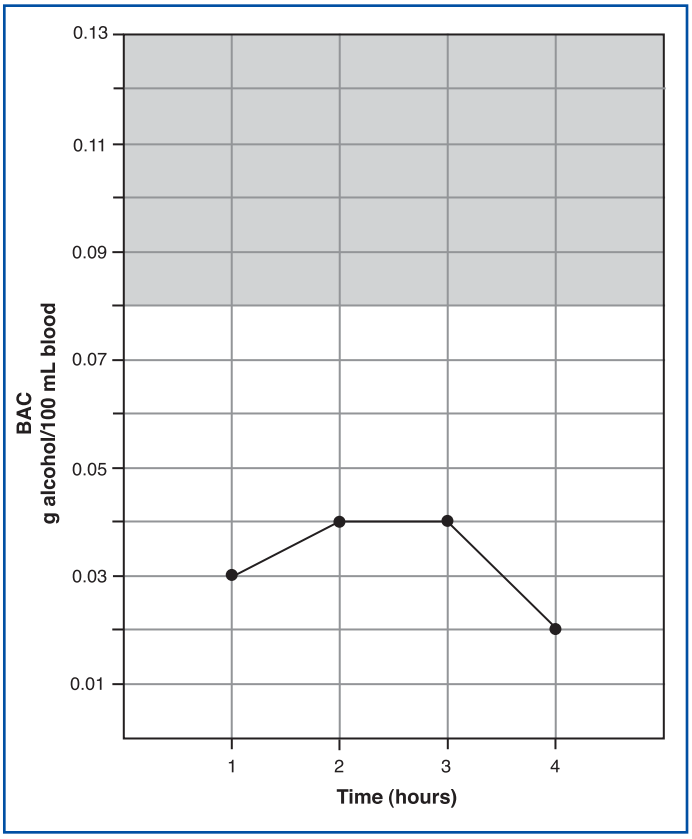


Figure 5.8. BAC over time for Guest 6.

10. **Conclude the activity by asking students to respond to the following questions.**

- **Which individuals could drive home legally?**

  If the legal BAC limit in the state is 0.08 percent, Guests 2, 3, and 6 would be below the legal limit for intoxication and able to drive home legally. Note that if an individual's BAC is right at the legal limit (BAC = 0.08 in this case), it is *not* legal for that individual to drive a car.

  Although these individuals could *legally* drive, they might not be *safe* drivers. In the following activity, students will learn more about how even low BACs can impair judgment, coordination, and reflexes.

- **What factors described in this activity affected the party guests' BAC levels?**

  Students should recognize that number of drinks, pattern of drinking, gender, and body weight all influence a person's BAC.

- **Why, on average, is a larger person affected less by a given amount of alcohol than a smaller person?**

  A larger person has more body water for the alcohol to be distributed in. This means that a given amount of alcohol will reach a lower BAC in a large person than a smaller person.

- **Why, on average, are females more affected by drinking the same amount of alcohol as males?**

  Females tend to be affected more by a given amount of alcohol than males for two reasons. First, they tend to be smaller than their male counterparts and second, they tend to have more body fat than males do, which has the effect of reducing the amount of body water in which to distribute the alcohol.

- **How does the pattern of drinking relate to an individual's BAC?**

  A person's BAC is affected mainly by how much alcohol he or she drinks and over what period of time the drinking occurs. Alcohol metabolism occurs at a constant rate. If the rate of alcohol consumption is faster than the body's metabolism rate, then the BAC will increase.

- **Are there differences in how fast alcohol breaks down in the body among different individuals?**

  Students should notice that in this activity, the BAC always decreases by approximately 0.02 percent per hour for all individuals. In reality, metabolism rates can vary somewhat among individuals. The important point here is that when a person drinks alcohol, it is broken down at a constant rate, regardless of how quickly or slowly the person drinks.

- **Do you think that each of the individuals whose behavior was modeled in this activity would have reached the same conclusions as you did about who should drive from the party?**

  The guests attending the party in this activity would not have access to information about their BACs. Therefore, it is likely that some of them would have judged themselves fit to drive, even though their BAC exceeded the legal limit.

- **Are there any factors not taken into account during this activity that could influence an individual's BAC?**

  Student responses will vary. Accept all reasonable responses and list them on the board. Direct their attention to factors such as the amount and type of food in the stomach, body type (amount of body fat), and genetic factors.

11. **Ask students to keep their copies of Masters 5.1 and 5.2 for use in the next activity.**

Content Standard A: Identify questions that can be answered through scientific investigation.

Content Standard A: Design and conduct a scientific investigation.

Optional Activity

1. **Give students an opportunity to ask their own questions about how an individual's BAC is affected by drinking alcohol. For convenience, students can work in their same teams to decide on a question they want to investigate. Remind students to ask a question that can be answered given the information found in Masters 5.1 and 5.2. Some questions that students may investigate include the following:**

- **Can a person who weighs 200 pounds drink twice as much as a person who weighs 100 pounds and have the same BAC?**

- **If a person has a BAC of 0.08 and stops drinking, how long will that person have to wait before their BAC drops to zero?**

- **Consider someone attending a party that lasts for 4 hours. The person consumes 4 drinks during the party. How will their BAC at the end of the party vary if they drink all 4 four drinks during the first hour, drink 1 drink each hour, or drink all 4 drinks during the last hour?**

  Asking an appropriate question might be difficult for some students. Explain that they should try to keep all variables constant, except for the one that they are investigating. Circulate around the room and ask them to explain how they are answering their question. If they have difficulty making proper comparisons, guide them with questions that will help them refine their question or the way they are conducting their analysis.

2. **After teams finish analyzing their question, ask them to present their results to the class. Encourage each member of the class to participate in the presentation by discussing a specific aspect of the work, such as framing the question, performing the calculations, or stating the conclusions. Ask other members of the class if they agree or disagree with the conclusions.**

Assessment:
This part of the activity enables you to assess students' abilities to identify questions that can be answered through scientific investigation. It also provides assessment opportunities relating to methods of analysis and drawing of conclusions.

Activity 2: *Alcohol and Driving Behavior*

This activity requires the use of computers with access to the Internet and a sound card. If this is not possible, give each student team a copy of Master 5.4, *Progressive Effects of Alcohol*, and proceed with this activity starting with Step 8.

1. **Introduce the activity by explaining to the class that they will watch two brief driving simulations. The simulations show the view as the driver would see things.**

2. **Divide the class into teams of two to three students who will work at one computer. Log onto the Web site *http://science.education.nih.gov/supplements/alcohol/student* and click on "Lesson 5—Alcohol and Driving: When to Say No."**

Teacher note
This activity is designed for students to work at a computer in small teams. This approach stimulates interaction and discussion among students. You may, however, need to modify the size of the groups depending on the number of computers available. For alternate strategies, see *Using the Web Site*, on page 19.

3. **Instruct students to watch Simulation A and Simulation B and to record the differences they observe between the two drivers.**

   Students will not know at the beginning which simulation represents which driver. However, they should record their observations about each simulation. Students may need to watch each simulation a few times.

4. **After students have viewed the simulations and recorded their observations, discuss their findings and record their observations on the board. The major differences are listed below:**

Simulation A (intoxicated)	Simulation B (sober)
Staggers while walking to car	Walks in a straight line to car
Has blurred vision	Has clear vision
Does not look both ways before crossing the street	Looks both ways before crossing the street
Does not fasten seat belt	Does fasten seat belt
Has trouble putting key in ignition	Puts key in ignition easily
Exceeds speed limit	Does not exceed speed limit
Does not always stay in correct lane	Stays in correct lane
Drives using one hand	Drives using both hands
Runs through stop signs	Stops smoothly at stop signs
Does not stop for pedestrian	Stops to allow pedestrian to cross street
Does not use turn signals	Does use turn signals
Hits the trash can in driveway	Parks car without hitting trash can

   Students may notice other minor differences, but the ones listed above are the primary ones.

5. **One simulation portrays a sober driver and the other portrays an intoxicated driver. Ask students which simulation shows the intoxicated individual.**

   Students will respond correctly that Simulation A shows the intoxicated driver.

6. **Ask students what they think the BAC of the driver in Simulation A was. Display a transparency of Master 5.4, *Progressive Effects of Alcohol*. This chart depicts the escalating impairments that happen as increasing amounts of alcohol are consumed. Explain that impairments associated with low BACs still apply at higher BACs.**

NSES

Content Standard A:
Think critically and logically to make the relationships between evidence and explanations.

7. **Ask students to provide reasons for their BAC estimates.**

   Students should estimate a BAC for the intoxicated driver based on information in Master 5.4 and on what they observed in the simulation. Because students know that the driver is intoxicated, they will estimate BACs of 0.08 and higher. Students might say that the BAC could be as high as 0.21 to 0.30 because the person staggered when walking. If the BAC is in this range, in addition to the more severe impairments of reaction time and lack of balance, the driver would also display impaired alertness, judgment, depth perception, reasoning skills, and coordination. Each of these impairments would make this person a hazardous driver.

8. **Ask students to get out their copies of Master 5.2, *Drinking Patterns for Party Guests*, from Activity 1 in this lesson. Ask them to examine the data for each of the party guests they evaluated. Using Master 5.4, *Progressive Effects of Alcohol*, instruct the class to estimate how each individual's BAC would affect his or her ability to drive a car. Revisit the question of whether or not each individual should drive home. Students can write their responses on the back of Master 5.2.**

   Students should compare the BAC of each individual with the table. They should list activities that are impaired in individuals who have a BAC in that range.

   You will notice that the chart on Master 5.4 is depicted as a continuum and that there are no distinct cut-off points between impairments at adjacent BAC ranges. This is intended to convey the idea that impairments exist in varying degrees as opposed to simply being present or absent. This depiction is also consistent with human variation; that is, two people may be affected slightly differently from each other at a given BAC.

9. **Give students the opportunity to share with the class their conclusions about each of the party guests and the impairments that would affect their driving.**

   Guest 1 has a BAC of 0.08 at the end of the party. Students may respond that she should exhibit impairments in alertness, judgment, depth perception, and visual tracking. Most will agree that she should not be behind the wheel.

Assessment:
If you wish to use this question as a more formal opportunity to evaluate students' understanding, ask them to write their answers to this question. You may then review the responses from each student. Asking students to write their answers before sharing them with the class allows them to organize their thoughts and reflect on what they have learned.

Guest 2 has a BAC of 0.04 at the end of the party. Students may respond that even though he has a BAC below the legal limit for driving, he is still affected by the alcohol. He may be less alert and less coordinated and make poorer judgments than if he hadn't drunk any alcohol.

Similar types of observations can be made for the other four party guests. Some students may conclude that it may not be a good idea for any of the party guests to drive a car.

10. **Ask students to consider the question, Does a BAC below the legal limit mean that it is *safe* for an individual to drive a car?**

Even though some individuals have BACs that are below the legal limit for driving, it may not be safe for them to operate a car. This is an important point for students to understand. A BAC below the legal limit does not mean that a person's mental and physical skills are not impaired. In fact, there is no one particular BAC where hazardous driving begins. Even one drink can cause impairment. This helps explain why different states and different countries set different legal limits for drinking and driving.

Lesson 5 Organizer

Activity 1: *Patterns of Drinking*

What the Teacher Does	Procedure Reference
Ask the class if two people attend a party and drink the same amount of alcohol, will they be affected in the same way?	Page 151 Step 1
Ask students to recall information they learned in previous lessons. • What factors influence how different people respond to alcohol? • Where does alcohol go in the body? • Where is alcohol broken down?	Pages 151–152 Step 2
Help the class understand how to use Master 5.1, *Blood Alcohol Concentration Tables.* • Make sure that the students understand how metabolism reduces BACs.	Pages 152–153 Steps 3 and 4 
Divide the class into teams and make sure they know how to • determine BAC levels for fictitious individuals attending a party. • determine if those individuals can legally drive a car.	Page 153 Steps 5 and 6
Pass out to each team a copy of Master 5.2, *Drinking Patterns for Party Guests.*	Pages 153–154 Step 7 
Have students graph the BACs over time for each guest using Master 5.3, *Blood Alcohol Concentration Graph Template.*	Page 154 Step 8 

 = Involves copying a master.

 = Involves using a transparency.

 = Involves using the Internet.

Have student teams share their results with the class using a transparency of Master 5.3, *Blood Alcohol Concentration Graph Template.*	Pages 155–160 Step 9
Summarize results from the activity. Ask the class, • Which individuals could drive home legally? • What factors affected the party guests' BAC levels? • Why is a larger person affected less by a given amount of alcohol than a smaller person? • Why are females more affected by drinking the same amount of alcohol as males? • How does the pattern of drinking relate to an individual's BAC? • Are there differences in how fast alcohol breaks down in the body among different individuals? • Do you think that the individuals whose behavior was modeled in this activity would have reached the same conclusions as you did about who should drive from the party? • Are there factors not taken into account during this activity that could influence an individual's BAC?	Pages 161–162 Step 10
Instruct students to keep their copies of Masters 5.1 and 5.2 for use in the next activity.	Page 162 Step 11

Activity 2: *Alcohol and Driving Behavior*

What the Teacher Does	Procedure Reference
Explain to the class that they will watch two short driving simulations.	Page 163 Step 1
Divide the class into student teams and have them log onto the Web site. Have the students click on "Lesson 5—Alcohol and Driving: When to Say No."	Page 163 Step 2

Instruct students to watch each simulation and record their observations.	Page 164 Step 3
Reconvene the class, discuss the students' findings, and record their observations on the board.	Page 164 Step 4
Ask the students which simulation portrayed the intoxicated driver.	Page 164 Step 5
Display a transparency of Master 5.4, *Progressive Effects of Alcohol,* give each team a copy, and ask the class to estimate the BAC of the intoxicated driver.	Pages 164–165 Steps 6 and 7
Have students retrieve their results from Activity 1 and ask them to consider how alcohol impaired each of the party guests.	Page 165 Step 8
Have students share their conclusions with the class.	Pages 165–166 Step 9
Discuss whether a BAC below the legal limit means that it is safe for an individual to drive a car.	Page 166 Step 10

Blood Alcohol Concentration Tables*

For Women

	Body weight in pounds							
Drinks per hour	100	120	140	160	180	200	220	240
1	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02
2	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04
3	0.14	0.11	0.10	0.09	0.08	0.07	0.06	0.06
4	0.18	0.15	0.13	0.11	0.10	0.09	0.08	0.08
5	0.23	0.19	0.16	0.14	0.13	0.11	0.10	0.09
6	0.27	0.23	0.19	0.17	0.15	0.14	0.12	0.11
7	0.32	0.27	0.23	0.20	0.18	0.16	0.14	0.13
8	0.36	0.30	0.26	0.23	0.20	0.18	0.17	0.15
9	0.41	0.34	0.29	0.26	0.23	0.20	0.19	0.17
10	0.45	0.38	0.32	0.28	0.25	0.23	0.21	0.19

For Men

	Body weight in pounds							
Drinks per hour	100	120	140	160	180	200	220	240
1	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02
2	0.08	0.06	0.05	0.05	0.04	0.04	0.03	0.03
3	0.11	0.09	0.08	0.07	0.06	0.06	0.05	0.05
4	0.15	0.12	0.11	0.09	0.08	0.08	0.07	0.06
5	0.19	0.16	0.13	0.12	0.11	0.09	0.09	0.08
6	0.23	0.19	0.16	0.14	0.13	0.11	0.10	0.09
7	0.26	0.22	0.19	0.16	0.15	0.13	0.12	0.11
8	0.30	0.25	0.21	0.19	0.17	0.15	0.14	0.13
9	0.34	0.28	0.24	0.21	0.19	0.17	0.15	0.14
10	0.38	0.31	0.27	0.23	0.21	0.19	0.17	0.16

*Blood alcohol concentrations are expressed as percent, meaning grams of alcohol per 100 milliliters (per deciliter) of blood. Tables are adapted from those of the Pennsylvania Liquor Control Board, Harrisburg.

Drinking Patterns for Party Guests

Name(s)_____ Date _____

Guest 1 is a 120-pound female:

Hour	1	2	3	4
Number of drinks	2	1	1	0
BAC at start of hour	0.00			
BAC from table				
BAC (start + table)				
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour				

Should Guest 1 drive home? _____

Guest 2 is a 180-pound male:

Hour	1	2	3	4
Number of drinks	2	2	1	0
BAC at start of hour	0.00			
BAC from table				
BAC (start + table)				
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour				

Should Guest 2 drive home? _____

Drinking Patterns for Party Guests

Name(s)_____ Date _____

Guest 3 is a 160-pound female:

Hour	1	2	3	4
Number of drinks	3	2	0	0
BAC at start of hour	0.00			
BAC from table				
BAC (start + table)				
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour				

Should Guest 3 drive home? _____

Guest 4 is a 160-pound male:

Hour	1	2	3	4
Number of drinks	0	0	3	2
BAC at start of hour	0.00			
BAC from table				
BAC (start + table)				
Alcohol broken down	0.00	0.00	–0.02	–0.02
BAC at end of hour				

Should Guest 4 drive home? _____

Drinking Patterns for Party Guests

Name(s)_____ Date _____

Guest 5 is a 140-pound male:

Hour	1	2	3	4
Number of drinks	3	2	1	0
BAC at start of hour	0.00			
BAC from table				
BAC (start + table)				
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour				

Should Guest 5 drive home? _____

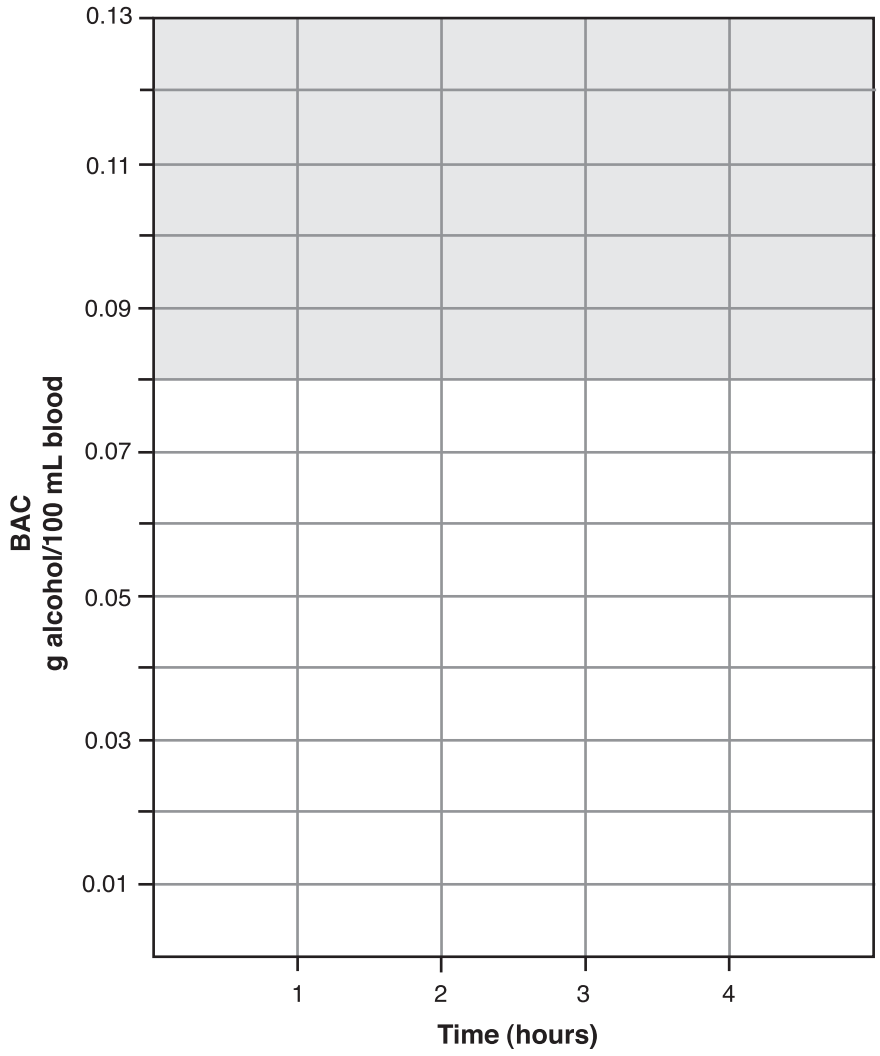
Guest 6 is a 220-pound male:

Hour	1	2	3	4
Number of drinks	3	2	1	0
BAC at start of hour	0.00			
BAC from table				
BAC (start + table)				
Alcohol broken down	–0.02	–0.02	–0.02	–0.02
BAC at end of hour				

Should Guest 6 drive home? _____

Blood Alcohol Concentration Graph Template

Name(s)_____ Date _____



Note: The shaded portion of the graph corresponds to BACs of 0.08 and above, which is the legal limit for driving in this activity.

Progressive Effects of Alcohol

Blood Alcohol Concentration	Changes in Feelings and Personality	Brain Regions Affected	Impaired Activities (continuum)
0.01 – 0.05	Relaxation Sense of well being Loss of inhibition	Cerebral cortex	Alertness Judgment Coordination
0.06 – 0.10	Pleasure Numbing of feelings Nausea, Sleepiness Emotional arousal	Cerebral cortex + forebrain	(especially fine motor skills) Visual tracking Reasoning and
0.11 – 0.20	Mood swings Anger Sadness Mania	Cerebral cortex + forebrain + cerebellum	depth perception Inappropriate social behavior (e.g. obnoxiousness)
0.21 – 0.30	Aggression Reduced sensations Depression Stupor	Cerebral cortex + forebrain + cerebellum + brain stem	Slurred speech Lack of balance Loss of temperature regulation
0.31 – 0.40	Unconsciousness Death possible Coma	Entire brain	Loss of bladder control Difficulty breathing
0.41 and greater	Death		Slowed heart rate

Source: Advisory committee and NIAAA scientists.

Lesson 6
Elaborate/
Evaluate

Using Alcohol: Setting Limits

Figure 6.1. Users of alcoholic beverages have the responsibility to drink wisely.

At a Glance

Overview

Students consider whether a legal limit for alcohol use should be imposed for *all* public activities, not just driving. Students use the knowledge from previous lessons and evaluate new information to decide whether such a limit should be established and, if so, what BAC limit to impose. Students then revisit the Statements about Alcohol from Lesson 1 to assess how their understanding of alcohol and its effects has changed over the course of this module.

Major Concept

Low concentrations of alcohol in the body may cause impairment of physical and cognitive skills. The consequences of low BACs include increased tendencies to participate in a variety of risky behaviors.

Objectives

After completing this lesson, students will

- be able to identify how different BACs, including low ones, affect a person's functioning;

- be able to differentiate between alcohol-related risks to the individual and risks to the public; and
- apply the knowledge they have gained about the effects of alcohol by establishing a policy for alcohol use and defending their position.

Teacher Background

Consult the following sections in Information about Alcohol:

7 *Alcohol: Behavioral Effects* (pages 37–39)
10 *Consequences of Alcohol Abuse and Alcoholism* (pages 42–46)
10.1 *The costs to society* (page 42)
10.2 *Drinking and driving* (pages 42–43)
10.3 *Drinking and risky behavior* (pages 43–44)
10.4 *Drinking and pregnancy* (pages 44–45)
10.5 *Drinking and violence* (pages 45–46)

In Advance

Web-Based Activities

Activity	Web Version?
1	No
2	No

Photocopies

Activity 1	Master 6.1, *Issues to Think About* (Prepare an overhead transparency.) Master 6.2, *Alcohol Information Sheets* (Make 1 copy per student team.)
Activity 2	Master 6.3, *Alcohol: Is This Right? What Do I Think Now?* (Make 1 copy per student and prepare an overhead transparency.) Master 6.4, *Alcohol: Is This Right? Class Responses* (Prepare an overhead transparency.) Have students refer to their copies of Master 5.1, *Blood Alcohol Concentration Tables*, and Master 5.4, *Progressive Effects of Alcohol* (saved from Lesson 5).

Materials

Activity 1	no materials needed for this lesson, except for photocopies
Activity 2	no materials needed for this lesson, except for photocopies

Preparation

Have the copies of Master 1.1, *Alcohol: Is This Right?* that students completed in Lesson 1 available.

Activity 1: *Alcohol—Risks and Consequences*

Procedure

1. **Remind students that the legal BAC for driving is 0.08 (or 0.10, depending on your state). Ask students to speculate why the BAC was set at that particular level. Is it true that alcohol consumption is safe as long as the BAC is below that level? Is it true that activities other than driving are safe, regardless of a person's BAC?**

   Students will give a variety of responses. Some students will say that the BAC was set at a particular level because a person's skills are more severely affected at that point. Others may respond that it was a rather arbitrary cut-off point. This discussion may remind students of what they learned in Lesson 5.

2. **Ask students to consider whether there should be a legal BAC for all activities (not just driving) when a person is in public. Allow students to share their thoughts with the class.**

   Some students will say that no such limit should exist, while others will suggest a specific BAC limit. For the purposes of this activity, insist that each student support a particular BAC level. Give students the opportunity to express the reasons for their opinions.

3. **Write the following BAC numbers on the board: 0.00, 0.02, 0.04, 0.06, 0.08, and 0.10. Be sure to space them out so that students can stand in front of each category. Instruct students to stand in front of the number that they think should be the legal BAC for all public activities. Students will form a "human histogram."**

4. **Explain that students who support a particular BAC limit will form a team. They are to use information they have learned from the earlier lessons and information provided in this lesson to justify their position. They are to write a brief summary of their position and its justification to share with the class.**

Assessment:
Ask students to recall what BAC means. Do students remember what BAC stands for and the factors that influence it?

Teacher note
Ideally, students will work in teams of three to four. If a particular BAC category has more students than that, ask them to form into multiple teams. Also, if you have a BAC category that is supported by just one student, then you may wish to combine that BAC with the next higher or lower one to create a team of three to four students. Finally, if you have a small class, consider reducing the number of BAC categories (0.0, 0.03, 0.06, and 0.09, for example).

5. **Display a transparency of Master 6.1, *Issues to Think About*, and explain that these issues can guide students as they work to justify their positions.**

   Encourage students to use these questions as a way to get started, but not to be limited by them.

Content Standard C:
Behavior is one kind of response that an organism can make to an internal or environmental stimulus.

6. **Pass out to each student team a copy of Master 6.2, *Alcohol Information Sheets*.**
   - **Explain that Master 6.2 provides additional information about the effects of alcohol use.**
   - **Encourage students to provide information not only about potential consequences of alcohol use, but also about *how* alcohol may be involved in causing a particular outcome.**
   - **Ask students to include information they have learned from the previous lessons in this module to support their positions. For example, Master 5.1, *Blood Alcohol Concentration Tables*, and Master 5.4, *Progressive Effects of Alcohol*, are especially helpful here.**

   Master 6.2 provides supplemental information about alcohol's effects that students can use in justifying their positions. It also includes information not directly relevant to their task. Part of the challenge is for students to sift through the information provided and to use only what supports their position (or contradicts a different position). Students should not simply copy complete sections from the information sheets. Ideally, students should construct a justification statement that presents all sides of the issues involved.

   If student teams need additional guidance to prepare their justifications, you can suggest that one or two team members focus on explaining why the BAC limit should be set at the chosen level while the rest of the team focuses on the potential problems of using that BAC limit. The team should then discuss both sides of the issues and work together to write their team's justification.

Teacher note
Students will find that information about alcohol's effects is not always broken down by BAC range. Often terms like "heavy or chronic drinking" are encountered. For the purposes of this activity, students can consider heavy or chronic drinking to imply that the affected individuals reach BAC levels that render them intoxicated (BAC of 0.08 to 0.10).

7. **After student teams have prepared their justifications, ask them to share their statements with the class. Encourage the rest of the students to ask the presenting team questions.**

   Encourage all team members to participate actively in their presentation. Note that this activity does not have a single "correct" answer. The important aspect of this activity is that students present relevant facts on which to base their conclusions. During the course of writing their justification, some students may want to change their minds and support a different BAC limit. In such cases, ask them to explain the BAC limit they would select and why.

   If students feel that they cannot justify one BAC level as opposed to the next one, this is acceptable. A goal of the activity is to help students appreciate the nature of science. They may not be able to reach a firm conclusion. This is an opportunity to discuss what additional information they would like to have and how they could obtain it.

   This activity may raise additional questions about alcohol use. Encourage students to continue their investigation through Internet searches. Several helpful Web sites, including that for the National Institute on Alcohol Abuse and Alcoholism (NIAAA), are listed in the section *Additional Web Resources for Teachers* (see page 199). This activity also raises an important issue about the nature of science. When students raise additional questions, they are learning how science is done.

8. **Following the student presentations, ask students to consider the implications of setting BAC limits. Use questions like the following to guide the discussion.**
   - **Do people know their BAC after they consume alcohol?**
   - **Is there a significant difference in a person's mental or physical impairment between a BAC of 0.06 and 0.08? Between 0.04 and 0.06?**
   - **Will a person with a BAC of 0.08 always be more affected than a person whose BAC is 0.06? Why or why not?**

   Of course, people do not know their BACs while they are drinking alcohol. Usually, BACs are only measured after there is an accident or some other problem. Help students recognize that there is variation

Content Standard A:
Develop descriptions, explanations, predictions, and models, using evidence.

Assessment:
The process of having student teams first write their justification and then present it orally helps you evaluate their understanding in two ways. First, you can collect the students' written statements and evaluate their reasoning. Second, listening to their presentations and their answers to questions by classmates gives you further insight into their understanding. Make sure that each student participates in the oral presentation so that you have an opportunity to evaluate his or her understanding.

NSES

Content Standard F: Alcohol and other drugs are often abused substances. Such drugs change how the body functions and can lead to addiction.

in people's response to drinking alcohol. Students should recall from previous lessons that alcohol response depends on many factors including the amount consumed, the pattern of drinking, body weight, gender, and even genetics (Lessons 2, 3, and 5). This means that the same amount of alcohol can affect different individuals differently.

Activity 2: *How Much Have You Learned about Alcohol?*

1. Give each student a copy of Master 6.3, *Alcohol: Is This Right? What Do I Think Now?* Ask students to agree or disagree with each statement as they did earlier.

2. After students have completed Master 6.3, give each student the copy of Master 1.1, *Alcohol: Is This Right?*, that he or she completed during Lesson 1.

3. Display an overhead transparency of Master 6.4, *Alcohol: Is This Right? Class Responses*. For each statement, write on the transparency how many students agreed with it at the start of the module.

4. For each statement, ask how many agree with it now. Write these numbers on the transparency in the spaces provided.

5. Ask the class whether they changed their minds about any of the statements about alcohol. If so, which ones?

   Answers will vary, though most students will change their minds about some of the statements.

6. If students changed their minds about some of the statements, why did they do so?

   Allow students to share their thoughts with the class or ask questions about the statements. Encourage students to provide specific examples from the activities in this module to explain their thinking. If students cannot reach a consensus about a statement, refer them to the outcomes of specific activities.

   Use the following information about the statements to guide the discussion:

1. ***Alcohol is a stimulant.***

   Alcohol is actually a depressant. It can appear to be a stimulant because it initially depresses the part of the brain that controls inhibitions.

2. ***Caffeine will sober you up.***

   Caffeine will not help an individual become sober more quickly. The factors that influence a person's BAC include the amount of alcohol consumed, the pattern of drinking, body weight, and gender. Only time will reduce the BAC as the body breaks down the alcohol.

3. ***Food will keep you from becoming intoxicated.***

   Food in the stomach causes alcohol to be absorbed more slowly than when the stomach is empty. Food can delay the effects of alcohol, but it cannot eliminate them.

4. ***Drinking beer is safer than drinking wine or hard liquor, such as vodka or whiskey.***

   The type of drink is not an important factor when considering the effects of drinking alcohol. As students learned in Lesson 2, 12 ounces of beer contain the same amount of alcohol as 5 ounces of wine, or 1.5 ounces of hard liquor.

5. ***Alcohol-related car crashes are all caused by drunk drivers.***

   Most alcohol-related car crashes are caused by drivers with BACs over the legal limit. However, as seen in Master 6.2, *Alcohol Information Sheets*, drivers with BACs less than the legal limit also have crash rates higher than nondrinkers. Also, as presented on Master 5.4, *Progressive Effects of Alcohol*, BACs below the legal limit produce impairments.

6. ***Alcoholism is a disease.***

   Alcoholism is a chronic disease involving a strong craving for alcohol, a constant or periodic reliance on use of alcohol despite adverse consequences, the inability to limit drinking, physical illness when drinking is stopped, and the need for increasing amounts of alcohol in order to feel its effects.

7. ***Alcohol abuse and alcoholism affect only the abuser.***

   Unfortunately, alcohol abuse and alcoholism affect other individuals in addition to the abuser. For example, the abuser's family and friends are affected. Alcohol abuse leads to missed work, thereby affecting coworkers. Abusers are also more likely to engage in risky behaviors that can lead to accidents and even criminal behaviors that produce victims.

8. ***Alcohol abuse or alcoholism will never be my problem.***

   As students learned in Lesson 4, many factors influence whether a person uses alcohol, abuses alcohol, or becomes an alcoholic. Some factors are genetic, many others are environmental, but the primary factor is personal choice.

9. ***Nothing can be done about alcohol abuse or alcoholism.***

   Alcohol abuse and alcoholism can be treated effectively using medications and psychosocial (behavioral) therapies. Currently, there is no cure for alcoholism.

10. ***It is a good idea to drink alcohol to prevent heart disease.***

    Studies have shown that alcohol in moderate amounts (about one drink per day) can reduce the risk for heart disease. However, in larger amounts, alcohol makes heart disease worse and can actually interfere with the rhythm of the heart. Doctors do not recommend that nondrinkers start drinking alcohol in an effort to prevent heart disease. There are many people who should not drink even one drink per day, including pregnant women, recovering alcoholics, and people taking certain medications.

11. ***Drinking a large amount of alcohol occasionally is less harmful than drinking a smaller amount every day.***

    Binge drinking can cause severe problems. Drinking a large amount of alcohol at one time can raise the BAC to such a dangerous level that the individual can lose consciousness and even die. However, even at lower levels, alcohol makes it more likely that a person will engage in risky behaviors with potentially serious consequences. Lessons 5 and 6 should help students understand the consequences of consuming alcohol.

12. Drinking alcohol makes you feel more confident.

The effects of alcohol at a BAC between 0.01 and 0.05 include the loss of inhibitions and a sense of well being. When the BAC increases to between 0.06 and 0.20, some individuals become more boisterous and extroverted. These behaviors can be interpreted as confidence. However, the behavioral changes caused by alcohol consumption can vary greatly depending on the amount consumed and the individual's response. At high BAC levels, some individuals experience severe emotional swings.

Lesson 6 Organizer

Activity 1: *Alcohol Risks and Consequences*

What the Teacher Does	Procedure Reference
Ask the class why the legal BAC for driving is set where it is. • Is it true that alcohol consumption is safe as long as the BAC stays below the legal limit? • Is it true that activities other than driving are safe, regardless of a person's BAC?	Page 179 Step 1
Ask the class whether there should be a legal BAC for all activities (not just driving) when a person is in public.	Page 179 Step 3
Write the following series of BAC numbers on the board: 0.00, 0.02, 0.04, 0.06, 0.08, and 0.10. • Have students stand in front of the BAC that they feel should be the legal BAC for all public activities.	Page 179 Step 4
Divide the class into student teams and instruct them to write a brief justification of their position. • Discuss Master 6.1, *Issues to Think About.* • Pass out Master 6.2, *Alcohol Information Sheets.*	Pages 179–180 Steps 4–6 
Allow student teams to share their justifications with their classmates and encourage questions of the presenters.	Page 181 Step 7

 = Involves using a transparency.

 = Involves copying a master.

Ask the class to consider the implications of setting such BAC limits. • Does a person know their BAC after they consume alcohol? • Is there a significant difference in a person's mental or physical impairment between a BAC of 0.06 and 0.08? Between 0.04 and 0.06? • Will a person with a BAC of 0.08 always be more affected than a person whose BAC is 0.06?	Pages 181–182 Step 8

Activity 2: *How Much Have You Learned about Alcohol?*

What the Teacher Does	Procedure Reference
Pass out to each student a copy of Master 6.3, *Alcohol: Is This Right? What Do I Think Now?* Ask students to agree or disagree with the statements.	Page 182 Step 1 
Return Master 1.1 to the students so they can review their responses made during Lesson 1.	Page 182 Step 2
Display a transparency of Master 6.4, *Alcohol: Is This Right? Class Responses.* • Record the number of students who agreed with each statement at the beginning of the module. • Record the number of students who agree with each statement now.	Page 182 Steps 3 and 4 
Ask students if they changed their minds about any of the statements. If they have, ask them to explain their reasons.	Pages 182–185 Steps 5 and 6

Issues to Think About

- The effect of alcohol on a person's physical abilities
- The effect of alcohol on a person's mental abilities
- The effect of alcohol on a person's risk of injury
- The effect of alcohol on the risk of injury to other people
- Positive effects of alcohol on a person or on society
- Economic costs or benefits of alcohol to an individual or to society

Alcohol Information Sheets

TYPES OF ALCOHOLS

Alcohols are a useful class of chemical compounds. The most common alcohols that we encounter in daily life are methanol (also called wood alcohol), isopropanol (rubbing alcohol), and ethanol (or ethyl alcohol). Of these three, only ethanol is safe to drink. Other alcohols are poisons. When the word *alcohol* is used in association with beverages, it always refers to ethanol.

Alcohols, including ethanol, are used by the chemical industry in many ways. Methanol is used as antifreeze, and isopropanol is the main ingredient of rubbing alcohol. Ethanol has many uses in addition to being a beverage ingredient. It is used as an alternative fuel source and as a solvent for other chemicals, including some medicines. For example, some types of cough syrup have ethanol concentrations similar to those found in hard liquor.

Alcohol Information Sheets

ALCOHOL AND SOCIETY

Adults drink alcoholic beverages for many reasons—to celebrate holidays, to celebrate good times, as an emotional release, and for cultural and religious reasons. The movies, television, and advertisements often promote alcohol as an almost required part of a happy and successful lifestyle.

Most adults who drink alcohol do so responsibly. However, the time and place where alcoholic beverages are consumed are important in determining how appropriate the drinking is. In the United States, it is common for people to drink at parties. For many people, BACs in the range of 0.01–0.05 help them feel more relaxed and friendly. At parties, drinking alcohol is acceptable, as long as guests don't drink too much. In other settings, drinking alcohol is a serious problem. For example, drinking and then driving a car can lead to crashes, and drinking at work can lead to serious accidents. Drinking alcohol while taking certain medications can produce serious health problems and even death.

Different cultures view drinking alcohol differently. Some cultures prohibit drinking altogether, while others include it as part of everyday living. In some countries, many people who drink do so with the intention of becoming intoxicated. Not surprisingly, different countries have different laws about the use of alcohol. The chart below lists the legal drinking age and legal BAC limit for driving in various countries.

Country	Minimum drinking age	Legal BAC limit for driving
Australia	18	0.05
Austria	16 for beer and wine, 18 for all types	0.05 0.01 for new drivers
Belgium	15	0.05
Canada	18–19 (depending on province)	0.08
Denmark	18	0.05
England	18	0.05
France	16	0.05
Germany	16 for beer and wine, 18 for all types	0.05
Italy	16	0.08
Japan	20	0.03
Russia	18	0.02
Spain	16	0.03–0.05 (depending on type of vehicle)
Sweden	18 for certain beers, 20 for all types	0.02–0.05 (depending on type of vehicle)

Alcohol Information Sheets

ALCOHOL'S EFFECTS ON THE BRAIN

The brain, with its high water content, is very sensitive to the effects of alcohol. Low BAC levels affect a part of the brain called the cerebral cortex, producing a sense of relaxation and well being. People who drink moderate amounts of alcohol may have problems with certain mental activities, such as those involved with getting, storing, and using information. These effects can cause problems in school for young people and at work for adults.

At higher BACs, additional parts of the brain become affected, resulting in changes in feelings and personality as well as impaired activities. People who drink heavily and for a long time often show evidence of brain damage. If an alcoholic stops using alcohol, some brain damage can be reversed. Master 5.4, *Progressive Effects of Alcohol*, lists how increasing BACs affect the brain and describes the effects.

The effects of alcohol are not limited to the brains of those who drink but also extend to the developing brains of fetuses. Pregnant women who drink expose their unborn children to alcohol when it passes through the placenta. This exposure can lead to a birth defect known as fetal alcohol syndrome (FAS). Children born with FAS have a number of symptoms including mental retardation, developmental delays, and behavioral problems.

Animal studies have been used to understand how alcohol exposure causes FAS. If drinking occurs during the time when the developing brain is growing the fastest, then FAS is more likely to occur. A recent study suggested that a single exposure to high alcohol concentrations is enough to cause FAS in rats. Healthcare providers should warn pregnant women not to drink any alcohol during their pregnancy or if they are planning to become pregnant.

Alcohol Information Sheets

ALCOHOL'S EFFECTS ON THE BODY

Alcohol and the Heart
Drinking alcohol affects the functioning of the heart and circulatory system. Studies have shown that small amounts of alcohol (about one drink per day for a woman and two drinks per day for a man) can reduce the risk of heart disease. The reason for this protective effect is not understood. Doctors do not recommend that nondrinkers start drinking to reduce their risk for heart disease, however; even moderate drinking increases the risk for other alcohol-related problems, including other medical problems, accidents, violence, and other risky behaviors. There is no question that heavy drinking is bad for the heart. It can damage heart tissue, produce an irregular heartbeat, and increase the risk of stroke.

Alcohol and the Liver
The liver is critical to our health. It helps break down food during digestion and processes waste so it can be excreted from the body. It also helps make needed substances such as cholesterol. Heavy drinking is often associated with liver damage. The liver is the main organ where alcohol is metabolized, or broken down, into different chemicals that can be passed out of the body. Some of these breakdown products are toxic to the liver. If these toxic substances build up in the liver, alcohol-induced liver damage can result. Women develop liver disease after a shorter time and with less alcohol exposure than men do.

Alcohol and the Digestive System
Heavy drinking can stop the esophagus from contracting and helping move food to the stomach. This allows stomach acids to back up into the esophagus. Stomach acid in the esophagus causes an inflammation of the cells, which can progress to esophageal cancer. Heavy alcohol use also is associated with inflammation of the pancreas and cancers in other body parts, including the mouth, throat, breast, colon, and rectum. Alcohol consumption apparently does not cause stomach cancer, but it may be involved in gastritis (inflammation of the stomach).

Alcoholics often have poor diets, so they don't get enough essential nutrients. Alcohol also interferes with the body's ability to break down food and absorb nutrients such as vitamins. Vitamin deficiencies can lead to other medical problems including softening of the bones and poor blood clotting.

Alcohol and Hormones
Hormones are chemical messengers in the body that coordinate the functions of tissues and organs. Alcohol can impair the functions of both the glands that release hormones and the tissues that respond to them. These effects can lead to problems regulating blood sugar, infertility, and osteoporosis (softening of bones).

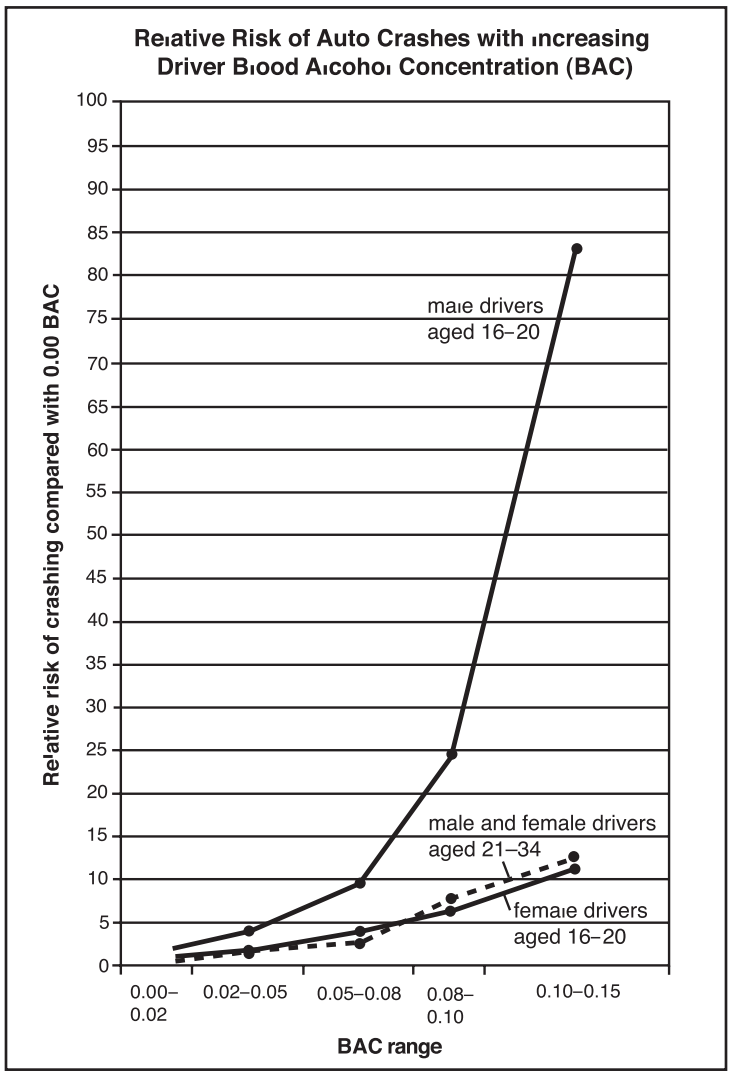
Alcohol and Sleep
Sleep is important for good health. Many people think that alcohol will help them sleep better. In fact, alcohol can cause problems with sleeping. It interferes with the normal sleep pattern and may leave the person feeling tired and unrefreshed upon awakening.

Alcohol Information Sheets

DRINKING AND DRIVING

Driving a car requires the driver to take in information from the environment and make many decisions about how to respond to all this information. Road conditions may be especially difficult to determine if it is dark, raining, or snowing. Roads that are narrow, have many curves, or have heavy traffic also challenge drivers.

In the United States, the legal BAC for driving is set at 0.08 or 0.10, depending on the state. The skills involved in driving are not all impaired at the same BAC. A driver's ability to divide attention between two or more sources of visual information can be impaired at a BAC of 0.02 or lower. When the BAC reaches 0.05 or higher, a person's reaction time slows, visual perception decreases, some steering tasks are impaired, eye movements slow, and glare on the windshield becomes more difficult to deal with.



The risk of a motor vehicle crash increases as the BAC increases. In addition to the amount of alcohol in the blood, the age of the driver is an important factor in determining the risk of a crash. The following graph illustrates how the risk of being in a crash increases as the BAC increases.

Alcohol is involved in about 30 percent of all traffic fatalities. In 1998, 12,663 people died in alcohol-related crashes in the United States. Of those killed, 35 percent were driving the car, 31 percent were passengers, and 11 percent were not in the vehicle.

If a person is arrested for driving under the influence of alcohol, several consequences may occur. The driver's license can be suspended or revoked. The vehicle can be impounded. If the driver has previous drunk-driving convictions, the driver may go to jail.

In addition to contributing to motor vehicle crashes on roads and highways, alcohol can impair the abilities of pilots and boaters. A pilot's abilities can be impaired for up to 14 hours after having a BAC between 0.10 and 0.12.

Alcohol Information Sheets

ALCOHOL, AGGRESSION, AND VIOLENCE

Violence concerns all of us, whether it is violence against one's self, such as suicide; violence against another person, such as rape, homicide, domestic abuse (marital violence or child abuse); or violence against a group, such as riotous acts at a sporting event. Consuming alcohol can make a person more aggressive, to the point of violence. A violent behavior is defined as one that intentionally harms, or attempts to harm, another person physically. Aggressive behaviors, in addition to attempting to cause physical harm, are threatening, hostile, or harmful in a nonphysical way.

One study reported that 42 percent of violent crimes reported to the police involved alcohol. The following chart summarizes the extent to which alcohol is involved in various crimes.

Crime	Proportion involving alcohol
Murders	86%
Sexual crimes	60%
Assault	37%
Marital violence committed by men, by women	 57% 27%
Child abuse	13%

A BAC between 0.01 and 0.05 can cause a lack of inhibitions and cause a person to make poor judgments. As the BAC rises to 0.06–0.10, a person may become more emotional. When the BAC increases to 0.11–0.20, the person may experience anger and act inappropriately in a social setting. For example, he or she may become loud and obnoxious in a crowd.

Alcohol by itself may not cause a person to commit a violent act; however, if a person who has consumed alcohol feels threatened or provoked, he or she may respond in a more severe way than if sober. Research suggests that alcohol may encourage aggression or violence by changing the way the brain works. Alcohol may make a person act more impulsively. People who have been drinking are more likely to engage in risky behaviors, including sexual behaviors. For example, surveys indicate that drinking is often associated with date rape. Drinking alcohol can also cause a person to misjudge other people's actions and overreact to a real or imagined threat. People who have been drinking alcohol can make poor decisions about how their aggressive actions can affect themselves or others.

Aggression and violence can also lead the victims to increase their consumption of alcohol, perhaps as a way to cope with the physical or emotional problems brought on by the violence.

Alcohol Information Sheets

ALCOHOL AND RISKY BEHAVIORS

People under the influence of alcohol are more likely to engage in risky behaviors compared with people who are sober. Even BACs well below the legal limit for driving can reduce alertness and affect judgment. These same BACs also impair people's coordination. So, while alcohol makes people feel more confident and willing to participate in risky behaviors, it lessens their ability to control their body movements.

When we think about alcohol and risky behaviors, drinking-and-driving usually comes to mind. There are, however, a number of other risky behaviors that should be considered. For example, the same poor judgment and loss of coordination that can lead to car crashes also can lead to other types of accidents, such as falls. Workers who drink on the job put themselves and others at risk for injury.

Sexual activity is another example of risky behavior. Surveys of young people show that they are more likely to engage in sex if they have been drinking. Additionally, 22 percent of surveyed young men and 15 percent of young women said they were less likely to use protection if they had been drinking. Such unprotected sex not only can result in pregnancy, but it also leaves the participants at risk to sexually transmitted diseases, including AIDS.

Reasoning and coordination are affected more severely at higher BACs. In addition, BACs in the range of 0.20–0.30 may lead to a loss of body-temperature regulation. Every year, some people drink to the point of intoxication and climb into a hot tub to relax. The alcohol prevents their bodies from maintaining a healthy temperature. The body temperature continues to rise to the point where it can cause brain damage and even death.

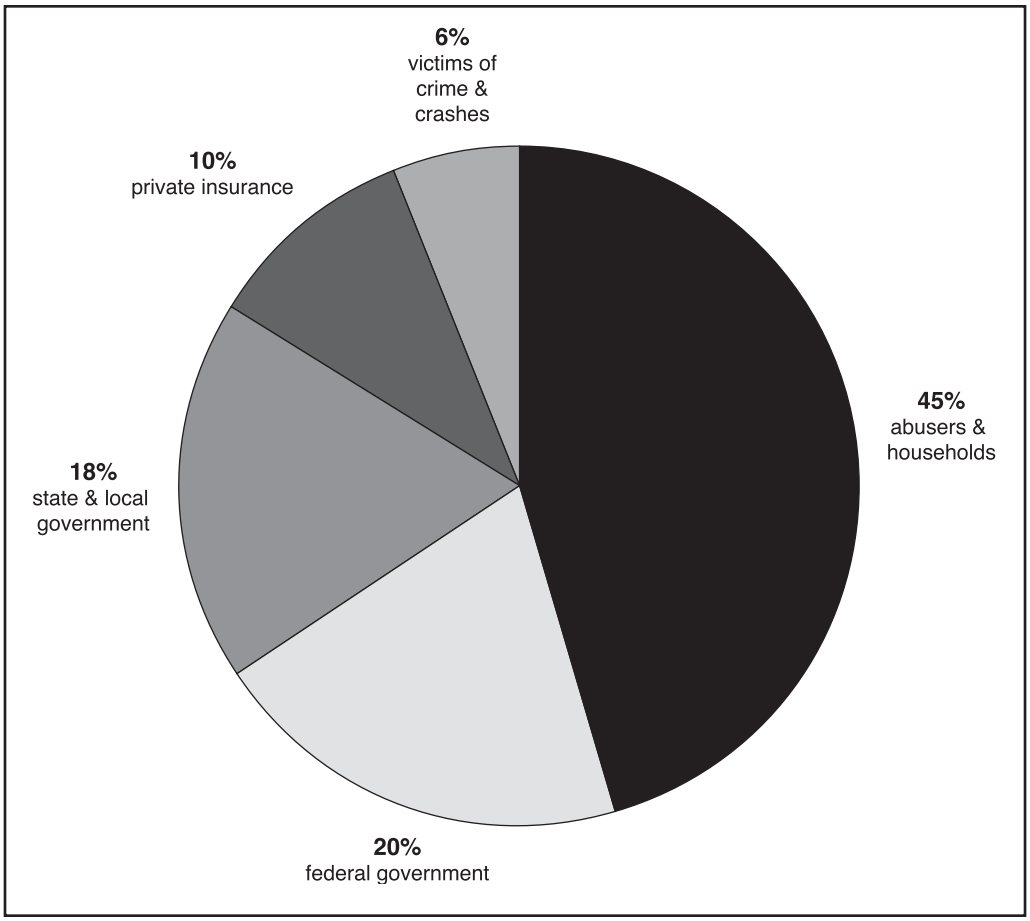
Alcohol Information Sheets

ALCOHOL AND THE ECONOMY

The production, sale, and consumption of alcoholic beverages have many effects on the economy. On the positive side, the alcoholic-beverage industry creates thousands of jobs for farmers, factory workers, advertisers, truck drivers, and store clerks. Federal taxes on alcoholic beverages amounted to $7.5 billion in 1995. State and local governments brought in even more tax revenue than the federal government.

Of course, alcohol abuse creates costs to society. About two-thirds of American adults drink an alcoholic beverage during the year. Most drink responsibly, but an estimated 13.8 million Americans have problems related to alcohol. In 1998, it was estimated that alcohol-abuse costs totaled over $184 billion. These costs come from illness, premature death, car crashes, loss of productivity at work, higher insurance rates, and costs to the criminal justice system.

Many of the costs of alcohol abuse are paid for by the majority of people who do not abuse alcohol. Some of the costs of alcohol abuse, such as human suffering, cannot be expressed in dollars and are left out of this type of analysis. The following chart illustrates who in our society bears the costs of alcohol abuse.



Master 6.2h

Alcohol: Is This Right? What Do I Think Now?

Name _____ Date _____

Please circle whether you agree or disagree with each statement.

1. Alcohol is a stimulant.	Agree	Disagree
2. Caffeine will sober you up.	Agree	Disagree
3. Food will keep you from becoming intoxicated.	Agree	Disagree
4. Drinking beer is safer than drinking wine or hard liquor such as vodka or whiskey.	Agree	Disagree
5. Alcohol-related car crashes are all caused by drunk drivers.	Agree	Disagree
6. Alcoholism is a disease.	Agree	Disagree
7. Alcohol abuse and alcoholism affect only the abuser.	Agree	Disagree
8. Alcohol abuse or alcoholism will never be my problem.	Agree	Disagree
9. Nothing can be done about alcohol abuse or alcoholism.	Agree	Disagree
10. It is a good idea to drink alcohol to prevent heart disease.	Agree	Disagree
11. Drinking a large amount of alcohol occasionally is less harmful than drinking a smaller amount every day.	Agree	Disagree
12. Drinking alcohol makes you feel more confident.	Agree	Disagree

Alcohol: Is This Right?
Class Responses

	Agreed at beginning	Agreed at end
1. Alcohol is a stimulant.	_____	_____
2. Caffeine will sober you up.	_____	_____
3. Food will keep you from becoming intoxicated.	_____	_____
4. Drinking beer is safer than drinking wine or hard liquor such as vodka or whiskey.	_____	_____
5. Alcohol-related car crashes are all caused by drunk drivers.	_____	_____
6. Alcoholism is a disease.	_____	_____
7. Alcohol abuse and alcoholism affect only the abuser.	_____	_____
8. Alcohol abuse or alcoholism will never be my problem.	_____	_____
9. Nothing can be done about alcohol abuse or alcoholism.	_____	_____
10. It is a good idea to drink alcohol to prevent heart disease.	_____	_____
11. Drinking a large amount of alcohol occasionally is less harmful than drinking a smaller amount every day.	_____	_____
12. Drinking alcohol makes you feel more confident.	_____	_____

Additional Web Resources for Teachers

1. National Institute on Alcohol Abuse and Alcoholism
   http://www.niaaa.nih.gov/

   This site is a resource for alcohol researchers as well as the general public. You can access
   - About NIAAA
   - Conferences/Events
   - Databases
   - Frequently Asked Questions
   - Other Resources
   - Press Releases
   - Publications
   - Research Programs

2. National Clearinghouse for Alcohol and Drug Information
   http://www.health.org/pubs/catalog/series.htm

   This site features the Publications in Series. It includes the NIAAA Alcohol Alert Series.

3. The Indiana Prevention Resource Center at Indiana University
   http://www.drugs.indiana.edu/druginfo/alcohol.html

   This site connects a large number of resources including
   - Alcohol-Related Topics
   - Impaired Driving Links
   - Alcoholism and Recovery Links
   - Alcohol, Other Drugs, Sexual Behavior and AIDS

4. The American Medical Association
   http://www.ama-assn.org/special/aos/alcohol1/facts01.htm

   This site contains research/facts about youth and alcohol. You can click on
   - The Minimum Legal Drinking Age: Facts and Fallacies
   - Youth, Young Adults, and Alcohol
   - Alcohol and Driving: Key Facts

5. National Association for Children of Alcoholics
   http://www.nacoa.org

   The site offers a number of publications including a kit for educators.

Appendix I
More About the National Institutes of Health

Begun as a one-room Laboratory of Hygiene in 1887, the National Institutes of Health today is one of the world's foremost medical research centers and the federal focal point for medical research in the United States.

What Is the NIH Mission and Organization?

The NIH mission is to uncover new knowledge that will lead to better health for everyone. NIH works toward that mission by

- conducting research in its own laboratories;
- supporting the research of nonfederal scientists in universities, medical schools, hospitals, and research institutions throughout the country and abroad;
- helping in the training of research investigators; and
- fostering communication of medical information.

NIH is one of eight health agencies of the Public Health Service, which, in turn, is part of the U.S. Department of Health and Human Services. NIH's institutes and centers encompass 75 buildings on more than 300 acres in Bethesda, Md. The NIH budget has frown from about $300 in 1887 to more than $23.5 billion in 2002.

What Is the Goal of NIH Research?

Simply described, the goal of NIH research is to acquire new knowledge to help prevent, detect, diagnose, and treat disease and disability, from the rarest genetic disorder to the common cold.

How Does NIH Help Scientists Reach This Goal?

Approximately 82 percent of the investment is made through grants and contracts supporting research and training in more than 2,000 research institutions throughout the United States and abroad. In fact, NIH grantees are located in every state in the country. These grants and contracts make up the **NIH Extramural Research Program**.

Approximately 10 percent of the budget goes to NIH's **Intramural Research Programs**, the more than 2,000 projects conducted mainly in its own laboratories.

The Intramural Research Programs are central to the NIH scientific effort. First-rate intramural scientists collaborate with one another regardless of institute affiliation or scientific discipline and have the intellectual freedom to pursue their research leads in NIH's own laboratories. These explorations range from basic biology, to behavioral research, to studies on treatment of major diseases. NIH scientists conduct their research in laboratories located on the NIH campus in Bethesda and in several field units across the country and abroad.

NIH Research Grants

Final decisions about funding extramural research are made at NIH headquarters. But long before this happens, the process begins with an idea that an individual scientist describes in a written application for a research grant.

The project might be small, or it might involve millions of dollars. The project might become useful immediately as a diagnostic test or new treatment, or it might involve studies of basic biological processes whose practical value may not be apparent for many years.

Peer Review

Each research grant application undergoes a peer-review process.

A panel of scientific experts, primarily from outside the government, who are active and productive researchers in the biomedical sciences, first evaluates the scientific merit of the application. Then, a national advisory council or board, composed of eminent scientists as well as public members who are interested in health issues or the biomedical sciences, determines the project's overall merit and priority in advancing the research agenda of the particular NIH funding institute.

Altogether, about 38,500 research and training applications are reviewed annually through the NIH peer-review system. At any given time, NIH supports 35,000 grants in universities, medical schools, and other research and research training institutions both nationally and internationally.

Who Are the Scientists NIH Supports?

Scientific progress depends mainly on the scientist. About 50,000 principal investigators—working in every state and in several foreign countries, from every specialty in medicine, every medical discipline, and at every major university and medical school—receive NIH extramural funding to explore unknown areas of medical science.

Supporting and conducting NIH's extramural and intramural programs are about 15,600 employees, more than 4,000 of whom hold professional or research doctorate degrees. The NIH staff includes intramural scientists, physicians, dentists, veterinarians, nurses, and laboratory, administrative, and support personnel, plus an ever-changing array of research scientists in training.

The NIH Nobelists

The roster of those who have conducted NIH research or who have received NIH support over the years includes the world's most illustrious scientists and physicians. Among them are 97 scientists who have won Nobel Prizes for achievements as diverse as deciphering the genetic code and identifying the causes of hepatitis.

Five Nobelists made their prize-winning discoveries in NIH laboratories. You can learn more about Nobelists who have received NIH support at *http://www.nih.gov/about/almanac/nobel/index.htm*.

What Impact Has NIH Had in the Health of the Nation?

NIH research has played a major role in making possible the following achievements of the last few decades:

- Mortality from **heart disease**, the number one killer in the United States, dropped by 36 percent between 1977 and 1999.
- Death rates from **stroke** decreased by 50 percent during the same period.
- Improved treatments and detection methods increased the relative five-year survival rate for people with **cancer** to 60 percent.
- Paralysis from **spinal cord injury** is significantly reduced by rapid treatment with high doses of a steroid. Treatment given within the first eight hours after injury increases the likelihood of recovery in severely injured patients who have lost sensation or mobility below the point of injury.
- Long-term treatment with anticlotting medicines cuts **stroke** risk by 80 percent from a common heart condition known as atrial fibrillation.
- In **schizophrenia**, where patients suffer frightening delusions and hallucinations, new medications can reduce or eliminate these symptoms in 80 percent of patients.
- Chances for survival increased for infants with **respiratory distress syndrome**, an immaturity of the lungs, due to development of a substance to prevent the lungs from collapsing. In general, life expectancy for a baby born today is almost three decades longer than one born at the beginning of the century.
- With effective medications and psychotherapy, the 19 million Americans who suffer from **depression** can now look forward to a better, more productive future.
- Vaccines protect against **infectious diseases** that once killed and disabled millions of children and adults.
- Dental sealants have proved 100 percent effective in protecting the chewing surfaces of chil-

dren's molars and premolars, where most **cavities** occur.
- In 1990, NIH researchers performed the first trial of **gene therapy** in humans. Scientists are increasingly able to locate, identify, and describe the functions of many of the genes in the human genome. The ultimate goal is to develop screening tools and gene therapies for cancer and many other diseases.

NIH Research in the 21st Century

NIH has enabled scientists to learn much since its humble beginnings. But many discoveries remain to be made:

- Better ways to prevent and treat cancer, heart disease, stroke, blindness, arthritis, diabetes, kidney diseases, Alzheimer's disease, communication disorders, mental illness, drug abuse and alcoholism, and AIDS, and other unconquered diseases.
- Ways to continue improving the health of infants and children, women, and minorities.
- Better ways to understand the aging process and behavior and lifestyle practices that affect health.

These are some of the areas where NIH's investment in health research promises to yield the greatest good for the greatest number of people.

For more about NIH, visit its Web site at *http://www.nih.gov.*

Appendix II

More About the National Institute on Alcohol Abuse and Alcoholism and Its Science Education Program

The Public Health Problem of Alcohol

In 1970, the U.S. Congress recognized that alcohol is the number one drug of abuse in our nation and created the National Institute on Alcohol Abuse and Alcoholism (NIAAA) as the principal federal focus for research to address this public health problem. Today, as one of the research institutes of the National Institutes of Health (NIH), NIAAA manages about 90 percent of the nation's investment in research aimed at developing, through science, the knowledge of that problem, whom it affects, and how, as the basis for more effective treatment and prevention methodologies.

What is the scope of the problem? Approximately 1 million youth, ages 12–17, are consuming alcohol. Nearly 14 million American adults develop problems from drinking. Death can be, and too often is, the ultimate consequence. About 100,000 deaths each year are due to alcohol abuse and alcoholism. Short of death, specific problems include health deterioration such as damage to the brain, liver, gastrointestinal tract, and heart; injuries such as automobile crashes and household accidents; domestic and other forms of violence; neglect of work and family; and costs to society associated with police, courts, jails, and unemployment.

It has been estimated that every dollar invested in treatment yields seven dollars in savings in health-care costs and lost-productivity costs from job absenteeism, injuries, and poor work performance. Specific benefits of adolescent treatment include better psychological adjustment and improved school performance after treatment, less heavy drinking, less use of other drugs, and less criminal involvement.

Thirty Years of Research Progress

NIAAA's 30 years of attention to the science of alcohol-use problems has produced results. For example, it is now clear that a portion of the risk for developing alcoholism is the result of genetics, and scientists are making progress in finding the genes that influence vulnerability to alcoholism. We also have learned many of the ways alcohol affects the brain. Alcohol neuroscience research has already provided the basis for new medications to treat alcoholism. We have begun to understand more about the risks—and benefits—to health that result from alcohol use and how to treat alcohol-related health conditions, including the damage caused to major body organs by excessive alcohol use. Alcohol researchers have defined populations at risk and have developed and tested programs that have proved successful in reducing alcohol-related problems in schools and communities. In fact, research findings from NIAAA-supported investigators have provided the basis for changes in policy and legislation that have saved many lives. These include raising the minimum legal drinking age to 21 and establishing 0.08 percent as the legal blood alcohol limit for driving. A growing body of research on improving treatment effectiveness has resulted in, among other things, improved diagnostic systems and methods of screening and assessment.

NIAAA Overview

NIAAA supports research principally through extramural grants awarded to scientists at leading U.S. academic and research institutions and through research conducted by NIAAA's own intramural staff scientists. Findings from these research areas are made available and accessible

through a variety of dissemination activities, including the Institute's science education program. Research and dissemination activities are summarized below.

Extramural Research

Genetics: NIAAA supports research aimed at discovering the genes that predispose individuals to alcoholism and the environmental factors that influence the development of alcohol dependency in susceptible individuals. Areas of genetics research include

- studies of twins to define precisely what is being inherited;
- genetic linkage and association studies to identify the genes for alcoholism and their precise number, identity, and modes of action; and
- genetic analysis of alcohol-related behavior in animals, the genes that influence these behaviors, and studies to determine the respective contributions of the environment and genetics to alcohol-related medical disorders such as liver cirrhosis, pancreatitis, and fetal alcohol syndrome.

Alcohol and the Brain: Many of the behaviors associated with alcohol-use problems are the result of alcohol's effects on the brain. NIAAA-supported research is designed to learn how these effects influence the development of alcohol abuse and alcoholism. Molecular biology and genetic techniques, including the use of transgenic animals, are becoming an integral part of this research. In addition, noninvasive imaging technologies are used in animal and human studies to identify neural circuits influenced by alcohol.

Medications Development: NIAAA is strongly committed to developing medications to diminish alcoholics' craving for alcohol, safely detoxify dependent individuals who are entering treatment, and reduce risk of relapse. Naltrexone—the first medication approved as a safe and effective adjunct to psychosocial treatment for alcoholism since 1949—was developed from neuroscience research. It is an opiod antagonist. Findings from neuroscience and from genetics point to promising targets for the future development of additional pharmacological interventions.

Prevention: NIAAA-supported prevention research is aimed at developing effective measures to reduce alcohol-related problems, including studies of alcohol-related intentional and unintentional injury, alcohol-related violence, alcohol in the workplace, drinking and driving deterrence, and the relationship between simply the availability of alcohol and incidence of alcohol-related problems. New methodologies permit prevention researchers to target high-risk neighborhoods within larger cities.

Treatment: NIAAA supports a range of treatment (clinical) studies, including trials of newly developed treatment therapies, treatment-matching studies that look at the relationship between patient characteristics and type of treatment, and behavioral-pharmacological treatment approaches.

Epidemiology: Alcohol epidemiology provides the foundation for monitoring the health of a population, as distinguished from an individual's health; developing and evaluating alcohol prevention and treatment services; and establishing alcohol-related social policies. NIAAA-supported epidemiology research examines the context, volume, and specific drinking patterns that lead to particular alcohol-related problems. Epidemiology research also studies the impact of gender, race and ethnicity, and other sociodemographic factors on alcohol use and abuse. Genetic, environmental, and other factors that influence alcohol-related injury or disease occurrence in a defined population are also topics of epidemiology research.

Intramural Research

NIAAA intramural scientists focus on unique research opportunities that require intensive, long-term commitment, together with flexibility to adjust research priorities quickly in response to new findings. Because clinical and laboratory studies occur side-by-side in the intramural program, new findings from basic research may be transferred readily for appropriate testing and application. Conversely, clinical hypotheses may, in turn, be posited to lab scientists. Areas of intramural study include

- identification and assessment of genetic and environmental risk factors for the development of alcoholism;
- the effects of alcohol on an individual's central nervous system, including how alcohol modifies brain activity and behavior;
- metabolic and biochemical effects of alcohol on various organs and systems of the body; and
- noninvasive imaging of the brain structure and activity related to alcohol-use development in animal models of alcoholism.

An 11-bed inpatient alcohol ward and a large outpatient program are located at the National Institutes of Health Clinical Center in Bethesda, Md., in close proximity to NIAAA laboratories where basic research is conducted. Coordinated interaction between these facilities is essential in pursuing the goals of the intramural research program.

Research Dissemination

NIAAA shares findings from alcohol research with healthcare practitioners, policymakers, social service program providers, and others, including the general public through publications. These include scientific and clinical journals and monographs and general and specialized manuals, clinical bulletins, brochures, and pamphlets. Research findings are also shared through three on-line database services sponsored by the Institute: Quick Facts, an epidemiological database; ETOH (chemical name for alcohol), an alcohol-related bibliographic reference database; and the NIAAA clinical trials database. Publications, reports, and database services are accessible online at *http://www.niaaa.nih.gov.* This website can also be a valuable resource for teachers.

The NIAAA Science Education Program

Dissemination of research findings through science curricula in our nation's schools is part of the continuing commitment of NIAAA to make the science of alcohol problems both accessible and understandable to the public. Although many youth receive information about alcohol use as part of a health education or physical education curriculum, NIAAA believes that understanding the science involved in developing this information is important to the choices that students will make about drinking. Alcohol use is part of the American culture, and most adults who drink do so with a minimum of risk. Thus, despite what young people are taught in health education or physical education about the potential for alcohol use to cause them problems, many nevertheless take drinking for granted—a common "rite of passage" for American youth, especially boys. However, being told in a health education class that alcohol use by underage drinkers can cause cognitive damage is very different from learning the *science* behind this finding. Moreover, "telling" is not always "teaching." The critical-thinking skills involved in the methodology of doing science are learned in science education. Critical thinking is an invaluable asset in personal decision making.

The NIAAA science education program, of which this curriculum is one product, is designed to support teachers in their efforts to help students enjoy the process of discovery and to appreciate how medical science generally, and alcohol science specifically, addresses public health issues and, in so doing, positively affects their lives and that of their families.

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