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# CHAPTER 8

# Alcohol

## THINK About It

1. In a word or two, how would you describe alcohol? Is it a nutrient?
2. Compared with beer, what's your impression of the alcohol content of wine? How about compared with vodka?
3. Have you ever thought of alcohol as a poison?
4. After a night of drinking and carousing, your friend awakens with a splitting headache and asks you for a pain reliever. What would you recommend?

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## *Quick* Bite

### Preferred Beverages

Beer is the national beverage of Germany and Britain. Wine is the national beverage of Greece and Italy.

Think about alcohol. What image comes to mind: Champagne toasts? Elegant gourmet dining? Hearty family meals in the European countryside? Or do you think of wild parties? Or sick, out-of-control drunks? Violence? Car accidents? Broken homes? No other food or beverage has the power to elicit such strong, disparate images—images that reflect both the healthfulness of alcohol in moderation, the devastation of excess, and the political, social, and moral issues surrounding alcohol.

Alcohol has a long and checkered history. More drug than food, alcoholic beverages produce druglike effects in the body while providing little, if any, nutrient value other than energy. Yet it still is important to consider alcohol in the study of nutrition. Alcohol is common to the diets of many people. In moderation, it may impart significant health benefits, yet even small quantities can raise risks for birth defects and breast cancer. In large amounts, it interferes with our intake of nutrients as well as the body's ability to use them, and it causes significant damage to every organ system in the body. The *Dietary Guidelines for Americans* advises us, "Those who choose to drink alcohol should do so sensibly and in moderation—defined as the consumption of up to one drink per day for women and up to two drinks per day for men."[1]

For most people, alcohol consumption is a pleasant social activity. Moderate alcohol use does not harm most adults. Nonetheless, many people have serious trouble with drinking. Episodes of heavy drinking are common among adult populations and are on the rise.[2] Adult excessive drinkers and underage drinkers currently account for half of all alcohol consumption and half of consumer spending on alcohol.[3] Heavy drinking can increase the risk for certain cancers. It can also cause liver cirrhosis, brain damage, and harm to the fetus during pregnancy. In addition, drinking increases the number of deaths from automobile crashes, recreational accidents, on-the-job accidents, homicide, and suicide. Underage alcohol use is more likely to kill young people than all illegal drugs combined.[4] An analysis found that alcohol use is the third leading actual cause of death in the United States, after tobacco use and poor diet and/or inactivity.[5]

**alcohol** Common name for ethanol or ethyl alcohol. As a general term, it refers to any organic compound with one or more hydroxyl (–OH) groups.

**ethanol** Chemical name for drinking alcohol. Also known as ethyl alcohol.

**ethyl alcohol** See *ethanol*.

**methanol** The simplest alcohol. Also known as methyl alcohol and wood alcohol.

**methyl alcohol** See *methanol*.

**wood alcohol** Common name for methanol.

**fermentation** The anaerobic conversion of various carbohydrates to carbon dioxide and an alcohol or organic acid.

## History of Alcohol Use

Alcohol has had a prominent role throughout history. Old religious and medical writings frequently recommend its use, although with warnings for moderation. Thanks to alcohol's antiseptic properties, fermented drinks were safer than water during the centuries before modern sanitation, especially as people moved to towns and villages where water supplies were contaminated. Even mixing alcohol with dirty water afforded some protection from bacteria.[6]

At a time when life was filled with physical and emotional hardships, people valued alcohol for its analgesic and euphoric qualities. People relied on it to lift spirits, ease boredom, numb hunger, and dull the discomfort, even pain, of daily routine. Before the twentieth century, it was one of the few painkillers available in the Western world.

In sharp contrast to what is allowed today, drinking was often encouraged at the work site. Workers might be given alcohol as an inducement to do boring, painful, or dangerous jobs. Distilled spirits, beer, and wine accompanied sailors and passengers on all long voyages, supplying relatively pathogen-free fluid and calories. Legend has it that even the Puritans, a group known for rigid morality, disembarked at Plymouth Rock because their beer supply was depleted.[7]

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## The Character of Alcohol

Although there are many types of alcohol, the term **alcohol** commonly refers to the specific alcohol compound in beer, wine, and spirits. (See **Figure 8.1**.) Its technical name is **ethanol**, or **ethyl alcohol**. Ethanol is commonly abbreviated to "EtOH," shorthand often preferred by health professionals. In this chapter, when we use the term *alcohol*, we are referring to ethanol.

Other types of alcohol are unsafe to drink. The simplest alcohol is **methanol**, also called **methyl alcohol** or **wood alcohol**, a solvent used in paints and for woodworking. Some years ago, down-on-their-luck alcoholics thought they had discovered a way to save money—wood alcohol, used at that time to heat chafing dishes, was intoxicating but considerably cheaper than beer or wine. Unfortunately, methanol caused blindness and death. Methanol is no longer used in these products, but methanol poisoning from other sources still occurs.[8] Today, methanol is used in a number of consumer products, including paint strippers, duplicator fluid, model airplane fuel, and dry gas. Most windshield washer fluids are 50 percent methanol.

## Alcohol: Is It a Nutrient?

Alcohol eludes easy classification. Like fat, protein, and carbohydrate, it provides energy when metabolized. Laboratory experiments in the nineteenth century demonstrated that upon oxidation pure alcohol releases 7 kilocalories per gram, but many people doubted it actually produced energy in the body. These doubts were the basis of the controversial conclusion that alcohol was not food—a conclusion used by early Prohibitionists in their fight against alcohol. (See **Figure 8.2**.) However, a classic series of experiments by energy researchers Francis Atwater and Wilbur Benedict showed that alcohol did indeed produce 7 kilocalories per gram in the body—findings that were a great disappointment to the Temperance Movement, because they showed that alcohol was a food.[9]

But alcohol's status as a nutrient is more questionable. It is certainly different from any other substance in the diet. It provides energy but is not essential, performing no necessary function in the body. Unlike the nutrients, alcohol is not stored in the body. And for no nutrient are the dangers of overconsumption so dramatic and the window of safety so narrow. In the small amounts most people usually consume, alcohol acts as a drug, producing a pleasant euphoria. For some people, it is addictive, with the characteristics of tolerance, dependence, and withdrawal symptoms. Certainly, alcohol is a substance available in the diet, but it does not meet the technical definition of a nutrient. (See Chapter 1 for the definition of a nutrient.)

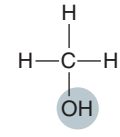
THINK About It 1

**Key Concepts** *Alcohol—or, more specifically, the compound ethyl alcohol—has been part of people's diets for thousands of years. Although it provides calories, alcohol performs no essential function in the body and therefore is not a nutrient.*

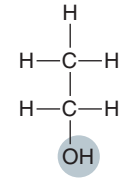
## Alcohol and Its Sources

When yeast cells metabolize sugar, they produce alcohol and carbon dioxide by a process called **fermentation**. If little oxygen is present, these cells produce more alcohol and less carbon dioxide. **Figure 8.3** shows living yeast cells.

Fermentation can occur spontaneously in nature—all that's needed is sugar, water, a warm environment, and yeast (whose spores are present in air



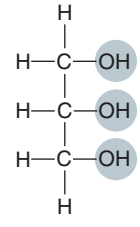

**Methanol**
(wood alcohol)



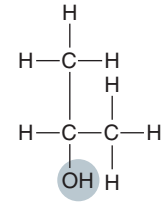

**Ethanol**
(EtOH)

Methanol is an alcohol used as an alternative car fuel and in paint strippers, duplicator fluid, and model airplane fuels.

Ethanol is the alcohol in beer, wine, and liquor.




**Glycerol**




**Isopropanol**
(rubbing alcohol)

Glycerol is the alcohol that forms the backbone of triglyceride molecules.

Isopropanol is an alcohol that is used as a disinfectant or solvent, and in making many commercial products.

**Figure 8.1** **Alcohols.** Ethanol is not the only alcohol people consume. When people eat fat, they consume the alcohol glycerol. Consuming the alcohol methanol or isopropanol can be deadly.

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## *Quick* Bite

### Nutrients in Beer?

Most of the carbohydrate used in the production of alcohol is converted to ethanol. In beer, however, some carbohydrate remains, along with a little protein and some vitamins. So although it is technically correct to say there are nutrients in beer, the amounts are small when beer is consumed at recommended low levels.

**congeners** Biologically active compounds in alcoholic beverages that include nonalcoholic ingredients as well as other alcohols such as methanol. Congeners contribute to the distinctive taste and smell of the beverage and may increase intoxicating effects and subsequent hangover.

**standard drink** One serving of alcohol (about 15 grams), defined as 12 ounces of beer, 4 to 5 ounces of wine, or 1.5 ounces of liquor.

**binge drinking** Consuming excessive amounts of alcohol in short periods of time.

and soil). Human experience with alcohol probably began at least 10,000 years ago with spontaneously fermented fruits or honey. Because all humans possess the enzymes to metabolize at least minimal amounts of alcohol,[10] it's reasonable to assume that humans have always had small quantities of alcohol in their diets. Very small amounts of alcohol are even produced by the microorganisms in our intestines.

Humans probably learned to make wine from fruits, mead from honey, and beer from grain about 5,000 years ago. In some areas, people made alcohol-containing dairy products. Using simple yeast fermentation, they could not produce beverages with alcohol levels exceeding 16 percent—the point at which alcohol kills off the yeast, halting alcohol production. Later, seventh-century Egyptian chemists discovered how to use distillation to capture concentrated alcohol, which could be added to drinks to boost alcohol content. Distilled alcoholic beverages (such as rum, gin, and whiskey) are called spirits, liquor, or hard liquor.

Distillation can yield more than just ethanol. Traces of other compounds, such as methanol, evaporate and then condense in the distilled product. Called **congeners**, these biologically active compounds help to create the distinctive taste, smell, and appearance of alcoholic beverages such as whiskey, brandy, and red wine. But congeners are also suspected of causing or contributing to hangovers[11] and may play a role in alcohol's relationship to cancer.

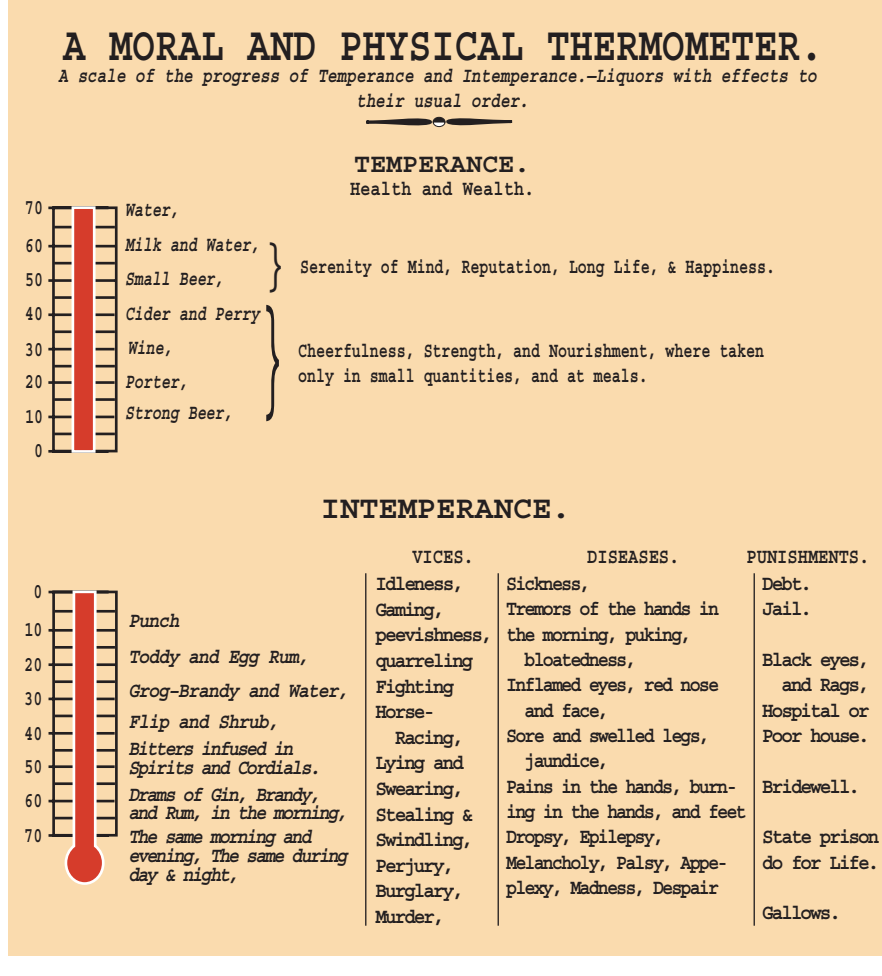


**Figure 8.2** **A moral and physical thermometer of temperance and intemperance.** As part of a late eighteenth century temperance movement, Philadelphian Dr. Benjamin Rush (1745–1813) created the Moral and Physical Thermometer and distributed it to the clergy in a campaign against heavy drinking.

Source: Reprinted with permission from *Quarterly Journal of Studies on Alcohol*, vol 4, pp. 321–341, 1943 (presently *Journal of Studies on Alcohol*). Copyright Alcohol Research Documentation, Inc., Rutgers Center of Alcohol Studies, Piscataway, NJ 08854.

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THINK About It 2

Beer, wine, and liquor have different alcohol levels: most beer is up to 5 percent alcohol, although some beers exceed 6 percent; wine is 8 to 14 percent alcohol; and hard liquor is typically 35 to 45 percent alcohol. Beer and wine are labeled with the percentage of alcohol, but hard liquor is labeled by "proof," which is twice the alcohol percentage (an 80 proof whiskey is 40 percent alcohol).

Pure alcohol—a clear, colorless liquid used in chemistry labs—is 95 percent alcohol. (Even "pure" alcohol contains some water.) The beverage closest to pure alcohol is vodka, which is alcohol, water, and almost nothing else; gin is similar but flavored with juniper berries. Scotch, rum, rye, whiskey, and other liquors have residual flavor traces of the grain from which they were fermented or flavors introduced during storage. All liquors, however, offer little nutritional value besides energy. Beer and wine do contain unfermented carbohydrates and a trace of protein but, like liquor, have negligible minerals. With the exception of niacin in beer (a 12-ounce beer contains 1.8 milligrams of niacin, nearly 10 percent of the Daily Value), alcoholic beverages have negligible vitamins as well. **Table 8.1** shows the number of calories in various alcoholic beverages.

One serving of alcohol, or a **standard drink**, is defined as 12 ounces of regular beer, 5 ounces of wine (12 percent alcohol), or 1.5 ounces (a "jigger") of 80 proof liquor.[12] All contain roughly 15 grams (1 measuring tablespoon) of pure alcohol. Most health professionals who speak of "moderate alcohol intake" usually mean no more than one (for women) or two (for men) servings in a day.[13] (See **Figure 8.4**.) Moderate intake is not an average of seven drinks per week, when there are six days of abstinence followed by seven drinks in one night! That's **binge drinking**, and it's dangerous.

**Key Concepts** *Alcohol is formed when yeast ferments sugars to yield energy. Distillation methods produce concentrated solutions containing up to 95 percent alcohol. A typical serving of beer, wine, or distilled spirits contains about 15 grams of alcohol.*

**Figure 8.3** A micrograph of yeast.

**Table 8.1** Calories in Selected Alcoholic Beverages

| Beverage | Serving Size | Approximate Kcalories |
|---|---|---|
| Beer (regular) | 12 fl oz | 153 |
| Beer (light) | 12 fl oz | 103 |
| White wine | 5 fl oz | 121 |
| Red wine | 5 fl oz | 125 |
| Sweet dessert wine | 3.5 fl oz | 165 |
| 80 proof distilled spirits (gin, rum, vodka, whiskey) | 1.5 fl oz | 97 |

This table is a guide to estimate the caloric intake from various alcoholic beverages. Higher alcohol content and mixing alcohol with other beverages, such as calorically sweetened soft drinks, tonic water, fruit juice, or cream, increases the amount of calories in the beverage. Alcoholic beverages supply calories but provide few essential nutrients.

Source: US Department of Agriculture, Agricultural Research Service. USDA National Nutrient Database for Standard Reference, Release 20. 2007. http://www.ars.usda.gov/ba/bhnrc/ndl. Accessed 3/31/08.


**Figure 8.4** **Moderate drinking.** Source: USDA Center for Nutrition Policy and Promotion.

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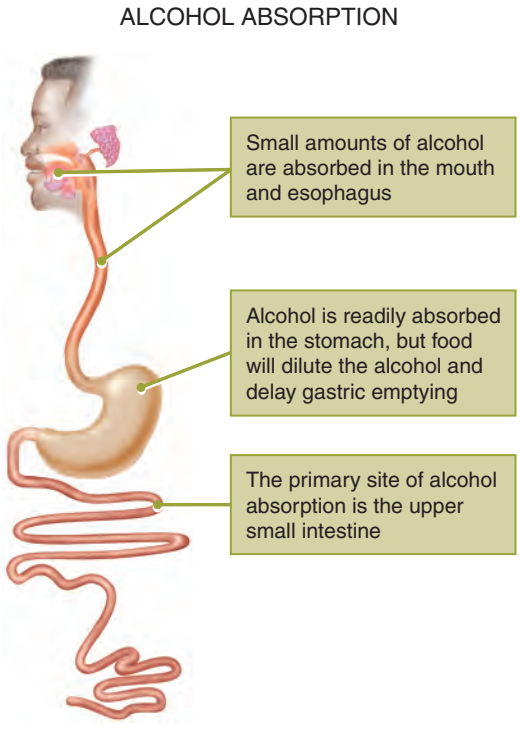


**Figure 8.5** **Alcohol absorption.** Alcohol easily diffuses in and out of cells, so most alcohol is absorbed unchanged.

## *Quick* Bite

### Alcohol Aversion Therapy

In alcohol aversion therapy, the medication disulfiram (Antabuse) deliberately blocks the conversion of toxic acetaldehyde to acetate (acetic acid). Even small amounts of alcohol trigger the highly unpleasant Antabuse–alcohol reaction, which includes a throbbing headache, breathing difficulties, nausea, copious vomiting, flushing, vertigo, confusion, and a drop in blood pressure.

**alcohol dehydrogenase (ADH)** The enzyme that catalyzes the oxidation of ethanol and other alcohols.

**acetaldehyde** A toxic intermediate compound formed by the action of the alcohol dehydrogenase enzyme during the metabolism of alcohol.

## Alcohol Absorption

Alcohol absorption begins immediately in the mouth and esophagus, where small quantities enter the bloodstream. Although alcohol absorption continues in the stomach, the small intestine efficiently absorbs most of the alcohol a person consumes.[14] (See **Figure 8.5**.)

You've heard it before: "Don't drink on an empty stomach." Eating before or with a drink slows down the rush of alcohol into the bloodstream in several ways. Food, especially if it contains fat, delays emptying of the stomach into the small intestine. The delay also provides a longer opportunity for oxidizing stomach enzymes to work. And food dilutes the stomach contents, lowering the concentration of alcohol and its rate of absorption.

About 80 to 95 percent of alcohol is absorbed unchanged. However, some oxidation does take place in the digestive tract, mainly in the stomach, and products of this metabolism join alcohol as it diffuses into the gut cells.[15] These products travel via the portal vein directly to the liver, where most alcohol metabolism takes place. When all goes well, metabolism achieves two goals: energy production and protection from the damaging effects of alcohol and its even more toxic metabolite, acetaldehyde.

## Alcohol Metabolism

The body cannot store potentially harmful alcohol, and so it works extra hard to get rid of it. To prevent alcohol from accumulating and destroying cells and organs, the body quickly metabolizes it and removes it from the blood. The liver selectively metabolizes alcohol before other compounds and has alternative pathways to handle excess consumption.

### Metabolizing Small Amounts of Alcohol

**Alcohol dehydrogenase (ADH)** is a zinc-containing enzyme that catalyzes the conversion of small to moderate amounts of alcohol to **acetaldehyde**, a toxic substance. To avoid toxic buildup, another enzyme, **aldehyde dehydrogenase (ALDH)**, quickly and effectively converts acetaldehyde to acetate. (See **Figure 8.6**.) People differ in their ability to eliminate toxic acetaldehyde, and small amounts of it are found in the blood of intoxicated people.[16]

Dehydrogenases in the gastrointestinal tract and the liver are responsible for almost all alcohol metabolism. Probably about 4 to 9 percent, but possibly as much as 20 percent, of alcohol is changed to acetaldehyde in the digestive tract.[17] Gastrointestinal aldehyde dehydrogenase does not completely convert acetaldehyde to acetate, however. The remaining acetaldehyde is more destructive than alcohol itself and can damage the mucous membranes lining the gut.[18]

Alcohol breakdown always takes priority over the breakdown of carbohydrates, proteins, and fats. Liver cells detoxify alcohol and use the products to synthesize fatty acids, which are assembled into fats. Fat accumulation in the liver can be seen after a single bout of heavy drinking, and fatty acid synthesis accelerates with chronic alcohol consumption. **Fatty liver** is the first stage of liver destruction in alcoholics.

### Metabolizing Large Amounts of Alcohol

Large amounts of alcohol can overwhelm the alcohol dehydrogenase system, the usual metabolic path. As alcohol builds up, the body identifies it

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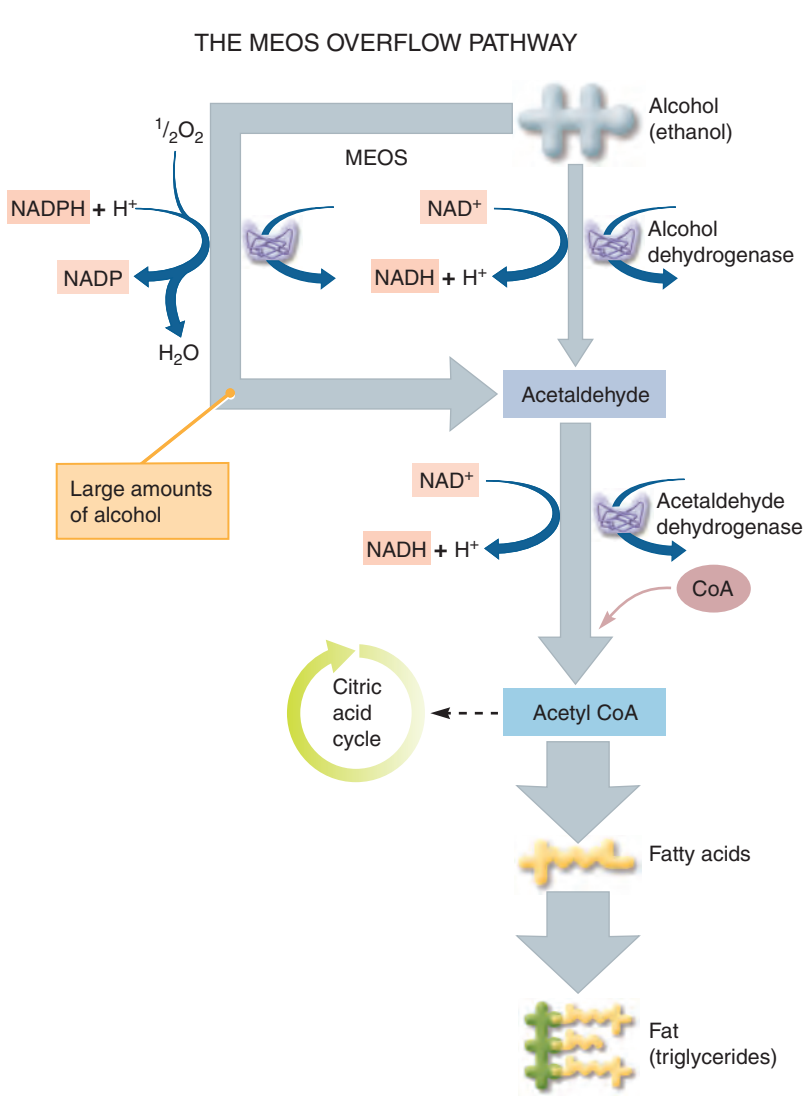


**Figure 8.7** **The MEOS overflow pathway.** Large amounts of alcohol can overwhelm its typical metabolic route, so excess alcohol enters an overflow pathway called the microsomal ethanol-oxidizing system (MEOS).

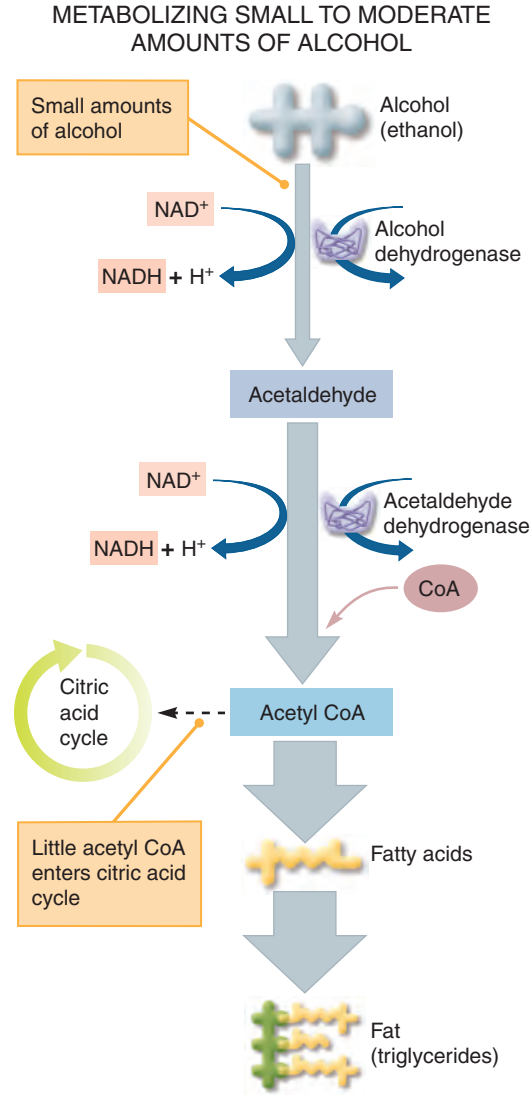


**Figure 8.6** **Metabolizing alcohol.** The metabolism of alcohol inhibits the citric acid cycle and primarily forms fat.

as a foreign substance and routes it into the primary overflow pathway, the **microsomal ethanol-oxidizing system (MEOS)**. (See **Figure 8.7**.) The liver ordinarily uses the MEOS bypass pathway to metabolize drugs and detoxify "foreign" substances. Chronic heavy drinking appears to activate MEOS enzymes, which may be responsible for transforming the pain reliever acetaminophen into chemicals that can damage the liver.

To transform alcohol into acetaldehyde, the MEOS pathway uses different enzymes than the alcohol dehydrogenase system. When repeatedly exposed to large doses of alcohol, the MEOS pathway increases its capacity and processing speed. Whether alcoholics metabolize alcohol differently from nonalcoholics is unknown. Clearly, chronic ingestion of alcohol leads to changes in the liver, and the alcohol abuser acquires an increased tolerance to alcohol and to drugs such as sedatives, tranquilizers, and antibiotics.

**aldehyde dehydrogenase (ALDH)** The enzyme that catalyzes the conversion of acetaldehyde to acetate, which forms acetyl CoA.

**fatty liver** Accumulation of fat in the liver, a sign of increased fatty acid synthesis.

**microsomal ethanol-oxidizing system (MEOS)** An energy-requiring enzyme system in the liver that normally metabolizes drugs and other foreign substances. When the blood alcohol level is high, alcohol dehydrogenase cannot metabolize it fast enough, and the excess alcohol is metabolized by MEOS.

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## Quick Bite

### How to Shock Your Surgeon

If a former alcoholic neglects to disclose past alcohol use before undergoing surgery, the surgeon could be in for a big surprise. Even if the patient is now a teetotaler, his or her MEOS could still act like that of an alcoholic—operating at the faster speed it once needed to process alcohol quickly. The overactive MEOS would deplete anesthesia much quicker than expected. Theoretically, the patient could wake up in the middle of surgery, much to the shock of the surgeon. That's why anesthesiologists and surgeons ask their patients about alcohol use, past and present.

**alcohol poisoning** An overdose of alcohol. The body is overwhelmed by the amount of alcohol in the system and cannot metabolize it fast enough.

**hangover** The collection of symptoms experienced by someone who has consumed a large quantity of alcohol. Symptoms can include pounding headache, fatigue, muscle aches, nausea, stomach pain, heightened sensitivity to light and sound, dizziness, and possibly depression, anxiety, and irritability.

## Quick Bite

### Is the Alcoholic Beverage Industry Addicted to Alcohol Abuse?

The combined value of illegal and underage drinking and adult alcohol abuse to the alcoholic beverage industry is estimated to be at least $48.3 billion, or 37.5 percent of consumer expenditures for alcohol in 2001. Other estimates suggest the value may be closer to $62.9 billion (48.8 percent of expenditures).

## Removing Alcohol from Circulation

Despite its multiple alcohol-processing pathways, the liver can metabolize only a certain amount of alcohol per hour, regardless of the amount in the bloodstream. The rate of alcohol metabolism depends on several factors, including the amount of metabolizing enzymes in the liver, and varies greatly between individuals. In general, after one standard drink, the amount of alcohol in the drinker's blood (blood alcohol concentration, or BAC) peaks in 30 to 45 minutes. (See **Figure 8.8**.) When absorption exceeds the liver's capacity, a bottleneck develops, and alcohol enters the general circulation. Alcohol diffuses rapidly, dispersing equally into all body fluids, including cerebrospinal fluid and the brain and, during pregnancy, into the placenta and fetus. About 10 percent of circulating alcohol is lost in urine, through the lungs, and through skin. Consequently, urine tests and breathalyzer tests both reflect concentrations of blood alcohol as well as alcohol levels in the brain and can indicate how much a person's mental and motor functions may be impaired.

Even after a person stops drinking, alcohol in the stomach and small intestine continues to enter the bloodstream and circulate throughout the body. Blood alcohol concentration continues to rise, and it is dangerous to assume the person will be fine by sleeping it off. Rapid binge drinking (which often happens as a result of a bet or a dare) is especially dangerous, because the victim can ingest a fatal dose of alcohol before becoming unconscious. Even if the victim lives, an alcohol overdose can lead to irreversible brain damage.

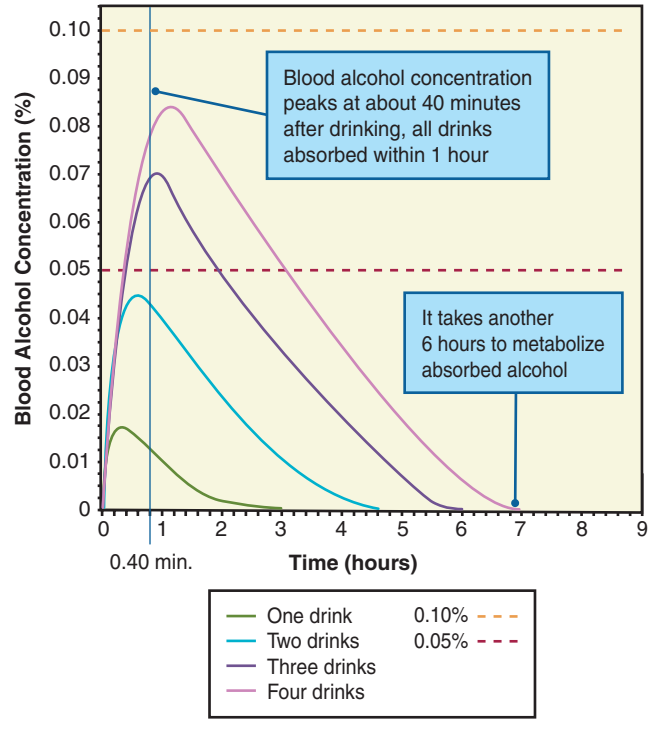


**Figure 8.8** **Blood alcohol concentration over time.**
Because the body metabolizes alcohol at a relatively constant rate, it clears small amounts faster than large amounts.

Source: National Institute on Alcohol Abuse and Alcoholism. *Alcohol Metabolism*. Bethesda, MD: NIAAA, 1997. Alcohol Alert, No. 35. http://pubs.niaaa.nih.gov/publications/aa35.htm. Accessed 3/31/08.

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THINK About It 3

Excessive alcohol consumption deprives the brain of oxygen. The struggle to deal with an overdose of alcohol and lack of oxygen eventually causes the brain to shut down functions that regulate breathing and heart rate. This shutdown leads to a loss of consciousness and, in some cases, coma and death. When a drinker passes out, the body is actually protecting itself: When you lose consciousness, you can't add more alcohol to your system. When you hear of an **alcohol poisoning** death, it usually is the result of consuming such a large quantity of alcohol in such a short period of time that the brain of the victim is overwhelmed. Heart and lung functions shut down, and the person dies.

### *The Morning After*

After a night of heavy alcohol consumption, the drinker may suffer from a pounding headache, fatigue, muscle aches, nausea, and stomach pain as well as a heightened sensitivity to light and noise—a **hangover** in full force. The sufferer may be dizzy, have a sense that the room is spinning, and be depressed, anxious, and irritable. Usually a hangover begins within several hours after the last drink, when the blood alcohol level is dropping. Symptoms normally peak about the time the alcohol level reaches zero, and they may continue for an entire day.[19]

What causes a hangover? Scientists have identified several causes of the painful symptoms of a hangover. (See **Figure 8.9**.) Alcohol causes dehydration, which leads to headache and dry mouth. Alcohol directly irritates the stomach and intestines, contributing to stomach pain and vomiting. The sweating, vomiting, and diarrhea that can accompany a hangover cause additional fluid loss and electrolyte imbalance. Alcohol's hijacking of the metabolic process diverts liver activity away from glucose production and can lead to low blood glucose (hypoglycemia), causing light-headedness and lack of energy. Alcohol also disrupts sleep patterns, interfering with the dream state and contributing to fatigue. The symptoms of a hangover are largely due to inflammation. During a hangover, blood levels of C-reactive protein are elevated and strongly associated with hangover severity.[20] In general, the greater the amount of alcohol consumed, the more likely a hangover will strike. However, some people experience a hangover after only one drink, whereas some heavy drinkers do not have hangovers.[21]

In addition, factors other than alcohol may contribute to the hangover. A person with a family history of alcoholism has increased vulnerability to hangovers. Mixing alcohol and drugs also is suspected of increasing the likelihood of a hangover. The congeners in most alcoholic beverages can contribute to more vicious hangovers. Research shows that gin and vodka—beverages that contain less of these biologically active compounds—cause fewer headaches.[22]

### *Treating a Hangover*

How can you plan to minimize the symptoms of a hangover? You may want to consider these ways to help minimize the symptoms of a hangover:[23]

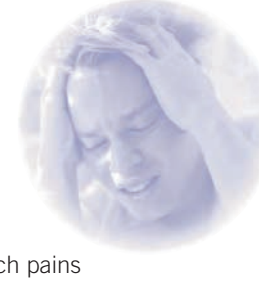
- Be sure to eat before you start to drink. Having a full stomach helps slow down the absorption of alcohol and gives the body more time to process the toxins.
- Drink in moderation. Limiting yourself to one drink per hour will give your body more time to process the alcohol.

So what can you do about a hangover? Few treatments have undergone rigorous, scientific investigation. Time works best, however. Hangover symp-

## *Quick* Bite

**Ancient Hangover Helpers**

According to the ancient Persians, eating five almonds could prevent a hangover. The Romans and Greeks had a different solution: celery.



**Hangover Symptoms**

*Constitutional*—fatigue, weakness, and thirst
*Pain*—headache and muscle aches
*Gastrointestinal*—nausea, vomiting, and stomach pains
*Sleep and biological rhythms*—decreased sleep, decreased dreaming when asleep
*Sensory*—vertigo and sensitivity to light and sound
*Cognitive*—decreased attention and concentration
*Mood*—depression, anxiety, and irritability
*Sympathetic hyperactivity*—tremor, sweating, increased pulse, and blood pressure

**Possible Contributing Factors**

Direct effects of alcohol
- Dehydration
- Electrolyte imbalance
- Gastrointestinal disturbances
- Low blood sugar
- Sleep and biological rhythm disturbances

Alcohol withdrawal
Alcohol metabolism (i.e., acetaldehyde toxicity)
Nonalcohol factors
- Compounds other than alcohol in beverages, especially the congener methanol
- Use of other drugs, especially nicotine
- Personality traits such as neuroticism, anger, and defensiveness
- Negative life events and feelings of guilt about drinking
- Family history for alcoholism

**Figure 8.9** **Hangovers.** Factors other than just alcohol contribute to the misery of a hangover.

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toms usually disappear in 8 to 24 hours. No matter what you do to help get over your hangover, your body still has to clean up all the toxic by-products left over from the alcohol.[24] Eating bland foods that contain complex carbohydrates, such as toast or crackers, can combat low blood glucose and possibly nausea. Sleep can ease fatigue, and drinking nonalcoholic beverages can alleviate dehydration. Limited research suggests that taking vitamin $B_6$ or an extract from *Opuntia ficus indica* (a type of prickly pear cactus) before drinking may reduce the severity of hangover symptoms.[25] The prickly pear cactus extract may reduce three symptoms of hangover—nausea, dry mouth, and loss of appetite.[26]

Certain medications also can relieve some symptoms. Antacids, for example, may relieve nausea and stomach pains. Aspirin may reduce headache and muscle aches, but could increase stomach irritation. Avoid acetaminophen because alcohol metabolism enhances its toxicity to the liver.[27] In fact, people who drink three or more alcoholic beverages per day should avoid all over-the-counter pain relievers and fever reducers. These heavy drinkers may have an increased risk of liver damage and stomach bleeding from medicines that contain aspirin, acetaminophen (Tylenol), ibuprofen (Advil), naproxen sodium (Aleve), or ketoprofen (Orudis KT and Actron).[28]

THINK About It 4

People with hangovers should avoid "the hair of the dog that bit you," a remedy that calls for drinking more alcohol. Additional drinking only enhances the toxicity of the alcohol previously consumed and extends the recovery time.

## Individual Differences in Alcohol Metabolism

Individuals vary in their ability to metabolize alcohol and acetaldehyde. As a consequence, they differ in their susceptibility to intoxication, hangover, and, in the long term, addiction and organ damage.

The result of individual differences is easiest to see in acute responses to alcohol. For example, when people of Asian descent drink alcohol, about half experience flushing around the face and neck, probably as a result of high blood acetaldehyde levels.[29] These individuals lack gastric alcohol dehydrogenase, and their livers have an inefficient form of aldehyde dehydrogenase. This may explain why their ancestors depended on boiled water (for teas) as a source of safe fluid. In contrast, Europeans are able to metabolize larger quantities of alcohol and historically have relied on fermentation to produce fluids that were safer to drink.[30]

Elderly people often find their tolerance for alcohol is less than it used to be. Due to decreased tolerance, the effects of alcohol, such as impaired coordination, occur at lower intakes in the elderly than in younger people, whose tolerance increases with increased consumption. This reduced tolerance is compounded by an age-related decrease in body water, so that blood alcohol concentrations in older people are likely to rise higher after drinking.[31]

### *Women and Alcohol*

Men and women respond differently to alcohol. (See **Figure 8.10**.) Blood alcohol rises faster in women, so they become more intoxicated than men with an equivalent dose of alcohol.[32] Accordingly, moderate drinking is usually defined as "two standard drinks for men and one for women."[33] Women also metabolize alcohol more slowly than men. Several factors are responsible for alcohol's greater effect on women:

- *Body size and composition.* Women, on average, are smaller than men and have smaller livers; thus, they have less capacity for


**Figure 8.10** **Women and men respond differently to alcohol.** Women tend to have a lower capacity for alcohol than men.

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metabolizing alcohol. Women also have lower total body water and higher body fat than men of comparable size. After alcohol is consumed, it diffuses uniformly into all body water, both inside and outside cells. Because of their smaller quantity of body water, women have higher concentrations of alcohol in their blood than men do after drinking equivalent amounts of alcohol.[34]

- *Less enzyme activity.* Women also have less alcohol dehydrogenase (the primary enzyme involved in the metabolism of alcohol) activity than men—about 40 percent less.[35] This contributes to higher blood alcohol concentrations and lengthens the time needed to metabolize and eliminate alcohol. The gender difference in blood alcohol levels is due mainly to the significantly lower activity of gastric enzymes in women.[36]
- *Chronic alcohol abuse.* Alcoholism and other abuses exact a greater physical toll on women than men. Female alcoholics have death rates 50 to 100 percent higher than those of male alcoholics. Furthermore, a higher percentage of female alcoholics die from suicides, alcohol-related accidents, circulatory disorders, and cirrhosis of the liver.

**Key Concepts** *Alcohol does not need to be digested prior to absorption and moves easily across the GI tract lining into the bloodstream. Once alcohol is absorbed, the liver metabolizes it. The primary metabolic enzymes are alcohol dehydrogenase and aldehyde dehydrogenase. When large amounts of alcohol are consumed, some alcohol is metabolized by the MEOS pathway. Genetic and gender differences in the amount and activity levels of alcohol-metabolizing enzymes influence a person's response to consuming alcohol.*

## When Alcohol Becomes a Problem

Alcohol affects every organ system in the body. In the short term, small amounts of alcohol change the levels of neurotransmitters in the brain, reducing inhibitions and physical coordination. In the long term, chronic intake of large amounts of alcohol damages the heart, liver, GI tract, and brain. When a pregnant woman drinks, alcohol can have a devastating effect on the development of her baby.

### Alcohol in the Brain and the Nervous System

Alcohol diffuses readily into the brain, and because a small amount is absorbed from the mouth directly into circulating blood, its effects can be almost immediate, reaching the brain in as little as one minute after consumption. Alcohol can produce detectable impairments in memory after only a few drinks and, as the amount of alcohol increases, so does the degree of impairment. Large quantities of alcohol, especially when consumed quickly and on an empty stomach, can produce a blackout—that is, an interval of time for which the intoxicated person cannot recall key details of events, or even entire events. **Figure 8.11** shows the effects alcohol has on the brain.

Because alcohol is soluble in fat, it can easily cross the protective fatty membrane of nerve cells. There, it disrupts the brain's complex system for communicating between nerve cells. Neurotransmitters that excite nerve cells and those that inhibit nerve cells are thrown out of balance. Excess of some neurotransmitters produces sleepiness; high levels of others cause a loss of coordination; an imbalance of others impairs judgment and mental ability;

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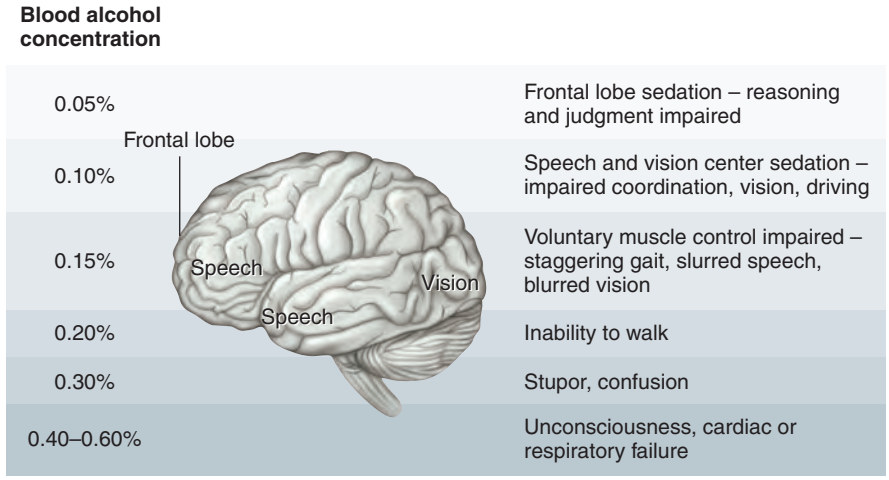
**Figure 8.11** **Effects of alcohol on the brain.** As blood alcohol concentration rises, different parts of the brain are affected.




and still other neurotransmitters perpetuate the desire to keep drinking, even when it's clearly time to stop. Changes in these messengers are suspected of leading to addiction and symptoms of alcohol withdrawal.[37] In the short run, they probably contribute to a hangover.

Alcohol's short-term effects are related to how much a person drinks. One or two drinks typically bring alcohol blood levels to 0.04 percent and usually


## Myths About Alcohol

Myths and misunderstandings just keep circulating about alcohol. Some of these statements are partly true, but most are completely false. You may have heard some of the following:

- *Drinking isn't all that dangerous.* Wrong! One in three 18- to 24-year-olds admitted to emergency rooms for serious injuries is intoxicated. Alcohol use is also associated with homicides, suicides, and drownings.
- *I can manage to drive well enough after a few drinks.* No. About one-half of all fatal traffic crashes among 18- to 24-year-olds involve alcohol.
- *I can sober up quickly if needed.* No. It takes about three hours to eliminate the alcohol content of two drinks, depending on your weight and other factors. Nothing can speed up this process—not even coffee or cold showers.
- *Alcohol is a stimulant.* No. It's actually a depressant, but its initial depressing effect on inhibitions and judgment may make it seem stimulating.
- *Alcohol keeps you warm.* Partly true. It dilates blood vessels near the body's surface, giving a feeling of warmth. But as body heat escapes, alcohol cools the inner body.
- *Alcohol is an aphrodisiac.* Partly true. By suppressing inhibitions, it may loosen behavior. However, sexual function is often compromised by alcohol.
- *Most alcoholics live on skid row.* No. The highly visible skid-row alcoholic represents only a minority of alcoholics.
- *Beer is a source of vitamins.* Partly true. Beer does contain a fair amount of niacin. But you'd need about 1 liter to fulfill daily niacin requirements. Levels of other vitamins are much lower.
- *Alcohol helps you sleep.* No. Alcohol disrupts sleep patterns, leading to a restless, unsatisfying sleep.
- *Laboratory animals love to drink.* No. Alcohol is usually given by tube feeding because most animals refuse to drink it willingly.
- *It's good to have a beer before breast-feeding.* No. Alcohol may be relaxing and allow milk to flow more readily, but alcohol concentrations in breast milk are similar to those in the mother's blood. Alcohol in breast milk reduces milk production by reducing the intensity of the infant's suckling.

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cause only mild, pleasant changes in mood and release of inhibitions. With more drinks and rising blood alcohol levels, coordination, judgment, reaction time, and vision are increasingly impaired. In the United States and Canada, it is illegal for a person whose blood level of alcohol has reached or exceeds 0.08 percent to drive a motor vehicle. A review of 112 studies concludes that certain skills required to drive a motor vehicle can become significantly impaired at a blood alcohol concentration as low as 0.05 percent.[38] For commercial drivers, a BAC of 0.04 percent is illegal nationwide. **Table 8.2** shows the effects various amounts of alcohol have on mood and behavior.

The acute effect of a large alcohol intake—swallowed accidentally by children, for example—is hypoglycemia (low blood glucose) severe enough to kill.[39] Binge drinking, especially following several days of little food, also can be deadly. The lack of food depletes glycogen stores, and heavy drinking suppresses gluconeogenesis. The resulting severe hypoglycemia is a medical emergency with the potential for coma and death.

**Table 8.2** Alcohol Impairment Chart

**Men**

| Drinks | Body Weight in Pounds: 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | |
|---|---|---|---|---|---|---|---|---|---|
| | Approximate Blood Alcohol Percentage | | | | | | | | |
| 0 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | Only Safe Driving Limit |
| 1 | .04 | .03 | .03 | .02 | .02 | .02 | .02 | .02 | Impairment Begins |
| 2 | .08 | .06 | .05 | .05 | .04 | .04 | .03 | .03 | Driving Skills Affected |
| 3 | .11 | .09 | .08 | .07 | .06 | .06 | .05 | .05 | |
| 4 | .15 | .12 | .11 | .09 | .08 | .08 | .07 | .06 | Possible Criminal Penalties |
| 5 | .19 | .16 | .13 | .12 | .11 | .09 | .09 | .08 | |
| 6 | .23 | .19 | .16 | .14 | .13 | .11 | .10 | .09 | |
| 7 | .26 | .22 | .19 | .16 | .15 | .13 | .12 | .11 | Legally Intoxicated |
| 8 | .30 | .25 | .21 | .19 | .17 | .15 | .14 | .13 | |
| 9 | .34 | .28 | .24 | .21 | .19 | .17 | .15 | .14 | Criminal Penalties |
| 10 | .38 | .31 | .27 | .23 | .21 | .19 | .17 | .16 | |

**Women**

| Drinks | Body Weight in Pounds: 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Approximate Blood Alcohol Percentage | | | | | | | | | |
| 0 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | Only Safe Driving Limit |
| 1 | .05 | .05 | .04 | .03 | .03 | .03 | .02 | .02 | .02 | Impairment Begins |
| 2 | .10 | .09 | .08 | .07 | .06 | .05 | .05 | .04 | .04 | Driving Skills Affected |
| 3 | .15 | .14 | .11 | .10 | .09 | .08 | .07 | .06 | .06 | Possible Criminal Penalties |
| 4 | .20 | .18 | .15 | .13 | .11 | .10 | .09 | .08 | .08 | |
| 5 | .25 | .23 | .19 | .16 | .14 | .13 | .11 | .10 | .09 | |
| 6 | .30 | .27 | .23 | .19 | .17 | .15 | .14 | .12 | .11 | |
| 7 | .35 | .32 | .27 | .23 | .20 | .18 | .16 | .14 | .13 | Legally Intoxicated |
| 8 | .40 | .36 | .30 | .26 | .23 | .20 | .18 | .17 | .15 | |
| 9 | .45 | .41 | .34 | .29 | .26 | .23 | .20 | .19 | .17 | Criminal Penalties |
| 10 | .51 | .45 | .38 | .32 | .28 | .25 | .23 | .21 | .19 | |

Note: Subtract .01% for each 40 minutes of drinking. Your body can get rid of one drink per hour. One drink is 1.25 oz of 80-proof liquor, 12 oz of beer, or 5 oz of table wine. Data supplied by the Pennsylvania Liquor Control Board.

Source: The National Clearinghouse for Alcohol and Drug Information, Substance Abuse and Mental Health Services Administration. http://www.lcb.state.pa.us/edu/cwp/view.asp?a=1346&q=555292. Accessed 9/22/09. Reprinted with permission.

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# Changing the Culture of Campus Drinking

From car crashes to alcohol poisoning, the culture of drinking on many college campuses puts students at grave risk. Alcohol use is pervasive among college students, many of whom are younger than the legal drinking age.

Annually, at least 1,700 student deaths and nearly 600,000 unintentional injuries involve alcohol.[1] College students who drink are more likely to drink and drive, have failing grades, and have medical and legal problems. Increased rates of crime, traffic crashes, rapes and assaults, property damage, and other alcohol-related consequences affect both drinking and nondrinking students, as well as members of the surrounding community. Each year, for example, students who have been drinking assault more than 696,000 of their classmates.[2]

## The Culture of College Drinking

On many campuses, alcohol consumption is a rite of passage, and the influence of peers is an especially powerful force driving college problem drinking.[3] Traditions and beliefs handed down through generations of college drinkers reinforce the perception that alcohol is a necessary component of social success.[4] Many students arrive at college with a history of alcohol consumption and positive expectations about alcohol's effects. Thirty percent of twelfth-graders, for example, report heavy episodic drinking in high school, slightly more report having "been drunk," and almost three-fourths report drinking in the past year.[5]

Rates of excessive alcohol use are highest at colleges and universities where fraternities and sororities are popular, where sports teams have a prominent role, and at schools located in the Northeast.[6] In the local community, tolerance of student drinking may permit alcoholic beverage outlets and advertising to be located near campus. Due to lax enforcement, selling alcohol to students below the legal drinking age often has few consequences. Also, underage students who are caught using fake IDs to obtain alcohol are seldom penalized.[7] Just look at the advertising and sale of alcoholic beverages on or near campuses, and the role of alcohol in college life is evident.

## Alcohol Use and Abuse by College Students

Approximately 70 percent of college students consumed some alcohol within 30 days of being surveyed.[8] Although some of these students are problem drinkers (e.g., frequent heavy episodic drinkers or those who display symptoms of dependence), others may drink moderately or may misuse alcohol only occasionally (e.g., drink and drive infrequently). Surveys of drinking patterns show that college students are more likely than nonstudents of similar age to consume any alcohol, to drink heavily, and to engage in heavy episodic drinking. Young people who are not in college, however, are more likely to consume alcohol every day.[9] Even though college students tend to drink more, they are not at greater risk of alcohol-related problems.[10]

A survey questioned students about patterns and consequences of their alcohol use during the past year.[11] Thirty-one percent reported symptoms associated with alcohol abuse (e.g., drinking in hazardous situations and alcohol-related school problems), and 6 percent reported three or more symptoms of alcohol dependence (e.g., drinking more or longer than initially planned and experiencing increased tolerance to alcohol's effects). What happens when these student imbibers leave college? Surprisingly, most high-risk student drinkers reduce their consumption of alcohol. Nevertheless, some continue frequent, excessive drinking, leading to alcoholism or medical problems associated with chronic alcohol abuse.[12]

## Binge Drinking

Binge drinking is especially worrisome, and it is widespread on college campuses. What is binge drinking? Binge drinking is defined as the consumption of at least five drinks in a row for men or four drinks in a row for women. Just over two in five students (44 percent) report binge drinking behaviors, and about one in four (23 percent) report bingeing frequently, defined as three or more times in a two-week period. Frequent binge drinkers average more than 14 drinks per week and account for more than two-thirds of the alcohol consumed by college students.[13] Most college binge drinkers drink not for sociability, but solely and purposefully to get drunk.

Binge drinkers often do something they later regret—argue with friends, make fools of themselves, get sick, engage in unplanned (and often unprotected) sexual activity, or drive drunk. Afterward they may forget where they were or what they did, but the consequences of the binge remain. These consequences may include alienated friends, a hangover, and embarrassment. Or the consequences could be much more serious—sexually transmitted disease, hospitalization, permanent injury, rape, pregnancy, or death.

## Abstaining

There is a polarizing trend in college drinking, with binge drinkers at one extreme and abstainers at the other. The number of college students who drink no alcohol is rising and now nearly equals the number who binge frequently. About one in five students (19 percent) report consuming no alcohol within the past year.[14] In a survey, one in three college campuses reported banning the use of alcohol on campus by all students regardless of age.[15]

## Prevention Strategies and Changing the Culture of Drinking

Changing the culture of college drinking represents the first step toward an effective prevention strategy, according to a task force of college presidents, alcohol researchers, and students established by the National Institute on Alcohol Abuse and Alcoholism. Their report emphasizes the need for collaboration between academic institutions, researchers, and the community to effect lasting change.[16]

The task force strongly supports the use of a "3-in-1 Framework" to target three primary audiences simultaneously: (1) individual students, including high-risk drinkers; (2) the student body as a whole; and (3) the surrounding community.[17] The task force reviewed potentially useful preventive interventions, grouping them into "tiers" according to evidence for their effectiveness.

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### Tier 1: Strategies Effective Among College Students

Strong evidence supports the following strategies:

1. Simultaneously address alcohol-related attitudes and behaviors (e.g., refuting false beliefs about alcohol's effects while teaching students how to cope with stress without resorting to alcohol).
2. Use survey data to counter students' misperceptions about their fellow students' drinking practices and attitudes toward excessive drinking.
3. Increase student motivation to change drinking habits by providing nonjudgmental advice and progress evaluations.

Programs that combine these three strategies have proved effective in reducing alcohol consumption.[18]

### Tier 2: Strategies Effective Among the General Population That Could Be Applied to College Environments

These strategies have proved successful in populations similar to those found on college campuses. Measures include the following:

1. Increase enforcement of minimum legal drinking age laws.[19]
2. Implement, enforce, and publicize other laws to reduce alcohol-impaired driving, such as zero-tolerance laws that reduce the legal blood alcohol concentration for underage drivers to near zero.[20]
3. Increase the prices or taxes on alcoholic beverages.[21]
4. Institute policies and training for servers of alcoholic beverages to prevent sales to underage or intoxicated patrons.[22]

### Tier 3: Promising Strategies That Require Research

These strategies make sense intuitively or show theoretical promise, but their usefulness requires further testing. They include more consistent enforcement of campus alcohol regulations and increasing the severity of penalties for violating them, regulating happy hours, enhancing awareness of personal liability for alcohol-related harm to others, establishing alcohol-free dormitories, restricting or eliminating alcohol-industry sponsorship of student events while promoting alcohol-free student activities, and conducting social norms campaigns to correct exaggerated estimates of the overall level of drinking among the student body.

## How Can I Say No to Drinking Alcohol and Still Fit in with My Friends?

Drinking alcohol is a personal decision. It is best to make your decision to drink or not to drink based on your own feelings, knowledge, and experiences. Things you may want to consider the following things before you are put in a position where alcohol is available:[23]

- If you choose to abstain, make up your mind to say no before you are ever in the situation.
- Tell people that you feel better when you drink less.
- Stay away from people who give you a hard time about not drinking.
- Learn to hold a glass or beer bottle for a long time, and refill it with whatever you want (such as water or club soda).


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A person who drinks heavily over a long period of time may have brain deficits that persist well after he or she achieves sobriety. Exactly how alcohol affects the brain and the likelihood of reversing the impact of heavy drinking on the brain remain hot topics in alcohol research today.[40] Chronic alcoholism produces many different mental disorders. Malnutrition is a probable factor in most of these, even when diet appears adequate. After years of drinking, brain cells become permanently damaged and unable to metabolize nutrients properly.

## Alcohol's Effect on the Gastrointestinal System

Years of heavy drinking and ongoing contact with alcohol and acetaldehyde eventually damage the gastrointestinal system, which in turn discourages eating, affects absorption of protective nutrients, and leaves the digestive lining even more vulnerable to damage as the vicious cycle continues.

**esophagitis** Inflammation of the esophagus.

**gastritis** Inflammation of the stomach.

Chronic irritation from alcohol and acetaldehyde erodes protective mucosal linings, causing inflammation and release of destructive free radicals. **Esophagitis** (inflammation of the esophagus), esophageal stricture (closing), and swallowing difficulties are common among alcoholics. When the stomach is exposed repeatedly to alcohol at high concentrations, **gastritis** (inflammation of the stomach) often develops. Alcoholics frequently have diarrhea and malabsorption, evidence of intestinal damage. The mouth, throat, esophagus, stomach, and small and large intestines are all at greatly increased risk of cancer.[41] Smoking dramatically multiplies this risk.

## Alcohol and the Liver

Metabolizing and detoxifying alcohol is almost entirely the responsibility of the liver. So it's not surprising that too much drinking hurts the liver more than any other site in the body. In the United States, heavy alcohol use is considered the most important risk factor for chronic liver disease. During the 1980s, alcoholic fatty liver, acute alcoholic hepatitis, and alcoholic cirrhosis together accounted for 46 percent of deaths from chronic liver disease and 49 percent of hospitalizations for liver disease.[42]

The earliest evidence of liver damage is fat accumulation, which can appear after only a few days of heavy drinking. Fatty liver (see **Figure 8.12**) recedes with abstinence but persists with continued drinking. Is fatty liver in and of itself harmful? The answer is controversial among liver researchers, with some experts suggesting it's a benign condition. However, studies show that 5 to 15 percent of people with alcoholic fatty liver who continue to drink develop liver fibrosis (excessive fibrous tissue) or cirrhosis (scarring) in only 5 to 10 years.[43]

**Figure 8.12** Fatty liver.

Fat accumulation is one of several factors resulting in alcoholic liver disease. With regular high intakes of alcohol, alcohol and acetaldehyde continually irritate and inflame the liver, producing alcoholic hepatitis (persistent inflammation of the liver) in 10 to 35 percent of heavy drinkers. The inflammatory process also generates free radicals that batter away at liver cells.[44] The destruction of liver cells becomes self-perpetuating, especially if antioxidant nutrients are unavailable to help break the cycle. If the intestines also have been damaged, toxins, including those produced by the gut's microorganisms, may be able to cross the intestinal barrier into circulation, worsening inflammation.[45]

Alcoholic hepatitis may be treatable, but it's often fatal. Alcoholic hepatitis also predisposes a person to liver cancer and cirrhosis, conditions that are usually fatal. With continued inflammation, the liver makes excessive colla-

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gen and becomes fibrous (fibrotic liver disease) and scarred (cirrhosis). This ultimately kills liver cells by choking off tiny blood vessels that nourish them. About 10 to 20 percent of heavy drinkers develop cirrhosis.[46]

Dietary changes may be helpful in treating liver disease, but abstinence from alcohol is essential. Reducing dietary fats somewhat reduces fat accumulation in the liver. Consuming adequate micronutrients and a healthful balance of macronutrients probably speeds recuperation from liver diseases in their earlier stages.[47] In late-stage liver disease, dietary restrictions, often of proteins, may slow disease progression or improve symptoms.

## Fetal Alcohol Syndrome

**Fetal alcohol syndrome** is perhaps the saddest result of alcohol consumption. Victims of this syndrome suffer a variety of congenital defects: mental retardation, coordination problems, and heart, eye, and genitourinary malformations, as well as low birth weight and slowed growth rate. Most apparent are characteristic facial abnormalities. Severe cases of fetal alcohol syndrome are rare, but subtle damage with one or two abnormalities, sometimes called "fetal alcohol effects," is probably much more widespread. Symptoms of the syndrome may not emerge until months after birth and are apt to go undiagnosed.[48] This disorder, a major cause of mental retardation in the United States, is preventable.

**fetal alcohol syndrome** A set of physical and mental abnormalities observed in infants born to women who abuse alcohol during pregnancy. Affected infants exhibit poor growth, characteristic abnormal facial features, limited hand–eye coordination, and mental retardation.

Alcohol is especially damaging in the early weeks of pregnancy, before a woman may know she's pregnant. It crosses the placenta into the tiny body of the fetus, where its effects are grossly magnified. Both the congeners in alcoholic beverages and the associated disturbed metabolism of vitamin A and folic acid, nutrients clearly required for fetal growth and development, can interfere with embryonic development.[49]

Relatively small amounts of alcohol may cause fetal alcohol syndrome. A safe level during pregnancy is not known; therefore, pregnant women should abstain from alcohol consumption. Unlike most other alcohol-related diseases, fetal alcohol damage does not require chronic intake. A binge—even having several drinks at a party—at the wrong moment of pregnancy can cause serious problems. However, population studies show that babies with neurodevelopmental problems are more common among women who drink more frequently during pregnancy.[50]

Official health advisories warn women against drinking alcohol if they are pregnant or considering becoming pregnant. Labels on alcoholic beverages must carry a warning for pregnant women. In 2002, 10.1 percent of pregnant women consumed alcohol, and 1.9 percent did so frequently.[51] **Figure 8.13** shows the prevalence of binge drinking by women of childbearing age.

**Key Concepts** *Alcohol affects every organ system of the body. In the brain and nervous system, alcohol impairs coordination, judgment, reaction time, and vision. In the GI tract, alcohol damages cells of the esophagus and stomach and increases the risk for GI cancers. The liver is most affected by alcohol consumption, culminating in alcoholic hepatitis and cirrhosis after years of alcohol abuse. Alcohol intake during pregnancy can have devastating effects on fetal development.*

# Alcoholics and Malnutrition

In the United States and Canada, where food is plentiful and fortification of foods with vitamins and minerals is common, overt nutrient deficiencies are rare—except among alcoholics. The results of their poor diet interact with

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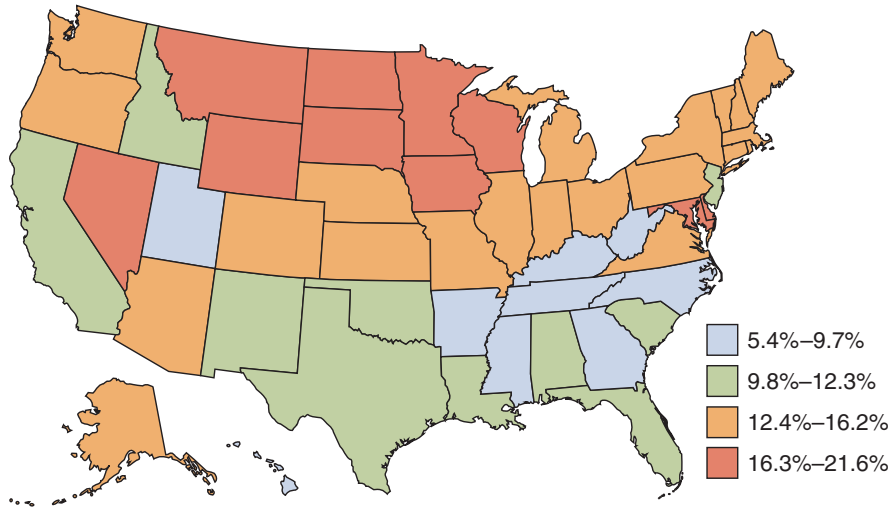
**Figure 8.13** Prevalence of binge drinking among childbearing-aged women (18–44 years), by state: United States, 2002.

Source: Centers for Disease Control and Prevention. Alcohol consumption among women who are pregnant or who might become pregnant—United States, 2002. *MMWR*. 2004;53(50):1178–1181.




the results of alcohol's toxicity—which include diarrhea, malabsorption, liver malfunction, bleeding, bone marrow changes, and hormonal changes—to worsen malnutrition. (See **Figure 8.14**.) In general, the more a person drinks, the worse the malnutrition.

## Poor Diet

A nationally representative study found that as alcohol quantity increased, diet quality worsened, but as alcohol frequency increased, diet quality improved. Diet quality was poorest among the highest-quantity, lowest-frequency drinkers and best among the lowest-quantity, highest-frequency drinkers.[52]

Disordered eating is common among heavy drinkers, especially among alcoholic women.[53] Factors responsible for the poor diet of alcoholics are much easier to identify than to correct. Economic factors include poverty, lack of cooking facilities, and homelessness. Anxiety, depression, loneliness, and isolation are all characteristic of alcoholism, and all contribute to loss of appetite. So can physical pain. Lack of interest in food is common. There may be an aversion to many specific foods or to eating in general, especially after the experience of diarrhea, painful indigestion, or difficulty swallowing.

Heavy drinkers who get about half their calories from alcohol cannot eat enough to obtain adequate vitamins and minerals. Severely malnourished alcoholics often have multiple deficiencies.

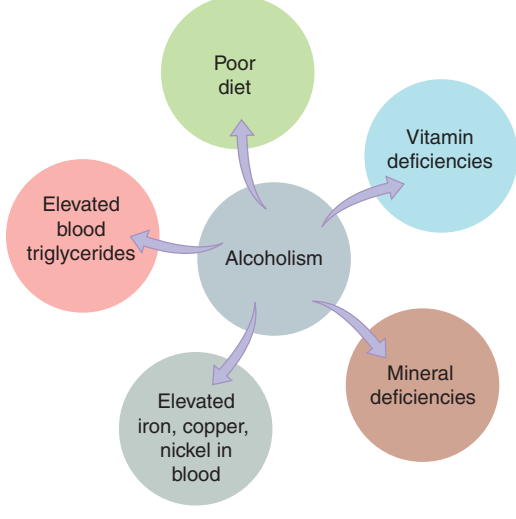



**Figure 8.14** **Alcoholism and malnutrition.** Alcoholics' poor diets interact with alcohol's toxicity to worsen their malnutrition.

## Vitamin Deficiencies

Inadequate intake, poor absorption, increased vitamin destruction in the body, and urinary losses all contribute to vitamin deficiencies in the alcoholic. Alcohol also interferes with the conversion of vitamin precursors to active forms.

Folate, thiamin, and vitamin A are most often affected by alcoholism. Folate deficiency contributes to malabsorption, anemia, and nerve damage—

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all of which worsen malnutrition. Vitamin A deficiency also creates a vicious cycle by damaging gastrointestinal lining and by impairing immunity, leaving the victim susceptible to infections. Thiamin deficiency contributes to classic diseases of alcoholism: the brain damage of Wernicke-Korsakoff syndrome, polyneuropathy (nerve inflammation), and cardiomyopathy (heart inflammation). Alcoholics can have overt scurvy from vitamin C deficiency. Vitamin $B_6$ and vitamin $B_{12}$ deficiencies are less common.

Alcohol metabolism interferes with the normal metabolism of vitamins and other nutrients. For example, metabolism of ethanol uses up the dehydrogenase enzyme that is also used for metabolism of retinol.[54] Retinol (vitamin A) uses that enzyme for its conversion to other active forms of vitamin A, and the disruption of its metabolism is probably one way that alcohol increases cancer risk. The same disruption may produce fetal birth defects when pregnant women drink.

Alcohol-induced fat malabsorption and metabolic abnormalities contribute to the depletion of fat-soluble vitamins A, D, E, and K. Blood-clotting factors drop with depleted vitamin K, increasing risk of bleeding and anemia. Vitamin E deficiency is not generally recognized as a complication of alcoholism, but its depletion due to fat malabsorption is possible. Optimal vitamin E status is necessary to quench free radicals generated during alcohol metabolism.[55]

## Mineral Deficiencies

Alcoholics are commonly deficient in minerals such as calcium, magnesium, iron, and zinc. Alcohol itself does not seem to affect their absorption. Rather, fluid losses and an inadequate diet are the primary culprits. Magnesium deficiency causes "shakes" similar to that seen in alcohol withdrawal. Chronic diarrhea and loss of epithelial tissue (caused by skin rashes or sloughing off of the digestive lining) may seriously deplete zinc, a mineral needed for immune function. In cases of bleeding, especially gastrointestinal blood loss, iron levels fall.

Not all minerals are lower in heavy drinkers than in nondrinkers. If there is no bleeding, a heavy drinker's iron levels tend to be higher than normal in the blood and liver, potentially contributing to harmful oxidation. Copper and nickel levels also may be elevated in advancing disease, but the reason and the effects are unclear.[56]

## Macronutrients

Animal experiments can demonstrate a number of ways that alcohol alters digestion and metabolism of carbohydrate, fat, and protein, but the relevance to humans at usual levels of intake is not certain. Alcohol interferes with amino acid absorption, but its overall effect on protein balance appears minimal. It inhibits gluconeogenesis and lowers blood glucose levels, probably contributing to hangovers and, at the most extreme, causing acute, potentially lethal hypoglycemia if a person who drinks heavily neglects to eat.[57]

Alcohol's most dramatic effect is on fats. You have seen that alcohol causes fatty liver. On the one hand, excess alcohol has the undesirable effect of raising blood triglyceride levels, often significantly. Hyperlipidemia (high blood fats) is common among heavy drinkers. Abstinence and a balanced diet can usually return blood lipids to normal.[58] On the other hand, moderate alcohol use increases protective high-density lipoproteins (HDL, or "good cholesterol"), an important factor in alcohol's relationship to the reduced risk for coronary artery disease.

***Dietary Guidelines for Americans, 2009***
**Key Recommendations**

- Those who choose to drink alcoholic beverages should do so sensibly and in moderation—defined as the consumption of up to one drink per day for women and up to two drinks per day for men.
- Alcoholic beverages should not be consumed by some individuals, including those who cannot restrict their alcohol intake, women of childbearing age who may become pregnant, pregnant and lactating women, children and adolescents, individuals taking medications that can interact with alcohol, and those with specific medical conditions.
- Alcoholic beverages should be avoided by individuals engaging in activities that require attention, skill, or coordination, such as driving or operating machinery.

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## Body Weight

Although alcoholic beverages provide minimal nutrient value, they do provide calories; alcohol contains 7 kilocalories per gram. Does alcohol consumption contribute to obesity? It appears likely. One reason for weight gain associated with alcohol intake is that the calories in alcohol can easily add up. Some cocktail-type drinks, such as margaritas or piña coladas, contain more than 500 calories per drink! In addition, food choices that accompany drinking are generally low in nutrient density and high in calories, adding to an overall excess calorie intake. The excess calories promote body fat accumulation and weight gain.

In an analysis of data collected from more than 37,000 people, researchers found that overweight drinkers consumed more drinks than leaner drinkers on the days that they drank.[59] Men and women who infrequently consume the greatest quantity of alcohol weigh more than those who frequently drink small amounts. Because smoking and drinking interact to influence body weight, the researchers looked only at current drinkers who had never smoked.

**Key Concepts** *Alcohol interferes with normal nutrition by reducing the intake of nutrient-dense foods and by affecting the absorption, metabolism, and excretion of many vitamins and minerals. Alcohol contains a significant number of calories (7 kilocalories per gram), and heavy episodic drinkers tend to weigh more than light drinkers.*

## Does Alcohol Have Benefits?

Can a potentially harmful drink like alcohol play a role in a healthful diet? The consensus of health experts is that it can—but not for everyone. The question continues to arouse much debate, however, and even those supporting alcohol's usefulness often have reservations. Public health statements on alcohol are typically accompanied by plenty of "ifs" and "buts."

Consistent epidemiological evidence suggests that low to moderate drinking reduces mortality among some groups.[60] (**Table 8.3** gives definitions of different levels of drinking.) Compared with nondrinkers or heavy drinkers, middle-aged and older adults who drink moderate amounts of alcohol have a lower risk of mortality from all causes.[61] This includes people with heart disease,[62] diabetes,[63] high blood pressure,[64] or a prior heart attack.[65] Consistent and growing evidence shows that alcohol reduces insulin resistance and may protect against heart disease by improving "good" cholesterol levels and reducing blood clotting.[66]

No evidence has suggested that moderate drinking harmed the people in the studies. In fact, analysis of data from the Nurses' Health Study, which involves more than 12,000 participants, suggests that in women, up to one drink per day does not impair mental functioning and may actually decrease the risk of mental decline with age.[67]

Tracked against alcohol intake, death rates typically follow what statisticians describe as a "U-shaped curve." Compared with people who rarely or never drink, people who drink slightly or moderately have lower total mortality rates. The lowest rate is seen in people who consume one drink per week. Increasing the number of drinks confers no additional benefit. In fact, as the number of drinks increases, the mortality rate rises. People who consume two drinks per day have about the same mortality rate as nondrinkers.[68] Beyond three drinks per day, the death rate rises dramatically.[69] Heavy alcohol consumption increases the risk of stroke, for example, whereas light or moderate drinking appears to reduce that risk.[70] Alcohol's primary benefit

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**Table 8.3** How Much Is Too Much?

| Term | Criterion |
|---|---|
| Moderate drinking (NIAAA) | Men: ≤ 2 drinks per day |
| | Women: ≤ 1 drink per day<br>Over 65: ≤ 1 drink per day |
| At-risk drinking (NIAAA) | Men: > 14 drinks per week or > 4 drinks per occasion<br>Women: > 7 drinks per week or > 3 drinks per occasion |
| Alcohol abuse (APA) | Maladaptive pattern of alcohol use leading to clinically significant impairment or distress, manifested within a 12-month period by one or more of the following:<br>• Failure to fulfill role obligations at work, school, or home<br>• Recurrent use in hazardous situations<br>• Legal problems related to alcohol<br>• Continued use despite alcohol-related social or interpersonal problems<br>• Symptoms have never met criteria for alcohol dependence |
| Alcohol dependence (APA) | Maladaptive pattern of alcohol use leading to clinically significant impairment or distress, manifested within a 12-month period by three or more of the following:<br>• Tolerance (either increasing amounts used or diminished effects with the same amount)<br>• Withdrawal (withdrawal symptoms or use to relieve or avoid symptoms)<br>• Use of larger amounts over a longer period than intended<br>• Persistent desire or unsuccessful attempts to cut down or control use<br>• Great deal of time spent obtaining or using or recovering from use<br>• Important social, occupational, or recreational activities given up or reduced<br>• Use despite knowledge of alcohol-related physical or psychological problems |
| Hazardous use (WHO) | Person at risk for adverse consequences |
| Harmful use (WHO) | Use resulting in physical or psychological harm |

Note: NIAAA = National Institute on Alcohol Abuse and Alcoholism; APA = American Psychiatric Association; WHO = World Health Organization.

Source: O'Connor PG, Schottenfield RS. Patients with alcohol problems. *N Engl J Med*. 1998;338(9):593. Copyright © 1998 Massachusetts Medical Society. All rights reserved. Reprinted with permission.

is to raise protective HDL cholesterol levels. It may also inhibit formation of blood clots, but this connection is less clear.[71] In addition, alcohol may have subjective benefits such as stress relief and relaxation.

In most studies, wine, beer, and spirits appear equal in offering protection against heart disease. Findings of reduced rates of nonfatal heart attacks

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among moderate drinkers support the view that protective benefits are due to alcohol itself rather than other substances in alcoholic beverages.[72] However, international comparisons that highlight unexpectedly low rates of heart disease in France, despite a high-fat diet (the **French paradox**), suggest that red wine may have a unique protective effect. The apparent benefits of red wine may result from overall healthier behavior of people who drink red wine. As yet, a direct connection between red wine and health benefits remains unproved.[73] Nevertheless, recognizing that alcohol generally confers moderate protection and noting the possibility that wine has a particular benefit, the Bureau of Alcohol, Tobacco, and Firearms granted permission for wine labels to include one of the following statements:[74]

### *American Heart Association*

**Alcohol**

If you drink alcohol, do so in moderation. This means an average of one to two drinks per day for men and one drink per day for women. Drinking more alcohol increases such dangers as alcoholism, high blood pressure, obesity, stroke, breast cancer, suicide and accidents. Also, it's not possible to predict in which people alcoholism will become a problem. Given these and other risks, the American Heart Association cautions people *not* to start drinking . . . if they do not already drink alcohol. Consult your doctor on the benefits and risks of consuming alcohol in moderation.

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**French paradox** A phenomenon observed in the French, who have a lower incidence of heart disease than people whose diets contain comparable amounts of fat. Part of the difference has been attributed to the regular and moderate drinking of red wine.

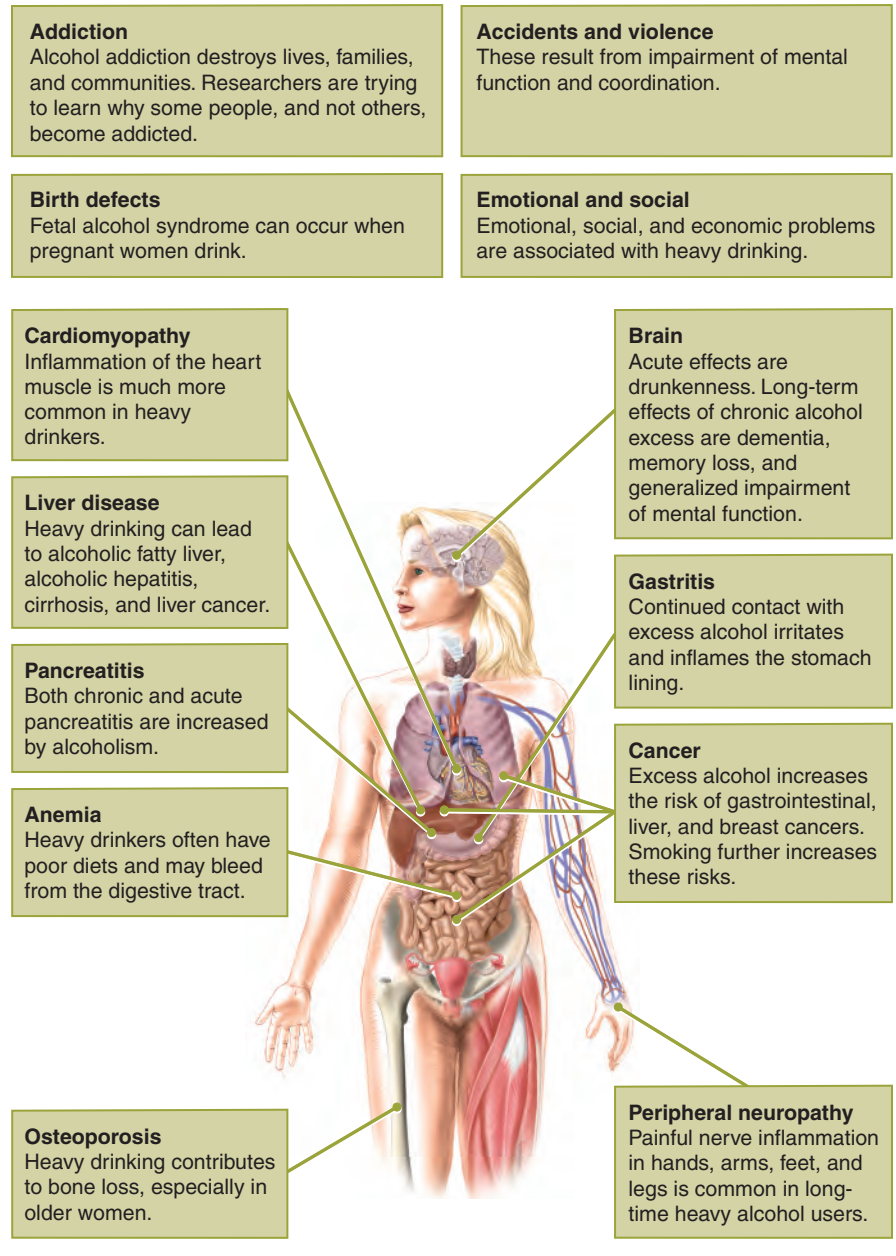


**Figure 8.15** **Harmful effects of alcohol.** Because excess alcohol reaches all parts of the body, it causes a wide array of physical problems. Here are some of the ways alcohol can cause harm.

## *Quick* Bite

**A What?**

An oenologist is an expert in the science of wine and wine making

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"The proud people who made this wine encourage you to consult your family doctor about the health effects of wine consumption."
"To learn the health effects of wine consumption, send for the Federal Government's Dietary Guidelines for Americans. . . ."

Because of the many harmful effects of alcohol (see **Figure 8.15**), public health agencies and organizations caution against inappropriate drinking. Although low to moderate alcohol use may offer some benefit, these groups advise people to discuss their alcohol intake with their doctors, and they urge moderation. The U.S. Preventive Services Task Force recommends that primary care doctors routinely screen patients for unhealthy alcohol use and,


Have you ever wondered how much protein, carbohydrate, and fat are in a can of beer? If you've ever looked at a beer label, you know it's quite different from a food label. Look at the following information from a can of light beer and see if you can calculate the calories from carbohydrate, fat, and protein.

Serving size = 12 fl oz
Calories = 103 (kcal)
Carbohydrate = 5 g
Protein = 1 g
Fat = 0 g

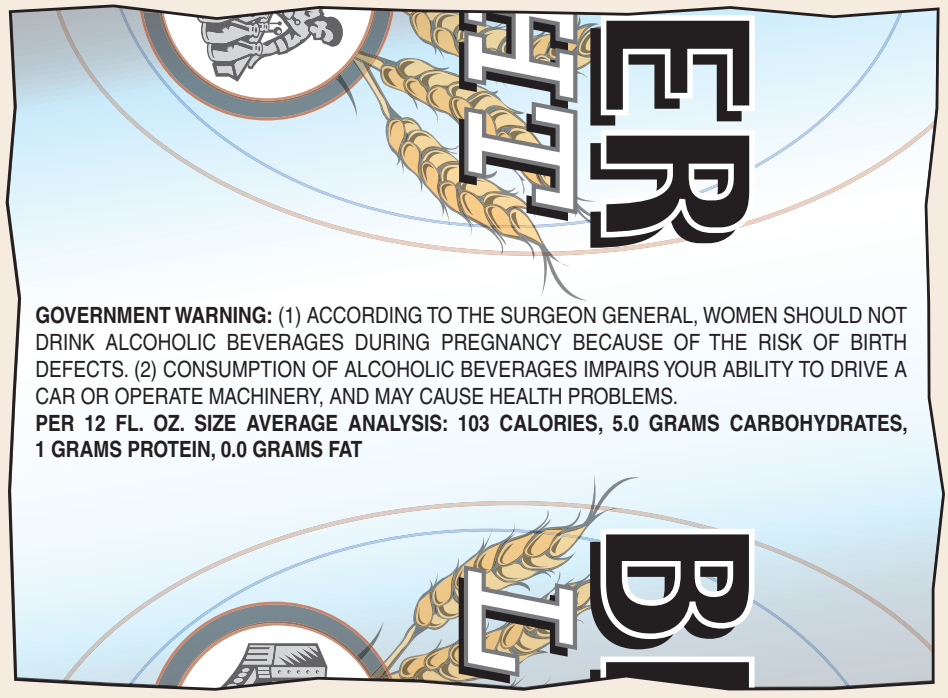
First, to figure out how many calories come from the three macronutrients, multiply the number of grams by their respective calorie contribution per gram:

5 g carbohydrate × 4 kcal/g = 20 kcal from carbohydrate
1 g protein × 4 kcal/g = 4 kcal from protein
0 g fat × 9 kcal/g = 0 kcal from fat

Uh oh. Is this adding up correctly? So far we have accounted for only 24 of the 103 kilocalories in this beer. Where are the other 79 kilocalories? Don't forget that many of the calories in beer come from alcohol, and it's easy to calculate just how many grams are in this can of light beer. Remember, alcohol has 7 kilocalories per gram, so the remaining 79 kilocalories come from 11 grams of alcohol (79 ÷ 7 = 11.3).

So, for the 103 kilocalories this beer provides, you get very little (if any) protein, carbohydrate, or fat. Instead, a majority of the calories come from alcohol. This holds true for the micronutrients as well: beer contains negligible amounts of vitamins or minerals.

This is why people say alcoholic beverages have only "empty calories." They provide calories, but almost no nutrient value!



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when appropriate, intervene with a brief counseling session to reduce alcohol misuse.[75] Public health officials also point out that numerous groups should not drink any alcohol:[76]

- People who cannot restrict their alcohol intake to moderate levels
- Children and adolescents
- People taking medications that can interact with alcohol
- People who have an alcohol-related illness or another illness that will be worsened by alcohol
- People who plan to drive, operate machinery, or take part in other activities that require attention, skill, or coordination
- Women who are pregnant or may become pregnant
- Women who are breastfeeding
- People with a personal or strong family history of alcoholism

**Key Concepts** *Although alcohol has the potential to reduce risk for heart disease, most health organizations recommend moderate to no drinking. It is too early in the scientific investigation of alcohol's benefits to recommend alcohol intake for all adults. Some people, such as pregnant women, should not drink any alcohol.*

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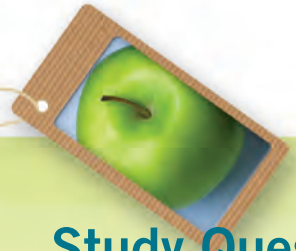
# *Learning* Portfolio



## Key Terms

| | page | | page |
|---|---|---|---|
| acetaldehyde | 000 | fermentation | 000 |
| alcohol | 000 | fetal alcohol syndrome | 000 |
| alcohol dehydrogenase (ADH) | 000 | French paradox | 000 |
| alcohol poisoning | 000 | gastritis | 000 |
| aldehyde dehydrogenase (ALDH) | 000 | hangover | 000 |
| binge drinking | 000 | methanol | 000 |
| congeners | 000 | methyl alcohol | 000 |
| esophagitis | 000 | microsomal ethanol-oxidizing system (MEOS) | 000 |
| ethanol | 000 | standard drink | 000 |
| ethyl alcohol | 000 | wood alcohol | 000 |
| fatty liver | 000 | | |

## Study Points

- Alcohol provides 7 kilocalories per gram but no essential function for the body; therefore, alcohol is not a nutrient.
- Alcohol requires no digestion and is absorbed easily all along the gastrointestinal tract.
- Fatty liver is apparent even after one night of binge drinking.
- Different rates of alcohol metabolism can be attributed to different levels of the alcohol-metabolizing enzymes; these differences are due to genetic and gender variations.
- Alcohol affects all organs in the body, but the most obvious effects are in the brain and the nervous system, the GI system, and the liver.
- Malnutrition among alcoholics is common due to poor food choices and alcohol's interference with the absorption, metabolism, and excretion of nutrients.
- Fetal alcohol syndrome is one of the most devastating consequences of alcohol consumption, and it is preventable.
- Moderate alcohol consumption has been linked to reduced risk of heart disease.
- The potential benefits of moderate alcohol consumption may be related to effects on lipoprotein levels and the antioxidant components of beverages such as wine.
- Health organizations recommend moderate to no alcohol consumption.

## Study Questions

1. How much alcohol is in beer, wine, and liquor?
2. List the ways food helps to delay or avoid inebriation.
3. Where does alcohol metabolism take place?
4. What causes a hangover? Is there any way to relieve one?
5. List some factors that affect our ability to metabolize alcohol.
6. Why do health care professionals advise pregnant women not to drink alcohol?
7. List the positive and the negative effects of alcohol.

## Try This

### Cruising Through the Medicine Cabinet

This exercise will increase your awareness of the amounts of alcohol in over-the-counter medications. Look through your medicine cabinet and check the ingredient lists of all the products there. In particular, take a close look at any mouthwash or cough syrup. Which products contain alcohol? How much? What do you think its purpose is in these medicines?

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