CHAPTER 18 Binge Drinking

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The Digestive and Urinary Systems

It's Saturday night and Malik is hosting a surprise party to celebrate the 21st birthday of his friend Lin. Lin is several years younger than Malik. She lived with Malik's family, sharing a room with his younger sister, for 2 years when she was a high school exchange student. Now an international student attending college in the United States, Lin has had almost no experience with alcohol. Malik knows that Lin is eagerly anticipating this birthday and that she is planning to drink at least a little alcohol. Because he feels as protective of Lin as he does his little sister, Malik wants to help Lin learn how to enjoy the benefits of alcohol consumption while limiting the negative consequences that can also occur.

He does not want her alcohol consumption to place her at risk of overdose ...

Some of Malik's concerns about negative consequences are based on situations he has witnessed and others on information he came across while writing a paper on alcohol abuse for a health class he took last semester.

A student who lived on Malik's dorm floor freshman year broke his ankle when he tripped while running from the police to avoid an underage consumption ticket. His chemistry lab partner broke her nose when she was riding with an intoxicated driver whose car hit a tree on a snow-covered road. While working on the paper for his health class, he came across a government website that indicated over 30,000 students required medical treatment for alcohol poisoning last year and he does not want this to happen to Lin. He also worries about the high rate of sexual assault on college campuses. He does not want Lin to become one of the 20% of female students who will be sexually assaulted while in college.

Malik wants to develop a plan for convincing Lin, a pre-med biology major, that drinking too much is bad for her body, an argument he thinks she may find credible. Because he has heard that eating food before drinking might help absorb some of the alcohol and that alcohol consumption causes dehydration, he plans to focus his efforts on the effects of drinking on the digestive and urinary systems.

Malik is worried about his friend Lin.

... or jeopardize her safety.
Malik wants to help Lin learn how to enjoy the benefits of alcohol consumption while limiting the negative consequences that can also occur.

18.1 The Digestive System

The job of the digestive system is to break down or metabolize food so that the body can utilize the energy stored in its chemical bonds. Food is broken down into successively smaller units as it is passed through a long tube with openings at the mouth and anus. Called the alimentary canal or digestive tract, this tube allows food to be exposed to the actions and secretions of various organs and glands.

The breakdown of food begins in the mouth, or oral cavity, where chewing fractures food into smaller pieces (Figure 18.1). Mechanical digestion of food occurs as teeth grind down food, which increases the surface area exposed to enzymes within the mouth. Chemical digestion also begins in the mouth with the secretion of saliva from salivary glands. Saliva contains the enzyme salivary amylase, which breaks down sugars.

The carbohydrate breakdown that begins in the mouth is the first step in the conversion of polymers that we consume (carbohydrates, proteins, and fats) into their component subunits (monosaccharides, amino acids, and glycerol and fatty acids, respectively). This conversion is necessary because the body cannot absorb ingested polymers or utilize them to build cellular structures directly. Instead, the polymers are broken down and rebuilt according to your body’s specifications.

Mechanical and Chemical Breakdown of Food

The tongue has taste buds that help you taste food. This muscular structure shapes food into a ball and pushes the ball of food, called the bolus, to the back of the mouth. From there it is swallowed and enters the digestive tract.

Visualize This ▼

The third molars are the last molars to emerge. Located at the back of the mouth, they typically appear in young adults. If a person has all of these “wisdom teeth” removed, how many adult teeth would they have?

![Diagram of human oral cavity](image)

**Figure 18.1** The human oral cavity. Food is ground into smaller pieces by the 32 adult teeth. Incisors are specialized to enable biting off pieces of food. Canine teeth are sharp enough to help rip food apart. Molars have broad surfaces that enhance grinding.
system (FIGURE 10.2). Malik knows from his research that oral cancers are more common in those who abuse alcohol than in those who do not and that alcohol has been shown to increase incidence of tooth decay, gum disease, and tooth loss.

When you swallow chewed food, it moves from your mouth to your pharynx. The pharynx, forming the back of your throat, branches to feed into both the trachea (which leads to the lungs) and the esophagus (which leads to the stomach). The epiglottis is a thin flap of cartilage below the tongue that keeps swallowed food from entering the trachea. The esophagus brings food to a large digestive organ called the stomach. At the base of the esophagus is a ring of contracting muscles called the lower esophageal sphincter, which serves to prevent backflow of stomach contents into the lower esophagus. Alcohol can weaken this sphincter, allowing acidified stomach contents to move backwards up the esophagus, causing heartburn.

The movement of a bolus of food is hastened by rhythmic waves of smooth muscle contraction down the esophagus, through a process called peristalsis. Once inside the stomach, food is subjected to degradation by digestive enzymes and acids secreted by specialized cells that line the stomach.

### Allimentary canal

1. **Mouth**
   - Teeth reduce the size of food, increasing the surface area available for digestion by enzymes.
   - Enzymes in saliva then start breaking down carbohydrates.

2. **Pharynx**
   - The pharynx connects the oral cavity to the esophagus. The epiglottis is a flap of tissue in the pharynx that blocks the opening of the windpipe so that swallowed food cannot enter the lungs.

3. **Esophagus**
   - The esophagus transports food to the stomach by rhythmic waves of muscle contractions called peristalsis.

4. **Stomach**
   - Acidic gastric juices start breaking down food.
   - The enzyme pepsin breaks down proteins.
   - Mucus prevents gastric juices from breaking down the stomach lining.
   - The pyloric sphincter regulates the movement of food from the stomach to the small intestine.

5. **Small intestine**
   - Most digestion of carbohydrates, proteins, and fats occurs here.
   - Nutrients are absorbed into the bloodstream.

6. **Large intestine**
   - Water is reabsorbed.

7. **Anus**
   - Undigested materials are excreted as feces.

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**FIGURE 10.2 The digestive system.** The digestive system consists of accessory organs and the alimentary canal.
Over 30,000 students required medical treatment for alcohol poisoning last year.

Only a small percentage of alcohol is metabolized in the stomach. Epithelial cells that line the stomach secrete enzymes called alcohol dehydrogenases. These enzymes help metabolize alcohol, which means there will be less alcohol in the bloodstream to cause intoxication. Women have smaller stomachs than men and thus produce less of this enzyme. Interestingly, women also have less of this enzyme per pound of body weight than men. This means that a man and a woman of the same size and weight will metabolize alcohol at different rates. Women metabolize alcohol more slowly, thus becoming intoxicated from less alcohol consumption. Malik plans to caution Lim not to try to keep up with her male friends, even those that aren't any bigger than her.

There is one additional stomach-related factor Lim must consider when drinking alcohol. One of the alcohol dehydrogenase enzymes, abbreviated ALDH1, differs from the most common alcohol dehydrogenase by a single amino acid. This variant, common in people of East Asian descent, more slowly metabolizes one of the products of alcohol breakdown, called acetaldehyde. High concentrations of acetaldehyde cause flushing of the face, dizziness, nausea, and an irregular heartbeat. Because Lim comes from Chengdu, China, Malik will also warn her that she may experience this reaction when drinking alcohol.

Once the bolus makes its way to the stomach, peristalsis helps mix it into a slurry with digestive enzymes, becoming a substance called chyme. When chyme contains a high concentration of alcohol, the stomach lining is irritated, which can trigger the vomiting reflex. At the base of the stomach is another sphincter. The pyloric sphincter regulates the secretion of chyme into the small intestine, a long tube (around 30 feet long in adult humans) that serves as the major site of chemical digestion and the absorption of nutrients into the bloodstream via its epithelium. It is in the small intestine that the majority of food and alcohol is broken down and absorbed across the intestinal wall and into the bloodstream. When alcohol relaxes muscles involved with peristalsis, food spends more time in the digestive tract than normal and this increased exposure to digestive enzymes can cause diarrhea.

Malik has heard that it is good to eat a large meal before drinking. This is because the presence of food in the stomach causes the pyloric sphincter to remain closed. Since the stomach does not absorb alcohol as readily as the small intestine, preventing the alcohol from reaching the small intestine can slow the rate at which it reaches the bloodstream. Therefore, Malik plans to take Lim out to eat before the birthday party.

Many of the digestive enzymes used in the small intestine are produced by an organ called the pancreas. Secretions from the pancreas neutralize stomach acids that enter the small intestine and contain enzymes that break down carbohydrates, fats, proteins, and nucleic acids. While in the small intestine, chyme is exposed to a substance called bile, which is synthesized by the liver.

The liver, pancreas, and gallbladder are considered accessory organs. In a sense, they are accessories to the alimentary canal because they are outside the tube but produce or secrete substances required for digestion. The gallbladder stores and concentrates bile, which will be released into the small intestine to help dissolve fats. Concentrating bile involves removing water from it. When the gallbladder removes too much water, the bile can crystallize, causing gallstones.

The liver and pancreas are very susceptible to the effects of alcohol, in the form of both long-term alcohol abuse and binge drinking, which is typically defined as the consumption of more than four drinks in a 2-hour time period.

One of the functions of the liver is to help metabolize toxins, including some drugs and alcohol. Heavy drinking can damage the liver, in some cases causing healthy liver tissue to be replaced by scar tissue, a progressive and irreversible process called cirrhosis. Scar tissue prevents proper blood flow through the liver and can result in liver failure.
Inflammation of the pancreas, called pancreatitis, can be caused by excessive alcohol consumption. Pancreatitis prevents the pancreas from secreting digestive enzymes and thus disrupts digestion, which can lead to life-threatening complications.

Absorption of Digested Foods

Substances that move from the stomach to the small intestine are absorbed into the bloodstream through finger-like membranous projections of the small intestine called villi. An individual villus contains both a blood and a lymphatic vessel. Surface area is further increased by the presence of even smaller microvilli that transport nutrients into the blood vessels inside each villus. Together, the villi and microvilli have as much surface area as does a tennis court. Alcohol can interfere with the absorption of nutrients by damaging intestinal villi.

After traversing the small intestine, most polymers have been converted into monomers and can move across the small intestine into the bloodstream, where they are transported to individual cells. Materials that are not absorbed are passed through the large intestine (also known as the colon) through the rectum to the anus, where they exit the body as feces. Fecal matter consists largely of indigestible plant fibers.

Regulation of Digestive Secretions

The secretion of digestive juices is regulated hormonally. After a meal, the stomach produces the hormone gastrin, which stimulates the upper part of the stomach to produce acidic gastric juices,
thus facilitating digestion. The secretion of gastrin also results in release of the hormones secretin and cholecystokinin (CCK) from the small intestine. Secretin and CCK cause the pancreas and gallbladder to increase their output of digestive juices.

STOP & STRETCH: Gastrin release is inhibited by high concentrations of stomach acid (HCl). How might this negative feedback loop protect the stomach?

After alcohol makes its way out of the intestine and into the bloodstream, the body begins the process of removing it from the body. This is necessary to prevent damage such as the decrease in testosterone production that occurs in males after binge drinking. This hormonal decline can result in erectile dysfunction and lower sperm production while alcohol remains in the system. Removing such toxins from the body is one of the jobs of the urinary system.

18.2 Removing Toxins from the Body: The Urinary System

The metabolism of any substance, including alcohol, results in waste products that circulate through the bloodstream until they are expelled from the body. The urinary system has the task of efficiently removing wastes while retaining valuable materials that can be reused and recycled. In humans, the major organs of the urinary system are the kidneys, which filter and cleanse circulating blood before sending the waste through ureters to the bladder. Urine is stored in the urinary bladder until it is expelled via the urethra (Figure 18.5).

Kidney Structure and Function

The kidneys are paired, approximately fist-sized organs that sit behind the liver and stomach in the upper abdominal cavity. Each kidney is densely packed with looped tubules called nephrons. There are close to 1,250,000 nephrons in each kidney, with a combined length in an adult human of about 145 kilometers (85 miles). Networks of capillaries surround the nephrons, allowing wastes to diffuse out of the blood and into these tubules for excretion. The entire volume of blood in the circulatory system passes through the kidneys hundreds of times per day, such that each kidney filters about 1000 liters of blood every 24 hours.

Blood is brought to the kidneys by large vessels called the renal arteries. The processing of waste in the kidneys has four distinct phases, which we can follow on a diagram of a single, loop-shaped nephron embedded in the body of a kidney (Figure 18.6). The first step, filtration, occurs within the Bowman's capsule, a structure at the head of a nephron. The Bowman's capsule encloses the glomerulus, a compact ball of blood vessels. The capillaries in the glomerulus contain tiny pores, and blood pressure forces the plasma portion of the blood through these pores and into the upstream end of the nephron. When blood reaches the glomerulus, this filter allows water and small molecules through, but retains large proteins in the plasma. The fluid that enters the interior of the nephron via this process is called filtrate.

One way that kidney health is assessed is by measuring the glomerular filtration rate. Preliminary studies suggest that those who drink alcohol in
Visualize This

Where does urine go after it makes it to the collecting duct?

1. **Filtration:** Blood pressure forces plasma into the nephron through tiny holes in the adjacent capillaries.

2. **Reabsorption:** Sugars, amino acids, and water are reabsorbed into the kidney tissue across the nephron loop. Salt actively removed from the filtrate on the ascending limb of the nephron loop becomes concentrated in the interior of the kidney, causing water to flow out.

3. **Secretion:** Wastes that are in low concentration in the blood are actively secreted into the far end of the nephron. Waste then flows into the collecting duct.

4. **Excretion:** After the filtrate is further concentrated as the collecting duct extends into the salty tissue of the kidney, urine is excreted into the bladder.

**Figure 18.6 Nephron Function.** The nephron, the functional unit of a kidney, controls the excretion of nongaseous waste from the blood.

Moderation has slightly better filtration rates than those who don't. Drinking in moderation is usually defined as the consumption of one to two alcoholic drinks per day for men and one alcoholic drink per day for women. If you don't drink alcohol, however, this slight potential benefit does not make it advisable to start drinking.

Because filtrate contains both wastes and valuable substances, such as sugars, amino acids, and water, the next step of waste processing is reabsorption of these materials across the walls of each nephron. Water moves by osmosis out of the nephron and into the kidney interior as it descends into this salty environment. On the ascending limb, the nephron walls are impermeable to water but actively transport salt into the kidney. The structure of the nephron allows for a gradient of salt concentration to be maintained, from relatively low at the top of the loop to relatively high at the base. What remains in the filtrate after the reabsorption phase is water containing a high concentration of urea, the waste product of the breakdown of amino acids.
The last segment of the nephron permits the secretion into the filtrate, via active transport, of certain wastes that are in low concentration in the plasma. The filtrate then moves from the nephron into a collecting duct that leads to the center of the kidney, called the renal pelvis. As the collecting duct crosses the salty kidney interior, more water moves by osmosis from the filtrate into the kidney tissue. Water and other materials removed from the filtrate are drawn into the capillaries, returned to the bloodstream, and eventually leave the kidney via the renal vein. The fluid that collects in the renal pelvis is called urine and is made up of water, and organic wastes including urea and various ions. During urine excretion, urine leaves the kidneys and flows to the bladder.

Alcohol is a diuretic, which means that it promotes the formation of urine and increases the volume of urine that is released from the bladder, a process called micturition. Coupling the increased volume of urine produced with the deadening of awareness of the need to urinate that goes with intoxication can result in a very full bladder. Even though micturition is typically under conscious control, an intoxicated person that passes out before emptying the bladder may end up urinating on himself. In this case, the body overrides the conscious control of micturition to prevent a potentially lethal bladder rupture.

Alcohol is a depressant, slowing down brain function and altering perceptions, reflexes, and balance, and causing slurred speech. In an attempt to prevent the depressant effects of intoxication, some of Malik’s friends mix alcohol with energy drinks. Malik will recommend to Lin that she does not do this because Lin should develop an awareness of when to stop drinking. It is harder to do if the depressant effects of intoxication are, in part, masked by the stimulant effects of the energy drink.

In addition to managing wastes, the urinary system also plays an important role in regulating blood volume, acidity, and salt balance. The kidneys regulate acidity and salt balance by actively excreting acids and reabsorbing salts during the secretion and reabsorption steps of urine formation. The kidneys help maintain blood pressure by regulating water excretion. When blood pressure is low, antidiuretic hormone (ADH) released by the pituitary gland increases the permeability of the collecting duct to water, allowing more water from the filtrate to return to the bloodstream. When blood pressure is high, ADH release is curtailed, and more water is excreted.

**STOP & STRETCH**

High blood pressure damages cells in the filtering structure of the nephron, making the pores between cells much larger. How is the urine of someone with damage to these structures likely to be different from someone with an undamaged filter?

Alcohol acts on the pituitary to lessen ADH secretion. As ADH levels drop, the kidneys reabsorb less water and thus produce even more urine. Therefore, you actually urinate a higher volume of liquid than you consume when drinking alcohol. This is, in part, the cause of the dehydration experienced after an episode of heavy drinking. Dehydration can also cause nausea and headaches.

**Engaging Safely with Alcohol**

Malik’s research has also made it clear that moderate alcohol consumption can have some positive physiological effects as well. He will discuss the evidence suggesting that moderate drinkers experience lower rates of cardiovascular
disease and stroke with Lin. This may be because small amounts of alcohol can relax the heart muscle, thereby lowering the rate the heart beats and lowering blood pressure. This is true whether the alcohol consumed is wine, beer, or distilled spirits, but these benefits occur only with moderate drinking. In fact, larger doses of alcohol have the opposite effect, increasing risk of heart disease and stroke when blood pressure increases in the body's attempt to rid itself of the toxin via increased breathing, sweating, and urination. He hopes it will be clear to Lin that when it comes to heart health, it is better not to drink and to perform cardiovascular exercise than it is to drink moderately and not exercise, or to drink to excess. Table 18.1 gives other examples of how to more safely engage with alcohol.

Alcohol in the circulatory system will also make its way to the lungs, where it evaporates from the lung surface and is expelled in each breath. Because the concentration of alcohol in the air breathed out is proportional to the amount of alcohol in the blood, testing devices like the breathalyzer can be used to determine the blood alcohol concentration (BAC). You can also approximate your BAC using your weight, gender, and rate of consumption (Table 18.2, on the next page).

The effects of alcohol in the blood are progressive. A BAC of 0.03 to 0.04 results in relaxation, mild euphoria, and decreased inhibition. Concentration is slightly impaired. By 0.05, impairment increases, affecting reasoning and motor skills. By 0.08, a person is considered legally intoxicated and should not drive. Above 0.1, emotions can become uncontrolled and behavior boisterous; reflexes, reaction time, and speech are impaired. By 0.2, a person can become unconscious and experience blackouts. A BAC of 0.3 or higher results in central nervous system depression, causing impaired breathing and heart rate. Death can result. In a 140 lb female or male, ingesting three drinks in rapid succession results in a BAC of 0.1 and 0.08, respectively.

The brain is particularly sensitive to toxins during times of rapid development, most of which occurs before a person reaches their middle twenties. During these years, lifelong traits such as the ability to reason and to critically evaluate information are developing. Binge drinking and excess alcohol consumption have been shown to disrupt brain activity and impair memory, decreasing the ability to develop these traits.

**Table 18.1** Safer engagement with alcohol.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Reason</th>
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</thead>
<tbody>
<tr>
<td>Eat before consuming alcohol.</td>
<td>Alcohol will pass into the intestine more slowly and thus enter the circulatory system more slowly.</td>
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<tr>
<td>Pay attention to how your body responds to alcohol.</td>
<td>While most people can metabolize around one drink per hour, your metabolic rate could be slower.</td>
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<tr>
<td>Alternate drinking water with drinking alcohol.</td>
<td>Can lessen the severity of the dehydration caused by lowered ADH secretion.</td>
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<td>Understand Medical Amnesty laws in your state.</td>
<td>Some students delay calling 911 when concerned about an intoxicated friend for fear of prosecution. Medical Amnesty laws prohibit prosecution of both the person who calls for help and the victim.</td>
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<tr>
<td>Never have sex with an intoxicated person.</td>
<td>It is a felony offense to have sex with a drunk person. An intoxicated person is not legally capable of giving consent, even if he or she expresses interest in having sex.</td>
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TABLE 18.2 Blood alcohol content in women (W) and men (M).
Subtract 0.01% for every 40 minutes of drinking.

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After explaining the biological effects of alcohol on the body to Lin, Malik will plan to present her with some data, because he knows biologists, including Lin, like to make evidence-based decisions. He will show her study after study, showing that students who do not drink, or only drink in moderation, have higher grades, better social relationships, and less involvement with law enforcement agencies, that they sleep better, suffer fewer injuries, and are less likely to engage in unplanned or unprotected sexual activity. Once she understands the biological basis of the damage caused by excess consumption of alcohol and the negative effects that can ensue (FIGURE 18.7), he hopes she will choose to engage safely with alcohol, if at all.

**FIGURE 18.7 The destructive path of alcohol.** Alcohol crosses cell membranes readily, leaving the stomach and small intestine and entering the liver and bloodstream before it can be metabolized. When a person drinks more rapidly than the liver can process, the alcohol is circulated throughout the entire body.
Glossy college brochures mailed to prospective students extol not only the educational experiences students can have, but also provide reassurance about the safety of the campus. These statements were excerpted from admission brochures sent out by different colleges across the United States and Canada.

- “Nothing is more important to this College than your safety.”
- “This University does everything in its power to protect you.”
- “The campus police department provides around-the-clock police and patrol protection.”
- “The college-wide safe walk program provides male and female escorts to walk you home from night classes and on-campus activities.”

But college students are not safe from sexual assault. Approximately 1 in 5 women and 1 in 70 men will be sexually assaulted during their 4-year college career. In spite of this, most people believe that campuses are safe places for students. Recently, a television journalist came under fire after asking, “When was the last time you heard about rape on a college campus?”

More often than not, rape on college campuses is committed by a student at the same university, and alcohol is involved.

1. Federal law requires that colleges and universities disclose information about crime on and around their campuses. Only rapes that are reported to the police are disclosed, and the vast majority of rapes go unreported. Do you think disclosure laws could lead to university personnel pressuring rape victims not to press charges? Why or why not?

2. Most rapes on college campuses involve alcohol. In fact, some rapists will deliberately get the victim intoxicated, so it is easier to commit the assault. Women who are victims of sexual assault often do not report the crime. Do you think there is a difference in how we view a male student who is drunk and gets robbed and beaten up, and a female who is sexually assaulted while drunk? Why or why not?

3. What kinds of actions by colleges and universities might back up the safety claims they make on brochures?

4. When you plan to go out, before drinking, have a conversation with your friends about what you would like them to do if you get intoxicated. Clearly state whether you want them to leave you at the party or make sure you come home with them. Can you think of other strategies for preventing sexual assault from occurring?
SOUNDS RIGHT BUT IS IT?

After a night of drinking at a house party, your roommate appears to have passed out. He is seated at the end of a couch, slumped sideways on the armrest. The fingers of one hand are wrapped around the neck of a half-empty beer bottle, which also leans against the armrest. It's 2 a.m. You are tired and want to go home. You gently shake him to see if he will awaken but he does not. You are a little relieved because he was getting pretty obnoxious before he passed out, and it would likely be a struggle to get him home. You ask the people you came with—some sober, some not—for help. The consensus of the group is that because he's breathing, it is probably okay to leave him on the couch for the night.

While your friends grab him under the arms and lay him on his side on the couch in case he vomits, you find a pillow and blanket for him. You alert the few remaining partgoers, all people you know fairly well, that you will return for him in the morning.

A passed-out drunk is safe as long as he is breathing and placed on his side.

Sounds right, but it isn't.

1. If your friend had been drinking steadily all night, then had two shots of alcohol right before passing out, what is the minimum amount of time it will take before his blood alcohol concentration peaks?
2. If your friend is breathing now, is there any guarantee he will be when his blood alcohol concentration peaks?
3. If you are trying to determine whether an intoxicated person is responsive, what might you do, aside from gentle shaking, to get a response?
4. If an intoxicated person is unresponsive, what should you do?
5. Consider your answers to questions 1–4 and explain why the original statement bolded above sounds right, but isn't.

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Summary
Section 18.1

Describe the structures and functions of the digestive system.

- The digestive system is a group of organs and glands working together to break foods into their component parts for reassembly into forms that the body can use or for use in generating energy (p. 416).
- Food moves from the mouth to the pharynx and through the esophagus to the stomach to the small intestine. Digested nutrients are absorbed into the bloodstream across the small intestine and brought to cells (pp. 416–417).

List the accessory organs of the digestive system, and outline their roles in digestive processes.

- The pancreas, liver, and gallbladder are accessory organs that secrete substances that aid in digestion (p. 418).
- Digestive enzymes produced by the pancreas help break down most food molecules. Bile produced by the liver facilitates the breakdown of fats and the gallbladder stores and concentrates bile before its release into the small intestine (p. 418).

Section 18.2

List the structures composing the mammalian urinary system.

- The urinary system consists of the kidneys, bladder, ureters, and urethra (p. 420).

Describe the steps in the process of urine excretion.

- In the nephrons of the kidney, the process of filtration forces most liquid, but not cells or larger molecules, from the plasma into the kidney tubules. As the filtrate travels through the nephron, water, glucose, and other valuable molecules are reabsorbed through both active and passive mechanisms. Secretion occurs when waste materials that did not leave with the filtrate are actively brought into the nephron tubules from surrounding capillaries (pp. 420–422).
- Hormones that regulate blood pressure control the concentration of water in urine. Urine collects in the renal pelvis, then travels down the ureters to be stored in the bladder. During urination, urine is released from the bladder through the urethra and exits the body (p. 422).
Roots to Remember

The following roots of words come mainly from Latin and Greek and will help you decipher terms:

- **epi-** means upon, beside, or among. Chapter term: epiglottis
- **ex-** means out or out of. Chapter term: excretion
- **itis** refers to inflammation. Chapter term: pancreatitis
- **peri-** means around. Chapter term: peristalsis
- **renal** comes from the Greek word for kidney. Chapter term: renal arteries
- **stasis** means to wrap or surround. Chapter term: peristalsis

Learning the Basics

1. Describe the hollow organs a piece of apple would move through as it makes its way through the digestive system, from its ingestion in the mouth to its excretion by the anus.

2. List the accessory organs in the digestive system.

3. Describe the main function of the kidney.

4. The pharynx
   - A. forms the connection between the small and large intestine; B. keeps swallowed food from entering the epiglottis; C. connects the esophagus to the stomach; D. branches to feed into the trachea and esophagus.

5. Which of the following lists digestive processes in the correct order?
   - A. ingestion, absorption, peristalsis, B. peristalsis, absorption, ingestion; C. peristalsis, ingestion, absorption; D. ingestion, peristalsis, absorption

6. The pancreas
   - A. secretes bile; B. produces stomach acid; C. secretes digestive enzymes; D. all of the above.

7. True/False: Most of the digestion of nutrients occurs across the membrane that lines the interior stomach wall.

8. The villi that help absorb nutrients line the __________.
   - A. small intestine; B. large intestine; C. stomach; D. pharynx.

9. Blood enters the kidneys from the
   - A. duodenal vein; B. nephron; C. renal artery; D. gall bladder.

10. True/False: The kidneys help regulate blood pressure.

Analyzing and Applying the Basics

1. Studies show that aspirin inhibits the alcohol dehydrogenase family of enzymes. What advice would you give a friend who thinks he should take aspirin before drinking alcohol?

2. When food goes “down the wrong tube” after swallowing, what path does it take?

3. When food is in the alimentary canal, is it actually part of the body? Why or why not?

Connecting the Science

1. Based on your understanding of the movement of water into and out of cells, which is more likely to help mitigate the effects of dehydration: tap water or a sugar- and electrolyte-containing sports drink? Why?

2. What would you say to a friend who believes that limiting her drinking to 1 night a week, but on that night drinks six drinks in 2 hours, will not affect her studies? What would be a better strategy for limiting the negative consequences of drinking on her studies?

Answers to Stop & Stretch, Visualize This, Working with Data, Savvy Reader, Sounds Right, But Is It?, and Chapter Review questions can be found in the Answers section at the back of the book.