

## Key Terms

peptic ulcer  
inflammatory bowel  
disease  
Crohn's disease  
ulcerative colitis  
hepatitis  
cirrhosis  
diabetes

**peptic ulcer** a sore in the lining of the stomach or duodenum, most commonly caused by infection with the bacterium *Helicobacter pylori*

**inflammatory bowel disease** the general name for a group of diseases that cause inflammation in the intestines

**Crohn's disease** a form of inflammatory disease that can affect any part of the alimentary canal from the mouth to the anus

**ulcerative colitis** a form of inflammatory disease that attacks the colon

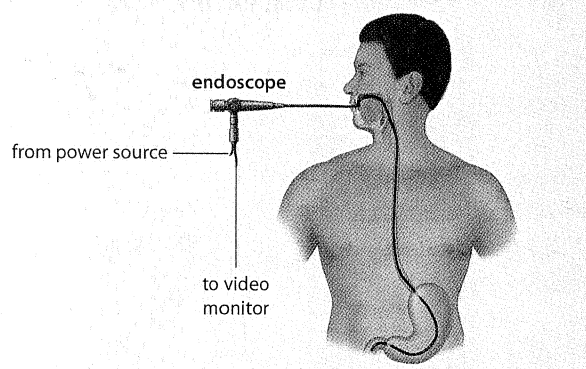
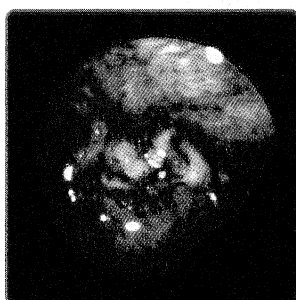
Go to **scienceontario**  
to find out more



Digestive system disorders can occur when any part of the system is not working properly during the digestive process. In this section you will learn about these disorders, and how technological advances help doctors diagnose and treat them.

## Peptic Ulcers

Abdominal pain, bloating, nausea, and loss of appetite can all be symptoms of a **peptic ulcer**. A peptic ulcer is a sore in the lining of the stomach or duodenum, where hydrochloric acid and pepsin are present. Ulcers form when the tissues become inflamed because the protective mucus that covers the lining has weakened, as shown in **Figure 10.15**. Ulcers are very painful because exposed, unprotected tissue comes into contact with acidic gastric juice. They can occur in people of all ages. Most ulcers begin when populations of an acid-resistant bacterium, *Helicobacter pylori*, attach themselves to the wall of the digestive tract and prevent that area from producing the protective mucus. Because ulcers are caused by a bacterium, they can be treated with antibiotics that kill the bacteria. Along with antibiotics, doctors also often prescribe medications that reduce acidity in the stomach. Treatment may also include lifestyle changes, such as losing weight if overweight, avoiding alcohol, and not smoking.



**Figure 10.15** This photo of a bleeding ulcer in the stomach was taken with an *endoscope*, a tube-shaped instrument with a tiny lens and light source that is inserted into the digestive tract.

## Inflammatory Bowel Disease

Often referred to as IBD, **inflammatory bowel disease** is a general name for a group of diseases that cause inflammation in the intestines. The incidence of inflammatory bowel disease is increasing in Canada—over 200 000 people (1 in 160) are living with the disease. IBD is a chronic disease, meaning that it is long lasting or recurrent. IBD can only be treated—not cured—by a special diet and by taking medication to reduce pain and inflammation. The main forms of IBD are Crohn's disease and ulcerative colitis.

**Crohn's disease** is a form of IBD that can affect any part of the alimentary canal from the mouth to the anus. Children with Crohn's disease generally do not grow properly during puberty. They develop thinner bones that increase the future risk of fractures, and they experience poor muscle development. **Ulcerative colitis** is a form that attacks the colon. Symptoms of colitis include loose and bloody stools, cramps, and abdominal pain. In severe cases of IBD, it may be necessary for surgeons to remove the affected part of the colon and create a new external opening for digestive waste. Research scientists are trying to find out why these diseases of the digestive tract have been increasing among children, and why rates are much higher in western nations than in other countries.

## Constipation

Constipation is a common disorder of the digestive system in which bowel movements are reduced to three per week or less and stools are dry, small, and difficult to eliminate. Constipation can be caused by inadequate water intake (which leaves the stools dry) and lack of good nerve and muscle function in the bowel. An unhealthy diet and lack of physical activity can also cause constipation.

Although fibre is not a nutrient and is not digested, it is essential for maintaining a healthy digestive system. Fibre refers to parts of fruits, vegetables, and grains that are not broken down in the digestive system—they pass through the body almost unchanged. Foods rich in fibre include whole grain bread, brown rice, whole grain pasta, oats, beans, peas, lentils, grains, seeds such as flax, some fruits, and vegetables. Most dietary fibre is made up of cellulose, which humans are unable to digest. The bulk and soft texture of fibre helps to prevent constipation.

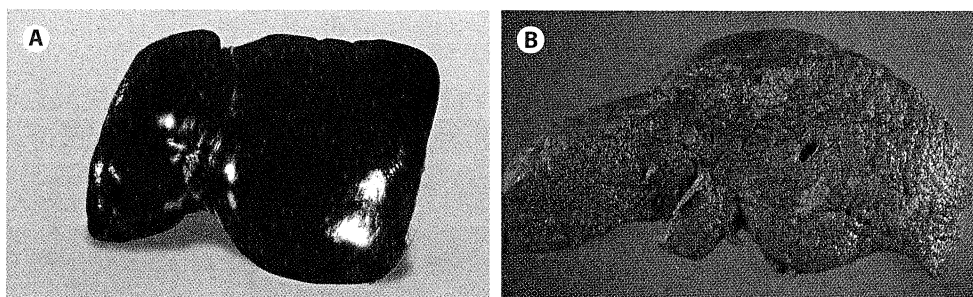
## Disorders of the Accessory Organs

Two of the most serious disorders of the liver are hepatitis and cirrhosis, and both are life-threatening. **Hepatitis** is an inflammation of the liver. There are three types of hepatitis: A, B, and C. Hepatitis A is usually contracted from drinking contaminated water. Hepatitis B is spread by sexual contact but there is a vaccine to protect against it. Hepatitis C is usually contracted by contact with infected blood. There is no vaccine for hepatitis C.

**Figure 10.16** shows part of the liver of someone who has **cirrhosis**—a chronic disease of the liver that occurs when scar tissue replaces healthy liver tissue and prevents the liver from functioning properly. Chronic alcoholism and hepatitis C are the most common causes of cirrhosis of the liver. There are few symptoms in the early stages of the disease. Blood tests, however, can determine if the liver is becoming fatty—an early warning sign that cirrhosis is developing. The liver has the ability to heal itself, but in many cases there is not enough regeneration to avoid liver failure. A liver transplant is the primary treatment for liver failure.

**hepatitis** inflammation of the liver, most commonly caused by a virus

**cirrhosis** the irreversible replacement of healthy liver tissue with non-functioning scar tissue; most commonly caused by excessive alcohol intake or hepatitis



**Figure 10.16** (A) A normal, healthy human liver, and (B) a liver affected by cirrhosis. The word *cirrhosis* comes from the Greek word *khirros*, which means tawny, referring to the brownish-orange colour of the diseased liver.

Another common disorder that affects the accessory organs is gallstones, which are small hard masses that form in the gall bladder. Remember that the gall bladder stores bile from the liver. Sometimes, cholesterol (a fat-like substance found in the blood and cells) in the bile can precipitate out of the bile and form crystals. The crystals grow and become gallstones. Factors that are related to the formation of gallstones are obesity, alcohol intake, and heredity. Gallstones are usually treated with medications or with ultrasound shock waves to disintegrate the stones so that they can be passed out in the urine. Since gallstones often reoccur, it is important to reduce the causal factors. Cholesterol in the gall bladder can be lowered by losing weight, increasing the intake of omega-3 fatty acids (unsaturated fats that are found in fish and nut oils), and decreasing the size of meals. If the gallstone problem is serious, the entire gall bladder may need to be surgically removed.

## Learning Check

19. How do *Helicobacter pylori* cause the condition shown in **Figure 10.15**? Explain your answer.
20. Identify some lifestyle changes that can reduce the risk of developing a gallstone.
21. Why might Crohn's disease be difficult to diagnose?
22. Distinguish between inflammatory bowel disease, Crohn's disease, and ulcerative colitis, and describe in which part of the digestive tract each disease occurs.
23. Define the following disorders of the digestive system, and identify the causes of each.
  - a. constipation
  - b. hepatitis
  - c. cirrhosis
24. Why are coffee and citrus fruits, such as oranges and grapefruits, not recommended for patients with ulcers?

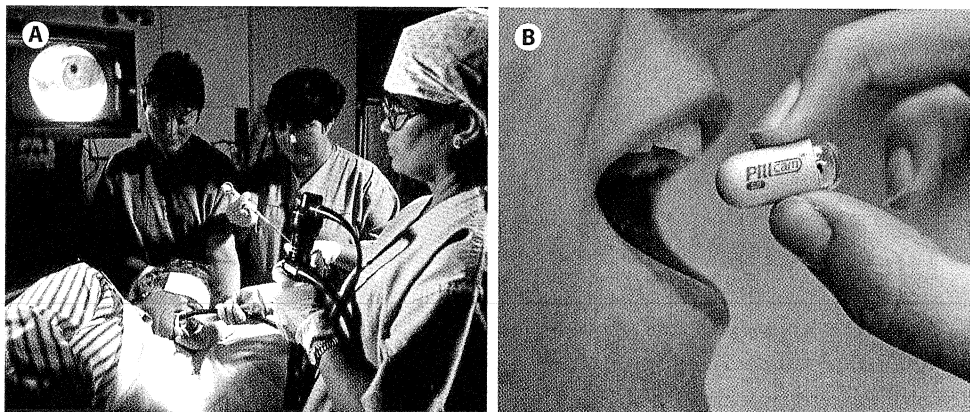
### The Endoscope and Digestive System Disorders

Modern technology allows surgeons to locate, diagnose, and remove ulcers, tumours, and other problems of the digestive tract without having to cut into the body of the patient. Recall that the alimentary canal is a tube running from the mouth to the anus. Therefore, physicians can get access to it through these natural openings at either end. A device used for this purpose is the endoscope.

The endoscope often helps to confirm medical problems that are hard to observe using other methods, such as X rays. It allows a surgeon to visually inspect the lining of any part of the alimentary canal, including the stomach as shown in **Figure 10.17 (A)**. Other attachments that can be fitted to the endoscope include a camera to photograph and record portions of the alimentary canal for further study; a laser that can be used to cut through tissue and seal blood vessels; and tiny forceps that can be used to extract samples of tissue for laboratory examination.

A more recent development is the capsule endoscope, shown in **Figure 10.17 (B)**—a tiny camera placed inside a capsule that can be swallowed. The capsule endoscope is especially useful for seeing inside the small intestine, which is too long and coiled to allow an endoscope tube to be pushed through its entire length.

**Figure 10.17 (A)** Doctors perform an endoscopy to examine a woman's stomach and take a tissue sample (a biopsy). **(B)** The patient swallows a tiny capsule endoscope. Over the next eight hours, it travels down the digestive tract, where it takes about 30 pictures per second.



Technologies such as endoscopy are known as non-invasive surgery, in contrast to traditional surgery in which a physician must cut into the body to repair or remove tissues and organs. Non-invasive surgery is relatively painless and allows patients to recover much faster than they do from traditional surgery. Complications from non-invasive surgery are rare. It can be carried out with only a local anesthetic, and it reduces the risk of infection.

## Diabetes

**Diabetes** is a chronic disease in which body cells are unable to use glucose to provide energy for muscles and tissues. Normally, the pancreas releases insulin into the bloodstream after the individual has eaten. Insulin allows glucose from the digested food to enter the body's cells, and this lowers the amount of glucose circulating in the bloodstream throughout the body. As the glucose level in the bloodstream drops, so does the release of insulin from the pancreas. As you learned earlier in the chapter, glycogen can be temporarily stored in the liver so that when the insulin level gets low—for example, when you have not eaten for a while—some of that stored glycogen is converted back to glucose to keep the blood glucose at a normal level.

Diabetes develops when there is not enough insulin in the bloodstream or when the body cannot properly use the insulin that the pancreas makes. Without insulin, glucose cannot get into the cells and the glucose level in the blood can increase to life-threatening levels.

**diabetes** a condition in which the body is unable to use glucose for energy

### The Three Types of Diabetes

The three types of diabetes are type 1, type 2, and gestational diabetes. Type 1 diabetes occurs when the insulin-producing cells of the pancreas are destroyed by the immune system and therefore no longer produce insulin. Type 1 diabetes is most often diagnosed in children, teens, and young adults. Type 2 diabetes occurs when either the body does not make enough insulin or it is unable to properly use the insulin it makes. Although Type 2 diabetes is most often diagnosed in people over the age of 40, it is becoming increasingly common in children and adolescents.

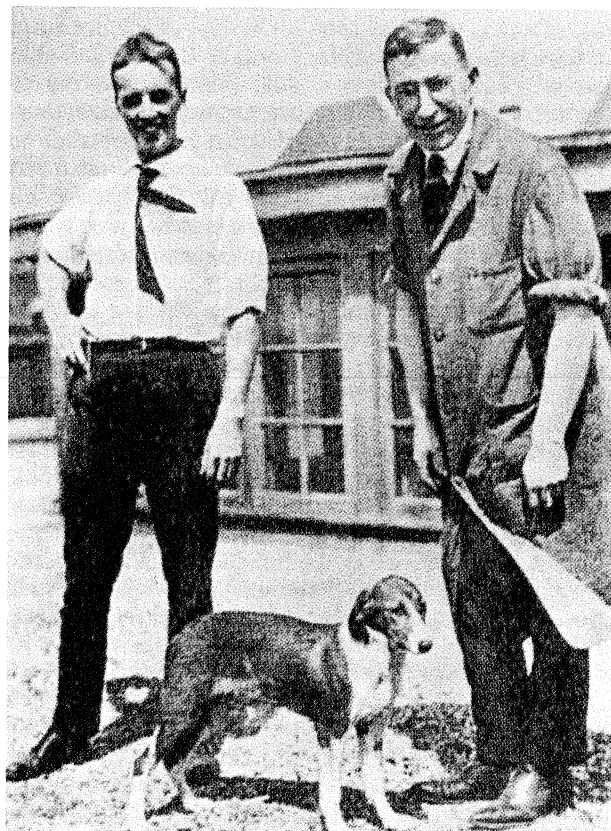
Gestational diabetes can develop during pregnancy. Even though this type of diabetes often ends when the baby is born, women who have had gestational diabetes are more likely to develop type 2 diabetes later in life. Gestational diabetes is often the result of pregnancy hormones or inadequate levels of insulin production.

### Canadian Contributions to Diabetes Research

In 1922, Canadian scientists Frederick Banting and Charles Best, seen in **Figure 10.18**, discovered the connection between insulin and diabetes. Before then, diabetes usually resulted in early death.

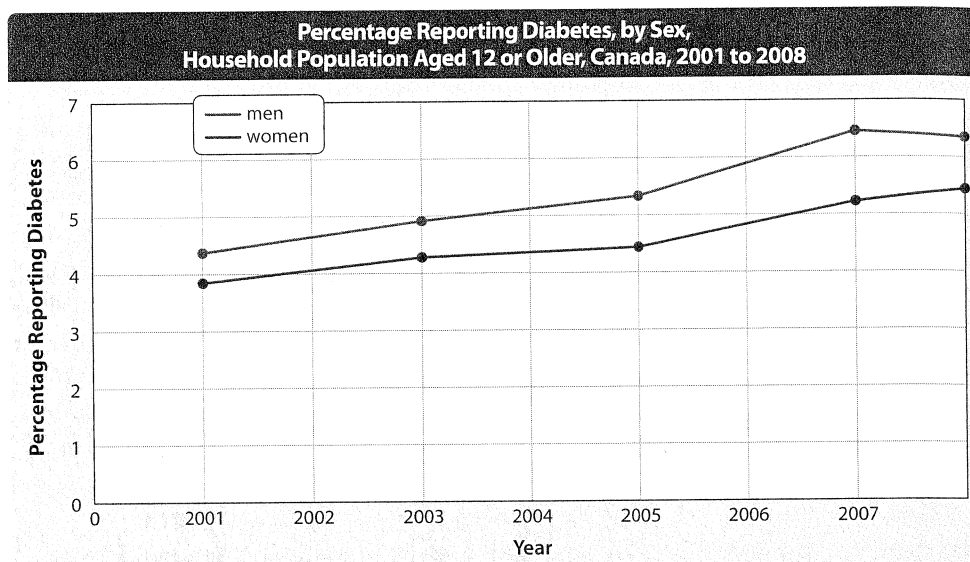
After Banting and Best demonstrated that insulin injections could help people with diabetes, the University of Toronto's Connaught Laboratories developed ways to produce the hormone in large quantities. Some of these methods are described on the following page. The production of insulin in such large quantities has prolonged the lives of millions of people around the world.

**Figure 10.18** Charles Best (left) and Frederick Banting (right) discovered that people suffering from diabetes could be saved from an early death by taking injections of the pancreatic hormone insulin.

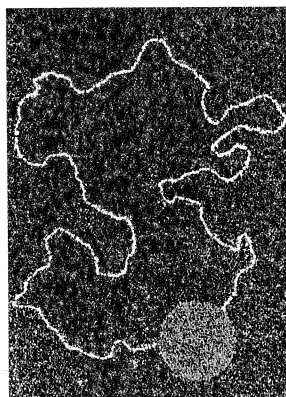


### Technological Advances in Treating Diabetes

Diabetes is becoming a more common medical condition in Canada as a result of increasingly sedentary lifestyles and an ageing population. **Figure 10.19** shows a steady increase in the number of Canadians with diabetes over a seven-year period. According to Statistics Canada, from the period 2001 through 2008, men were more likely than women to report that they had diabetes. In 2008, the incidence of diabetes ranged from 0.3% at ages 12 to 19 to 16.0% for seniors (65 or older). At ages 20 to 34, women were more likely than men to have diabetes (1.1% versus 0.6%), but by age 55 men were more likely than women to be diabetic.



**Figure 10.19** Survey respondents were asked to report diabetes that had been diagnosed by a doctor, so type 1, type 2, and gestational diabetes are all included in these percentages.



**Figure 10.20** Human DNA with instructions for making insulin can be added into this bacterial plasmid, resulting in recombinant DNA. Once the recombinant DNA is inserted into bacteria, the bacteria begin to produce human insulin.

According to the Public Health Agency of Canada, the risk factors for diabetes also include being of advanced age, having a family history of the disease, and belonging to certain high-risk ethnic groups (Aboriginal peoples and people of African, Asian, Hispanic, and Pacific Island descent). To meet a growing demand for improved treatment for diabetes, scientists have developed several new technologies, described below.

### Manufacturing Human Insulin

Until the early 1980s, insulin used to treat diabetes was extracted from pigs or cattle. However, the human body treats these kinds of insulin as a “foreign” contaminant, and injections of this type of insulin eventually trigger an immune response. The immune response is how the body recognizes and defends itself against bacteria and other harmful substances.

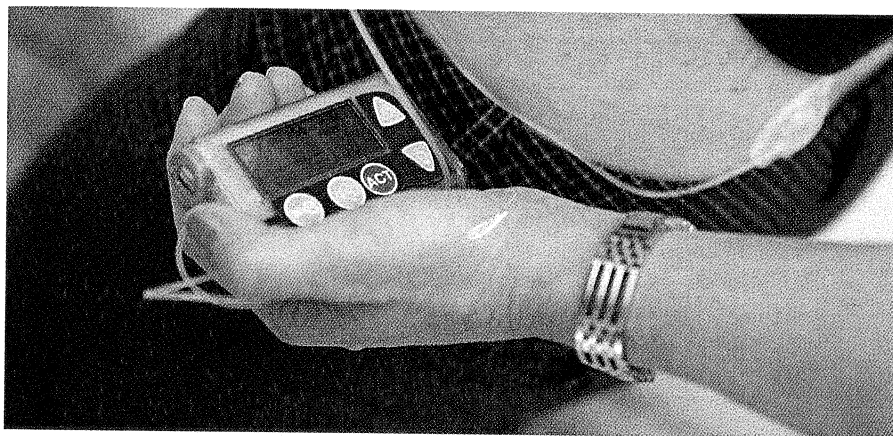
The development of genetic engineering during the 1990s allowed pharmaceutical companies to manufacture human insulin using bacteria and modified bacterial *plasmids*, as shown in **Figure 10.20**. A plasmid is a circular molecule of DNA that is commonly found in bacteria. Large vats of genetically engineered bacteria produce human insulin in the lab, and this is now the main source of insulin for people with diabetes in Canada.



### Timing Insulin Delivery

Until the 1980s, people with diabetes had to monitor their blood glucose levels regularly using a glucose meter in order to know when to inject insulin into their bloodstream at times when it was most needed. To replace this form of monitoring, researchers developed computerized insulin pumps, as shown in **Figure 10.21**. The device includes the pump itself (the processing module, controls, and batteries) and a disposable internal insulin reservoir. It also comes with a disposable infusion set, consisting of a cannula (a soft plastic needle) and the tubing that runs from the insulin reservoir to the cannula.

An advantage of this technology is that it provides better control over blood glucose levels, reducing the risk of long-term complications that can affect the eyes, kidneys, and blood vessels. A disadvantage is that pumps are far more expensive than the syringes used for insulin injection. Because a pump must be attached most of the time, users may find it uncomfortable and must avoid jarring activities that might damage it.



**Figure 10.21** This small insulin pump is an alternative to multiple daily self-administered insulin shots.

## Activity

### 10.3

### Digestive System Cancers

Aside from lung cancer, digestive system cancers kill more Canadians than any other type of cancer. Every year, about 15 000 Canadians die of cancers of the digestive tract, including the accessory organs. According to the Canadian Cancer Society, about half of all cancers can be prevented by maintaining a healthy lifestyle. In this activity you will research and report on one type of digestive system cancer, and evaluate the importance of technological advances in detection, diagnosis, and treatment of the disease.

#### Materials

- reference books
- computer with Internet access

#### Procedure

1. Choose one type of digestive system cancer that you would like to research, such as cancer of the esophagus, colon, rectum, stomach, pancreas, liver, or gall bladder.
2. Using print or on-line resources, research your chosen disease to find out the causes, symptoms, diagnostic technologies, treatments, and prognosis. Include in your research any screening tests that can aid in early detection of the disease.
3. Summarize your findings in an appropriate format and present them to the class.

#### Questions

1. What are some lifestyle factors that increase the risk of developing digestive system cancers? What lifestyle changes can help minimize this risk?
2. What are some of the social and economic costs associated with cancer? Explain your answer.
3. Evaluate the importance of technological advances in diagnosing and treating digestive system cancers.