SBI3U-C

Disorders of Internal Systems

Introduction

Good health is not something you can buy from a store. It's partly the result of good luck, partly genetics, and partly a state achieved by engaging in healthy behaviour, based on choices made from available options. The benefits of a healthy lifestyle include fewer illnesses and injuries, fewer doctor visits, and reduced health care costs. To reap these benefits, you have to incorporate some pattern of healthy behaviour into your regular daily or weekly routine, including eating right and exercising regularly.

The lesson covers disorders of the three main organ systems in the body: digestive, respiratory, and circulatory. You will review your knowledge of these organ systems and how they relate to each other by performing a virtual dissection of a fetal pig. You will learn about the causes and treatments for a variety of common disorders such as cancers, ulcers, heart attacks, and emphysema. Finally, you will examine how new medical technologies are being used to diagnose, treat, or prevent many of these disorders.

Planning Your Study

You may find this time grid helpful in planning when and how you will work through this lesson.

Suggested Timing for This Lesson (hours)	
Disorders of Internal Systems	½
Disorders of the Digestive System	½
Disorders of the Respiratory System	½
Disorders of the Circulatory System	½
Medical Technologies for Disorders of Internal Systems	½
Activity: Fetal Pig Anatomy	1
Key Questions	1

What You Will Learn

After completing this lesson, you will be able to

- describe some disorders related to the digestive, respiratory, and circulatory systems
- evaluate the importance of various technologies to our understanding of internal body systems
- assess how societal needs lead to scientific and technological developments related to internal systems
- perform a laboratory or computer-simulated dissection of a representative animal

Disorders of Internal Systems

In the following sections, you will explore disorders in three systems: digestive, respiratory, and circulatory. One type of disorder, cancer, can occur in any of these systems. Because it is not confined only to one system, you will first learn about it in general terms, then explore the specifics of cancer in each system.

Your lifestyle and the choices you make can help prevent all of the major causes of death such as cancer, heart disease, stroke, lung disease, and injury.

Importance of Lifestyle Choices

Smoking and using tobacco are very dangerous habits. Smoking causes many deaths in the United States and Canada every year. More preventable illnesses (such as emphysema, cancer of the mouth, throat and lung, and heart disease) are caused by tobacco use than by anything else.

Figure 12.1 shows there is a clear correlation between the rate of smoking and the rate of lung cancer, but it is delayed by about 20 years because it takes that long, on average, for the disease to develop.

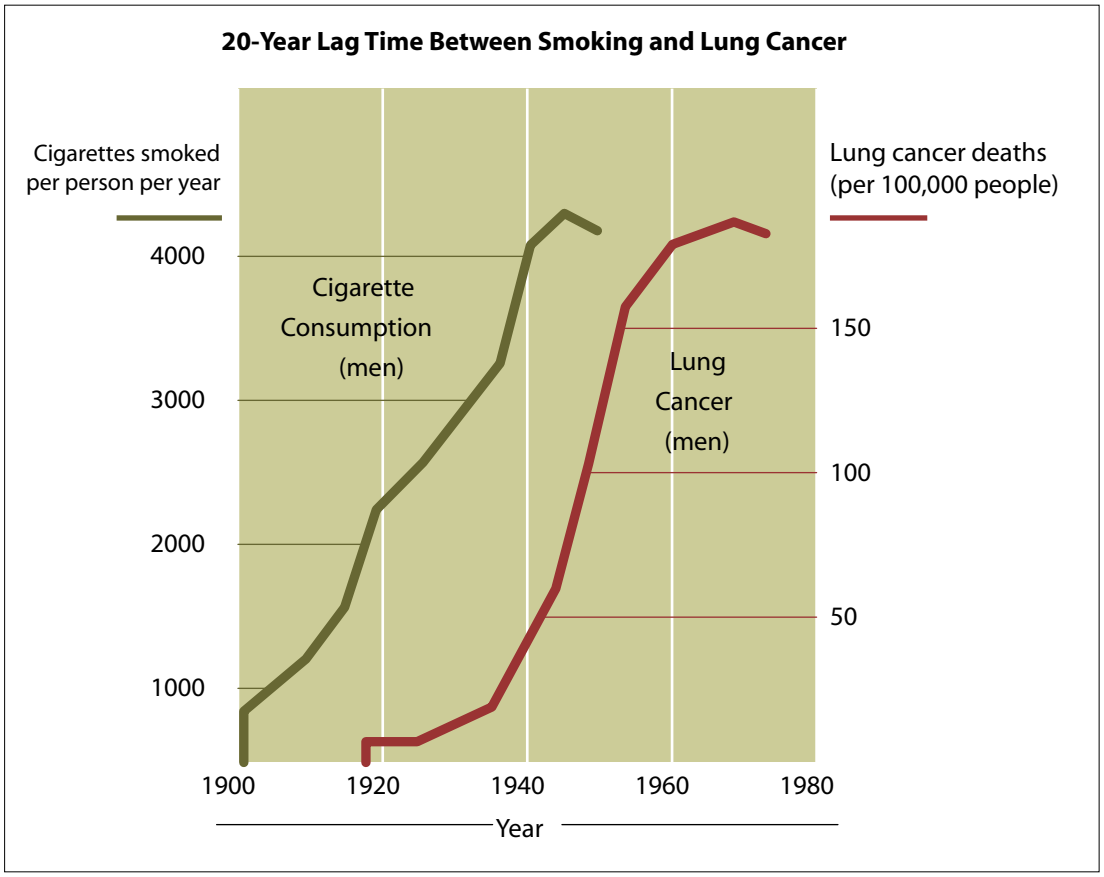


Figure 12.1: There is a strong correlation between the rate of smoking and the rate of lung cancer.
Source: Wikipedia

Excessive consumption of alcohol can damage the liver and contribute to some cancers, such as throat and liver cancer. Carrying too much weight increases your risk for high blood pressure, high cholesterol, diabetes, heart disease, stroke, certain cancers, gallbladder disease, and arthritis in the weight-bearing joints (such as the spine, hips, or knees).

A high-fibre, low-fat diet and regular exercise can help you lose weight and keep it off. Exercise can help prevent heart disease, high blood pressure, diabetes, osteoporosis, and depression. It can also help prevent colon cancer, stroke, and back injury. Studies suggest that you will feel better and keep your weight under control if you exercise regularly.

To safeguard against disorders of your internal systems, it is important that you eat well, get plenty of exercise, and treat your body right.

Cancer

Cancer occurs when cells become abnormal and divide without control or order. Cancer is not limited to one internal system—it is non-selective, and may occur in any area of the body. Normally, cells divide to produce more cells only when the body needs them. This orderly process helps keep us healthy. If cells keep dividing when new cells are not needed, a mass of tissue forms. This mass of extra tissue, called a growth or tumour, can be benign or malignant. Benign tumours are not cancer. They can usually be removed and, in most cases, they do not come back. Most importantly, cells from benign tumours do not spread to other parts of the body. Benign tumours are rarely a threat to life. Malignant tumours are cancer. Cancer cells can invade and damage tissues and organs near the tumour. Also, cancer cells can break away from a malignant tumour and enter the bloodstream or lymphatic system. This is how cancer spreads from the original (primary) tumour to form new tumours in other parts of the body. The spread of cancer is called metastasis. Different kinds of cancers occur in different internal systems. You will examine these in more detail in later sections.

Disorders of the Digestive System

Managing body weight is a key factor in attaining all of the benefits of a healthy lifestyle. In overweight individuals, a weight reduction of just 10 percent will significantly reduce risk of heart disease and other obesity-related illnesses. Obesity and excess weight is the second leading contributing factor to many childhood diseases such as orthopedic disorders (feet problems), sleep apnea (interruptions in breathing during sleep), type 2 diabetes mellitus, asthma, high blood pressure and cholesterol, skin disorders, and emotional and psychosocial problems.

Eating Disorders

Eating disorders are more than just going on a diet to lose weight or trying to make sure you exercise every day. They are extremes in eating behaviour, typically characterized by a diet that never ends and gradually becomes more and more restrictive. The eating behaviour eventually spills over into other aspects of life, interfering with regular social activities (for example, a person may always choose to go running instead of meeting friends for a coffee when invited).

The most common types of eating disorder are anorexia nervosa and bulimia nervosa, normally called simply anorexia and bulimia. They are both eating disorders with a psychological aspect. Anorexia occurs when a person starves themselves, resulting in a nutritional deficiency. This disorder usually starts during adolescence and typically affects females. Most start at a normal weight, then start extreme dieting with excessive exercising. Symptoms of this disorder can range from muscle atrophy, hair loss, hypotension (low blood pressure), dental problems such as cavities, irregular or stopped menstrual periods, electrolyte imbalances, and susceptibility to other infections, along with many other disorders. In a small number of cases, it can be fatal. Successful treatment of anorexia can take years. Bulimia also mainly occurs in young females of a normal weight. It is characterized by bingeing (eating large amounts of food) followed by purging (self-induced vomiting or use of laxatives). This can lead to dehydration, electrolyte and metabolic imbalances, impaired kidney and liver function, dry skin, frequent infections, and muscle spasms. Both of these disorders put the person at an increased risk of heart attack, which may lead to death.

Other food-related disorders like binge eating disorders, body image disorders, and food phobias are showing up more frequently than they used to. Binge eating can occur on its own, without bulimia being present. These bouts of overeating can have a signficant negative impact on health and well-being, such as morbid obesity and increased risk of developing certain weight-related diseases, including type 2 diabetes. Binge eating differs from normal overeating in two main ways: a larger amount of food is consumed at one time, and the binge eater feels a sense of loss of control. Emotional eating (eating to obtain release from psychological stress) is often an issue for binge eaters, which can also be treated with therapy, stress management techniques, and improved self-care skills, such as journaling and planning relaxing activities as alternatives to eating.

Scientists are not sure what causes eating disorders, although there are several theories. Many people who develop an eating disorder begin to exhibit symptoms between the ages of 13 and 17. This is a time of emotional and physical changes, academic pressures, and a greater degree of peer pressure. Many people with eating disorders also suffer from depression or anxiety, or have other mental health problems such as obsessive-compulsive disorder (OCD). There is also evidence that eating disorders may run in families. So, while a predisposition to eating disorders may be in our genes, these disorders also occur because our values and behaviours are strongly influenced by our environment.

Colon Cancer

The colon is the part of the digestive system where waste material is stored. When colon cancer is suspected, either a barium enema X-ray or colonoscopy is performed to locate the potential tumour(s). A barium enema involves taking X-rays of the colon and the rectum after the patient is given an enema with a white, chalky liquid containing barium, which outlines the large intestines on the X-rays. Tumours, polyps, and other abnormalities will now appear as shadows on the X-rays (Figure 12.2).

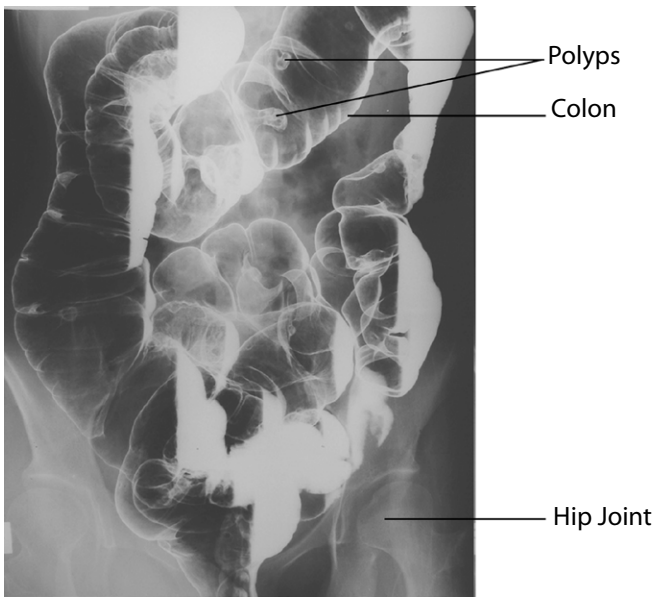


Figure 12.2: X-ray showing the large intestines after coating the inside of the colon with barium. Two polyps growing on the inside surface can be clearly seen against the silhouette of the colon.

Source: Wikimedia Commons

Colonoscopy is a procedure whereby a doctor inserts a long, flexible viewing tube into the rectum for the purpose of inspecting the inside of the entire colon. Colonoscopy is generally considered more accurate than barium enema X-rays, especially in detecting small polyps, which can be the early signs of cancer. If colon polyps are found, they are usually removed and sent to a lab for futher testing to determine if they indicate signs of cancer.

Tumours of the colon and rectum are growths arising from the inner wall of the large intestine. Benign tumours of the large intestine are called polyps. Malignant (cancerous) tumours of the large intestine are called cancers. Benign polyps do not invade nearby tissue or spread to other parts of the body. Benign polyps can be easily removed during colonoscopy, and are not life-threatening. However, if benign polyps are not removed from the large intestine, they can potentially develop into malignant tumours over time. Most of the cancers of the large intestine are believed to have developed from polyps. Cancer of the colon and rectum (colorectal cancer) can invade and damage adjacent tissues and organs. Cancer cells can also break away and spread to other parts of the body such as the liver and lungs, where new tumours form (metastasis). Once metastasis has occurred in colorectal cancer, a complete cure of the cancer is unlikely. Early diagnosis and treatment are therefore crucial to survival.

When it comes to cancer-related deaths in Canada, colorectal cancer is second only to lung cancer. Diets high in fat are believed to predispose humans to colorectal cancer. In countries with high colorectal cancer rates, the fat intake by the population is much higher than in countries with lower cancer rates. It is believed that the breakdown products of fat metabolism lead to the formation of cancer-causing chemicals (carcinogens). Diets high in vegetables and high-fibre foods such as whole-grain breads and cereals may rid the bowel of these carcinogens and help reduce the risk of cancer.

Crohn's Disease

Crohn's disease is a condition in which there is chronic inflammation in the gastrointestinal (GI) tract or bowel. It is a type of inflammatory bowel disease (IBD). The first signs of Crohn's disease are usually abdominal pains and diarrhea after eating. Other symptoms include loss of appetite, weight loss, stomach cramps, fever, rectal bleeding, and abdominal tenderness or swelling. The two main diagnostic tools are X-ray and colonoscopy. While Crohn's disease can affect any part of the digestive system, it occurs most commonly in the ileum (part of the small intestine) and colon (large intestine). The exact cause of Crohn's disease is unknown. Research suggests that there is an autoimmune element: the body's natural defenses, which are normally supposed to fight infection, fail to distinguish the body itself from foreign material, and attack the body's own tissue.

Autoimmune diseases run in families. About one-quarter of Crohn's patients have relatives who also suffer from IBD. Furthermore, it is believed that a virus or bacteria may be involved, which may cause the initial damage to the lining of the GI tract. However, it is not yet known which organism might be involved.

While there is no cure, Crohn's disease is treatable. Many medications can help control the symptoms of Crohn's disease. Just as important as medications in the treatment of Crohn's disease is a good diet. Not only are some foods gentler on an inflamed intestine, it is also vital to get the right nutrition even when the gut is not processing food efficiently. Crohn's cannot be completely cured by surgery. Removing an inflamed part of the colon may offer many symptom-free years. But eventually, inflammation recurs at the site where the two cut ends have been joined together, causing symptoms to appear again.

Peptic Ulcers

Ulcers are lesions (sores) that are usually found in the stomach, called peptic ulcers, or in the small intestine, called duodenal ulcers. Over 80% of these ulcers are caused by a bacterium called *Helicobacter pylori*, (Figure 12.3), which thrive in an acidic environment.

Figure 12.3: *Helicobacter pylori* bacteria possessing multiple flagella (tails). These bacteria are responsible for most stomach ulcers.

Source: Wikimedia Commons

Symptoms include pain, nausea, vomiting (sometimes blood), gastrointestinal bleeding, loss of appetite, and weight loss. For almost 100 years, doctors believed that stress, spicy foods, and alcohol caused most ulcers. Now we know that most peptic ulcers are caused by a *Helicobacter pylori* bacterial infection in the stomach and upper intestine, by certain medications, or by smoking.

Helicobacter pylori bacteria weaken the protective coating of the stomach and upper small intestine. Acid in the stomach then gets through to the sensitive tissues lining the digestive system underneath; the acid and bacteria directly irritate this lining, resulting in ulcers. Smoking increases someone's risk of getting an ulcer because the nicotine in cigarettes causes the stomach to produce more acid. Drinking a lot of alcohol each day for a period of time can also increase a person's risk of ulcers because, over time, alcohol can wear down the lining of the stomach and intestines.

Heartburn

Heartburn is an uncomfortable feeling of burning or warmth in the chest. Although the pain of heartburn is felt in the chest, heartburn has nothing to do with your heart. Instead, heartburn is caused by stomach acid in the esophagus. Before entering the stomach, food must pass through a tight muscle at the lower part of the esophagus called the lower esophageal sphincter or cardiac sphincter, which prevents food from traveling backward into the esophagus. Once in the stomach, stomach acid digests the food. This acid is very strong and can damage most parts of the body. Fortunately, the stomach is protected from its own acid by a special mucous layer. The esophagus, however, does not have any such special protection. If the cardiac sphincter does not close completely, stomach acid can travel back up into the esophagus, leading to heartburn. Incomplete closing of the cardiac sphincter can happen for a number of reasons:

- Certain foods and drinks are known to loosen the lower esophageal sphincter. These include chocolate, peppermint, caffeine-containing beverages (such as coffee, tea, and soft drinks), fatty foods, and alcohol.
- Heartburn often depends on the body's position. It is easier for stomach acid to flow back into the esophagus if you are lying down or bending over.
- An increase of pressure on the stomach forces stomach acid backward into the esophagus, so lifting, straining, coughing, obesity, and pregnancy can worsen heartburn.
- Many prescription medications can loosen the lower esophageal sphincter, including certain blood pressure and heart medications, as well as an asthma medication called theophylline.

Continual bouts of heartburn can be a symptom of a more serious condition called gastroesophageal reflux disease (GERD). Frequent or severe heartburn may limit daily activities and lead to further complications such as ulcers in the esophagus.

Support Questions

Be sure to try the Support Questions on your own before looking at the suggested answers provided.

56. Identify the disorder of the digestive system. Suggested answer

Disorder	Description
1.	When a person starves themselves, resulting in a nutritional deficiency.
2.	It is characterized by bingeing followed by purging, or use of laxatives.
3.	It can be a serious problem with serious ramifications, such as morbid obesity and increased risk of developing certain weight-related diseases, such as type 2 diabetes.
4.	Develops from growths arising from the inner wall of the large intestine called polyps.
5.	Chronic inflammation in the gastrointestinal (GI) tract or bowel.
6.	Eighty percent of these are caused by a bacterium called *Helicobacter pylori*, which thrive in an acidic environment.
7.	If the cardiac sphincter does not close completely, the lower part of the esophagus can be irritated by stomach acid and create an uncomfortable feeling.

57. What is the difference between a benign and a malignant tumour? Suggested answer

58. List two disorders of digestion that are not a direct result of lifestyle choices. Suggested answer

Disorders of the Respiratory System

Bronchitis

Bronchitis occurs when the bronchi of the lungs become inflamed. The thin mucous lining of the bronchi and/or bronchioles becomes irritated and swollen. The inflammation is caused by either a bacteria or virus, and lasts for approximately two to three weeks. Symptoms include a cough, mucus production, fever, shortness of breath, and wheezing. For acute bronchitis, if the cause is a bacterium, which your doctor would determine through a culture, it can be treated with antibiotics. If it is caused by a virus, it has to run its course. Most doctors would also recommend that smokers quit smoking completely in order to allow the bronchi to heal properly and reduce tar buildup, which increases recovery time.

Chronic bronchitis lasts a much longer time, and the mucus is much thicker and therefore more difficult to get rid of. Because the mucus cannot be expelled, it sits lower in the bronchi, allowing bacteria to set in and infection to occur. Chronic bronchitis occurs more often in smokers, and again doctors would suggest quitting to allow sufficient healing to occur.

Asthma

Asthma is a chronic lung condition. An asthma attack is usually brought on by an allergic reaction to something in the environment, but can also be brought on by exercise, changes in weather or temperature, or emotional upset. Inflammation, increased mucus, and muscle tightening cause the airways to narrow, and as a result, air cannot move through the lungs as well as it should, which makes it difficult to breathe. The cause of asthma is poorly understood, but it may be partly inherited. Everyone's lungs are sensitive to different things such as pollen, air pollution, or strong chemicals. People with asthma have lungs that are more sensitive than average. There are three processes in the lungs that produce asthma symptoms:

- The inner linings of the airways become inflamed. They swell up, leaving less room for air to pass through.
- The muscles around the airways tighten, closing them further.
- The airways produce mucus in response to the inflammation, clogging the already shrunken tubes.

Asthma is not always dangerous, but it can lead to long-term, permanent damage of the alveoli as well as death if a severe attack goes untreated. A really severe asthma attack is life-threatening. Even if some air is coming in, deadly carbon dioxide builds up in the blood.

Asthma treatment can vary from anti-inflammatory and bronchodilator inhalers to oral medications to asthma drugs delivered in an asthma nebulizer or breathing machine.

Emphysema

Emphysema is caused by the loss of elasticity of the lungs. The bronchi are permanently and abnormally enlarged, and accompanied by destruction of the alveolar walls. The alveolar septa (the walls that separate the alveoli) are destroyed, the airway partially collapses, and the elasticity of the lungs decreases—all of which results in breathing difficulty, especially during exhalation.

A person who has emphysema is unable to exhale normal amounts of air, which causes a buildup of carbon dioxide in the lungs. In the long term, this may cause the alveoli to deteriorate further, the walls to harden, and the capillaries to be damaged. The average adult has more alveoli than necessary for normal events, therefore emphysema does not always affect the person with the severity that it potentially could. However, in the case of chronic emphysema, the heart becomes overworked in trying to provide enough blood/oxygen to the lungs through the hardened capillaries, which leads to shortness of breath even during the simplest of exercises. The most common cause of emphysema is the inhalation of pollutants such as tobacco smoke, industrial solvents, and agricultural dust. Sometimes, in elderly people, emphysema can develop with no apparent reason other than old age.

Lung Cancer

Lung cancer is the most common cause of death due to cancer in both men and women throughout the world. Lung cancer was not common prior to the 1920s, but increased dramatically over the following decades as tobacco smoking increased. The incidence of lung cancer is strongly correlated with cigarette smoking, with about 90% of lung cancers arising as a result of tobacco use. The risk of lung cancer increases with the number of cigarettes smoked and the time over which smoking has occurred. Doctors refer to this risk in terms of pack-years of smoking history (the number of packs of cigarettes smoked per day multiplied by the number of years smoked). For example, a person who has smoked two packs of cigarettes per day for 10 years has a 20 pack-year smoking history. Among those who smoke two or more packs of cigarettes per day, one in seven will die of lung cancer.

Lung cancer is caused by an abnormal growth of cells in the lung. While smoking is the most common cause of lung cancer, it can also be caused by any inhaled irritant that could stimulate abnormal cell growth. Asbestos fibres are silicate fibres that can persist for a lifetime in lung tissue following exposure to asbestos. The workplace is a common source of exposure to asbestos fibres, as asbestos was widely used in the past as both thermal and acoustic insulation. Today, asbestos use is limited or banned in many countries, including Canada and the United States. Both lung cancer and mesothelioma (cancer of the pleura of the lung as well as of the lining of the abdominal cavity called the peritoneum) are associated with exposure to asbestos.

If caught early enough, lung cancer can be treated before it starts to grow and spread throughout the rest of the lungs and body. Symptoms of lung cancer include a cough, shortness of breath, breathing difficulty, and even chest pain and spitting up blood. Even though lung cancer can be treated, the outlook is usually not good, with an average survival time of nine months after the original diagnosis. Smokers have about twenty times the risk of non-smokers.

Support Questions

59. Identify the disorder of the respiratory system. Suggested answer

Disorder	Description
1.	It occurs when the bronchi of the lungs become inflamed.
2.	It is brought on by an allergic reaction to something in the environment but can also be brought on by exercise, changes in weather or temperature, or emotional upset. Inflammation, increased mucus, and muscle tightening cause the airways to narrow, which makes it difficult to breathe.
3.	It occurs when the alveolar septa (the walls that separate the alveoli) are destroyed, the airway partially collapses, and the elasticity of the lungs decreases—all of which result in breathing difficulty, especially during exhalation.
4.	It was not common prior to the 1920s, but increased dramatically over the following decades as tobacco smoking increased.
5.	Cancer of the pleura of the lung as well as of the lining of the abdominal cavity called the peritoneum.

60. Put the following steps in order, numbering them from first to last, to describe the progress of an asthma attack. Suggested answer

Order	Event
	Breathing is restored to normal
	Environmental trigger (like cold weather) brings on asthma attack
	Individual takes puffer
	Constriction of airways occurs
	Amount of air entering the lungs decreases
	Airways dilate
	Amount of air entering the lungs increases

Disorders of the Circulatory System

Hypertension (High Blood Pressure)

A certain amount of pressure is needed to carry the blood through your body. If that pressure is too great, however, it is called hypertension, or high blood pressure. It is a condition that many people have without knowing it. Because of this, it is known as the silent killer.

Blood pressure increases with age. More than nine in ten Canadians will develop high blood pressure unless they follow a healthy lifestyle. High blood pressure is the leading risk factor for death; it can cause strokes, heart attacks, and heart and kidney failure. It is also related to dementia and sexual disorders. These problems can be prevented if high blood pressure is controlled. Heart disease is one of the leading causes of death worldwide, and people who have abnormally high pressure in their arteries are far more likely than others to die prematurely of heart disease.

In Canada, it has been estimated that 25% of men and 18% of women have high blood pressure. Many are not aware of the problem. Of those who are, less than one-third receive adequate treatment to control their blood pressure. Controlling blood pressure with medication can decrease the risk of stroke and heart disease. To prevent hypertension and heart disease, it is recommended that people stop smoking, lose weight, cut down on salt consumption, eat more fruits, vegetables, grains, and fibre, control alcohol intake (no more than two drinks per day to a maximum of nine per week for women or 14 per week for men) and get regular physical activity (30 to 45 minutes of activity most days of the week). Proper treatment of high blood pressure can add years to a person's life.

Heart Attack and Stroke

A heart attack (myocardial infarction) occurs when there is a reduction in the blood flow to the arteries supplying the heart muscles. This is usually the result of a blockage caused by an accumulation of fat or cholesterol in the bloodstream. Due to an inadequate blood supply, the affected heart tissue will die.

There are various degrees of severity of heart attacks. Some are so mild that a person may not even realize they are having one. Some are so severe that they can cause immediate death. The symptoms can, but may not always, include chest pain or pain in the left arm, shortness of breath, tiredness, heartburn or nausea, or there could be no symptoms at all. The most common type of heart attack is called ventricular fibrillation. Ventricular fibrillation occurs when there is an uncoordinated series of contractions of the heart muscles that prevent the heart from pumping blood.

A stroke is very similar to a heart attack, except that it is a blockage of an artery leading to the brain. The symptoms of a stroke can, but may not always, include a sudden headache, slurred speech, vision problems, dizziness, and sudden weakness of the face, arm, or leg. The severity of a stroke depends on the area of the brain that was affected and the duration. Without oxygen, brain damage can occur within four to six minutes.

Diets rich in fatty foods and a sedentary (non-active) lifestyle are significant risk factors for heart disease. Although drugs alone can often bring cholesterol down to normal levels to help prevent heart disease, diet and exercise provide benefits that drugs do not. Together, they help lower blood pressure, reduce weight, and lower the risk of developing diabetes. As with high blood pressure, exercise, quitting smoking, eating a high-fibre, low-fat diet, controlling body weight, and learning to cope with stress all help reduce the risk of heart disease.

Atherosclerosis

Atherosclerosis is a disease in which a sticky substance called plaque builds up on the inside walls of arteries. Plaque is made up of fat, cholesterol, calcium, and other substances found in the blood.

Over time, plaque hardens and narrows your arteries, limiting the flow of oxygen-rich blood to your organs and other parts of your body. If the coronary arteries become too narrow, blood flow to the heart can slow down or stop. This can cause chest pain, shortness of breath, heart attack, and other symptoms. Pieces of plaque can also break off and move through the bloodstream and become stuck, causing a blockage in other vessels. This is called an embolism. If the clot occurs in an artery in the heart, lungs, or brain, it can cause a heart attack or stroke.

To prevent atherosclerosis, it is recommended that people eat well-balanced meals that are low in fat and cholesterol and include several daily servings of fruits and vegetables. Other lifestyle changes include limiting alcohol to one or two alcoholic drinks per day, and getting regular exercise.

Support Questions

61. Identify the disorder of the circulatory system.

Suggested answer

Disorder	Description
1.	It can cause strokes, heart attacks, and heart and kidney failure, and is referred to as the silent killer.
2.	A reduction in the blood flow to the heart. The reduction is usually the result of a blockage caused by an accumulation of fat or cholesterol in the bloodstream.
3.	A blockage of an artery leading to the brain.
4.	A partial blockage of the arteries leading to the heart, causing discomfort and mild chest pain. The symptoms disappear after a few minutes of rest.
5.	A disease in which plaque builds up inside the arteries.

Medical Technologies for Disorders of Internal Systems

As you have learned in this lesson, many disorders of internal systems create severe hardships for people and society. There are also enormous economic costs. The annual health care costs in Canada due to heart disease, stroke, type 2 diabetes, and lung cancer alone are in the tens of billions. To reduce these costs and to improve the lives of Canadians, there are new scientific and technological developments to help prevent, diagnose, or treat these internal disorders. In the next sections, you will examine some of the more important new technologies available to deal with these disorders.

Imaging and Diagnosis

Endoscopy

Endoscopy is a broad term used to describe examining the inside of the body using a lighted, flexible instrument called an endoscope (Figure 12.4).

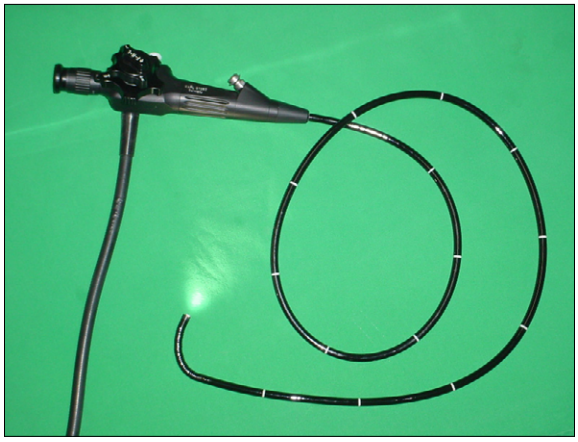


Figure 12.4: Endoscope showing the flexible tube with the light at its end
Source: Wikimedia Commons

Endoscopy provides an image for visual inspection and photography, and can also be used to take biopsies and retrieve foreign objects. In general, an endoscope is introduced into the body through a natural opening like the mouth or anus. Although endoscopy can include examination of other organs, the most common endoscopic procedures evaluate the esophagus, stomach, and portions of the intestine. Endoscopy is considered minimally invasive surgery. Many endoscopic procedures are considered to be relatively painless and, at worst, associated with mild discomfort. For example, in an endoscopy of the esophagus, most patients undergo the procedure with only a local anesthetic applied to the pharynx with a spray.

Two-Photon Microscopy

During the past two decades, new techniques have been developed to see deeper inside the tissue and even look inside living tissue. One new technique is called nonlinear optical microscopy, or two-photon microscopy. Two-photon microscopy allows for cellular imaging several hundred microns deep with no blurring of the image. It can produce stunning images of living tissue in colour or black and white (Figure 12.5). This new imaging technique can be used to improve health professionals' ability to locate and analyze rare types of cancerous cells.

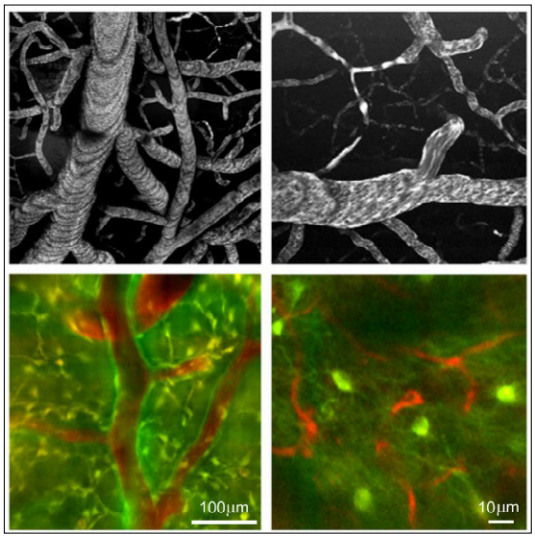


Figure 12.5: Images of blood vessels and nerve cells in a living human brain obtained using two-photon microscopy

Source: Wikimedia Commons

Imaging Technologies

Magnetic resonance imaging (MRI) is a process in which the nuclei of certain atoms absorb energy from an external magnetic field to produce an image. The images can be of living or dead tissue. MRI machines can be used to diagnose injuries and diseases such as metabolic liver disease and atherosclerotic vascular disease in their early stages, as well as to assess blood flow in major vessels and aneurysms (Figure 12.6).

Figure 12.6: MRI image showing blood vessels in upper chest and head

Source: Wikimedia Commons

MRI is one of several non-invasive imaging technologies that produce three-dimensional views of organs, tissues, and bones, providing valuable information on internal body systems. Imaging equipment, like an MRI machine, is expensive to buy, operate, and maintain, so it is usually available only in large urban centres with high demand.

Treatments

Stents and Angioplasty

A stent is a small mesh tube that is used to treat narrowed or weakened arteries in the body. Stents are placed in an artery as part of a procedure called angioplasty (Figure 12.7). Angioplasty restores blood flow by inserting an inflatable balloon into narrowed or blocked arteries, which are stretched open when the balloon is inflated. The stent is stretched by the balloon so that it opens up the artery. When the balloon is deflated and removed, the stretched stent remains in place to keep the artery open.

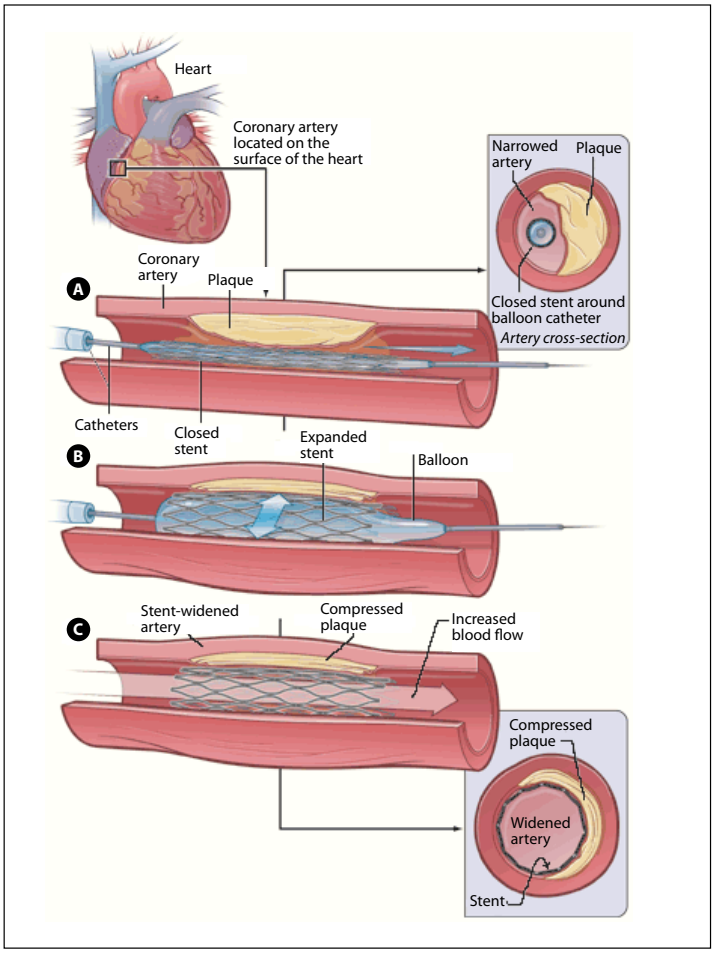


Figure 12.7: An angioplasty puts a stent into an artery to compress the plaque against the artery wall and create more room for blood to flow.

Source: Wikimedia Commons

Stents help prevent the arteries from becoming narrowed or blocked again in the months or years after angioplasty. Stents can also be placed in a weakened artery to improve blood flow and to help prevent the artery from bursting. Stents are usually made of metal mesh, but sometimes they are made of fabric. Fabric stents, also called stent grafts, are used in larger arteries. Some stents are coated with medicine that is slowly released into the artery; these are called drug-eluting stents. The medicine helps prevent the artery from becoming blocked again.

Nanotechnology

Nanotechnology is the science of designing, producing, and using devices having dimensions of about 100 millionth of a millimetre (100 nanometres) or less. One application of nanotechnology in medicine involves employing tiny nanoparticles to deliver drugs, heat, light, or other substances to specific types of cells. For example, nanoparticles can be engineered to destroy cancer cells. Once delivered to the targeted cancer cells, the nanoparticles can be activated by X-rays so they generate electrons that destroy the cancer cells to which they have attached themselves. This treatment is intended to replace radiation therapy, as it causes much less damage to the healthy tissue surrounding the tumour.

Scientists are also working to create nanostructures that can act as new kinds of drugs for treating cancer, Parkinson's, and cardiovascular disease. Other applications include creating nanomaterials for use as artificial tissues that would replace diseased kidneys and livers, and help build new prosthetic limbs. Finally, tiny machines called nanodevices are being designed to work with the nervous system to repair nerve damage and create implants that restore vision and hearing.

Organ Transplants

During the last 20 years, important medical breakthroughs such as tissue typing and development of immunosuppressive drugs have led to more successful organ transplants and a higher survival rate for transplant recipients. Transplants of kidneys, livers, hearts, lungs, pancreases and small bowels are now considered an accepted part of medical treatment. Bone marrow transplants are saving lives, corneal transplants are restoring sight, and medical miracles are happening every day. Unfortunately, the need for organ transplants continues to exceed the organ supply. But as medical technology improves, and more donors become available, thousands of people each year will live longer and better lives.

Support Questions

62. Identify the cutting-edge technology. Suggested answer

Technology	Description
1.	Examining the inside of the body using a lighted, flexible instrument that provides an image for visual inspection and photography, and can also be used to take biopsies and retrieve foreign objects.
2.	These tiny particles are engineered to deliver drugs, heat, light, or other substances to specific types of cells (such as cancer cells).
3.	This allows for cellular imaging several hundred microns deep in various organs of living tissue with no blurring of the image.
4.	A process in which the nuclei of certain atoms absorb energy from an external magnetic field.
5.	A small mesh tube that is used to treat narrowed or weakened arteries in the body.
6.	Important medical breakthroughs such as tissue typing and development of immunosuppressive drugs have enabled this procedure to achieve better success rates.

Activity: Fetal Pig Anatomy

Dissections of animals help us understand our bodies and how they function. The following online activity will enable you to learn about the internal systems of mammals using a virtual dissection of a fetal pig. The fetal pig is used because it is an organism whose internal anatomy is very similar to a human's.

Now do this activity called Fetal Pig Anatomy, then answer the following Support Questions.

Support Questions

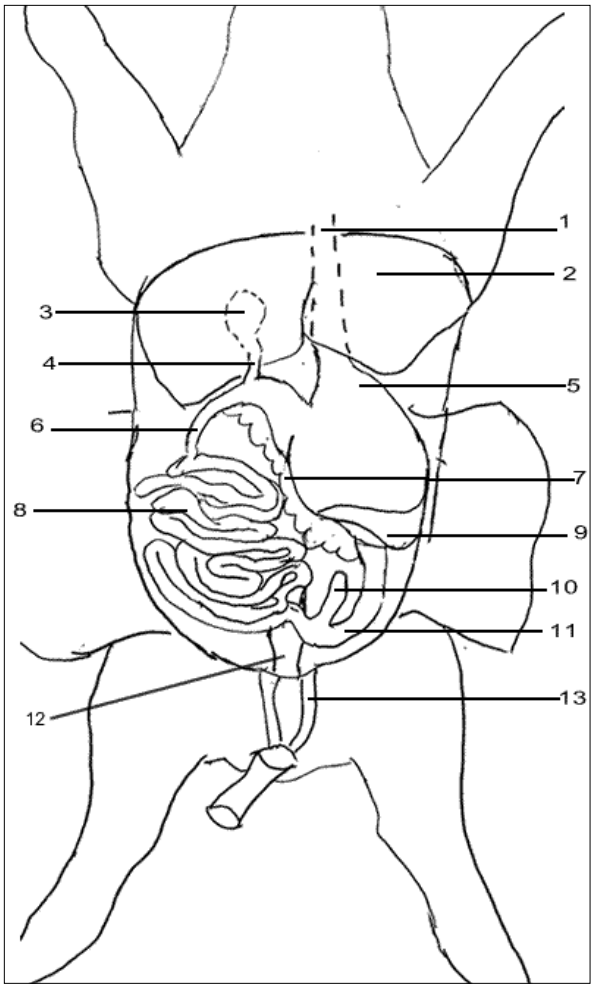


Diagram showing the internal anatomy of a fetal pig

63. Identify the 13 structures numbered in the diagram.

Suggested answer

64. Identify the organ or structure of the digestive system. Suggested answer

Organ or structure	Description
1.	The opening (valve) between the stomach and small intestine.
2.	This organ stores bile, and lies underneath the liver.
3.	A branch of the large intestine; a dead end.
4.	This muscle separates the thoracic and abdominal cavities, and aids in breathing.
5.	The membrane that holds the coils of the small intestine.
6.	The straight part of the small intestine just after the stomach.
7.	This structure empties bile into the duodenum from the gallbladder.
8.	The last stretch of the large intestine before it ends at the anus.
9.	A bumpy structure located under the stomach, this organ makes insulin.

65. Identify the organ or structure found in the thoracic cavity. Suggested answer

Organ or structure	Description
1.	The membrane covering the heart
2.	The airway connecting the mouth and lungs
3.	The lower chambers of the heart
4.	The large vessel at the top of the heart
5.	The arteries on the surface of the heart
6.	The upper chambers of the heart

Key Questions

Now work on your Key Questions in the online submission tool. You may continue to work at this task over several sessions, but be sure to save your work each time. When you have answered all the unit's Key Questions, submit your work to the ILC.

(17 marks)

35. List two disorders caused by lifestyle choices for each of the following systems:

a) Digestive

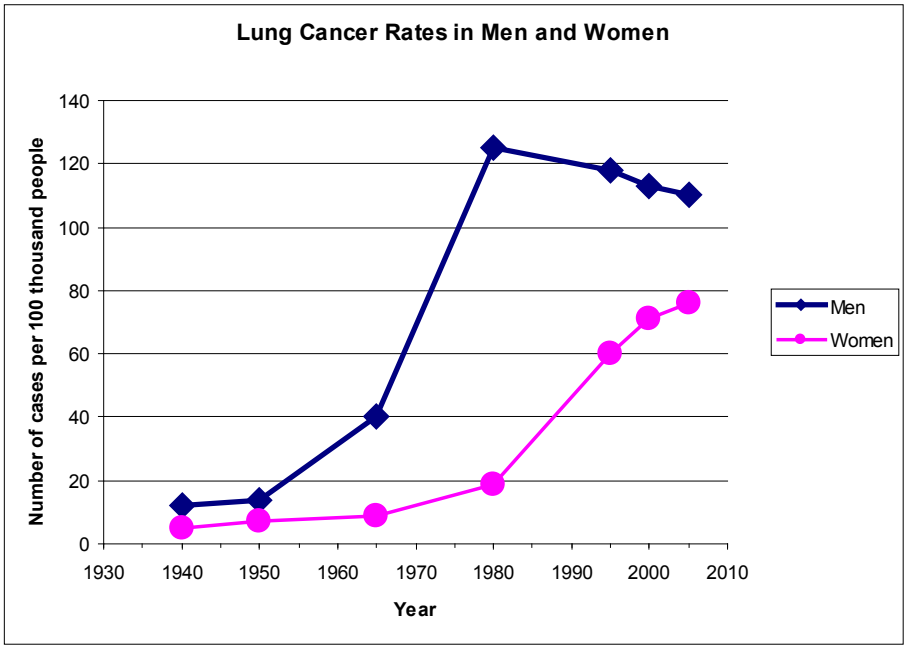
b) Respiratory

c) Circulatory

(6 marks: 2 marks for each)

36. North Americans have among the highest rates of colon cancer in the world. Rates of type 2 diabetes and cardiovascular disease are also among the highest in the world. Give two reasons why these rates are so high, and explain how they could be reduced. **(3 marks: 2 marks for the reasons, 1 mark for the explanation)**

37. Lung cancer is the leading cause of cancer-related death in Canada in both men and women. Interpret the information presented in the following graph.



Lung cancer occurrences in males and females from 1940 to 2005

a) Compare the trends of men and women between 1980 and 2005. Suggest a reason why the trends are there. **(2 marks: 1 mark for the trend, 1 mark for the explanation)**

b) Based on the graph, predict trends in lung cancer rates for men and women from 2005 to 2015. **(2 marks)**

38. Describe two ways that the internal anatomy of the fetal pig differs from that of a human. **(4 marks: 2 marks for each difference)**

This is the last lesson in Unit 3. When you have completed all the Key Questions, submit your work to the ILC. A teacher will mark it and you will receive your results online.