

Practice 6.5 (page 218)

Understanding Concepts

1. When acids enter the small intestine, prosecretin is converted to secretin. Secretin signals the pancreas to release bicarbonate ions, which buffer HCl. The basic pH inactivates pepsin.
2. Trypsinogen and erepsins are enzymes secreted by the pancreas that promote protein digestion. Amylase enzymes are secreted by the pancreas and continue carbohydrate digestion. Lipases are also secreted by the pancreas and aid in lipid digestion.
3. In protein digestion, the pancreas secretes trypsinogen, a protein-digesting enzyme. When trypsinogen reaches the small intestine, an enzyme called enterokinase converts the inactive trypsinogen into trypsin, which breaks down long-chain peptides into shorter-chain peptides. The pancreas and small intestine also release erepsins, which break down the shorter-chain peptides into individual amino acids.
In carbohydrate digestion, the pancreas releases amylase enzymes, which continue the digestion of carbohydrates begun in the mouth by salivary amylase. The intermediate-size chains are broken down into disaccharides. The small intestine releases disaccharidases, which complete the digestion of carbohydrates. Carbohydrates are not digested in the stomach because the acidic environment makes amylase inactive. The stomach doesn't produce carbohydrate-digesting enzymes.
4. Pancreatic lipase breaks down fats into fatty acids and glycerol. Phospholipase acts on phospholipids. Since lipase breaks down lipids into their basic components, fatty acids and glycerol, the breakdown is complete.
5. When acids enter the duodenum, prosecretin is converted into secretin, which enters the bloodstream and signals the pancreas to produce bicarbonate ions. These bicarbonate ions neutralize the HCl and create a basic environment in the duodenum. This basic pH level renders pepsin inactive.
6. Not as much absorption takes place and more material is passed on to the large intestine. Therefore, overall food energy intake is reduced.

Investigation 6.5.1 (pages 219–222)

Part 1

- (a) Starch digestion occurred in the test tube at pH 7, this was indicated by the colour change of the solution.
- (b) Test tube 1 was the control.
- (c) Amylase works best to control starch digestion at pH 7.

Part 2

- (a) Overheating would have caused the enzyme to be altered; starch digestion would have been arrested or inhibited. The ability of the enzyme to convert starch to sugar was maximized in the beaker kept at room temperature.
- (b) Test tubes 2, 4, and 6 were controls.
- (c) Amylase works best to convert starch to sugar near 37°C. Thus amylase worked best in the beaker kept at room temperature, which approached 37°C when immersed in the hot water bath.
- (d) The enzyme concentration may not be exactly the same in all test tubes, nor is the concentration quantified. Also, the measured amount of suspension might not be consistent in all test tubes.

- (e) The conditions are similar because the enzymes used and the hydrolysis reaction occur in both the experiment and the digestive system. The conditions are different in that within the digestive system the temperature does not fluctuate, and enzymes are released on demand in the stomach (the release of enzymes is controlled by hormones and nerves).

Sections 6.4–6.5 Questions (page 222)

1. Amylase initiates the breakdown of carbohydrates, and pepsin initiates the breakdown of proteins.
2. Most are linked to bacteria. Pepsin and stomach acids destroy the cells lining the stomach. This may occur if the mucous cells are impaired, or if an emulsifying agent reduces the protective covering.
3. If they were stored in active form, they would digest proteins and long chain peptides even in the absence of food. Erepsins can be stored in active form because they only act on partially digested proteins, therefore cells with intact proteins are not at danger.
4. Enzymes that function best at pH 2 would be found in the stomach; enzymes that function best at pH 7 would be found in the mouth.
5. The lower pH of the stomach changes the shape of the amylase from the mouth, making it inactive. The advantage of this process is that the energy in complex carbohydrates can be stored in the body until that energy is required.
6. A mouth with a pH of 5 would have more tooth decay than a mouth with a pH of 7. Acids, produced by bacteria, cause tooth decay.
7. Proteins have 20 different components. There are many differently shaped bond sites joining different amino acids. Each bond site requires an enzyme of a specific shape. The components of fats and complex-carbohydrates have greater similarity, and thus they are broken down more easily.
8. Antacids buffer the excess acids in the stomach. Excess acids are neutralized; however, the condition may result in the stomach cells producing even more acids.

Practice 6.6 (page 224)

1. The liver continually produces bile, which is composed of bile salts and pigments. When the stomach is empty, bile is stored in the gall bladder. When there are fats in the stomach, the gall bladder releases bile salts.
2. Bile contains bile salts, which emulsify fats, physically breaking fats down into smaller droplets. This provides more surface area upon which fat-digesting enzymes can work.
3. Fat is a non-polar molecule (it has no charged poles) while water is polar (it has charged poles). Polar solvents only dissolve polar solutes.
4. The liver can make harmful chemicals soluble so that they can be dissolved in the blood and eliminated in the urine. The liver breaks down alcohol to usable materials and wastes. If toxin levels are high, liver cells can be damaged. Damaged liver cells are replaced by connective tissue and fat, which are not able to carry out normal liver duties.

Practice 6.7 (page 226)

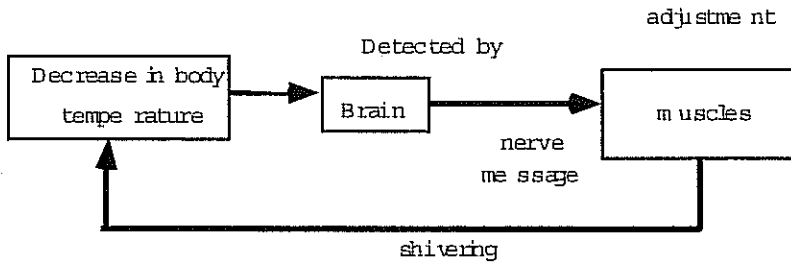
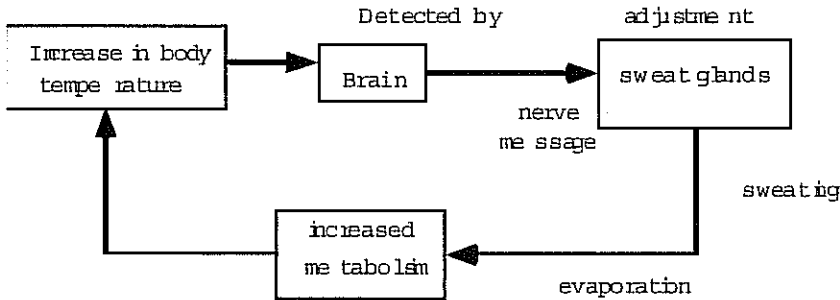
1. The colon is the largest segment of the large intestine. Water reabsorption occurs in the colon.
2. Cellulose provides bulk. A build-up of wastes in the large intestine triggers a bowel movement. Bowel movements are important because they ensure that potentially

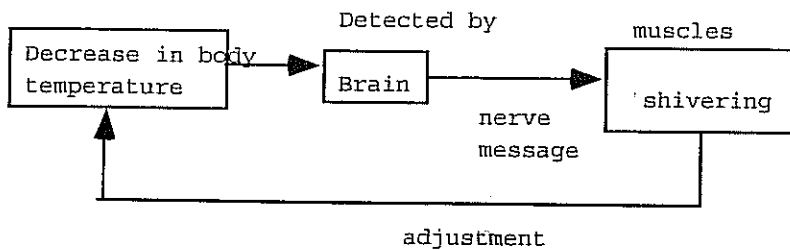
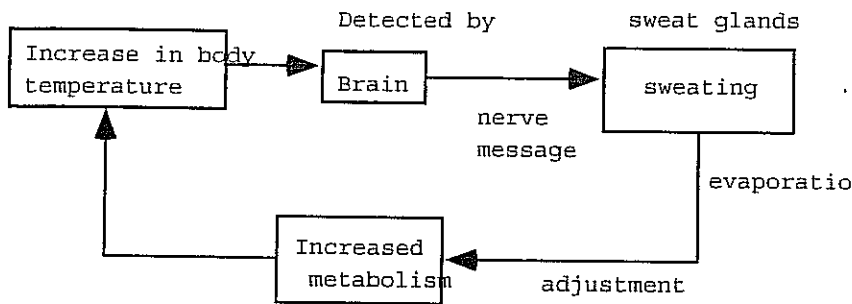
toxic wastes are removed from the body. Individuals who do not eat sufficient amounts of roughage or fibre have fewer bowel movements.

- The small intestine is lined with long fingerlike tubes called villi, which are in turn covered with fine, threadlike extensions of the membrane called microvilli. Both villi and microvilli increase surface area for absorption.

Practice 6.8 (page 228)

- Homeostasis is a process by which a constant internal environment is maintained despite changes in the internal and external environment
- A thermostat is a mechanical homeostatic device. As the temperature begins to drop, the bimetallic strip begins to uncoil. The uncoiling separates the magnet from the stationary bar, causing the glass-enclosed contact points to come together. This completes the electric circuit and turns on the furnace. When the temperature increases, the bimetallic bar coils and causes the contact points to separate, turning the furnace off. The system of active balance requires constant monitoring or feedback about body conditions. Similarly, the body has special receptors that sense information about blood sugar, body temperature, oxygen levels, and many other body conditions. When homeostasis is disrupted, a monitor sends a signal to the coordinating centre (the brain) where the normal limits are set. The brain relays the information to the appropriate regulator, which helps restore balance.
- When partially digested proteins are in the stomach, the hormone gastrin is released. Gastrin stimulates the release of gastric juices which digest proteins.
- Here are two possible arrangements of the terms:





Sections 6.7–6.8 Questions (pages 229–230)

1. Bile salts emulsify, or physically break down, large fat globules. This occurs in the small intestine. Physical digestion prepares the fat for chemical digestion by increasing the exposed surface area on which fat-digesting enzymes, such as pancreatic lipase, can work.
2. When there are fats in the small intestine, the hormone cholecystokinin (CCK) is released. CCK is carried in the blood to the gall bladder and triggers the gall bladder to release bile salts.
3. Each villus is supplied with a capillary network that intertwines with lymph vessels called lacteals that transport materials. Some nutrients are absorbed by diffusion, others are actively transported. Carbohydrates and amino acids are absorbed into the capillary networks; fats are absorbed into the lacteals.
4. Monosaccharides are carried across the membrane of the microvilli by active transport. Once inside the cells of the microvilli, the sugars are secreted into the blood capillaries within the villus and then carried in the blood. Amino acids are absorbed through the walls of the villi and then secreted into the blood capillaries. Fats are broken down into fatty acids and glycerols by pancreatic lipase. These molecules combine with bile salts to form fat droplets. These droplets penetrate the cells of the villi where they are secreted into the lacteals. From there they are carried into the lymphatic system and then enter the venous blood system.
5. Control over digestive fluids is exerted by the nervous and hormonal systems and the nerves in the stomach wall. Seeing, smelling, or tasting food, and even just swallowing motions all stimulate production of gastric juices, regardless of whether food is actually swallowed.
6. Hormones signal the release of gastric juices in the gastrointestinal tract. Some hormones also slow peristalsis, allowing greater time for digestion. Some hormones initiate the release of acids that activate or inactivate enzymes.
7. Gallstones are caused by the precipitation of bile salts, forming crystals in the gall bladder. Gallstones can block the bile duct, preventing bile from reaching the small intestine, impairing the digestion of fats and causing considerable pain.