

Carbohydrates: Plant-Derived Energy Nutrients

Chapter Summary

Carbohydrates are one of the three macronutrient types that provide energy to our bodies. They contain carbon, hydrogen, and oxygen. Simple carbohydrates include monosaccharides, such as glucose, fructose, and galactose. Ribose is a monosaccharide produced by the body and found in genetic material of cells. Two monosaccharides joined together by alpha or beta bonds form the disaccharides lactose, maltose, and sucrose. Oligosaccharides are complex carbohydrates that contain three to ten monosaccharides. Complex carbohydrates are polysaccharides. Starch is a polysaccharide used for glucose storage in plants. Glycogen is the storage form of glucose in animals and helps maintain blood glucose levels and provides energy during exercise.

Dietary fiber forms the support structures of plants and is nondigestible in humans. Functional fiber is nondigestible carbohydrates extracted from plants or manufactured. Both may reduce the risk of many diseases and digestive conditions. Carbohydrate digestion begins in the mouth and continues in the small intestine. Specific enzymes break down polysaccharides and disaccharides into monosaccharides. Glucose and other monosaccharides are absorbed into the bloodstream and travel to the liver, where nonglucose sugars are converted to glucose. Glucose is either used by the cells for energy or is converted to glycogen and stored in the liver and muscle for later use or stored as fat. Insulin assists with the transport of glucose into the cells. When blood glucose levels are low, glucagon and other hormones assist in the conversion of glycogen to glucose, gluconeogenesis, and reducing the use of glucose by muscles and organs. The glycemic index and glycemic load are values that indicate the potential of foods to raise blood glucose and insulin levels. The higher the glycemic index/load, the larger the increase in blood glucose and insulin levels, although use of these two for making dietary decisions is controversial. All cells can use glucose as energy, but red blood cells, the brain, and the central nervous system prefer to use glucose exclusively.

Carbohydrates provide energy during exercise, help spare body protein, prevent ketosis, and provide 4 kcal of energy per gram. Complex carbohydrates contain fiber and other nutrients that can reduce the risk for obesity, colon cancer, heart disease, and diabetes. Fiber also helps to prevent hemorrhoids, constipation, and diverticulosis and may assist with weight loss. The RDA for carbohydrate is 130 grams per day, and the AMDR is 45–65% of total energy intake. Added sugars—sugars and syrups added to foods during processing—can cause tooth decay, elevate triglycerides and LDLs, and contribute to obesity. The Adequate Intake for fiber is 25 grams per day for women and 38 grams for men. Foods high in fiber and complex carbohydrates include whole grains and cereals, fruits, vegetables, and legumes. Alternative sweeteners can be used in place of sugar to sweeten foods without

promoting tooth decay and contributing little or no energy. There are a variety of alternative sweeteners that are safe if eaten in quantities below the ADI.

Diabetes is a chronic disease caused by insufficient insulin or by the cells becoming resistant or insensitive to insulin. Diabetes causes dangerously high blood glucose levels. The two primary types of diabetes are type 1, a disorder in which the body cannot produce enough insulin, and type 2, the more common type occurring when body cells become resistant to insulin. Type 1 diabetics must take daily insulin injections. Type 2 diabetics may need insulin but can sometimes control their disease with changes in lifestyle. In both types of diabetes, strict control of blood glucose is necessary to minimize complications such as heart disease, blindness, kidney disease, and amputations. Hypoglycemia is lower-than-normal blood glucose, which may result from too much insulin being secreted (reactive hypoglycemia) or from blood glucose levels dropping even when a person has eaten (fasting hypoglycemia). Lactose intolerance results from the inability to digest lactose due to insufficient amounts of the enzyme lactase.

Nutrition Myth or Fact addresses the question: Are added sugars the cause of the obesity epidemic?

Learning Objectives

After studying this chapter, the student should be able to:

1. Compare and contrast simple and complex carbohydrates (pp. 113–114).
2. Describe the difference between alpha and beta bonds, and discuss how these bonds are related to the digestion of fiber and lactose intolerance (pp. 114–116).
3. Explain the properties and health benefits of the soluble and insoluble fibers found in fiber-rich carbohydrate foods (pp. 118–119).
4. Discuss how carbohydrates are digested and absorbed by the body (pp. 119–121).
5. List four functions of carbohydrates in the body (pp. 125–126).
6. Define the RDA and AMDR for carbohydrates and the AI for fiber (pp. 128–129).
7. Identify the potential health risks associated with diets high in added sugars (pp. 129–131).
8. List four types of foods that are generally good sources of fiber (pp. 131–133).
9. Identify several alternative sweeteners, and discuss their role in a healthful diet (pp. 137–138).
10. Describe type 1 and type 2 diabetes, and discuss how diabetes differs from hypoglycemia (pp. 142–145).

Key Terms

Acceptable Daily Intake
added sugars
alpha bond
beta bond
carbohydrates
complex carbohydrate

diabetes
dietary fiber
disaccharide
enriched foods
fermentation
fiber-rich carbohydrates

fortified foods
fructose
functional fiber
galactose
glucagon
glucose

glycemic index	levulose	salivary amylase
glycemic load	maltase	simple carbohydrate
glycogen	maltose	soluble fibers
hyperglycemia	mannitol	sorbitol
hypoglycemia	monosaccharide	stachyose
impaired fasting glucose	non-nutritive sweeteners	starch
insoluble fibers	nutritive sweeteners	sucrase
insulin	oligosaccharides	sucrose
ketoacidosis	pancreatic amylase	total fiber
ketones	photosynthesis	type 1 diabetes
ketosis	polysaccharide	type 2 diabetes
lactase	pre-diabetes	viscous
lactose	raffinose	xylitol
lactose intolerance	ribose	

Chapter Outline

I. What Are Carbohydrates?

- A. Carbohydrates are one of the three macronutrients and are an important energy source for the body.
 1. Carbohydrates contain carbon, hydrogen, and oxygen.
 2. We obtain carbohydrates predominately from plant foods.
 - a. Plants make glucose through photosynthesis.
 3. Carbohydrates can be classified as simple or complex.
 - a. Simple carbohydrates contain one or two molecules.
 - b. Complex carbohydrates contain hundreds to thousands of molecules.
- B. Simple carbohydrates include monosaccharides and disaccharides.
 1. Simple carbohydrates are commonly referred to as sugars.
 - a. Four of these sugars are monosaccharides because they consist of a single sugar molecule.
 - b. The three other sugars are disaccharides, which consist of two molecules of sugar joined together.
 2. Glucose, fructose, galactose, and ribose are monosaccharides.
 - a. Glucose, fructose, and galactose contain 6 carbon atoms, 12 hydrogen atoms, and 6 oxygen atoms.
 - i. Glucose is the preferred source of energy for the brain and is a very important energy source for all cells but seldom occurs alone.
 - ii. Fructose (also called levulose, or fruit sugar) is the sweetest natural sugar, occurs naturally in fruits and vegetables, and is used in many processed foods.
 - iii. Galactose joins with glucose to create lactose, one of the three most common disaccharides.
 - b. Ribose contains five carbons and is produced by the body rather than consumed.
 3. Lactose, maltose, and sucrose are disaccharides.
 - a. Lactose consists of one glucose molecule and one galactose molecule and is found in cow's milk and, more abundantly, in human breast milk.

- b. Maltose consists of two glucose molecules and is a by-product of the breakdown of larger molecules in the body and also fermentation of sugar to form alcohol.
 - c. Sucrose is composed of one glucose molecule and one fructose molecule and is the sweetest disaccharide.
4. Alpha and beta bonds attach two monosaccharides to form a disaccharide.
 - a. Sucrose and maltose contain alpha bonds, which are easily digestible.
 - b. Lactose and high-fiber foods contain beta bonds, which are difficult to digest.
- C. Oligosaccharides and polysaccharides are complex carbohydrates.
1. Complex carbohydrates consist of long chains of glucose molecules.
 2. Oligosaccharides contain few (3 to 10) monosaccharides and are found in beans and other vegetables.
 - a. Raffinose and stachyose are the two most common oligosaccharides.
 - b. Oligosaccharides are digested by fermentation in the large intestine.
 3. Polysaccharides consist of hundreds of thousands of glucose molecules and include starch, glycogen, and most fibers.
 4. Starch is a polysaccharide stored in plants.
 - a. Amylose is a straight-chain starch and is more slowly digested than the branched chain amylopectin.
 - b. Grains, legumes, and tubers are all excellent sources of starch.
 - c. Starches that contain beta bonds are called resistant starches and may be beneficial to health.
 5. Glycogen is a polysaccharide stored by animals.
 6. Fiber is a polysaccharide that gives plants their structure.
 - a. Dietary fiber is the nondigestible part of plants that forms the support structures of leaves, stems, and seeds.
 - b. Functional fiber consists of nondigestible forms of carbohydrates that are extracted from plants or manufactured in the laboratory and have known health benefits.
 - c. Total fiber is the sum of dietary fiber and functional fiber.
 - d. Soluble fibers dissolve in water, are viscous, form gels, and are fermentable.
 - i. They are associated with reducing the risk of cardiovascular disease and type 2 diabetes.
 - ii. Examples include pectins, fructans, gums, and mucilages.
 - e. Insoluble fiber does not dissolve in water, is nonviscous, and cannot be fermented by bacteria in the colon.
 - i. It is known for promoting regular bowel movements, alleviating constipation, and reducing risk for diverticulosis.
 - ii. Examples include lignins, cellulose, and hemicelluloses.
 - f. Fiber-rich carbohydrates are a group of foods containing either simple or complex carbohydrates that are rich in dietary fiber and are known to contribute to good health.

Key Terms: carbohydrates, glucose, photosynthesis, simple carbohydrate, monosaccharide, disaccharide, fructose, levulose, galactose, ribose, lactose, maltose, fermentation, sucrose, alpha bond, beta bond, complex carbohydrate, oligosaccharides, raffinose, stachyose, poly-

saccharide, starch, glycogen, dietary fiber, functional fiber, total fiber, soluble fibers, viscous, insoluble fibers, fiber-rich carbohydrates

Figures and Table:

Figure 4.1: Plants make carbohydrates through the process of photosynthesis.

Figure 4.2: The three most common monosaccharides.

Figure 4.3: Galactose, glucose, and fructose join together in different combinations.

Figure 4.4: The two monosaccharides that compose a disaccharide are attached by either an alpha bond or a beta bond.

Figure 4.5: Polysaccharides, also referred to as complex carbohydrates, include starch, glycogen, and fiber.

Table 4.1: Nutrient Comparison of Four Different Sugars

II. How Does the Body Break Down Carbohydrates?

- A. Digestion breaks down most carbohydrates into monosaccharides.
 - 1. Starch digestion begins in the mouth through the action of salivary amylase.
 - 2. Most carbohydrate digestion occurs in the small intestine.
 - a. Pancreatic amylase digests any remaining starch to maltose.
 - b. Additional enzymes break down disaccharides into monosaccharides.
 - c. Maltase, sucrase, and lactase break down maltose, sucrose, and lactose, respectively.
 - 3. Monosaccharides are absorbed through intestinal mucosal cells into the bloodstream.
 - a. Glucose and galactose are absorbed by active transport, requiring energy.
 - b. Fructose is absorbed by facilitated diffusion, requiring no energy but more time.
- B. The liver converts most non-glucose monosaccharides into glucose.
 - 1. The liver releases glucose into the bloodstream if needed for immediate energy.
 - 2. If there is no immediate demand for glucose, it is stored as glycogen.
 - 3. The liver can break down glycogen when energy is required and no glucose is present.
 - 4. Muscle glycogen continuously provides energy to the muscles, especially during intense exercise.
 - 5. When glycogen storage capacity is reached, glucose can be stored as fat.
- C. Fiber is excreted from the large intestine.
 - 1. Fiber enters the large intestine undigested because the small intestine does not possess enzymes to break it down.
 - 2. Bacteria break down some previously undigested carbohydrates by fermentation.
 - 3. The fiber remaining in the colon provides bulk to stools.
- D. A variety of hormones regulate blood glucose levels.
 - 1. Insulin lowers blood sugar by facilitating uptake of glucose by body cells.
 - a. Glucose molecules are too large to cross the cell membrane.
 - b. Insulin acts as a “key” to assist glucose in entering the cells.
 - c. Insulin stimulates the liver and muscles to store excess glucose as glycogen.
 - 2. Glucagon raises blood glucose by causing the liver to convert its stored glycogen into glucose and stimulating gluconeogenesis.

3. Epinephrine and norepinephrine increase glycogen breakdown and gluconeogenesis.
 4. Cortisol increases gluconeogenesis and decreases use of glucose by muscles and organs.
 5. Growth hormone decreases glucose uptake by muscle, and increases use of fatty acids and release of glucose by the liver.
- E.** The glycemic index shows how foods affect our blood glucose levels.
1. The glycemic index refers to the potential for individual foods to raise blood sugar as compared to pure glucose.
 2. Preparation, fat, and fiber content, and combination with other foods, all affect glycemic index.
 3. Glycemic load is the amount of carbohydrate in a food times the glycemic index and may be a more useful tool.
 4. Despite encouraging research on eating foods with a lower glycemic index/load, using either as a tool still remains controversial.

Key Terms: salivary amylase, pancreatic amylase, maltase, sucrase, lactase, insulin, glucagon, glycemic index, glycemic load

Nutrition Animations: Carbohydrate Absorption; Carbohydrate Digestion; Hormonal Control of Blood Glucose (located in IR-DVD folder)

Figures:

Figure 4.6: Carbohydrate Digestion Overview

Figure 4.7: Glucose is stored as glycogen in both the liver and muscle.

Figure 4.8: Regulation of Blood Glucose

III. Why Do We Need Carbohydrates?

- A.** Carbohydrates provide energy.
1. Carbohydrates provide 4 kcal per gram as a fuel source of cells.
 2. Red blood cells, the brain, and nerve tissue primarily rely on glucose for energy.
 3. Carbohydrates fuel daily activity.
 - a. The body relies on a combination of carbohydrates and fat to fuel daily activity.
 - b. Fat is the primary source of fuel during rest or low-intensity activity.
 4. Carbohydrates fuel exercise.
 - a. As the intensity of exercise increases, the percentage of carbohydrates used to fuel the exercise increases because glucose is burned with or without oxygen.
 - b. When carbohydrate intake is insufficient, the body will use protein and fat as energy sources.
 5. Low carbohydrate intake can lead to ketoacidosis.
 - a. Ketones are an alternative fuel produced from fat when carbohydrate intake is inadequate.
 - b. Ketones are used as an energy source for the brain when there is inadequate glucose.
 - c. The presence of excessive ketones in the blood leads to ketoacidosis.
 - d. Ketoacidosis increases the acidity of the blood, damages body tissues, and can lead to coma and death.

6. Low carbohydrate intake can lead to ketoacidosis.
 - a. When we don't eat enough carbohydrates a process called ketosis occurs whereby the body begins to break down stored fat to produce an alternative fuel called ketones.
 - b. If inadequate carbohydrate intake continues for an extended period, the body will produce excessive amounts of ketones leading to a dangerous condition called ketoacidosis.
 7. Carbohydrates spare protein.
 - a. Gluconeogenesis is the generation of glucose from the breakdown of proteins into amino acids.
 - b. During fasting or very low carbohydrate dieting, the body first takes amino acids from the blood, and then from muscle tissue, which can result in severe organ damage.
- B. Fiber helps us stay healthy.**
1. Potential benefits of fiber consumption include:
 - a. Prevention of hemorrhoids and constipation
 - b. Reduced risk of diverticulosis
 - c. Reduced risk of colon cancer
 - d. Reduced risk of heart disease
 - e. Reduced risk of type 2 diabetes
 - f. Enhancement of weight loss

Key Terms: ketosis, ketones, ketoacidosis

Nutrition Animation: Diverticulosis and Fiber (located in IR-DVD folder)

Figures:

Figure 4.9: Amounts of carbohydrate and fat used during light, moderate, and intense exercise.

Figure 4.10: Diverticulosis occurs when bulging pockets form in the wall of the colon.

IV. How Much Carbohydrate Should We Eat?

- A. The RDA for carbohydrates is 130 grams per day to supply adequate glucose to the brain, not to support daily activity.
- B. The AMDR for carbohydrates is 45–65% of total energy intake to reduce risk of chronic disease and support activity.
 1. Most health agencies recommend that most carbohydrate choices be high in fiber.
 2. Eating the recommended servings for grains, fruits, and vegetables in the USDA Food Guide should ensure adequate fiber intake.
- C. Most Americans eat too much added sugar.
 1. The average person consumes 50% of Calories as carbohydrate, with as much as half being simple sugars.
 2. Added sugars are sugars and syrups that are added to food during processing or preparation.
 3. The most common source of added sugars in the U.S. diet is sweetened beverages.
 4. To figure out how much sugar is in processed food, find the line on the Nutrition Facts panel that identifies “Sugars” and divide the number of grams by 4 to get teaspoons.

- D.** Sugars are blamed for many health problems.
1. Sugar feeds bacteria that causes tooth decay.
 2. There is no link between sugar and hyperactivity in children.
 3. High sugar intake can lead to unhealthful levels of blood lipids.
 4. High sugar intake is associated with diabetes and obesity.
- E.** Most Americans eat too little fiber-rich carbohydrates.
1. On ingredient labels, whole wheat identifies unrefined flour, not wheat flour.
 2. A whole grain includes the bran, endosperm, and germ.
 - a. The bran is the outermost covering, is high in fiber, and contains most of the grain's vitamins and minerals.
 - b. The endosperm is the grain's midsection and contains most of the grain's carbohydrates and protein.
 - c. The germ sits deep in the base of the kernel, surrounded by the endosperm, and is rich in healthful fats and some vitamins.
 - d. Grains that are stripped of fiber contain fewer nutrients than the original.
 - e. Products are enriched to add back some of the lost nutrients lost during processing.
 - f. Products are fortified to add nutrients that were not originally present in the grain.
 3. We need at least 25 grams of fiber daily.
 - a. The AI for fiber is 25 daily grams for women, and 38 grams for men.
 - b. When increasing fiber intake, plenty of fluid is important to prevent constipation.
 - c. Excessive fiber can result in gas, bloating, constipation, dehydration, and reduced absorption of some minerals.
 4. To increase fiber in the daily diet:
 - a. Select whole-grain breads and cereals.
 - b. Buy fresh fruits and vegetables whenever possible.
 - c. Buy frozen fruits and vegetables when fresh produce is not available.
 - d. Choose canned fruits packed in juice and canned vegetables lower in sodium.
 - e. Eat legumes frequently.

Key Terms: added sugars, enriched foods, fortified foods

Figures and Tables:

Figure 4.11: How fiber might help decrease blood cholesterol levels.

Figure 4.12: Eating sugar can cause an increase in cavities and gum disease.

Figure 4.13: A whole grain includes the bran, endosperm, and germ.

Figure 4.14: Fiber content in common foods.

Figure 4.15: Maximizing Fiber Intake

Figure 4.16: Labels for two breakfast cereals

Table 4.2: Dietary Recommendations for Carbohydrates

Table 4.3: Terms Used to Describe Grains and Cereals on Nutrition Labels

V. What's the Story on Alternative Sweeteners?

- A. Nutritive sweeteners contribute Calories (energy).
 - 1. Sugar alcohols are nutritive sweeteners used in sugar-free gums and candies.
 - a. Examples include mannitol, sorbitol, isomalt, and xylitol.
 - 2. Sugar alcohols reduce glycemic response and decrease the risk of dental cavities.
 - 3. Although they provide fewer Calories than sugar, sugar alcohols are not completely absorbed by the intestine and are more likely to cause diarrhea.
- B. Alternative sweeteners are non-nutritive.
 - 1. Non-nutritive sweeteners are manufactured sweeteners that provide little or no energy.
- C. Limited use of alternative sweeteners is not harmful.
 - 1. The Acceptable Daily Intake (ADI) is an FDA estimate of the amount of a sweetener that is safe to consume daily.
 - 2. The ADI is typically well above the average human consumption.
 - 3. The major alternative sweeteners available today are:
 - a. Saccharin
 - i. After 20 years of research, saccharin no longer carries a cancer warning.
 - b. Acesulfame-K
 - i. Acesulfame-K can be used in cooking without losing its sweet taste.
 - ii. It is excreted unchanged by the kidneys.
 - c. Aspartame
 - i. Aspartame is made of amino acids, and its taste is destroyed by heat.
 - ii. Scientific studies do not support claims of negative health effects.
 - iii. People with the metabolic disorder phenylketonuria (PKU) cannot consume aspartame.
 - d. Sucralose
 - i. Sucralose is made of sucrose but passes through the digestive tract unchanged.
 - ii. It is 600 times sweeter than table sugar and is heat stable.
 - e. Neotame, Stevia, and Advantame
 - i. Neotame is an alternative sweetener that is 7,000 times sweeter than sugar.
 - ii. Stevia is 300 times sweeter than table sugar.
 - iii. Advantame is 20,000 times sweeter than sugar and is Calorie free.
- D. The effect of artificial sweeteners on weight management is unclear.

Key Terms: nutritive sweeteners, non-nutritive sweeteners, mannitol, sorbitol, xylitol, Acceptable Daily Intake (ADI),

Table:

Table 4.4: Foods and Beverages That a Child and an Adult Would Have to Consume Daily to Exceed the ADI for Aspartame

VI. What Disorders Are Related to Carbohydrate Metabolism?

- A. Diabetes is a result of impaired regulation of glucose.
 - 1. Hyperglycemia refers to higher-than-normal blood glucose levels.

- a. Diabetes is a chronic condition in which the body cannot regulate glucose and blood glucose levels become dangerously high.
 - b. Left untreated, diabetes can cause serious life-threatening complications.
 - c. Approximately 9.3% of the U.S. population has diagnosed diabetes.
2. Diabetes damages blood vessels.
- a. Increased glucose attaches to proteins that make up blood vessels causing them to dysfunction.
 - b. Damage to large blood vessels results in macrovascular complications, like cardiovascular disease.
 - c. Microvascular complications occur with damage to small blood vessels like those in the kidneys and eyes.
 - d. Neuropathy, damage to the nerves, can occur when blood vessels that supply nutrients and oxygen to the nerves are affected.
 - e. Because uncontrolled diabetes impairs carbohydrate metabolism, ketoacidosis is another complication.
3. In type 1 diabetes the body does not produce enough insulin.
- a. Type 1 diabetes is an autoimmune disease—the body’s immune system attacks and destroys its own tissues, the beta cells of the pancreas.
 - b. It is most often diagnosed in adolescents and appears to have a genetic link.
 - c. The only treatment is daily insulin injections.
4. In type 2 diabetes, cells become less responsive to insulin.
- a. Type 2 diabetes develops progressively and is often the result of obesity.
 - i. Accumulation of lipids in muscle, liver, and beta cells of the obese reduces the ability to respond to insulin causing insulin insensitivity (insulin resistance).
 - b. A condition called pre-diabetes or impaired fasting glucose may precede a diagnosis of type 2 diabetes.
 - c. Type 2 diabetes results from insulin insensitivity or the inability of the pancreas to produce enough insulin.
 - d. In type 2 diabetes blood glucose levels may be elevated because the person:
 - i. has developed insulin insensitivity.
 - ii. can no longer secrete enough insulin.
 - iii. has entirely stopped insulin production.
5. The many risk factors for developing type 2 diabetes include:
- a. genetics
 - b. obesity and inadequate physical activity
 - c. metabolic syndrome
 - d. increased age
6. Lifestyle choices can help prevent or control diabetes.
- a. The risk for developing type 2 diabetes can be kept low by eating a healthy diet, staying active, and maintaining a healthful body weight.
 - b. Alcohol can cause hypoglycemia.
 - c. When lifestyle changes can’t adequately control blood glucose levels, oral medications may be required.
 - d. If the pancreas can no longer secrete enough insulin, daily injection are required.

- B.** Hypoglycemia refers to lower-than-normal blood glucose levels.
1. People with diabetes may develop hypoglycemia if they take too much insulin or exercise without consuming adequate carbohydrates.
 2. Reactive hypoglycemia occurs when the pancreas secretes too much insulin after a high-carbohydrate meal.
 - a. This condition is rare.
 - b. Treatment requires eating smaller, more frequent meals.
 3. Fasting hypoglycemia occurs when the body continues to produce too much insulin even when someone has not eaten, usually caused by a more serious disease.
- C.** Lactose intolerance is an inability to digest lactose.
1. The body does not produce sufficient amounts of the enzyme lactase in the small intestine causing an inability to digest foods containing lactose.
 - a. It is different from a milk allergy, which is an immune reaction to proteins in cow's milk.
 2. Symptoms include intestinal gas, bloating, cramping, diarrhea, and nausea.
 3. Not everyone experiences lactose intolerance to the same extent.
 4. Some people can tolerate small amounts of dairy foods, others can take lactase drops or pills, and the most severe must find alternate foods to provide calcium.

Key Terms: hyperglycemia, diabetes, type 1 diabetes, type 2 diabetes, impaired fasting glucose, pre-diabetes, hypoglycemia, lactose intolerance

Figures and Tables:

Figure 4.17: The percentage of adults from various ethnic and racial group in the United States with type 2 diabetes.

Figure 4.18: Diabetes

Figure 4.19: Monitoring blood glucose

Table 4.5: Signs and Symptoms of Type 1 and Type 2 Diabetes

Table 4.6: Values for fasting blood glucose and HbA1c indicating normal, pre-diabetes, and diabetes

Activities

1. Have students bring to class the Nutrition Facts label of their favorite cereal. Make a list on the board containing the following information for each cereal:
 - a. the number of Calories per serving
 - b. the amount of sugar per serving
 - c. the amount of fiber per serving

Discuss which cereals represent the best choices. You may want to review the concept of nutrient density during this discussion. Use the ingredient labels to look for various terms that denote sugar, refined carbohydrates, and whole grain. Remind the students that the ingredients are listed in descending order by weight. Ask students to decide whether the cereal is enriched or fortified. Note the differences in added vitamins and minerals between cereals that are more refined and those that contain whole grains.

2. Before the lecture, ask students to explain how they think they would have to change their lifestyle if they had diabetes. If you have students who have the condition or who have close family members with the condition, request that they wait to answer. Once you have discussed diabetes, allow students who have experienced the condition, firsthand or through family, to share how controlling blood sugar affects daily life. Ask students to discuss how their perceptions of diet and diabetes changed after hearing the lecture.
3. Have students use their own one-day menu and adapt it for an individual with lactose intolerance.
4. For this demonstration, you will need a teaspoon, sugar, and a clear glass. Ask students how much sugar they put in coffee or tea. Start adding sugar to the glass as students offer their suggestions. When you reach the maximum amount of sugar suggested by students, note the amount you added. Continue adding sugar until you have added 10 teaspoons. Hold the glass up and ask if students would drink a liquid poured into the glass with that much sugar. Explain that it is the amount of sugar in a 12-ounce can of soda.
5. Ask students to select a snack that they believe would be good for someone with diabetes to eat, and bring the label to class. (If they don't have the label, one can be printed from the Internet.) Bring extra labels for those who forget. Explain how to select a good snack to maintain blood glucose levels in a person who has diabetes. Then, have students assess their choice. Explain good choices for a person with diabetes when blood sugar is dangerously low. Have students rate the various snacks that are represented for use as a regular snack, an emergency food, or a special treat. This exercise can be used to discuss glycemic index/load, alternative sweeteners, treating and preventing hypoglycemia, and preventing hyperglycemia.
6. As the reputation of fiber for reducing risk of chronic disease grows, more and more food companies are adding fiber to their products. Ask students to look at labels on foods that claim to have added fiber or claim to be made with whole grain. Ask: Are these products as good as the whole-grain alternatives? Do they have value? Are there problems with promoting processed foods as whole-grain or high-fiber?

Diet Analysis Activity

7. Using the nutritional assessment previously completed, students should note the following:
 - a. How many grams of carbohydrate do you consume daily?
 - b. What percentage of your daily Calories comes from carbohydrate?
 - c. How many grams of sugar do you consume daily (if you are using MyDietAnalysis)?
 - d. What percentage of your daily Calories comes from sugar (if you are using MyDietAnalysis)?
 - e. How many grams of fiber do you consume daily?
 - f. Do your intakes meet recommendations for these nutrients?
 - g. What three foods did you consume that contain the highest level of added sugar? How many grams of sugar were in each food?
 - h. What changes can you make in your diet to more closely meet carbohydrate, fiber, and sugar recommendations?

Nutrition Debate Activity

Many people believe that sugar substitutes are unsafe or increase cravings for sugary food or more Calories. They believe that these man-made products cause many diseases and medical conditions and may actually promote obesity. Information abounds to support these beliefs. When educating the public, the simple explanation that research does not support these claims will not be enough to change people's beliefs. Develop a list of false claims about sugar substitutes. Assign students various claims to research and then discuss ways to refute such claims in a way that would be better accepted and more likely to change opinions. This activity can be done in a small-group role-play setting with one or two students resisting the factual information. Be sure to discuss the power of anecdotal information. If this activity is done as a debate rather than a role play, students will be able to visualize how difficult it is to change popular perceptions.

Web Resources

Academy of Nutrition and Dietetics

www.eatright.org

Food Insight--International Food Information Council Foundation

www.foodinsight.org

American Dental Association

www.ada.org

National Institute of Dental and Craniofacial Research

www.nidcr.nih.gov

American Diabetes Association

www.diabetes.org

National Institute of Diabetes and Digestive and Kidney Diseases

www.niddk.nih.gov

Calorie Control Council

www.caloriecontrol.org
