

OUTLINE

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CHAPTER

4

Carbohydrates and Fats: Implications for Health

Time for completion

Activities: 1 hour

Optional examination: ½ hour



OBJECTIVES

Carbohydrates and Health

Upon completion of this chapter the student should be able to do the following:

1. Identify the types of carbohydrates, their fuel value, and storage methods.
2. Summarize the major functions and food sources of carbohydrates.
3. Discuss nutritive and nonnutritive sweeteners.
4. Evaluate blood glucose level as an indicator of certain body conditions.
5. Define fiber and list its functions and food sources.
6. Discuss health problems associated with excess sugar or low-fiber intake.
7. Describe the effects of carbohydrate consumption on athletic activity.

Fats and Health

Upon completion of this chapter the student should be able to do the following:

1. Classify fats and state their fuel value.
2. List the major functions and food sources of fats.
3. Discuss body utilization of essential fatty acids and cholesterol.
4. Explain the difference between saturated and unsaturated fatty acids and identify their food sources.
5. Evaluate storage of fat in the body and the relationship of fat to normal body weight.
6. Relate a body's health to excess total fat intake and excess saturated fat intake.

GLOSSARY

Carbohydrates

Cellulose: a fibrous form of carbohydrate that makes up the framework of a plant. A component of fiber.

Complex carbohydrates: a class of carbohydrates called polysaccharides; foods composed of starch and cellulose.

Cruciform: cross shaped; bearing a cross. The name *cruciferous* is given to certain vegetables, namely broccoli, cabbage, Brussels sprouts, and cauliflower. These plants have four-petaled flowers that resemble a cross, hence the botanical name *crucifera*, and the term *cruciferous vegetables*.

Diabetes mellitus: a condition characterized by an elevated level of sugar in blood and urine, increased urination, and increased intake of both fluid and food, with an absolute or relative insulin deficiency. Complications include heart disease, high blood pressure, and kidney disease. Diabetes can cause blindness and is frequently associated with severe infections.

Diverticulitis: inflammation of the sacs that form at weakened points along the colon lumina, especially in older people.

Fiber: a group of compounds that make up the framework of plants. Fiber includes the carbohydrate substances (cellulose, hemicellulose, gums, and pectin) and a non-carbohydrate substance called lignin. These compounds are not digested by the human digestive tract.

Glycogen: the form in which carbohydrate is stored in humans and animals.

Insulin: a hormone secreted by the pancreas that is necessary for the proper metabolism of blood sugar.

Ketosis: an accumulation of ketone bodies from partly digested fats due to inadequate carbohydrate intake.

Lactose intolerance: a condition in which the body is deficient in lactase, the enzyme needed to digest lactose (the sugar in milk). Leads to abdominal bloating, gas, and watery diarrhea. Affects 70%–75% of blacks, almost all Asians, and 5%–10% of whites.

Naturally occurring sugars: sugars found in foods in their natural state; for example, sugar occurs naturally in grapes and other fruits.

Refined food: food that undergoes many commercial processes resulting in the loss of nutrients in the food.

Fats

Atherosclerosis: thickening of the inside wall of the arteries by fatty deposits, resulting in plaques that narrow the arteries and hinder blood flow. Can lead to heart disease.

Bile salts: the substance from the gallbladder that breaks fats into small particles for digestion.

Cholesterol: a fatlike compound occurring in bile, blood, brain and nerve tissue, liver, and other parts of the body. Cholesterol comes from animal foods and is used

by the body for the synthesis of necessary tissues and fluids. Cholesterol is also found in plaques that line the inner wall of the artery in atherosclerosis.

Fatty acids: the basic unit of all fats. Essential fatty acids are those that cannot be produced by the body and must be obtained in the diet. A saturated fatty acid is one in which the fatty acids contain all the hydrogen they can hold. A monounsaturated fatty acid is one into which hydrogen can be added at one double bond. Polyunsaturated fatty acids have two or more double bonds into which hydrogen can be added.

Hydrogenation: the addition of hydrogen to a liquid fat, changing it to a solid or semisolid state. Generally, the harder the product, the higher the degree of saturation with hydrogen.

Lipoproteins: transport form of fat (attached to a protein) in the bloodstream.

Satiety value: a food's ability to produce a feeling of fullness.

BACKGROUND INFORMATION

Carbohydrates

Carbohydrates are the most abundant organic substances on Earth, comprising approximately 70% of plant structure. They are the main source of the body's energy.

In the United States, about 50% of dietary energy comes from carbohydrates. This level of intake is considered acceptable, but the type of carbohydrates consumed has caused concern among health professionals. Although both starches and sugars are carbohydrates, they differ in food sources and nutrient values. Starches are mainly found in certain fresh and processed products such as vegetables, breads, and cereals. They provide a large amount of calories and lesser amounts of protein, vitamins, minerals, and water. Sugars, on the other hand, furnish only calories and no nutrients. They are derived from sugar cane and sugar beets. The typical Western diet contains more carbohydrates from sugary foods than from starches. The government guidelines for healthy eating strongly recommend the reverse. Fiber, another plant component, is also an important carbohydrate. Although it neither furnishes energy nor is digestible, it is important for health. All plant foods contain fiber, and we obtain it mainly from cereal grains, especially unrefined ones.

Fats

Fats, chemically termed *lipids*, are also organic compounds. They are insoluble in water. Most fat in the diet is in the form known as triglycerides. Fats differ in chemical structure from carbohydrates, though both contain carbon, hydrogen, and oxygen. Based on their chemical bonding arrangements, fats can be saturated, monounsaturated, or unsaturated. Many different properties of fats are determined by the degree of saturation.

The typical Western diet derives approximately 38%–40% of its total daily calories from fats, mainly saturated fats. Ninety percent of fats in the American diet come from fats and oils, meat, poultry, fish, and dairy products. We are advised to eat about 30% of our total daily calories from fat, with no more than 10% in saturated forms.

Dietary fats are important because they serve as stored energy reserves and as carriers of essential fatty acids and fat-soluble vitamins. Fats must combine with bile from the gallbladder to be digested. Since they are not soluble in water, they must attach themselves to proteins before they can travel through the intestinal walls, lymph system, and bloodstream. From the bloodstream they are delivered to body tissues.

Cholesterol, which is a cross between fat and alcohol, is derived both from foods and body synthesis. Although much maligned because of its implication in heart disease, cholesterol is an important body component and is transported by low-density or high-density lipoproteins in body circulation. Lipoproteins are discussed in Chapter 16 in relation to cardiovascular disease, and will not be explored here.

ACTIVITY 1:

Carbohydrates: Characteristics and Effects on Health

DEFINITIONS, CLASSIFICATION, AND REQUIREMENTS

Carbohydrates are composed of carbon, hydrogen, and oxygen. Sugars, starches, and fiber are the main forms in which carbohydrates occur in food. Starches and sugars are the major source of body energy. They are the cheapest and most easily used form of fuel for the body. Fibrous materials provide bulk and aid digestion. Although most carbohydrates occur in plant foods, a few are of animal origin. These include glycogen, which is stored in the liver and muscle as a small reserve supply, and lactose, a sugar found in milk.

Carbohydrates are classified as monosaccharides (simple sugars), disaccharides (double sugars), and polysaccharides (mainly starches). All carbohydrates must be reduced to simple sugars (monosaccharides) in the intestine before they can be absorbed into the bloodstream. Glucose, a simple sugar, is the form in which carbohydrates circulate in the bloodstream. Glucose is commonly referred to as blood sugar. Table 4-1 classifies carbohydrates according to their chemical structures.

The nutrients and calories contributed by different carbohydrates vary. For example, whole grains, enriched cereal products, fruits, and vegetables provide vitamins,

TABLE 4-1 Classification of Carbohydrates

Carbohydrates	
Starches Kinds and Sources	Sugars Kinds and Sources
Polysaccharides	Monosaccharides
1. Starch—cereals grains vegetables	1. Glucose—blood sugar
2. Dextrin—digestion product infant formula	2. Fructose—sugar found in fruit
3. Cellulose*—stems, leaves coverings seeds skins, hulls	3. Galactose—digestion product
4. Pectin*—fruits	Disaccharides
5. Glycogen—muscle and liver	1. Sucrose—table sugar
	2. Lactose—sugar found in milk
	3. Maltose—germinating seed

*Nondigestible.

minerals, fiber, and energy. Sugars, sweets, and unenriched refined cereals provide calories only.

Carbohydrates are also good sources of fiber, which is the nondigestible part of plant foods. It is nutritionally significant in gastrointestinal functioning. Fiber is classified as soluble or insoluble.

Insoluble fiber (cellulose and hemicellulose) is found in legumes, vegetables, whole grains, fruits, and seeds. Soluble fibers are the pectins, gums, mucilages, and algae and are found in vegetables, fruits, oats and oat bran, legumes, rye, and barley.

The NAS has established DRIs/RDA for carbohydrates for individuals at different stages of life. For example, for an adult aged 19–30 years:

- Males: RDA is 130 g/day
- Females, not pregnant: RDA is 130 g/day

The NAS has established DRIs/AI for total fiber for individuals at different stages of life. For example, for an adult aged 19–30 years:

- Males: AI is 38 g/day
- Females, not pregnant: AI is 25 g/day

FUNCTIONS

Energy Source

Carbohydrates are the most economical and efficient source of energy. They furnish 4 kcal/g of energy. The body requires a constant source of energy to support its vital functions.

Protein-Sparing Action

Carbohydrates prevent protein from being used as energy. Carbohydrate, protein, and fat can all be used to produce energy. However, the body utilizes carbohydrate first. When not enough carbohydrate is present, the body uses protein and fat for its energy needs. Thus, an adequate amount of carbohydrate can spare protein that can then be used for tissue building and repair rather than energy.

Metabolic Functions

Under normal conditions, the tissues of the central nervous system (especially the brain) can use only glucose as an energy source. Muscles can use either glucose or fats as fuel. Body fat is used by the muscles only during physical activity varying from walking up stairs to lifting weights.

Some carbohydrate is needed for the proper utilization of fat. In the absence of carbohydrate, fats are not completely burned, and ketosis results (see later discussion). Severe restriction of carbohydrate in reducing diets can cause ketosis, which can produce adverse effects.

Carbohydrates are important components of certain substances needed for regulating body processes. They also encourage the growth of beneficial bacteria involved in the production of certain vitamins and in the absorption of calcium and phosphorus.

Fiber and Health

Insoluble fiber has a laxative effect. It provides bulk, leading to regular elimination of solid wastes. By promoting normal function, insoluble fiber is useful in reducing pressure on the lumina of the colon, thus helping prevent diverticulitis. Insoluble fiber provides a feeling of fullness, thereby reducing the amount of food eaten. Most food sources of insoluble fiber such as legumes, vegetables, and fruits are not calorie dense. These factors are helpful when weight-reduction diets are needed. Insoluble fibers also exert a binding effect on bile salts and cholesterol, preventing their absorption. Excessive ingestion of fiber, however, is undesirable, as this fiber also binds with minerals such as calcium, zinc, and iron, which are essential for body function.

Soluble fibers are important factors in preventing diseases such as heart disease, colon cancer, and diabetes mellitus. They form soft gels by absorbing water, which slows carbohydrate absorption and binds cholesterol and bile acids. Slow absorption reduces fasting blood sugar and lowers insulin requirements. Binding of the bile acids and cholesterol permits cholesterol to be excreted instead of absorbed. Studies indicate that bile acids may contribute to colon cancer; therefore, this binding capacity is important. Major sources of soluble fiber include vegetables and fruits.

Combinations of both soluble and insoluble fibers produce the best effects; many of the recommended foods

contain both types of fiber. The recommended daily intake of fiber, consumed from plant sources, varies though our DRI/AI requirements are defined as mentioned previously. Our actual consumption of fiber is unknown and influenced by such factors as gas formation. The fermentation of carbohydrate by intestinal bacteria produces volatile gases that are socially unacceptable and may occasionally cause bloating and pain, especially in those persons who decide to drastically increase their fiber intake. Clients are advised to do so gradually, to eat a variety of fiber-containing foods and avoid just one source, such as bran, for all their fiber intake.

The NCI dietary guidelines, directed especially toward the prevention of colon cancer, recommend high intakes of vegetables (especially cruciferous), fruits, and whole grains, which facilitate the removal of bile salts and cholesterol, along with a low-fat diet. The *Dietary Guidelines for Americans* and MyPyramid also highly encourage eating these foods and reducing fat in the diet.

Blood Glucose

The form of carbohydrate used by the body is a monosaccharide—glucose. All forms of carbohydrate except fiber eventually are broken down by the body to glucose. Glucose is the form of sugar found in the blood, and its control at normal blood levels is important to health. Without sufficient glucose, the body will use its protein to make glucose, since the brain requires glucose to function. This diverts protein from its important functions of building and repairing tissues. When carbohydrate is insufficient, the body metabolizes fat differently to produce ketosis, a condition in which unusual by-products of fat metabolism break down into ketones and accumulate in the blood. Ketosis during pregnancy can result in brain damage and irreversible mental retardation in the infant. Some experts suggest that ketosis is potentially dangerous for all adults.

Blood glucose levels vary. Normal levels range between 70 to 120 mg per 100 ml of blood. When blood sugar is less than 70 mg, hunger occurs. After eating, blood sugar levels normally rise. The beta cells in the pancreas respond to the increase by secreting insulin. Insulin causes the liver, muscle, and fat cells to increase their uptake of sugar, which in turn reduces the blood sugar levels to normal. The glucose entering the cells is then converted to glycogen or fat or is used for energy if the body needs it. Insulin also assists in regulating the metabolism of fat by the body.

Insulin is the only hormone that directly lowers blood sugar levels. If there is insufficient production of insulin by the pancreas, or if it is unavailable, the blood cannot be cleared of excess glucose. This condition is hyperglycemia, the term used to describe blood glucose levels above the normal range. It occurs in diabetes mellitus. This abnormal response to glucose can sometimes be controlled by diet therapy and weight control, but in

certain types of diabetes, insulin may have to be administered to help lower blood glucose levels.

When blood glucose drops below the normal limits, the condition is called hypoglycemia. Symptoms of hypoglycemia vary, depending on blood sugar level. Early symptoms include weakness, dizziness, hunger, trembling, and mental confusion. If the levels drop very low, convulsions or unconsciousness may occur. Although it can occur, as a spontaneous reaction in some people, most often it happens when a diabetic uses excess insulin and/or has not eaten for a long period. A glucose-tolerance test will determine true hypoglycemia. People who are not diabetic but are sensitive to changes in blood sugar levels should follow a calculated diet much the same as a diabetic, avoiding sweets and eating regular, balanced meals.

SOURCES, STORAGE, SWEETENERS, AND INTAKE

The major food sources of carbohydrate are plants, which vary in the amounts of sugar and starches they provide. Milk and milk products containing lactose are the only significant animal sources of carbohydrates. Food sources of carbohydrate include cereal grains, fruits, vegetables, nuts, milk, and concentrated sweets. Table 4-2 compares the carbohydrate content of selected foods.

TABLE 4-2 Carbohydrate Content of Some Selected Foods

Food	Serving Size	Carbohydrate Content
Milk, skim	1 c	12 g
Milk, whole	1 c	12 g
Bread (white or whole wheat)	1 slice	15 g
Oatmeal	$\frac{1}{2}$ c (cooked)	15 g
Green peas (frozen or canned)	$\frac{1}{2}$ c	15 g
Puffed wheat	$1\frac{1}{2}$ c	15 g
Popcorn (popped)	3 c	15 g
Yam, sweet potato	$\frac{1}{2}$ c	15 g
Mushrooms, cooked	$\frac{1}{2}$ c	5 g
Asparagus	$\frac{1}{2}$ c	5 g
Green beans	$\frac{1}{2}$ c	5 g
Strawberries, raw/ whole/unsweetened	$1\frac{1}{4}$ c	15 g
Pineapple juice (unsweetened)	$\frac{1}{2}$ c	15 g
Cantaloupe, cubed	$\frac{1}{2}$ melon	15 g
Angel food cake	$\frac{1}{2}$ cake	15 g
Ice cream, any flavor	$\frac{1}{2}$ c	15 g
Granola	$\frac{1}{4}$ c	15 g
Cheese pizza, thin crust	$\frac{1}{4}$ of 10'' pie	30 g
Chile, with beans	1 c	30 g
Frozen fruit yogurt	$\frac{1}{2}$ c	15 g

Nutritive sweeteners provide calories. Examples include sugar, honey, molasses, and syrup (corn, maple). The most common is table sugar, which comes from sugar beets or sugar cane. Table sugar is sucrose, two simple sugars chemically joined. Sugar can be white or brown. White sugar contains mainly sucrose. Brown sugar contains trace amounts of protein, minerals, vitamins, water, and pigment in addition to sucrose.

Synthetic sweeteners are nonnutritive and furnish no calories. They have been used for many years by diabetics and dieters. Since 1969 saccharin was the only legal nonnutritive sweetener until the recent availability of aspartame. Cyclamates were used until 1969, when they were banned because they were shown to cause bladder cancer in rats. Since the consumption of artificially sweetened beverages and foods has increased drastically in recent years, the Food and Drug Administration (FDA) is studying saccharin and aspartame carefully. Aspartame is made from the amino acids aspartic acid and phenylalanine. Although it is on the GRAS (generally recognized as safe) list, precautions are advised about the use of aspartame by pregnant women and young children. Other people may be sensitive to aspartame and should avoid using it. Products sweetened with aspartame carry a warning label for people who have phenylketonuria (PKU) to avoid the use of the product. PKU is an inherited disorder of defective protein metabolism. It is discussed in Chapter 29. The newest synthetic sweetener on the market is acesulfame K (potassium). Brand names are Sweet One and Sunette.

In general, carbohydrate stores in the body are small. Carbohydrate in excess of the body's energy needs is stored in limited amounts in the liver and muscle. Most excess is converted to fat and stored as such. Less than one pound is stored as glycogen. This amount can furnish energy for 12 to 24 hours. However, the excess converted to fat can be stored in unlimited amounts in the body.

A carbohydrate deficiency leads to a loss of muscle tissue as protein is burned to meet energy and glucose needs. In addition, fats are incompletely broken down and a condition of ketosis results. Prolonged carbohydrate deficiencies can cause damage to the liver. Low-fiber diets are associated with constipation and are linked to colon cancer. Scientists now recommend that 50%–60% of the daily caloric intake be from carbohydrate foods, especially the complex carbohydrates (starches).

Of the classes of carbohydrate, sugars and sweets are the least desirable. Overconsumption of sugar promotes dental caries and frequently leads to a poor nutritional quality diet. Table 4-3 shows the sugar content of some popular foods. Diabetes mellitus and lactose intolerance are examples of diseases in which carbohydrates are not utilized normally by the body.

TABLE 4-3 Sugar Content of Selected Foods

Food	Serving Amount	Total Grams Sugar (Sucrose, Glucose, Fructose, Maltose)*
Apple juice	8 oz	25–35
Beer (average of all brands)	12 oz	3–4
Brownie	50 gm	22.5
Carbonated beverages	12 oz	38–41
Chocolate	2 oz	35–43
Granola (average of all brands)	¼ c	7–8
Honey	1 tbsp	14–16
Ketchup	1 tbsp	4–6
Nondairy creamer	1 tbsp	9–11
Pineapple juice	8 oz	28–31
Tomato, red (raw)	1 tomato	4–6
Tomato paste (canned)	½ c	23–27
Yogurt (sweetened)	8 oz	30–40

*Types of sugars in each food not differentiated. Calories for each item may be obtained by multiplying total \times 4.
 Source: Adapted from Food Nutrients Database, www.usda.gov.

ATHLETIC ACTIVITIES

Except for an increased energy requirement, athletes require the same basic nutrients that all people require. The amount of energy expended in training and competition determines the amount of food needed. The recommended distribution of nutrients for anyone is 50% to 60% of daily caloric intake from carbohydrate, 15% to 20% from protein, and 30% to 35% from fat. If energy needs increase, the distribution should remain the same, with the size of individual portions being increased to meet the requirements.

Carbohydrates are the most efficient energy source for both athletes and nonathletes and, as such, should be used to meet the need for increased energy. Athletes' carbohydrate needs are better met through extensive use of grains, fruits, and vegetables instead of sugary foods. For the body to convert foods into energy, certain vitamins and minerals are necessary. These are found only in nutrient-dense foods, not in candies and other sweets.

Of all athletic activities, endurance performance is most frequently associated with carbohydrate consumption. The premise is simple. A high carbohydrate diet helps increase body glycogen storage and extend the endurance of an athlete. In a process called carbohydrate or glycogen loading, athletes adjust their carbohydrate consumption and practice schedules to maximize their muscle glycogen storage.

There are professional guidelines to help adult athletes to implement a safe and effective carbohydrate loading regimen. Such guidelines are available in some of

the books in the references for this chapter. They are also available in training manuals for both amateur and professional athletes engaged in endurance sports such as short- and long-distance running. In general such guidelines revolve around the following premises:

1. Carbohydrate intake before exercise
2. Carbohydrate intake during exercise
3. Carbohydrate intake following exercise
4. Meal plans and menus

The concept of carbohydrate loading is also practiced by athletes in other sports that are not endurance sports such as basketball, football, and soccer. However, it is recommended that the practice of carbohydrate loading should be implemented under the directions of a qualified professional, especially for nonadult athletes.

HEALTH IMPLICATIONS

Health risks are associated with excessive sugar consumption, but it is difficult to make positive correlations between sugar consumption and the development of many diseases that have been linked to it. Included among the associations of sugar and health problems are the following:

1. Obesity—Sugar is often named as being the cause of obesity. If persons are obese, they certainly have consumed excess calories. It is probably an overall excess intake rather than sugar alone. Sugar is usually curtailed in reduction diets along with fats and alcohol because such foods contribute mainly calories.
2. Cardiovascular disease—Except for certain types of lipid disorder, in which an individual exhibits abnormal glucose tolerance along with an elevation of blood triglycerides, research studies cannot prove any correlation between sugar intake and cardiovascular disorder. Obesity is probably more closely related to this disorder than a high sugar consumption.
3. Diabetes—The cause of the malfunction of the pancreas is not known, but heredity plays a role as well as obesity. The chance of becoming diabetic more than doubles for every 20% of excess weight, according to the U.S. National Diabetes Commission. While studies have shown that the incidence of diabetes rose in population groups that “Westernized” and started consuming excess sugary foods, most researchers agree that individuals have become fat from excess calories, not just sugar.
4. Dental caries—Carbohydrates, especially sugar, play a role in tooth decay. Sucrose is especially implicated. The frequency of eating sugar, sweets, and similar snacks is more damaging than the amount eaten in one sitting. Good oral hygiene (brushing after meals) helps prevent dental caries. The general state of health also influences susceptibility to caries.

5. Cancer—Population group studies have not linked nonnutritive sweeteners to cancer. Certain groups with increased susceptibility to bladder cancer include some heavy saccharine users. This correlation is also associated with heavy cigarette smokers. At present, the use of saccharine is in a “suspended” status—that is, if new data show definitive hazards, the use of this substance will be banned.
6. Fiber—Low-fiber diets are believed to play a major role in the onset of diverticulosis and may contribute to appendicitis. The added pressure in the colon caused by a low-fiber intake may increase the occurrence of hemorrhoids, varicose veins, and hiatal hernia. Colon cancer has been linked to low-fiber diets, but the relationship is not clear. There are several theories regarding the cause-and-effect relationships, but the current general recommendation is to maintain a balanced diet with ample intake of fiber and fluids. No RDA has been set for fiber, but 15 g/day is recommended in *Healthy People 2000*.

PROGRESS CHECK ON ACTIVITY 1

SHORT ANSWERS

1. Using meal planning exchange lists in Appendix F, rank the following foods by carbohydrate content, beginning with the food that has the most carbohydrate. If two foods have the same value, give them the same number.
 - _____ a. 1 orange
 - _____ b. 1 c whole kernel corn
 - _____ c. $\frac{1}{10}$ of a devil's food cake with icing (from a mix)
 - _____ d. 1 slice wheat bread
 - _____ e. $\frac{1}{2}$ c zucchini squash
 - _____ f. $\frac{1}{2}$ c cooked oatmeal
2. Rank the following vegetables by carbohydrate content, beginning with the one that has the most carbohydrate. If two foods have the same value, give them the same number.
 - _____ a. $\frac{1}{2}$ c green beans, cooked
 - _____ b. $\frac{1}{2}$ c cooked carrots
 - _____ c. 1 baked potato
 - _____ d. 1 sweet potato
 - _____ e. 1 stalk broccoli
 - _____ f. $\frac{1}{2}$ c lettuce, chopped
3. If a person's carbohydrate intake is greater than his or her energy needs, what happens to the excess? _____
4. What is the function of fiber in the diet? _____

5. Name three good food sources of fiber.
 - a. _____
 - b. _____
 - c. _____
6. Name two health problems related to overconsumption of sugar.
 - a. _____
 - b. _____
7. Why are diets that severely restrict carbohydrates dangerous? _____

MULTIPLE CHOICE

Circle the letter of the correct answer.

8. If a 2000 kcal/day diet derives approximately 1000 kcal from carbohydrates, how many grams of carbohydrate does that diet contain?
 - a. 150
 - b. 200
 - c. 250
 - d. 400
9. Identify the trend in food consumption in the United States that has occurred since the turn of the century.
 - a. Potato consumption has continued to increase.
 - b. Consumption of refined sugar and processed sugar products has increased.
 - c. Fruit and vegetable consumption has greatly increased.
 - d. Consumption of cereals has greatly increased.
10. Cellulose is a _____ carbohydrate.
 - a. digestible
 - b. nondigestible
 - c. disaccharide
 - d. processed
11. Which two of the following food groups contain the greatest amounts of cellulose and other food fiber?
 - a. meat and dairy products
 - b. whole grain cereals
 - c. fruit juices
 - d. raw fruits and vegetables
12. Which of the following represent blood sugar levels within the normal range?
 - a. 30 to 60 mg per 100 ml
 - b. 70 to 120 mg per 100 ml

- c. 140 to 160 mg per 100 ml
 - d. 100 to 120 mg per 100 ml
13. Insulin is secreted by the:
- a. alpha cells of the pancreas.
 - b. beta cells of the pancreas.
 - c. nephron of the kidney.
 - d. digestive cells in the intestinal wall.
14. From the items below, choose the snack that produces the least amount of caries.
- a. plain popcorn and an apple
 - b. taffy and raisins
 - c. noodles with butter
 - d. sherbet and 7-Up float
15. Carbohydrates are the raw materials that we eat mainly as:
- a. starches and sugars.
 - b. proteins and fats.
 - c. plants and animals.
 - d. pectin and cellulose.
16. Carbohydrates provide one of the main fuel sources for energy. Which of the following carbohydrate foods provides the quickest source of energy?
- a. slice of bread
 - b. glass of orange juice
 - c. chocolate candy bar
 - d. glass of milk
17. Chemical digestion of carbohydrates is completed in the small intestine by enzymes from the:
- a. pancreas and gallbladder.
 - b. gallbladder and liver.
 - c. small intestine and pancreas.
 - d. liver and small intestine.
18. The refined fuel glucose is delivered to the cells by the blood for production of energy. The hormone controlling use of glucose by the cells is:
- a. thyroxin.
 - b. growth hormone.
 - c. adrenal steroid.
 - d. insulin.

MATCHING

Match the phrases on the right with the terms on the left that they best describe.

- | | |
|-------------------|--|
| 19. Insulin | a. hormone that causes the release of glucose into the blood |
| 20. Hyperglycemia | b. glucose in the blood |

- | | |
|------------------|--|
| 21. Glycemia | c. low blood glucose levels |
| 22. Hypoglycemia | d. high blood glucose levels |
| 23. Glucagon | e. hormone that affects the uptake of glucose from the blood into various body cells |

Match the carbohydrate in Column A to its type in Column B. Terms may be used more than once.

- | Column A | Column B |
|---------------|-------------------|
| 24. Sucrose | a. polysaccharide |
| 25. Glucose | b. monosaccharide |
| 26. Glycogen | c. disaccharide |
| 27. Lactose | |
| 28. Grains | |
| 29. Fructose | |
| 30. Cellulose | |

ACTIVITY 2:

Fats: Characteristics and Effects on Health

DEFINITIONS AND FOOD SOURCES

Although both fats and carbohydrates contain carbon, hydrogen, and oxygen, fats are entirely different compounds from carbohydrates because of their chemical structures. Foods that contribute fat to the diet include whole milk and milk products containing whole milk or butterfat, such as butter, ice cream, and cheese; egg yolk; meat, fish, and poultry; nuts and seeds; vegetable oils; and hydrogenated vegetable fats (shortenings and margarine).

A fat is classified as saturated, monounsaturated, or polyunsaturated according to the type of fatty acids it contains in greatest quantity. Saturated food fats are generally solid at room temperature and come from animal sources. Saturated fats are found in whole milk and products made from whole milk; egg yolk; meat; meat fat (bacon, lard); coconut oil and palm oil; chocolate; regular margarine; and hydrogenated vegetable shortenings. Unsaturated food fats are generally liquid at room temperature and come from plant sources. They can be monounsaturated or polyunsaturated. Sources of polyunsaturated fats are safflower, sunflower, corn, cottonseed, soybean, and sesame oil; salad dressings made from these oils; special margarines that contain a high percentage of such oils; and fatty fish such as mackerel, salmon, and herring. Sources of monounsaturated fats are olive oil and most nuts. Diets rich in saturated fat and/or cholesterol can lead to elevated blood cholesterol levels. Polyunsaturated and monounsaturated fats appear to lower blood cholesterol level.

Cholesterol is a fatlike substance (lipid) that is a key component of cell membranes and a precursor of bile acids and steroid hormones. Cholesterol travels in the circulation in spherical particles containing both lipids and proteins called lipoproteins. A lipoprotein is made up of fats (cholesterol, triglycerides, fatty acids, etc.), protein, and a small amount of other substances. The cholesterol level in blood plasma is determined partly by inheritance and partly by the fat and cholesterol content of the diet. Other factors, such as obesity and physical inactivity, may also play a role.

Organ meats and egg yolk are very rich sources of cholesterol; shrimp is a moderately rich source. Other sources include meat, fish, poultry, whole milk, and foods made from whole milk or butterfat.

FUNCTIONS AND STORAGE

Fat functions in the body as the following:

1. A source of essential fatty acids
2. The most concentrated source of energy (9 kcal/g)
3. A reserve energy supply in the body
4. A carrier for the fat-soluble vitamins (A, D, E, and K)
5. A cushion and an insulation for the body
6. A satiety factor (satisfaction from a fatty meal)

All fats that are not burned as energy are stored as adipose tissue. Most people have a large storage of fat in the body.

DIET, FATS, AND HEALTH

All information in this section has been modified from official publications distributed by the United States Department of Agriculture (USDA), the National Institute of Health (NIH), and Food and Drug Administration (FDA). There are three major publications:

1. *Dietary Guidelines for Americans*, 2005. (www.healthierus.gov, www.usda.gov). See also Chapter 1 and Chapter 16.
2. MyPyramid (www.usda.gov, www.mypyramid.gov). See also Chapter 1.
3. National Cholesterol Education Program. *Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults* (ATP-III), 2001, (www.NIH.gov). See also Chapter 16.

Background Information

Fats and oils are part of a healthful diet, but the type of fat makes a difference to heart health, and the total amount of fat consumed is also important. High intake of saturated fats, trans fats, and cholesterol increases the risk of unhealthy blood lipid levels, which, in turn, may increase the risk of coronary heart disease. A high intake

of fat (greater than 35% of calories) generally increases saturated fat intake and makes it more difficult to avoid consuming excess calories. A low intake of fats and oils (less than 20% of calories) increases the risk of inadequate intakes of vitamin E and of essential fatty acids and may contribute to unfavorable changes in high-density lipoprotein (HDL) blood cholesterol and triglycerides.

Fats supply energy and essential fatty acids and serve as a carrier for the absorption of the fat-soluble vitamins A, D, E, and K and carotenoids. Fats serve as building blocks of membranes and play a key regulatory role in numerous biological functions. Dietary fat is found in foods derived from both plants and animals. The recommended total fat intake is between 20% and 35% of calories for adults. A fat intake of 30%–35% of calories is recommended for children 2 to 3 years of age, and 25%–35% of calories for children and adolescents 4 to 18 years of age. Few Americans consume less than 20% of calories from fat. Fat intakes that exceed 35% of calories are associated with both total increased saturated fat and calorie intakes.

Considerations for the General Public

Three major classes of lipoproteins can be measured in the serum of a fasting individual: very-low-density lipoproteins (VLDL), low-density lipoproteins (LDL), and high-density lipoproteins (HDL). The LDL are the major culprits in cardiovascular diseases (CVD) and typically contain 60%–70% of the total serum cholesterol. The HDL usually contain 20%–30% of the total cholesterol, and their levels are inversely correlated with risk for coronary heart disease (CHD). The VLDL, which are largely composed of triglycerides, contain 10%–15% of the total serum cholesterol.

To decrease their risk of elevated low-density lipoprotein (LDL) cholesterol in the blood, most Americans need to decrease their intakes of saturated fat and trans fats, and many need to decrease their dietary intake of cholesterol. Because men tend to have higher intakes of dietary cholesterol, it is especially important for them to meet this recommendation. Population-based studies of American diets show that intake of saturated fat is more excessive than intake of trans fats and cholesterol. Therefore, it is most important for Americans to decrease their intake of saturated fat. However, intake of all three should be decreased to meet recommendations. Table 4-4 shows, for selected calorie levels, the maximum gram amounts of saturated fat to consume to keep saturated fat intake below 10% of total calorie intake. This table may be useful when combined with label-reading guidance. Table 4-5 gives a few practical examples of the differences in the saturated fat content of different forms of commonly consumed foods. The contribution of saturated fat intake varies with the type of foods being consumed. Diets can be planned to meet nutrient recommendations for linoleic acid and α -linolenic acid while providing very low amounts of saturated fatty acids.

TABLE 4-4 Maximum Daily Amounts of Saturated Fat to Keep Saturated Fat Below 10% of Total Calorie Intake

Total Calorie Intake	Limit on Saturated Fat Intake
1600	18 g or less
2000 ^a	20 g or less
2200	24 g or less
2500 ^b	25 g or less
2800	31 g or less

Notes:

^aThe maximum gram amounts of saturated fat that can be consumed to keep saturated fat intake below 10% of total calorie intake for selected calorie levels. A 2000-calorie example is included for consistency with the food label. This table may be useful when combined with label-reading guidance.

^bPercent Daily Values on the Nutrition Facts panel of food labels are based on a 2000-calorie diet. Values for 2000 and 2500 calories are rounded to the nearest 5 grams to be consistent with the Nutrition Facts panel.

Source: Courtesy of the USDA.

Based on 1994–1996 data, the estimated average daily intake of trans fats in the United States was about 2.6% of total energy intake. Processed foods and oils provide approximately 80% of trans fats in the diet, compared to 20% that occur naturally in food from animal sources. Table 4-6 provides the major dietary sources of trans fats listed in decreasing order. Trans fat content of certain processed foods has changed and is likely to continue to change as the industry reformulates products. Because the trans-fatty acids produced in the partial hydrogenation of vegetable oils account for more than 80% of total intake, the food industry has an important role in decreasing trans-fatty acid content of the food supply. Limited consumption of foods made with processed sources of trans fats provides the most effective means of reducing intake of trans fats. By looking at the food label, consumers can select products that are lowest in saturated fat, trans fats, and cholesterol.

TABLE 4-5 Differences in Saturated Fat and Calorie Content of Commonly Consumed Foods

Food Category	Portion	Saturated Fat Content (grams)	Calories
Cheese			
Regular cheddar cheese	1 oz	6.0	114
Low-fat cheddar cheese	1 oz	1.2	49
Ground beef			
Regular ground beef (25% fat)	3 oz (cooked)	6.1	236
Extra-lean ground beef (5% fat)	3 oz (cooked)	2.6	148
Milk			
Whole milk (3.25%)	1 c	4.6	146
Low-fat (1%) milk	1 c	1.5	102
Breads			
Croissant (med)	1 medium	6.6	231
Bagel, oat bran (4")	1 medium	0.2	227
Frozen desserts			
Regular ice cream	½ c	4.9	145
Frozen yogurt, low-fat	½ c	2.0	110
Table spreads			
Butter	1 tsp	2.4	34
Soft margarine with zero trans fats	1 tsp	0.7	25
Chicken			
Fried chicken (leg with skin)	3 oz (cooked)	3.3	212
Roasted chicken (breast no skin)	3 oz (cooked)	0.9	140
Fish			
Fried fish	3 oz	2.8	195
Baked fish	3 oz	1.5	129

Note: This table shows a few practical examples of the differences in the saturated fat content of different forms of commonly consumed foods. Comparisons are made between foods in the same food group (e.g., regular cheddar cheese and low-fat cheddar cheese), illustrating that lower saturated fat choices can be made within the same food group.

Source: ARS/USDA Nutrient Database for Standard Reference, Latest Release (www.ars.usda.gov, www.usda.gov).

TABLE 4-6 Contribution of Various Foods to Trans Fat Intake in the American Diet (Mean Intake = 5.84 g)^a

Food Group	Contribution (percent of total trans fats consumed)
Cakes, cookies, crackers, pies, bread, etc.	40
Animal products	21
Margarine	17
Fried potatoes	8
Potato chips, corn chips, popcorn	5
Household shortening	4
Other ^b	5

^aThe major dietary sources of trans fats listed in decreasing order. Processed foods and oils provide approximately 80 percent of trans fats in the diet, compared to 20 percent that occur naturally in food from animal sources. Trans fats content of certain processed foods has changed and is likely to continue to change as the industry reformulates products.

^bIncludes breakfast cereal and candy. USDA analysis reported 0 grams of trans fats in salad dressing.

Source: Adapted from *Federal Register* notice. Food Labeling; Trans Fatty Acids in Nutrition Labeling; Consumer Research to Consider Nutrient Content and Health Claims and Possible Footnote or Disclosure Statements; Final Rule and Proposed Rule. (2003). 68(133), 41433–41506.

To meet the total fat recommendation of 20% to 35% of calories, most dietary fats should come from sources of polyunsaturated and monounsaturated fatty acids. Sources of omega-6 polyunsaturated fatty acids are liquid vegetable oils, including soybean oil, corn oil, and safflower oil. Plant sources of omega-3 polyunsaturated fatty acids (α -linolenic acid) include soybean oil, canola oil, walnuts, and flaxseed. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are omega-3 fatty acids that are contained in fish and shellfish. Fish that naturally contain more oil (e.g., salmon, trout, herring) are higher in EPA and DHA than are lean fish (e.g., cod, haddock, catfish). Limited evidence suggests an association between consumption of fatty acids in fish and reduced risks of mortality from cardiovascular disease for the general population. Other sources of EPA and DHA may provide similar benefits; however, more research is needed. Plant sources that are rich in monounsaturated fatty acids include nuts and vegetable oils (e.g., canola, olive, high oleic safflower, and sunflower oils) that are liquid at room temperature.

Considerations for Specific Population Groups

Evidence suggests that consuming approximately two servings of fish per week (approximately 8 ounces total)

may reduce the risk of mortality from coronary heart disease and that consuming EPA and DHA may reduce the risk of mortality from cardiovascular disease in people who have already experienced a cardiac event.

Federal and state advisories provide current information about lowering exposure to environmental contaminants in fish. For example, methylmercury is a heavy metal toxin found in varying levels in nearly all fish and shellfish. For most people, the risk from mercury by eating fish and shellfish is not a health concern. However, some fish contain higher levels of mercury that may harm an unborn baby or young child's developing nervous system. The risks from mercury in fish and shellfish depend on the amount of fish eaten and the levels of mercury in the fish. Therefore, the Food and Drug Administration (FDA) and the Environmental Protection Agency are advising women of childbearing age who may become pregnant, pregnant women, nursing mothers, and young children to avoid some types of fish and shellfish and eat fish and shellfish that are lower in mercury. For more information, see Chapter 9.

Recommendations

Lower intakes (less than 7% of calories from saturated fat and less than 200 mg/day of cholesterol) are recommended as part of a therapeutic diet for adults with elevated LDL blood cholesterol (i.e., above their LDL blood cholesterol goal [see Table 4-7]). People with an elevated LDL blood cholesterol level should be under the care of a healthcare provider.

Key recommendations for the general public are as follows:

1. Consume less than 10% of calories from saturated fatty acids and less than 300 mg/day of cholesterol, and keep *trans*-fatty acid consumption as low as possible.
2. Keep total fat intake between 20 to 35% of calories, with most fats coming from sources of polyunsaturated and monounsaturated fatty acids, such as fish, nuts, and vegetable oils.
3. When selecting and preparing meat, poultry, dry beans, and milk or milk products, make choices that are lean, low fat, or fat free.
4. Limit intake of fats and oils high in saturated and/or *trans*-fatty acids, and choose products low in such fats and oils.

Key recommendations for specific population groups are:

Keep total fat intake between 30 to 35% of calories for children 2 to 3 years of age and between 25 to 35% of calories for children and adolescents 4 to 18 years of age, with most fats coming from sources of polyunsaturated and monounsaturated fatty acids, such as fish, nuts, and vegetable oils.

TABLE 4-7 Relationship Between LDL Blood Cholesterol Goal and the Level of Coronary Heart Disease Risk^a

If Someone Has:	LDL Blood Cholesterol Goal Is:
CHD or CHD risk equivalent ^b	Less than 100 mg/dL
Two or more risk factors other than elevated LDL blood cholesterol ^c	Less than 130 mg/dL
Zero or one risk factor other than elevated LDL blood cholesterol ^c	Less than 160 mg/dL

^aInformation for adults with elevated LDL blood cholesterol. LDL blood cholesterol goals for these individuals are related to the level of coronary heart disease risk. People with an elevated LDL blood cholesterol value should make therapeutic lifestyle changes (diet, physical activity, weight control) under the care of a healthcare provider to lower LDL blood cholesterol. *Source:* NIH Publication No. 01-3290, U.S. Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute, National Cholesterol Education Program Brochure, High blood cholesterol: What you need to know, May 2001. www.nhlbi.nih.gov/health/public/heart/choh/hbc_what.htm.

^bCHD (coronary heart disease) risk equivalent = presence of clinical atherosclerotic disease that confers high risk for CHD events:

1. Clinical CHD
2. Symptomatic carotid artery disease
3. Peripheral arterial disease
4. Abdominal aortic aneurysm
5. Diabetes
6. Two or more risk factors with > 20% risk for CHD (or myocardial infarction or CHD death) within 10 years

^cMajor risk factors that affect your LDL goal:

1. Cigarette smoking
2. High blood pressure (140/90 mmHg or higher or on blood pressure medication)
3. Low HDL blood cholesterol (less than 40 mg/dl)
4. Family history of early heart disease (heart disease in father or brother before age 55; heart disease in mother or sister before age 65)
5. Age (men 45 years or older; women 55 years or older)

PROGRESS CHECK ON ACTIVITY 2

MULTIPLE CHOICE

1. Which of the following is incorrect?
 - a. When the total calorie intake is 2200, limit saturated fat intake to 24 g or less.
 - b. When the total calorie intake is 2800, limit saturated fat intake to 31 g or less.
 - c. When the total calorie intake is 2000, limit saturated fat intake to 18 g or less.
 - d. When the total calorie intake is 2500, limit saturated fat intake to 28 g or less.
2. Cholesterol:
 - a. in blood is determined by height.
 - b. is a key component of cell membranes.
 - c. in shrimp is more than that in eggs.
 - d. is found in some plant foods.
3. Describe the key recommendations for a specific population group.
 - a. Keep total fat intake between 30 to 35% of calories for children 2 to 3 years of age.
 - b. Keep total fat intake between 35 to 40% of calories for children 2 to 3 years of age.
 - c. Keep total fat intake between 25 to 35% of calories for children 4 to 11 years of age.
 - d. Keep total fat intake between 25 to 35% of calories for adolescents 11 to 18 years of age.

TRUE OR FALSE

4. T F Lower intakes (less than 7% of calories from saturated fat and less than 200 mg/day of cholesterol) are recommended as part of a therapeutic diet for adults with elevated LDL blood cholesterol.
5. T F Fat functions in the body as the major protection for the womb and the fetus in a pregnant woman.
6. T F Regular ground beef (3 oz) has three times more fat than extra-lean ground beef (3 oz).
7. T F Smoking cigarettes is a one of the major risk factors that affect a person's LDL goal.
8. T F The risk of CHD increases when one has prostate cancer.

FILL-IN

9. The reading for high blood pressure is _____.
10. The level of low HDL blood cholesterol is _____.
11. What is highest percentage of total trans fats consumed by Americans? _____

DEFINE

12. LDL: _____
13. Lipoprotein: _____

14. CHD: _____
15. EPA: _____
16. DHA: _____

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