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Carbohydrates & Dietary Fats

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Carbohydrates and Dietary Fat

September 11, 2020

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Objectives

- Identify the different types of carbohydrates and fats
- Define the dietary recommendations for carbohydrate and fat intake
- Understand the role of carbohydrates and fat in the body
- Understand the link between dietary fat and risk of cardiovascular disease
- Understand the health benefits of carbohydrates and fat

Source for presentation: Pope and Nizielski. *Nutrition: For a changing world, 2nd edition*. 2019.



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Carbohydrates

Image: <https://www.diagnosisdiet.com/full-article/carbohydrates>

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What are carbohydrates?

COMPOSITION

- Carbon, hydrogen, and oxygen



- Composed of one or more sugar (saccharide) units



- Contains 4 kcal per gram

FUNCTIONS IN FOOD

- Source of fiber
- Adds sweetness and flavor

FUNCTIONS IN THE BODY

- Source of energy for all cells in the body
- Indispensable source of energy for the brain, red blood cells, and muscles during intense exercise
- Important for intestinal health
- Reduces the use of protein for energy



Fruits, vegetables, grains, and milk and milk products are sources of carbohydrates.

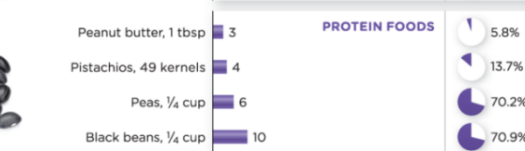
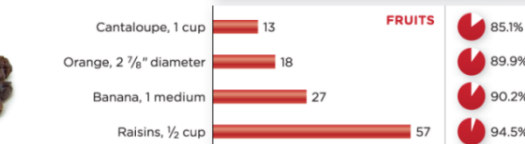
Pope/Nizielski, *Nutrition for a Changing World*, 2e © 2019 W. H. Freeman and Company
Ivonne Wierink/Shutterstock

Carbohydrates have vital functions in nutrition and health

- Source of energy for all cells of the body
 - Provide **4 calories per gram**
 - Recommendation: Consume **45% to 65% of total calories** from carbohydrate
- Indispensable source of energy for the brain, red blood cells, and exercising muscles
- Reduces the use of protein for energy
- Source of fiber (intestinal health)
- Adds sweetness and flavor to foods

Carbohydrates are classified as simple or complex

- **Simple** carbohydrates
 - Sugars and syrups
 - Fruits
 - Many vegetables
 - Milk
- **Complex** carbohydrates
 - Grains
 - Beans and legumes
 - Some vegetables

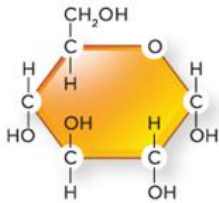

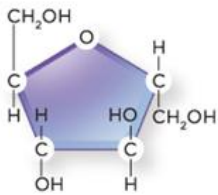

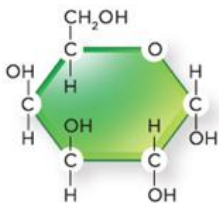



Although carbohydrates are plentiful in a variety of foods, muscle meats and fish contain no carbohydrates.

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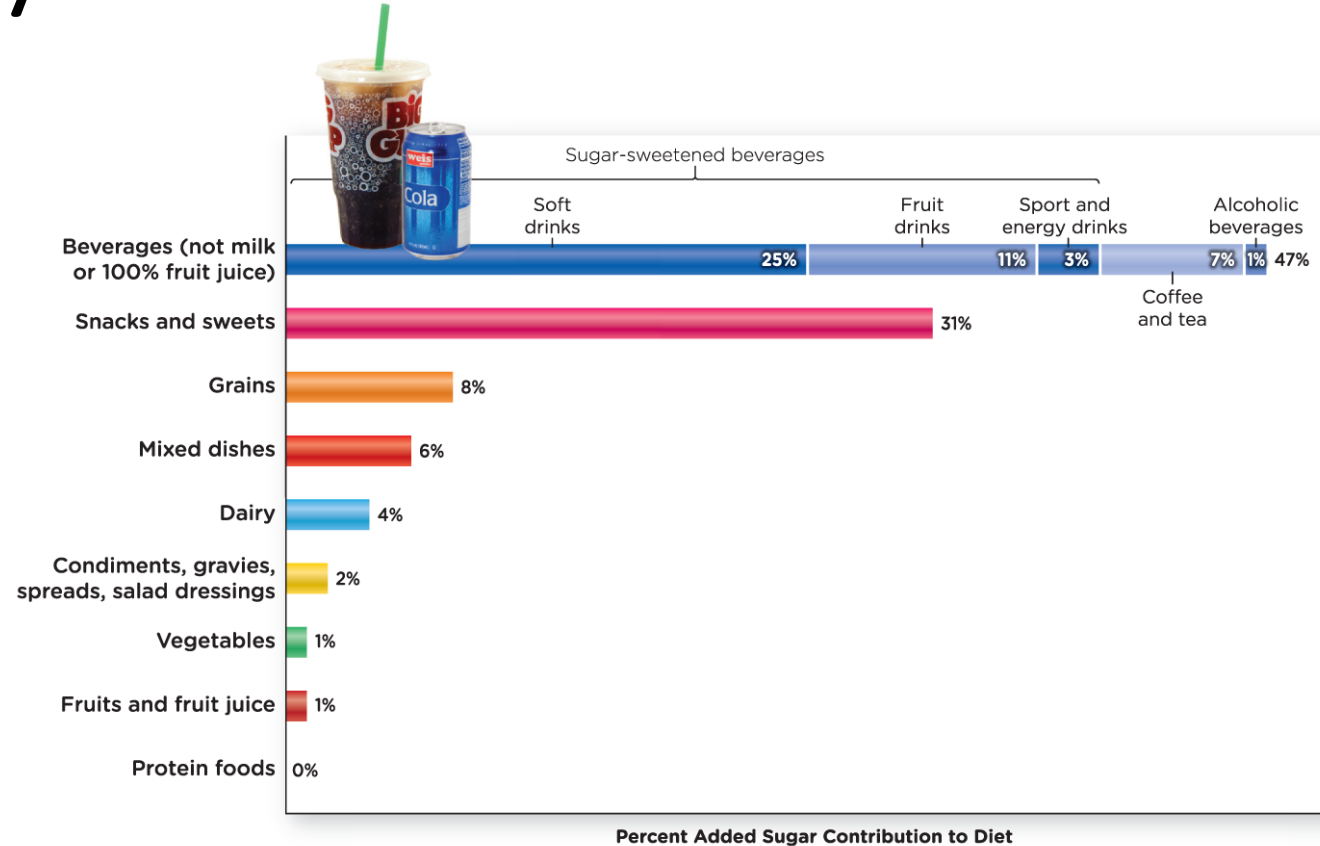


Simple carbohydrates are made from one or two sugars

SIMPLE CARBOHYDRATES	
Monosaccharides: made up of one sugar unit	Disaccharides: made up of two sugar units
 <p>Glucose circulates in the bloodstream. It is found in fruits, vegetables, and honey.</p>	 <p>Maltose is formed in large amounts as a product of starch digestion; however, very little is found in the foods we eat.</p>
 <p>Fructose is found in fruits, vegetables, and honey.</p>	 <p>Sucrose is otherwise known as "table sugar." It is found in fruits and vegetables.</p>
 <p>Galactose is one of the monosaccharides that make up milk sugar.</p>	 <p>Lactose is often called "milk sugar," as it is found only in milk, yogurt, and other dairy products.</p>

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Added sugars comprise approximately 13% of the daily calories in the United States



Source: What We Eat in America (WWEIA) Food Category analyses for the 2015 Dietary Guidelines Advisory Committee. Estimates based on day 1 dietary recalls from WWEIA, NHANES 2009-2010.

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Photo credit: Eli Ensor

Sugar alternatives and non-nutritive sweeteners

Non-nutritive Sweeteners				
Sweetener	Trade Name	Kcal/g	Sweetness Relative to Sucrose	Uses & Highlights
Acesulfame K	Sunnet, Sweet One	0	200X	Long-lasting and heat stable. It is used in a wide variety of products, particularly in sugar-free beverages and desserts.
Aspartame	Equal, NutraSweet	0	160–220X	Widely used in sugar-free soft drinks. Composed of two amino acids (aspartate, phenylalanine). Can withstand elevated temperatures for only a brief period but is destroyed at baking temperatures. When in solution it is not as stable as other sweeteners.
Neotame	<i>Used infrequently</i>	0	7,000–13,000X	Very similar in structure to aspartame. Much greater stability in solution and can withstand high temperatures encountered during baking.
Saccharin	Sweet’N Low Sugar Twin	0	300X	Discovered in 1878. Widely used in sugar-free soft drinks and as a tabletop sweetener. Can be used in baking without losing its sweetness. Once listed as a possible carcinogen, it has since been shown to not cause cancer in humans.
Stevia	Pure Via Truvia	0	250X	Rebaudioside A (rebiana) is the active compound that is isolated from the leaves of the South American plant stevia. Approved for use in the United States in 2008. Used primarily in beverages, as a tabletop sweetener, and in yogurt. It is heat stable.
Sucralose	Splenda	0	600X	It is made from sucrose by replacing 3 -OH groups with chlorine. It is used as a tabletop sweetener, and it is widely used in beverages where it is remarkably stable over long periods. It is also used as a tabletop sweetener.

Sources: *Alternative Sweeteners*, 4th ed. Nabors, Lyn O'Brien editor. CRC Press. 2011.

Infographic 4.8 part 2

Scientific American: Nutrition for a Changing World

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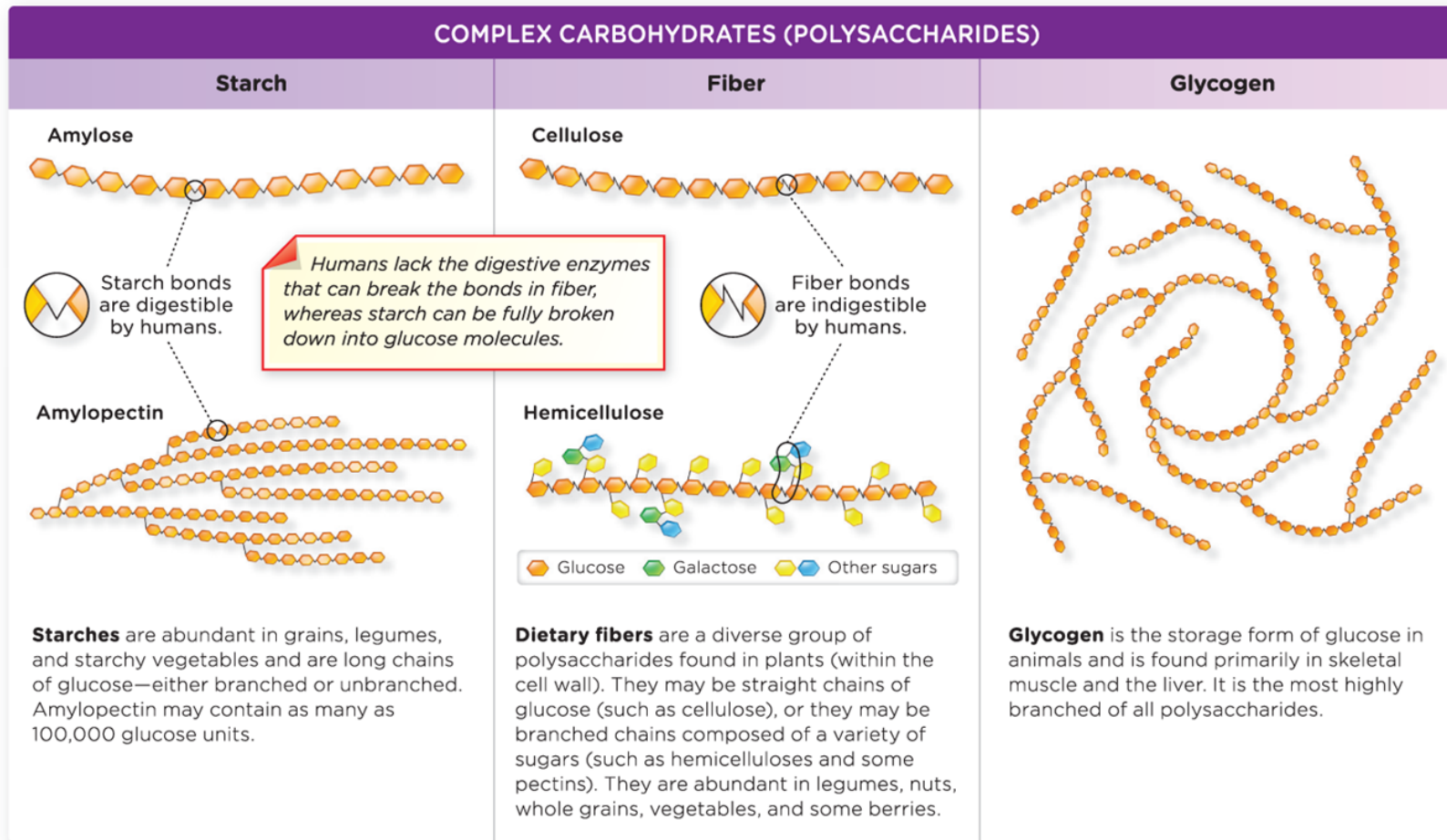
Sugar alternatives and non-nutritive sweeteners

Nutritive Sweeteners				
Sweetener	Trade Name	Kcal/g	Sweetness Relative to Sucrose	Uses and Highlights
Tagatose	Naturlose	1.5	0.75-0.92	A monosaccharide almost identical to fructose. Provides fewer calories because it is poorly absorbed. It also occurs naturally in foods (dairy) in small amounts. Is used much like sucrose to provide both bulk and sweetness in foods such as ice cream, cakes, and candies.
Sugar Alcohol Sweeteners (Polyols) <i>Provide reduced calories because they are poorly absorbed. Also occur naturally in foods.</i>				
Sorbitol	Sorbitol	2.6	0.5-0.7	Used in sugarless gums, chocolate candies, and ice cream. It is not metabolized by bacteria in the mouth and therefore does not promote tooth decay. Prunes naturally contain high amounts. Likely to cause a laxative effect when consumed at ≥ 50 g/day.
Mannitol	Mannitol	1.6	0.5-0.7	Used primarily in making chewable tablets. Likely to cause a laxative effect when consumed at ≥ 20 g/day.
Xylitol	Xylitol	2.4	1	Used in mouthwash, sugarless gums, and candies. Like sorbitol, it does not promote tooth decay. Causes a cooling sensation in the mouth when used in chewing gums and hard candies (as do sorbitol and mannitol). The laxative effect appears to be slightly less than that of sorbitol.

Food manufacturers have turned to alternative sweeteners as a way to replace sugar.

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Complex carbohydrates: Starch and Fiber



Humans lack the digestive enzymes that can break the bonds in fiber, whereas starch can be fully broken down into glucose molecules.

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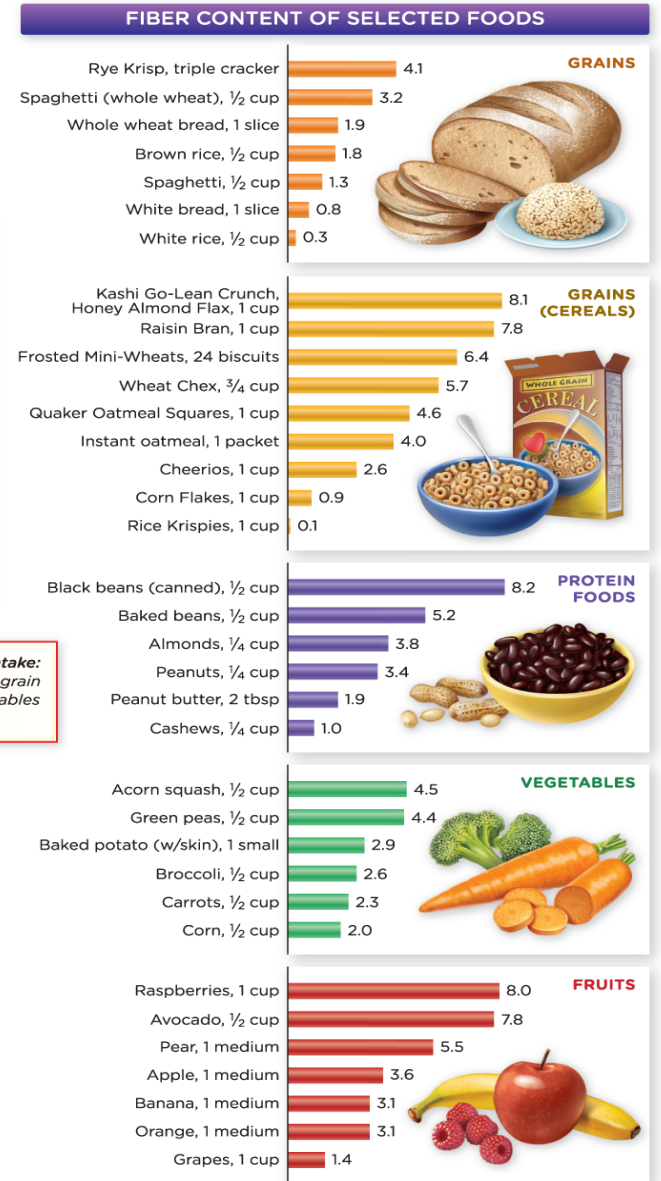
Recommended Fiber Intake

- Males ages 19–50: 38 grams/day
- Females ages 19–50: 25 grams/day
- Average U.S. intake: 17 grams/day

Health Benefits of Fiber

- Soluble fiber may reduce the risk of cardiovascular disease.
- High-fiber foods promote satiety and may reduce the risk of obesity.
- High intakes of insoluble cereal fiber may reduce the risk of type 2 diabetes.
- Soluble fiber slows the increase in blood glucose following carbohydrate ingestion.
- High insoluble fiber intake softens stools and reduces the occurrence of constipation.
- High intake of a variety of high-fiber foods may reduce risk of some cancers.

Tips to increase your fiber intake:
Choose the right type of whole grain cereals, and eat plenty of vegetables (especially beans) and fruits.



Fiber Content (grams)

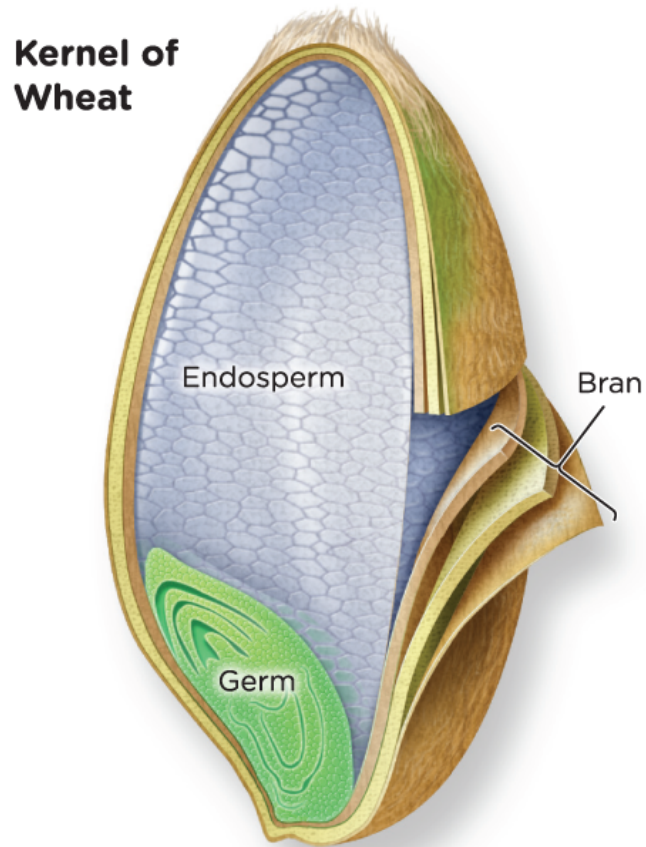
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Fiber has multiple health benefits

- Soluble fiber may reduce the risk of cardiovascular disease.
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Anatomy of a Whole Grain



Endosperm contains the highest amount of starch and protein and is all that remains when a grain is refined.

Bran contains the majority of dietary fiber and a significant amount of B vitamins and minerals.

Germ, the embryo of the seed that germinates and grows and contains essential fatty acids and a number of B vitamins and minerals.

The vast majority of vitamins, minerals, and phytochemicals are found in the germ and bran of whole grains.

Whole grains contain the endosperm, germ, and bran in original proportions

- Refined grains (white grain)
 - Stripped of the germ and bran, leaving only the endosperm
- Enriched grains
 - Some nutrients lost in processing are added back



fcafotodigital/Getty Images

The Whole Grains Stamp used in 36 countries tells consumers that a product contains at least 8 grams of whole grains per serving



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- Dietary Guidelines for Americans
 - Consume at least half of grains as whole grain
- USDA MyPlate
 - Look for whole grains as the first ingredient in food products
- American Heart Association
 - Look for products with a total carbohydrate-to-fiber ratio that is less than 10:1

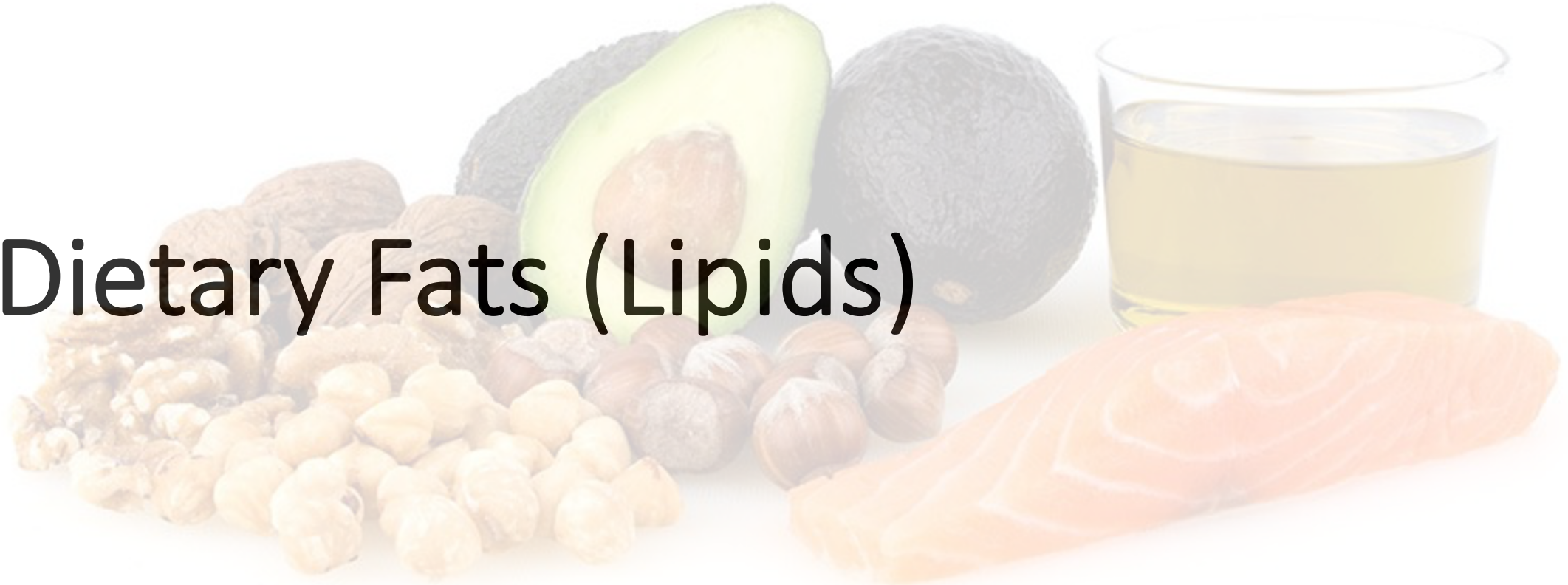
Recommendations for Carbohydrate Intake

Source	Total Carbohydrates	Fiber	Added Sugars
2015 Dietary Guidelines for Americans	Consume at least half of all grains as whole grains. Increase whole grain intake by replacing refined grains with whole grains.		Consume less than 10% of total calories from added sugars.
Health and Medicine Division Recommendations (DRIs)	RDA: 130 g/day AMDR: 45-65% of total calories • 2,000 kcal/day diet: 225-325 g/day • 2,500 kcal/day diet: 281-406 g/day	AI: 14 g per 1,000 kcal/day Women Men Age 19-50: 25 g/day 38 g/day Age ≤51: 21 g/day 30 g/day	≤ 25% of total calories consumed
American Heart Association (2009)			Women Men ≤ 100 kcal/day (25 g) ≤ 150 kcal/day (38 g)
World Health Organization (2003)			≤ 10% of energy intake

You can help meet dietary recommendations for carbohydrates by limiting added sugars such as sweets and soda, eating more fruits and vegetables, and checking the ingredient list on foods for the words whole or whole grain.





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Dietary Fats (Lipids)



Types of fats/lipids

- **Lipids include fatty acids, triglycerides, sterols, and phospholipids**
- Diverse in structure and function
- Contain carbon, hydrogen, and oxygen
- Generally insoluble in water

Fatty Acids	Triglycerides	Sterols	Phospholipids
<p>A major energy source.</p> 	<p>The most abundant lipid in our diet and storage form of fat in our bodies.</p> 	<p>Cholesterol is the primary dietary sterol.</p> 	<p>The primary lipid in cell membranes.</p> 

Fatty acids not only are a class of lipids but also are components of both triglycerides and phospholipids.

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Functions of fats in the **body**

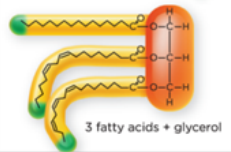
- Component of cell membranes
 - Give cell membranes flexibility and integrity
- Various lipids required for synthesis of hormones
- Fats supply a concentrated source of energy and fat-soluble nutrients
 - **9 calories per gram**
 - Essential fatty acids (linoleic acid and alpha-linolenic acid)
 - Fat-soluble vitamins A, D, E, and K
- Facilitate the transport of nutrients
- Enhance the absorption of fat-soluble vitamins
- Lipids are the primary source of the body's energy reserves (stored in adipose tissue)
- Adipose tissue cushions, protects, and insulates the body's organs

Functions of fats in **food**

- Fats contribute to the sensation of feeling full
 - Fats stay in the stomach longer
 - Fats are absorbed over a longer period of time
- Fats increase the palatability (flavor and taste) of foods
- Fats contribute to the texture and aroma of foods

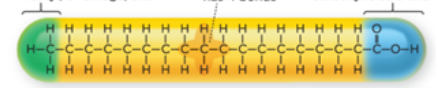


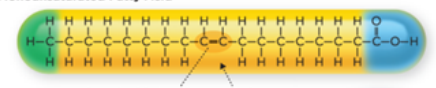


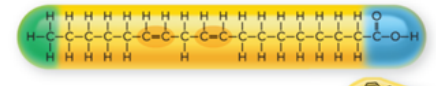


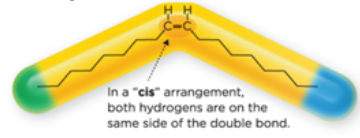
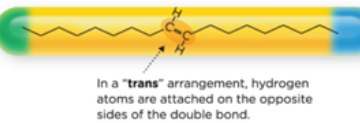

Fats in food are a mixture of different fatty acids

TRIGLYCERIDES: Compounds made up of a glycerol molecule and three fatty acids.

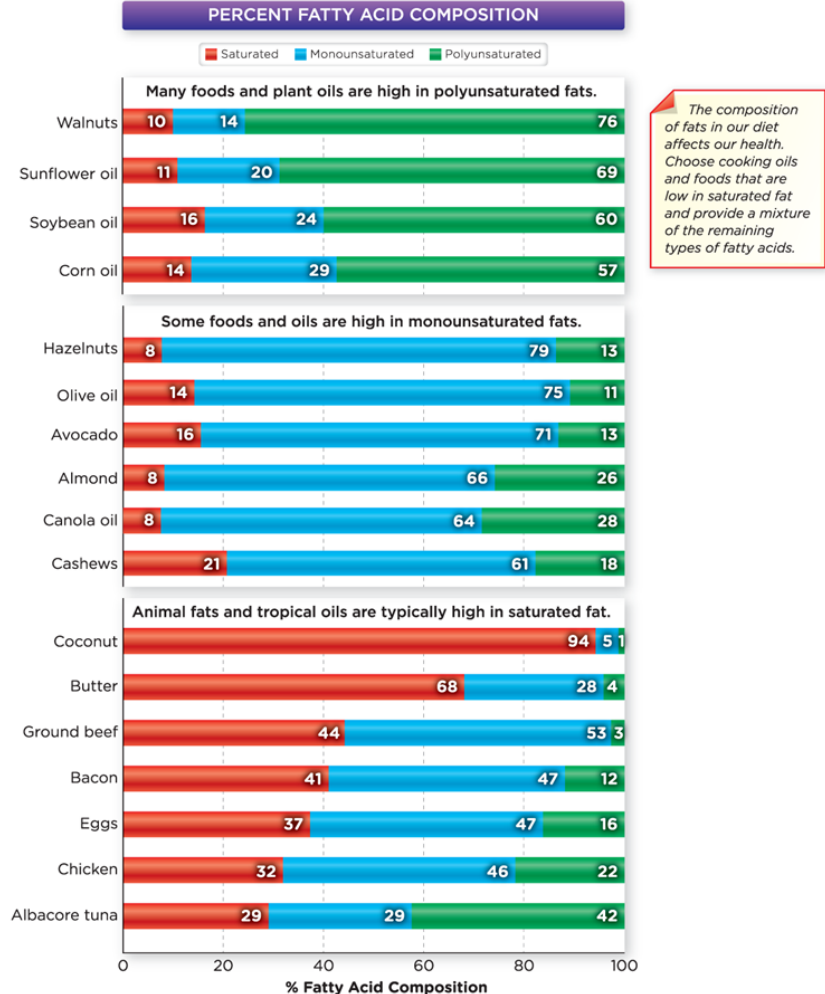


3 fatty acids + glycerol

FATTY ACIDS: Vary in degree of saturation and chain length.

Fatty Acid Type	Solid or Liquid at Room Temperature?	Food Sources
<p>Saturated Fatty Acid</p> <p>Methyl, or omega, end Each carbon has 4 bonds Carboxylic acid end</p>  <p>Shorthand notation for fatty acid (every bend represents a carbon and 2 hydrogen atoms).</p> 	Solid	
<p>Monounsaturated Fatty Acid</p>  <p>A carbon-carbon double bond replaces the missing C-H bonds and each carbon still has 4 bonds. Hydrogen atoms "missing"</p> 	Liquid	
<p>Polyunsaturated Fatty Acid</p>  <p>Polyunsaturated fatty acids contain more than one carbon-carbon double bond.</p> 	Liquid	
<p>Cis and Trans Fatty Acids</p>  <p>In a "cis" arrangement, both hydrogens are on the same side of the double bond.</p>  <p>In a "trans" arrangement, hydrogen atoms are attached on the opposite sides of the double bond.</p>	<p>Cis fatty acid</p> <p>Trans fatty acid</p> <p>Most unsaturated fatty acids found in nature are in the cis configuration; however, small amounts of trans fatty acids naturally occur in dairy and beef. The addition of artificial trans fats during food manufacturing or processing was recently banned by the FDA.</p>	

All dietary fats contain saturated, monounsaturated, and polyunsaturated fatty acids in varying proportions



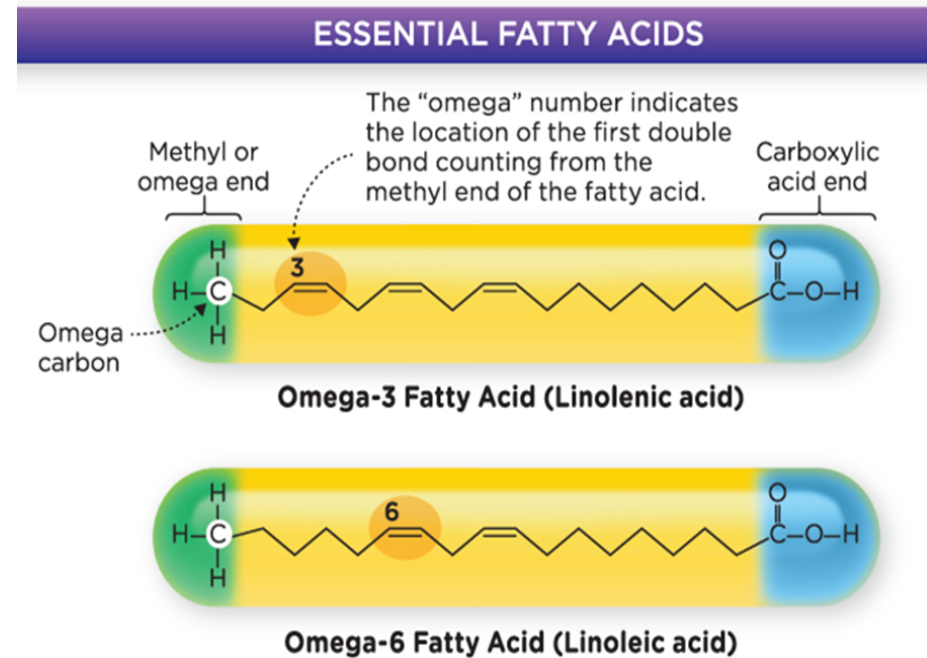
The composition of fats in our diet affects our health. Choose cooking oils and foods that are low in saturated fat and provide a mixture of the remaining types of fatty acids.

Cholesterol

- Cholesterol is found only in animal foods
- It is not an essential nutrient, as the liver produces sufficient amounts to meet the body's needs
- Required for synthesis of bile acids, vitamin D, and steroid hormones
- Does not provide energy

Essential fatty acids must be supplied through the diet

- Body cannot synthesize these fatty acids
- Linoleic acid
 - Omega-6 fatty acid
- Linolenic acid
 - Omega-3 fatty acid
- Both long-chain polyunsaturated fatty acids
 - 18 carbon molecules

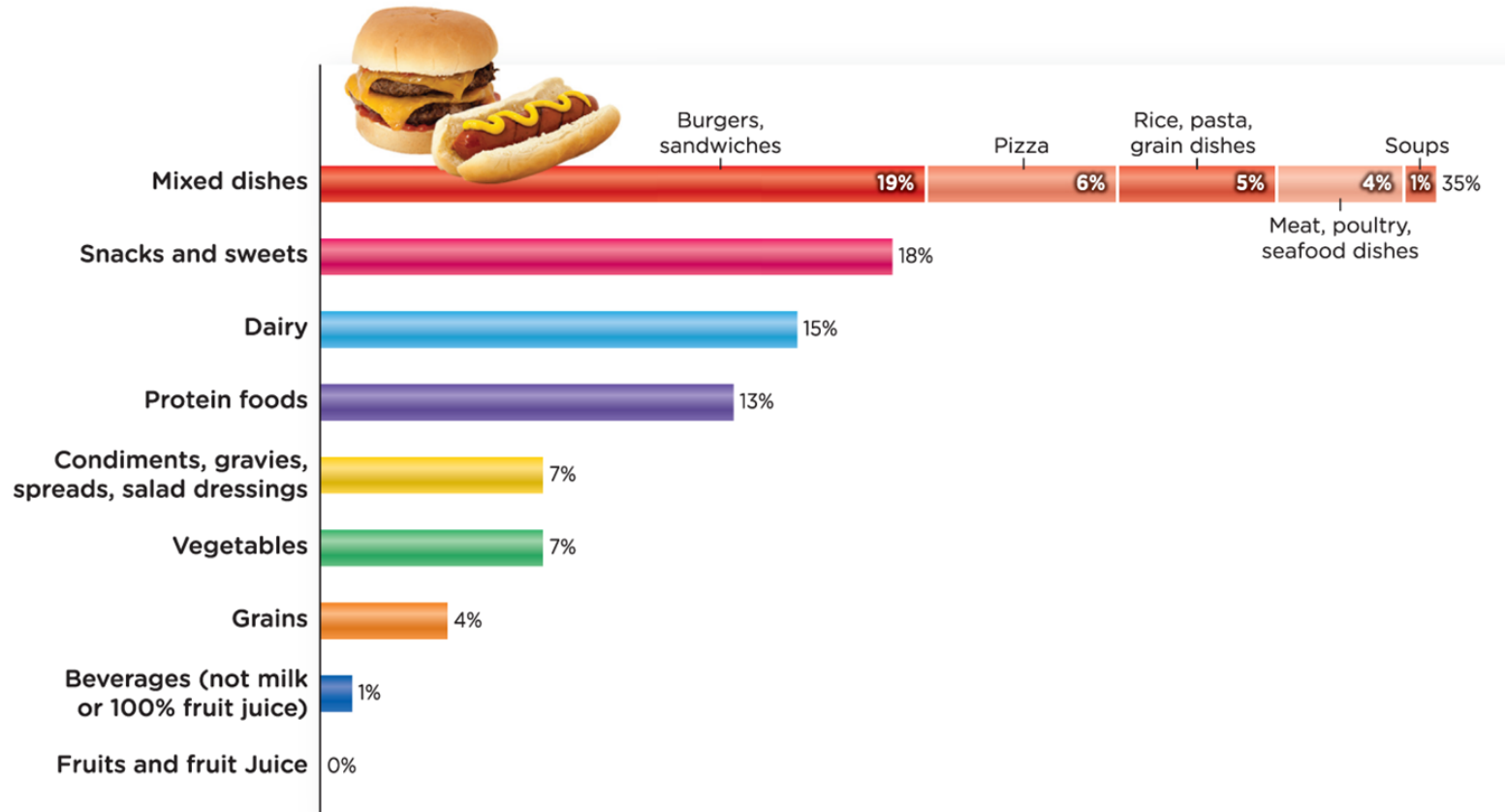


The AMDR for total fat is 20–35% of total calories, and most should come from unsaturated fats

- Eat as little saturated fat (<10%), trans fat, and cholesterol as possible
- Use caution when substituting fat with simple or refined carbohydrates



Reduce intake of foods and added fats high in saturated in favor of unsaturated fats



Percent Saturated Fat Contribution to Diet

Pope/Nizielski, *Nutrition for a Changing World*, 10th Edition
 Editor: Eli Ensor

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How do we determine the amounts and types of fats in the foods we eat? Read food labels.

Double Chocolate Chip COOKIES

Nutrition Facts	
24 servings per container	
Serving size	1 Cookie (19g)
Amount per serving	
Calories	90
	% Daily Value*
Total Fat 4.5g	8%
Saturated Fat 2g	10%
Trans Fat 0g	
Polyunsaturated Fat 0g	
Monounsaturated Fat 1.5g	
Cholesterol 5mg	2%
Sodium 70mg	3%
Total Carbohydrate 11g	4%
Dietary Fiber 0g	0%
Total Sugars 6g	
Includes 6g Added Sugars	12%
Protein 1g	2%

Ingredients: Enriched Wheat Flour, Sugar, Semi-Sweet Chocolate Chips (Sugar, Chocolate, Milkfat, Cocoa Butter, Soy Lecithin), White Chips [Sugar, Fractionated Palm Kernel Oil, Milk, Nonfat Milk, Fully-Hydrogenated Palm Oil, Soy Lecithin, Natural Flavor], Vegetable Oil (Palm Oil, Canola Oil), Water, 2% or Less of Corn Syrup Solids, Eggs, Molasses, Salt, Baking Soda, Sodium Aluminum Phosphate, Natural Flavor, Vanilla Extract.

% OF CALORIES FROM FAT: Look beyond the grams of total fat, and determine the percentage of total calories that are provided by fat. To do this, multiply fat grams by 9 to determine the number of kcals from fat ($4.5 \times 9 = 40.5$ kcals), divide fat calories by total calories, and multiply by 100. $(40.5 \div 90) \times 100 = 45\%$ of calories from fat. That's above the upper end of the AMDR range of 35% for fat.

UNHEALTHY SATURATED AND TRANS FATS: Even when total fat is low, unhealthy fats may be high. Half of the fat in this product is from saturated fats. Note that the %DV for saturated fats is much higher than for total fat.

TRANS FAT: The adding of artificial trans fats to foods was banned by the FDA in July 2018, so this value will generally be zero, unless the food has large amounts of beef or lamb meat with naturally occurring trans fats.

CHECK FOR SOURCES OF SATURATED FAT: Fully hydrogenated and tropical oils (coconut, palm, and palm kernel oils) are sources of saturated fat.

Is fish really brain food?

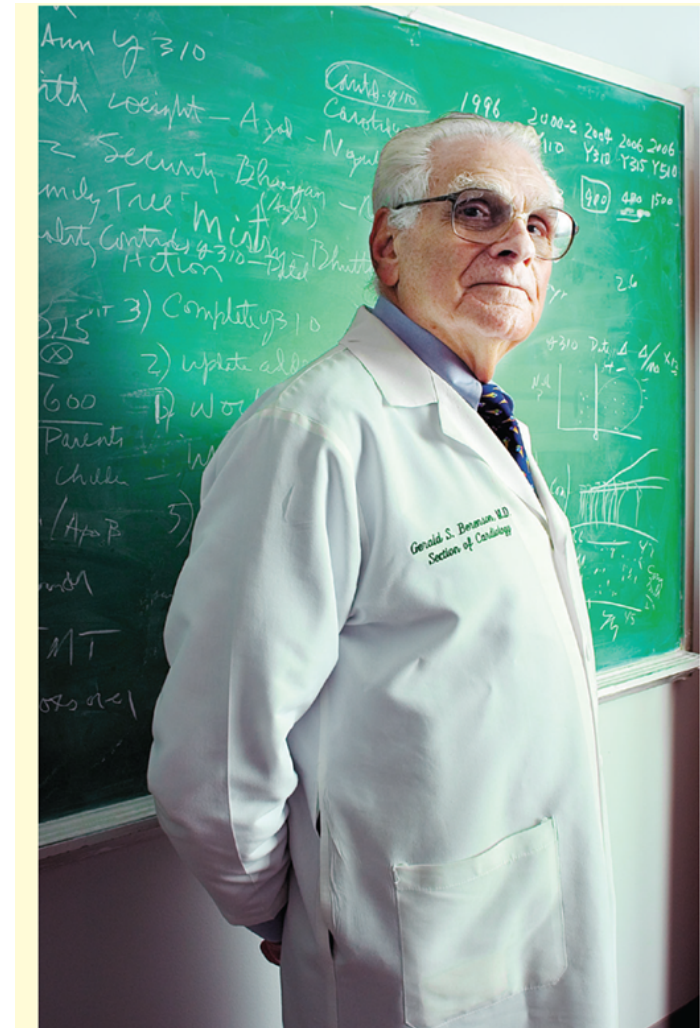


Eli Ensor

Dietary lipids may play a role in decreasing humans' risk of developing dementia

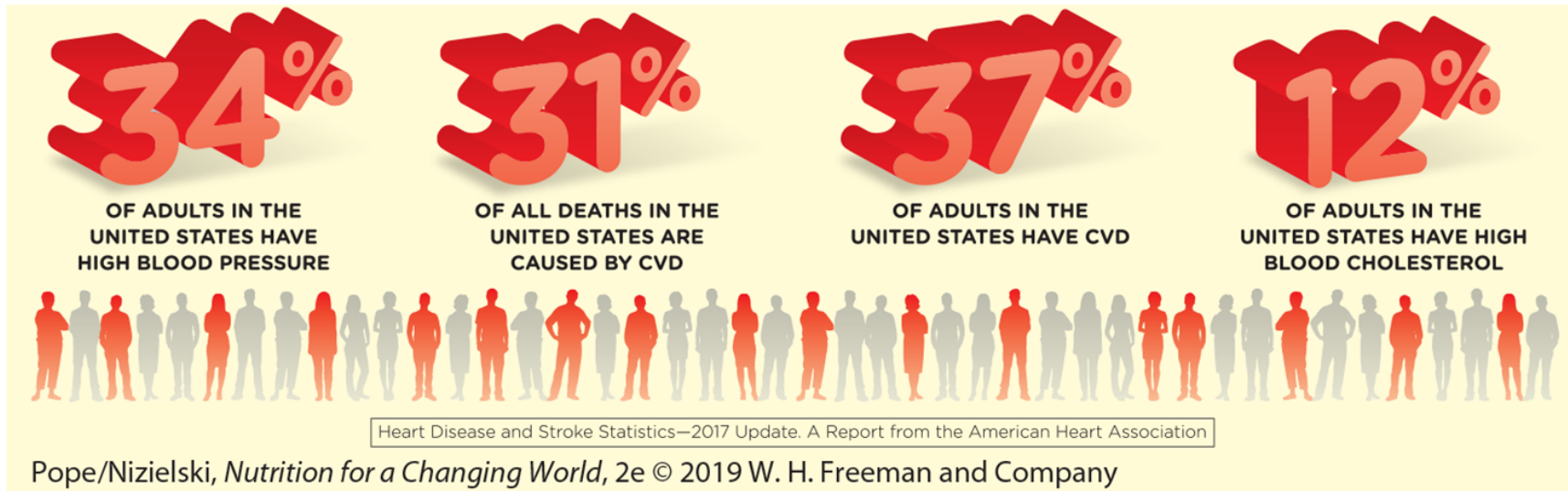
The Bogalusa Heart Study was the first study to demonstrate that heart disease begins in childhood

- Gerald Berenson, M.D., conducted the study from 1972 to 1998 in a rural southern town
 - Followed 16,000 individuals from childhood
 - 40% living below poverty
- Physical and lifestyle attributes contribute to developing heart disease



Greg Miles

Cardiovascular disease is the leading cause of death in the United States



Certain risk factors increase the likelihood of developing CVD

Some risk factors cannot be modified

- Family history of heart disease at an early age
- Race
 - African Americans at higher risk
- Age
 - Risk increases with age for both men and women

Appropriate diet and lifestyle choices may reduce our risk for CVD by about 80%

Poor Diets: Diets high in trans fats, saturated fats, and cholesterol and low in polyunsaturated fats, vegetables, fruits, and whole grains increase the risk of CVD. Excess intake of sodium can lead to hypertension, which increases the risk of CVD.



Physical Inactivity: It is estimated that individuals who engage in 150 minutes of moderate- to vigorous-intensity exercise per week will reduce the risk of CVD mortality by 30-35% compared with those who are physically inactive.



Obesity: Particularly central or abdominal obesity is a major independent risk factor for CVD. It also increases the occurrence of other CVD risk factors (hypertension, diabetes, high blood cholesterol, and high triglycerides).



Smoking: Smokers are two to four times more likely to develop heart disease or experience a stroke than are nonsmokers. Exposure to secondhand smoke at home or work increases the risk of heart disease.



Excessive Alcohol Consumption: Excessive alcohol consumption causes hypertension that dramatically increases the risk of stroke. Drinking large amounts can also cause the heart to enlarge and heart muscles to thin and weaken. Heavy or at-risk alcohol use is defined as more than 3 drinks a day or 7 per week for women, and 4 drinks a day or 14 per week for men.



Heart-Related Conditions: The risk of CVD is increased by high blood pressure, blood glucose, LDL cholesterol, and triglycerides and by low HDL cholesterol. Improving one's diet and exercising regularly will help manage these conditions.

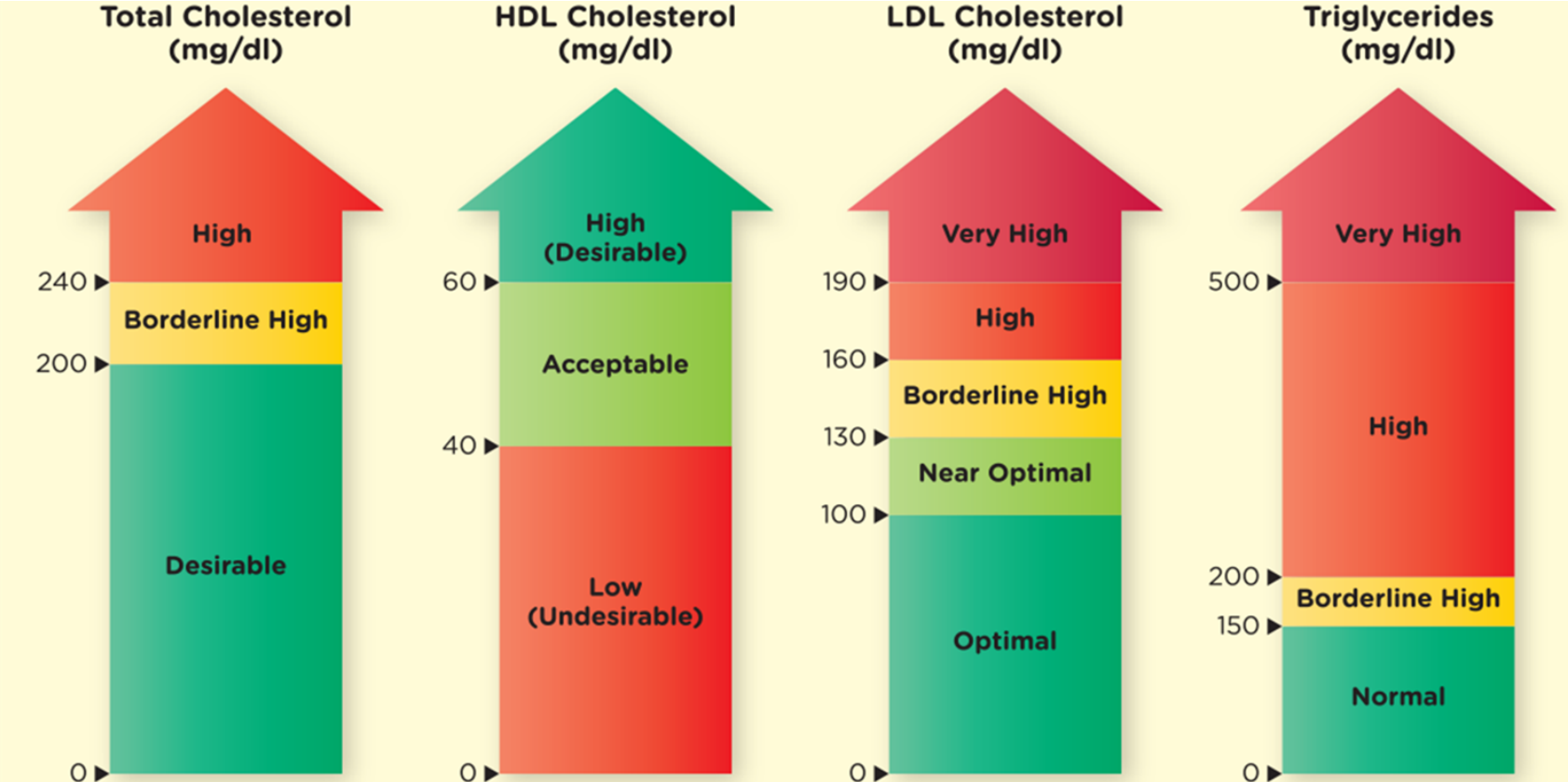


Unmodifiable risk factors for CVD are age, race, and family history of CVD (genetics).

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The concentrations of total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides in the blood affect the risk of cardiovascular disease

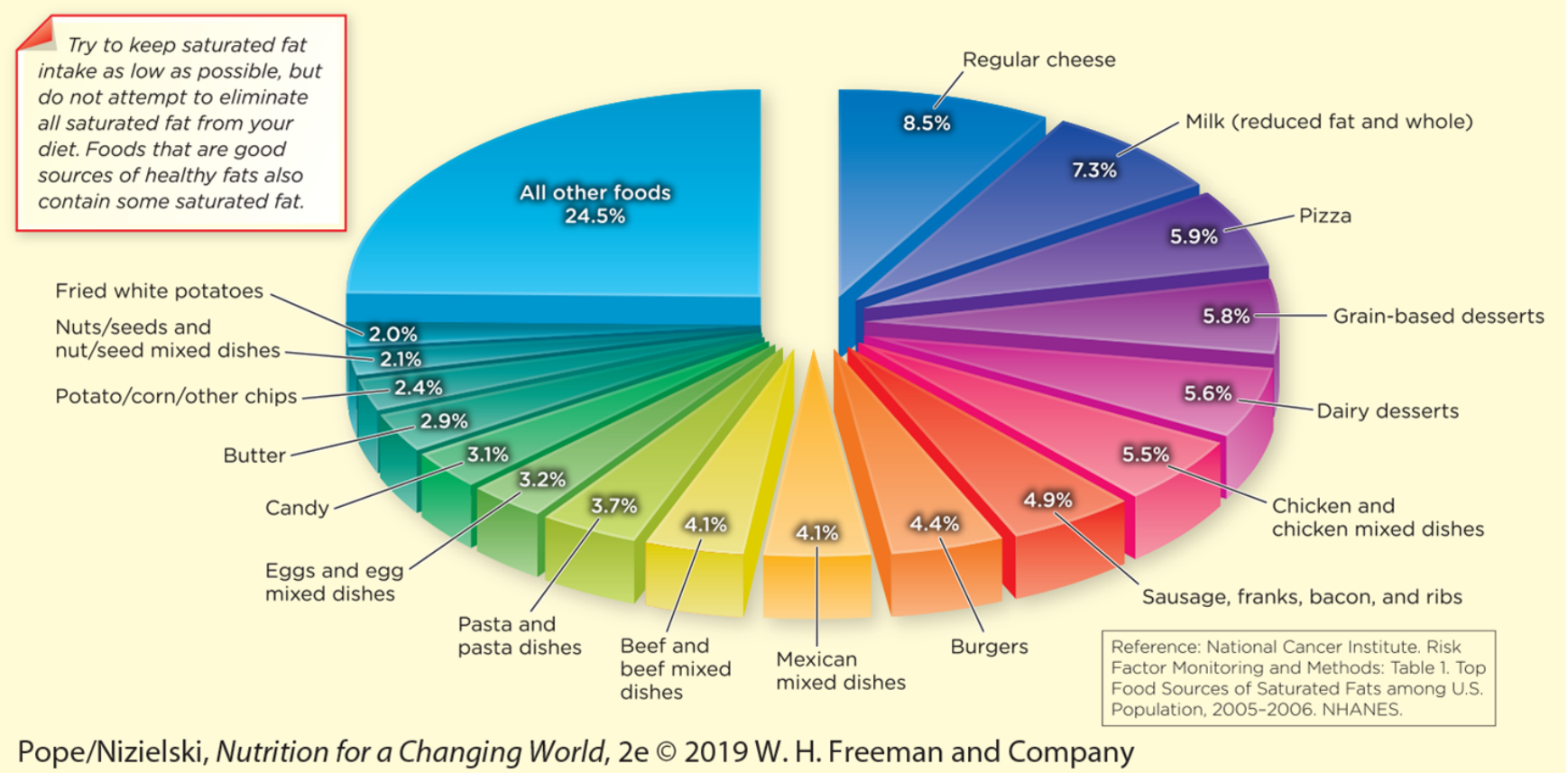


The figures in this table are provided by the National Cholesterol Education Program (NCEP) of the NIH.

A complex relationship exists between dietary fats and heart disease

- Saturated fats and trans fats
 - Raise total cholesterol and LDL cholesterol
- Polyunsaturated fats
 - Lower risk of heart disease
 - Lower cholesterol without lowering HDL cholesterol
- Monounsaturated fats
 - May raise HDL, and lower cholesterol and overall triglyceride levels
- Omega-6 fatty acids
- Omega-3 fatty acids
 - Ratio of omega-6 and omega-3 fatty acids

Percent contribution of specific foods to saturated fat intake for Americans age 2 and older



Summary

- Identify the different types of carbohydrates and fats
- Define the dietary recommendations for carbohydrate and fat intake
- Understand the role of carbohydrates and fat in the body
- Understand the link between dietary fat and risk of cardiovascular disease
- Understand the health benefits of carbohydrates and fat