Energy-Providing Nutrients: Carbohydrate, Fat and Protein

**Printer-Friendly Option**

Nutrients are substances the body needs for life, maintenance, growth, repair, maintenance and energy. There are six basic types of nutrients, three of which provide the body with the energy while the other three do not. The three energy-providing nutrients are carbohydrates, fats, and proteins. The other three nutrients--vitamins, minerals, and water--do not provide energy. There will be more information about the non-energy-providing nutrients during week five of the course. Technically, alcohol is also a source of energy, but because it is not considered essential to the body, it is not usually included in assessing what is needed.

**Carbohydrates**

Many individuals, when asked to provide examples of carbohydrate-rich foods, may cite bread, cereal, rice and pasta among their lists. Carbohydrates, however, are found in many other plant-based foods, including fruits, vegetables, nuts, and seeds. Carbohydrates are the body's main source of energy, and the brain particularly relies on the micronutrient to function, so a healthy person's diet should contain enough of the fuel to keep the body's muscles and brain working optimally. The amounts of energy in carbohydrates, fats, and proteins are measured in kilocalories, although we often refer to kilocalories as just plain "calories." There are approximately four (4) calories per gram of carbohydrate.

Carbohydrates are most frequently categorized by their structure: **simple** and **complex**. Simple carbohydrates include:

- **monosaccharides** are single-unit carbohydrates, and include glucose, fructose, galactose
- **disaccharides** are two-unit carbohydrates, and include lactose and maltose
- **oligosaccharides** contain three units to approximately nine units of carbohydrate; their names are quite complex, as seen online in [Nutrientsreview.com](http://Nutrientsreview.com) (O)

Complex carbohydrates are also known as **polysaccharides**, which means they consist of numerous sugar units, usually with more complicated structures. Examples of complex carbohydrates include:

- **starches** are long chains of many sugar units; foods rich in starch include potatoes, rice, wheat, corn, and oats, and these foods are often used to make other "starchy" foods, such as bread, pasta, and cereal
- **glycogen** is the form carbohydrates take when they are stored in the body's muscles and in the liver
- **cellulose** is a major structural component of plants, so is found in vegetables, fruits, and seeds, but it is indigestible; cellulose is one component of what we know as "fiber"

Health-related resources typically recommend a diet in which the carbohydrate content equals 45-65% of the total caloric intake. This is a general number, applied to a healthy individual with an average diet. Different percentages or absolute amounts will change across special populations. One of the main reasons dieters and other nutrition experts recommend ample carbohydrate consumption is because foods high in complex carbohydrates are also usually higher in vitamins and minerals (two of the three non-energy containing nutrients).

Carbohydrates have received a lot of public attention, with some organizations citing the nutrient as being over-consumed, particularly in America. Many carbohydrate-based foods tend to be considered tasty and subsequently consumed in fairly large quantities. As a result, too many consumed calories and unused glucose from the carbohydrate consumption can result in weight gain and fat deposition. Realistically, then, much of America may have less of a carbohydrate problem than a calorie balance problem. That is, Americans are eating too much food in general while failing to exercise enough.
Low-carbohydrate diets, like other diet plans, incorporate a reduced caloric intake as part of the overall program. When a person consumes fewer calories than usual, over time he or she may lose weight, particularly if the diet program is paired with a regular exercise regimen. Aside from weight loss, these low-carbohydrate diets do seem to help some people improve other cardiovascular disease risk factors, as well, though current evidence is more short-term in nature. Travel to the Harvard School of Public Health to read more information on carbohydrates (R).

Given the caloric intake challenge many Americans share, some people may find their bodies react differently to various carbohydrate forms. The Glycemic Index (GI) scale is a numerical scale used to rank carbohydrates based on how quickly they can raise blood sugar. Foods with high glycemic index values (70+) are thought to result in greater, more rapid increases in blood sugar than foods with lower glycemic index values (55 or less). Since some people may be sensitive to marked blood sugar fluctuations typical of high GI foods, they may wish to consume more foods with lower GI values. The concept is especially interesting because GI values of complex carbohydrates--considered to be generally preferred over simple carbohydrates--can vary considerably. A potato, for example, has a very high GI value while brown rice has a low GI value, even though both foods are considered complex carbohydrates. To read more about the GI, travel to the Glycemic Index website (O).

The GI scale is used to compare the same amount of carbohydrate across different foods. Of course, foods contain differing amounts of carbohydrate. For example, a food may have a high GI value, but there may not be much actual carbohydrate in the food, which could make a difference in a person's reaction. The Glycemic Load (GL) is a numerical tool used to account for the amount of carbohydrate in a food. Higher GL values (20+) means a food has more carbohydrate than a food with a lower GL value (10 or below). Freelance medical writer David Mendosa received permission from Professor Jennie Brand-Miller, University of Sydney, to publish a list of 750 foods with their respective GI and GL values on his website (O). He also provides a much shorter list on his website (O).

Proteins

Protein is the second most abundant source in the body next to water. Protein contains four calories per gram and is found in meat, fish, eggs, milk, cheese, beans, and whole grains. The basic unit of a protein is the amino acid. There are approximately 20 different amino acids in the body required for human function. Of these 20, 11 of them are already produced by the body and hence termed nonessential amino acids. Nine of these 20 must be obtained from food and hence called "essential" amino acids. Foods containing all nine required amino acids in them are termed complete proteins, such as meat, fish, poultry, eggs, and milk. Some plant foods are complete protein sources, but many are incomplete proteins, lacking one or more of the required nine amino acids. This fact becomes important when considering a vegetarian diet.

All vegetarians refrain from eating meat and fish products. Some of them, however consume milk and egg products (ovolactovegetarians), some of them only consume milk products (lactovegetarians), while others consume only plant products (vegans). While all vegetarians can easily meet their protein needs, vegans should vary their diets to ensure adequate protein intake. For more information, travel to the American Dietetic Association's stance on vegetarianism (O).

Although some individuals need to be concerned about inadequate protein intake, excessive protein intake is not a good idea, either. The body can either store the excess protein as fat or excrete it. When protein is broken down for excretion, one of the bi-products is ammonia. When the body processes the ammonia into a less-toxic substance, one of the products is water, also excreted with the protein. In chronic and extreme circumstances, this can lead to dehydration and kidney complications. Excessive animal protein intake also may be related to bone loss. Enerex Botanicals provides information on Soy Protein Products (O-pdf file).
There are approximately four (4) calories per gram of protein. Many health-related sources will recommend a diet in which the protein content equals 10-15% of the total caloric intake. Again, this number will change across populations.

Many like to obtain their protein through fish consumption. In 2004 the FDA and EPA released advisories on fish consumption, linking specific conditions with methylmercury poisoning (O). There are advisories against consuming high-mercury content fish (shark, swordfish), recommendations to limit intake of other fish containing mercury, and a third recommendation about fish caught by friends and family in local waters. Travel to the FDA website to see a list of mercury levels present in a variety of fish and shellfish (O).

The Harvard School of Public offers information on protein and weight control (O).

Fats
Everyone needs at least a little fat, as evident in every cell membrane, which contains a layer of fat. Fat is used to insulate, to protect the body's organs, to carry the fat-soluble vitamins A, D, E, and K, and to provide an extra energy source. Examples of food sources containing fat include meat products, milk, cheese, nuts, avocados, and processed foods. There are approximately nine calories per gram of fat. Triglycerides and cholesterol are examples of fats. Triglycerides are the form of fat most commonly consumed. Triglycerides consist of a glycerol molecule and three fatty acids. The fatty acids will vary in their chemical length as well as their saturation.

The saturation of a fatty acid refers to its chemical structure. A saturated fat has no double bonds between carbon atoms, but instead features hydrogen saturation around each carbon atom. Examples of saturated fatty acids include those fats that are solid at room temperature, such as lard and butter, and also tropical oils, such as coconut and palm oils. Saturated fats tend to increase the liver's production of cholesterol, and diets high in saturated fats tend to increase one's risk for cardiovascular disease. To see the chemical structures of fatty acids at different levels of saturation, travel to a University of California biology class web page (O).

Polyunsaturated fatty acids feature one or more multiple bonds between carbon atoms. There are two general types of unsaturated fatty acids: monounsaturated, containing one multiple bond and polyunsaturated, containing more than one multiple bond. Unsaturated fats are generally liquid at room temperature and are considered a more healthful choice than saturated fats. Some unsaturated fats, however, are hydrogenated (hydrogen atoms are added) to improve texture or spreadability, which decreases their benefits over saturated fats. Good sources of monounsaturated fats include some nuts and avocados, as well as olive, canola and tea seed oil. Omega-3 and omega-6 fatty acids are two examples of polyunsaturated fats. The BBC has an online article, Omega Wave, regarding the unexpected "brainpower" benefits provided by omega fatty acids (O).

There are approximately nine (9) calories per gram of fat. Most health-related sources will recommend a diet in which the fat content equals 25-30% of the total caloric intake. This number will vary for individuals with special needs, such as people with cardiovascular disease.

While many physicians and dieticians recommend a low-fat diet for weight loss and general health, there are also many professionals who believe a higher-fat and lower-carbohydrate diet is an answer for weight control. There is research backing up both sides, so consumers need to educate themselves, thinking critically when reading nutrition information and news.

Fat Substitutes
Many Americans recognize too much fat can be harmful to one's health. Fat, containing over double the calories per gram as either carbohydrate or protein, can increase risk for obesity. A high-fat diet can also set a person up for high levels of low density lipoproteins (LDL's), tagged in the media as "the 'bad' cholesterol." Because fats
have been an area of concern within the public, foods containing fat substitutes have been widely researched, marketed and used.

As the American Heart Association (O) describes, fat substitutes are agents placed in food to mimic the texture and flavor of fat. These fat substitutes may be carbohydrate-based, protein-based or even fat-based, but their general commonality is a lower calorie value. The Calorie Control Council provides a glossary of fat replacers. Travel to the website to view the many substitutes available (R, to see the list, but you will not need to describe each one)

What About Trans Fats? Is Butter Better?
For years butter has been marketed as a generally unhealthy food due to its high content of saturated fat. Foods containing higher levels of saturated fat are linked to higher LDL levels in the blood than foods containing higher levels of unsaturated fat, particularly monounsaturated fat. As explained in Week 4, "saturation" of a fat refers to the fat's chemical structure. Within the saturated fat, a carbon atom will be surrounded— or saturated—with hydrogen atoms. In an unsaturated fat, the carbon atom is not surrounded by hydrogen atoms. Many margarines are put through a hydrogenation process in order to improve spreadability and enhance shelf life, but in the process this hydrogenation creates a trans fat. The man-made hydrogenation process makes the unsaturated fat more saturated in nature, perhaps increasing the risk for higher blood LDL levels and concomitant cardiovascular disease risk. Since many resources cite a link between cancer and trans fat consumption, many health advocates are currently recommending consumers choose butter over a trans fat-laden margarine.

Softer, tub-based margarines tend to have less hydrogenation—and therefore fewer trans fatty acids—than harder cube-based margarines. A canola margarine, for example, typically is low in saturated and trans fat contents. Ultimately, maintaining a diet low in overall fat and high in vitamins and minerals can decrease the need to worry about making such a choice. To assist the general public in making healthier fat consumption decisions, the American Heart Association provides some "smart substitutions (O)," including recipe and snacking substitutions.