

Nutrition

Introduction to Nutrition – Definition,
objectives, importance
in cosmetics and dermatology



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What are Nutrients:

The Nutrients are substances required by the body to perform its basic functions. Nutrients must be obtained from our diet, since the human body does not synthesize or produce them. Nutrients have one or more of three basic functions: they provide energy, contribute to body structure, and/or regulate chemical processes in the body. These basic functions allow us to detect and respond to environmental surroundings, move, excrete wastes, respire (breathe), grow, and reproduce.

There are six classes of nutrients required for the body to function and maintain overall health.

These are carbohydrates, lipids, proteins, water, vitamins, and minerals.

Foods also contain non-nutrients that may be harmful (such as natural toxins common in plant foods and additives like some dyes and preservatives) or beneficial (such as antioxidants)

Definitions

Nutrition

Nutrition is the branch of science that studies the process by which living organisms take in and use food for the maintenance of life, growth, reproduction, the functioning of organs and tissues, and the production of energy.

Nutrition is defined as a biological process in animals and plants involving the intake of food and its subsequent **assimilation into** the tissues. absorbing nutrients during digestion and distributing them to the body for growth and repair.

Food any substance, solid or liquid, that contains nutrients

Elements: All nutrients are made up of elements. They are simple substances that cannot be broken down into anything simpler.

malnutrition

is an impairment of health resulting from

a deficiency, excess, or imbalance of nutrients. It includes :

Under nutrition: which refers to a deficiency of calories &/or one or more essential nutrients.

Over nutrition (obesity): which is an excess of one or more nutrients & usually of calories.

diet : it includes the kinds & amounts of foods & drink consumed each day. It includes the normal diet consumed by various age groups & the therapeutic or modified diets used in the treatment of the diseases.

Meal : include the kinds & amount of foods & drink consumed at one time.

Calorie : the amount of heat energy required to raise the temperature of 1 ml of water by 1° at 15 °

kilo calorie Kcal : is the amount of heat required to raise the temp of 1 Liter of water 1 centigrade at 15 ° . in the nutrition literature the Kcal is intended whether it is expressed as calorie.

Balanced diet: contains all the nutrients in the correct amount for the needs of the body.

RDA: Recommended dietary allowance.

Nutrients profoundly influence skin health and cosmetic appearance by affecting collagen synthesis, antioxidant defense, and skin cell turnover.

Key nutrients like vitamins A, C, and E promote cell repair and elasticity, while minerals such as zinc and selenium provide antioxidant and UV-protective benefits.

A balanced diet rich in fruits, vegetables, and healthy fats supports a strong skin barrier and radiant complexion, whereas a diet high in processed foods and sugar can accelerate skin aging by promoting inflammation and the formation of damaging Advanced Glycation End Products (AGEs).

Key Nutrients and Their Roles:

Vitamins:

Vitamin A (and Carotenoids): Essential for skin repair, maintenance, and cell turnover, preventing signs of aging and infections .

Vitamin C: Crucial for collagen and elastin production, which provides skin elasticity and resilience, and helps inhibit melanin production .

Vitamin E: An antioxidant that protects skin lipids from oxidative stress, supporting overall skin health .

Vitamin D: Synthesized in the skin from sunlight and found in foods like fatty fish, it's vital for overall skin health .

Minerals:

Zinc: Acts as a cofactor for metalloenzymes, contributing to skin health .

Selenium & Copper: Provide protective effects against UV-induced skin damage .

Other Beneficial Compounds:

Fatty Acids: Important components of the skin that influence its structure and function .

Polyphenols: Potent plant compounds with antioxidant properties that support skin health .

Dietary Habits and Their Influence:

Beneficial Practices:

A diet rich in antioxidants, vitamins, and essential nutrients promotes collagen production and combats oxidative stress, contributing to a youthful complexion. Diets emphasizing fruits, vegetables, whole grains, and healthy fats are beneficial .

Detrimental Practices:

High consumption of refined sugars can lead to the formation of AGEs, predisposing the skin to premature aging. Diets high in saturated fat and refined carbohydrates are generally not recommended for skin health .

Dermatological Conditions and Nutrition:

Nutritional deficiencies can lead to various skin diseases .

A balanced diet can help manage and mitigate symptoms of skin conditions such as acne and atopic dermatitis .

Nutrition is critical for skin wound healing and can significantly impact aesthetic outcomes after procedures.

Main Textbooks:

- 1. Human Nutrition: 2020 Edition**
- 2. Understanding Nutrition by Whitney & Rolfes**
- 3. Nutrition for Healthy Skin by Jean Krutmann**
- 4. Dietary Guidelines (WHO, FAO, USDA)**

Nutrition

Macroneutreint and microneureint



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Classification of Nutrients :

Macronutrient and micronutrient

Macronutrients

Nutrients that are needed in large amounts are called macronutrients.

There are three classes of macronutrients: **carbohydrates, lipids, and proteins.**

These can be metabolically processed into cellular energy. The energy from macronutrients comes from their chemical bonds. This chemical energy is converted into cellular energy that is then utilized to perform work, allowing our bodies to conduct their basic functions.

the calorie A unit of measurement of food energy is. On nutrition food labels the amount given for “calories” is actually equivalent to each calorie multiplied by one thousand. A kilocalorie (one thousand calories, denoted with a small “c”) is synonymous with the “Calorie” (with a capital “C”) on nutrition food labels.

Water is also a macronutrient in the sense that you require a large amount of it, but unlike the other macronutrients, it does not yield calories.

Carbohydrates

Carbohydrates are the perfect nutrient to meet your body’s nutritional needs. They nourish your brain and nervous system, provide energy to all of your cells when within proper caloric limits, and help keep your body fit and lean. Specifically, digestible carbohydrates provide bulk in foods, vitamins, and minerals.

Lipids

Lipids are important molecules that serve different roles in the human body.

Lipids are a family of organic compounds that are mostly insoluble in water. Composed of fats and oils, lipids are molecules that yield high energy and have a chemical composition mainly of **carbon, hydrogen, and oxygen.**

Proteins
Proteins are macromolecules composed of chains of subunits called amino acids. Amino acids are simple subunits composed of carbon, oxygen, hydrogen, and nitrogen. Food sources of proteins include meats,

dairy products, seafood, and a variety of different plant-based foods, most notably soy.

Figure 1.1 The Macronutrients: Carbohydrates, Lipids, Protein, and Water

Nutrient	kcal/g	kJ/g	Comments
Protein	4	17	
Fat	9	37	Original Atwater factor was 8.9 kcal, ∴ the lower kJ figure is preferable
Carbohydrate	3.75	16	Value is for available carbohydrate expressed as monosaccharides. If carbohydrate is expressed directly or by difference 4 kcal/g is used

Water :

There is one other nutrient that we must have in large quantities: water. Water does not contain carbon, but is composed of two hydrogens and one oxygen per molecule of water. More than 60 percent of your total body weight is water. Without it, nothing could be transported in or out of the body, chemical reactions would not occur, organs would not be cushioned, and body temperature would fluctuate widely. On average, an adult consumes just over two liters of water per day from food and drink combined. Since water is so critical for life's basic processes, the amount of water input and output is supremely important

Micronutrients

Micronutrients are nutrients required by the body in lesser amounts, but are still essential for carrying out bodily functions. Micronutrients include all the essential minerals and vitamins. There are sixteen essential minerals and thirteen vitamins (See Table 1.1 "Minerals and Their Major Functions" and Table 1.2 "Vitamins and Their Major Functions" for a complete list and their major functions). In contrast to carbohydrates, lipids, and proteins, micronutrients are not sources of energy (calories), but they assist in the process as cofactors or components of enzymes (i.e., coenzymes). Enzymes are proteins that catalyze chemical reactions in the body and are involved in all aspects of body functions from producing energy, to digesting nutrients, to building macromolecules. Micronutrients play many essential roles in the body.

Table 1.1 Minerals and Their Major Functions

Major Functions	8 Introduction Minerals
Macro	
Sodium	Fluid balance, nerve transmission, muscle contraction
Chloride	Fluid balance, stomach acid production
Potassium	Fluid balance, nerve transmission, muscle contraction
Calcium	Bone and teeth health maintenance, nerve transmission, muscle contraction, blood clotting
Phosphorus	Bone and teeth health maintenance, acid-base balance
Magnesium	Protein production, nerve transmission, muscle contraction
Sulfur	Protein production
Trace	
Iron	Carries oxygen, assists in energy production
Zinc	Protein and DNA production, wound healing, growth, immune system function
Iodine	Thyroid hormone production, growth, metabolism
Selenium	Antioxidant
Copper	Coenzyme, iron metabolism
Manganese	Coenzyme
Fluoride	Bone and teeth health maintenance, tooth decay prevention
Chromium	Assists insulin in glucose metabolism
Molybdenum	Coenzyme

Minerals

Minerals are solid inorganic substances that form crystals and are classified depending on how much of them we need. Trace minerals, such as molybdenum, selenium, zinc, iron, and iodine, are only required in a few milligrams or less. Macrominerals, such as calcium, magnesium, potassium, sodium, and phosphorus, are required in hundreds of milligrams. Many minerals are critical for enzyme function, others are used to maintain fluid balance, build bone tissue, synthesize hormones, transmit nerve impulses, contract and relax muscles, and

protect against harmful free radicals in the body that can cause health problems such as cancer.

Vitamins

The thirteen vitamins are categorized as either water-soluble or fat-soluble. The water-soluble vitamins are vitamin C and all the B vitamins, which include thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folate and cobalamin. The fat-soluble vitamins are A, D, E, and K. Vitamins are required to perform many functions in the body such as making red blood cells, synthesizing bone tissue, and playing a role in normal vision, nervous system function, and immune system function.

Vitamins	Major Functions
Water-soluble	
Thiamin (B1)	Coenzyme, energy metabolism assistance
	Riboflavin (B2) Coenzyme, energy metabolism assistance
Niacin (B3)	Coenzyme, energy metabolism assistance
Pantothenic acid (B5)	Coenzyme, energy metabolism assistance
Pyridoxine (B6)	Coenzyme, amino acid synthesis assistance
Biotin (B7)	Coenzyme, amino acid and fatty acid metabolism
Folate (B9)	Coenzyme, essential for growth
Cobalamin (B12)	Coenzyme, red blood cell synthesis
C (ascorbic acid)	Collagen synthesis, antioxidant
Fat-soluble	
A	Vision, reproduction, immune system function
D	Bone and teeth health maintenance, immune system function
E	Antioxidant, cell membrane protection
K	Bone and teeth health maintenance, blood clotting

Oxford Handbook of Nutrition and Dietetics

Table 1.3 Functions of Nutrients

Protein	Necessary for tissue formation, cell repair, and hormone and enzyme production. It is essential for building strong muscles and a healthy immune system.
Carbohydrates	Provide a ready source of energy for the body and provide structural constituents for the formation of cells
Fat	Provides stored energy for the body, functions as structural components of cells and also as signaling molecules for proper cellular communication. It provides insulation to vital organs and works to maintain body temperature
Vitamins	Regulate body processes and promote normal body-system functions
Minerals	Regulate body processes, are necessary for proper cellular function, and comprise body tissue
Water	Transports essential nutrients to all body parts, transports waste products for disposal, and aids with body temperature maintenance.

Nutrition

Carbohydrate
carbohydrates



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Carbohydrates

The Chemist's View of Carbohydrates

Identify the monosaccharides, disaccharides, and polysaccharides common in nutrition by their chemical structures and major food sources.

The dietary carbohydrate family includes:

- 1- Mono saccharides: single sugars.
- 2-Disaccharides: pairs of mono saccharides.
- 3-Polysaccharides: chains of mono saccharides.

***Monosaccharides** and **disaccharides** (the sugars) are sometimes called **simple carbohydrates**, and polysaccharides (starches and fibers) are sometimes called **com-plex carbohydrates**.

Carobo=carbon (C)

hydrate =with water
(H₂O)

Each atom can form a certain number of chemical bonds with other atoms:

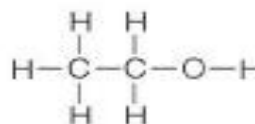
- 1-Hydrogen atoms ,one.
- 2-Oxygen atoms, two.
- 3-Nitrogen atoms, three.
- 4-Carbon atoms, four.

toms and Their Bonds

The four main types of atoms found in nutrients are hydrogen (H), oxygen (O), nitrogen (N), and carbon (C).



Each atom has a characteristic number of bonds it can form with other atoms.



Notice that in this simple molecule of ethyl alcohol, each H has one bond, O has two, and each C has four.

three are mono saccharides:

1. Glucose.
2. Fructose.
3. Galactose.

Three are disaccharides:

1. Maltose (glucose + glucose)
2. Sucrose (glucose + fructose)
3. Lactose (glucose + galactose)

First .Monosaccharides

The three monosaccharides most important in nutrition all have the same numbers and kinds of atoms-each contains 6 carbons, 12 hydrogens, and 6 oxygens (written in shorthand as C₆H₁₂O₆).

intensely sweet as **honey** and, in fact, is the sugar primarily responsible for honey's sweetness.

Classification of *Monosaccharides*:

1-**Glucose** Chemically, glucose is a larger and Glucose is one of the two sugar, but it obeys the same rules of chemistry: each carbon atom has four bonds; each oxygen, two bonds; and each hydrogen, one Bond.

Ose = **carbohydrate**

 = **Glucose**

Commonly known as **blood sugar**, glucose serves as an essential energy source for all the body's activities.

2- **Fructose** is the sweetest of the sugars. fructose stimulates the taste buds on the tongue to produce the sweet sensation. Fructose occurs naturally in **fruits** and **honey**.

fructose (FRUK- tose or FROOK-tose) monosaccharide; sometimes known as **fruit sugar** or levulose.

Fructose is found abundantly in **fruits, honey, and saps**.

Fruc= **fruit**

 = **Fructose**

3-Galactose The monosaccharide galactose occurs naturally in foods as a single sugar only in very small amounts

galactose (ga-LAK-tose): a monosaccharide; part of the disaccharide lactose.

 = galactose.

Second Disaccharides

The disaccharides are pairs of monosaccharides linked to-gether. The three disaccharides most important in nutrition all contain glucose: the second member of the pair is fructose, galactose, or another glucose.

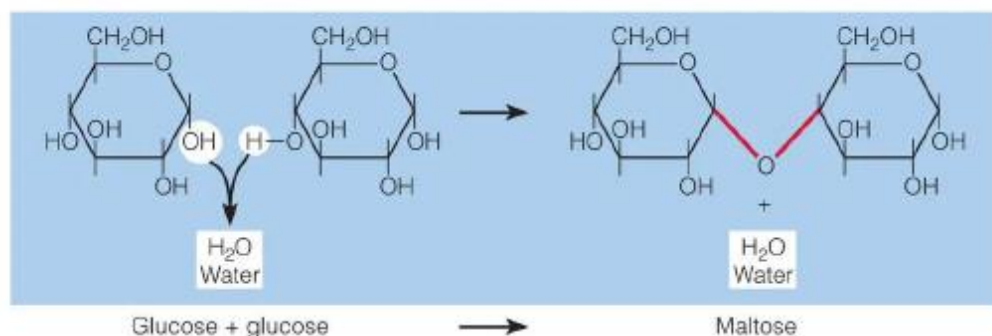
disaccharides (dye-SACK-uh-rides): pairs of monosaccharides linked together.

Di = Two

These carbohydrates-and all the other energy nutrients-are put together and taken apart by similar chemical reactions: condensation and hydrolysis

1-Condensation ; a chemical reaction in which water is released as two molecules combine to form one larger product

> **FIGURE 4-4** Condensation of Two Monosaccharides to Form a Disaccharide

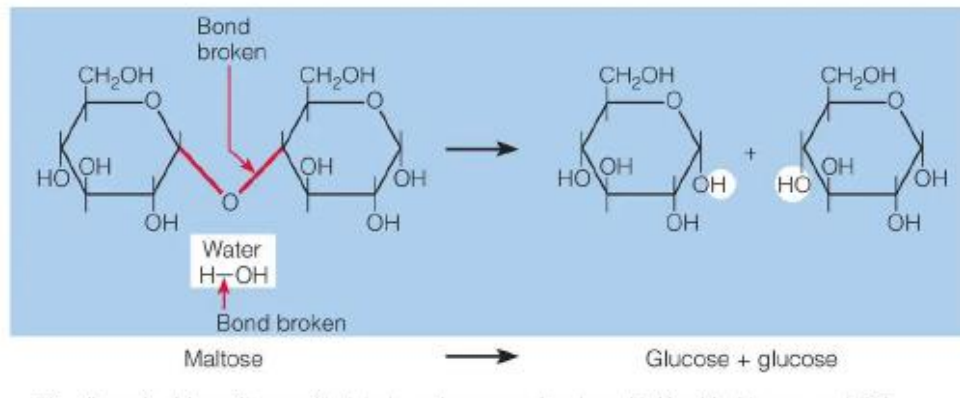


2-Hydrolysis

hydrolysis (high-DROL-th-sis) a chemical reaction in which one molecule is split into two molecules, with hydrogen (H) added to one and a hydroxyl group (OH) to the other (from water, H.O). (The noun is hydrolysis, the verb is hydrolyze.)

- hydro = water
- lysis – breaking

> **FIGURE 4-5 Hydrolysis of a Disaccharide**



1-**Maltose** The disaccharide maltose consists of two glucose units. Maltose is produced whenever starch breaks down—as happens during carbohydrate digestion. It also occurs during the fermentation process that yields alcohol. Maltose is only a minor constituent of a few foods, most notably **barley**.

2-**Sucrose** Fructose and glucose together form the disaccharide sucrose. Sucrose is the sweetest of the disaccharides because it contains fructose, the sweetest of the mono-saccharides. These sugars account for the natural sweetness of **fruits, vegetables, and grains**.

3-**Lactose** The combination of galactose and glucose makes the disaccharide lactose, the principal carbohydrate of milk. Known as milk sugar, lactose contributes half of the energy (kcalories) provided by fat-free **milk**.

Third Polysaccharides:

In contrast to the simple carbohydrates just described—the monosaccharides glucose, fructose, and galactose and the disaccharides maltose, sucrose, and lactose—the polysaccharides contain many glucose units and, in some cases, a few other monosaccharides linked together.

Three types of polysaccharides are important in nutrition: 1-glycogen. Glycogen is a storage form of energy in the body

2-starches. starch is the storage form of energy in plants

3-fibers. fibers provide structure in stems, trunks, roots, leaves, and skins of plants

Both glycogen and starch are built of glucose units, fibers are composed of a variety of monosaccharides and other carbohydrate derivatives

Food Sources of Carbohydrates

Glucose: Honey ,corn syrup.

Fructose: Fruits

Galactose: Milk.

Maltose: backed starch.

Sucrose: cane and beat sugar.

Lactose: milk product.

Starch: Cereals, Pasta, Flour, Bread,

Potatoes, Root Vegetables ,Pulses .

Pectin and gum: fruits, plant secretion, seeds>

Glycogen: meat product, sea food.

Cellulose: vegetables, outer coat of seeds.

Fiber: Cereals, Bran, Outer skin of Fruits &

Vegetables ,Brown rice, Oatmeals.

THE CARBOHYDRATE FAMILY

Monosaccharides

Glucose



Fructose



Galactose



Disaccharides

Maltose (glucose + glucose)



Sucrose (glucose + fructose)



Lactose (glucose + galactose)



Polysaccharides

Glycogen^a

Starches (amylose and amylopectin)

Fibers (soluble and insoluble)

^aGlycogen is a polysaccharide, but not a common dietary source of carbohydrate.

Digestion of Carbohydrates

When a person eats foods containing starch, enzymes hydrolyze the long chains to shorter chains, the short chains to disaccharides, and, finally, the disaccharides to monosaccharides. This process begins in the mouth.

1-In the Mouth.

The salivary enzyme amylase starts to work in the mouth hydrolyzing starch to shorter polysaccharides and to the disaccharide maltose. You can actually taste the change if you chew a piece of starchy food such as a cracker and hold it in your mouth for a few minutes without swallowing it—the cracker tastes increasingly sweet as the enzyme acts on it. Because food is in the mouth for a relatively short time, very little carbohydrate digestion takes place there.

2-In the Stomach

The activity of salivary amylase diminishes as the stomach's acid and protein-digesting enzymes inactivate the enzyme. The stomach's digestive juices contain no enzymes to break down carbohydrates, so carbohydrate digestion ceases in the stomach. Fibers are not digested, but because they

linger in the stomach, they delay gastric emptying, thereby providing a feeling of fullness and satiety

3-In the Small Intestine The small intestine performs most of the work of carbohydrate digestion. A major carbohydrate-digesting enzyme, pancreatic amylase, enters the intestine via the pancreatic duct and continues breaking down the polysaccharides to shorter glucose chains and maltose. The final step takes place on the outer membranes of the intestinal cells where

three specific enzymes break down three specific disaccharides:

- **Maltase** breaks maltose into two glucose molecules.
- **Sucrase** breaks sucrose into one glucose and one fructose molecule
- **Lactase** breaks lactose into one glucose and one galactose molecule .

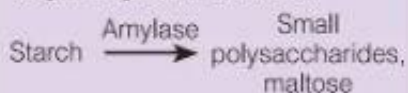
4-In the Large Intestine (Colon) Within 1 to 4 hours after a meal, as digestive activities slow to a halt, only the nondigestible carbohydrates remain in the colon. Fibers linger in the large intestine and attract water, which softens the stools for passage without straining. Also, bacteria in the GI tract ferment some fibers. This process generates water, gas, and short-chain fatty acids .

> **FIGURE 4-8 Carbohydrate Digestion in the GI Tract**

STARCH

Mouth and salivary glands

The salivary glands secrete saliva into the mouth, where it moistens the food and the salivary enzyme amylase begins digestion of starch:



Stomach

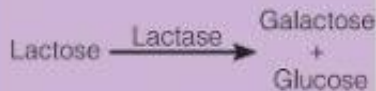
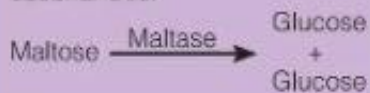
Stomach acid inactivates salivary amylase, halting starch digestion.

Small intestine and pancreas

The pancreas produces an amylase that is released through the pancreatic duct into the small intestine:



Then disaccharidase enzymes on the surfaces of the small intestinal cells hydrolyze the disaccharides into monosaccharides:



Intestinal cells absorb these monosaccharides and release them into the blood.

FIBER

Mouth

The mechanical action of the mouth crushes and tears food and mixes it with saliva to moisten it for swallowing.

Stomach

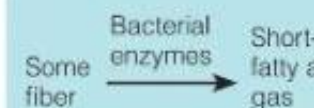
Fiber is not digested; it delays gastric emptying.

Small intestine

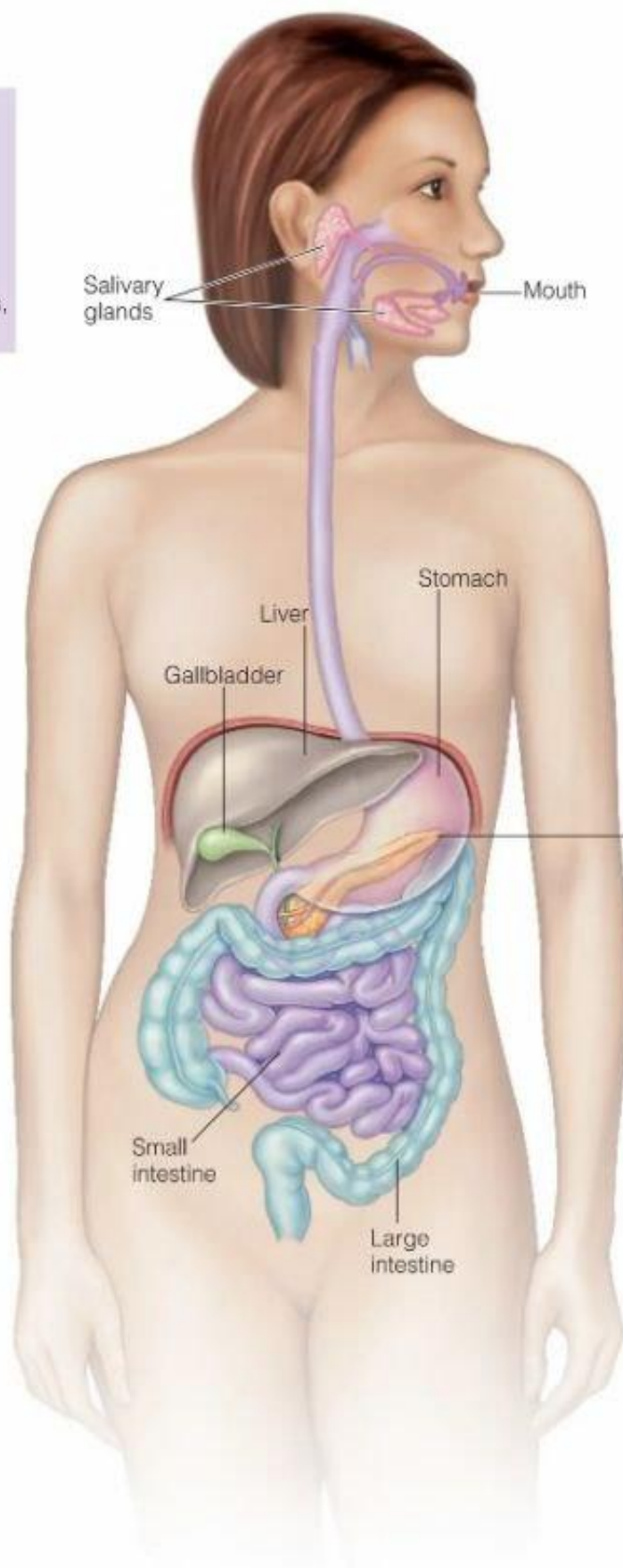
Fiber is not digested; it delays absorption of other nutrients.

Large intestine

Most fiber arrives intact in the large intestine. Here, bacterial enzymes digest some fiber:



Fiber holds water; regulates bowel activity; and binds substances such as bile, cholesterol, and some minerals, carrying them out of the body with the feces.



A Preview of Carbohydrate Metabolism

1. Storing Glucose as Glycogen
2. Using Glucose for Energy
3. Making Glucose from Protein
4. Making Ketone Bodies from Fat Fragments
- 5.5 Using Glucose to Make Fat After

gluconeogenesis (gloo-ke-nee-oh-JEN-ih-sis) the making of glucose from a noncarbohydrate source such as amino acids or glycerol

- gluco = glucose
- neo= new
- genesis= making

ketone (KEE-tone) bodies: acidic compounds produced by the liver during the breakdown of fat when carbohydrate is not available.

ketosis (kee-TOE-sis), an undesirably high concentration of ketone bodies in the blood and urine.

acid-base balance: the equilibrium in the body between acid and base concentrations

The Glycemic Response

The glycemic response refers to how quickly glucose is absorbed after a person eats, how high blood glucose rises, and how quickly it returns to normal. Slow absorption, a modest rise in blood glucose, and a smooth return to normal are desirable (a low glycemic response). Fast absorption, a surge in blood glucose, and an overreaction that plunges glucose below normal are less desirable (a high glycemic response).

Figure 4-11 compares the response of a high-glycemic meal with a low-glycemic meal. The glycemic response may be particularly important to people with diabetes, who may benefit from limiting foods that produce too great a rise, or too sudden a fall, in blood glucose

hypoglycemia (HIGH-po-gly-SEE-me-ah): an abnormally low blood glucose concentration.

glycemic (gly-SEEM-ic) response: the extent to which a food raises a person's blood glucose concentration and elicits an insulin response .

glycemic index: a method of classifying foods according to their potential for raising blood glucose.

TABLE 4-3 Glycemic Index of Selected Common Foods

Glycemic Index	Grains	Fruits	Vegetables	Milk Products	Protein Foods ^a	Other
Low	Barley, chapati, corn tortilla, rice noodles, rolled oats, udon noodles, spaghetti	Apple, apple juice, banana, dates, mango, orange, orange juice, peaches (canned), strawberry jam	Carrots, corn	Ice cream, milk, soy milk, yogurt	Legumes	Chocolate
Medium	Brown rice,	Pineapple	Potatoes (french fries), sweet potatoes			Popcorn, potato chips, soft drinks
High	Breads, breakfast cereals, white rice	Watermelon	Potatoes (boiled)			Rice crackers

> **FIGURE 4-11 The Glycemic Response**

After a high-glycemic meal, blood glucose levels rise dramatically and then fall below normal. After a low-glycemic meal, blood glucose levels rise gradually and then fall to near normal.



Key:	
—	High glycemic response
—	Low glycemic response
—	Normal blood glucose level

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Medium	Brown rice,	Pineapple	Potatoes (french fries), sweet potatoes			Popcorn, potato chips, soft drinks
High	Breads, breakfast cereals, white rice	Watermelon	Potatoes (boiled)			Rice crackers

> How To 1-2 Calculate the Energy Available from Foods

To calculate the energy available from a food, multiply the number of grams of carbohydrate, protein, and fat by 4, 4, and 9, respectively. Then add the results together. For example, 1 slice of bread with 1 tablespoon of peanut butter on it contains 16 grams carbohydrate, 7 grams protein, and 9 grams fat:

$$\begin{aligned}
 16 \text{ g carbohydrate} \times 4 \text{ kcal/g} &= 64 \text{ kcal} \\
 7 \text{ g protein} \times 4 \text{ kcal/g} &= 28 \text{ kcal} \\
 9 \text{ g fat} \times 9 \text{ kcal/g} &= 81 \text{ kcal} \\
 \text{Total} &= 173 \text{ kcal}
 \end{aligned}$$

From this information, you can calculate the percentage of kcalories each of the energy nutrients contributes to the total. To determine the percentage of kcalories from fat, for example, divide the 81 fat kcalories by the total 173 kcalories:

$$\begin{aligned}
 81 \text{ fat kcal} \div 173 \text{ total kcal} &= 0.468 \\
 &\text{(rounded to 0.47)}
 \end{aligned}$$

Then multiply by 100 to get the percentage:

$$0.47 \times 100 = 47\%$$

Dietary recommendations that urge people to limit fat intake to 20 to 35 percent of kcalories refer to the day's total energy intake, not to individual foods. Still, if the proportion of fat in each food choice throughout a day exceeds 35 percent of kcalories, then the day's total surely will, too. Knowing that this snack provides 47 percent of its kcalories from fat alerts a person to the need to make lower-fat selections at other times that day.

> TRY IT Calculate the energy available from a bean burrito with cheese (55 grams carbohydrate, 15 grams protein, and 12 grams fat). Determine the percentage of kcalories from each of the energy nutrients.

Nutrition

proteins



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Proteins are macromolecules composed of chains of subunits called amino acids.

compounds composed of carbon, hydrogen, oxygen, and nitrogen atoms, arranged into amino acids linked in a chain. Some amino acids also contain sulfur atoms.

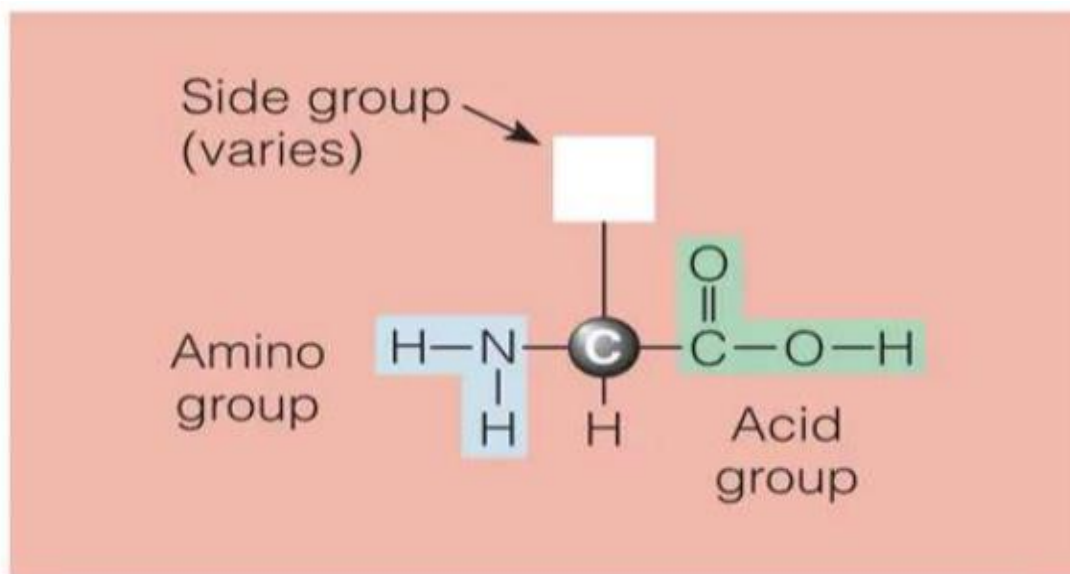
amino (a-MEEN-oh) acids: building blocks of proteins. Each contains an amino group, an acid group, a hydrogen atom, and a distinctive side group, all attached to a central carbon atom.

- **amino= containing nitrogen**

The versatility of proteins in the body is impressive. They help your muscles to contract, your blood to clot, and your eyes to see. They keep you alive and well by facilitating the body's chemical reactions and defending against infections. Without them, your bones, skin, and hair would have no structure. No wonder they were named proteins, meaning of prime importance." Does that mean proteins deserve top billing in your diet as well! Are the best sources of protein beef, beans, or broccoli? Learn which foods will supply you with enough, but not too much, high-quality protein.

Chemically, proteins contain

nitrogen (N) atoms in addition to the same atoms as carbohydrates and lipids-carbon (C), hydrogen (H), and oxygen (O). These nitrogen atoms give the name amine (nitrogen-containing) to the amino acids that are the basic units of protein chains.



Amino Acids All amino acids have the same basic structure—a central carbon atom (C) with a hydrogen atom (H), an amino group (NH₂), and an acid group (COOH) attached to it. Remember, however, that carbon atoms must have four bonds, so a fourth attachment is necessary. This fourth site distinguishes each amino acid from the others. Attached to the central carbon at the fourth bond is a distinct atom, or group of atoms, known as the side group or side chain .

Unique Side Groups The side groups on the central carbon vary from one amino acid to the next, making proteins more complex than either carbohydrates or lipids. A polysaccharide (starch, for example) may be several thousand units long, but each unit is a glucose molecule just like all the others. A protein, on the other hand, is made up of about 20 different amino acids, each with a different side group.

The simplest amino acid, glycine, has a hydrogen atom as its side group. A slightly more complex amino acid, alanine, has an extra carbon with three hydrogen atoms.

Thus, although all amino acids share a common structure, they differ in size, shape, electrical charge, and other characteristics because of differences in these side groups.

nonessential amino acid: an amino acid that the body can make also called a dispensable amino acid.

essential amino acid: an amino acid that the body requires but cannot make, and so must be obtained from the diet also called an indispensable amino acid.

conditionally essential amino acid: an amino acid that is normally nonessential, but must be supplied by the diet in special circumstances when the need for it exceeds the body's ability to make it.

TABLE 6.1 Amino acids

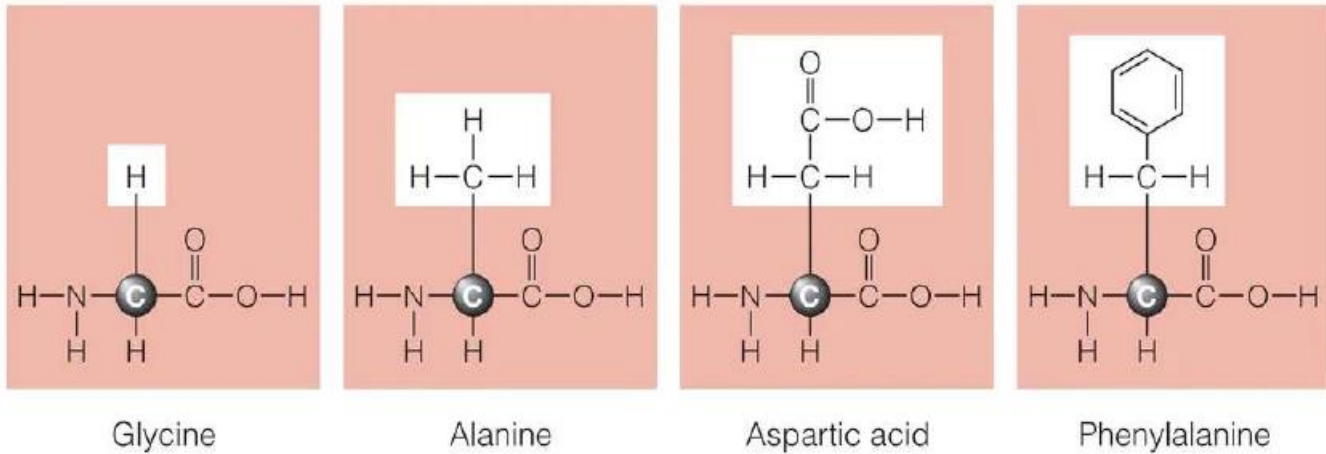
Proteins are made up of about 20 common amino acids. The first column lists the *essential amino acids* for human beings (those the body cannot make – that must be provided in the diet). The second column lists the *non-essential amino acids*. In special cases, some non-essential amino acids may become *conditionally essential*. In a newborn, for example, only five amino acids are truly non-essential; the other non-essential amino acids are conditionally essential until the body's metabolic pathways are developed enough to make those amino acids in adequate amounts.

ESSENTIAL AMINO ACIDS	
Histidine	(HISS-tuh-deen)
Isoleucine	(eye-so-LOO-seen)
Leucine	(LOO-seen)
Lysine	(LYE-seen)
Methionine	(meh-THIGH-oh-noon)
Phenylalanine	(fen-il-AL-ah-noon)
Threonine	(THREE-oh-noon)
Tryptophan	(TRIP-toe-fan, TRIP-toe-fane)
Valine	(VAY-leen)

NON-ESSENTIAL AMINO ACIDS	
Alanine	(AL-ah-noon)
Arginine	(ARJ-ih-noon)
Asparagine	(ah-SPAR-ah-geen)
Aspartic acid	(ah-SPAR-tic acid)
Cysteine	(SIS-teh-noon)
Glutamic acid	(GLU-tam-ic acid)
Glutamine	(GLU-tah-meen)
Glycine	(GLY-seen)
Proline	(PRO-leen)

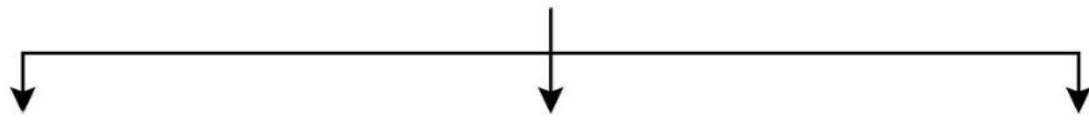
> FIGURE 6-2 Examples of Amino Acids

Note that all amino acids have a common chemical structure but that each has a different side group. Appendix C presents the chemical structures of the 20 amino acids most common in proteins.



Amino Acid Chains Condensation reactions connect amino acids, just as they combine two monosaccharides to form a disaccharide and three fatty acids with a glycerol to form a tri-glyceride. Two amino acids bonded together form a dipeptide. By another such reaction, a third amino acid can be added to the chain to form a tripeptide. As additional amino acids join the chain, a polypeptide is formed. Most proteins are a few dozen to several hundred amino acids long.

Carbohydrates



Monosaccharide

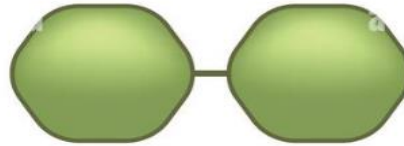
Glucose
Fructose
Galactose



Single Sugar Molecule

Disaccharide

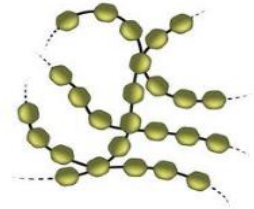
Maltose
Sucrose
Lactose



Two Sugar
Molecules Linked

Polysaccharide

Starch
Glycogen
Cellulose

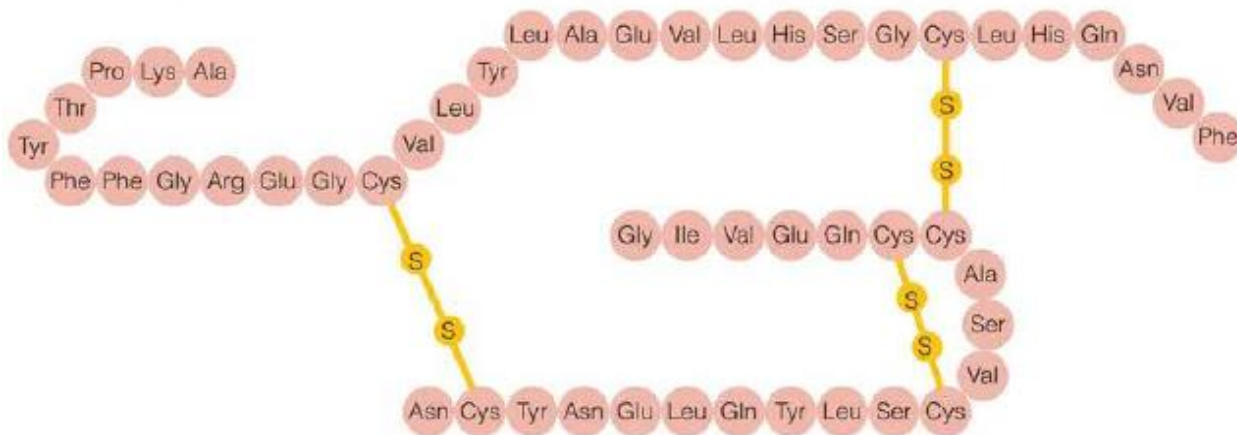


Many Sugar
Molecules Linked

> FIGURE 6-4 Amino Acid Sequence of Human Insulin

Human insulin is a small protein that consists of 51 amino acids in two short polypeptide chains. (For amino acid abbreviations, see Appendix C.)

Two bridges link the two chains. A third bridge spans a section within the short chain. Known as *disulfide bridges*, these links form between the cysteine (Cys) amino acids, whose side groups contain sulfur (S).



peptide bond: a bond that connects the acid end of one amino acid with the amino end of another, forming a link in a protein chain.

dipeptide (dye-PEP-tide): two amino acids bonded together.

di = two

peptide = amino acid

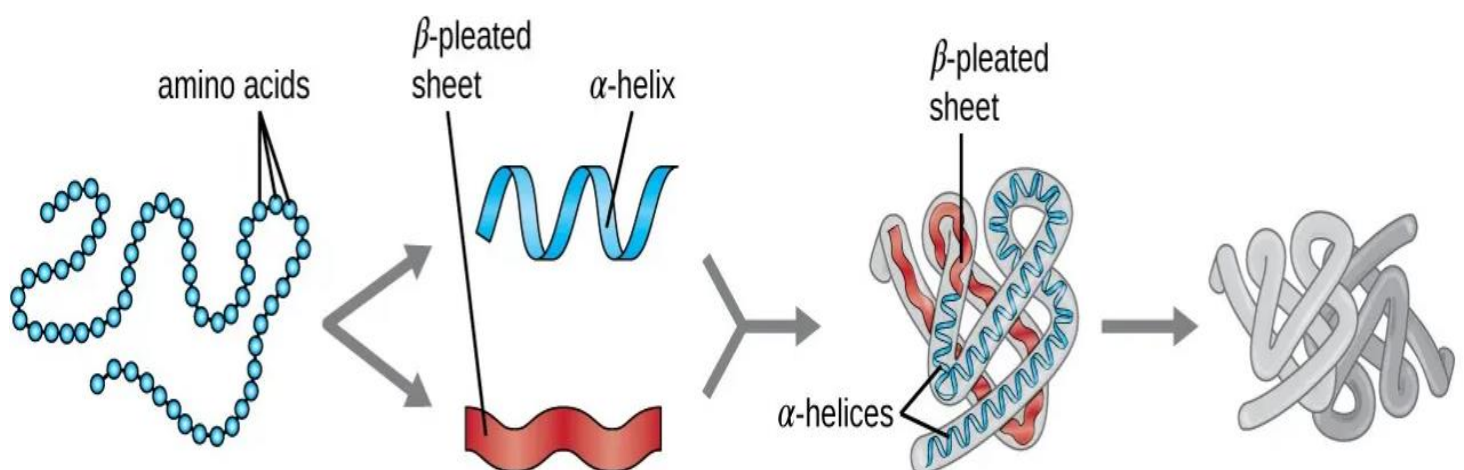
tripeptide: three amino acids bonded together.

tri = three

polypeptide: many (10 or more) amino acids bonded together. A short peptide chain of four to nine amino acids is called an oligopeptide (OL-ee-go-PEP-tide).

poly = many

oligo = few



Primary Protein Structure

Sequence of a chain of amino acids

Secondary Protein Structure

Local folding of the polypeptide chain into helices or sheets

Tertiary Protein Structure

three-dimensional folding pattern of a protein due to side chain interactions

Quaternary Protein Structure

protein consisting of more than one amino acid chain

Primary Structure-Amino Acid Sequence The primary structure of a protein is determined by the sequence of amino acids. If a person could walk along a carbohydrate molecule like starch, the first stepping stone would be a glucose. The next stepping stone would also be a glucose, and it would be followed by a glucose, and yet another glucose. But if a person were to walk along a polypeptide chain, each stepping stone would be one of 20 different amino acids. The first stepping stone might be the amino acid methionine. The second might be an alanine. The third might be a glycine, the fourth a tryptophan, and so on. Walking along another polypeptide path, a person might step on a phenylalanine, then a valine, then a glutamine. In other words, amino acid sequences within proteins vary.

Secondary Structure-Polypeptide Shapes The secondary structure of proteins is determined not by chemical bonds as between the amino acids but by weak electrical attractions within the polypeptide chain. As positively charged hydrogens attract nearby negatively charged oxygens, sections of the polypeptide chain twist into helices or fold into pleated sheets, for example. These shapes give proteins strength and rigidity

Tertiary Structure-Polypeptide Tangles The tertiary structure of proteins occurs as long polypeptide chains twist and fold into complex, tangled shapes. The unique side group of each amino acid attracts it to, or repels it from, the surrounding fluids and other amino acids. Some amino acid side.

Quaternary Structure-Multiple Polypeptide Interactions

Some polypeptides are functioning proteins just as they are; others need to associate with other polypeptides to form larger working complexes. The quaternary structure of proteins involves interactions between two or more polypeptides. One molecule of hemoglobin-the large, globular protein molecule that, by the billions, packs the red blood cells and carries oxygen-is made of four associated polypeptide chains, each holding the mineral iron.

Protein Denaturation When proteins are subjected to heat, acid, or other conditions that disturb their stability, they undergo denaturation-that is, their structures are disrupted or destroyed. Consequently, they uncoil and lose their shapes and, as a result, also lose their ability to function. Beyond a certain point, denaturation is irreversible. Familiar examples of denaturation include the hardening of an egg when it is cooked (see Photo 6-1), the curdling of milk when acid is added, and the stiffening of egg whites when they are whipped In the body, proteins are denatured during digestion when they are exposed to stomach acid.



> **PHOTO 6-1** Cooking an egg denatures its proteins.

REVIEW

Chemically speaking, proteins are more complex than carbohydrates or lipids, they are made of some 20 different amino acids, 9 of which the body cannot make (the essential amino acids). Each amino acid contains an amino group, an acid group, a hydrogen atom, and a distinctive side group, all attached to a central carbon atom. Peptide bonds link amino acids together by way of a series of condensation reactions to create proteins. The distinctive sequence of amino acids in each protein determines its unique shape and function

Protein Synthesis Each human being is unique because of small differences in the body's proteins. These differences are determined by the amino acid sequences of proteins, which, in turn, are determined by genes.

The instructions for making every protein in a person's body are transmitted by way of the genetic information received at conception. This body of knowledge is filed in the DNA (deoxyribonucleic acid) within the nucleus of every cell.

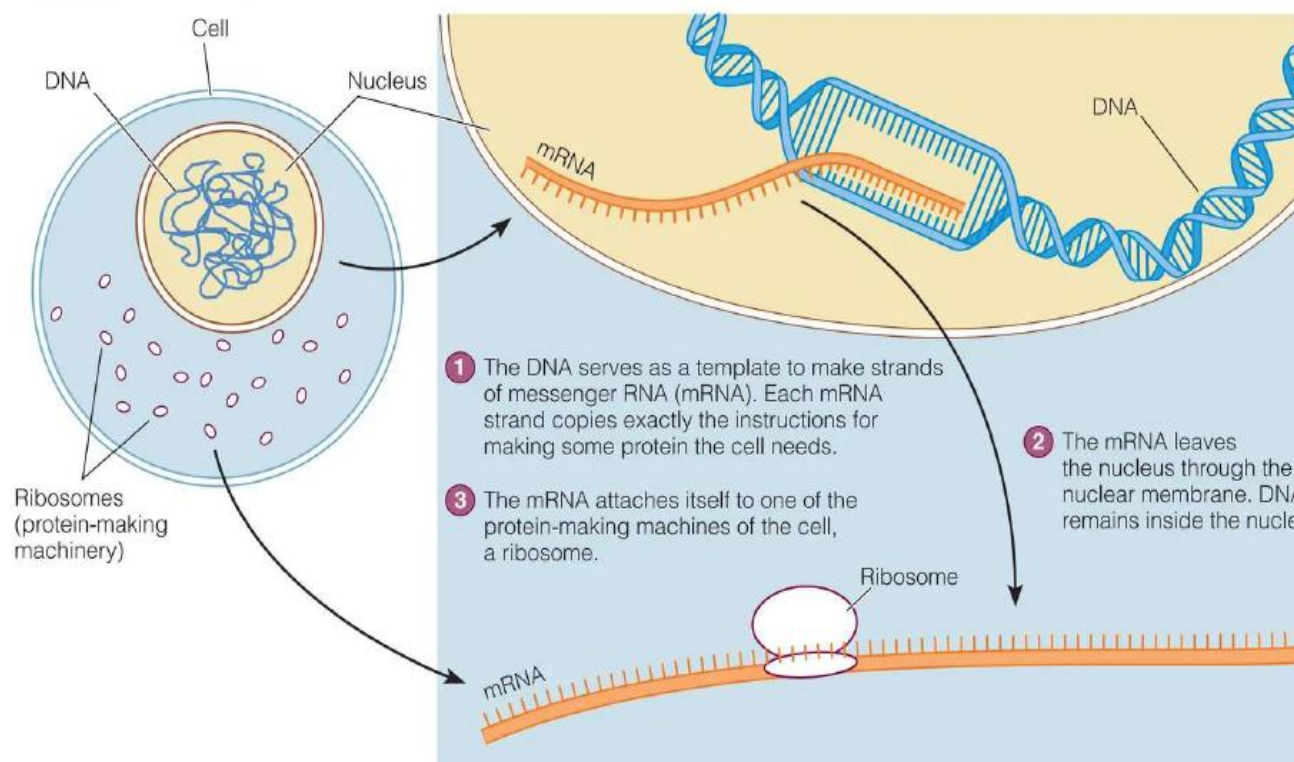
Delivering the Instructions Transforming the information in DNA into the appropriate sequence

of amino acids needed to make a specific protein requires two major steps:

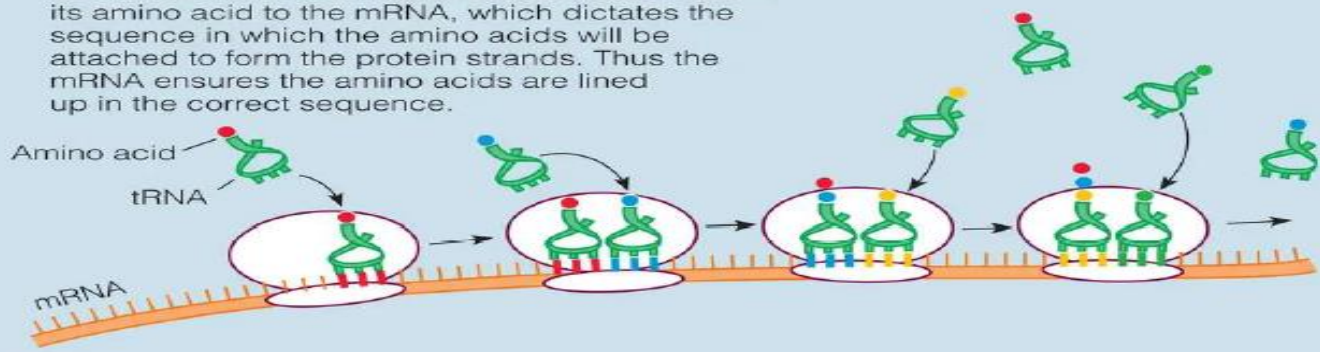
DNA transcription → MRNA Translation → protein

In the first step, known as transcription, a stretch of DNA is used as a template to make messenger RNA (mRNA); in other words, the genetic code is transcribed

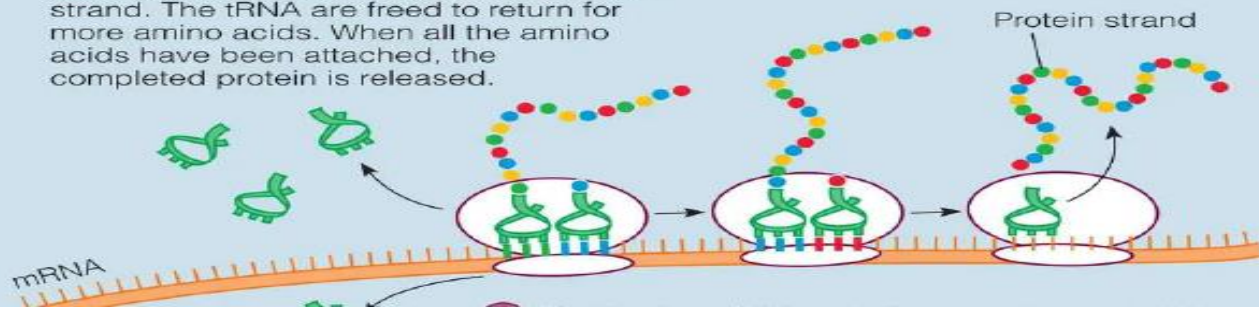
> **FIGURE 6-7 Protein Synthesis**



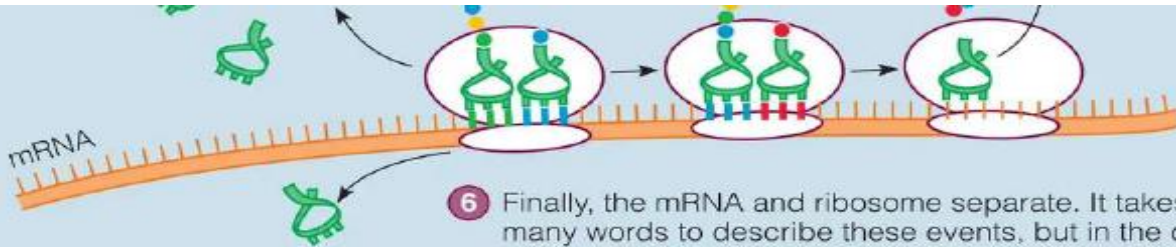
- 4** Another form of RNA, transfer RNA (tRNA), collects amino acids from the cell fluid. Each tRNA carries its amino acid to the mRNA, which dictates the sequence in which the amino acids will be attached to form the protein strands. Thus the mRNA ensures the amino acids are lined up in the correct sequence.



- 5** As the amino acids are lined up in the right sequence, and the ribosome moves along the mRNA, an enzyme attaches one amino acid after another to the growing protein strand. The tRNA are freed to return for more amino acids. When all the amino acids have been attached, the completed protein is released.



- 6** Finally, the mRNA and ribosome separate. It takes many words to describe these events, but in the cell, 40 to 100 amino acids can be added to a growing protein strand in only a second. Furthermore, several ribosomes can simultaneously work on the same mRNA to make many copies of the protein.



Nutrition

fats

Saturated, unsaturated



Dr.abdulla Abbas

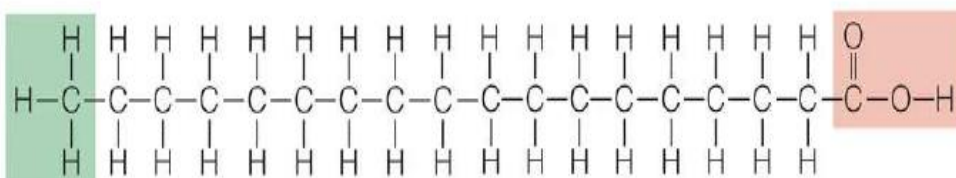
The Chemist's View of Fatty Acids and Triglycerides

Like carbohydrates, lipids are composed of carbon (C), hydrogen (H), and oxygen (O). Because lipids have many more carbons and hydrogens in proportion to their oxygens, they can supply more energy per gram than carbohydrates can

lipids: a family of compounds that includes **triglycerides**, **phospholipids**, and **sterols**. Lipids are characterized by their insolubility in water. (Lipids also include the fat-soluble vitamins)

Fatty Acids All fatty acids have the same basic structure. Each fatty acid is a chain of **carbon** and **hydrogen** atoms with an **acid group (COOH)** at one end and a **methyl** group (CH₃) at the other end. Fatty acids may differ from one another.

The Length of the Carbon Chain Most naturally occurring fatty acids contain even numbers of carbons in their chains-up to 24 carbons in length. This discussion begins with the 18-carbon fatty acids, which are abundant in our food supply. Stearic acid is the simplest of the **18-carbon fatty acids**; the bonds between its carbons are all alike:



Stearic acid, an 18-carbon saturated fatty acid

fatty acids: organic compounds composed of carbon chains with hydrogens attached. Each fatty acid has an acid group (COOH) at one end and a methyl group (CH₃) at the other end.

monounsaturated fatty acid: a fatty acid that lacks two hydrogen atoms and has one double bond between atoms and has two or more double bonds between carbons. Examples include linoleic acid (two double bonds) and linolenic acid (three double bonds).

A polyunsaturated fat is composed of triglycerides in which most of the fatty acids are polyunsaturated.

poly = many

saturated fatty acid: a fatty acid carrying the maximum possible number of hydrogen atoms-for example, stearic acid. A saturated fat is composed of triglycerides in which most of the fatty acids are saturated.

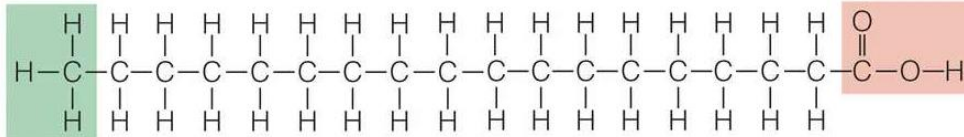
unsaturated fatty acid: a fatty acid that lacks hydrogen atoms and has at least one double bond between carbons (that is, a monounsaturated or polyunsaturated fatty acid).

An unsaturated fat is composed of triglycerides in which most of the fatty acids are unsaturated.

1. The chemical structure of a triglyceride resembles the letter E; it contains one molecule of glycerol with three fatty acids (basically, chains of carbon atoms) attached.
2. Fatty acids may be 4 to 24 (even numbers of) carbons long. The 18-carbon ones are the most common in foods and are especially noteworthy in nutrition.
3. Fatty acids may be saturated or unsaturated. Unsaturated fatty acids may have one or more points of unsaturation-that is, they may be monounsaturated or polyunsaturated
4. Of special importance in nutrition are the polyunsaturated fatty acids known as omega-3 fatty acids and omega-6 fatty acids.

5. The 18-carbon polyunsaturated fatty acids are linolenic acid (omega-3) and linoleic acid (omega-6). Both are essential fatty acids that the body cannot make. Each is the primary member of a family of longer-chain fatty acids that help regulate blood pressure, blood clotting, and other body functions important to health.

Fatty Acids All fatty acids have the same basic structure. Each fatty acid is a chain of carbon and hydrogen atoms with an acid group (COOH) at one end and a methyl group (CH) at the other end. Fatty acids may differ from one another, however, in the length of their carbon chains and in the number and location of their double bonds, as the following paragraphs describe. (Fatty acids and related terms are defined in Glossary 5-1.)

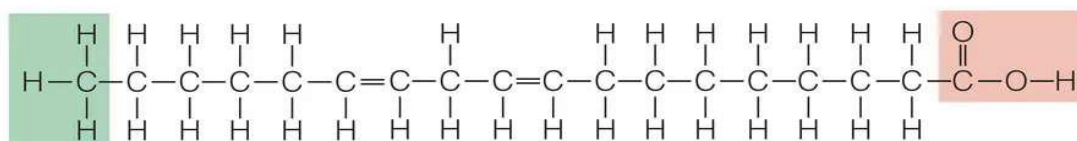


As mentioned earlier, the carbon chains of fatty acids vary in length. The long-chain (more than 12 carbons) fatty acids of meats, seafood, and vegetable oils are most common in the diet. Smaller amounts of medium-chain (8 to 12 carbons) and short-chain (up to 6 carbons) fatty acids also occur, primarily in dairy products. (Tables C-1 and C-2 in Appendix C provide the names, chain lengths, and sources of fatty acids commonly found in foods.)

linoleic (lin-oh-LAY-ick) acid: an essential fatty acid with 18 carbons and two double bonds.

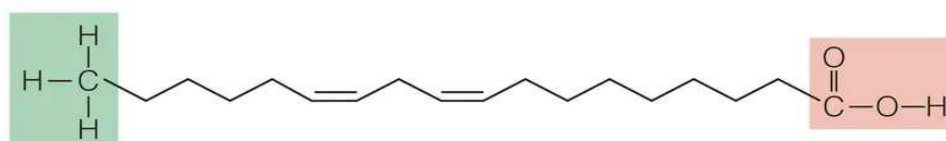
linolenic (lin-oh-tin-ick) acid: an essential fatty acid with 18 carbons and three double bonds.

Linoleic acid, the 18-carbon fatty acid common in vegetable oils, lacks four hydrogens and has two double bonds:



Linoleic acid, an 18-carbon polyunsaturated fatty acid

Drawn more simply, linoleic acid looks like this (though the actual shape would bend at the double bonds):



Linoleic acid (simplified structure)

A fourth 18-carbon fatty acid is **linolenic acid**, which has three double bonds. Table 5-1 (p. 130) presents the 18-carbon fatty acids.

TABLE 5-1 18-Carbon Fatty Acids

Name	Number of Carbon Atoms	Number of Double Bonds	Saturation	Common Food Sources
Stearic acid	18	0	Saturated	Most animal fats
Oleic acid	18	1	Monounsaturated	Olive and canola oils
Linoleic acid	18	2	Polyunsaturated	Sunflower, safflower, corn, and soybean oils
Linolenic acid	18	3	Polyunsaturated	Soybean and canola oils, flaxseed, walnuts

NOTE: Chemists use a shorthand notation to describe fatty acids. The first number indicates the number of carbon atoms; the second, the number of double bonds. For example, the notation for stearic acid is 18:0.

omega: the last letter of the Greek alphabet (ω), used by chemists to refer to the position of the closest double bond to the methyl (CH_3) end of a fatty acid.

omega-3 fatty acid: a polyunsaturated fatty acid in which the closest double bond to the methyl (CH_3) end of the carbon chain is three carbons away.

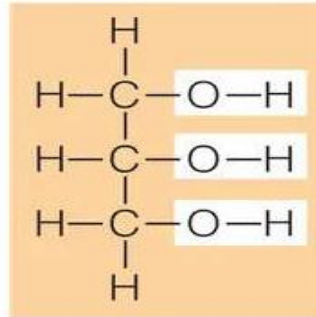
omega-6 fatty acid: a polyunsaturated fatty acid in which the closest double bond to the methyl (CH_3) end of the carbon chain is six carbons away.

triglycerides (try-GLISS-er-rides): the chief form of fat in the diet and the major storage form of fat in the body. Each triglyceride is composed of a molecule of glycerol with three fatty acids attached, also called triacylglycerols (try-ay-seel-GLISS-er-ols).

glycerol (GLISS-er-oll) an alcohol composed of a three-carbon chain, which can serve as the backbone for a triglyceride.

> **FIGURE 5-2** Glycerol

When glycerol is free, an OH group is attached to each carbon. When glycerol is part of a triglyceride, each carbon is attached to a fatty acid (as shown in Figure 5-3).



condensation: a chemical reaction in which water is released as two molecules combine to form one larger product.

fats: lipids that are solid at room temperature (77°F, or 25°C).

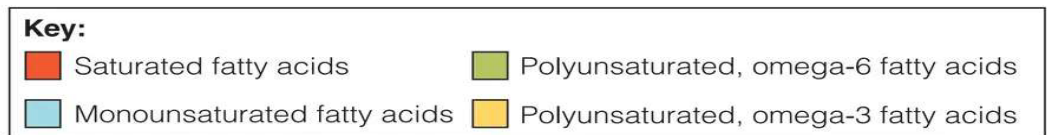
oils: lipids that are liquid at room temperature (77°F, or 25°C).

oxidation (OKS-ee-day-shun): the process of a substance combining with oxygen; oxidation reactions involve the loss of electrons.

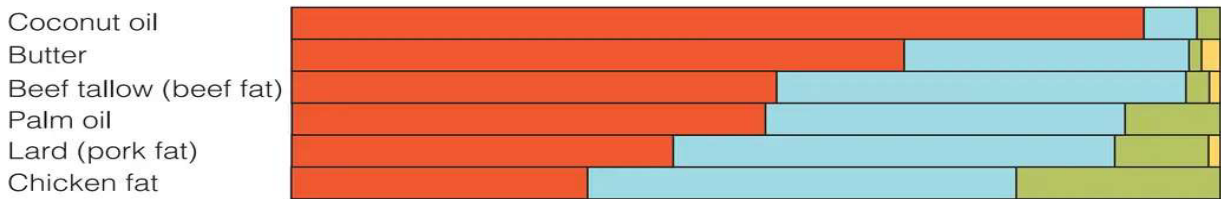
antioxidants: as a food additive, preservatives that delay or prevent rancidity of fats in foods and other damage to food caused by oxygen.

> **FIGURE 5-5 Fatty Acid Composition of Common Food Fats**

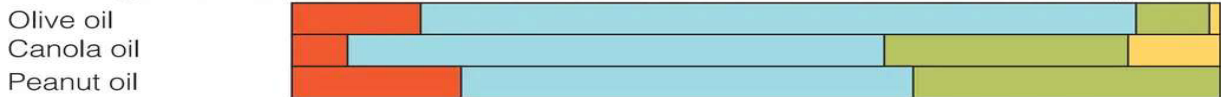
Most fats are a mixture of saturated, monounsaturated, and polyunsaturated fatty acids.



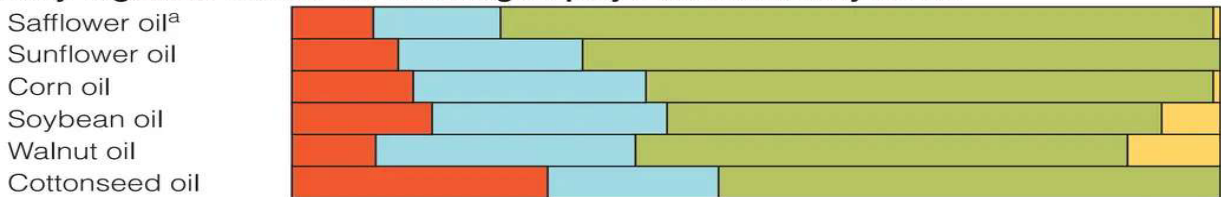
Animal fats and the tropical oils of coconut and palm contain mostly saturated fatty acids.



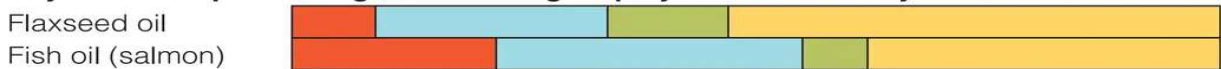
Some vegetable oils, such as olive and canola, are rich in monounsaturated fatty acids.



Many vegetable oils are rich in omega-6 polyunsaturated fatty acids.



Only a few oils provide significant omega-3 polyunsaturated fatty acids.



Essential Fatty Acids The human body needs fatty acids, and it can make all but two of them—linoleic acid (the 18-carbon omega-6 fatty acid) and linolenic acid (the 18-carbon omega-3 fatty acid). These two fatty acids must be supplied by the diet and are therefore essential fatty acids. The cells do not possess the enzymes to make any of the omega-6 or omega-3 fatty acids from scratch, nor can they convert an omega-6 fatty acid to an omega-3 fatty acid or vice versa. Cells can, however, use the 18-carbon member of an omega family from the diet to make the longer fatty acids of that family by forming double bonds (desaturation) and lengthening the chain two carbons at a time (elongation), as shown in Figure 5-19. This is a slow process because the omega-3 and omega-6 families compete for the same enzymes. Too much of a fatty acid from one family can create a deficiency of the other family's longer fatty acids, which becomes critical only when the diet fails to deliver adequate supplies. Therefore, the most effective way to maintain body supplies of

all the omega-6 and omega-3 fatty acids is to obtain them directly from foods—most notably, from vegetable oils, seeds, nuts, fish, and other seafoods.

Linoleic Acid and the Omega-6 Family Linoleic acid is an essential fatty acid and the primary member of the omega-6 fatty acid family. When the body receives linoleic acid from the diet, it can make other members of the omega-6 family—such as the 20-carbon polyunsaturated fatty acid, arachidonic acid (mentioned in Figure 5-19). Should a linoleic acid deficiency develop, arachidonic acid, and all other omega-6 fatty acids that derive from linoleic acid, also become essential and

conditionally essential nutrient: a nutrient that is normally nonessential, but must be supplied by the diet in special circumstances when the need for it exceeds the body's ability to produce it

Lipid Metabolism This preview of metabolism describes how the cells store and release energy from fat

Storing Fat as Fat

When meals deliver more energy than the body needs, the excess is stored as fat in the adipose cells for later use. As Figure 5-18 (p. 142) shows, triglycerides fill the adipose cells, storing a lot of energy in a relatively small space. This accumulation of fat in adipose tissue provides a key benefit; it enables humans to survive through times when food is unavailable.

Using Fat for Energy

After meals, the blood delivers chylomicrons and VLDL loaded with triglycerides to the body's cells. An enzyme—lipoprotein lipase (LPL)—hydrolyzes those triglycerides, releasing fatty acids, diglycerides, and monoglycerides into the cells, where they provide energy. Fat supplies about 60 percent of the body's ongoing energy needs during rest. During prolonged light to moderately intense exercise, fat may make a slightly greater contribution to energy needs (see Photo 5-4). As exercise intensity increases, fat contributes less and carbohydrate contributes more) to the fuel mix.

Fat also makes a slightly greater contribution to energy needs during extended periods of food deprivation. When energy needs are not being met, several lipase enzymes (most notably hormone-sensitive lipase)

inside the adipose cells respond by dismantling stored triglycerides and releasing the glycerol and fatty acids directly into the blood. Energy-hungry cells throughout the body can then capture these compounds and process them, through a series of chemical reactions to yield energy, carbon dioxide, and water.

A person who fasts (drinking only water) will rapidly metabolize body fat. Even with abundant body fat, the person has to obtain some energy from lean protein tissue because the brain, nerves, and red blood cells need glucose—and without carbohydrate, only protein and the small glycerol molecule of a triglyceride can be converted to glucose, fatty acids can be. Even in times of severe hunger and starvation, a fatter person can survive longer than a thinner person thanks to the energy reserve of adipose tissue, for fasting for too long will eventually cause death, even if the person still has energy. In Chapter 7 revisits this topic.