Part I

The Basic Facts about Nutrition

The 5th Wave By Rich Tennant

"Of course you're better off eating grains and vegetables, but for St.Valentine's Day, we've never been very successful with 'Say it with Legumes.'"

In this part . . .

To use food wisely, you need a firm grasp of the basics. This part defines nutrition and offers a detailed explanation of digestion (how your body turns food into nutrients). It also documents the expansion of the average American body, explains why calories are useful, and sets forth a no-nonsense starter guide to your daily requirements of vitamins, minerals, and other good stuff.

Chapter 1

What's Nutrition, Anyway?

In This Chapter

- Exploring why nutrition matters
- Determining the value of food
- Locating reliable sources for nutrition information
- Finding out how to read (and question) a nutrition study

You are *what* you eat. You are also *how* you eat. And *when* you eat.

Choosing a varied diet of healthful foods supports any healthy mind and body, but *which* healthful foods you choose says much about your personal tastes as well as the culture from which you come.

How you eat may do the same: Do you use a knife and fork? A pair of sticks? Your hands and a round of bread? Each is a cultural statement. As for *when* you eat (and when you stop), that is a purely personal physiological response to signals from your digestive organs and your brain: "Get food now!" or "Thank you, that's enough."

If you read chapter by chapter through this book, you can follow what you eat and drink as it moves from your plate to your mouth to your digestive tract and into every tissue and cell. Along the way, you discover how your organs and systems work. You observe firsthand why some foods and beverages are essential to your health. And you find out how to manage your diet so that you can get the biggest bang (nutrients) for your buck (calories).

Nutrition Equals Life

Technically speaking, *nutrition* is the science of how the body uses food. In fact, nutrition is life. All living things, including you, need food and water to live. Beyond that, you need good food, meaning food with the proper nutrients, to live well. If you don't eat and drink, you'll die. Period. If you don't eat and drink nutritious food and beverages:

- Your bones may bend or break (not enough calcium).
- Your gums may bleed (not enough vitamin C).
- Your blood may not carry oxygen to every cell (not enough iron).

And on, and on, and on. Understanding how good nutrition protects you against these dire consequences requires a familiarity with the language and concepts of nutrition. Knowing some basic chemistry is helpful. (Don't panic: Chemistry can be a cinch when you read about it in plain English.) A smattering of sociology and psychology is also useful because although nutrition is mostly about how food revs up and sustains your body, it's also about the cultural traditions and individual differences that explain how you choose your favorite foods (see Chapter 15).

To sum it up: Nutrition is about why you eat what you eat and how the food you get affects your body and your health.

First principles: Energy and nutrients

Nutrition's primary task is figuring out which foods and beverages (in what quantities) provide the energy and building material you need to construct and maintain every organ and system. To do this, nutrition concentrates on food's two basic attributes: energy and nutrients.

Energy from food

Energy is the ability to do work. Virtually every bite of food gives you energy, even when it doesn't give you nutrients. The amount of energy in food is measured in *calories,* the amount of heat produced when food is burned (metabolized) in your body cells. You can read all about calories in Chapter 3. But right now, all you need to know is that food is the fuel on which your body runs. Without enough food, you don't have enough energy.

Nutrients in food

Nutrients are chemical substances your body uses to build, maintain, and repair tissues. They also empower cells to send messages back and forth to conduct essential chemical reactions, such as the ones that make it possible for you to

- Breathe
- Move
- Eliminate waste
- Think
- See
- Hear
- Smell
- Taste

. . . and do everything else natural to a living body.

Food provides two distinct groups of nutrients:

- **Macronutrients (macro = big):** Protein, fat, carbohydrates, and water
- **Micronutrients (micro = small):** Vitamins and minerals

What's the difference between these two groups? The amount you need each day. Your daily requirements for macronutrients generally exceed 1 gram. (For comparison's sake, 28 grams equal 1 ounce.) For example, the average man needs about 63 grams of protein a day (slightly more than 2 ounces), and the average woman needs about 50 grams (slightly less than 2 ounces).

Your daily requirements for micronutrients are much smaller. For example, the Recommended Dietary Allowance (RDA) for vitamin C is measured in milligrams ($\frac{1}{1,000}$ of a gram), while the RDAs for vitamin D, vitamin B12, and folate are even smaller and are measured in micrograms ($\frac{1}{1,000,000}$ of a gram). You can find out much more about the RDAs, including how they vary for people of different ages, in Chapter 4.

What's an essential nutrient?

A reasonable person may assume that an essential nutrient is one you need to sustain a healthy body. But who says a reasonable person thinks like a nutritionist? In nutritionspeak, an *essential nutrient* is a very special thing:

- **An essential nutrient cannot be manufactured in the body.** You have to get essential nutrients from food or from a nutritional supplement.
- **An essential nutrient is linked to a specific deficiency disease.** For example, people who go without protein for extended periods of time develop the protein-deficiency disease *kwashiorkor.* People who don't get enough vitamin C develop the vitamin C–deficiency disease *scurvy.* A diet rich in the essential nutrient cures the deficiency disease, but you need the proper nutrient. In other words, you can't cure a protein deficiency with extra amounts of vitamin C.

Not all nutrients are essential for all species of animals. For example, vitamin C is an essential nutrient for human beings but not for dogs. A dog's body makes the vitamin C it needs. Check out the list of nutrients on a can or bag of dog food. See? No C. The dog already has the C it — sorry, he or she — requires.

Essential nutrients for human beings include many well-known vitamins and minerals, several *amino acids* (the so-called building blocks of proteins), and at least two fatty acids. For more about these essential nutrients, see Chapters 6, 7, 11, and 12.

Protecting the nutrients in your food

Identifying nutrients is one thing. Making sure you get them into your body is another. Here, the essential idea is to keep nutritious food nutritious by preserving and protecting its components.

Some people see the term *food processing* as a nutritional dirty word. Or words. They're wrong. Without food processing and preservatives, you and I would still be forced to gather (or kill) our food each morning and down it fast before it spoiled. For more about which processing and preservative techniques produce the safest, most nutritious — and yes, delicious — dinners, check out Part IV.

Considering how vital food preservation can be, you may want to think about when you last heard a rousing cheer for the anonymous cook who first noticed that salting or pickling food could extend food's shelf life. Or for the guys who invented the refrigeration and freezing techniques that slow food's natural tendency to degrade (translation: spoil). Or for Louis Pasteur, the man who made it ab-so-lute-ly clear that heating food to boiling kills bugs (translation: microorganisms) that might otherwise cause food poisoning. Hardly ever, that's when. So give them a hand, right here. Cool.

Essential nutrients for Fido, Fluffy, and your pet petunia

Vitamin C isn't the only nutrient that's essential for one species but not for others. Many organic compounds (substances similar to vitamins) and elements (minerals) are essential for your green or furry friends but not for you because you can synthesize them from the food you eat.

One good example is the organic compound myoinositol. *Myoinositol* is an essential nutrient for gerbils and rats who cannot make it in their own bodies and thus must get what they need from food. Human beings, on the other hand, synthesize myoinositol naturally and then use it in many body processes, such as transmitting signals between cells.

Here's a handy list of nutrients that are essential for (some) animals and/or plants but not for you:

Organic Compounds	***Elements***
Carnitine	Arsenic
Myoinositol	Cadmium
Taurine	Lead
	Nickel
	Silicon
	Tin
	Vanadium

Other interesting substances in food

The latest flash in the nutrition sky is caused by phytochemicals. *Phyto* is the Greek word for plants, so *phytochemicals* are simply — yes, you've got it — chemicals from plants. Although the 13-letter group name may be new to you, you're already familiar with some phytochemicals. Pigments such as beta carotene, the deep yellow coloring in fruits and vegetables that your body can convert to a form of vitamin A, are phytochemicals.

And then there are *phytoestrogens,* hormone-like chemicals that grabbed the spotlight when it was suggested that a diet high in phytoestrogens, such as the isoflavones found in soybeans, may lower the risk of heart disease and reduce the incidence of reproductive cancers (cancers of the breast, ovary, uterus, and prostate). More recent studies suggest that phytoestrogens may have some problems of their own, so to find out more about phytochemicals, including phytoestrogens, check out Chapter 22.

You are what you eat

Oh boy, I bet you've heard this one before. But it bears repeating, because the human body really is built from the nutrients it gets from food: water, protein, fat, carbohydrates, vitamins, and minerals. On average, when you step on the scale

- About 60 percent of your weight is water.
- About 20 percent of your weight is fat.
- About 20 percent of your weight is a combination of mostly protein (especially in your muscles) plus carbohydrates, minerals, and vitamins.

TIP

An easy way to remember your body's percentage of water, fat, and protein and other nutrients is to think of it as the "60-20-20 Rule."

What's a body made of?

Sugar and spice and everything nice . . . Oops. What I meant to say was the human body is made of water and fat and protein and carbohydrates and vitamins and minerals.

On average, when you step on the scale, approximately 60 percent of your weight is water, 20 percent is body fat (slightly less for a man), and 20 percent is a combination of mostly protein, plus carbohydrates, minerals, vitamins, and other naturally occurring biochemicals.

Based on these percentages, you can reasonably expect that an average 140-pound person's body weight consists of about

- 84 pounds of water
- 28 pounds of body fat
- 28 pounds of a combination of protein (up to 25 pounds), minerals (up to 7 pounds), carbohydrates (up to 1.4 pounds), and vitamins (a trace).

Yep, you're right: Those last figures do total more than 28 pounds. That's because "up to" (as in "up to 25 pounds of protein") means that the amounts may vary from person to person. Ditto for minerals and carbohydrates.

For example, a young person's body has proportionately more muscle and less fat than an older person's, while a woman's body has proportionately less muscle and more fat than a man's. As a result, more of a man's weight comes from protein and muscle and bone mass, while more of a woman's weight comes from fat. Protein-packed muscles and mineral-packed bones are denser tissue than fat.

Weigh a man and a woman of roughly the same height and size, and his greater bone and muscle mass means he's likely to tip the scale higher every time.

The National Research Council, Recommended Dietary Allowances (Washington D.C.: National Academy Press, 1989); Sharon Rady Rolfes, Kathryn Pinna, Ellie Whitney, Understanding Normal and Clinical Nutrition, 7th edition (Belmont CA: Thomson Wadsworth, 2006)

Your nutritional status

Nutritional status is a phrase that describes the state of your health as related to your diet. For example, people who are starving do not get the nutrients or calories they need for optimum health. These people are said to be *malnourished* (mal = bad), which means their nutritional status is, to put it gently, definitely not good. Malnutrition may arise from

- **A diet that doesn't provide enough food.** This situation can occur in times of famine or through voluntary starvation because of an eating disorder or because something in your life disturbs your appetite. For example, older people may be at risk of malnutrition because of tooth loss or age-related loss of appetite or because they live alone and sometimes just forget to eat.
- **A diet that, while otherwise adequate, is deficient in a specific nutrient.** This kind of nutritional inadequacy can lead to — surprise! — a deficiency disease, such as beriberi, the disease caused by a lack of vitamin B1 (thiamine).
- **A metabolic disorder or medical condition that prevents your body from absorbing specific nutrients, such as carbohydrates or protein.** One common example is diabetes, the inability to produce enough insulin, the hormone your body uses to metabolize (digest) carbohydrates. Another is celiac disease, a condition that makes it impossible for the body to digest gluten, a protein in wheat. Need more info on either diabetes or celiac disease? Check out *Diabetes For Dummies,* 2nd Edition, by Alan L. Rubin, MD, and *Living Gluten-Free For Dummies,* by Danna Korn (both published by Wiley — of course).

Doctors and registered dieticians have many tools with which to rate your nutritional status. For example, they can

- Review your medical history to see whether you have any conditions (such as dentures) that may make eating certain foods difficult or that interfere with your ability to absorb nutrients.
- Perform a physical examination to look for obvious signs of nutritional deficiency, such as dull hair and eyes (a lack of vitamins?), poor posture (not enough calcium to protect the spinal bones?), or extreme thinness (not enough food? An underlying disease?).
- Order laboratory blood and urine tests that may identify early signs of malnutrition, such as the lack of red blood cells that characterizes anemia caused by an iron deficiency.

At every stage of life, the aim of a good diet is to maintain a healthy nutritional status.

Fitting food into the medicine chest

Food is medicine for the body and the soul. Good meals make good friends, and modern research validates the virtues of not only Granny's chicken soup but also heart-healthy sulfur compounds in garlic and onions, anticholesterol dietary fiber in grains and beans, bone-building calcium in milk and greens, and mood elevators in coffee, tea, and chocolate.

Of course, foods pose some risks as well: food allergies, food intolerances, food and drug interactions, and the occasional harmful substances such as the dreaded *saturated fats* and *trans fats* (quick — Chapter 8!). In other words, constructing a healthful diet can mean tailoring food choices to your own special body. Not to worry: You can do it. Especially after reading through Part V. Would a *For Dummies* book leave you unarmed? Not a chance!

Finding Nutrition Facts

Getting reliable information about nutrition can be a daunting challenge. For the most part, your nutrition information is likely to come from TV and radio talk shows or news, your daily newspaper, your favorite magazine, a variety of nutrition-oriented books, and the Internet. How can you tell whether what you hear or read is really right?

Nutritional people

The people who make nutrition news may be scientists, reporters, or simply someone who wandered in with a new theory (Artichokes prevent cancer! Never eat cherries and cheese at the same meal! Vitamin C gives you hives!), the more bizarre the better. But several groups of people are most likely to give you news you can use with confidence. For example:

- **Nutrition scientists:** These are people with graduate degrees (usually in chemistry, biology, biochemistry, or physics) engaged in research dealing primarily with the effects of food on animals and human beings.
- **Nutrition researchers:** Researchers may be either nutrition scientists or professionals in another field, such as medicine or sociology, whose research (study or studies) concentrates on the effects of food.

- **Nutritionists:** These are people who concentrate on the study of nutrition. In some states, a person who uses the title "nutritionist" must have a graduate degree in basic science courses related to nutrition.
- **Dietitians:** These people have undergraduate degrees in food and nutrition science or the management of food programs. A person with the letters R.D. after his or her name has completed a dietetic internship and passed an American Dietetic Association licensing exam.
- **Nutrition reporters and writers:** These are people who specialize in giving you information about the medical and/or scientific aspects of food. Like reporters who concentrate on politics or sports, nutrition reporters gain their expertise through years of covering their beat. Most have the science background required to translate technical information into language nonscientists can understand; some have been trained as dietitians, nutritionists, or nutrition scientists.

REMEMBER

Consumer alert: Regardless of the source, nutrition news should always pass what you may call *The Reasonableness Test.* In other words, if a story or report or study sounds ridiculous, it probably is.

The next section offers some guidelines for evaluating nutrition studies.

Can you trust this study?

You open your morning newspaper or turn on the evening news and read or hear that a group of researchers at an impeccably prestigious scientific organization has published a study showing that yet another thing you've always taken for granted is hazardous to your health. For example, the study says drinking coffee stresses your heart, adding salt to food raises blood pressure, or fatty foods increase your risk of cancer or heart disease.

So you throw out the offending food or drink or rearrange your daily routine to avoid the once-acceptable, now-dangerous food, beverage, or additive. And then what happens? Two weeks, two months, or two years down the road, a second, equally prestigious group of scientists publishes a study conclusively proving that the first group got it wrong: In fact, this study shows coffee has no effect on the risk of heart disease — and may even improve athletic performance; salt does not cause hypertension except in certain sensitive individuals; only *some* fatty foods are risky.

Who's right? Nobody seems to know. That leaves you, a layperson, on your own to come up with the answer. Never fear — you may not be a nutritionist, but that doesn't mean you can't apply a few common-sense rules to any study you read about, rules that say, "Yes, this may be true," or "No, this may not be."

Does this study include human beings?

True, animal studies can alert researchers to potential problems, but working with animals alone cannot give you conclusive proof.

Different species react differently to various chemicals and diseases. For example, although cows and horses can digest grass and hay, human beings can't. And while outright poisons such as cyanide clearly traumatize any living body, many foods or drugs that harm a laboratory rat won't harm you. And vice versa. For example, mouse and rat embryos suffer no ill effects when their mothers are given thalidomide, the sedative that's known to cause deformed fetal limbs when given to pregnant monkeys — and human beings — at the point in pregnancy when limbs are developing. (And here's an astounding turn: Modern research shows that thalidomide is beneficial for treating or preventing *human* skin problems related to Hansen's disease [leprosy], cancer, and/or autoimmune conditions, such as rheumatoid arthritis, in which the body mistakenly attacks its own tissues.)

Are enough people in this study?

Hey, researchers' saying, "Well, I did give this to a couple of people," is simply not enough. The study must include sufficient numbers and a variety of individuals, too. If you don't have enough people in the study — several hundred to many thousand — to establish a pattern, there's always the possibility that an effect occurred by chance.

If you don't include different types of people, which generally means young and old men and women of different racial and ethnic groups, your results may not apply across the board. For example, the original studies linking high blood cholesterol levels to an increased risk of heart disease and linking small doses of aspirin to a reduced risk of a second heart attack involved only men. It wasn't until follow-up studies were conducted with women that researchers were able to say with any certainty that high cholesterol is dangerous and aspirin is protective for women as well — but not in quite the same way: In January 2006, the *Journal of the American Medical Association* reported that men taking low dose aspirin tend to lower their risk of heart attack. For women, the aspirin reduces the risk of stroke. Vive la difference!

Is there anything in the design or method of this study that may affect the accuracy of its conclusions?

Some testing methods are more likely to lead to biased or inaccurate conclusions. For example, a retrospective study (which asks people to tell what they did in the past) is always considered less accurate than a prospective study (one that follows people while they're actually doing what the researchers are studying), because memory isn't always accurate. People tend to forget details or, without meaning to, alter them to fit the researchers' questions.

Was this study reviewed by the author's peers?

Serious researchers subject their studies to review by others working in the same field, a process called *peer review.* All reliable scientific journals have studies reviewed before they're published.

Are the study's conclusions reasonable?

When a study comes up with a conclusion that seems illogical to you, chances are the researchers feel the same way. For example, in 1990, the long-running Nurses' Study at the Harvard School of Public Health reported that a high-fat diet raised the risk of colon cancer. But the data showed a link only to diets high in beef. No link was found to diets high in dairy fat. In short, this study was begging for a second study to confirm (or deny) its results, and in 2005, a large study of more than 60,000 Swedish women, reported in the *American Journal of Clinical Nutrition,* showed that eating lots of high-fat dairy foods actually reduced the risk of colorectal cancer.

Finally, the nature of life is a continuing surprise. Even in nutrition. Consider dioxin, a toxic contaminant found in some fish. Consider Olestra, the calorie-free fat substitute that makes some tummies rumble. As you read this page, dioxin's still a bad actor, but in 2005, researchers at the University of Cincinnati and the University of Western Australia announced that eating foods containing Olestra may speed your body's elimination of — you guessed it — dioxin.

Chapter 2

Digestion: The 24/7 Food Factory

In This Chapter

- Getting acquainted with your digestive organs
- Following the food through your body
- Absorbing nutrients and passing them along to your body

When you see (or smell) something appetizing, your digestive organs leap into action. Your mouth waters. Your stomach contracts. Intestinal glands begin to secrete the chemicals that turn food into the nutrients that build new tissues and provide the energy you need to keep zipping through the days, months, and years.

This chapter provides a basic primer on the digestive system and explains exactly how your body digests the many different kinds of foods you eat, all the while extracting the nutrients you need to keep on truckin'.

Introducing the Digestive System

Your *digestive system* is a collection of organs specifically designed to turn complex substances (food) into basic components (nutrients) during the two-part process known as *digestion.*

The digestive organs

Although exceedingly well organized, your digestive system is basically one long tube that starts at your mouth, continues down through your throat to your stomach, and then goes on to your small and large intestines and past the rectum to end at your anus.

In between, with the help of the liver, pancreas, and gallbladder, the usable (digestible) parts of everything that you eat are converted to simple compounds that your body can easily absorb to burn for energy or to build new tissue. The indigestible residue is bundled off and eliminated as waste.

Figure 2-1 shows the body parts and organs that comprise your digestive system.

Digestion: A two-part process

Digestion is a two-part process — half mechanical, half chemical:

- *Mechanical digestion* takes place in your mouth and your stomach. Your teeth break food into small pieces that you can swallow without choking. In your stomach and small intestine, a churning action called *peristalsis* continues to break food into smaller particles.
- *Chemical digestion* occurs at every point in the digestive tract where enzymes and other substances, such as *hydrochloric acid* (from stomach glands) and *bile* (from the liver), dissolve food, releasing the nutrients inside.

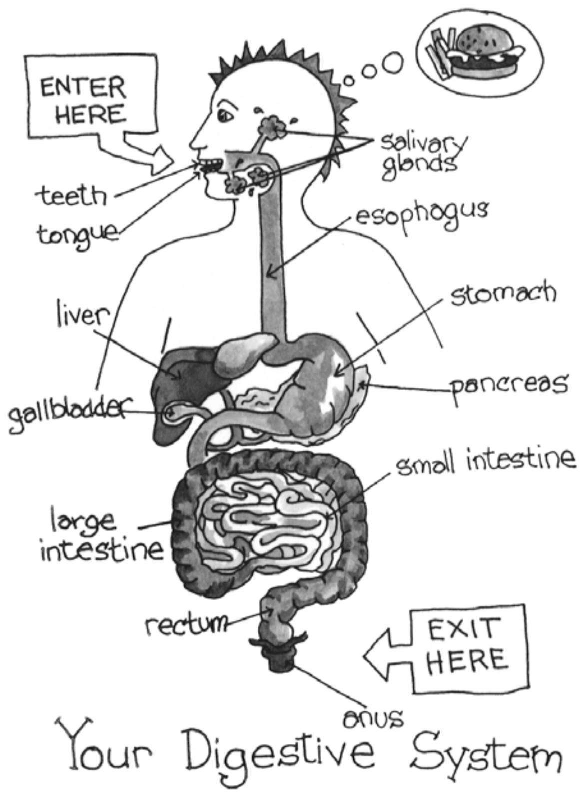


Figure 2-1: Your digestive system in all its glory.

Understanding How Your Body Digests Food

Each organ in the digestive system plays a specific role in the digestive drama. But the first act occurs in two places that are never listed as part of the digestive tract: your brain, your eyes, and your nose.

The brain, eyes, and nose

When you see appetizing food, you experience a conditioned response. (For the lowdown on how your digestive system can be conditioned to respond to food, see Chapter 14; for information on your food preferences, see Chapter 15.) In other words, your thoughts — "Wow! That looks good!" — stimulate your brain to tell your digestive organs to get ready for action.

What happens in your nose is purely physical. The tantalizing aroma of good food is transmitted by molecules that fly from the surface of the food to settle on the membrane lining of your nostrils; these molecules stimulate the receptor cells on the olfactory nerve fibers that stretch from your nose back to your brain. When the receptor cells communicate with your brain — your brain sends encouraging messages to your mouth and digestive tract.

In both cases — eyes and nose — the results are the same: In other words, the sight and scent of food has made your mouth water and your stomach contract in anticipatory hunger pangs.

But wait! Suppose that you hate what you see or smell? For some people, even the thought of liver is enough to make them want to barf — or simply leave the room. At that point, your body takes up arms to protect you: You experience a *rejection reaction* — a reaction similar to that exhibited by babies given something that tastes bitter or sour. Your mouth purses, and your nose wrinkles as if to keep the food (and its odor) as far away as possible. Your throat tightens, and your stomach *turns* — muscles contracting not in anticipatory pangs but in movements preparatory for vomiting up the unwanted food. Not a pleasant moment.

But assume that you like what's on your plate. Go ahead. Take a bite.

The mouth

Lift your fork to your mouth, and your teeth and salivary glands swing into action. Your teeth chew, grinding the food, breaking it into small, manageable pieces. As a result:

- You can swallow without choking.
- You break down the indigestible wrapper of fibers surrounding the edible parts of some foods (fruits, vegetables, whole grains) so that your digestive enzymes can get to the nutrients inside.

At the same time, salivary glands under your tongue and in the back of your mouth secrete the watery liquid called *saliva,* which performs two important functions:

- Moistening and compacting food so that your tongue can push it to the back of your mouth and you can swallow, sending the food down the slide of your *gullet* (esophagus) into your stomach.
- Providing *amylases,* enzymes that start the digestion of complex carbohydrates (starches), breaking the starch molecules into simple sugars (Check out Chapter 9 for more on carbs.)

No protein digestion occurs in your mouth, though saliva does contain very small amounts of lingual lipases, fat-busting enzymes secreted by cells at the base of the tongue; however, the amount is so small that the fat digestion that occurs in the mouth is insignificant.

Turning starches into sugars

Salivary enzymes (like amylases) don't lay a finger on proteins and leave fats pretty much alone, but they do begin to digest complex carbohydrates, breaking the long, chainlike molecules of starches into individual units of sugars. This simple experiment enables you to taste firsthand the effects of amylases on carbohydrates.

1. **Put a small piece of plain, unsalted cracker on your tongue.**

   No cheese, no chopped liver — just the cracker, please.

2. **Close your mouth and let the cracker sit on your tongue for a few minutes.**

   Do you taste a sudden, slight sweetness? That's the salivary enzymes breaking a long, complex starch molecule into its component parts (sugars).

3. **Now swallow.**

   The rest of the digestion of the starch takes place farther down, in your small intestine.

The stomach

If you were to lay your digestive tract out on a table, most of it would look like a simple, rather narrow, tube. The exception is your stomach, a pouchy part just below your *gullet* (esophagus).

Like most of the digestive tube, your stomach is circled with strong muscles whose rhythmic contractions — called *peristalsis* — move food smartly along and turn your stomach into a sort of food processor that mechanically breaks pieces of food into ever smaller particles. While this is going on, glands in the stomach wall are secreting *stomach juices* — a potent blend of enzymes, hydrochloric acid, and mucus.

One stomach enzyme — *gastric alcohol dehydrogenase* — digests small amounts of alcohol, an unusual nutrient that can be absorbed directly into your bloodstream even before it's been digested. For more about alcohol digestion, including why men can drink more than women without becoming tipsy, see Chapter 10.

Other enzymes, plus stomach juices, begin the digestion of proteins and fats, separating them into their basic components — amino acids and fatty acids.

Stop! If the words amino acids and fatty acids are completely new to you and if you're suddenly consumed by the desire to know more about them this instant, stick a pencil in the book to hold your place and flip to Chapters 7 and 8, where I discuss them in detail.

Stop again!! For the most part, digestion of carbohydrates comes to a temporary halt in the stomach because the stomach juices are so acidic that they deactivate *amylases,* the enzymes that break complex carbohydrates apart into simple sugars. However, stomach acid can break some carbohydrate bonds, so a bit of carb digestion does take place.

Back to the action. Eventually, your churning stomach blends its contents into a thick soupy mass called *chyme* (from *cheymos,* the Greek word for juice). When a small amount of chyme spills past the stomach into the small intestine, the digestion of carbohydrates resumes in earnest, and your body begins to extract nutrients from food.

The small intestine

Open your hand and put it flat against your belly button, with your thumb pointing up to your waist and your pinkie pointing down.

Your hand is now covering most of the relatively small space into which your 20-foot-long small intestine is neatly coiled. When the soupy, partially digested chyme spills from your stomach into this part of the digestive tube, a whole new set of gastric juices are released:

- *Pancreatic and intestinal enzymes* that finish the digestion of proteins into amino acids
- *Bile,* a greenish liquid (made in the liver and stored in the gallbladder) that enables fats to mix with water
- *Alkaline pancreatic juices* that make the chyme less acidic so that amylases (the enzymes that break down carbohydrates) can go back to work separating complex carbohydrates into simple sugars
- *Intestinal alcohol dehydrogenase,* which digests alcohol not previously absorbed into your bloodstream

While these chemicals are working, contractions of the small intestine continue to move the food mass down through the tube so that your body can absorb sugars, amino acids, fatty acids, vitamins, and minerals into cells in the intestinal wall.

TECHNICAL STUFF

The lining of the small intestine is a series of folds covered with projections that have been described as “finger-like” or “small nipples.” The technical name for these small structures is *villi.* Each villus is covered with smaller projections called *microvilli,* and every villus and microvillus is programmed to accept a specific nutrient — and no other.

Nutrients are absorbed not in their order of arrival in the intestine but according to how fast they’re broken down into their basic parts:

- Carbohydrates — which separate quickly into single sugar units — are absorbed first.
- Proteins (as amino acids) go next.
- Fats — which take longest to break apart into their constituent fatty acids — are last. That’s why a high-fat meal keeps you feeling fuller longer than a meal such as chow mein or plain tossed salad, which are mostly lowfat carbohydrates.
- Vitamins that dissolve in water are absorbed earlier than vitamins that dissolve in fat.

Peephole: The first man to watch a living human gut at work

William Beaumont, MD, was a surgeon in the United States Army in the early 19th century. His name survives in the annals of medicine because of an excellent adventure that began on June 6, 1822. Alexis St. Martin, an 18-year-old French Canadian fur trader, was wounded by a musket ball that discharged accidentally, tearing through his back and out his stomach, leaving a wound that healed but didn't close.

St. Martin's injury seems not to have affected what must have been a truly sunny disposition: Two years later, when all efforts to close the hole in his gut had failed, he granted Beaumont permission to use the wound as the world's first window on a working human digestive system. (To keep food and liquid from spilling out of the small opening, Beaumont kept it covered with a cotton bandage.)

Beaumont's method was simplicity itself. At noon on August 1, 1825, he tied small pieces of food (cooked meat, raw meat, cabbage, bread) to a silk string, removed the bandage, and inserted the food into the hole in St. Martin's stomach.

An hour later, he pulled the food out. The cabbage and bread were half digested; the meat, untouched. He reinserted the food into the hole. After another hour, he pulled the string out again. This time, only the raw meat remained untouched, and St. Martin, who now had a headache and a queasy stomach, called it quits for the day. But in more than 230 later trials, Beaumont — with the help of his remarkably compliant patient — discovered that although carbohydrates (cabbage and bread) were digested rather quickly, it took up to eight hours for the stomach juices to break down proteins and fats (the beef). Beaumont attributed this to the fact that the cabbage had been cut into small pieces and the bread was porous. Modern nutritionists know that carbohydrates are simply digested faster than proteins and that digesting fats (including those in beef) takes longest of all.

By withdrawing gastric fluid from St. Martin's stomach, keeping it at 100°F (the temperature recorded on a thermometer stuck into the stomach), and adding a piece of meat, Beaumont was able to clock exactly how long the meat took to fall apart: 10 hours.

Beaumont and St. Martin separated in 1833 when the patient, who was then a sergeant in the United States Army, was posted elsewhere, leaving the doctor to write "Experiments and Observations on the Gastric Juice and the Physiology of Digestion." The treatise is now considered a landmark in the understanding of the human digestive system.

After you've digested your food and absorbed its nutrients through your small intestine:

- Amino acids, sugars, vitamin C, the B vitamins, iron, calcium, and magnesium are carried through the bloodstream to your liver, where they are processed and sent out to the rest of the body.
- Fatty acids, cholesterol, and vitamins A, D, E, and K go into the lymphatic system and then into the blood. They, too, end up in the liver, are processed, and are shipped out to other body cells.

Inside the cells, nutrients are *metabolized,* or burned for heat and energy or used to build new tissues. The metabolic process that gives you energy is called *catabolism* (from *katabole,* the Greek word for casting down). The metabolic process that uses nutrients to build new tissues is called *anabolism* (from *anabole,* the Greek word for raising up).

How the body uses nutrients for energy and new tissues is, alas, a subject for another chapter. In fact, this subject is enough to fill seven different chapters, each devoted to a specific kind of nutrient. For information about metabolizing proteins, turn to Chapter 7. I discuss fats in Chapter 8, carbohydrates in Chapter 9, alcohol in Chapter 10, vitamins in Chapter 11, minerals in Chapter 12, and water in Chapter 13.

The large intestine

After every useful, digestible ingredient other than water has been wrung out of your food, the rest — indigestible waste such as fiber — moves into the top of your large intestine, the area known as your *colon.* The colon's primary job is to absorb water from this mixture and then to squeeze the remaining matter into the compact bundle known as feces.

Feces (whose brown color comes from leftover bile pigments) are made of indigestible material from food, plus cells that have sloughed off the intestinal lining and bacteria — quite a lot of bacteria. In fact, about 30 percent of the entire weight of the feces is bacteria, microorganisms that live in permanent colonies in your colon, where they

- Manufacture vitamin B12, which is absorbed through the colon wall
- Produce vitamin K, also absorbed through the colon wall
- Break down amino acids and produce nitrogen (which gives feces a characteristic odor)
- Feast on indigestible complex carbohydrates (fiber), excreting the gas that sometimes makes you physically uncomfortable — or a social pariah

When the bacteria have finished, the feces — perhaps the small remains of yesterday's copious feast — pass down through your rectum and out through your anus. But not necessarily right away: Digestion of any one meal may take longer than a day to complete.

After that, digestion's done!

Chapter 3

Calories: The Energizers

In This Chapter

- Defining a calorie
- Counting the calories in different nutrients
- Explaining why men generally need more calories than women
- Estimating your calorie requirements

Automobiles burn gasoline to get the energy they need to move. Your body burns *(metabolizes)* food to produce energy in the form of heat. This heat warms your body and (as energy) powers every move you make.

The amount of heat produced by metabolizing food is measured in units called kilocalories. A *kilocalorie* is the amount of energy it takes to raise the temperature of 1 kilogram of water 1 degree on a Centigrade (Celsius) thermometer at sea level.

In common use, nutritionists substitute the word *calorie* for *kilocalorie.* Strictly speaking, a calorie is really $\frac{1}{1000}$ of a kilocalorie. But the word calorie is easier to say and easier to remember, so that's the term you see whenever you read about the energy in food. Read on to find out what calories mean to you and your nutrition.

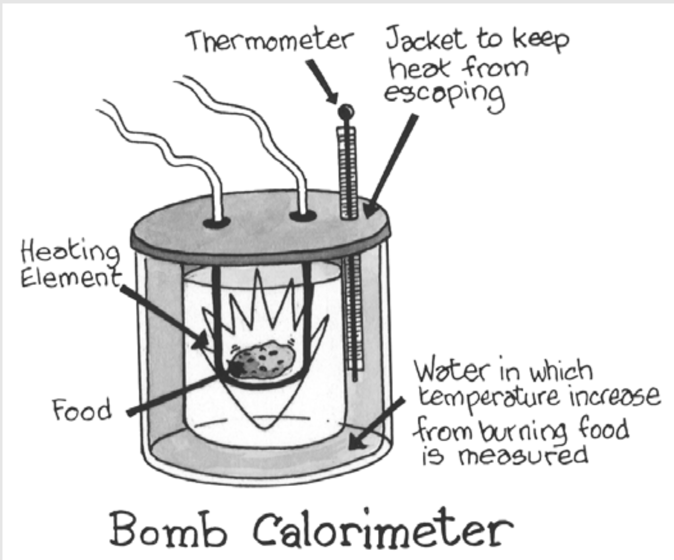
Counting the Calories in Food

When you read that a serving of food — say, one banana — has 105 calories, that means your metabolizing the banana produces 105 calories of heat that your body can use for work.

TECHNICAL STUFF

Measuring the number of calories

Nutrition scientists measure the number of calories in food by actually burning the food in a *bomb calorimeter,* which is a box with two chambers, one inside the other. The researchers weigh a sample of the food, put the sample in a dish, and put the dish into the inner chamber of the calorimeter. They fill the inner chamber with oxygen and then seal it so the oxygen can't escape. The outer chamber is filled with a measured amount of cold water, and the oxygen in the first chamber (inside the chamber with the water) is ignited with an electric spark. When the food burns, an observer records the rise in the temperature of the water in the outer chamber. If the temperature of the water goes up 1 degree per kilogram, the food has 1 calorie; 2 degrees, 2 calories; 235 degrees, 235 calories — or one 8-ounce chocolate malted made with powder mix and whole milk.



You may wonder which kinds of food have the most calories. Here's how the calories measure up in 1 gram of the four basic food types:

- **Protein:** 4 calories
- **Carbohydrates:** 4 calories
- **Alcohol:** 7 calories
- **Fat:** 9 calories

In other words, ounce for ounce, proteins and carbohydrates give you fewer than half as many calories as fat. That's why — again, ounce for ounce — high-fat foods, such as cream cheese, are high in calories, while lowfat foods, such as bagels (minus the cream cheese, of course) are not.

Sometimes foods that seem to be equally low-calorie really aren't. You have to watch all the angles, paying attention to fat in addition to protein and carbohydrates. Here's a good example: A chicken breast and a hamburger are both high-protein foods. Both should have the same number of calories per ounce. But if you serve the chicken without its skin, it contains very little fat, while the hamburger is chock-full of it. A 3-ounce serving of skinless chicken provides 140 calories, while a 3-ounce burger yields 230 to 245 calories, depending on the cut of the meat and its fat content.

Empty calories

All food provides calories. All calories provide energy. But some foods are said to give you *empty calories.* This term has nothing to do with the calorie's energy potential; it simply describes a calorie with no extra benefits, such as amino acids, fatty acids, fiber, vitamins, and minerals.

The best-known empty-calorie foods are table sugar and *ethanol* (the kind of alcohol found in beer, wine, and spirits). On their own, sugar and ethanol give you energy — but no nutrients. (See Chapter 9 for more about sugar and Chapter 10 for more about alcohol.)

Of course, sugar and alcohol are ingredients often found in foods that do provide other nutrients. For example, sugar is found in bread, and alcohol is found in beer — two very different foods that both have calcium, phosphorus, iron, potassium, sodium, and B vitamins.

In the United States, some people are malnourished because they can't afford enough food to get the nutrients they need. The school lunch program started by President Franklin Delano Roosevelt in 1935 and expanded by almost every president, Republican and Democrat, since then has been a largely successful attempt to prevent malnutrition among poor schoolchildren.

But many Americans who can afford enough food nevertheless are malnourished because they simply don't know how to choose a diet that gives them nutrients as well as calories. For these people, eating too many foods with empty calories can cause significant health problems, such as weak bones, bleeding gums, skin rashes, mental depression, and preventable birth defects as well as being overweight or underweight (yes, being too thin can be a problem).

Every calorie counts

People who say that "calories don't count" or that "some calories count less than others" are usually trying to convince you to follow a diet that concentrates on one kind of food to the exclusion of most others. One common example that seems to arise like a phoenix in every generation of dieters is the *high-protein diet.*

MYTH BUSTER

The high-protein diet tells you to cut back or even entirely eliminate carbohydrate foods on the assumption that because your muscle tissue is mostly protein, the protein foods you eat will go straight from your stomach to your muscles, while everything else turns to fat. In other words, this diet says that you can stuff yourself with protein foods because no matter how many calories you get, they'll all be protein calories, and they'll all end up in your muscles, not on your hips. Wouldn't it be nice if that were true? The problem is, it isn't. All calories, regardless of where they come from, give you energy. If you take in more energy (calories) than you spend each day, you'll gain weight. If you take in fewer calories than you use up, you'll lose weight. This nutrition rule is an equal opportunity, one-size-fits-all proposition that applies to everyone. No exceptions.

How Many Calories Do You Need?

Think of your energy requirements as a bank account. You make deposits when you consume calories. You make withdrawals when your body spends energy on work. Nutritionists divide the amount of energy you withdraw each day into two parts:

- The energy you need when your body is at rest
- The energy you need to do your daily "work"

To keep your energy account in balance, you need to take in enough each day to cover your withdrawals. As a general rule, infants and adolescents burn more energy per pound than adults do, because they're continually making large amounts of new tissue. Similarly, an average man burns more energy than an average woman because his body is larger and has more muscle (see the upcoming section "Sex, glands, and chocolate cake"), thus leading to the totally unfair but totally true proposition that a man who weighs, say, 150 pounds can consume about 10 percent more calories than a woman who weighs 150 pounds and still not gain weight. For the numbers, check out the next section and Table 3-1.

Resting energy expenditure (REE)

Even when you're at rest, your body is busy. Your heart beats. Your lungs expand and contract. Your intestines digest food. Your liver processes nutrients. Your glands secrete hormones. Your muscles flex, usually gently. Cells send electrical impulses back and forth among themselves, and your brain continually signals to every part of your body.

The energy that your resting body uses to do all this stuff is called (surprise! surprise!) *resting energy expenditure,* abbreviated REE. The REE, also known as the *basal metabolism,* accounts for a whopping 60 to 70 percent of all the energy you need each day.

To find your resting energy expenditure (REE), you must first figure out your weight in kilograms (kg). One kilogram equals 2.2 pounds. So to get your weight in kilograms, divide the number in pounds by 2.2. For example, if you weigh 150 pounds, that's equal to 68.2 kg (150 ÷ 2.2). Plug that into the appropriate equation in Table 3-1 — and bingo! You have your REE.

What do you do with this information? First, simply appreciate its scientific value in describing the most basic fact about how many calories you need to survive. Second, and more pragmatically, regard it as a base on which to build a nutritional, real-life, daily menu.

Table 3-1 How Many Calories Do You Need When You're Resting?

Sex and Age	*Equation to Figure Out Your REE*
Males	
18–30 years	(15.3 × weight in kg) + 679
31–60 years	(11.6 × weight in kg) + 879
Older than 60 years	(13.5 × weight in kg) + 487
Females	
18–30 years	(14.7 × weight in kg) + 496
31–60 years	(8.7 × weight in kg) + 829
Older than 60 years	(10.5 × weight in kg) + 596

The National Research Council, Recommended Dietary Allowances (Washington, D.C.: National Academy Press, 1989)

Sex, glands, and chocolate cake

A *gland* is an organ that secretes *hormones,* which are chemical substances that can change the function — and sometimes the structure — of other body parts.

Hormones secreted by three glands — the pituitary, the thyroid, and the adrenals — influence how much energy you use when your body's at rest.

Your pituitary gland, a small structure in the center of your brain, stimulates your thyroid gland (which sits at the front of your throat) to secrete hormones that impact the rate at which your tissues burn nutrients to produce energy.

Muscle versus fat versus weight loss

Muscle weighs more than fat. This is why many people who take up exercise to lose weight discover, one month or so into the barbells and step-up-step-down routine, their clothes fit better, but the scale points slightly higher. They've traded lightweight fat for heavier muscle, proving that sometimes you can't win for losing.

When your thyroid gland doesn't secrete enough hormones (a condition known as *hypothyroidism*), you burn food more slowly, and your REE drops. When your thyroid secretes excess amounts of hormones (a condition known as *hyperthyroidism*), you burn food faster, and your REE is higher.

When you're frightened or excited, your adrenal glands (two small glands, one on top of each kidney) release *adrenaline,* the hormone that serves as your body's call to battle stations. Your heartbeat increases. You breathe faster. Your muscles clench. And you burn food faster, converting it as fast as possible to the energy you need for the reaction commonly known as *fight or flight.* But these effects are temporary. The effects of your sex glands, on the other hand, last as long as you live.

If you're a woman, you know that your appetite may rise and fall in tune with your menstrual cycle. In fact, this fluctuation parallels what's happening to your REE, which goes up just before or at the time of ovulation. Your appetite is highest when menstrual bleeding starts and then falls sharply. Yes, you really are hungrier (and need more energy) just before you get your period.

Being a man (and making lots of testosterone) makes satisfying your nutritional needs on a normal American diet easier. Your male bones are naturally denser, so you're less dependent on dietary or supplemental calcium to prevent *osteoporosis* (severe loss of bone tissue) late in life. You don't lose blood through menstruation, so you need only less than half as much iron (8 mg for an adult male; 18 mg for a premenopausal woman who is neither pregnant nor nursing). Best of all, you can consume about 10 percent more calories than a woman of the same weight without adding pounds.

It is no accident that while teenage boys' are developing wide shoulders and biceps, teenage girls are getting hips. Testosterone, the male hormone, promotes the growth of muscle and bone. Estrogen gives you fatty tissue. As a result, the average male body has proportionally more muscle; the average female body, proportionally more fat.

Muscle is active tissue. It expands and contracts. It works. And when a muscle works, it uses more energy than fat (which insulates the body and provides a source of stored energy but does not move an inch on its own). What this muscle versus fat battle means is that the average man's REE is about 10 percent higher than the average woman's. In practical terms, that means a 140-pound man can hold his weight steady while eating about 10 percent more than a 140-pound woman who is the same age and performs the same amount of physical work.

No amount of dieting changes this unfair situation. A woman who exercises strenuously may reduce her body fat so dramatically that she no longer menstruates — an occupational hazard for some professional athletes. But she'll still have proportionately more body fat than an adult man of the same weight. If she eats what he does, and they perform the same amount of physical work, she still requires fewer calories than he to hold her weight steady.

Energy for work

Your second largest chunk of energy after the REE is the energy you withdraw to spend on physical work, everything from brushing your teeth in the morning to planting a row of petunias in the garden or working out in the gym.

Your total energy requirement (the number of calories you need each day) is your REE plus enough calories to cover the amount of work you do.

Does thinking about this use up energy? Yes, but not as much as you'd like to imagine. To solve a crossword puzzle — or write a chapter of this book — the average brain uses about 1 calorie every four minutes. That's only one-third the amount needed to keep a 60-watt bulb burning for the same length of time.

Table 3-2 defines the energy level of various activities ranging from the least energetic (sleep) to the most (playing football, digging ditches). Table 3-3 shows how many calories you use in an hour's worth of different kinds of work.

Table 3-2 How Active Are You When You're Active?

Activity Level	*Activity*
Resting	Sleeping, reclining
Very light	Seated and standing activities, painting, driving, laboratory work, typing, sewing, ironing, cooking, playing cards, and playing a musical instrument

(continued)

Table 3-2 *(continued)*

Activity Level	*Activity*
Light	Walking on a level surface at 2.5 to 3 mph, garage work, electrical trades, carpentry, restaurant trades, housecleaning, child care, golfing, sailing, and table tennis
Moderate	Walking 3.5 to 4 mph, weeding and hoeing, carrying a load, cycling, skiing, tennis, and dancing
Heavy	Walking with a load uphill, tree felling, heavy manual digging, basketball, climbing, football, and soccer
Exceptionally heavy	Professional athletic training

The National Research Council, Recommended Dietary Allowances (Washington, D.C.: National Academy Press, 1989)

Table 3-3 How Many Calories Do You Need to Do the Work You Do?

Activity Level	*Calories Needed for This Work for One Hour*
Very light	80–100
Light	110–160
Moderate	170–240
Heavy	250–350
Exceptionally heavy	350+

"Food and Your Weight," House and Garden Bulletin, No. 74 (Washington, D.C.: U.S. Department of Agriculture)

How Many Calories Do You Really Need?

Figuring out exactly how many calories to consume each day can be a consuming task. Luckily, the Institute of Medicine, the group whose Food and Nutrition Board determines the RDAs for vitamins, minerals and other nutrients, has created a list of the average daily calorie allowance for healthy people from infants to senior citizens who maintain a healthful weight (see Chapter 4) based on the amount of activity a person performs each day.

Table 3-4 shows the calorie recommendations. Note that in this context, *sedentary* means a lifestyle with only the light physical activity associated with daily living; *moderately active* means a lifestyle that adds physical activity equal to a daily 1.5–3 mile walk at a speed of 3–4 miles per hour; *active* means adding physical activity equal to walking 3 miles a day at the 3–4 mph clip.

Table 3-4 Estimated Daily Calorie Requirements for Healthy Adults* Based on Activity Level

	Age (Years)	*Sedentary*	*Moderate*	*Active*
Women	19–30	2000	2000–2200	2300
	31–50	1800	2000	2200
	51+	1600	1800	2000–2200
Men	19–30	2400	2600–2800	3000
	31–50	2200	2400–2600	2800–3000
	51+	2000	2200–2400	2400–2800

** These calorie recommendations assume a person of healthful weight, that is women with a Body Mass Index (BMI) of 21.5 and men with a BMI of 22.5 (for more on BMI, see Chapter 4).*

Source: Institute of Medicine, "Estimated Energy Requirements (EER), IOM Dietary Reference Intakes macronutrients report," 2002.

The Last Word on Calories

Calories are not your enemy. On the contrary, they give you the energy you need to live a healthy life.

The trick is to manage your calories and not let them manage you. After you know that fats are more fattening than proteins and carbohydrates and that your body burns food to make energy, you can strategize your energy intake to match your energy expenditure, and vice versa. Chapter 16 covers the details of a healthful diet. Chapter 17 shows how to plan nutritious meals.

Chapter 4

Big, Bigger, Biggest: The Growing American Body

In This Chapter

- Tracking America's weight gains
- Listing the fattest and fittest cities and states
- Defining obesity
- Identifying the consequences of being overweight

Americans are fat. And getting fatter.

According to the Dietary Guidelines 2010 (see Chapter 16), in 1970, about 15 percent of all Americans were obese. By 2008, that figure had more than doubled to 34 percent, and in 32 of the 50 states, more than one in every four people were obese.

And the kids are *not* all right. Overall, the National Survey of Children's Health (2007) says that more than 12 million American children and adolescents are obese, and the National Center for Health Statistics says that the number of obese 6- to 11-year-olds has quadrupled since 1970.

This excess poundage isn't pretty, and it comes at a cost. The Centers for Disease Control and Prevention (CDC) puts the price of treating obesity-related illnesses at nearly $150 billion each year, an amount equal to about 10 percent of all medical spending in the United States, including your health insurance premiums.

And if these trends continue, researchers at the Johns Hopkins Bloomberg School of Public Health, the Agency for Healthcare Research and Quality, and the University of Pennsylvania School of Medicine predict that by the year 2030, nearly 90 percent of American adults will be overweight, and the cost of treating their obesity-related health problems will approach $1 trillion a year.

No wonder the American Heart Association says we're in the grip of an obesity epidemic.

The Obesity Epidemic

The word *epidemic* conjures up images of polio, plague, flu, measles — a host of contagious illnesses that pass more or less easily from one person to another.

But does obesity qualify? Maybe.

In 2007, Nicholas Christakis, who teaches sociology at Harvard, and James Fowler, a political scientist at the University of California, San Diego, suggested in *The New England Journal of Medicine* that gaining weight may be a "socially contagious" event. In other words, people in groups tend to adopt similar behavior, and gaining or losing weight in tandem with friends and relatives may be one of those activities.

To reach this conclusion, Christakis and Fowler had analyzed more than 30 years' worth of information for more than 12,000 volunteers in the famed Framingham Heart Study, the project that has tracked the incidence and causes of heart disease in a Massachusetts city since 1948.

The Framingham people were weighed during checkups every two to four years. When Christakis and Fowler toted up the results, they discovered that the risk of becoming obese rose nearly 60 percent for someone with an obese friend, 40 percent for someone with an obese brother or sister, and 37 percent for someone whose husband or wife is obese. And these people didn't even have to live close to each other for the risk to rise: The co-incidence of obesity existed even when the subjects lived in different cities.

And here's a fascinating factoid: Other studies show that you can actually pinpoint the places where Americans are most likely to be overweight on a map of the United States.

The Obesity Map

For several years, *Men's Health* magazine has rated the top fattest and fittest (leanest) cities in the United States. To do these rankings, *Men's Health* looks at

- The percentage of the city's population that is overweight
- The percentage of people in the city who have been diagnosed with Type 2 diabetes

- The percentage of residents who haven't left the couch in a month (the figures comes from the CDC Behavioral Risk Factor Surveillance System, an ongoing telephone survey)
- The amount of money these people spend on junk food as reported by the Bureau of Labor Statistics)
- The number of people who ate fast food nine or more times in a month

Then the editors crunch the numbers to come up with the list of the fattest and fittest cities. The 2010 version is in Table 4-1.

Table 4-1 The Ten Fattest and Leanest U.S. Cities

Fattest Cities (Fattest First)	*Leanest Cities (Leanest First)*
Corpus Christi	San Francisco
Charleston (WV)	Burlington
El Paso	Washington, D.C.
Dallas	Seattle
Memphis	Austin
Kansas City (MO)	Albuquerque
San Antonio	Portland (OR)
Baltimore	Cincinnati
Houston	Denver
Birmingham	Aurora (CO)

Source: " America's Fattest Cities," Men's Health, May 2010. `www.menshealth.com/fattestcities2010`

You may want a more global picture of who's fat and who's not, in which case you will be pleased to hear that The Trust for America's Health and the Robert Woods Johnson Foundation have collected data from the CDC to produce that list (see Table 4-2).

What do the fattest cities and states have in common? According to Michael Wimberly of the Geographic Information Science Center of Excellence at South Dakota State University, the people living there are less likely to engage in physical activity, less likely to eat five servings of fruits and veggies a day, more likely to eat the "wrong" foods, and likely to be living somewhere pretty far away from a really good supermarket. Wimberly calls this an *obesogenic environment,* a situation that encourages weight gain.

Do you live in one of the 30 states not included in Table 4-2? Not to worry. Type this address into your search bar to access an interactive map of the United States with the appropriate stats per state: `http://healthyamericans.org/reports/obesity2010`.

Table 4-2 The Fattest and Leanest U.S. States

Fattest State	*% of Adults Who Are Obese*	*Leanest State*	*% of Adults Who Are Obese*
Mississippi	33.8	Colorado	19.1
Alabama	31.6	Connecticut	21.4
Tennessee	31.6	Washington, D.C.	21.5
West Virginia	31.3	Massachusetts	31.7
Louisiana	31.2	Hawaii	22.6
Oklahoma	30.6	Vermont	22.8
Kentucky	30.5	Rhode Island	22.0
Arkansas	30.1	Utah	23.2
South Carolina	29.9	Montana	23.5
North Carolina	29.4	New Jersey	23.9
Michigan	29.4		

Source: Trust for America's Health & Robert Woods Johnson Foundation, "F as in Fat: How Obesity Threatens America's Future," June 2010. `http://healthyamericans.org/reports/obesity2010`

How Much Should You Really Weigh?

Through the years, many health organizations ranging from insurance companies to the U.S. federal government have created charts and tables purporting to establish *healthy weight* standards for adult Americans.

Some of these efforts set the figures so low that you can hardly get there without severely restricting your diet — or being born again with a different body, preferably with light bones and no curves.

Others are more reasonable.

Weight charts and tables

In 1959, the Metropolitan Life Insurance Company published the first set of standard weight charts. The weights were drawn from insurance statistics showing what the healthiest, longest-living people weighed — with clothes on and (for the women) wearing shoes with one-inch heels. The problem? At the time, the class of people with insurance was so small and so narrow that it was hard to say with certainty that their weight could predict healthy poundage for the rest of the population.

Thirty-one years later, the government published the weight chart shown in Table 4-3. This moderate, eminently usable set appeared in the 1990 edition of *Dietary Guidelines for Americans* produced by the U.S. Department of Agriculture and the U.S. Department of Health and Human Services. The weights are listed in ranges for both men and women of specific heights. Here, height is measured without shoes, and weight is measured without clothes. (For more on the latest Dietary Guidelines, see Chapter 16.)

Because most people gain some weight as they grow older, the people who compiled these recommendations did a really sensible thing, dividing the ranges into two broad categories, one for people age 19 to 34, the other for those age 35 and older.

Obviously, individuals with a small frame and proportionately more fat tissue than muscle tissue (muscle is heavier than fat) are likely to weigh in at the low end. People with a large frame and proportionately more muscle than fat are likely to weigh in at the high end. As a general (but by no means invariable) rule, that means that women — who have smaller frames and less muscle — weigh less than men of the same height and age.

Later editions of the Dietary Guidelines omitted the higher weight allowances for older people, so that the "healthy" weights for everyone, young or old, became the ones listed in 1990 in the column for 19- to 34-year-olds. I'm going to go out on a limb here to say that I prefer the 1990 recommendations because they are

- Achievable without constant dieting
- Realistic about how your body changes as you get older
- Less likely to make you totally crazy about your weight

Which is a pretty good description of how nutritional guidelines need to work, don't you think?

Table 4-3 How Much Should You Weigh?

Height	*Weight (Pounds) for 19- to 34-Year-Olds*	*Weight (Pounds) for 35-Year-Olds and Older*
5'	97–128	108–138
5'1"	101–132	111–143
5'2"	104–137	115–148
5'3"	107–141	119–152
5'4"	111–146	122–157
5'5"	114–150	126–162
5'6"	118–155	130–167
5'7"	121–160	134–172
5'8"	125–164	138–178
5'9"	129–169	142–183
5'10"	132–174	146–188
5'11"	136–179	151–194
6'	140–184	155–199
6'1"	144–189	159–205
6'2"	148–195	164–210
6'3"	152–200	168–216
6'4"	156–205	173–222
6'5"	160–211	177–228
6'6"	164–216	182–234

Nutrition and Your Health: Dietary Guidelines for Americans, 3rd ed. (Washington D.C.: U.S. Department of Agriculture, U.S. Department of Health and Human Services, 1990)

The BMI: Another way to rate your weight

The *Body Mass Index* (BMI) is a number that measures the relationship between your weight and your height.

In the United States, a BMI below 18.5 is currently considered underweight, 18.5–24.9 is normal, 25.0–29.9 is overweight, 30.0 to 39.9 is obese, and 40.00 or greater is severely obese. Previously, other countries were slightly more lenient in their estimate of normal and overweight (for example, in Australia, a BMI of less than 20 was considered underweight). Today, the American standards are generally accepted around the world.

The equation used to calculate your BMI is called the *Quetelet Index,* named after the 19th century Belgian mathematician and astronomer who invented the concept of “the average man” (see the sidebar in this section). The equation is W/H^2, which originally meant weight (in kilograms) divided by height (in meters, squared).

To figure your BMI, divide your weight (in pounds) by your height (in inches, squared). The new equation looks like this:

$$W/H^2 \times 705$$

For example, if you are 5’3” tall and weigh 138 pounds, the equation for your BMI looks like this:

$$BMI = W/H^2 \times 705$$

$$= (138 \text{ pounds}/63 \times 63 \text{ inches}) \times 705$$

$$= (138/3{,}969) \times 705$$

$$= 24.5 \text{ BMI}$$

TIP

Or you could just run your finger down the table in Figure 4-1, which does the math for men and women from 4’10” to 6’4” tall, weighing 91 to 443 pounds.

The man who invented the average man

Lambert Adolphe Jacques Quetelet (1795–1874) was a Belgian mathematician, astronomer, statistician, and sociologist who invented the concept of the *homme moyen* (middle man), the average Joe who stands at the center of any bell curve.

Quetelet’s main concern was predicting criminal behavior. To this end, he hoped to develop statistical patterns based on a person’s deviation from average (read: normal) social behavior that could be used to predict his actions including moral (good) and criminal (bad) behavior. While this idea provoked many lively discussions among 19th-century social scientists, it never really worked as a crime-fighting tool. But it is extremely useful in estimating health risks.

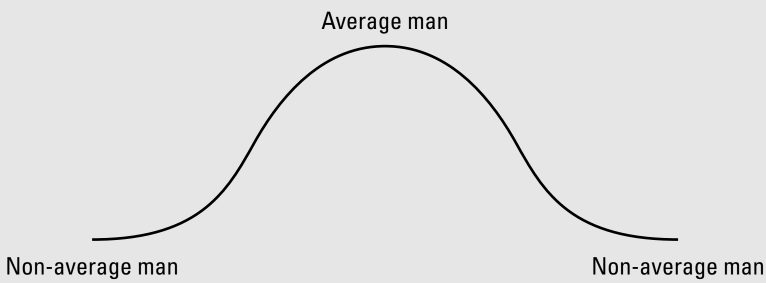


Figure 4-1: Calculating your BMI the easy way.

Body Mass Index Table

	Normal						Overweight					Obese									
BMI	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**
Height (inches)																Body Weight (pounds)					
58	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167	172	177	181	186
59	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173	178	183	188	193
60	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179	184	189	194	199
61	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185	190	195	201	206
62	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191	196	202	207	213
63	107	113	118	124	130	135	141	146	152	158	163	169	175	180	186	191	197	203	208	214	220
64	110	116	122	128	134	140	145	151	157	163	169	174	180	186	192	197	204	209	215	221	227
65	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234
66	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216	223	229	235	241
67	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223	230	236	242	249
68	125	131	138	144	151	158	164	171	177	184	190	197	203	210	216	223	230	236	243	249	256
69	128	135	142	149	155	162	169	176	182	189	196	203	209	216	223	230	236	243	250	257	263
70	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243	250	257	264	271
71	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250	257	265	272	279
72	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258	265	272	279	287
73	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265	272	280	288	295
74	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272	280	287	295	303
75	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279	287	295	303	311
76	156	164	172	180	189	197	205	213	221	230	238	246	254	263	271	279	287	295	304	312	320

	Extreme Obesity														
BMI	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**
Height (inches)															
58	191	196	201	205	210	215	220	224	229	234	239	244	248	253	258
59	198	203	208	212	217	222	227	232	237	242	247	252	257	262	267
60	204	209	215	220	225	230	235	240	245	250	255	261	266	271	276
61	211	217	222	227	232	238	243	248	254	259	264	269	275	280	285
62	218	224	229	235	240	246	251	256	262	267	273	278	284	289	295
63	225	231	237	242	248	254	259	265	270	278	282	287	293	299	304
64	232	238	244	250	256	262	267	273	279	285	291	296	302	308	314
65	240	246	252	258	264	270	276	282	288	294	300	306	312	318	324
66	247	253	260	266	272	278	284	291	297	303	309	315	322	328	334
67	255	261	268	274	280	287	293	299	306	312	319	325	331	338	344
68	262	269	276	282	289	295	302	308	315	322	328	335	341	348	354
69	270	277	284	291	297	304	311	318	324	331	338	345	351	358	365
70	278	285	292	299	306	313	320	327	334	341	348	355	362	369	376
71	286	293	301	308	315	322	329	338	343	351	358	365	372	379	386
72	294	302	309	316	324	331	338	346	353	361	368	375	383	390	397
73	302	310	318	325	333	340	348	355	363	371	378	386	393	401	408
74	311	319	326	334	342	350	358	365	373	381	389	396	404	412	420
75	319	327	335	343	351	359	367	375	383	391	399	407	415	423	431
76	328	336	344	353	361	369	377	385	394	402	410	418	426	435	443

Source: Adapted from *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report.*

Adapted from Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report.

High-tech fat figuring

A tape measure or a weight chart is a low-tech tool anyone can handle. But science loves complexity, so weight experts have several complicated ways to figure out if you're fat. Here are three of the most interesting. *Caveat:* These are not your handy home tests — they're performed in some doctor's office, but more likely in a research hospital or bariatric clinic.

Bioelectric impedance. Your body is full of fluids packed with *electrolytes,* such as sodium and potassium, ions that conduct the electrical impulses that send messages back and forth among your cells. Muscle tissue contains more fluid than fat tissue, so a body with more muscle than fat is less resistant to an outside electrical current. To measure your body's resistance to electrical current (a phenomenon known as *impedance*), the technician conducting the test places electrodes at your wrists and ankles and zaps a harmless low-intensity electrical current through. Then, she calculates how resistant your tissues were to the current. The final number indicates how much body fat you have.

The Bod Pod. This egg-shape chamber measures how much air you displace when you step in. Because muscle is more dense than body fat and displaces more air, the tech running the test can calculate the amount of fat in your body by looking at your weight and then at the amount of air you push aside when you enter the chamber.

Dual Energy X-Ray Absorptiometry (DEXA). This test uses X-rays to measure muscle, bone, and body fat. The test — which takes about 10 minutes — produces an image of the tissues that allows the tech to estimate the amount of body fat.

Surprise: The "normal" weights on this chart are within a pound or two of the healthful weights proposed for people younger than 35 in the 1990 *Dietary Guidelines for Americans.*

How Reliable Are the Numbers?

Weight charts and tables and numbers and stats are so plentiful that you may think they're totally reliable in predicting who's healthy and who's not. They aren't. Real people and their real differences keep sneaking into the equation.

For example, BMI is not a reliable guide for

- Women who are pregnant or nursing
- People who are very tall or very short
- Professional athletes or weight trainers with very well-developed muscle tissue. ***Remember:*** Muscle weighs more than fat, so a person with lots of muscle tissue may have a higher BMI and still be really healthy.

In addition, the value of the Body Mass Index in predicting your risk of illness appears to be tied to your age. If you're in your 30s, a lower BMI is clearly linked to better health. If you're in your 70s or older, no convincing evidence points to your weight playing a significant role in determining how healthy you are or how much longer you'll live. In between, from age 30 to age 74, the relationship between your BMI and your health is, well, in between — more important early on, less important later in life.

Increasing the odds of accuracy

To make the BMI a more accurate tool for predicting the health risks of carrying extra weight, the National Institutes of Health suggests adding a second measurement, the waist circumference — in other words, the apple/pear test.

If you look like an apple, with a lot of fat around your waist rather than around your hips (the pear shape), your risk of diabetes, high blood pressure, and heart disease go up. (And, yes, some people are neither apples nor pears, simply humans with relatively flat tummies and hips.)

To figure out which one you are, wrap a measuring tape around your middle, just above your hip bones. Take a deep breath. Let it out. Measure. That's your waist. Table 4-4 shows the relative risks associated with different waist measurements.

Table 4-4 Estimated Risk of Type 2 Diabetes, Hypertension, and Heart Disease Linked to BMI and Waist Size

	BMI	*Risk at Waist size <40 Inches (Men), <35 Inches (Women)*	*Risk at Waist Size >40 Inches (Men), >35 Inches (Women)*
Underweight	<18.5	—	—
Normal	19–24.9	—	—
Overweight	25–29.9	Increased	High
Obese	30–34.9	High	Very high
	35–39.9	Very high	Very high
	>40	Extremely high	Extremely high

Source: National Heart, Lung and Blood Institute, National Institutes of Health, `www.nhlbi.nih.gov/health/public/heart/obesity/lose_wt/bmi_dis.htm`.

Confounding the predictions

Although an increasing number of Americans should work at losing weight, the fact is that many larger people, even people who are clearly obese, do live long, happy, and healthy lives.

To figure out why some overweight people's health status does not follow the "rules," many nutrition scientists now focus on the importance of *confounding variables,* sciencespeak for "something else is going on here."

Here are three potential confounding variables in the obesity/health equation:

- Maybe people who are overweight are more prone to illness because they exercise less, in which case stepping up the workouts may reduce the perceived risk of being overweight.
- People who are overweight may be more likely to be sick because they eat lots of foods containing high-calorie ingredients, such as saturated fat, that can trigger adverse health effects; in this case, the remedy may simply be a change in diet.
- Maybe people who are overweight have a genetic predisposition to a serious disease. If that's true, you'd have to ask whether losing 20 pounds really reduces their risk of disease to the level of a person who is naturally 20 pounds lighter. Perhaps not: In a few studies, people who successfully lost weight actually had a higher rate of death.

Seeing red flags on weight and health

Regardless of your BMI, the risk of health problems rises if you have

- High blood pressure
- High levels of LDL ("bad") cholesterol
- Low levels of HDL ("good") cholesterol
- High levels of triglycerides (a kind of fat found in blood)
- A family history of premature heart disease, meaning one or more close relatives who suffered a heart attack before age 50 for a man or age 60 for a woman
- Not being physically active or being a smoker

If the profile fits, check with your doctor about a sensible weight loss plan.

Facing the Numbers When They Don't Fit Your Body

Right about here, you probably feel the strong need for a really big chocolate bar — not such a bad idea now that nutritionists have discovered that dark chocolate is rich in disease-fighting antioxidants that benefit your various organs (so long as you stick to a 1-ounce daily "dose").

But it makes sense to consider the alternative — realistic rules that enable you to control your weight safely and effectively.

- **Rule No. 1: Not everybody starts out with the same set of genes — or fits into the same pair of jeans.** Some people are naturally larger and heavier than others. If that's you, and all your vital stats satisfy your doctor, don't waste time trying to fit someone else's idea of perfection. Relax and enjoy your own body.
- **Rule No. 2: If you're overweight and your doctor agrees with your decision to diet, you don't have to set world records to improve your health.** Even a moderate drop in poundage can be highly beneficial. According to *The New England Journal of Medicine* (`www.nejm.org` on the Net), losing just 10 to 15 percent of your body weight can lower high blood sugar, high cholesterol, and high blood pressure, reducing your risks of diabetes, heart disease, and stroke.
- **Rule No. 3: The number you really need to remember is 3,500, the number of calories it takes to gain or lose one pound of body fat.** In other words, 3,500 food calories equal one pound of body weight. So if you simply
  - Cut your calorie consumption from 2,000 calories a day to 1,700 and continue to do the same amount of physical work, you'll lose one pound of fat in just 12 days.
  - Go the other way, increasing calories from 1,700 to 2,000 a day without increasing the amount of work you do, 12 days later you'll be one pound heavier.

- **Rule No.4: Moderation is the best path to weight control.** Moderate calorie deprivation on a sensible diet produces healthful, moderate weight loss; this diet includes a wide variety of different foods containing sufficient amounts of essential nutrients. Abusing this rule and cutting calories to the bone can turn you literally into skin and bones, depriving you of the nutrients you need to live a normal healthy life. For more on the potentially devastating effects of starvation, voluntary and otherwise, check out Chapter 14.
- **Rule No. 5: Be more active.** Exercise allows you to take in more calories and still lose weight. In addition, exercise reduces the risk of many health problems, such as heart disease. Sounds like a recipe for success.

Snooze to lose

Two 2010 studies, one at the University of Chicago Medical Center and the other at the Division of Sleep Medicine at Brigham and Women's Hospital and Beth Israel Deaconess Medical Center in Boston, link sleep deprivation to weight gain. In the first study, dieters who had a full 7 to 8 hours of sleep each night lost fat when they lost weight. In the second study, teenagers who slept fewer than eight hours a night ate more fatty foods than did those who caught a full night's sleep.

Why? Some believe the answer may lie in the sleep-satisfied body's ability to regulate hormones that control appetite, but conclusive evidence must wait for another study.

In the meantime, here's a motto for the weight conscious: 40 winks or 40 pounds.

Chapter 5

How Much Nutrition Do You Need?

In This Chapter

- Defining the Recommended Dietary Allowances (RDAs)
- Explaining the Adequate Intake (AI)
- Taking a new look at nutrition numbers with the Dietary Reference Intake (DRI)
- Defining the terms used to describe amounts of vitamins and minerals in your dietary

A healthful diet provides sufficient amounts of all the nutrients that your body needs. The question is, how much is enough?

Today, three sets of recommendations provide the answers, and each comes with its own virtues and deficiencies. The first, and most familiar, is the *RDA* (short for *Recommended Dietary Allowance*). The second, originally known as the *Estimated Safe and Adequate Daily Dietary Intakes (ESADDI),* now shortened to *Adequate Intake* or simply *AI,* describes recommended amounts of nutrients for which no RDAs exist. The third is the *DRI (Dietary Reference Intake),* an umbrella term that includes RDAs plus several innovative categories of nutrient recommendations.

Confused? Not to worry. This chapter spells it all out.

RDAs: Guidelines for Good Nutrition

The Recommended Dietary Allowances (RDAs) were created in 1941 by the Food and Nutrition Board, a subsidiary of the National Research Council, which is part of the National Academy of Sciences in Washington, D.C.

RDAs originally were designed to make planning several days' meals in advance easy for you. The *D* in RDA stands for dietary, not daily, because the RDAs are an average. You may get more of a nutrient one day and less the next, but the idea is to hit an average over several days.

For example, the current RDA for vitamin C is 75 mg for a woman and 90 mg for a man (age 18 and older). One 8-ounce glass of fresh orange juice has 120 mg vitamin C, so a woman can have an 8-ounce glass of orange juice on Monday and Tuesday, skip Wednesday, and still meet the RDA for the three days. A man may have to toss in something else — maybe a stalk of broccoli — to be able to do the same thing. No big deal.

The amounts recommended by the RDAs provide a margin of safety for healthy people, but they're not therapeutic. In other words, RDA servings won't cure a nutrient deficiency, but they can prevent one from occurring.

The essentials

RDAs offer recommendations for protein and 18 essential vitamins and minerals, a list that includes

Vitamin A	Folate	Vitamin B12
Vitamin E	Phosphorus	Vitamin K
Magnesium	Vitamin C	Iron
Thiamin (vitamin B1)	Zinc	Riboflavin (vitamin B2)
Copper	Niacin	Iodine
Vitamin B6	Selenium	

The newest essential nutrient, choline, won its wings in 2002, but no RDAs have yet been established. Calcium also has an Adequate Intake (AI) rather than an RDA.

Recommendations for carbohydrates, fats, dietary fiber, and alcohol

What nutrients are missing from the RDA list of essentials? Carbohydrates, fiber, fat, and alcohol. The reason is simple: If your diet provides enough protein, vitamins, and minerals, it's almost certain to provide enough carbohydrates and probably more than enough fat. Although no specific RDAs exist for carbohydrates and fat, guidelines definitely exist for them and for dietary fiber and alcohol.

In 1980, the U.S. Public Health Service and the U.S. Department of Agriculture joined forces to produce the first edition of *Dietary Guidelines for Americans* (see Chapter 16). A new edition of the Dietary Guidelines has been issued every five years since then to set parameters for what you can consider reasonable amounts of calories, carbohydrates, dietary fiber, fats, protein, and alcohol. According to these guidelines, several general rules advise you to

- **Balance your calorie intake with energy output in the form of regular exercise.** Check out Chapter 3 for specifics on how many calories a person of your weight, height, and level of activity (couch potato? marathon runner?) needs to consume each day.
- **Eat enough carbohydrates (primarily the complex ones from fruits, vegetables, and whole grains) to account for 45 to 65 percent of your total daily calories.** That's 900 to 1,300 calories on a 2,000-calorie diet (25 grams dietary fiber on a 2,000 calorie/day diet).
- **Keep your saturated fat intake to no more than 7 percent of your daily calories.** But to be realistic, you can consider starting with no more than 10 percent and then moving on to the more healthful lower amount. Your daily diet should have less than 300 mg cholesterol; people at risk of heart disease should lower their intake to 200 mg per day. Read the Nutrition Facts label on your food to avoid trans fats created in producing foods such as margarines. (For the skinny on saturated, unsaturated, and trans fats, plus cholesterol, check out Chapter 8.)
- **Drink alcohol only in moderation.** That means one drink a day for a woman and two for a man.

Different people, different needs

Because different bodies require different amounts of nutrients, RDAs currently address as many as 22 specific categories of human beings: boys and girls, men and women, from infancy through middle age. The RDAs recently were expanded to include recommendations for groups of people ages 50 to 70 and 70 and older. Eventually, recommendations will be made for people older than 85. These expanded groupings are a *really* good idea. In 1990, the U.S. Census counted 31.1 million Americans older than 65. By 2050, the U.S. government expects more than 60 million mostly active older citizens.

If age is important, so is gender. For example, because women of childbearing age lose iron when they menstruate, their RDA for iron is higher than the RDA for men. On the other hand, because men who are sexually active lose zinc through their ejaculations, the zinc RDA for men is higher than the zinc RDA for women. And gender affects body composition, which influences other RDAs, such as protein: The RDA for protein is set in terms of grams of protein per kilogram (2.2 pounds) of body weight. Because the average man weighs more than the average woman, his RDA for protein is higher than hers. The RDA for an adult male, age 19 or older, is 56 grams; for a woman, it's 46 grams.

AIs: The Nutritional Numbers Formerly Known as ESADDIs

In addition to the RDAs, the Food and Nutrition Board has created an *Adequate Intake* (AI) for eight nutrients considered necessary for good health, even though nobody really knows exactly how much your body needs. Not to worry: Sooner or later some smart nutrition researcher will come up with a hard number and move the nutrient to the RDA list.

You can find the AIs for biotin, choline, pantothenic acid, and vitamin D in Chapter 11, along with the requirements for other vitamins. The AIs for the minerals calcium, chromium, molybdenum, and manganese are in Chapter 12 with the other dietary minerals.

DRI: The Totally Complete Nutrition Guide

In 1993, the Food and Nutrition Board's Dietary Reference Intakes committee set up several panels of experts to review the RDAs and other recommendations for major nutrients (vitamins, minerals, and other food components) in light of new research and nutrition information.

The first order of business was to establish a new standard for nutrient recommendations called the *Dietary Reference Intake* (DRI). DRI is an umbrella term that embraces several categories of nutritional measurements for vitamins, minerals, and other nutrients. It includes

- **Estimated Average Requirement (EAR):** The amount that meets the nutritional needs of half the people in any one group (such as teenage girls or people older than 70). Nutritionists use the EAR to figure out whether an entire population's normal diet provides adequate amounts of nutrients.
- **Recommended Dietary Allowance (RDA):** The RDA, now based on information provided by the EAR, is still a daily average that meets the needs of 97 percent of a specific population, such as women age 18 to 50 or men aged 70 and older.
- **Adequate Intake (AI):** The AI is a new measurement, providing recommendations for nutrients for which no RDA is set. (***Note:*** AI replaces ESADDI.)
- **Tolerable Upper Intake Level (UL):** The UL is the highest amount of a nutrient you can consume each day without risking an adverse effect.

Reviewing terms used to describe nutrient recommendations

Nutrient listings use the metric system. RDAs for protein are listed in grams. The RDA and AIs for vitamins and minerals are shown in milligrams (mg) and micrograms (mcg). A milligram is 1⁄100 of a gram; a microgram is 1⁄100 of a milligram.

Vitamin A, vitamin D, and vitamin E are special cases. For instance, one form of vitamin A is *preformed vitamin A,* a form of the nutrient that your body can use right away. Preformed vitamin A, known as *retinol,* is found in food from animals — liver, milk, and eggs. Carotenoids (red or yellow pigments in plants) also provide vitamin A. But to get vitamin A from carotenoids, your body has to convert the pigments to chemicals similar to retinol. Because retinol is a ready-made nutrient, the RDA for vitamin A is listed in units called retinol equivalents (RE). One mcg (microgram) RE is approximately equal to 3.33 international units (IU, the former unit of measurement for vitamin A).

Vitamin D consists of three compounds: vitamin D1, vitamin D2, and vitamin D3. Cholecalciferol, the chemical name for vitamin D3, is the most active of the three, so the RDA for vitamin D is measured in equivalents of cholecalciferol.

Your body gets vitamin E from two classes of chemicals in food: tocopherols and tocotrienols. The compound with the greatest vitamin E activity is a tocopherol: *alpha*-tocopherol. The RDA for vitamin E is measured in milligrams of *alpha*-tocopherol equivalents (a-TE).

The DRI panel's first report, listing new recommendations for calcium, phosphorus, magnesium, and fluoride, appeared in 1997. Its most notable change was upping the recommended amount of calcium from 800 mg to 1,000 mg for adults ages 31 to 50 as well as post-menopausal women taking estrogen supplements; for post menopausal women not taking estrogen, the recommendation is 1,500 mg.

The DRI panel's second report appeared in 1998. The report included new recommendations for thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, pantothenic acid, biotin, and choline. The most important revision was increasing the folate recommendation to 400 mcg a day based on evidence showing that folate reduces a woman's risk of giving birth to a baby with spinal cord defects and lowers the risk of heart disease for men and women. (See the sidebar "Reviewing terms used to describe nutrient recommendations" in this chapter to brush up on your metric abbreviations.)

As a result of the 1989 DRI panel's report, the FDA ordered food manufacturers to add folate to flour, rice, and other grain products. (Multivitamin products already contain 400 mcg of folate.) In May 1999, data released by the Framingham Heart Study, which has followed heart health among residents of a Boston suburb for nearly half a century, showed a dramatic increase in blood levels of folate. Before the fortification of foods, 22 percent of the study participants had folate deficiencies; after the fortification, the number fell to 2 percent.

A DRI report with revised recommendations for vitamin C, vitamin E, the mineral selenium, beta-carotene, and other antioxidant vitamins was published in 2000. In 2001, new DRIs were released for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. In 2004, the Institute of Medicine (IOM) released new recommendations for sodium, potassium, chloride, and water, plus a special report on recommendations for two groups of older adults (ages 50 to 70 and 71 and over). By 2005, the Food and Nutrition Board had established an AI of 600 IU vitamin D for men and women older than 71. Put all these findings together, and they spell out the recommendations you find in this chapter.

Table 5-1 shows the most recent RDAs for vitamins for healthy adults; Table 5-2 shows RDAs for minerals for healthy adults. Where no RDA is given, an AI is indicated by an asterisk (*) by the column heading. The complete reports on which these tables are based are available online at `www.iom.edu/Object.File/Master/21/372/0.pdf`. (If you want an idea of what kinds of foods provide these vitamins and minerals, check out Chapters 11 and 12.)

Hankering for more details? Notice something missing? Right — no recommended allowances for protein, fat, carbohydrates, and, of course, water. You can find those (respectively) in Chapters 7, 8, 9, and 13.

Table 5-1 Vitamin RDAs for Healthy Adults

Age (Years)	*Vitamin A (RE/IU)†*	*Vitamin D (mcg/IU)‡**	*Vitamin E (a-TE)*	*Vitamin K (mcg)**	*Vitamin C (mg)*
Males					
19–30	900/2,970	15/600	15	120	90
31–50	900/2,970	15/600	15	120	90
51–70	900/2,970	15/600	15	120	90
Older than 70	900/2,970	20/800	15	120	90
Females					
19–30	700/2,310	15/600	15	90	75
31–50	700/2,310	15/600	15	90	75
51–70	700/2,310	15/600	15	90	75
Older than 70	700/2,310	20/900	15	90	75

** Adequate Intake (AI)*
† The "official" RDA for vitamin A is still 1,000 RE/5,000 IU for a male, 800 RE/4,000 IU for a female who isn't pregnant or nursing; the lower numbers listed on this chart are the currently recommended levels for adults.
‡ The current recommendations are the amounts required to prevent vitamin D deficiency disease; recent studies suggest that the optimal levels for overall health may actually be higher, in the range of 800–1,000 IU a day.

Age (years)	Thiamin (Vitamin B1) (mg)	Riboflavin (Vitamin B2) (mg)	Niacin (NE)	Pantothenic acid (mg)*	Vitamin B6 (mg)	Folate (mcg)	Vitamin B12 (mcg)	Biotin (mcg)*
Males								
19–30	1.2	1.3	16	5	1.3	400	2.4	30
31–50	1.2	1.3	16	5	1.3	400	2.4	30
50–70	1.2	1.3	16	5	1.7	400	2.4	30
Older than 70	1.2	1.1	16	5	1.7	400	2.4	30
Females								
19–30	1.1	1.1	14	5	1.3	400	2.4	30
31–50	1.1	1.1	14	5	1.3	400	2.4	30
51–70	1.1	1.1	14	5	1.5	400	2.4	30
Older than 70	1.1	1.1	14	5	1.5	400	2.4	30
Pregnant	1.4	1.1	18	6	1.9	600	2.6	30
Nursing	1.4	1.1	17	7	2.0	500	2.8	35

* Adequate Intake (AI)

How much is that?

Nutrient amounts are measured in various units:

- g = gram
- mg = milligram = 1⁄1000th of a gram
- mcg = microgram = 1⁄1,000,000th of a gram
- IU = international unit
- RE = retinol equivalent = the amount of "true" vitamin A in an IU
- a-TE = alpha-tocopherol equivalent = the amount of alpha-tocopherol in a unit of vitamin E

Table 5-2 Mineral RDAs for Healthy Adults

Age (years)	*Calcium (mg)**	*Phosphorus (mg)*	*Magnesium (mg)*	*Iron (mg)*	*Zinc (mg)*	*Copper (mcg)*
Males						
19–30	1,000	700	400	8	11	900
31–50	1,000	700	420	8	11	900
51–70	1,200	700	420	8	11	900
Older than 70	1,200	700	420	8	11	900
Females						
19–30	1,000	700	310	18	8	900
31–50	1,000	700	320	18	8	900
51–70	1,000/1,500**	700	320	8	8	900
Older than 70	1,000/1,500**	700	320	8	8	900
Pregnant	1,000–1,300	700–1,250	350–400	27	11–12	1,000
Nursing	1,000–1,300	700–1,250	310–350	9–10	12–13	1,300

** Adequate Intake (AI)*
*** The lower recommendation is for postmenopausal women taking estrogen supplements; the higher figure is for postmenopausal women not taking estrogen supplements.*

Age (years)	*Iodine (mcg)*	*Selenium (mcg)*	*Molybdenum (mcg)*	*Manganese (mg)**	*Fluoride (mg)**	*Chromium (mcg)**	*Choline (mg)**
Males							
19–30	150	55	45	2.3	4	36	550
31–50	150	55	45	2.3	4	36	550
51–70	150	55	45	2.3	4	30	550
Older than 70	150	55	45	2.3	4	30	550
Females							
19–30	150	55	45	1.8	3	25	425
31–50	150	55	45	1.8	3	25	425
51–70	150	55	45	1.8	3	20	425
Older than 70	150	55	45	1.8	3	20	425
Pregnant	220	60	50	2.0	1.5–4.0	29–30	450
Nursing	290	70	50	2.6	1.5–4.0	44–45	550

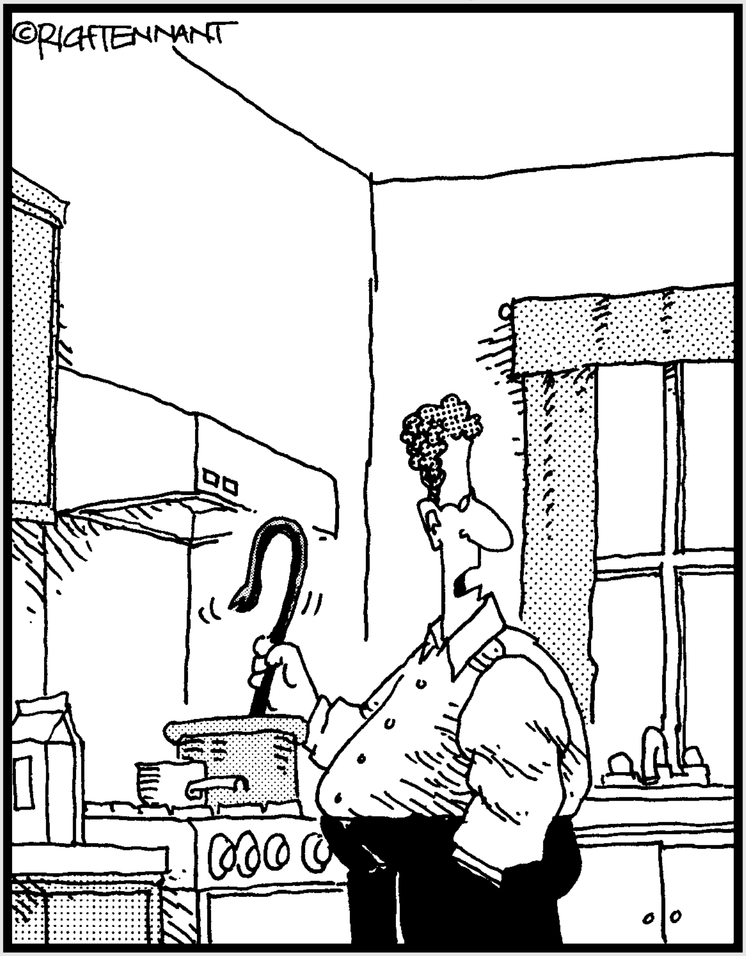
**Adequate Intake (AI)*
Adapted with permission from Recommended Dietary Allowances (Washington D.C.: National Academy Press, 1989), and DRI panel reports, 1997–2004

No Sale Ever Is Final

The slogan “No Sale Ever Is Final,” printed on the sales slips at one of my favorite clothing stores, definitely applies to nutritional numbers. RDAs, AIs, and DRIs should always be regarded as works in progress, subject to revision at the first sign of a new study. In other words, in an ever-changing world, here’s one thing of which you can be *absolutely* certain: The numbers in this chapter will change. Sorry about that.

Part II
What You Get from Food

The 5th Wave By Rich Tennant



"I'm not sure we're getting enough iron in our diet, so I'm stirring the soup with a crowbar."

In this part . . .

This part is an up-to-the-minute guide to nutrients you've heard about practically forever: protein, fat, carbohydrates, alcohol, vitamins, minerals, and water. This part provides the newest numbers available on how each works and how much of each one you need to keep your body humming happily.

Because this is a *For Dummies* book, you don't have to read straight through from protein to water to see how things work. You can skip from chapter to chapter, back and forth, side to side. Any way you take it, this part is bound to clue you in to the value of the nutrients in food.

Chapter 7

Powerful Protein

In This Chapter

- Defining proteins
- Finding the proteins in your body
- Getting the best quality protein from food
- Deciding how much protein you need

Protein is an essential nutrient whose name comes from the Greek word *protos,* which means "first." To visualize a molecule of protein, close your eyes and see a very long chain, rather like a chain of sausage links. The links in the chains are *amino acids,* commonly known as the building blocks of protein. In addition to carbon, hydrogen, and oxygen atoms, amino acids contain a nitrogen (amino) group. The *amino group* is essential for synthesizing (assembling) specialized proteins in your body.

In this chapter, you can find out more — maybe even more than you ever wanted to know — about this molecule, how your body uses the proteins you take in as food, and how the body makes some special proteins you need for a healthy life.

How Your Body Uses Proteins

Your body uses proteins to build new cells, maintain tissues, and synthesize new proteins that make it possible for you to perform basic bodily functions.

The human body is chock-full of proteins. Proteins are present in the outer and inner membranes of every living cell. Here's where else protein makes an appearance:

- Your hair, your nails, and the outer layers of your skin are made of keratin, a *scleroprotein,* or a protein resistant to digestive enzymes. If you bite your nails, you can't digest them.
- Muscle tissue contains *myosin, actin, myoglobin,* and a number of other proteins.

- Bone's outer layer is hardened with minerals such as calcium, but the basic, rubbery inner structure is protein; and bone marrow, the soft material inside the bone, is also protein-rich.
- Red blood cells contain *hemoglobin,* a protein compound that carries oxygen throughout the body. *Plasma,* the clear fluid in blood, contains fat and protein particles known as *lipoproteins,* which ferry cholesterol around and out of the body.

About half the dietary protein that you consume each day goes into making *enzymes,* the specialized worker proteins that do specific jobs such as digesting food and assembling or dividing molecules to make new cells and chemical substances. To perform these functions, enzymes often need specific vitamins and minerals.

Your ability to see, think, hear, and move — in fact, to do just about everything that you consider part of a healthy life — requires your nerve cells to send messages back and forth to each other and to other specialized kinds of cells, such as muscle cells. Sending these messages requires chemicals called *neurotransmitters.* Making neurotransmitters requires proteins.

Finally, proteins play an important part in the creation of every new cell and every new individual. Your chromosomes consist of *nucleoproteins,* which are substances made of amino acids and nucleic acids. (See the "DNA/RNA" sidebar in this chapter for more information about nucleoproteins.)

DNA/RNA

Nucleoproteins are chemicals in the nucleus of every living cell. They're made of proteins linked to *nucleic acids* — complex compounds that contain phosphoric acid, a sugar molecule, and nitrogen-containing molecules made from amino acids.

Nucleic acids (molecules found in the chromosomes and other structures in the center of your cells) carry the genetic codes, the genes that help determine what you look like, your general intelligence, and who you are. They also contain one of two sugars, either *ribose* or *deoxyribose.* The nucleic acid containing ribose is called *ribonucleic acid* (RNA). The nucleic acid containing deoxyribose is called *deoxyribonucleic acid* (DNA).

DNA is a very long molecule with two strands twisting about each other (the *double helix*); it carries and transmits the genetic inheritance in your chromosomes. DNA's job is to provide instructions that determine how your body cells are formed and how they behave. RNA, a single-strand molecule, is created in the cell nucleus according to the pattern determined by the DNA. Then RNA carries the DNA's instructions to the rest of the cell,

DNA is the most distinctly "you" thing about your body. Chances that another person on Earth has exactly the same DNA as you are really small. That's why DNA analysis is so valuable in identifying individuals in various situations. Most commonly, this means criminal behavior, but some now propose that parents store a sample of their children's DNA to have a conclusive way of identifying a missing child, even years later.

How the Proteins You Eat Move Into Your Cells

The cells in your digestive tract can absorb only single amino acids or very small chains of two or three amino acids called *peptides.* So proteins from food are broken into their component amino acids by digestive enzymes — which are, of course, specialized proteins. Then other enzymes in your body cells build new proteins by reassembling the amino acids into specific compounds that your body needs to function. This process is called *protein synthesis.* During protein synthesis

- Amino acids hook up with fats to form *lipoproteins,* the molecules that ferry cholesterol around and out of the body. Or amino acids may join up with carbohydrates to form the *glycoproteins* found in the mucus secreted by the digestive tract.
- Proteins combine with phosphoric acid to produce *phosphoproteins,* such as casein, a protein in milk.
- Nucleic acids combine with proteins to create *nucleoproteins,* which are essential components of the cell nucleus and of cytoplasm, the living material inside each cell.

The carbon, hydrogen, and oxygen that are left over after protein synthesis is complete are converted to glucose and used for energy. The nitrogen residue (ammonia) isn't used for energy. It's processed by the liver, which converts the ammonia to urea. Most of the urea produced in the liver is excreted through the kidneys in urine; very small amounts are sloughed off in skin, hair, and nails.

Every day, you *turn over* (reuse) more proteins than you get from the food you eat, so you need a continuous supply to maintain your protein status. If your diet does not contain sufficient amounts of proteins, you start digesting the proteins in your body, including the proteins in your muscles and — in extreme cases — your heart muscle.

Differentiating Dietary Proteins

All the proteins in your food are made of building blocks called amino acids, but not all proteins contain all the amino acids you require. This section helps you figure out how you can get the most useful proteins from your varied diet.

Essential and nonessential proteins

To make all the proteins that your body needs, you require 22 different amino acids. Ten are considered *essential,* which means you can't synthesize them in your body and must obtain them from food. (Two of these, arginine and histidine, are essential only for children.) Several more are *nonessential:* If you don't get them in food, you can manufacture them yourself from fats, carbohydrates, and other amino acids. Three — glutamine, ornithine, and taurine — are somewhere in between essential and nonessential for human beings: They're essential only under certain conditions, such as with injury or disease.

Essential Amino Acids	***Nonessential Amino Acids***
Arginine*	Alanine
Histidine*	Asparagine
Isoleucine	Aspartic acid
Leucine	Citrulline
Lysine	Cysteine
Methionine	Glutamic acid
Phenlyalanine	Glycine
Threoniwne	Hydroxyglutamic acid
Tryptophan	Norleucine
Valine	Proline
	Serine
	Tyrosine

** Essential for children; nonessential for adults*

High-quality and low-quality proteins

Because an animal's body is similar to yours, its proteins contain similar combinations of amino acids. That's why nutritionists call proteins from foods of animal origin — meat, fish, poultry, eggs, and dairy products — *high-quality proteins.* Your body absorbs these proteins more efficiently; they can be used without much waste to synthesize other proteins. The proteins from plants — grains, fruit, vegetables, legumes (beans), nuts, and seeds — often have limited amounts of some essential amino acids, which means their nutritional content is not as high as animal proteins.

Super soy: The special protein food

Nutrition fact No. 1: Food from animals has complete proteins. **Nutrition fact No. 2:** Vegetables, fruits, and grains have incomplete proteins. **Nutrition fact No. 3:** Nobody told the soybean.

Unlike other vegetables, including other beans, soybeans have complete proteins with sufficient amounts of all the amino acids essential to human health. In fact, food experts rank soy proteins on par with egg whites and casein (the protein in milk), the two proteins easiest for your body to absorb and use (see Table 7-1).

Some nutritionists think soy proteins are even better than the proteins in eggs and milk, because the proteins in soy come with no cholesterol and very little of the saturated fat known to clog your arteries and raise your risk of heart attack. Better yet, more than 20 recent studies suggest that adding soy foods to your diet can actually lower your cholesterol levels.

One-half cup (4 ounces) of cooked soybeans has 14 grams of protein; 4 ounces of tofu has 13. Either serving gives you approximately twice the protein you get from one large egg or one 8-ounce glass of skim milk, or two-thirds the protein in 3 ounces of lean ground beef. Eight ounces of fat-free soy milk has 7 grams protein — a mere 1 gram less than a similar serving of skim milk — and no cholesterol. Soybeans are also jam-packed with dietary fiber, which helps move food through your digestive tract.

The basic standard against which you measure the value of proteins in food is the egg. Nutrition scientists have arbitrarily given the egg a *biological value* of 100 percent, meaning that, gram for gram, it's the food with the best supply of complete proteins. Other foods that have proportionately more protein may not be as valuable as the egg because they lack sufficient amounts of one or more essential amino acids.

For example, eggs are 11 percent protein, and dry beans are 22 percent protein. However, the proteins in beans don't provide sufficient amounts of *all* the essential amino acids, so they (the beans) are not as nutritionally complete as proteins from animal foods. The prime exception is the soybean, a legume that's packed with abundant amounts of all of the amino acids essential for adults. Soybeans are an excellent source of proteins for vegetarians, especially *vegans,* which are vegetarians who avoid all products of animal origin, including milk and eggs.

The term used to describe the value of the proteins in any one food is *amino acid score.* Because the egg contains all the essential amino acids, it scores 100. Table 7-1 shows the protein quality of representative foods relative to the egg.

Table 7-1 Scoring the Amino Acids in Food

Food	*Protein Content (Grams)*	*Amino Acid Score (Compared to the Egg)*
Egg	33	100
Fish	61	100
Beef	29	100
Milk (cow's whole)	23	100
Soybeans	29	100
Dry beans	22	75
Rice	7	62–66
Corn	7	47
Wheat	13	50
Wheat (white flour)	12	36

Nutritive Value of Foods (Washington, D.C.: U.S. Department of Agriculture, 1991); George M. Briggs and Doris Howes Calloway, Nutrition and Physical Fitness, 11th ed. (New York: Holt, Rinehart and Winston, 1984)

Complete proteins and incomplete proteins

Another way to describe the quality of proteins is to say that they're either complete or incomplete. A *complete protein* is one that contains ample amounts of all essential amino acids; an *incomplete protein* does not. A protein low in one specific amino acid is called a *limiting protein* because it can build only as much tissue as the smallest amount of the necessary amino acid. You can improve the protein quality in a food containing incomplete/limiting proteins by eating it along with one that contains sufficient amounts of the limited amino acids.

Matching foods to create complete proteins is called *complementarity,* a concept first popularized by Frances Moore Lappe in her bestselling book, Diet for a Small Planet (1971). Moore's intent was to convince people to become vegetarians or at least to increase the amount of plant foods in their diets while decreasing the amount of foods from animals so as to conserve energy and reduce the overall cost of producing food.

MYTH BUSTER

The lowdown on gelatin and your fingernails

Everyone knows that gelatin is a protein that strengthens fingernails. Too bad *everyone's* half-wrong.

Yes, gelatin is protein, and yes, protein makes nails strong. But, not the incomplete protein in gelatin, a food made by treating animal bones with acid, thus destroying the essential amino acid tryptophan.

Luckily, you can improve the protein value of gelatin by slicing a banana onto the dish (bananas are tryptophan-rich) and pouring on some milk (also a good source of tryptophan).

One example of complementarity is rice and beans. The rice is low in the essential amino acid lysine, and beans are low in the essential amino acid methionine. By eating rice with beans, you improve (or complete) the proteins in both. Another example is pasta and cheese. Pasta is low in the essential amino acids lysine and isoleucine; milk products have abundant amounts of these two amino acids. Shaking Parmesan cheese onto pasta creates a higher-quality protein dish. In each case, the foods have complementary amino acids. Other examples of complementary protein dishes are peanut butter with bread, and milk with cereal. Many such combinations are a natural and customary part of the diet in parts of the world where animal proteins are scarce or very expensive.

Table 7-2 shows how to combine foods to improve the quality of their proteins. Once upon a time, nutritionists insisted that you had to consume these combinations in rigorous combination — that is, in the same dish or the same meal. But time moves on, and so does nutrition knowledge. Today, those same nutritionists accept the idea that when you eat a food with incomplete proteins, the proteins hang around in your body several hours, long enough to hook up with incomplete proteins in other foods in your next meal, which certainly makes meal planning ever so much easier.

Table 7-2 How to Combine Foods to Complement Proteins

This Food	*Complements This Food*	*Examples*
Whole grains	Legumes (beans)	Rice and beans
Dairy products	Whole grains	Cheese sandwich, pasta with cheese, pancakes (wheat and milk/egg batter)
Legumes (beans)	Nuts and/or seeds	Chili soup (beans) with caraway seeds
Dairy products	Legumes (beans)	Chili beans with cheese
Dairy products	Nuts and seeds	Yogurt with chopped nut garnish

How Much Protein Do You Need?

The National Academy of Sciences Food and Nutrition Board, which sets the requirements (for example, RDAs) for vitamins and minerals, also sets goals for daily protein consumption. As with other nutrients, the board has different recommendations for different groups of people: young, older, male, and female.

Calculating the correct amount

In 2005, the Academy set a Dietary Reference Intake (DRI) of 46 grams protein per day for a healthy adult woman and 56 grams per day for a healthy adult man. (Check out Chapter 5 for a complete explanation of the DRI.)

These amounts are easily obtained from two to three 3-ounce servings of lean meat, fish, or poultry (21 grams each). Vegetarians can get their protein from 2 eggs (12–16 grams), 2 slices of packaged fat-free cheese (10 grams), 4 slices of bread (3 grams each), and one cup of yogurt (10 grams). Vegans (those who do not eat any foods from animals, including dairy products) get the protein they need from a cup of oatmeal (6 grams) with a cup of soymilk (7 grams), 2 tablespoons peanut butter (8 grams) sandwiched on one large pita (5–6 grams), 6 ounces soy milk yogurt (6 grams), 6 ounces tofu (13 grams) with 1 cup cooked brown rice (5 grams), and 1 cup steamed broccoli (5 grams).

Muscle into fat? No way

An older body synthesizes new proteins less efficiently than a younger one, so muscle mass (protein tissue) diminishes while fat content stays the same or rises. This change is often erroneously described as muscle "turning to fat." The aging body still uses protein to build new tissue, however, including hair, skin, and nails, which continue to grow until death. By the way, the idea that nails continue to grow after death — a staple of shock movies and horror comics — arises from the fact that after death, tissue around the nails shrinks, making a corpse's nails simply look longer.

For the protein values in literally thousands of servings of literally thousands of foods, check out the USDA National Nutrient Database for Standard Reference at `www.nal.usda.gov/fnic/foodcomp/search`.

Dodging protein deficiency

The first sign of protein deficiency is likely to be weak muscles — the body tissue most reliant on protein. For example, children who do not get enough protein have shrunken, weak muscles. They may also have thin hair, their skin may be covered with sores, and blood tests may show abnormally low blood levels of *albumin,* a protein that helps maintain the body's fluid balance, keeping a proper amount of liquid in and around body cells.

A protein deficiency may also affect red blood cells. The cells live for only 120 days, so the body needs a regular supply of protein to make new ones. People who do not get enough protein may become *anemic,* having fewer red blood cells than they need. Other signs of protein deficiency are fluid retention (the big belly on a starving child), hair loss, and muscle wasting caused by the body's attempt to protect itself by digesting the proteins in its own muscle tissue, a phenomenon that explains why victims of starvation are, literally, skin and bones.

Given the high protein content of a normal American diet (which generally provides far more protein than you actually require), protein deficiency is rare in the United States except as a consequence of eating disorders such as *anorexia nervosa* (refusal to eat) and *bulimia* (regurgitation after meals).

Boosting your protein intake: Special considerations

Anyone who's building new tissue quickly needs extra protein. For example, the Dietary Reference Intake (DRI) for protein for women who are pregnant or nursing is 71 grams per day. Injuries also raise your protein requirements. An injured body releases above-normal amounts of protein-destroying hormones from the pituitary and adrenal glands. You need extra protein to protect existing tissues, and after severe blood loss, you need extra protein to make new hemoglobin for red blood cells. Cuts, burns, or surgical procedures mean that you need extra protein to make new skin and muscle cells. Fractures mean extra protein is needed to make new bone. The need for protein is so important when you've been badly injured that if you can't take protein by mouth, you'll be given an intravenous solution of amino acids with glucose (sugar) or emulsified fat.

Do athletes need more proteins than the rest of us? Recent research suggests that the answer may be yes, but athletes easily meet their requirements simply by eating more food, not necessarily increasing the amount of any specific food.

Avoiding protein overload

Yes, you can get too much protein. Several medical conditions make it difficult for people to digest and process proteins properly. As a result, waste products build up in different parts of the body.

People with liver disease or kidney disease either don't process protein efficiently into urea or don't excrete it efficiently through urine. The result may be uric acid kidney stones or *uremic poisoning* (an excess amount of uric acid in the blood). The pain associated with *gout* (a form of arthritis that affects nine men for every one woman) is caused by uric acid crystals collecting in the spaces around joints. Doctors may recommend a low-protein diet as part of the treatment in these situations.

Chapter 8

Facing Facts on Fat and Cholesterol

In This Chapter

- Defining the different kinds of fat in food
- Listing the good and bad points of dietary fat
- Explaining cholesterol's good and bad points
- Balancing the fat (and cholesterol) in your diet

The chemical family name for fats and related compounds, such as cholesterol, is *lipids,* from *lipos,* the Greek word for fat. Liquid fats are called *oils;* solid fats are called, well, *fat,* and the fat in food is called *dietary fat.*

With the exception of *cholesterol* (a fatty substance that has no calories and provides no energy), dietary fats are high-energy nutrients. Gram for gram, fats have more than twice as much energy potential (calories) as protein and carbohydrates: 9 calories per fat gram versus 4 calories per gram for the other two. (For more calorie information, see Chapter 3.)

This chapter cuts the fat away from the subject of fats and zeroes in on what you need to put together a diet with just enough fat to control your cholesterol.

How Your Body Uses Fats

Dietary fats are sources of energy that add flavor to food — the characteristic sizzle on the steak, so to speak. Unfortunately, this tasty nutrient may also be hazardous to your health. The trick is to separate the good from the bad.

What fats do for you

A healthy body needs fats to build body tissues and manufacture biochemicals, such as hormones. Some of the *adipose* (fatty) tissue in your body is plain to see. For example, even though your skin covers it, you can *see* the fat deposits in female breasts, hips, thighs, buttocks, and belly or on the male abdomen and shoulders.

This relatively visible body fat

- Provides a source of stored energy
- Gives shape to your body
- Cushions your skin (imagine sitting in a chair without your buttocks to pillow your bones)
- Acts as an insulation blanket that reduces heat loss

Other body fat is tucked away in and around your internal organs. This hidden fat is

- Part of every cell membrane (the outer skin that holds each cell together)
- A component of *myelin,* the fatty material that sheathes nerve cells and makes it possible for them to send the electrical messages that enable you to think, see, speak, move, and perform the multitude of tasks natural to a living body (Your brain is about 60 percent fat, giving a whole new meaning to the term "fat head.")
- A constituent of hormones and other biochemicals, such as vitamin D and bile
- A shock absorber that protects your organs (as much as possible) if you fall or are injured

Pulling energy from fat

Although dietary fat has more energy (calories) per gram than protein and carbohydrates, your body has a more difficult time pulling the energy out of fatty foods than out of foods high in protein and carbs.

Imagine a chain of long balloons — the kind people twist into shapes that resemble dachshunds, flowers, and other amusing things. When you drop one of these balloons into water, it floats. That's exactly what happens when you swallow fat-rich foods. The fat floats on top of the watery food-and-liquid mixture in your stomach, which limits the effects of *lipases,* the enzymes that break fats apart so you can digest them. As a result, fat is digested more slowly than proteins and carbohydrates, so you feel fuller, a condition called *satiety* (pronounced *say-ty-eh-tee*) longer after eating high-fat food.

Into the intestines

When the fat moves down your digestive tract into your small intestine, an intestinal hormone called *cholecystokinin* alerts your gallbladder to release *bile.* Bile is an emulsifier, a substance that enables fat to mix with water so that lipases can start breaking the fat into *glycerol* and *fatty acids.* These smaller fragments may be stored in special cells (fat cells) in adipose tissue, or they may be absorbed into cells in the intestinal wall, where one of the following happens:

- They're combined with oxygen (or burned) to produce heat/energy, water, and the waste product carbon dioxide.
- They're used to make lipoproteins that haul fats, including cholesterol, through your bloodstream.

Into the body

Glucose, the molecule you produce by digesting carbohydrates, is the body's basic source of energy. Burning glucose is easier and more efficient than burning fat, so your body always goes for carbohydrates first. But if you've used up all your available glucose — maybe you're stranded in a cabin in the Arctic, you haven't eaten for a week, a blizzard's howling outside, and the corner deli 500 miles down the road doesn't deliver — then it's time to start in on your body fat.

The first step is for an enzyme in your fat cells to break up stored *triglycerides* (the form of fat in adipose tissue). The enzyme action releases glycerol and fatty acids, which travel through your blood to body cells, where they combine with oxygen to produce heat/energy, plus water — lots of water — and the waste product carbon dioxide.

As anyone who has used a high-protein/high-fat/low-carb weight-loss diet such as the Atkins regimen can tell you, in addition to all that water, burning fat without glucose produces a second waste product called *ketones*. In extreme cases, high concentrations of ketones (a condition known as *ketosis*) alter the acid/alkaline balance (or pH) of your blood and may trip you into a coma. Left untreated, ketosis can lead to death. Medically, this condition is most common among people with diabetes. For people on a low-carb diet, the more likely sign of ketosis is stinky urine or breath that smells like acetone (nail polish remover).

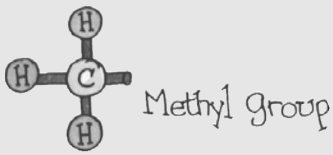
Defining fatty acids and their relationship to dietary fat

Fatty acids are the building blocks of fats. Chemically speaking, a *fatty acid* is a chain of carbon atoms with hydrogen atoms attached and a *carbon-oxygen-oxygen-hydrogen group* (the unit that makes it an acid) at one end.

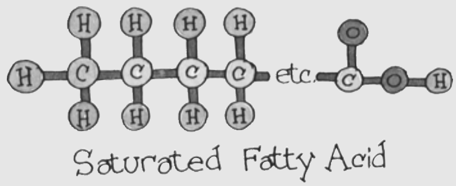
Exploring the chemical structure of fatty acids

Molecules are groups of atoms hooked together by chemical bonds. Different atoms form different numbers of bonds with other atoms. For example, a hydrogen atom can form one bond with one other atom; an oxygen atom can form two bonds with other atoms; and a carbon atom can form four bonds to other atoms.

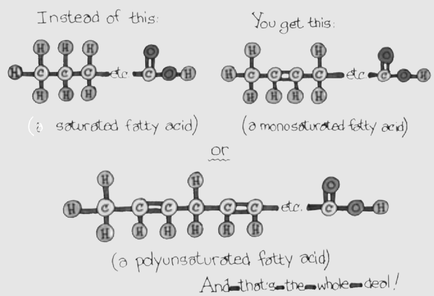
To actually see how this bonding works, visualize a carbon atom as one of those round pieces in a child's Erector set or Tinkertoy kit. Your carbon atom (C) has — figuratively speaking, of course — four holes: one on top, one on the bottom, and one on each side. If you stick a peg into each hole and attach a small piece of wood representing a hydrogen atom (H) to the pegs on the top, the bottom, and the left, you have a structure that looks like this:



This unit, called a *methyl group,* is the first piece in any fatty acid. To build the rest of the fatty acid, you add carbon atoms and hydrogen atoms to form a chain. At the end, you tack on a group with one carbon atom, two oxygen atoms, and a hydrogen atom. This group is called an *acid group,* the part that makes the chain of carbon and hydrogen atoms a fatty acid.



The preceding molecule is a *saturated fatty acid* because it has a hydrogen atom at every available carbon link in the chain. A *monounsaturated fatty acid* drops two hydrogen atoms and forms one double bond (two lines instead of one) between two carbon atoms. A *polyunsaturated fatty acid* drops more hydrogen atoms and forms several (poly) double bonds between several carbon atoms. Every hydrogen atom still forms one bond, and every carbon atom still forms four bonds, but they do so in a slightly different way. These sketches are not pictures of real fatty acids, which have many more carbons in the chain and have their double bonds in different places, but they can give you an idea of what fatty acids look like up close.



An *essential fatty acid* is one that your body needs but cannot assemble from other fats. You have to get it whole, from food. Linoleic acid, found in vegetable oils, is an essential fatty acid. Two others — linolenic acid and arachidonic acid — occupy a somewhat ambiguous position. You can't make them from scratch, but you can make them if you have enough linoleic acid on hand, so food scientists often argue about whether linolenic and arachidonic acids are actually "essential."

In practical terms, who cares? Linoleic acid is so widely available in food, you're unlikely to experience a deficiency of any of the three — linoleic, linolenic, or arachidonic acid — as long as a measly 2 percent of the calories you get each day come from fat.

Focusing on the fats in food

Food contains three kinds of fats: triglycerides, phospholipids, and sterols. Here's how they differ:

- **Triglycerides:** You use these fats to make adipose tissue to burn for energy.
- **Phospholipids:** Phospholipids are hybrids — part lipid, part phosphate (a molecule made with the mineral phosphorus) — that ferry hormones and the fat-soluble vitamins A, D, E, and K through your blood and back and forth in the watery fluid that flows across cell membranes.
- **Sterols (steroid alcohols):** These are fat and alcohol compounds with no calories. Vitamin D is a sterol. So is the sex hormone testosterone. And so is cholesterol, the base on which your body builds hormones and vitamins.

The fatty acids in food

All the fats in food are combinations of fatty acids. Nutritionists characterize fatty acids as saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), or polyunsaturated fatty acids (PUFA), depending on how many hydrogen atoms are attached to the carbon atoms in the chain. The more hydrogen atoms, the more saturated the fatty acid. Depending on which fatty acids predominate, a food fat is likewise characterized as saturated, monounsaturated, or polyunsaturated.

- A *saturated fat,* such as butter, has mostly saturated fatty acids. Saturated fats are solid at room temperature and get harder when chilled.
- A *monounsaturated fat,* such as olive oil, has mostly monounsaturated fatty acids. Monounsaturated fats are liquid at room temperature; they get thicker when chilled.
- A *polyunsaturated fat,* such as corn oil, has mostly polyunsaturated fatty acids. Polyunsaturated fats are liquid at room temperature; they stay liquid when chilled.

So why is margarine, which is made from unsaturated fats such as corn and soybean oil, a solid? Because it's been artificially saturated by food chemists who add hydrogen atoms to some of its unsaturated fatty acids. This process, known as *hydrogenation,* turns an oil, such as corn oil, into a solid fat that can be used in products such as margarines without leaking out all over the table. A fatty acid with extra hydrogen atoms is called a *hydrogenated* *fatty acid.* (*Trans fatty acids* are hydrogenated fatty acids.) Because of those extra hydrogen atoms, hydrogenated fatty acids behave like saturated fats, clogging arteries and raising the levels of cholesterol in your blood.

One answer to the problem of hydrogenated fatty acids is plant *sterols* and *stanols.* Plant sterols are natural compounds in the oils in grains, fruits, and vegetables, including soybeans. *Stanols* are compounds created by adding hydrogen atoms to sterols from wood pulp and other plant sources; the first commercial stanol food was Benecol (bene = good, col = cholesterol) spread.

Sterols and stanols work like little sponges, sopping up cholesterol in your intestines before it can make its way into your bloodstream. As a result, your total cholesterol levels and your levels of low-density lipoproteins (LDLs or "bad cholesterol") go down. In some studies, one to two 1-tablespoon servings a day of sterols and stanols can lower levels of bad cholesterol by 10 to 17 percent, with results showing up in as little as two weeks.

Table 8-1 shows the kinds of fatty acids found in some common dietary fats and oils. Fats are characterized according to their predominant fatty acids. For example, as you can plainly see in the table, nearly 25 percent of the fatty acids in corn oil are monounsaturated fatty acids. Nevertheless, because corn oil has more polyunsaturated fatty acid, corn oil is considered a polyunsaturated fatty acid. Note for math majors: Some totals in Table 8-1 don't add up to 100 percent because these fats and oils also contain other kinds of fatty acids in amounts so small that they don't affect the basic character of the fat.

Table 8-1 What Fatty Acids Are in That Fat or Oil?

Fat or Oil	*Saturated Fatty Acid (%)*	*Monounsaturated Fatty Acid (%)*	*Polyunsaturated Fatty Acid (%)*	*Kind of Fat or Oil*
Canola oil	7	53	22	Monounsaturated
Corn oil	13	24	59	Polyunsaturated
Olive oil	14	74	9	Monounsaturated
Palm oil	52	38	10	Saturated
Peanut oil	17	46	32	Monounsaturated
Safflower oil	9	12	74	Polyunsaturated
Soybean oil	15	23	51	Polyunsaturated

Fat or Oil	*Saturated Fatty Acid (%)*	*Monounsaturated Fatty Acid (%)*	*Polyunsaturated Fatty Acid (%)*	*Kind of Fat or Oil*
Soybean-cotton-seed oil	18	29	48	Poly-unsaturated
Butter	62	30	5	Saturated
Lard	39	45	11	Saturated*

** Because more than one-third of its fats are saturated, nutritionists label lard a saturated fat.*
Nutritive Value of Foods (Washington, D.C.: U.S. Department of Agriculture); Food and Life (New York: American Council on Science and Health)

Identifying the foods with fats

As a general rule:

- Fruits and vegetables have only traces of fat, primarily unsaturated fatty acids.
- Grains have small amounts of fat, up to 3 percent of their total weight.
- Dairy products vary. Cream is a high-fat food. Regular milks and cheeses are moderately high in fat. Skim milk and skim milk products are lowfat foods. Most of the fat in any dairy product is saturated fatty acids.
- Meat is moderately high in fat, and most of its fats are saturated fatty acids.
- Poultry (chicken and turkey), without the skin, is relatively low in fat.
- Fish may be high or low in fat, primarily unsaturated fatty acids that — lucky for the fish — remain liquid even when the fish is swimming in cold water. (Remember, saturated fats harden when cooled.)
- Vegetable oils, butter, and lard are high-fat foods. Most of the fatty acids in vegetable oils are unsaturated; most of the fatty acids in lard and butter are saturated.
- Processed foods, such as cakes, breads, canned or frozen meat, and vegetable dishes, are generally higher in fat than plain grains, meats, fruits, and vegetables.

TIP

Here's a simple guide to finding which foods are high (or low) in fat. Oils are virtually 100 percent fat. Butter and lard are close behind. After that, the fat level drops, from 70 percent for some nuts down to 2 percent for most bread. The rule to take away from these numbers? A diet high in grains and plants always is lower in fat than a diet high in meat and oils.

A nutritional fish story

When Sir William Gilbert, lyricist to songsmith Sir Arthur Sullivan, wrote, "Here's a pretty kettle of fish!" he may well have been talking about the latest skinny on seafood.

The good news from a 2002 Harvard survey of more than 43,000 male health professionals was that those who ate 3 to 5 ounces of fish just once a month have a 40 percent lower risk of *ischemic stroke,* a stroke caused by a blood clot in a cranial artery. The Harvard study did not include women, but a report on women and stroke published in the *Journal of the American Medical Association* in 2000 showed that women who consume about 4 ounces of fish — think one small can of tuna — two to four times a week appear to cut their risk of stroke by a similar 40 percent.

These benefits are, in large part, because of the presence of *omega-3 fatty acids,* unsaturated fatty acids found most commonly in fatty fish such as salmon and sardines. The primary omega-3 is *alpha*-linolenic acid, which your body converts to hormone-like substances called eicosanoids. The *eicosanoids* — eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) — reduce inflammation, perhaps by inhibiting an enzyme called COX-2, which is linked to inflammatory diseases such as rheumatoid arthritis (RA).

Omega-3s also are heart-friendly. They make the tiny blood particles called platelets less sticky, reducing the possibility that they'll clump together to form blood clots that might obstruct a blood vessel and trigger a heart attack. Omega-3s also knock down levels of bad cholesterol so effectively that the American Heart Association recommends eating fish at least twice a week. Besides, fish also is a good source of *taurine,* an amino acid the journal *Circulation* notes helps maintain the elasticity of blood vessels.

Finally omega-3s are bone builders. Fish oils enable your body to create *calciferol,* a naturally occurring form of vitamin D, the nutrient that enables your body to absorb bone-building calcium — which may be why omega-3s appear to help hold minerals in bone — and increase the formation of new bone.

A pretty kettle of fish, indeed.

Consumer Alert No. 1

Not all omegas are equally beneficial. Omega-6 fatty acids — polyunsaturated fats found in beef, pork, and several vegetable oils, including corn, sunflower, cottonseed, soybean, peanut, and sesame oils — are chemical cousins of omega-3s, but the omega-6s lack the benefits of the omega-3s.

Consumer Alert No. 2

Despite all the benefits fish bring to a healthful diet, it is also true that some fish, particularly those caught in the wild (rather than raised on a fish farm), may be contaminated with metals such as methyl mercury, a hazardous metal that makes its way into the water as industrial pollution and may be hazardous for children as well as women who are or may be pregnant because mercury targets the developing fetus's and child's brain and spinal cord. To keep methyl mercury ingestion as low as possible, the 2010 Dietary Guidelines for Americans (see Chapter 16) say these people should avoid *all* King mackerel, shark, swordfish, and tile fish, species likely to be highly contaminated.

Getting the right amount of fat

Getting the right amount of fat in your diet is a delicate balancing act. Too much, and you increase your risk of obesity, diabetes, heart disease, and some forms of cancer. (The risk of colon cancer seems to be tied more clearly to a diet high in fat from meat rather than a diet high in fat from dairy products.) Too little fat, and infants don't thrive, children don't grow, and everyone, regardless of age, is unable to absorb and use fat-soluble vitamins that smooth the skin, protect vision, bolster the immune system, and keep reproductive organs functioning.

In 2002, the National Academies' Institute of Medicine (IOM) recommended that no more than 20 to 45 percent of daily calories should come from fat. On a 2,000-calorie daily diet, that's 400 to 900 calories from fats a day. The Dietary Guidelines for Americans 2010 (see Chapter 16) recommends that adults keep fat consumption at the lower end of the scale, say, 20 to 30 percent of total calories — 400 to 600 of the calories on a 2,000-calorie/day regimen.

WARNING!

This advice about fat intake is primarily for adults. Although many organizations, such as the American Academy of Pediatrics, the American Heart Association, and the National Heart, Lung, and Blood Institute, recommend restricting fat intake for older children, they stress that infants and toddlers require fatty acids for proper physical growth and mental development. Never limit the fat in your baby's diet without checking first with your pediatrician.

Considering Cholesterol and You

Every healthy body *needs* cholesterol. Look carefully, and you will find cholesterol in and around your cells, in your fatty tissue, in your organs, in your brain, and in your glands. What's it doing there? Plenty.

Cholesterol

- Protects the integrity of cell membranes
- Helps nerve cells to send messages back and forth
- Is a building block for vitamin D (a sterol), made when sunlight hits the fat just under your skin (for more about vitamin D, see Chapter 11)
- Enables your gallbladder to make *bile acids,* digestive chemicals that, in turn, enable you to absorb fats and fat-soluble nutrients such as vitamin A, vitamin D, vitamin E, and vitamin K
- Is a base on which you build steroid hormones such as estrogen and testosterone

Cholesterol and heart disease

Doctors measure your cholesterol level by taking a sample of blood and counting the milligrams of cholesterol in 1 deciliter (1⁄10 liter) of blood. When you get your annual report from the doctor, your total cholesterol level looks something like this: 225 mg/dL. In other words, you have 225 milligrams of cholesterol in every tenth of a liter of blood. The more cholesterol you have floating in your blood, the more cholesterol is likely to cross into your arteries, where it may stick to the walls, form deposits that eventually block the flow of blood, and thus increase your risk of heart attack or stroke.

As a general rule, the National Cholesterol Education Program (NCEP) defines total cholesterol levels this way:

- **<200 mg/dL:** Desirable with a low risk for coronary heart disease (CHD)
- **200 to 239 mg/dL:** Borderline high
- **>240 mg/dl:** High with double the risk of CHD as a person with <200 mg/dl

Cholesterol season

Even if you allow yourself to indulge in (a few) high-cholesterol ice cream cones and burgers every day of the year, your cholesterol level may still be naturally lower in the summer than in winter.

The basis for this intriguing culinary conclusion is the 2004 University of Massachusetts SEASONS (Seasonal Variation in Blood Lipids) Study of 517 healthy men and women ages 20 to 70. The volunteers started out with an average cholesterol level of 213 mg/dl (women) to 222 mg/dl (men). A series of five blood tests during the one-year study showed an average drop of 4 points in the summer for men and 5.4 points for women. People with high cholesterol (above 240 mg/dl) did better, dropping as much as 18 points in the summer.

U. Mass cardiologists say one explanation for the summer downswing may be the normal increase in human blood volume in hot weather. Cholesterol levels reflect the total amount of cholesterol in your bloodstream. With more blood in the stream, the amount of cholesterol per deciliter declines, producing a lower total cholesterol reading. A second possibility is that people tend to eat less and be more active in summer. They lose weight, and weight loss equals lower cholesterol.

The first bit of wisdom from this study is obvious: Being physically active reduces your cholesterol level. The second is that environment matters. In other words, if you're planning to start a new cholesterol-buster diet, you may just do better to start during the cool weather, when your efforts may lower your total cholesterol as much as 12 points over a reasonable period of time, say, six months. Then when your doctor runs a follow-up test the following summer, you'll get the added benefit of the seasonal slip to make you feel really, really good about how well you're doing. For more on controlling your cholesterol, check out *Controlling Cholesterol For Dummies,* 2nd Edition (Wiley), which I wrote with Martin W. Graf, MD.

But total cholesterol levels alone are not the entire story. Many people with high cholesterol levels live to a ripe old age, while others with low total cholesterol levels develop heart disease because cholesterol is only one of several risk factors for heart disease. Here are some more:

- An unfavorable ratio of lipoproteins (see the following section)
- Smoking
- Obesity
- Age (being older is riskier)
- Sex (being male is riskier)
- A family history of heart disease

Living with lipoproteins

A *lipoprotein* is a fat and protein particle that carries cholesterol through your blood. Your body makes four types of lipoproteins: chylomicrons, very low-density lipoproteins (VLDLs), low-density lipoproteins (LDLs), and high-density lipoproteins (HDLs). As a general rule, LDLs take cholesterol into blood vessels; HDLs carry it out of the body.

A lipoprotein is born as a *chylomicron,* made in your intestinal cells from protein and triglycerides (fats). After 12 hours of traveling through your blood and around your body, a chylomicron has lost virtually all of its fats. By the time the chylomicron makes its way to your liver, the only thing left is protein.

The liver, a veritable fat and cholesterol factory, collects fatty acid fragments from your blood and uses them to make cholesterol and new fatty acids. Time out! How much cholesterol you get from food may affect your liver's daily output: Eat more cholesterol, and your liver may make less. If you eat less cholesterol, your liver may make more. And so it goes.

Churning out harmful lipoproteins

Okay, after your liver has made cholesterol and fatty acids, it packages them with protein as very low-density lipoproteins (VLDLs), which have more protein and are denser than their precursors, the chylomicrons. As VLDLs travel through your bloodstream, they lose triglycerides, pick up cholesterol, and turn into low-density lipoproteins (LDLs). LDLs supply cholesterol to your body cells, which use it to make new cell membranes and manufacture sterol compounds such as hormones. That's the good news.

The bad news is that both VLDLs and LDLs are soft and squishy enough to pass through blood vessel walls. The larger and squishier they are, the more likely they are to slide into your arteries, which means that VLDLs are more hazardous to your health than LDLs although elevated levels of all LDLs are strongly linked to an increased risk of cardiovascular disease.

VLDLs and LDLs are sometimes called "bad cholesterol," but this characterization is a misnomer. They aren't cholesterol; they're just the rafts on which cholesterol sails into your arteries. Traveling through the body, LDLs continue to lose cholesterol. In the end, they lose so much fat that they become mostly protein — turning them into high-density lipoproteins, the particles sometimes called "good cholesterol." Once again, this label is inaccurate. HDLs aren't cholesterol: They're simply protein and fat particles too dense and compact to pass through blood vessel walls, so they carry cholesterol out of the body rather than into arteries.

That's why a high level of HDLs may reduce your risk of heart attack regardless of your total cholesterol levels. Conversely, a high level of LDLs may raise your risk of heart attack, even if your overall cholesterol level is low.

Setting limits on the bad guys

At one point, back in the Dawn of the Cholesterol Age, the "safe" upper limit for LDLs was assumed to be around 160 mg/dl. Now, the National Heart, Lung, and Blood Institute, American College of Cardiology, and the American Heart Association have all put their stamps of approval on the National Cholesterol Education Program's (NCEP) recommendations for new, lower levels of LDLs.

For healthy people with two or more risk factors, the *Optimal* level for LDLs is below 100 mg/dL; 100–129 mg/dL is considered *Near or above optimal.*

The "near" applies to healthy people; the "above," to those at high risk or with existing CHD. Very high-risk patients such as those who are hospitalized with heart disease or have heart disease plus several risk factors are often told to push their LDLs under 70 mg/dL, a level virtually impossible to reach without a cholesterol-busting drug, usually a statin, such as atorvastatin (Lipitor).

Diet and cholesterol

Most of the cholesterol that you need is made right in your own liver, which churns out about 1 gram (1,000 milligrams) a day from the raw materials in the proteins, fats, and carbohydrates that you consume. But you also get cholesterol from food of animal origin: meat, poultry, fish, eggs, and dairy products. Although some plant foods, such as coconuts and cocoa beans, are high in saturated fats, no plants produce cholesterol.

Table 8-2 lists the amount of cholesterol in normal servings of some representative foods.

Table 8-2 How Much Cholesterol Is on That Plate?

Food	*Serving Size*	*Cholesterol (mg)*
Meat		
Beef (stewed) lean and fat	3 ounces	87
Beef (stewed) lean	2.2 ounces	66
Beef (ground) lean	3 ounces	74
Beef (ground) regular	3 ounces	76
Beef steak (sirloin)	3 ounces	77
Bacon	3 strips	16
Pork chop, lean	2.5 ounces	71
Poultry		
Chicken (roast) breast	3 ounces	73
Chicken (roast) leg	3 ounces	78
Turkey (roast) breast	3 ounces	59
Fish		
Clams	3 ounces	43
Flounder	3 ounces	59
Oysters (raw)	1 cup	120
Salmon (canned)	3 ounces	34
Salmon (baked)	3 ounces	60
Tuna (water canned)	3 ounces	48
Tuna (oil canned)	3 ounces	55
Cheese		
American	1 ounce	27
Cheddar	1 ounce	30
Cream	1 ounce	31
Mozzarella (whole milk)	1 ounce	22
Mozzarella (part skim)	1 ounce	15
Swiss	1 ounce	26
Milk		
Whole	8 ounces	33
2%	8 ounces	18
1%	8 ounces	18
Skim	8 ounces	10

(continued)

Table 8-2 *(continued)*

Food	*Serving Size*	*Cholesterol (mg)*
Other dairy products		
Butter	Pat	11
Other		
Eggs, large	1	213
Lard	1 tbsp.	12

Nutritive Value of Foods (Washington, D.C.: U.S. Department of Agriculture)

Chapter 9

Carbohydrates: A Complex Story

In This Chapter

- Discovering the different kinds of carbohydrates
- Understanding how your body uses carbohydrates
- Choosing the foods with the best carbs
- Deciphering dietary fiber

Carbohydrates — the name means carbon plus water — are sugar compounds that plants make when they're exposed to light. This process of making sugar compounds is called *photosynthesis,* from the Latin words for "light" and "putting together."

This chapter shines a bright light on the different kinds of carbohydrates, illuminating all the nutritional nooks and crannies to explain how each contributes to your vim and vigor — not to mention a tasty daily menu.

Checking Out Carbohydrates

Carbohydrates come in three varieties: simple carbohydrates, complex carbohydrates, and dietary fiber. All are composed of units of sugar. What makes one carbohydrate different from another is the number of sugar units it contains and how the units are linked together.

Simple carbohydrates

These carbohydrates have only one or two units of sugar.

- A carbohydrate with one unit of sugar is called a *simple sugar* or a *monosaccharide* (mono = one; saccharide = sugar). Fructose (fruit sugar) is a monosaccharide, and so are glucose (blood sugar), the sugar produced when you digest carbohydrates, and galactose, the sugar derived from digesting lactose (milk sugar).

- A carbohydrate with two units of sugar is called a *double sugar* or a *disaccharide* (di = two). Sucrose (table sugar), which is made of one unit of fructose and one unit of glucose, is a disaccharide.

Complex carbohydrates

These carbohydrates, which are also known as *polysaccharides* (poly = many), have more than two units of sugar linked together. Carbs with three to ten units of sugar are sometimes called *oligosaccharides* (oligo = few).

- Raffinose is a *trisaccharide* (tri = three) that's found in potatoes, beans, and beets. It has one unit each of galactose, glucose, and fructose.
- Stachyose is a *tetrasaccharide* (tetra = four) found in the same vegetables mentioned in the previous item. It has one fructose unit, one glucose unit, and two galactose units.
- Starch, a complex carbohydrate in potatoes, pasta, and rice, is a definite polysaccharide. In fact, it's an *oligosaccharide* built of many units of glucose.

Because complex carbohydrates may have anywhere from three to several thousand units of sugars, your body takes longer to digest them than it takes to digest simple carbohydrates. As a result, digesting complex carbohydrates releases glucose into your bloodstream more slowly and evenly than digesting simple carbs. (For more about digesting carbs, see the section "Carbohydrates and Energy: a Biochemical Love Story," later in this chapter.)

Dietary fiber

Dietary fiber is a term used to distinguish the fiber in food from the natural and synthetic fibers (silk, cotton, wool, nylon) used in fabrics. Dietary fiber is a third kind of carbohydrate.

Like the complex carbohydrates, dietary fiber (cellulose, hemicellulose, pectin, beta-glucans, gum) is a polysaccharide. Lignin, a different kind of chemical, is also called a dietary fiber.

Some kinds of dietary fiber also contain units of soluble or insoluble uronic acids, compounds derived from the sugars fructose, glucose, and galactose. For example, pectin — a soluble fiber in apples — contains soluble galacturonic acid.

Dietary fiber is not like other carbohydrates. The bonds that hold its sugar units together cannot be broken by human digestive enzymes. Although the bacteria living naturally in your intestines convert very small amounts of dietary fiber to fatty acids, dietary fiber is not considered a source of energy. (For more about fatty acids, see Chapter 8.)

Carbohydrates and Energy: a Biochemical Love Story

Your body runs on glucose, the molecules your cells burn for energy. (For more information on how you get energy from food, check out Chapter 3.)

Proteins, fats, and alcohol (as in beer, wine, and spirits) also provide energy in the form of calories. And protein does give you glucose, but it takes a long time, relatively speaking, for your body to get it.

When you eat carbohydrates, your pancreas secretes insulin, the hormone that enables you to digest starches and sugars. This release of insulin is sometimes called an *insulin spike,* also known as "insulin secretion."

Eating simple carbohydrates such as sucrose (table sugar) provokes higher insulin secretion than eating complex carbohydrates such as starch. If you have a metabolic disorder such as diabetes that keeps you from producing enough insulin, you must be careful not to take in more carbs than you can digest. (See "Some problems with carbohydrates," later in this chapter.)

Some perfectly healthful foods, such as carrots, potatoes, and white bread, have more simple carbs than others, such as apples, lentils, peanuts, and whole wheat bread. The Glycemic Index, a carbohydrate measurement scheme developed at the University of Toronto in 1981, gives you a handle on the amount of carbs by ranking foods according to how quickly they affect blood sugar levels when compared to glucose (the form of sugar your body uses as energy).

Most healthy people can metabolize even very large amounts of carbohydrate foods easily. Their insulin secretion rises to meet the demand and then quickly settles back to normal. In other words, although some popular weight loss programs, such as the South Beach Diet, rely on the Glycemic Index as a weight loss tool, the fact remains that for most people, a carb is a carb is a carb, regardless of how quickly the sugar enters the bloodstream. Check it out in *Diabetes For Dummies* (Wiley) by Dr. Alan L. Rubin, MD.

For info on why the difference between simple and complex carbs can matter for athletes, check out the section called "Who needs extra carbohydrates?"

How glucose becomes energy

Inside your cells, glucose is burned to produce heat and *adenosine triphosphate,* a molecule that stores and releases energy as required by the cell. By the way, nutrition scientists, who have as much trouble pronouncing polysyllabic words as you probably do, usually refer to adenosine triphosphate by its initials: ATP.

The transformation of glucose into energy occurs in one of two ways: with oxygen or without it. Glucose is converted to energy with oxygen in the *mitochondria* — tiny bodies in the jellylike substance inside every cell. This conversion yields energy (ATP, heat) plus water and carbon dioxide, a waste product.

Red blood cells do not have mitochondria, so they change glucose into energy without oxygen. This yields energy (ATP, heat) and lactic acid.

Glucose is also converted to energy in muscle cells. When it comes to producing energy from glucose, muscle cells are, well, double-jointed. They have mitochondria, so they can process glucose with oxygen. But if the level of oxygen in the muscle cell falls very low, the cells can just go ahead and change glucose into energy without it. This is most likely to happen when you've been exercising so strenuously that you (and your muscles) are, literally, out of breath.

Being able to turn glucose into energy without oxygen is a handy trick, but here's the downside: One byproduct is lactic acid. Why is that a big deal? Because too much lactic acid makes your muscles ache.

How pasta ends up on your hips when too many carbs pass your lips

Your cells budget energy very carefully. They do not store more than they need right now. Any glucose the cell does not need for its daily work is converted to glycogen (animal starch) and tucked away as stored energy in your liver and muscles.

Your body can pack about 400 grams (14 ounces) of glycogen into liver and muscle cells. A gram of carbohydrates — including glucose — has four calories. If you add up all the glucose stored in glycogen to the small amount of glucose in your cells and blood, it equals about 1,800 calories of energy.

If your diet provides more carbohydrates than you need to produce this amount of stored calories in the form of glucose and glycogen in your cells, blood, muscles, and liver, the excess will be converted to fat. And that's how your pasta ends up on your hips.

Other ways your body uses carbohydrates

Providing energy is an important job, but it isn't the only thing carbohydrates do for you. Carbohydrates also protect your muscles. When you need energy, your body looks for glucose from carbohydrates first. If none is available, because you're on a carbohydrate-restricted diet or have a medical condition that prevents you from using the carbohydrate foods you consume, your body begins to pull energy out of fatty tissue and then moves on to burning its own protein tissue (muscles). If this use of proteins for energy continues long enough, you run out of fuel and die.

A diet that provides sufficient amounts of carbohydrates keeps your body from eating its own muscles. That's why a carbohydrate-rich diet is sometimes described as *protein sparing*.

Carbohydrates also

- Regulate the amount of sugar circulating in your blood so that all your cells get the energy they need
- Provide nutrients for the friendly bacteria in your intestinal tract that help digest food
- Assist in your body's absorption of calcium
- May help lower cholesterol levels and regulate blood pressure (these effects are special benefits of dietary fiber (see "Dietary Fiber: The Non-Nutrient in Carbohydrate Foods," later in this chapter)

Finding the Carbohydrates You Need

The most important sources of carbohydrates are plant foods — fruits, vegetables, and grains. Milk and milk products contain the carbohydrate lactose (milk sugar), but meat, fish, and poultry have no carbohydrates at all.

The National Academy of Sciences Institute of Medicine (IOM) recommends that 45 to 65 percent of your daily calories come from carbohydrate foods such as grains (bread, cereals, pasta rice), fruit, and vegetables, foods that provide simple carbohydrates, complex carbohydrates, and the natural bonus of dietary fiber. Table sugar, honey, and sweets — which provide simple carbohydrates — are recommended only on a once-in-a-while basis.

One gram of carbohydrates has four calories. To find the number of calories from the carbohydrates in one food serving, multiply the number of grams of carbohydrates by four. For example, one whole bagel has about 38 grams of carbohydrates, equal to about 152 calories (38×4). (You have to say "about" because the dietary fiber in the bagel provides no calories, because the body can't metabolize it.) ***Wait:*** That number does not account for all the calories in the serving. Remember, the foods listed here may also contain at least some protein and fat, and these two nutrients add calories.

Some problems with carbohydrates

Some people have a hard time handling carbohydrates. For example, people with Type 1 ("insulin dependent") diabetes do not produce sufficient amounts of insulin, the hormones needed to carry all the glucose produced from carbohydrates into body cells. As a result, the glucose continues to circulate in the blood until it's excreted through the kidneys. That's why one way to tell whether someone has diabetes is to test the level of sugar in that person's urine.

Other people can't digest carbohydrates because their bodies lack the specific enzymes needed to break the bonds that hold a carbohydrate's sugar units together. For example, many (some say most) Asians, Africans, Middle Easterners, South Americans, and Eastern, Central, or Southern Europeans are deficient in lactase, the enzyme that splits lactose (milk sugar) into glucose and galactose. If these people drink milk or eat milk products, they end up with a lot of undigested lactose in their intestinal tracts. This undigested lactose makes the bacteria living there happy as clams — but not the person who owns the intestines: As bacteria feast on the undigested sugar, they excrete waste products that give their host gas and cramps.

To avoid this anomaly, many national cuisines purposely avoid milk as an ingredient. (Quick! Name one native Asian dish that's made with milk. No, coconut milk doesn't count.) To get the calcium their bodies need, these people simply substitute high-calcium foods such as greens or calcium-enriched soy products for milk.

Time out for the name game!

Here's an interesting bit of nutritional information. The names of all enzymes end in the letters *-ase.* An enzyme that digests a specific substance in food often has a name similar to the substance but with the letters *-ase* at the end. For example, *proteases* are enzymes that digest protein; *lipases* are enzymes that digest fats (lipids); and *galactase* is the enzyme that digests galactose.

A second solution for people who don't make enough lactase is to use a *predigested milk product,* such as yogurt or buttermilk or sour cream, all of which are created by adding friendly bacteria that digest the milk (that is, break the lactose apart) without spoiling it. Other solutions include lactose-free cheeses and enzyme-treated milk.

Who needs extra carbohydrates?

The small amount of glucose in your blood and cells provides the energy you need for your body's daily activities. The 400 grams of glycogen stored in your liver and muscles provides enough energy for ordinary bursts of extra activity.

But what happens when you have to work harder or longer than that? For example, what if you're a long-distance athlete, which means that you use up your available supply of glucose before you finish your competition? (That's why marathoners often run out of gas — a phenomenon called *hitting the wall* — at 20 miles, six miles short of the finish line.)

If you were stuck on an ice floe or lost in the woods for a month or so, after your body exhausts its supply of glucose, including the glucose stored in glycogen, it would start pulling energy first out of stored fat and then out of muscle. But extracting energy from body fat requires large amounts of oxygen — which is likely to be in short supply when your body has run, swum, or cycled 20 miles. So athletes have found another way to leap the wall: They load up on carbohydrates in advance.

Carbohydrate-loading is a dietary regimen designed to increase temporarily the amount of glycogen stored in your muscles in anticipation of an upcoming event. You start about a week before the event, says the University of Maine's Alfred A. Bushway, PhD, exercising to exhaustion so your body pulls as much glycogen as possible out of your muscles. Then, for three days, you eat foods high in fat and protein and low in carbohydrates to keep your glycogen level from rising again.

Three days before the big day, reverse the pattern. Now you want to build and conserve glycogen stores. What you need is a diet that's about 70 percent carbohydrates, providing 6 to 10 grams of carbohydrates for every kilogram (2.2 pounds) of body weight for men and women alike. And not just any carbohydrates, mind you. What you want are the complex carbohydrates in starchy foods like pasta and potatoes, rather than the simple ones more prominent in sugary foods like fruit. And of course, candy.

This carb-loading diet is not for everyday use, nor will it help people competing in events of short duration. It's strictly for events lasting longer than 90 minutes.

What about while you're running, swimming, or cycling? Will consuming simple sugars during the race give you extra short-term bursts of energy? Yes. Sugar is rapidly converted to glycogen and carried to the muscles. But you don't want plain table sugar (candy, honey) because it's *hydrophilic* (hydro = water; philic = loving), which means that it pulls water from body tissues into your intestinal tract. This can increase dehydration and trigger nausea. Getting the sugar you want from sweetened athletic drinks, which provide fluids along with the energy, is safer, especially since the athletic drink also contains salt (sodium chloride) to replace the salt that you lose when perspiring heavily. Turn to Chapter 13 to find out why this is important.

Dietary Fiber: The Non-Nutrient in Carbohydrate Foods

Dietary fiber is a group of complex carbohydrates that are not a source of energy for human beings. Because human digestive enzymes cannot break the bonds that hold fiber's sugar units together, fiber adds no calories to your diet and cannot be converted to glucose.

Ruminants (animals, such as cows, that chew the cud) have a combination of digestive enzymes and digestive microbes that enable them to extract the nutrients from insoluble dietary fiber (cellulose and some hemicelluloses). But not even these creatures can pull nutrients out of lignin, an insoluble fiber in plant stems and leaves and the predominant fiber in wood. As a result, the U.S. Department of Agriculture specifically prohibits the use of wood or sawdust in animal feed.

But just because you can't digest dietary fiber doesn't mean it isn't a valuable part of your diet. The opposite is true. Dietary fiber is valuable *because* you can't digest it!

The two kinds of dietary fiber

Nutritionists classify dietary fiber as either insoluble fiber or soluble fiber, depending on whether it dissolves in water.

- **Insoluble dietary fiber** includes cellulose, some hemicelluloses, and lignin found in whole grains and other plants. This kind of dietary fiber is a natural laxative. It absorbs water, helps you feel full after eating, and stimulates your intestinal walls to contract and relax. These natural contractions, called *peristalsis,* move solid materials through your digestive tract.

By moving food quickly through your intestines, insoluble fiber may help relieve or prevent digestive disorders such as constipation or diverticulitis (infection that occurs when food gets stuck in small pouches in the wall of the colon). Insoluble fiber also bulks up stool and makes it softer, reducing your risk of developing hemorrhoids and lessening the discomfort if you already have them.

- **Soluble dietary fiber** includes pectins (found in most fruit) and beta-glucans (found in oats and barley). Soluble dietary fiber seems to lower the amount of cholesterol circulating in your blood (your *cholesterol level*), which is why a diet rich in fiber appears to lower cholesterol levels and thus offer some protection against heart disease.

Here's a benefit for dieters: Soluble fiber forms gels in the presence of water, which is what happens when apples and oat bran reach your digestive tract. So, like insoluble fiber, soluble fiber can make you feel full without adding calories.

Ordinary soluble dietary fiber can't be digested, so your body doesn't absorb it. But in 2002, researchers at Detroit's Barbara Ann Karamonos Cancer Institute fed laboratory mice a form of soluble dietary fiber called *modified citrus pectin*. The fiber, which is made from citrus fruit peel, can be digested. When fed to laboratory rats, it appeared to reduce the size of tumors caused by implanted human breast and colon cancer cells. The researchers believe that the fiber prevents cancer cells from linking together to form tumors. Today, modified citrus pectin is being sold as a dietary supplement, but the American Cancer Society notes on its Web site that this fiber's effects on human bodies (and human cancers) remain unproven.

Getting dietary fiber from food

You will find absolutely no fiber in foods from animals: meat, fish, poultry, milk, milk products, and eggs. But you will find lots of dietary fiber in all plant foods — fruits, vegetables, and grains.

A balanced diet with plenty of foods from plants gives you both insoluble and soluble fiber. Most foods that contain fiber have both kinds, although the balance usually tilts toward one or the other. For example, the predominant fiber in an apple is pectin (a soluble fiber), but an apple peel also has some cellulose, hemicellulose, and lignin.

Table 9-1 shows you which foods are particularly good sources of specific kinds of fiber. A diet rich in plant foods (fruits, vegetables, grains) gives you adequate amounts of dietary fiber.

Table 9-1 Food Sources of Different Kinds of Fiber

Fiber	*Where Found*
Soluble fiber	
Pectin	Fruits (apples, strawberries, citrus fruits)
Beta-glucans	Oats, barley
Gums	Beans, cereals (oats, rice, barley), seeds, seaweed
Insoluble fiber	
Cellulose	Leaves (cabbage), roots (carrots, beets), bran, whole wheat, beans
Hemicellulose	Seed coverings (bran, whole grains)
Lignin	Plant stems, leaves, and skin

How much fiber do you need?

According to the U.S. Department of Agriculture, the average American woman gets about 12 grams of fiber a day from food; the average American man, 17 grams. Those figures are well below the new IOM (Institute of Medicine) recommendations that I conveniently list here:

- 25 grams a day for women age 19 to 50
- 38 grams a day for men age 19 to 50
- 21 grams a day for women older than 50
- 30 grams a day for men older than 50

The amounts of dietary fiber recommended by IOM are believed to give you the benefits you want without causing fiber-related unpleasantries.

Unpleasantries? Like what? And how will you know if you've got them?

Trust me: If you eat more than enough fiber, your body will tell you right away. All that roughage may irritate your intestinal tract, which will issue an unmistakable protest in the form of intestinal gas or diarrhea. In extreme cases, if you don't drink enough liquids to moisten and soften the fiber you eat so that it easily slides through your digestive tract, the dietary fiber may form a mass that can end up as an intestinal obstruction. (For more about water, see Chapter 13.)

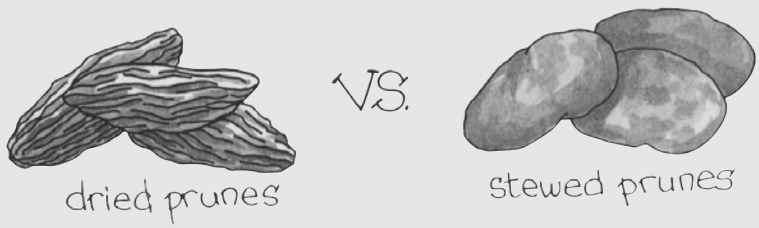
TIP

If you decide to up the amount of fiber in your diet, follow this advice:

Fiber factoid

The amount of fiber in a serving of food may depend on whether the food is raw or cooked. For example, as you can see from Table 9-2, a 3.5-ounce serving of plain dried prunes has 7.2 grams of fiber while a 3.5-ounce serving of stewed prunes has 6.6 grams of fiber.

Why? When you stew prunes, they plump up — which means they absorb water. The water adds weight but (obviously) no fiber. So a serving of prunes-plus-water has slightly less fiber per ounce than a same-weight serving of plain dried prunes.



- **Do it *very* gradually, a little bit more every day.** That way, you're less likely to experience intestinal distress. In other words, if your current diet is heavy on no-fiber foods such as meat, fish, poultry, eggs, milk, and cheese, and low-fiber foods such as white bread and white rice, don't load up on bran cereal (35 grams dietary fiber per 3.5-ounce serving) or dried figs (9.3 grams per serving) all at once. Start by adding a serving of cornflakes (2.0 grams dietary fiber) at breakfast, maybe an apple (2.8 grams) at lunch, a pear (2.6 grams) at mid-afternoon, and a half cup of baked beans (7.7 grams) at dinner. Four simple additions, and already you're up to 15 grams dietary fiber.
- **Always check the nutrition label whenever you shop.** (For more about the wonderfully informative guides, see Chapter 17.) When choosing between similar products, just take the one with the higher fiber content per serving. For example, white pita bread generally has about 1.6 grams dietary fiber per serving. Whole wheat pita bread may have as much as 7.4 grams.
- **Get enough liquids.** Dietary fiber is like a sponge. It sops up liquid, so increasing your fiber intake may deprive your cells of the water they need to perform their daily work. (For more about how your body uses the water you drink, see Chapter 13.) That's why the American Academy of Family Physicians (among others) suggests checking to make sure you get plenty of fluids when you consume more fiber. How much is enough? Back to Chapter 13.

Table 9-2 shows the amounts of all types of dietary fiber — insoluble plus soluble — in a 100-gram (3.5-ounce) serving of specific foods. By the way, nutritionists like to measure things in terms of 100-gram portions because that makes comparing foods at a glance possible.

To find the amount of dietary fiber in your own serving, divide the gram total for the food shown in Table 9-2 (or the appendix) by 3.5 to get the grams per ounce, and then multiply the result by the number of ounces in your portion. For example, if you're having 1 ounce of cereal, the customary serving of ready-to-eat breakfast cereals, divide the gram total of dietary fiber by 3.5; then multiply by one. If your slice of bread weighs ½ ounce, divide the gram total by 3.5; then multiply the result by 0.5 (½).

Or you can just look at the nutrition label on the side of the package because it lists the amounts of the nutrients per serving.

Finally, the amounts on this chart are averages. Different brands of processed products (breads, some cereals, cooked fruits, and vegetables) may have more (or less) fiber per serving.

Table 9-2 Dietary Fiber Content in Common Foods

Food	*Grams of Fiber in a 100-Gram (3.5-Ounce) Serving*
Bread	
Bagel	2.1
Bran bread	8.5
Pita bread (white)	1.6
Pita bread (whole wheat)	7.4
White bread	1.9
Cereals	
Bran cereal	35.3
Bran flakes	18.8
Cornflakes	2.0
Oatmeal	10.6
Wheat flakes	9.0
Grains	
Barley, pearled (minus its outer covering), raw	15.6
Cornmeal, whole grain	11.0
De-germed	5.2
Oat bran, raw	6.6
Rice, raw (brown)	3.5
Rice, raw (white)	1.0–2.8
Rice, raw (wild)	5.2
Wheat bran	15.0

Food	***Grams of Fiber in a 100-Gram (3.5-Ounce) Serving***
Fruits	
Apple, with skin	2.8
Apricots, dried	7.8
Figs, dried	9.3
Kiwi fruit	3.4
Pear, raw	2.6
Prunes, dried	7.2
Prunes, stewed	6.6
Raisins	5.3
Vegetables	
Baked beans (vegetarian)	7.7
Chickpeas (canned)	5.4
Lima beans, cooked	7.2
Broccoli, raw	2.8
Brussels sprouts, cooked	2.6
Cabbage, white, raw	2.4
Cauliflower, raw	2.4
Corn, sweet, cooked	3.7
Peas with edible pods, raw	2.6
Potatoes, white, baked, w/ skin	5.5
Sweet potato, cooked	3.0
Tomatoes, raw	1.3
Nuts	
Almonds, oil-roasted	11.2
Coconut, raw	9.0
Hazelnuts, oil-roasted	6.4
Peanuts, dry-roasted	8.0
Pistachios	10.8
Other	
Corn chips, toasted	4.4
Tahini (sesame seed paste)	9.3
Tofu	1.2

Provisional Table on the Dietary Fiber Content of Selected Foods (Washington, D.C.: U.S. Department of Agriculture, 1988)

Fiber and your heart: The continuing saga of oat bran

Oat bran is the second chapter in the fiber fad that started with wheat bran around 1980. Wheat bran, the fiber in wheat, is rich in the insoluble fibers cellulose and lignin. Oat bran's gee-whiz factor is the soluble fiber beta-glucans. For more than 30 years, scientists have known that eating foods high in soluble fiber can lower your cholesterol, although nobody knows exactly why. Fruits and vegetables (especially dried beans) are high in soluble fiber, but ounce for ounce, oats have more. In addition, beta-glucans are a more effective cholesterol-buster than pectin and gum, which are the soluble fibers in most fruits and vegetables.

By 1990, researchers at the University of Kentucky reported that people who add ½ cup dry oat bran (*not* oatmeal) to their regular daily diets can lower their levels of low density lipoproteins (LDLs), the particles that carry cholesterol into your arteries, by as much as 25 percent (see Chapter 8 for more on cholesterol).

Recently, scientists at the Medical School of Northwestern University, funded by Quaker Oats, enlisted 208 healthy volunteers whose normal cholesterol readings averaged about 200 mg/dl for a study involving oat bran. The volunteers' total cholesterol levels decreased an average of 9.3 percent with a lowfat, low-cholesterol diet supplemented by 2 ounces of oats or oat bran every day. About one-third of the cholesterol reduction was credited to the oats.

Oat cereal makers rounded the total loss to 10 percent, and the National Research Council said that a 10 percent drop in cholesterol could produce a 20 percent drop in the risk of a heart attack.

Do I have to tell you what happened next? Books on oat bran hit the bestseller list. Cheerios elbowed Frosted Flakes aside to become the number one cereal in America. And people added oat bran to everything from bagels to orange juice.

Today scientists know that although a little oat bran can't hurt, the link between oats and cholesterol levels is no cure-all.

As a general rule, a cholesterol level higher than 240 mg/dl is considered to be *high.* A cholesterol reading between 200 and 239 mg/dl is considered *borderline high.* A cholesterol level below 200 mg/dl is considered *desirable*.

If your cholesterol level is above 240 mg/dl, lowering it by 10 percent through a diet that contains oat bran may reduce your risk of heart attack without the use of medication. If your cholesterol level is lower than that to begin with, the effects of oat bran are less dramatic. For example:

- If your cholesterol level is below 240 mg/dl, a lowfat, low-cholesterol diet alone may push it down 24 points into the moderately risky range, but doesn't take you into "safe" territory, under 200 mg/dl.
- If your cholesterol is already low, say 199 mg/dl or less, a lowfat, low-cholesterol diet plus oats may drop it to 180 mg/dl, but the oats account for only a third of your loss.

Recognizing oat bran's benefits, the Food and Drug Administration now permits health claims on oat product labels. For example, the product label may say: "Soluble fiber from foods such as oat bran, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease."

By the way, the soluble pectin in apples and the soluble beta-glucans (gums) in beans and peas also lower cholesterol levels. The insoluble fiber in wheat bran does not.

Chapter 10

Alcohol: Another Form of Grape and Grain

In This Chapter

- Discovering how alcohol is made
- Exploring different kinds of alcohol beverages
- Digesting alcohol
- Evaluating alcohol's effect on health

Alcohol beverages are among mankind's oldest home remedies and simple pleasures, so highly regarded that the ancient Greeks and Romans called wine a "gift from the gods," and when the Gaels — early inhabitants of Scotland and Ireland — first produced whiskey, they named it *uisge beatha* (whis-key-ba), a combination of the words for "water" and "life." Today, although you may share their appreciation for the product, you know that alcohol beverages may have risks as well as benefits.

This chapter refers to beverages made from alcohol as "alcohol beverages" rather than "alcoholic beverages," a term that immediately brings to mind the image of tipsy beer bottles rather than simple beer, wine, or spirits.

Revealing the Many Faces of Alcohol

When microorganisms (yeasts) digest (ferment) the sugars in carbohydrate foods, they make two byproducts: a liquid and a gas. The gas is carbon dioxide. The liquid is *ethyl alcohol,* also known as *ethanol,* the intoxicating ingredient in alcohol beverages.

This biochemical process is not an esoteric one. In fact, it happens in your own kitchen every time you make yeast bread. Remember the faint, beer-like odor in the air while the dough is rising? That odor is from the alcohol the yeasts make as they chomp their way through the sugars in the flour. (Don't worry; the alcohol evaporates when you bake the bread.) As the yeasts digest the sugars, they also produce carbon dioxide, which makes the bread rise.

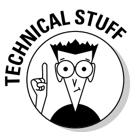
Whenever you see the word *alcohol,* unless otherwise noted, it means ethanol, the only alcohol used in alcohol beverages.

Creating Alcohol Beverages

Alcohol beverages are produced either through fermentation or through a combination of fermentation plus distillation.

Fermented alcohol products

Fermentation is a simple process in which yeasts or bacteria are added to carbohydrate foods such as corn, potatoes, rice, or wheat, which are used as starting material. The yeasts digest the sugars in the food, leaving liquid (alcohol); the liquid is filtered to remove the solids, and water is usually added to dilute the alcohol, producing — voilà — an alcohol beverage.



Beer is made this way. So is wine. *Kumiss,* a fermented milk product, is slightly different because it's made by adding yeasts and friendly bacteria called *lactobacilli* (lacto = milk) to mare's milk. The microorganisms make alcohol, but it isn't separated from the milk, which turns into a fizzy fermented beverage with no water added.

Distilled alcohol products

The second way to make an alcohol beverage is through *distillation.*

As with fermentation, yeasts are added to foods to make alcohol from sugars. But yeasts can't thrive in a place where the concentration of alcohol is higher than 20 percent. To concentrate the alcohol and separate it from the rest of the ingredients in the fermented liquid, distillers pour the fermented liquid into a *still,* a large vat with a wide column-like tube on top. The still is heated so that the alcohol, which boils at a lower temperature than everything else in the vat, turns to vapor, which rises through the column on top of the still, to be collected in containers where it condenses back into a liquid.

This alcohol, called *neutral spirits,* is the base for the alcohol beverages called spirits or distilled spirits: gin, rum, tequila, whiskey, and vodka. Brandy is a special product, a spirit distilled from wine. Fortified wines, such as Port and Sherry, are wines with spirits added.

The foods used to make beverage alcohol

Beverage alcohol can be made from virtually any carbohydrate food. The foods most commonly used are cereal grains, fruit, honey, molasses, or potatoes. Table 10-1 shows you which foods are used to produce the different kinds of alcohol beverages.

On its own, alcohol provides energy (7 calories per gram) but no nutrients, so distilled spirits, such as whiskey or plain, unflavored vodka, serve up nothing but calories. Beer, wine, cider, and other fermented beverages, such as kumiss (fermented milk), contain some of the food from which they were made, so they contain small amounts of proteins and carbohydrates, vitamins, and minerals.

Table 10-1 Foods Used to Make Alcohol Beverages

Original Food	*Alcohol Beverage Produced*
Fruit and fruit juice	
Agave plant	Tequila
Apples	Hard cider
Grapes and other fruits	Wine
Grain	
Barley	Beer, various distilled spirits, kvass
Corn	Bourbon, corn whiskey, beer
Rice	Sake (a distilled product), rice wine
Rye	Whiskey
Wheat	Distilled spirits, beer
Others	
Honey	Mead
Milk	Kumiss (koumiss), kefir
Potatoes	Vodka
Sugar cane	Rum

How Much Alcohol Is in That Bottle?

No alcohol beverage is 100 percent alcohol. It's alcohol plus water, and — if it's a wine or beer — some residue of the foods from which it was made.

The term ABV on the label shows the amount of alcohol as a percentage of all the liquid in the container. For example, if your container holds 10 ounces of liquid and 1 ounce of that is alcohol, the product is 10 percent ABV — the alcohol content divided by the total amount of liquid.

Proof — an older term to describe alcohol content —is two times the ABV. For example, an alcohol beverage that is 10 percent alcohol by volume is 20 proof.

Alcohol beverages may use the term "organic" on the label so long as they comply with the standards set for all foods (see Chapter 17), but right now, alcohol beverages are the only entries in the food and drink market sold without a Nutrition Facts label. Since 2003, The National Consumers League and the Washington-based Center for Science in the Public Interest have petitioned the Food and Drug Administration to create an ingredients label for alcohol beverages to list the ingredients, the number of standard servings in the container, and the alcohol content and calorie count per serving so you can compare products — and control what you drink. To date: No label.

Moving Alcohol through Your Body

Other foods must be digested before being absorbed by your cells, but alcohol flows directly through your body's membranes into your bloodstream, which carries alcohol to nearly every organ in your body. Here's a road map to show you the route traveled by the alcohol in every drink you take:

- **Flowing down from mouth to stomach:** Alcohol is an *astringent;* it coagulates proteins on the surface of the lining of your mouth to make it "pucker." Some alcohol is absorbed through the lining of the mouth and throat, but most of the alcohol you drink spills into your stomach, where an enzyme called *gastric alcohol dehydrogenase* (gADH) begins to metabolize (digest) it.

  How much alcohol dehydrogenase your body churns out is influenced by your ethnicity and your gender. For example, Asians, Native Americans, and Inuits appear to secrete less gastric alcohol dehydrogenase than do most Caucasians, and the average woman (regardless of her ethnicity) makes less gADH than the average man does. As a result, more unmetabolized alcohol flows from their stomach into their bloodstream, and they're likely to become tipsy on smaller amounts of alcohol than does an average Caucasian male. In any case, a certain amount of unmetabolized alcohol flows through the stomach walls into the bloodstream and on to the small intestine.

- **Stopping at the liver:** Most of the alcohol you drink is absorbed through the *duodenum* (the first part of the small intestine), from which it flows through a large blood vessel (the portal vein) into the liver. There, ADH, an enzyme similar to gADH, metabolizes the alcohol, which is then converted to energy by a coenzyme called *nicotinamide adenine dinucleotide* (NAD). NAD is also used to convert the glucose derived from other carbohydrates (check Chapter 9) to energy, so while NAD is being used for alcohol, glucose conversion grinds to a halt.

  The normal, healthy liver can process about ½ ounce of pure alcohol (that's 6 to 12 ounces of beer, 5 ounces of wine, or 1 ounce of spirits) in an hour. The rest flows on to your heart.

- **Taking time out to breathe:** When it enters the heart, alcohol reduces the force with which the heart muscle contracts. You pump out slightly less blood for a few minutes, blood vessels all over your body relax, and your blood pressure goes down temporarily. The contractions soon return to normal, but the blood vessels may remain relaxed and blood pressure lower for as long as half an hour.

  At the same time, alcohol flows in blood from the heart through the pulmonary vein to the lungs. Now you breathe out a tiny bit of alcohol every time you exhale, and your breath smells of liquor. Then the newly oxygenated, still alcohol-laden blood flows back through the pulmonary artery to your heart, and up and out through the *aorta* (the major artery that carries blood out to your body).

- **Rising to the surface:** As it circulates in the blood, alcohol raises the level of high-density lipoproteins (HDLs), although not necessarily the specific *good* ones that carry cholesterol out of your body. (For more about lipoproteins, see Chapter 7.) Alcohol also makes blood less likely to clot, temporarily reducing the risk of heart attack and stroke.

  Alcohol makes blood vessels expand, so more warm blood flows up from the center of your body to the surface of the skin. You feel warmer for a while and, if your skin is fair, you may flush and turn pink. (Asians, who tend to make less alcohol dehydrogenase than do Caucasians, often experience a characteristic flushing when they drink even small amounts of alcohol.) At the same time, tiny amounts of alcohol ooze out through your pores, and your perspiration smells of alcohol.

- **Creating curves in the road:** Alcohol is a sedative. When it reaches your brain, it slows the transmission of impulses between nerve cells that control your ability to think and move.

Do you feel a sudden urge to urinate? Alcohol reduces your brain's production of *antidiuretic hormones,* chemicals that keep you from making too much urine. You may lose lots of liquid, plus vitamins and minerals. You also grow very thirsty, and your urine may smell faintly of alcohol.

- **Ending the process:** This cycle continues as long as you have alcohol circulating in your blood, or in other words, until your liver can manage to produce enough ADH to metabolize all the alcohol you've consumed. How long is that? Most people need an hour to metabolize the amount of alcohol (½ ounce) in one drink. But that's an average: Some people have alcohol circulating in their blood for up to three hours after taking a drink.

Alcohol and Health

Beverage alcohol has benefits as well as side effects. The benefits are strongly linked to what is commonly called *moderate drinking* — no more than one drink a day for a woman, two drinks a day for a man. The risks generally arise from excessive drinking and alcohol abuse.

Moderate drinking: Some benefits, some risks

Moderate amounts of alcohol not only reduce stress but also appear to have beneficial effects on various parts of the human body.

For example:

- In March 2010, a study of 2,900 Swiss adults, published in the journal *Arthritis and Rheumatism,* suggested that moderate drinking might slow the progression of rheumatoid arthritis (RA); data from earlier studies had noted a lower risk of RA among adults who drink in moderation.
- The American Cancer Society's Cancer Prevention Study 1 followed more than one million Americans in 25 states for 12 years to find that moderate alcohol intake had an "apparent protective effect on coronary heart disease." Translation: Men who drink moderately lower their risk of heart attack. The risk is 21 percent lower for men who have one drink a day than for men who never drink.
- A similar analysis of data for nearly 600,000 women in the long-running (Harvard) Nurses' Health Study showed that women who drink occasionally or have one drink a day are less likely to die of heart attack than those who don't drink at all.

- In 2010, data from a Wageningen University (The Netherlands) study of 35,625 adults age 20 to 70, published in the *American Journal of Clinical Nutrition,* showed that moderate drinkers (one to two drinks a day) have a lower risk than teetotalers of developing Type 2 (non-insulin dependent) diabetes. This confirms many previous reports including one 2003 article in the Archives of Internal Medicine.
- A 2003 study at Tulane University School of Public Health and Tropical Medicine shows that men who drink moderately (two drinks a day) also are less likely to die of clot-related stroke. But because alcohol reduces blood clotting, it increases the risk of *hemorrhagic* stroke (stroke caused by bleeding in the brain). Sorry about that.

That's the good news. Here's the bad news: The same studies that applaud the effects of moderate drinking on heart health are less reassuring about the relationship between alcohol and cancer:

- The National Cancer Institute labels alcohol, in conjunction with smoking, as a clear risk factor for cancers of the mouth, throat (esophagus, pharynx, larynx), and liver.
- Researchers at the University of Oklahoma say that men who drink five or more beers a day double their risk of rectal cancer.
- American Cancer Society (ACS) statistics show a higher risk of breast cancer among women who have more than three drinks a week; some studies suggest this effect may apply only to older women using hormone replacement therapy.

A lot and a little versus the middle

When scientists talk about the relationship between alcohol and heart disease, the words *J-curve* often pop up. What's a J-curve? A statistical graph in the shape of the letter J.

In terms of heart disease, the lower peak on the left of the J shows the risk among teetotalers, the high spike on the right shows the risk among those who drink too much, and the curve in the center shows the risk in the moderate middle. In other words, the J-curve says that people who drink moderately have a lower risk of heart disease than people who drink too much or not at all.

According to a recent report from the Alberta (Canada) Alcohol and Drug Abuse Commission, the J-curve may also describe the relationship between alcohol and stroke, alcohol and diabetes, alcohol and bone loss, and alcohol and longevity. The simple fact is that moderate drinkers appear to live longer, healthier lives than either teetotalers or alcohol abusers. Cheers!

Binge drinking: A behavioral no-no

Binge drinkers have been described as "once-in-a-while alcoholics." They don't drink every day, but when they do indulge, they go so far overboard that they sometimes fail to come back up. In simple terms, binge drinking is downing very large amounts of alcohol in a short time, not for a pleasant lift but to get drunk. As a result, binge drinkers may consume so much beer, wine, or spirits that the amount of alcohol in their blood rises to lethal levels that, in the worst case, may lead to death by alcohol poisoning.

Efforts to stamp out binge drinking, which often occurs on college campuses, may rely on guilt or shame to change behavior, but a 2008 study at the Kellogg School of Management at Northwestern University found that binge drinkers are already uncomfortable with their behavior. Attempting to make them more so doesn't work. Instead, the researchers suggested couching anti-binge messages in simple, intelligent language focusing on how to avoid situations that lead to binge drinking rather that the nasty effects of the overindulgence.

The physical effects of excessive drinking

Alcohol abuse is a term generally taken to mean drinking so much that it interferes with your ability to have a normal, productive life. *Excessive drinking,* including binge drinking (see the sidebar "Binge drinking: A behavioral no-no" later in this chapter), can also make you feel terrible the next day. *The morning after* is not fiction. A hangover is a miserable physical fact:

- You're thirsty because you lost excess water through copious urination.
- Your stomach hurts and you're queasy because even small amounts of alcohol irritate your stomach lining, causing it to secrete extra acid and lots of *histamine,* the same immune system chemical that makes the skin around a mosquito bite red and itchy.
- Your muscles ache and your head pounds because processing alcohol through your liver requires an enzyme — nicotinamide adenine dinucleotide (NAD) — normally used to convert *lactic acid,* a byproduct of muscle activity, to other chemicals that can be used for energy. The extra, unprocessed lactic acid piles up painfully in your muscles.

Alcoholism: An addiction disease

No one knows exactly why some people are able to have a drink once a day or once a month or once a year, enjoy it, and move on, while others become addicted to alcohol. In the past, alcoholism has been blamed on "bad genes," lack of willpower, or even a nasty childhood.

As science continues to unravel the mysteries of body chemistry, it's reasonable to expect that researchers will eventually come up with a rational scientific explanation for the differences between social drinkers and people who can't safely use alcohol. It just hasn't happened yet.

What is clear, however, is that *alcoholics* are people who can't control their drinking. Untreated alcoholism is a life-threatening disease that can lead to death either from an accident or suicide (both are more common among heavy drinkers) or from a toxic reaction (acute alcohol poisoning that paralyzes body organs, including the heart and lungs) or from liver damage (cirrhosis) or from malnutrition.

Alcoholics are often emaciated, with such visible symptoms of malnutrition as problem skin, broken nails, and dull hair; less visible symptoms of vitamin and mineral deficiencies may hide underneath the surface. Why? Because alcohol abuse makes it extremely difficult — if not impossible — for the body to extract essential nutrients from food. That's because

- Alcohol depresses appetite.
- An alcoholic may substitute alcohol for food, getting calories but no nutrients.
- Even when the alcoholic eats, the alcohol in his tissues can prevent the proper absorption of vitamins (notably the B vitamins), minerals, and other nutrients. Alcohol may also reduce the alcoholic's ability to synthesize proteins.

This set of problems cannot be resolved simply by downing a multivitamin with the alcohol; it requires medical attention to understand and treat the primary cause, which is — to put it bluntly — drinking too much, much too often.

Who should not drink

WARNING!

No one should drink to excess. But some people shouldn't drink at all, not even in moderation. They include

- **People who plan to drive or do work that requires both attention and skill.** Alcohol slows reaction time and makes your motor skills — turning the wheel of the car, operating a sewing machine — less precise, which make you more likely to end up with a needle through the hand or a head through the windshield.
- **Women who are pregnant or who plan to become pregnant in the near future.** *Fetal alcohol syndrome* (FAS) is a collection of birth defects including low birth weight, heart defects, retardation, and facial deformities documented only in babies born to female alcoholics.

No evidence links FAS to casual drinking — that is, one or two drinks during a pregnancy or even one or two drinks a week. In fact, for years before FAS was identified and diagnosed, pregnant women were routinely advised to drink beer as a source of nutritious calories.

However, the National Institute on Alcohol Abuse and Alcoholism (NIAAA) says that it is not clear yet whether there is any completely safe level of alcohol during pregnancy and notes that in 2005 the U.S. Surgeon General urged women who are pregnant or may become pregnant to abstain from alcohol.

Finally, the sad but scientific fact is that about 7 percent of the babies born in the United States each year are born with birth defects independent of any parental behavior. The parents of these children may feel guilty, even though their behavior had absolutely nothing to do with the birth defect. Your decision about alcohol should take into consideration the psychological possibility of (misplaced) lifelong guilt caused by having had a drink.

- **People who take certain prescription drugs or over-the-counter medication.** Alcohol makes some drugs stronger, increases some drugs' side effects, and renders other drugs less effective. At the same time, some drugs make alcohol a more powerful sedative or slow down the elimination of alcohol from your body.

Table 10-2 shows some of the interactions known to occur between alcohol and some common prescription and over-the-counter drugs. This short list gives you an idea of some of the general interactions likely to occur between alcohol and drugs. But the list is far from complete. Today, by law, drugs that interact with alcohol usually carry a warning on the label, but if you're taking any kind of medication — over-the-counter or prescription — and you're not sure of the possibility of interactions, check with your doctor or pharmacist.

Table 10-2 Drug and Alcohol Interactions

Drug	*Possible Interaction with Alcohol*
Analgesics (acetaminophen)	Increased liver toxicity
Analgesics (aspirin and other nonsteroidal inflammatory drugs — NSAIDs)	Increased stomach bleeding; irritation
Anti-arthritis drugs	Increased stomach bleeding; irritation
Antidepressants	Increased drowsiness/intoxication; high blood pressure (depends on the type of drug — check with your doctor)
Antidiabetes drugs	Excessively low blood sugar
Antihypertension drugs	Very low blood pressure

Drug	*Possible Interaction with Alcohol*
Antituberculosis medication (isoniazid)	Decreased drug effectiveness; higher risk of hepatitis
Diet pills	Excessive nervousness
Diuretics	Low blood pressure
Iron supplements	Excessive absorption of iron
Sleeping pills	Increased sedation
Tranquilizers	Increased sedation

James W. Long and James J. Rybacki, The Essential Guide to Prescription Drugs 1995 (New York: Harper Collins, 1995)

Alcohol and age

As we grow older, our reaction time slows, we see and hear less clearly, and changes in the body's ability to metabolize food may lower our tolerance for alcohol. Each problem increases the risk of injury associated with drinking more than the body can handle.

On the other hand, moderate drinking remains a pleasant experience for people healthy enough to indulge. It also appears to be beneficial to intellectual health. In 2000, data from a 15-year, 1,700-person heart disease study at the Institute of Preventive Medicine, at Kommunehospitalet in Copenhagen, Denmark, showed that older men and women who regularly consumed up to 21 drinks of wine a week were less likely than teetotalers to develop Alzheimer's disease and other forms of dementia. Similarly, a recent 12-year, 1,488-person survey at Johns Hopkins University in Maryland suggests that regular, moderate drinkers score better over time than teetotalers do on the Mini-Mental State Examination (MMSE), a standard test for memory, reasoning, and decision making.

Advice from the Sages: Moderation

Good advice is always current. The folks who wrote Ecclesiastes (a book in the Bible) centuries ago may have been speaking to you when they said, "Wine is as good as life to man if it be drunk moderately." And it's impossible to improve on this slogan from the Romans (actually, one Roman writer named Terence): "Moderation in all things." Hey, you can't get a message more direct — or more sensible — than that.

The power of purple (and peanuts)

Grape skin, pulp, and seeds contain *resveratrol,* a naturally occurring plant chemical that seems to reduce the risk of heart disease and some kinds of cancer. The darker the grapes, the higher the concentration of resveratrol.

Dark purple grape juice, for example, has more resveratrol than red grape juice, which has more resveratrol than white grape juice. Because wine is made from grapes, it, too, contains resveratrol (red wine has more resveratrol than white wine).

But you don't need to drink grape juice or wine or eat grapes to get resveratrol. You can simply snack on peanuts. A 1998 analysis from the USDA Agricultural Research Service in Raleigh, North Carolina, showed that peanuts have 1.7 to 3.7 micrograms of resveratrol per gram of nuts (boiled peanuts are at the upper end). Compare that to the 0.7 micrograms of resveratrol in a glass of red grape juice or 0.6 to 8.0 micrograms of resveratrol per gram of red wine.

In the body, resveratrol appears to reduce inflammation. This fact may explain why a multitude of studies show a lower risk of heart disease among wine drinkers. In 2010, researchers at Johns Hopkins reported that drinking red wine may also reduce the risk of brain damage after a stroke. When they fed one group of lab mice red grape skin and seeds and then induced a stroke, the animals that had been fed the grape appetizers had less brain damage than did a control group of mice which had not. Whether this applies to human beings and how much resveratrol would be needed to produce the same effect remains to be shown.

Finally, a 2010 article in the *American Journal of Pathology* documents the discovery by Washington University researchers that resveratrol appears to inhibit *angiogenesis* (the formation of new blood vessels). Angiogenesis, which is essential to the formation and growth of tumors, also plays a role in the development of extra blood vessels in the eye leading to macular degeneration and diabetes-related blindness. Once again, whether what happened in lab animals will happen in human beings is an open, but intriguing, question.

Chapter 11

Vigorous Vitamins

In This Chapter

- Understanding the value of vitamins
- Finding vitamins in food
- Considering the consequences of vitamin deficiencies or overdoses
- Deciding when extra vitamins make sense

Vitamins are *organic chemicals,* substances that contain carbon, hydrogen, and oxygen that occur naturally in all living things: both plants and animals, such as flowers, trees, fruits, vegetables, chickens, fish, cows, and you. These natural compounds regulate a variety of bodily functions and are essential for building tissues, such as bones, skin, glands, nerves, and blood. They also assist in metabolizing (digesting) proteins, fats, and carbohydrates so that you can extract energy from food. Finally, they prevent nutritional deficiency diseases, promote healing, and encourage good health.

This chapter tells you where the vitamins are, how to add them to your diet, exactly how much of each you should consume each day, and how to tell how much is more than enough.

Listing the Vitamins Your Body Needs

For optimum health, your body requires at least 11 vitamins: vitamin A, vitamin D, vitamin E, vitamin K, vitamin C, and the members of the B vitamin family — thiamin (vitamin B1), riboflavin (B2), niacin, vitamin B6, folate, and vitamin B12. Two more B vitamins (biotin and pantothenic acid) and one unusual compound (choline) are also valuable.

You need only miniscule quantities of each vitamin for good health. In some cases, the recommended dietary allowances (RDAs), determined by the National Research Council, may be as small as several micrograms — $\frac{1}{1,000,000}$, or one one-millionth of a gram.

The father of all vitamins: Casimir Funk

Vitamins are so much a part of modern life you may have a hard time believing they were first discovered less than a century ago. Of course, people have long known that certain foods contain something special. For example, the ancient Greek physician Hippocrates prescribed liver for night-blindness (the inability to see well in dim light). By the end of the 18th century (1795), British Navy ships carried a mandatory supply of limes or lime juice to prevent scurvy among the men, thus earning the Brits once and forever the nickname limeys. Later on, the Japanese Navy gave its sailors whole grain barley to ward off beriberi.

Everyone knew these prescriptions worked, but nobody knew why — until 1912, when Casimir Funk (1884–1967), a Polish biochemist working first in England and then in the United States, identified "somethings" in food that he called *vitamines* (*vita* = life; *amines* = nitrogen compounds).

The following year, Funk and a fellow biochemist, Briton Frederick Hopkins, suggested that some medical conditions, such as scurvy and beriberi, were simply deficiency diseases caused by the absence of a specific nutrient in the body. Adding a food with the missing nutrient to one's diet would prevent or cure the deficiency disease. What else is there to say except, Eureka!

Which, since Funk was Polish but working in England, is probably exactly what he said.

Nutritionists classify vitamins as either *fat soluble* or *water soluble,* meaning that they dissolve either in fat or in water. If you consume larger amounts of fat-soluble vitamins than your body needs, the excess is stored in body fat. Large amounts of fat-soluble vitamins stored in your body may cause problems (see the section "Fat-soluble vitamins" in this chapter). With water-soluble vitamins, your body simply shrugs its shoulders, so to speak, and urinates away most of the excess.

Medical students often use mnemonic (pronounced *neh-mah-nic*) devices — memory joggers — to remember complicated lists of body parts and symptoms of diseases. Here's one to help you remember which vitamins are fat-soluble: "<u>A</u>ll <u>D</u>ogs <u>E</u>at <u>K</u>idneys." In other words, vitamins A, D, E, and K are fat soluble. All the rest dissolve in water.

Fat-soluble vitamins

Vitamin A, vitamin D, vitamin E, and vitamin K have two characteristics in common: All dissolve in fat, and all are stored in your fatty tissues. But like members of any family, they also have distinct personalities. One keeps your skin moist. Another protects your bones. A third keeps reproductive organs purring happily. And the fourth enables you to make special proteins.

Vitamin A

Vitamin A is the moisturizing nutrient that keeps your skin and *mucous membranes* (the slick tissue that lines the eyes, nose, mouth, throat, vagina, and rectum) smooth and supple. Vitamin A is also the vision vitamin, a constituent of *11-cis retinol,* a protein in the *rods* (cells in the back of your eye that enable you to see even when the lights are low) that prevents or slows the development of age-related *macular degeneration,* or progressive damage to the retina of the eye, which can cause the loss of central vision (the ability to see clearly enough to read or do fine work). Finally, vitamin A promotes the growth of healthy bones and teeth, keeps your reproductive system humming, and encourages your immune system to churn out the cells you need to fight off infection.

Your body gets its vitamin A from two classes of chemicals:

- *Retinoids* are compounds whose names all start with *ret:* retinol, retinaldehyde, retinoic acid, and so on. These fat-soluble substances are found in several foods of animal origin: liver (again!) and whole milk, eggs, and butter. Retinoids give you *preformed* vitamin A, the kind of nutrient your body can use right away.
- *Carotenoids* are *vitamin A precursors,* chemicals such as beta carotene, a deep yellow carotenoid (pigment) found in dark green, bright yellow, and orange fruits and vegetables. Your body transforms a vitamin A precursor into a retinol-like substance. So far, scientists have identified at least 500 different carotenoids. Only 1 in 10 — about 50 altogether — are considered to be sources of vitamin A.

Traditionally, the recommended dietary allowance of vitamin A is measured in International Units (IU). However, because retinol is the most efficient source of vitamin A, the modern way to measure the RDA for vitamin A is as *retinol equivalents,* abbreviated as RE. One microgram (mcg) RE = 3.3 IU. But a simple trip through the vitamin aisle at the drugstore shows that vitamin products still list the RDA for vitamin A in IUs.

Vitamin D

Calcium is essential for hardening teeth and bones, but no matter how much calcium you consume, without vitamin D, your body can't absorb and use the mineral. Researchers at the Bone Metabolism Laboratory at the Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University in Boston say vitamin D may also reduce the risk of tooth loss by preventing the inflammatory response that leads to periodontal disease, a condition that destroys the thin tissue (ligaments) that connects the teeth to the surrounding jawbone. And a report in the February 2006 issue of *The American Journal of Public Health* was the first to suggest that vitamin D supplements might cut in half a person's risk of developing some forms of cancer, including cancer of the colon, breast, or ovaries.

These last claims remain to be proven, but the very fact that they exist has made vitamin D supplements hot stuff. According to the market research firm Packaged Facts' market study, *Nutritional Supplements in the U.S.,* 4th Edition, sales of vitamin D rose a whopping 8 percent between 2006 and 2010, almost certainly due to a long list of good-news studies linking adequate doses of D to bone health, heart health, and general all around bounciness.

Vitamin D comes in three forms:

- *Calciferol* occurs naturally in fish oils and egg yolk, and, in the United States, it's added to margarines and milk.
- *Cholecalciferol* is created when sunlight hits your skin and ultraviolet rays react with steroid chemicals in body fat just underneath.
- *Ergocalciferol* is synthesized in plants exposed to sunlight. Cholecalciferol and ergocalciferol justify vitamin D's nickname: the Sunshine Vitamin.

The RDA for vitamin D is measured either in International Units (IUs) or micrograms (mcg) of cholecalciferol: 10 mcg cholecalciferol = 400 IU vitamin D.

Vitamin E

Vitamin E maintains your healthy reproductive system, nerves, and muscles. You get vitamin E from *tocopherols* and *tocotrienols,* two families of naturally occurring chemicals in vegetable oils, nuts, whole grains, and green leafy vegetables — your best natural sources of vitamin E.

Tocopherols, the more important source, have two sterling characteristics: They're anticoagulants and antioxidants that reduce blood's ability to clot, thus reducing the risk of clot-related stroke and heart attack. *Antioxidants* prevent free radicals (incomplete pieces of molecules) from hooking up with other molecules or fragments of molecules to form toxic substances that can attack tissues in your body. In fact, nutrition scientists at Purdue University released a study showing that vitamin E promotes bone growth by stopping free radicals from reacting with polyunsaturated fatty acids (see Chapter 8 for information on fats) to create molecules that interfere with the formation of new bone cells.

Some claims about E's heart health benefits are now considered iffy. True, a recent clinical trial at Cambridge University in England showed that taking 800 IU (International Units) vitamin E, two times the RDA, may reduce the risk of nonfatal heart attacks for people who already have heart disease. And, yes, the federal Women's Health Study found that older women taking 600 IU vitamin E per day had a lower risk of heart attack and a lower risk of death from heart disease. But the Heart Outcomes Prevention Evaluation (HOPE) study showed no such benefits. In fact, people taking 400 IU vitamin E per day were more likely to develop heart failure. No one (and no study) has found similar problems among those taking less vitamin E, say 100 IU/day. Whew.

The best sources of vitamin E are vegetables, oils, nuts, and seeds. The RDA is expressed as milligrams *a-tocopherol equivalents* (abbreviated as *a-TE*).

Vitamin K

Vitamin K is a group of chemicals that your body uses to make specialized proteins found in blood *plasma* (the clear fluid in blood). One such protein is prothrombin, the protein chiefly responsible for blood clotting. You also need vitamin K to make bone and kidney tissues. Like vitamin D, vitamin K is essential for healthy bones, activating at least three different proteins that take part in forming new bone cells. In 2003, a report from the long-running Framingham (Massachusetts) Heart Study showed adults consuming the least vitamin K each day are likely to have the highest incidence of broken bones. Finally, in the spring of 2010, a report from the Mayo Clinic suggested to the 101st Annual Meeting of the American Association for Cancer Research that an adequate intake of vitamin K cut the risk of non-Hodgkin's lymphoma, a cancer of the blood, almost in half.

Vitamin K is found in dark green leafy vegetables (broccoli, cabbage, kale, lettuce, spinach, and turnip greens), cheese, liver, cereals, and fruits, but most of what you need comes from resident colonies of friendly bacteria in your intestines, an assembly line of busy bugs churning out the vitamin day and night.

Water-soluble vitamins

The good news about water-soluble vitamins is that it is virtually impossible to overdose on them without taking enormous amounts of supplements. The bad news is that you have to take enough of these vitamins on a more or less regular schedule to protect yourself against deficiencies. (You don't have to take them every day; you could take less one day and more the next, and over time it evens out.)

Vitamin C

Vitamin C, also known by its chemical name ascorbic acid, is essential for the development and maintenance of connective tissue (the fat, muscle, and bone framework of the human body). Vitamin C speeds the production of new cells in wound healing, protects your immune system, helps you fight off infection, reduces the severity of allergic reactions, and plays a role in the syntheses of hormones and other body chemicals.

Lemons, limes, oranges — and bacon?

Check the meat label. Right there it is, plain as day — vitamin C in the form of *sodium ascorbate*, *isoascorbate,* or *sodium erythorbate.*

Processed meats such as bacon and sausages are preserved with sodium nitrite, which protects the meat from *Clostridium botulinum,* microorganisms that cause the potentially fatal food poisoning known as botulism.

On its own, sodium nitrite reacts at high temperatures with compounds in meat to form carcinogens called nitrosamines. Antioxidant vitamin C prevents the chemical reaction. It also prevents free radicals (incomplete pieces of molecules) from hooking up with each other to form damaging compounds — in this case *carcinogens,* substances that cause cancer.

Which is why Food and Drug Administration (FDA) and Department of Agriculture/Food Safety and Inspection Service (USDA FISIS) rules require vitamin C in your lunchmeat.

Thiamin (vitamin B1)

Call it thiamin. Call it B1. Just don't call it late for lunch (or any other meal). This sulfur *(thia)* and nitrogen *(amin)* compound, the first of the B vitamins to be isolated and identified, helps ensure a healthy appetite. It acts as a *coenzyme* (a substance that works along with other enzymes) essential to at least four different processes by which your body extracts energy from carbohydrates. Thiamin also is a mild diuretic (something makes you urinate more frequently). This vitamin is found in every body tissue, the highest concentrations are in your vital organs — heart, liver, and kidneys.

The richest dietary sources of thiamin are unrefined cereals and grains, lean pork, beans, nuts, and seeds. In the United States, refined flours, stripped of their thiamin, are a nutritional reality, so most Americans get most of their thiamin from breads and cereals enriched with additional B1.

Riboflavin (vitamin B2)

Riboflavin (vitamin B2), the second B vitamin to be identified, was once called vitamin G. Its present name is derivative of its chemical structure, a carbon-hydrogen-oxygen skeleton that includes *ribitol* (a sugar) attached to a *flavonoid* (a substance from plants containing a pigment called flavone).

Like thiamin, riboflavin is a coenzyme. Without it, your body can't digest and use proteins and carbohydrates. Like vitamin A, it protects the health of mucous membranes — the moist tissues that line the eyes, mouth, nose, throat, vagina, and rectum.

You get riboflavin from foods of animal origin (meat, fish, poultry, eggs, and milk), whole or enriched grain products, brewer's yeast, and dark green vegetables (like broccoli and spinach).

Niacin

Niacin is one name for a pair of naturally occurring nutrients, nicotinic acid and nicotinamide. Niacin is essential for proper growth, and like other B vitamins, it's intimately involved in enzyme reactions. In fact, it's an integral part of an enzyme that enables oxygen to flow into body tissues. Like thiamin, it gives you a healthy appetite and participates in the metabolism of sugars and fats.

Niacin is available either as a preformed nutrient or via the conversion of the amino acid tryptophan. Preformed niacin comes from meat; tryptophan comes from milk and dairy foods. Some niacin is present in grains, but your body can't absorb it efficiently unless the grain has been treated with lime — the mineral, not the fruit. This is a common practice in Central American and South American countries, where lime is added to cornmeal in making tortillas. In the United States, breads and cereals are routinely fortified with niacin. Your body easily absorbs the added niacin.

The term used to describe the niacin RDA is NE (niacin equivalent): 60 milligrams tryptophan = 1 milligram niacin = 1 niacin equivalent (NE).

Vitamin B6 (pyridoxine)

Vitamin B6 is another multiple compound, this one comprising three related chemicals: pyridoxine, pyridoxal, and pyridoxamine. Vitamin B6, a component of enzymes that metabolizes proteins and fats, is essential for getting energy and nutrients from food. It also helps lower blood levels of homocysteine (see Chapter 7), an amino acid produced when you digest proteins.

The American Heart Association calls a high level of homocysteine an independent (but not major) risk factor for heart disease, and the American Journal of Clinical Nutrition reported in 2005 that a high homocysteine level may be associated with an age-related decline in memory. Alas, follow-up studies show no reduction in the risk of heart disease or improvement in memory in those who reduce their blood levels of homocysteine.

The best food sources of vitamin B6 are liver, chicken, fish, pork, lamb, milk, eggs, unmilled rice (rice with the bran intact), whole grains, soybeans, potatoes, beans, nuts, seeds, and dark green vegetables, such as turnip greens. In the United States, bread and other products made with refined grains have added vitamin B6.

Folate

Folate, also known as folacin or folic acid, plays a role in the synthesis of DNA, the metabolism of proteins, and the subsequent synthesis of amino acids used to produce new body cells and tissues. It is vital for normal growth and wound healing, and the vitamin is essential to a pregnant woman's ability to create new maternal tissue as well as fetal tissue. The fetus, too, benefits from her mother's folate consumption: An adequate supply of folate during pregnancy dramatically reduces the risk of neural tube (spinal cord) birth defects such as *spina bifida* (the failure of the bones of the spine to close properly around the spinal cord).

Beans, dark green leafy vegetables, liver, yeast, and various fruits are excellent food sources of folate; all multivitamin supplements — and all grain products — in the United States must now include 400 mcg of folate per dose.

Vitamin B12

Vitamin B12 (cyanocobalamin) is a unique nutrient, the only vitamin that contains a mineral — in this case, cobalt. (Cyanocobalamin, a cobalt compound, is commonly used as vitamin B12 in vitamin pills and nutritional supplements.)

Vitamin B12 makes healthy red blood cells. It protects *myelin,* the fatty material that covers your nerves and enables you to transmit electrical impulses (messages) between nerve cells that make it possible for you to see, hear, think, move, and do all the things a healthy body does each day.

This vitamin cannot be produced by higher plants (the ones that yield our fruits and vegetables), but like vitamin K, vitamin B12 is made by beneficial bacteria living in the small intestine. Meat, fish, poultry, milk products, and eggs are good sources of vitamin B12. Grains don't naturally contain vitamin B12, but like other B vitamins, it's added to grain products in the United States.

Biotin

Biotin is a B-vitamin, a component of enzymes that ferry carbon and oxygen atoms between cells. Biotin helps you metabolize fats and carbohydrates and is essential for synthesizing fatty acids and amino acids needed for healthy growth. And it seems to prevent a buildup of fat deposits that may interfere with the proper functioning of liver and kidneys. (No, biotin won't keep fat from settling in more visible places, such as your hips.)

The best food sources of biotin are liver, egg yolk, yeast, nuts, and beans. If your diet doesn't give you all the biotin you need, bacteria in your gut will synthesize enough to make up the difference. No RDA exists for biotin, but the Food and Nutrition Board has established an Adequate Intake (AI), the safe and effective daily dose for nutrients for which no RDA has been set (see Chapter 5).

Pantothenic acid

Pantothenic acid, another B-vitamin, is vital to enzyme reactions that enable you to use carbohydrates and create steroid biochemicals such as hormones. Pantothenic acid also helps stabilize blood sugar levels, defends against infection, and protects *hemoglobin* (the protein in red blood cells that carries oxygen through the body), as well as nerve, brain, and muscle tissue.

You get pantothenic acid from meat, fish, poultry, beans, whole grain cereals, and fortified grain products. As with biotin, the Food and Nutrition Board has established an Adequate Intake (AI) for pantothenic acid.

Choline

In 1998, 138 years after choline was first identified, the Institute of Medicine (IOM) finally declared it essential for human beings. The IOM had good reasons for doing so. Although choline is neither a vitamin, a mineral, a protein, a carbohydrate, nor a fat, it does help keep body cells healthy. It's used to make *acetylcholine,* a chemical that enables brain cells to exchange messages. It protects the heart and lowers the risk of liver cancer. And new research at the University of North Carolina (Chapel Hill) shows that choline plays a role in developing and maintaining the ability to think and remember, at least among rat pups and other beasties born to lab animals that were given choline supplements while pregnant. Follow-up studies showed that prenatal choline supplements helped the animals grow bigger brain cells. True, no one knows whether this would also be true for human babies, but some researchers advise pregnant women to eat a varied diet, because getting choline from basic stuff like eggs, meat, and milk is so easy.

IOM's Food and Nutrition Board, the group that sets the RDAs, has established an AI (Adequate Intake) for choline.

Hand in hand: How vitamins help each other

All vitamins have specific jobs in your body. Some have partners. Here are some examples of nutrient cooperation:

- Vitamin E keeps vitamin A from being destroyed in your intestines.
- Vitamin D enables your body to absorb calcium and phosphorus.
- Vitamin C helps folate build proteins.
- Vitamin B1 works in digestive enzyme systems with niacin, pantothenic acid, and magnesium.

Taking vitamins with other vitamins may also improve body levels of nutrients. For example, in 1993, scientists at the National Cancer Institute and the U. S. Department of Agriculture (USDA) Agricultural Research Service gave one group of volunteers a vitamin E capsule plus a multivitamin pill; a second group, vitamin E alone; and a third group, no vitamins at all. The people getting vitamin E plus the multivitamin had the highest amount of vitamin E in their blood — more than twice as high as those who took plain vitamin E capsules.

Sometimes, one vitamin may even alleviate a deficiency caused by the lack of another vitamin. People who do not get enough folate are at risk of a form of anemia in which their red blood cells fail to mature. As soon as they get folate, either by injection or by mouth, they begin making new healthy cells. That's to be expected. What's surprising is the fact that anemia caused by *pellagra,* the niacin deficiency disease, may also respond to folate treatment.

Get Your Vitamins Here

One reasonable set of guidelines for good nutrition is the list of Recommended Dietary Allowances (RDAs) established by the National Research Council's Food and Nutrition Board. The RDAs present safe and effective doses for healthy people.

You can find the complete chart of RDAs for adults (ages 19 and up) in Chapter 5. Table 11-1 is the easy alternative, presenting the RDAs for adult men and women (ages 19 to 50) plus a quick guide to food portions that give you at least 25 percent of the recommended dietary allowances of vitamins for healthy adult men and women, ages 25 to 50.

Photocopy this chart. Pin it on your fridge. Tape it to your organizer or appointment book. Stick it in your wallet. Think of it as the truly simple way to see how easy it is to eat healthy.

Table 11-1 Servings That Provide at Least 25% of the RDA

Food	*Serving = 25% of the RDA*
VITAMIN A	***RDA: Women 4,000 IU, Men 5,000 IU****
Breads, cereals, grains	
Oatmeal — instant, fortified	2⅓ cup
Cold cereal	1 ounce
Fruits	
Apricots (dried, cooked)	½ cup
Cantaloupe (raw)	½ cup
Mango (raw)	½ medium
Vegetables	
Carrots, kale, peas and carrots, sweet red pepper (all cooked)	½ cup
Meat, poultry, fish	
Liver — chicken, turkey	½ cup (diced)
Dairy products	
Milk — low-fat, skim	2 cups
VITAMIN D	***RDA: Women 5 mcg/200 IU, Men 5 mcg/200 IU***
Meat, poultry, fish	
Salmon (canned)	1½ ounces
Tuna (canned)	2 ounces

Food	***Serving = 25% of the RDA***
Dairy products	
Eggs	3 medium
Milk — enriched	1 cup
VITAMIN E	***RDA: Women 15 mg a-TE, Men 15 mg a-TE***
Breads, cereals, grains	
Cold cereal	1 ounce
Wheat germ — plain	2 tbsp.
Fruits	
Apricots, peaches (canned)	1 cup
Vegetables	
Greens (cooked) — dandelion, mustard, turnip	1 cup
Meat, poultry, fish	
Shrimp	3 ounces
Other	
Almonds, hazelnuts/filberts	2 tbsp.
Peanut butter	2 tbsp.
Sunflower seeds	2 tbsp.
VITAMIN C	***RDA: Women 75 mg, Men 90 mg*****
Breads, cereals, grains	
Cold cereal	1 ounce
Fruits	
Cantaloupe	½ cup, diced
Grapefruit	½
Mango (raw)	½ medium
Orange	1 medium
Strawberries	½ cup
Grape, orange, or tomato juice	¼ cup
Vegetables	
Asparagus, broccoli, Brussels sprouts, kale, kohlrabi, sweet peppers, snow peas (cooked)	½ cup

(continued)

Table 11-1 *(continued)*

Food	*Serving = 25% of the RDA*
Sweet potato	1 medium
Meat, poultry, fish	
Liver — beef, pork	3 ounces
THIAMIN (VITAMIN B1)	***RDA: Women 1.1 mg, Men 1.2 mg***
Breads, cereals, grains	
Bagel, English muffin, roll	2 whole
Bread	4 slices
Farina, grits	½ cup
Oatmeal — instant, fortified	⅓ cup
Fruits	
Cantaloupe, honeydew	1 cup
Vegetables	
Corn, peas, peas and carrots (cooked)	1 cup
Meat, poultry, fish	
Ham — roast, smoked, cured, lean	3 ounces
Liver — beef, pork	3 ounces
Pork — all varieties except sausage	3 ounces
Other	
Sunflower seeds (hulled, unroasted)	2 tbsp.
RIBOFLAVIN (VITAMIN B2)	***RDA: Women 1.1 mg, Men 1.3 mg***
Breads, cereals, grains	
Bagel, English muffin, pita	2 whole
Cold cereal	1 ounce
Meat, poultry, fish	
Liver — beef, calf, pork	3 ounces
Liver — chicken, turkey	½ cup, diced
Liverwurst	1 ounce

Food	***Serving = 25% of the RDA***
Dairy products	
Milk — all varieties	2 cups
Yogurt — lowfat, nonfat	1 cup
NIACIN	***RDA: Women 14 mg NE, Men 16 mg NE***
Breads, cereals, grains	
Bagel, bran muffin, English muffin, pita, roll	2 whole
Cold cereal — fortified	1 ounce
Meat, poultry, fish	
Lamb, pork, veal — lean	3 ounces
Liver — beef, calf, pork	3 ounces
Chicken (no skin)	3 ounces (½ breast)
Mackerel, mullet, salmon, swordfish	3 ounces
Other	
Peanuts, peanut butter	4 tbsp.
VITAMIN B6	***RDA: Women 1.3 mg, Men 1.3 mg***
Breads, cereals, grains	
Oatmeal — instant, fortified	⅓ cup
Cold cereal	1 ounce
Fruits	
Banana (raw)	1 medium
Prunes (dried, cooked)	1 cup
Vegetables	
Plantain (boiled)	1 medium
Meat, poultry, fish	
Chicken (roasted, no skin)	½ breast
Lamb — lean only	1 chop
Liver — beef	3 ounces
FOLATE	***RDA: Women 400 mcg, Men 400 mcg***
Breads, cereals, grains	
Whole wheat English muffin, pita	2 whole
Cold cereal	1 ounce

(continued)

Table 11-1 *(continued)*

Food	***Serving = 25% of the RDA***
Vegetables	
Asparagus, beets, broccoli, Brussels sprouts, cauliflower, Chinese cabbage, creamed corn, spinach (cooked)	1 cup
Beans (dry, cooked) — black-eyed peas, lentils, red kidney	½ cup
Greens (cooked) — mustard, turnip	1 cup
Meat, poultry, fish	
Liver — beef, calf, pork	3 ounces
VITAMIN B12	***RDA: Women 2.4 mcg, Men 2.4 mcg***
Meat, poultry, fish	
Beef, pork, lamb, veal	3 ounces
Liver — beef, calf, pork	3 ounces
Liver — chicken, turkey	½ cup, diced
Catfish, crabmeat, croaker, lobster, mackerel, mussels, oysters, scallops, swordfish, trout, tuna	3 ounces
Dairy products	
Eggs	2 large
Milk — whole, lowfat, skim	2 cups
Yogurt	2 cups
Food	Serving (mg)
CHOLINE	***Adequate Intake: Women 425 mg, Men 550 mg***
Fruits	
Grape juice (canned)	8 ounces (13 mg)
Vegetables	
Cauliflower (cooked)	1 cup (55 mg)
Potato (baked)	1 medium (18 mg)

Food	*Serving = 25% of the RDA*
Meat, poultry, fish	
Beef (cooked)	3 ounces (59 mg)
Liver (cooked) — beef	3 ounces (453 mg)
Dairy	
Eggs	1 large (200–300 mg)
Milk — whole	8 ounces (10 mg)
Other	
Peanut butter	2 tbsp. (26 mg)

** Although these remain the "official" RDAs, newer recommendations are 900 mcg RE/3,000 IU per day for men and 700 mcg RE/2,300 IU per day for women (the IU amounts are rounded off).*
*** The Food and Nutrition Board is debating whether to raise the RDA for vitamin C to 200 mg for both men and women.*
"Good Sources of Nutrients" (Washington D.C.: U.S. Department of Agriculture/Human Nutrition Service, 1990); "Nutritive Value of Food" (Washington D.C.: U.S. Department of Agriculture, 1991).

Too Much or Too Little: Avoiding Two Ways to Go Wrong with Vitamins

RDAs are broad enough to prevent vitamin deficiencies and avoid the side effects associated with very large doses of some vitamins. If your diet doesn't meet these guidelines, or if you take very large amounts of some vitamins as supplements, you may be in for trouble.

Vitamin deficiencies

The good news is that vitamin deficiencies are rare among people who have access to a wide variety of foods and know how to put together a balanced diet. For example, the only people likely to experience a vitamin E deficiency are premature and/or low-birth-weight infants and people with a metabolic disorder that keeps them from absorbing fat. A healthy adult may go as long as ten years on a vitamin E-deficient diet without developing any signs of a problem.

Aha, you say, but what's this subclinical deficiency I hear so much about?

Nutritionists use the term *subclinical deficiency* to describe a nutritional deficit not yet far enough advanced to produce obvious symptoms. In lay terms, however, the phrase has become a handy explanation for common but hard-to-pin-down symptoms, such as fatigue, irritability, nervousness, emotional depression, allergies, and insomnia. And it's a dandy way to increase the sale of nutritional supplements.

Simply put, the RDAs protect you against deficiency. If your symptoms linger even after you take reasonable amounts of vitamin supplements, something other than a lack of any one vitamin may be to blame. Don't wait until your patience or your bank account has been exhausted to find out. Check with your doctor. While you're waiting for an appointment, Table 11-2 lists the symptoms of various vitamin deficiencies.

Table 11-2 Vitamin Alert: What Happens When You Don't Get the Vitamins You Need

A Diet Low in This Vitamin	*May Produce These Signs of Deficiency*
Vitamin A	Poor night vision; dry, rough, or cracked skin; dry mucous membranes including the inside of the eye; slow wound healing; nerve damage; reduced ability to taste, hear, and smell; inability to perspire; reduced resistance to respiratory infections
Vitamin D	In children: rickets (weak muscles, delayed tooth development, and soft bones, all caused by the inability to absorb minerals without vitamin D) In adults: osteomalacia (soft, porous bones that fracture easily); fatigue
Vitamin E	Inability to absorb fat
Vitamin K	Blood fails to clot
Vitamin C	Scurvy (bleeding gums; tooth loss; nosebleeds; bruising; painful or swollen joints; shortness of breath; increased susceptibility to infection; slow wound healing; muscle pains; skin rashes)
Thiamin (vitamin B1)	Poor appetite; unintended weight loss; upset stomach; gastric upset (nausea, vomiting); mental depression; an inability to concentrate; fatigue
Riboflavin (vitamin B2)	Inflamed mucous membranes, including cracked lips, sore tongue and mouth, burning eyes; skin rashes; anemia; fatigue

A Diet Low in This Vitamin	***May Produce These Signs of Deficiency***
Niacin	Pellagra (diarrhea; inflamed skin and mucous membranes; mental confusion and/or dementia); fatigue
A Diet Low in This Vitamin	***May Produce These Signs of Deficiency***
Vitamin B6	Anemia; convulsions similar to epileptic seizures; skin rashes; upset stomach; nerve damage (in infants); fatigue
Folate	Anemia (immature red blood cells); fatigue
Vitamin B12	Pernicious anemia (destruction of red blood cells, nerve damage, increased risk of stomach cancer attributed to damaged stomach tissue, neurological/psychiatric symptoms attributed to nerve cell damage); fatigue
Biotin	Loss of appetite; upset stomach; pale, dry, scaly skin; hair loss; emotional depression; skin rashes (in infants younger than 6 months)

Big trouble: Vitamin megadoses

Can you get too much of a good thing? Yes. In fact, some vitamins are toxic when taken in the very large amounts popularly known as *megadoses.* How much is a megadose? Nobody knows for sure. The general consensus is that a megadose is several times the RDA, but the term is so vague that it isn't even in the 28th edition of Stedman's Medical Dictionary (2006), a tome that's pretty much the gold standard in medical word books.

Nonetheless, it is clear that

- Megadoses of vitamin A (as retinol) may cause symptoms that make you think you have a brain tumor. Taken by a pregnant woman, megadoses of vitamin A may damage the fetus.
- Megadoses of vitamin D may cause kidney stones and hard lumps of calcium in soft tissue (muscles and organs), as well as nausea and other gastro discomfort.
- Megadoses of niacin (sometimes used to lower cholesterol levels) can damage liver tissue.
- Megadoses of vitamin B6 can cause (temporary) damage to nerves in arms and legs, fingers, and toes.

The interesting fact is that with one exception, the likeliest way to get a megadose of vitamins is to take supplements (see Chapter 6 for more on supplements) since it it's pretty much impossible for you to cram down enough food to overdose on vitamins D, E, K, C, and all the Bs.

The exception? Vitamin A. Liver and fish liver oils are concentrated sources of preformed vitamin A (retinol), the potentially toxic form of vitamin A. Liver contains so much retinol that early 20th century explorers to the South Pole made themselves sick on seal and whale liver. (See Table 11-3 for more on vitamin A toxicity, this time from supplements.) On the other hand, even very large doses of vitamin E, vitamin K, thiamin (vitamin B1), riboflavin (vitamin B2), folate, vitamin B12, biotin, and pantothenic acid appear safe for human beings. Table 11-3 lists the effects of vitamin overdoses.

Table 11-3 Amounts and Effects of Vitamin Overdoses for Healthy People

Vitamin	*Overdose and Possible Effect*
Vitamin A	15,000 to 25,000 IU retinol a day for adults (2,000 IU or more for children) may lead to liver damage, headache, vomiting, abnormal vision, constipation, hair loss, loss of appetite, low-grade fever, bone pain, sleep disorders, and dry skin and mucous membranes. A pregnant woman who takes more than 10,000 IU a day doubles her risk of giving birth to a child with birth defects.
Vitamin D	2,000 IU a day can cause irreversible damage to kidneys and heart. Smaller doses may cause muscle weakness, headache, nausea, vomiting, high blood pressure, retarded physical growth, mental retardation in children, and fetal abnormalities.
Vitamin E	Large amounts (more than 400 to 800 IU a day) may cause upset stomach or dizziness. Similarly, in 2005 a meta-analysis (a study comparing the results of several studies) in the *Annals of Internal Medicine* showed that use of "high dose" (400 IU or more) vitamin E supplements might "increase all causes of mortality [death] and should be avoided."
Vitamin C	1,000 mg or higher may cause upset stomach, diarrhea, or constipation.
Niacin	Doses higher than the RDA raise the production of liver enzymes and blood levels of sugar and uric acid, leading to liver damage and an increased risk of diabetes and gout.
Vitamin B6	Continued use of 50 mg or more a day may damage nerves in arms, legs, hands, and feet. Some experts say the damage is likely to be temporary; others say that it may be permanent.
Choline	Very high doses (14 to 37 times the adequate amount) have been linked to vomiting, salivation, sweating, low blood pressure, and — ugh! — fishy body odor.

Acceptable Exceptions: Taking Extra Vitamins as Needed

Who needs extra vitamins? Maybe you. The RDAs are designed to protect healthy people from deficiencies, but sometimes the circumstances of your life (or your lifestyle) mean that you need something extra. Are you taking medication? Do you smoke? Are you on a restricted diet? Are you pregnant? Are you a nursing mother? Are you approaching menopause? Answer yes to any of these questions, and you may be a person who needs larger amounts of vitamins than the RDAs provide.

I'm taking medication

Many valuable medicines interact with vitamins. Some drugs increase or decrease the effectiveness of vitamins; some vitamins increase or decrease the effectiveness of drugs. For example, a woman who's using birth control pills may absorb less than the customary amount of the B vitamins. For more about vitamin and drug interactions, see Chapter 25.

I'm a smoker

It's a fact — you probably have abnormally low blood levels of vitamin C. More trouble: Chemicals from tobacco smoke create more free radicals in your body. Even the National Research Council, which is tough on vitamin overdosing, says that regular smokers need to take about 66 percent more vitamin C — up to 100 mg a day — than nonsmokers.

I never eat animals

On the other hand, if you're nuts for veggies but follow a vegan diet — one that shuns all foods from animals (including milk, cheese, eggs, and fish oils) — you simply cannot get enough vitamin D without taking supplements. Vegans also benefit from extra vitamin C because it increases their ability to absorb iron from plant food. And vitamin B12–enriched grains or supplements are a must to supply the nutrient found only in fish, poultry, milk, cheese, and eggs.

I'm pregnant

Keep in mind that "eating for two" means that you're the sole source of nutrients for the growing fetus, not that you need to double the amount of food you eat. If you don't get the vitamins you need, neither will your baby.

The RDAs for many nutrients are the same as those for women who aren't pregnant. But when you're pregnant, you need extra

- **Vitamin D:** Every smidgen of vitamin D in a newborn's body comes from his or her mom. If the mother doesn't have enough D, neither will the baby. Are vitamin pills the answer? Yes. And no. The qualifier is how many pills, because although too little vitamin D can weaken a developing fetus, too much can cause birth defects. That's why until new recommendations for vitamin D are issued, the second important *d*-word is "doctor." As in, check with yours to see what's right for you.
- **Vitamin E:** To create all that new tissue (the woman's as well as the baby's), a pregnant woman needs an extra 2 a-TE each day, the approximate amount in one egg.
- **Vitamin C:** The level of vitamin C in your blood falls as your vitamin C flows across the placenta to your baby, who may — at some point in the pregnancy — have vitamin C levels as much as 50 percent higher than yours. So you need an extra 10 milligrams vitamin C each day (½ cup cooked zucchini or 2 stalks of asparagus).
- **Riboflavin (vitamin B2):** To protect the baby against structural defects such as cleft palate or a deformed heart, a pregnant woman needs an extra 0.3 milligrams riboflavin each day (slightly less than 1 ounce of ready-to-eat cereal).
- **Folate:** Folate protects the child against cleft palate and neural tube (spinal cord) defects such as *spina bifida.* As many as 2 of every 1,000 babies born each year in the United States have a neural tube defect such as spina bifida because their mothers didn't get enough folate to meet the RDA standard. Taking 400 micrograms folate daily before becoming pregnant and through the first two months of pregnancy significantly lowers the risk of giving birth to a child with cleft palate. Taking 400 micrograms folate each day through an entire pregnancy reduces the risk of neural tube defects.
- **Vitamin B12:** To meet the demands of the growing fetus, a pregnant woman needs an extra 0.2 micrograms vitamin B12 each day (just 3 ounces of roasted chicken).

I'm breast-feeding

You need extra vitamin A, vitamin E, thiamin, riboflavin, and folate to produce sufficient quantities of nutritious breast milk, about 25 ounces/750 ml each day. You need extra vitamin D, vitamin C, and niacin as insurance to replace the vitamins you lose — that is, the ones you transfer to your child in your milk.

I'm approaching menopause

Information about the specific vitamin requirements of older women is as hard to find as, well, information about the specific vitamin requirements about older men. It's enough to make you wonder what's going on with the people who set the RDAs. Don't they know that everyone gets older? Right now, just about all anybody can say for sure about the nutritional needs of older women is that they require extra calcium to stem the natural loss of bone that occurs when women reach menopause and their production of the female hormone estrogen declines. They may also need extra vitamin D to enable their bodies to absorb and use the calcium.

Gender Bias Alert! No similar studies are available for older men. But adding vitamin D supplements to calcium supplements increases bone density in older people.

The current RDA for vitamin D is set at 5 micrograms/200 IU for all adults, but the new AI (Adequate Intake) for vitamin D is 10 micrograms/400 IU for people ages 51 to 70 and 15 micrograms/600 IU or more for people 71 and older. Some researchers suggest that even these amounts may be too low to guarantee maximum calcium absorption. Check with your doctor before adding vitamin D supplements. In very large amounts, this vitamin can be toxic.

I have very light skin or very dark skin

Sunlight — yes, plain old sunlight — transforms fats just under the surface of your skin to vitamin D. So getting what you need should be a cinch, right? Not necessarily. Getting enough vitamin D from sunlight is hard to do when you have very light skin and avoid the sun for fear of skin cancer. Even more difficult is getting enough vitamin D when you have very dark skin, which acts as a kind of natural sun block.

Chapter 12

Mighty Minerals

In This Chapter

- Explaining how your body uses minerals
- Getting the minerals you need from foods
- Naming signs of overdose and deficiency
- Identifying times when you need a little extra

Minerals are *elements,* substances composed of only one kind of atom. They're inorganic. (Translation: They don't contain the carbon, hydrogen, and oxygen atoms found in all organic compounds, including vitamins.) And they occur naturally in nonliving things, such as rocks and metal ores. Although minerals also are present in plants and animals, they're imported: Plants absorb minerals from the soil; animals obtain minerals by eating plants.

Most minerals have names that describe where they're found or what they look like. For example, the name calcium comes from *calx,* the Greek word for "lime" (chalk), a source of calcium. The name chlorine comes from *chloros,* the Greek word for "greenish-yellow," which just happens to be the color of the mineral. Other minerals, such as americium, curium, berkelium, californium, fermium, and nobelium, are named for where they were first identified or to honor an important scientist.

This chapter tells you which minerals your body requires, which foods provide what minerals, and how much of each mineral a healthy person needs.

The Minerals You Need

Think of your body as a house. Vitamins (see Chapter 11) are like tiny little maids and butlers, scurrying about to turn on the lights and make sure that the windows are closed to keep the heat from escaping. Minerals are more sturdy stuff, the mortar and bricks that strengthen the frame of the house and the current that keeps the lights running.

An elementary guide to minerals

The early Greeks thought that all material on Earth was constructed of a combination of four basic elements: earth, water, air, and fire. Centuries later, alchemists looking for the formula for precious metals, such as gold, decided that the essential elements were sulfur, salt, and mercury. Wrong again.

In 1669, a group of German chemists isolated phosphorus, the first mineral element to be accurately identified. After that, things moved a bit more swiftly. By the end of the 19th century, scientists knew the names and chemical properties of 82 elements. Today, 112 elements have been identified.

The classic guide to chemical elements is the periodic table, a chart devised in 1869 by Russian chemist Dimitri Mendeleev (1834–1907), for whom mendelevium was named. The table was revised by British physicist Henry Moseley (1887–1915), who came up with the concept of *atomic numbers,* numbers based on the number of *protons* (positively charged particles) in an elemental atom.

The periodic table is a clean, crisp way of characterizing the elements, and if you are now or ever were a chemistry, physics, or premed student, you can testify firsthand to the joy (maybe that's not the best word?) of memorizing the information it provides. Personally, I'd rather be forced to watch reruns of *The Dating Game.*

Nutritionists classify the minerals essential for human life as either *major minerals* (including the principal electrolytes — see Chapter 13) or *trace elements.* Nutritionally speaking, the difference between the two is the amount of the mineral you store in your body and how much you need to take in to maintain a steady supply.

Your body stores more than 5 grams (about ⅙ of an ounce) of each of the major minerals and principal electrolytes. To replace what you lose and maintain a healthy level, you need to consume more than 100 milligrams (3.5 ounces) a day of each major mineral. The quantities for trace elements are smaller. You store less than 5 grams of each trace element and need to take in less than 100 milligrams a day to stay even.

The major minerals

The following major minerals are essential for human beings:

- Calcium
- Phosphorus
- Magnesium

- Sulfur
- Sodium
- Potassium
- Chloride

Note: Sodium, potassium, and chloride, also known as the principal electrolytes, are covered in Chapter 13.

Although sulfur, a major mineral, is an essential nutrient for human beings, it's almost never included in nutritional books and/or charts. Why? Because it's an integral part of all proteins. Any diet that provides adequate protein also provides adequate sulfur. (For more on proteins, check out Chapter 7.)

Calcium

When you step on the scale in the morning, you can assume that about 3 pounds of your body weight is calcium, most of it packed into your bones and teeth.

Calcium is also present in extracellular fluid (the liquid around body cells), where it performs the following duties:

- Regulating fluid balance by controlling the flow of water in and out of cells
- Enabling cells to send messages back and forth from one to another
- Keeping muscles moving smoothly and preventing cramping

An adequate amount of calcium is important for controlling high blood pressure — and not only for the person who takes the calcium directly. At least one study shows that when a pregnant woman gets a sufficient amount of calcium, her baby's blood pressure stays lower than average for at least the first seven years of life, meaning a lower risk of developing high blood pressure later on.

Your best food sources of calcium are milk and dairy products, as well as fish, such as canned sardines and salmon, which come with bones that have been softened and made edible by processing. (***Caution:*** Bones in fresh fish are *not* edible and should not be eaten.) Calcium also is found in dark green leafy vegetables, but the calcium in plant foods is bound into compounds that are less easily absorbed by your body.

TECHNICAL STUFF

Calcium: The bone team player

Like all body tissues, bones are constantly being replenished. Old bone cells break down, and new ones are born. Specialized cells called *osteoclasts* start the process by boring tiny holes into solid bone so that other specialized cells, called *osteoblasts,* can refill the open spaces with fresh bone. At that point, crystals of calcium, the best-known dietary bone builder, hook onto the network of new bone cells to harden and strengthen the bone.

Calcium begins its work on your bones while you're still in your mother's womb. But it's not the only mineral at play. Think iron and zinc. Based on a survey of 242 pregnant women in Peru, where zinc deficiency is common, Johns Hopkins researchers found the babies born to women who got prenatal supplements with iron, folic acid, and zinc had longer, stronger leg bones than did babies born to women who got the same supplement minus the zinc.

Once you're born, calcium continues to build your bones, but only with the help of vitamin D, which produces a calcium-binding protein that enables you to absorb the calcium in milk. To make sure you get your D, virtually all milk sold in the United States is fortified with the vitamin. And because you may outgrow your taste for milk but never outgrow your need for calcium, calcium supplements for adults frequently include vitamin D. (Your body also makes vitamin D when you're exposed to sunlight.)

But vitamin D isn't milk's only contribution. Milk also contains *lactoferrin* (*lacto* = milk; *ferri* = iron), an iron-binding compound that stimulates the production of the cells that promote bone growth.

Finally, note that the word *bones* begins with *b* — as in vitamin B12. The female sex hormone estrogen preserves bone; the male sex hormone testosterone builds new bone. As people age and their supply of sex hormones diminishes, they lose bone faster than they can replace it. One complicating factor may be low levels of vitamin B12. A report in the *Journal of Clinical Endocrinology and Metabolism* says that researchers at the University of California, San Francisco, found that women with lower levels of this vitamin also have less dense hip bones.

To summarize: To protect your bones, you need calcium, zinc, iron, and vitamins D and B12, all found most abundantly in milk, cheese, eggs, and red meat. Which sounds like a cardiologist's nutritional high-fat, high-cholesterol nightmare — except that you certainly will edit the menu to read: skim milk, lowfat cheese, egg whites, and lean beef.

Phosphorus

Like calcium, phosphorus is essential for strong bones and teeth. For tiptop performance, you need about half as much phosphorus as calcium. Phosphorus also enables a cell to transmit the *genetic code* (genes and chromosomes that carry information about your special characteristics) to the new cells created when a cell divides and reproduces. In addition, phosphorus

- Helps maintain the pH balance of blood (that is, keeps it from being too acidic or too alkaline)
- Is vital for metabolizing carbohydrates, synthesizing proteins, and ferrying fats and fatty acids among tissues and organs
- Is part of *myelin,* the fatty sheath that surrounds and protects each nerve cell

Phosphorus is in almost everything you eat, but the best sources are high-protein foods, such as meat, fish, poultry, eggs, and milk. These foods provide more than half the phosphorus in a nonvegetarian diet; grains, nuts, seeds, and dry beans also provide respectable amounts.

Magnesium

Your body uses magnesium to make body tissues, especially bone. The adult human body has about an ounce of magnesium, and three-quarters of it is in the bones. Magnesium also is part of more than 300 different enzymes that trigger chemical reactions throughout your body. You use magnesium to

- Move nutrients in and out of cells
- Send messages between cells
- Transmit the genetic code (genes and chromosomes) when cells divide and reproduce

An adequate supply of magnesium also is heart-healthy because it enables you to convert food to energy using less oxygen.

Plant foods such as bananas, dark green fruits and vegetables (magnesium is part of chlorophyll, the green pigment in plants), whole seeds, nuts, beans, and grains are excellent sources of magnesium.

The trace elements

Trace elements also are minerals, but they're present in much, much smaller amounts. That's why they are called *trace* elements. The list includes

- Iron
- Zinc
- Iodine
- Selenium
- Copper

- Manganese
- Fluoride
- Chromium
- Molybdenum

Iron

Iron is an essential constituent of *hemoglobin* and *myoglobin,* two proteins that store and transport oxygen. You find hemoglobin in red blood cells (it's what makes them red). Myoglobin (*myo* = muscle) is in muscle tissue. Iron also is part of various enzymes.

The best food sources of iron are organ meats (liver, heart, kidneys), red meat, egg yolks, wheat germ, and oysters. These foods contain *heme* (*heme* = blood) iron, a form of iron that your body can easily absorb.

Whole grains, wheat germ, raisins, nuts, seed, prunes and prune juice, and potato skins contain nonheme iron. Because plants contain substances called *phytates,* which bind this iron into compounds, your body has a hard time getting at the iron. Eating plant foods with meat or with foods that are rich in vitamin C (like tomatoes) increases your ability to split away the phytates and get iron out of plant foods.

Zinc

Zinc protects nerve and brain tissue, bolsters the immune system, and is essential for healthy growth. Zinc is part of the enzymes (and hormones such as insulin) that metabolize food, and you can fairly call it the macho male mineral.

The largest quantities of zinc in the male human body are in the testes, where it's used in making a continuous supply of *testosterone,* the hormone a man needs to produce plentiful amounts of healthy, viable sperm. Without enough zinc, male fertility falters. So, yes, the old wives' tale is true: Oysters — a rich source of zinc — are useful for men (yes, women also need zinc).

In addition to oysters, good sources of zinc are meat, liver, and eggs. Zinc is also plentiful in nuts, beans, miso, pumpkin and sunflower seeds, whole-grain products, and wheat germ. But the zinc in plants, like the iron in plants, occurs in compounds that your body absorbs less efficiently than the zinc in foods from animals.

Iodine

Iodine is a component of the thyroid hormones thyroxine and triiodothyronine, which help regulate cell activities. These hormones are also essential for protein synthesis, tissue growth (including the formation of healthy nerves and bones), and reproduction.

The best natural sources of iodine are seafood and plants grown near or in the ocean, but modern Americans are most likely to get the iodine they need from iodized salt (plain table salt with iodine added).

And here's an odd nutritional note: You may get substantial amounts of iodine from milk because the milk is processed and stored in machines and vessels kept clean and sanitary with iodine-based disinfectants that send tiny trace amounts of iodine into the milk. Iodine compounds are also used as dough conditioners (additives that make dough more pliable), so you're also likely to find some iodine in most commercial breads.

Selenium

Selenium was identified as an essential human nutrient in 1979 when Chinese nutrition researchers discovered that people with low body stores of selenium were at increased risk of *Keshan disease,* a disorder of the heart muscle with symptoms that include rapid heartbeat, enlarged heart, and (in severe cases) heart failure, a consequence most common among young children and women of childbearing age.

Although fruits and vegetables grown in selenium-rich soils are themselves rich in this mineral, the best sources of selenium are seafood, meat and organ meats (liver, kidney), eggs, and dairy products.

Copper

Copper is an antioxidant found in enzymes that deactivate free radicals (pieces of molecules that can link up to form compounds that damage body tissues) and make it possible for your body to use iron. Copper also may play a role in slowing the aging process by decreasing the incidence of *protein glycation,* a reaction in which sugar molecules (*gly* = sugar) hook up with protein molecules in your bloodstream, twist the protein molecules out of shape, and make them unusable. Protein glycation may result in bone loss, high cholesterol, cardiac abnormalities, and a slew of other unpleasantries. In people with diabetes, excess protein glycation may also be one factor involved in complications such as loss of vision.

In addition, copper

- Promotes the growth of strong bones
- Protects the health of nerve tissue
- Prevents your hair from turning gray prematurely. But, no, no, a thousand times, no: Large amounts of copper absolutely will not turn gray hair back to its original color. Worse yet, megadoses of copper are potentially toxic.

You can get the copper you need from organ meats (such as liver and heart), seafood, nuts, and dried beans, including cacao beans (the beans used to make chocolate).

Manganese

Most of the manganese in your body is in your glands (pituitary, mammary, pancreas), organs (liver, kidneys, intestines), and bones. Manganese is an essential constituent of the enzymes that metabolize carbohydrates and synthesize fats (including cholesterol). Manganese is important for a healthy reproductive system. During pregnancy, manganese speeds the proper growth of fetal tissue, particularly bones and cartilage.

You get manganese from whole grains, cereal products, fruits, and vegetables. Tea is also a good source of manganese.

Fluoride

Fluoride is the form of fluorine (an element) in drinking water. Your body stores fluoride in bones and teeth. Although researchers still have some questions about whether fluoride is an essential nutrient, it's clear that it hardens dental enamel, reducing your risk of getting cavities. In addition, some nutrition researchers suspect (but cannot prove) that some forms of fluoride strengthen bones.

All soil, ground water, plants and animal tissue contain small amounts of fluoride, but the most steady supply of fluoride comes from fluoridated drinking water (see Chapter 13).

Chromium

Very small amounts of *trivalent chromium,* a digestible form of the very same metallic element that decorates your car and household appliances, are essential for several enzymes that you need to metabolize fat.

Chromium also partners with glucose tolerance factor (GTF), a group of chemicals that enables insulin (an enzyme from the pancreas) to regulate your use of glucose, the end product of metabolism and the basic fuel for every body cell (see Chapter 3). In a recent joint study by USDA and the Beijing Medical University, adults with non-insulin-dependent diabetes who took chromium supplements had lower blood levels of sugar, protein, and cholesterol, which are all good signs for people with diabetes. In a related study, chromium reduced blood pressure in laboratory rats bred to develop hypertension (high blood pressure), a common complication in diabetes.

Right now, little information exists about the precise amounts of chromium in specific foods. Nonetheless, yeast, calves' liver, American cheese, wheat germ, and broccoli are regarded as valuable sources of this trace element.

Molybdenum

Molybdenum (pronounced mo-*lib*-de-num) is part of several enzymes that metabolize proteins. You get molybdenum from beans and grains. Cows eat grains, so milk and cheese have some molybdenum. Molybdenum also leeches into drinking water from surrounding soil. The molybdenum content of plants and drinking water depends entirely on how much molybdenum is in the soil.

Getting the Minerals You Need

Table 12-1 is a handy guide to foods that provide the minerals and trace elements your body needs. This chart is the easy way to figure out which foods (and how much) provide at least 25 percent of the recommended dietary allowance (RDA) for healthy adults ages 25 to 50.

No muss, no fuss, no calculators. Just photocopy these pages and stick them on the fridge. What an easy way to eat right! Wait! One more important note: When you see "men" or "women" in the following chart, it means "men and women ages 25 to 50" — unless otherwise noted.

Table 12-1 Get Your Minerals Here! — Foods and Serving Sizes

Food	*Serving*
CALCIUM and PHOSPHORUS	***RDA: Calcium — men and women 1,000 mg*** ***RDA: Phosphorus — men and women 700 mg***
Breads, cereals, grains	
Bran muffin, English muffin	2 whole
Vegetables	
Broccoli, spinach, turnip greens (cooked)	1 cup
Dairy products	
Natural Gruyère, Romano, Swiss, Parmesan cheeses	1 ounce
Processed cheddar or Swiss cheeses	1½ ounces
Natural blue, brick, Camembert, feta, Gouda, Monterey, mozzarella, Muenster, provolone, Roquefort cheeses	2 ounces
Ricotta cheese	½ cup
Ice cream/ice milk	1 cup
Milk — all varieties, including chocolate	1 cup
Yogurt — all varieties	1 cup (8 ounces)

(continued)

Table 12-1 *(continued)*

Food	*Serving*
Other	
Tofu	½ cup, cubed
MAGNESIUM	***RDA: Men 400–420 mg,* women 310–320 mg****
Breads, cereals, grains	
Bread — whole wheat	4 slices
Bran muffin, English muffin, pita — whole wheat	2 whole
Cold cereal	2 ounces
Vegetables	
Artichoke	2 medium
Black-eyed peas, chickpeas, soybeans, white beans (dry, cooked)	1 cup
Dairy products	
Milk — chocolate, made with skim milk	2 cups
Yogurt — plain nonfat	2 cups
Other	
Nuts and seeds	2 tbsp.
Tofu	½ cup cubed
IRON	***RDA: Men 8 mg, women 18 mg, 8 mg****
Breads, cereals, grains	
Bagel, bran muffin, pita	2 whole
Farina, oatmeal — instant, fortified	⅓ cup
Cold cereal	1 ounce
Fruits	
Apricots (dried, cooked)	1 cup
Vegetables	
Black-eyed peas, chickpeas, lentils, red and white beans (dried, cooked)	1 cup
Soybeans (cooked)	½ cup
Meat, poultry, fish	
Clams (raw) — meat only	3–4 ounces
Oysters (raw) — meat only	1–2 ounces
Other	

Food	*Serving*
Pine nuts, seeds — pumpkin or squash	4 tbsp.
ZINC	***RDA: Men 11 mg, women 8 mg***
Breads, cereals, grains	
Cold cereals — fortified	2 ounces
Meat, poultry, fish	
Beef — all varieties, lean	3 ounces
Lamb — all varieties, lean	3 ounces
Tongue (braised)	3 ounces
Veal — roast, lean only	3 ounces
Chicken (no skin)	2 legs
Oysters	3 ounces
Dairy products	
Yogurt — all varieties	2 cups
Other	
Seeds — pumpkin or squash	4 tbsp.
COPPER	***AI: Men and women 900 mg***
Breads, cereals, grains	
Barley (cooked)	⅓ cup
Bran muffin, English muffin, pita	2 whole
Fruits	
Prunes (dried, cooked)	1 cup
Vegetables	
Black-eyed peas, lentils, soybeans (cooked)	1 cup
Meat, poultry, fish	
Liver — beef, calf	3 ounces
Liver — chicken, turkey	½ cup, diced
Crabmeat, lobster, oysters, shrimp	3 ounces
Other	
Almonds, Brazil nuts, cashews, hazelnuts/filberts, peanuts, pistachios, walnuts, mixed nuts	4 tbsp.
Seeds — pumpkin, sesame, squash, sunflower	4 tbsp.

**The lower numbers are for people age 19–30; the higher numbers, for people age 31+.*
Good Sources of Nutrients (Washington, D.C.: U.S. Department of Agriculture/Human Nutrition Service, 1990); Nutritive Value of Food (Washington, D.C.: USDA, 1991); DRI reports 1998–2004.

Did you notice something missing from this list? Right: There are no entries for the essential trace elements chromium, fluoride, iodine, molybdenum, and selenium, because a healthful, varied diet provides sufficient quantities of these nutrients. Iodized salt and fluoridated water are extra insurance.

Too Much and Too Little

The Recommended Dietary Allowances (RDAs) and Adequate Intakes (AIs) for minerals and trace elements are generous allowances, large enough to prevent deficiency but not so large that they trigger toxic side effects. (Read more about RDAs and AIs in Chapter 5.)

Avoiding mineral deficiency

What happens if you don't get enough minerals and trace elements? Some minerals, such as phosphorus and magnesium, are so widely available in food that deficiencies are rare to nonexistent. No nutrition scientist has yet been able to identify a naturally occurring deficiency of sulfur, manganese, chromium, or molybdenum in human beings who follow a sensible diet. Most drinking water contains adequate fluoride, and Americans get so much copper (can it be from chocolate bars?) that deficiency is practically unheard of in the United States.

But other minerals are more problematic:

- **Calcium:** Without enough calcium, a child's bones and teeth don't grow strong and straight, and an adult's bones lose minerals and weaken. Calcium is a team player. To protect against deficiency, you also need adequate amounts of vitamin D, the nutrient that allows you to absorb the calcium you get from food or supplements. Milk fortified with vitamin D has done much to eliminate rickets (see Chapter 11 on vitamins).
- **Iron:** *Iron deficiency anemia* is not just an old advertising slogan. Lacking sufficient iron, your body can't make the hemoglobin it requires to carry energy-sustaining oxygen to every tissue. As a result, you're often tired and feel weak. Mild iron deficiency may also inhibit intellectual performance. In one Johns Hopkins study, high school girls scored higher verbal, memory, and learning test scores when they took supplements providing Recommended Dietary Amounts of iron.

  WARNING!

  Check with your doctor before downing iron supplements or cereals fortified with 100 percent of your daily iron requirement, the *Environmental Nutrition* newsletter warns. *Hemochromatosis,* a common but often-undiagnosed genetic defect affecting one in every 250 Americans, can lead to *iron overload,* an increased absorption of the mineral linked to arthritis, heart disease, and diabetes, as well as an increased risk of infectious diseases and cancer (viruses and cancer cells thrive in iron-rich blood).

- **Zinc:** An adequate supply of zinc is vital for making testosterone and healthy sperm. Men who don't get enough zinc may be temporarily infertile. Zinc deficiency leads to loss of appetite and the ability to taste food. It may also weaken your immune system, increasing your risk of infections. Wounds heal more slowly when you don't get enough zinc. That includes the tissue damage caused by working out. In plain language: If you don't get the zinc you need, your charley horse may linger longer. And, yes, several studies have confirmed that sucking on lozenges containing one form of zinc (zinc gluconate) shortens a cold — by a day or two. Other studies show no effect. Your choice.
- **Iodine:** A moderate iodine deficiency leads to *goiter* (a swollen thyroid gland) and reduced production of thyroid hormones. A more severe deficiency early in life may cause a form of mental and physical retardation called *cretinism.*
- **Selenium:** Not enough selenium in your diet? Watch out for muscle pain or weakness. To protect against selenium problems, make sure that you get plenty of vitamin E. Some animal studies show that a selenium deficiency responds to vitamin E supplements. And vice versa.

The risks of overdoses

Like any medications, some vitamins and minerals are potentially toxic in large doses. For example:

- **Calcium:** Though clearly beneficial in amounts higher than the current RDAs, calcium is not problem-free:
  - Constipation, bloating, nausea, and intestinal gas are common side effects among healthy people taking supplements equal to 1,500 to 4,000 milligrams of calcium a day.
  - Doses higher than 4,000 milligrams a day may be linked to kidney damage.
  - Megadoses of calcium can bind with iron and zinc, making it harder for your body to absorb these two essential trace elements.
- **Phosphorus:** Too much phosphorus can lower your body stores of calcium.
- **Magnesium:** Megadoses of magnesium appear safe for healthy people, but if you have kidney disease, the magnesium overload can cause weak muscles, breathing difficulty, irregular heartbeat, and/or cardiac arrest (your heart stops beating).

- **Iron:** Overdosing on iron supplements can be deadly, especially for young children. The lethal dose for a young child may be as low as 3 grams (3,000 milligrams) elemental iron at one time. This is the amount in 60 tablets with 50 milligrams elemental iron each. For adults, the lethal dose is estimated to be 200 to 250 milligrams elemental iron per kilogram (2.2 pounds) of body weight. That's about 13,600 milligrams (13.6 g) for a 150-pound person — the amount you'd get in 292 tablets with 50 milligrams elemental iron each. New FDA rules require individual blister packaging for supplements containing more than 30 milligrams iron to foil tiny fingers and prevent accidental overdoses.
- **Zinc:** Moderately high doses of zinc (up to 25 milligrams a day) may slow your body's absorption of copper. Doses 27 to 37 times the RDA (11 mg/males; 8 mg/females) may interfere with your immune function and make you more susceptible to infection, the very thing that normal doses of zinc protect against. Gram doses (2,000 milligrams/2 grams) of zinc cause symptoms of zinc poisoning: vomiting, gastric upset, and irritation of the stomach lining.
- **Iodine:** Overdoses of iodine cause exactly the same problems as iodine deficiency: goiter. How can that be? When you consume very large amounts of iodine, the mineral stimulates your thyroid gland, which swells in a furious attempt to step up its production of thyroid hormones. This reaction may occur among people who eat lots of dried seaweed for long periods of time.
- **Selenium:** Doses as high as 5 milligrams of selenium a day (90 times the RDA) have been linked to thickened but fragile nails, hair loss, and perspiration with a garlicky odor. Extreme megadoses — 27.3 milligrams selenium/436 times the RDA from mislabeled supplements — have been linked to *selenium intoxication* (fatigue, abdominal pain, nausea and diarrhea, and nerve damage). The longer they used the supplements, the worse their symptoms were.
- **Fluoride:** Despite decades of argument, no scientific proof exists that the fluorides in drinking water increase the risk of cancer in human beings. But there's no question that large doses of fluoride — for example from heavily fluoridated well or groundwater in the western United States — leads to *fluorosis* (brown patches on your teeth), brittle bones, fatigue, and muscle weakness. Over long periods of time, high doses of fluoride may also cause *outcroppings* (little bumps) of bone on the spine.

  Fluoride levels higher than 6 milligrams a day are considered hazardous; never take fluoride supplements except as directed by your doctor or dentist.
- **Molybdenum:** Doses of molybdenum two to seven times the Adequate Intake (AI) (45 micrograms) may increase the amount of copper you excrete in urine.

Caution: Interaction ahead

Some minerals interact with other minerals or with medical drugs. For example, calcium binds tetracycline antibiotics into compounds your body can't break apart so that the antibiotic moves out of your digestive tract, unabsorbed and unused. That's why your doctor warns you off milk and dairy products when you're taking this medicine. For more about interactions between minerals and medicines, turn to Chapter 25.

When You May Need More than the RDA

If your diet provides enough minerals to meet the RDAs, you're in pretty good shape most of the time. But a restrictive diet, the circumstances of your reproductive life, and just plain getting older can increase your need for minerals. Here are some scenarios.

You're a strict vegetarian

Vegetarians who pass up fish, meat, and poultry must get their iron either from fortified grain products such as breakfast cereals or commercial breads or naturally from foods such as seeds, nuts, blackstrap molasses, raisins, prune juice, potato skins, green leafy vegetables, tofu, miso, or brewer's yeast. Because iron in plant foods is bound into compounds that are difficult for the human body to absorb, iron supplements are pretty much standard fare.

Vegans — vegetarians who avoid all foods from animals, including dairy products — have a similar problem getting the calcium they need. Calcium is in vegetables, but it, like iron, is bound into hard-to-absorb compounds. So vegans need calcium-rich substitutes. Good food choices are soybean milk fortified with calcium, orange juice with added calcium, and tofu processed with calcium sulfate.

You live inland, away from the ocean

Now here's a story of 20th-century nutritional success. Seafood and plants grown near or in the ocean are exposed to iodine-rich seawater. Freshwater fish, plants grown far from the sea, and the animals that feed on these fish and plants are not exposed to iodine. So people who live inland and get all their food from local gardens and farms cannot get the iodine they need from food.

I'm looking for an iron supplement. What's this "ferrous" stuff?

The iron in iron supplements comes in several different forms, each one composed of elemental iron (the kind of iron your body actually uses) coupled with an organic acid that makes the iron easy to absorb.

The iron compounds commonly found in iron supplements are

- Ferrous citrate (iron plus citric acid)
- Ferrous fumarate (iron plus fumaric acid)
- Ferrous gluconate (iron plus a sugar derivative)
- Ferrous lactate (iron plus lactic acid, an acid formed in the fermentation of milk)
- Ferrous succinate (iron plus succinic acid)
- Ferrous sulfate (iron plus a sulfuric acid derivative)

In your stomach, these compounds dissolve at different rates, yielding different amounts of elemental iron. So supplement labels list the compound and the amount of elemental iron it provides, like this:

Ferrous gluconate 300 milligrams

Elemental iron 34 milligrams

This tells you that the supplement has 300 milligrams of the iron compound ferrous gluconate, which gives you 34 milligrams of usable elemental iron. If the label just says "iron," that's shorthand for elemental iron. The elemental iron number is what you look for in judging the iron content of a vitamin/mineral supplement.

American savvy and technology rode to the rescue in 1924 with the introduction of iodized salt. Then came refrigerated railroad cars and trucks to carry food from both coasts to every inland city and state. Together, modern salt and efficient shipment virtually eliminated goiter, the iodine deficiency disease, in this country. Nonetheless, millions of people worldwide still suffer from chronic iodine deficiency.

You're a man

Just as women lose iron during menstrual bleeding, men lose zinc at ejaculation. Men who are extremely active sexually may need extra zinc. The trouble is, no one has ever written down standards for what constitutes "extremely active." Check this one out with your doctor.

You're a woman

The average woman loses about 2 to 3 teaspoons of blood during each menstrual period, a loss of 1.4 milligrams of iron. Women whose periods are very heavy lose more blood and more iron. Because getting the iron you need from a diet providing fewer than 2,000 calories a day may be virtually impossible, you may develop a mild iron deficiency. To remedy this, some doctors prescribe a daily iron supplement.

Women who use an intrauterine device (IUD) may also be given a prescription for iron supplements because IUDs irritate the lining of the uterus and cause a small but significant loss of blood and iron.

You're pregnant

The news about pregnancy is that women may not need extra calcium. This finding, released late in 1998, is so surprising that it probably pays to stay tuned for more — and definitely check with your own doctor. Meanwhile, pregnant women still need supplements to build not only fetal tissues but also new tissues and blood vessels in their own bodies. Animal studies suggest (but don't prove) that you may also need extra copper to protect nerve cells in the fetal brain. Nutritional supplements for pregnant women are specifically formulated to provide the extra nutrients they need.

You're breast-feeding

Nursing mothers need extra calcium, phosphorus, magnesium, iron, zinc, and selenium to protect their own bodies while producing nutritious breast milk. The same supplements that provide extra nutrients for pregnant women will meet a nursing mother's needs.

Wow — You think that was a hot flash?

Then you need extra calcium. Both men and women produce the sex hormones testosterone and estrogen, although men make proportionately more testosterone, and women, more estrogen. Testosterone builds bone; estrogen preserves it.

At menopause, a woman's production of estrogen drops precipitously, and her bones rapidly become less dense. As men age and their testosterone levels drop, they're also at risk of losing bone tissue, but the loss is less rapid and dramatic than a woman's.

Nutritionists once thought it impossible to reduce the age-related loss of bone density, believing that body ceased to absorb calcium after the mid-20s. Today, that is no longer the case. Regardless of gender, an increased consumption of calcium plus vitamin D appears to help. Not only does vitamin D increase the body's absorption of calcium and protect bones. It may also protect the heart: In 2010, a team of researchers at the University of Auckland (New Zealand) announced that taking calcium supplements alone, without vitamin D, might increase the risk of heart attack.

Chapter 13

Water Works

In This Chapter

- Understanding why you need water
- Discovering how much water you need
- Explaining the nature and functions of electrolytes
- Heeding the signs that you need more water

The human body is mostly (50 to 70 percent) water. Exactly how much water your own human body contains depends on how much muscle and fat you have. Muscle tissue has more water than fat tissue, so, because the average male body has proportionately more muscle than the average female body, it also has more water. For the same reason — more muscle — a young body has more water than an older one.

You definitely won't enjoy the experience, but if you have to, you can live without food for weeks at a time, obtaining subsistence levels of nutrients by digesting your own muscle and fat. But water's different. Without it, you'll die in a matter of days — more quickly in a place warm enough to make you perspire and lose water more quickly.

This chapter explains why water is so important and offers some pointers on how to keep your body's water level *level.*

Investigating the Many Ways Your Body Uses Water

Water is a solvent. It dissolves other substances and carries nutrients and other material (such as blood cells) around the body, making it possible for every organ to do its job. You need water to

- Digest food, dissolving nutrients so that they can pass through the intestinal cell walls into your bloodstream, and move food along through your intestinal tract
- Carry waste products out of your body
- Provide a medium in which biochemical reactions, such as metabolism (digesting food, producing energy, and building tissue), occur
- Send electrical messages between cells so that your muscles can move, your eyes can see, your brain can think, and so on
- Regulate body temperature — cooling your body with moisture (perspiration) that evaporates on your skin
- Lubricate your moving parts

Maintaining the Right Amount of Water in Your Body

As much as three-quarters of the water in your body is in *intracellular fluid,* the liquid inside body cells. The rest is in *extracellular fluid,* which is all the other body liquids, such as

- Interstitial fluid (the fluid between cells)
- Blood plasma (the clear liquid in blood)
- Lymph (a clear, slightly yellow fluid collected from body tissues that flows through your lymph nodes and eventually into your blood vessels)
- Bodily secretions such as sweat, seminal fluid, and vaginal fluids
- Urine

A healthy body must have just the right amount of fluid inside and outside each cell, a situation described as *fluid balance.* Maintaining your fluid balance is essential to life. If there is too little water inside a cell, the cell shrivels and dies. If there's too much water, the cell bursts.

The body maintains its fluid balance through the action of substances called *electrolytes,* mineral compounds that, when dissolved in water, become electrically charged particles called *ions.*

Many minerals, including calcium, phosphorus, and magnesium, form compounds that dissolve into charged particles. But nutritionists generally use the term electrolyte to describe sodium, potassium, and chlorine. The most familiar electrolyte is the one found on every dinner table: sodium chloride — plain old table salt. (In water, its molecules dissolve into two ions: one sodium ion and one chloride ion.)

Fluoridated water: The real Tooth Fairy

Except for the common cold, dental cavities are the most common human medical problem.

You get cavities from *mutans streptococci,* bacteria that live in dental plaque. The bacteria digest and ferment carbohydrate residue on your teeth (plain table sugar is the worst offender) leaving acid that eats away at the mineral surface of the tooth. This eating away is called *decay.* When the decay gets past the enamel to the softer pulp inside of the tooth, your tooth hurts. And you head for the dentist even though you hate it so much you'd almost rather put up with the pain. But almost doesn't count, so off you go.

Brushing and flossing help prevent cavities by cleaning your teeth so that bacteria have less to feast on. Another way to reduce your susceptibility to cavities is to drink *fluoridated water* — water containing the mineral fluorine.

Fluoride — the form of fluorine found in food and water — combines with other minerals in teeth and makes the minerals less soluble (harder to dissolve). You get the most benefit by drinking water containing 1 part fluoride to every 1 million parts water (1 ppm) from the day you're born until the day you get your last permanent tooth, usually around age 11 to 13.

Some drinking water, notably in the American Southwest, is fluoridated naturally when it flows through rocks containing fluorine. Sometimes so much fluoride is in this water that it causes a brownish spotting (or mottling) that occurs while teeth are developing and accumulating minerals. This effect doesn't occur with drinking water artificially supplemented with fluoride at the approved standard of one part fluoride to every million parts of water.

Because fluorides concentrate in bones, some people believe that drinking fluoridated water raises the risk of bone cancers, but no evidence to support this claim has ever been found in human beings. However, in 1990, a U.S. Public Health Service's National Toxicology Program (NTP) study of the long-term effects of high fluoride consumption on laboratory rats and mice added fuel to the fire: Four of the 1,044 laboratory rats and mice fed high doses of fluoride for two years developed *osteosarcoma,* a form of bone cancer.

The study sent an immediate *frisson* (shiver of fear) through the health community, but within a year, federal officials reviewing the study issued an opinion endorsing the safety and effectiveness of fluoridated water.

Here's why: First, the number of cancers among the laboratory animals was low enough to have occurred simply by chance. Second, the cancers occurred only in male rats; no cases were reported in female rats or mice of either sex. Finally, the amount of fluorides the animals ingested was 50 to 100 times higher than what you get in drinking water. To get as much fluoride as those rats did, human beings would have to drink more than 380 8-ounce glasses of fluoridated water a day.

Today, more than half the people living in the United States have access to adequately fluoridated public water supplies. The result is a lifelong 50 percent to 70 percent reduction in cavities among the residents of these communities.

The electrolytes' primary job

Under normal circumstances, the fluid inside your cells has more potassium than sodium and chloride. The fluid outside is just the opposite: more sodium and chloride than potassium. The cell wall is a *semipermeable membrane;*

some things pass through, but others don't. Water molecules and small mineral molecules flow through freely, unlike larger molecules such as proteins.

The process by which sodium flows out and potassium flows in to keep things on an even keel is called the *sodium pump.* If this process were to cease, sodium ions would build up inside your cells. Sodium attracts water; the more sodium there is inside the cell, the more water flows in. Eventually, the cell would burst and die. The sodium pump, regular as a clock, prevents this imbalance from happening so you can move along, blissfully unaware of those efficient, electric ions that tell the water in your body where to go. (See the sidebar "How does water know where to go?")

Other tasks electrolytes perform

In addition to maintaining fluid balance, sodium, potassium, and chloride (the form of chlorine found in food) ions create electrical impulses that enable cells to send messages back and forth between themselves so you can think, see, move, and perform all the bioelectrical functions that you take for granted.

Sodium, potassium, and chloride are also major minerals (see Chapter 12) and essential nutrients. Like other nutrients, they're useful in these bodily processes:

- Sodium helps digest proteins and carbohydrates and keeps your blood from becoming too acidic or too alkaline.
- Potassium is used in digestion to synthesize proteins and starch and is a major constituent of muscle tissue.
- Chloride is a constituent of hydrochloric acid, which breaks down food in your stomach. It's also used by white blood cells to make *hypochlorite,* a natural antiseptic.

Getting the Water You Need

Because the body doesn't store water, you need to take in a new supply every day, enough to replace what you lose when you breathe, perspire, urinate, and defecate. On average, this adds up to 1,500 to 3,000 milliliters (50 to 100 ounces; 6 to 12.5 cups) a day. Here's how:

- 850 to 1,200 milliliters (28 to 40 ounces) is lost in breath and perspiration.
- 600 to 1,600 milliliters (20 to 53 ounces) is lost in urine.
- 50 to 200 milliliters (1.6 to 6.6 ounces) is lost in feces.

How does water know where to go?

Osmosis is the principle that governs how water flows through a semipermeable membrane (one that lets only certain substances pass through) such as the one surrounding a body cell.

Here's the principle: Water flows through a semipermeable membrane from the side where the liquid solution is least dense to the side where it's denser. In other words, the water, acting as if it has a mind of its own, tries to equalize the densities of the liquids on both sides of the membrane.

How does the water know which side is more dense? Now that one's easy: Wherever the sodium content is higher. When more sodium is inside the cell, more water flows in to dilute it. When more sodium is in the fluid outside the cell, water flows out of the cell to dilute the liquid on the outside.

When The Ancient Mariner complained, "Water, water everywhere, and not a drop to drink," he wasn't kidding. He was talking about osmosis. Drink seawater, and liquid flows out of your cells to dilute the salty solution in your intestinal tract. The more seawater you drink, the more water you lose. In other words, when you drink seawater, you're literally drinking yourself into dehydration.

Of course, the same thing happens — though certainly to a lesser degree — when you eat salted pretzels or nuts. The salt in your mouth makes your saliva saltier, drawing liquid out of the cells in your cheeks and tongue, which feel uncomfortably dry. Solution: A glass of water!

Toss in some extra ounces for a safe margin, and you get the current recommendations that women age 19 and up consume about 11 cups of water a day and men age 19 and up, about 15.

Not all that water must come in a cup from the tap. About 15 percent of the water that you need is created when you digest and metabolize food. The end products of digestion and metabolism are carbon dioxide (a waste product that you breathe out of your body) and water composed of hydrogen from food and oxygen from the air that you breathe. The rest of your daily water comes directly from what you eat and drink. You can get water from, well, plain water. Eight 10-ounce glasses give you 2,400 milliliters, approximately enough to replace what your body loses every day, so everyone from athletes to couch potatoes knew that a healthy body needed eight full glasses of water a day.

Or at least they *thought* they knew. But then Dartmouth Medical School kidney specialist Heinz Valtin turned off the tap with one simple question: "Who says that all the water you need has to come from water?"

Valtin's report in the *American Journal of Physiology* (2003) notes that some of the water you require is right there in your food. Fruits and vegetables are full of water. Lettuce, for example, is 90 percent water. Furthermore, you get water from foods that you'd never think of as water sources: hamburger (more than 50 percent), cheese (the softer the cheese, the higher the water content — Swiss cheese is 38 percent water; skim milk ricotta, 74 percent), a plain, hard bagel (29 percent water), milk powder (2 percent), and even butter and margarine (10 percent). Only oils have no water.

In 2008, the National Institutes of Health agreed, issuing new recommendations saying that women appear to get enough water from about 91 ounces (2.7 liters) of water a day from all sources; men, about 125 ounces (3.7 liters) a day. And the usual qualifier holds: Every body is individual, so these are only guidelines.

It is important to recognize that not all liquids are equally liquefying. The caffeine in coffee and tea and the alcohol in beer, wine, and spirits are *diuretics,* chemicals that make you urinate more copiously. Although caffeinated and alcohol beverages provide water, they also increase its elimination from your body — which is why you feel thirsty the morning after you've had a glass or two of wine.

In other words (actually in Valtin's words), a healthy adult in a temperate climate who isn't perspiring heavily can get enough water simply by drinking only when he or she is thirsty.

Bottle battle

Most people in the United States get their drinking water straight from the tap, but a steadily growing number of Americans get theirs in plastic bottles.

Most people who buy the bottles say the liquid inside just tastes better. Others think the bottled stuff is safer, even though municipal water systems are subject to more rigorous regulation than water bottlers, and some plastic water bottles contain BPA (bisphenola), a potential carcinogen that you can avoid by looking for a triangle and the number 7 stamped on the bottom, indicating that the bottle is BPA-free.

Exactly how many people buy exactly how many bottles of water may vary a bit from source to source, but one 2009 report in *Bottled Water Reporter* says that from 2000 to 2008, the total amount of bottled water sold in the United States climbed from 4,725,000,000 gallons to 8,665,600,000. That number translates to nearly 29 gallons of bottled water per year for every man, woman, and child in the country.

Those gallons don't come cheap. The National Resource Defense Council estimates that bottled water costs anywhere from 240 to 10,000 (!) times as much as safe tap water. They're also expensive for the environment. According to the Environmental Protection Agency, Americans tossed away 2,480,000 tons of plastic bottles and jars in 2008 to live forever in landfills or make their way out to sea. Worldwide, the United Nations estimates that every single square mile of ocean on the planet contains 48,000 pieces of floating plastic to drift on the water for years and years and years and years until the plastic finally degrades. Or doesn't.

Container recycling laws, local bans on bottled water, and newly reusable bottles offer hope of some relief from the tons of plastic garbage. So does new technology suggesting that ultraviolet light and heat may render plastic bottles degradable.

Until then, buy a thermos and carry tap water. Your wallet and your planet will thank you.

Taking in Extra Water and Electrolytes As Needed

In the United States, most people regularly consume much more sodium than they need. In fact, some people who are sodium-sensitive may end up with high blood pressure that can be lowered if they reduce their sodium intake. For more about high blood pressure, check out *High Blood Pressure For Dummies* (published by Wiley) by Alan L. Rubin, MD.

Potassium and chloride are found in so many foods that here, too, a dietary deficiency is a rarity. In fact, the only recorded case of chloride deficiency was among infants given a formula liquid from which the chloride was inadvertently omitted.

In 2004, the Adequate Intake (AI) for sodium, potassium, and chloride were set at one-size-fits-all averages for a healthy adult age 19–50 weighing 70 kilograms (154 pounds; see Chapter 5 for more on AI):

- **Sodium:** 1,500 milligrams
- **Potassium:** 4,700 milligrams
- **Chloride:** 2,300 milligrams

Most Americans get much more as a matter of course, and sometimes you actually need extra water and electrolytes. The next sections tell you when.

You're sick to your stomach

Repeated vomiting or diarrhea drains your body of water and electrolytes. Similarly, you also need extra water to replace the liquid lost in perspiration when you have a high fever.

When you lose enough water to be dangerously dehydrated, you also lose the electrolytes you need to maintain fluid balance, regulate body temperature, and trigger dozens of biochemical reactions. Plain water doesn't replace those electrolytes. Check with your doctor for a drink that will hydrate your body without upsetting your tummy.

When plain water is too plain

Serious dehydration calls for serious medicine, such as the World Health Organization's handy-dandy, two-tumbler electrolyte replacement formula.

Caution: If you're reading this while lying in bed exhausted by some variety of *turista,* the traveler's diarrhea acquired from impure drinking water, do not make the formula without absolutely clean glasses, washed in bottled water. Better yet, get paper cups.

Now here's what you need:

Glass No. 1

8 ounces orange juice

A pinch of salt

½ teaspoon sweetener (honey, corn syrup)

Glass No. 2

8 ounces boiled or bottled or distilled water

¼ teaspoon baking soda

Take a sip from one glass, then the other, and continue until finished. If diarrhea continues, contact your doctor.

You're exercising or working hard in a hot environment

When you're warm, your body perspires. The moisture evaporates and cools your skin so that blood circulating up from the center of your body to the surface is cooled. The cooled blood returns to the center of your body, lowering the temperature (your *core temperature*) there, too.

If you don't cool your body down, you continue losing water. If you don't replace the lost water, things can get dicey because not only are you losing water, you're also losing electrolytes. The most common cause of temporary sodium, potassium, and chloride depletion is heavy, uncontrolled perspiration.

WARNING!

Deprived of water and electrolytes, your muscles cramp, you're dizzy and weak, and perspiration, now uncontrolled, no longer cools you. Your core body temperature begins rising, and without relief — air conditioning or a cool shower, plus water, ginger ale, or fruit juice — you may progress from heat cramps to heat exhaustion to heat stroke. The latter is potentially fatal.

But drinking *too much* water while exercising can also be hazardous to your health. Flooding your body with liquid dilutes the sodium in your bloodstream. This may cause body tissues, including your brain, to swell, a condition known as *hyponaturemia,* or "water intoxication." The New Rule from the American College of Sports Medicine is to drink just enough water to maintain your body weight while working out. How much is that? Step on a scale before exercising. Exercise for an hour. Step back on the scale. You need 16 ounces of water to replace every pound lost in your one hour's exercise. Lose one pound, drink 16 ounces. Lose ½ pound, drink 8 ounces.

You're on a high-protein diet

You need extra water to eliminate the nitrogen compounds in protein. This is true of infants on high-protein formulas and adults on high-protein weight-reducing diets. See Chapter 7 to find out why too much protein may be so harmful.

You're taking certain medications

Because some medications interact with water and electrolytes, always ask whether you need extra water and electrolytes whenever your doctor prescribes

- **Diuretics:** These drugs increase the loss of sodium, potassium, and chloride.
- **Neomycin (an antibiotic):** This medicine binds sodium into insoluble compounds, making it less available to your body.
- **Colchicine (an antigout drug):** This medicine lowers your body's absorption of sodium.

Dehydration: When the Body Doesn't Get Enough Water

Every day, each of us loses an amount of water equal to about 4 percent of our total weight. If we don't take in enough water to replace it, warning signals go off loud and clear.

First signs

Early on, when you've lost just a little water, equal to about 1 percent of your body weight, you feel thirsty. If you ignore thirst, it grows more intense.

When water loss rises to about 2 percent of your weight, your appetite fades. Your circulation slows as water seeps out of blood cells and blood plasma.

And you experience a sense of emotional discomfort, a perception that things are, well, not right.

Worsening problems

By the time your water loss equals 4 percent of your body weight (5 pounds for a 130-pound woman; 7 pounds for a 170-pound man), you're slightly nauseated, your skin is flushed, and you're very, very tired. With less water circulating through your tissues, your hands and feet tingle, your head aches, your temperature rises, you breathe more quickly, and your pulse quickens.

Really bad trouble

After this, things go downhill more quickly. When your water loss reaches 10 percent of your body weight, your tongue swells, your kidneys start to fail, and you're so dizzy that you can't stand on one foot with your eyes closed. In fact, you probably can't even try: Your muscles are in spasm.

When you lose enough water to equal 15 percent of your body weight, you're deaf and pretty much unable to see out of eyes that are sunken and covered with stiffened lids. Your skin has shrunk, and your tongue has shriveled.

The crash

When you've lost water equal to 20 percent of your body weight, your body is at the limit of its endurance.

Deprived of life-giving liquid, your skin cracks, and your organs grind to a halt. And so do you.

Ave atque vale, or as the Romans say when in the United States, Canada, Great Britain, Australia, or any place where English is the mother tongue: "Hail and Farewell."

Water words

Chemically speaking, H_2O (one molecule hydrogen, two molecules oxygen) is a queer duck, the only substance on earth that exists as a liquid (water) and a solid (ice) — but never as a bendable plastic material. (No, as chemistry teachers explain each year to first-year chemistry students, snow is not plastic water. It's a collection of solids [ice crystals]).

Semantically speaking, water is also challenging.

For starters, water may be hard or soft, but these terms have nothing to do with how the water feels on your hand. They describe the liquid's mineral content:

- *Hard water* has lots of minerals, particularly calcium and magnesium. This water rises to the Earth's surface from underground springs, picking up calcium carbonate as it moves up through the ground.
- *Soft water* has fewer minerals. In nature, soft water is surface water, the runoff from rain-swollen streams or rainwater that falls directly into reservoirs. *Water softeners* are products that attract and remove the minerals in water.

What you get at the supermarket is another list of water words:

- *Distilled water* is tap water that has been *distilled,* or boiled until it turns to steam, which is then collected and condensed back into a liquid free of impurities, chemicals, and minerals. The term *distilled* is also used to describe a liquid produced by *ultrafiltration,* a process that removes everything from the water except water molecules. Distilled water makes clean, clear ice cubes and serves as a flavor-free mixer or base for tea and coffee. It won't clog a steam iron, and it's valuable for chemical and pharmaceutical processing.
- S*pring water* is water from springs relatively near the Earth's surface. This water has fewer mineral particles and what some people describe as a "cleaner taste" than mineral water.
- *Mineral water* is water from deeper down; it picks up minerals on its journey upwards. Mineral spring water is naturally alkaline, which makes it a natural antacid and a mild diuretic.
- *Still water* is spring water that flows up to the surface on its own. *Sparkling water* is pushed to the top by naturally occurring gases in the underground spring. So, you ask, what's the big difference? Sparkling water has bubbles; still water doesn't.
- *Springlike* or *spring fresh* are terms designed to make the water in the bottle seem more prestigious. Products labeled with these terms aren't spring water; they're most likely to be filtered tap water, the liquid that flows out when you turn on the faucet (see *distilled water,* earlier in this list).