

## *Fantastic Taoist Voyage - Kurzweil & Grossman*

### **Chapter 1: You Can Live Long-Enough To Live Forever**

Immortality is within our grasp. The knowledge exists, if aggressively applied, for you to slow aging and disease processes to such a degree that you can be in good health and good spirits when the more radical life-extending and life-enhancing technologies become available over the next couple of decades.

### **Chapter 2: The Bridges To Come**

"We are in the early stages of multiple profound revolutions spawned by the intersection of biology, information science, and nanotechnology. "With the decoding of the genome and our efforts to decode its expression in proteins, many new and powerful methodologies are emerging. These include rational drug design (drugs designed for very precise missions with little or no side effects), tissue engineering (regrowing our cells, tissues, and organs), reversal of aging processes, gene therapy (essentially reprogramming our genetic code), nanobots (robots the size of blood cells built from molecules placed in our bodies and bloodstreams to enhance every aspect of our lives), and many others. Some of these transformations will bear fruit before the ink is dry from printing this book.

### **Chapter 3: Our Personal Journeys**

Each of us comes to concerns about our health and well-being in a different way. Study and reflection, the experiences of relatives and friends, and our own experiences of pain and joy all play a role. These are our stories, a journey of decades of exploration and the intersection of our paths that brought us to write this book together.

### **Chapter 4: Food And Water**

Animals spend most of their effort pursuing food as well as avoiding becoming a predator's next meal. Most of human effort throughout our history has also been devoted to hunting, foraging, growing, cultivating, transporting, and preparing food. Our food choices also have a profound impact on health and disease. We start our exploration of food by looking at its most common constituent: water, a far more complex substance than is commonly understood. Consuming the right type of water is vital to detoxifying the body's acidic waste products and is one of the most powerful health treatments available.

### **Chapter 5: Carbohydrates And The Glycemic Load**

Carbohydrates are vital to the primary energy cycle in the biological world. But we did not evolve to consume the large quantities of refined sugars and starches that make up most of the modern diet. Sugar and simple starches, which are converted into sugar in the body almost immediately, produce spikes in insulin, which in turn create carbohydrate cravings. This process underlies much of the population's inability to control excess weight, accelerates the aging process, and increases the risk for heart disease. Sharply limiting these "high-glycemic-load" foods will break this vicious cycle.

### **Chapter 6: Fat And Protein**

Fat is well known as a primary means of storing energy, both in the food we consume and in our body's own fat cells. In an era of abundant calories, excessive energy storage in the form of fat significantly accelerates atherosclerosis, glucose intolerance, and other degenerative processes. The modern Western diet has gone to an extreme imbalance in the omega-6 to omega-3 fatty acid ratio, so most people need to sharply reduce omega-6 fats, which encourage inflammatory processes, and increase omega-3 fats, which are anti-inflammatory and have been shown to dramatically reduce heart disease. Protein is another class of caloric nutrient that we cannot live without—it is nature's primary building block for our tissues and organs. The right types and balance of protein are the mainstay of a healthy diet low in carbohydrates and that sharply restricts bad fats.

### **Chapter 7: You Are What You Digest**

Nutrition is one of the most powerful lifestyle influences on your health. Metabolic processes underlie the paths to the primary degenerative diseases. By understanding and assessing your personal metabolic pathways, you can reprogram these processes away from disease and toward long-term vitality. Many digestive problems, such as leaky gut syndrome, will contribute to long-term degenerative disease if not diagnosed and corrected. Nutrition starts with what you eat, but the digestive process is also critical, because nutrients are beneficial only if they reach your cells.

### **Chapter 8: Change Your Weight For Life In One Day**

You can significantly reduce your risk of all degenerative diseases, including heart disease, cancer, type 2 diabetes, and hypertension, by reaching your optimal weight. You'll have more energy and feel better. You'll look better too—perhaps the main reason losing weight has become a national preoccupation. Closely related to losing weight is caloric restriction, the only proven method of extending life and slowing down aging. We provide a program that you can adopt quickly while reaching your ideal weight gradually. No radical changes in diet are required. You only need to make a single change to a healthy pattern of eating.

### **Chapter 9: The Problem With Sugar (And Insulin)**

Per capita consumption of sugar and sugary sweeteners in the United States now exceeds 150 pounds per year. When sugar or high glycemic foods are eaten, blood levels of insulin rise dramatically. While insulin is necessary to health, elevated levels are highly toxic. Over time, excessive sugar consumption and high insulin levels will often lead to metabolic syndrome, also known as syndrome X, a major risk factor for heart disease now found in one-third of the adult population. Another result is one adult in twelve now has type 2 diabetes. There are simple ways to find out if you have, or are at risk of having, these conditions, and there are dietary and nutritional strategies for effectively controlling them.

#### ***Chapter 10: Ray's Personal Program***

My father's premature death at the age of 58 from heart disease and my own diagnosis of type 2 diabetes at the age of 35 motivated my early health concerns. The conventional medical advice made my diabetes worse and did little to alleviate my concern about a genetic predisposition to heart disease. Nevertheless, I have been able to overcome these challenges by aggressively applying the right ideas. More recently, I have become aware of a more insidious problem: as a biological human, I am potentially subject to aging processes. I am now engaged in the same sort of multifaceted warfare against this pervasive challenge. Although I am now a chronological 56, my goal is to be no more than a biological 40 by the time we have the means to completely arrest and reverse aging in about 20 years. So far, so good.

#### ***Chapter 11: The Promise Of Genomics***

Your genes provide you with a powerful set of tendencies, but you need to remember that these are predispositions only. The lifestyle choices you make control how these tendencies will ultimately manifest themselves, but to make the right lifestyle choices, you need to know what genes you carry. Personal genomics technology, which became commercially available in 2002, allows you to do so. Yes, it can be unsettling to find you have a predisposition for certain diseases, but the good news is that ultimately we will have the tools to directly block killer genes as well as creating and inserting new healthy genes directly into your cells. For now, our priority is to modify the expression of these genes by controlling how our metabolic pathways affect our proteins, enzymes, and hormones. Ignorance is not bliss, and understanding your own genetic code represents vital intelligence in the battle for a long and healthy life.

#### ***Chapter 12: Inflammation—The Latest "Smoking Gun"***

When injury or a pathogenic invader disrupts our normal state of balance, our bodies respond with a complex cascade of reactions to restore balance. This reaction, which often manifests itself as inflammation, is critical to our survival. But in addition to acute inflammation, which is easily noticed, there is another, less obvious type of inflammation that smolders in the body for decades. The over activity of this "silent" inflammatory response can lead to cardiovascular disease, Alzheimer's disease, irritable bowel syndrome, several types of cancer, and other conditions. But we now have a new tool for measuring your level of silent inflammation—hs-CRP—and effective ways of decreasing inflammation.

#### ***Chapter 13: Methylation— Critically Important To Your Health***

Defective methylation processes can interfere with removal of toxins and lead to genetic damage. One major methylation process is involved in converting the dietary amino acid methionine into homocysteine, a toxic by-product. Many people have genetic defects that cause levels of this toxic metabolite to rise. This can accelerate numerous disease processes and aging. However, by appropriate nutritional supplementation you can optimize methylation reactions in the body to avoid these diseases and optimize health.

#### ***Chapter 14: Cleaning Up The Mess: Toxins And Detoxification***

Every system in your body has its own method of detoxification, with the liver doing the lion's share of the job. Over time, the onslaught of toxic material— chemicals, pollution of various kinds, pesticides, gasoline fumes, heavy metals, plastics, and drugs, just to name a few—and the inadequacies in your body's ability to deal effectively with the massive cleanup task takes its toll. Avoidance of toxins and optimizing the detoxification process is crucial to maintaining health and slowing down the aging process.

#### ***Chapter 15: The Real Cause Of Heart Disease And How To Prevent It***

Heart disease is the number one killer of both men and women. About 68 million Americans have heart disease, and more than a million suffer heart attacks each year, 40 percent of them fatal. But there has been a recent revolution in our understanding of the underlying process. The primary cause of heart attacks is not the large, hard, calcined plaque that has been the focus of medical treatments such as angioplasty and bypass surgery. It's the less obstructing but more volatile and inflammatory soft plaque. The good news is that soft plaque can be dealt with more effectively than hard plaque. There is an intricate sequence of events that leads up to heart attacks and you can effectively attack the risk factors associated with each step along the way.

#### ***Chapter 16: The Prevention And Early - -Detection Of Cancer***

We don't "catch" cancer; our bodies create it. While age-adjusted death rates for heart disease have fallen almost 60 percent in the past 50 years, the percentage of Americans dying from cancer has barely changed since 1950. You can dramatically reduce your risk of cancer with the right diet, nutritional supplements, and lifestyle choices. Routine screening tests for cancer detection require that the patient already have a

moderately large tumor before they can detect it. We'll tell you about a novel test that can identify cancer when only a few cancer cells are found in the body.

#### **Chapter 17: Terry's Personal Program**

It is said that among the things you can do to enjoy a long and healthy life, it is best to start by picking your parents wisely. I am fortunate, on many levels, that both of my parents are alive and well at 80 years of age. They are physically and mentally active and enjoy a rich and varied social and cultural life. So it would appear that I started life with "a leg up" on longevity, thanks to their genes. Things aren't always so straightforward in medicine, however. My genomic testing revealed that I harbor several harmful genetic tendencies. Although I have enjoyed excellent health so far, I am now at the stage of my life where one's genetic predispositions have a way of manifesting themselves as "full-blown" diseases. But with the genetic information I now possess, I have been able to take specific measures to maintain my health, using the best of the Bridge One therapies. I am very optimistic about what the future Bridge Two and Bridge Three therapies will be able to do for both myself and the rest of humankind.

#### **Chapter 18: Your Brain: The Power Of Thinking . . . And of ideas**

We now know that the brain is continuously rebuilding and reorganizing itself. While it's true that we are what we eat (and digest), it is also the case that we are what we think. The brain represents more than half of our biological complexity. The most important way to keep the brain healthy is to keep it busy. Incidentally, one important topic that we can keep it busy thinking about is the health of our bodies and brains. There are also nutritional steps we can take to provide the metabolic foundation for cognitive health. The most important ally we have in maintaining our health is the power of ideas. Our primary adversary is ignorance. It is our view that the right ideas can overcome any problem and conquer any challenge.

#### **Chapter 19: Hormones Of Aging, Hormones Of Youth**

A decrease in hormone levels has long been associated with aging. The hormones most commonly associated with youthfulness gradually diminish over time, and some fall off rapidly, such as during menopause. Other hormones decline only slightly or even tend to increase with age. Aging results from a combination of these effects: the decrease in the hormones of youth and the relative increase (or slower decrease) in the hormones of aging. We'll discuss methods to maintain a healthy balance of hormones as you age.

#### **Chapter 20: Other Hormones Of Youth: Sex Hormones**

The sex hormones—estrogen, testosterone, and progesterone—have powerful youth-promoting effects. But there's a lot of controversy over the merits and dangers of hormone replacement therapy (HRT). Most of the negative results coming from recent studies have involved chemically altered hormones. By utilizing bio-identical hormones, which are the same hormones as are found naturally in the body, research suggests you can still receive the benefits of HRT without the risk. We'll discuss a program of testing for hormone imbalances and methods of remediation with bio-identical hormones as well as herbal remedies and other supplements that will help you maintain a youthful balance of hormones throughout life.

#### **Chapter 21: Aggressive Supplementation**

Recent studies have proven that almost everyone requires one or more vitamins far in excess of PDA-suggested RDA amounts to avoid illness. An optimal supplement program goes beyond just taking vitamins, minerals, and antioxidants. By utilizing genomics testing to diagnose your individual metabolic requirements, you can restore healthy balances and maintain optimal health with a personalized program of aggressive supplementation.

#### **Chapter 22: Keep Moving The Power Of Exercise**

Primitive man and woman were not couch potatoes. In fact, they were more like marathon runners. The evidence is overwhelming that exercise enhances every one of your body's systems and reduces the risk of virtually every degenerative disease. Exercise works synergistically with a healthy diet and other lifestyle choices to enhance your sense of well being and prevent disease. Aerobic, anaerobic, and stretching exercises are all important and have distinct benefits.

#### **Chapter 23: Stress And Balance**

The ability to confront danger is critical to our survival. But chronic activation of this mechanism can lead to increases in blood pressure and cholesterol, decreased blood flow to the liver and digestive organs, suppression of the immune system, and serious illnesses such as heart disease. Simply avoiding stress isn't the complete answer. We need a certain amount of challenge in our lives to avoid apathy and boredom. Our lives should be animated by the four C's: challenge, commitment, curiosity, and creativity. We present 12 effective ways to manage stress and achieve balance.

The metaphor of *Fantastic Voyage* fits our book on several levels. First, we hope to treat you, our readers, to a fantastic voyage through the human body. Our understanding of the complex processes underlying life, disease, and aging has progressed enormously since 1966. We now have an unprecedented ability to comprehend our biology at the level of the tiniest molecular structures. We also have the opportunity to vastly extend our longevity, improve our well-being, and expand our ability to experience the world around us.

Asimov's fascination with miniaturization was prophetic. We are now in the early stages of a profound revolution in which we are indeed shrinking our technology down to the molecular level. We actually are developing blood cell—size submarines called nanobots (robots whose key features are measured in nanometers, or billionths of a meter) to be sent into the human body on vital health missions. Although we won't literally be shrinking ourselves to ride inside these nanobots, as in Asimov's imagined tale (at least not in the next several decades), we will be able to place ourselves in virtual-reality environments and see out of the eyes of these tiny robots. We will be able to control their movements as if we were inside, just as soldiers today remotely control intelligent weapons systems.

### ***The 21st Century Is Worth Living To Experience***

As interesting as the first two decades of this century are likely to be, subsequent decades should lead to even more dramatic changes. Ray has spent several decades studying and modeling technology trends and their impact on society. Perhaps his most profound observation is that the rate of change is itself accelerating. This means that the past is not a reliable guide to the future. The 20th century was not 100 years of progress at *today's* rate but, rather, was equivalent to about 20 years, because we've been speeding up to current rates of change. And we'll make another 20 years of progress at today's rate, equivalent to that of the entire 20th century, in the next 14 years. And then we'll do it again in just 7 years. Because of this exponential growth, the 21st century will equal 20,000 years of progress at today's rate of progress—1,000 times greater than what we witnessed in the 20th century, which itself was no slouch for change. The result will be profound changes in every facet of our lives, from our health and longevity to our economy and society, even our concepts of who we are and what it means to be human. Within a couple of decades we will have the knowledge to revitalize our health, expand our experiences—such as full-immersion virtual reality incorporating all of the senses, augmented reality, and enhanced human intelligence and capability—and expand our horizons. Older boomers now in their 50s are a pivotal group, living on the cusp. They are the last generation in which the vast majority will die in the more or less "old-fashioned" way, generally from debilitating progressive conditions that severely interfere with quality of life.

### ***A Decades-Long March To Health —Or Disease***

The leading causes of death—heart disease, cancer, stroke, respiratory disease, kidney disease, liver disease, and diabetes<sup>6</sup>—do not appear out of the blue. They are the end result of processes that are decades in the making. To help you understand how long-standing imbalances in the metabolic processes underlying life functions can lead to disease, we have developed Ray & Terry's Longevity Program, which is laid out over the course of this book. (Our program is Bridge One, as mentioned above; Bridges Two and Three are detailed in chapter 2.) The advice we offer on how to keep your body optimally healthy—from what to put into it ("Food and Water," chapter 4) to how to fine-tune it ("Stress and Balance," chapter 23)—will enable you to determine your own specific health status and teach you how to take effective corrective action when necessary. Our program does require time and commitment to implement, but the rewards are considerable: Conventional medical care is geared toward dealing with long-term degenerative processes only after they erupt into advanced clinical disease, but by this time it is often too late. It's like approaching a cliff but walking backward. You need to recognize that you're getting closer to the edge and stop. Once you fall off, it's difficult to do anything about it. This is what *Fantastic Voyage* is all about: to provide the knowledge and the specific steps to take, sooner rather than later, to extend your life, your vitality, and your well-being.

### ***Who is the enemy?***

It is wise to consider the process of reversing and overcoming the dangerous progression of disease as a war. As in any war, if the enemy is at the gates—or worse, inside the gates—it's important to mobilize all the means of intelligence and weaponry that can be harnessed. That's why we'll advocate that key dangers be attacked on multiple fronts. For example, we'll discuss 10 approaches that should be practiced concurrently for preventing heart disease, particularly for people with elevated risk factors. But if fighting disease and extending longevity and vitality is a war, who is the enemy? At the top of the list we should put ourselves. Of course, health issues get our attention the moment clinical disease strikes, but most people fail to focus on prevention and health enhancement in a timely manner *before* the onset of overt symptoms. Unfortunately, the medical profession is oriented toward detecting and treating these conditions only *after* they reach the point of crisis (symptom-control medicine), so most people receive limited guidance on disease prevention from their health professionals. You should not wait for others to show you the path to healing; the only person who can take responsibility for your health is you. Our second enemy is the disease process itself. Our bodies evolved when it was not beneficial to the survival of the species for people to live beyond their child-rearing years and compete for the tribe's or communities limited food and other resources. Only a century and a half ago, life expectancy was 37 years. If we want to remain vital for as long as possible, we cannot simply rely on the natural order that biological evolution has given us. A significant number of cardiac patients receive the first warning that something is wrong when they suffer a heart attack, a third of which are fatal and another third of which cause permanent heart damage. Atherosclerosis, the buildup of cholesterol-laden deposits in the arteries, is rarely detected until it produces either a heart attack or, if the patient is "lucky,"

angina pain or an abnormal stress test. At that point, coronary artery disease is already advanced. More than 1,250,000 Americans suffer heart attacks each year, while 710,000 die of heart disease,<sup>10</sup> with most of these deaths following long periods of debilitation. Hypertension, or high blood pressure, although easily diagnosed, has no obvious symptoms. Strokes typically cause brain damage without warning. Cancer is often not detected until it has metastasized (spread throughout the body).<sup>11</sup> In fact, most of the degenerative biological processes that result in devastating clinical disease are invisible and silent, and most of these, and the deaths and suffering they cause, can be prevented or significantly delayed.

### ***The Importance Of Being Alkaline***<sup>8</sup>

To understand why the alkalinity or acidity of the water-based liquids is important to health, we need to understand how the body controls the ionization levels of its fluids. Different pH levels support different types of chemistry, so it's essential that body fluids be maintained within very narrow acid/alkaline limits.<sup>9</sup> Your health is extremely sensitive to the slightest change in the pH level of your body's vital fluids. Stomach fluid, for example, is extremely acidic, with a pH of 1.5 (pH less than 7 is acid, more than 7 is alkaline). Pancreatic fluid, on the other hand, is quite alkaline, with a pH of 8.8. The pH inside of our cells ranges from 6.8 to 7.1. The most important balance of all is maintained in our blood, where the pH is very tightly controlled between 7.35 and 7.45. Your body will act to neutralize acidic drinks such as colas and coffee with alkaline blood buffers, which are then unavailable to neutralize other acidic waste products continually produced by the body, including organic byproducts of digestion such as acetic acid,<sup>10</sup> lactic acid,<sup>11</sup> carbonic acid,<sup>12</sup> uric acid,<sup>13</sup> and fatty acids.<sup>14</sup> There are also inorganic by-products created or found in food, such as sulfuric acid<sup>19</sup> and phosphoric acid.<sup>20</sup> When the body's limited supply of alkaline buffers is defeated, these toxic acidic waste products accumulate in the body, causing significant health damage.<sup>21</sup>

The body uses calcium to convert the poisonous liquid phosphoric acid in colas into the more stable solid phosphates, for example.<sup>22</sup> But these phosphates may form into calcified kidney stones, or calcium deposits (which can also result from a urinary infection, inherited metabolic disorders, and other causes<sup>23</sup>). Many people erroneously think kidney stones are caused by excessive calcium. But the real culprit may be the high level of phosphoric acid, which happens to be a primary ingredient of colas. Anyone with a concern about kidney stones should avoid colas. Consuming acidic foods such as soft drinks may also create an ideal environment for cancer to form. Animal cells survive best in an alkaline environment with a blood pH of 7.35 to 7.45. Plant cells are the opposite; they prefer an acidic environment. As our bodies become increasingly acidic, some cells adapt through an internal evolutionary process and become more like plant cells. These abnormal plantlike cells have a high tendency to become cancer cells, which thrive in an acidic environment.<sup>24</sup> So an important strategy for preventing or treating cancer is to maintain an alkaline environment in the body. Routine consumption of soft drinks containing phosphoric acid (that is, colas) is a risk factor for bone loss.<sup>25</sup> Consumption of alkalizing mineral water helps retain bone health and improve digestive functions.<sup>26</sup> A comprehensive review comparing alkalizing diets to acidic diets reported in *The American Journal of Clinical Nutrition* concluded that alkalizing diets improve bone density, nitrogen balance, and serum growth hormone concentrations, whereas the low-grade acidosis resulting from acidic diets contributes to bone loss, osteoporosis, and loss of muscle. Not all acidic foods increase the acidity inside our bodies. Orange juice, for example, has an extremely acidic pH of 3.5 because of its citric acid content, but the citric acid is burned away during digestion. Orange juice also contains potassium and magnesium, which interact with water to create alkaline ions. Thus, the overall effect of drinking orange juice is to increase alkalinity, despite its acidic content.<sup>29</sup> The inability of your body to fully detoxify underlies many disease processes, including heart disease and cancer. Oxygen free radicals (molecules unpaired with electrons) are highly reactive substances that are deficient in electrons and can cause enormous damage to the body if not quickly neutralized. Adequate alkaline reserves offer a first line of defense against these oxygen free radicals by providing free electrons, which neutralize the radicals and prevent them from damaging healthy cells.<sup>30</sup>

### ***Carbohydrates In Our Diet***

Carbohydrates have powerful effects on the body. The proportion of your diet that is carbohydrates and, more important, the type of carbohydrates you consume, have vital effects on your health. Of the three sources of calories—carbohydrates, fat, and protein—carbohydrates are the only one *not* necessary for survival.<sup>3</sup> Without certain essential fats and the right protein building blocks, you could not live. But you don't need carbohydrates to build the structure of your cells; you could get all the energy you need from fat and protein. However, we do recommend a healthy balance of carbohydrates because certain carbohydrate foods, such as vegetables, are rich in vitamins, minerals, and other nutrients. But a principal problem with our modern diet is its dependence on a large quantity of the wrong kind of carbohydrates. To understand the proper role of carbohydrates in your diet, you need to understand a few things about how they are digested. Simple sugars are directly absorbed by the epithelial (lining) cells in the small intestine. Disaccharides such as sucrose, table sugar, or lactose, milk sugar are also absorbed directly by the epithelial cells, but these double-sugar molecules require certain enzymes so they can be broken down into their constituent monosaccharides. The enzyme sucrose, for example, breaks down table sugar, sucrose, into glucose and fructose. Lactase converts

the disaccharide lactose (the sugar in dairy products) into glucose and galactose. More than half the adult human population of the world has a genetic deficiency of lactase, which allows lactose to arrive in the colon undigested, where it ferments and causes gastrointestinal upset. Starchy foods, or polysaccharides, cannot be directly absorbed by the epithelial (lining) cells of the small intestine, but must first be broken down into monosaccharides and disaccharides. This is accomplished by the enzyme amylase, secreted by the salivary glands and pancreas. The most common polysaccharide is amylose, which consists of a long string of glucose units. As its name suggests, amylase is the enzyme designed to break down amylose. The carbohydrates found in refined grains and starchy vegetables such as potatoes are mostly amylose and are digested very quickly. There is not much difference between eating these quickly digested starches and eating simple sugar in terms of quickly boosting the level of glucose in the blood. Rather than merely forming long, beadlike strands of simple sugars, polysaccharides can also be formed from more complex arrangements of mono-saccharide units that include many cross-links between molecules. Fiber is an example of an extensively cross-linked polysaccharide. Over time, the continual abuse of this cycle—eating large amounts of carbs, leading to high blood glucose levels, leading to quick bursts of insulin, leading to low levels of blood glucose, leading to consuming more carbohydrates, etc.—results in a lower level of sensitivity of the body's cells to insulin. This insulin resistance is a principal cause of the metabolic syndrome (also called syndrome X), a major health problem that accelerates atherosclerosis and other aging processes. Insulin resistance can also lead to type 2 diabetes,<sup>9</sup> in which case it doesn't matter how much insulin the body makes—the blood sugar is still too high. Other problems caused by excess levels of glucose in the blood:

- *The rapid conversion into triglycerides or fats accelerates atherosclerosis and other degenerative processes.*
- *The immune system is inhibited.*
- *Adrenaline production increases by up to four times. This chronic activation of the fight-or-flight stress reaction (see chapter 23) worsens the damage to the body, including increased levels of cortisone, which further inhibits the immune system, and cholesterol.*
- *Sugar promotes growth of a broad variety of pathological cells, including Candida (yeast), fungal infections, and cancer.*
- *Sugar and vitamin C compete for the same transport system, so excess glucose in the blood interferes with vitamin C's vital roles in combating infection and building body tissues.*
- *Sugar causes protein molecules to become cross-linked to one another, a primary cause of the aging process.*
- *The lack of insoluble fiber in simple starches causes food to pass too slowly through the intestines, which encourages gas, bloating, and formation of toxins. This effect may contribute to colon cancer.<sup>10</sup>*

**Stevia** is one sweetener that is even good for you. This is a plant indigenous to South America and is a natural food supplement that is 30 to 100 times sweeter than table sugar. It has been valued for its medicinal effects and natural sweetness in Paraguay for 1,500 years. It has been used similarly in Japan for the past two decades and has recently become popular in the United States as an all-natural, healthy sweetener.

We are not aware of any adverse reactions reported from the use of stevia. Numerous studies have been performed in Japan and in the United States on stevia's effects on cell membranes, enzyme systems, and cancer,<sup>29</sup> and no negative effects have ever been discovered. In fact, many significant health benefits have been observed:

- *It is highly nutritious.*
- *It can lower blood sugar in diabetics, but also regulates blood sugar in nondiabetics.*
- *It can lower elevated blood pressure.*
- *It kills bacteria that cause tooth decay. V*
- *It can increase energy levels and mental activity.*
- *It helps reduce cravings for alcohol and tobacco.*

Foods that contain healthful amounts of omega-3s include walnuts, seeds (particularly hemp seed), fish, fish oil, flaxseed, flaxseed oil (linseed oil), canola oil, soy, and dark green leaves such as spinach, broccoli, kale, and seaweed (although leaves have little oil, it primarily contains alpha-linolenic acid).

• *Alpha-linolenic acid, sometimes incorrectly referred to as linoleic acid. This is one of the two EFAs (essential fatty acids) because it's required for life and cannot be created in the human body from other foods.*

*Alpha-linolenic acid helps:*

- *Improve oxygenation of tissues*
- *Improve oxidation of food in the mitochondria (the small fuel cells in every cell)*
- *Speed muscle recovery during exercise*
- *Speed healing*
- *Improve sense of calmness*
- *Reduce inflammation*

- *Reduce platelet stickiness*
- *Reduce blood pressure*

**Virgin** olive oil refers to oil obtained by pressing whole, ripe, healthy olives with no heat applied—neither external nor from the pressing process—and with no refining or other processing steps such as bleaching or deodorizing. Olive oil that is not labeled "virgin" is refined and will contain the same types of pathological fats found in any other refined vegetable oil.

**Extra virgin** olive oil is even better. This oil meets a stricter set of guidelines, including the use of only very-high-quality olives. We recommend that you use only organic extra virgin olive oil for salads, cooking, and other culinary uses. Keep in mind, though, that when oils, even beneficial types such as extra virgin olive oil, are heated to very high temperatures (above 320 degrees Fahrenheit), toxic chemicals are formed, including acrylamides, and toxic cyclic monomers, which have been linked to abnormal liver deposits.<sup>19</sup> Deep-frying creates large numbers of free radicals that interfere with vital metabolic processes.<sup>20</sup> We recommend that you avoid deep-frying altogether and instead stir-fry. A healthy method is to first put water in the pan (a wok is recommended), then add a small amount of extra virgin olive oil. Keep the temperature at a moderate level (under 180 degrees; if the oil is smoking, the temperature is too high), and cook the food for only a brief period of time. This approach will avoid the creation of most toxic by-products.

### **Cholesterol**

Our discussion of fat would not be complete without considering cholesterol. Cholesterol is not a fat, but its metabolism is closely related to fat in the diet. Cholesterol is a 27-carbon molecule made in the body from two-carbon acetates, which are breakdown products from fats and sugars (as well as protein through a less direct pathway). Cholesterol is a hard, waxy substance that is essential for human health and life. It plays a vital role in maintaining the health of our cellular membranes.<sup>30</sup> It is also the precursor to the male and female sex (steroid) hormones, including estrogen, progesterone, and testosterone, as well as cortisone, the stress hormone. Cholesterol is, of course, well known as a primary risk factor for atherosclerosis, the process of plaque formation in the arteries that can lead to heart attack or stroke. Elevated levels of cholesterol play an important role in this process, although there are other equally crucial risk factors. Cholesterol is found in your food, but your cells, especially in the liver, manufacture the primary source of cholesterol in the body. Cholesterol is unique because the body can make it, but cannot break it down. Excess cholesterol can only be removed from the body in the stool, where it is combined with bile acid. This process is facilitated by dietary fiber, which is another benefit of fiber in the diet.<sup>31</sup> Excess calories contribute to the body manufacturing more cholesterol than is healthy.<sup>32</sup> These come especially from high-glycemic-load carbohydrates and unhealthy fats, specifically saturated fat, trans-fatty acids, and pathological forms of polyunsaturated fatty acids. Stress also contributes to excessive cholesterol levels because the body needs to make cholesterol to produce the stress hormone cortisol.<sup>33</sup> The average person has about 150,000 milligrams of cholesterol, most of which is incorporated into cell membranes, with only about 7,000 milligrams circulating in the blood. The daily usage of this circulating cholesterol is typically around 1,000 milligrams. So consuming several hundred milligrams per day of cholesterol can increase blood cholesterol levels, particularly if cholesterol-related pathways are impaired (as indicated by a tendency toward elevated levels). We recommend that dietary cholesterol consumption be kept under 1,400 milligrams per week. If you have elevated risk factors of heart disease, you should reduce this to 700 milligrams per week.<sup>36</sup> The average American diet contains about 800 milligrams of cholesterol each day. Cholesterol is found only in animal products, including egg yolks (one yolk has about 250 milligrams of cholesterol); shellfish, including shrimp and lobster; meats, including beef, pork, and poultry; organ meats (4 ounces of liver has 250 milligrams); and dairy products (each ounce of butter has 60 milligrams). Note that 25 percent of calories means less than 12 percent of food weight because of fat's higher caloric density. More important than how much fat you eat is what kind. Focus on getting dietary fat from:

- *Nuts*
- *Fish high in EPA and DHA, especially salmon, which is rich in EPA and DHA (wild salmon has even more than farm-raised) and relatively low in mercury*
- *Extra virgin olive oil*
- *Flaxseed and naturally pressed flaxseed oil, which can be transformed by the body into EPA and DHA. However, many people lack the critical enzymes needed for this conversion and should consume EPA and DHA directly.*
- *Vegetables, which contain small but mostly healthful forms of fat*
- *Tofu*

### **How Digestion Works**

The diagram of the human gastrointestinal system on page 87 shows the organs involved in digestion, which takes place in the following steps:

**Step 1.** Digestion begins in the mouth, where chewing breaks down food into manageably small particles. The salivary glands produce about a quart of saliva per day, which moistens and lubricates dry food and

buffers it (changes the acid-alkaline balance) to maintain an optimal (alkaline) pH level. The primary digestive enzyme in saliva is amylase, which begins the breakdown of starch (polysaccharides) into glucose (a monosaccharide) and maltose (a disaccharide). Cleansing of the mouth by saliva is also important for oral hygiene. Thorough chewing is vital to health. Swallowing solid food before it's been adequately broken down and mixed with saliva places a real strain on the digestive process, and can result in inadequate digestion and malabsorption. Insufficient chewing forces the digestive tract to secrete higher levels of powerful digestive enzymes, which can result immediately in excess gas and bloating. Over time, these enzymes can damage both the stomach and digestive system. So slow down when you eat.

**Step 2.** Next, food travels through the esophagus, where involuntary peristaltic contractions (wormlike movements) send it to the stomach. The stomach can expand to accommodate different-size meals. It serves as a temporary way station that releases food into the intestines in a gradual and controlled manner, through peristaltic contractions as well as overall contractions of the gastric wall.

**Step 3.** The gastric mucosal cells lining the stomach wall secrete about a quart of gastric juice each day. This juice is the most acidic bodily fluid, consisting largely of hydrochloric acid, with a pH between 1.0 and 2.0. This acid dissolves food into a nearly liquid form called chyme. Gastric juice also contains digestive enzymes, most notably pepsins, which begin to break down proteins into their constituent amino acids. By the time the chyme leaves the stomach, these digestive processes have broken down about 30 to 50 percent of the starches and 10 to 15 percent of the proteins, but virtually none of the fats. Gastric juice also contains a special protein called *intrinsic factor*, which is required for the absorption of vitamin B<sub>12</sub>. Inadequate B<sub>12</sub> absorption interferes with proper folic acid cycle metabolism, resulting in elevated levels of homocysteine (see chapter 13). To assess this condition, it is not enough to simply test for blood levels of B<sub>12</sub>, because this will not reveal if the body is able to use this nutrient. A better test is to measure blood levels of methyl-malonic acid, which is a metabolic intermediate that requires vitamin B<sub>12</sub> to break down. If methylmalonic acid levels are elevated in the blood, it indicates the vitamin is not doing its job, regardless of the actual level of B<sub>12</sub> in the blood. Inadequate B<sub>12</sub> metabolism can be helped by supplementation with intrinsic factor and introducing higher levels of B<sub>12</sub> directly into the bloodstream through sublingual tablets or injection. Cells in the gastric wall also make two kinds of mucus to protect themselves from being digested by their own acidic juices. There is a delicate balance between these acids, pepsins (which are effective only in a very acidic environment), and the protective action of the stomach mucus. Disruptions in this process are often the result of infection with bacteria known as *Helicobacter pylori* (or *H. pylori*), which can result in severe damage, such as peptic ulcers, to the stomach lining. Very little absorption of food into the bloodstream takes place in the stomach, although small amounts of simple sugars such as glucose and amino acids do get absorbed through the gastric mucosa. Ethyl alcohol from alcoholic beverages is also readily absorbed directly from the stomach, as is excess water. A common problem at this stage in the digestive process is hypochlorhydria (inadequate hydrochloric acid), which results in poor absorption of vital nutrients. Indigestion resulting from a lack of stomach acid is often misdiagnosed as caused by excess acid and treated with powerful acid-suppressing medications, which lead to even further digestive maladies.<sup>2</sup> See Fantastic-Voyage.net for recommendations for alleviating this problem.

**Step 4.** After spending up to about three hours in the stomach (or longer, if the meal has a high fat content or you take antacids), the chyme exits through the pyloric valve and enters the small intestine. About 25 feet in length, the small intestine, or "gut," is the body's longest organ and its principal digestive organ. During this stage we see all three methods of digestion: motor activity, enzyme secretion, and absorption. The primary kind of movement of chyme through the gut is from segment-to-segment contractions, although peristaltic contractions also play a role. The small intestine has three regions: the duodenum, the jejunum, and the ileum. Slightly less than a foot in length, the duodenum receives digestive enzymes from the pancreas along with bile formed in the liver and concentrated in the gallbladder. Pancreatic enzymes, including trypsin and chymotrypsin (which break down proteins into amino acids), lipase (which breaks down fats), and additional amylase for continued digestion of poly-saccharides, are also secreted into the duodenum. Bile is excreted into the duodenum as slurry containing many solids, chiefly the bile salts, which assist in fat digestion. Bile emulsifies fats so they mix well with the other digestive juices, and also activates lipase, the pancreatic enzyme that breaks down fats into their constituent fatty acids. The bile and partially digested fat form small colloidal particles called micelles, which are absorbed by special ducts, called lacteals, into the bloodstream. The mucosal cells in the duodenum also secrete digestive enzymes, including a form of pepsin (for protein), amylase (for starch), and lactase (for digesting lactose or milk sugar). About a third of all American adults, including 80 percent of African-Americans and 50 percent of Hispanics, lack adequate lactase, the enzyme needed to digest lactose (milk sugar). This well-known digestive deficit, known as lactose intolerance, affects a significant portion the world's population.<sup>3</sup>

Hormones control the rate that chyme is released from the stomach, and the duodenum controls that part of the nervous system that regulates the movement of food through the gut.

**Step 5.** Some absorption of nutrients takes place in the duodenum, but most occurs in the next section, the jejunum. This middle region uses folds in the mucosa called the plicae circulares to increase the surface area of the small intestine for optimal absorption. The most important structures for absorption are the intestinal villi, which are well developed in the jejunum. These fingerlike projections are about a millimeter in height. The epithelial cells on the surface of the villi have their own fingers called microvilli, which increase the surface area even further.

**Step 6.** Remaining nutrients are digested by less-developed villi (that don't have microvilli) in the ileum, the longest portion of the gut. Vitamin B<sub>12</sub>, which must be bound to intrinsic factor, can be absorbed only in the ileum.

**Step 7.** Digestion is essentially complete by the time the chyme passes from the small to the large intestine. The large intestine, also known as the colon or bowel, typically receives about a pint of chyme a day from the ileum. The chyme is moved primarily by segmental contractions similar to those of the small intestine. The mucosal cells in the large intestine mostly secrete potassium, bicarbonate, and mucus to lubricate the chyme and facilitate its movement. The large intestine contains large, column-shaped epithelial cells that absorb water, sodium, and chloride. The main digestive process that occurs in the colon is the result of intestinal bacteria interacting with non-absorbable materials, including cellulose and other forms of fiber. These bacteria play an important role in changing the chyme into a form that is suitable for elimination as feces. The digestive process ends with a bowel movement, which is often triggered by consumption of a meal—but normally, it is not the most recent meal that is being eliminated. The entire trip through the alimentary canal typically takes 24 to 48 hours or longer.

### ***Eat Organic Whole Foods***

One of the drawbacks of modern factory-produced foods is the excessive use of chemicals and pesticides and the depletion of nutrients in the soil. An understanding of the principles of eating organic whole foods is important for optimal nutrition. Whole foods are foods in their unprocessed state. Most food is far removed from this. Most grains are "polished," a process that removes the grain's outer coating, which contains selenium, an important antioxidant mineral; fiber; and other valuable nutrients. This processing is done primarily for convenience—longer shelf life and faster cooking time—but the loss in nutritional value is considerable. Avoid quick-cooking products such as instant rice or oatmeal, since these forms of grains are particularly heavily processed. • Another type of non-whole food is fruit juice, which is missing a key ingredient of the original fruit: its fiber. So fruit juice is equivalent to sugar water with some vitamins and minerals. To your body, drinking a glass of orange juice is not a lot different from eating a candy bar, in terms of the sudden increase in the blood levels of glucose and insulin. Eating whole fruit with its fiber content slows down the digestion of the fruit's sugar content. "Whole" vegetables and grains are grown in "whole" soil that contains all of the minerals and other nutrients required for a nutrient-rich plant. The soil used in factory farms, however, tends to be depleted of important trace minerals. Factory farms also tend to use large amounts of pesticides, insecticides, and other chemicals that end up in the produce.<sup>24</sup> Animals that eat grain produced in this way will concentrate the poisonous chemicals in their fat cells, while those raised on organic produce tend to have significantly lower concentrations of these toxins. Since it takes about 7 pounds of grain to produce 1 pound of meat, toxic chemicals are more concentrated in meat than in vegetables and fruits, so relying on organic food sources is even more important when consuming meat.

Fresh organic vegetables retain their vitamins, minerals, enzymes, phyto-chemicals, and other nutrients. Frozen vegetables are a close second, because most nutrients (except for vitamin K and some enzymes that are destroyed by freezing) survive in a digestible form. Canned vegetables, on the other hand, look and taste "dead" because they have lost most of their useful nutrients. The basic caloric nutrients—carbohydrates, protein, fat—remain, but most of the vitamins and minerals do not survive. Moreover, most canned vegetables have a lot of added salt. Virtually all of the varied nutritional programs agree on one thing: emphasize fresh organic vegetables in your diet. Why organic? "Organic foods" refers to produce, grains, and animals produced without artificial fertilizers, pesticides, insecticides, herbicides, hormones, antibiotics, and other chemicals, many of which are approved by the EPA and routinely used in commercial food production. These chemicals are classified by their toxicity, from Category I (highly toxic) to Category V (relatively nontoxic).<sup>25</sup> Consider terbutryn, a Category III herbicide used to destroy weeds in wheat and barley crops.<sup>26</sup> In animal tests, moderate doses of terbutryn caused nervous system defects, convulsions, cancer, and damage to the kidney and liver. Only tiny amounts of terbutryn are allowed on human food, but we simply don't know the impact of long-term continual exposure to small amounts of this chemical. The same is true for the scores of other chemicals, including insecticides and pesticides, routinely used on non-organic foods. We recommend that if you do eat non-organic produce, soak it in dilute hydrogen peroxide before cooking or eating. Add <sup>1</sup>A cup of 3 percent hydrogen peroxide (food-grade hydrogen peroxide can be found in health food stores) to a sink full of water and soak the food in the solution for 20 minutes.

### ***How To Eat For Health***

The following principles and recommendations should be the basis of your healthy diet.

**Eat a variety of foods.** Eating the same foods day after day may cause sensitivities and allergies to develop.<sup>27</sup> Also, eating the same foods will cause "taste fatigue" and encourage overeating. You will be more satisfied and enjoy your food more if you vary what you eat. Eating a variety of foods also will promote a balance of nutrients. Each vegetable has specific amino acids, vitamins, minerals, and other nutrients, but no single vegetable provides all of what you need. One way to practice this recommendation is to rotate your foods.

**Reduce or eliminate wheat.** Wheat, which is a relatively recent agricultural innovation, is eaten in enormous quantities in Western countries. This has led to high levels of wheat sensitivity, particularly to gluten, which is a major protein component of wheat. Many people have discovered that going off wheat has resolved long-standing digestive problems. You can experiment with this yourself by avoiding wheat for two weeks to see what impact this has on otherwise unresolved digestive symptoms. You can also assess your sensitivity or allergy to wheat through the type of food antibody testing discussed above, as well as by specific blood tests for "gluten intolerance." See *Fantastic-Voyage.net* for specific recommendations on tests.

**Eat your vegetables.** We cannot emphasize enough the benefits of eating fresh, organic, low-starch vegetables. They contain a myriad of valuable nutrients and fiber, and are low in glycemic index and caloric density. Be careful not to overcook them, though. Overcooking will deplete vegetables of their vitamins, phytochemicals, and other nutrients. We recommend light steaming as the ideal way to cook vegetables. Many can also be eaten raw, although excessive consumption of raw vegetables may cause GI distress.

**Eat colorful foods (but not moldy meat!).** By eating a variety of naturally colored vegetables, you obtain a broad spectrum of vital nutrients. An entertaining book on this topic is *Eat Your Colors* by Marcia Zimmerman.<sup>28</sup>

**Drink freshly squeezed vegetable juice.** About the healthiest drink available is made by putting fresh, organic, low-starch vegetables through a juicer. The result will be a low-calorie drink extremely high in vitamins, minerals, and phytochemicals. Ideal vegetables for juicing include celery, cucumber, and fennel. You can also use smaller amounts of red and green leaf lettuce, romaine lettuce, endive, escarole, spinach, parsley, and kale. Carrots and beets are high in sugar, so use these in moderation, if at all.

**Drink tea instead of coffee.** We are not opposed to moderate consumption of caffeine, which is useful for improving concentration. We strongly recommend tea rather than coffee, however. We talked about the highly acidic nature of coffee in chapter 4. Also, coffee contains very high levels of caffeine; black tea has about one-third the level of caffeine, and green tea has about one-fourth. Moreover, there are many healthful constituents of tea. A recent study published in *Circulation*, the journal of the American Heart Association, found that drinking at least two cups of tea a day reduced the risk of dying from a heart attack by a remarkable 44 percent.<sup>29</sup> This finding applies to both black and green teas, but not to herbal teas. Tea also contains 1-theonine, which reduces cortisol levels and promotes relaxation. Green tea is particularly beneficial, with additional antioxidants that reduce the risk of both heart disease and cancer.<sup>30</sup>

#### **Some Tips For Healthy—And Permanent—Weight Loss**

Your weight reflects your total calorie consumption, how much you exercise, and your metabolic rate, but the composition of the food you eat is also important. Here are some tips.

**Reduce carbs.** We have found that it's almost impossible to lose weight and keep it off without eating substantially fewer carbohydrates, particularly those with a high glycemic load (GL). As we discussed in chapter 5, "Carbohydrates and the Glycemic Load," consumption of high-GL carbohydrates leads to a desire for more carbohydrates. Eating a low-carbohydrate, low-GL diet will help you control your appetite and decrease cravings. You'll feel full sooner, you'll find it far easier to stop eating once you're satisfied, and you'll find yourself less hungry between meals. If you are trying to lose weight, we recommend you keep total carbohydrates under one-sixth of your calories and eliminate all high-GL carbohydrates such as sugary foods, pastas, and breads.

**Reduce fats.** Reducing fat in the diet aids weight loss because high-fat foods are more calorically dense—9 calories per gram versus 4 for carbohydrates and protein.

**Go for veggies.** Emphasize foods that are low in caloric density (that is, low in calories but high in weight). The ideal category: low-starch vegetables, which have a low glycemic index and are rich in valuable nutrients of all kinds, high in fiber, and filling.

**Eat fiber.** Consume at least 25 grams per day, including at least 10 grams of insoluble fiber.

**Don't switch foods radically.** While you are losing weight, we strongly recommend against diets that involve eating in a significantly different way from how you intend to eat when not "dieting."<sup>15</sup> People count the days until they are released from this type of gastronomic prison. They do not associate the benefit of weight loss with learning proper eating habits—changing tastes, desires, and attitudes—but rather with the artificial eating patterns that they are anxious to leave.

By adopting our "change your weight for life in one day" advice—to consume the maintenance number of calories for your optimal weight as your starting point—you need to make only a single adjustment once. It may take a couple of weeks to adapt, but you will be on a track that you can maintain indefinitely.

**Make health, not weight loss, your goal.** If you set a healthy lifestyle as your goal, you are more likely to succeed in both improving your health and attaining permanent weight loss. Don't be too anxious to drop pounds right away. Enjoying the experience is crucial. You want to associate the experience of reaching a healthy weight with that of healthy eating. It may take a few months longer, but it will ensure that you'll never have to lose weight again.

A major reason people get discouraged and drop out of weight-loss programs is *weight plateaus*. Gained muscle mass and blood vessel expansion due to exercise may temporarily halt weight loss or cause a small gain, but these are actually very desirable phenomena. Since muscle weighs more than fat, you can lose body fat and inches without dropping pounds if you are building muscles at the same time. Changes in medication, menstruation, constipation, water retention, and other factors may also cause weight loss to slow down or even reverse. Remember that your goal is to lose body fat. None of these factors causes an increase in body fat, so do not be discouraged by minor shifts of weight in the wrong direction. Be patient.

**Don't rush weight reduction.** One of the most important issues in weight loss is recidivism. Most people who lose weight end up gaining it back. Preliminary research on the *ghrelin* hormone, which is secreted in the stomach, may explain part of this troublesome problem. Ghrelin stimulates appetite at the same time that it slows down metabolism. Both of these effects contribute to increased fat storage. Levels of this hormone spike before each meal and drop after you're full. People given injections of ghrelin become extremely hungry, and studies show they eat much more when unlimited food is available, such as at a buffet. A recent study at the University of Washington showed that ghrelin levels increase substantially after a period of rapid weight loss.<sup>16</sup> Dr. David E. Cummings, the lead scientist on the study, thinks this was an evolutionary adaptation to encourage the body to regain the lost fat as protection from possible future famine. This genetic program no longer applies to our modern situation. Research is currently under way to develop medications that block ghrelin and its stimulation of appetite and storage of body fat. Slow, gradual weight loss does not appear to cause the same spike in ghrelin levels, however. This is another important reason to approach your ideal weight gradually. Setting your daily caloric level to match your target weight's maintenance level is the best way to lose weight once and to keep it off.

**Get exercise.** Physical activity is very important for burning calories, lowering your "set point" (the weight your body gravitates toward), and increasing your metabolic level (rate of burning calories), even while you are not exercising.<sup>17</sup> We recommend burning at least 300 calories daily through exercise.

**Raise your metabolic rate.** A primary factor in determining your metabolic rate—the rate at which you burn calories—is the number of mitochondria in cells. Mitochondria are tiny energy factories that fuel every cell. The more you have, the more energy you will burn, which will keep you leaner.<sup>18</sup> Unfortunately, we cannot simply take a mitochondria supplement. However, fat cells have very few mitochondria because fat cells store energy rather than burn it, whereas muscle cells have many because they need energy to perform their job. So as you build muscle cells from a regular exercise program, you increase your mitochondria, thereby permanently raising your metabolic rate, even when you are not exercising.

### **Sugar And Aging**

Persistently elevated blood glucose levels have another undesirable consequence: the formation of AGEs, which are created in the body when sugar molecules stick to proteins (remember, sugar is sticky), a chemical reaction known scientifically as the Maillard or "browning" reaction. These sticky conglomerations of sugar and protein gum up your vital enzymes, increasing free-radical damage to tissues, which accelerates the aging process dramatically.<sup>19</sup> Age spots on the skin indicate AGE formation. Cataracts in the lens of the eye are another example. If you eat a diet containing less sugar and emphasize food with a lower glycemic load—food that doesn't turn into sugar quickly in the body—you can reduce the formation of AGEs and help slow down visible signs of aging. Seen in this light, perhaps that dish of ice cream doesn't look quite as tempting. How you cook your food also influences AGE formation. Cooking at high temperatures such as baking, barbecuing, frying, roasting, or broiling increases AGE formation. Boiling or steaming is safer because the cooking temperature won't go above 212 degrees Fahrenheit, the boiling point of water. When foods brown during cooking, as with bread crust, basted meats, even coffee beans, it means that their AGE content has increased. Since most fast foods and processed foods are subject to browning, that's one more reason to avoid them. We like many aspects of the Mediterranean diet, such as the widespread use of heart-healthy olive oil both as a condiment and for cooking. Other types of Mediterranean food, such as Greek or Middle Eastern, are also good. Unfortunately, some people believe the diet includes large amounts of refined-flour products such as pastas and breads. That applies more to American-style Italian cuisine; in Italy, smaller portions of pasta are generally eaten. One way to make Italian food healthier is by replacing the pasta with the same amount of shredded spaghetti squash—the carbohydrates drop from 40 to an acceptable 5 grams per serving, of which 1.1 grams are fiber.<sup>20</sup>

### **Role Of Inflammation In Specific Diseases**

Chronic low-grade inflammation can smolder silently within your body for decades without causing any obvious or outward problems. But all the while, it is eroding your health and taking years from your life. Taking

steps to control silent inflammation gives you a powerful tool to combat several major degenerative diseases, including cardiovascular disease, Alzheimer's disease, diabetes, and cancer.

### **Cardiovascular Disease**

Until recently, cardiologists thought that heart disease was caused simply by the buildup of cholesterol deposits inside the walls of the coronary (heart) arteries. New research suggests that silent inflammation is a fundamental cause for cholesterol being deposited in the arteries in the first place. Silent inflammation has also been shown to be a potent cardiovascular risk factor itself, independent of other well-known risk factors.<sup>1</sup> We know that significant protection against heart disease comes from eating a low-fat, cholesterol-lowering diet, but it is also very important to eat a diet that decreases inflammation as well.

### **Alzheimer's Disease**

Just as inflammation in the heart arteries increases heart attack risk, inflammation of brain tissue increases risk of Alzheimer's disease (AD). Here's how: Silent inflammation in the brain increases production of soluble amyloid protein and increases its conversion into insoluble amyloid fibrils (discussed further in chapter 14, "Cleaning Up the Mess: Toxins and Detoxification"), which are actually toxic waste products that interfere with normal brain functioning and kill brain cells. If the brain cells do not remove these amyloid fibrils immediately, the dead and dying cells stick together to form pleated sheets of crystalline debris called *plaque*. One scenario for development of Alzheimer's includes the following steps:

1. *As the fibrils accumulate within brain cells, deterioration of brain function (as seen in AD) begins. Amyloid deposits formed of the dead and dying cells impair the supply of blood to the brain, compounding the problem.*<sup>2</sup>
2. *Amyloid fibril is identical to one of the amino acid chains that make up immunoglobulins (antibodies), the proteins at the front line in the immune system. So the inflammation started by amyloid fibrils overstimulates the immune system.*<sup>3</sup>
3. *Over activity of the immune system then leads to further inflammation.*
4. *Plaque deposits disrupt normal cellular metabolism, causing further inflammation.*

Inflammation in the brain also generates free radicals that destroy neurons in genetically predisposed individuals. This loss of brain cells can result in dementia.<sup>4</sup> As discussed in the previous chapter, people who carry the Apo E4 allele, a genetic variation seen in over 25 percent of the population, are at increased risk of developing AD.<sup>5</sup> They also develop dementia at a younger age, an average of 10 years earlier than people who do not carry this gene.<sup>6</sup> Apo E proteins are responsible for clearing away soluble amyloid protein quickly, so it doesn't have a chance to form the dangerous crystalline amyloid fibrils or plaque.<sup>7</sup> The Apo E4 variant (as opposed to the E2 and E3 genotypes) clears soluble amyloid protein slowly, so more plaque has a chance to form. But just because you carry the Apo E4 variant doesn't mean you're destined to develop AD. We need to look for other risk factors. One of these seems to be, of all things, the herpes simplex virus, specifically herpes simplex type 1, which causes cold sores. In combination with Apo E4, the herpes simplex virus can be a trigger for AD.<sup>8</sup> This is an example of how a usually benign environmental factor (herpes simplex) can increase the risk of a serious disease when a certain genetic predisposition (Apo E4) is present. In any event, if you perform genetic testing and find that you carry the Apo E4 allele, you know that you need to be particularly careful to help control your increased risk of AD and cardiovascular disease. Use your genetic information to individualize your personal health program and minimize risk.

### **Diabetes**

A similar story unfolds in the case of type 2 diabetes mellitus. In Alzheimer's disease, deposits of amyloid form in the brain. In type 2 diabetes, a different type of amyloid forms in the pancreas.<sup>9</sup> Chronic elevation of blood sugar and insulin levels increases inflammation in the bloodstream, triggering a cascade of events in the pancreas of a type 2 diabetes patient similar to what is seen in the brain of an AD patient. In AD, the trigger may be herpes; in diabetes, dietary sugar is the culprit. Even if you don't have diabetes, when you eat sugary foods or foods with a high glycemic load, you increase the amount of silent inflammation in your body. The aging process itself is, in a sense, a sugar disease, as seen in Figure 12-1.

By avoiding sugar and other high-glycemic foods, you can break this vicious cycle, decrease the amount of inflammation in your body, and slow aging.

### **Cancer**

Research into the connection between inflammation and cancer has become so intense that Dr. Robert Tepper of Millennium Pharmaceuticals has stated, "Virtually our entire R&D effort is [now] focused on inflammation and cancer."<sup>10</sup> Inflammation promotes several different cancers, including colon and lung. NSAIDs (nonsteroidal anti-inflammatory drugs) such as aspirin and ibuprofen decrease inflammation, and people who take these drugs on a regular basis have a decreased risk of several types of cancer, including colon cancer.<sup>11</sup> A study involving more than 14,000 women showed that those who took aspirin regularly had less than half the rate of the most common type of lung cancer.<sup>12</sup> The theory is that silent inflammation alters how certain genes are expressed, setting the stage for malignant growth. By reducing levels of inflammation in the body, the cancer-promoting genes are turned off more of the time, decreasing cancer risk.

### ***Dietary And Lifestyle Choices To Reduce Inflammation***

As you can see, what you eat significantly affects the level of silent inflammation within your body and, in turn, your risk of serious inflammatory-mediated diseases. If you consume a diet rich in high-glycemic foods (such as sugary foods, refined white flour products, and fruit juices) or foods high in preformed arachidonic acid (red meat and eggs), you increase PG-E2 and your amount of silent inflammation. Here's the diet we recommend to reduce inflammation: **Avoid foods that increase inflammation, such as** Red meat, eggs, Sugar, Coffee, alcohol, High-glycemic carbohydrates (such as pastries and pasta)

Emphasize Foods That Decrease Inflammation, Such As Cold-water fish, Spices and herbs like turmeric (contains curcumin), rosemary, ginger, and hot peppers (contain capsaicin) Green tea, Low-glycemic carbohydrates (such as whole grains and green vegetables)

- *Lose weight. Fat cells are very powerful generators of inflammation. As you lose weight, you automatically reduce your amount of silent inflammation. Maintaining your optimal body weight through diet and regular exercise is critically important, because excess fat tissue increases the level of inflammation in the body.*<sup>17</sup>
- *Exercise more. A program of regular exercise averaging 30 minutes daily will also significantly reduce inflammation.*
- *Reduce stress. Stress causes inflammation. A recent study has shown that chronic exposure to stress significantly raises levels of the inflammatory compound IL-6 (interleukin-6).*<sup>18</sup> *Overproduction of IL-6 has been linked to numerous diseases, including cardiovascular disease, arthritis, type 2 diabetes, certain cancers, and accelerated aging. Taking steps to control stress in your life is an important step toward reducing inflammation in your body.*

### ***Methylation Processes - Methylation Can Cause DNANa Changes***

Methylation is essential in the proper formation of DNA. We previously mentioned SNPs (single nucleotide polymorphisms), where just one nucleotide in the DNA of a gene is changed. For example, if a DNA region that contains the nucleic acid cytosine (C) becomes methylated, it can turn into the nucleic acid thymine (T).<sup>5</sup> This common mutation is referred to as a "C→T (cytosine to thymine) polymorphism" and can lead to dramatic (and sometimes catastrophic) genetic changes. All it takes to produce an often-spectacular change in your genes is to put a methyl group somewhere it wasn't before. Such methylation reactions might cause something quite benign, while at the most serious level they can increase the risk of cancer.<sup>6</sup>

### ***Blocked Detoxification***

The body also uses methylation to help rid itself of a number of dangerous heavy metal toxins, such as mercury, lead, antimony, and arsenic. If you have defective methylation, these toxic metals may accumulate, which interferes with normal functioning of numerous bodily functions. By performing a hair minerals test, you can find out if you have excessive amounts of toxic heavy metals in your body, which also suggests defective methylation. The liver uses methylation to assist in excretion of external toxins as well as some of its own chemical wastes, such as hormone by-products. Defective methylation leads to a buildup of external toxins such as pesticides as well as excessive levels of your body's own hormones, such as estrogen. This is a significant problem because excess estrogen has been associated with an increased risk of several types of cancer.<sup>7</sup>

### ***Effect on the Brain***

Methylation reactions are also critical to normal brain function. The body uses the amino acid tryptophan to form the calming neurotransmitters (chemicals used by brain cells to communicate with one another) serotonin and melatonin. The amino acids phenylalanine and tyrosine are transformed into the neurotransmitters adrenaline, noradrenaline, and dopamine, which have just the opposite effect—they tend to stimulate the mind and make you excited. Methylation is involved in a number of these reactions. So whether you are excited or calm may be a direct function of methylation reactions in your brain. The brain also uses methylation to form acetylcholine, the neurotransmitter needed for memory. Decreased acetylcholine levels in the brain have been linked to memory loss and Alzheimer's disease.

Methylation defects have been associated with an increased risk of Alzheimer's disease as well as many of the mood disorders commonly seen in the elderly, such as depression and paranoia. Numerous studies have shown a link between defective methylation and abnormal brain function. In one study, an elevated homocysteine level was found in a high percentage of hospitalized psychiatric patients. Patients with mood disorders such as anxiety and depression have a high incidence of elevated homocysteine. Alzheimer's patients often have both elevated homocysteine and low blood levels of folic acid, one of the nutrients that lower homocysteine.<sup>8</sup> Heart disease continues to be our leading cause of death among both men and women, killing more than 600,000 Americans each year<sup>1</sup> (although a woman's comparable risk trails a man's by about 10 years; a major risk factor is being 45 years of age or older for a male versus 55 for a woman).<sup>2</sup> Until recently, the conventional understanding underlying the cause of most heart attacks was this: over time, excess cholesterol delivered by LDL-C (low-density lipoprotein, or bad, cholesterol) becomes oxidized, builds up in the coronary arteries, and eventually calcifies into a hard plaque. These calcifications narrow the passageway for blood through these arteries. If this plaque reaches a dangerous level—closing off 80 percent

or more of the artery—a blood clot may get stuck in the narrow passageway and obstruct blood flow. This sudden total blockage of the artery—a coronary thrombosis, or heart attack—causes the portion of heart muscle fed by that artery to die, resulting in either the death of the patient or permanent damage to the heart. ^ This old understanding of heart disease led to the development of two major operations, both of which have become large industries.<sup>3</sup> Bypass surgery "bypasses" the problem of a clogged artery by diverting blood flow through a grafted vein or mammary artery. Coronary artery bypass surgery is one of the most invasive surgeries available and carries a 2 to 6 percent rate of surgical mortality.<sup>4</sup> Among its many complications is a significant decline in mental function and mood in up to 80 percent of coronary bypass survivors.<sup>5</sup> Even more popular is balloon angioplasty, during which a thin, flexible tube (called a catheter) with a tiny inflatable bulb at the end is inserted into an artery in the patient's groin and guided up through the artery to the blockage. After the "balloon" is positioned, it is inflated to compress the plaque and widen the lumen, or opening, of the blocked artery. A refinement to the technique was introduced around 2000: adding a stent, a rigid tube designed to prevent the compressed plaque from re-expanding and forming future blockages in the same spot. Angioplasty is less invasive than bypass surgery, but it too has significant complications. Angina is experienced as pressure, tightness, or pain in the heart area. The leading theory about its cause is that in an attempt to prevent rupture of the vulnerable plaque and the ensuing catastrophe, the body "walls off" the vulnerable plaques by placing a calcified layer over it. If too much calcified plaque forms, it interferes with blood flow. With physical exertion, not enough blood reaches the heart, resulting in the discomfort or pain called angina pectoris (literally, pain in the chest). It is also possible for a calcified plaque to grow large enough to block blood flow completely, leading to a heart attack or stroke, but this explains less than 15 percent of heart attacks.<sup>8</sup>

### ***The New Understanding: Most Heart Attacks Are Caused By Vulnerable Plaque And Inflammation***

The large, calcified plaque growing on the inside surface of coronary arteries is *not* the cause of most heart attacks. Rather, the primary culprit is the soft, relatively small "vulnerable" plaque that forms within the vessel walls.<sup>10</sup> Large, calcified plaque is actually relatively stable and, because of its hard calcified covering, less commonly cracks. The more dynamic, less stable soft plaque is much more likely to suddenly rupture. As the body forms a clot to try to heal such a rupture, the result may be a total blockage of blood flow; in other words, a heart attack. The soft plaque is hidden inside the walls of the artery and often causes no obvious blockage or loss of blood flow until, of course, the often-fatal rupture. Yet there is good news hidden in this new understanding because the buildup of soft, vulnerable plaque is much easier to reverse than that of hard, calcified plaque. Levels of the two types of plaque are related, since the same process (see page 203) appears to result in both forms. One prevalent theory on the origin of the hard plaque is that it's the body's attempt to protect the artery from vulnerable plaque by covering it with a hard, calcified layer. However, bypass surgery and balloon angioplasty do not slow down the process of soft or hard plaque formation; they often accelerate them. An early research study in 1986 by Dr. Greg Brown of the University of Washington at Seattle demonstrated that sudden blockages causing heart attacks were occurring in locations of coronary arteries that had very little plaque, not nearly enough to qualify for bypass or angioplasty surgery.<sup>11</sup> In the late 1980s, Dr. Steven Nissen of the Cleveland Clinic began to examine the coronary arteries of heart patients with an innovative ultrasound camera that he guided into the blood vessels. He found many soft bulges of plaque, often numbering into the hundreds in a single patient, but relatively few areas of calcified plaque. He proposed the idea that it was these widely distributed soft bulges of plaque, not the deposits of hard plaque, that were the primary culprit behind heart attacks.<sup>12</sup> Brown's and Nissen's research, as well as similar studies, were slow to be accepted. Recently, Dr. Nissen has emerged as a leading innovator in fostering new therapies for heart disease, playing a leading role in several new drugs (see Bridge Two sidebar on Pfizer's new Torcetrapib drug and new PPAR drugs, on page 207). Dr. Nissen also conducted an important study (mentioned below) that indicates that lowering LDL cholesterol to levels significantly below the standard recommendations reduces risk. Dr. David D. Waters of the University of California conducted the pivotal study that began to rapidly change minds on the importance of vulnerable plaque in 1999. In the study, which was called AVERT (atorvastatin versus revascularization treatments), Dr. Waters randomly assigned patients who had been referred for angioplasty surgery to two groups. One received the surgery and standard follow-up care. The other received cholesterol-lowering statin drugs but no surgery. The non-surgery group actually had fewer heart attacks and fewer visits to the hospital for chest pain than the surgery group.<sup>13</sup> Dr. Waters commented that the research "caused an uproar. We were saying that atherosclerosis is a systemic disease. It occurs throughout all the coronary arteries. If you fix one segment, a year later it will be another segment that pops and gives you a heart attack, so systemic therapy, with statins or antiplatelet drugs, has the potential to do a lot more. There is a tradition in cardiology that doesn't want to hear that. There is a culture that the narrowing are the problem and that if you fix them, the patient does better."<sup>14</sup>

### ***Male-Pattern Baldness***

An 11-year study at Harvard Medical School of 22,071 male physicians showed increasing risk of heart disease with increasing levels of hair loss.<sup>71</sup> The link appears to be due to the fact that the vasoconstriction of

blood vessels that underlies baldness also plays a role in accelerating both atherosclerosis and heart attacks. Attacking the symptom of baldness with such drugs as Propecia is unlikely to improve this risk factor. However, adopting a heart-healthy diet, supplement, and exercise program will reduce both heart disease risk and further hair loss (but it won't reverse prior hair loss).

### **Why We Get Cancer And How To Prevent It**

Cancer is a disease characterized by uncontrolled cellular proliferation. While normal cells have a fixed life span, as long as there is enough food, cancer cells will continue to grow and multiply indefinitely. This difference in cancer cells has been linked to mutations in their DNA, primarily caused by exposure to highly unstable and reactive chemicals known as free radicals. Free radicals form naturally in the body, but some specific environmental factors increase your exposure to these highly unstable molecules. You are exposed to excess free radicals from:

- *Radiation exposure (such as X-rays and bright sunshine)*
- *Toxic heavy metals (lead, cadmium, mercury)*
- *Environmental toxins (pesticides, plastics, pollution)*
- *Cigarette smoke*
- *Deep-fried foods*
- *Excessive stress*
- *Excess dietary iron*

Every cell in your body experiences more than 100,000 free radical attacks each day. To maintain health and prevent your tissues from becoming cancerous, you require powerful mechanisms to counteract and repair this constant barrage. Luckily, each cell comes equipped with a system of built-in enzymes designed to neutralize free-radical attacks. Many of these enzymes require a continuous supply of vitamins and minerals to function properly. This is another reason; fundamental aspect of our program involves aggressive nutritional supplementation. We feel that by ensuring that you have an adequate supply of vitamin: and minerals in your body at all times, you can decrease your cancer risk.<sup>8</sup> Toxic metals, meanwhile, can bind to your enzymes, taking the place of beneficial minerals and render these "polluted" enzyme molecules useless. So another aspect of our program emphasizes detoxification strategies. Nutritional antioxidants—such as vitamins A, C, and E, the mineral selenium, and "super-nutrients" like coenzyme Q<sub>10</sub> and alpha Lipoic acid—are very powerful free-radical scavengers. We will discuss these nutritional supplements at more length in chapter 21, "Aggressive Supplementation." Minimizing your exposure to pollution and stress and making other health-promoting lifestyle choices are also critical to optimal enzyme function and cancer prevention.

### **Prevention Of Cancer**

Let's move now from early detection and determination of genetic risk to cancer prevention. An effective program for avoiding cancer in the first place entails diet and nutrition, lifestyle modification, and chemoprevention.

### **Diet and Nutrition**

Thinking has changed since 1949, when the American Medical Association stated, "There is no scientific evidence that food or other *nutritional essentials* are of any specific value in the control of cancer." Diet, lifestyle, and nutrition have actually been shown to play an important role in determining cancer risk.<sup>40</sup> For instance, research indicates that populations that consume large quantities of plant-derived foods have a lower incidence of several types of cancer. In 1991, the National Cancer Institute incorporated these findings into the 5 a Day for Better Health Program. It recommended five daily servings<sup>41</sup> of fruits and vegetables as part of a low-fat, high-fiber diet. Despite widespread promotion of this program over the past decade, fewer than one in five American children and fewer than one in four adults eat five portions of produce a day, a statistic that hasn't changed in 10 years.<sup>42</sup> Ray & Terry's Longevity Program regards the 5 a Day program as a good start, but we recommend our 5-to-10-a-Day program, encouraging life to *seven servings of vegetables and zero to three servings of fruit daily*. See Ray & Terry's Food Pyramid on page 106. Emphasis should be on low-glycemic-load (low-starch) vegetables—typically, green vegetables as opposed to higher-carbohydrate root vegetables. Fruit is beneficial, but caution is needed—while it's almost impossible to eat too many low-starch vegetables, you *can* eat too much fruit and consume excessive sugar. Some people feel that by taking nutritional supplements, they can compensate for a diet insufficient in plant-based foods. While supplements are clearly of proven value, taken alone they do not offer sufficient protection against cancer. A diet rich in naturally occurring nutrients, as found in fruits and vegetables, is needed for optimal cancer prevention.<sup>43</sup> Our dietary recommendations include:

**Drink vegetable juice.** Start your day right with an 8-to-12-ounce glass of freshly squeezed vegetable juice as part of, or instead of, breakfast: juice some cucumber, broccoli, kale, cabbage, a carrot (for flavor, but not more than one, to avoid excess sugar), and other green vegetables you find in your refrigerator. This can provide almost half of your 5-to-10-a-Day requirements even before you leave your house in the morning. We also reemphasize the importance of eating *organic* produce whenever possible to minimize exposure to pesticides and other carcinogenic chemical residues.

**Eat a Mediterranean diet.** The Mediterranean diet, which is low in red meat and emphasizes whole grains, fish, and fresh fruits and vegetables, has been associated with reduced cancer risk.<sup>44</sup> Digestive-tract cancers (mouth, esophagus, stomach, and colon) and cancers of the lung and prostate are lower. In a recent study of more than 22,000 Greeks, those who followed the Mediterranean diet had a 24 percent decrease in total incidence of cancer, compared with individuals who did not eat this way.<sup>45</sup> The Mediterranean diet includes generous amounts of extra virgin olive oil which protects against several types of cancer—colon, breast, and skin—a; well as coronary heart disease.<sup>49</sup> The Mediterranean diet also calls for large portions of fresh tomatoes and tomato sauces. Cooked tomatoes, along with most other red fruits and vegetables, are rich in the bioflavonoid lycopene, which has been associated with a lower risk of prostate cancer.<sup>50</sup>

**Avoid the white Satan—sugar.** Because cancer cells consume sugar so avidly, the PET scan used by doctors to locate cancer in the body involves giving patients radioactive glucose (or sugar), which is concentrated in areas harboring malignancies and shows up as hot spots on the scan. The 1931 Nobel laureate Otto Warburg demonstrated that cancer cells have a fundamentally different metabolism than normal cells and utilize sugar as their predominant food for growth.<sup>51</sup> You can inhibit cancer formation by avoiding dietary sources of simple sugar as well as foods with a high glycemic load, which are rapidly converted to sugar in the body. A direct relationship between sugar consumption and pancreatic cancer was seen in women who participated in the Nurses' Health Study. The Women's Health Study, published by researchers at UCLA in 2004, found that a high-glycemic-load diet significantly increased risk of colorectal cancer.<sup>52</sup> When coupled with excess weight and a sedentary lifestyle, women in this study who consumed excess sugar had more than three times the average risk of developing cancer of the pancreas.<sup>53</sup> Avoid "the white Satan" whenever and wherever possible.

#### ***How To Keep Your Brain Healthy - "Use it or Lose it"***

New brain cells are formed primarily in two areas: the fluid-filled ventricles of the forebrain and the hippocampus, the region of the brain where new memories are created. As mentioned above, mouse experiments have shown that regular exposure to new experiences results in a dramatic increase in new neuron formation. You can even "bulk up" your brain by doing exercise, just like for your muscles below the neck. A German team recently taught a group of young volunteers how to juggle. These individuals had increases in the size of the gray matter in specific areas over the course of their training, but the gains disappeared when they quit practicing.<sup>39</sup> Some studies in humans also suggest that maintaining intellectual activity throughout life can protect against cognitive decline in later years. The Victoria Longitudinal Study currently under way in western Canada has shown that middle-aged and older individuals who engage in intellectually stimulating and challenging projects, including everyday activities such as reading the daily newspaper, are less likely to suffer declines in cognitive functioning.<sup>40</sup> In addition to exercising your left brain, you should also keep your right brain in top form by expressing your creative or artistic urges: study a musical instrument; learn to paint, sculpt, or sing; take up a new hobby. Stay connected to others. Make new friends and continue to maintain longstanding personal relationships. With these simple techniques, you can help avoid the deterioration of intellectual function as well as many of the mood disorders so common among older individuals.

#### ***Rust-Proofing Your Body***

Leave your bike out in the rain and it rusts. Leave a cut apple on the counter and it turns brown. Forget to put the butter back in the refrigerator and it becomes rancid. These changes are due to oxygen combining with the exposed molecules in a process known as oxidation. We cannot live without oxygen, yet this same element that is so vital to our existence is also instrumental in the aging process. So does that mean as we age, we get rusty? Well, sort of. To better explain what happens, we have to talk about free radicals. Very simply, free radicals are molecules that are missing an electron in their outer shell. Molecules are composed of atoms that are bound together by shared pairs of electrons. All stable molecules are composed of a set number of paired electrons. When a bond between an electron pair is broken, free radicals are formed. These free radicals are highly unstable and must restore their paired electron status by getting hold of another electron immediately. They do so by stealing electrons from whatever molecules happen to be close by, damaging these other molecules and turning *them* into free radicals. If that molecule is DNA, the genetic blueprint for replication of all cells in the body, the damage will persist as the DNA replicates. This will cause cellular damage and increase the risk of cancer. Free radicals are generated constantly within cells as oxygen is burned to create energy from nutrients. Other conditions that can increase the load of free radicals in the body include inflammation, infection, not eating enough antioxidant-rich foods, and exposure to high levels of free radicals in the environment.

Antioxidants, also known as free-radical scavengers, function by offering easy electron targets for free radicals. In absorbing a free radical, antioxidants "trap" (de-energize) the lone free-radical electron and make it stable enough to be transported to an enzyme, which combines two free radicals together, neutralizing both. Without these antioxidant buffers, free-radical damage would quickly spiral out of control and destroy the entire organism.

### **Our Free-Radical Defenses: Enzymes And Antioxidants**

Fortunately, your body is equipped with two sets of defense systems that are able to neutralize these free radicals before they lead to tissue damage—one that is built into your cells and one that you take in through foods or supplements. Your built-in free-radical scavengers are called *antioxidant enzymes* such as SOD (superoxide dismutase). These beneficial antioxidant enzymes stabilize free radicals so they can't damage tissues in the body.<sup>14</sup> Your dietary antioxidant system includes *vitamins, minerals, and other antioxidant nutrients*, the best known of which are vitamins A, C, E, and the mineral selenium (our "ACES"). Other vitamins, such as vitamins B<sub>2</sub>, B<sub>3</sub>, and B<sub>6</sub>, as well as some non-vitamins such as coenzyme Q<sub>10</sub>, alpha Lipoic acid, and the proanthocyanidins (grape seed extract), also serve as powerful antioxidants. The genes found in your DNA are the blueprints that direct your body to build the proteins it needs. Among the most important of those proteins are your enzymes, which help your cells make the other critical compounds they need for healthy functioning. Of the 3,870 enzymes in the human body identified to date, 860 (22 percent) require a vitamin-derived cofactor.<sup>15</sup> Many enzymes require mineral cofactors as well. Without these cofactors in place, the enzymes are useless. So vitamins and minerals have two critical roles in providing antioxidant protection and maintaining health: they themselves serve as antioxidants and they are needed for built-in antioxidant enzymes to work. By taking supplemental vitamins and minerals, you ensure that your body will have the necessary building blocks to create an adequate supply of functioning antioxidant enzymes at all times.

You could take these antioxidant enzymes as supplements, but they tend to be poorly absorbed when taken by mouth, so it is better simply to take the vitamin and mineral cofactors and let your body build its own enzymes. But genomic research has revealed that many people have genetic defects that cause these cofactors to attach improperly to the enzymes that need them, a problem that can be corrected only by taking larger amounts of these nutrients. This has led us to the important discovery that most people need one or more vitamins or antioxidants far in excess of the RDA amount, and to the even more important conclusion that optimal health is not possible without supplementation.

### **Aerobic Exercise**

The mainstay of your exercise program should be regular aerobic exercise. Aerobic exercise is intended to raise both your heart and breathing rates and, as the name suggests, results in increased air (oxygen) consumption. Aerobic exercise such as walking, swimming, cycling, rowing, and cross-country skiing significantly lowers the risk of cardiovascular disease, cancer, and other diseases, as well as providing immediate benefits in terms of weight loss, reduced hypertension, improved sleep, and better mood. Regular aerobic exercise can also reduce elevated triglyceride levels and boost levels of HDL, the good cholesterol.<sup>6</sup> A key aspect of aerobic exercise is that it involves continuous, rhythmic exertion of the large upper or lower body muscles for at least 20 minutes. It increases your heart rate and your demand for oxygen but is sustainable for an extended period of time. Although there is some cardiac benefit from the significant exertion involved in stop-and-go sports such as tennis and basketball, these are not optimal forms of aerobic exercise. We would consider these types of sports more as supplements to a regular aerobic exercise program, not the primary component of one. During aerobic exercise, you should be at your training heart rate. That's between 50 and 75 percent of your maximum attainable heart rate, which you can estimate as 220 minus your age, according to the American College of Sports Medicine (ACSM) and Mayo Clinic.<sup>7</sup> So, for example, if you are age 40, your theoretical maximum heart rate is 180, and your training range would be between 90 and 135 beats per minute.<sup>8</sup> The best way to determine your heart rate is with a sports watch that provides a pulse readout. Otherwise, you need to briefly interrupt your exercise and count your pulse for 15 seconds, then multiply this figure by four. It is important to take your pulse as soon as you stop exercising, because your heart rate will slow down immediately. Once you have estimated your heart rate, continue your exercise routine. The ideal aerobic exercise is walking. Virtually everyone can do it, almost anywhere. You should have little difficulty elevating your heart rate into your training range on a sustained basis, and it does not put undue strain on any of your joints.

Society has a number of powerful and widely held but misleading ideas that we have tried to counter:

- *The health care system will take care of me if I have a problem. The reality: Our medical system is largely geared toward dealing with health issues once they erupt as full-blown disease. Very little attention is paid in our medical schools to nutrition and disease prevention. Waiting until symptoms of disease appear is often too late. The first symptom of heart disease may be a heart attack; cancer may not be evident until it has already metastasized. The knowledge to avoid the degenerative diseases that cause more than 90 percent of all deaths and vast suffering is available, but the responsibility to apply this knowledge is yours.*
- *Taking a supplement or drug is a last resort. The reality: When our bodies evolved tens of thousands of years ago, it was in the interest of the species for humans (and other animals) not to live much beyond their child-rearing days. Now that we live in an era of abundance rather than scarcity, this evolutionary program is no longer relevant. We have the means to dramatically slow down and in many cases halt and reverse degenerative disease and aging processes, but these require reprogramming your biochemistry through nutrition, exercise, and lifestyle as well as taking advantage of supplements and drugs. This process will*

*become easier with the more powerful Bridge Two and Bridge Three therapies and interventions being developed, but today it requires understanding and effort.*

- *The only things we can count on are death and taxes. The reality: We'll leave the issue of taxes for another book, but the means to extend longevity indefinitely are in our grasp. Although we do not yet have all the tools we need to stop and reverse all aging processes, we do have the means right now to stay in good health and spirits until the full blossoming of the biotechnology and nanotechnology/artificial intelligence revolutions, which will indeed provide radical life extension.*