On the desk in my office, my purified drinking water
is in a special gold-amber bottle engraved with the slogan
"Nectar of the Golden Life of Health and Vitality."
I believe **water** to be that substance.

Water

Water is the medium in which all other nutrients are found. Three simple molecules—2 hydrogen and 1 oxygen—bind together to form 1 molecule of water, the most abundant and important substance both on Earth and in the human body. The hydrogen and oxygen atoms in water are never alone, however. Water is the universal solvent, as most other substances on Earth dissolve in water in varying degrees. In a mountain stream or in our bloodstream, minerals and other substances are always naturally present. Pure (100%) water does not exist naturally on our planet. There is no place that is just water, like distilled water; there are always minerals and other substances contained. The planet's natural water varies in mineral content, as does the water found within the human body. The adult body is at least 60% water, but this percentage is even higher before birth. As late as 32 weeks of gestation, the fetus is more than 80% water and is surrounded by the oceanlike water of amniotic fluid. The fetus continuously swallows this fluid for nourishment—each day about 250 milliliters for every kilogram of body weight (the equivalent for an adult of about 5 gallons per day). Without this constant swallowing of water and nutrients, the fetus would become malnourished and the digestive system itself could not be properly formed.

Water is the primary component of all the bodily fluids—blood, lymph, digestive juices, urine, tears, and sweat. Water is involved in almost every bodily function: circulation, digestion, absorption, and elimination of wastes, to name a few. Water carries the electrolytes, mineral salts that help convey electrical currents in the body; the major minerals that make up these salts are calcium, chloride, magnesium, potassium, and sodium. Water requirements vary greatly from person to person. The climate in which we live, our activity level, and our diet all influence our individual needs for water.

WATER AND HEALING

Anything that nourishes can heal, but among all nutrients—perhaps all substances of any kind—water is unsurpassed in its ability to heal. We turn to water for healing (and feelings) in all dimensions of our lives—from hot tubs to hydrotherapy, from bathing to baptism—and the mere sight of water, a mountain

Staying Healthy with Nutrition

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21ST-CENTURY EDITION

Elson M. Haas, MD
with Buck Levin, PhD, RD

lake or ocean tide, can ease the pain of psychological wounds.

The pain of physical wounds is also healed through water. When we're injured, our bloodstream carries repair substances to the injury site. About 81% of that bloodstream is water. When toxic substances from the environment make their way inside our bodies, our urine (95% water) or our sweat (99% water) usually carries the toxins back out. Skin wounds heal most quickly in a wet environment, because water accelerates re-epithelialization (the making of new skin) and the rate of wound contraction. Hyaluronan, the well-researched glycosaminoglycan in skin, is believed to promote skin healing by increasing skin hydration.

In these and countless other ways, water is fundamental to life. Without clean water, we cannot experience optimum health, but by practically every public health standard issued during the past 50 years, humans have not experienced optimum health. One of the reasons for this fact is simple: **the Earth's water is in crisis.** *Crisis*—from the Greek word *krisis*, meaning "turning point" or "point of decision"—is exactly the right word to describe our present-day relationship with water, both nutritionally and ecologically. The resolution of this crisis is so fundamental to our personal health and the health of our planet that we must look more closely at water than we look at any other nutrient. What is happening to our water is simple: it is Drying Up, Getting Diverted, and Becoming Toxic.

Drying Up

On average, we need about 12 cups worth of water each day to stay hydrated. These cups don't have to come from our drinking water, however. They can include the water our food contains, as well as the water that is released when our food digests. In the United States, we average about 4 cups of water from a day's food, and the breakdown of this food provides us with an additional cup. But we actually need to drink the remaining 7 cups! According to Wirthlin Worldwide, a market research company, 20% of us drink no water at all, and 42% of us consume a mere 2 glasses or fewer. At the same time, we are consuming, on average, 1.8 cups of coffee, 1.3 cups of soda, 1.2 cups of milk, and 1.1 cups of juice a day.

Without enough water, we basically dry ourselves out (the technical term is *dehydration*). In the medical research it is linked to a long list of chronic health problems, including adult-onset diabetes, arthritis, asthma, back pain, cataracts, chronic fatigue syndrome, colitis, depression, heartburn, high blood pressure, high cholesterol, kidney stones, lupus, migraine, multiple sclerosis, and muscular dystrophy. Even 3 to 4 cups a day is not enough to lower risk for these problems. We need to increase our water intake!

Eerily similar to the health crisis in our own bodies, where dehydration is increasing our risk of chronic disease, we are experiencing a crisis with the water in our environment. There is a fascinating and probably not accidental set of events going on in many communities, as some bodies of water in the United States are drying up. Many rivers no longer reach their destination, having been diverted for irrigation or dammed up for generation of hydroelectric power. Chronic environmental problems—like decrease in salmon runs up the Columbia River in the Pacific Northwest—are riddling the country. According to the International Rivers Network based in Berkeley, California, over 77% of all river discharge in North America is affected by dams. The reservoir of water created by a large dam can trap almost all of the sediment in a river. When the dynamic flow of this sediment is lost, wildlife habitats downstream lose their ecological balance. Currently, 40 different species of freshwater fish in North America are endangered—largely as a result of this process.

Getting Diverted

All water needs to get where it was originally designed to go, and in the case of humans, that means directly into our bodies and not detoured as a result of drinking soda pop or coffee. Most people don't realize it, but coffee typically upsets our water balance, even though it consists mostly of water. Coffee is a diuretic and can actually cause us to excrete more water than it contains. Soda pop, with so much concentrated sugar, can also upset our water balance. When the highly sugar-concentrated water in soda pop enters our digestive system, it can cause the body to "steal" water from elsewhere to dilute the soda pop and make it less concentrated. This soda pop problem is referred to as *hyperosmotic load.*

Cutting back on coffee and pop are not the only steps we can take to improve our water status, however. We could also take some environmental steps by helping water reach its natural destination. Water likes to move down (from mountain snowpacks to lowland watersheds) and further down (through soil and rock and to groundwater and underground aquifers). When water passes through limestone, it picks up calcium. When it passes through dolomite, it picks up magnesium. If we leave water alone—rather than diverting it into reservoirs or damming its flow—it will typically become more mineralized and more supportive of our health. Studies in Sweden have shown that if everyone in that country were to drink water with the highest naturally occurring magnesium levels, death from heart attacks would drop by about 19%. In fact, increases in water magnesium as small as 6 mg (milligrams) per liter might be able to reduce deaths from ischemic heart disease by 10%. Similar studies in Poland and South Africa have come up with comparable conclusions. A 1-quart bottle of highly mineralized spring-water can contain well over 75% of the recommended daily allowance (RDA) for magnesium. By comparison, tap water in most U.S. cities contains fewer than 10 mg per quart, or about 3% of the RDA.

Becoming Toxic

Some toxins, like MTBE (methyl tertiary butyl ether), have been placed there "accidentally." MTBE is the gasoline additive used in the United States since the 1980s to enhance octane and cut air pollution. Scientists at the U.S. Geological Survey have estimated that as many as 250,000 underground tanks used to store gasoline may have accidentally leaked MTBE into nearby soil and groundwater, contaminating as many as 9,000 community wells in 31 states. MTBE is one of several hundred substances that are now accidentally present as water percolates through the Earth.

Alongside these toxic substances that have accidentally found their way into soil and groundwater are substances we have put there intentionally. For example, a total of about 150 million tons of solid waste is deposited in our country's 7,500 municipal landfills each year. Treated sewage sludge used as agricultural fertilizer, municipal waste incineration, volatile organic compounds (VOCs) released into the air by manufacturing plants—all of these deliberate and legally sanctioned practices create a toxic pathway for water.

The U.S. Environmental Protection Agency (EPA) currently monitors about 80 toxic substances found in our drinking water. These substances include chlorination by-products like trihalomethanes (THMs), heavy metals like cadmium, pesticides like alachlor, and plastics like styrene. Because water contaminants can originate from a wide variety of sources, the exact combination and level of toxins found in water differs from region to region and depends on manufacturing and other pollution-related activities. Municipal wastewater-treatment plants, land-based disposal of treated sewage sludge, agricultural use of treated sewage sludge as a fertilizer, sewage sludge incineration, open lagoon treatment of toxic waste, and municipal waste incineration are included in the list of practices that can contaminate our drinking water. For example, water in the Mississippi River—the longest river in the United States—gets a daily dose of cadmium, mercury, and lead from a large wastewater treatment facility in St. Paul, Minnesota. Freshwater regions like the Great Lakes also get daily toxic input from industrial activities along the shoreline. This toxic input includes asbestos, dioxins, pesticides, and polychlorinated biphenyls (PCBs). The PCBs in the Great Lakes exceed international agreements for the region.

Although water purification plants that process water for human consumption take steps to minimize toxins, toxic compounds are present at potentially health-damaging levels in municipal drinking water nationwide. Over 1,100 potentially toxic compounds have been identified in drinking water across the United States. A 2001 survey of 374 communities in 12 states found the pesticide atrazine, a reproductive and immune system toxin, to be present in 96% of all water supplies tested. Drinking water in almost 30% of these communities contained at least 5 pesticides.

When water picks up toxins, the EPA has a special word for it: "impaired" (that is, the water cannot be used for the full range or purposes for which we might want to use it). The EPA estimates that 85% of all river miles and 68% of all lake acreage in the United States are currently impaired. It might be unhealthy for fishing, or swimming, or drinking. And exactly what counts as "fit for drinking" is unfortunately a matter of much debate. Toxic substances found in municipal drinking water across the United States have been indirectly linked to many chronic, degenerative diseases, including Alzheimer's, asthma, most forms of cancer, infertility, Parkinson's, and rheumatoid arthritis.

I use the word *indirectly* here because contaminated water has not been shown to directly cause disease in some simple, straightforward way. In fact, toxic substances found in drinking water may *never* be shown to *directly* cause disease, for three reasons. First, contaminants in a single glass of water are present in very small amounts, and a lifelong study would be needed to measure the effects over one's lifetime. Second, water toxins work behind the scenes, compromising our health at a largely invisible cellular level. They disrupt the energy-producing mechanisms inside our cells, they disturb chemical signals that are sent across our cell membranes, and they drain our nutrient supplies by asking our livers to work overtime. I am convinced that the negative impact of contaminated water is real, even if it is difficult to prove. We need to drink water that contains as few toxins as possible.

OUR DRINKING WATER

Fortunately, awareness of the urgent need to address water pollution is growing, both nationally and internationally, and healing our waters and providing safe and tasty drinking water are becoming a major industry in the way of filtered water systems, international springwaters, designer water, flavored waters, juice waters, and more, including nutrient-enhanced waters, making a market splash. This chapter offers a synergistic collation of the most current, usable information on water safety and toxicity. Much water information is purported to be fact by business interests, yet scientific study is lacking at this time. Surely this will change, so look for upcoming data on this crucial subject.

Because water is a basic life need, a "life force" if you will, the government and the people should spend more energy and dollars researching how to keep it safe for human consumption. My concern is that our governments will wait too long to correct the current water problems, much like modern Western medicine focuses on end-stage disease rather than on preventive medicine (although this is changing in some circles). Keeping people well and learning more about the factors that affect their well-being must be a primary goal. Healing and maintaining the environment, keeping our basic elements (water, air, and food) clean and wholesome, is a good place to start!

Drinking water has become an issue of concern. Many water tests have shown that tap water is not totally safe. We need to ask what role drinking tap water plays in our health. What is its subtle effect on biochemical processes in our body, and what is its relationship to symptoms of illness or chronic disease? Not enough research has come out to date showing how tap water and its contents influence our health. The water supply in many U.S. cities has a high sodium level, which has been correlated with an increased likelihood of high blood pressure and subsequent cardiovascular disease. Soft water, in which a high level of sodium has replaced such biologically important minerals as calcium and magnesium, has also been implicated in reducing our resistance to heart disease.

With the trend toward using pure and natural products in personal health care, city tap water has come to be considered by many a processed, unnatural substance, containing potentially hazardous chemical additives. No wonder bottled water has become a huge industry in the past decade! In 2003, bottled water (of all kinds) was one of the fastest growing segments of the U.S. beverage market. More than 6.4 billion gallons were sold at a wholesale market value of more than $8.3 billion. These sales represented a 7.5% increase from the 2002 level, and the sixth straight year of surging growth in this sector.

For the most part, city water is heavily chlorinated to kill germs and fluoridated to prevent tooth decay; some cities add calcium hydroxide or other alkaline substances to change the pH (acidity) of the water so it does not corrode pipes. Chlorine and other additives used to treat water can react with other organic chemicals to produce chlorinated hydrocarbons that may act as carcinogens. For example, chloramines, including chloroform and other trihalomethanes, are formed in water from chlorine and such organic matter as ammonia or decaying leaves. Water pipes may contribute chemicals or metals such as copper or lead.

The EPA currently oversees implementation of the Safe Drinking Water Act (SDWA) of 1974—the nation's primary law for regulating safety of tap water. As part of its responsibility, the EPA monitors groundwater throughout the United States and has special enforcement powers to protect areas in which a single underground aquifer serves as the primary source of drinking water. Under the SDWA, the EPA monitors levels of approximately 100 potential toxins in drinking water. It also establishes safety ranges for each of these toxins.

Possible Contaminants in Our Drinking Water (Municipal and Well Water)

- Microorganisms (bacteria, viruses, parasites)
- Disinfectants (chlorine, chloramines)
- Disinfectant by-products (bromates, chlorites, trihalomethanes)
- Inorganic chemicals (heavy metals, asbestos, nitrates, nitrites)
- Organic chemicals (solvents, pesticides, plastics, resins)
- Radionucleotides (radium, uranium)

CHOOSING YOUR DRINKING WATER

I urge people to use purified drinking water and to avoid the faucet. I personally have not drunk tap water in more than 20 years; instead, I have used well water or springwater collected from mountain or underground sources (unfortunately these waters can be contaminated also) or, more recently, home-filtered tap water using a reverse osmosis (RO) system (see page 21). But lately there have even been questions regarding the purity of bottled waters and the effectiveness of filters. What is the right thing to do? Clearly, scientific research and the marketing information of companies selling bottled water and the various water cleaners may differ. After all, advertising has a big influence on our nutrition in general and certainly has been (and continues to be) a hindrance that must be overcome to achieve a healthier diet and lifestyle. The government can only protect the consumer from gross misrepresentation and not subtle interpretation of "facts."

Let's look at our drinking water choices before we decide what the right thing to do is. Because water is second in importance only to air for sustaining life, we *do* want to do the best we can with the current knowledge and inner guidance we have, without being too fanatical. Taste and smell can help us assess if our water is good for us. However, the presence of negative health factors may not alter taste or smell. Because of space limitations, there is much technical information I cannot include in this discussion; thus my goal is to give you the basics about drinking water so you can at least ask yourself what is best for you. The first step of good nutrition is to know the origin, processing, and contents of anything we take into our bodies. Now let's talk about the many sources of water available.

Tap Water

Most tap water comes from groundwater or from surface reservoirs formed from rivers, streams, and lakes. Groundwater refers to the subterranean reservoirs that hold much of the Earth's water and supply nearly all the rural drinking water and about half of city water supplies. The water from these sources goes through local treatment plants, many of which use an old process of settling tanks, filtration through sand and gravel, and then chemicals to clean up the water so it is fit for human consumption.

All of the categories I listed in the table of possible contaminants (adjacent) contain drinking water toxins that are currently monitored by the EPA using National Primary Drinking Water Standards. Maximum allowable contamination levels (or MCLs) are currently in place for about 80 toxic substances present in our tap water. The MCLs constitute mandatory standards, and a public water system is not allowed to exceed these standards without legal penalty. In addition to the MCLs, a second set of standards called the Secondary Drinking Water Standards, established in 1992, help ensure the safety of tap water. However, compliance with these secondary standards is voluntary, not mandatory, and substances regulated under these secondary standards are not regarded by the EPA as posing a significant health risk. The position of the EPA on these secondary substances—including aluminum and fluoride—remains open to question, because several have been well-researched and show significant health risks for some individuals. Both sets of standards are available online at www.epa.gov/water/laws.html.

Contaminants found in surface water and groundwater are also routinely monitored by the U.S. Geological Survey (USGS), which operates a Toxic Substances Hydrology Program (http://toxics.usgs.gov) and a National Water Quality Laboratory (http://nwql.usgs.gov). Pesticides, VOCs, arsenic, bacteria, and radionucleotides are among the potential toxins monitored in surface water and groundwater by the USGS.

In 2002 the Environmental Working Group (EWG), a not-for-profit environmental research organization based in Washington, D.C., completed a study on tap water quality in 42 states and found repeated violations of Primary Drinking Water Standards. Among other findings, the EWG determined that:

- More than 16 million people in 1,258 communities had been served tap water containing chlorination by-products like chloramines or THM at levels exceeding the MCLs for 12 consecutive months.
- Although large cities like Philadelphia, Pittsburgh, San Francisco, and Washington, D.C., served above-MCL contaminated tap water, more than 1,100 smaller towns with populations under 10,000 also served tap water contaminated with chlorination by-products.
- In the case of some contaminants, like THM, levels found in tap water were more than 5 times the maximum allowable level.

In a 1995 study of 26 U.S. communities on the East Coast and in the Midwest, pesticides used in the nonorganic production of corn were found to be routinely present in public drinking water. The pesticide atrazine, for example, was found in 25 out of 26 drinking water systems surveyed. In 5 of the 25 communities, atrazine levels exceeded the MCL standard, 5 or more different pesticides were found in 11 out of 26 water supplies.

One area I am especially concerned about with respect to tap water is toxic fertilizers. The recycling of industrial waste into fertilizers exposes soil and groundwater to a wide variety of toxins. The numbers here are mind-boggling. Between 1990 and 1995, 270 million pounds of industrial waste were shipped either directly to farms or to fertilizer manufacturers across the United States; 80 million tons came from the steel industry alone. The California Public Interest Research Group (CALPIRG) Charitable Trust tested 29 fertilizers from 12 states in 1998 and found all 29 to contain potentially toxic metals, including aluminum, cadmium, lead, mercury, and uranium. Astonishing as it may be, heavy metals in fertilizer are not regulated with respect to health impact, although they are regulated with respect to land disposal as a way of preventing leakage from lined landfills. The study found 20 of 29 fertilizers to contain metals in excess of land disposal restriction levels. This problem is going to get worse, and we need to take action now to protect our tap water.

Many minerals and chemicals are used for "purification," including chlorine, alum or sodium aluminum salts, soda, ash, phosphates, calcium hydroxide, and activated carbon. Yet this process may not clear all of the many environmental pollutants, which can include fertilizers and insecticides, chemicals and wastes from industry, and air pollutants such as lead or radon. Toxic organic chemicals and petroleum spills can also pollute large amounts of water. Because much of this pollution affects groundwater as well as surface waters, most municipal or artesian well drinking waters are at risk and deserve our concern.

A January 1990 *Consumer Reports* analysis suggested that the three drinking water pollutants of most concern were lead, radon, and nitrates. Every year, the Agency for Toxic Substances and Disease Registry (ATSDR) publishes a list of the most hazardous toxins in U.S. soils, water, and air. In 2003, this list was headed up by arsenic, lead, mercury, vinyl chloride, and PCBs (polychlorinated biphenyls). Of these five substances, we are particularly likely to be exposed to arsenic and lead through drinking water. And although much further down on the ATSDR list, two other substances of particular concern are radon and nitrates.

Lead may contaminate the water of more than 40 million Americans. It occurs mainly from corrosion of water pipes, from lead solder in plumbing, and from lead in brass faucets. The possibility of contamination is of greatest concern to people living in homes more than 30 years old, whose pipes contain more lead, and for families with young children, who are more sensitive to lead toxicity (see chapter 6, Minerals, for further discussion on this topic). Testing for lead is relatively easy and inexpensive. Reverse osmosis will remove lead; solid carbon filters may also remove it to some degree.

Mercury and **arsenic** also contaminate our waters. Mercury is the more serious concern since it is toxic; some naturally-occurring arsenic is tolerated by the human body. Mercury consumption via fish is now common. Most people who consume ocean fish several times weekly have elevated levels of mercury. Since mercury is a toxin to the nervous system, this is a potential problem, although each person seems to handle mercury loads differently. (For a more thorough discussion of mercury see page 241 in chapter 6, Minerals).

Radon, a radioactive gas, is a by-product of uranium and is found in the Earth's crust. High radon gas levels are associated with an increased risk of lung cancer. This carcinogenic element can be present in any home in levels high enough to cause concern, but it is more likely to be found in Arizona, in North Carolina, and in the northeastern United States. Groundwater and water that comes from wells have a higher incidence of contamination. Municipal waters that come from lakes, rivers, and reservoirs are usually low in radon. When present in the water, radon can be released into the air when someone is showering, laundering, or washing dishes. Radon in the air at home can be tested with several new devices available on the market. If present in the water in high amounts, radon can be removed with carbon filtration, but this system must be attached to the home's entire water system.

Nitrates are present mostly in groundwater sources that have agricultural contamination; these waters may also then have higher amounts of toxic pesticides and herbicides. High nitrate levels are of greatest risk to infants and seriously ill people. Nitrates are converted to nitrites by certain intestinal bacteria; these nitrites may alter the hemoglobin molecule, converting it to methemoglobin, which cannot carry oxygen. In rural communities, pregnant women and families with infants should test their water for nitrates. If it is present in high amounts, either reverse osmosis or distillation systems will help to clear the nitrate molecules.

Other major concerns in drinking water are the chemicals that are released into our waters by industry and the agricultural chemical pesticides, herbicides, and fertilizers that run off into local waters. These organic chemicals are more toxic and carcinogenic at lower levels than many other contaminants. The THMs formed in chlorinated water are also a carcinogenic concern.

With all these possible health threats, however, the government would like us to believe that we should have no concerns about our drinking water. Clearly, tap water consumption usually does not cause immediate or significant health problems unless it is contaminated with infectious organisms. Millions of people drink water from this source every day, although many avoid drinking it straight because of the taste. More research studying the relationship of drinking water to chronic disease needs to be done. Until we know more about tap water (and even well water) and its long-range effects on well-being, it is better to be careful and not drink it. Unless we've been able to analyze the tap water (and even well water) that we are planning to drink, it is best to avoid it whenever we can make water of known quality available. It may be worthwhile to analyze questionable water for toxic chemicals and metals, as well as to analyze mineral content, hardness, and pH. Several U.S. companies analyze water, including Water Test in New Hampshire, National Testing Labs in Ohio, and Suburban Water Testing Labs in Pennsylvania. They all have toll-free 800 numbers.

Ever since 1998 and the first airing of the PBS television special "The Poisoning of America," we've been aware of the clear dangers associated with our water. Although some countries have concerns about infectious water, that problem is minimal for Americans. Our woes are problems of modern technology—toxic chemical wastes, farming wastes, and heavy metals. Yet technology can also help us correct these difficulties. We have made some progress with filtration, purification, and distillation through more chemicals and water units, but we still have a ways to go. I believe we can do better. I also believe it is going to take a half century or more to clean up our waters and counteract the destruction we've done to our planet. Thus, the next two or three generations will need to be the "dismantlers," the cleanup generation. Let us hope this process is successful.