Well Water

Well water comes primarily from groundwater supplies and can vary greatly in its mineral content. Some is very low in most minerals, while other well water is a rich source of such beneficial nutritional minerals as iron, zinc, selenium, magnesium, or calcium. Unfortunately, groundwater may also contain toxic heavy metals or such agricultural and industrial chemical pollutants as pesticides, herbicides, radon, asbestos, or hydrocarbons (gasoline by-products). If your water source is a well, have the water analyzed for bacteria, mineral content, and organic chemical pollutants. With a clean bill of health, go ahead and use this potentially nutritious water freely.

Springwater

Springwater is the "natural" water found in surface or underground springs. Some companies retrieve and bottle this water. Other than being disinfected (chlorine may be used to this end), springwater is not processed. It tastes very different from tap water and, to me, is a refreshing drink. The mineral content depends on the region from which the water is taken and on whether it is surface or underground water (surface springwater is relatively low in minerals). For example, the lakes, streams, and springwater from the southeastern and northwestern regions of the United States are relatively low in minerals, and this "soft" water may increase the incidence of cardiovascular disease. The Midwest, in contrast, has high-mineral underground waters, and the farm people who drink this unchlorinated well water have a lower cardiovascular disease rate. Of course, there may be other lifestyle factors that contribute to this finding.

Just as groundwater can be polluted, springwater can also be contaminated. It is a good idea to have springwater checked out or to get full reports or summaries of tests from companies selling springwater. Ideally, these are independent lab reports performed yearly. Also, find out if the water is bottled at the source or transported and then treated and bottled. (Water bottled at the source is preferable.) Although springwater can be costly, it is high on the list of drinkable waters.

Some water experts suggest that three ideal characteristics of drinking water are total dissolved solids of about 300 parts per million (ppm), hardness (containing at least 170 mg/l of calcium carbonate), and an alkaline pH (over 7.0), to reduce leaching of metals from pipes. Springwater and well waters may fit into these categories.

Mineral Water

Most waters are mineral waters—that is, they contain minerals. In California, the standard for bottled mineral water is more than 500 ppm of dissolved minerals. Underground bubbly water, called "natural sparkling water," usually contains lots of minerals as well as carbon dioxide (CO_2). Many companies bottling this "mineral" water must inject carbon dioxide back into the water, however, because it is easily lost between the ground and the bottle. Seltzer is any water that is carbonated with carbon dioxide; it is usually filtered tap water. Club soda is essentially the same, although it usually has more minerals added, particularly magnesium sulfate, potassium sulfate, and sodium bicarbonate. These types of waters can also be polluted, although any bottled carbonated water would be free of microorganisms, as they cannot live in that environment. Generally, though, they should be checked out for mineral levels and chemicals if you consume them in any quantity. I do not recommend large amounts of these carbonated waters, however. The carbon dioxide can get into the blood and affect the acid-alkaline balance, although the body usually handles this easily through respiration or kidney filtration.

Filtered Water

Filtration, or purification, involves the removal of extraneous matter—be it chemicals, metals, or bacteria—from water. Legally, anything called a "purifier" must remove 99.75% of incoming bacteria. Americans are purchasing about 2 million home filtering systems annually, and there are a great many models and types from which to choose, including carbon filters, both granulated and solid, and reverse osmosis. (Distillation will be discussed on page 22.) All filters that are placed at or near the faucet are referred to as point-of-use (POU) filters, as opposed to point-of-entry (POE) filters. It is a good idea to educate your-

self about water filtration before purchasing a home unit. In the long run, home filters/purifiers are the least expensive and safest way to obtain safe, good-tasting drinking water.

Activated carbon (AC) is the most common type of filter. Carbon, used for centuries as a filtering substance, is "activated" by exposing it to chemicals at high temperatures and steam in the absence of oxygen. That gives the carbon a large surface on which to attach and absorb contaminants. Most carbon filtration units mechanically and biomagnetically (ionically) filter the water and remove the unpleasant appearance, odor, and taste by cleaning it of bacteria, parasites, most viruses, chlorine, and the heavier minerals and particulate matter. However, carbon is best at removing organic chemicals and chlorine and isn't perfect for all microorganisms and metals. Basically, these systems will filter out any particles or organisms over 0.04 microns, or whatever the size of the filter pores. The filters can collect bacteria and sediment, however; as a result, there is some concern that they may breed bacteria and dump it back into the water. **Hot water should not be run through carbon filters because it can cause contaminant release.** Carbon is excellent at trapping the larger molecules, chemicals, and larger microorganisms; it is not good at removing inorganic minerals, including fluoride bound strongly to sodium or calcium, the way it is added to municipal waters. Despite these limitations, solid carbon filtration is believed to be relatively effective (although this point is still controversial) at removing many of the toxic minerals with higher molecular weights, such as lead or mercury.

The two main types of carbon filters are granulated carbon and solid carbon block filters. The granulated carbon filter has air spaces between the carbon particles to trap bacteria and remove it from the water; but the bacteria can multiply within the air spaces. Silver is used in most granulated filters to assist in killing the bacteria. These silver-impregnated filters help reduce the bacterial growth within the filter, but there are concerns about ineffectiveness and silver toxicity. Although granulated carbon filters are economical, their use is short-lived and their safety is definitely questionable. For these reasons, I do not recommend them.

The **solid carbon block** (with its surrounding filter) alleviates the concern of microorganism contamination. Not only can the filtering surface area of this denser carbon bed clean much more water but, because there is very little oxygen or supply nutrients within the filter, the germs will not thrive. To be safe, however, if the filter is not used for a day or longer, let the water run through it for 10 to 20 seconds before drinking. Research has demonstrated that these units also trap more chemicals, organic pollutants, radon, and asbestos than the looser granulated carbon filters. Some companies that sell solid carbon block water filters are Multi-Pure, Ametek, Omnipure, and Amway.

A key factor in determining what microorganisms are filtered out by a solid carbon block filter is the filter's micron rating. A highly efficient carbon block filter would have a rating of no greater than 1 micron, for example, and can filter out microorganisms 1 micron (micrometer) or greater, including *Giardia lamblia*, *Cyptosporidium parvum*, *Entamoeba histolytica*, and *Toxoplasma gondii*. Asbestos is also removed mechanically from filtered water by a 1 micron-rated solid carbon block. An activated carbon block removes most chemicals by adsorption (by electromagnetically attracting the chemicals to the block itself) as opposed to mechanically (by forcing the chemicals through small openings). Chemicals removed in this way usually include chloramines, chlordanes, lead, mercury, MTBE, PCBs, toxaphene, and VOCs like toluene and xylene.

Carbon filters are rated by volume of water treated, because they can hold only a limited amount of sediment. They should be changed regularly to avoid dumping more bacteria and chemicals back into the drinking water and because the filtration slows down when they near the end of their effectiveness. A carbon filter may clean roughly 400 to 1,000 gallons, and each unit may vary depending on the amount of sediment in the incoming water. For best results, a unit should probably be changed at about 75% of its maximum capacity. Figure your average daily usage and mark the time for change on your calendar. Activated carbon filters and purifiers, although they are more expensive than using tap water, are usually less expensive than distillers or units that use reverse osmosis.

Some authorities believe **reverse osmosis** (RO) is the best way to purify water. Under pressure, usually from the tap, water flows through special membranes with microporous holes the size of a water molecule.

These pores allow water molecules to pass through while rejecting the larger inorganic and organic materials. RO filters can remove much smaller particles than carbon block filters because of their microporous holes. For example, although a carbon block filter rated at 1 micron could remove particles 1 micron or greater, an RO filter could remove particles as small as 0.009 micron, about 100 times smaller.

RO units usually have two or three filtering mechanisms. First is a sedimentation filter, which merely allows particulate matter to settle. Then comes the RO filter. It is followed by a carbon filter that removes contaminants that cannot reliably be removed by the RO filter, including VOCs (like solvent residues) and THMs. With this system, nearly 100% of the organic material is removed, along with almost all the minerals. RO systems that use thin film composite (TFC) membranes also need carbon block prefilters, because the free chlorine found in tap water, which can deteriorate the TFC membrane, must be removed before the water is passed through the RO filter.

RO units range from small home units to those of industrial size. Home units can make from 3 to 10 gallons a day. They are energy efficient, as they require only tap water pressure, yet they are not water efficient. Until recently, these units were very expensive, but now there are good units available at competitive prices, about $300 to $700. Because the life of the RO filter is usually about 5 years, the price per gallon of water is approximately 20 to 30 cents. The carbon filter (and possibly the RO membrane) in this type of system should be replaced every year or so, and this is relatively inexpensive. Disadvantages of RO units include their bulky size, the limitation of water production determined by the size of the holding tank (usually 1 to 2 gallons), and the time involved to prepare the water for drinking (often 3 to 6 hours per gallon). The units produce many gallons of "wastewater" per gallon of drinking water because only 10% to 25% of the incoming water goes through the unit; waste can run between 2 and 30 gallons daily depending on the unit's efficiency. This is not ideal in arid climates, although this wastewater can be collected for other uses, such as watering gardens and plants.

RO units may not clear all bacteria and chemicals, but the addition of carbon filtration or purification makes them efficient. On the other hand, RO units remove almost all minerals (high-calcium waters may clog their filters), which many authorities feel are an important component in our drinking water. (Earlier in this chapter, I gave the example of naturally occurring magnesium in groundwater and mentioned research studies showing prevention of heart disease with consumption of magnesium-rich water.) Concern over the same hazard of leaching body minerals by drinking distilled water exclusively is not yet well-founded scientifically, although people drinking only these waters while fasting run the risk of depleting themselves more rapidly. Deionized water, however—different from RO or distilled—should not be used for drinking, as it can deplete body minerals more readily.

Distilled Water

The distillation process involves vaporizing water (turning it into steam) in one chamber and then condensing it into liquid in a separate chamber. This removes most minerals, organisms, and chemicals from the water. Chemicals that have a higher boiling point than water, however—like the VOC xylene—will not be removed by distillation. There is also some concern that certain volatile organic chemicals will vaporize and recondense into the second chamber's water; therefore, distillation should be preceded by solid carbon filtration. There is also concern that heating water to 212 degrees Fahrenheit before drinking it changes the water so it has a different biochemical effect in the body. Home distillers are fairly expensive and require electrical energy; furthermore, it takes significant time for the water to be distilled, usually 5 hours or more per gallon, so this limits the amount available for use.

Distilled water contains no minerals (as mentioned earlier, distillation takes out everything except volatile chemicals). Therefore, when consumed, it tends to attract minerals (and toxins) to balance with the other body fluids. The regular consumption of distilled water, especially by someone who may already be slightly deficient, can cause mineral deficiencies. Fasting for long periods exclusively on distilled water to pull out toxins is not recommended because of the potential mineral depletions it can create. However, when doing extractions (as in making herbal teas), distilled water may help bring out the most in the medic-

inal properties of the herbs. Also, during detoxification diets, distilled water may be suggested because it may be more effective for this process, having a stronger "magnetic" charge to pull out toxins.

A note on demineralized water: Many nutritional advocates, mostly the elders, recommend drinking demineralized water because they believe that the inorganic minerals contained naturally in some waters are not usable by the human body, and that these naturally dissolved inorganic minerals may even cause problems. This is simply not true; many of the minerals we acquire are in the inorganic or salt state and are not part of organic tissues. They can still be assimilated and used by the body. The mineral levels in water, however, are not anywhere near sufficient to satisfy body needs. Cooking foods in demineralized water pulls more minerals from them, whereas using water containing natural minerals will lessen this loss and possibly even improve food values. Furthermore, many of the dissolved solids—such as the trace minerals selenium, zinc, or silica—found in natural waters are associated with lower cancer rates in the people who consume them than in people who consume treated or demineralized water. Many of the cultures in which people live long healthy lives are located in regions with mineral-rich mountain waters. These waters have always tasted the best and felt the best to me when I have had the opportunity to drink them. I believe that the naturally occurring earth minerals contained in our water are beneficial to our health.

SO, WHAT DO WE DRINK?

Water is the substance we need most. Because good drinking water is so important to health, we should know what the water we drink contains. Water contamination is inescapable; if there is any question about the water we drink, we can have it checked for bacteria count, mineral content, and the presence of a wide number of chemical pollutants. If there is concern, we should find a filtration or purification system that makes the water safe or find another source of drinking water.

In the past, I believed that the prime choice of drinking water was the Earth's uncontaminated natural springs or wells (these may be extinct). Especially if this water comes from the area where we live, it puts us in harmony with our environment and often provides important minerals (although it should be checked for abnormally high mineral content). Because of our current pollution problems, however, it may be essential for all of us to purify our drinking water. Most of us who live in cities provided with municipal tap water from treatment plants must take appropriate steps to make our water the best it can be. Bottled water is expensive and may come in polyethylene containers, which raise their own health questions, such as plastic-toxin contamination, which is worsened by sun exposure over time. Besides, bottled water is often chlorinated and may have been in the containers for months, if not longer.

I believe that we need to create a cost-effective and water-efficient system to protect us from water pollution. Current technology is advancing, and it seems both solid carbon block and reverse osmosis technologies offer a reliable means of obtaining clean water. Solid carbon alone can help clear most bacteria, chlorine, and the majority of the chemical pollutants that infiltrate our water. At my office, we have an RO system for serving our patients water and herbal teas; at home I use a Multi-Pure stainless steel unit hooked up to our kitchen faucet, enabling my family to have purified water for drinking, cooking, and washing food (including our sprouts). This type of system is the most economical for the quality of water it delivers. Of course, it is more expensive than drinking tap water, but we have decided that it is worth the $5 to $10 a month it costs over time to know that our water is free of bacteria, chlorine, most toxic chemicals, and most heavy metals.

Solid carbon may actually be the best system for removing chemicals. An added advantage of solid carbon block filters over reverse osmosis and distillation, besides lower cost per gallon of water and easier accessibility, is that these systems leave the natural trace minerals that our bodies can use. However, if nitrate levels are high or if we want fluoride removed, reverse osmosis is necessary. Although some manufacturers offer special adsorbent resins, like activated alumina, to remove fluoride from water without having to resort to reverse osmosis, these resins may raise health questions of their own. We should remember that solid carbon block filters are very different from carbon granule filters (often silver impregnated), which can harbor bacteria and then release them, and chemicals, back into the water in even greater concentrations.

To review, the three common, most effective home treatment systems are solid carbon block filters, reverse osmosis, and distillation. Purchasing prebottled water is an unnecessary expense, and in many cases, the water is not as good and definitely not as fresh as water purified at home. All three systems will remove chlorine (although in RO it's the prefilter that does this), bacteria, metals, and chemicals, although I have some concern about volatile chemicals left after distillation. (Distilled water should be prefiltered by solid carbon.) Because solid carbon filtration is more economical in time, water use, and dollars—and very good at removing chemicals—this may be the best process for urban residents unless you want the added fluoride taken out. Solid carbon will not remove the fluoride ions, which are strongly bonded to sodium or calcium. Natural springwater or well water

Water Systems Analysis: What Works?

	SOURCE		PURIFICATION		
CONTENTS	**Tap Water**	**Well or Spring**	**Solid Carbon**	**Reverse Osmosis**	**Distillation**
Chlorine	yes	not unless treated used also	removed unless carbon	not removed	removed
Fluoride	if added	natural or if treated	not removed	removed	removed
Bacteria	unlikely	possibly	most likely removed	removed	removed
Parasites	possibly	possibly	removed	removed	removed
Pesticides	yes	likely	removed	removed	removed
Solvents	likely	possibly	removed	not removed unless carbon used also	not removed (including VOCs)*
Heavy Metals	some	likely	possibly removed	removed	removed
Basic Minerals	some	likely	not removed	removed	removed
RESOURCE FACTORS					
Electricity Used	no	probably	no	no	yes
Wastes Water	no	no	no	yes	some

*VOCs like xylene can have higher boiling points than water and are not removed by distillation. Many VOCs are also not readily removed by reverse osmosis.

that is tested and clean may be the best choice for people living in the country. (See more on water quality and contamination in chapter 11, Food and the Earth.)

Traveler's Water

In the United States and much of the Westernized world, the greatest concern is contamination of water by pesticides and herbicides used in agriculture; by chemicals, such as hydrocarbons, from industry; and by the chlorine and other agents added to kill existing and potential germs in the water. When traveling to developing countries and other areas that do not treat their water, or when hiking or camping in natural areas in the United States, we may need to take measures to make the water safe from microorganisms.

There are always potential dangers from microbial contamination in water or food. Awareness and safety measures are important. Untreated water may harbor bacteria or parasites most commonly, or viruses on occasion. U.S. mountain rivers and streams or lake waters may contain giardia (*Giardia lamblia*) or parasitic amoeba, campylobacter or other bacteria, metals, chemicals, or radioactivity. Common organisms that may cause intestinal infection in developing countries (or in contaminated food or water in the United States) include salmonella, shigella, *Escherichia coli* (E. coli), giardia, amoebas, and cryptosporidium. Contracting hepatitis from water may also be a slight concern, but foods are a more common transmitter of infectious hepatitis.

We have a few options when traveling: First, we may carry our own water, although this is limited to short trips or when camping with a vehicle. We may also avoid drinking water totally as some try, for example, when traveling to Mexico or South America. Drinking bottled carbonated beverages such as waters, sodas, or beer usually keeps us safe from germs, as they cannot exist in the high carbon dioxide levels. But food might be washed or ice cubes made with contaminated water. Overall, there are three ways to clean water to make it safer: treating by heat, chemicals, or filtration. At sea level, boiling water for 1 minute will kill bacteria and parasites; boil 10 minutes to destroy viruses. For every 1,000 feet of elevation, add 1 minute to the boiling time to clean the water of possible germs. So in the mountains, at 10,000 feet, water must be boiled for 10 to 20 minutes, depending on your concerns. Little heating coils or stoves may be used, but overall this process may be cumbersome, especially when larger amounts of water are needed.

Chemical treatment may be simplest and the least expensive, yet it has drawbacks—most people do not like the taste and some people might experience side effects or reactions. Both chlorine and iodine have been used effectively for this purpose. Halazone tablets release chlorine into the water. Five tablets per quart will effectively kill almost all microorganisms, but the taste is not to my liking. In my opinion iodine as 2% liquid is preferable—use 10 drops per quart and let it sit for 30 minutes to kill the germs. Globaline is a crystalline iodine. One tablet can be added to a quart of water and will work in 10 minutes. Generally, I believe that chemical treatment is a last resort for water purification.

The goal at home or when traveling is to have germ-free water without undesirable chemicals or chlorine. Filtration is the best way to do this. I have already discussed home filters, and there are also filters designed for travel and camping. These are small units that have pumps so lake or river waters can be used. In the past 10 years, the number of states reporting cases of giardiasis to the CDC (Centers for Disease Control) has almost doubled from 23 to 43. An outbreak of giardiasis can even be contracted by drinking the crystal clear, good-tasting mountain stream waters in the United States; even wilderness packers need to carry some type of water purification. With the difficulty of boiling at higher altitudes and the bad taste of chemically treated water, filtration is the best way to go for backpacking, especially if large amounts of water are needed.

Most hand filters are granulated carbon, often with silver added. Although these are not ideal for home use, they are simplest for travel. They will take out some chemicals, but our biggest concern is microorganisms. Here the pore size of the filter, which should be clearly stated in the product information, is the crucial factor in determining what germs will be removed.

The pore size of available filters ranges from 0.2 to 2.0 microns. They all will remove parasites, some will travel water pump: Katadyn unit

Micron Sizes of Relevant Organisms

Organism	Size in microns
Giardia lamblia	10–20
Amoebas	10–50
Cryptosporidium	2–5
Campylobacter bacteria	0.2–0.3
Cytomegalo virus (CMV) and Herpes virus	0.15–0.2
Retrovirus (AIDS)	0.1–0.12
Hepatitis viruses	0.025–0.04

remove bacteria, but most will not take out viruses. In drinking water our biggest concerns are from parasites and bacteria; viruses, more unlikely to survive in water, are really a lesser concern. The Katadyn unit, claiming a pore size of 0.2 microns, may remove some viruses as well. It is the most expensive of the travel-pump units. Most of the available travel filters can clean about 1 to 2 pints per minute. If the water is dirty or turbid, use a prefilter such as a coffee filter or clean cotton bandana, for example, before pumping. Prefiltering extends the life of the carbon filter.

WATER REQUIREMENTS

Water is essential for all life, and drinking the right amount is important to achieving optimum health. All the beverages we drink—teas, coffee, sodas, beer—are basically water that contains other ingredients as well. Drinking good water is still the best way, I believe, to obtain our fluid requirements.

The amount of water we need is based on a number of factors—our size; our activity level, which influences the amount of fluid we lose through sweat; the climate or temperature (higher environmental temperatures increase our fluid losses); and our diet. Special circumstances in which increased amounts of water may be needed include fever, diarrhea, kidney disease, or any situation where excessive fluid losses occur through normal body elimination processes.

We lose water daily through our skin, urine, bowels, and lungs (as water vapor in the air). About half of our water losses can be replaced with the water content in our food. The remaining half requires specific fluid intake, primarily from drinking good water. Caffeinated beverages, such as coffee, tea, cocoa, or colas, and alcoholic beverages do not count as the same volume of water because they act as diuretics in the body, increasing fluid losses from the kidneys. The average human requirement is about 3 quarts of water per day, including food and beverages. An inactive person in a cool climate may need less, while an athlete training in the desert will need much more. People who eat a lot of fruits and vegetables, which are high in water content, will require less drinking water than people who consume proportionally more meats and fats, which are more concentrated and require additional water to help utilize them. In addition to a healthy diet containing fresh fruits and vegetables, I recommend that the average person consume at least 1.5 to 2 quarts of water daily.

Water is best consumed at several intervals throughout the day—1 or 2 glasses upon awakening and also about an hour before each meal. Water should not be drunk with or just after meals, as it can dilute digestive juices and reduce food digestion and nutrient assimilation. Some people like to drink 1 or 2 glasses in the evening to help flush out their system overnight, even though this may result in getting up during the night to urinate. It is important to drink water to avoid problems such as constipation and dry skin. Drinking enough contaminant-free water is likely our most significant nutritional health factor. Water will keep us current, clean, and flowing through life.

THE FUTURE OF WATER

Writing this chapter on water was a difficult task. There is so much opinion, misinformation, and proprietary hype that companies use to sell their water or their filter systems. I have distilled the best I could with what I believe. I know there are concerns with public utility water and the Earth's natural resources. Yet, what's the best way to clean it up? What's the most efficient way to filter water at home and ensure drinking safety? And what about all the new "scientific" waters, such as alkaline and "ionic" waters for better body balance (we want to be more alkaline) or microclusters and M-water, which propose to hold together in different

molecular balance to be better utilized? What water will allow us to hydrate our cells and tissues better? I see all of this being explored more scientifically in the coming years. Since water is second only to air as our most important substance and body component, we really need to know the truth about it and how to make it work right in our body.

Titan, Saturn's largest moon, and Europa, a moon in Jupiter's collection first noticed by Galileo about 400 years ago, may each contain more water than all oceans on earth combined. That's why scientists have started using the word "extraterrestrial" to describe water. We should have been using that word long ago. Water is out of this world when it comes to nutritional magic, and we're going to find ourselves more and more dazzled by the miracles of water. What comes out of the tap we will end up calling "bath water"—at best. And water that has percolated down through healthy soil, water without the pesticides and heavy metals, "real water," will refresh us in a way we can hardly imagine. On account of its mineral content alone, truly natural and pure, fresh water shall take its place along with the most touted foods and supplements as the key for prevention of heart disease and hypertension, and the key to optimal health.

Water in the Body

Composition,
Distribution,
Daily Loss