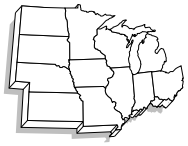
FOOD & WATER

Partners for Survival

fact sheet series



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FOOD & WATER:
Partners for Survival

fact sheet series

FOOD AND WATER: PARTNERS FOR SURVIVAL

Food and water are partners that have a lot in common. Both are lifelines to our survival, both tend to be taken for granted, and both carry an element of risk.

Most things in life carry some risk, but in recent years food and water have been the focus of particularly intense scrutiny over what they contain. Of course, concern about what you might find in your food and water is nothing new. Gold rush prospectors in the 1800s complained that their drinking water "is one-third green fine moss, one-third polliwogs, and one-third embryo mosquitoes." The difference today is that most of the concern centers on the microscopic variety of contaminants.

Also, a lot of the contaminants generating concern are substances that occur in both food and water. This series examines five such substances—sodium, minerals, lead, chlorine, and microoganisms. Some of these substances, such as sodium and minerals, are good for us in small amounts, but they can pose health risks when you ingest them in larger amounts. Some of them can be beneficial in food but are a nuisance when they appear in our water supplies. And some of them—lead and microorganisms—can pose serious health risks even in small amounts, and must be continually monitored to reduce their potential for causing illness.

The purpose of this series of fact sheets is to increase awareness about the interrelationships between natural and human-produced substances in food and water. The fact sheets explain the degree of risk posed by these substances and ways to keep them at safe levels.

The following fact sheets provide basic information about the health benefits and risks for each of these substances. Questions are also provided to stimulate discussion when using the fact sheets in a group setting.

This series of fact sheets is especially timely as it tackles wider issues: our increasingly global food supply; changes in the way food is processed, packaged, and prepared; and changes in water ecosystems, leading to cycles of flood and drought.

Food and Water: Partners for Survival contains the following fact sheets:

- Minerals: Important to Your Health
- Chlorine: Technology's Water Disinfectant
- Sodium: Too Much of a Good Thing?
- Lead: The Unseen Danger
- Microorganisms: Eat, Drink, and Be Wary
- Discussion Questions and Answer Sheet

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MINERALS: IMPORTANT TO YOUR HEALTH

A black-brown slime is forming in the toilet bowl. Scaly deposits are clogging water pipes and fixtures. White porcelain sinks and tubs are streaked with red. What causes such problems in our homes? The minerals calcium, magnesium, iron, and manganese wreak havoc with water pipes and with our laundry when they are present in our water in large amounts. But these important nutrients also contribute to good health.

Interestingly enough, we take preventive measures to eliminate or reduce minerals in our water supply; then we frequently take vitamin supplements or eat foods we know will provide these nutrients to avoid mineral deficiencies.

HAVE YOU HAD YOUR IRON AND MANGANESE TODAY?

Iron-poor blood, or anemia, is uncommon in the United States because the American diet favors red meats, vegetables, and iron-enriched breads. Other good sources of iron are liver, oysters, shellfish, dried beans, egg yolk, dried fruits, and dark molasses.

We need iron to carry oxygen to our blood and muscles. Anemia is most common in children 1 to 2 years old and in young women from 15 to 19 years old. It is frequently treated with iron supplements or by changing the diet.

Because women lose iron during menstruation, they require more iron than men. The recommended dietary allowance for women 11 to 50 years old is 15 mg of iron per day; the allowance for men, children, and women over age 51 is 10 mg per day. Pregnant women should consume 30 mg per day.

Manganese plays an important role in carbohydrate metabolism. There is no recommended daily allowance for manganese, but most people can obtain sufficient quantities from a varied diet because trace amounts of the element are found in virtually all foods. The best sources of this essential element are blueberries, wheat bran, dried beans, nuts, lettuce, and pineapple. Instant coffee and tea also contain relatively high amounts of manganese.

IRON AND MANGANESE IN WATER: APPEARING NOW IN YOUR BATHROOM SINK

High concentrations of iron and manganese in the water supply are not hazardous to human health, but they can stain everything from porcelain sinks and tubs to fixtures, pipes, tanks, and water heaters, to laundry.

When high levels of iron and manganese combine with organic matter in water, a chemical reaction sets

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off bacterial activity. These bacteria do not cause disease, but they do act as scavengers looking for mineral deposits to feast upon. The bacteria cling to pipe surfaces, clogging household water systems and creating a black-brown slime commonly found in toilet tanks.

Iron and manganese deposits in water can be successfully removed through a variety of treatment techniques. These techniques include using water softening equipment, iron removal filters, chlorination, carbon filtration, or a chemical process that holds iron and manganese ions in solution to prevent staining.

Treatment techniques vary depending on the type of iron in the water, the level of staining, the concentration of minerals, the pH level of the water, and the presence of other contaminants.

CALCIUM AND MAGNESIUM: BUILDING STRONG BONES AND TEETH

Mom always said to drink your milk–with good reason. Milk and dairy products are the best sources of calcium, which builds and maintains bones and teeth, aids in blood clotting, and helps with nerve transmission and heartbeat. This mineral is needed throughout life, but especially during periods of growth, pregnancy and lactation, and menopause.

It is especially important for teens to consume adequate amounts of calcium because they are building bone mass as their bodies mature. When calcium is deficient in the diet, bone loss can result. Older women should consume calcium to maintain the bone mass they ideally had during their teen years. Low dietary intake of calcium over an extended period of time can contribute to the development of osteoporosis, a bone disease.

The recommended daily allowance for calcium is 1,200 mg for young persons from 14 to 24, and 800 mg for children and persons who are 25 and older. One cup of milk has about 300 mg of calcium, or 25 percent of the recommended daily allowance for a teenager. One ounce of cheddar cheese has 240 mg of calcium. Dark green, leafy vegetables, such as kale, turnip greens, and broccoli are good sources of the nutrient, and clams and oysters are also high in calcium.

The body uses about 700 mg of calcium each day. Calcium continually enters and leaves bones so that a daily supply is needed to maintain healthy bones and teeth.

Like calcium, magnesium is essential for such bodily functions as building strong bones and muscles, transmitting nerve impulses, and metabolizing energy. Magnesium is plentiful in nuts, dried beans, cereal grains, dark green vegetables, seafood, and chocolate.

CALCIUM AND MAGNESIUM IN WATER: TOO MUCH OF A GOOD THING?

Calcium and magnesium—so crucial in the daily diet—can cause problems if they are present in water in large amounts. These minerals contribute to water "hardness," which is a measure of the amount of dissolved minerals in the water supply. About 85 percent of water systems in the United States exhibit some degree of hardness.

Minerals in water can cause water to taste strange, and mineral deposits on clothes may give a dingy and gray appearance to light or white clothes. Also, teapots, sinks, and water heaters may develop scale

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deposits due to hard-water deposits. These deposits can reduce the flow of water in pipes and affect heat transfer throughout a plumbing system.

Controlling hardness in water involves connecting water-softening equipment to mineral-reduced tap water. There are many different softeners on the market, but the most common is the ion exchange softener, which requires the exchange of sodium (salt) ions with the calcium and magnesium ions. Certain individuals with high blood pressure may be sensitive to sodium-conditioned water; they may want to check with their physician before purchasing a water softener.

Because treatment of water hardness varies with the extent of the problem, it is best to check with a certified water treatment representative affiliated with the national Water Quality Association for advice. Call (708)505-0160 or write the Water Quality Association, 4151 Naperville Road, Lisle, IL 60532.

FLUORIDE FOR A BRIGHTER SMILE

Most people equate fluoride with toothpaste, mouthwash, and a trip to the dentist. That's because fluoride is added to our water supply and dental products to help prevent tooth decay and minimize the loss of bone tissue in our bodies.

However, children can retain more fluoride than they ingest, and some people are concerned that at the levels currently being added to the water supply, this excess fluoride will cause internal damage to growing, vital organs. Also, fluoride has the potential to cause cosmetic mottling (brown gray discoloration) of teeth, so some communities have opted not to add fluoride to the water supply.

Most public water systems maintain fluoride levels at about 1 to 2 milligrams per liter (mg/L), which are well within the EPA's acceptable standards. According to the EPA, the primary standard for fluoride in drinking water is 4 milligrams per liter (mg/L)—a standard that is periodically reviewed, most recently in 1993. At 4 mg/L, the National Research Council did not find any link between fluoride and the following human health problems: cancer, kidney disease, stomach/intestinal problems, genetic mutations, birth defects, bone fractures, or osteoporosis (thinning of the bones).

The EPA has also set a secondary standard for fluoride of 2 mg/L; this is a nonenforceable health standard recommended to water suppliers to prevent cosmetic damage to teeth.

Public water systems monitor their supply regularly to make sure fluoride levels do not get too high. But people who own private wells need to be aware that *naturally occurring* fluorine in the soil can lead to fluoride levels in well water that may be above the 4 mg/L standard. The risk of excessive fluoride in well water generally is greatest in the Midwest and Southwest, but it all depends on the type of soil.

Although fluoride is most commonly associated with water, trace amounts occur naturally in virtually all foods, with the highest levels in tea, coffee, rice, soybeans, gelatin, onions, lettuce, fish, and beef liver. However, the greater exposure to fluoride still comes from water; therefore, if your water supplier keeps fluoride levels at 1 to 2 mg/L, it is highly unlikely that the amounts found in food would increase your exposure levels beyond the 4 mg/L standard.

continued

MINERALS, CONTINUED

MINERAL CONTENT OF COMMON FOODS

FOOD	*AMOUNT*	*IRON, mg*	*CALCIUM, mg*	*MAGNESIUM, mg*	*MANGANESE, mg*
Beef round steak, braised	3 oz.	2.66	5	19	0.01
Beef liver, braised	3 oz.	5.75	6	17	0.35
Kidney beans, cooked	1/2 c.	2.58	25	40	0.42
Oysters, cooked	3 oz.	11.39	76	92	7.58
Oatmeal, cooked	1/2 c.	0.80	10	28	0.68
Peanuts	1 oz.	0.54	24	53	0.35
Milk, 2 percent	1 c.	0.12	290	33	——
Cheddar cheese	1 oz.	0.19	240	8	——
Broccoli, raw	1/2 c.	0.39	21	11	0.10
Kale, raw	1 c.	1.14	90	23	0.52
Raisins	1/2 c.	1.51	35	24	0.22
Blueberries, raw	1 c.	0.24	9	7	0.41
Orange	1 med.	0.13	52	13	0.03

Source: USDA Composition of Foods. Agriculture Handbook Number 8.

CHLORINE: TECHNOLOGY'S WATER DISINFECTANT

Before chlorination of drinking water became a standard practice in the late 1800s, the water supply was a common source of the deadly diseases cholera, typhoid fever, dysentery, and hepatitis. Chlorine, a disinfectant, ended these waterborne epidemics by ridding the water supply of the bacteria that cause these illnesses.

Chlorine is added to 90 percent of the nation's public drinking water supply at least twice during the treatment process—once during the pre-treatment phase to remove impurities and destroy bad tastes and odors, and again after filtration to keep bacteria from growing as the water travels to homes and businesses along distribution lines. Generally, doses of chlorine added at the end of the filtration process are proportionately smaller than those added at the "raw water" phase. A residual of 1 to 2 ppm is left in water to kill any remaining microbials.

This double dose of chlorine may have an adverse effect on human health. We assume that our drinking water is safe because of these treatments, but scientists wonder if we are paying too high a price. In 1975, researchers discovered that when chlorine is added twice during water processing, it can combine with organic materials, such as decaying leaves, bark, and soil, to form disinfectant byproducts (DBPs). Persons exposed to these chlorination byproducts over a long period of time may develop cancers of the colon, rectum, and bladder. Approximately 11,000 of the 91,000 rectal and bladder cancer cases each year may be caused by exposure to DBPs.

DBPs can be controlled by managing water chemistry. The secret is to add just enough chlorine to kill harmful bacteria without allowing high levels of byproducts to develop. Differing amounts of chlorine are added to different types of water supplies, depending on the source of the water. Lakes, rivers, and streams require different concentration levels of chlorine.

The law requires water suppliers to monitor the formation of trihalomethanes (THMs), a byproduct of chlorination, produced from organic materials in the water. The Environmental Protection Agency, under increasing public pressure, is continuing to investigate the formation of DBPs (including THMs) and is reestablishing a safe DBP level in drinking water.

Chlorine is also used by the food-processing industry to disinfect equipment and packaging, but the research linking chlorine with cancer-causing byproducts in drinking water has brought its use as a disinfectant in the food-processing industry into question. Chlorine is not used as a direct food additive.

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ALTERNATIVE SOLUTIONS

Alternative treatments for disinfecting water exist, but each has inherent problems. These treatments were developed to minimize chlorine-related taste and odor problems or to enhance the effectiveness of disinfection in problem waters.

Ozone treatments, for example, have been used routinely in France and Germany to purify surface waters and are used occasionally in the United States by larger water suppliers. Ozone is a form of oxygen, used to disinfect water and to remove taste, odor, and color. It disinfects water very well initially, but, unlike chlorine, it leaves no disinfection residual in the water to kill bacteria that collect en route to houses.

Ultraviolet light, or UV, is also a common disinfectant used by over 100 wastewater treatment plants in the United States.

Both alternative processes are currently too expensive to be used extensively, and they are not as effective as chlorine treatments in eradicating bacteria.

Water treatment plants are exploring different ways to minimize the risks of disinfecting our drinking water supply. The problem is complicated because incidences of microbial and viral diseases attributed to our drinking water still occur. Examples are *giardiasis*, hepatitis A, *Cryptosporidium parvum*, *legionellosis* and Pontiac Fever, and other respiratory and gastrointestinal disorders. Many of these viruses and bacteria are not killed by existing disinfectants.

Despite its drawbacks, the benefits of using chlorine in drinking water to control disease far outweigh the public's risk of cancer from chlorine byproducts. Until more is known about alternative disinfectants, chlorine will continue to be the treatment of choice for U.S. water suppliers.

SODIUM: TOO MUCH OF A GOOD THING?

Sodium, found in food and water, is critical to human existence. Sodium maintains blood pressure and volume, regulates water balance, and is needed for body movement and heartbeat.

Most healthy individuals are able to excrete excess sodium if they drink enough water. In fact, about 82 percent of the population is able to eliminate unneeded sodium and to maintain normal blood pressure at average levels of sodium intake.

However, some people are especially sensitive to sodium and do not excrete it efficiently. Sodium buildup in the body can cause fluid retention. If too much water is retained, high blood pressure may result.

SODIUM IN FOOD

Sodium occurs naturally in many foods and is also added to foods during processing and at the table. It is used to suppress bacterial growth, control the moisture level and texture of foods, and add flavor. Salt is a component of many ingredients and additives because of its solubility.

Although there is no recommended daily allowance for sodium, the estimated minimum requirement for healthy adults is 500 mg of sodium. Most people take in between 2,300 and 6,900 mg of sodium daily.

People on sodium-restricted diets can reduce their sodium intake by reading food labels to identify sodium sources, eating a well-balanced diet, and reducing their consumption of high-sodium foods. Foods with high sodium content include processed foods, baked goods, most cheeses, lunch meats, dry cereals, and canned or dried products. Examples of low-sodium foods are most fresh fruits and vegetables, fresh meats and poultry, hot cereals, and grains.

SODIUM IN WATER

While processed foods are the main source of sodium in the diet, 10 percent of an adult's daily sodium intake comes from tap water. The negligible levels of sodium found naturally in water are usually not a health concern.

Sodium in water may become a health issue when homeowners install water softeners to reduce water hardness. Hardness in the water source occurs when dissolved minerals, usually calcium and magnesium, build up in the water. Scales form on the inside of pipes and on laundry sinks and cooking utensils.

The water softener removes these minerals by exchanging the calcium and magnesium ions for the sodium ions, thereby producing water with reduced hard mineral levels that is more pleasing for household use.

continued

SODIUM, CONTINUED

Depending on the original hardness levels in the household water, between 7.5 to 300 mg/liter of sodium are usually added to water to achieve the desired softness. In comparison, one slice of white bread has about 114 mg of sodium, and an 8-ounce glass of milk has about 120 mg of sodium.

Sodium may also enter the water supply in small amounts during municipal water treatment. For instance, the community water supplier may choose to disinfect the drinking water with sodium hypochlorite, sodium hydroxide, or sodium carbonate to adjust its acid-alkalinity balance.

It is important to remember that these compounds are used to balance the water chemically so that it complies with federal and state standards. Road salt run-off can also contribute to increased levels of sodium found in water from private wells.

Because drinking water contributes negligible levels of sodium to a person's daily intake, it is usually not necessary for persons with high blood pressure to cut back or eliminate their water consumption.

However, people on physician-prescribed, low-sodium diets who use water softeners should connect the softener to the hot water tap only for household uses and use the cold unsoftened tap water for cooking and drinking. "Hardness" in water is measured in grains per gallon (or the weight of calcium + magnesium). The higher the grain concentration, the harder the water. One grain per gallon of water is equivalent to about 17 parts per million or 17 mg/liter.

If it is necessary to remove additional sodium from the water, treatment techniques using distillation and reverse osmosis are available to remove not only the sodium but all minerals from the water.

A distiller heats water until it becomes steam and then condenses the steam back into water in a separate chamber, leaving behind most contaminants. Reverse osmosis is a purification system that forces water through a special membrane that allows only pure water molecules to pass through.

If you would like to know the sodium content of your water, contact the water utility that services your household. If you are on a private water system, call the local health department. The water company is required to keep records of the sodium level in the water, while the local public health department can either help the consumer test for sodium or recommend an independent laboratory to sample the water and provide an analysis.

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MICROORGANISMS: EAT, DRINK, AND BE WARY

The United States has the safest food and water supply in the world. Nevertheless, microorganisms can contaminate our food and water at times, sometimes causing life-threatening illness. Every year, between 10 million and 24 million people in the United States suffer from foodborne illness. Reports of disease caused by waterborne microorganisms number in the thousands. The most recent and largest waterborne outbreak in the U.S. recently was the April 1993 *Cryptosporidium* outbreak. Over 400,000 Milwaukee citizens became ill as a result of the presence of a protozoal parasite in the drinking water. Water is treated (chlorinated, filtered) so that contaminants like protozoal parasites are removed from it along with other biological and chemical agents that may imperil public health.

Outbreaks of illness from microbial contaminants in food and water are reported frequently in the media. Because of these recurring reports, consumers are increasingly concerned about the safety of our food and water supply. In fact, the increased numbers can be at least partly attributed to government reporting systems that are better able to track and report illness.

When it comes to the food we eat and the water we drink, consumers want zero risk. Unfortunately, that is an unobtainable goal. Microorganisms occur naturally in food and water. The good news is that although there is *some* risk in eating food and drinking water, the risk can be minimized.

MICROBIALS IN THE DRINKING WATER SUPPLY

The water we drink from our kitchen taps is not sterile. It is filtered and purified to meet federal safe drinking water standards, but minute amounts of substances still remain. Among those substances are microorganisms that are naturally found in soil, air, water, and food. These potentially harmful organisms can remain at dangerous levels if drinking water is inadequately filtered or ineffectively disinfected.

Most waterborne illnesses have common symptoms—usually abdominal discomfort or cramping followed by fever, vomiting, or diarrhea if the illness is caused by bacterial contaminants. Common symptoms of viral illnesses are weight loss and fatigue.

Healthy individuals are usually not affected by disease-causing waterborne microorganisms unless there is enough microbial contamination to cause a major outbreak. People with weakened immune systems—AIDS patients, the terminally ill, the frail elderly, and young children whose resistance to disease is not as high as a healthy adult's would be—are more susceptible to waterborne illnesses.

You don't have to drink contaminated water to become ill from waterborne microbial pathogens. You can

continued

get sick from inhaling disease-causing organisms that live in water or from exposure to contaminants at beaches and pools, in standing water, or in moisture that collects in ventilation and air conditioning systems. Such diseases include Legionnaire's disease and Pontiac fever.

The most common disease-causing microbials in water are *Giardia lamblia* and *Cryptosporidium*. Other microbials are responsible for a host of acute gastrointestinal illnesses.

GIARDIA LAMBLIA

Giardiasis is commonly called "backpacker's illness" because backpackers frequently drink from remote streams or ponds. The water appears "clean" to the naked eye, but it may be teeming with *Giardia* cysts. Giardiasis is also called "beaver fever" because the beavers and muskrats who live in the streams act as animal reservoirs for the *Giardia* protozoa. *Giardia* outbreaks are common to mountain communities where only disinfection of the water supply is done and there is no routine filtration.

People become ill with giardiasis when they ingest the cysts from infected animal feces in untreated water. Symptoms include diarrhea, abdominal discomfort, bloating, gas, and gas pains.

The infection can be treated with prescription medication, although some infections may disappear without any treatment. Giardiasis can be prevented by using proper hygiene, disposing of wastes adequately, and avoiding unfiltered, untreated water supplies.

If you are camping or hiking in a remote area, it is wise to bring along a clean supply of bottled water; or, if there is no other source of water, use iodine or chlorine tablets to clean stream water before drinking it. Also, if you are visiting a rural, mountainous community with lakes and plentiful streams but no evidence of water treatment facilities within the vicinity, you should suspect that the water is contaminated with *Giardia*.

Levels of *Giardia* are regulated in our public water supply under the 1986 EPA amendments to the Safe Drinking Water Act. This act requires that at least 99.9 percent of *Giardia* cysts be removed or killed prior to water disinfection. Because chlorine is not completely effective in eliminating *Giardia*, the water should also be filtered so the cysts are strained out of the water supply.

CRYPTOSPORIDIUM

Cryptosporidium is a protozoan parasite that ranks as the leading cause of diarrheal illness in the world. Again, people most susceptible to the illness are those with weakened immune systems. The disease can affect a wide variety of mammals as well as man.

Besides diarrhea, which may last a month or more in people with this illness, common symptoms of cryptosporidiosis include abdominal cramping, vomiting, and fever. There is no specific medical therapy for cryptosporidiosis other than alleviating the patient's symptoms.

The disease spreads through oocysts, which are eggs from 4 to 6 micrometers in diameter, excreted by infected animals and humans. They are widely distributed in water and have been detected in highly

continued

MICROORGANISMS, CONTINUED

variable quantities in both waste- and surface-water supplies in the United States.

Large outbreaks of this illness have occurred in the last ten years in both the United States and the United Kingdom. Certain occupational groups are at risk for exposure to cryptosporidiosis, including veterinarians, farmers, and other persons who come in close contact with infected lambs or calves.

Cysts can be removed from water through filtration and inactivated by heat. Disinfection with chlorine or other products is ineffective in killing the cysts.

Outbreaks of cryptosporidiosis have occurred even when water facilities were operating within the established guidelines for safe drinking water. These outbreaks indicate that *Cryptosporidium* oocysts can survive both the disinfection and filtration techniques that we rely on to provide a safe water supply. Research is ongoing to find better ways to extract cysts from raw water and to find new ways to inactivate cysts before they reach the drinking water supply.

ACUTE GASTROINTESTINAL ILLNESS

Acute gastrointestinal illness (AGI) refers to any illness that is generally caused by viruses, bacteria, or protozoa. When a health professional is unable to identify the exact cause of an outbreak of waterborne illness, the disease is usually classified as AGI. The microorganisms are more often found in surface water than in groundwater.

Symptoms of AGI include diarrhea, nausea, vomiting, and abdominal discomfort. These symptoms mimic other flu-like illnesses and food poisoning so the incidence of waterborne disease from AGI may be greatly underreported.

"It must be something I ate," says the person who has an upset stomach or diarrhea. That "something" could be a microbiological organism that causes illness when it is present in food at high levels. Foodborne infections rank second only to the common cold as the most frequent cause of short-term illness in the United States.

Foodborne illness is caused by infection or intoxication. Infection occurs when live bacteria consumed in food cause illness; intoxication (sometimes called food poisoning) occurs when toxins produced by microorganisms are consumed in food.

Diarrhea is the most common symptom of foodborne illness. Other symptoms are vomiting, nausea, fever, cramps, and false appendicitis. More severe—even life-threatening—symptoms include dehydration, arthritis, muscle paralysis, and meningitis (inflammation of the brain and spinal cord).

Foodborne illness is usually caused by mishandled food. Most mishandling of food occurs in foodservice establishments (65 percent) and in the home (31 percent). Only 3 percent of cases are attributed to problems in the food processing industry. Foodborne illnesses happen most frequently around Thanksgiving and Christmas when people are preparing large amounts of food and may not have adequate storage. Summertime picnics and potlucks are a problem because prepared foods are often refrigerated inadequately.

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MICROORGANISMS, CONTINUED

The good news is that foodborne illness can be prevented. Foodborne illness occurs most often when people who are preparing food hold it at the wrong temperature, cook it inadequately, use contaminated equipment, or practice poor personal hygiene.

Follow these safety measures to avoid microbial contamination of foods.

- After shopping at the grocery store, quickly refrigerate or freeze perishable foods.
- Freeze fresh meat, poultry, or fish immediately if you won't be using it within a few days. Store fresh meat in the refrigerator three to five days; store ground beef and poultry no longer than one to two days.
- Never thaw meat on the counter or leave it out of the refrigerator for more than two hours.
- Wash hands, utensils, and work areas with hot, soapy water after they have come in contact with raw meat, poultry, or other animal products.
- Microwave carefully. Rotate, stir, and cover foods to ensure even heating. Use a meat thermometer.
- Reheat leftovers thoroughly to eliminate bacterial growth.
- When in doubt, throw it out.

The three most common microbial pathogens in foods are *Clostridium perfringens*, *Salmonella*, and *Escherichia coli* (*E. coli*).

CLOSTRIDIUM PERFRINGENS

This bacteria, which is found naturally in soil, grows in high-protein foods such as meat and meat dishes, poultry, meat or poultry-based soups and stews, gravies, fish, and milk. When it is ingested in contaminated food, the toxin causes rapid onset of severe diarrhea and abdominal cramps, usually without vomiting, within 8 to 24 hours. The illness usually lasts no longer than 12 to 24 hours.

Refrigeration temperatures below 40°F slow the growth of *Clostridium perfringens*. Temperatures between 40° and 122°F promote bacterial growth.

The organism can be controlled by cooking foods thoroughly, keeping cooked foods above 140°F while they are being served, and cooling foods rapidly. Leftover food should be heated to 165°F.

SALMONELLA

You may not be familiar with *Clostridium perfringens*, but you have probably heard of *Salmonella*. Actually, *Salmonella* is a generic term for more than 2,000 types of bacteria.

One of today's most common types, *Salmonella enteritidis*, has been implicated in a number of outbreaks of foodborne illness linked to raw, undercooked, or mishandled eggs. In many cases, the source is a flock of infected chickens. The bacteria is passed from the chicken to the egg before it is laid, and the eggs show no evidence of being contaminated.

continued

Other foods commonly involved with salmonellosis are meats and dairy products. Pet ducklings, chicks, and turtles can also be sources of *Salmonella*, primarily through contact with their feces.

Symptoms of salmonellosis are very similar to intestinal flu, and the illness is often mistaken for the 24-hour virus. Symptoms include stomach pain, usually diarrhea, and often nausea, chills, fever, or headache that begins 6 to 48 hours after contaminated food is eaten. Symptoms last 1 to 7 days.

Salmonellosis can be prevented by cooking food thoroughly. The bacteria are destroyed when food is heated to 140°F for 10 minutes. Other prevention practices include using proper hygiene, keeping foods either hot (above 140°F) or cold (40°F or below), and cooking food thoroughly. Only clean, uncracked eggs should be used in cooking, and raw or undercooked eggs should not be eaten.

ESCHERICHIA COLI

E. coli is a group of bacteria with thousands of different strains. Many strains of the bacteria are found normally in the intestines of animals and humans and are harmless. A rare and more deadly strain, *E. coli* 0157:H7, brought this bacteria into the limelight after an outbreak at a fast-food chain in several states during 1992 and 1993. Undercooked hamburgers were implicated in this outbreak. Unpasteurized milk, low-acid apple cider, and contaminated water supplies have also been linked to this strain. *E. coli* is present in the water supply because of fecal contamination from animals.

E. coli produces a toxin that can cause acute hemorrhagic colitis. Symptoms of this illness include severe abdominal cramps, followed by diarrhea that often becomes bloody. Vomiting and nausea are occasionally accompanied by a low-grade fever. In some cases, the bacteria can cause irreversible kidney damage.

Illness caused by *E. coli* can also be prevented by following basic food safety practices. The bacteria can be eliminated in meat if it is cooked thoroughly. All meat and poultry should be cooked until the juices run clear and the meat is no longer pink. A good rule is to cook meat, including ground meat, to 160°F, poultry to 180°F, and ground poultry to 165°F.

Bacterial contamination will always be a threat to safe food and water, but researchers are developing new ways to minimize the risk of illness from foodborne and waterborne microorganisms. Consumers, however, must also play their part by following basic food safety practices.

continued

MICROORGANISMS, CONTINUED

WATERBORNE PATHOGENS THAT CAN CAUSE ILLNESS

DISEASE	*MICROBIAL AGENT*	*SOURCES*	*SYMPTOMS*
Amebiasis*	*Entamoeba hystolytica*	sewage, nontreated drinking water, flies in water supply	abdominal discomfort, fatigue, weight loss, diarrhea, gas pains
Campylobacteriosis	*Campylobacter jejeuni*	poultry, livestock manure, municipal water-line breakdown, chlorine contamination, or other disinfectant contamination	fever, abdominal pain, diarrhea
Cholera*	Vibrio cholerae	untreated water, sewage, poor hygiene, crowded living conditions with inadequate sewage facilities	watery diarrhea,vomiting, occasional muscle cramps
Cryptosporidiosis	*Cryptospo-ridium parvum*	collects on water filters and membranes that cannot be disinfected, animal manure, seasonal runoff of water	diarrhea, abdominal discomfort
Hemorrhagic diarrhea	*E. coli/H0157:H7*	poultry, livestock manure, under-ground well water, inadequately treated drinking water and sewage	hemorrhagic diarrhea, cramps, nausea, low-grade fever
Giardiasis*	*Giardia lamblia*	untreated water, poor disinfection, pipe breaks, leaks, groundwater contamination, campgrounds in which humans and wildlife use same source of water (beavers and muskrats act as a reservoir for *Giardia*)	diarrhea, abdominal discomfort, bloating, gas and gas pains
Hepatitis*	Hepatitis A	raw sewage, untreated drinking water, poor hygiene, ingestion of shellfish from sewage-flooded beds	fever, chills, abdominal discomfort, jaundice, dark urine
Shigellosis*	*Shigella species*	sludge, untreated wastewater, groundwater contamination, poorly disinfected drinking water	fever, diarrhea, bloody stools
Typhoid fever*	*Salmonella typhi*	raw sewage (carried and excreted in feces by humans), water supplies with surface water source	fever, headache, constipation, appetite loss, nausea, diarrhea, vomiting, abdominal rash
Legionnaire's disease	*Legionellaceae* and *L. cincinnatus*	cooling towers, showers through inhalation of vapors; raw sewage, stagnant clean drinking water in water tanks or towers, construction sites near rivers, lakes	flu- and pneumonia-like symptoms: malaise, achiness, fever, chills, headache, nausea, dizziness, coughing, chest congestion, chest pain, pressure, possible vomiting
Pontiac fever	*Legionellaceae*	same sources as Legionnaire's disease	milder form of Legionnaire's disease; pneumonia-like symptoms but without fever; illness of shorter duration
Viral gastroenteritis	*Viruses, including Norwalk and rotavirus family*	sewage, contaminated water, inadequately disinfected drinking water (mostly surface-water sources)	repeated vomiting and diarrhea over 24-hour period, gastrointestinal discomfort, headache, fever

***Physicians must report these illnesses to the Illinois Department of Public Health.**

continued

FOODBORNE PATHOGENS THAT CAN CAUSE ILLNESS

DISEASE	*MICROBIAL AGENT*	*SOURCES*	*SYMPTOMS*
Botulism	*Clostridium botulinum*	home-canned low-acid foods, smoked fish, luncheon meats, ham, sausage	double vision, inability to swallow, speech difficulties, progressive paralysis of the respiratory system
Campylobacteriosis	*Campylobacter jejeuni*	beef, poultry, lamb, milk	diarrhea, abdominal cramping, fever
Listeriosis	*Listeria monocytogenes*	soft cheese, raw milk, imported seafood, frozen cooked crab meat, cooked shrimp	fever, headache, nausea and vomiting, miscarriages, death—particularly in infants
Shigellosis	Shigella bacteria	milk and dairy products, potato salad	abdominal cramps, diarrhea, fever, sometimes blood in stool
Staphylococcal food poisoning	*Staphylococcus aureus*	meats, poultry, egg products, tuna, potato and macaroni salad, cream-filled pastries	diarrhea, vomiting, nausea, abdominal pain, cramps
Vibrio infection	*Vibrio cholarae*	seafood	abrupt chills, fever, watery diarrhea
Yersinia infection	*Yersinia enterocolitica*	milk, meat, pork	diarrhea, vomiting, blood poisoning, false appendicitis, arthritis

DISCUSSION QUESTIONS AND ACTIVITIES

MINERALS

1. How do minerals get into water? How does the interaction of soil and water affect the mineral content of water?

2. How is "hardness" in water measured? What is the difference between soft water and hard water?

3. What is the difference between primary and secondary drinking water standards? What minerals belong in the primary standards category? What minerals belong in the secondary standards category?

4. Besides milk, what foods are good sources of calcium?

5. Compare the calcium content of various foods. The amount of calcium in a food product can be found on the nutrition facts panel of the food label.

6. Call the National Safe Drinking Water Hotline at 1-(800)-426-4491. They will provide a free list of the maximum contaminant levels (MCLs) allowed for certain minerals in drinking water. Ask for the MCLs for barium, cadmium, manganese, magnesium, iron, fluoride, and calcium.

7. Get a piece of old water piping from a plumber, a plumbing supply store, or your local water utility. Look inside and outside the pipe and note its color and texture. If there is an odor, note the characteristics. Touch interior coatings with instruments only—no bare fingers. Examine a piece of coating under a microscope to see if you can more easily identify its makeup.

continued

DISCUSSION QUESTIONS AND ACTIVITIES, CONTINUED

CHLORINE

1. What purpose does naturally occurring ozone serve in our environment? List other uses for ozone besides disinfecting water.

2. Check with water treatment plants in your area about their preferred method of disinfecting water. Keep a tally of the plants that use chlorine and the plants that use other treatments.

3. Do you notice more chlorine taste and odor in your drinking water at certain times of the year? Ask the operator at your water utility why this might occur.

4. List other uses for chlorine besides disinfecting drinking water.

SODIUM

1. Is sodium abundant on our earth, or are we rapidly depleting our supplies?

2. What is the percentage of natural sodium (brine) in our oceans?

3. What is the principal sodium byproduct in a water softener?

4. Compare the sodium content of various foods. (The amount of sodium in a food product can be found on the nutrition facts panel of the food label.) Identify the food additives containing sodium. (Ingredients are listed in order of decreasing quantity by weight in the food.)

5. Discuss ways to decrease sodium content in the diet.

continued

DISCUSSION QUESTIONS AND ACTIVITIES, CONTINUED

LEAD

1. Does lead occur naturally in our water? How does lead come into contact with water?

2. What does corrosion mean? How does this process apply to drinking water? List three factors that affect the degree of corrosivity in drinking water.

3. List four water treatment techniques that remove lead from drinking water. Rank them in order of cost—from least expensive to most expensive.

4. Heat and/or acid enhances leaching of lead from improperly glazed ceramicware. Name several hot or acidic foods that should not be served or stored in improperly glazed mugs, pitchers, and bowls.

MICROORGANISMS

1. Should you drink from a pond that appears to have clear water? Why or why not?

2. List three types of microorganisms that can cause waterborne illness.

3. List four symptoms that occur in humans and animals indicating waterborne illness.

4. Are we more or less likely to be exposed to waterborne microorganisms today?

5. Because of possible *Salmonella* contamination, you should avoid eating foods that contain raw eggs. Name several foods that contain raw eggs.

ANSWERS FOR DISCUSSION QUESTIONS

MINERALS

1. Minerals come into contact with water because they occur naturally in soil. Dissolved minerals in sand/rocks are picked up and mixed with groundwater. Sometimes minerals are added to surface water to give it taste and flavor. If well water contains a high level of minerals, however, it can be unpleasant to drink or to use in cooking.

2. Hardness in water is measured in grains per gallon. The higher the grain concentration, the harder the water. Soft water has lower concentrations (less than 4.4 grains per gallon) of calcium/magnesium ions. Water can be made artificially soft by using a water softener to remove calcium/magnesium ions.

3. Primary drinking water standards protect the public's health by keeping unwanted chemical and biological pollutants at levels in drinking water that do not harm human health. These standards are enforceable by law, and all drinking water companies must adhere to them. Secondary standards relate to substances that have no health impact, but they are aesthetically important to drinking water. Aesthetic factors include taste, odor, color, hardness, and pH. Minerals in the primary standards category include barium, arsenic, beryllium, cadmium, and nickel. The secondary category includes aluminum, copper, manganese, silver, fluoride, and iron.

4. Other good sources of calcium are cheese, yogurt, ice cream, pudding, cream soups, broccoli, clams, oysters, sardines, and green, leafy vegetables such as spinach, kale, and turnip greens.

5. Activity

6. Activity

7. Activity

CHLORINE

1. Ozone filters out harmful ultraviolet light and radiation in our atmosphere. It is used by industry both to disinfect water and to eliminate strong odors and flavors in the water.

continued

ANSWERS FOR DISCUSSION QUESTIONS, CONTINUED

2. Other methods include using chlorine and ammonia, chlorine dioxides, bromines, iodine, ultraviolet light, or ozone.

3. At certain times of the year (when snows melt or when temperatures get very high), water treatment operators may have to use more chlorine to kill pathogens and other organic matter that result from climatic changes. When weather changes, there may be more organic matter in the raw water supply; therefore, additional chlorine may need to be added to the water to kill bacteria in both the water and within the pipes that carry the water.

4. Chlorine can be used as a bleach, as a disinfectant in swimming pools, and as a compressed gas in industry to clean the parts of machines or as a liquid solvent.

SODIUM

1. Sodium is naturally abundant on earth.

2. Approximately 3-1/2 percent of the ocean's makeup is sodium chloride. Other minerals in the ocean which contribute to the ocean's saltiness include sulfur, magnesium, calcium, and potassium.

3. Brine is the principal byproduct.

4. Activity

5. Decrease the amount of sodium in your diet by reading food labels. The labels will help you avoid salty snack foods and processed and convenience foods that are typically high in sodium. Eat moderate amounts of processed meats, processed cheese, instant and canned soups, and prepared condiments. Reduce the amount of salt added to foods during cooking or at the table, or replace the salt with low-sodium seasoning and herbs.

LEAD

1. Lead does not occur naturally in water. It is a byproduct of the corrosion of lead piping. When water comes in contact with lead piping or with pumps made with lead, it helps corrode (or wear away) the metal. The lead is then carried through the water supply.

2. Corrosion is an electrochemical reaction that destroys metal when such elements as air, water, or soil act upon it. Certain waters are naturally corrosive and tend to increase their corrosivity through trans-

continued

port in piping systems, valves, and distribution systems. These distribution systems in turn transport water to customers.

3. The least expensive way to remove lead from water is to run the water for 15 to 30 seconds until it is as cold as it will get. It also helps to flush the toilet in the morning to force water that has been stagnating in the pipes overnight through the pipes. A second way to remove lead (slightly more expensive) is to alter the pH of the water. This can be done by making the water more alkaline. To do this, use sodium bicarbonate (baking soda) or lime. A third, more expensive method is to use treatment equipment. **Reverse osmosis** uses a microscopic membrane to filter out impurities in drinking water. This method, however, is costly, slow, and wasteful. For example, in reverse osmosis systems, for every gallon of drinkable, leadfree water that is produced, four to six gallons go down the drain. **Distillation** draws out impurities by turning water into steam, then turning it back again into a liquid form. This method can be costly. **Activated carbon systems** use granular carbon or charcoal particles to filter impurities. They can be placed on the sink, under the sink, or on a tabletop. This is the most expensive treatment method.

4. Foods that should not be served or stored in improperly glazed ceramicware include fruit juices, tomato juice, coffee, tea, wine, sauerkraut, some soups, salad dressing, tomato products, and foods containing vinegar.

MICROORGANISMS

1. No, you should not take a drink from the pond. Water that appears clear may, in fact, harbor many pathogens, microbials, or other contaminants invisible to the naked eye that may harm your health.

2. Three such pathogens are bacteria, protozoa, and fungi.

3. Symptoms include stomachache, fever, diarrhea, dehydration, nausea, vomiting, aches, and abdominal cramps.

4. We are less likely to be exposed to waterborne microorganisms today because of better treatment and filtration techniques. We should still be on guard against new forms of disease-causing organisms in water.

5. Some foods that contain raw eggs are homemade eggnog, homemade ice cream, homemade mayonnaise and bearnaise sauce, and raw cookie dough. Decrease risk by using egg substitutes from the refrigerated or frozen food section of the supermarket; pasteurized eggs from the health-food section of the supermarket or a cake-decorating store; or an ice-cream recipe with a cooked custard base.

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