Cleaning Water

"Water, water, everywhere, and not a drop to drink." This famous line from Samuel Taylor Coleridge's *The Rime of the Ancient Mariner* is one of the most famous lines from English literature. In the passage, sailors are surrounded by miles and miles of seawater. Although they are very thirsty, they cannot drink the water to satisfy their thirst.

Water is safe to drink when it is free of pathogens.

The same is true of water containing pathogens. A pathogen is any organism that can cause disease. A pathogen can be bacterial, viral, or fungal. Water is unsafe to drink in areas of the world where pathogens cannot be removed. The World Health Organization estimates that 13% of the world's population does not have access to safe drinking water. That is around 780 million people.

Unsafe drinking water can also be an issue in industrialized nations. In the United States, drinking water from wells is more likely to contain pathogens than municipal (public) water supplies, which are treated to prevent pathogen contamination. In the event that a pathogen is detected, the water supplier takes steps to remove the pathogen before the water reaches people.

Water monitoring relies on indicators that give information about the water quality. An indicator is a sign that something has gone wrong. Common water indicators include:

- **Turbidity:** Turbidity is a measure of water clarity or cloudiness. If water is cloudy, it is said to have high turbidity. Turbidity can sometimes indicate the presence of bacteria, viruses, or parasites, or it may signify that the water is dirty and needs to be cleaned before human consumption.
- **Coliforms:** Coliforms are bacteria, like *E. coli*, and are usually not pathogenic. In fact, they are normally found in the environment. However, a large amount of coliform bacteria indicates the likely presence of other, more harmful bacteria.

Removal of contaminants from water does not just occur at water treatment facilities. For some people, water purification takes place at home. Some people purify their water right at the faucet. How do these different technologies work?

Prevention is the best medicine

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The best way to keep drinking water safe is to prevent it from becoming contaminated in the first place, so water is often treated with chemicals that prevent growth of bacteria, algae, and other organisms.

Different water systems take different approaches, depending on the water that comes into the treatment plant. The most common pre-treatment may be surprising: chlorine. The same chorine used in swimming pools to keep them free of growth is also used in drinking water.

Water treatment plants make water safe to drink.

Removing the invaders

Chlorine is also used to eliminate pathogens once they have begun to grow in water, but chlorine is not the only line of defense. Some water systems use ultraviolet (UV) light to kill invading organisms.

How does UV light work? UV light acts as a mutagen, which is anything that changes an organism's genetic material. If bacteria are growing in the water, the UV light will damage their DNA. This leaves them unable to reproduce, and often destroys the microorganisms. The U.S. Environmental Protection Agency (EPA) has approved the use of UV light for removing *Cryptosporidium* and *E. coli* from drinking water.

Another EPA-approved method of disinfecting drinking water is using ozone, a powerful oxidizing agent. Ozone destroys pathogens, including bacteria and viruses.

Catching contaminants in a filter

The EPA also approves the use of filters to remove pathogens from drinking water. These filters work the same way a coffee filter does: water passes through the filter, and anything too large to pass through the holes in the filter gets trapped. Filters cannot differentiate between different types of contaminants. Instead, they catch anything too big to fit through the filter holes.

Filters are not perfect. They can be expensive, and they slow down water flow. However, they are a great tool for purifying water without adding chemicals.

Filters are also the basis of water "purifying" systems that attach to kitchen faucets. One has to be careful with terminology when describing faucet-mounted filters. Some are advertised as "purifying"

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drinking water. Purification means the removal of microbiological organisms from water but in reality, these systems do not remove living organisms. They clean the water, but do not purify it.

So how do faucet-mounted filters work? First, water passes through a mesh screen to remove any large particles, like dirt. Next, the water moves through a layer of carbon. Carbon has long been used to eliminate chemicals in water, because the carbon binds to chemicals and removes them from the water.

Attaching a filter to a faucet reduces contaminants in the water.

When the system fails

How do people know if their drinking water is unsafe? If they use well water, they are required to have the water tested. For people using public water systems, they receive notification if there is an issue with their drinking water. The EPA has strict guidelines for how to detect and treat contaminated water, and how to notify people that the water is unsafe to drink. These types of measures help make drinking water safe for everyone.