bacteria...

How Much Do They Bug You?

Overview of bacteria commonly found in drinking water

By Jonathan Dyer

The World Health Organization stated that infectious diseases are the world's single largest source of human mortality (WHO, 1996). Many of these infectious diseases are waterborne and have a tremendous adverse impact on developing countries. Waterborne pathogens also pose threats to ambient recreational waters resulting in illnesses and economic impacts on local communities.

Bacteria exist throughout our environment. In the air we breathe, the food we eat, and especially the water we drink. It is natural for bacteria to exist in these places. If it didn't then we would have a "sterile" situation. Sterility in the natural environment is not a normal scenario.

What is Bacteria?

Bacteria are single-cell creatures. However, they are complex and fascinating. They can live in temperatures above the boiling point and exist in cold that would freeze blood. Their diet can range from sugars and starches to sulfur and iron. Some species of bacteria have been shown to withstand blasts of radiation 1,000 times greater than a human being could tolerate.

Bacteria fall into the category of life called *Prokaryotes* (pro-carry-oats). *Prokaryotes* DNA is not enclosed in a nucleus. Almost all other life forms are *Eukaryotes* (you-carry-oats), creatures whose cells have nuclei.

Bacteria come in basically three different shapes: 1) rod or stick-shaped called bacilli (buh-sill-eye); 2) ball-shaped called cocci (cox-eye); or 3) spiral-shaped. They can exist as single units or in clusters to form pairs, chains and other groupings.

Some can move about their environment by means of a long whip-like structure called a flagella. Other bacteria secrete a slime layer to travel over and there are stationary bacteria as well.

Bacteria are essential for biological life. Antibiotics such streptomycin and nocardin are produced by bacteria called actinomycetes. Bacteria are found in the intestinal tracts of animals (humans included) and break down food to a usable form. They convert nitrogen to a usable form for plants. Bacteria, as you know, exist in water naturally to breakdown organic materials.

Bacteria in Water

Water is not naturally sterile. It can contain thousands of species of bacteria. Bacteria that live in water are called "natural flora" or organisms that have evolved to exist in water. These natural flora have adapted to living in this type of environment and most do not have the biochemical capabilities of causing problems to humans. Of the thousands of species of bacteria only a very few could lead to disease.

The pathogenic (disease causing) bacteria that are found in water, originate from the intestinal tract of warm-blooded animals (fecal contamination, sub-surface sewage disposal system failure, etc.). These atypical flora enter the water source through some sort of fecal contamination.

The bacteria that do exist in water have the ability to assimilate the minute amounts of dissolved organic carbon and nitrogen found in ground water. The carbon and nitrogen levels vary with the water source. A deep well water source would contain less carbon and nitrogen then a shallow well water source. The source of the carbon and nitrogen is decaying vegetation from leaves, soil, etc.

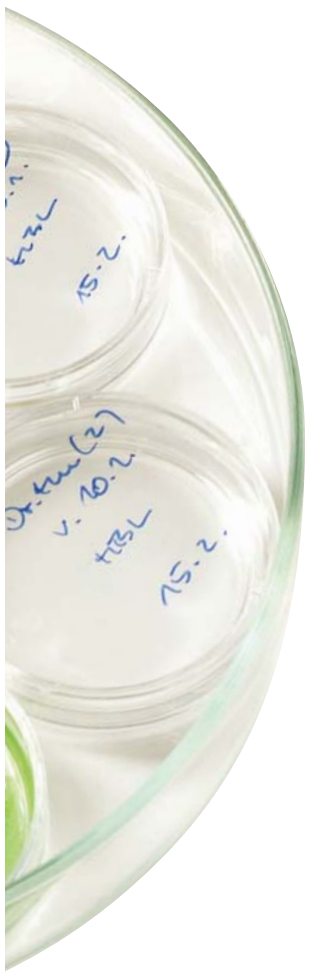
Because the bacteria could be as small as a single cell they only have enough DNA to do certain things. For instance, if the bacteria have enough DNA to metabolize carbon and nitrogen to produce amino acid, more DNA and RNA, chances are that they will not have enough DNA left over to be pathogenic to humans.

For a bacterium to be disease causing it must possess three things:

- It must have great numbers in order to survive a trip through the stomach. The stomach with its hydrochloric acid can drop the pH down to below 2.0. Not a "friendly" environment for bacteria;
- The bacterium must be able to produce anti-human enzymes such a elastase and/or hyaluronidase; and
- The bacterium must be "cytotoxic," which means to have the ability to invade human cells.

So either the bacterium has enough DNA to assimilate carbon and nitrogen in water or it has enough DNA to be pathogenic. It is rare that species of bacteria can perform both of these feats but the *Pseudomonas* organism does have this capability. This topic will be discussed later in this article.

When a water sample is sent to the



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laboratory for a bacteria analysis the sample has to be received within 30 hours from the time sampling. This is because the bacteria like total coliforms and *E.coli* do not reproduce well in water and will die out over a certain period of time. You could have a million total coliforms to begin with and have those all die out over a weekend.

Time is essential when it comes to accuracy in bacteria determination.

Bacteria in General

If you "hop on" the Internet and search the words "pathogenic bacteria" you will find a great number of articles. In the case of drinking water, we can narrow the scope done to a few "bad boys." The following is a list of the major bacteria that we look for in the normal drinking water laboratory profile.

Total coliform - Total coliform organisms are called "indicator organisms." This means that if you find a total coliform in the water there might be a possibility of pathogenic organisms also existing in the water sample. Total coliforms are found in two places: decaying organic matter such as leaves or soil, and/or the intestinal tract of warm-blooded animals.

When a water testing laboratory gets a positive for total coliform they are required to "confirm" as to whether that total coliform is a fecal coliform or an *E.coli* organism. This is done through different types of confirmation methods.

If the results show a positive for total coliform but negative for fecal coliform or *E.coli,* then the contamination into the

well could be soil bacteria. This bacterium was probably transported from the soil into the well water system by surface water intrusion.

If the results are positive for both total coliform and fecal coliform or *E.coli,* then the problem is more serious. Now you have bacteria in the well water that is also found in the feces of humans and animals.

Fecal coliform - Fecal coliform bacteria are a group of bacteria that are from the intestinal tract of warm-blooded animals. They aid in the digestion of food. The presence of these bacteria in water samples indicates that the contamination is from a animal related source (i.e. runoff from fields and pastures, malfunctioning septic tanks, storm-water runoff, etc.).

Fecal coliform alone, generally do not pose a danger to humans but they indicate the presence of other disease causing bacteria such as those that cause typhoid, cholera and/or dysentery.

If these organisms are in the water there is a very good chance of a health risk if the water is consumed.

E.coli - *E.coli* is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. *E.coli* is short for Escherichia (e-shreek-ee-ah) coli.

There are hundreds of strains of *E.coli* and most of them are harmless and live in our intestinal tract. Some strains, however, can produce powerful toxins that can cause severe illness such as the bacterium *E.coli* 0157:H7. Although most *E.coli* 0157:H7 were related to undercooked ground beef some waterborne outbreaks have been identified from people drinking the water (1999, Washington County, N.Y.) or swimming in the water (1999 Clark County, Wash.).

Pseudomonas - *Pseudomonas* contains many species of which a few are pathogenic for humans. The pseudomonas aeruginosa bacterium is a species that can be virulent (ability of a bacteria to cause disease) to humans.

Pseudomonas form biofilms in water pipes. Biofilms are more difficult to eradicate then bacteria groups because you have to first breakdown the biofilm and physically remove it from the water system before disinfection. Once established these biofilms can cause odor, color, taste and turbidity problems.

Heterotrophic Bacteria - *Heterotrophs* are bacteria that normally live in water. There has been no scientific proof that

heterotrophs are harmful to humans. *Heterotrophs* are indeed a natural flora.

Their life cycle consists of living and dying in the water environment. You will find these bacteria in all types of untreated water including bottled water.

In bottled water these bacteria can peak then die out, and the next generation of *heterotrophs* will live off their remains, they will peak and die out and so on. This is the natural order of their life cycle.

In the case of well water you are dealing with heterotrophic bacteria. Which can be eliminated with the installation of a disinfection system (i.e. chlorination, ozonation, or UV).

Summary

The bacteria mentioned in this article are pretty basic to identify and almost any environmental laboratory will have the capabilities to identify them. These bacteria are "indicator" bacteria. They indicate the presence of a more dangerous bacteria in the water system. Such bacteria as *Salmonella*, *Shigella*, *Campylobacter*, *Klebsiella*, and *Yersinia* will require a more sophisticated microbiological laboratory in order to isolate and speciate these organisms.

Not all bacteria are out to get us. In fact, only a very small percentage of the thousands of species that exist are harmful to humans. No water is naturally sterile. Well water, bottled water and some tap waters contain bacteria (providing they are not chemically treated). This is okay as long as the bacteria are natural flora.

It is the bacteria that are not found naturally in water that could be a problem. These are the bacteria that do not have the DNA to assimilate the minute amounts of organic carbon and nitrogen in the water and prefer to live in nice warm protein-rich bodies…like us. *wqp*

About the Author
Jonathan Dyer is president of A&L Laboratories, Inc., Auburn, Maine.
He can be reached at 207.784.5354.

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