


# Water Microbiology 101

Dr. Natalie Prystajeky  
BCCDC Public Health Microbiology and Reference Laboratory  
University of British Columbia  
Email: [natalie.prystajeky@bccdc.ca](mailto:natalie.prystajeky@bccdc.ca)

Provincial Health Services Authority  
Province-wide solutions. Better health.

PHSA Laboratories  
Public Health Microbiology & Reference Laboratory



**Silverescent luon®**  
Anti-Skin® bonded silver ions inhibit the growth of odour-causing bacteria to ensure your gear stays fresh and stink-free. Your friends will appreciate it.



**EXPRESS**

**Mirror LIFESTYLE**  
Going out? Staying in? Start here

### More germs on an average sofa than a loo seat

A FAMILY sofa harbours more nasty bacteria than the average toilet study has found.

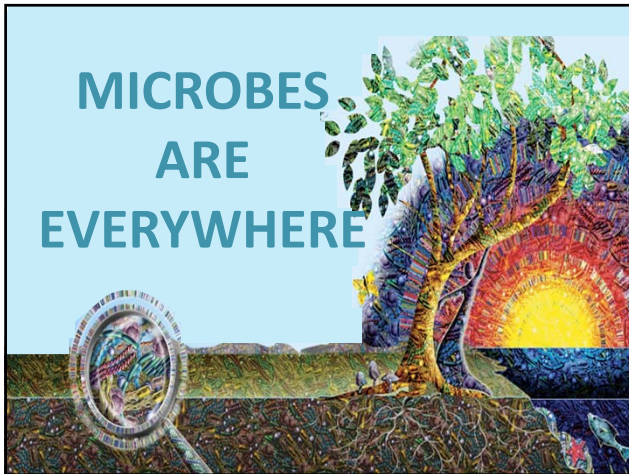
By Andrew Gregory | 11 Comments | 14 Sep 2013 08:30

### Games console controllers have FIVE TIMES more germs than toilet seat

Researchers swabbed everyday things around the home for bacteria including E-coli, APC and Enterobacteriaceae

SEE MORE STORIES YOU'LL LOVE

RECOMMENDED IN LIFESTYLE



### Not All Microbes Are Created Equally

*Yersinia pestis*  
Black Plague




*Yersinia pseudotuberculosis*  
Fever, rash and  
appendicitis-like pain

### Not All Microbes Are Created Equally

Generic *E.coli*  
Harmless, used to assess water quality

Pathogenic *E.coli* (O157, O104)  
Causes diarrhea, can be deadly

### Not All Microbes Are Equal

VIRUSES	BACTERIA	PROTOZOA
		
Rotavirus Adenovirus Norovirus	<i>E.coli</i> O157 <i>Salmonella</i> <i>Campylobacter</i>	<i>Toxoplasma</i> <i>Giardia</i> <i>Cryptosporidium</i>

## Not All Microbes Are Equal

VIRUSES

BACTERIA

PROTOZOA



## Common Waterborne Pathogens

Viruses

- Adenovirus
- Norovirus



- Small size means they can be found in aquifers
- Most viruses are highly restricted by their host, such that human strains can only infect humans
- Susceptible to chlorine, removed by filtration, most strains susceptible to UV (except adenoviruses)
- Most challenging to detect

## Common Waterborne Pathogens

Bacteria

- *Escherichia coli* O157:H7
- *Campylobacter jejuni*



- Wide range of bacterial pathogens
- Often many animal hosts
- Varying infectious doses
- Low to moderate survival in water
- Susceptible to all water treatment approaches

## Common Waterborne Pathogens

Protozoa

- *Cryptosporidium* sp.
- *Giardia lamblia*



- Low infectious dose
- Multiple animal hosts (zoonotic)
- Survive for a long time in cool water
- Resistant to disinfection with chlorine
- Susceptible to UV disinfection and removed by filtration

# Multiple Barrier Approach - MBA

## MBA - Micro

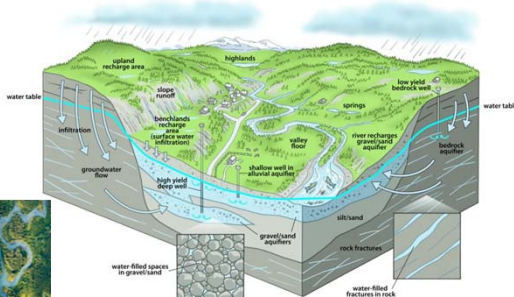
### Source



- Which types of microbes are present?
- What are the sources of these microbes?
- How do they get transported into the water source?

## MBA - Source

Not all sources are created equally



## MBA - Source

### Types of Water

1. Surface water and groundwater under direct influence (GUDI): greatest risk of pathogens
2. Groundwater: lesser risk of pathogens



## MBA - Micro

### Treatment



- Which treatment is needed to remove the microbes found in the source?
- What other compounds can impact the effectiveness of microbes treatment?
- How can I tell that the treatment is working?

## MBA - Treatment

Key aim treatment: kill or damage microbial cells

**BUT**  
**BOL**

Not all microbes are created equally  
Not all treatment types work the same way



## How Does Water Treatment Remove/Kill Microorganisms

Treatment	Mechanism/Considerations
Filtration (w/ or w/o coagulation, flocculation and sedimentation)	Physical removal Dependent on organism charge, size Dependent on water condition, filter age etc.
Chlorination	Damages cell membrane so cells cannot replicate or cause infection Dependent on organism, organic load etc.
UV Disinfection	Damages nucleic acid (DNA and RNA) so cells cannot replicate or cause infection Dependent on turbidity, organic and microbial load Some organisms have enzymes to repair damaged DNA

## Not All Microbes Are Equal

### Viruses

- Susceptible to filtration, UV light, chlorine & other disinfectants

### Bacteria

- Susceptible to filtration, UV light, chlorine & other disinfectants

### Protozoa

- Resistant to chlorine
- Susceptible to filtration and UV light

## MBA - Micro

### Distribution

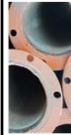


- What is needed to prevent microbial re-growth?
- How can contaminant intrusion be avoided?

## MBA - Distribution

How do microbes enter distribution system?

- Cross-connections, deadends, cracks, backflow
- Biofilms & conditions allowing microbial growth



## MBA - Distribution

How are microbes controlled in distribution systems?

- Good distribution system design
- **Secondary disinfection**



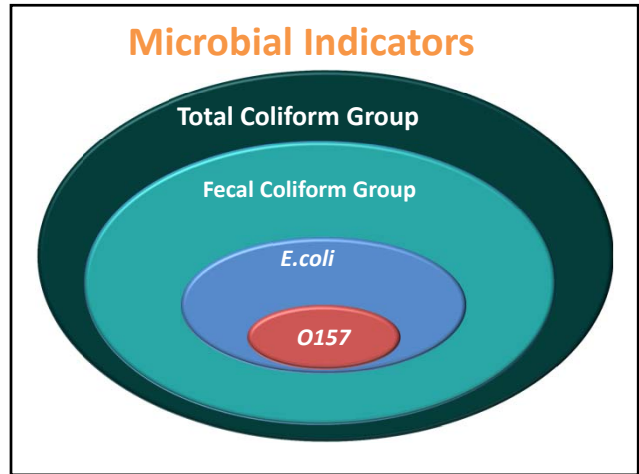
## MBA - Micro

### Monitoring



- Is the water free of harmful microbes and safe for human consumption?
- Is the drinking water treatment process working?

*Giardia lamblia*    *Escherichia coli* non-O157    *Legionella pneumophila*  
*Shigella sonnei*    *Naegleria fowleri*    Enterovirus  
*Campylobacter jejuni*    *Dracunculus medinensis*    *Cyclospora cayetanensis*  
Hepatitis E Virus    *Salmonella enteritidis*    Adenovirus    *Fasciola spp.*  
*Escherichia coli* O157  
**IMPOSSIBLE TO TEST FOR ALL**  
*Lymanobacteria*    Norovirus    *Arcobacter butzleri*  
Astrovirus    *Mycobacterium avium* complex    *Cryptosporidium parvum*  
Hepatitis A Virus    *Toxoplasma gondii*    *Leptospira spp.*    *Alexandria spp.*  
*Schistosoma spp.*    *Vibriocholerae*  
*Acanthamoeba bacastellani*    Rotavirus  
*Shigella flexneri*    *Pseudomonas aeruginosa*  
*Enterocytozoon bienersi*    *Campylobacter coli*    *Cryptosporidium hominis*  
*Yersinia enterocolitica*    Coxsackie A virus    Sapovirus  
*Strongyloides stercoralis*




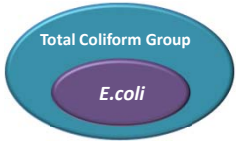
### Microbial Indicators

**Total coliforms**

- Broad group of fecal and environmental bacteria
- Indicates treatment effectiveness


***Escherichia coli* (aka *E.coli*)**

- Only found in feces of warm blooded mammals
- Indicates recent fecal contamination & public health risk

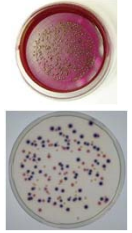
### How is Indicator Monitoring is Performed

Enzyme-Substrate



i.e Colilert test

Membrane Filtration



i.e. m-Endo or Chromocult



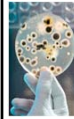
## Question

For distribution water, how much *E.coli* is too much?

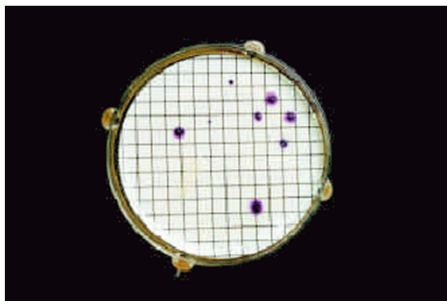


## How Much *E.coli* is Too Much *E.coli*?

> 0 CFU/100mL  
CFU = Colony Forming Unit



## What is a CFU?



## Benefits of Indicator Testing

- Not pathogenic
- Easier to detect than pathogens
- Relatively simple testing
- Relatively inexpensive
- Standardized

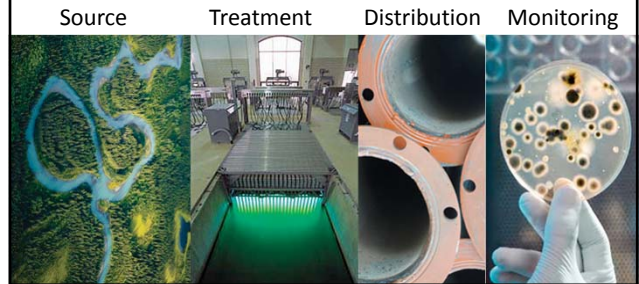


### Pitfalls of Indicator Testing

- Correlate ok with bacterial pathogens, poorly with viral and protozoan pathogens
- Slow turn-around-time (TAT)
- Testing in specialized laboratories; transport time (up to 30 hours)
- Century old technology



### Multiple Barrier Approach (MBA)



### Thank-You Questions?

