



# ***Microbial Water Quality***

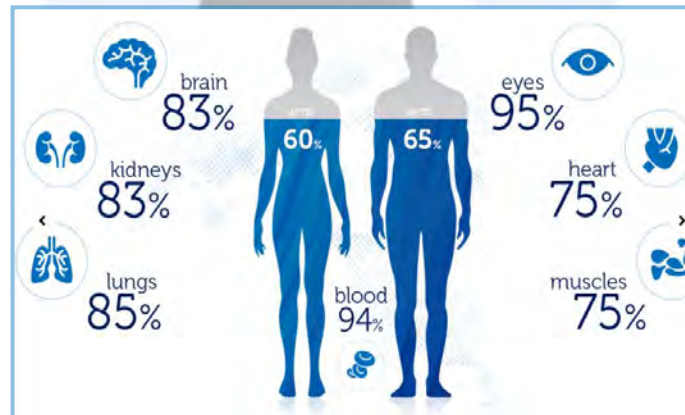
Oded Sued, PhD  
Molecular Microbiologist  
Central Laboratory  
Mekorot – Israel National Water Co.

## **Small Water & Wastewater Systems, IWA**

18.10.2018



1. Mekorot
2. Laws and Regulations
3. Classical techniques
4. Rapid at-line techniques



# The Mekorot Group



Reuses **60%**  
of Israel's  
treated wastewater

Supplies **85%**  
of Israel's drinking  
water

Supplies **70%**  
of total water  
consumption

**1,200**  
well drillings

**12,000 km**  
water pipelines

**3,000** facilities



Investments  
**\$350 million** per  
annum

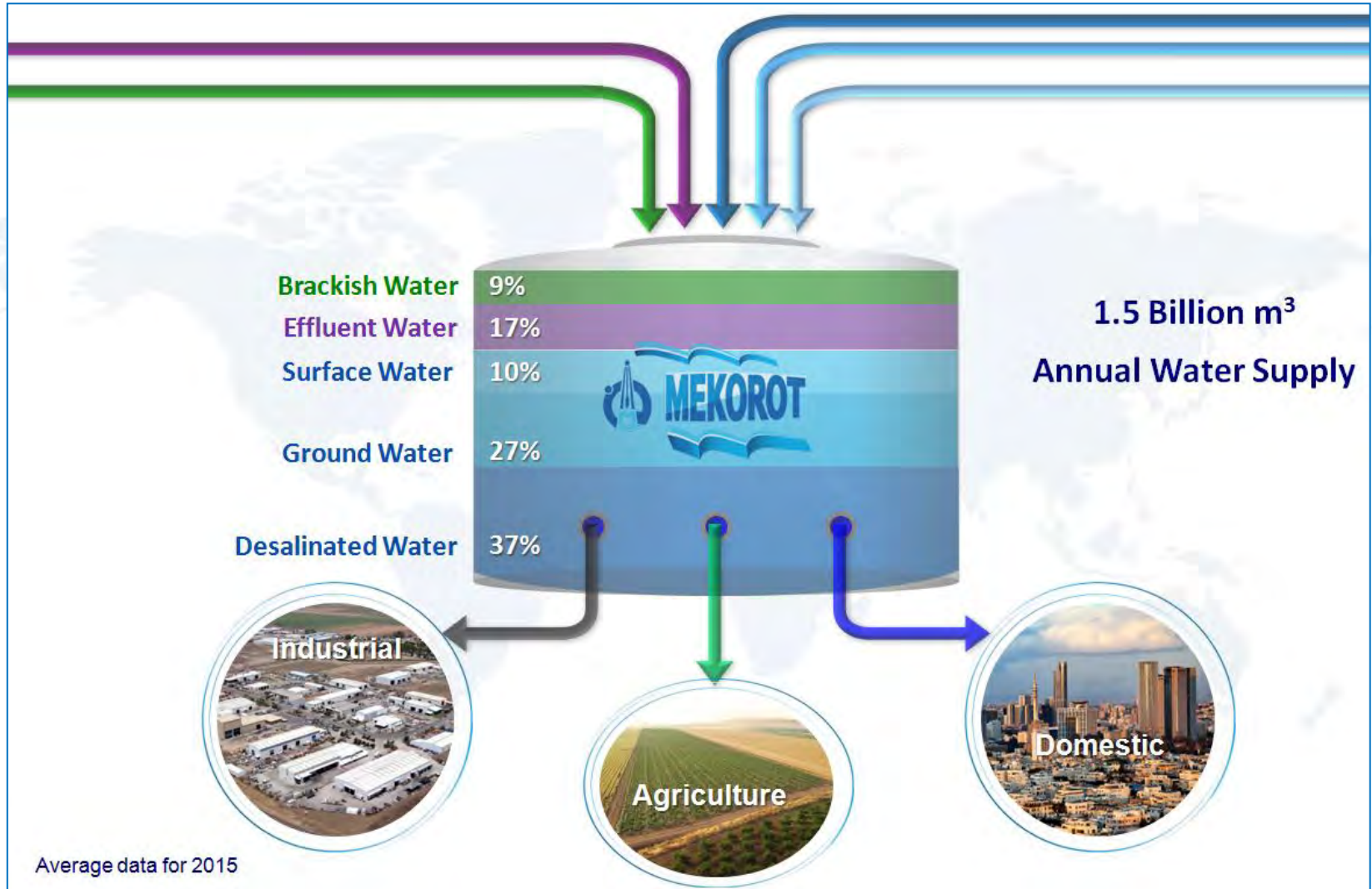
Revenue  
**\$1.3 billion** per  
annum

Ranking **iAAA**  
Standard & Poor's





# Water Resources



Average data for 2015



Authorized by the **Israel Laboratory Accreditation Authority** to perform water testing, according to ISO17025

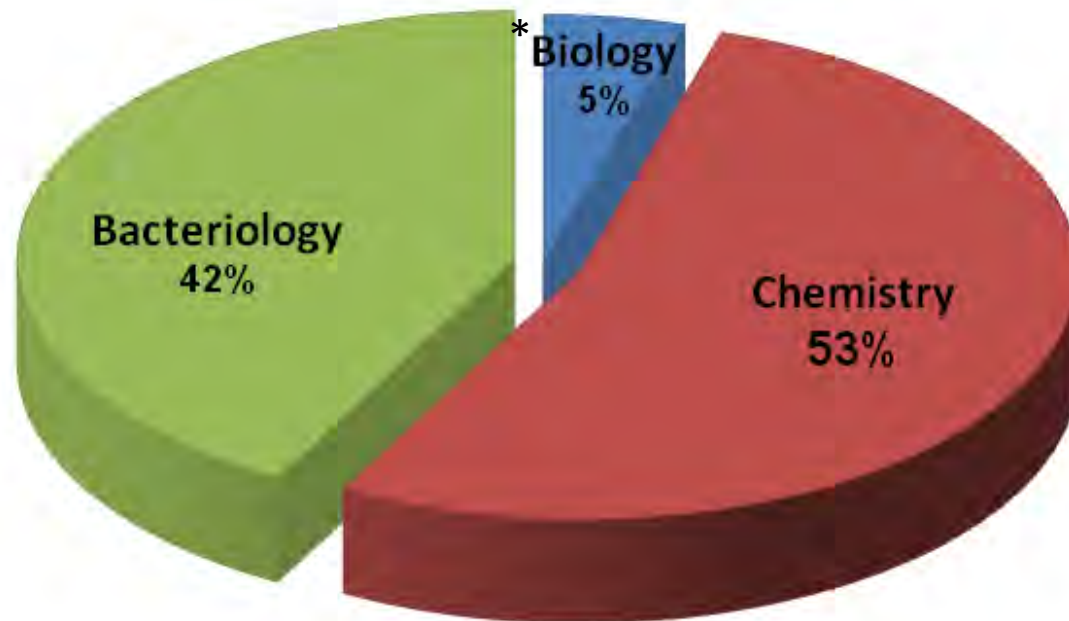
## Water sources

- 💧 Ground water & Surface water
- 💧 Drinking water
- 💧 Waste water
- 💧 Sludge
- 💧 Reclaimed water (Effluents)
- 💧 Sea water
- 💧 Recreational water
- 💧 Irrigation water

-Microbiology  
-Chemistry  
-Biology



**Distirbution of samples between departments  
(2016; 27,340)**



\* Biology – Plankton counting by microscopy



# Pathogenic Microorganisms in water

"In wine there is wisdom. In beer there is strength. In water there are bacteria." German Proverb

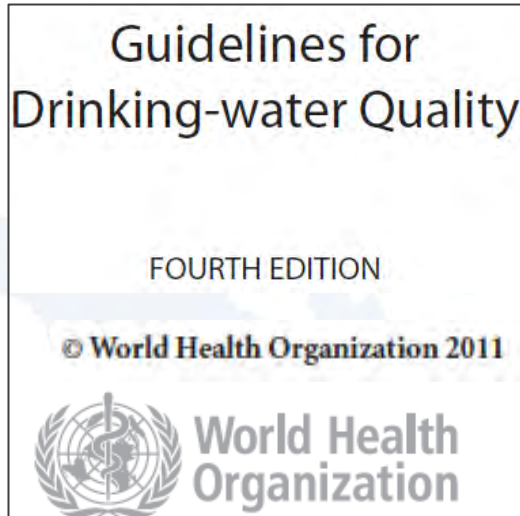
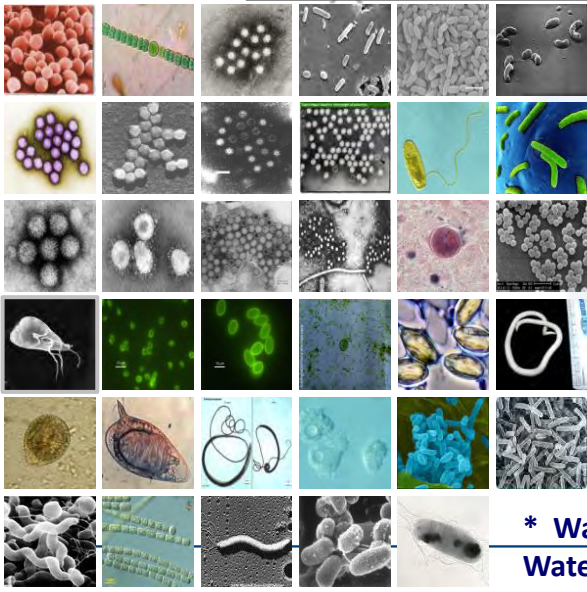


Table 7.1 Pathogens transmitted through drinking-water<sup>a</sup>

Pathogen	Health significance <sup>b</sup>	Persistence in water supplies <sup>c</sup>	Resistance to chlorine <sup>d</sup>	Relative infectivity <sup>e</sup>	Important animal source
<b>Bacteria</b>					
<i>Burkholderia pseudomallei</i>	High	May multiply	Low	Low	No
<i>Campylobacter jejuni</i> , <i>C. coli</i>	High	Moderate	Low	Moderate	Yes
<i>Escherichia coli</i> – Pathogenic <sup>f</sup>	High	Moderate	Low	Low	Yes
<i>E. coli</i> – Enterohaemorrhagic	High	Moderate	Low	High	Yes
<i>Francisella tularensis</i>	High	Long	Moderate	High	Yes
<i>Legionella</i> spp.	High	May multiply	Low	Moderate	No
<i>Leptospira</i>	High	Long	Low	High	Yes
Mycobacteria (non-tuberculous)	Low	May multiply	High	Low	No
<i>Salmonella</i> Typhi	High	Moderate	Low	Low	No
Other salmonellae	High	May multiply	Low	Low	Yes
<i>Shigella</i> spp.	High	Short	Low	High	No
<i>Vibrio cholerae</i>	High	Short to long <sup>g</sup>	Low	Low	No
<b>Viruses</b>					
Adenoviruses	Moderate	Long	Moderate	High	No
Astroviruses	Moderate	Long	Moderate	High	No
Enteroviruses	High	Long	Moderate	High	No
Hepatitis A virus	High	Long	Moderate	High	No
Hepatitis E virus	High	Long	Moderate	High	Potentially
Noroviruses	High	Long	Moderate	High	Potentially
Rotaviruses	High	Long	Moderate	High	No
Sapoviruses	High	Long	Moderate	High	Potentially
<b>Protozoa</b>					
<i>Acanthamoeba</i> spp.	High	May multiply	High	High	No
<i>Cryptosporidium hominis/parvum</i>	High	Long	High	High	Yes
<i>Cyclospora cayentanensis</i>	High	Long	High	High	No
<i>Entamoeba histolytica</i>	High	Moderate	High	High	No
<i>Giardia intestinalis</i>	High	Moderate	High	High	Yes
<i>Naegleria fowleri</i>	High	May multiply <sup>h</sup>	Low	Moderate	No
<b>Helminths</b>					
<i>Draunculus medinensis</i>	High	Moderate	Moderate	High	No
<i>Schistosoma</i> spp.	High	Short	Moderate	High	Yes

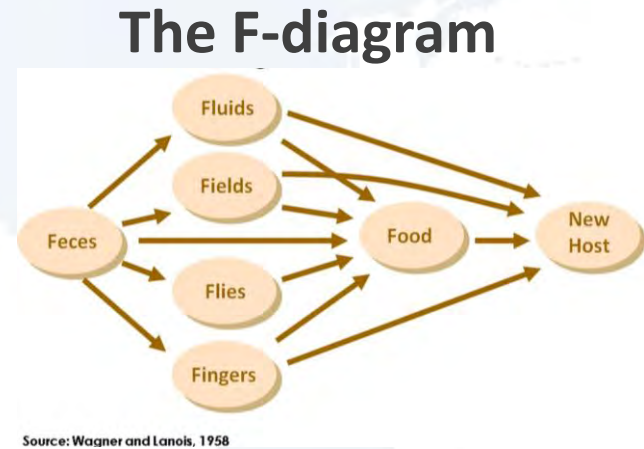
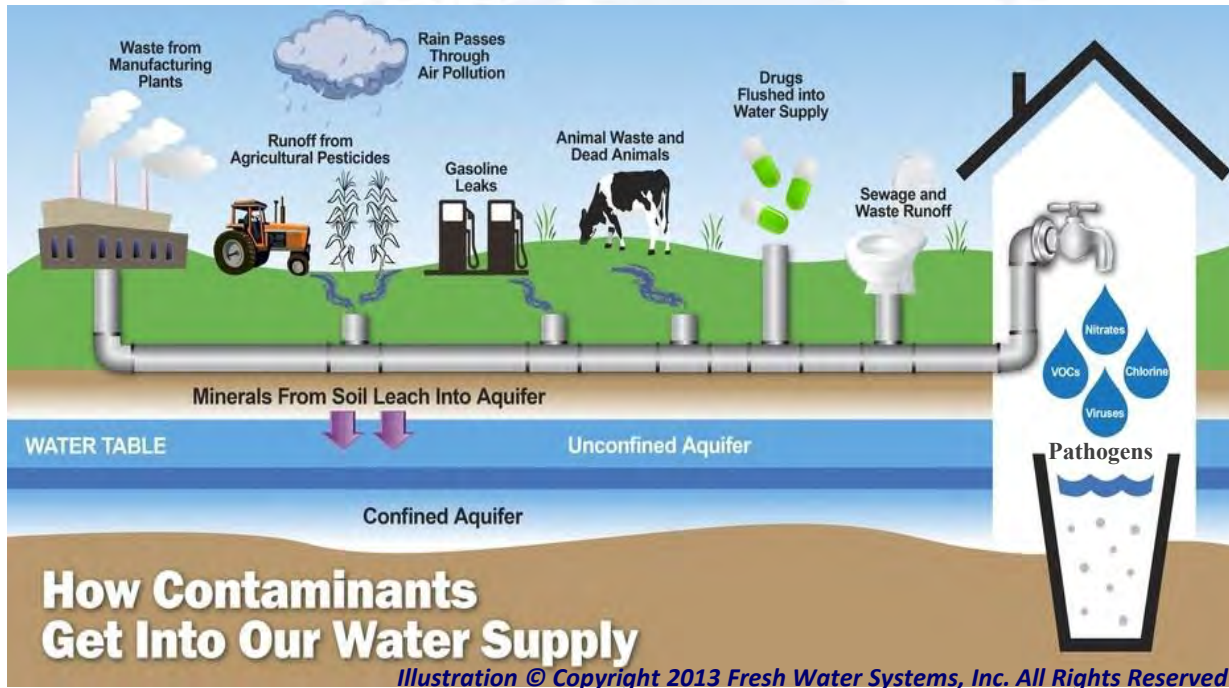


Yeast  
Algae  
\*Viruses (11)  
\*Protozoa (15)  
\*Bacteria (19)

\* Waterborne Pathogens (2006), American Water Works Association (AWWA)

# Where does it come from?

We are worried about 'holes' in the water supply system where sewage can penetrate and mix with drinking water.





# Difficulties with Routine Testing of Pathogens in Water → Indicators

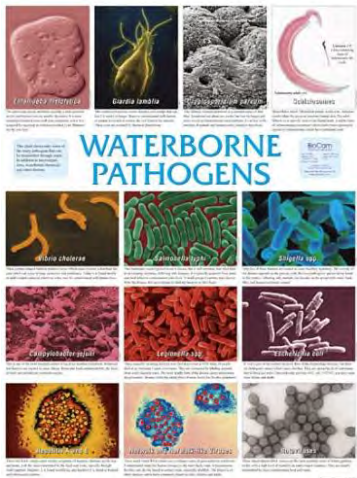
## Pathogens



## Indicators

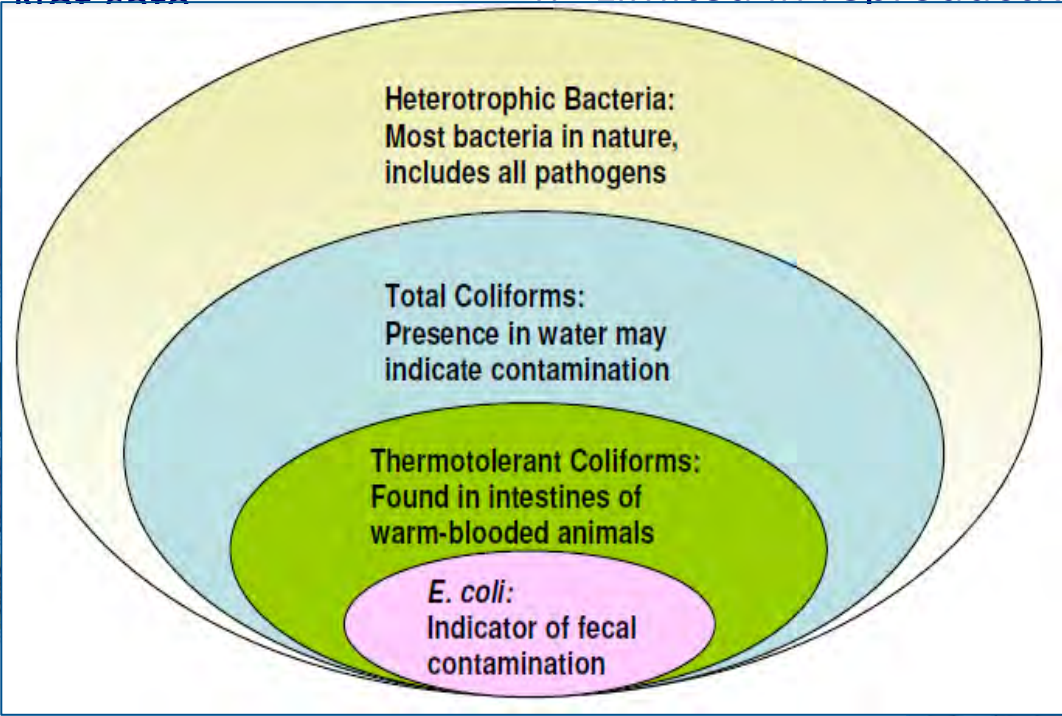
1. Low numbers
2. Limited survival time
3. Numerous pathogens
4. Time and cost
5. Not safe

1. Present when fecal pollution is present
2. Biological markers for all sources of water
3. Survive longer than most stable fecal pathogen
4. Limited in reproductive ability in water
5. Large quantities in feces of warm blooded organisms
6. Easy to find and identify
7. Concentration is correlated to level of contamination
8. Non pathogenic (safe to work with)
9. Rapid reproduction in lab compared to pathogens



## Regulations

1. Low numbers
2. Limited survival time
3. Numerous pathogens
4. Time and cost
5. Not safe



pollution is present

of water

ogen

es of warm-blooded organisms

ify

related to level of contamination

to work with)

lab compared to pathogens

# Water regulation agencies



European Environment Agency



World Health  
Organization

## Standard Methods

For the Examination of  
Water and Wastewater™

22ND EDITION



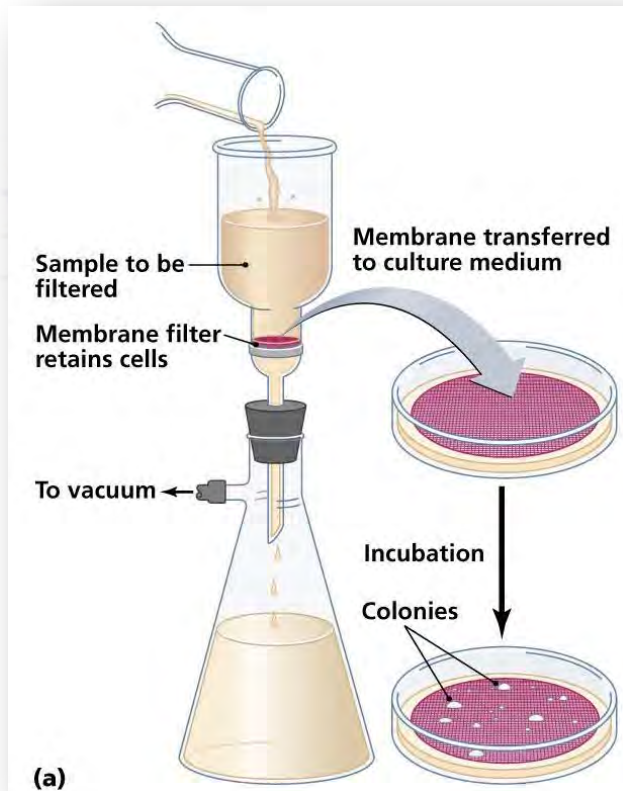
American Public Health Association®  
American Water Works Association®  
Water Environment Federation®

Edited by  
Eugene W. Rice  
Rodger B. Baird  
Andrew D. Eaton  
Lenore S. Clesceri



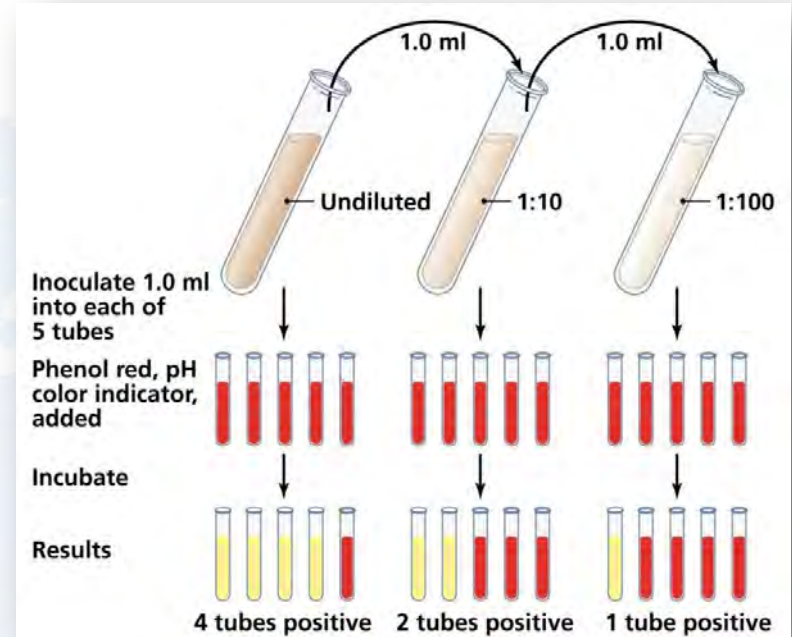


## Membrane filtration (MF)



Standard Methods 9222  
Membrane Filtration

## Most Probable Number (MPN)

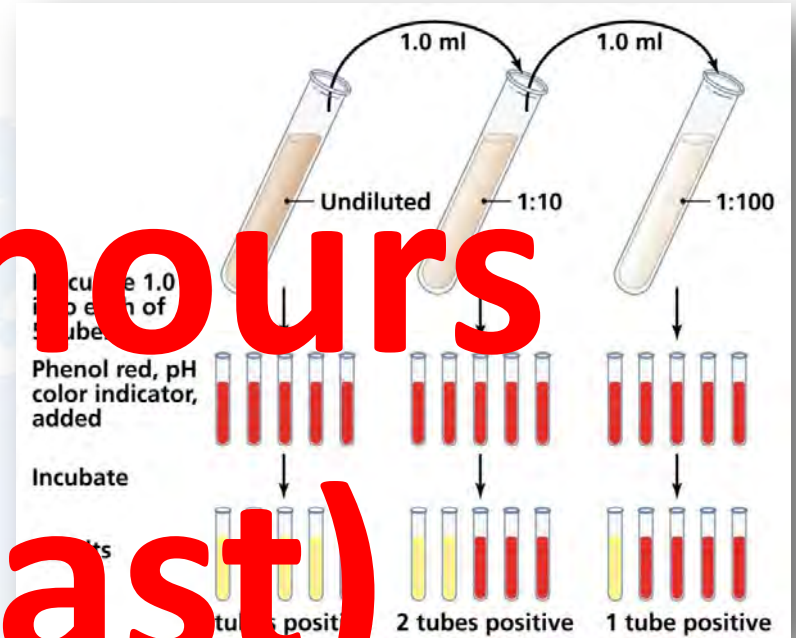
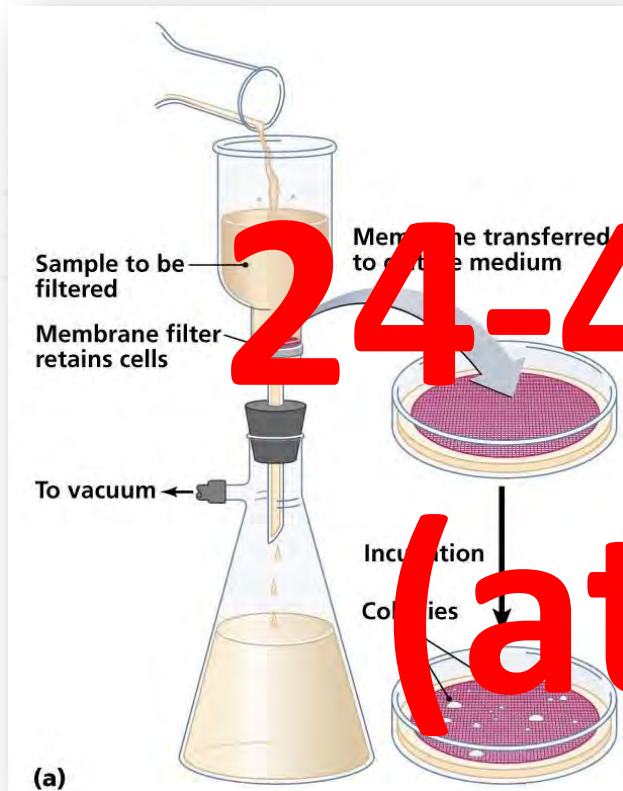


Standard Methods 9221  
Multiple-tube fermentation



## Membrane filtration (MF)

## Most Probable Number (MPN)



**24-48 hours (at least)**

Standard Methods 9222  
Membrane Filtration

Standard Methods 9221  
Multiple-tube fermentation

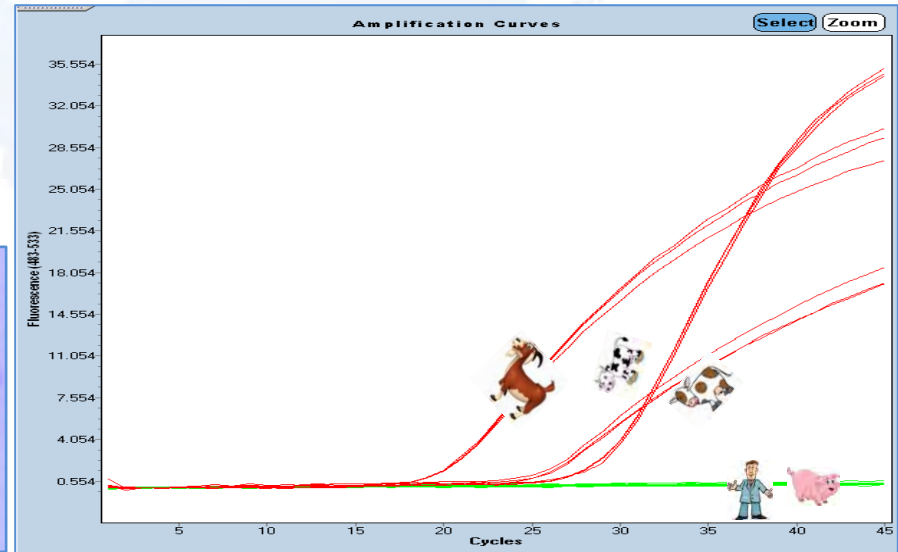
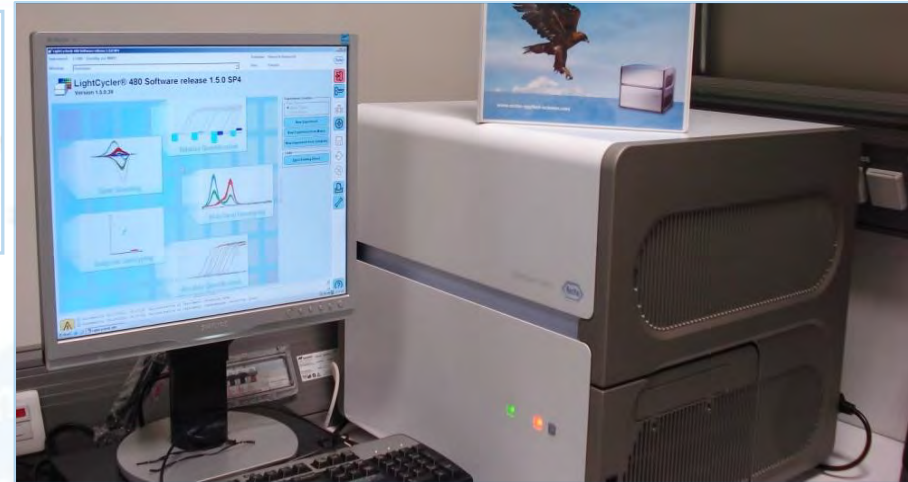


Method 1611: Enterococci in Water by TaqMan® Quantitative Polymerase Chain Reaction (qPCR) Assay

October 2012

We use it to detect:

1. Pathogenic bacteria
2. Indicating bacteria
3. Protozoa (*Giardia*, *Cryptosporidium*)
4. Microbial Source Tracking



1

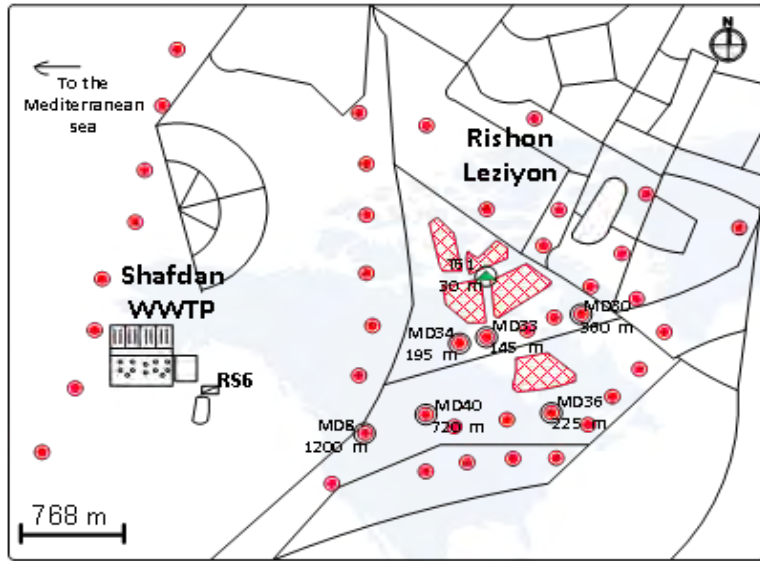


2



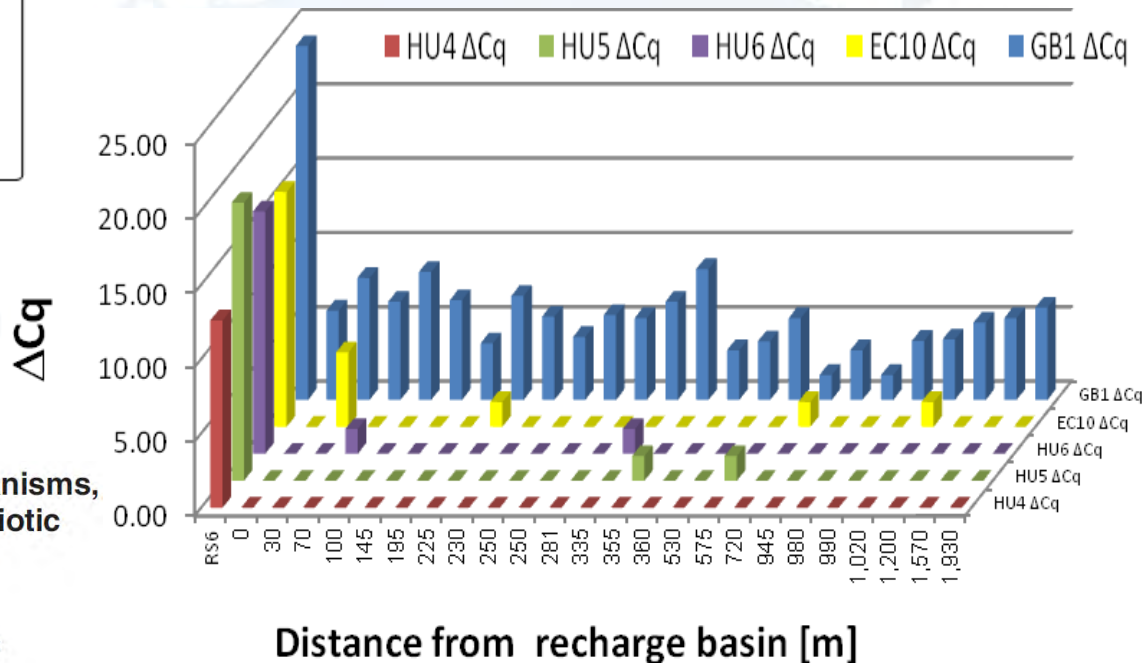
3





In Shafdan Waste Water Treatment Plant, **human markers before SAT (RS6) disappear after SAT (0-1.93km from percolation site)**

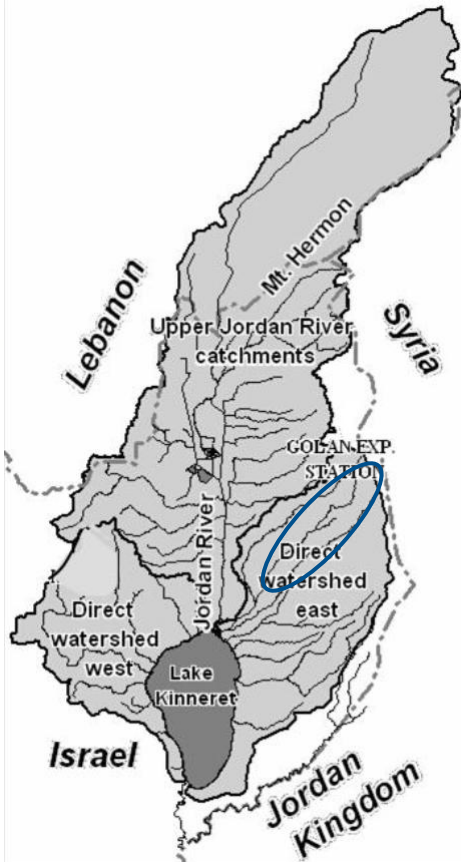
RS6 – percolation site



Viral and Microbial Pathogens, Indicator Microorganisms, Microbial Source Tracking Indicators, and Antibiotic Resistance Genes in a Confined Managed Effluent Recharge System

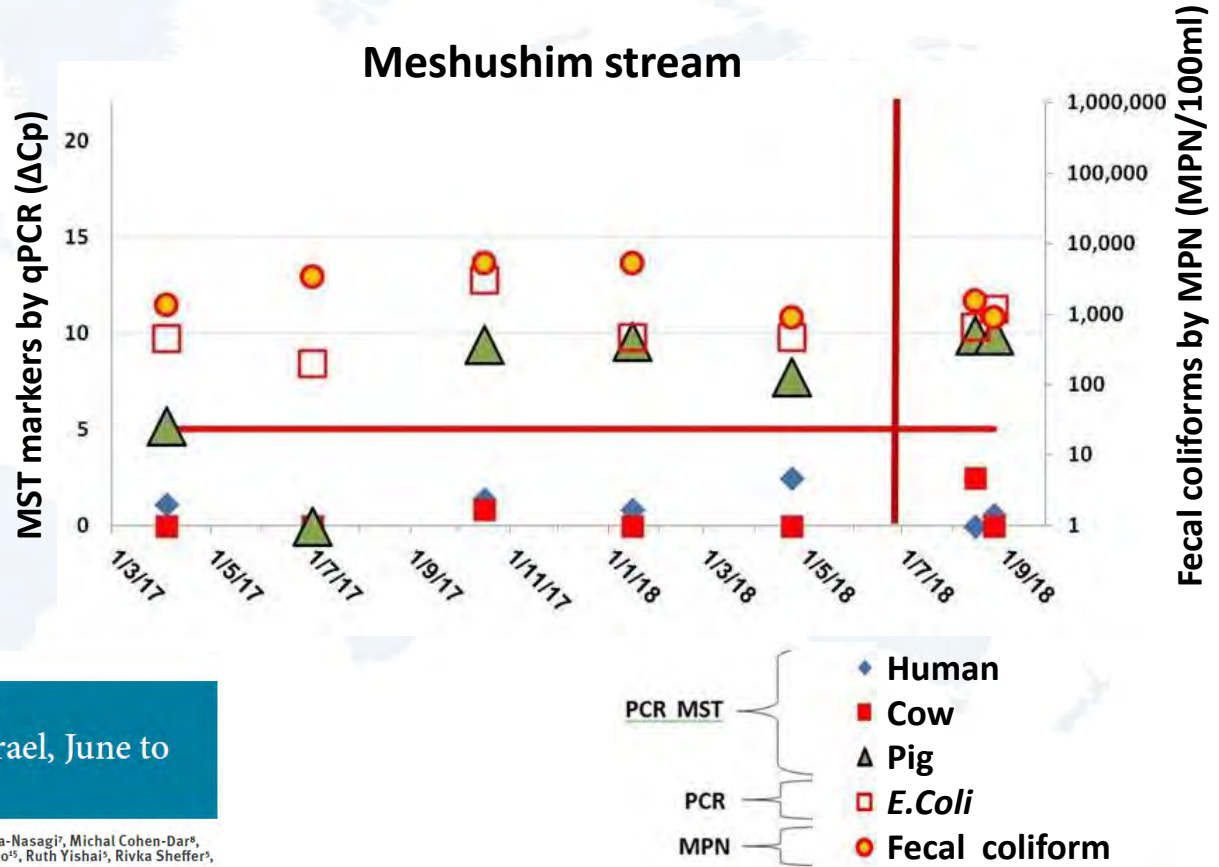
R. Elkayam<sup>1</sup>; A. Aharoni<sup>2</sup>; D. Vaizel-Ohayon<sup>3</sup>; O. Sued<sup>4</sup>; Y. Katz<sup>5</sup>; I. Negev<sup>6</sup>; R. B. M. Marano<sup>7</sup>; F. Cvtrvn<sup>8</sup>; I. Shtrasler<sup>9</sup>; and O. Lev<sup>10</sup>

J. Environ. Eng., 2018, 144(3): 05017011



Leptospirosis (Rat Fever, ענברת) outbreak in north of Israel, summer 2018

Meshushim stream



RAPID COMMUNICATION

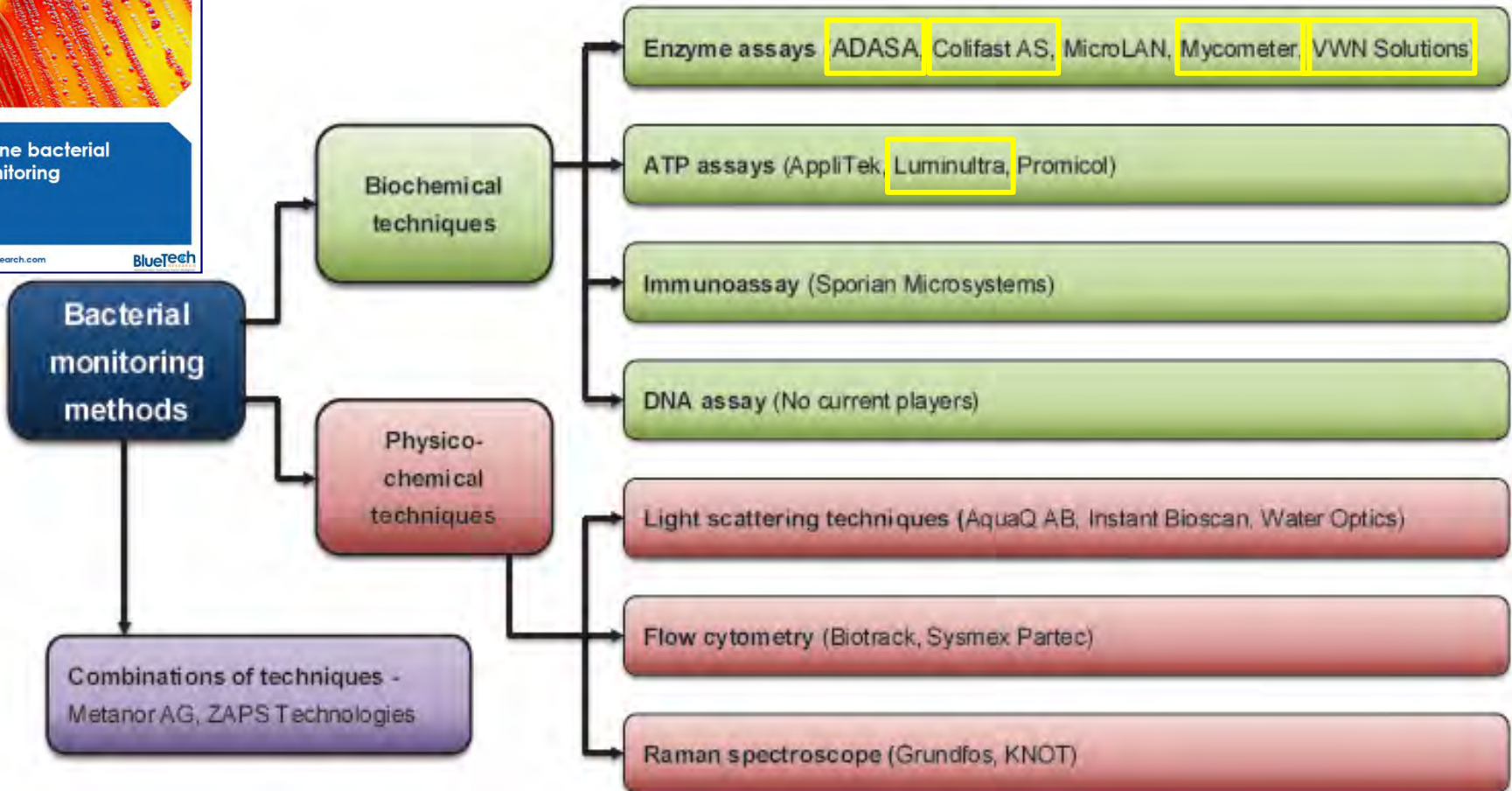
Outbreak of human leptospirosis linked to contaminated water bodies in Northern Israel, June to August 2018

Yuval Dadon<sup>1,2,3</sup>, Eric J. Haas<sup>2,3,4</sup>, Ehud Kaliner<sup>5</sup>, Emilia Anis<sup>2,6</sup>, Shepherd Roe Singer<sup>2,6</sup>, Yafit Atiya-Nasagi<sup>7</sup>, Michal Cohen-Dar<sup>8</sup>, Eva Avramovich<sup>9</sup>, Roni King<sup>10</sup>, Oded Sued<sup>11</sup>, Tamir Goshen<sup>12</sup>, Sharon Amit<sup>13</sup>, Ian Miskin<sup>14</sup>, Efrat Gino<sup>15</sup>, Ruth Yishai<sup>16</sup>, Rivka Sheffer<sup>17</sup>, Itamar Grotto<sup>1,4</sup>, Jacob Moran-Gilad<sup>1,4,5</sup>

Eurosurveillance, Volume 23, Issue 38, 20/Sep/2018



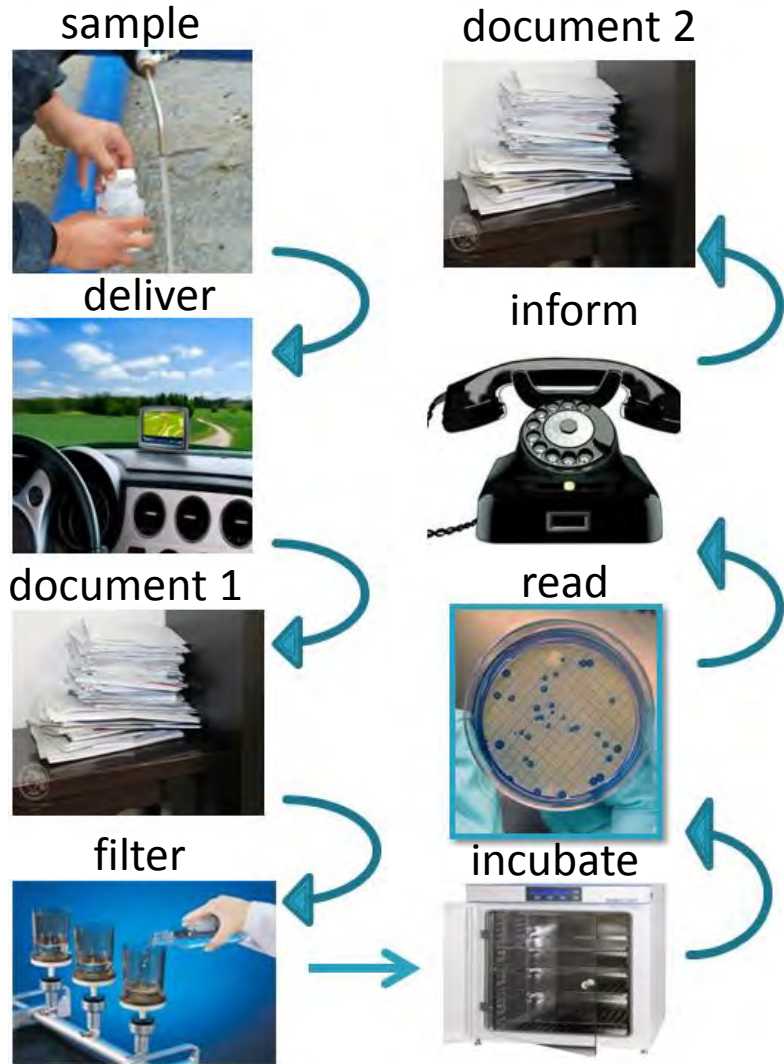
## Online bacterial monitoring market analysis (BlueTech)





The dominant players in each area of online bacterial monitoring



# At-line bacteria detecting instruments



# At-line bacteria detecting instruments

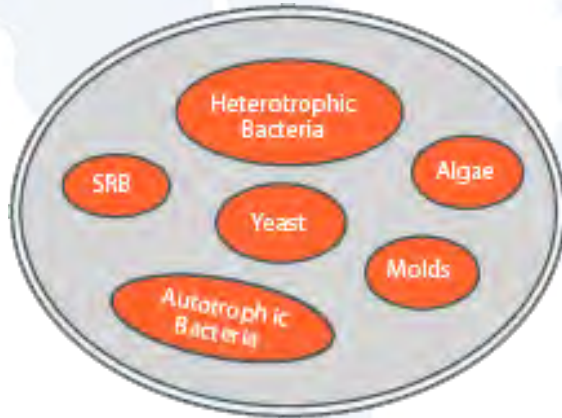
<b>ColiMinder (VWM, Austria)</b>	<b>aquaBio (Adasa, Spain)</b>
<i>E.coli</i> , <i>Enterococcus</i> , Total bacteria	<i>E.coli</i> , coliform
Lysis	Incubation
20 min	7-18 h
2 consecutive tests (2 inlets)	2 parameters in parallel
X	EPA approved
Automatic alarm	Automatic alarm
	

## LUMINULTRA<sup>®</sup>

microbial monitoring

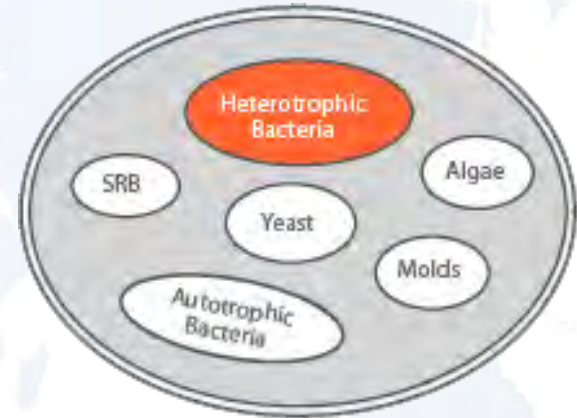


VBNC, sulfur and iron bacteria

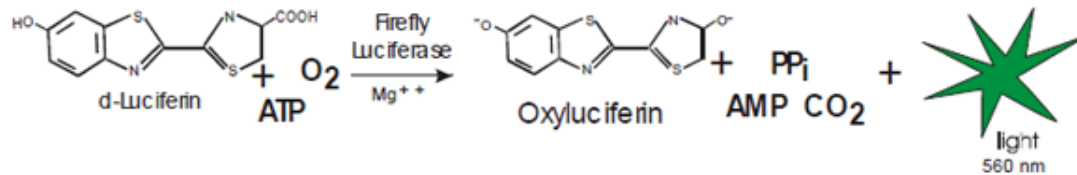


<1h  
ATP Measurement

Vs



~48h  
Heterotrophic Plate Count





## Bacteriology Department

**Dr. Dalit Vaizel-Ohayon**  
**Gilad Dan**  
**Varshevsky Svetlana**  
**Ravezin Vladimir**

