



**Aalto University**  
School of Engineering

# Physical & chemical treatment processes of water and waste

## WAT - E2120

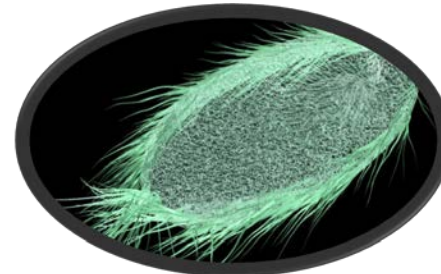
### Disinfection Methods

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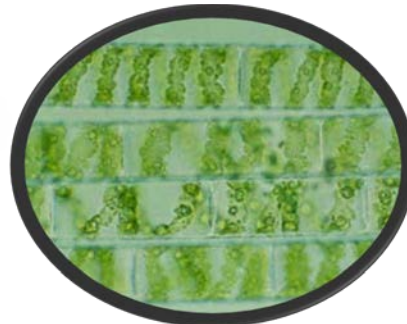
# Microorganisms found in Surface Waters and Wastewater



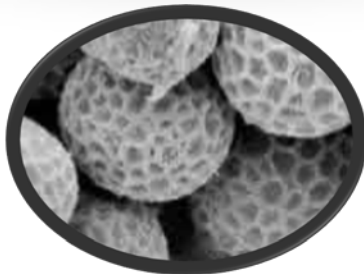
**bacteria**



**protozoa**



**algae**



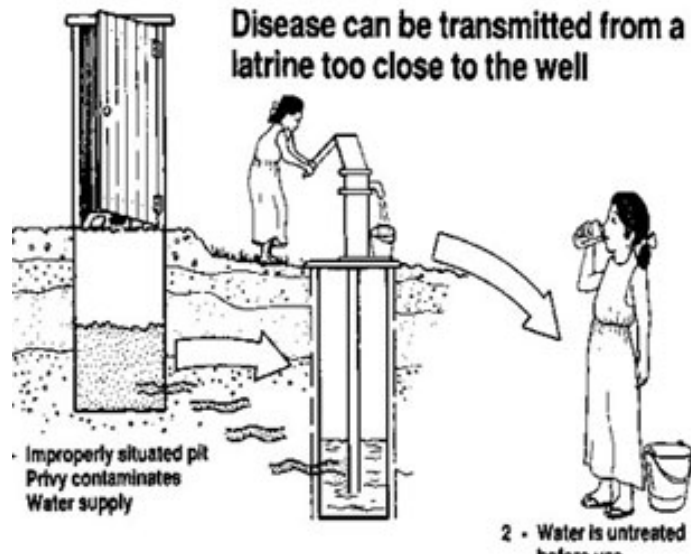
**fungi**



**viruses**



# Microorganisms found in Surface Waters and Wastewater



# Indicator organisms

## An Ideal Indicator Organism

- Must be present when **fecal contamination** is present;
- The **number of indicator organisms** should be equal or greater than those of the target pathogenic organisms;
- Indicator organism must exhibit the **same survival characteristics** in the environment as target pathogenic organism;
- Indicator organism **must not reproduce outside** of the host organism;
- The isolation and quantification of the indicator must be **faster** than that of the target pathogen;
- The indicator organism must be **member of the intestinal microflora** of warmblooded animals.



# Bacteria Indicators

coliform bacteria



**100 – 400 billion  
coliform/day**



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# Bacteria Indicators

| Indicator organism      | Characteristics  |
|-------------------------|--|
| Total coliform bacteria | The total coliform group includes four genera in the Enterobacteriaceae family. These are Escherichia, Citrobacter, Enterobacter, and Klebsiella. The Escherichia genus ( <i>E.coli</i> species) appears to be most representative of fecal contamination.   |
| Fecal coliform bacteria |  |
| <i>Klebsiella</i>       | It is included in fecal coliform group.  |
| <i>E.coli</i>           | It is one of the total coliform bacteria population and is more representative than other coliform genera.   |
| Bacteroides             | Anaerobic organism, it has been proposed as a human specific indicator.  |
| Fecal streptococci      | This group is used in conjunction with fecal coliforms. However, few strains appear to be ubiquitous under usual analytical procedures, which detract from their use as an indicator organism.   |
| Enterococci             | Two strains of fecal streptococci, <i>S.faecalis</i> and <i>S. Faecium</i> , are the most human-specific members of fecal streptococcus group. By eliminating the other strains through the analytical procedure, the two strains known as enterococci can be isolated and enumerated. The enterococci are generally found in lower numbers than other indicators, but they exhibit better survival in seawater. |



# Bacteria Indicators

| Indicator organism  | Characteristics   |
|---|---|
| <i>Clostridium perfringens</i>                                | Spore-forming anaerobic persistent bacteria. It is desirable indicator where disinfection is employed, where pollution may have occurred in the past.   |
| <i>Pseudomonas aeruginosa</i> and <i>Aeromonas hydrophila</i> | These organisms may be present in domestic wastewater in large numbers. Both can be considered aquatic organisms and can be recovered in water in absence of immediate source of fecal pollution. |

pathogenic bacteria and viruses



**Coliform bacteria**

waterborn protozoa



# Enumeration and Identification of Bacteria

## Enumeration

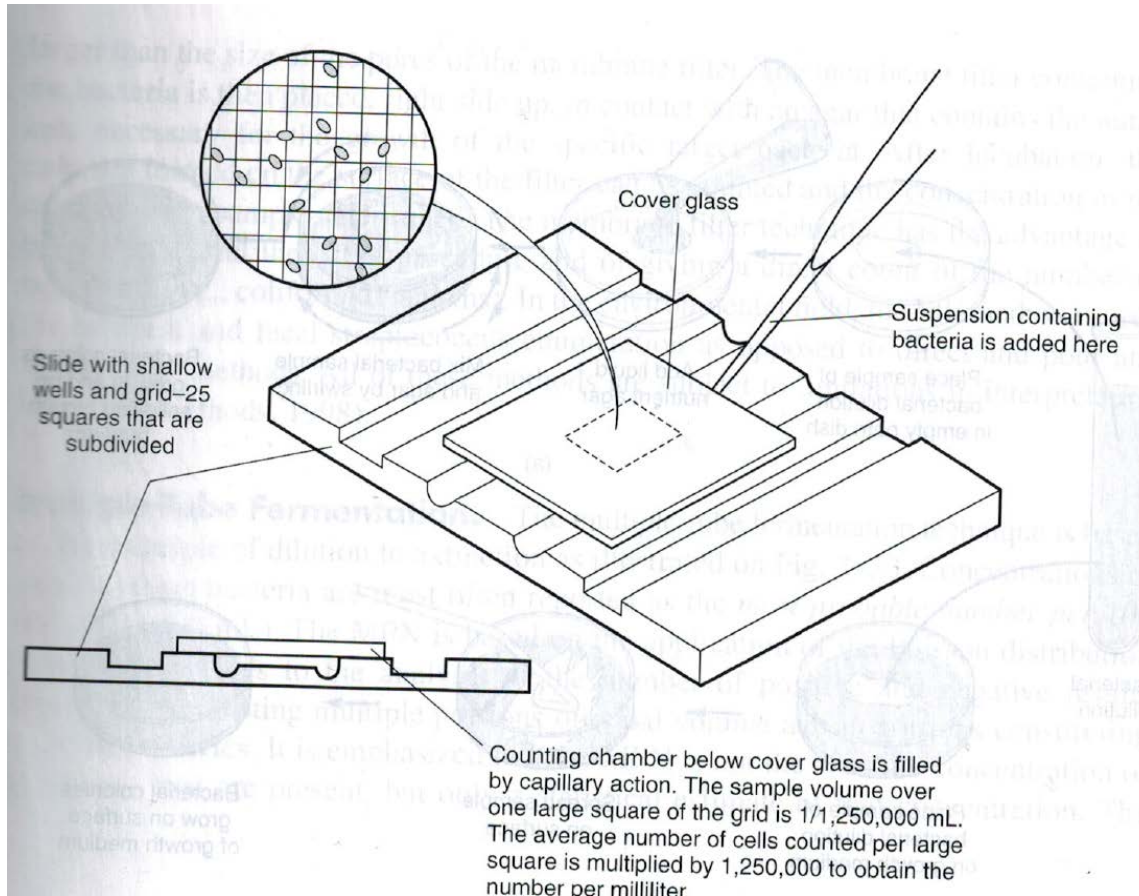
- Direct microscopic count
- Pour and spread counts
- Membrane filtration
- Multiple tube fermentation



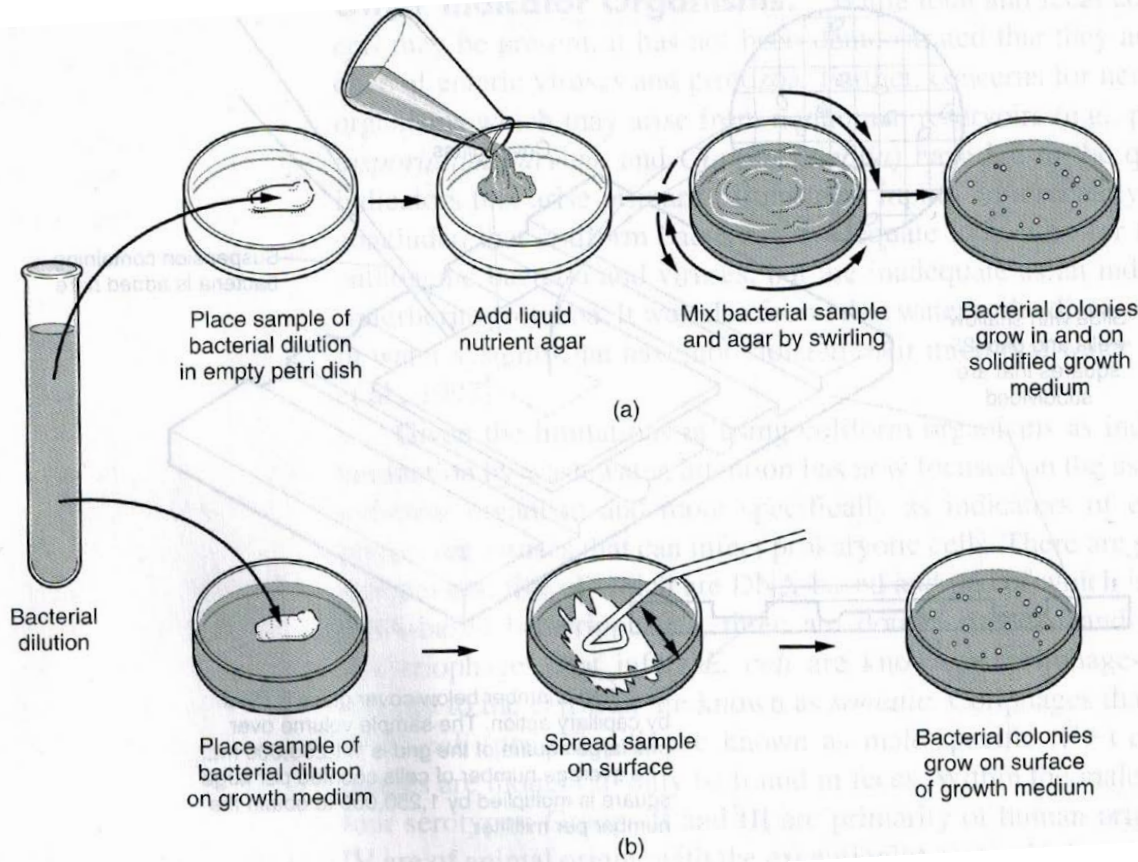


# Direct microscopic count

## Petroff-Hauser counting chamber

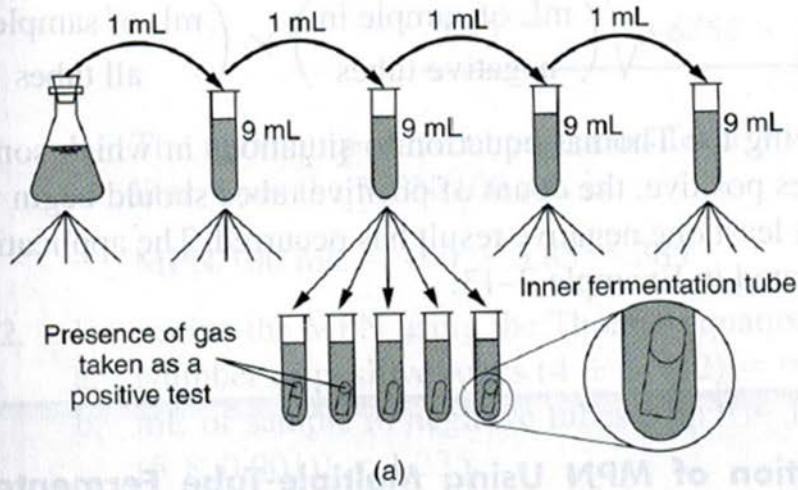


# Pour and spread counts

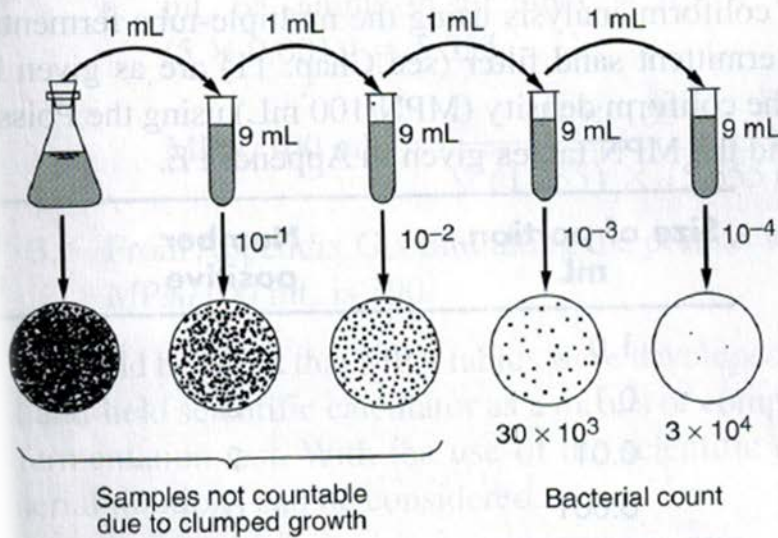


# Multiple tube fermentation

Most probable number (MPN) per 100 mL

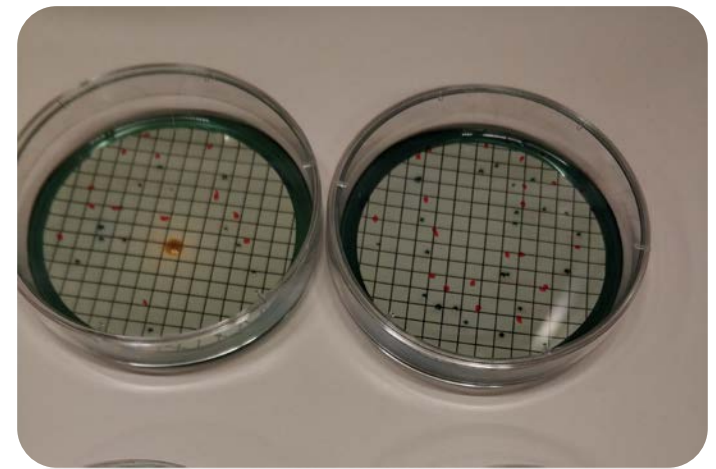
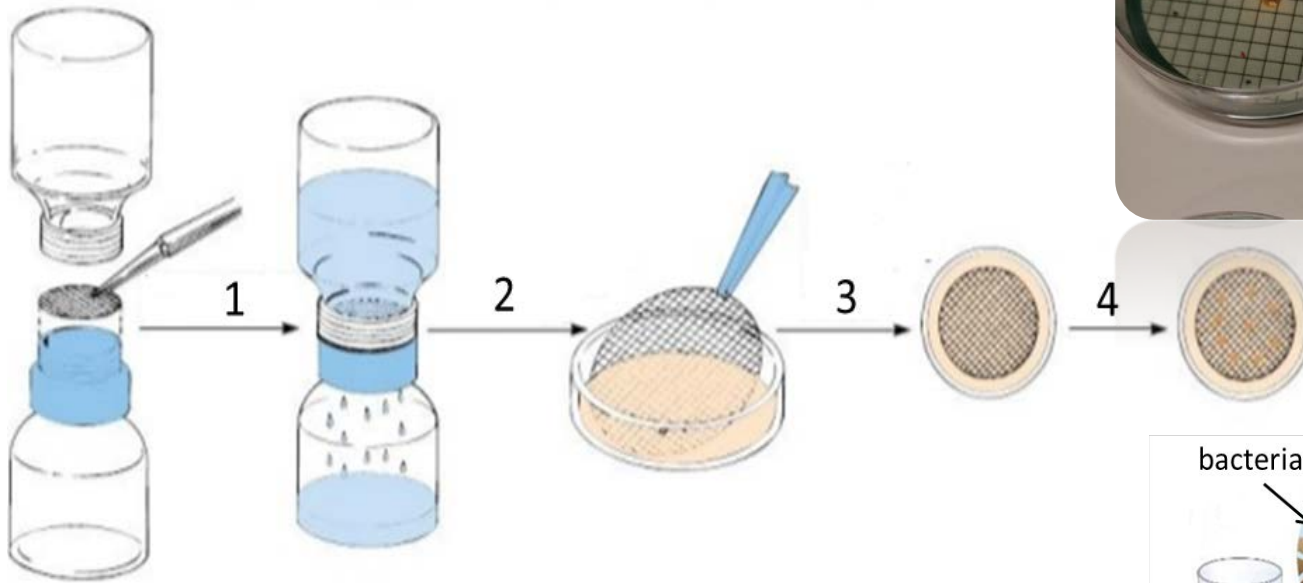


liquid medium



solid medium

# Membrane filtration



Faster than Multiple Tube Fermentation

