

## Lecture 2

### Why treat water and wastewater?

### Reasons for treating:

- Protect public health
- Protect surface-water quality
- Meet legal requirements

Preview from Notesale.co.uk  
Page 1 of 24

### Pathogenic microorganisms

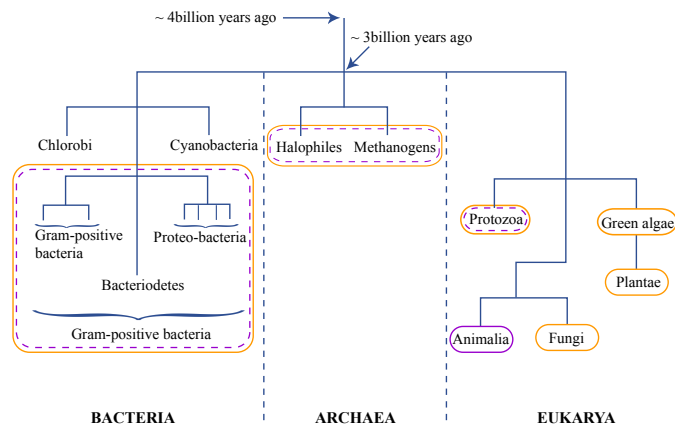


Figure by MIT OCW.

### Biological pathogens

| Pathogen                 | Size, $\mu\text{m}$        |
|--------------------------|----------------------------|
| Bacteria                 | $10^{-1} - 10$             |
| Viruses                  | $10^{-2} - 10^{-1}$        |
| Protozoa                 | $10 - 10^2$                |
| Nematode helminth worms  | $1 - 10^5$                 |
| Trematode helminth worms | $1 - 10^5$                 |
| Tapeworms                | ~40 (egg)<br>up 6 m (worm) |

Note: filter sand is 100 to  $10^3 \mu\text{m}$ , can strain particles to  $\sim 30 \mu\text{m}$

## Polioviruses

### Causes:

poliomyelitis  
aseptic meningitis

## Other viruses

Enteric viruses – gastrointestinal illness  
Adenoviruses – respiratory and eye infections  
Noroviruses – Norwalk viruses – gastrointestinal illness (“cruise ship disease”)  
Hepatitis A virus – infectious hepatitis

Preview from Notesale.co.uk  
Page 7 of 24

**Caption** Polio virus; RNA virus, *Picornaviridae* Family.

**File Name:** 24314A

**Category:** Viruses

**Type of Image:** TEM

**Magnification:** x46,050-- (Based on a 35mm slide image of 24mm in the narrow dimension)

**Keywords** 24314A.TIF human human disease infection Family Picornaviridae polio RNA virus viral pathogen virion virus viruses

### Inorganic chemicals

| Chemical | Adverse effect                            |
|----------|-------------------------------------------|
| Cyanide  | Nervous system impairment                 |
| Fluoride | Dental fluorosis (staining), bone disease |
| Lead     | Impaired mental development               |
| Mercury  | Kidney damage, birth defects              |
| Nitrate  | Methemoglobinemia (blue-baby syndrome)    |
| Selenium | Hair loss, circulatory problems           |
| Sodium   | High blood pressure                       |
| Thallium | Blood, kidney, liver, intestinal effects  |

### Radionuclides

Radioactive decay releases ionizing radiation which can cause cancer:

Alpha particles – two protons and two neutrons

Beta particles – electrons

Radium-226, Radium-228 – can cause cancer

Uranium – kidney damage, can cause cancer

Alpha radiation, radium and uranium all occur naturally

### Physical and aesthetic characteristics

| Property    | Adverse effect                              |
|-------------|---------------------------------------------|
| Turbidity   | Harbors bacteria, interferes with treatment |
| Color, odor | Aesthetic                                   |
| Silver      | Cause argyria (turns skin blue)             |
| Sulfate     | Laxative effect                             |
| Chloride    | Salty taste                                 |
| TDS         | Salty taste, scaling of pipes               |
| Hardness    | Cause deposits on bathroom fixtures         |

### Physical and aesthetic characteristics

| Property   | Adverse effect                 |
|------------|--------------------------------|
| Iron       | Stains laundry and fixtures    |
| Manganese  | Stains laundry and fixtures    |
| Copper     | Stains laundry and fixtures    |
| Detergents | Causes water to foam           |
| pH         | Pipe corrosion, impaired taste |
| Phenols    | Taste and odor                 |

## Clean Water Act

### 1977 – Clean Water Act

Included controls on toxic pollutants

### 1987 – Water Quality Act

Added permit requirements for stormwater

Preview from Notesale.co.uk  
Page 24 of 24

## Comparison of standards

| Water-quality constituent | Units         | U.S. EPA                   | European Union  | World Health Organization   |
|---------------------------|---------------|----------------------------|-----------------|-----------------------------|
| <i>E. coli</i>            | number/100 ml | Detected in <5% of samples | 0               | 0                           |
| Aluminum                  | µg/l          | 10                         | 10              | 10                          |
| Copper                    | mg/l          | 1.3                        | 2               | 2                           |
| Lead                      | µg/l          | 15                         | 10              | 10                          |
| Nitrate                   | mg/l as N     | 10.0                       | 11.3            | 11.3                        |
| TTHM                      | µg/l          | 100                        | 100             | 200/100/100/60 <sup>a</sup> |
| Chloride                  | mg/l          | 250                        | 250             | 250                         |
| Iron                      | µg/l          | 300                        | 200             | No guideline                |
| Benzene                   | µg/l          | 5                          | 1               | 10                          |
| Carbon tetrachloride      | µg/l          | 5                          | 4               | 4                           |
| Tetrachloroethylene       | µg/l          | 5                          | 10 <sup>b</sup> | 40                          |
| Trichloroethylene         | µg/l          | 5                          |                 | 70                          |

a Chloroform/bromoform/dibromodichloromethane/bromodichlorodimethane

b Sum of trichloroethylene and tetrachloroethylene