



IDEXX

A short history of water microbiology

Agenda



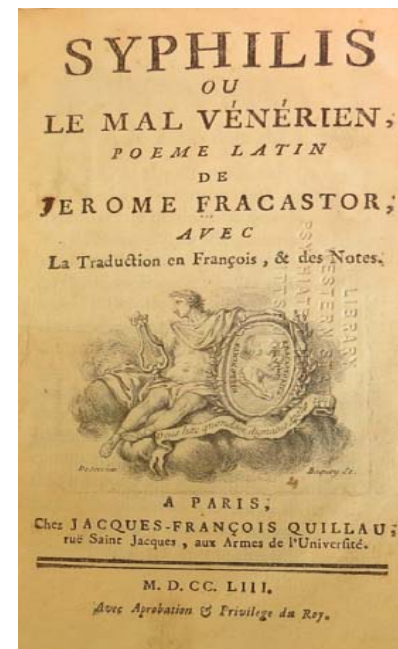
- How water microbiology began
- The establishment of the Environmental Protection Agency (EPA)
 - Clean Water Act (CWA)
 - Safe Drinking Water Act (SDWA)
 - Unregulated Contaminant Monitoring Rule (UCMR)
- Evolution of detection methods for microbes in water



In the beginning.....

Girolamo Fracastoro (1476 – 1553), Italy

- In 1546, Fracastoro proposed that epidemic diseases were caused by transferable ‘seed-like’ entities, transmitting infection by direct or indirect contact
- Fracastoro coined the first germ theory and the term ‘fomites’
- The name for syphilis is from Fracastoro's 1530 epic poem, *Syphilis sive morbus gallicus*



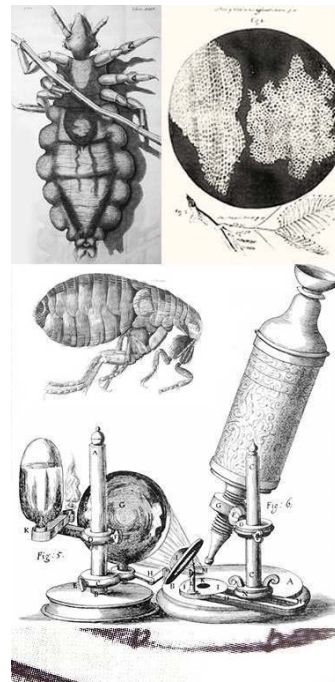
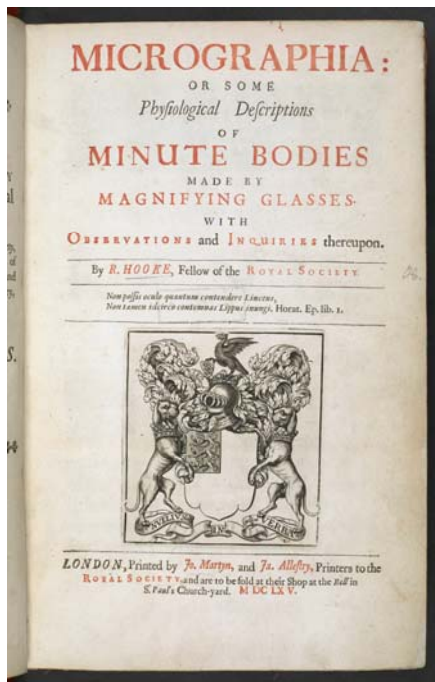
Antonie van Leeuwenhoek (1632–1723), Dutch

- Leeuwenhoek, a draper and *lens grinder*, is considered a father of microbiology
- In 1676, using his microscope, he established there were forms of life that were not visible to the naked eye
- He observed and described microscopic protozoa and bacteria, below is his drawing of yeast 'globules'



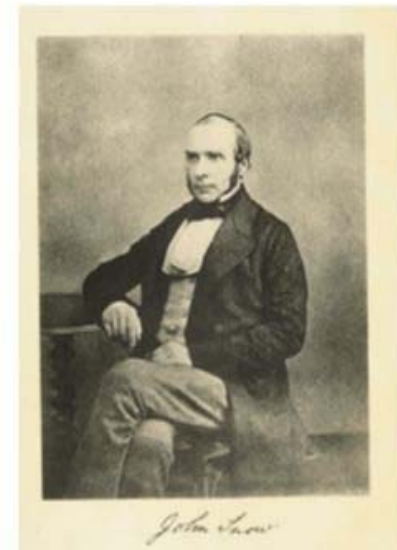
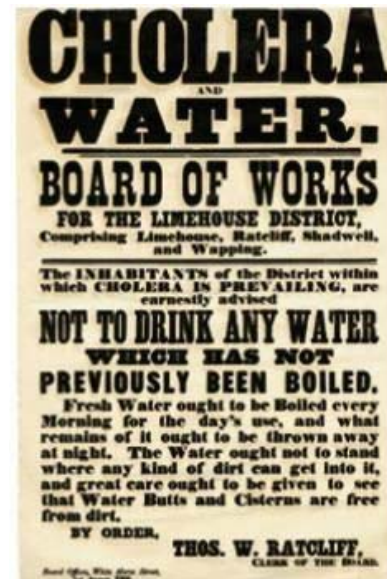
Robert Hooke (1635 – 1703), England

- Multi-talented, he was considered England's “Leonardo”
- Robert Hooke's 1665 book *Micrographia*, contained descriptions of the microfungus, *Mucor*, and other micro-organisms



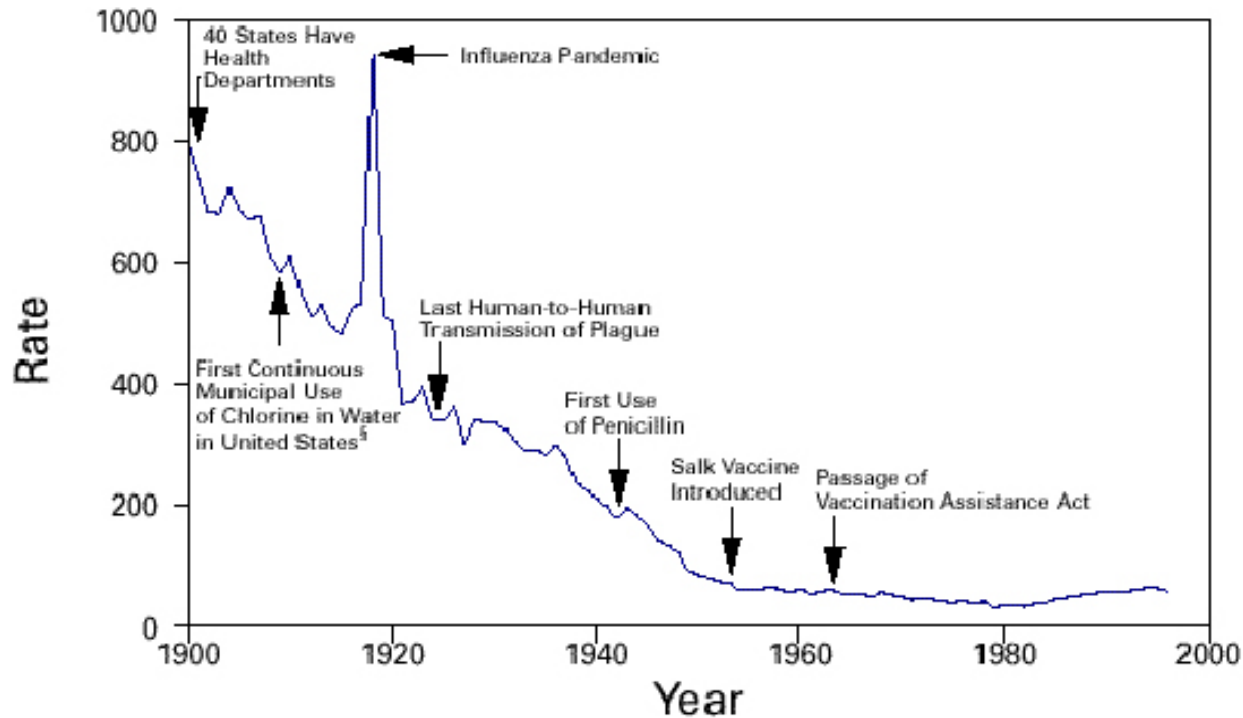
John Snow (1813 – 1858), England

- Snow is considered a founder of modern epidemiology, in part because of his work in tracing the source of a cholera outbreak in Soho, London, in 1854
- Snow's findings inspired fundamental changes in the water and waste systems of London, which led to similar changes in other cities, and a significant improvement in general public health around the world
- A water source on the street, which was only 3' from a cesspit had leaked fecal matter and caused the outbreak



Water disinfection becomes routine, prevents disease

- In 1908, Jersey City, New Jersey was the first city in the United States to begin routine disinfection of community drinking water
- Over the next decades, thousands of cities and towns across the United States followed suit, dramatically decreasing disease





Establishment of the EPA

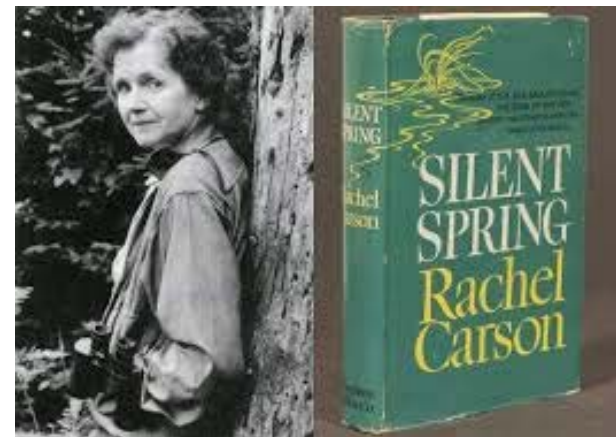
December 2, 1970 the EPA is born

- Following President Richard Nixon's 'Reorganization Plan No. 3' issued in July 1970, EPA was officially established on December 2nd, 1970
- EPA's mission is to **protect human health** by safeguarding the **air** we breathe, **water** we drink and **land** on which we live
- **US EPA has 4 functional roles:**
 1. Federal research
 2. Monitoring
 3. Standard-setting (e.g. Water Quality Standards)
 4. Rule writing and enforcement



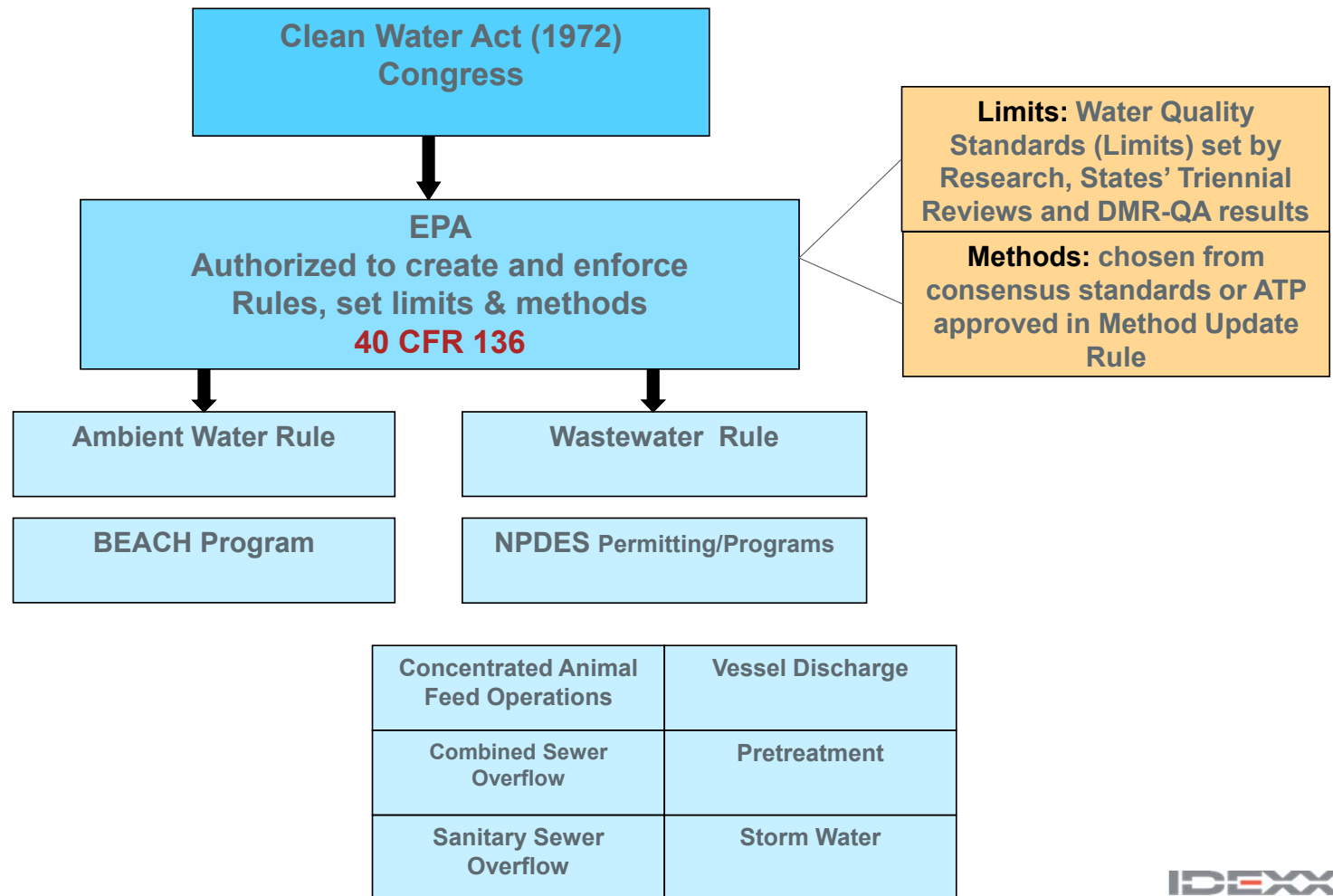
The first EPA Administrator, William Ruckelshaus

- Ruckelshaus served as the first head of the Environmental Protection Agency under President Richard Nixon from December 3, 1970 — April 29, 1973
- During his early years he oversaw a seven-month hearing on DDT, a carcinogenic pesticide, after which he instituted a ban of DDT.
 - DDT was the pesticide featured in **Rachel Carson's** 1962 book '*Silent Spring*' as a threat to wildlife, and perhaps to humans.



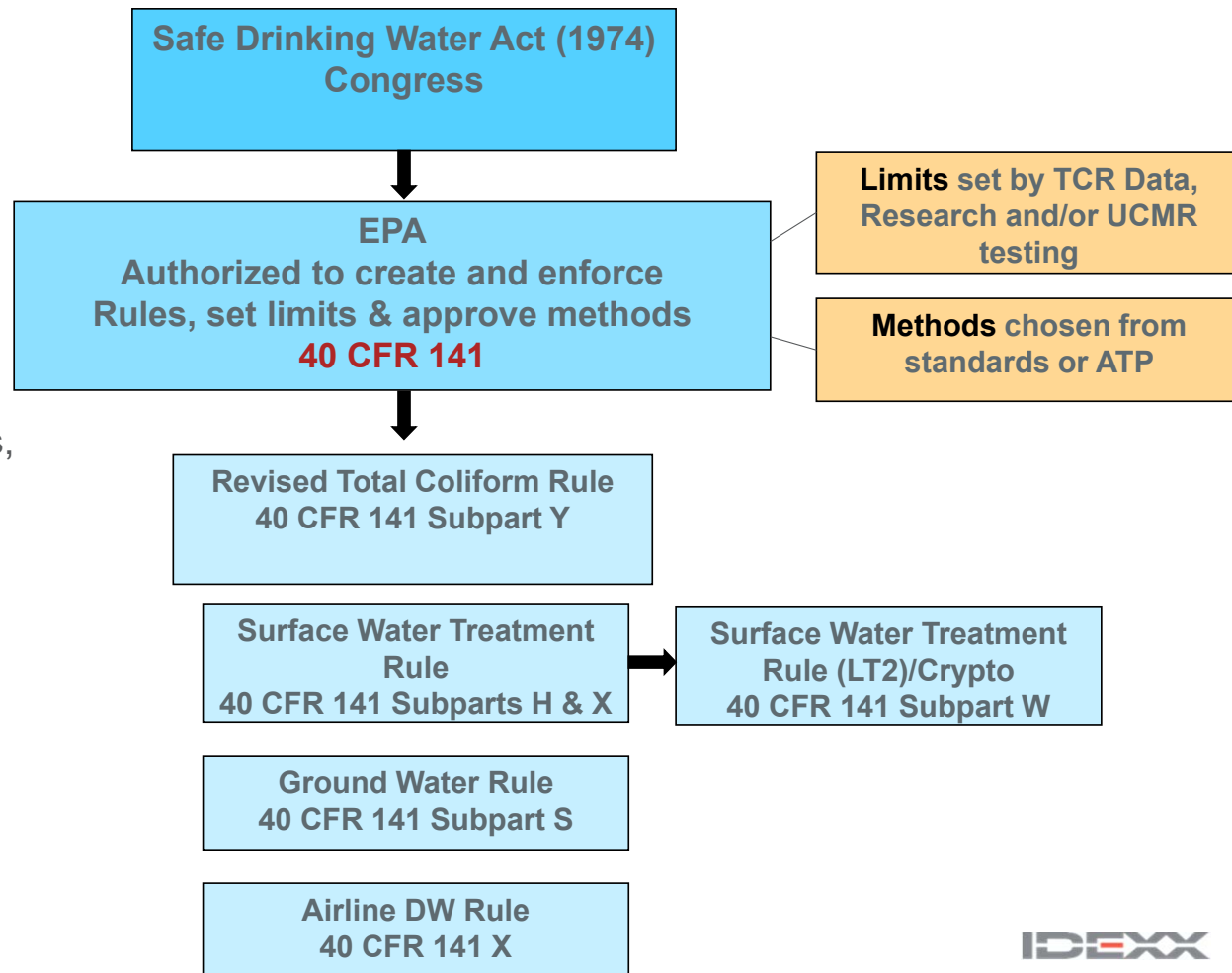
The Clean Water Act (CWA) 1972

- The basis of the CWA was enacted in 1948 and was called the *Federal Water Pollution Control Act*
- The Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name
- Regulations are at 40 CFR 136

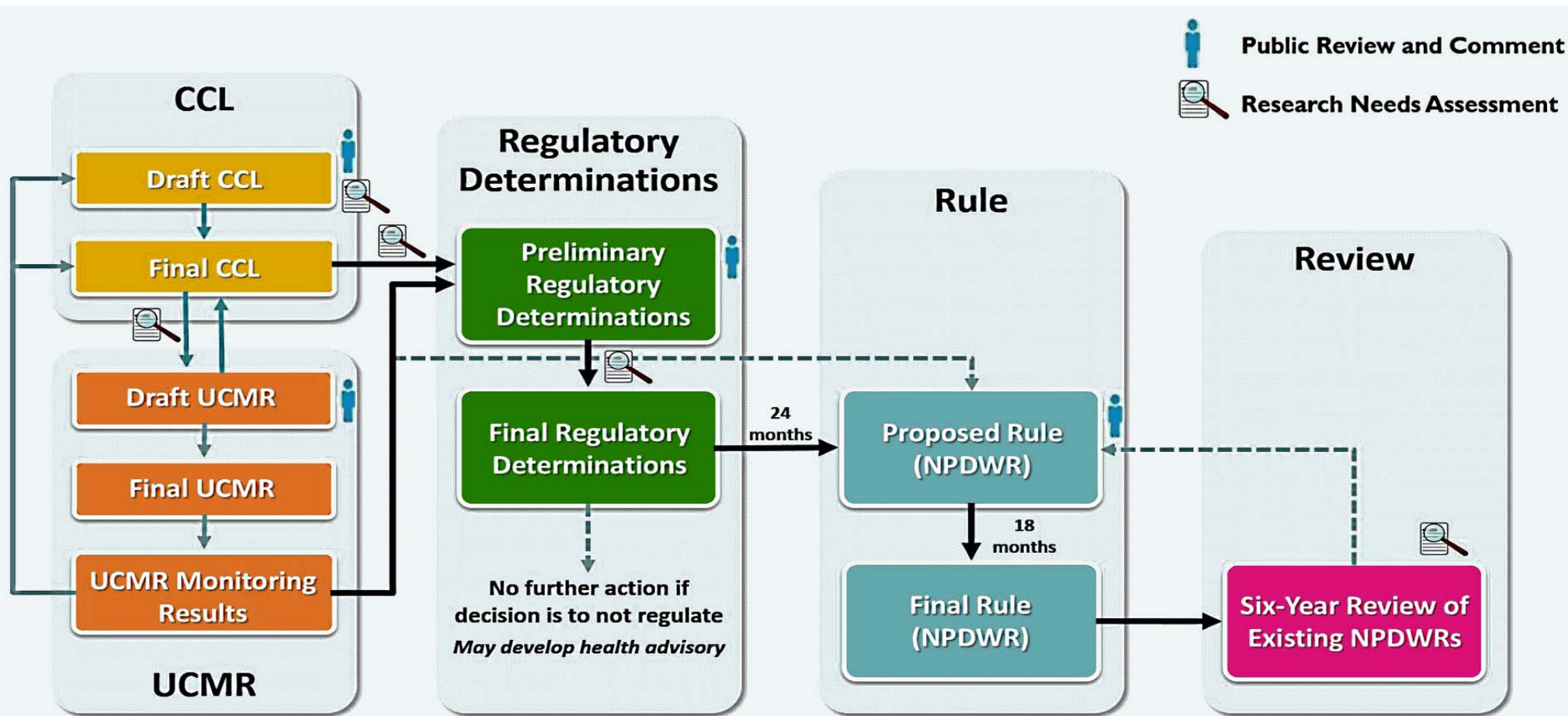


The Safe Drinking Water Act (SDWA) 1974

- Required EPA to establish *National Primary Drinking Water Regulations* (NPDWRs)
- EPA has:
 - mandatory requirements (Maximum Contaminant Levels or Treatment Techniques)
 - Non-enforceable health goals (Maximum Contaminant Level Goals, or MCLGs) for each included contaminant
- To date, EPA regulates 88 microorganisms, chemicals and radionuclides at 40 CFR 141



Unregulated Contaminant Monitoring Rule (UCMR)



EPA Celebrates Progress in Protecting America's Drinking Water



40%

Number of drinking water systems pre-1970 that failed to meet even the most basic standards

92%

Number of community water systems today that meet all health-based standards

EPA has developed standards for more than 90 contaminants



including microorganisms, disinfectants, disinfection byproducts, inorganic and organic chemicals, and radionuclides



Financing and funding support

DWSRF: \$41 billion for over **15,000** drinking water projects

Public Water System Supervision Grants: \$2.3 billion

Technical Assistance Grants: \$162 million

WIIN grants: \$126 million



Progress for a Stronger Future

#EPAat50



Evolution of microbial detection methods

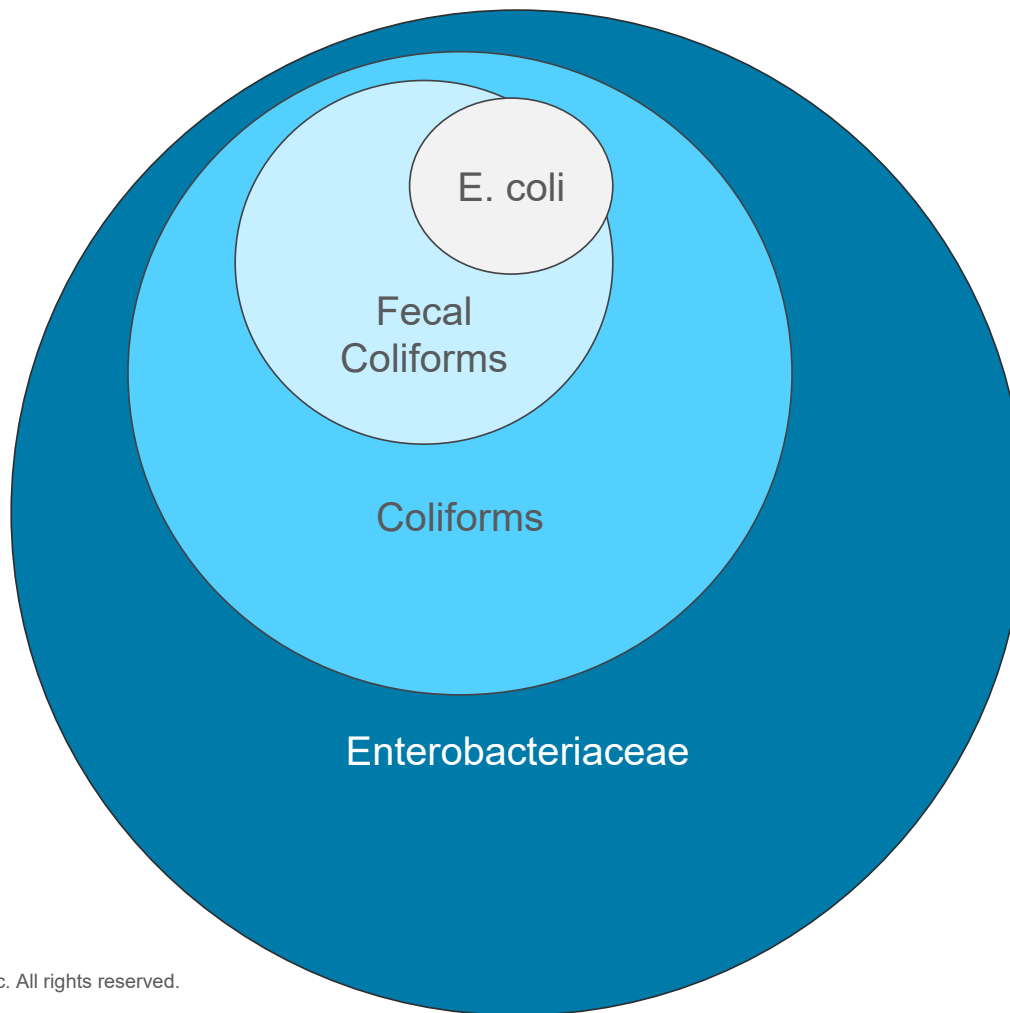
History of Petri plates

- 1881 Robert Koch was able to grow or “culture” bacteria plates on nutrient gelatin, a kind of solidified broth, which were kept under heavy bell jars
- 1882, Fannie Hesse, suggested replacing the gelatin with agar, which was used to make fruit jellies and found in red seaweed
- 1887, German microbiologist Julius Richard Petri covered agar plates with lids and this is still what’s used today, from over 100 years ago!



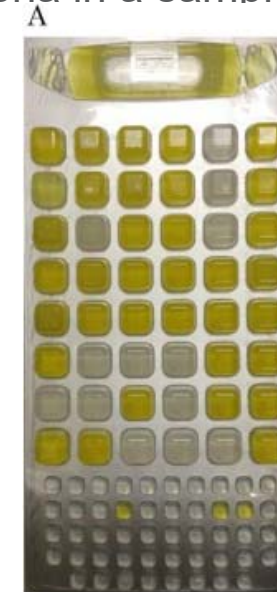
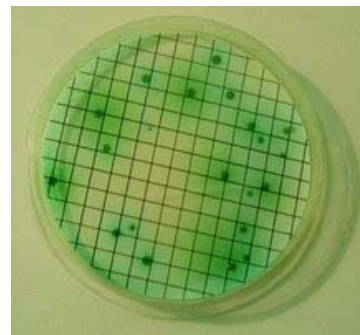
1905, MacConkey’s agar first used; distinguishes Gram-negative bacteria that can ferment the sugar lactose (Lac+) from those that cannot (Lac-). Additional components have been added since 1905, but same basic principle applies today.

Water is (usually) tested for indicator organisms



Solid or Liquid Medium – Laboratories & Agencies use both

- Both solid and liquid media have been used in laboratories since the beginning of testing
- Solid media report in CFU – Colony Forming Units
- Liquid media report in MPN – Most Probable Number
- BOTH CFU and MPN units are estimates of original number of bacteria in a sample



New frontiers in water testing



“New” bacterial pathogens:
Legionella pneumophila,
Pseudomonas aeruginosa
Non-tubucular Mycobacterium



“New” water matrices:
Premise Plumbing



New testing procedures:
RT-PCR testing of
wastewater for SARS CoV-2
virus

Summary

- We covered just the highlights on the history of microbiological testing – but there's so much more!
- Many of the liquid and solid media methods have not changed much since the 1880 early 1900
- We still look for indicator bacteria in drinking water, wastewater is getting more specific (*E. coli*, enterococci, viruses)
- New test methods leverage the expression of specific genes -> enzymes that can be manipulated to give even more specific and reliable results
- Different bacteria, matrices and places where water can be a risk to public health are fast emerging

