The Prehistory of the Activated Sludge Process

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Outline

- Disease theories
- Early process development
- Land treatment
- The fight against “artificial” processes

Demonic theory of disease

- Punishment for sins

Humoral theory

- Yellow bile
- Black bile
- Phlegm
- Blood

Miasmas

- Odors or vapors from decomposition
- Malaria = Mala + Aria
- Claims of reduction in tuberculosis and pneumonia when sewers were installed:

  - “The beneficial effects of sewerage are plainly seen in the statistics of towns where an efficient [sewerage] system has been carried out. By sewering certain towns in England, the death rate from pulmonary diseases alone was reduced 50 per cent.” (from McGuire)

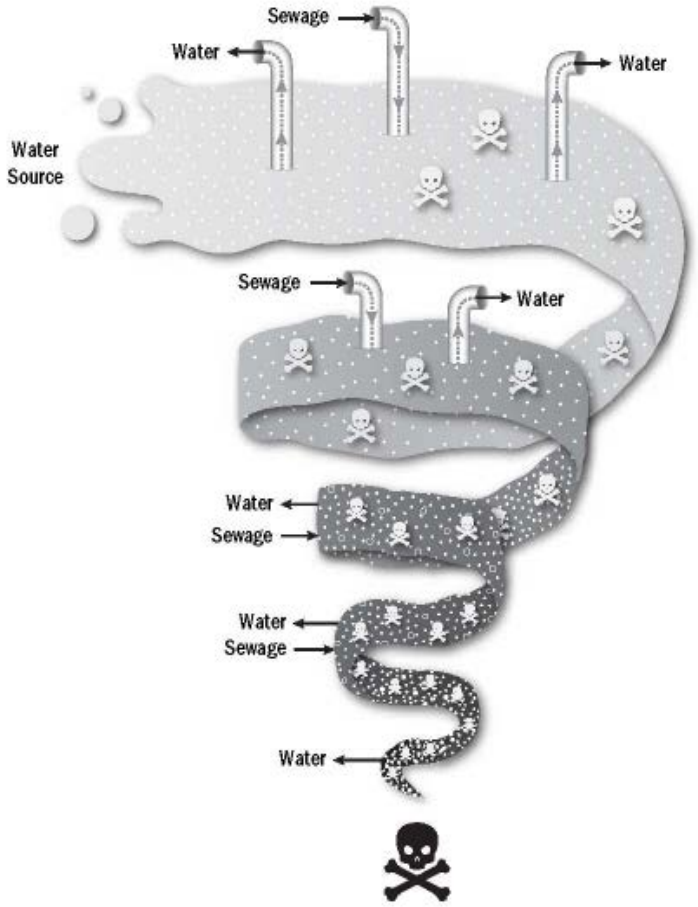
Filth theory

- Bubonic plague
- Yellow fever

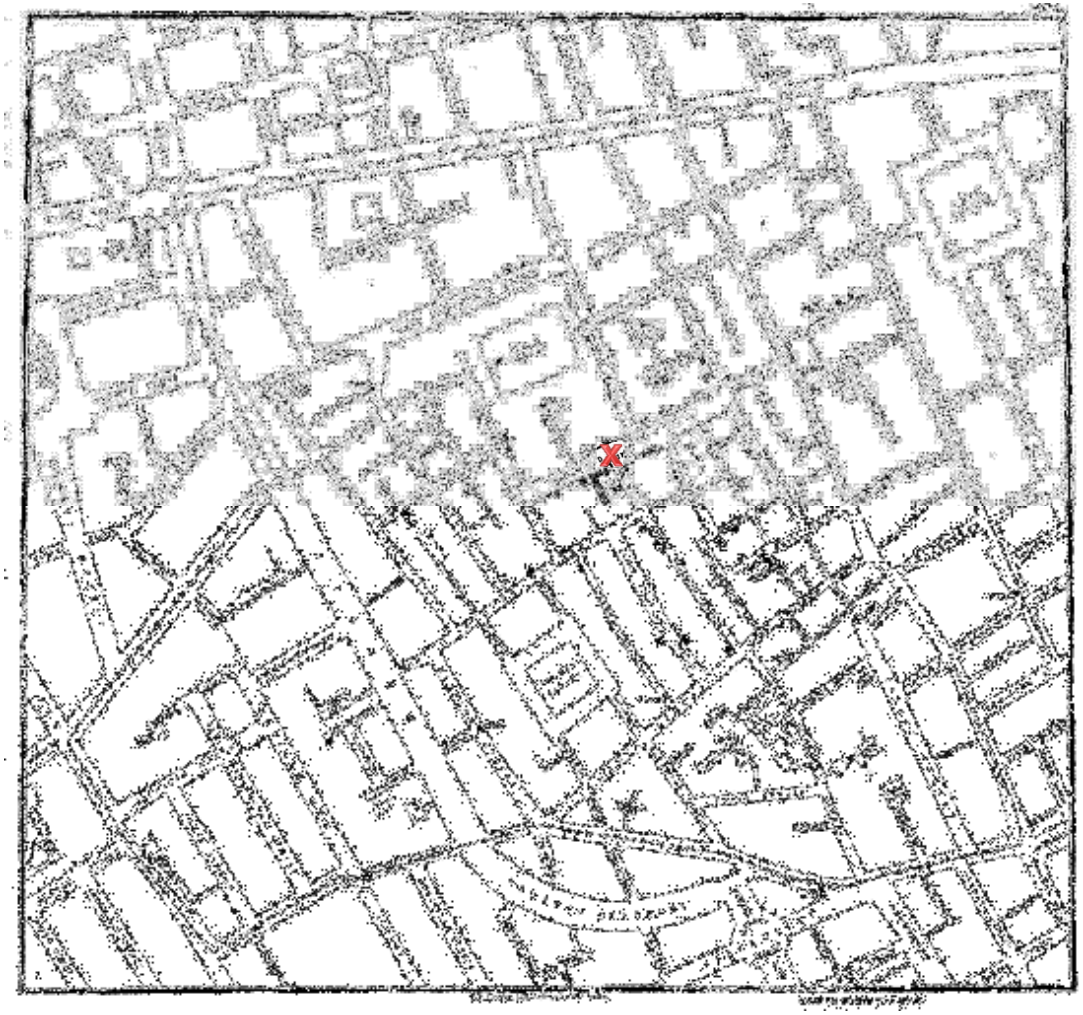
Water pipe / sewer pipe death spiral (McGuire)

- Development of plumbing and drainage systems led to water conveyance for human waste

- Invention of the toilet:
- John Harrington (1596)
- George Jennings (1852)
- Albert Giblin (1898)
- Popularized by Thomas Crapper (1880s)



John Snow and the Soho epidemic of 1854



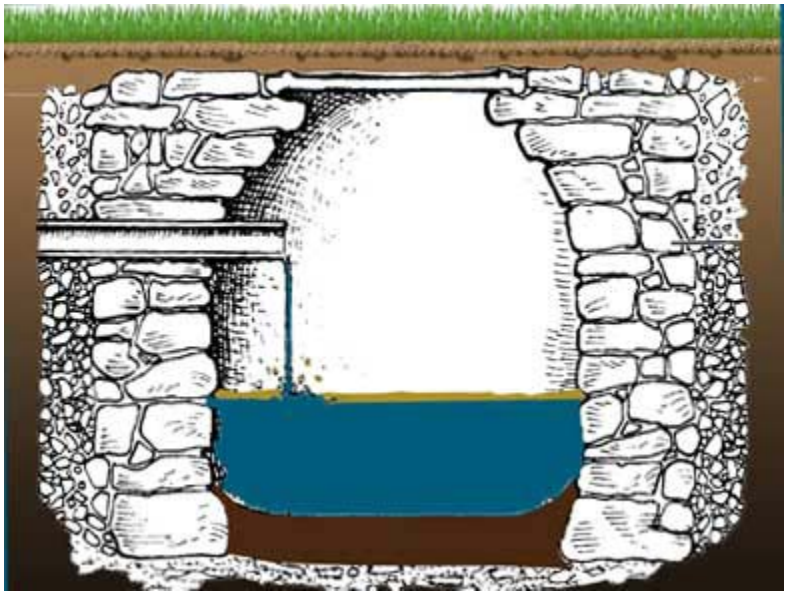
Germ theory – Pasteur (1859) and Koch's postulates (1884)

- The bacteria must be present in every case of the disease.
- The bacteria must be isolated from the host with the disease and grown in pure culture.
- The specific disease must be reproduced when a pure culture of the bacteria is inoculated into a healthy susceptible host.
- The bacteria must be recoverable from the experimentally infected host

Development of Biological Treatment of Wastewater

- 1865 – Land application
- 1870s – Intermittent filtration
- 1896 – Cameron's Septic Tank
- 1892 – Scott-Moncrieff – Cultivating Filter
- 1893 – J. Corbett – Trickling Filter

Cesspool



http://www.septicairaid.com/cesspoolproblems.html

Land application / sewage irrigation

- Plant growth not needed
  - Concluded to be a chemical process
  - Abandoned when alternate sources of fertilizer became available

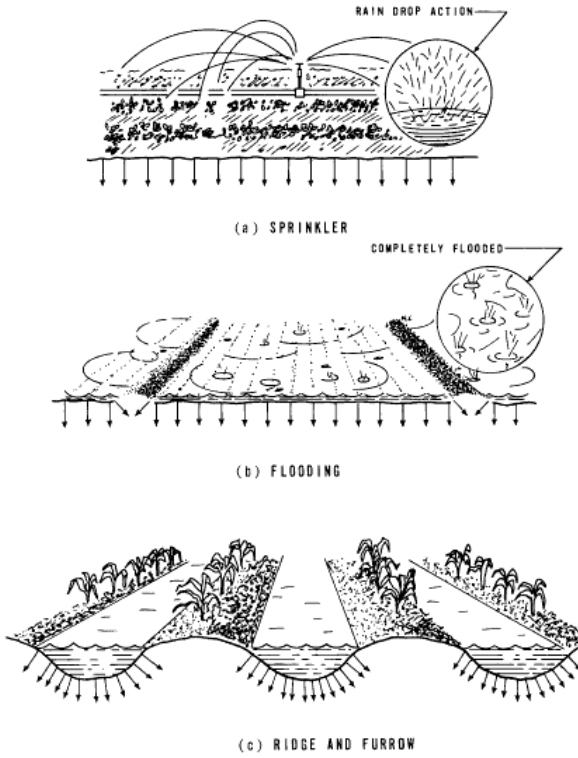


FIGURE 2. BASIC METHODS OF APPLICATION

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Sand filters

- Not successful

Intermittent Filtration

- 1884 – London's municipal sewage authority demonstrated biological nature of purification

- 1890 – William Sedgwick (MIT) and Hiram Mills (Lawrence Experiment Station) showed sand filters also were biological, and required periods of rest for aeration

- Led to trickling filter

The Trickling Filter

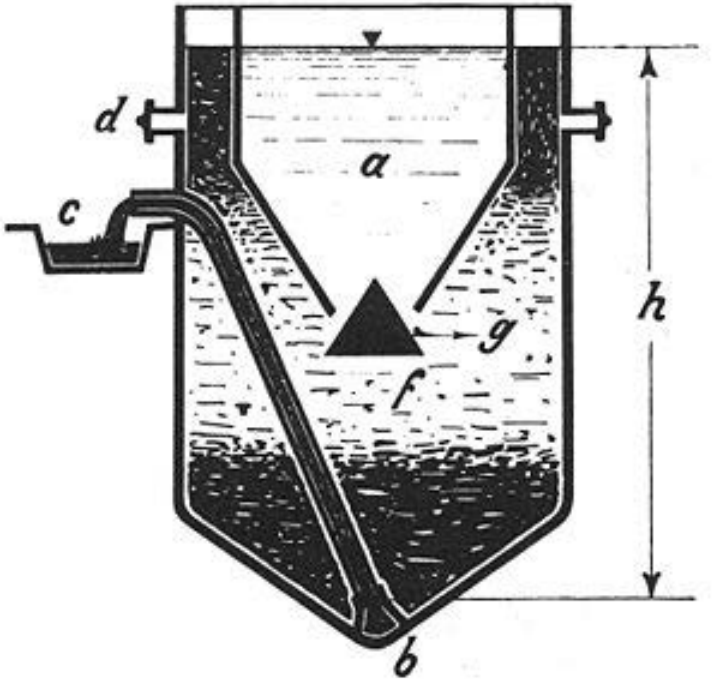
- Sir Edward Franklin – Croydon, England sewage farm
- Lawrence Experiment Station – 1890
- First large plants:
  - Manchester, England – 1893
  - Madison, Wisconsin - 1901

http://www.wastewatersystem.net/2009/05/trickling-filter-in-wastewater-plant.html

Primary sedimentation

- About 35% removal of BOD_5

The Imhoff Tank (1906)



Integrates sedimentation and anaerobic digestion

Wikipedia

Land application - Biology

- Chloroform-sterilized soil does not nitrify
- Established microbial basis of treatment
- “Natural” process
- Darwinian metaphor – adaptation of microbial population to conditions is like natural selection

Land application - Loading

- 1 acre land per 500 to 1000 p.e.
- 1.5 to 3 gal/d/sf
  - Compare to slow sand filter: 72-168 gal/d/sf
- London requires 40,000 acres
- Berlin requires 23,000 acres – more than the area of the city

Land application – Nature's Way

- "The 'law of nature' has made no provision whatever for the disposal of the sewage, otherwise than that of restoring it to the soil… It is idle in the extreme to attempt otherwise to deal with this great question."
- Thus, all other technologies are "artificial"
- Further, artificial = bad

The Activated Sludge Process

- Gilbert Fowler (Univ. of Manchester) visited Lawrence Experiment Station 1912 and observed experiments with aeration of sewage in bottles
- Edward Ardern and William Lockett conducted fill-and-draw experiments and produced complete nitrification after one month
- Published results in seminal 1914 paper
- First implemented in Worcester, England in 1916

Per capita area requirements for wastewater treatment

Land application	500	1,000	acres/kpe
Aerobic stabilization pond	0.26	0.78	acres/kpe
	11,351	34,054	sq ft/kpe
Trickling filter	555	1,733	sq ft/kpe
Conventional activated sludge	354	708	sq ft/kpe
Pure oxygen activated sludge	142	177	sq ft/kpe

Pure oxygen takes 200,000 times less space than land application

Thanks!

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