The History of Microbiology

http://nurhidayat.lecture.ub.ac.id

Please visit the Prescott website at www.mhhe.com/prescott7 for additional references.

Early Discoveries

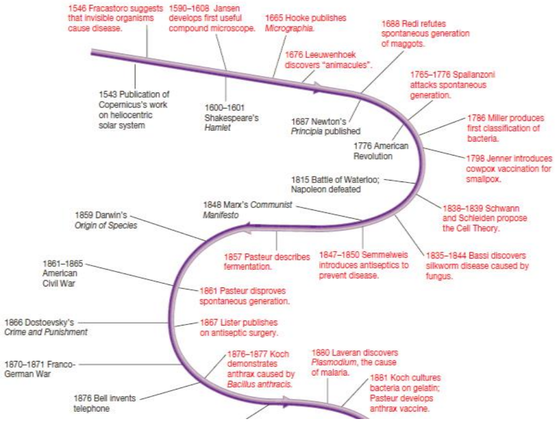
- Lucretius, a Roman philosopher (98-55 B.C.), and Girolamo Fracastoro, a physician (1478-1553) believed invisible creatures were responsible for disease
- Franscesco Stelluti observed bees and weevils using a microscope in the early 1600s
- Anton van Leeuwenhoek (1632 – 1723) was the first to report microorganisms (Royal Society) (Animalcules)
  - 50-300X magnification

- Spontaneous Generation
  - The belief that life could originate from non-living or decomposing matter

- Supported by:
  - Aristotle (384-322 BC) – Believed that imple invertebrates coould arise by spontaneous generation
  - John Needham (1713-1781) – Boiled mutton broth, then sealed and still observed growth after a period of time
  - Lazarro Spallanzani (1729-1799) No growth in sealed flask after boiling – proposed that air was needed for growth of organisms
  - Felix Pouchet (1859) – Proved growth without contamination from air

- Disproved by:
  - Francesco Redi (1626-1697) – maggot unable to grown on meat if meat was covered with gauze
  - Schwann, Friedrich Schroder and von Dusch (1830s) – Air allowed to enter flask but only after passing through a heated tube or sterile wool
  - John Tyndall (1820-1893) – Omission of dust → no growth. Demonstrated heat resistant forms of bacteria (endospores)

The Development of Microbiology



- Louis Pasteur (1822 – 1895)
  - trapped airborne organisms in cotton;
  - he also heated the necks of flasks, drawing them out into long curves, sterilized the media, and left the flasks open to the air;
  - no growth was observed because dust particles carrying organisms did not reach the medium, instead they were trapped in the neck of the flask; if the necks were broken, dust would settle and the organisms would grow; in this way Pasteur disproved the theory of spontaneous generation

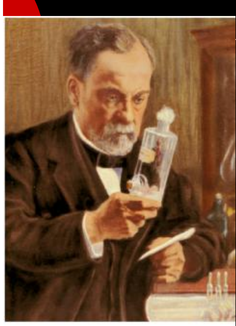


Figure 1.4 Louis Pasteur. Pasteur (1822–1895) working in his laboratory.

Figure 1.5 The Spontaneous Generation Experiment. Pasteur's swan neck flasks used in his experiments on the spontaneous generation of microorganisms. *Source: Annales Sciences Naturelle, 4th Series, Vol. 16, pp. 1–98, Pasteur, L., 1861, "Mémoire sur les Corpuscules Organisés Qui Existent Dans L'Atmosphère: Examen de la Doctrine des Générations Spontanées."*

Demonstrations that micoorganisms cause disease

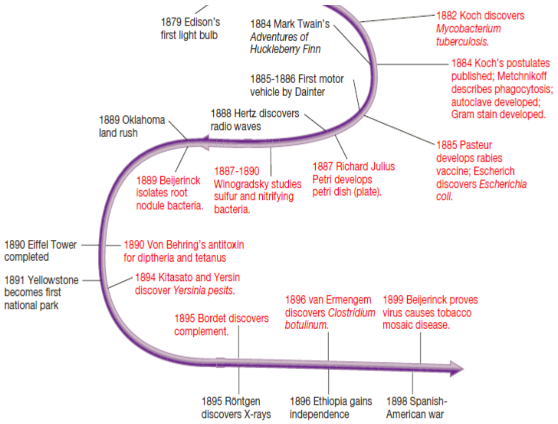
- Agostino Bassi (1773 – 1856)
  - showed that a silkworm disease was caused by a fungus (1835 – 1844)
- M. J. Berkeley (ca. 1845)
  - demonstrated that the Great Potato Blight of Ireland was caused by a Fungus
- Louis Pasteur
  - showed that the pébrine disease of silkworms was caused by a protozoan parasite

---

- Joseph Lister (1827 – 1912)
  - developed a system of surgery designed to prevent microorganisms from entering wounds – phenol sprayed in air around surgical incision
  - Decreased number of post-operative infections in patients
  - his published findings (1867) transformed the practice of surgery

---

- Louis Pasteur
  - demonstrated that alcoholic fermentations were the result of microbial activity,
  - that some organisms could decrease alcohol yield and sour the product, and
  - that some fermentations were aerobic and some anaerobic;
  - he also developed the process of pasteurization to preserve wine during storage



- Charles Chamberland (1851 – 1908)
  - identified viruses as disease-causing agents – Tobacco Mosaic Virus
- Edward Jenner (ca. 1798)
  - used a vaccination procedure to protect individuals from smallpox
- Louis Pasteur
  - developed other vaccines including those for chicken cholera, anthrax, and rabies

- Robert Koch (1843 – 1910),
  - using criteria developed by his teacher, Jacob Henle (1809-1895), established the relationship between *Bacillus anthracis* and anthrax;
  - his criteria became known as Koch's Postulates and are still used to establish the link between a particular microorganism and a particular disease:

Figure 1.6 Robert Koch. Koch (1843–1910) examining a specimen in his laboratory.

Table 1.1 Koch's Application of His Postulates to Demonstrate that *Mycobacterium tuberculosis* is the Causative Agent of Tuberculosis.

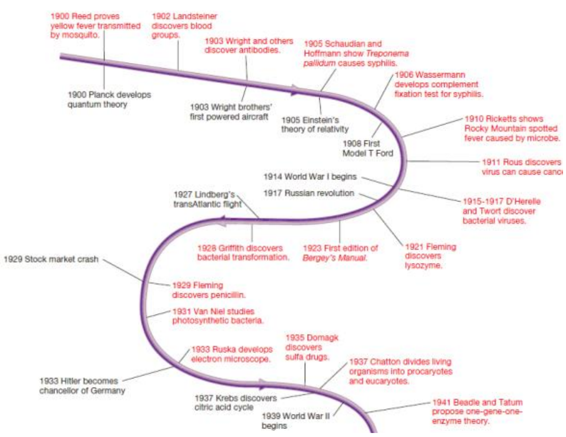
Postulate	Experimentation
1. The microorganism must be present in every case of the disease but absent from healthy organisms.	Koch developed a staining technique to examine human tissue. *M. tuberculosis* cells could be identified in diseased tissue.
2. The suspected microorganisms must be isolated and grown in a pure culture.	Koch grew *M. tuberculosis* in pure culture on coagulated blood serum.
3. The same disease must result when the isolated microorganism is inoculated into a healthy host.	Koch injected cells from the pure culture of *M.tuberculosis* into guinea pigs. The guinea pigs subsequently died of tuberculosis.
4. The same microorganism must be isolated again from the diseased host.	Koch isolated *M. tuberculosis* from the dead guinea pigs and was able to again culture the microbe in pure culture on coagulated blood serum.

Development of Culture Media

- **Why?**
  - **To enable the isolation of pure cultures (only one type of organism)**
- **Especially important during Koch's period**
- **Gelatin not useful as solidifying aen (melts at >28 degrees Celsius and some bacteria hydrolyze it with enzymes)**
- **Fannie Hesse, the wife of one of Koch's assistants, proposed using agar**
  - **Not digested by most bacteria**
  - **Melts at 100 degrees Celcius**
  - **Used today - ~2% in solid media**
- **Richard Petri, another of Koch's assistants, developed the Petri dish**

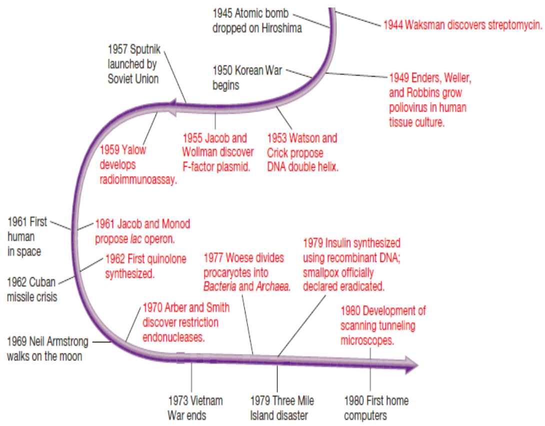
- Sergei Winogradsky (1856 – 1953)
  - worked with soil bacteria and discovered that they could oxidize iron, sulfur, and ammonia to obtain energy;
  - he also studied anaerobic nitrogen-fixation and cellulose decomposition

- Martinus Beijerinck (1851 – 1931)
  - isolated aerobic nitrogen-fixing soil bacteria (Azotobacter and Rhizobium) and sulfate reducing Bacteria
- Beijerinck and Winogradsky
  - pioneered the use of enrichment cultures and selective media (1887 – 1890)



Important Early Discoveries

- George W. Beadle and Edward L. Tatum (ca. 1941)
  - studied the relationship between genes and enzymes using the bread mold, *Neurospora*
  - Precursor→ ornithine → citrulline → arginine
  - One gene, one polypeptide hypothesis
- Salvadore Luria and Max Delbruck (ca. 1943)
  - Demonstrated spontaneous gene mutations in bacteria (not directed by the environment)



- In the 1970s new discoveries in microbiology led to the development of recombinant DNA technology and genetic engineering

The Development of Industrial Microbiology and Microbial Ecology

Agricultural microbiology is concerned with the impact of microorganisms on agriculture. Agricultural microbiologists try to combat plant diseases that attack important food crops, work on methods to increase soil fertility and crop yields, and study the role of microorganisms living in the digestive tracts of ruminants such as cattle. Currently there is great interest in using bacterial and viral insect pathogens as substitutes for chemical pesticides.

Microbial ecology is concerned with the relationships between microorganisms and the components of their living and nonliving habitats. Microbial ecologists study the global and local contributions of microorganisms to the carbon, nitrogen, and sulfur cycles. The study of pollution effects on microorganisms also is important because of the impact these organisms have on the environment. Microbial ecologists are employing microorganisms in bioremediation to reduce pollution.

The Development of Industrial Microbiology and Microbial Ecology

Scientists working in food and dairy microbiology try to prevent microbial spoilage of food and the transmission of food-borne diseases such as botulism and salmonellosis. They also use microorganisms to make foods such as cheeses, yogurts, pickles, and beer. In the future, microorganisms themselves may become a more important nutrient source for livestock and humans.

B_{12}, and monosodium glutamate. Today, industrial microbiologists use microorganisms to make products such as antibiotics, vaccines, steroids, alcohols and other solvents, vitamins, amino acids, and enzymes. Industrial microbiologists identify microbes of use to industry. They also engineer microbes with desirable traits and devise systems for culturing them and isolating the products they make.

One of the most active and important fields in microbiology is medical microbiology, which deals with diseases of humans and animals. Medical microbiologists identify the agents causing infectious diseases and plan measures for their control and elimination. Frequently they are involved in tracking down new, unidentified pathogens such as the agent that causes variant Creutzfeldt-Jakob disease, (the human version of "mad cow disease") the hantavirus, the West Nile virus, and the virus responsible for SARS. These microbiologists also study the ways in which microorganisms cause disease. Arthropod-borne viral diseases

Public health microbiology is closely related to medical microbiology. Public health microbiologists try to identify and control the spread of communicable diseases. They often monitor community food establishments and water supplies in an attempt to keep them safe and free from infectious disease agents.

Microbiologists working in microbial physiology and biochemistry study many aspects of the biology of microorganisms. They may study the synthesis of antibiotics and toxins, microbial energy production, the ways in which microorganisms survive harsh environmental conditions, microbial nitrogen fixation, and the effects of chemical and physical agents on microbial growth and survival.

Microbial genetics and molecular biology focus on the nature of genetic information and how it regulates the development and function of cells and organisms. The use of microorganisms has been very helpful in understanding gene structure and function. Microbial geneticists play an important role in applied microbiology because they develop techniques that are useful in agricultural microbiology, industrial microbiology, food and dairy microbiology, and medicine.