

Lecture PowerPoint to accompany

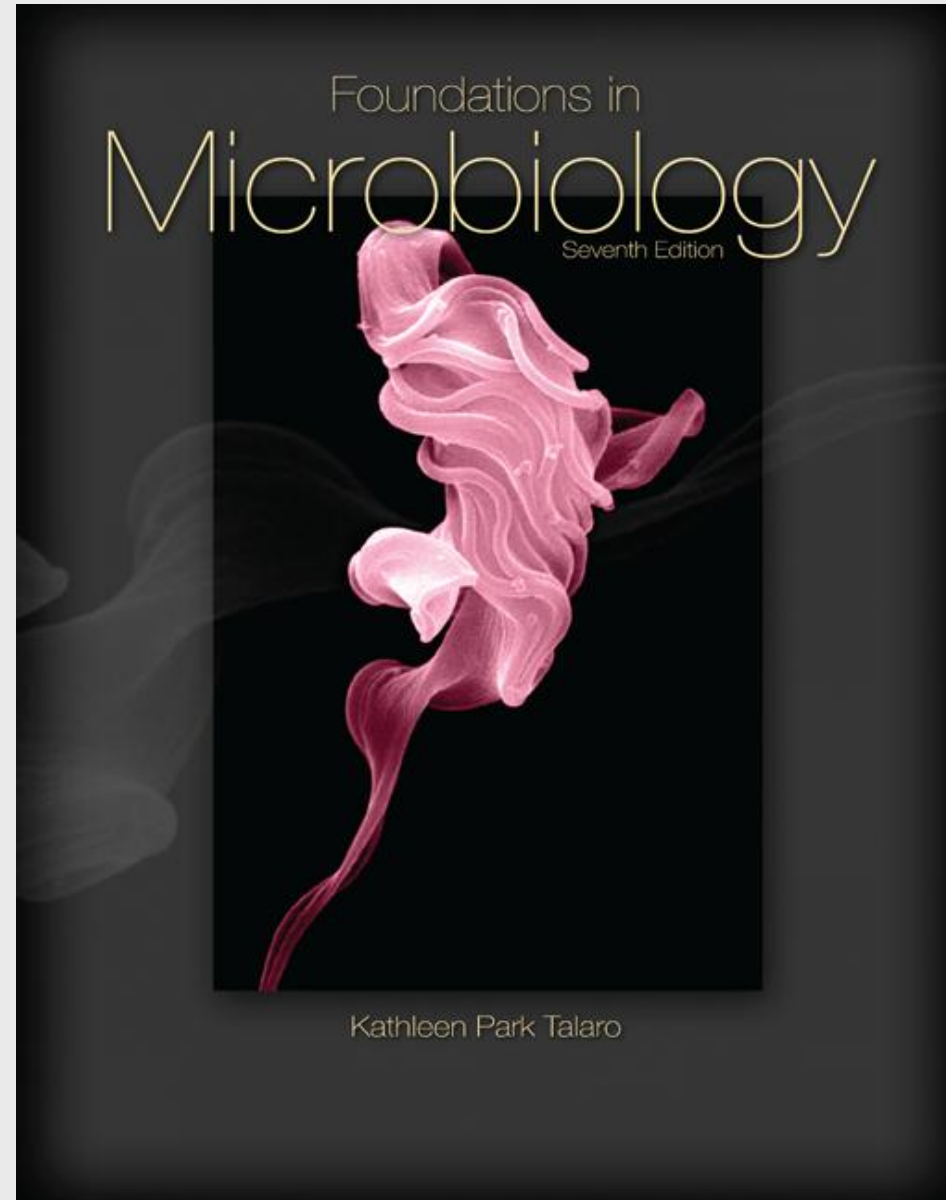
# Foundations in Microbiology

Seventh Edition

Talaro

Chapter 1

The Main Themes of  
Microbiology



# 1.1 Microbiology

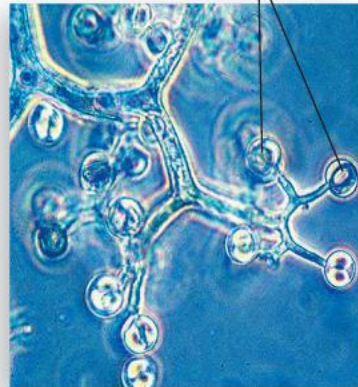
- The study of organisms too small to be seen without magnification
- Microorganisms include:
  - Bacteria
  - Viruses
  - Fungi
  - Protozoa
  - Helminths (worms)
  - Algae

# Figure 1.6 The six types of microorganisms

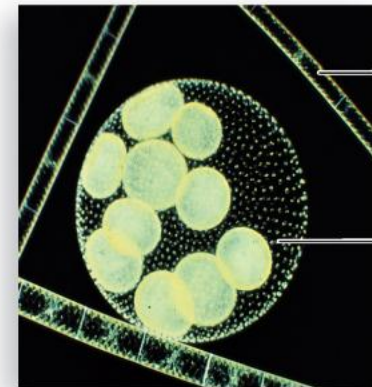
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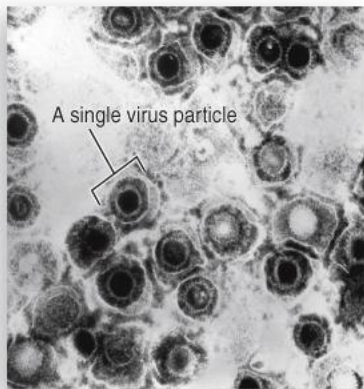
Bacteria: *E. coli* 3,000x. Fine filaments are flagella.



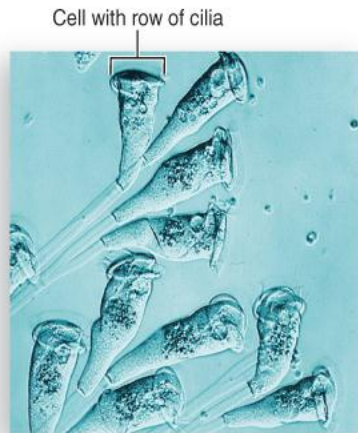
Fungus: *Thamnidium* 400x



Algae: *Volvox* and *Spirogyra* 200x



Virus: *Herpes simplex* 100,000x



*Vorticella*, a colonial protozoan 400x. Cilia beat to pull in food.



Helminth: Head (scolex) of *Taenia solium* 100x. Fine barbs on mouth are used for attachment.

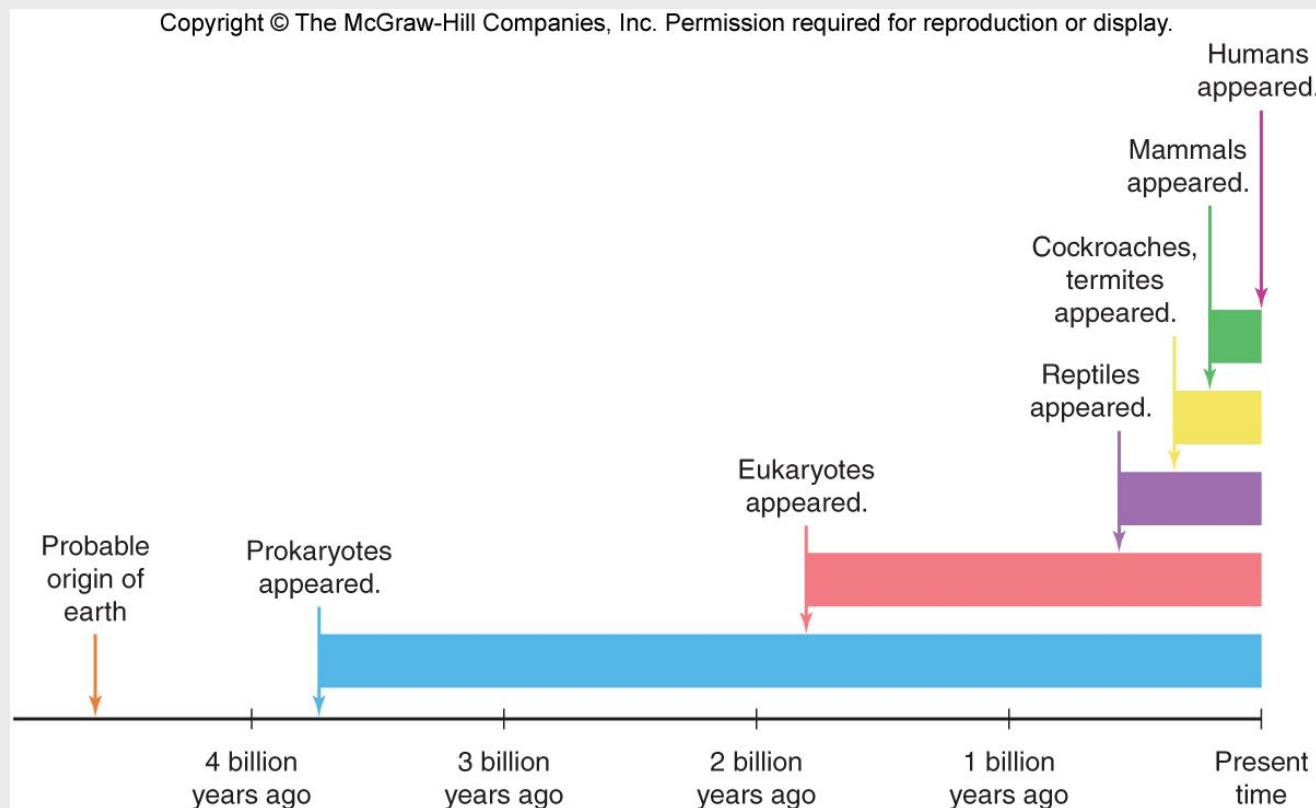
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# Microbiological Endeavors Table 1.1

- Immunology
- Public health microbiology and epidemiology
- Food, dairy, and aquatic microbiology
- Agricultural Microbiology
- Biotechnology
- Genetic Engineering and Recombinant DNA Technology

# 1.2 Origins of Microorganisms

- Bacteria-like organisms have existed on earth for about 3.5 billion years
  - Prokaryotes (pre-nucleus): Simple cells
  - Eukaryotes (true nucleus): Complex cells



# Microbial Involvement in Energy and Nutrient Flow

- The flow of energy and food through the earth's ecosystems
  - **Photosynthesis:** Light fueled conversion of carbon dioxide to organic material
  - **Decomposition:** Breakdown of dead matter and wastes into simple compounds

# 1.3 Human Uses of Microorganisms

- Biotechnology
  - Production of foods, drugs, and vaccines
- Genetic engineering
  - Recombinant DNA
- Bioremediation

# Microbes at Work

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(a)



(b)

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# Microbes at Work

- **How Fast Can Microbes Clean Up the Gulf Oil Spill?**
- New research suggests bacteria in the deep waters of the Gulf of Mexico may be eating oil plumes quickly
- <http://www.scientificamerican.com/article.cfm?id=how-fast-microbes-consume-gulf-oil-spill>
- <http://www.sciencemag.org/content/330/6001/204.abstract>



# 1.4 Infectious Diseases

- **Pathogens:** Microorganisms that do harm
- Nearly 2,000 different microbes cause diseases
- 10 B new infections/year worldwide
- 12 M deaths from infections/year worldwide

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**TABLE 1.2** Top Causes of Death—All Diseases

United States	No. of Deaths	Worldwide	No. of Deaths
1. Heart disease	696,950	1. Heart disease	8.12 million
2. Cancer	557,270	2. Stroke	5.51 million
3. Stroke	162,670	3. Respiratory infection	3.88 million
4. Chronic lower respiratory disease	124,800	4. Cancer	3.33 million
5. Unintentional injury (accidents)	106,740	5. HIV/AIDS	2.78 million
6. Diabetes	73,250	6. Chronic lower respiratory disease	2.75 million
7. Influenza and pneumonia*	65,680	7. Diarrheal disease	1.80 million
8. Alzheimer disease	58,870	8. Tuberculosis	1.57 million
9. Kidney problems	40,970	9. Malaria	1.27 million
10. Septicemia (bloodstream infection)	33,865	10. Accidents	1.19 million

\*Diseases in red are those most clearly caused by microorganisms although cancer and other diseases may be associated with infections.

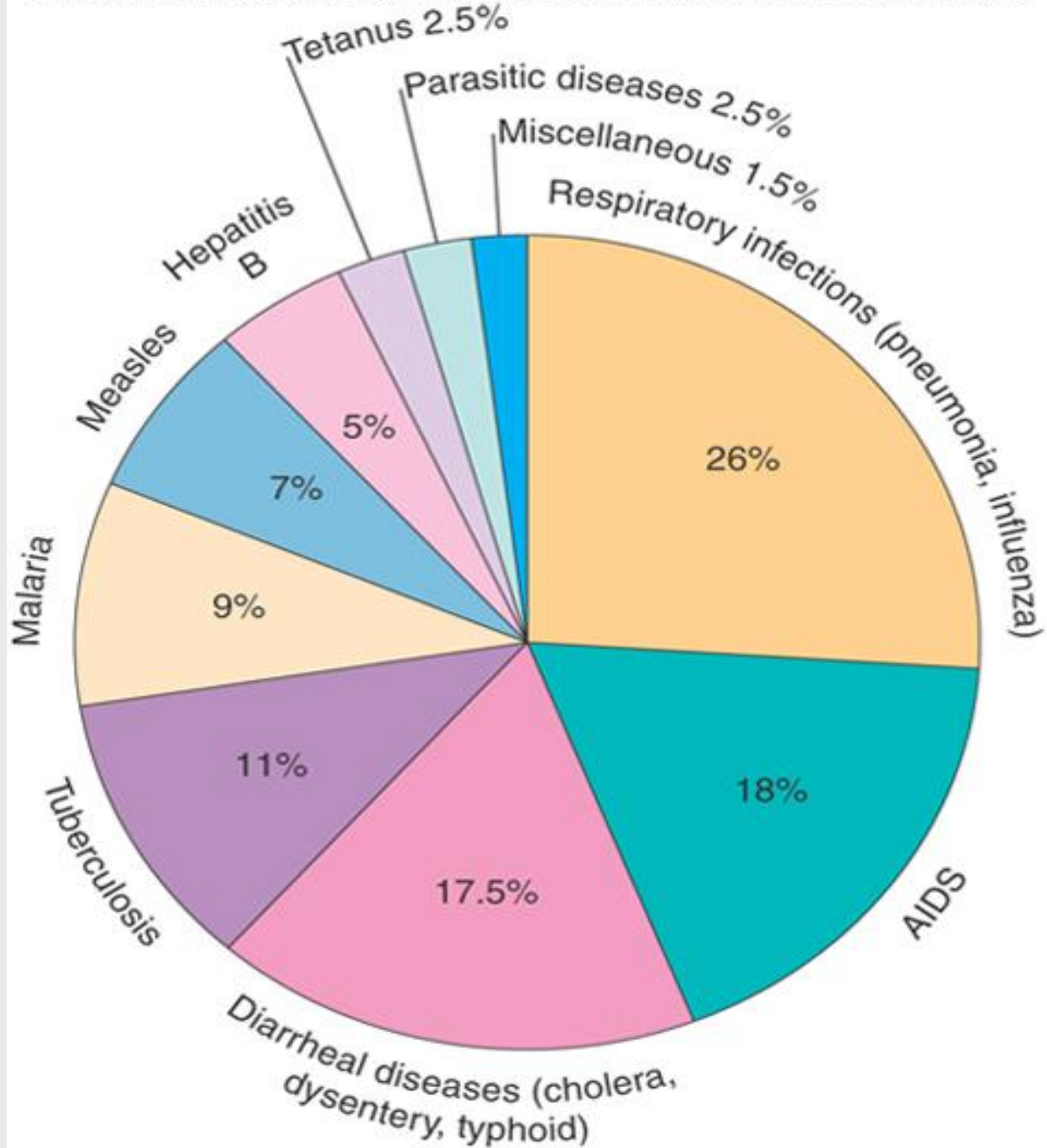


Figure 1.4  
Worldwide infectious  
disease statistics

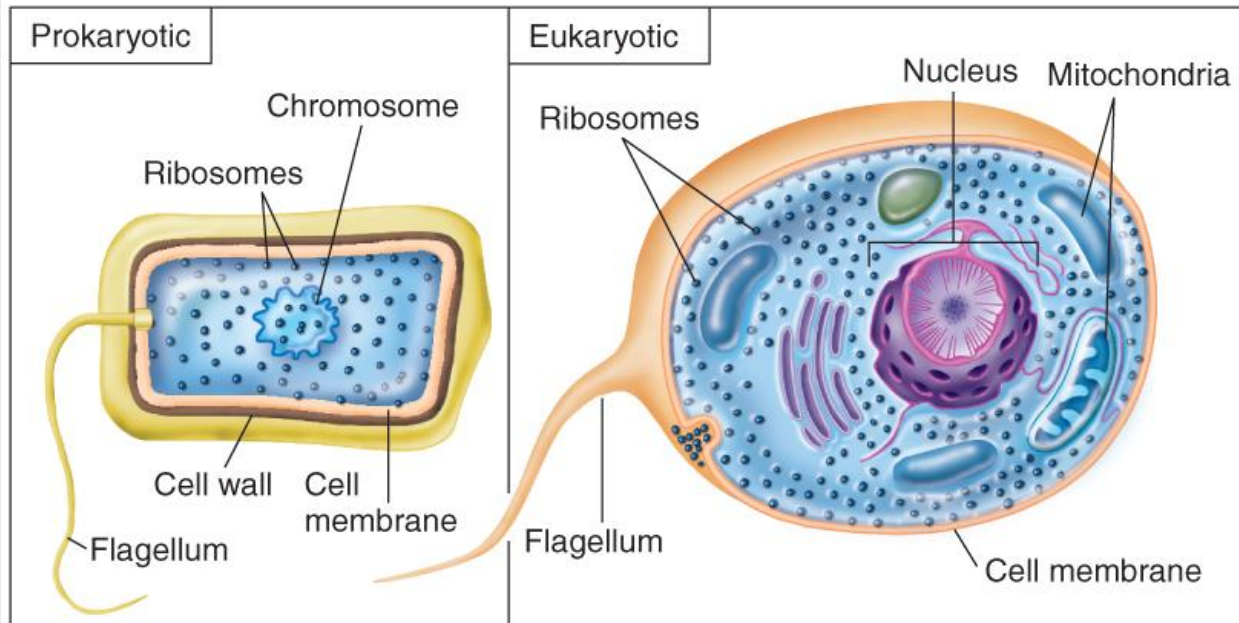
# 1.5 Characteristics of Microbes

- Two cell lines
  - Prokaryote – microscopic, unicellular organisms, lack nuclei and membrane-bound organelles
  - Eukaryote – unicellular (microscopic) and multicellular, nucleus and membrane-bound organelles
- Viruses
  - Acellular, parasitic particles composed of a nucleic acid and protein

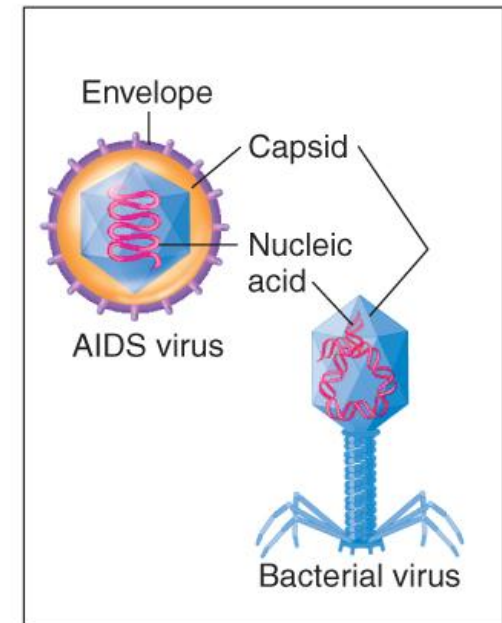
# Figure 1.5 Basic structure of cells and viruses

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(a) Cell Types

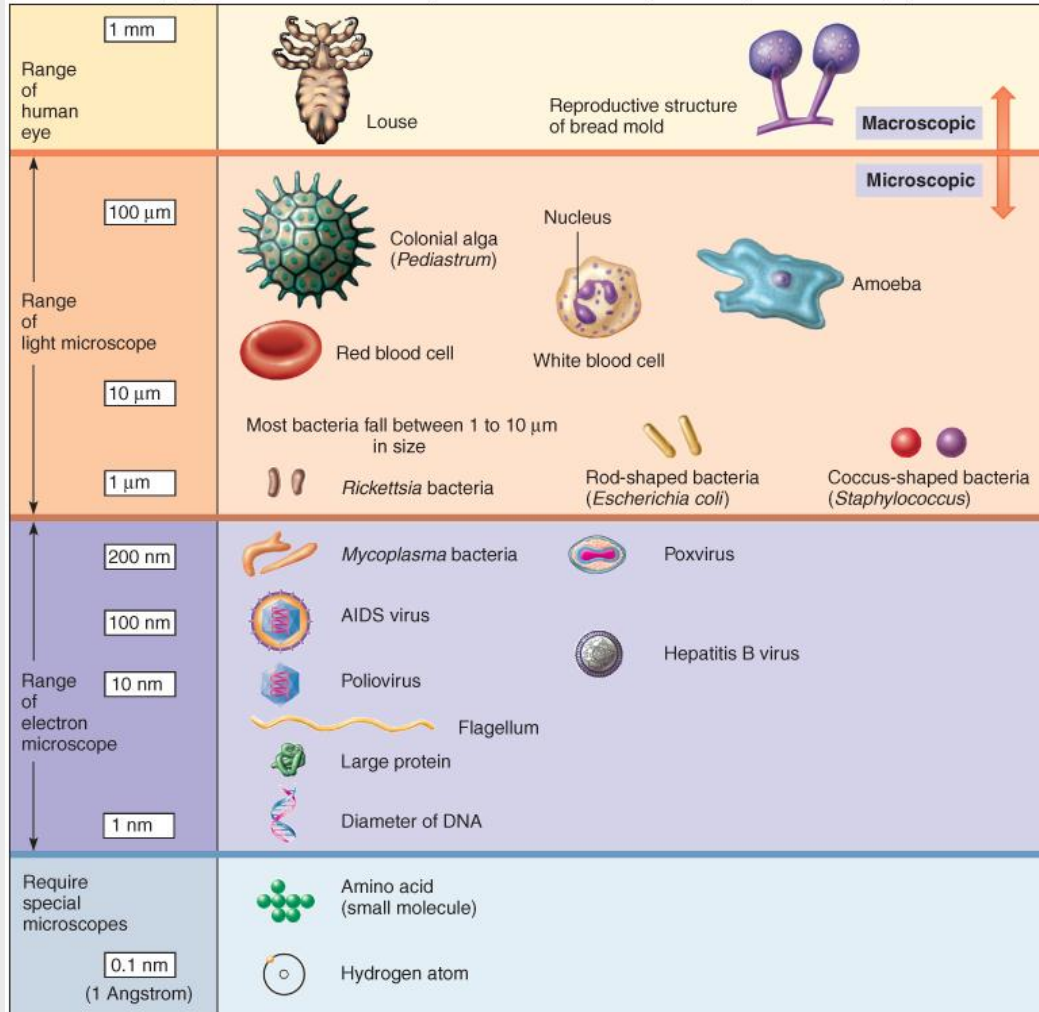


(b) Virus Types

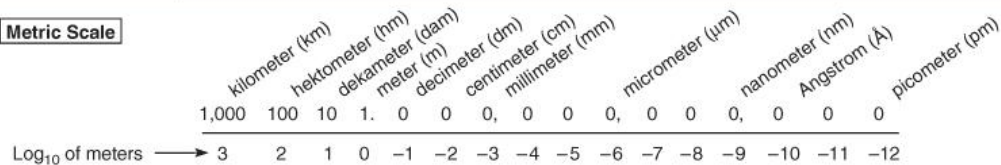


# Microbial Dimensions

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**Metric Scale**



# Lifestyles of Microorganisms

- Majority live a free existence, are relatively harmless and often beneficial
- Many microorganisms have close associations with other organisms
  - Parasites
  - Hosts

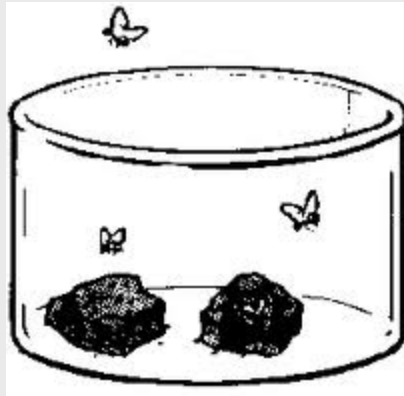


# 1.6 Historical Foundations of Microbiology

- Thousands of microbiologists, 300 years
- Prominent discoveries include:
  - Microscopy
  - Scientific method
  - Development of medical microbiology
  - Microbiology techniques

# Spontaneous Generation

Early belief that some forms of life could arise from vital forces present in nonliving or decomposing matter (flies from manure, etc.)



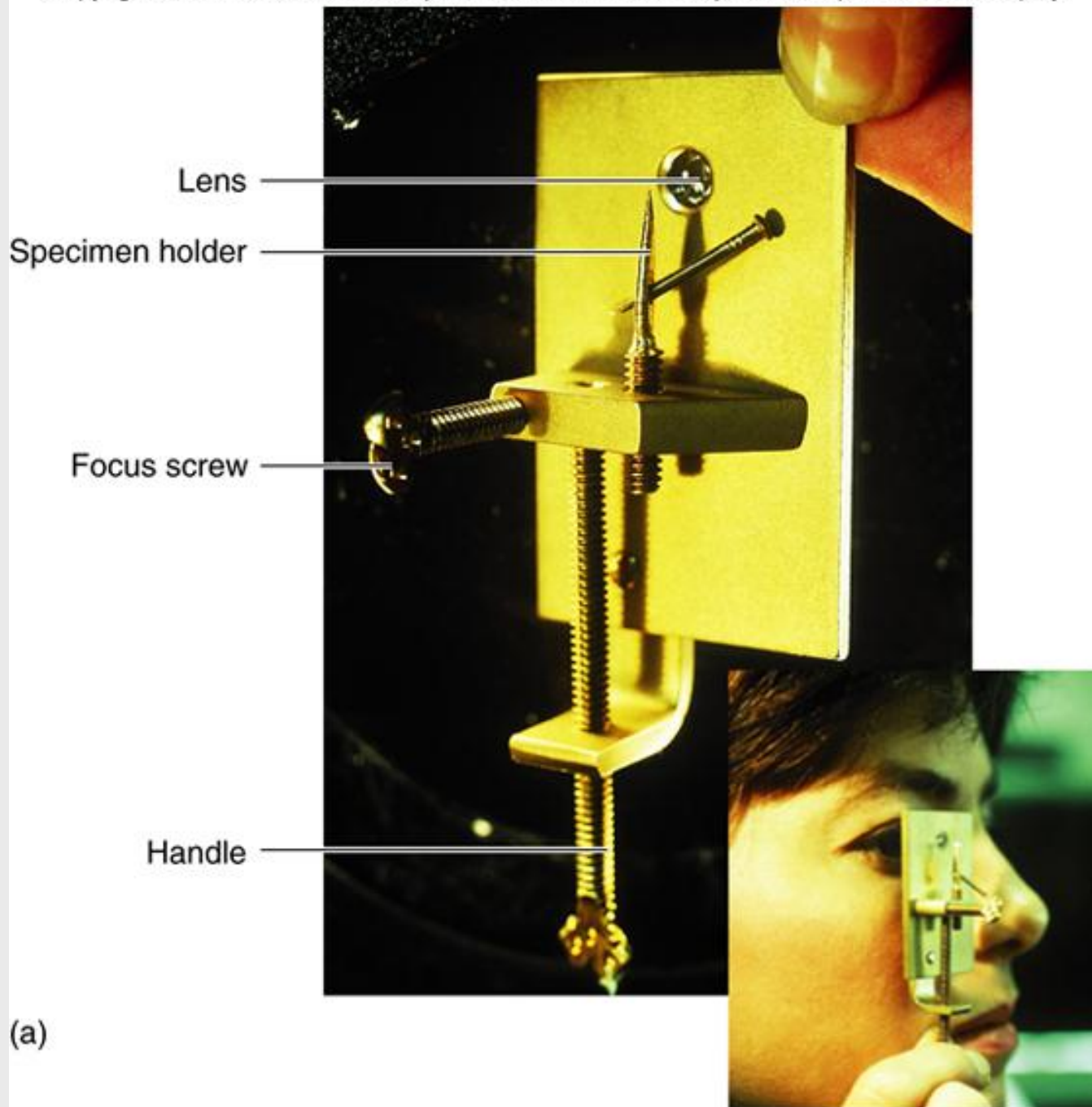
# Antoni van Leeuwenhoek (1632-1723)

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- Dutch linen merchant
- First to observe living microbes
- Single-lens magnified up to 300X



(a)

# Scientific Method

- Approach taken by scientists to explain a certain natural phenomenon
- Form a *hypothesis* - a tentative explanation that can be supported or refuted
  - Deductive approach “If..., then....”
- A lengthy process of experimentation, analysis, and testing either supports or refutes the hypothesis

- Results must be published and repeated by other investigators.
- If *hypothesis* is supported by a growing body of evidence and survives rigorous scrutiny, it moves to the next level of confidence - it becomes a *theory*.
- If evidence of a *theory* is so compelling that the next level of confidence is reached, it becomes a *Law* or *principle*.

# The Development of Medical Microbiology

- Early experiments led to the realization that microbes are everywhere
- This discovery led to immediate applications in medicine
  - *Germ theory of disease*: resulted in the use of sterile, aseptic, and pure culture techniques

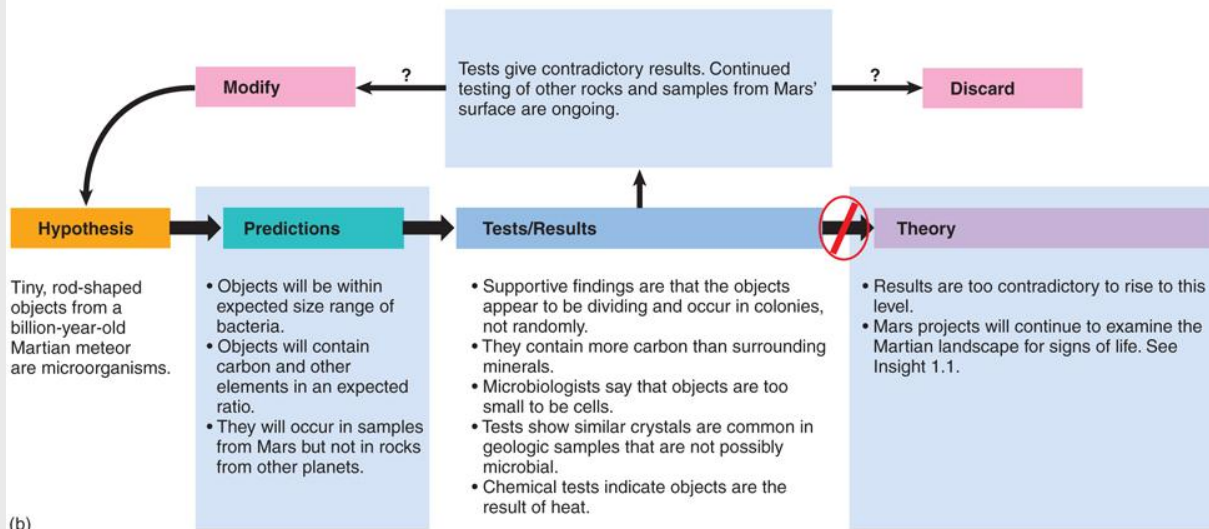
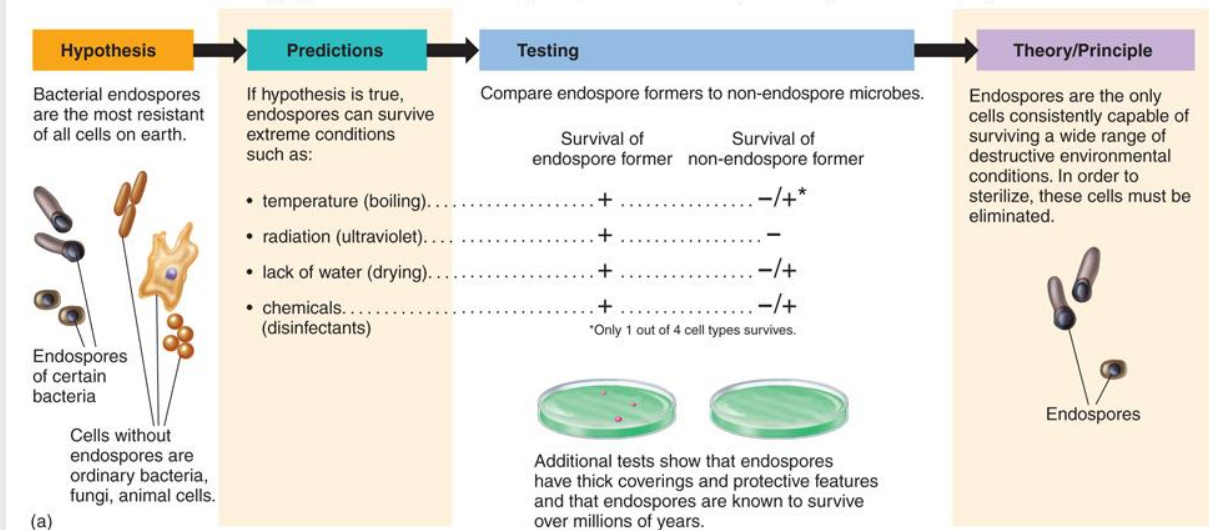
# Discovery of Spores and Sterilization

- **John Tyndall and Ferdinand Cohn** each demonstrated the presence of heat resistant forms of some microbes.
  - Cohn determined these forms to be heat-resistant bacterial **endospores**.
- **Sterility** requires the elimination of all life forms including endospores and viruses.



# Figure 1.10 The pattern of deductive reasoning

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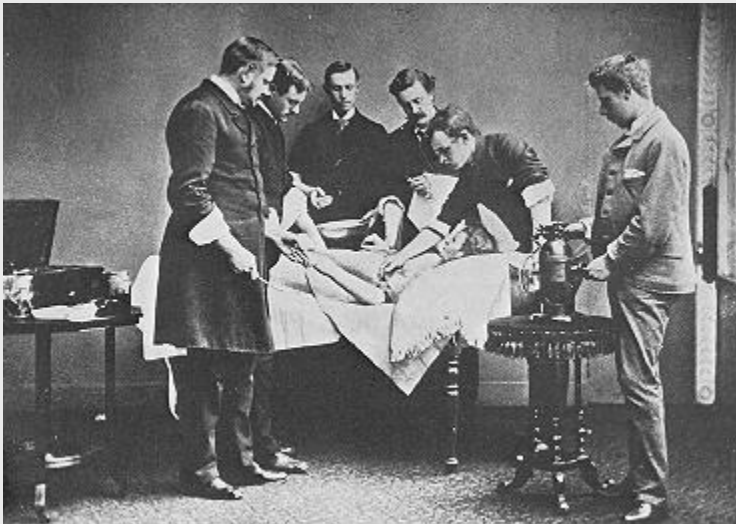


# Development of Aseptic Techniques

- The human body is a source of infection
  - **Dr. Oliver Wendell Holmes** – observed that mothers of home births had fewer infections than those who gave birth in hospitals
  - **Dr. Ignaz Semmelweis** – correlated infections with physicians coming directly from autopsy room to maternity ward



- **Joseph Lister** – introduced aseptic techniques reducing microbes in medical settings and preventing wound infections
  - Involved disinfection of hands using chemicals prior to surgery
  - Use of heat for sterilization

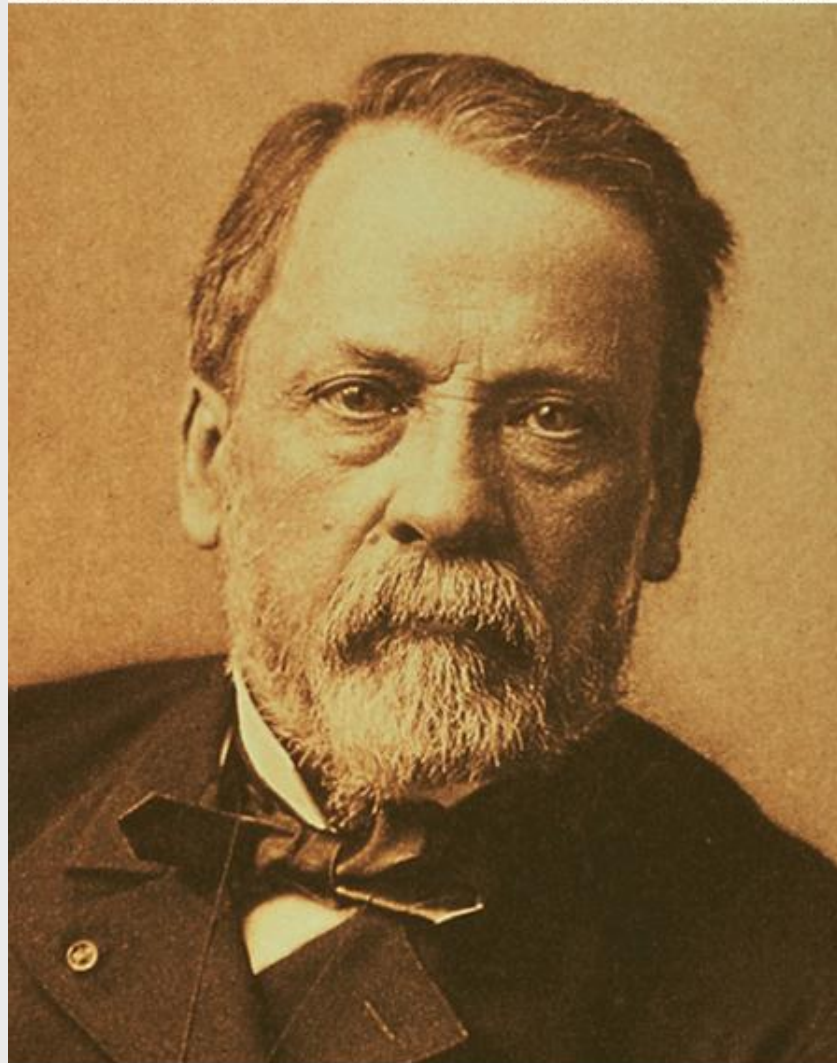


# Pathogens and Germ Theory of Disease

- Many diseases are caused by the growth of microbes in the body and not by sins, bad character, or poverty, etc.
- Two major contributors:  
Louis Pasteur and Robert Koch

# Louis Pasteur (1822-1895)

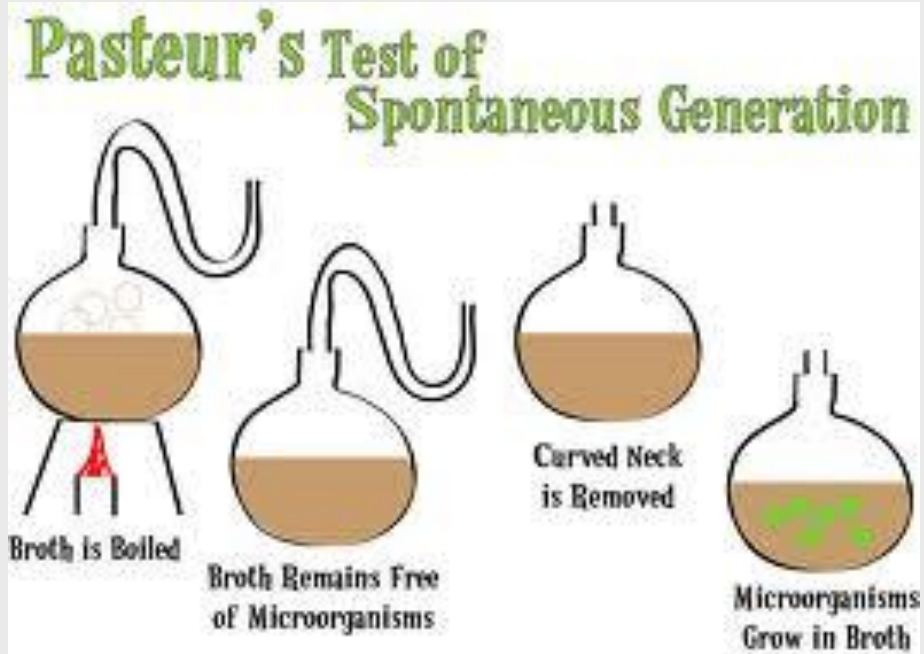
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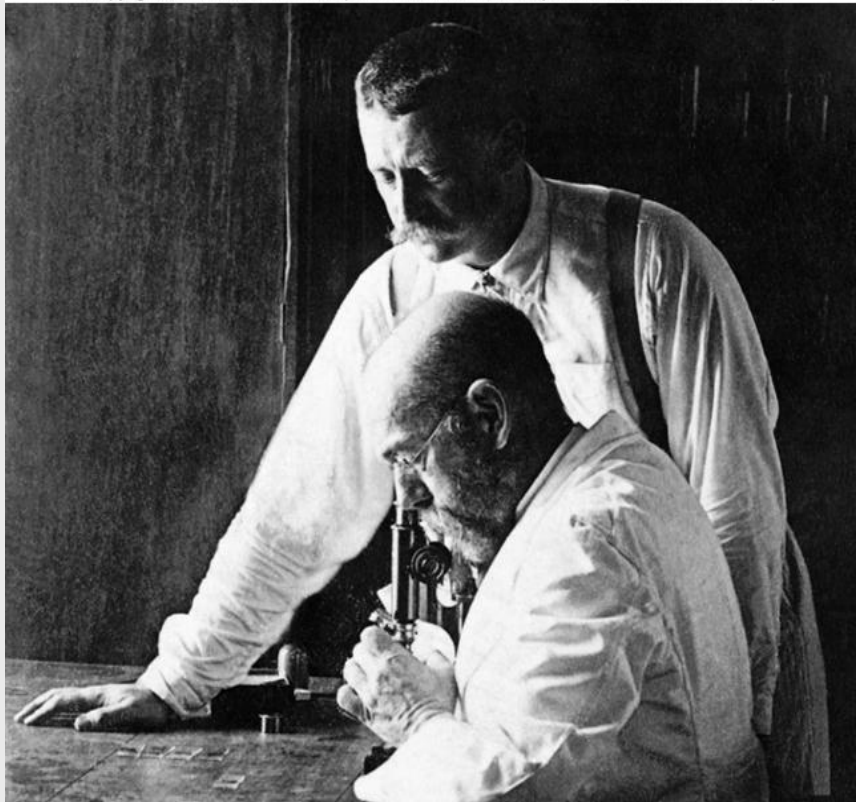
- Showed microbes caused fermentation and spoilage
- Disproved spontaneous generation of microorganisms
- Developed pasteurization
- Demonstrated what is now known as Germ Theory of Disease

# Louis Pasteur (1822-1895)



# Robert Koch (1843-1910)

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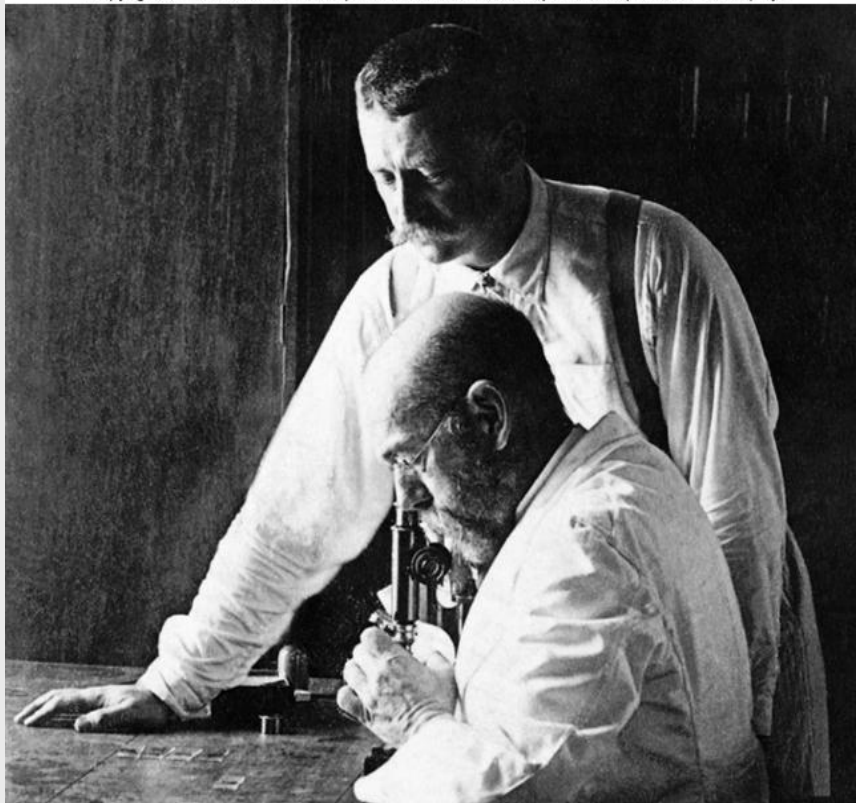


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- Established **Koch's postulates** - a sequence of experimental steps that verified the germ theory
- Identified cause of anthrax, TB, and cholera
- Developed pure culture methods

# Robert Koch (1843-1910)

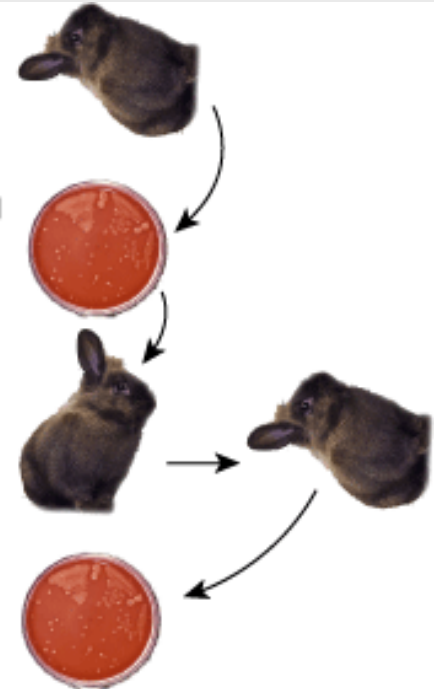
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## Koch's postulates

1. Isolate the pathogen (virus, microbe, etc.) from sick creature.
2. Grow the pathogen in the laboratory and obtain a pure culture.
3. Inoculate a healthy creature with a sample from the pure culture. The pathogen should cause the same disease symptoms that were seen in first creature.
4. Reisolate the same pathogen from the second sick animal.





# 1.7 Taxonomy

- **Taxonomy:** organizing, classifying, and naming living things
  - Formal system originated by Carl von Linné
- Concerned with:
  - Classification – orderly arrangement of organisms into groups
  - Nomenclature – assigning names
  - Identification – determining and recording traits of organisms for placement into taxonomic schemes

# Levels of Classification

- Domain - Archaea, Bacteria, & Eukarya
- Kingdom
- Phylum or Division
- Class
- Order
- Family
- Genus
- Species

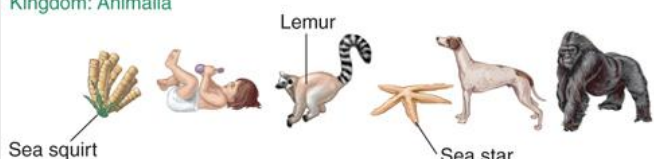
# Figure 1.13 Sample taxonomy

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**Domain: Eukarya (All eukaryotic organisms)**

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Kingdom: Animalia



Sea squirt      Lemur      Sea star


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Phylum: Chordata





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Class: Mammalia





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Order: Primates





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Family: Hominoidea




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Genus: *Homo*



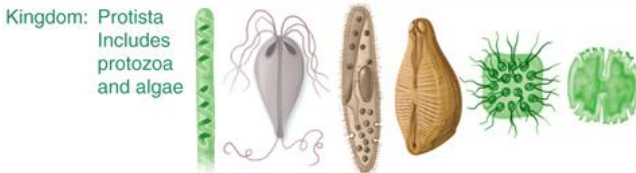
Species: *sapiens*

(a)

**Domain: Eukarya (All eukaryotic organisms)**


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Kingdom: Protista  
Includes protozoa and algae





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Phylum: Ciliophora  
Only protozoa with cilia





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Class: Hymenostomea  
Single cells with regular rows of cilia; rapid swimmers





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Order: Hymenostomatida  
Elongate oval cells with cilia in the oral cavity



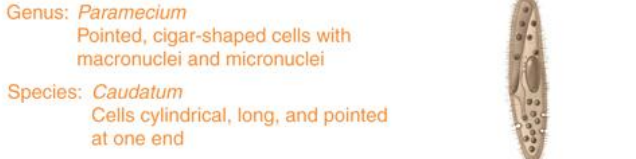

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Family: Parameciidae  
Cells rotate while swimming and have oral grooves.




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Genus: *Paramecium*  
Pointed, cigar-shaped cells with macronuclei and micronuclei



Species: *Caudatum*  
Cells cylindrical, long, and pointed at one end

(b)

# Assigning Specific Names

- Binomial (scientific) nomenclature
- Gives each microbe 2 names:
  - **Genus** - capitalized
  - **species** - lowercase
- Both italicized or underlined
  - *Staphylococcus aureus* (*S. aureus*)
- Inspiration for names is extremely varied and often imaginative

# The Origin and Evolution of Microorganisms

- Phylogeny: natural relatedness between groups of organisms
- Evolution
  - All new species originate from preexisting species
  - Closely related organism have similar features because they evolved from common ancestral forms
- Evolution usually progresses toward greater complexity

# 3 Domains

- Bacteria - true bacteria
- Archaea - odd bacteria that live in extreme environments, high salt, heat, etc.
- Eukarya - have a nucleus and organelles

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