

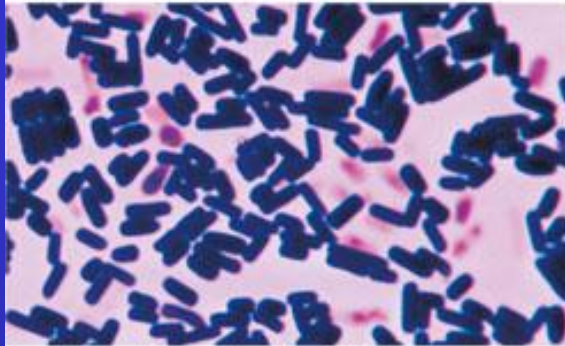
# Chapter 1

## The Science of Microbiology

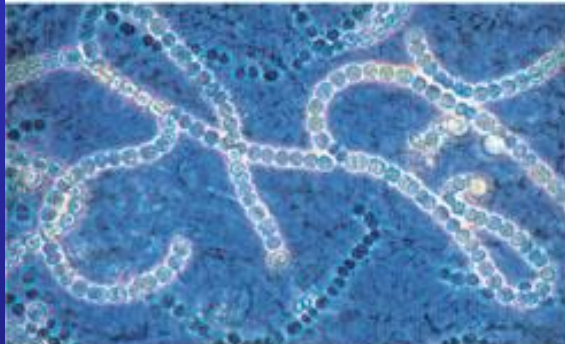
# Microbiology

- The study of of organisms too small to be seen without magnification
  - bacteria
  - viruses
  - fungi
  - protozoa
  - helminths (worms)
  - algae

(a) Examples of procaryotic organisms

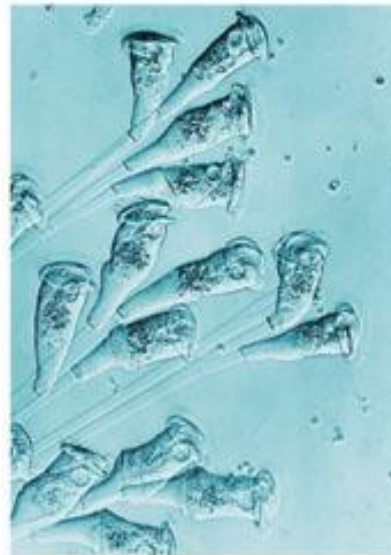


Rod-shaped bacteria, *Clostridium*, found in soil

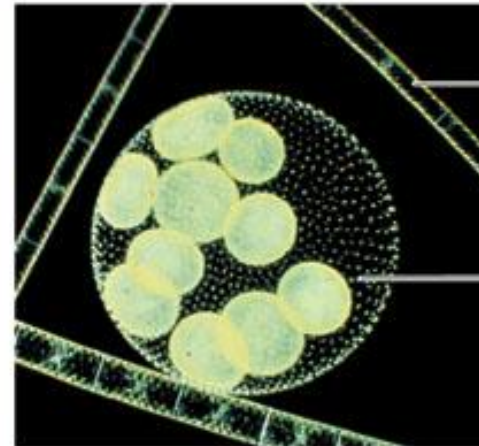


*Nostoc*, a cyanobacterium that lives in fresh water

(b) Examples of eucaryotic organisms



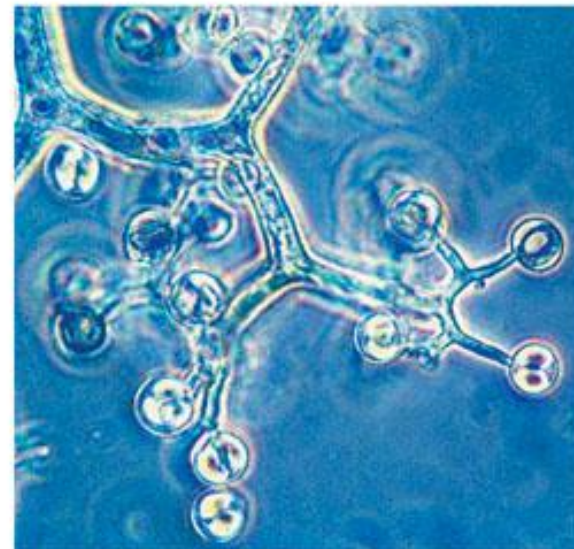
The stalked protozoan *Vorticella* is shown in feeding mode. These free-living eucaryotes are common in pond water.



Filamentous alga (*Spirogyra*)

Colonial alga (*Volvox*)

Representatives of algae. *Volvox* is a large, complex colony composed of smaller colonies (spheres) and cells (dots). *Spirogyra* is a filamentous alga composed of elongate cells joined end to end.



Example of a fungus; shown here is the mold *Thamnidium* displaying its sac-like reproductive vessels.

# Branches of study within microbiology

- Immunology
- Public health microbiology & epidemiology
- Food, dairy and aquatic microbiology
- Biotechnology
- Genetic engineering & recombinant DNA technology

# Microbes are involved in

- nutrient production & energy flow
- decomposition
- production of foods, drugs & vaccines
- bioremediation
- causing disease

# Impact of pathogens

- Nearly 2,000 different microbes cause diseases
- 10 B infections/year worldwide
- 13 M deaths from infections/year worldwide

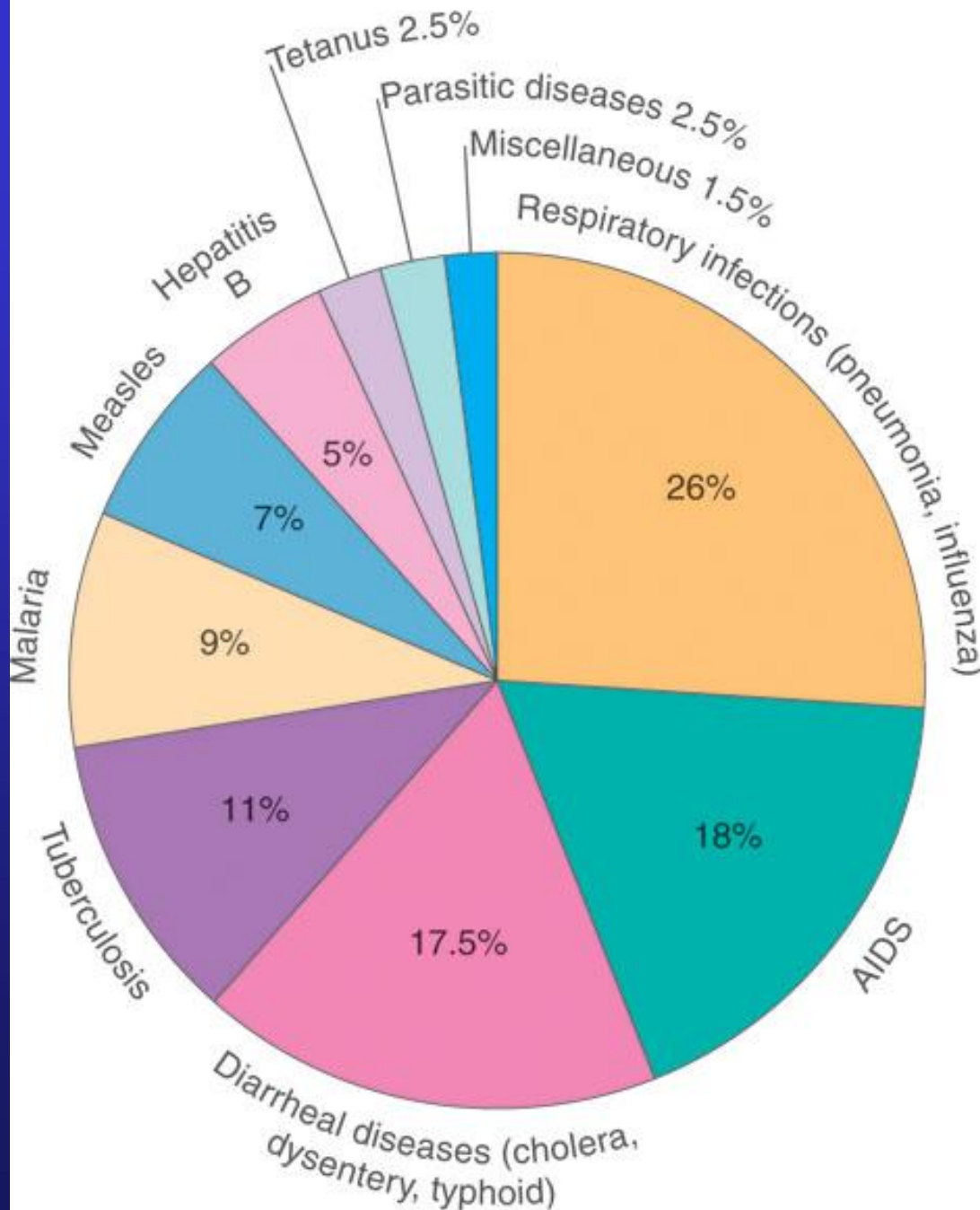
**TABLE 1.1**

**Top Causes of Death—All Diseases**

United States	No. of Deaths	Worldwide	No. of Deaths
1. Heart disease	725,000	1. Heart disease	11.1 million
2. Cancer	550,000	2. Cancer	7.1 million
3. Stroke	167,000	3. Stroke	5.5 million
4. Chronic lower-respiratory disease	124,000	4. <i>Respiratory infections<sup>1</sup></i>	3.9 million
5. Unintentional injury (accidents)	97,000	5. Chronic lower-respiratory disease	3.6 million
6. Diabetes	68,000	6. Accidents	3.5 million
7. <i>Influenza and pneumonia</i>	63,000	7. <i>HIV/AIDS</i>	2.9 million
8. Alzheimer disease	45,000	8. Perinatal conditions	2.5 million
9. Kidney problems	35,000	9. <i>Diarrheal diseases</i>	2.0 million
10. <i>Septicemia (bloodstream infection)</i>	30,000	10. <i>Tuberculosis</i>	1.6 million

<sup>1</sup>Diseases in red are those most clearly caused by microorganisms.

Data adapted from *The World Health Report 2002* (World Health Organization).

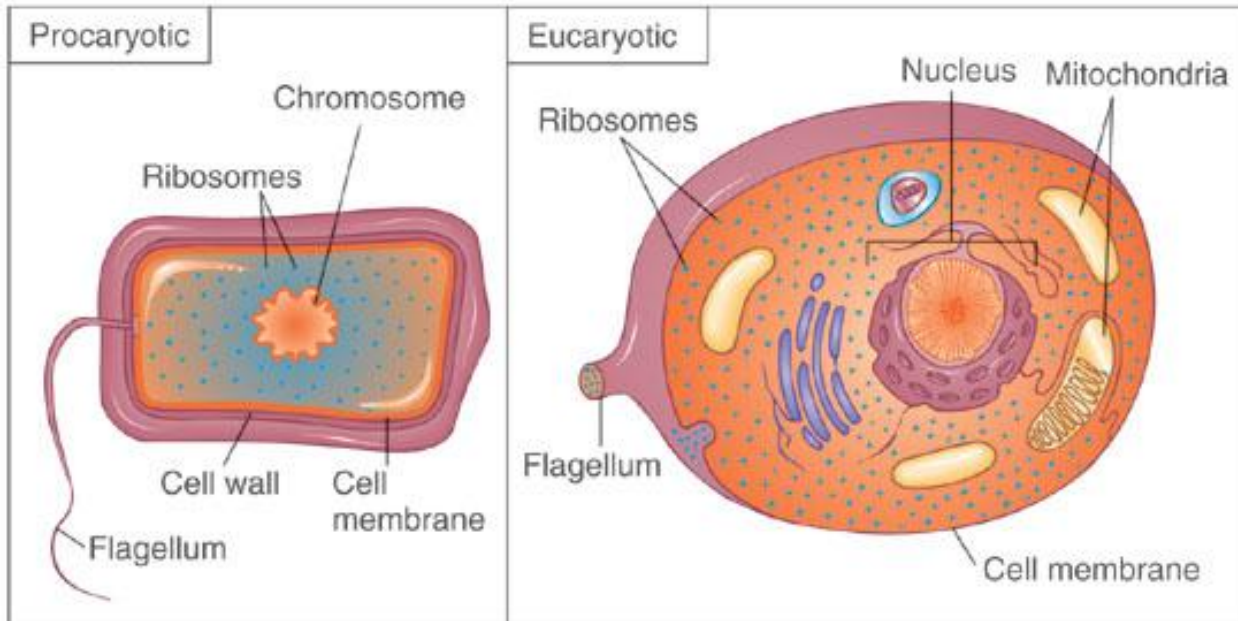




# Characteristics of microbes

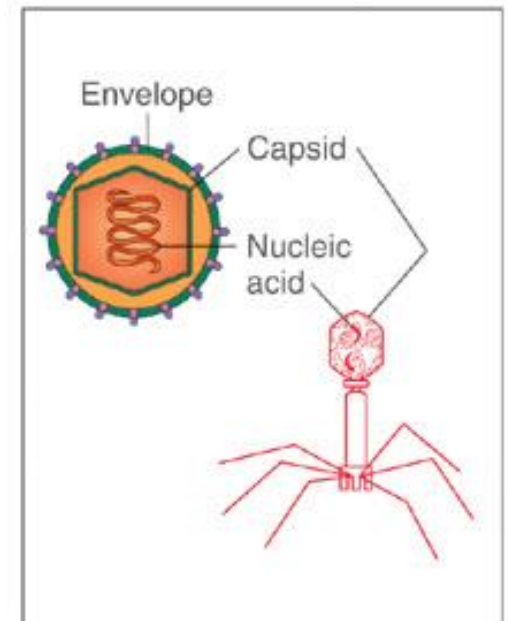
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## (a) Cell Types

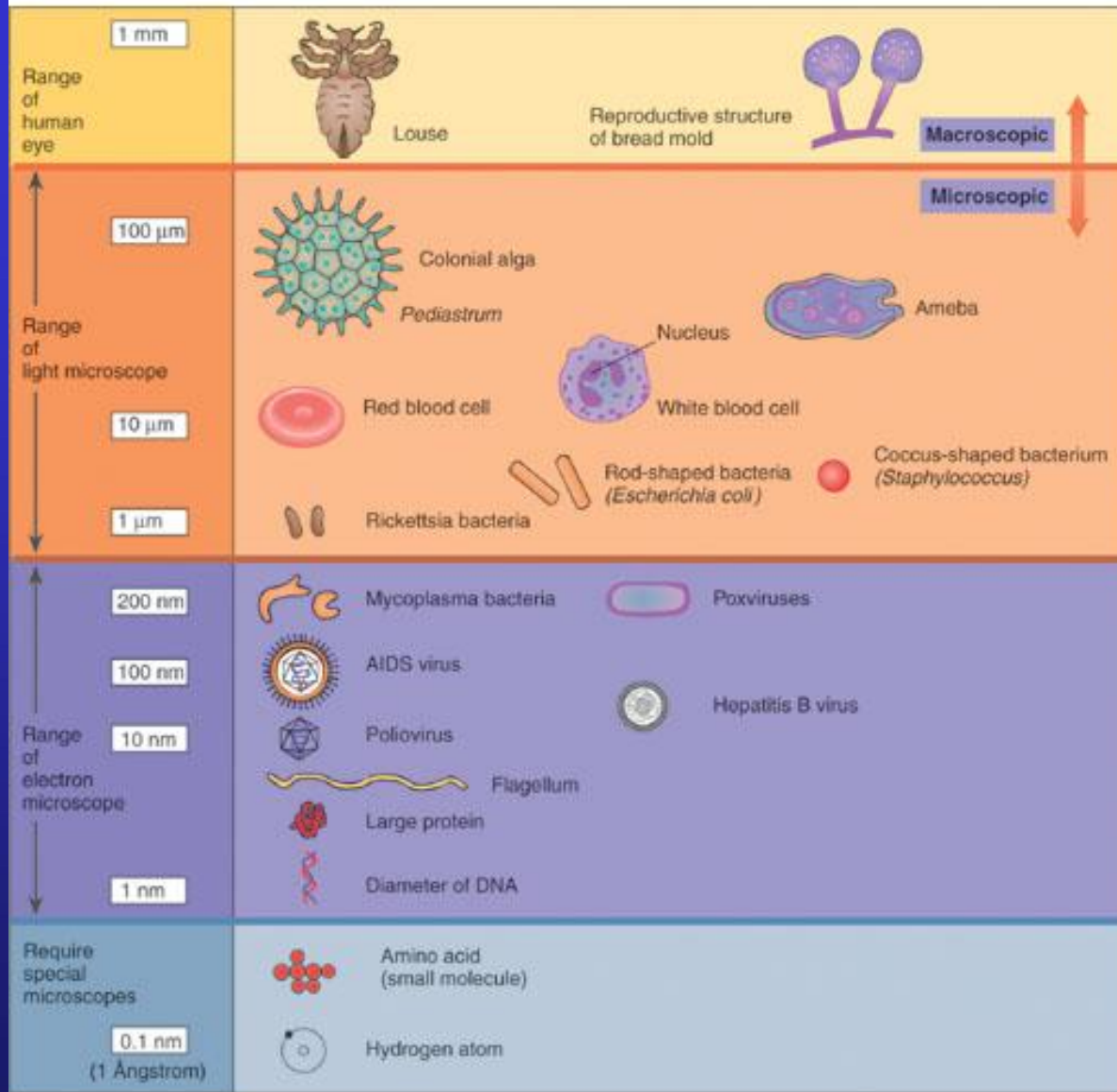


Microbial cells are of the small, relatively simple prokaryotic variety (left) or the larger, more complex eucaryotic type (right).

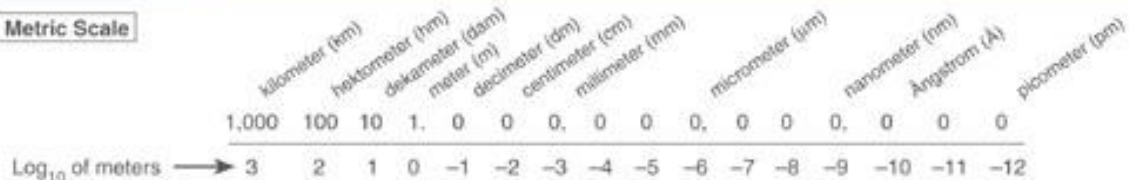
## (b) Virus Types



Viruses are tiny particles, not cells, that consist of genetic material surrounded by a protective covering. Shown here are a human virus (top) and bacterial virus (bottom).



**Metric Scale**



# Brief History of Microbiology

- 1674 Leeuwenhoek: sees microorganisms
- 1796 Jenner: vaccine for smallpox
- 1847 Semmelweis: cause of childbed fever
- 1859 Pasteur: disproves spontaneous gen.
- 1865 Lister: introduces antiseptic technique
- 1876 Koch: pure culture on agar
- 1892 Iwanowski: discovers viruses
- 1894 Ehrlich: selective toxicity
- 1929 Fleming: discovers penicillin
- 1977 Woese: classifies archaea

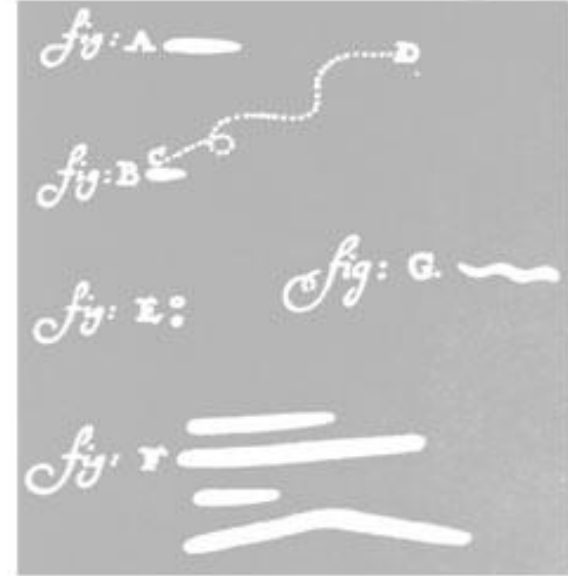
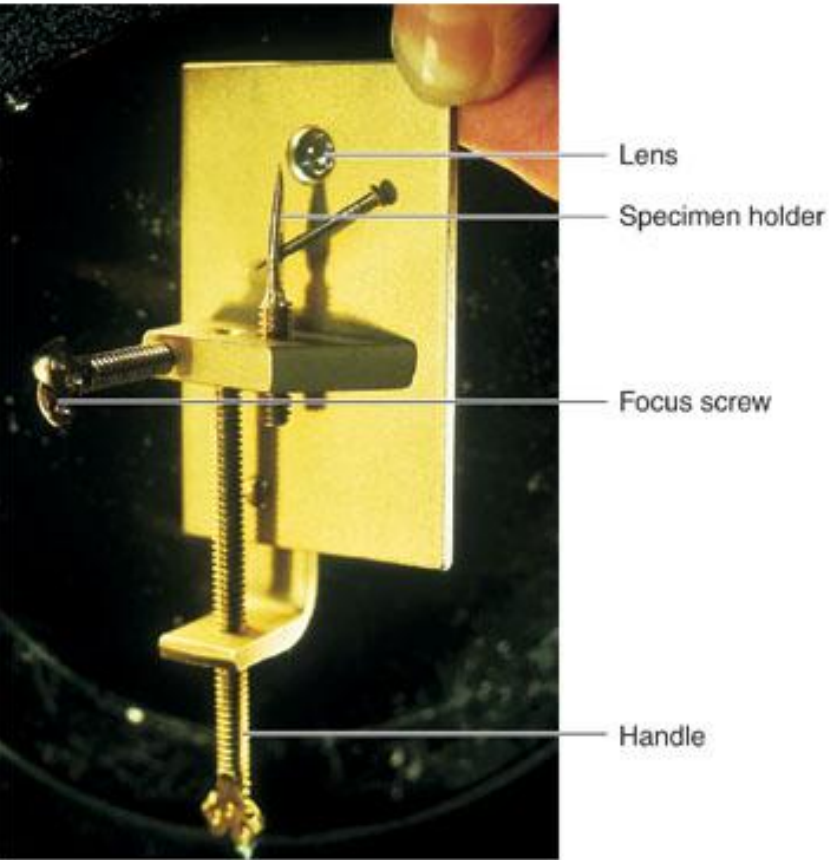
# Antonie van Leeuwenhoek

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- First to observe living microbes
- his single-lens magnified up to 300X

(1632-1723)



(a)

(b)

# Spontaneous generation

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

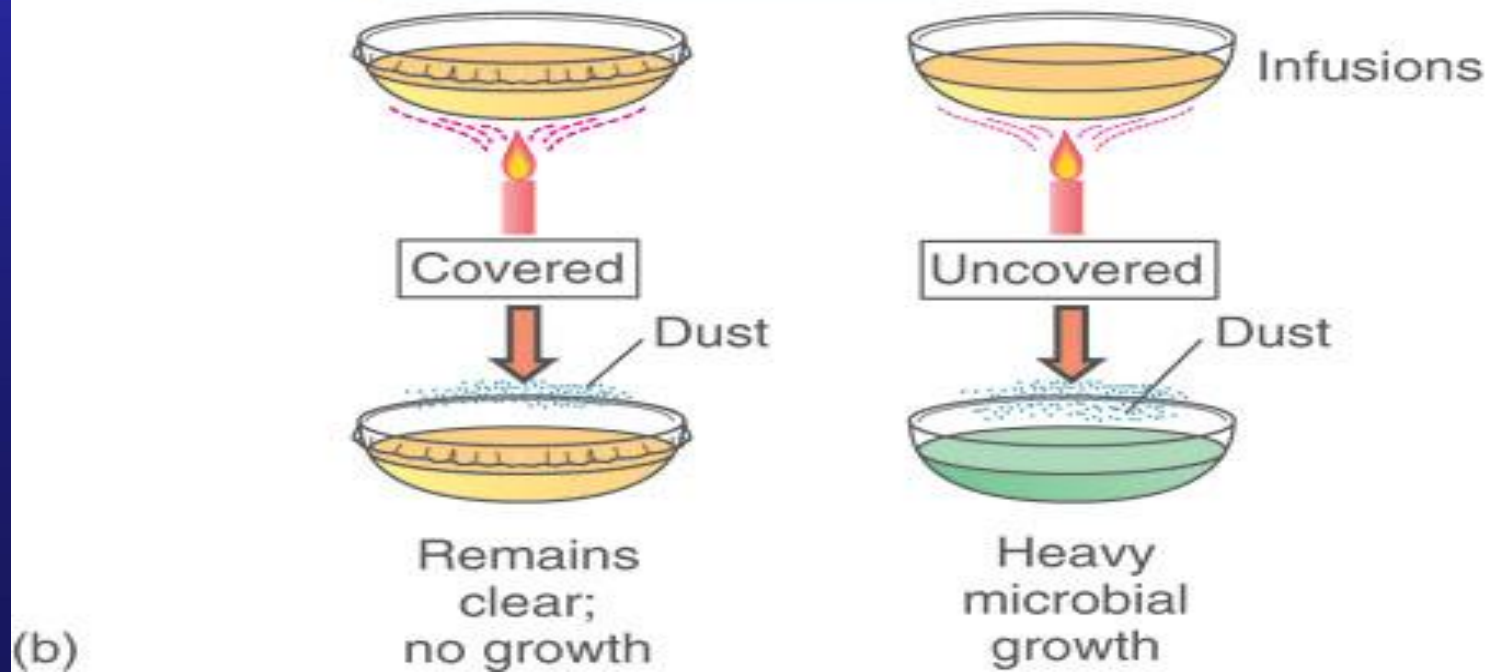
# Spontaneous Generation

- Life is formed from inanimate objects
  - Francesco Redi
    - Argued against: maggots grew only from eggs
  - John Needham
    - Argued for: boiled broth, covered, saw growth
  - Lazzaro Spallanzani
    - Argued against: covered broth, no growth
  - Counterargument
    - Covering removes air: necessary for generation

## Redi's Experiment



## Jablot's Experiment





# Louis Pasteur

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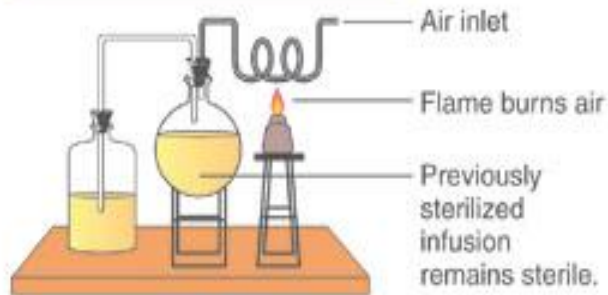
(1822-1895)

- Showed microbes caused fermentation & spoilage
- Disproved spontaneous generation of m.o.
- Developed aseptic techniques.
- Developed a rabies vaccine.

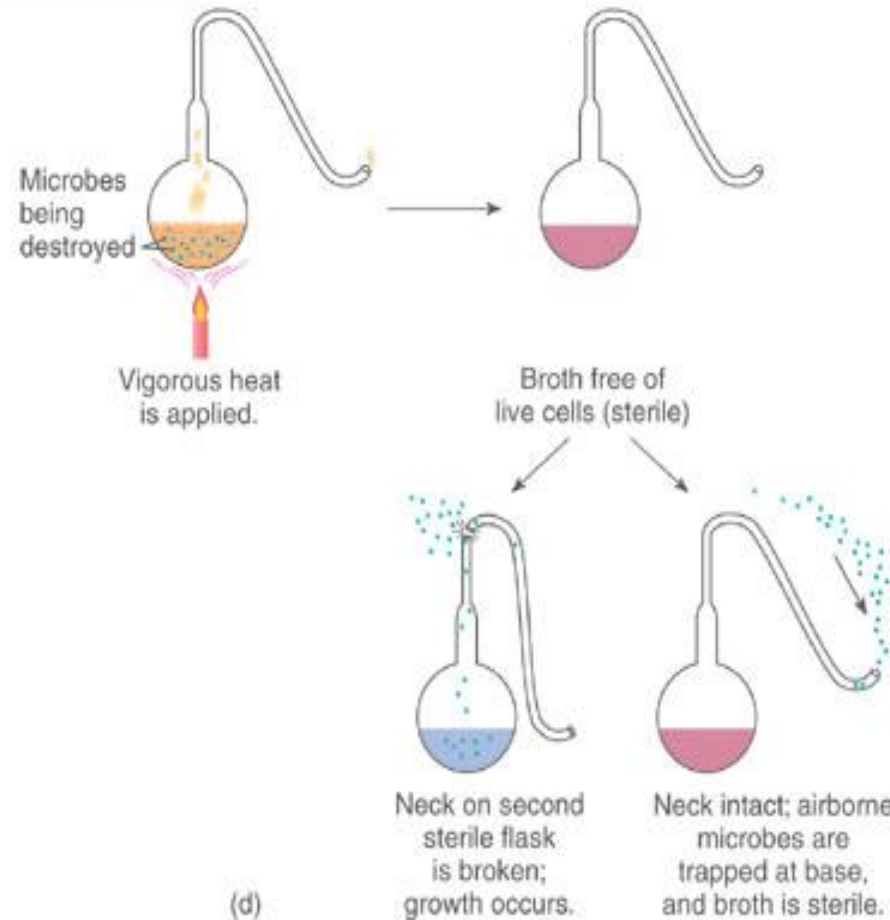
# Spontaneous Generation

- Louis Pasteur
  - Used swan-neck flask
  - Boiled broth
  - Open to the air
  - No growth unless broth was washed into the curved neck

### Shultze and Schwann's Test



### Pasteur's Experiment



(d)

# 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.

# Germ Theory of Disease

- Koch's Postulates
  1. Microbes present in samples of diseased animal
  2. Grow organism in pure culture
  3. Inject healthy animal with cultured cells
  4. Animal develops same disease

# Robert Koch

- Established a sequence of experimental steps to show that a specific m.o. causes a particular disease.
- Developed pure culture methods.
- Identified cause of anthrax, TB, & cholera.

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(1843-1910)

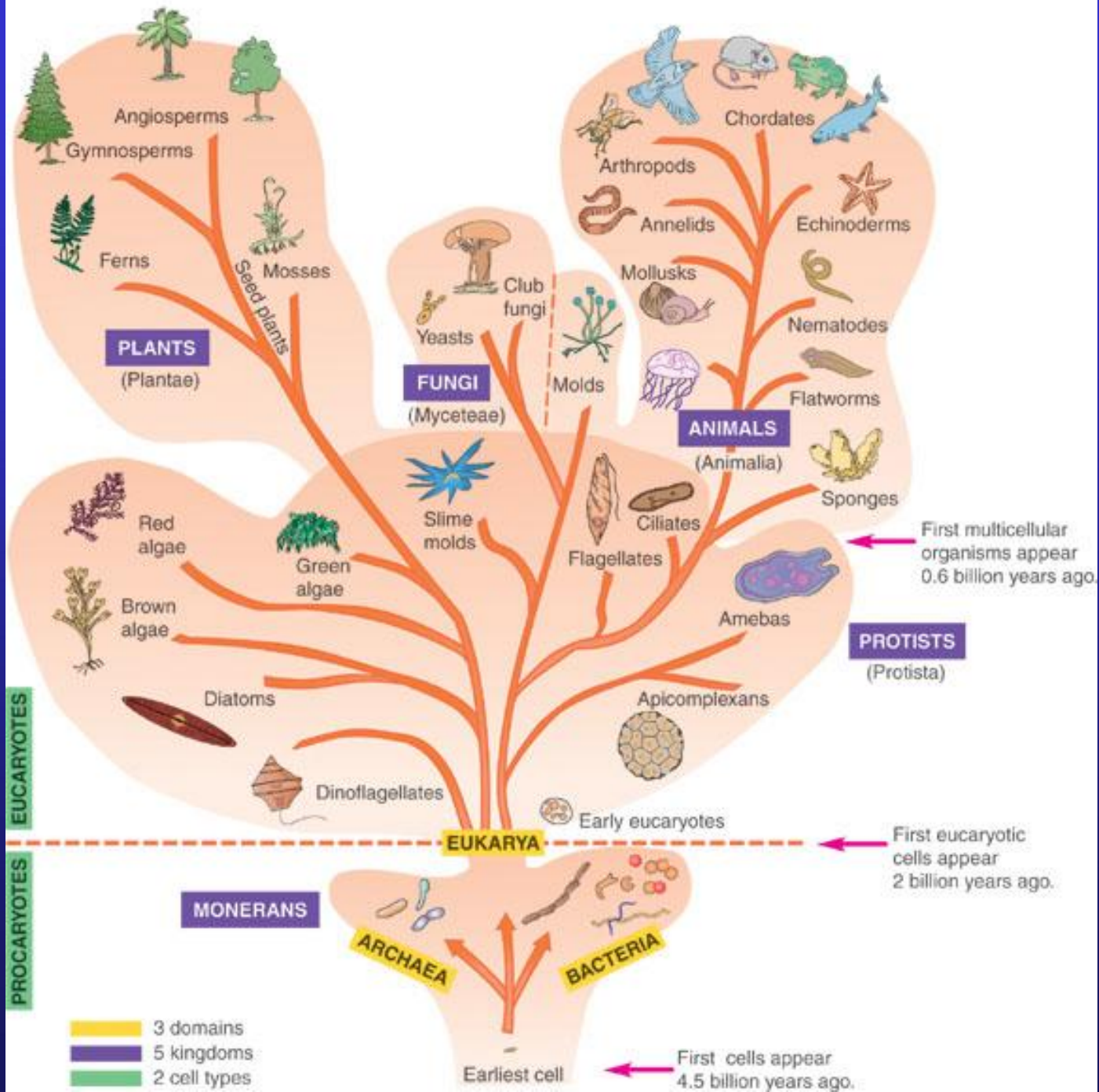
# Edward Jenner and Immunity

- Observation:
  - Dairymaids who had mild cowpox infections were protected from smallpox
- Hypothesis
  - Cowpox infection provides protection against smallpox
- Experiment
  - Inoculated boy with cowpox fluid and later challenged with smallpox fluid
- Result
  - Boy did not get smallpox

# Taxonomy - system for organizing, classifying & naming living things

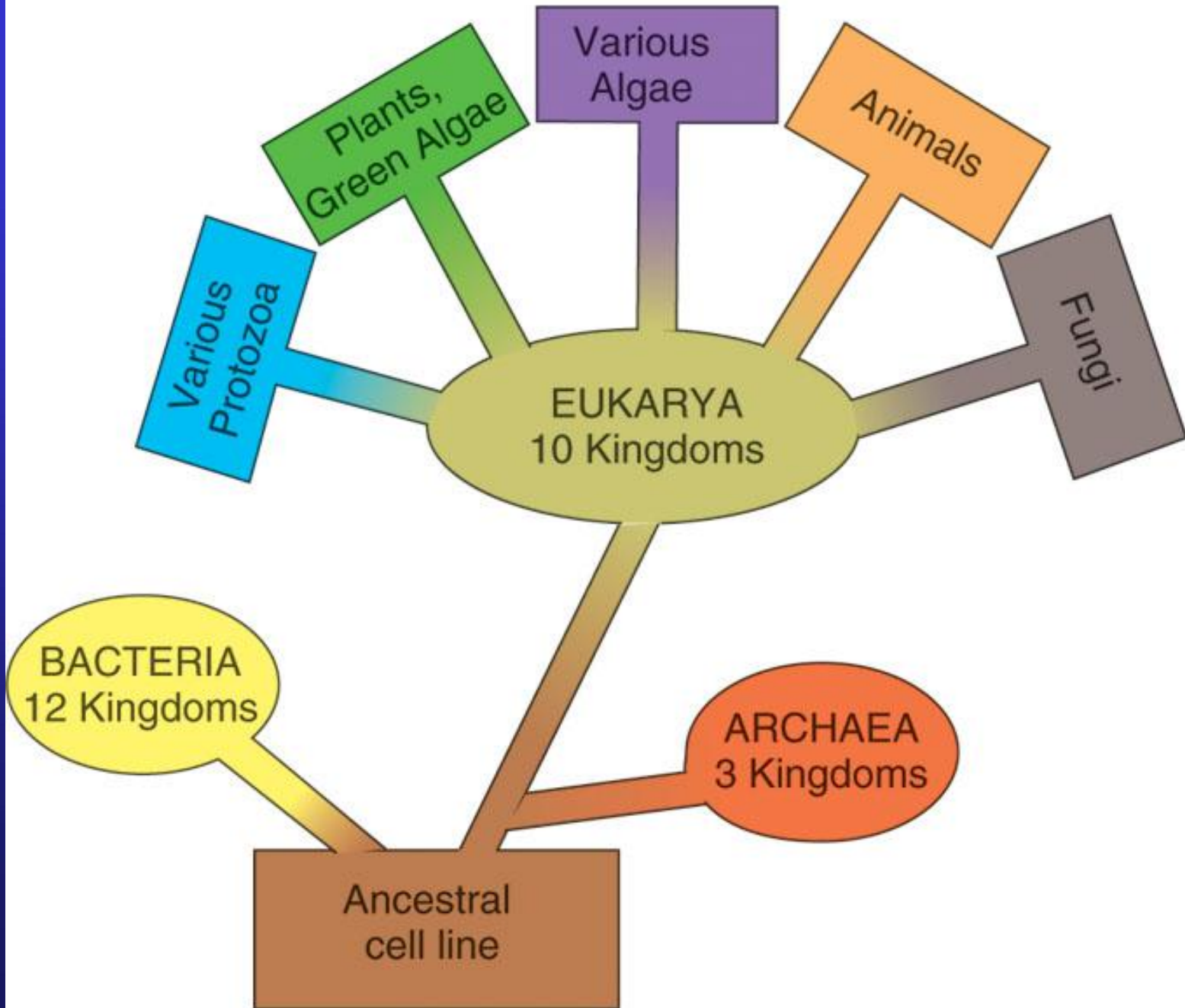
- Domain - Archaea, Bacteria & Eukarya
- Kingdom - 5
- Phylum or Division
- Class
- Order
- Family
- Genus
- species





# 3 domains

- Eubacteria -true bacteria, peptidoglycan
- Archaea –odd bacteria that live in extreme environments, high salt, heat, etc
- Eukarya- have a nucleus, & organelles



# The Scope of Microbiology

- Six subgroups
  - Bacteria: Prokaryotic
  - Archaea: Prokaryotic
  - Algae: Eukaryotic
  - Fungi: Eukaryotic
  - Protozoa: Eukaryotic
  - Viruses: Acellular

# Naming microorganisms

- Binomial (scientific) nomenclature
- Gives each microbe 2 names
  - **Genus** - noun, always capitalized
  - **species** - adjective, lowercase
- Both italicized or underlined
  - *Staphylococcus aureus* (*S. aureus*)
  - *Bacillus subtilis* (*B. subtilis*)
  - *Escherichia coli* (*E. coli*)

# Evolution- living things change gradually over millions of years

- Changes favoring survival are retained & less beneficial changes are lost.
- 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.

# Microbiology Today

- Virology
  - study of viruses
- Basic biology
  - metabolism and genetic properties similar to plants and animals
  - microorganisms suited for experimental investigation
- Genetic engineering and genomics
  - recombinant DNA
  - genomics

# Microbiology Today

- Chemotherapy
  - Paul Ehrlich
    - Selective toxicity: successful drug activity
    - Drug for syphilis
  - Synthetic drugs
    - Sulfa drugs
  - Antibiotics
    - Penicillin
- Immunology
  - Independent and fast-developing science



Welcome to  
Microbiology

Dr. P

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