



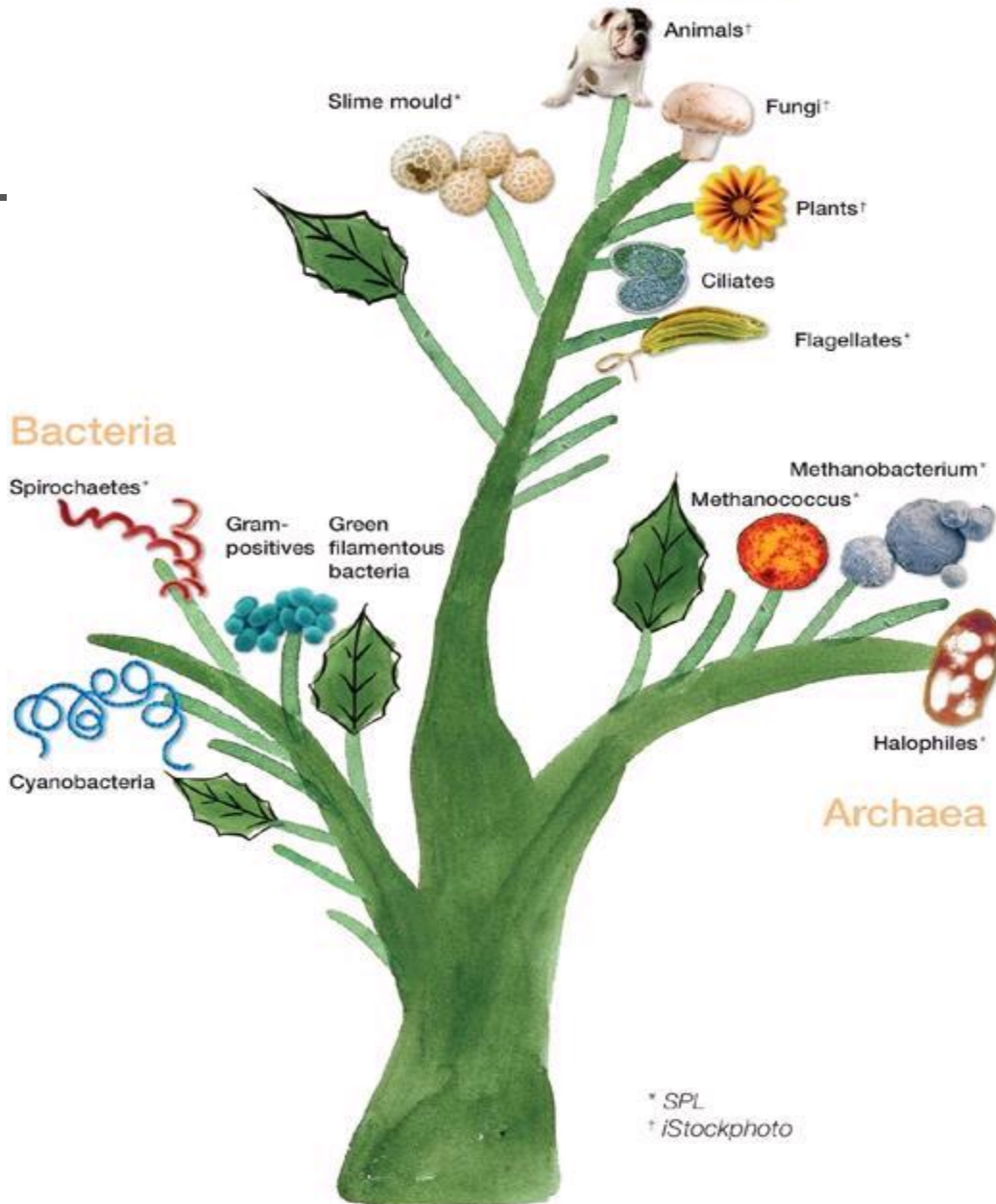
# INTRODUCTION AND HISTORY OF BACTERIOLOGY

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# TREE OF LIFE

## Eukaryotes



\* SPL  
† iStockphoto

# THE CELL

The cell is the fundamental unit of life; all organisms are made of cells.

A cell exchanges matter and energy with its environment and responds to its surroundings.

Life at the cellular level arises from the structure and function of the parts of the cell, but a cell is a living unit greater than the sum of its parts.

A basic unit of living matter separated from its environment by a plasma membrane.

## Unifying Properties of Cells

- All cells contain common functional and structural properties:
  - **Cytoplasmic membrane** (boundary between the living cell and the environment)
  - **Cytoplasm** (fluid substance where biological reactions take place)
  - **DNA** (hereditary material)
  - **Ribosomes** (translation of genetic information into proteins, the molecules that perform the metabolic functions of the cell)
  - **ATP** ('universal energy currency')



OXYGEN  
LEVELS IN  
ATMOSPHERE  
(%)

10

TIME  
(BILLIONS  
OF YEARS)

0

1

2

3

4

present day

formation of  
oceans and  
continents

formation  
of the earth

first  
living  
cells

first water-splitting  
photosynthesis  
releases  $O_2$

first photosynthetic  
cells

aerobic  
respiration  
becomes  
widespread

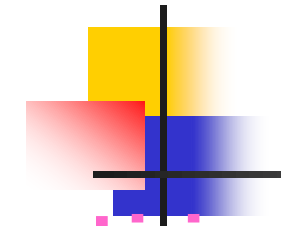
origin of eucaryotic  
photosynthetic cells

first vertebrates

first multicellular plants  
and animals

start of rapid  $O_2$   
accumulation ( $Fe^{2+}$   
in oceans used up)

# THE SCOPE AND RELEVANCE OF MICROBIOLOGY



- Living things too small to be seen with the unaided eye are called microorganisms
- Microorganisms are everywhere on Earth
- helped to create the biosphere
- continue to support the life processes on earth.
- live in some of the most unusual and seemingly inhospitable places.
- one of the oldest living organisms on the Earth
- of all the cells that make up the normal, healthy human body, more than 99 per cent are the cells of microorganisms living on the skin or in the gut, etc.

- **There are three major types of cellular microorganisms (bacteria, protists, fungi).**
- **These three types of microorganisms have two distinct ways of getting carbon to use as building blocks for body structures (Autotroph and Heterotroph).**
- **Autotrophs get the carbon from CO<sub>2</sub> in the atmosphere.**
- **Autotrophs are more plant-like, and are known as producers.**
- **Heterotrophs must ingest their carbon in the form of other organic materials ranging from dead or living plants to meat from animals.**
- **Heterotrophs can be considered more animal like, and are known as consumers.**



Bacteria

Protists

Fungi

Autotroph

**Gets carbon from atmosphere**

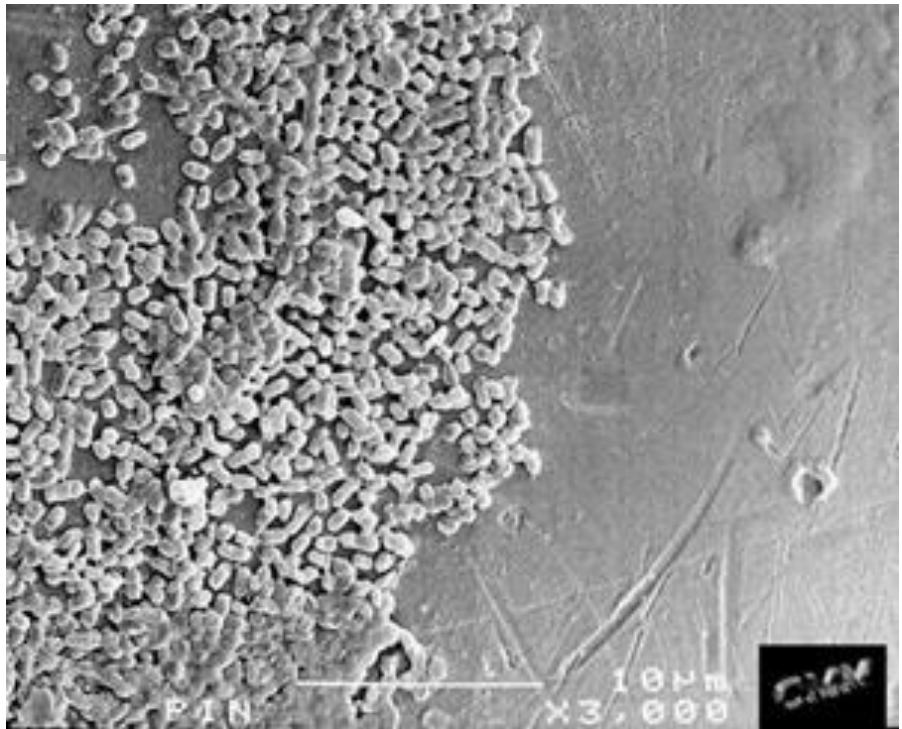
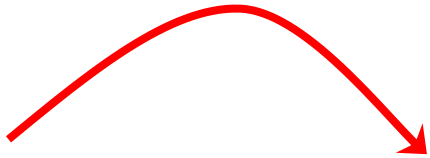
More  
plant-like  
(producer)

Heterotroph

**Gets carbon from organic materials**

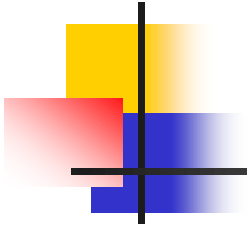
More  
animal-like  
(consumer)





Microorganisms can range in size from very small, such as these bacteria on the point of a pin.....

to exceptionally large. Some bacterial cells can be the size of a fly's head.





Microorganisms inhabit diverse habitats ranging from very salty environments such as the Great Salt Lake.... (orange color are salt loving bacteria)

to deep sea vents at the bottom of the ocean (white on column)...

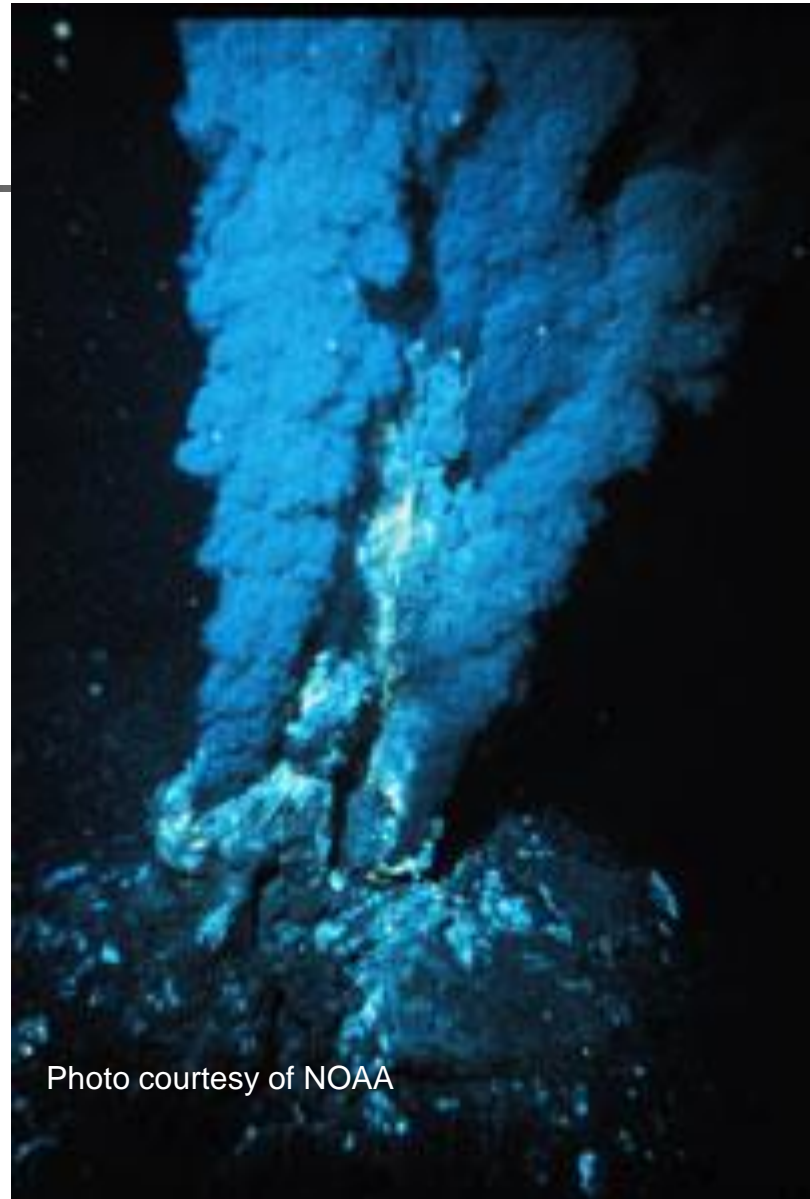


Photo courtesy of NOAA

to very hot environments such as this hot spring (orange).....

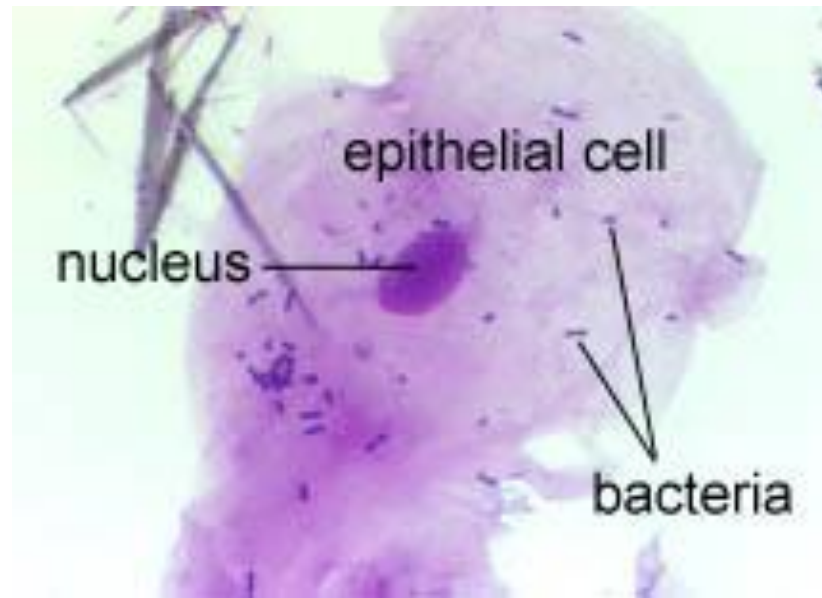




ASM.MicrobeLibrary.org © Fisher

Lime green mats of *Cyanidium* algae predominate in the runoff from highly acidic hot springs.

to as a normal flora in human mouth



more prokaryotes inhabit a human mouth than the total number of people who have ever lived

# MICROBES AND HUMAN WELFARE

- Microorganisms degrade dead plants and animals (saprophytes; saprophytic) and recycle chemical elements to be used by living plants and animals.

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- Element cycling on earth, especially carbon and nitrogen.

- Important in the nutrition of all organisms.; the ruminant animals would not survive if it were not for the bacteria present in their guts.

- Bacteria decompose organic matter in sewage.

- Ferment substrates to produce important metabolites

- Make products such as foods and chemicals.

- Bioremediation processes use bacteria to clean up toxic wastes.

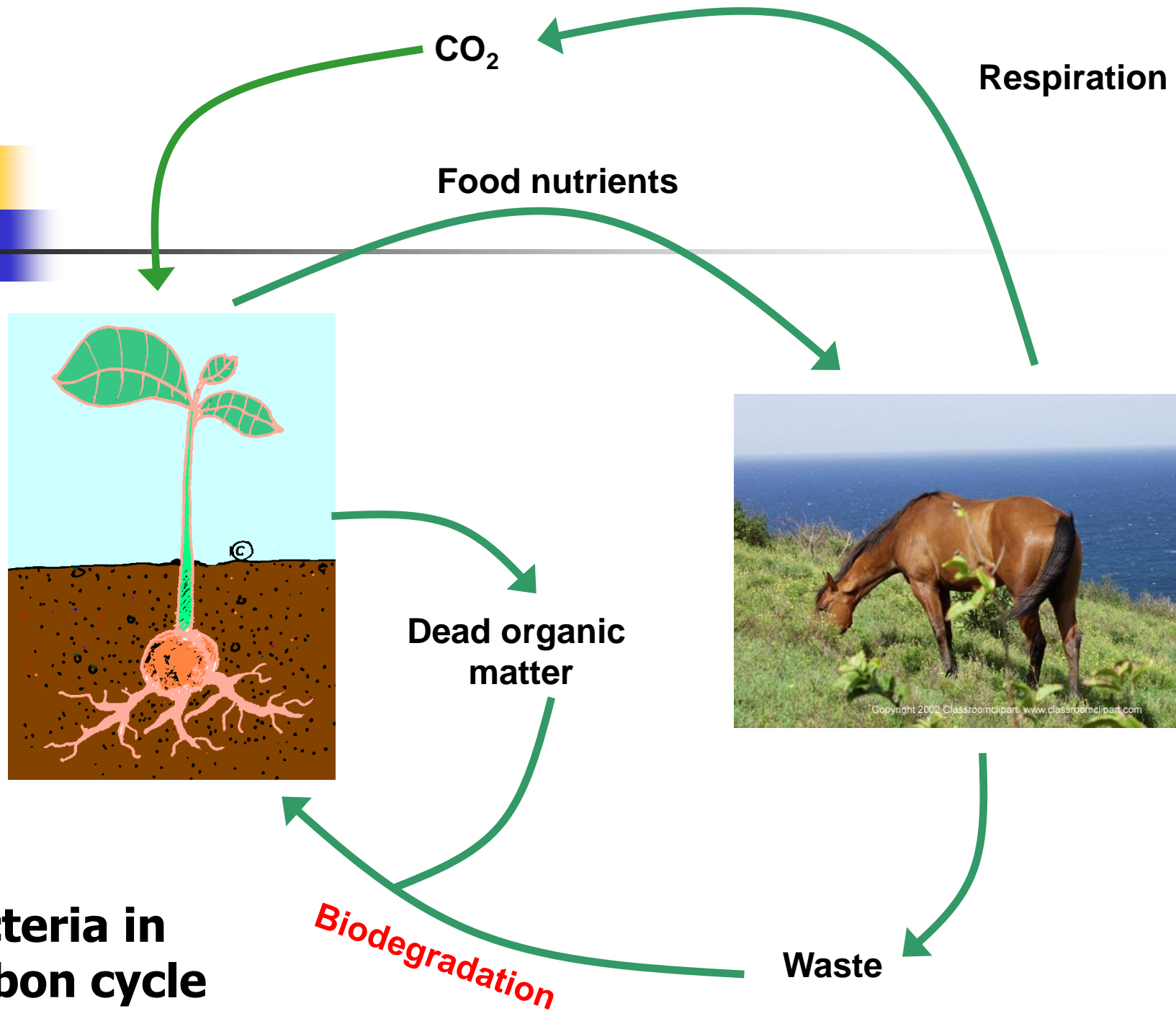
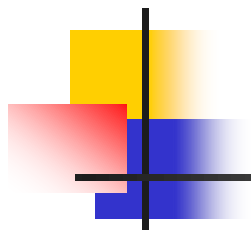
- Biological pest control

- Using recombinant DNA, bacteria can produce substances such as single cell proteins, vaccines, and enzymes.

- In gene therapy, viruses are used to carry replacements for defective or missing genes into human cells.

- Genetic engineering is used in agriculture to protect plants from frost and insects and to improve the shelf life of produce.





**Bacteria in  
carbon cycle**

# Bioremediation for an oil spill





ASM MicrobeLibrary.org © Burks

**Spirulina – a rich source of protein**

# BACTERIA AND HUMANS

- DISEASE
- The scientific study of disease is called PATHOLOGY
- Bacteria that cause disease are called PATHOGENS

**Infection** is the invasion of the host by microorganisms, which then multiply in close association with the host's tissues. Infection is distinguished from disease, a morbid process that does not necessarily involve infection (diabetes, for example, is a disease with no known causative agent). Bacteria can cause a multitude of different infections, ranging in severity from inapparent to fulminating.

# Major Groups of Microorganisms

## Microbial Group

## Structure

Viruses

No Cell

Archebacteria

Prokaryotic cell

Eubacteria

Prokaryotic cell

Fungi

Eukaryotic cell

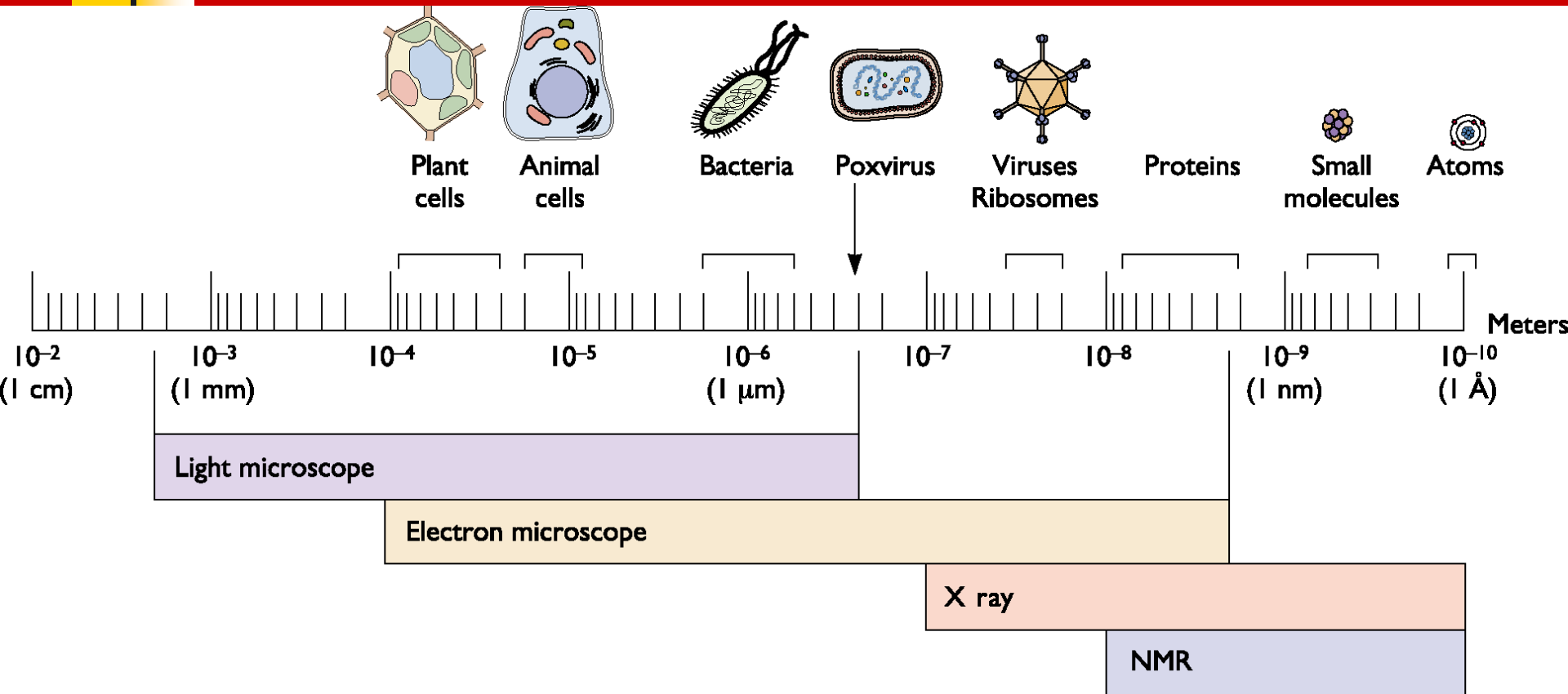
Algae

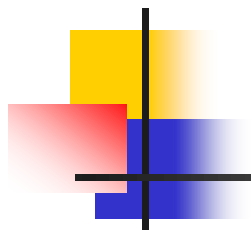
Eukaryotic cell

Protozoa

Eukaryotic cell

# Sizes of microscopic and submicroscopic biological entities and their ability to be examined using various technologies





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# HISTORY OF MICROBIOLOGY



# THEORY OF SPONTANEOUS GENERATION

- This theory states that living beings are produced spontaneously from non living matter. The formation of life from non living matter is called **abiogenesis**.
- **Francesco Redi** (1688) an Italian physician disproved the idea of *spontaneous generation* by showing that rotting meat carefully kept from flies will not spontaneously produce maggots. He filled six jars with decaying meat and covered three of them with lids . After several days meat in the open jars had maggots while the meat in the sealed jars had no maggots.
- **Spallanzani** (1769), a monk, boiled and sealed broths. When he was careful no microbes developed.
- **Needham** criticized this work. He said that factors, such as air was excluded by Spallanzani that prevented Spontaneous Generation.
- **Rudolph Virchow** (1858) claimed that living cells can only arise from preexisting living cells. This concept is called **biogenesis**.
- **Louis Pasteur** (1861) took up the challenge, performed the classical **Swan neck flask experiment**, utilized broths allowing air (cotton plugs) but disallowing microbes and showed that the germs accumulated on cotton.

# GERM THEORY OF DISEASE



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- **Germ theory** states that infectious diseases are caused by microbes. It was proposed by Robert Koch in 1876 and supported by Louis Pasteur. During the golden age of microbiology (1857-1914) the germ theory of disease was proposed in opposition to the then belief that disease was a punishment for crimes or caused by demon.
- **Joseph Lister** proved that pathogenic microbes could be transmitted from patient to patient in surgical wards if physicians hands were not washed, instruments were not sterilized and surgical wounds were not disinfected (**concept of asepsis**), which further supported the “Germ Theory of Disease”.

# **MILESTONES IN HISTORY OF MICROBIOLOGY**

**1677**

**Observed "little animals" (Antony Leeuwenhoek)**

**1796**

**First scientific Small pox vaccination (Edward Jenner)**

**1850**

**Advocated washing hands to stop the spread of disease (Ignaz Semmelweis)**

**1861**

**Disproved spontaneous generation (Louis Pasteur)**

**1862**

**Supported Germ Theory of Disease (Louis Pasteur)**

**1867**

**Practiced antiseptic surgery (Joseph Lister)**

**1876**

**First proof of Germ Theory of Disease with *B. anthracis* discovery (Robert Koch)**

**1881**

**Growth of Bacteria on solid media (Robert Koch)**

**1882**

**Outlined Kochs postulates (Robert Koch)**

**1882**

**Developed acid-fast Stain (Paul Ehrlich)**

**1884**

**Developed Gram Stain (Christian Gram)**

**1885**

**First Rabies vaccination (Louis Pasteur)**

**1887**

**Invented Petri Dish (R.J. Petri)**

**1892**

**Discovered viruses (Dmitri Iosifovich Ivanovski)**

**1899**

**Recognized viral dependence on cells for reproduction  
(Martinus Beijerinck)**

**1900**

**Proved mosquitoes carried the yellow fever agent (Walter  
Reed)**

**1928**

**Discovered Penicillin (Alexander Fleming)**

**1975**

**Hybridoma technology**

**1977**

**Developed a method to sequence DNA (W. Gilbert & F. Sanger)**

**1983**

**Polymerase Chain Reaction invented (Kary Mullis)**

**1995**

**First microbial genomic sequence published (*H. influenzae*) (TIGR)**

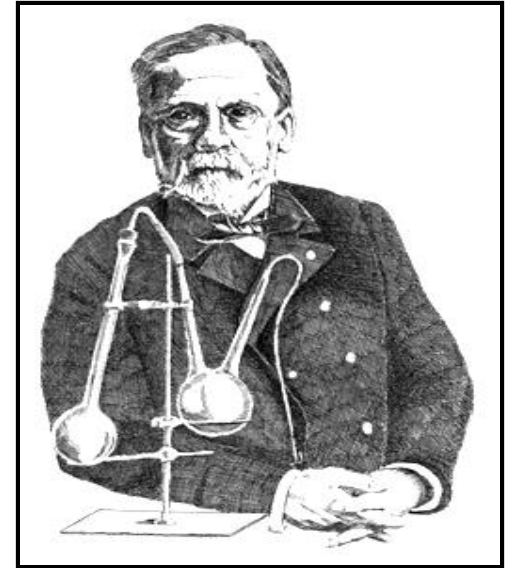
# STALWARTS OF MICROBIOLOGY



**Leeuwenhoek  
(Microscopy)**

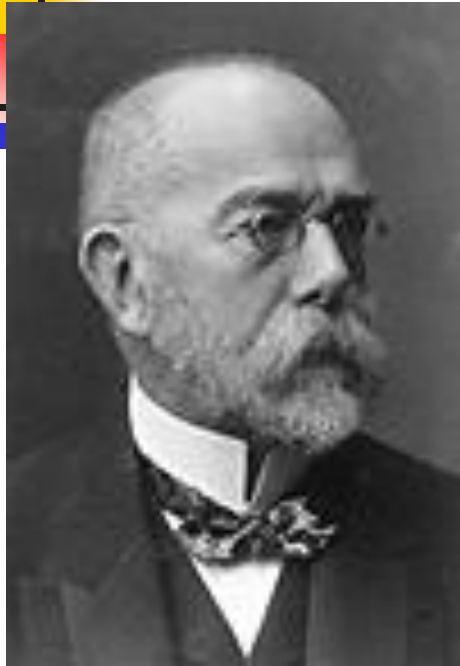


**Edward Jenner  
(Vaccinology)**



**Louis Pasteur  
(Microbiology)**

# STALWARTS OF MICROBIOLOGY



**Robert Koch**  
**(Med. Microbiology)**



**Joseph Lister**  
**(Antisepsis)**



**Alexander Fleming**  
**(Antibiotics)**

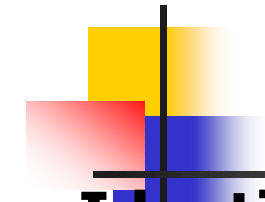


# Louis Pasteur (1822-1895)

- Showed that boiled broth did not become cloudy (turbid) when air but not dust could contact the broth.
- Built elegant "swan-necked" flasks, which trapped dust (and microorganisms) along their curved necks, thus showing that neither air nor broth were sufficient to allow the generation of microorganisms (Theory of Biogenesis)
- Showed that cotton plugs (a primitive air-filtration device) could prevent microbes from reaching otherwise air-exposed sterile broths
- Invented pasteurization, the heating of foods to eliminate harmful microorganisms while retaining not-harmful microorganisms
- He was responsible for the association of specific microbes with diseases
- He developed the vaccines for anthrax, fowl cholera, rabies and swine erysipelas.
- He discovered *Staphylococcus*, *Streptococcus* and *Pneumococcus*

**FATHER OF MICROBIOLOGY**

# Robert Koch (1843-1910)



- **Identified the bacteria that cause anthrax, tuberculosis, cholera.**
- **Contributed significantly to the development of pure culture technique.**
- **Introduction of agar to microbiology.**
- **Koch's Postulates, a way of ascribing a particular infectious disease to a particular, causing microorganism.**
- **Delayed type of hypersensitivity.**

**FATHER OF MEDICAL MICROBIOLOGY**

# Koch-Henle's Postulates



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- 1. The microorganisms must be present in every case of the disease but absent from healthy organisms**
- 2. The suspected microorganisms must be isolated and grown in a pure culture.**
- 3. The same disease must result when the isolated**
- 4. The same microorganisms must be isolated again from the diseased host.**