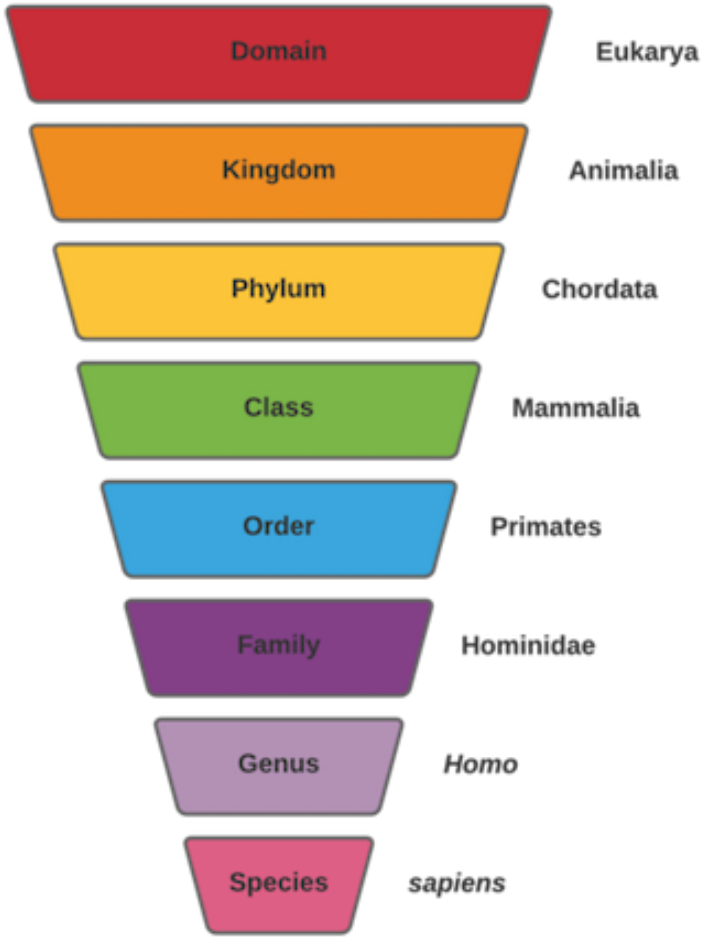
Introduction to Microbiology

MEDEMIA ACADEMY

Taxonomy

- **Taxonomy** is the science of classifying and naming living organisms
- The highest rank in taxonomy is **domain**, with three recognized domains: **Bacteria**, **Archaea**, and **Eukarya**
- Some older or simplified systems skip domains, focusing on 5 (old) or 6 **kingdoms** instead
- Scientific naming uses the *Genus* and the *species* of the organism, and both are italicized
  - **Genus**: begins with capital letter
  - **Species**: begins with a small letter
  - **Examples**
    - *Staphylococcus aureus* (S. aures)
    - *Fasciola hepatica* (F. hepatica)



Kingdom classification of Organisms

Five Kingdom classification of Organisms				
↓	↓	↓	↓	↓
Monera	Protista	Fungi	Plantae	Animalia
Bacteria Archaea	Protozoa Algae	Molds Yeasts		

Six Kingdom classification of Organisms					
↓	↓	↓	↓	↓	↓
Bacteria	Archaea	Protista	Fungi	Plantae	Animalia

Microbiology

- **Microbiology** is the science dealing with tiny organisms, invisible to the naked eye, named microbes or microorganisms.
- **Microorganisms** are **omnipresent** (nearly found everywhere in nature like air, soil, water, food we eat, surfaces of our body and inside alimentary canal)
- **Microorganisms** grow where they get food moisture and temperature suitable for growth
- **Distribution of microorganisms**
  - The majority of microorganisms thrive independently in environments like soil and water, playing a crucial role in maintaining the ecosystem.
  - Some microorganisms inhabit humans and animals, where they are essential for sustaining health.
  - Only a small fraction of microorganisms are pathogenic, causing diseases in humans and animals.

Why do we study Microbiology?

- They are found in all environments
- Related to life processes (food chains, nutrient cycling)
- They have many **beneficial aspects**
  - **Agriculture** → Recycling of elements, Nitrifying bacteria
  - **Food** → Bread, Cheese, Yoghurt, Vinegar
  - **Industrial applications** → Enzymes, Amino acids, Vitamins, Antibiotics, Vaccines, Pharmaceutical industries, Sewage treatment
- The **harmful minority** are responsible of a majority of our problems
  - Food spoilage
  - Diseases

Microbiology Subdivisions (branches)

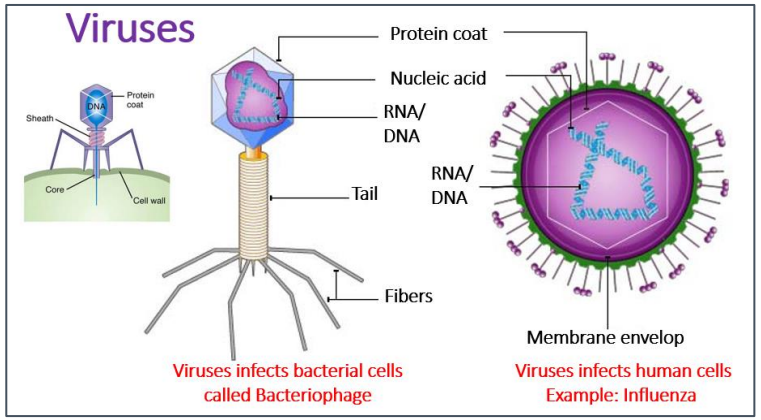
Virology	Bacteriology	Mycology	Parasitology	Algology or Phycology
↓	↓	↓	↓	↓
The science that study **viruses**, non-cellular living agents capable of causing infectious diseases in man	The science that study **bacteria**, the causative agents of several infectious diseases	The science that study **fungi** pathogenic for man	The science that study **parasites** pathogenic for man e.g., protozoa, helminths worms, and certain insects	The science that study **algae**
↓	↓	↓	↓	

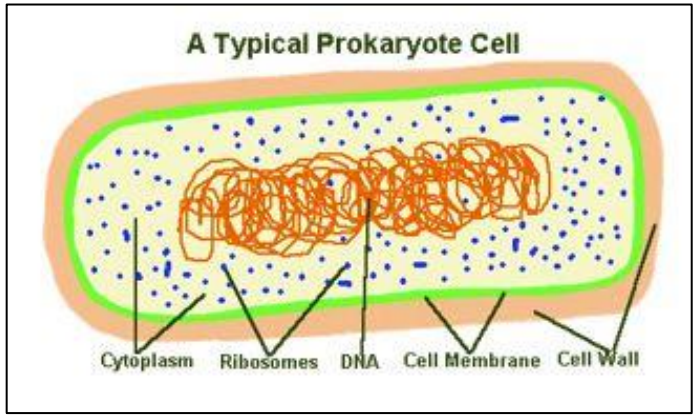
In addition, medical microbiology includes the study of the mechanisms of infection, the methods of diagnosis, specific therapy, and prophylaxis of infectious diseases

Note: Parasitology include **Protozoology** and **Helminthology**

Microorganisms biological classification

Microorganisms	Size	Characteristics
Viruses	0.015-0.2 µm	• They do not grow on artificial media and require living cells for reproduction, making them obligate parasites • Electron microscopy required to observe • **Practical significance**: Cause diseases in humans animals plants, also infect microorganisms
Bacteria	0.2-1.5 by 3-5 µm	• **Prokaryotic**; **Unicellular** • Simple Internal structure • Grow on artificial laboratory media • **Reproduction** asexual (mostly simple cell division)

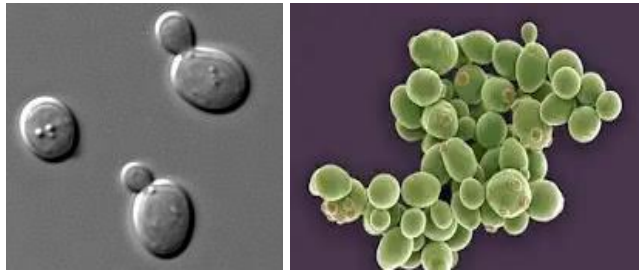


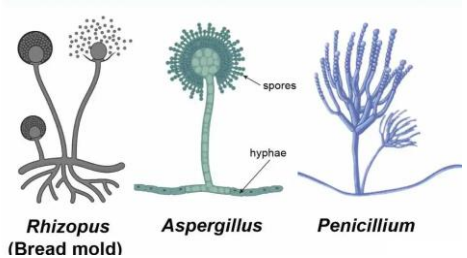


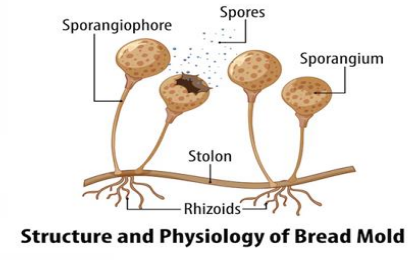
Microorganisms biological classification

Microorganisms		Size	Characteristics
Fungi	**Yeasts**	5.0-10.0 µm	• **Eukaryotic**; **Unicellular** • Grow on artificial laboratory media • **Reproduction** asexual (cell division/ budding) or sexual • **Practical significance**: Some cause diseases and some are used as food supplements and manufacture of alcohol
	Molds	2.0-10.0 µm by several mm	• **Eukaryotic**; **Multicellular** • Many distinctive structural features • Cultivated on artificial laboratory media • **Reproduction** asexual or sexual • **Practical significance**: Decomposition of many materials, Industrial production of many chemicals like antibiotics. • Can cause diseases

Yeasts



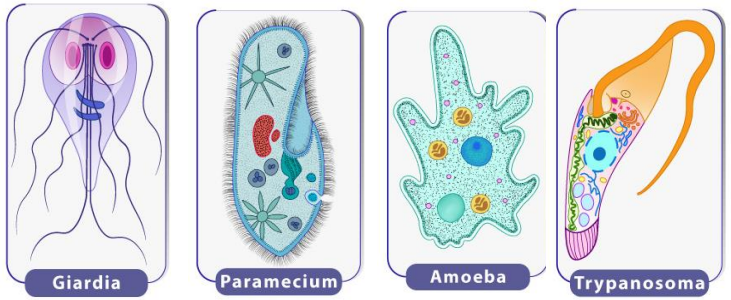




Molds

Microorganisms biological classification

Microorganisms	Size	Characteristics
Protozoa	2.0-200 µm	• **Eukaryotic**; **Unicellular** • Some cultivated on laboratory media while some are intracellular parasites • **Reproduction** asexual or sexual • **Practical significance**: Some cause diseases, Food for aquatic animals.
Algae	1.0 µm to several centimeters	• **Eukaryotic**; **Unicellular** or **Multicellular** • Photosynthetic • Most occur in aquatic environments • **Reproduction** asexual or Sexual • **Practical significance**: Production of food in aquatic environments, Some produce toxic substances.



Microorganisms biological classification – Summery table

	Size	Characteristics	Growth	Reproduction	Significance
Viruses	0.015-0.2 µm	Electron microscopy required to observe	They do not grow on artificial media and require living cells for reproduction, making them obligate parasites		Cause diseases in humans animals plants, also infect microorganisms
Bacteria	0.2-1.5 by 3-5 µm	• Prokaryotic • Unicellular • Simple Internal structure	Grow on artificial laboratory media	Asexual (mostly simple cell division)	
Yeasts	5.0-10.0 µm	• Eukaryotic • Unicellular		Asexual (cell division/ budding) or sexual	Some cause diseases and some are used as food supplements and manufacture of alcohol
Molds	2.0-10.0 µm by several mm	• Eukaryotic • Multicellular • Many distinctive structural features		Asexual or sexual	1. Decomposition of many materials, 2. Industrial production of many chemicals like antibiotics 3. Can cause diseases
Protozoa	2.0-200 µm	• Eukaryotic • Unicellular	• Some grow on laboratory media • Some are intracellular parasites	Asexual or sexual	Some cause diseases, Food for aquatic animals
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The History of Microbiology

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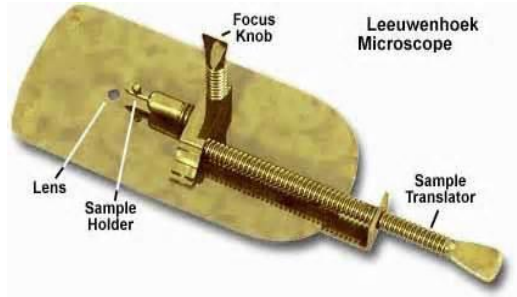
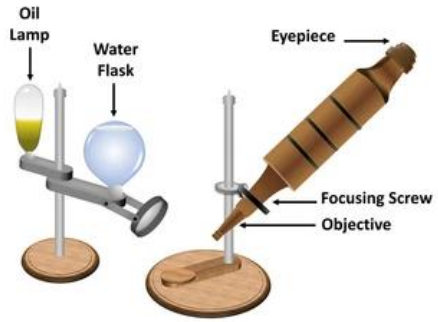
The History of Microbiology

1. Discovery Period (Before 1850s)
2. Transition Period (1850s – 1870s)
3. Golden Period (1870s – Early 20th Century)
4. Molecular Biology Period (Mid-20th Century – Present)

Discovery period – Pioneers of Microbiology

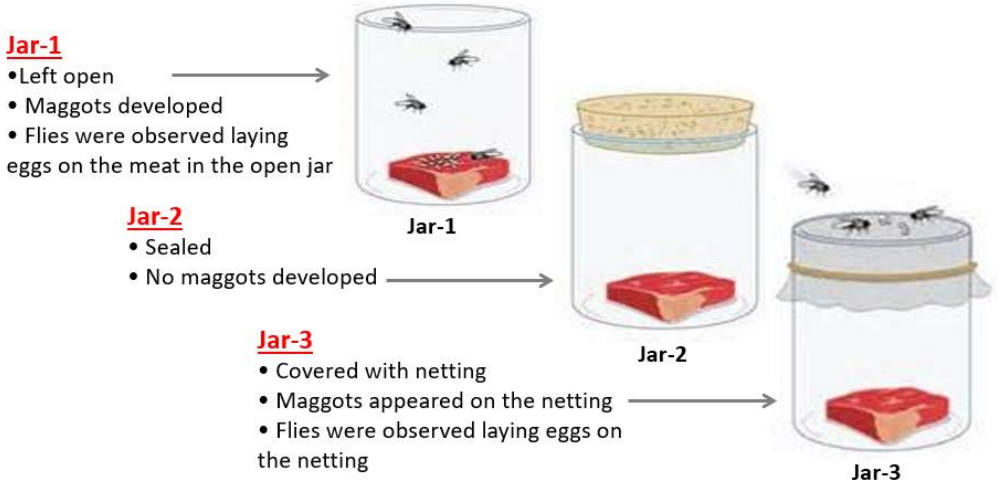
Dominated by Antony Van Leeuwenhoek (1632-1723)	• As a tailor, used lenses to examine cloth. He assembled hundreds of microscopes, some of which magnified objects 50-300 times. • As he looked at things with his microscopes, he discovered “micro” organisms • He called these tiny living organisms “animalcules”. • He first described bacteria and the protozoans.
Robert Hooke (1678)	• Developed Compound microscope • 1st to use the term ‘Cell’ • Proposed the Cell Theory: “All living things are composed of cells”
Ignaz Semmelweis (1846)	Concluded that puerperial sepsis was transmitted by contaminated hands of obstetricians, nurses and medical students. This could be prevented by washing hands in antiseptic solutions





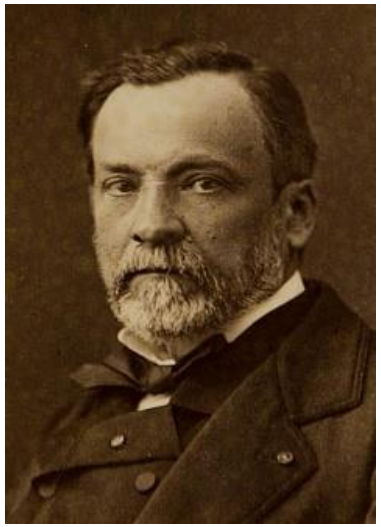
Transition Period

- The scientists disapproved the theory of spontaneous generation
- **Spontaneous generation** is a body of thought on the ordinary formation of living organisms without descent from similar organisms
- How did the scientists disapprove the theory of spontaneous generation?
  - **Redi's Question**: Where do maggots come from?
  - **Hypothesis**: Maggots come from flies.
  - **Experiment**: Redi put meat into three separate jars.



Golden Period

The golden period began with the work of **Louis Pasteur** and **Robert Koch**



- **Louis Pasteur (1822-1895)**: Father of Microbiology
  - Demonstrated anaerobic fermentation by both bacteria and yeasts → bacteria produce acid and yeast produce alcohol
  - Developed pasteurization to prevent spoilage of wine by bacteria
  - Introduction of sterilization techniques.
  - Studies on Anthrax and Cholera
  - Introduced live attenuated (weakened) vaccines [Accidental observation] chicken cholera bacillus cultures left for several weeks. They lost their pathogenicity but retained their ability to protect the chickens from infection. Chicken inoculated pure culture of Chicken Cholera bacteria 8 weeks old Remains Healthy **(Vaccine Concept)**

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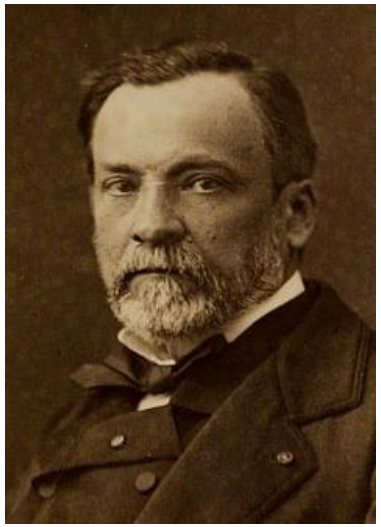

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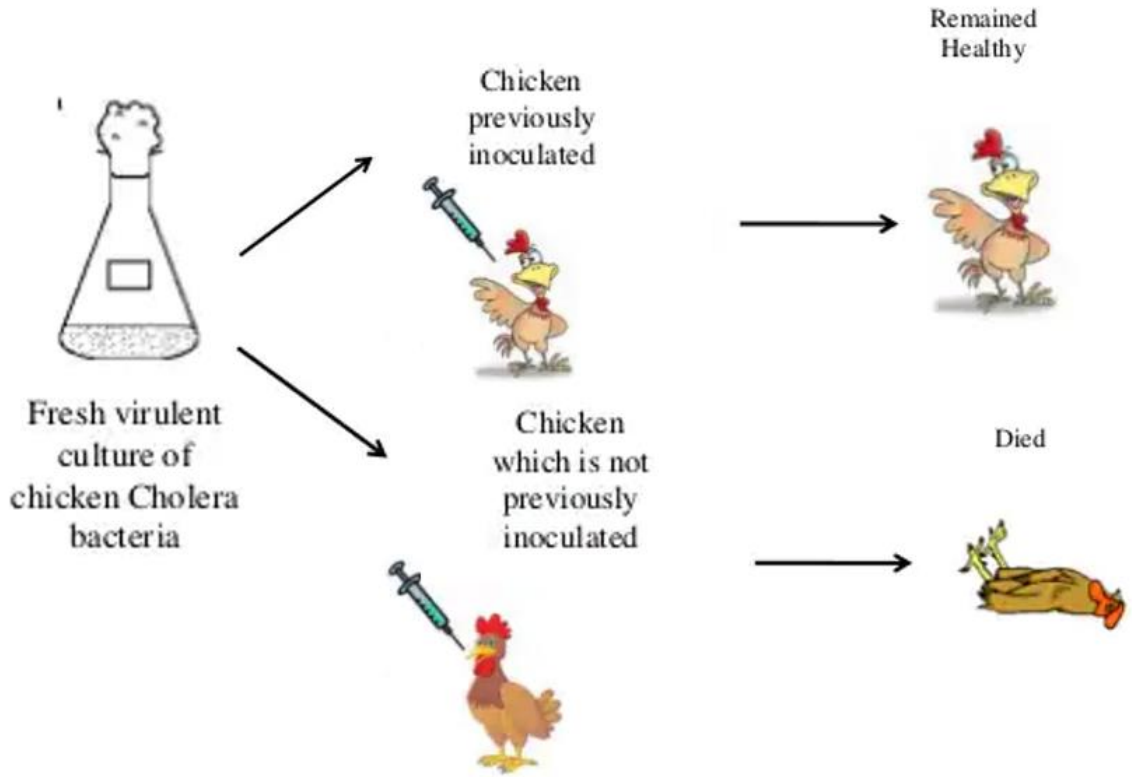
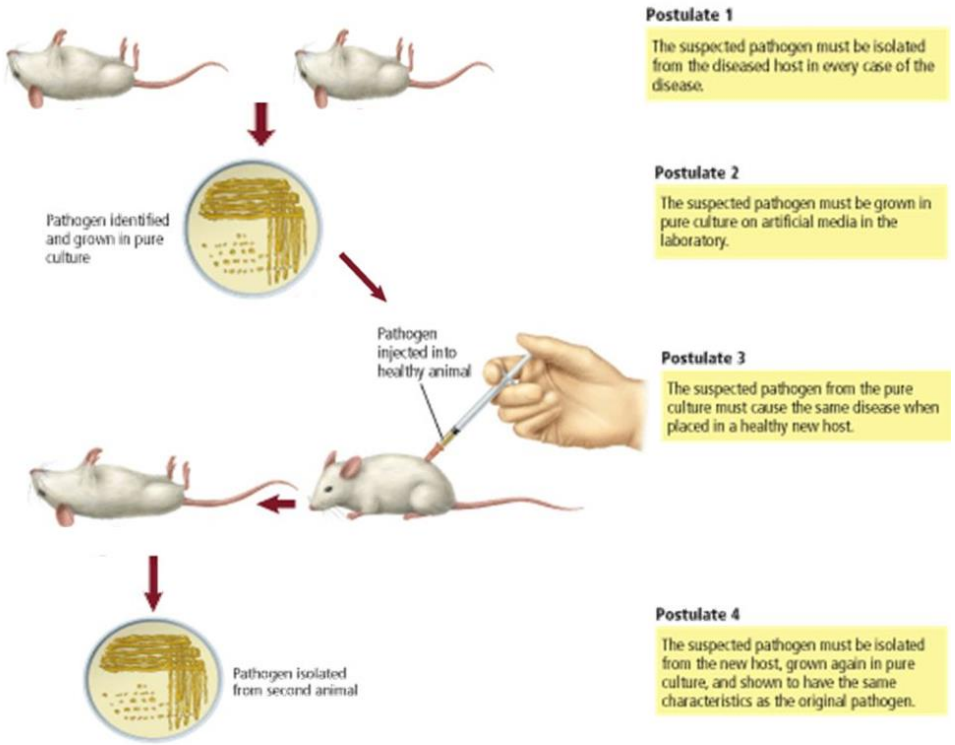


Golden Period

- **Robert Koch (1843-1910)**
  - Introduced methods for isolation of pure culture
  - Use of solid media for isolation of bacteria
  - Bacterial staining techniques
  - Established what is known Kock's postulates: "One microbe, one disease"
  - Discovered Anthrax bacillus (1876), Tubercle bacillus (1882) & cholera (1883)

Golden Period

- **Kock's postulates**: "One microbe, one disease"
  - Robert Koch was the first who demonstrate that a specific disease was caused by a specific microorganism
  - Four criteria designed to establish a causative relationship between a microbe and a disease
    1. The specific causative agent must be found in every case of the disease
    2. The disease organism must be isolated from the lesions of the infected case and maintained in pure culture
    3. The pure culture, inoculated into a susceptible or experimental animal, should produce the symptoms of the disease
    4. The same bacterium should be re-isolated in pure culture from the intentionally infected animal



Golden Period

❖**Dmitri Ivanowski 1864-1920**

- Russian Botanist
- **1892**: He publishes the first evidence of the filterability of a pathogenic agent, the virus of tobacco mosaic disease, launching the field of virology.

❖**Alexander Fleming 1881-1955**

- **1929**: Alexander Fleming publishes the first paper describing penicillin (produced from the mold *Penicillium*) and its effect on gram-positive microorganisms.
- Fleming kept his cultures 2-3 weeks before discarding them. When he looked at one set he noticed that the bacteria seemed to be dissolving and the mold was contaminating the culture.
- When penicillin is finally produced in major quantities in the 1940s, its power and availability effectively launch the "**Antibiotics Era**," a major revolution in public health and medicine