



History and Scope of Microbiology

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Course: General Microbiology (MA 211)

Fall-Semester

Week 1

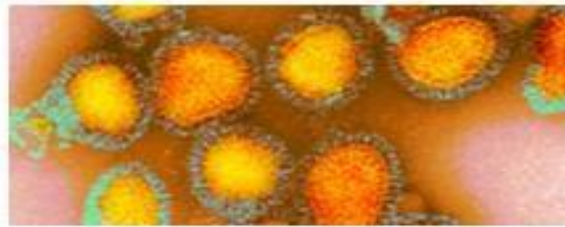
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■ WHAT IS MICROBIOLOGY?

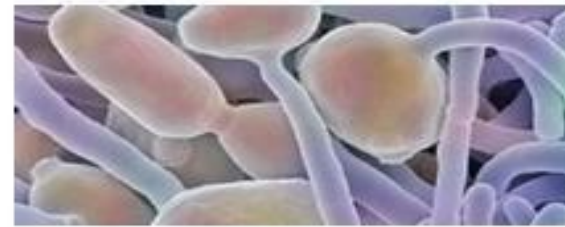
- ✓ Microbiology is the study of all living organisms that are too small to be visible with the naked eye.
- This includes bacteria, archaea, viruses, fungi, prions, protozoa and algae, collectively known as 'microbes'.



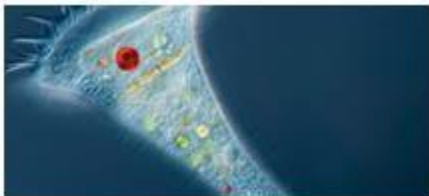
Bacteria



Viruses



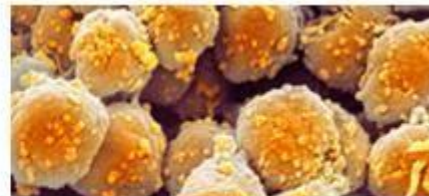
Fungi



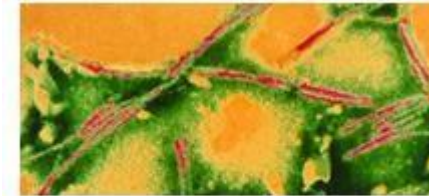
Protozoa



Algae



Archaea



Prions

Subdivisions of Microbiology

- Bacteriology
- Mycology
- Phycology
- Virology
- Protozoology

Branches of microbiology

Applied Microbiology:

- Medical Microbiology
- Food and Dairy Microbiology
- Agriculture Microbiology Water/Aquatic Microbiology
- **Pharmaceutical Microbiology**
- **Industrial Microbiology**
- **Microbial Biotechnology**

- ✓ These microbes play key roles in
 - Nutrient cycling
 - Biodegradation/biodeterioration
 - Food spoilage,
 - The cause and control of disease
 - Biotechnology





- The Brief History of Microbiology:

- ✓ **Antiquity:**

- Microorganisms were observed as early as ancient times.
- The use of microorganisms in food fermentation, such as the production of bread and beer, dates back thousands of years.
- However, the true nature of microorganisms and their role in disease was not understood until much later.

- 17th Century:

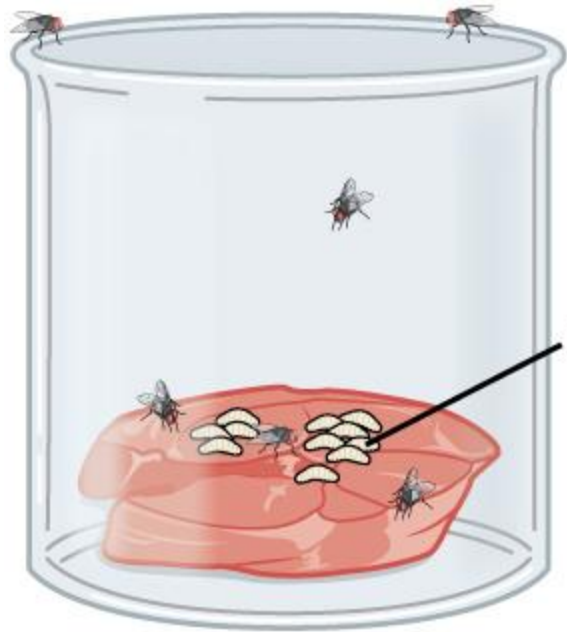
- ✓ Antonie van Leeuwenhoek, a Dutch scientist, is often considered the "Father of Microbiology."
- ✓ 1673-1723, Antoni van Leeuwenhoek described live microorganisms that he observed (**Animalcules**)
- ✓ He designed simple microscopes and was the first to observe and describe single-celled organisms, including bacteria and protozoa.



Leeuwenhoek
Microscope
(circa late 1600s)

The debate over spontaneous generation

- The hypothesis that living organisms arise from nonliving matter is known as **spontaneous generation**. According to spontaneous generation
- The Alternative hypothesis, that the living organisms arise from preexisting life, is called **biogenesis**.



maggots

open container



formation of maggots
in meat



cork-sealed container



no formation of maggots
in meat

maggots



gauze-covered container

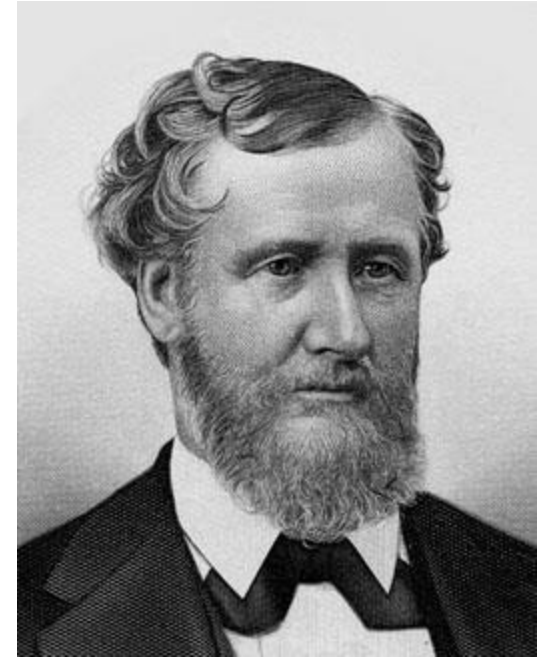
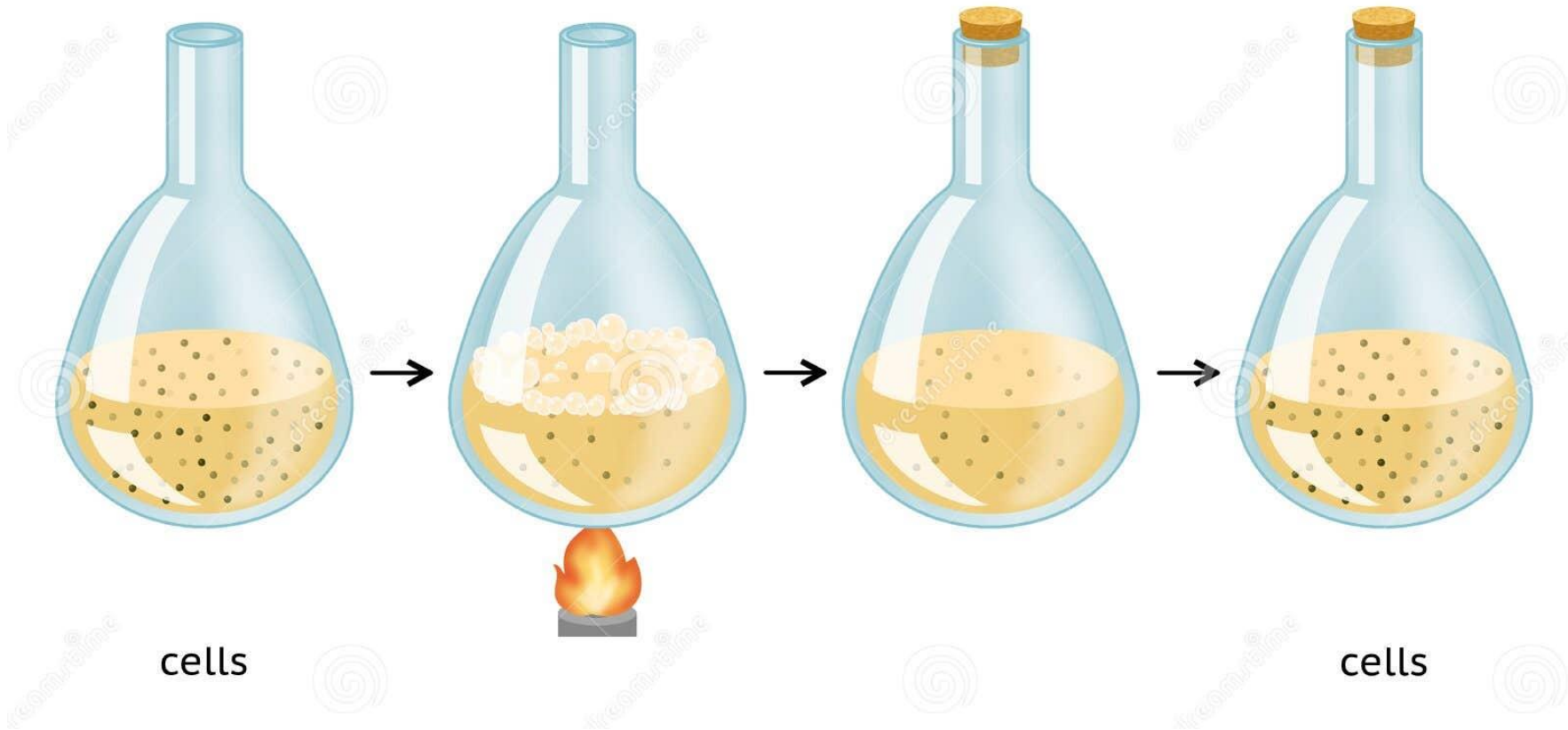


no formation of maggots
in meat

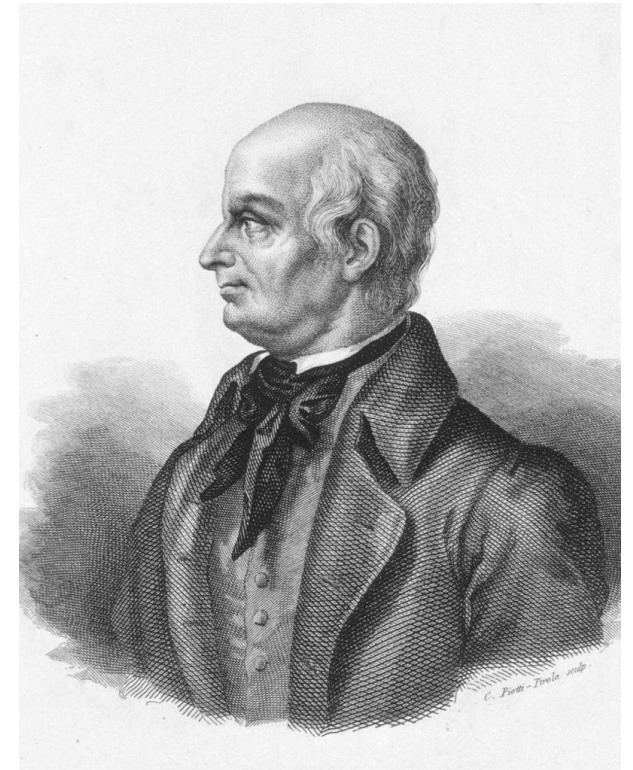
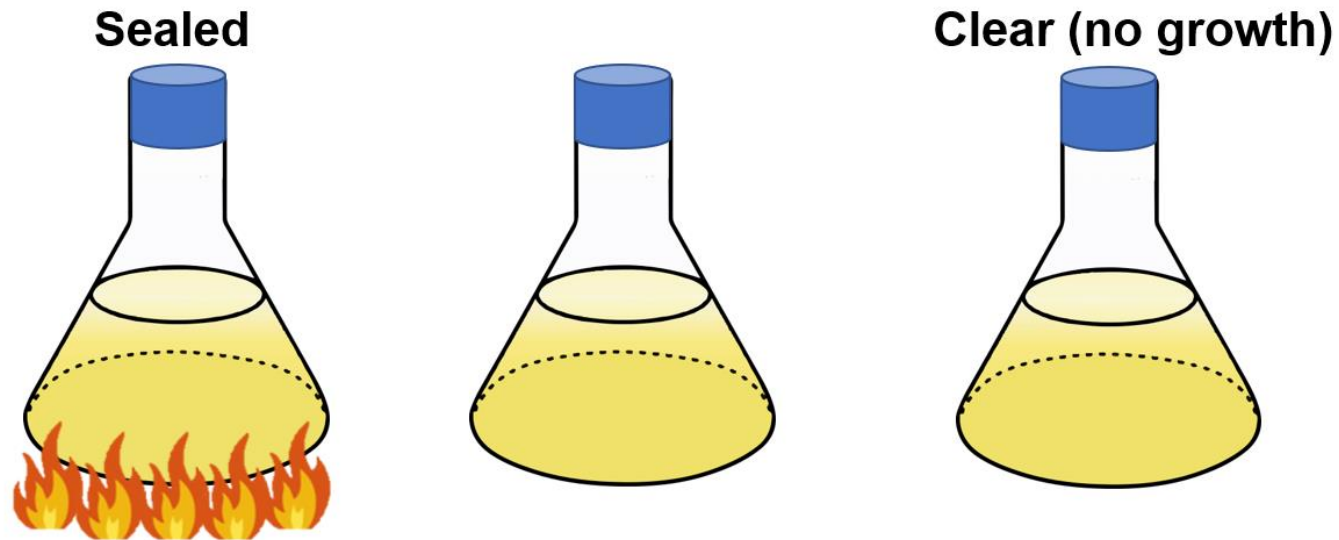
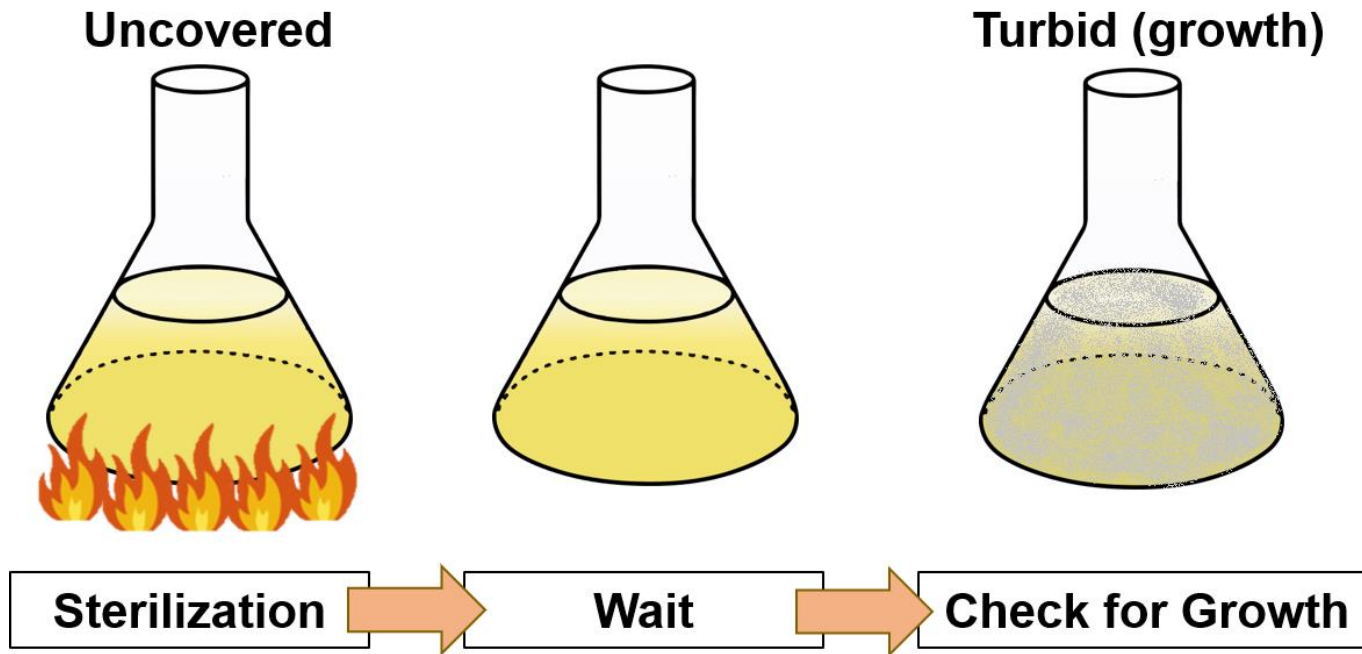


- 18th Century:
- The field of microbiology began to take shape during this century. Scientists like **Lazzaro Spallanzani** conducted experiments that demonstrated the role of microorganisms in **putrefaction**.
- **John Needham**, on the other hand, believed in spontaneous generation, the idea that life could spontaneously arise from non-living matter.

NEEDHAM'S EXPERIMENT



John Needham 1713-1781





- 19th Century:

- Louis Pasteur:

- ✓ A French chemist and microbiologist, conducted numerous experiments that had a profound impact on various scientific fields, particularly microbiology and immunology.

- **Some of his experiments:**

- Fermentation Studies (1857-1860):

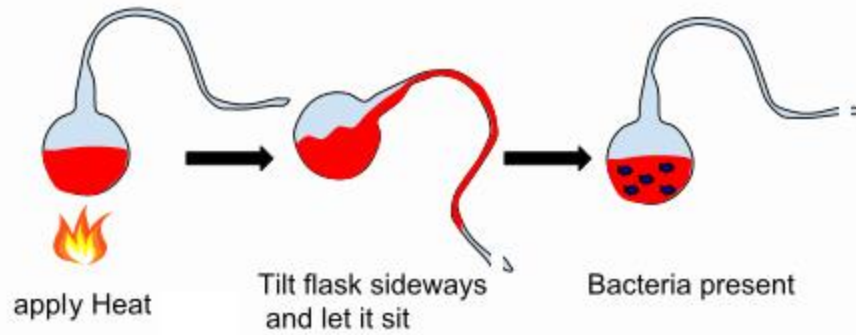
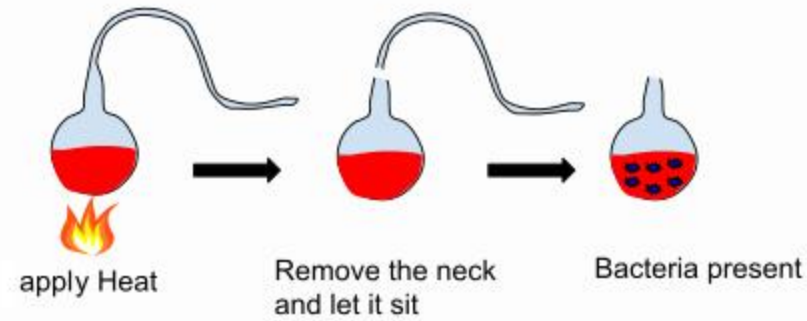
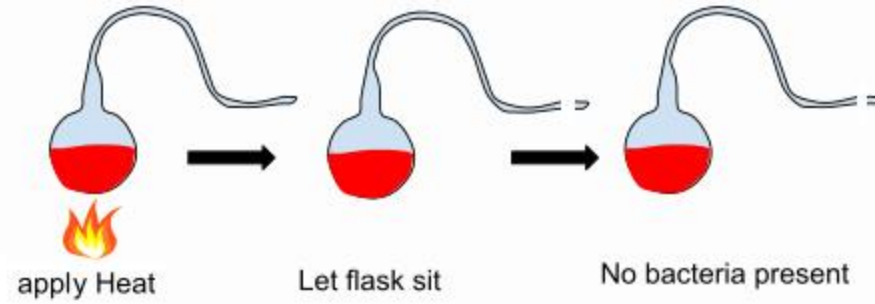
- Louis Pasteur disproving the idea of spontaneous generation; which state that living organisms could arise spontaneously from non-living matter.



- He conducted experiments to demonstrate that microorganisms, particularly yeast, were responsible for fermentation in alcoholic beverages.
- His experiments showed that fermentation occurred when yeast cells were present,
- And he developed the process of pasteurization to kill harmful microorganisms in liquids like wine and milk by heating them to a specific temperature.

The Theory of Biogenesis

- Louis Pasteur:



Germ Theory of Disease (1860s):



Pasteur's work on fermentation led him to the realization that microorganisms played a role in the development of diseases.

He conducted experiments to demonstrate that microorganisms were responsible for causing diseases in animals and humans.

Test the hypothesis that microorganisms, were responsible for fermentation and the spoilage of food and beverages.

This laid the foundation for the germ theory of disease, which revolutionized medicine and our understanding of infectious diseases.



The germ theory of disease

Koch's postulates

- Pathogen must be present in all cases of disease
- Pathogen must be isolated and grown in lab in pure culture
- Pathogen from pure cultures must cause disease when inoculated into healthy, susceptible lab animal
- Same pathogen must be isolated from the diseased lab animal



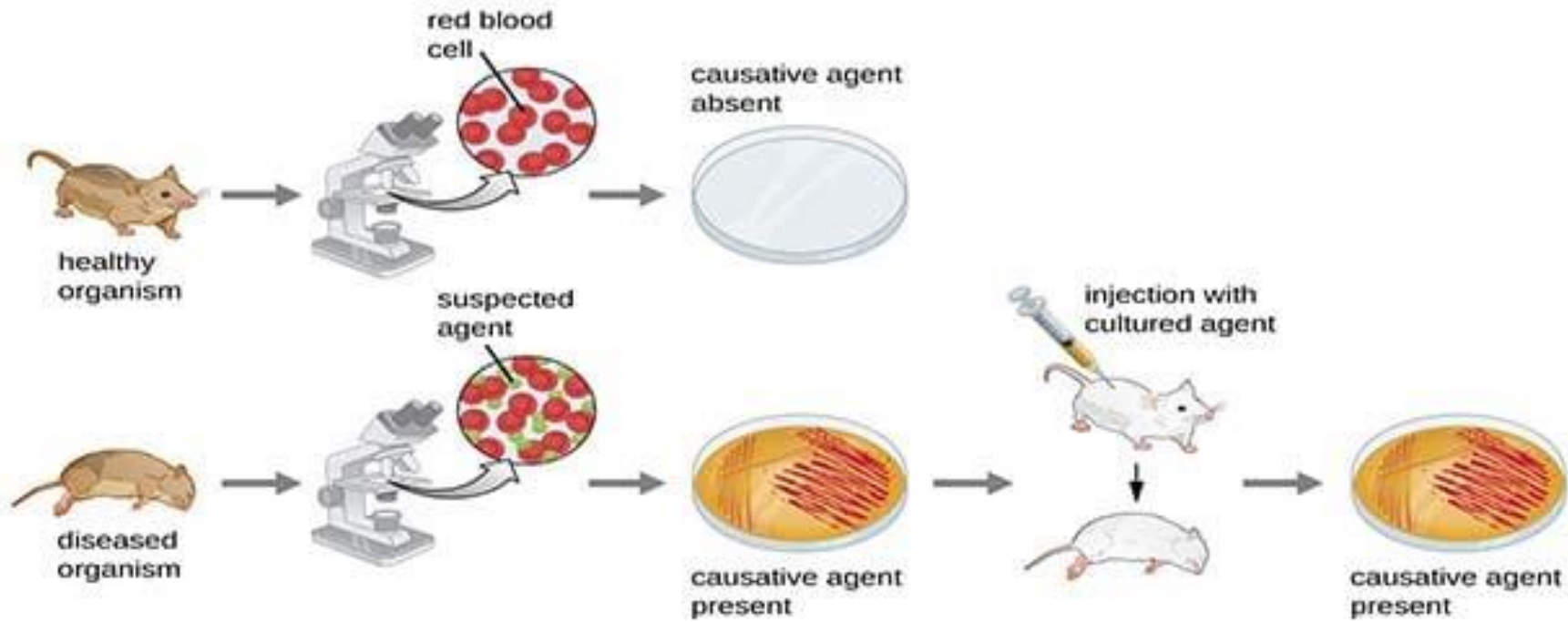
- **Rabies Vaccine (1885):**

- ✓ One of Pasteur's most famous achievements was the development of the **rabies vaccine**.
- ✓ He used a series of experiments involving infected animals, such as dogs and rabbits,
- ✓ To understand the nature of the rabies virus and develop a method for attenuating the virus.
- ✓ Pasteur's successful rabies vaccine marked a major breakthrough in the field of immunization.

Koch's postulates:



- ✓ In 1876 Robert Koch while studying anthrax, a disease of cattle and sheep that also affects humans established “scientific rules”
- ✓ To show a cause and effect relationship between a microbe and a disease known as Koch's postulates as follows:
 - The same organisms must be found in all cases of a given disease.
 - The organism must be isolated and grown in pure culture.
 - The isolated organism must reproduce the same disease when inoculated into a healthy susceptible animal.



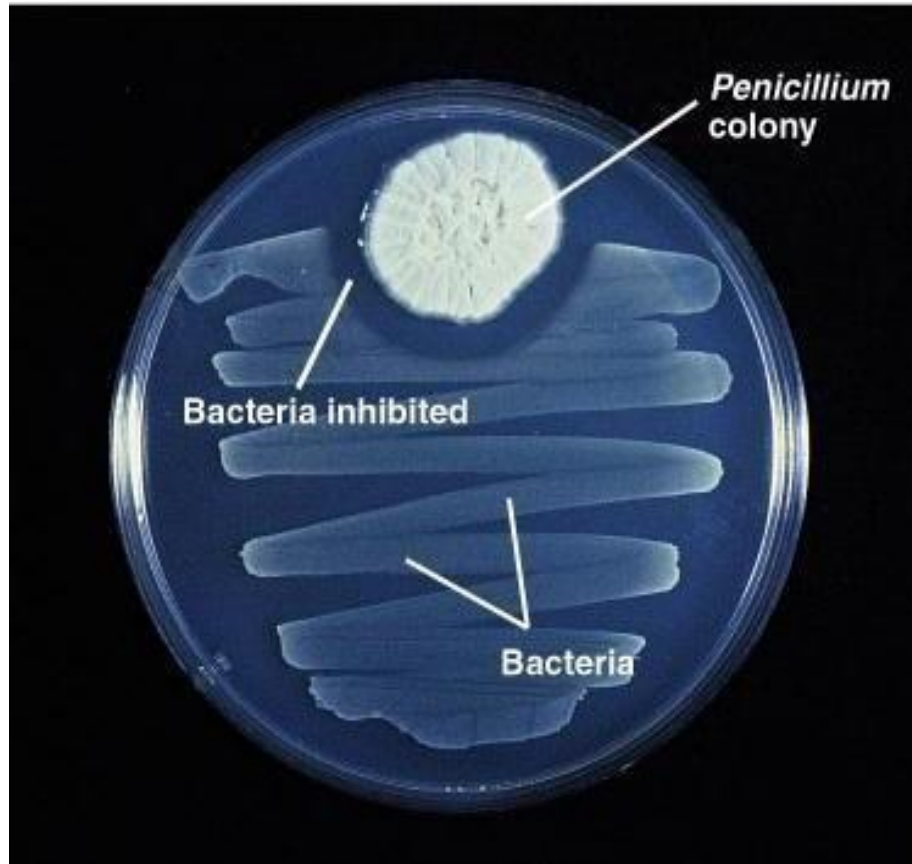
1 The suspected causative agent must be absent from all healthy organisms but present in all diseased organisms.

2 The causative agent must be isolated from the diseased organism and grown in pure culture.

3 The cultured agent must cause the same disease when inoculated into a healthy, susceptible organism.

4 The same causative agent must then be reisolated from the inoculated, diseased organism.

- The original organism must again be isolated from the experimentally infected animal.
- **20th Century:**
 - The development of antibiotics, such as **penicillin** and the advancement of molecular biology techniques
 - Including DNA sequencing, greatly expanded our understanding of microbiology.
 - This century saw significant progress in medical microbiology, genetics, and the study of viruses.



In 1928, at St. Mary's Hospital, London, Alexander Fleming discovered penicillin.

■ **21st Century:**

- ✓ Microbiology continues to evolve with advancements in genomics, metagenomics, synthetic biology, and the study of the human microbiome.
- ✓ These areas have led to a deeper understanding of microbial diversity and their roles in health, disease, and ecosystems.



▪ **Branches of Microbiology?**

- ✓ Focused on how various organisms can be used (applied) in given processes or the impact they can have in different industries.

- ✓ Some of the most important branches of microbiology based on application include:
 - **Food Microbiology:**
 - Deals with the microorganisms that contaminate/damage food and those that can be used for food processing and modification.



- **Medical Microbiology:**

- Is concerned with the diagnosis, prevention and treatment of diseases caused by different types of infection agents.

- **Industrial Microbiology:**

- Are used in various industrial processes, such as fermentation for food and beverage production, antibiotic production, and the bioremediation of pollutants.

- **Agricultural Microbiology:**

- To solve issues identified in agricultural practices while helping increase yields for farmers.



- **Soil Microbiology:**

- This is the branch of microbiology that deals with the study of soil microorganisms and how they impact soil properties.

- **Pharmaceutical Microbiology:**

- Concerned with the use of microorganisms for inhibiting contamination as well as the development of pharmaceuticals.



- **Veterinary Microbiology:**

- Focus on microbes that cause diseases in animals, Production from animals and birds etc.

- **Microbial biotechnology:**

- Area of microbiology and biotechnology aimed at using microbes for beneficial purposes



- **Application of Microbiology:**

- **Medicine and Healthcare:**

- **Infectious Disease Diagnosis:**

- ✓ Microbiologists play a critical role in diagnosing and identifying the causative agents of infectious diseases, leading to appropriate treatment.

- **Vaccine Development:**

- ✓ Microbiology is essential for developing vaccines against various pathogens, such as bacteria and viruses.



- **Antibiotic Development:**

- ✓ Microbiologists help discover and develop new antibiotics to combat drug-resistant bacteria.

- **Clinical Microbiology:**

- ✓ Microbiological techniques are used in clinical laboratories to analyze patient samples, including blood, urine, and swabs, to diagnose infections.



- **Water and Wastewater Treatment:**
 - ✓ **Microbial Treatment:** Microorganisms are used in wastewater treatment plants to break down organic matter and remove pollutants.
 - ✓ **Water Quality Monitoring:** Microbiological tests are used to assess the safety of drinking water and recreational water bodies.



- **Biotechnology:**

- ✓ Genetic Engineering:

- Microbes are modified for the production of enzymes, biofuels, and other bioproducts.



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Thanks