HAWASSA UNIVERSITY



COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF BIOLOGY

General Microbiology (Biol. 2062)

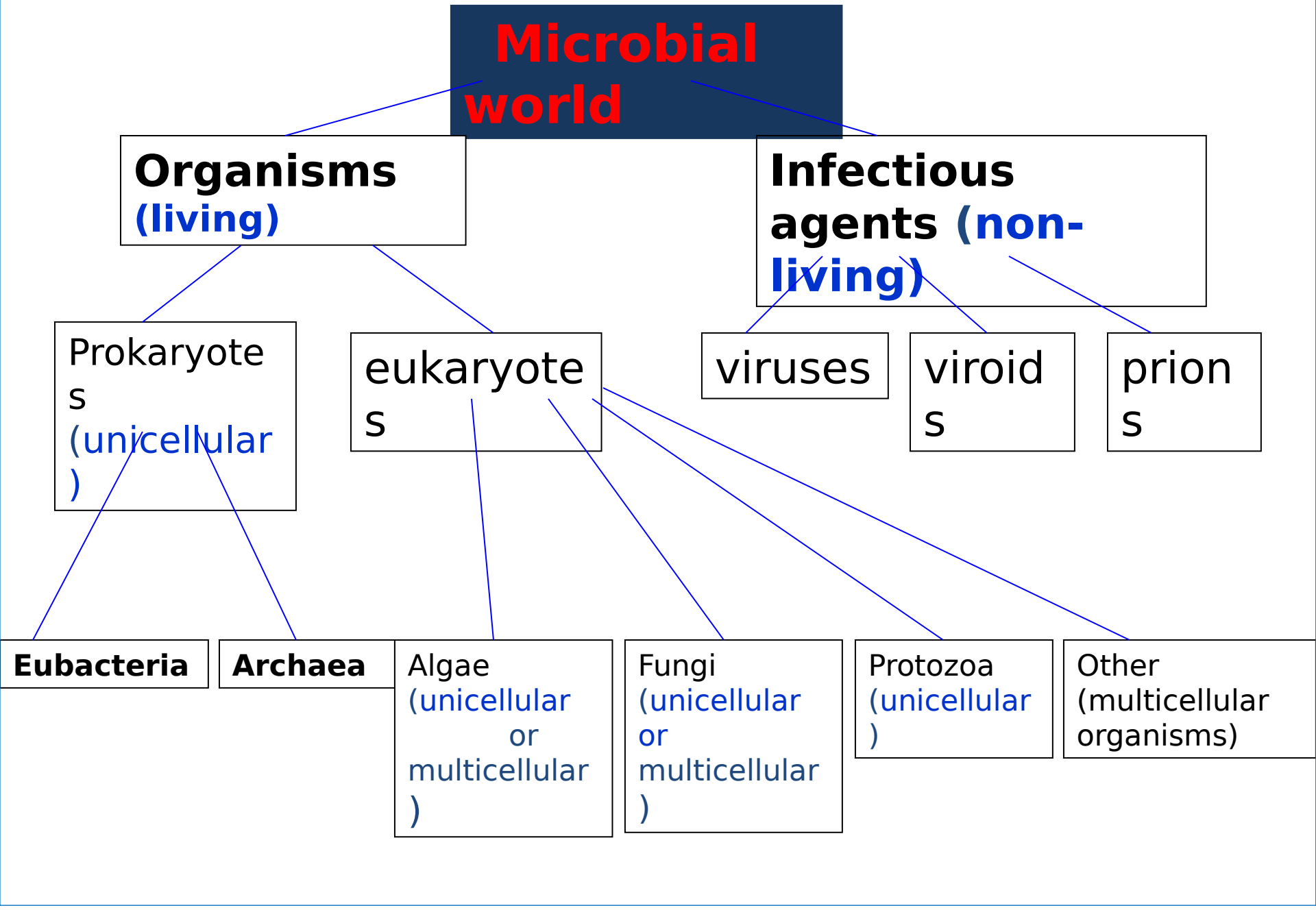
September 14, 2026

1. Introduction and History of Microbiology

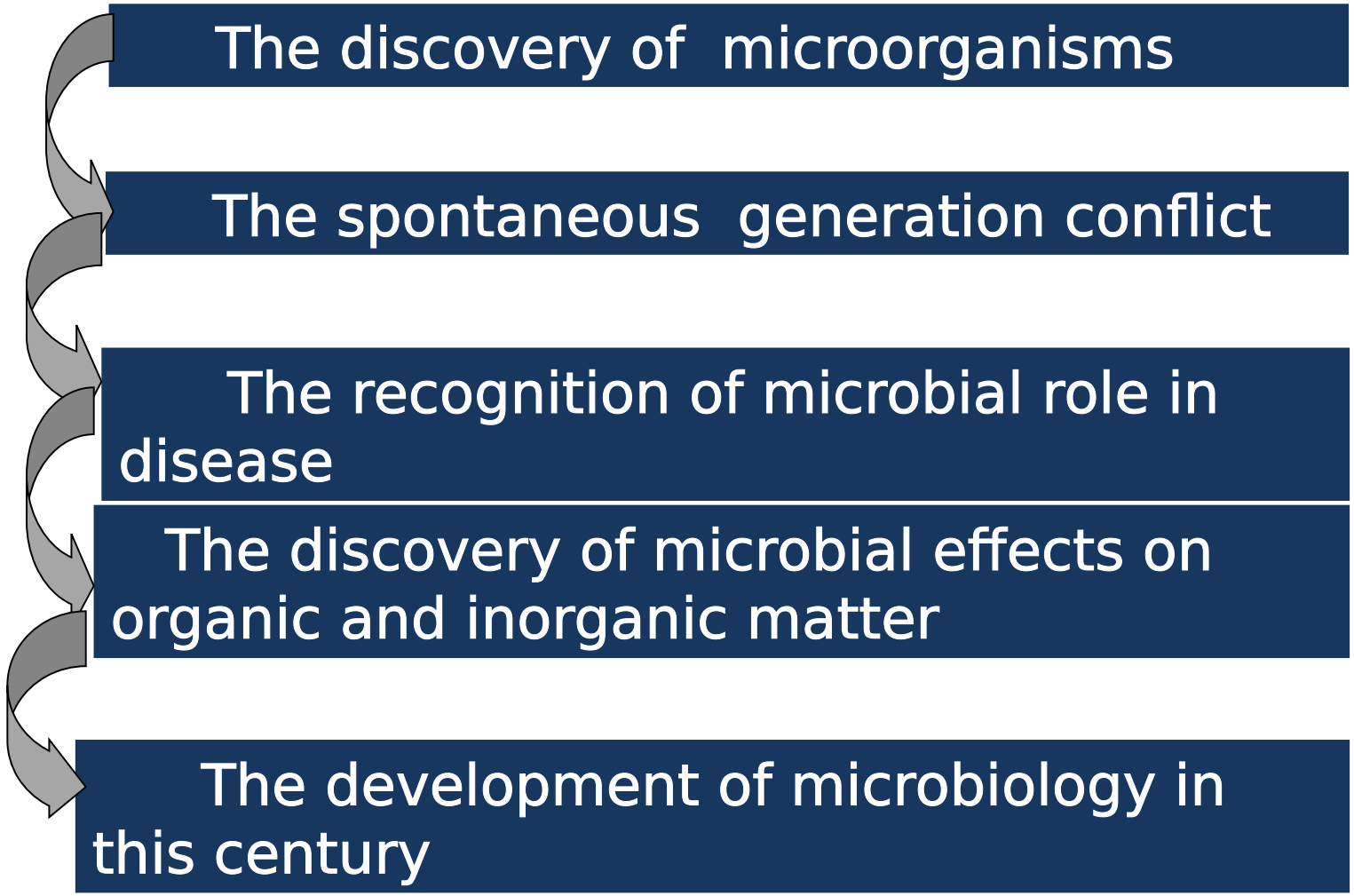
1.1. Definition and scope of microbiology

- The word Microbiology comes from Greek words
  - What is Microbiology?
    - Micro: too small
    - Bio: life
    - Logos: study

- ✓ **Microbiology** is a subject which deals with the scientific study of living things so small that they cannot be seen with the naked eye.
- Some organisms studies by microbiologists CAN be visualized without the aid of amplification [bread molds (fungus) and filamentous algae]
  - These organisms are included in the discipline of microbiology because of similarities in properties and techniques used to study them
- ✓ How we know their presence:- observed with a magnifying device called the microscope


Microbial world
Organisms (living)
Infectious agents (non-living)
Prokaryotes (unicellular)
eukaryotes
viruses
viroids
prions
Eubacteria
Archaea
Algae (unicellular or multicellular)
Fungi (unicellular or multicellular)
Protozoa (unicellular)
Other (multicellular organisms)

The History of Microbiology



Historical Background

- Microbiology has had a long, rich history, initially centered in the causes of infectious diseases but now including practical applications of the science.

- Many individuals have made significant contributions to the development of microbiology.

Historical Background cont'd

- **Hippocratus** first person who believed that disease is resulted due to changes in air, winds, water, climate, food, nature of soil and living habits of people.
- **Fracastorius** (1500 G.C.) proposed that the agents of communicable disease were living germs, that could be transmitted by direct contact with humans and animals, and indirectly by objects; but no proof

Giants of the early days of microbiology and their major contributions

Investigator	Nationality	Dates[a]	Contributions
Robert Hooke	English	1664	Discovery of microorganisms (fungi)
Antoni van Leeuwenhoek	Dutch	1684	Discovery of bacteria
Edward Jenner	English	1798	Vaccination (smallpox)
Louis Pasteur	French	Mid- to late 1800s	Mechanism of fermentation, defeat of spontaneous generation, rabies and other vaccines, principles of immunization
Joseph Lister	English	1867	Methods for preventing infections during surgeries
Ferdinand Cohn	German	1876	Discovery of endospores
Robert Koch	German	Late 1800s	Koch's postulates, pure culture microbiology, discovery of agents of tuberculosis and cholera
Sergei Winogradsky	Russian	Late 1800s to mid-1900s	Chemolithotrophy and chemoautotrophy, nitrogen fixation, sulfur bacteria
Martinus Beijerinck	Dutch	Late 1800s to 1920	Enrichment culture technique, discovery of many metabolic groups of bacteria, concept of a virus

Robert Hooke

One of the most important discoveries of biology occurred in 1665, with the help of a crude microscope, when Robert Hooke stated that life’s smallest structural units were cells.

❖**Antony Van Leeuwenhoek**

(1632-1723 GC.)

- First to observe living microbes
- His single-lens magnified **50-300X magnification**
- Between 1674-1723 he wrote series of papers describing his observations of bacteria, algae, protozoa, and fungi **(Animalcules)**



Cont’d

Arguments about the origin of living things

1. Theory of **Abiogenesis**
2. Theory of **Biogenesis**

Theory of Spontaneous Generation and the Beginning of Microbiology

- Although **Leeuwenhoek** was not concerned about the origin of micro-organism; many other scientists were searching for an explanation for spontaneous appearance of living things from **decaying meat**, **stagnating ponds**, **fermenting grains** and **infected wounds**.

Cont'd

- Theory of **Abiogenesis** deals with the theory of spontaneous generation
- Arguments about the origin of living things revolved around the long held belief in spontaneous generation, stating that living things originated "**spontaneously**" from non-living things.

❖ **Aristotle** (384-322 BC): the founder of a theory of spontaneous generation.

✓ He belief spontaneous existence of life from

The Controversy Over Spontaneous Generation

- The theory of **spontaneous generation** was put forward and believed by many scientists for centuries.
- Meanwhile, there were opponents of this idea.

- **The theory of Biogenesis:** which states that organisms comes from pre-existing life.

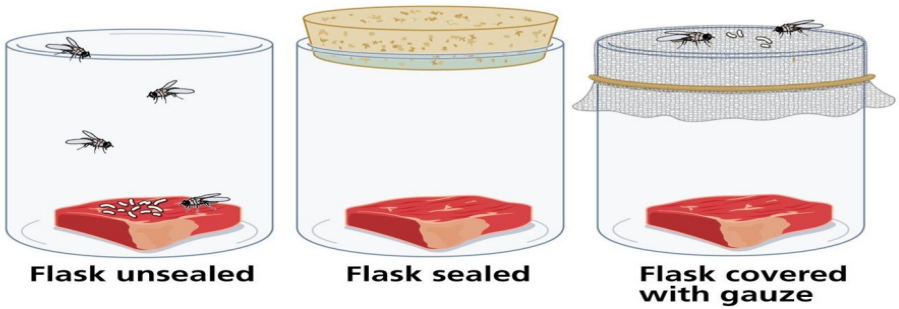
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- **Francesco Redi** (1626-1697): an Italian scientist who first tried to set an experiment to disprove spontaneous generation.

- His experiment was on flies
- He showed that **fly maggots do not arise from decaying meat** if the meat is covered to prevent the entry of flies.
- Disproved spontaneous generation of maggots.

Cont’d

- Utilized jars containing meat. Some were covered while others were not.
  - Maggots appeared in uncovered jars.
  - He showed that the larvae found on putrefying meat arose from eggs deposited by flies, and not spontaneously as a result of the decay process
  - Results were not accepted for microscopic orga



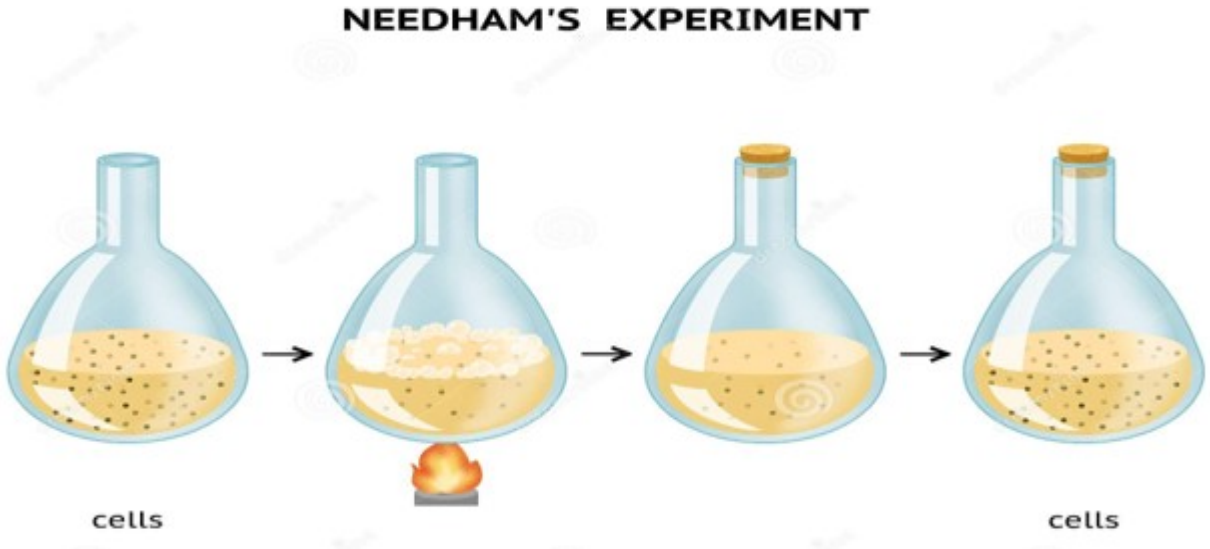
Francesco Redi’s experiment

❖**John Needham** (1749)

- Performed experiments similar to Redi’s on the origin of life in microscopic organisms.
- Introduced the **first culture medium** for microbial growth.
- Utilized **infusion broth** contains nutrients needed for microbial growth.
- Used turbidity to indicate growth.
- Broth put in flasks, some were sealed with corks, and some were not.

Cont’d

- All flasks became cloudy, result different from Redi’s experiment.
- **He suggested that life originate spontaneously from non-living matters**
- The spontaneous generation opponents didn’t accept his conclusion, they said it could be due to entrance or sealed.



- **Lazzaro Spallanzani** (1776)
  - Repeated Needham's experiments to disproof spontaneous generation in microscopic life.
  - Boiled broth after placing in flasks.
  - Sealed flasks by plugging with solid stopper.
  - Not accepted by spontaneous generation supporters, because they said that heating may have destroyed, degraded "vital force" and air was not allowed to enter.

Q. What causes tiny living things to appear in decaying broth?

- Spontaneous generation for small organisms again gained favor when John Needham showed that if a broth was boiled and then allowed to sit in the open air, it became cloudy

- Needham’s hypothesis: Spontaneous generation

- Spallazani’s hypothesis: Microbes come from the air. Boiling will kill them.

- **Louis pasture** (1822-1895) the **father of modern Microbiology**, who disproved the theory of abiogenesis it once and for all .

- He carried out a series of experiments that led to the acceptance of biogenesis, the idea that life arises only from already existing life.
- In 1861, Pasteur used swan-neck flasks for his experiments to disproof spontaneous generation of microorganisms

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- He exposed boiled broths to the air, in vessels that contained a filter air through cotton plug to prevent all particles from passing through to the growth medium, and

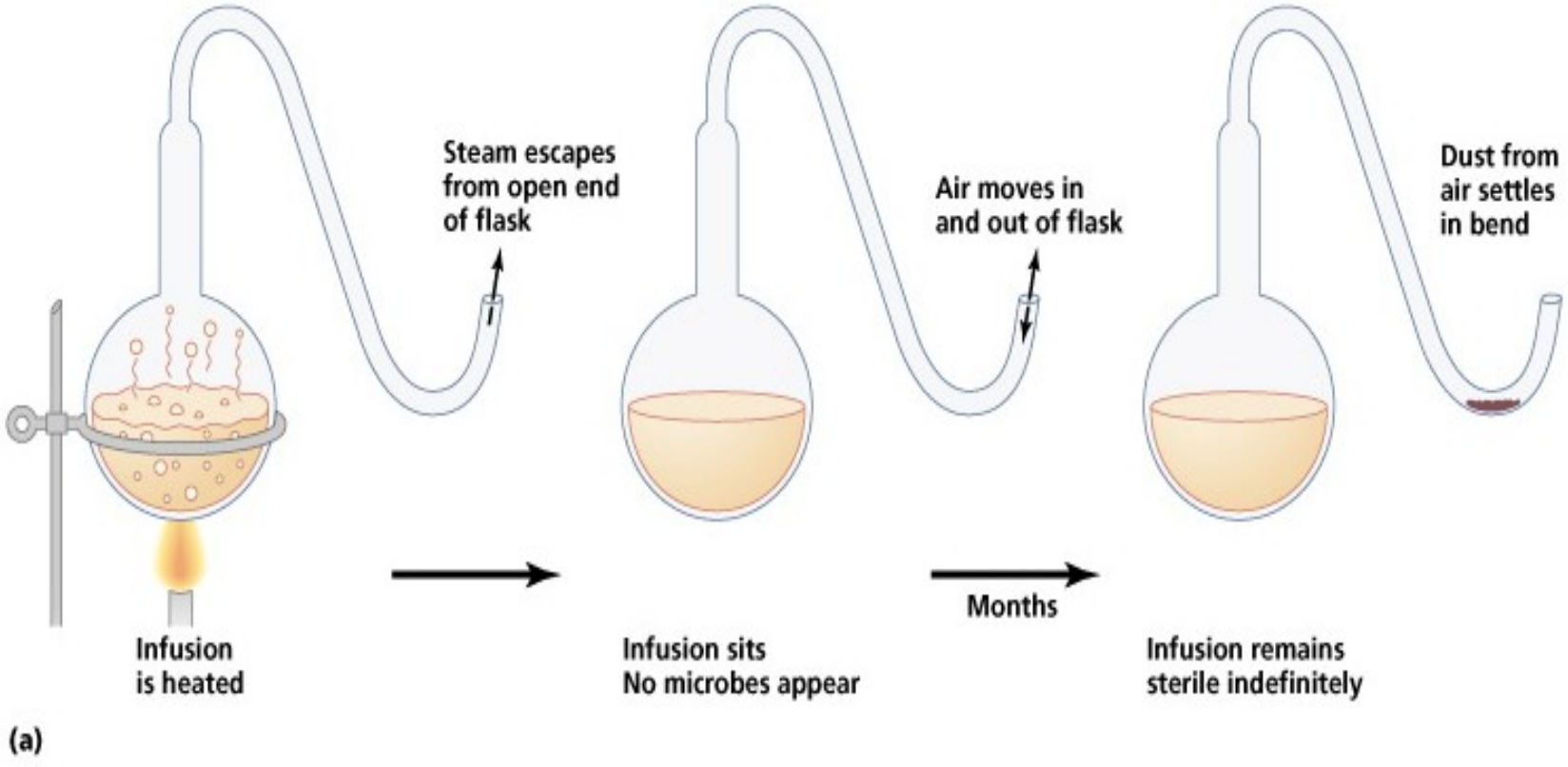
- also in vessels with no filter at all, with air being admitted via a curved tube.

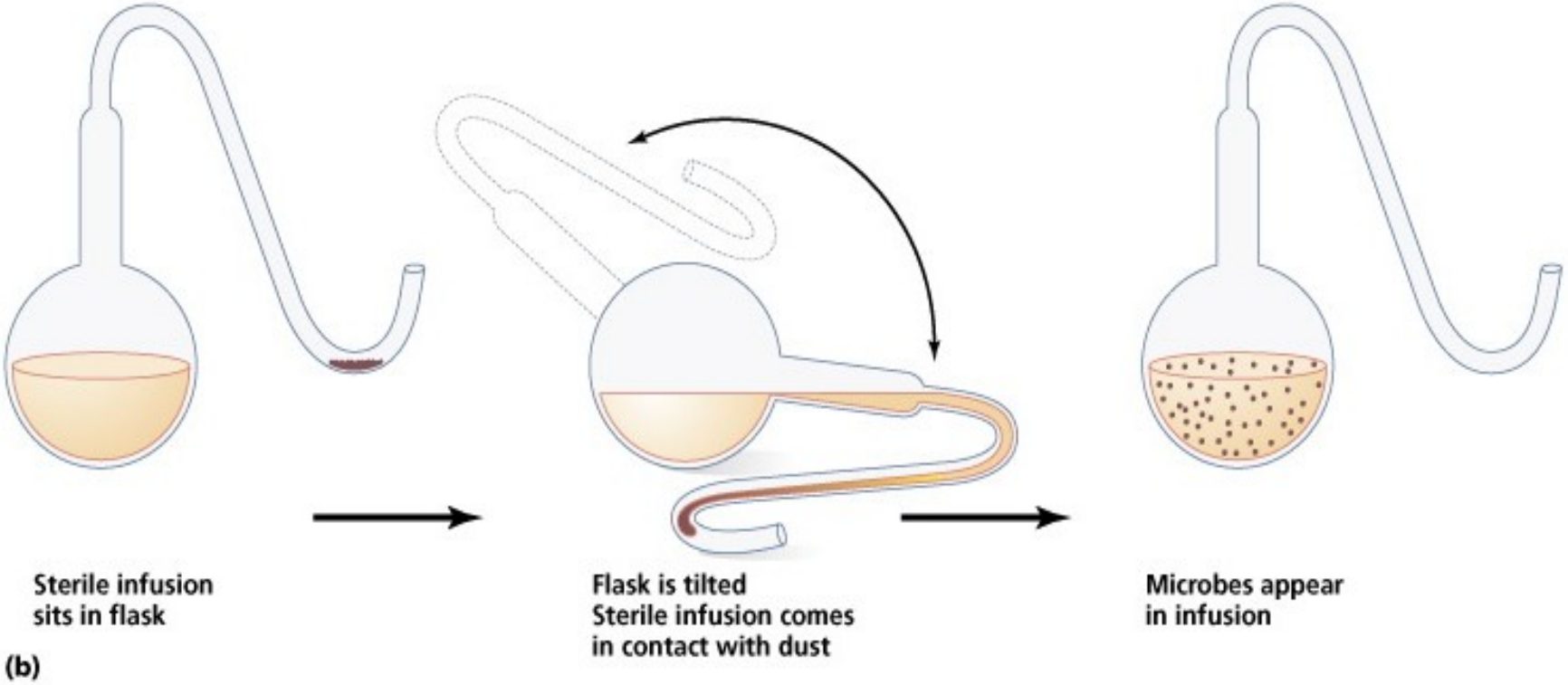
✓ He placed a sterile infusion broth in swan-necked flask.

✓ Flasks remained sterile unless tilted or neck broken.

- ✓ No microorganism was able to grow on the broth during Pasteur's experiment.
- This proved that the living organisms living in that broth came from the outside rather than been spontaneously created.
- Therefore, Louis Pasteur supported the germ theory and stated that microorganisms are the causes of infectious diseases.
- He also demonstrated that bacteria could be removed by boiling

- In air freely moved through the tube, but dust particles were trapped in the curved portion of the flask. And no microbial growth was observed

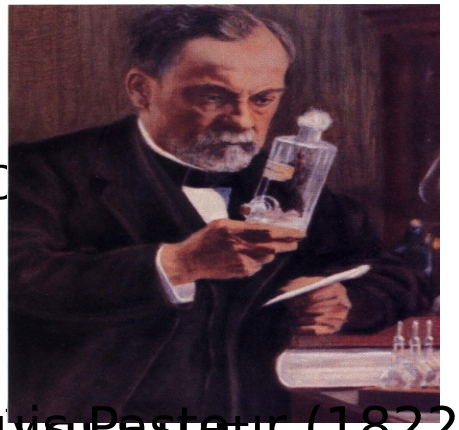




- Therefore, Pasteur proved that microorganisms entered to the broth with the air and microorganisms did not evolve spontaneously

Other major contribution of Louis Pasteur

- Principles and practices of sterilization and pasteurization
- Pasteur (1857) demonstrated that lactic acid fermentation is due to the activity of microorganisms
  - ✓ Why did wine sour? Believed that converted sugars into alcohol.
- He proved that fermentation was c
  microbial agents.
- Pasteur (1881) developed anthrax v



Louis Pasteur (1822 - 1895)

- He collaborated with **John Tyndall** (1820-1883) an Irish physicist, to convince others about fallacy of abiogenesis and proof of biogenesis.
- He concluded that different infusions require different boiling times to be sterilized. Because of heat resistant microorganisms: Endospores
- **Joseph Lister** a British surgeon, applied Pasteur's observations to the prevention of wound sepsis.
  - ✓ In 1867, he discovered the use antiseptic technique to kill bacteria in wound and air with carbolic acid.

- **Robert Koch (1843-1910)** a German scientist, discovered that bacteria caused diseases such as anthrax and tuberculosis.
- With his assistant, Ehrlich (who worked on dyes), they were able to stain bacteria and viewed them on the microscope.
- **Koch** introduced agar as gelling agent for culture media.
- He was the pioneer in laboratory technique.
- Robert Koch, in 1876 established an experimental procedure to prove the germ theory of disease

Cont’d

- Koch showed the relationship between the cattle disease anthrax and *Bacillus anthracis*
- The scientific procedure is known as **Koch’s Postulate**.
- Koch infected healthy mice with blood from diseased cattle and sheep, and noted that the symptoms of the disease appeared in the mice, and that rod shaped bacteria could be isolated from their blood.

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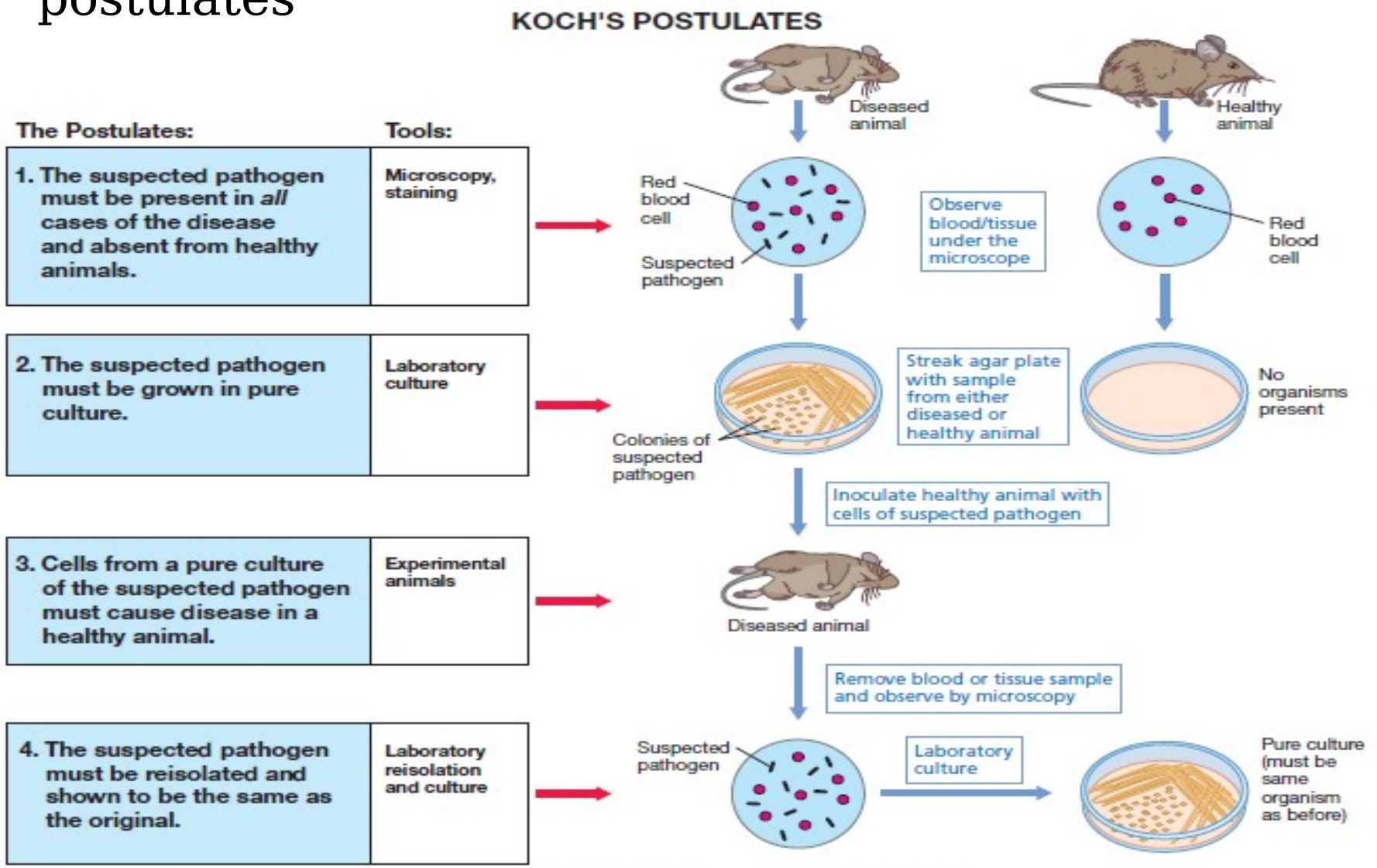
- These could be grown in culture, where they multiplied and produced spores.
- Injection of healthy mice with these spores (or more bacilli) led them too to develop anthrax and once again the bacteria were isolated from their blood.
- These results led Koch to formalize the criteria necessary to prove a causal relationship between a specific disease condition and a particular microorganism. These criteria became known as Koch’s postulates

Koch's Postulate- proof of germ theory of disease

- A Microorganism can be accepted as a causative agent of an infectious disease only if the following conditions are satisfied.

1) The microorganism must be present in every instance of the disease and absent from healthy individuals.
2) The microorganism must be capable of being isolated and grown in pure culture.
3) When the microorganism is inoculated into a healthy host, the same disease condition must result.

The germ theory of disease and Koch's postulates



Benefits of Microbiology

- Antibiotics
- Vaccine
- Biological weapons
- In industrially production of food
- Bioremediation
- In genetic engineering and etc