Lecture No 1

Introduction to Microbiology

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Introduction

- Microbiology is the study of organisms or agents too small to be seen with naked eyes.

- Microorganisms are present everywhere, as their presence can be marked in geothermal vents in the ocean depths to the person's skin.

- They are also present in soil, air and water.

- Microorganisms are involved in production of 50% of Carbon and 90% of Nitrogen.

- They are involved in different processes like biodegradation, process of photosynthesis, process of digestion and in production of vitamins B and 12.

- Society gets benefit from microorganisms by their use in bread, cheese, beer, vaccines and antibiotics production.

So we can say that…….

"Modern Biotechnology rests upon a microbiological foundation"

History

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) was the first one to provide somewhat accurate information about microorganisms.

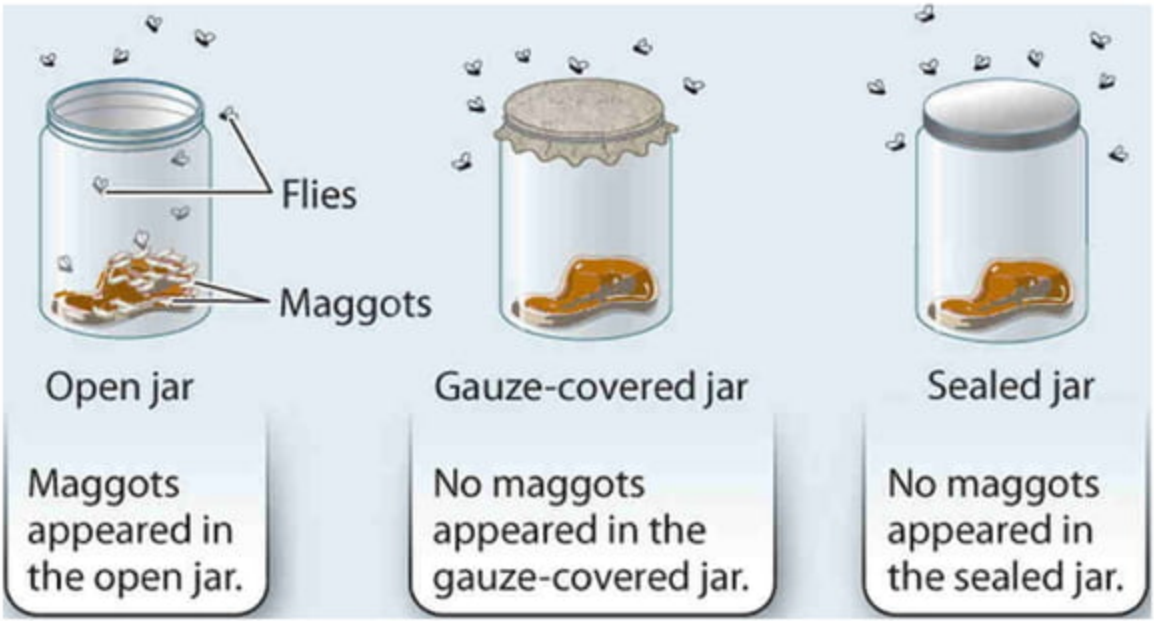
His microscope had a magnification of 50-300X.

Theory of Spontaneous Generation

Early belief that some forms of life could arise from "vital forces" present in nonliving or decomposing matter, abiogenesis. Or simply, organisms can arise form non-living matter.

But this theory was later challenged by many scientists.

Francesco Redi (1626-1697)



John Needham and Lazzaro Spallanzani were still supporting theory of spontaneous generation by proving that air carried germs to the culture media.

Schwann, Friedrich Schroder and von Dusch (1830s) disproved them by allowing air to enter flask but only after passing through a heated tube or sterile wool, so no growth appeared.

Still some scientists believed in theory of spontaneous generation.

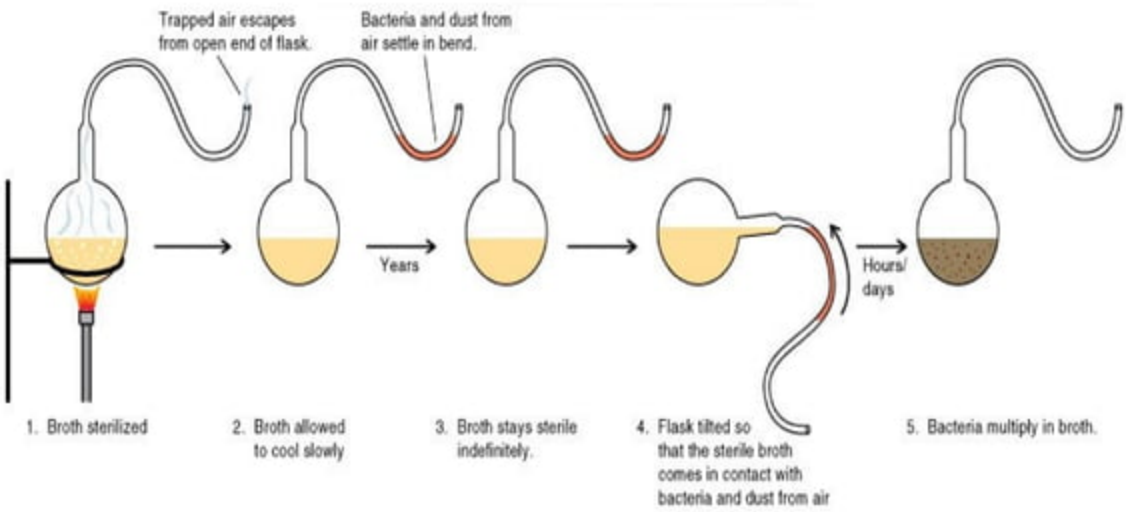
Pasteur's Experiment

- These assumptions provoked Louis Pasteur (1822-1895) to settle the matter once and for all.

- He first trapped airborne organisms in cotton, then showed , that piece of cotton caused microbial growth when placed in sterile medium. Then he did another experiment to solve the controversy.

- Considered by many as " Father of Microbiology"

Pasteur's Experiment



- John Tyndall (1820-1893) – dealt a final blow to spontaneous generation theory in 1877 by demonstrating that Omission of dust → no growth of microorganisms.

- He also provided evidence for heat resistant forms of bacteria.

- A German botanist Ferdinand Cohn (1828-1898) discovered existence of bacterial endospores.

Demonstrations that microorganisms cause disease

- The first direct demonstration of the role of bacteria in causing disease came from the study of anthrax by German Physician Robert Koch (1843-1910).

- His criteria (is still used) to establish the link between a microorganism and a particular disease that it cause, is known as Koch's postulates.

Koch's Postulates

- The causative agent must be present in all affected organisms but absent in healthy individuals.
- The agent must be capable of being isolated and cultured in pure form.
- When the cultured agent is introduced to a healthy organism, the same disease must occur.
- The same causative agent must be isolated again from the affected host.

Classification

Classifying microorganisms has always been a challenge for taxonomists, as they are diverse.

Some microorganisms are motile like animals, but also have cell walls and are photosynthetic like plants…..

These observations eventually led them to the development of a classification scheme, that divided organisms into Five kingdoms.

Five Kingdom System

- Monera
- Protista
- Fungi
- Animalia
- Plantae

Three Domain system

- Bacteria
- Archea
- Eucarya

- Carl Woese in 1970's proposed this system.

Bacteria

- Prokaryotes
- Single-celled organisms
- Cell wall → Peptidoglycan.
- Abundant in Soil, water, air and are the normal resident of skin, nose, mouth and intestine.
- Some live in extreme temperatures.
- They have harmful aspects but are usually beneficial as well.

Archea

- These are bacteria but are different due to their rRNA sequence.
- Cell wall composition is change as they lack peptidoglycan but contains lipids.
- Unique feature is that some are methanogens.
- Archea are found in environments that are too hostile for other life forms.
- No pathogenic archea have yet been identified.

Eucarya

- Multicellular organisms.
- The true nucleus is one of the distinguishing features of eukaryotes
- Contains microbes classified as protists or fungi.
- Animals and plants are also included in this group.

Protists

- These are larger than prokaryotes.
- It includes unicellular algae, protozoa, slime molds and water molds.

Algae

- The term algae has long been used to denote all organisms that produce Oxygen as a product of photosynthesis.

- All algae contain chlorophyll in their chloroplast.

- Many algal species are unicellular.
- Other algae may form extremely large multicellular structures.

- A number of algae produce toxins that are poisonous to humans and other animals.

- Dinoflagellates, a unicellular alga, cause algal blooms, or red tides, in the ocean. It produces neurotoxins which is accumulated in the shellfish, as shellfish feeds on this organism. Ingestion of these shellfish by humans results in paralytic shellfish poisoning and can lead to death.

- Together with cyanobacteria (blue green algae), it produces about 75% of planet's Oxygen.

- It forms foundation of aquatic food chains.

Protozoa

- Protozoa are unicellular non photosynthetic protists.

- It seems likely that the ancestors of these protozoa were algae that became heterotrophs—the nutritional requirements of such organisms are met by organic compounds.
- Adaptation to a heterotrophic mode of life was sometimes accompanied by loss of chloroplasts, and algae thus gave rise to the closely related protozoa. Similar events have been observed in the laboratory to be the result of either mutation or physiologic adaptation.

- Many free living protozoa's are hunter of microbes.
- They obtain nutrients by digesting organic matter and microbes.
- They are present in different environments, some are normal inhabitants of intestines of animals and helps them in digesting cellulose.
- Few of them causes diseases in animals and humans.

Fungi

- Diverse group of microorganism that range from unicellular (yeasts) to multicellular fungi (molds and mushrooms).
- They absorb nutrients from environment including organic molecules, that they use as carbon and energy source.
- They have metabolic capabilities, so many fungi are beneficial in making bread rise, producing antibiotics, decomposition of dead organic matter.
- Some causes diseases in humans, animals and plants.

- The fungi are non photosynthetic protists growing as a mass of branching, interlacing filaments ("hyphae") known as a **mycelium.**

- These tubes, made of polysaccharides such as chitin, are homologous with cell walls. **Yeasts,** do not form a mycelium but are easily recognized as fungi by the nature of their sexual reproductive processes.
- The fungi probably represent an evolutionary offshoot of the protozoa; they are unrelated to the actinomycetes, mycelial bacteria that they superficially resemble. The major subdivisions (phyla) of fungi are Chytridiomycota, Zygomycota (the zygomycetes), Ascomycota (the ascomycetes), Basidiomycota (the basidiomycetes), and the "deuteromycetes" (or imperfect fungi).

Slime molds

- These organisms are characterized by the presence, as a stage in their life cycle, of an ameboid multinucleate mass of cytoplasm called a **plasmodium.** The plasmodium of a slime mold is analogous to the mycelium of a true fungus. Both are coenocytic (an organism made up of a multinucleate, continuous mass of protoplasm enclosed by one cell wall). In slime molds the cytoplasm can flow in all directions. This flow causes the plasmodium to migrate in the direction of its food source, frequently bacteria.

- The life cycle of the slime molds depends upon interdependency of living forms. The growth of slime molds depends on nutrients provided by bacterial or, in some cases, plant cells. Reproduction of the slime molds via plasmodia can depend on intercellular recognition and fusion of cells from the same species.

Scope of microbiology

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- Microbiology has both **basic** and **applied** aspects.

- Basic aspects are concerned with biology of microorganisms themselves and includes fields like

- Bacteriology.
- Mycology.
- Phycology.
- Protozoology.
- Microbial cytology and physiology.
- Microbial genetics.
- Molecular biology.
- Microbial ecology.
- Microbial Taxonomy.

Applied aspects are concerned with practical problems.

These are:

Disease study.

Water and waste water treatment.

Food spoilage and food production.

Industrial uses of microbes.

Medical microbiology, Immunology, Industrial microbiology, Agricultural microbiology are also widely studied fields of microbiology.