



Fundamental, history & developments

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Introduction of microbiology

Microbiology is a branch of science that deals with the structure, function, classes and economic importance of microorganisms. Microbiology is one of the exciting; ever developing field of science with greater scopes as the microbes play a major role in our day to day life.

DEFINITION OF MICROBIOLOGY

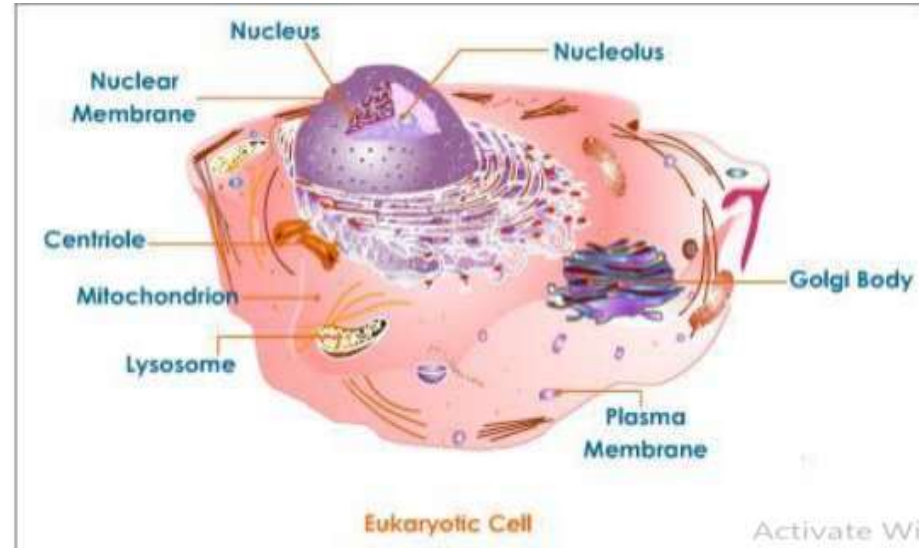
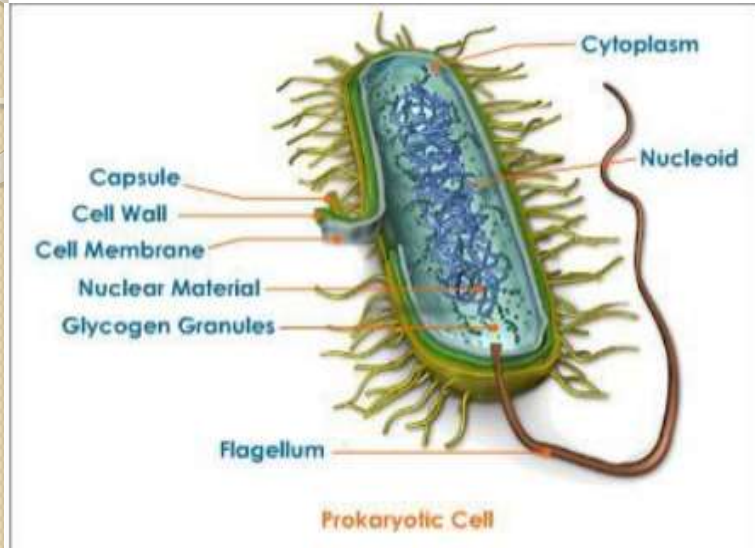
Microbiology is defined as the study of organisms and agents that are too small to be seen clearly by the unaided eye. To be more simple, microbiology is the study of microorganisms which are the living organisms of microscopic size. Microorganisms are the living organisms that are less than 1 millimeter in diameter which cannot be seen by our naked eye. Microorganisms can be viewed through microscopes and they can exist as single cells or clusters. Microorganisms include the cellular organisms like bacteria, fungi, algae and protozoa. Viruses are also included as one of the microorganism but they are acellular.

OCCURRENCE OF MICROORGANISMS

One of the interesting things about the microorganism is that, they occur everywhere, even in the atmosphere, water and soil. Almost all natural surfaces are colonized by microbes. Some microorganisms are even adapted to live comfortably in boiling hot springs and frozen sea ice. Microbes are the dominant form of life in the universe. More than 50 per cent of the biomass on earth consists of microorganisms compared to animals which constitute only 15 per cent of the mass of living organisms on earth. Majority of the microorganisms are not dangerous to humans. In fact, microbes help to digest our food and protect our bodies from pathogens. Additionally, they are considered as beneficial ones as they keep the biosphere running by carrying out essential functions such as decomposition of dead animals and plants, nutrient cycling which enhances the soil health and crop productivity.

MEMBERS OF THE MICROBIAL WORLD

Based on the structure of nucleus, fundamentally two types of cells exist. They are
i. Prokaryotes and ii. Eukaryotes



PROKARYOTIC CELLS -

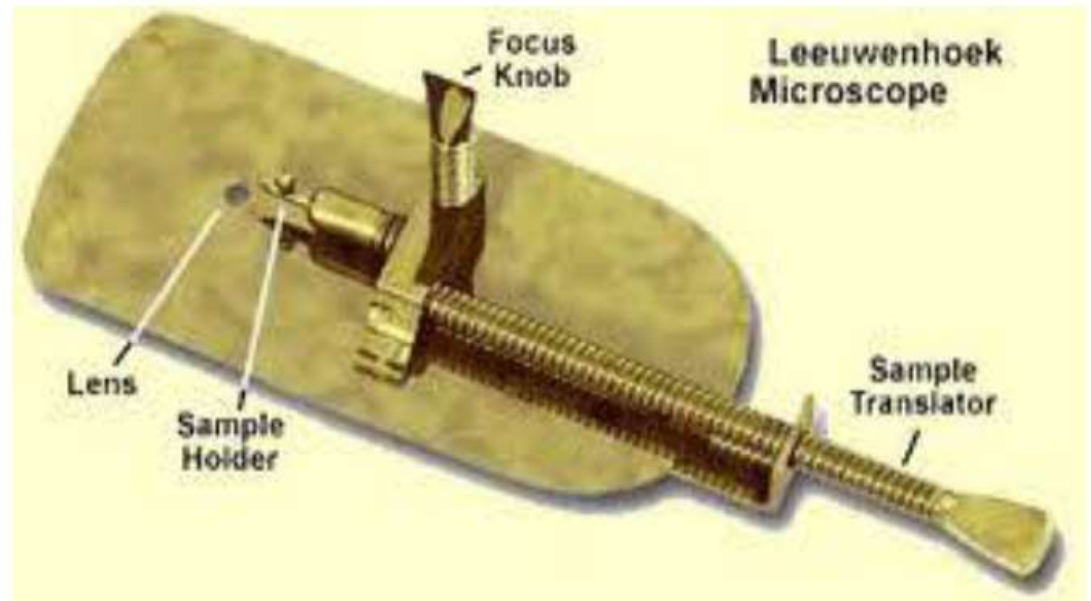
Prokaryote is a Greek word, pro - before and karyon - nut or kernel. Prokaryotes are the organism with a primordial nucleus. They have a much simpler morphology than eukaryotic cells and lack a true membrane bound nucleus and cell organelles like mitochondria, golgi bodies, endoplasmic reticulum, etc. All bacteria and archaea are prokaryotic.

EUKARYOTIC CELLS

Eukaryote is a Greek word, eu - true and karyon - nut or kernel. Eukaryotes possess a membrane enclosed nucleus and cell organelles. They are more complex morphologically and are usually larger than prokaryotes. Algae, fungi, protozoa, higher plants and animals are eukaryotic.

ANTONY VAN LEEUWENHOEK (1632 – 1723)

Leeuwenhoek is a famous person who is always praised as the Father of Microbiology. He was a Dutch merchant and his hobby was making lenses and microscopes. His microscopes were simple microscopes composed of double convex glass lenses held between two silver plates that could magnify 50 to 300 times. He was the first to describe the protozoa and bacteria. He observed some bacteria from plagues of his own teeth. He named them as animalcules.




Leeuwenhoek and his microscope that was developed first

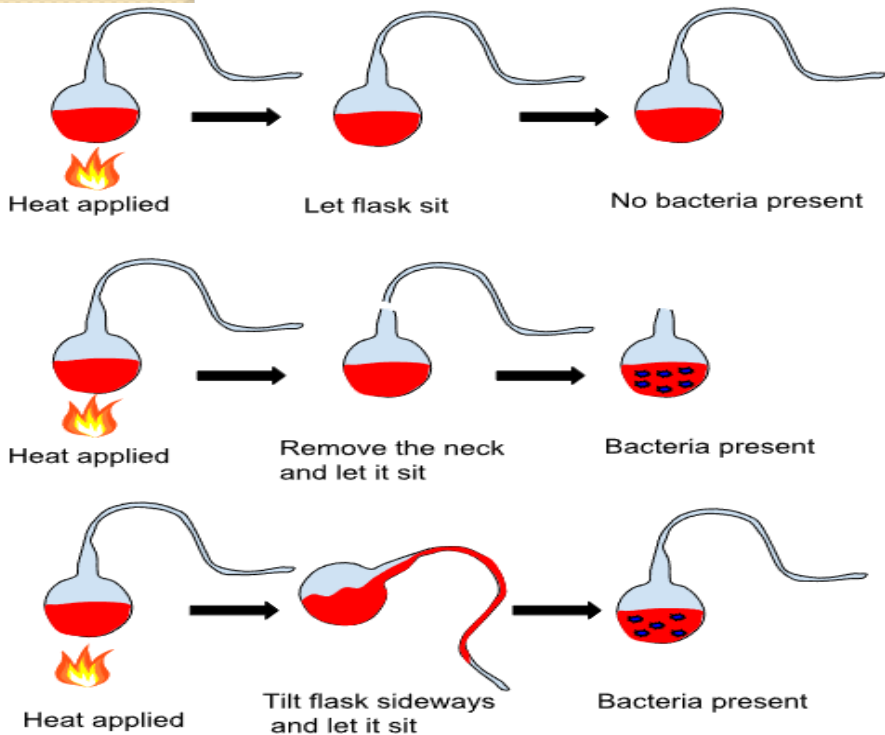
LOUIS PASTEUR (1822-1895)



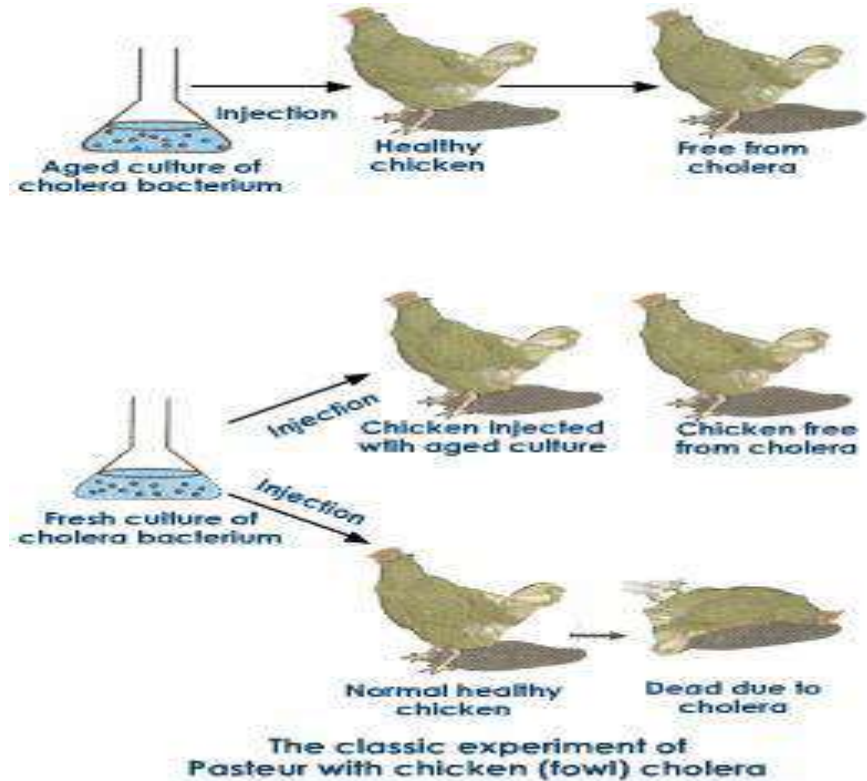
- He was a Professor of Chemistry at the University of Lille, France. He is considered as “Pioneer of Microbiology”, as his contribution led to the development of Microbiology as a separate scientific discipline.
- He proved the theory of “Biogenesis” and disproved the “**Theory of spontaneous generation**” (Abiogenesis), experimentally by using swan-necked flasks. Pasteur passed the untreated and unfiltered air in to boiled nutrient broth, germs settled in the goose neck and no microbes appeared in the solution. Thus he disproved that living organisms appear from non living matter.
- He also worked on souring of wine and beer and found that this alcohol spoilage is due to the growth of undesirable organisms, while the desirable microorganisms produce alcohol by a chemical process called “**Fermentation**”. He showed that wine did not spoil, if it is heated to 50-60°C for a few minutes. This method is called “**Pasteurization**”, now widely used in dairy units, to kill pathogenic microorganisms in milk.

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- He is a founder of “**Germ theory of disease**” as he visualized that diseases are caused by microorganisms. In course of his research, he discovered the importance of sterilization and discovered steam sterilizer, autoclave and hot air oven. He also established the importance of cotton wool plugs for protection of culture media from aerial contamination. He differentiated between aerobic and anaerobic bacteria and coined the term “anaerobic” to refer to the organisms that do not require oxygen for growth.
 - He developed the process of “attenuation” during his work on “**chicken cholera**” in fowls. He found that cultures which had been stored in the laboratory for sometime would not kill the animals as fresh cultures did. This attenuation is now used in protective vaccination against diseases.
 - Pasteur showed that the **anthrax disease** in cattle and sheep is caused by a bacterium. He cultivated anthrax organisms in sterile yeast water, and showed that these cultures can produce disease when inoculated in to healthy animals. He developed a live attenuated **anthrax vaccine**, by incubation at 40-42°C, which proved to be useful in protecting animals against anthrax. He also worked on swine erysipelas.

Pasteur developed a **vaccine against rabies** (Hydrophobia), which made a greatest impact in medicine. He obtained the causative agent of rabies by serial intracerebral passage in rabbits and the vaccine was prepared by drying pieces of spinal cord. He tested with a boy named Joseph Meister and he saved his life. In 1888, Pasteur institute was established for mass antirabic treatment. Pasteur gave the general term “Vaccine” (Vacca=cow) in honour of Jenner’s cow pox vaccine, to various materials used to induce active immunity.



Pasteur's goose neck flask experiment





Pasteur's study on immunization

MICROBIAL GROUPS -

Based on the morphological, phylogenetic and physiological characteristics, microorganisms are divided into six distinct groups, they are as follows.

- 1) Bacteria
- 2) Archaea
- 3) Fungi
- 4) Protozoa
- 5) Algae
- 6) Viruses

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- 1) **BACTERIA** are prokaryotes that are usually single celled organisms. They multiply by binary fission and reproduce asexually. They are the most dominant group of microorganisms in soil, water and air. Some bacteria even live in environment that has extreme temperatures, pH or salinity. Many of them play more beneficial roles in nutrient cycling, decomposition of organic matter, production of commercial industrial products like vitamins, antibiotics, etc. Wherein, some of them cause diseases and food spoilage. Ex: Bacillus, Pseudomonas.
 - 2) **ARCHAEA** are phylogenetically related prokaryotes that are distinguished from bacteria by many features, most notably their unique ribosomal RNA sequences. Many archaea are found in extreme environments. Some have unusual metabolic characteristics, such as the methanogens, which generate methane gas. Ex: Methanobacterium.
 - 3) **ALGAE** are eukaryotes that contain chlorophyll and are capable of performing photosynthesis. Algae are found most commonly in aquatic environments. They reproduce either sexually or asexually. Mostly they are used as food supplements. They are mainly used in the preparation of agar. Ex: Spirulina, Gelidium.

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- 4) **FUNGI** are eukaryotes. Next to bacteria, they are the most dominant organism in the soil. In general, fungi range in size and shape from single-celled microscopic yeasts to giant multicellular mushrooms. They possess filamentous mycelium composed of individual hyphae and reproduce either sexually or asexually by fission, budding or by means of spores borne on fruiting structures. Unicellular fungi like yeast are involved in the production of alcoholic beverages like wine and beer. Multicellular fungi like molds are useful for industrial production of antibiotics like penicillin. Ex: Mucor, Rhizopus.


 - 5) **PROTOZOA** are unicellular eukaryotes that are usually motile and lack cell wall. Many free living protozoa function as the primary hunters and grazers of the microbial world. They can be found in many different environments and some are normal inhabitants of the intestinal tracts of animals, where they aid in digestion of complex materials such as cellulose. Some of them are parasitic and can cause diseases. Ex: Amoeba, Paramecium.

 - 6) **VIRUSES** are acellular (non cellular) organisms that are too small and can be visualized only using electron microscopes. All are obligate parasites that require a living cell for reproduction. They are pathogenic to plants, animals and humans. At most of the cases they cause human diseases. Ex: Cauliflower mosaic virus, Cucumber mosaic virus.

SCOPE OF MICROBIOLOGY

Currently, we are in the era of Microbiology. Microorganisms are recognized as the basic research tools as they help to understand the chemical and physical basis of life as they are the dominant group of living organisms in the biosphere and are actively involved in our day to day activities. Microbiology primarily paves way to analyze the biochemical and genetic background of living things. Moreover as microbes are the excellent models for understanding the cell functions and as they play important role in the field of medicine, agriculture and industry that assures human welfare, microbiology is considered as one of the vital branch of science with utmost promising scopes. Microbiology is not just one small subject to be explored. It has nearly six major branches. They are as follows:

- 1) **Agricultural Microbiology** deals with soil nutrient cycling by microbes, microbial decomposition of organic wastes, plant associated microbes that enhance soil fertility, etc.
- 2) **Food Microbiology** covers information about the microbes involved in food spoilage, food borne diseases, commercial food products prepared using microbes, etc.

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- 3) **Industrial Microbiology** explores the utility of microbes in the production of antibiotics, enzymes, alcoholic beverages, fermented food products, etc.
 - 4) **Medical Microbiology** deals with the studies related to the microbes that causes diseases, their diagnostic and preventive measures, drug designing, etc.
 - 5) **Aquatic Microbiology** deals with water purification and biological degradation of wastes in aquatic ecosystems by microbes.
 - 6) **Aero Microbiology** talks about the microorganisms prevalent in air, their abundance and beneficial or harmful issues. 7. Exomicrobiology is all about the exploration of life in outer space. 8. Geochemical Microbiology analyses the microbial life and their contribution in coal, oil and gas formation areas.