HISTORY OF MICROBIOLOGY

ANTONY VAN LEEUWENHOEK (1632-1723)

He was the first Person, who invented the microscope and discovered the microbial world. He was a draper (Merchant) from Delft, Holland. He used to grind lenses and made microscopes as a hobby. The microscopes of Leeuwenhoek could magnify objects about 200-300 times.With his microscopes, Leeuwenhoek observed a variety of things like rain water, pond water and scrapings from his own teeth. He saw minute moving objects and called them as "**Little animalcules**",which we now know them as protozoa, yeasts and bacteria. He made accurate sketches and communicated his findings to "Royal Society of London".Thus, Leeuwenhoek was the first person to discover microscope and the presence of bacteria and spirochetes in mouth.

EDWARD JENNER (1749-1823):

Jenner was an English country physician, who discovered a safe and efficient vaccination against small pox. which ultimately led to the eradication of small pox (**Variola**).Jenner observed that dairy workers, exposed to occupational cowpox infection were immune to small pox. He proved experimentally that resistance to small pox can be induced by injecting cow pox material (**Vaccinia**) from disease pustules in to man (in 1796).Pasteur gave the general term "**Vaccine**" (Vacca = cow) in honour of Jenner's cow pox vaccine, to various materials used to induce active immunity. Jenner published his findings in 1798 in a pamphlet "*An inquiry into the cause and effect of variole vaccine*".

LOUIS PASTEUR (1822-1895)

He was a Professor of Chemistry at the University of Lille, France. He is considered as "**Father 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.

He 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.

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 steri-lizer, 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 worked on "Pebrine", a silk-worm disease caused by a protozoan and showed that infection can be controlled by choosing worms free from the parasite for breeding.

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 chord. In 1888, Pasteur institute was established for mass antirabic treatment.

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ROBERT KOCH (1843-1912):

He was a German country Doctor who later became the Professor of hygiene and Director of institute of infective diseases at Berlin. He perfected many bacteriological techniques and known as "**Father of Practical Bacteriology**".

He discovered rod shaped organisms in the blood of animals, that died of anthrax. He experimentally obtained the anthrax organisms in pure culture on a depression slide by inoculation of infected blood into the aqueous humour of a bullock's eye. He observed multiplication of bacteria and spore formation. He injected these spores into mice and reproduced the disease.He found that in certain conditions, the anthrax bacillus forms spores, that can survive on earth for years. He passed anthrax bacilli, from the blood of an infected animal, from one mouse to another through twenty generations, and found that they bred true. He worked out its life-history.

He introduced staining techniques. He prepared dried bacterial films (Smears) on glass slides and stained them with aniline dyes for producing a better contrast under microscope. He discovered tubercle bacillus (*Mycobacterium tuberculosis*) which is popularly called as **Koch's bacillus**. He injected tubercle bacilli into laboratory animals and reproduced the disease, satisfying all Koch's postulates.

He discovered *Vibrio cholerae*, the causative agent of cholera disease.

He developed pure culture techniques by introducing solid media. The use of agar-agar obtained from dried sea weeds (*Gelidium Sp.*) in the preparation of solid bacteriological media was first suggested by Frau Hesse, the wife of Koch' student. This agar-agar is totally inert with no nutritive value, solidifies at 45°C and melts at 90°C, and was found to be most suitable solidifying agent in the preparation of culture media. Koch isolated bacteria in pure cultures on these solid media. It revolutionized bacteriology.

He discovered “Old **Tuberculin**”. Koch noted that when tubercle bacilli or its protein extract was injected into a Guinea-pig already infected with the bacillus, an exaggerated reaction took place and the reaction remain localized. This is popularly called **“Koch Phenomenon”** and it is a demostration of cell mediated immunity. The tuberculin test is based on Koch’s phenomenon. He erroneously thought that protein extracted from tubercle bacilli, called “Old tuberculin”, could be used in the treatment of tuberculosis.

Koch did a series of experiments to fulfill the criteria laid by his teacher Henle to establish the causative role between a particular microorganism and a particular disease. They are popularly known as **Koch’s postulates** (Henle-Koch’s Posulates). They are :

1. A specific organism should be found constantly in association with the disease.
2. The organism should be isolated and grown in a pure culture in the laboratory.
3. The pure culture when inoculated into a healthy susceptible animal should produce symptoms/ lesions of the same disease.
4. From the inoculated animal, the microorganism should be isolated in pure culture.
5. An additional criterion introduced is that specific anitbodies to the causative organism should be demonstrable in patient’s serum.

IWANOWSKY (1892)

Dmitri Iwanowsky, a Russian botanist, occupies a pivotal position in the history of virology.

In 1866, Adeolf E. Meyer, a Dutch agricultural chemist described a disease of tobacco called “Mosaic” and showed that the disease could be transmitted to healthy plants through the sap of the diseased plant. Iwanowsky (1892) demonstrated that this disease was caused by an agent which could pass through the filter, which withholds bacteria. He obtained the sap from infected leaves and passed it through a bacterial filter, called chamberland candle filter, which retained all bacteria and the filtered sap still retained infectivity when applied to healthy leaves.

Beijerinck (1898), a Dutch Microbiologist, showed that this infectious agent could diffuse through

an agar gel and that it was a non-corpuscular “*Contagion vivum fluidum*” which he called “**Virus**”.

Stanley (1935), a British Mycologist was able to obtain the infectious agent of tobacco mosaic in

ALEXANDER FLEMMING (1881-1955):

He was an English scientist worked at St. Mary’s hospital in London. Flemming was associated with two major discoveries-**lysozyme** and **penicillin**. In 1922, he discovered lysozyme by demonstrating that the nasal secretion has the power of dissolving or lysing certain kinds of bacteria. Subsequently, he showed that lysozyme was present in many tissues of the body.

In 1929, Flemming made an accidental discovery that the fungus *Penicillium notatum* produces an antibacterial substance which he called penicillin. Flemming was culturing Staphylococci in petridishes and some of his cultures were contaminated with a mold, subsquently indetified as *Penicillium notatum*.Around the mold colony, there were clear zones, where Staphylococci disappeared. Flemming attributed this to the production of an antibacterial susbstance by the mold. Flemming cultured the fungus *Penicilium notatum* in broth cultures, filtered the fungal mat and obtained the penicillin in soluble form in the culture filtrate.

In 1940, Howard Florey and Ernst Chain demonstrated its antibacterial action *in vivo*. Working in U.S.A., they were able to produce large quantities of penicillin in pure form. In 1945, Flemming, Florey and Chain shared the nobel prize in physiology and medicine for the discovery of penicillin.

SELMAN WAKSMAN : Selman Waksman was born on July 22, 1888, to Jewish parents in Nova Pryluka, Podolia Governorate, in the Russian Empire, now Vinnytsia Oblast, Ukraine. He immigrated to the United States in 1910, shortly after receiving his matriculation diploma from the Fifth Gymnasium in Odessa, and became a naturalised American citizen six years later.

Waksman attended Rutgers College (now Rutgers University), where he was graduated in 1915 with a Bachelor of Science (B.Sc.) in Agriculture. He continued his studies at Rutgers, receiving a Master of Science (M.Sc.) the following year. During his graduate study, he worked under J. G. Lipman at the New Jersey Agricultural Experiment Station at Rutgers performing research in soil bacteriology. Waksman was then appointed as Research Fellow at the University of California, Berkeley from where he was awarded his Doctor of Philosophy (Ph.D.) in Biochemistry in 1918.

Later he joined the faculty at Rutgers University in the Department of Biochemistry and Microbiology. It was at Rutgers that Waksman's team discovered several antibiotics, including actinomycin, clavacin, streptothricin, streptomycin, grisein, neomycin, fradicin, candicidin, candidin, and others. Two of these, streptomycin and neomycin, have found extensive application in the treatment of numerous infectious diseases. Streptomycin was the first antibiotic that could be used to cure the disease tuberculosis. Waksman coined the term antibiotics.

Many awards and honors were showered on Waksman after 1940, most notably the Nobel Prize in 1952; the Star of the Rising Sun, bestowed on him by the emperor of Japan, and the rank of Commandeur in the French Légion d'honneur.

Selman Waksman died on August 16, 1973 and was interred at the Crowell Cemetery in Woods Hole, Barnstable County, Massachusetts. His tombstone is inscribed simply as *Selman Abraham Waksman: Scientist*, followed by his dates of birth and death, and the phrase "The earth will open and bring forth salvation" in Hebrew and English, which is a reference to *Isaiah 45:8*.

He was the father of Byron Waksman, involved in Multiple sclerosis research.

Other little known contributions of Selman Waksman include anti-fouling paints for the Navy, the use of enzymes in detergents, and the use of Concord grape root stock to protect the French Vineyards from fungal infection.

BRANCHES OF MICROBIOLOGY: The branches of microbiology can be classified into pure and applied sciences. Microbiology can be also classified based on taxonomy, in the cases of bacteriology, mycology, protozoology, and phycology. There is considerable overlap between the specific branches of microbiology with each other and with other disciplines.

Pure microbiology

Taxonomic arrangement

1. Bacteriology: The study of bacteria.
2. Mycology: The study of fungi.
3. Protozoology: The study of protozoa.
4. Phycology (or algology): The study of algae.
5. Parasitology: The study of parasites.
6. Immunology: The study of the immune system.
7. Virology: The study of the viruses.
8. Nematology:The study of the nematodes

Integrative arrangement

1. Microbial cytology: The study of microscopic and submicroscopic details of microorganisms.
2. Microbial physiology: The study of how the microbial cell functions biochemically. Includes the study of microbial growth, microbial metabolism and microbial cell structure.
3. Microbial ecology: The relationship between microorganisms and their environment.
4. Microbial genetics: The study of how genes are organized and regulated in microbes in relation to their cellular functions. Closely related to the field of molecular biology.
5. Cellular microbiology: A discipline bridging microbiology and cell biology.
6. Evolutionary microbiology: The study of the evolution of microbes. This field can be subdivided into:
   - Microbial taxonomy: The naming and classification of microorganisms.
   - Microbial systematics: The study of the diversity and genetic relationship of microorganisms.
7. Generation microbiology: The study of those microorganisms that have the same characters as their parents.
8. Systems microbiology: A discipline bridging systems biology and microbiology.
9. Molecular microbiology: The study of the molecular principles of the physiological processes in microorganisms.

Other

1. Nano microbiology: The study of those microorganisms on nano level.
2. Exo microbiology (or Astro microbiology): The study of microorganisms in outer space.
3. Weapon microbiology: The study of those microorganisms which are using in weapon industries.

Applied microbiology

1. Medical microbiology: The study of the pathogenic microbes and the role of microbes in human illness. Includes the study of microbial pathogenesis and epidemiology and is related to the study of disease pathology and immunology.
2. Pharmaceutical microbiology: The study of microorganisms that are related to the production of antibiotics, enzymes, vitamins,vaccines, and other pharmaceutical products and that cause pharmaceutical contamination and spoil.
3. Industrial microbiology: The exploitation of microbes for use in industrial processes. Examples include industrial fermentation and wastewater treatment. Closely linked to the biotechnology industry. This field also includes brewing, an important application of microbiology.
4. Microbial biotechnology: The manipulation of microorganisms at the genetic and molecular level to generate useful products.
5. Food microbiology and Dairy microbiology: The study of microorganisms causing food spoilage and foodborne illness. Using microorganisms to produce foods, for example by fermentation.
6. Agricultural microbiology: The study of agriculturally relevant microorganisms. This field can be further classified into the following:
    - Plant microbiology and Plant pathology: The study of the interactions between microorganisms and plants and plant pathogens.
    - Soil microbiology: The study of those microorganisms that are found in soil.
7. Veterinary microbiology: The study of the role in microbes in veterinary medicine or animal taxonomy.
8. Environmental microbiology: The study of the function and diversity of microbes in their natural environments. This involves the characterization of key bacterial habitats such as the rhizosphere and phyllosphere, soil and groundwater ecosystems, open oceans or extreme environments (extremophiles). This field includes other branches of microbiology such as:
    - Microbial ecology
    - Microbially-mediated nutrient cycling
    - Geomicrobiology
    - Microbial diversity
    - Bioremediation
9. Water microbiology (or Aquatic microbiology): The study of those microorganisms that are found in water.
10. Aeromicrobiology (or Air microbiology): The study of airborne microorganisms.
11. Epidemiology: The study of the incidence, spread, and control of disease.

SCOPE OF MICROBIOLOGY: Microbiology is a branch of Biology that includes the study of growth, characteristics and various other aspects related to the life cycle of micro organisms such as protozoa, algae, fungi, bacteria and viruses. In other words, it is the study of microscopic organisms.

A person who specializes in the area of Microbiology is called as Microbiologist. The task of microbiologists involves investigation of the fascinating world of micro organisms or microbes. Due to the advancement in the field of science and technology, the scope of research in the field of microbiology has widened .

A Career in microbiology can be a lucrative option in India as well as abroad. Numerous institutions all over India and abroad offer degree programs at under graduate as well as at post graduate levels in the field of microbiology. While a Ph.D or master's degree is required for Research & Development positions, Bachelor degree holders have employment potential as laboratory technicians, aids to biological scientists or as biology teachers.

Microbiologists find jobs in many places like research and development laboratories of government and private hospitals, research organisations, pharmaceutical, food, beverage and chemical industries. Universities, research institutes and industrial companies employ microbiologists to do basic, environmental, healthcare and agricultural research.

Microbiologists can also become faculty members in Universities, Colleges or teachers in Schools, etc. For college teaching, a master's degree may be acceptable along with qualification of CSIR – NET, but a doctorate opens more avenues.