Introduction and Brief History of Microbiology

Microbiology – Microbiology is the science or study of organisms too small to be observed with the naked eye, i.e., not visible without the aid of instruments capable of magnification.
Microorganisms (microbes) include eukaryotic cell types (protozoa, certain fungi, certain algae and the immature forms of multicellular parasites), and prokaryotic cell types (bacteria and archaea). Most microbiology texts also include information about viruses, viroids and prions (non-cellular entities).

Microorganisms were involved in the production of wine, beer, yogurt, cheese and other fermented foods prepared by Neolithic human societies. People "used" microbes to flavor and preserve foods, but did not know the tiny organisms were present. Many people still don't.
Louis Pasteur demonstrated that living microorganisms were responsible for fermentation.

Antone Van Leeuwenhoek – Sometimes called the "father of microbiology" because he made his own microscopes, observed live microorganisms, and documented his findings with an established scientific organization (the British Royal Society or Royal Society of London).

Abiogenesis (without life beginnings/origin) or **Spontaneous generation –** Belief in abiogenesis (the spontaneous generation of living organisms from non-living materials), was rekindled by Van Leeuwenhoek's discovery of microorganisms; however, belief in abiogenesis is not compatible with modern science. Many investigators conducted experiments to disprove abiogenesis.

Francesco Redi – Disproved abiogenesis at the macroscopic level by demonstrating flies did not arise spontaneously from decaying meat.
Lazzaro Spallanzani – Disproved abiogenesis at the microscopic level by sealing samples of boiled broth inside glass containers.
John Needham and **Jan Baptist van Helmont** – Supported abiogenesis.
Louis Pasteur – Credited with disproving abiogenesis of microorganisms using boiled broth samples maintained inside goose-necked flasks open to the air. Demonstrated microorganisms were present in air and developed a method for controlling them (pasteurization).
John Tyndall – Attempted to duplicate Pasteur's experiments with boiled broths in open flasks. He alternately boiled and cooled broths over a three-day period to kill endospores. His method was called fractional sterilization or Tyndallization.

Microbiology became a legitimate science only after the abiogenesis of microorganisms was shown to be a false concept (during the mid-1800s). Microorganisms do not arise spontaneously from non-living materials. Cells give rise to other cells through biogenesis.

Germ Theory – Certain types of microorganisms can cause disease.

Before microorganisms were discovered, people associated disease with natural phenomena such as earthquakes, floods, or exposure to bad air or bad weather. Disease was also attributed to mysterious or supernatural causes, e.g., punishment for sinful behavior.

Girolamo Fracastoro (1546) recorded his belief that disease was caused by tiny entities (spores) that could be passed from person to person. Without a microscope, he had no way to see these spores.
Ignaz Philipp Semelweis (1840) urged doctors working in Vienna General Hospital to wash their hands between conducting autopsies and assisting women with childbirth fever.

Joseph Lister (1867) pioneered the use of antiseptic techniques during surgical procedures. He washed his hands and instruments, and applied carbolic acid (phenol) to prevent infection. Lister knew about bacteria and is credited with developing the first pure bacterial cultures.

Robert Koch (1876) developed a set of experimental steps (**Koch's postulates**) that could be used to show that a particular type of microorganism was responsible for causing a specific type of disease. Initially he demonstrated that anthrax was caused by *Bacillus anthracis*.

Koch's Postulates:

1. The suspect causative agent must be found in every case of the disease. (Koch took samples from hundreds of animals over years of investigation to be certain of his conclusions.)
2. The specific type of microbe must be isolated from the infected individual and grown in a culture containing no other forms (pure culture).
3. Upon inoculation into a normal, healthy, susceptible animal, a pure culture of the microbial agent must produce the disease.
4. The same type of microbe must be recovered again from the experimentally infected host.

During the "Golden Years" of microbiology (1857-1914) investigators discovered the bacterial causes of major human diseases including cholera, diphtheria, leprosy, plague, tetanus, tuberculosis and typhoid. During this period, other important contributions to microbiology were made by:
Richard J. Petri, the man who developed the Petri dish.
Fanny Hesse, the woman who developed the use of agar as a solidifying agent.
Hans Christian Gram, the man who developed the Gram stain.

Immunization – Attenuated microbial culture (vaccines) can be used to prevent disease.

Louis Pasteur (1880) discovered that attenuated (weakened) microbial cultures could be used to prevent disease while studying chicken cholera. Pasteur called his attenuated cultures **vaccines** (vacca = cow) in recognition of the work carried out by Edward Jenner.

Edward Jenner (1796) noticed that dairymaids often contracted cowpox, but seemed resistant to smallpox. He used fluid from pustules formed on young women infected with cowpox to prevent small pox and called the procedure **vaccination**.

Magic bullets – Chemicals produced by microorganisms can be used to cure disease.

Paul Ehrlich (1910) searched for "magic bullets", i.e., chemical compounds that could be taken by patients to cure disease (magically seek out and kill microorganisms inside the body without causing damage to the patient). He developed Salvarsan, and arsenic compound used to cure syphilis.

Alexander Fleming (1928) found that fungi in the genus *Penicillium* could kill *Staphylococcus* and discovered Penicillin, one of the first antibiotics. Currently many different types of bacteria and fungi are used to produce antibiotics.

During the 20th century, microbiology has expanded and increased in importance. Although some microorganisms can cause disease, most of them are beneficial and essential to our survival.