Chapter 1 Lecture Notes: The History and Scope of Microbiology

I. What is microbiology?

A. Microbiology is the study of organisms and agents that are generally too small to be seen clearly by the unaided eye. These organisms include viruses, bacteria, algae, fungi, and protozoa.

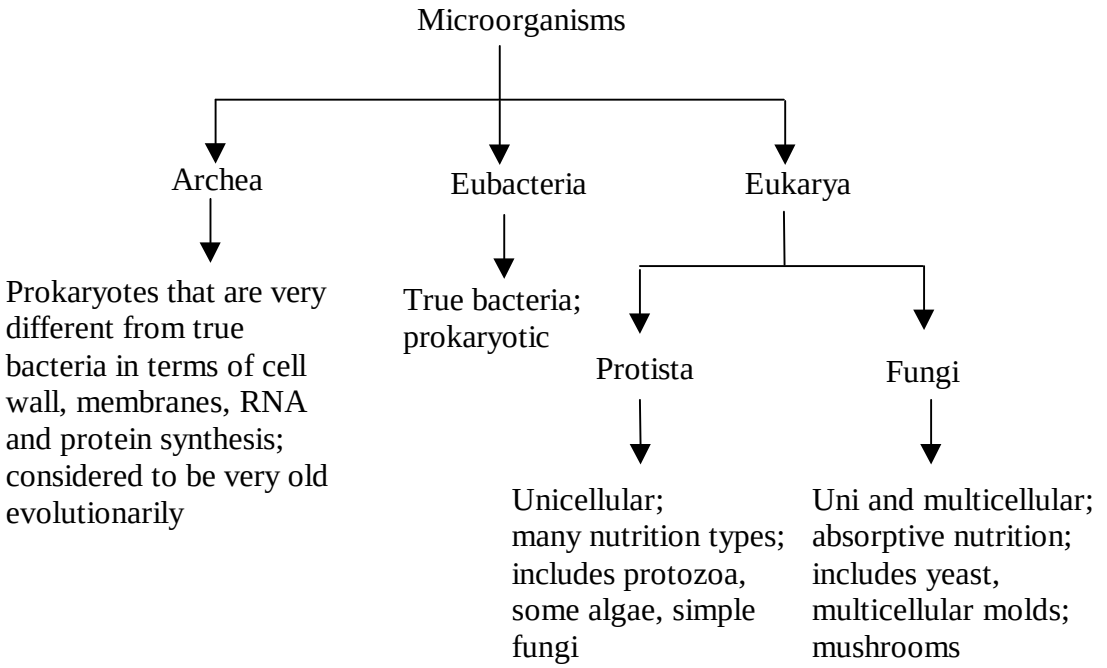
B. Microbiology can be applied or basic.

C. Microbiology is linked to many other scientific disciplines including biochemistry, cell biology, evolution, ecology.

D. Subdisciplines (both applied and basic research)

1. General microbiology: broad range of microbiological questions
2. Medical microbiology: microbes that cause human disease
3. Public health and epidemiology: Studies and controls transmission, frequency, and distribution of disease
4. Immunology: the immune system
5. Agricultural microbiology: impact of microbes on agriculture
6. Microbial ecology: relationships between microbes and their habitats
7. Food microbiology: Prevention of food borne disease; microbes that make food and drink
8. Industrial microbiology: commercial use of microbes to produce products
9. Biotechnology: manipulation of organisms to form useful products

II. What are microbes?



III. The scope and relevance of microbes

A. L. Pasteur "The role of the infinitely small in nature is infinitely large."
B. 1st living organisms
C. Live in every possible environment
D. More numerous than macroorganisms
E. Constitute the largest component of biomass
F. Fundamental to the ecosystem
G. Have changed the course of history in obvious and not so obvious ways

IV. History

A. Discovering the "organisms"
    1. 1676: A. Leeuwenhoek – first to observe and describe microbes accurately
    2. 1884: C. Chamberland – constructed a bacterial filter that allowed the identification of viruses
    3. 1898: Loeffler and Frosch – identified filterable infectious agent as cause of foot-and-mouth disease in cattle
    4. 1898-1900: M. Beijerinck – identified tobacco mosaic virus
    5. 1982: S. Prusiner – described prions (infectious protein that causes a particular normal protein to alter its shape and become a prion)

B. Disproving spontaneous generation (that living organisms could develop from nonliving matter)
    1. 1688: F. Redi – first to challenge theory of spontaneous generation by showing that if raw meat was protected from flies, the formation of maggots was prevented
    2. 1748: R. Needham – supported spontaneous generation of microbes by showing that even after boiling mutton broth and pouring into sealed containers, growth of microbes occurred
    3. 1776: L. Spallanzani - challenged spontaneous generation as it pertained to microbes by showing that sealed containers that were boiled do not produce microbes
    4. 1861: L. Pasteur – rigorously disproved spontaneous generation
        a) filtered air → showed that air contained microbial organisms
        b) constructed flasks with curved neck that allowed air into the flasks while dust, etc. remained in the neck → placed broth into the flasks and boiled → showed that no microbial growth resulted unless flasks were tipped to allow the broth into the neck

C. The germ theory of disease
    1. Previously, people thought that disease was punishment for an individual's crimes, due to poisonous vapors, and/or an imbalance of the "four humors".
    2. First proponents of the idea that invisible organisms caused disease were Lucretius (B.C.) and Fracastoro (1546)
    3. 1835: A. Bassi showed that silkworm disease was due to a fungus.

4. 1867: J. Lister showed that antiseptic surgical procedures reduced the frequency of wound infections.
5. 1876/1884: R. Koch definitively proved that *Bacillus anthracis* caused the disease anthrax in cows and *Mycobacterium tuberculosis* caused the disease tuberculosis using Koch's postulates.
    a) The suspected pathogen should be present in ALL cases of the disease and NOT present in healthy animals.
    b) The suspected pathogen should be grown *in vitro* in pure culture.
    c) Cells from a pure culture of the putative pathogen should cause disease in healthy animals.
    d) The putative pathogen should be reisolated from the infected animal.

D. Preventing disease by vaccination
1. E. Jenner inoculated people with cowpox to protect against smallpox.
2. 1885 – Pasteur developed the rabies vaccine.
3. 1890: von Behring and Kitasato produced antibodies to purified toxins to protect against diphtheria and tetanus.
4. 1884: E. Metchnikoff described phagocytosis of bacteria.

E. Discovering the effect of microbes on organic and inorganic matter
1. 1856: Pasteur described lactic acid fermentation; contributions to wine industry.
2. 1887-1900: S. Winogradsky and M. Beijerinck studied soil microbes and their role in the biochemical cycles of sulfur, carbon, nitrogen

V. Recent history of microbiology – the 20th century

A. Infectious diseases: The etiological agent of most infectious diseases has been ascertained. Current research focuses on understanding the molecular mechanisms by which disease is caused.

B. Chemotherapy: Discovery of antibiotics; antibiotic resistance

C. Immunology develops as a science.

D. Physiology and biochemistry: Using microbes as a model, many physiological and biochemical processes have been elucidated.

E. Genetics: Many of the advances in molecular genetics were made using bacteria as models. A few of the many:
1. 1941: Beadle and Tatum – 1 gene = 1 enzyme
2. 1943: Luria and Delbruck – mutations are spontaneous in nature
3. 1944: Avery, MacLeod, and McCarty – DNA is the genetic material
4. 1961: Jacob and Monod – the operon and gene regulation

F. Molecular biology: Many of the advances in molecular biology were made using bacteria as models. A few of the many:
1. 1970: Restriction enzymes discovered
2. 1979: Insulin synthesized using recombinant techniques
3. 1990: Gene therapy trials begin
4. 1995: The nucleotide sequence of the first free-living organism (*Haemophilus influenzea*) published