

CHAPTER 1: Microbial Life: Origin and Discovery

CONCEPT MAP

I. Section 1.1: From Germ to Genome: What Is a Microbe?

- A. Microbes are organisms that require a microscope to be seen
 - i. Prokaryotes—cells lacking a nucleus such as bacteria and archaea
 - ii. Eukaryotes—cells with nucleus such as algae, fungi, and protists
- B. Microbial genomes (cell's genetic information) can be sequenced
 - i. Can indicate degree of relatedness between species
 - ii. Comparative genomics is the comparison of genomes of all species

II. Section 1.2: Microbes Shape Human History

- A. Microbial disease devastates human populations
 - i. Tuberculosis, leprosy, bubonic plague, smallpox, AIDS
 - ii. Florence Nightingale—developed science of medical statistics to show impact of infectious disease on humans
- B. Microscopes reveal the microbial world
 - i. Robert Hooke—built compound microscope; first to publish illustrations of microbes
 - ii. Antoni van Leeuwenhoek—first to view single-celled organisms
- C. Spontaneous Generation—theory that living organisms arise spontaneously
 - i. Lazzaro Spallanzani
 - a. attempted to disprove theory using sealed flask of meat broth
 - ii. Louis Pasteur
 - a. Discovered that fermentation is caused by yeast
 - b. Disproved spontaneous generation using unsealed flasks with bent neck
 - iii. John Tyndall
 - a. Showed that repeated cycles of heat are necessary to destroy endospores (a heat-resistant form of bacteria)

III. Section 1.3: Medical Microbiology

- A. Germ theory of disease—theory that many diseases are caused by microbes
- B. Robert Koch
 - i. Developed pure culture techniques to study a single species
 - a. Used media which was solidified with agar and placed in petri dishes
 - ii. Developed postulates for proving that a specific organism causes a disease
- C. Immunization prevents disease
 - i. Edward Jenner developed first vaccination using cowpox virus to protect against smallpox
 - ii. Louis Pasteur developed immunization technique using attenuated pathogens such as rabies virus
 - iii. Ignaz Semmelweis and Joseph Lister discovered that use of antiseptics prevent infections
 - iv. Alexander Fleming discovered first antibiotic, penicillin. Howard Florey and Ernst Chain purified penicillin for commercial use.
- D. Discovery of viruses

IV. Section 1.4: Microbial Ecology

- A. Sergei Winogradsky
 - i. First to study microbes in their natural environment
 - ii. Discovered lithotrophs, which use inorganic minerals as food source
 - iii. Developed enrichment culture techniques for growing specific types of organisms
 - iv. Winogradsky column is an enclosed ecosystem with regions of enrichment for microbes of diverse metabolism
- B. Microbes are responsible for geochemical cycling of many minerals

V. Section 1.5: The Microbial Family Tree

- A. Microbes are a challenge to classify
 - i. Difficult to visualize distinguishing features
 - ii. Do not fit classic definition of species
- B. Microbes include prokaryotes and eukaryotes
- C. Lynn Margulis proposed that eukaryotes evolved through endosymbiosis—one cell internalizes another that grows within it
- D. Carl Woese discovered new domain of prokaryotes, archaea, using 16s rRNA sequencing

VI. Section 1.6: Cell Biology and the DNA Revolution

- A. Electron microscope
 - i. Invented by Ernst Ruska using electromagnets to focus rays of electrons
 - ii. Can magnify up to a millionfold to reveal cellular structures
- B. Ultracentrifuge
 - i. Invented by Theodor Svedberg
 - ii. Uses centrifugal force to separate and determine sizes of cellular components
- C. Discovery of structure and function of DNA led to many scientific advances
 - i. DNA sequencing
 - ii. Polymerase chain reaction
 - iii. Recombinant DNA
- D. Microbial discoveries enable production of new pharmaceuticals and industrial products