Chapter 10: Classification of Microorganisms

Phylogeny: The Study of Evolutionary Relationships of Living Organisms

- Over 1.5 million different organisms have been identified to date.
- Many similarities among living organisms:
  - Made up of cells surrounded by a plasma membrane.
  - Use ATP as an energy source.
  - Store genetic information as DNA.
  - Ribosomes are the site of protein synthesis.
- Both differences and similarities among organisms are caused by natural selection (Darwin, 1858).
- Organisms can be classified into taxonomic categories (taxa), based on the differences and similarities among them.

Phylogeny: The Study of Evolutionary Relationships of Living Organisms

- Ancient Greeks classified all living organisms into two groups
  - Kingdom Plantae
  - Kingdom Animalia
- In 1850s bacteria and fungi were incorrectly placed in the Plant Kingdom.
- In 1860s Kingdom Protista was proposed to include bacteria, fungi, algae, and protozoa, but many scientists still classified bacteria and fungi as plants.
- Intense disagreement over classification of bacteria and fungi persisted over 100 years.

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- In 1930s electron microscopy made it clear that bacterial cells lacked a nucleus. The term procaryote was introduced in 1937.
- In 1959 Kingdom Fungi was established.
- In 1961 the current definition of the term procaryote was established.
- In 1968 the Kingdom Procaryotae was accepted by biologists.
- In 1969 Robert Whitaker proposed a five-kingdom system of biological classification for all living organisms.

Five-Kingdom System of Biological Classification

Proposed in 1969 by Robert Whitaker:

2. Kingdom Protista: Mostly unicellular, lack a true nucleus and membrane-bound organelles.
3. Kingdom Fungi: May be unicellular (yeasts) or multicellular (molds). Many are saprotrophs.
5. Kingdom Animalia: Multicellular, heterotrophs that ingest food through a mouth or oral cavity.
Differences Between Eucaryotic and Procaryotic Cells

<table>
<thead>
<tr>
<th>Procaryotes</th>
<th>Eucaryotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell size</td>
<td>0.2-2 um in diameter</td>
</tr>
<tr>
<td>Nucleus</td>
<td>Absent</td>
</tr>
<tr>
<td>Membranous Organelles</td>
<td>Absent</td>
</tr>
<tr>
<td>Cell Wall</td>
<td>Chemically complex</td>
</tr>
<tr>
<td>Ribosomes</td>
<td>Smaller (70S)</td>
</tr>
<tr>
<td>DNA</td>
<td>Single circular chromosome</td>
</tr>
<tr>
<td>Cell Division</td>
<td>Binary fission</td>
</tr>
</tbody>
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Procaryotes: Lack Nucleus and Membrane-Bound Organelles

Phylogeny:
The Three Domain System

Domain: In 1978 Carl Woese proposed this level of classification above kingdom. There are three domains based on the following distinguishing criteria:
- Cell wall composition
- Membrane lipids
- RNA sequence
- Protein synthesis
- Antibiotic sensitivity

I. Domain Eubacteria: “True bacteria”
- Cell wall contains peptidoglycan.
- Sensitive to antibiotics.

II. Domain Archaeabacteria: “Ancient bacteria”
- Cell walls lack peptidoglycan, resistant to antibiotics.
- Live in extreme environments
- Three kingdoms:
  1. Methanogens: Strict anaerobes that produce methane.
  2. Extreme Halophiles: Require high salt concentrations.
  3. Thermocarchophiles: Live in hot, acidic environments.

III. Domain Eucarya: All eucaryotes: Protista, Fungi, Plantae, and Animalia.
Phylogenetic Relationships of Procaryotes

Classification of Organisms
Scientific Nomenclature
- **Scientific nomenclature**: Universal system for naming and classifying living organisms. Initially developed in the 18th century by Carl Linnaeus.
- **Binomial nomenclature**: Each organism (species) has a two-part name. Names are either italicized or underlined.
  - **Genus name**: Always capitalized, always a noun. May use initial.
  - **species name**: Always lower case, usually an adjective.
- Names are usually derived from Latin (or Greek) or may have latinized endings. Examples:
  - *Homo sapiens* (*H. sapiens*): Human
  - *Penicillium notatum* (*P. notatum*): Mold that produces penicillin
  - *Canis familiaris* (*C. familiaris*): Domestic dog

Classification of Organisms
Hierarchy of Taxonomic Categories
- **DOMAIN**
- **Kingdom**
  - **Phylum or Division (Bacteria)**
  - **Class**
  - **Order**
  - **Family**
  - **Genus**
  - **species**

Classification of Bacteria
Scientific Nomenclature
- **Bacterial species**: Population of cells with similar characteristics.
- **Bacterial strain**: A subgroup of a bacterial species that has distinguishing characteristics. Identified by numbers, letters, or names that follow the scientific name.
- *Escherichia coli* O157:H7: Strain that causes bloody diarrhea.
  - Classification initially based on cell morphology, staining, metabolism, biochemistry, serology, etc.
  - More recently, DNA, RNA, and protein sequence analysis are being used to study evolutionary relationships.

Classification of Viruses
- Viruses are not considered living organisms by most biologists, because they lack cells and their own anabolic machinery.
- Obligate intracellular parasites. Must have evolved after their host cell evolved.
- **Viral species**: Population of viruses with similar characteristics that occupies a particular ecological niche.
  - **Morphology**
  - **Genes**
  - **Enzymes**