

Chapter 10 Classification of Microorganisms

Overview

- Taxonomy & Systematics (phylogeny)
 - Three domains
 - Origin of Eukaryotes
- Classification
 - Phylogenetics, nomenclature, & hierarchy
 - Prokaryotes, Eukaryotes, Viruses
- Methods
 - Classification vs. Identification
 - Morphological
 - Staining
 - Biochemical
 - Serology (ELISA, Western Blot)
 - Phage typing
 - Flow cytometry
 - DNA (PCR, fingerprinting, hybridization)
 - Keys (dichotomous, cladograms)

Taxonomy

- The science of classifying organisms
- Provides universal names for organisms
- Provides a reference for identifying organisms

Systematics, or Phylogeny

- The study of the evolutionary history of organisms
- All Species Inventory (2001–2025)
 - To identify all species of life on Earth

Placing Bacteria

- 1735 Kingdoms Plantae and Animalia
- 1857 Bacteria and fungi put in the Kingdom Plantae – “Flora”
- 1866 Kingdom Protista proposed for bacteria, protozoa, algae, and fungi
- 1937 Prokaryote introduced for cells "without a nucleus"
- 1961 Prokaryote defined as cell in which nucleoplasm is not surrounded by a nuclear membrane
- 1959 Kingdom Fungi
- 1968 Kingdom Prokaryotae proposed
- 1978 Two types of prokaryotic cells found

The Three-Domain System

A Model of the Origin of Eukaryotes

Endosymbiotic Theory

Fossilized Prokaryotes

Phylogenetics

- Each species retains some characteristics of its ancestor
- Grouping organisms according to common properties implies that a group of organisms evolved from a common ancestor
 - Anatomy
 - Fossils
 - rRNA

Scientific Nomenclature

- Common names
 - Vary with languages
 - Vary with geography
- Binomial Nomenclature (genus + specific epithet)
 - Used worldwide
 - *Escherichia coli*
 - *Homo sapiens*

Scientific Names

Taxonomic Hierarchy

- Domain
- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species

Classification of Prokaryotes

- Prokaryotic species: A population of cells with similar characteristics
 - Culture: Grown in laboratory media
 - Clone: Population of cells derived from a single cell
 - Strain: Genetically different cells within a clone

Phylogenetic Relationships of Prokaryotes

Classification of Eukaryotes

- Eukaryotic species: A group of closely related organisms that breed among themselves

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Classification of Eukaryotes

- Animalia: Multicellular; no cell walls; chemoheterotrophic
- Plantae: Multicellular; cellulose cell walls; usually photoautotrophic
- Fungi: Chemoheterotrophic; unicellular or multicellular; cell walls of chitin; develop from spores or hyphal fragments
- Protista: A catchall kingdom for eukaryotic organisms that do not fit other kingdoms
 - Grouped into clades based on rRNA

Classification of Viruses

- Viral species: Population of viruses with similar characteristics that occupies a particular ecological niche
 - Non-living, acellular

Classification and Identification

- Classification: Placing organisms in groups of related species. Lists of characteristics of known organisms.
- Identification: Matching characteristics of an “unknown” organism to lists of known organisms.
 - Clinical lab identification
- Identifying *Klebsiella* doesn't tell you it's classified as gammaproteobacteria

Identification Methods

- Morphological characteristics: Useful for identifying eukaryotes
- Differential staining: Gram staining, acid-fast staining
- Biochemical tests: Determines presence of bacterial enzymes

Biochemical - Numerical Identification

Serology

- Combine known antiserum plus unknown bacterium
- Slide agglutination test

Serology - ELISA

- Enzyme-linked immunosorbent assay
- Known antibodies
- Unknown type of bacterium
- Antibodies linked to enzyme
- Enzyme substrate

Serology - The Western Blot

Phage Typing of *Salmonella enterica*

Flow Cytometry

- Uses differences in electrical conductivity between species
- Fluorescence of some species
- Cells selectively stained with antibody plus fluorescent dye

DNA - Genetics

- DNA base composition
 - Guanine + cytosine content
- DNA fingerprinting
 - Electrophoresis of restriction enzyme digests
- rRNA sequencing
- Polymerase chain reaction (PCR)

DNA - Nucleic Acid Hybridization

DNA - Identifying Bacteria with a probe

DNA - DNA Chip Technology

DNA - FISH

- Fluorescent in situ hybridization
- Add DNA probe for *S. aureus*

Keys - Dichotomous Key

Keys - Building a Cladogram