

# **Classification of Organisms & Microorganisms**

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**1st Course**

**Lec.#1**

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# Phylogeny: The Study of Evolutionary Relationships of Living Organisms

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- ◆ 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 energy source.
  - ◆ Store genetic information as DNA.
  - ◆ Ribosomes are the site of protein synthesis.
- ◆ 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

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- ◆ 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.

# Phylogeny: The Study of Evolutionary Relationships of Living Organisms

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

# Five-Kingdom System of Biological Classification

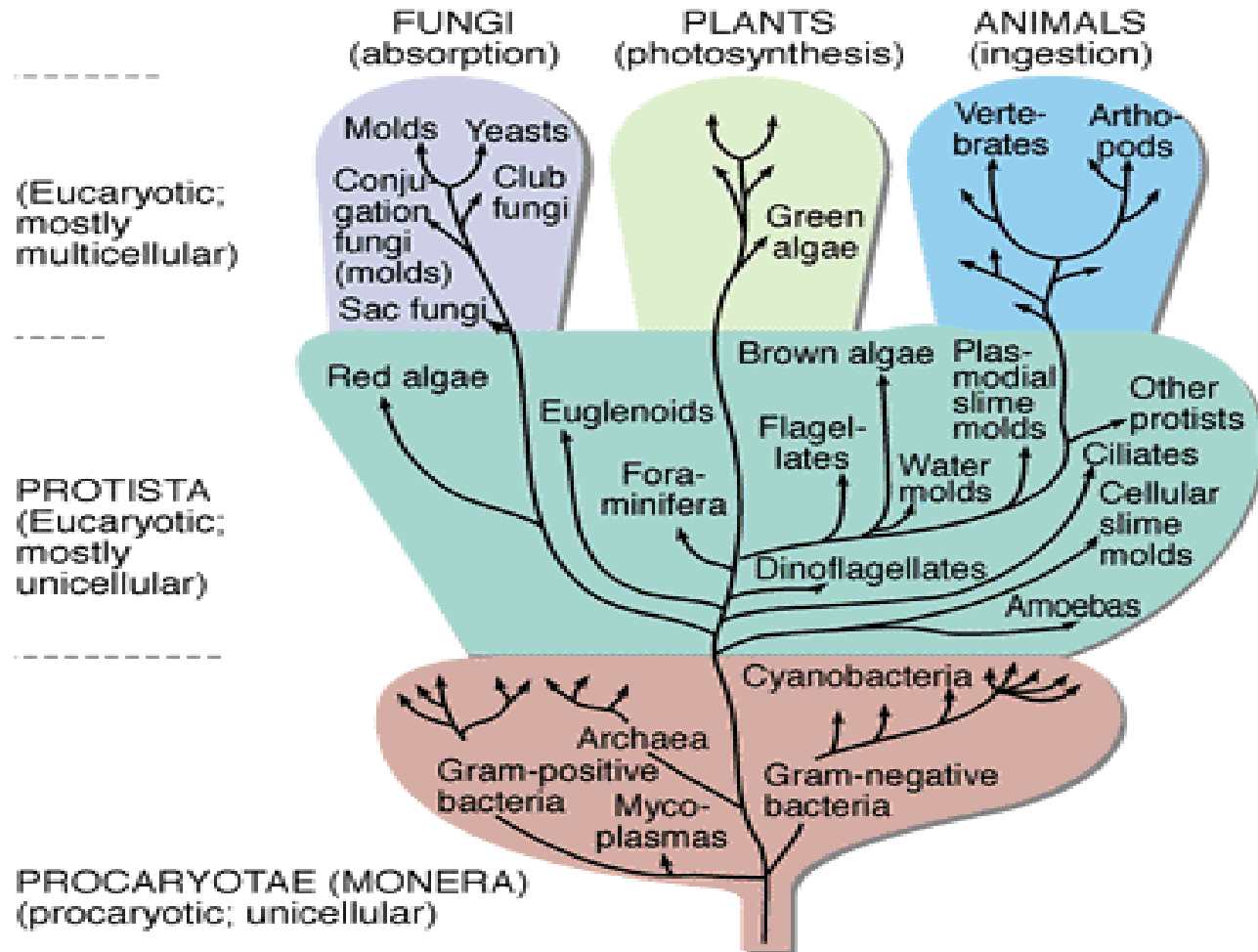
Proposed in 1969 by Robert Whittaker :

1. **Kingdom Prokaryotes (Monera):** Oldest known cells. Lived over 3.5 billion years ago. Lack a nucleus and membrane bound organelles.

The other four kingdoms are **eukaryotes**. Have a true nucleus and membrane bound organelles.

2. **Kingdom Protista:** Mostly unicellular, lack tissue organization. Most have flagella during life.
3. **Kingdom Fungi:** May be unicellular (yeasts) or multicellular (molds). Many are saprotrophs.
4. **Kingdom Plantae:** Multicellular, photosynthetic.
5. **Kingdom Animalia:** Multicellular, heterotrophs that ingest food through a mouth or oral cavity.

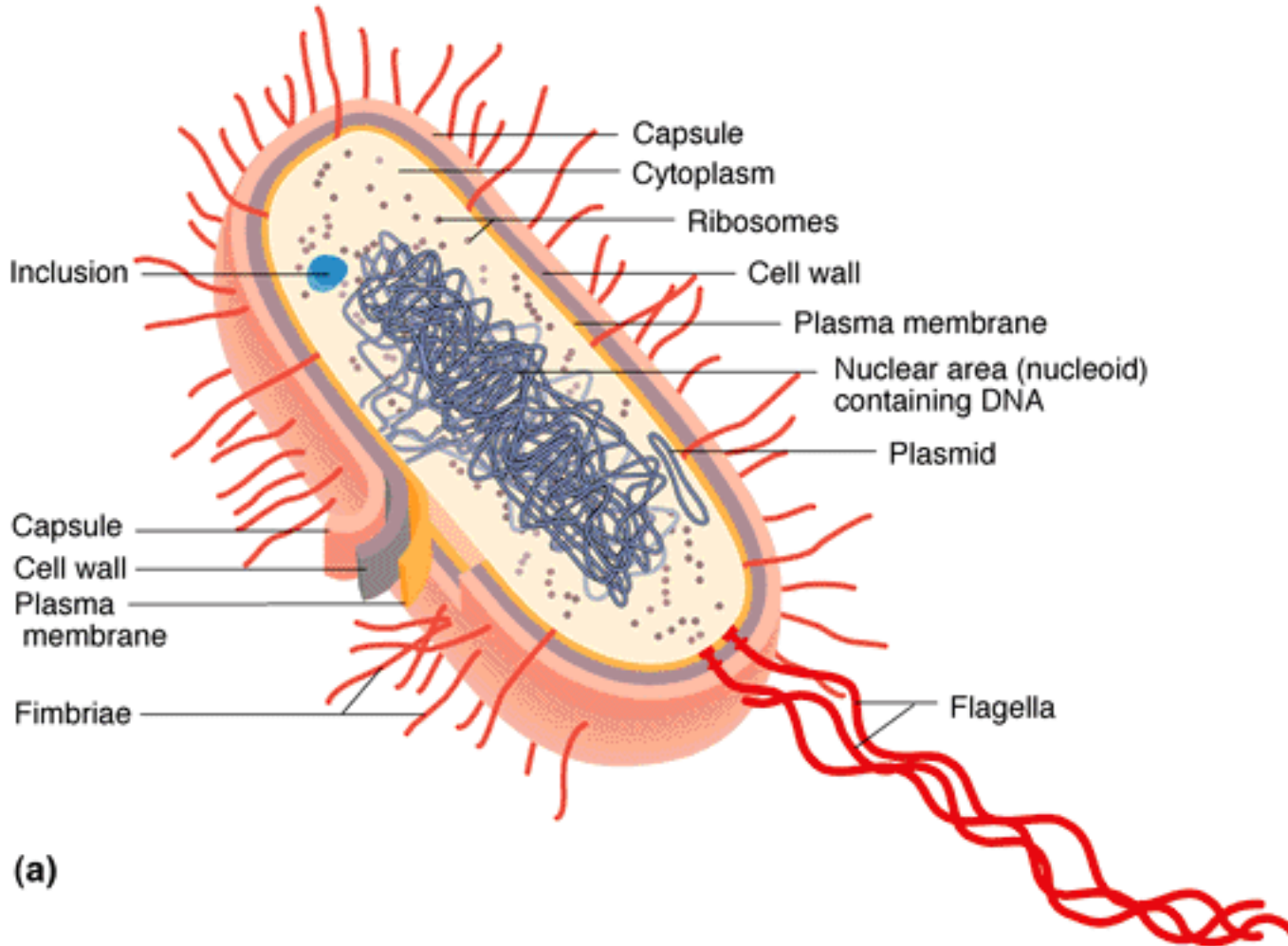
# Five-Kingdom Classification System



# Differences Between Eucaryotic and Prokaryotic Cells

	<u>Prokaryotes</u>	<u>Eucaryotes</u>
<b>Cell size</b>	0.2-2 um in diameter	10-100 um in diameter
<b>Nucleus</b>	Absent	Present
<b>Membranous Organelles</b>	Absent	Present
<b>Cell Wall</b>	Chemically complex	When present, simple
<b>Ribosomes</b>	Smaller (70S)	Larger (80S) in cell 70S in organelles
<b>DNA</b>	Single circular chromosome	Multiple linear chromosomes (histones)
<b>Cell Division</b>	Binary fission	Mitosis

# Prokaryotes: Lack Nucleus and Membrane-Bound Organelles



(a)



Figure 7.7 An animal cell

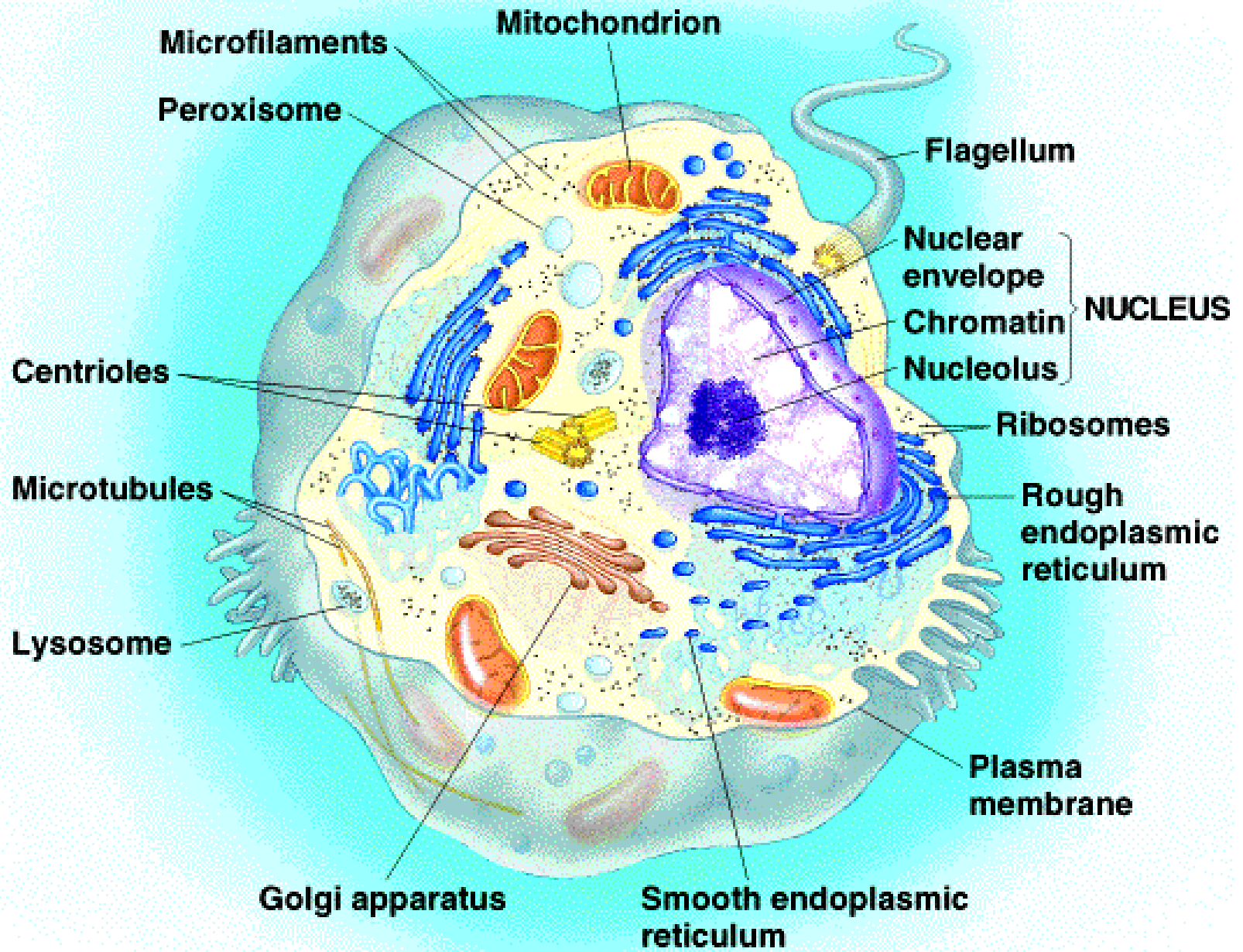
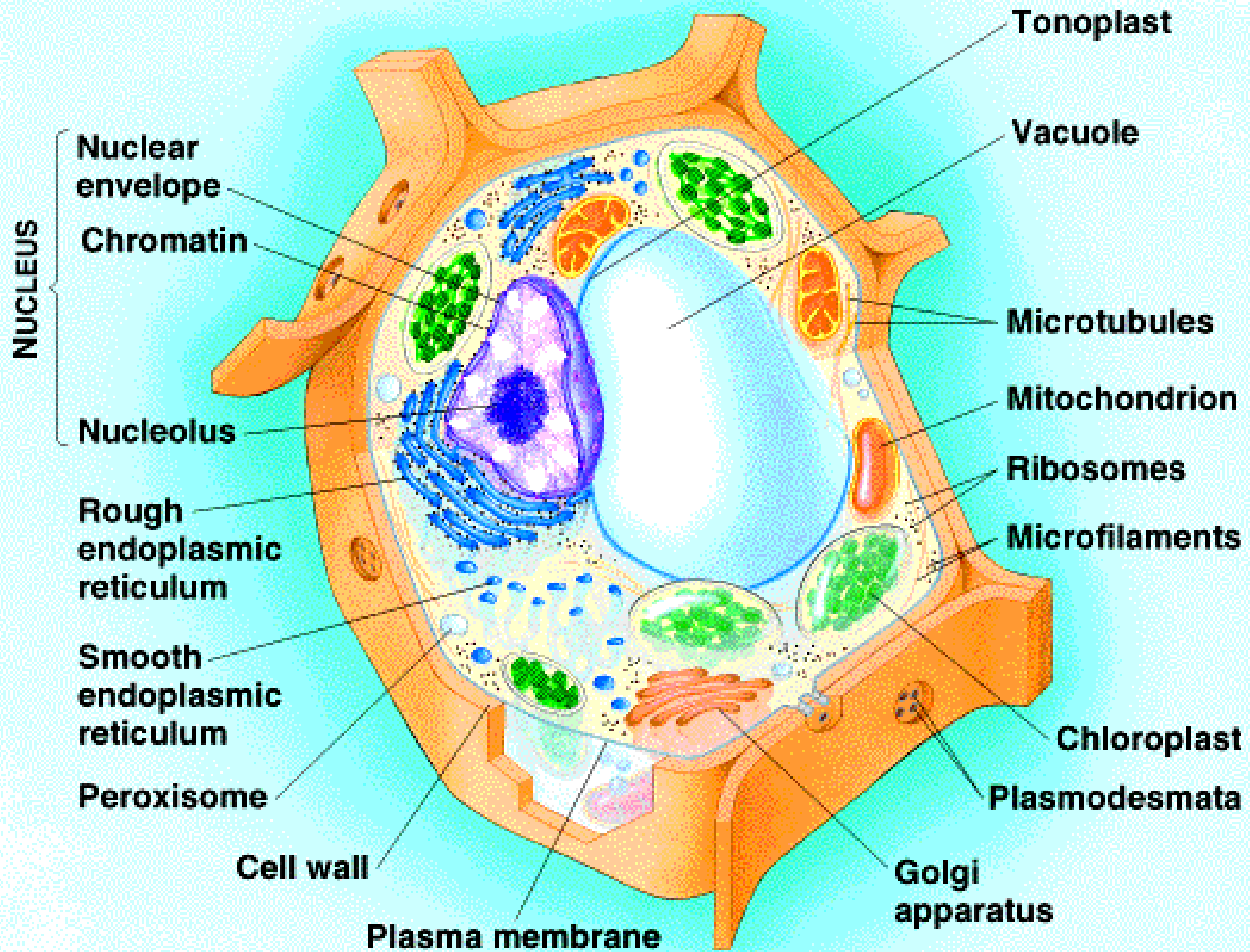


Figure 7.8 A plant cell



# Phylogeny:

## The Three Domain System

**Domain:** In 1999 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”.

**II. Domain Archaeobacteria:** “Ancient bacteria”

**III. Domain Eucarya:** All eukaryotes: **Protista, Fungi, Plantae, and Animalia.**

# Phylogeny:

## The Three Domain System

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Recent developments in molecular biology and biochemistry have revealed that there are two types of procaryotic cells, based on differences in their ribosomes, cell walls, and metabolism.

### 1. Eubacteria: “True bacteria”.

- ◆ Cell wall contains peptidoglycan.
- ◆ Sensitive to antibiotics.

### 2. Archaeobacteria: “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. Thermoacidophiles: Live in hot, acidic environments.

# Classification of Organisms

## Scientific Nomenclature

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- ◆ **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

# Bacteria Archaea Eukaryote

<b>Cell type</b>	<b>Prokaryotic</b>	<b>Prokaryotic</b>	<b>Eukaryotic</b>
<b>Cell wall</b>	<b>Made of peptidoglycan</b>	<b>Does not contain peptidoglycan</b>	<b>In plants and fungi, composed of polysaccharides</b>
<b>Sensitivity to antibiotics</b>	<b>Yes</b>	<b>No</b>	<b>No</b>
<b>First amino acid during protein synthesis</b>	<b><u>Formylmethionine</u></b>	<b>Methionine</b>	<b>Methionine</b>
<b>DNA</b>	<b>Mostly circular chromosome and plasmids</b>	<b>Circular chromosome and plasmids</b>	<b>Linear chromosome, rarely plasmids</b>
<b>Histones</b>	<b>No</b>	<b>Yes</b>	<b>Yes</b>
<b>Organelles</b>	<b>No</b>	<b>No</b>	<b>Yes</b>
<b>Ribosomes</b>	<b>70S</b>	<b>70S</b>	<b>80S</b>

# Classification of Organisms

## Hierarchy of Taxonomic Categories

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**DOMAIN**

**Kingdom**

◆ **Phylum or Division**

◆ **Class**

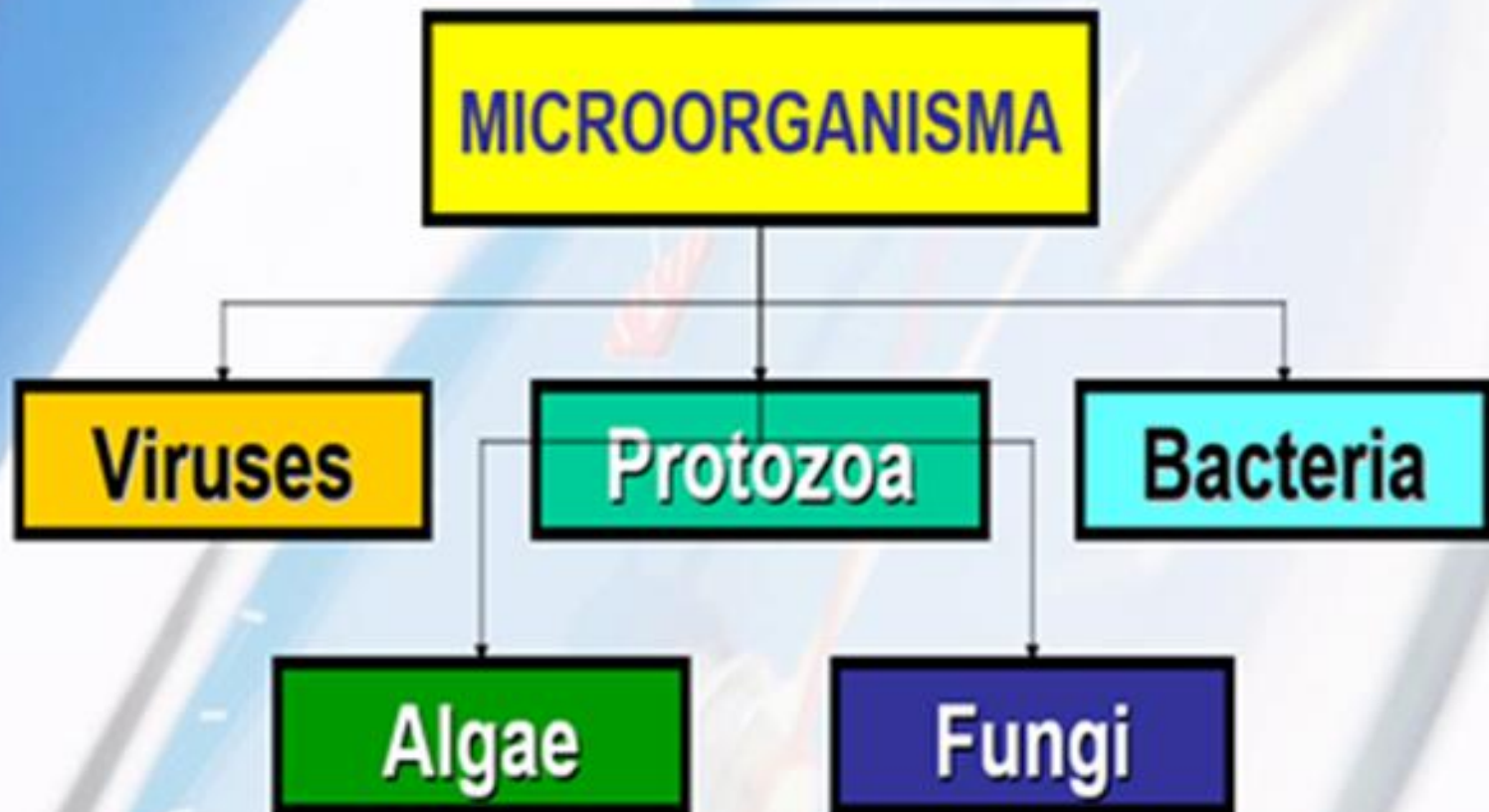
◆ **Order**

◆ **Family**

◆ *Genus*

*species*

# MICROORGANISMS





# Classification of Bacteria

## Scientific Nomenclature

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- ◆ **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.
- ◆ **Bergey's Manual:** Provides a reference for identifying and classifying bacteria.
  - ◆ 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

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- ◆ 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