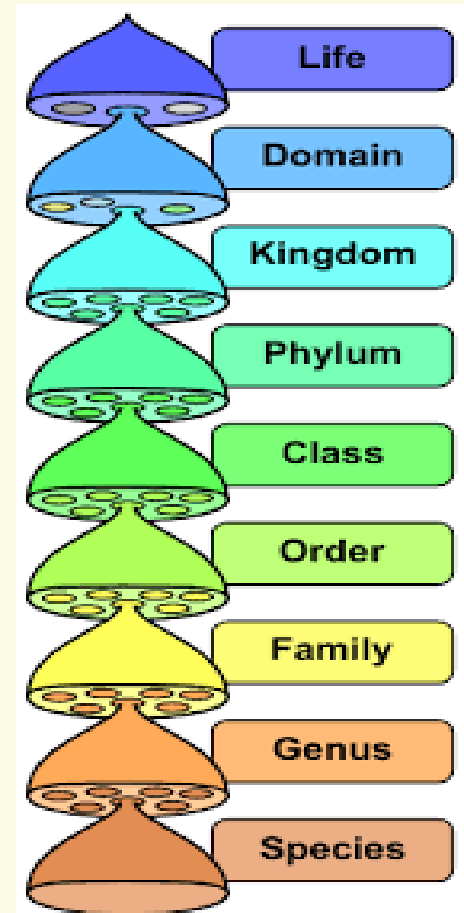


Classification of Organisms & Microorganisms

**1st Course
Lec.#2
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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 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

- ◆ 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

- ◆ 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

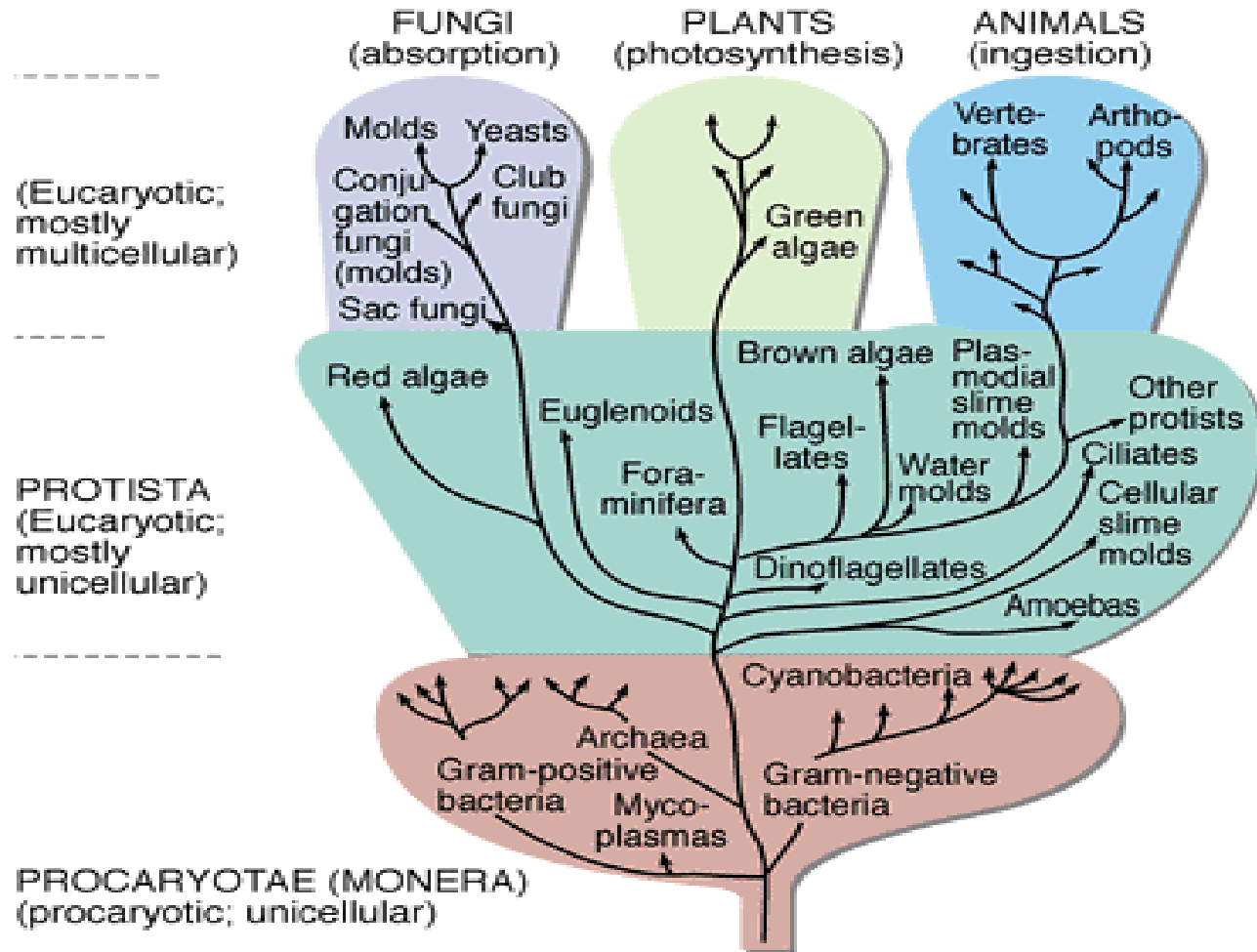
Proposed in 1969 by Robert Whittaker :

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.

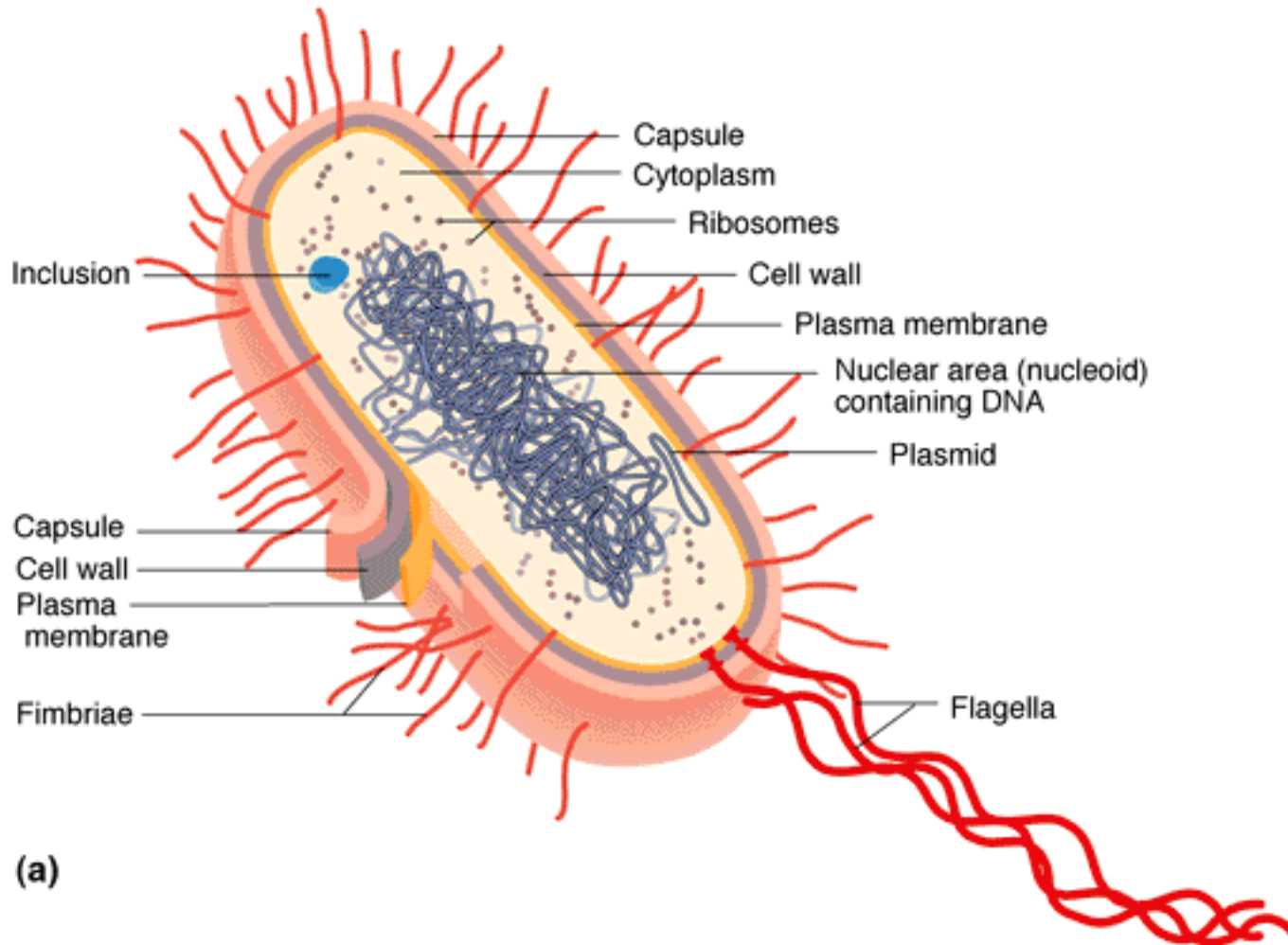
Five-Kingdom Classification System



Differences Between Eucaryotic and Procaryotic Cells

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

Procaryotes: Lack Nucleus and Membrane-Bound Organelles



(a)

Figure 7.7 An animal cell

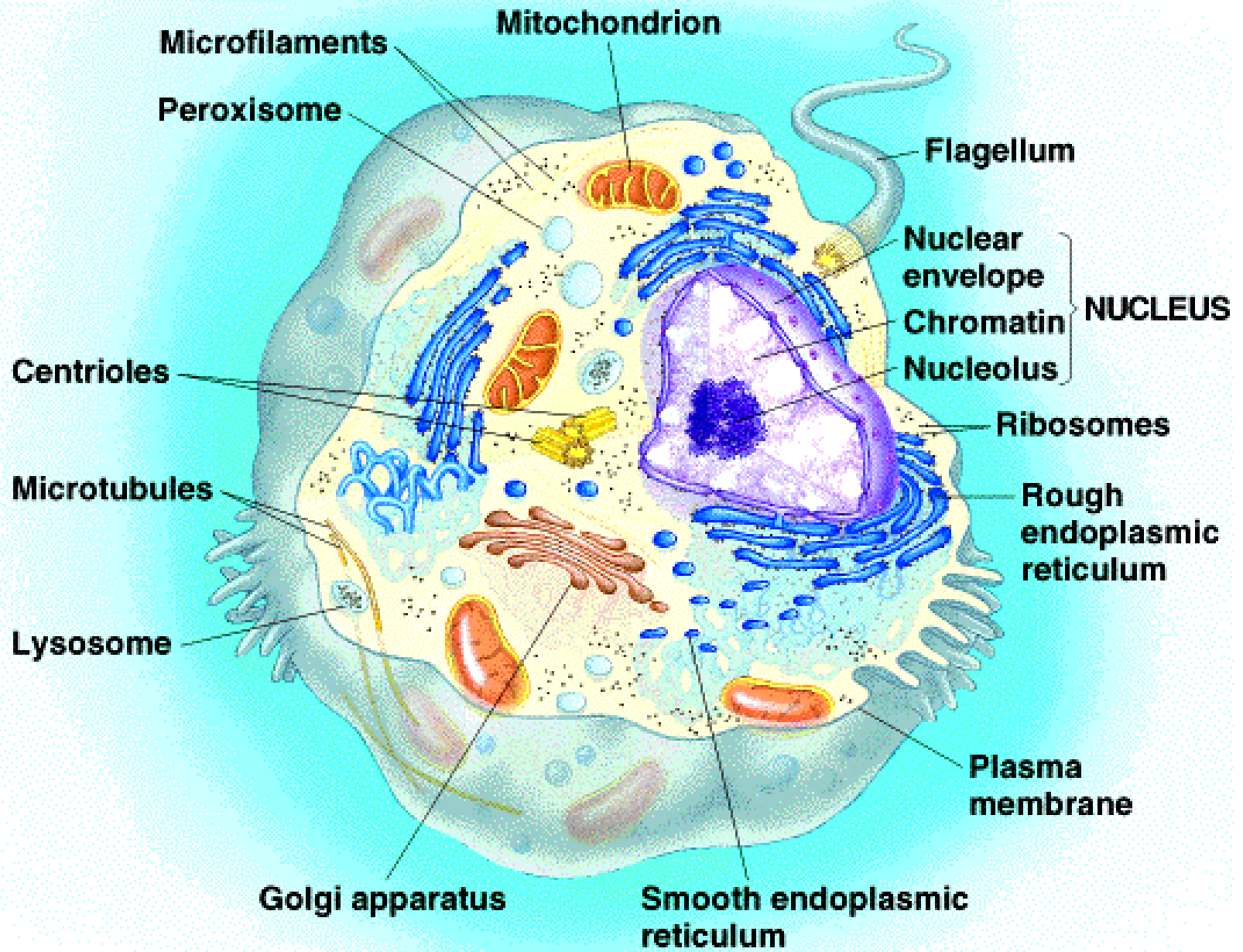
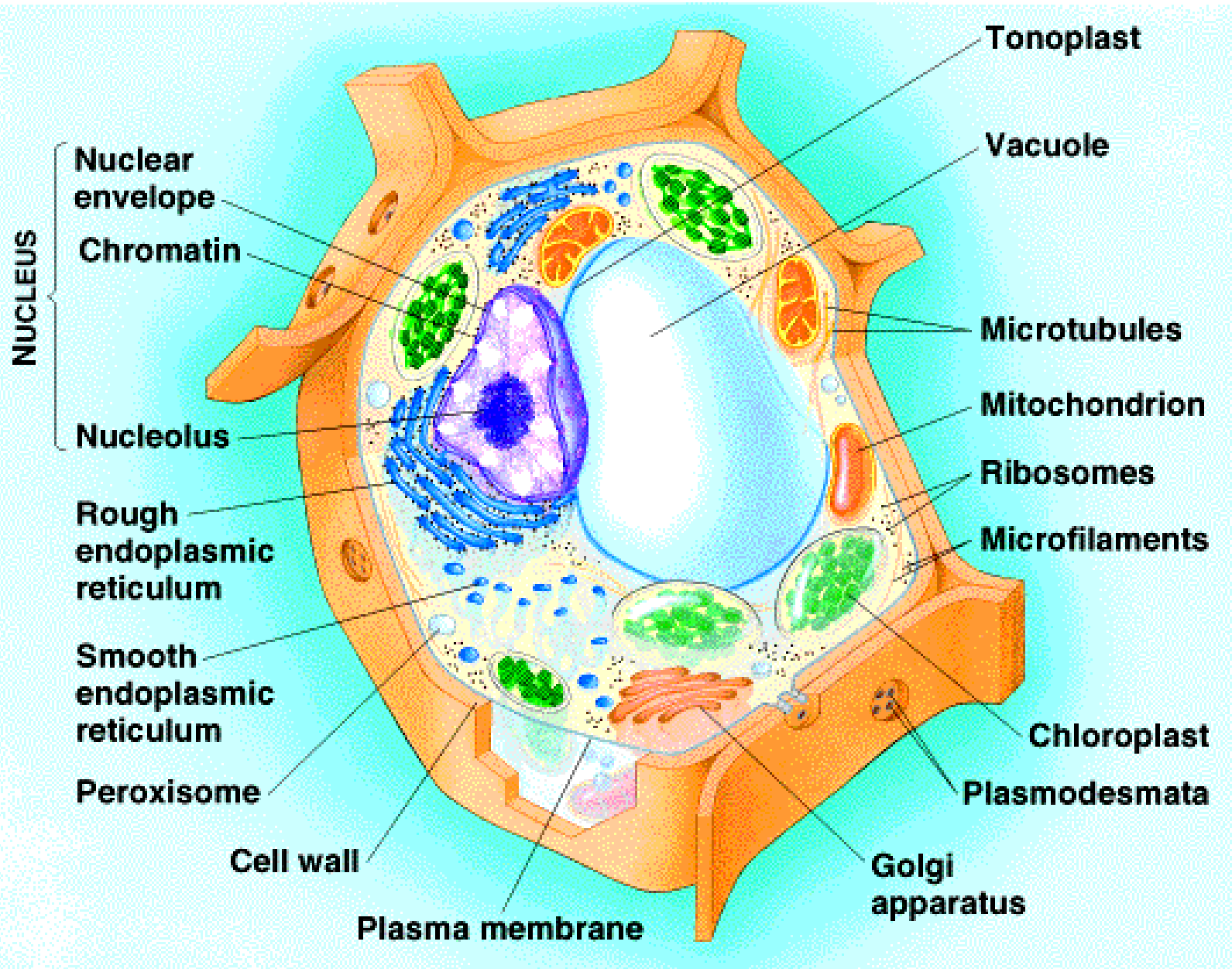


Figure 7.8 A plant cell



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

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

- ◆ **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

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

Classification of Organisms

Hierarchy of Taxonomic Categories

DOMAIN

Kingdom

◆ **Phylum or Division**

◆ **Class**

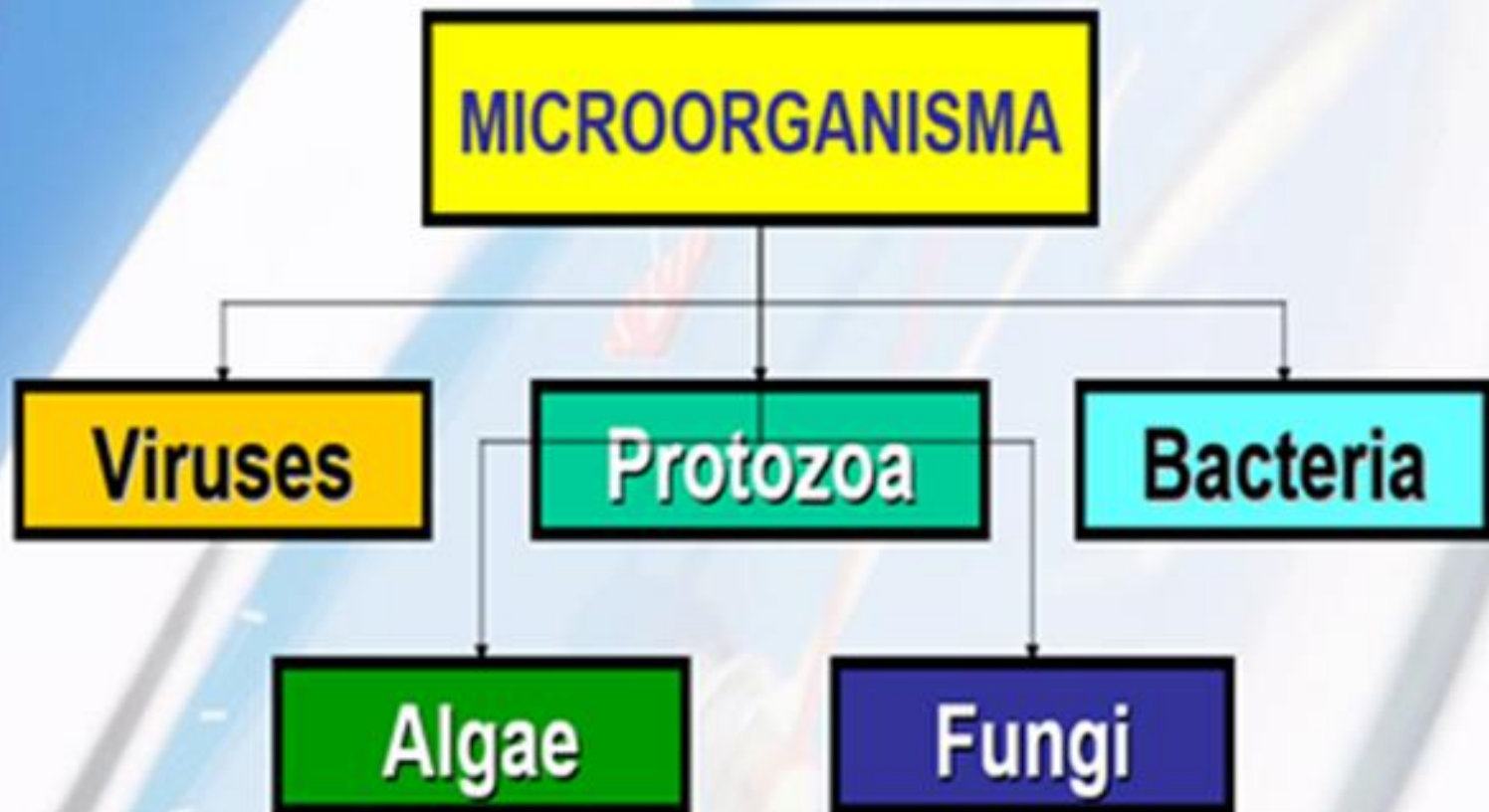
◆ **Order**

◆ **Family**

◆ *Genus*

species

MICROORGANISMS



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.
- ◆ **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

- ◆ 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