Classification of Microorganisms

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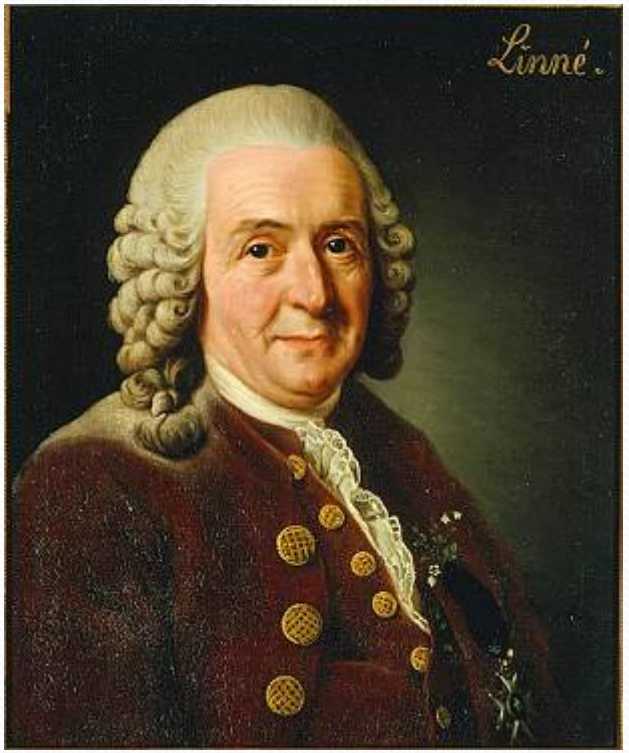
Taxonomy

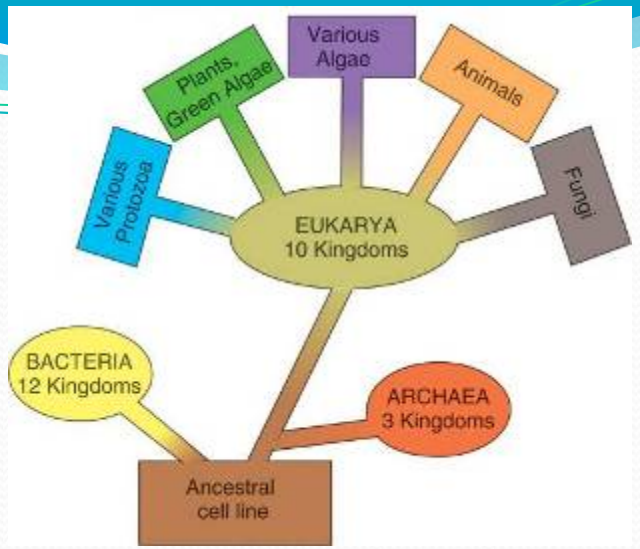
- Organizing, classifying and naming living things
- Formal system originated by Carl von Linné (1701-1778)
- Identifying and classifying organisms according to specific criteria
- Each organism placed into a classification system



Taxonomy

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

3 Domains



- Eubacteria
  - true bacteria, peptidoglycan
- Archaea
  - odd bacteria that live in extreme environments, high salt, heat, etc. (usually called extremophiles)
- Eukarya
  - have a nucleus & organelles (humans, animals, plants)

Domain: Eukarya (All eucaryotic organisms)

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Primates

Family: Hominoidea

Genus: Homo

Species: sapiens

(a)

Domain: Eukarya (All eucaryotic organisms)

Kingdom: Protista
(Protozoa and algae)

Phylum: Ciliophora
(Only protozoa with cilia)

Class: Oligohymenophorea
(Single cells with regular rows of cilia; rapid swimmers)

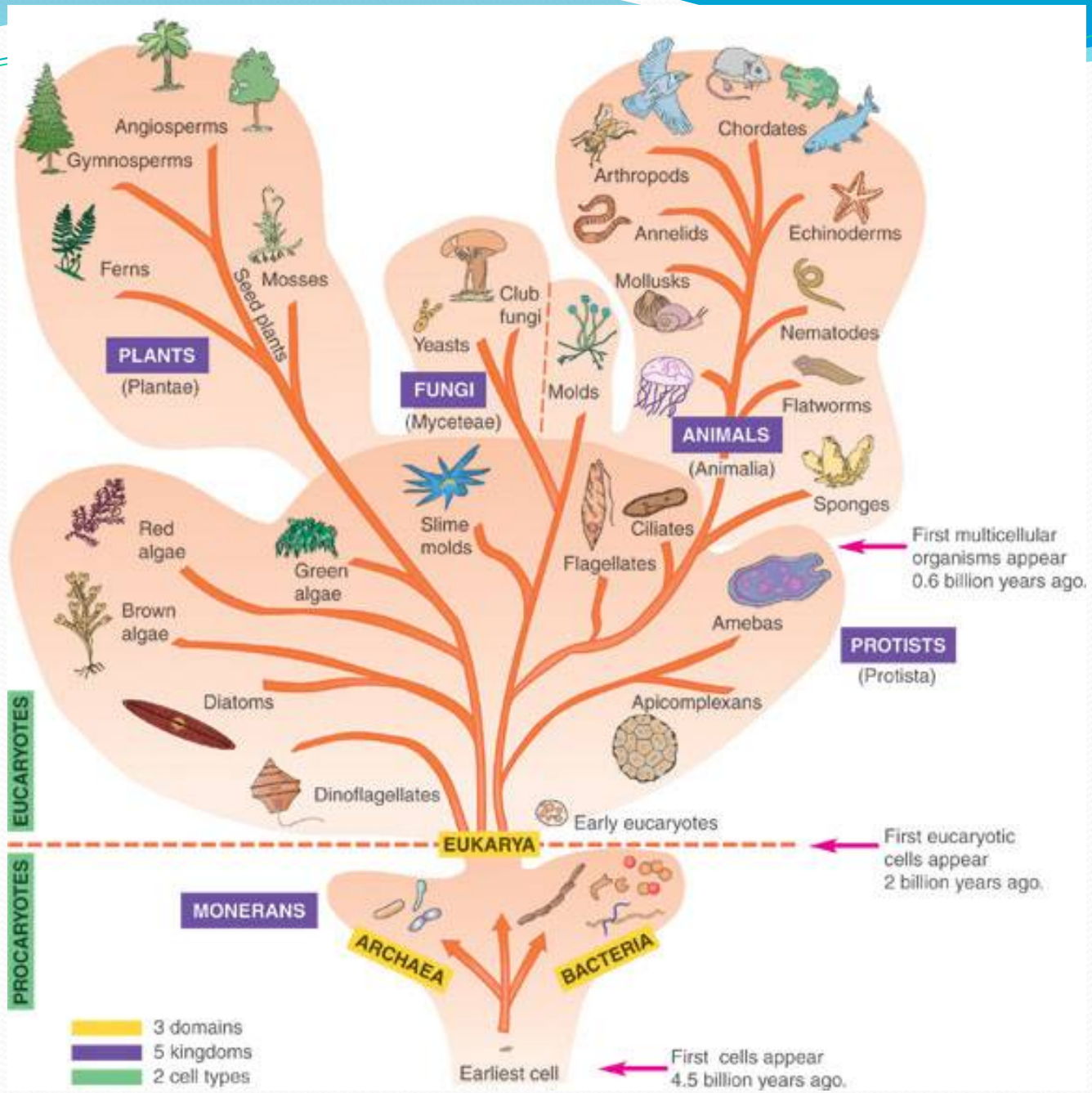
Order: Hymenostomatida
(Elongate oval cells)

Family: Parameciidae
(Cells rotate while swimming)

Genus: *Paramecium*
(Pointed, cigar shaped cells with an oral groove)

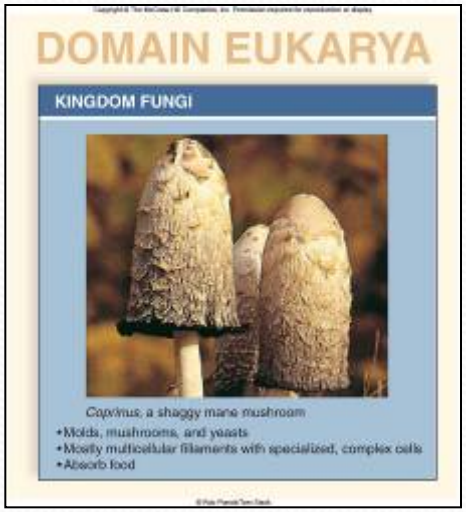
Species: *caudatum*
(Cells pointed at one end)

(b)


Angiosperms
Gymnosperms
Ferns
Seed plants
Mosses
PLANTS
(Plantae)
Club fungi
Yeasts
Molds
FUNGI
(Myceteae)
Chordates
Arthropods
Annelids
Echinoderms
Mollusks
Nematodes
Flatworms
ANIMALS
(Animalia)
Sponges
Red algae
Green algae
Brown algae
Diatoms
Dinoflagellates
Slime molds
Flagellates
Ciliates
Amebas
Apicomplexans
PROTISTS
(Protista)
First multicellular organisms appear 0.6 billion years ago.
EUCARYOTES
Early eucaryotes
EUKARYA
First eucaryotic cells appear 2 billion years ago.
PROCARYOTES
MONERANS
ARCHAEA
BACTERIA
3 domains
5 kingdoms
2 cell types
Earliest cell
First cells appear 4.5 billion years ago.

Taxonomy

- 4 main kingdoms:
  - Protista
  - Fungi
  - Plantae
  - Animalia
  - *Algae*

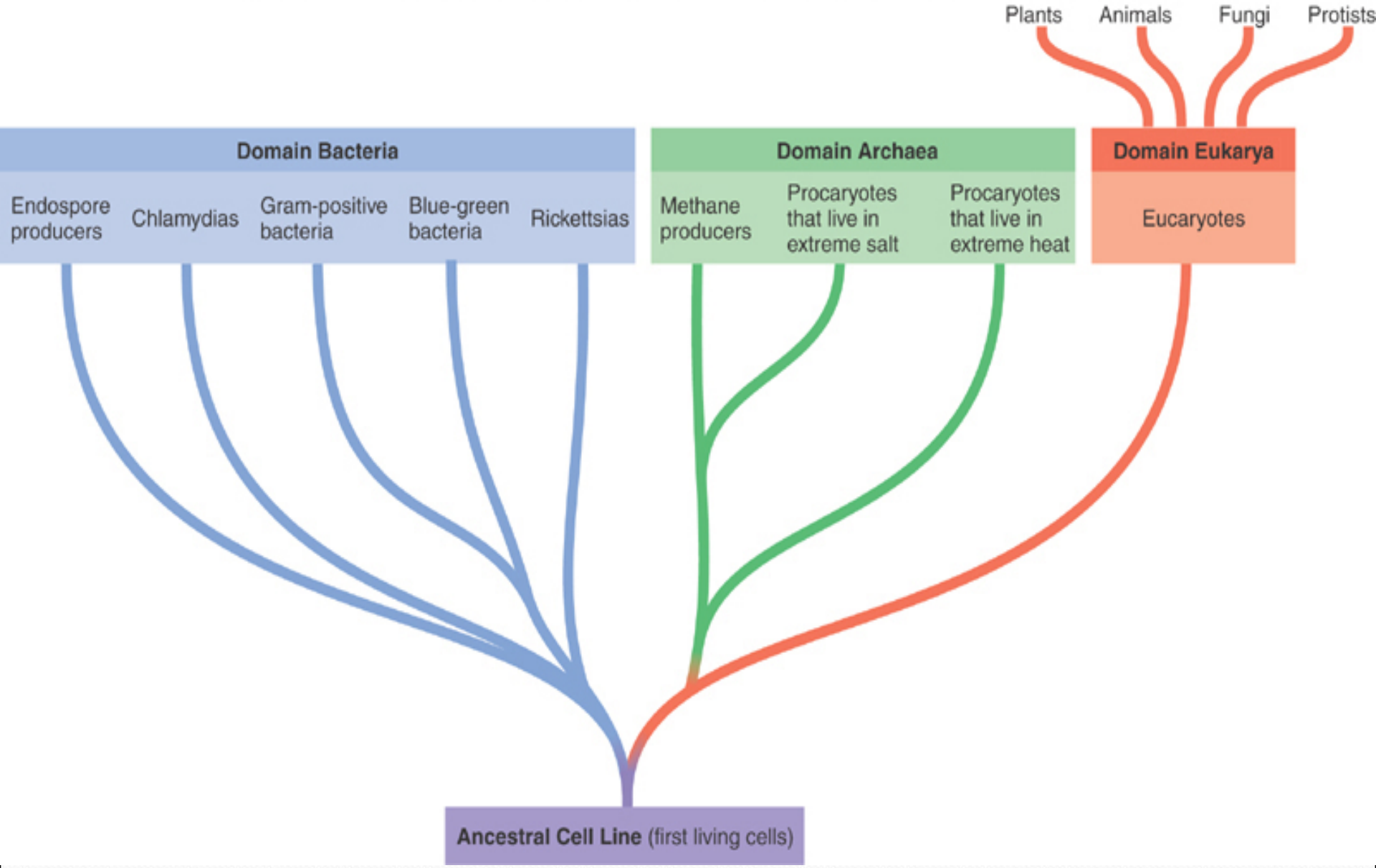


Naming Micoorganisms

- Binomial (scientific) nomenclature
- Gives each microbe 2 names:
  - **Genus** - noun, always capitalized
  - **species** - adjective, lowercase
- Both italicized or underlined
  - *Staphylococcus aureus (S. aureus)*
  - *Bacillus subtilis (B. subtilis)*
  - *Escherichia coli (E. coli)*

Evolution - living things change gradually over millions of years

- Changes favoring survival are retained and less beneficial changes are lost
- All new species originate from preexisting species
- Closely related organism have similar features because they evolved from common ancestral forms
- Evolution usually progresses toward greater complexity



Classification Systems in the Procaryotae

Classification Systems in the Procaryotae

1. Microscopic morphology
2. Macroscopic morphology – colony appearance
3. Physiological / biochemical characteristics
4. Chemical analysis
5. Serological analysis
6. Genetic and molecular analysis
   - G + C base composition
   - DNA analysis using genetic probes
   - Nucleic acid sequencing and rRNA analysis

Bacterial Taxonomy Based on *Bergey's Manual*

- *Bergey's Manual of Determinative Bacteriology* – five volume resource covering all known procaryotes
  - classification based on genetic information –**phylogenetic**
  - two domains: Archaea and Bacteria
  - five major subgroups with 25 different phyla

Major Taxonomic Groups of Bacteria

- **Vol 1A: Domain Archaea**
  - primitive, adapted to extreme habitats and modes of nutrition
- **Vol 1B: Domain Bacteria**
- Vol 2-5:
  - **Phylum Proteobacteria** – Gram-negative cell walls
  - **Phylum Firmicutes** – mainly Gram-positive with low G + C content
  - **Phylum Actinobacteria** – Gram-positive with high G + C content

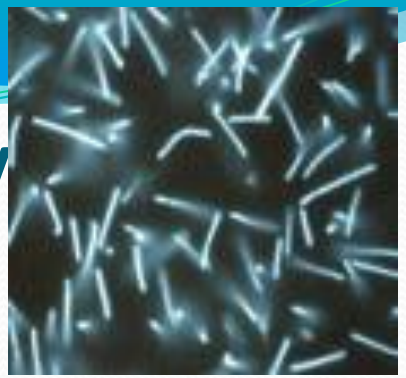
Diagnostic Scheme for Medical Use

- Uses phenotypic qualities in identification
  - restricted to bacterial disease agents
  - divides based on cell wall structure, shape, arrangement, and physiological traits

Species and Subspecies

- **Species**
  - collection of bacterial cells which share an overall similar pattern of traits in contrast to other bacteria whose pattern differs significantly
- **Strain** or **variety**
  - culture derived from a single parent that differs in structure or metabolism from other cultures of that species (biovars, morphovars)
- **Type**
  - subspecies that can show differences in antigenic makeup (serotype or serovar), susceptibility to bacterial viruses (phage type) and in pathogenicity (pathotype)

Archaea: The Other Procary

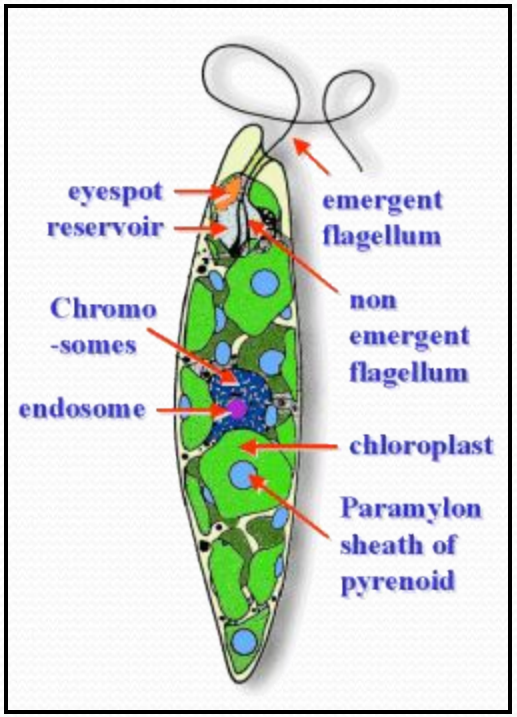


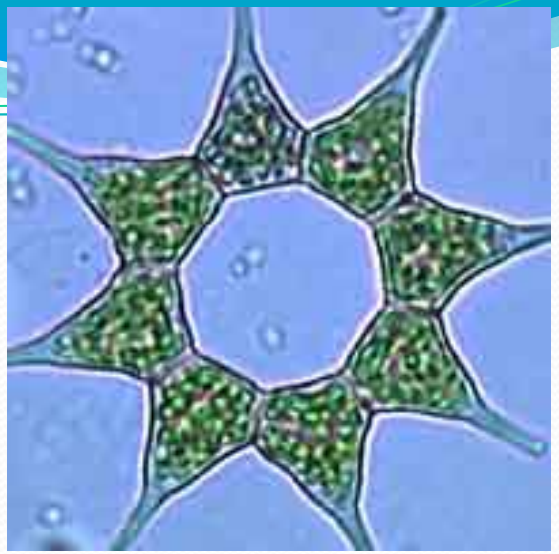
- Constitute third Domain Archaea
- Seem more closely related to Domain Eukarya than to bacteria
- Contain unique genetic sequences in their rRNA
- Have unique membrane lipids and cell wall construction
- Live in the most extreme habitats in nature, extremophiles
- Adapted to heat, salt, acid pH, pressure and atmosphere
- Includes: methane producers, hyperthermophiles, extreme halophiles, and sulfur reducers

Eukaryotes

Eukaryotes

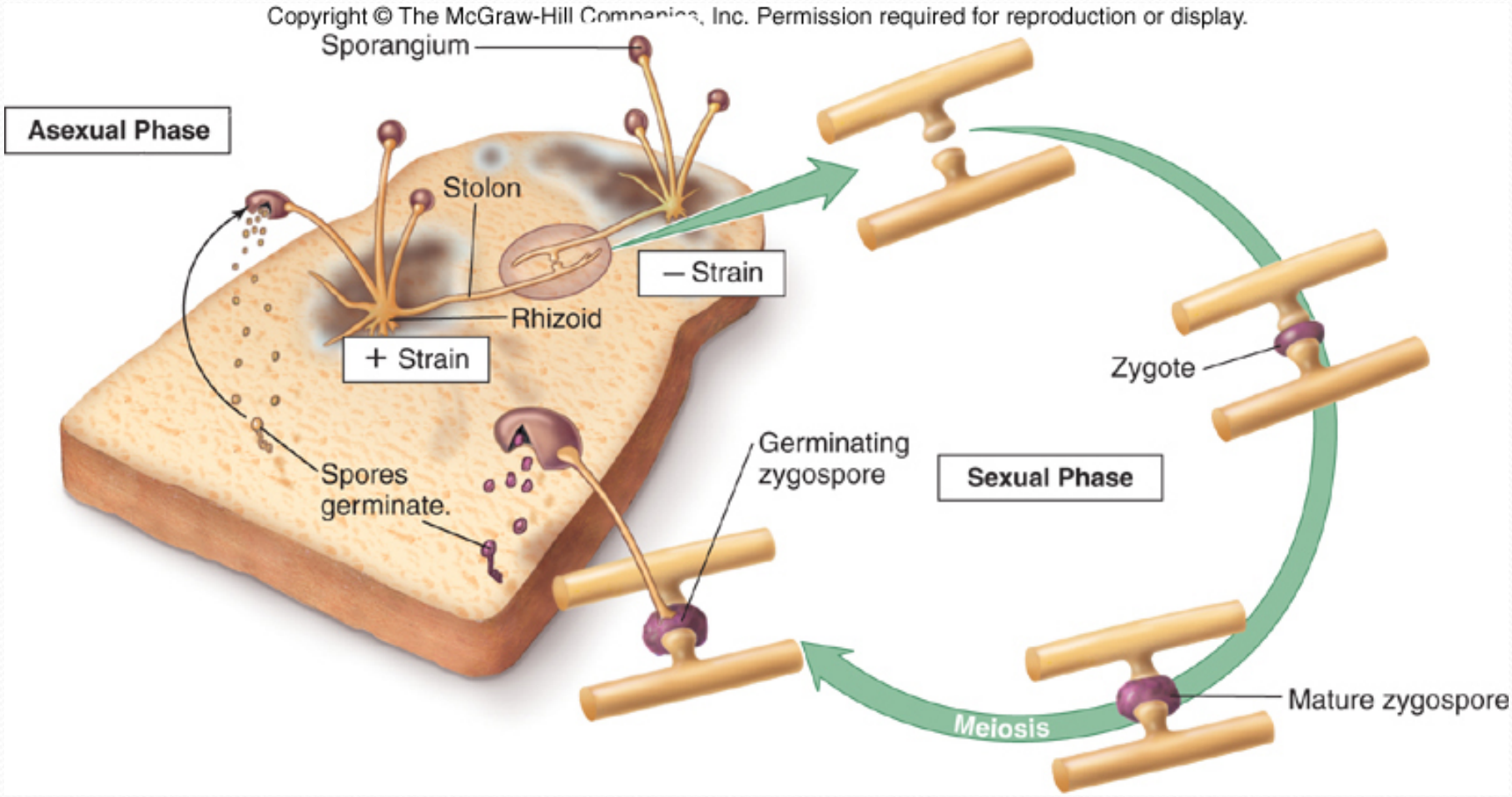
- **Protista**
- **Fungi**
- Plantae
- Animalia
- *Algae*





Fungal Classification

- Sexual reproduction
  - Spores are formed following fusion of male and female strains and formation of sexual structure
- Sexual spores and spore-forming structures are one basis for classification
  - Zygospores
  - Ascospores
  - Basidiospores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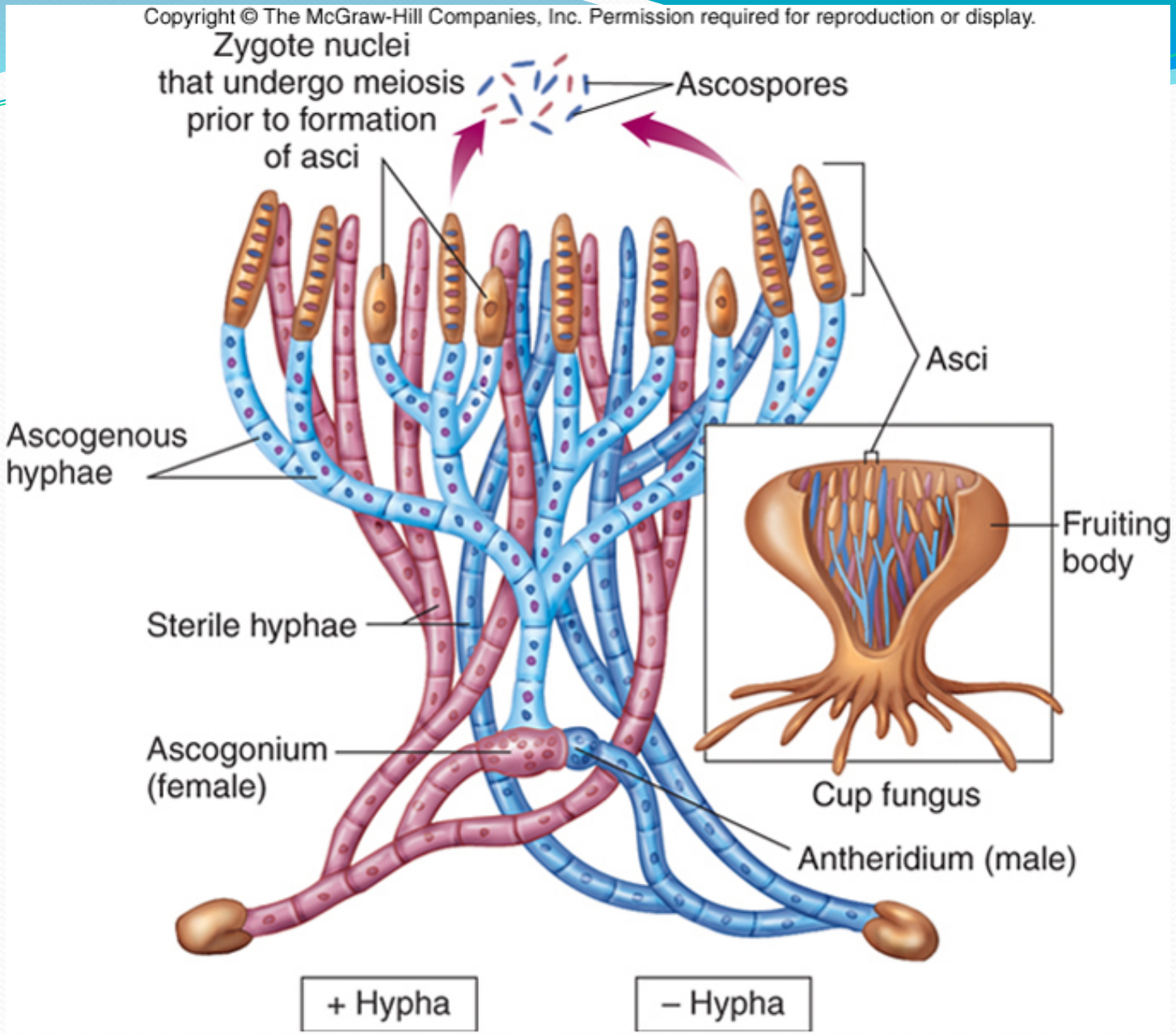
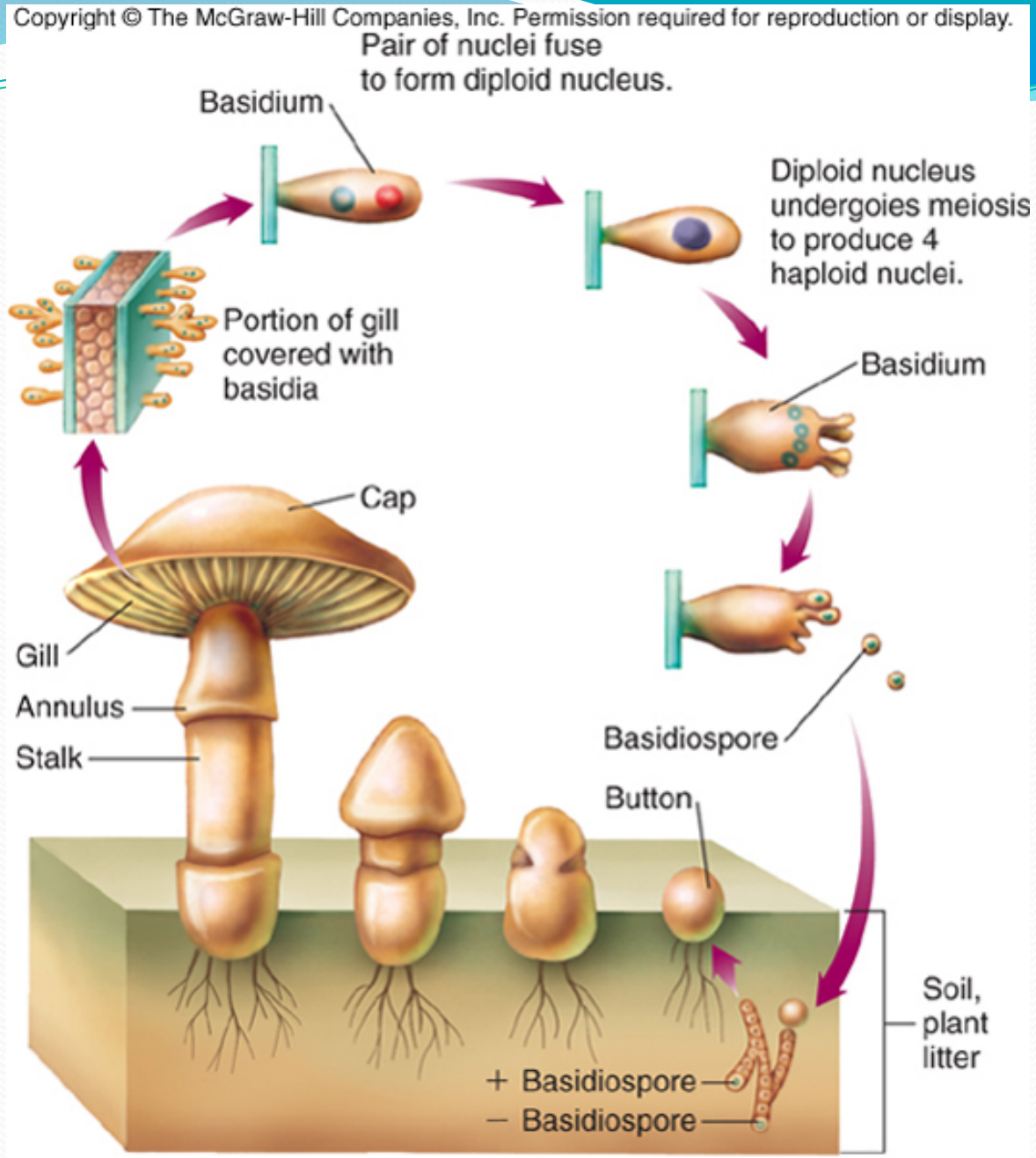
Sporangium
Asexual Phase
Stolon
– Strain
Rhizoid
+ Strain
Spores germinate.
Zygote
Germinating zygospore
Sexual Phase
Mature zygospore
Meiosis





Fungal Classification

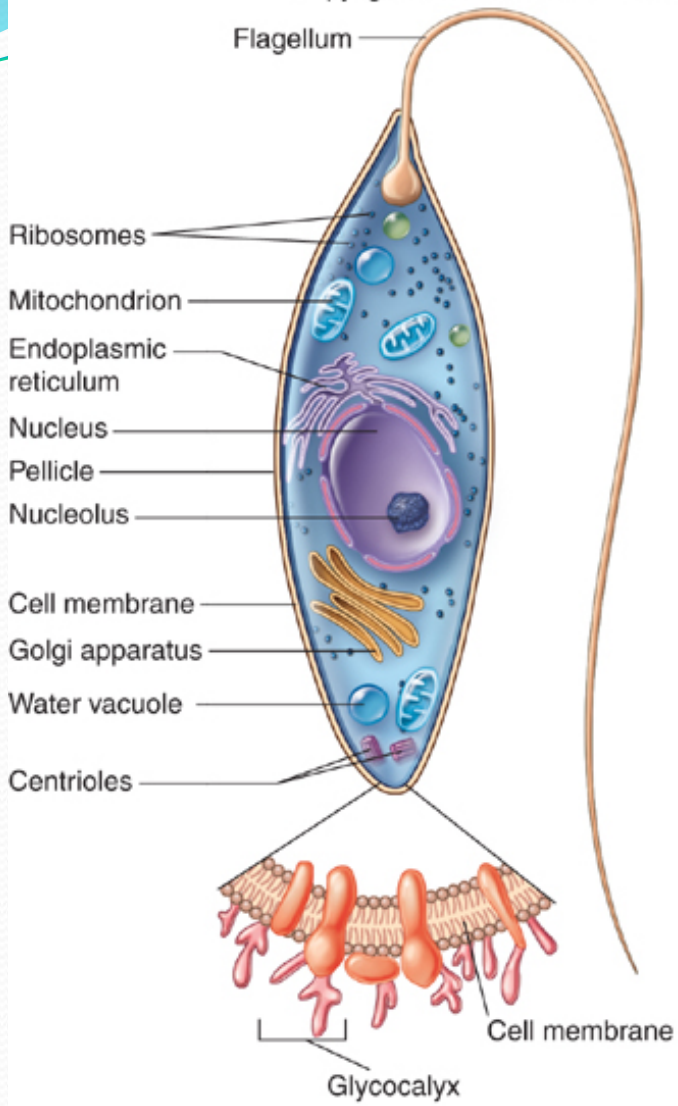
- Subkingdom Amastigomycota
  - Terrestrial inhabitants including those of medical importance:

1. **Zygomycota** – zygospores; sporangiospores and some conidia
2. **Ascomycota** – ascospores; conidia
3. **Basidiomycota** – basidiospores; conidia
4. **Deuteromycota** – majority are yeasts and molds; no sexual spores known; conidia

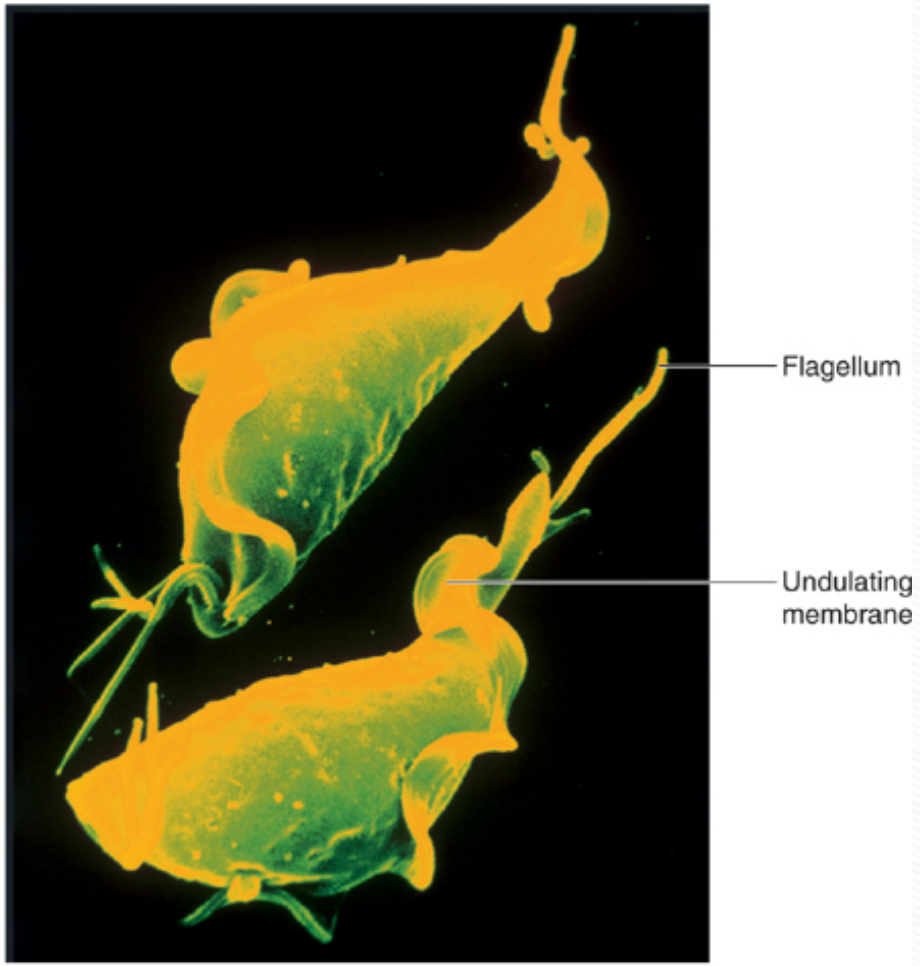
Protozoan Classification

- Difficult because of diversity
- Simple grouping is based on method of motility, reproduction, and life cycle

1. **Mastigophora** – primarily flagellar motility, some flagellar and amoeboid; sexual reproduction; cyst and trophozoite
2. **Sarcodina** – primarily ameba; asexual by fission; most are free-living
3. **Ciliophora** – cilia; trophozoites and cysts; most are free-living, harmless
4. **Apicomplexa** – motility is absent except male gametes; sexual and asexual reproduction; complex life cycle – all parasitic



(a) **Protozoan Cell**



(b)

TABLE 4.6

Comparison of Three Cellular Domains

Characteristic	Bacteria	Archaea	Eukarya
Cell type	Procaryotic	Procaryotic	Eucaryotic
Chromosomes	Single, or few, circular	Single, circular	Several, linear
Types of ribosomes	70S	70S but structure is similar to 80S	80S
Contains unique ribosomal RNA signature sequences	+	+	+
Number of sequences shared with Eukarya	One	Three	(All)
Protein synthesis similar to Eukarya	−	+	
Presence of peptidoglycan in cell wall	+	−	−
Cell membrane lipids	Fatty acids with ester linkages	Long-chain, branched hydrocarbons with ether linkages	Fatty acids with ester linkages
Sterols in membrane	− (some exceptions)	−	+