Diversity of Life - Classification and Phylogeny

Classification

Classification v. Taxonomy

Classification

- the systematic grouping of entities into categories

Taxonomy

- the *science* of describing, naming and classifying organisms

Diversity of Life - Classification and Phylogeny

Classification

Binomial name

- two-word naming system (Carolus Linnaeus)

- First part is the genus (genera, plural)
  Second part is the species

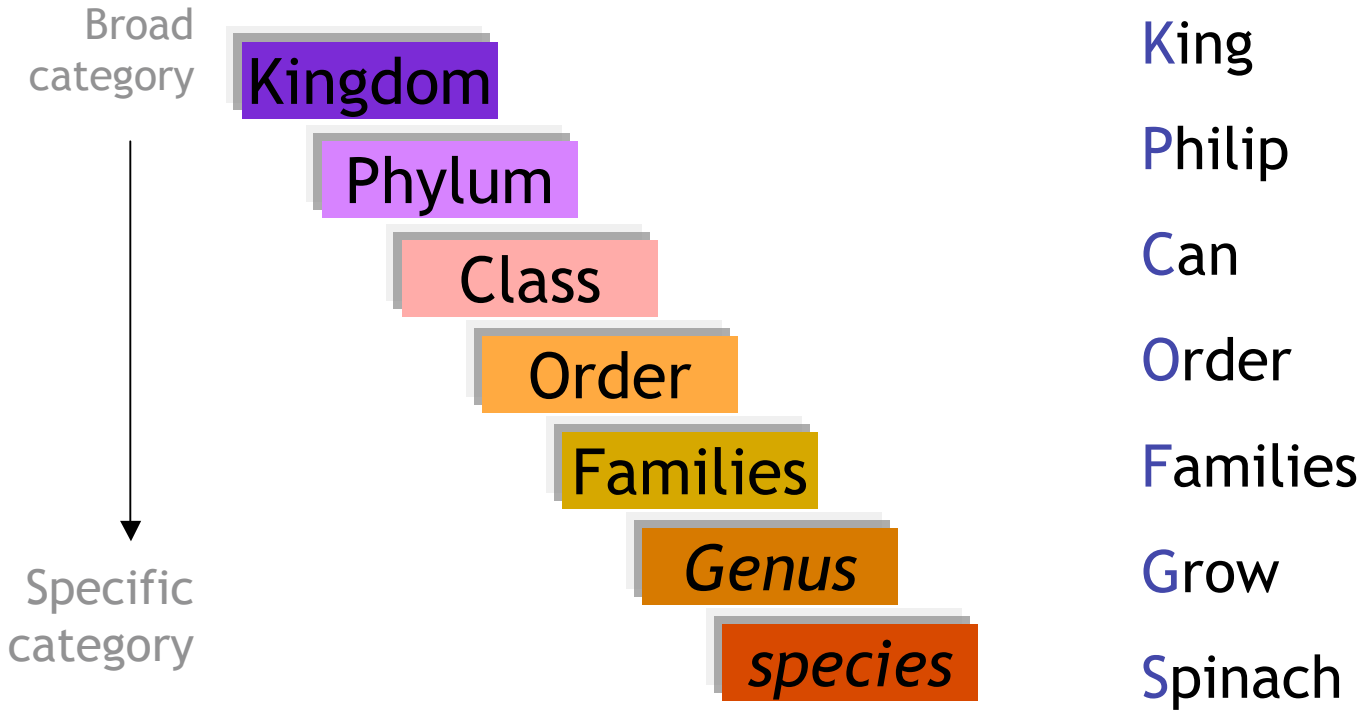
  written: *Genus species* or Genus species

  ex. *Felis catus* (domestic cat)

Diversity of Life - Classification and Phylogeny

Hierachical classification

- based on the grouping of related objects or description of objects



Diversity of Life - Classification and Phylogeny

Phylogeny

- the evolutionary history of a species or a group of related species.

Phylogenetic tree

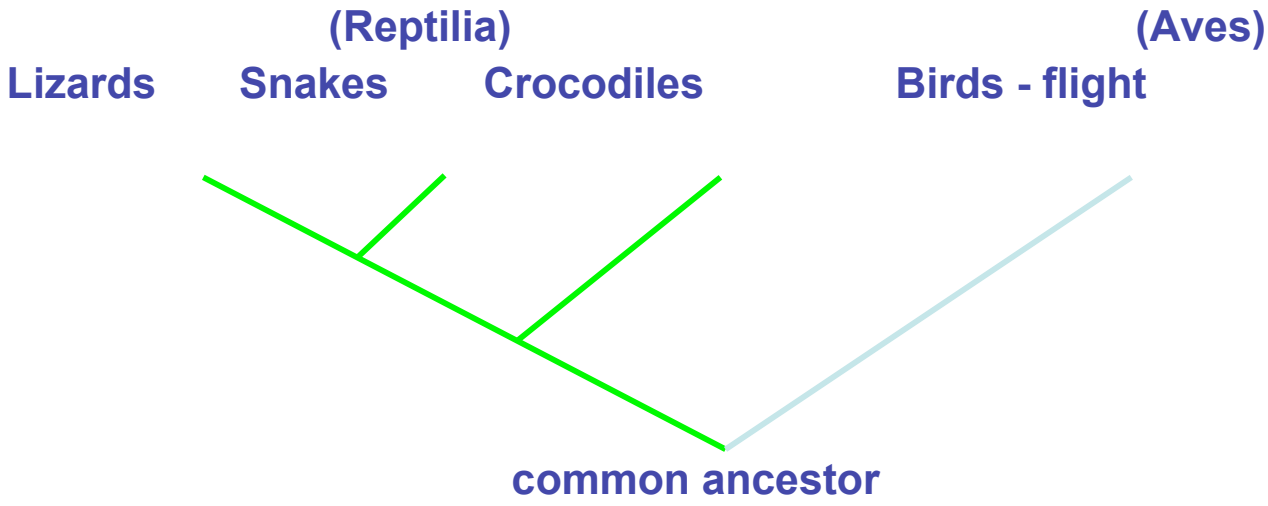
- a branching diagram that represents a hypothesis about evolutionary relationships among organisms.

Diversity of Life - Classification and Phylogeny

Two systems are used to classify organisms:

Traditional (Aristotelian) analysis

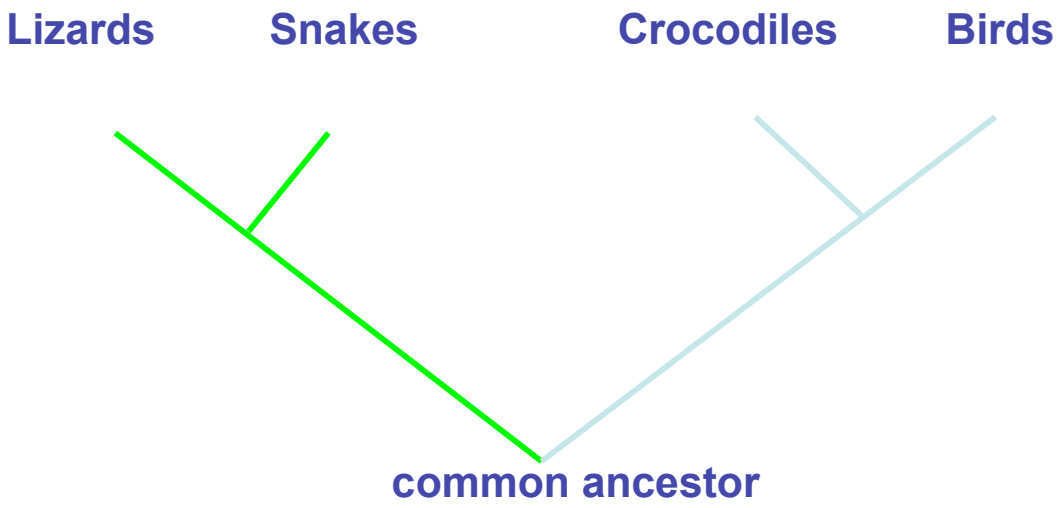
- Classification system based on similarities and differences showing increasing complexity.



Diversity of Life - Classification and Phylogeny

Cladistic analysis

- Classification system based on evolutionary relationships



Diversity of Life - Arranging Life

Arranging Life

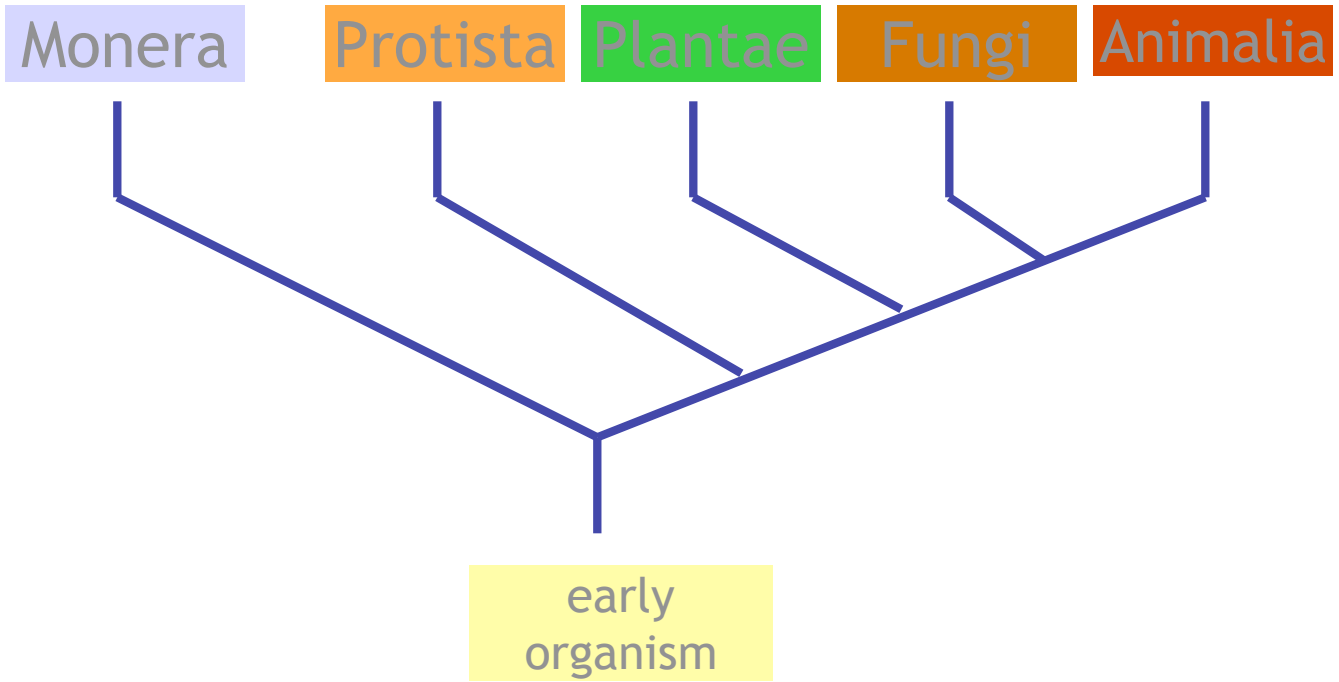
- remember that phylogenetic trees are hypotheses about evolutionary history
- they are always being revised or even rejected
- classification is a work in progress

Two-kingdom system

- life sub-divided into either plant or animals

Diversity of Life - Arranging Life

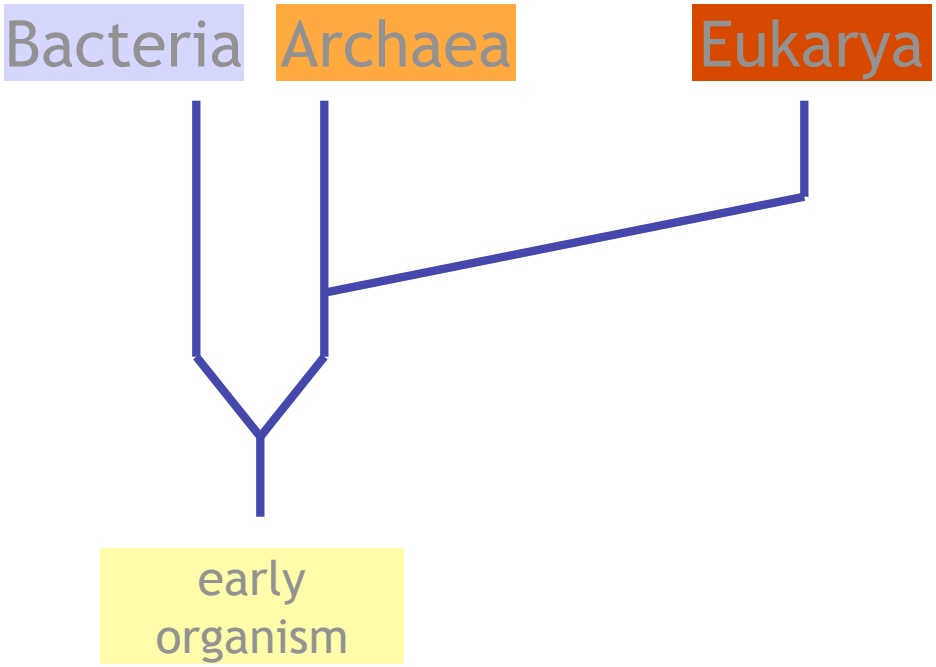
Five-kingdom system (Whittaker, 1969)



Diversity of Life - Arranging Life

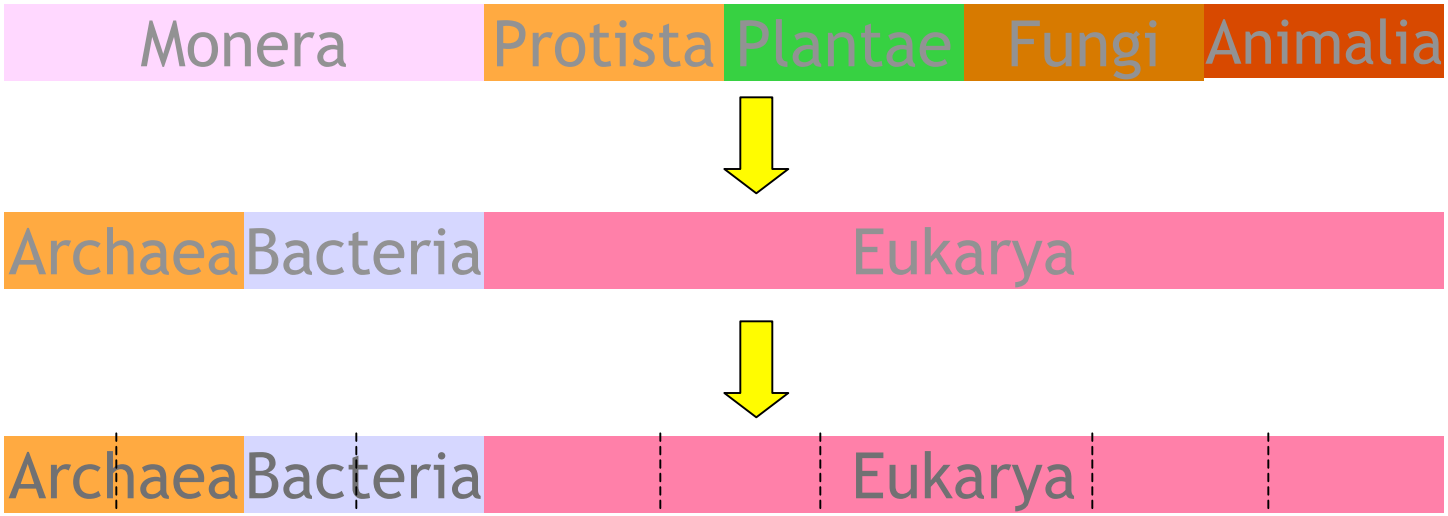
Three-domain system

- alternative system based on molecular and cladistical analysis



Diversity of Life - Arranging Life

Changing view of biodiversity



Diversity of Life - Prokaryotes

Prokaryotes

Found everywhere there is life:

- inhabiting fertile soils, dead organisms
- conditions from extreme cold --> extreme hot;
  from extremely acidic --> extremely alkaline
- inhabit humans (mouths, intestines)
- outnumber all eukaryotes combined

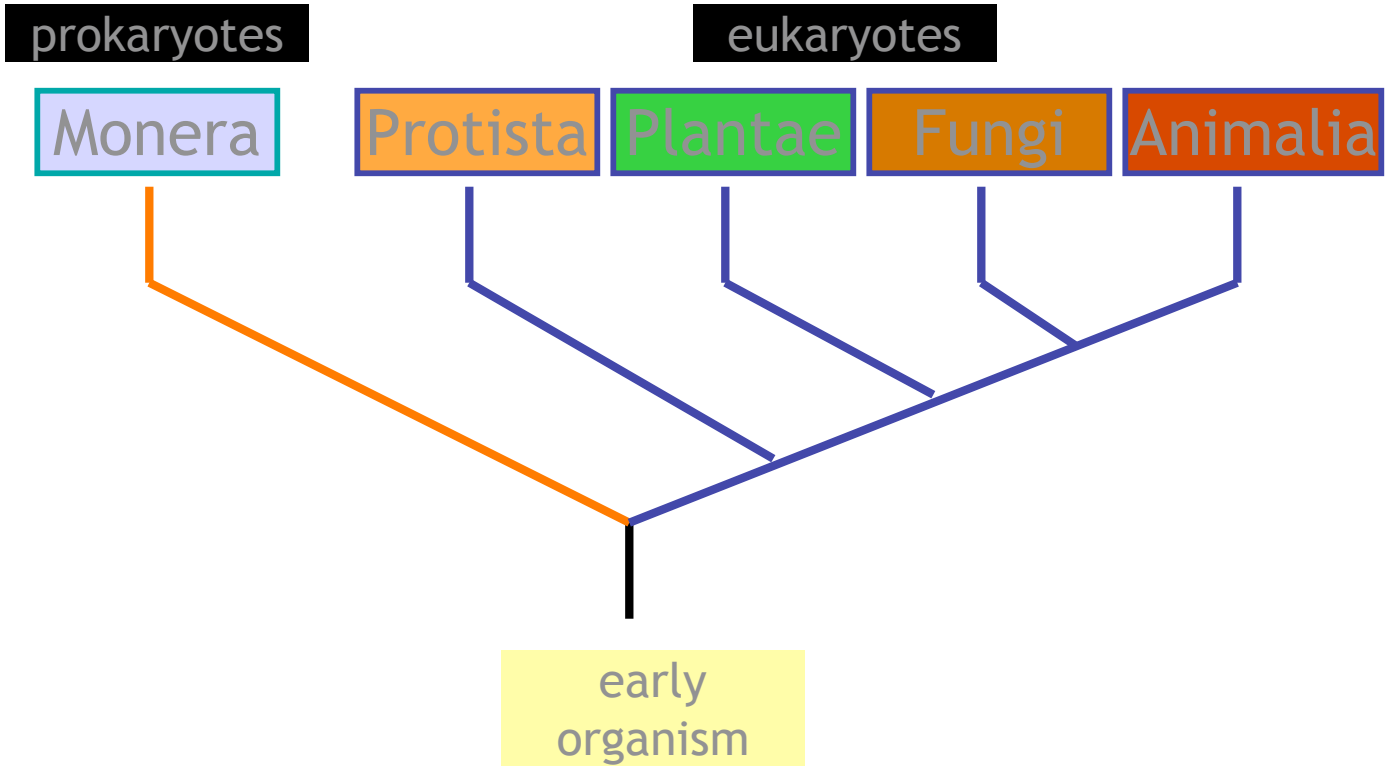
Diversity of Life - Prokaryotes

Cellular organization (prokaryotes v. eukaryotes)

Prokaryotes	Eukaryotes
No true nucleus	Membrane-bound nucleus
Cell organelles absent	Golgi apparatus, endoplasmic reticulum, lysosomes, mitochodria, chloroplasts present

Diversity of Life - Prokaryotes

This difference in cellular organization divides Prokaryotes and Eukaryotes in the Five-kingdom system.



Diversity of Life - Prokaryote evolution

Identification of two major branches of prokaryotic evolution:

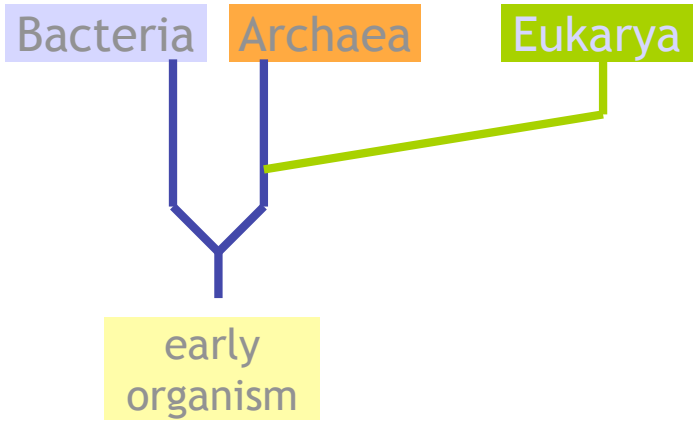
Bacteria and Archaea

similiar in:

- prokaryotic cell organization

differ in:

- structure, biochemistry and physiology



Archaea may be more related to eukaryotes than bacteria

Diversity of Life - Prokaryote evolution

Comparison of the Three Domains of Life

Characteristic	Bacteria	Archaea	Eukarya
Nuclear envelope	No	No	Yes
Membrane-enclosed organelles	No	No	Yes
Peptidoglycan in cell wall	Yes	No	No
Membrane lipids	Unbranched hydrocarbons	Some branched hydrocarbons	Unbranched hydrocarbons
RNA polymersase	1 kind	several kinds	several kinds
amino acid start of protein synthesis	Formyl-methionine	Methionine	Methionine
Introns	No	Some	Yes
Antibiotic responses	Yes	No	No
Histones	No	Yes	Yes
Circular chromosomes	Yes	Yes	No
growth at 100+^{o}C	No	Some	No

Diversity of Life - Prokaryotes

Bacteria

- found in soil, water, animal digestive tracks, etc.

- nutrition (fuel to drive cellular processes)
  - light energy (phototrophism)
  - organic/inorganic energy (chemotrophism)

Diversity of Life - Prokaryotes

Archaea (*archaios* = ancient)

- anaerobes
- most species inhabit extreme environments (extremophiles)

  halophiles - require salt for growth

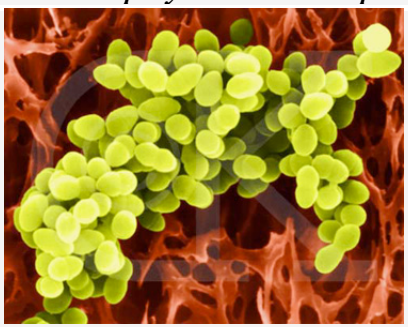
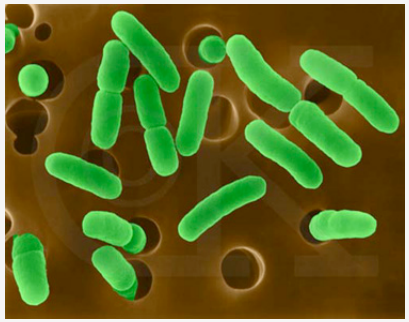
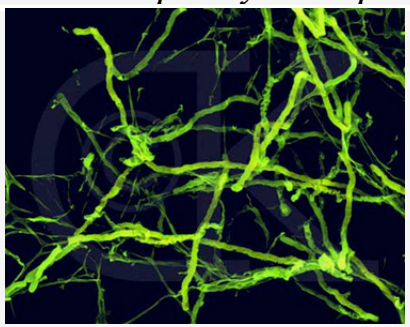
  thermophiles - live near deep-sea thermal vents, temps. >100^{o}C

  acidophiles - enjoy acidic conditions

Diversity of Life - Prokaryote Structure and Function

Structure

- identification by cell shape

Round - Coccus (pl. Cocci)	Rod - Bacillus (pl. Bacilli)	Spiral - Spirillum (pl. Spirilla)
Ex: *Staphylococcus sp.*	Ex: *Escherichia coli*	Ex: *Streptomyecin sp.*
		

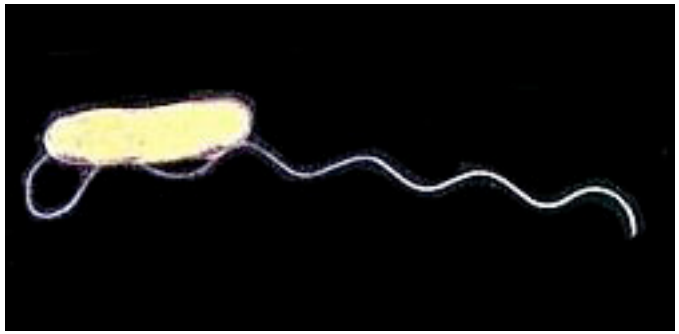
Bacteria images by Dennis Knunkle

Diversity of Life - Prokaryote Structure and Function

Structure

- microscopic
- unicellular

- motile (flagella)

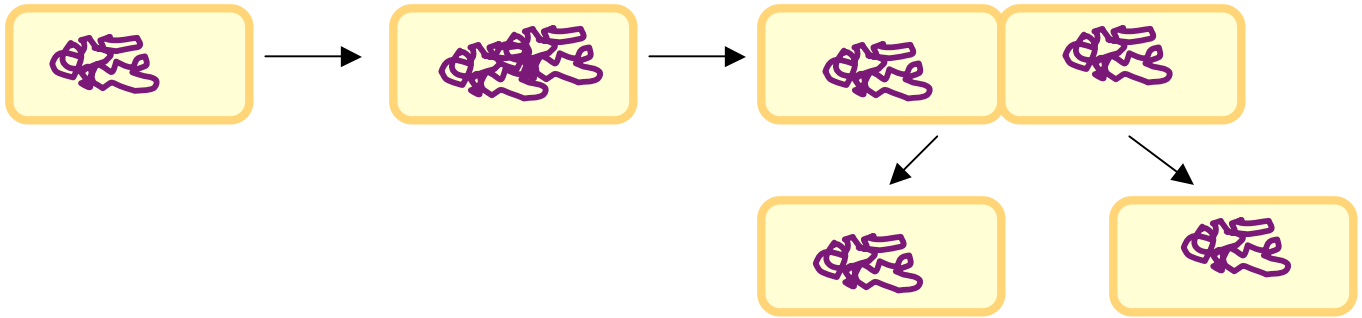


Diversity of Life - Prokaryote Structure and Function

Reproduction

Binary Fission

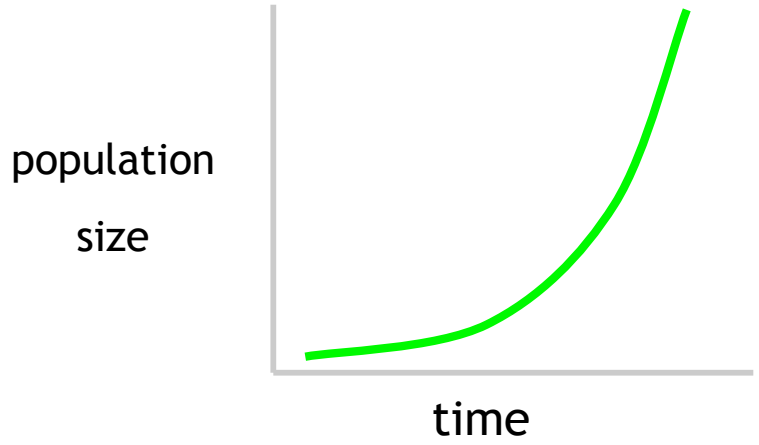
- asexual reproduction (creation of offspring by a single parent without a sperm and egg)
- parent organism divides into 2 individuals of about the same size



Diversity of Life - Prokaryote Structure and Function

Reproduction

- exhibit exponential growth



- limiting factors: nutrients, space and metabolic wastes

Diversity of Life - Prokaryote Nutrition

Prokaryote Nutrition

nutrition - method by which an organism obtains resources for synthesizing organic compounds

- energy
- carbon source

Energy sources	Carbon sources
light	organic compounds (containing carbon)
chemicals	inorganic compound

Diversity of Life - Prokaryote Nutrition

Four major modes of nutrition are classified according to these categories:

Photoautotrophs (photo = light; auto = self; troph = food)

- photosynthetic organisms that
  (1) use light energy to
  (2) synthesize organic compounds from CO_2

- examples: cyanobacteria, algae, plants

Diversity of Life - Prokaryote Nutrition

Four major modes of nutrition are classified according to these categories:

Chemoautotrophs (chemo = chemical; auto = self; troph = food)

- organisms that
  (1) extract energy from inorganic compounds (H_2S or NH_3) to
  (2) synthesize organic compounds from CO_2

- examples: prokaryotes living near deep-sea hot water vent

Diversity of Life - Prokaryote Nutrition

Four major modes of nutrition are classified according to these categories:

Photoheterotrophs (photo = light; hetero = other; troph = food)

- organisms that
  (1) use light energy to generate ATP but
  (2) must obtain carbon sources from outside organic forms

Diversity of Life - Prokaryote Nutrition

Four major modes of nutrition are classified according to these categories:

Chemoheterotrophs

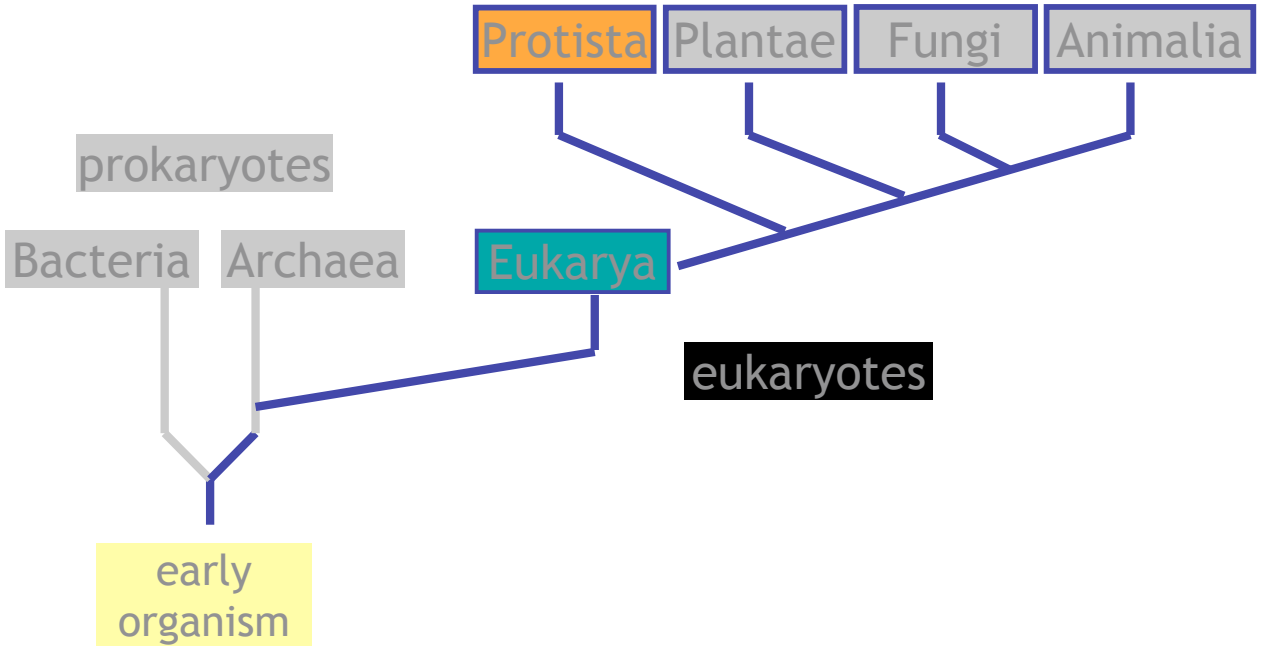
- organisms that must consume molecules for both energy and carbon

- examples: some prokaryotes, protists and plants
  all fungi and animals

Diversity of Life - Protista

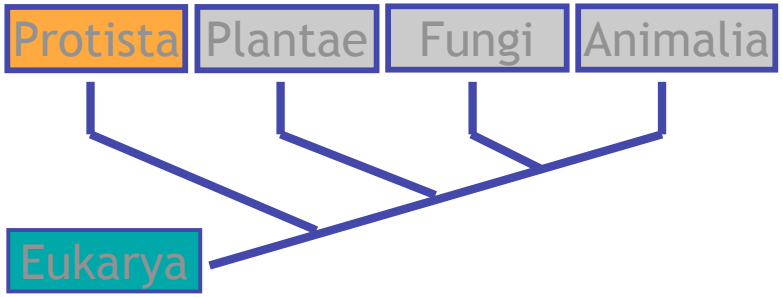
Protists

- eukaryotic
- probably evolved through endosymbiosis

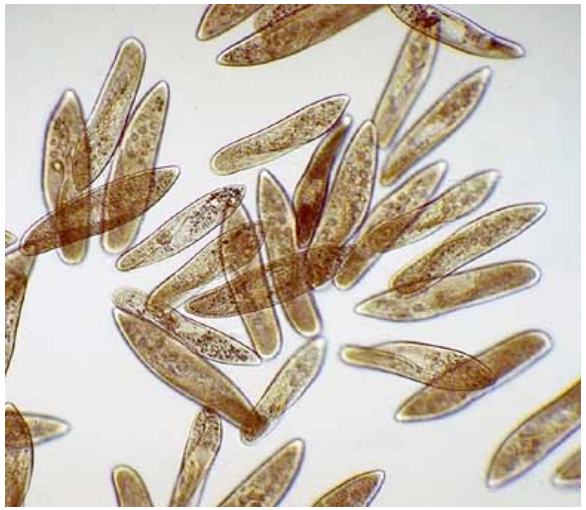


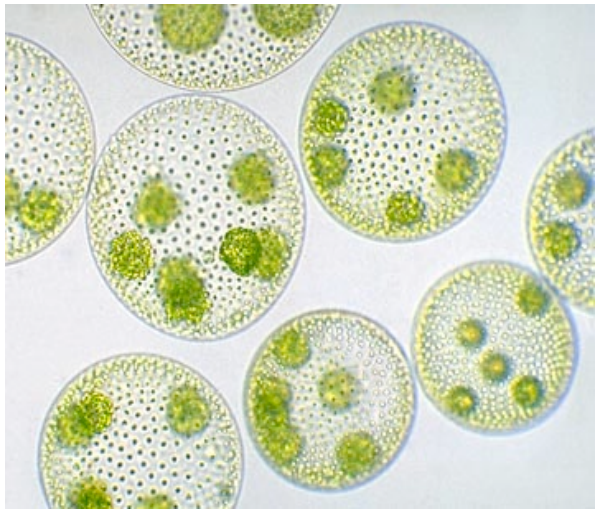
Diversity of Life - Protista

Protists



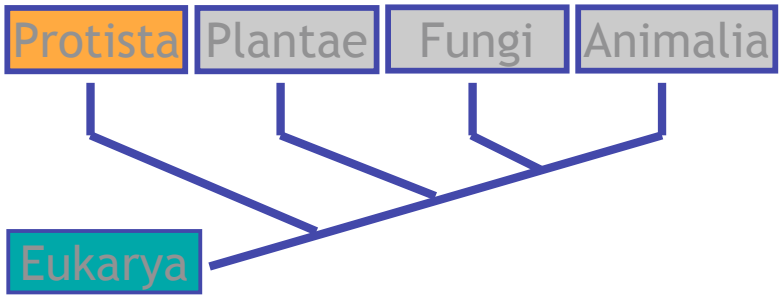
- simplest eukaryotic organism
- complex on the cellular level
- most unicellular (but some live in colonies)





Diversity of Life - Protista

Protists



<u>Four major categories</u>:

- Protozoans
- Slime Molds
- Unicellular Algae
- Multicellular Algae

Diversity of Life - Protista

Protozoans

- nutrition: ingest food/ nutrients
- habitat: watery environments

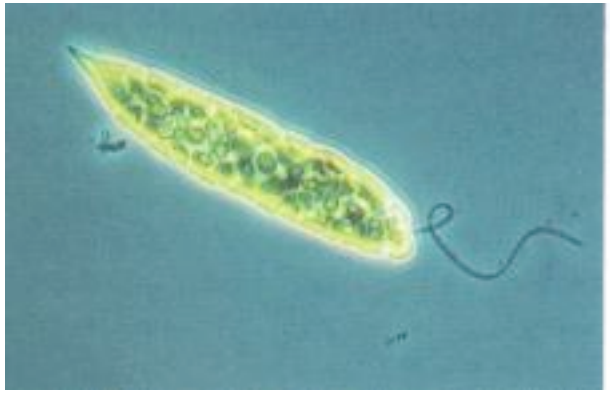
- classified by means of locomotion:
    - Flagellates
    - Ciliates
    - Amoebas

Diversity of Life - Protozoans

Flagellates

- move by means of one or more flagella (long appendage)
- most are free-living (non-parasitic)

- example: *Euglena sp.*



Diversity of Life - Protozoans

Ciliates

- use cilia (short appendages) to move and feed
- most are free-living

- example: *Paramecium sp.*

Diversity of Life - Protozoans

Amoebas

- use pseudopodia (temporary extension of the cell) for movement and feeding (phagocytosis)

- example: *Amoeba proteus*

Diversity of Life - Protists

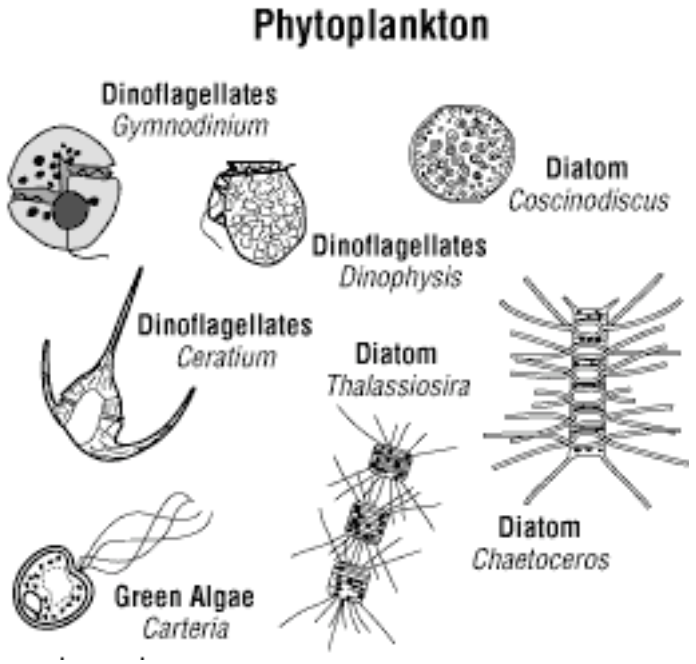
Slime Molds

- filamentous bodies (resembling fungi, but don't confuse them)
- pseudopodium for movement and feeding
- decomposers

Diversity of Life - Protists

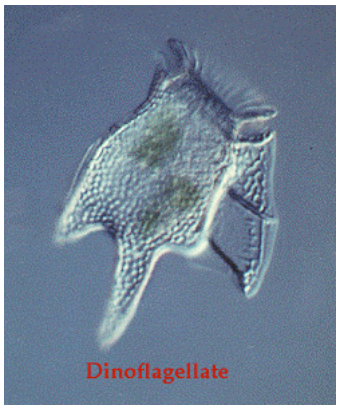
Unicellular Algae

- Photosynthetic
- many are components of plankton
  (organisms drifting near surface of lakes or oceans)
- planktonic algae are called phytoplankton (phyto = plant)
- primary producers in freshwater and marine ecosystems



Diversity of Life - Unicellular Algae

Dinoflagellates



- unicellular
- biflagellates (two whirling flagella)
- aquatic

Ecological importance:

- red tides

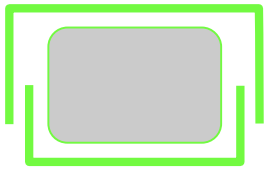
  - coastal water discoloration by a bloom of red dinoflagellates

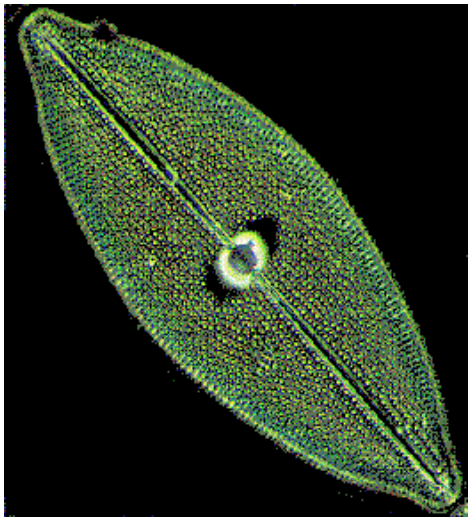
  - some red tide dinoflagellates produce toxins

Diversity of Life - Unicellular Algae

Diatoms

- unicellular
- exoskeleton (contains silicon) composed of 2 halves



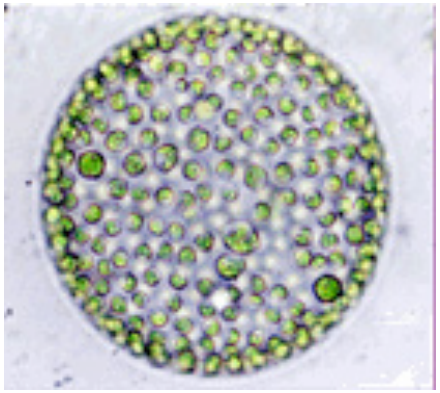


Diversity of Life - Unicellular Algae

Green Algae

- unicellular (some colonial)
- inhabit freshwater lakes and ponds
- most closely related to green plants

- example: *Volvox*



Diversity of Life - Protista

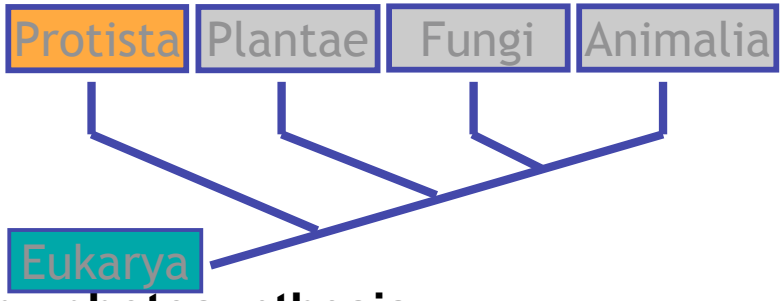
Multicellular

Seaweeds

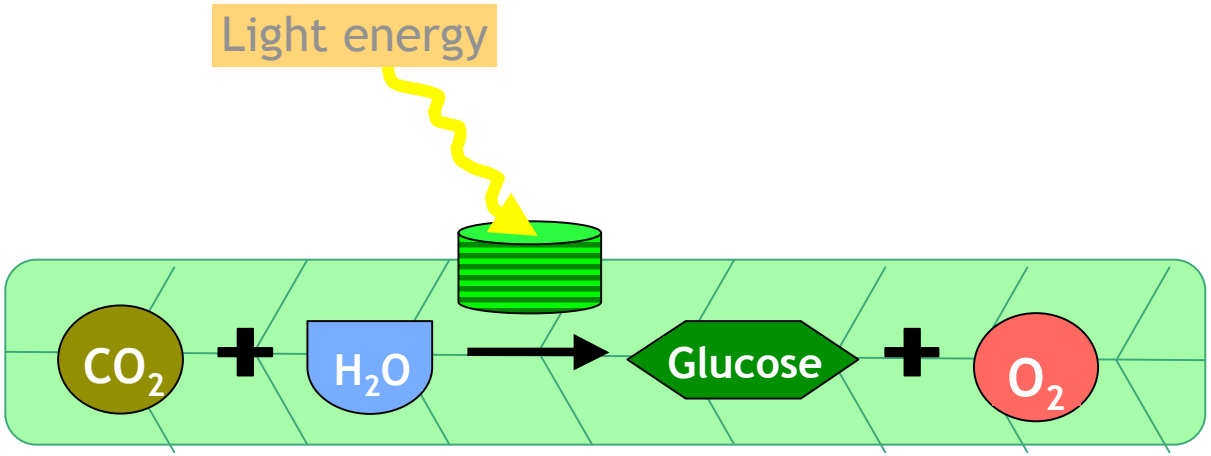
- large, multicellular marine algae
- similarity to true plants is an example of convergent evolution

Diversity of Life - Plantae

What is a Plant?



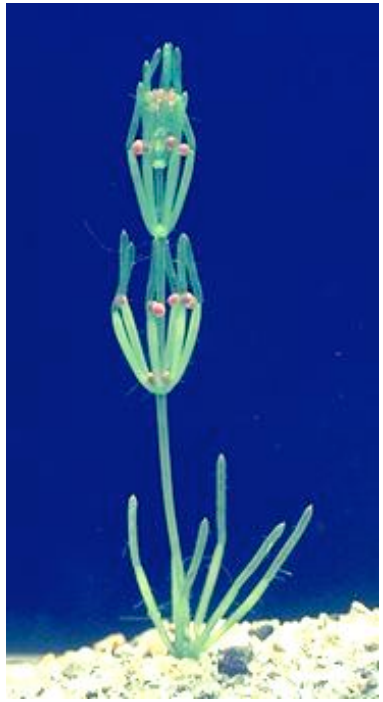
- multicellular eukaryotes
- terrestrial
- synthesizes organic molecules by photosynthesis



Diversity of Life - Plantae

Evolution to Land

- green algae are most closely related to plants
- molecular research shows that the multicellular, green algae (charophytes) is the closest relative to plants
- gradual accumulation of terrestrial adaptations



Diversity of Life - Plant Evolution

Terrestrial Adaptation

In the water ... all resources a plant needs are found all around

On land ... these resources are found in two different places

- light and CO_2 available above ground
- water and mineral nutrients are mainly in the soil

So ... some adaptations were needed for plants to exist on land

Diversity of Life - Plant adaptation to land

Structural Adaptations

Leaves - main photosynthetic organs

- exchange of gases (CO_2 / O_2) through pores on the leaf's surface called stomata
- cuticle (waxy layer) reduces water loss

Stems

- support for plant
- lignin-rich cell walls

Diversity of Life - Plant adaptation to land

Structural Adaptations

Roots

- anchorage
- absorption of water and minerial

Vascular Tissues

- transport of vital materials between organs
- system of tube-shaped cells

Diversity of Life - Plant Evolution

Plant Diversity

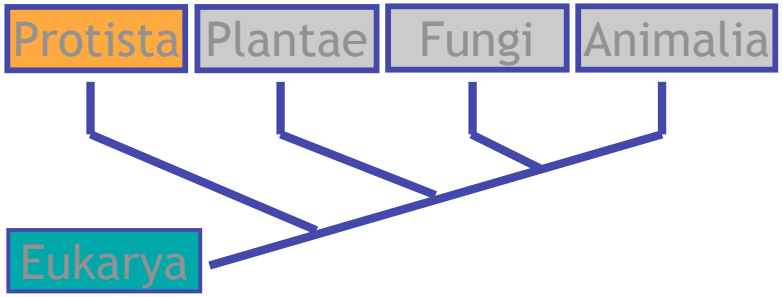
(1) Origin of plants ---> Bryophytes (mosses)

(2) Vascular plants ---> Ferns

(3) Seeded plants ---> Gymnosperms (conifers)

(4) Flowering plants ---> Angiosperms

Diversity of Life - Fungi



Fungi

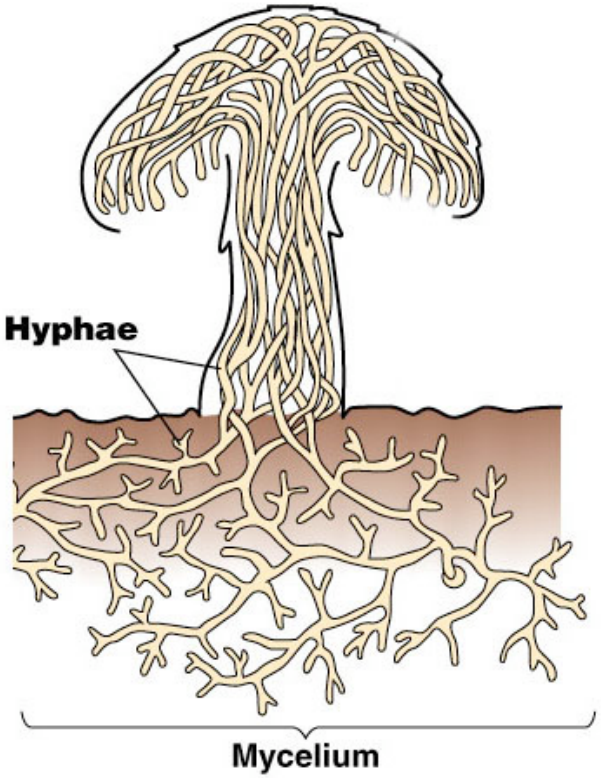
- eukaryotes
- mostly multicellular
- more closely related to animals than to plants

- heterotrophs
  - acquire nutrients by absorption
  - secret enzymes that breakdown food

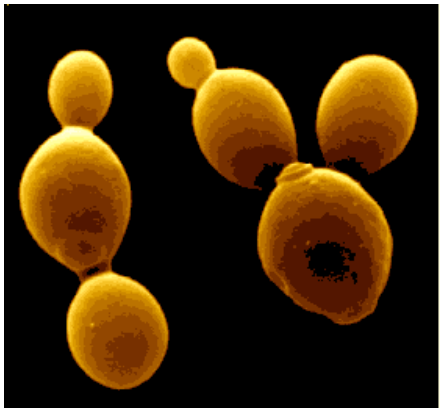
Diversity of Life - Fungi

Fungi Structure

- adapted for the purpose of absorbing nutrient
- bodies constructed of thread-like tubular structures called hyphae
- hyphae forms a feeding network called the mycelium
- most of these structures are underground

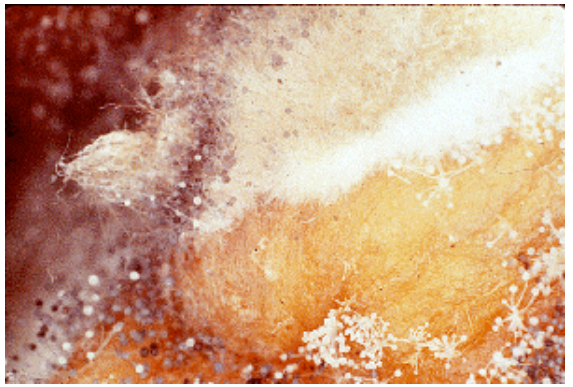


Diversity of Life - Fungi



Ecological Roles

- decomposers
- recycle chemical elements back into the environment



Diversity of Life

Calendar of Geological Time (1 day = 150 million years)

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

1: The origin of the Earth
8: Prokaryote cells
10: Oldest fossils - bacteria and blue-green algae
24: First eukaryotic cells
28: First land plants
29: Gymnosperms
30: Angiosperms; humans