

# Biological Classification

Fun!

# Classification

- Arranging organisms into hierarchical groups
  - each higher taxon contains one or more lower taxa
- based on similarities
- and naming the groups

# Phylogeny

- Branch of biology concerned with evolutionary origins and kinship
- Most zoologists favor classifications based on phylogeny.

# Taxonomy

- Branch of biology concerned with classification.
- Groups in a classification are **taxa** (*singular, taxon*).

# BINOMIAL NOMENCLATURE

A species consists of:

- all individuals that can interbreed under natural conditions (fish example)

Every species (30 million!) must have:

1. a unique genus name (*e.g.*, Homo)
2. a specific epithet that is unique within its genus (*e.g.*, sapiens)

# Classification of Humans

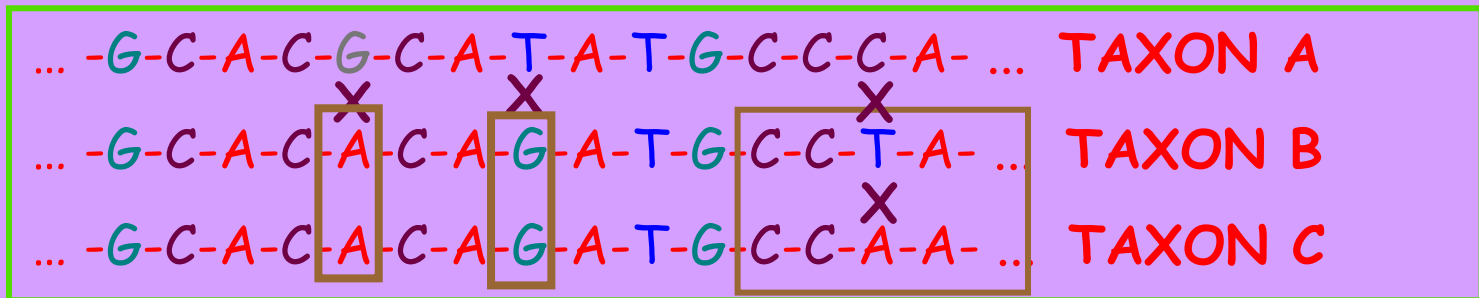
Table 10.1

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primates
Family	Hominidae
Genus	<u>Homo</u>
Species	<u>Homo sapiens</u>

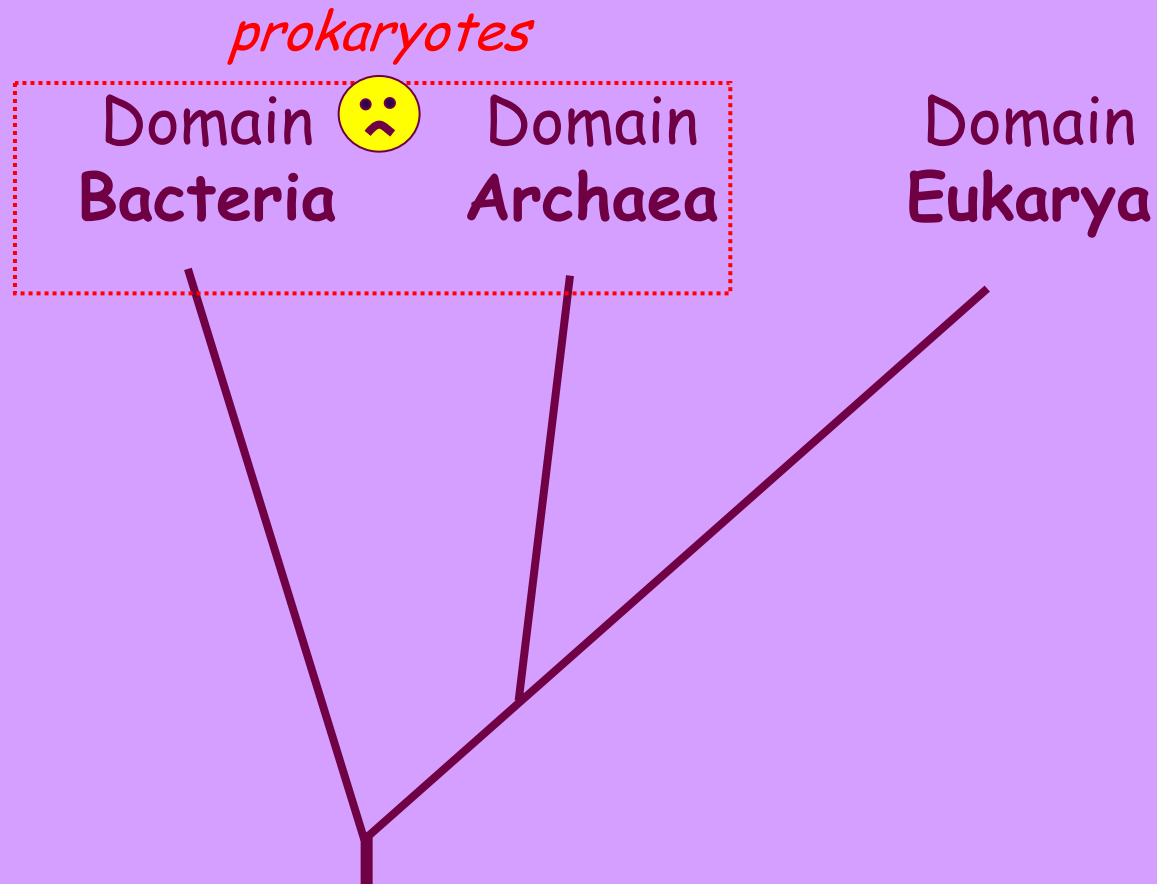


# Phylogenetic Classification

- Each lower taxon is supposed to have evolved from its next higher taxon
- Older classifications based on superficial similarities are being revised
- New evidence comes from comparisons of DNA and RNA nucleotide sequences



# Phylogeny of Domains





# Character variation and Phylogeny

- Character similarity/difference is used to reconstruct phylogeny
- **Ancestral** -characters present in a common ancestor
- **Derived**- characters that arose later
- **Outgroup** - shows if a character is ancestral or derived (polarity)
- **Clade (branch)** - a series of species that share derived characters

# Character variation and Phylogeny

- Example Character = Teeth
- Derived or ancestral?
- Reptiles                      Birds                      Mammals
- Present                      absent                      present
- Outgroup comparison: amphibians/fish
- Conclusion ?
- Teeth ancestral, absence of teeth is derived



# Theories of taxonomy

- Traditional
- Phylogenetic (cladistics)

# Construction of Phylogenetic trees and cladograms

- Comparative morphology
- Comparative biochemistry
- Comparative cytology

# Cladistic Reasoning

Hickman p. 200-201

- logical procedure for arranging taxa of organisms into phylogenetic trees
  - based on anatomy, embryology, etc.
- Asks basic question: "Of three taxa, which two are most closely related?"

# Criteria

- Proof of relatedness requires shared, derived characteristics
  - new features evolved by a recent, common ancestor
- Similarities must not be
  - retained from a much earlier ancestor
  - convergent, that is, evolved independently by the two taxa or their recent ancestors
- All forks have just two branches

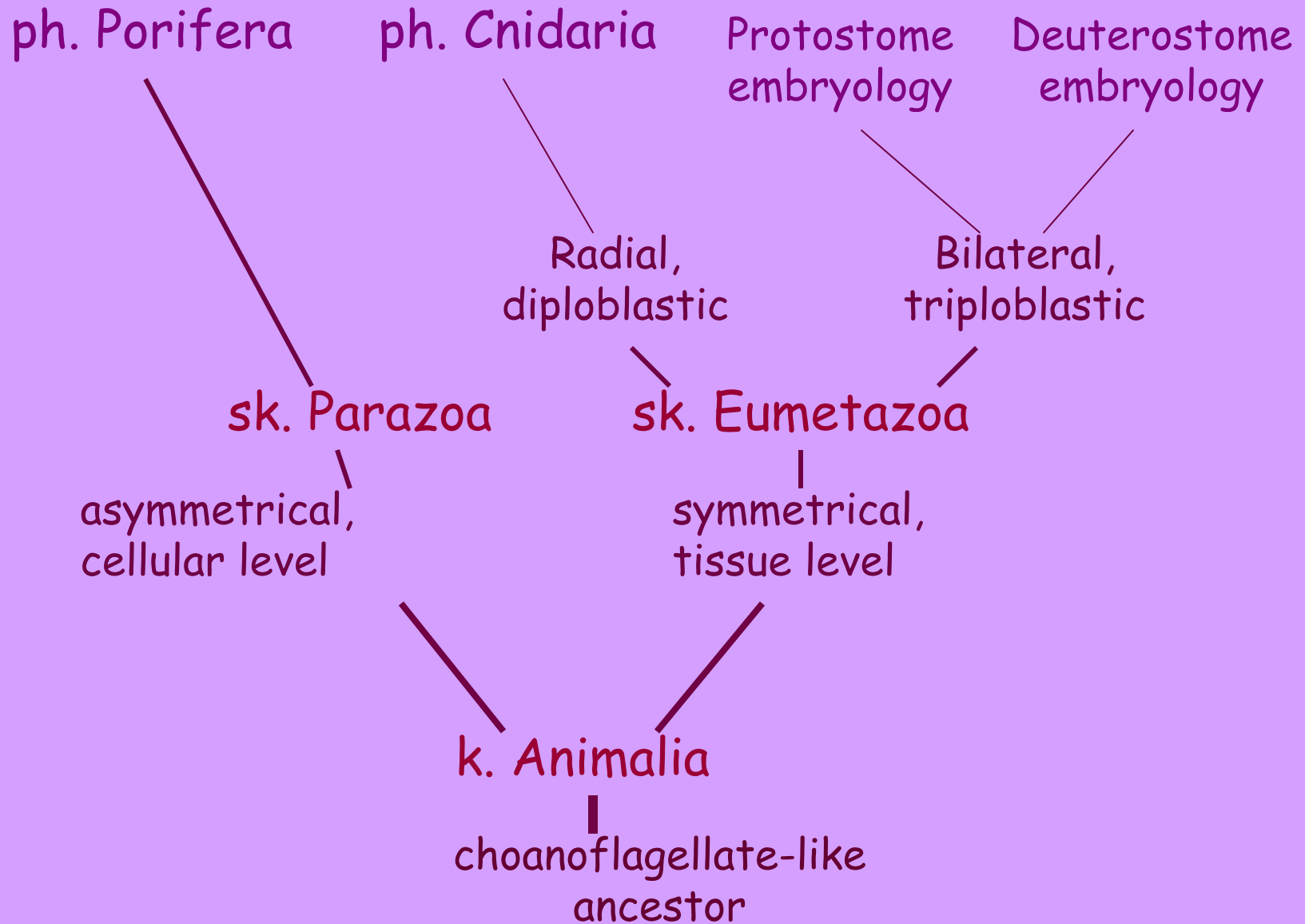
# Example

What is derived vs ancestral?

Cnidaria are closer to Bilateria than to Porifera, because:

- organized tissues, symmetry, and a digestive cavity are **shared, derived characters**
- similarities such as multicellularity, calcium carbonate skeletons, and ingestive heterotrophy, are likely **ancestral features**
- hollow tubes formed by some sponges and anemones are convergences





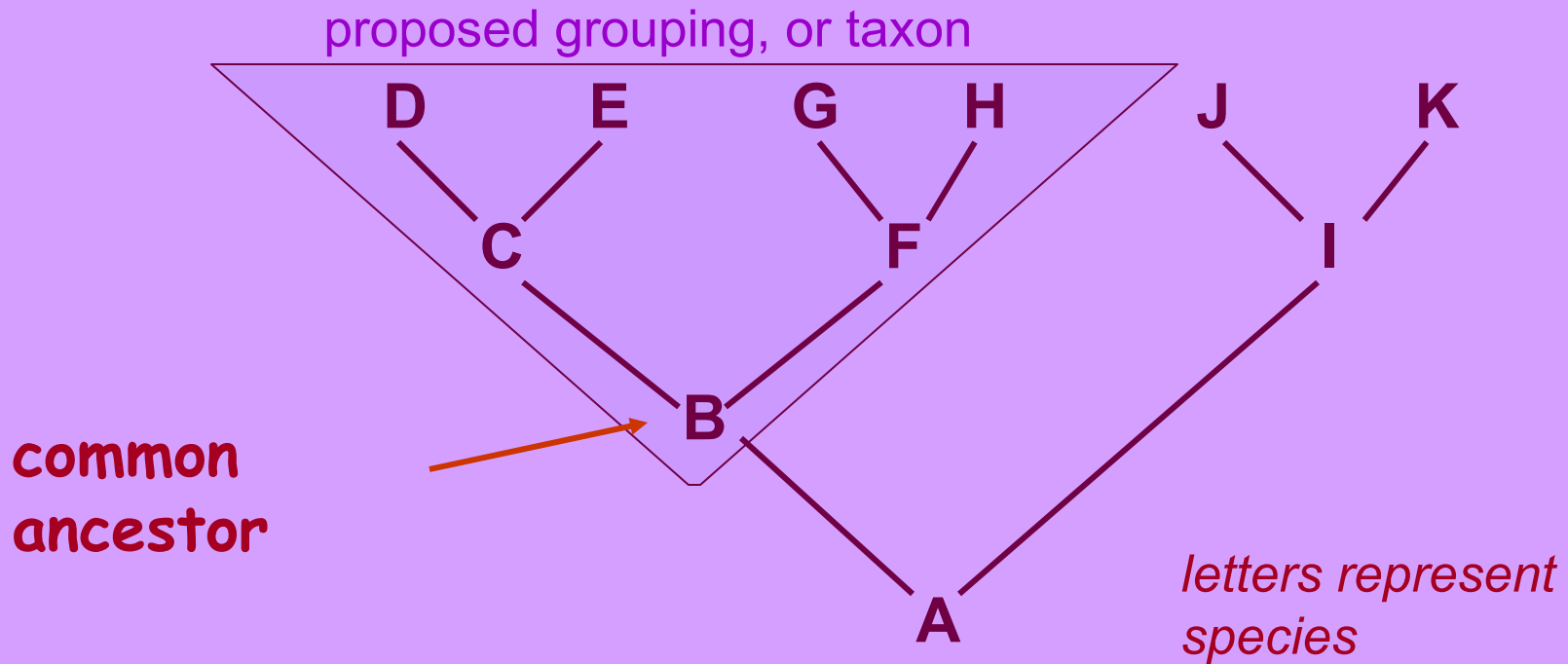
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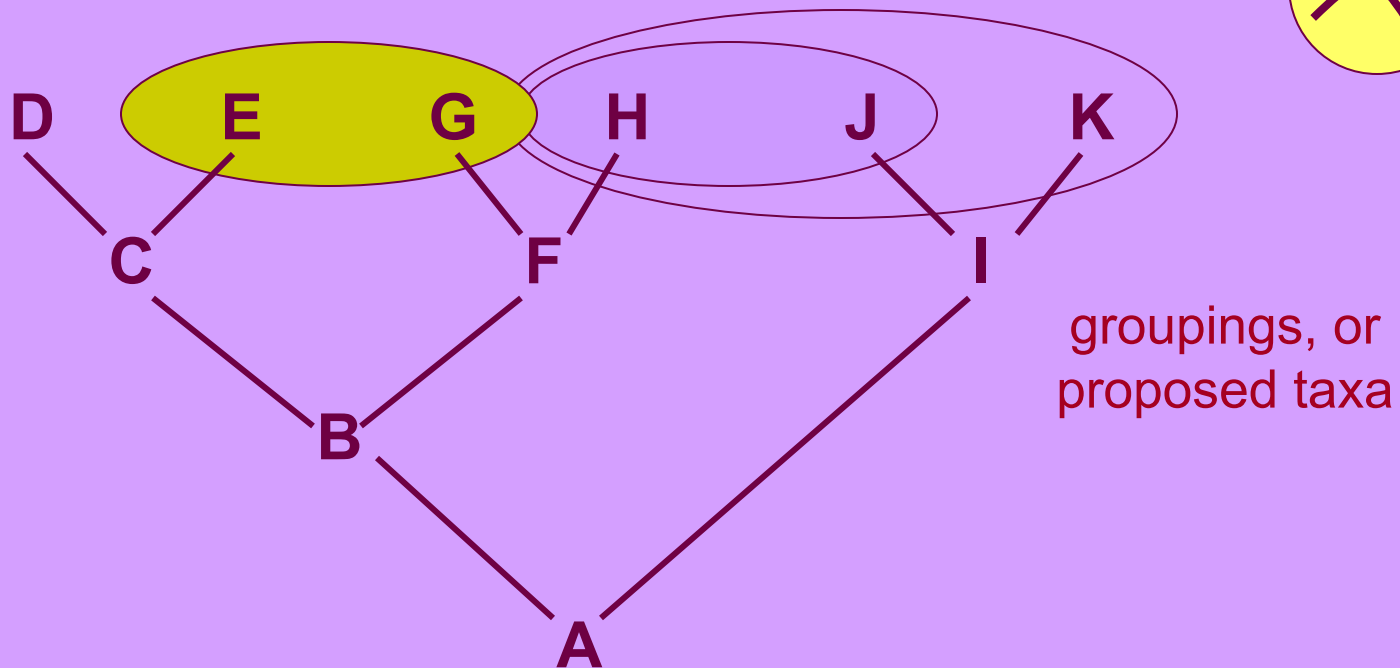
# Is a taxon monophyletic?

Is the common ancestor and all its descendants included in the taxon?



*See Hickman 10-4*

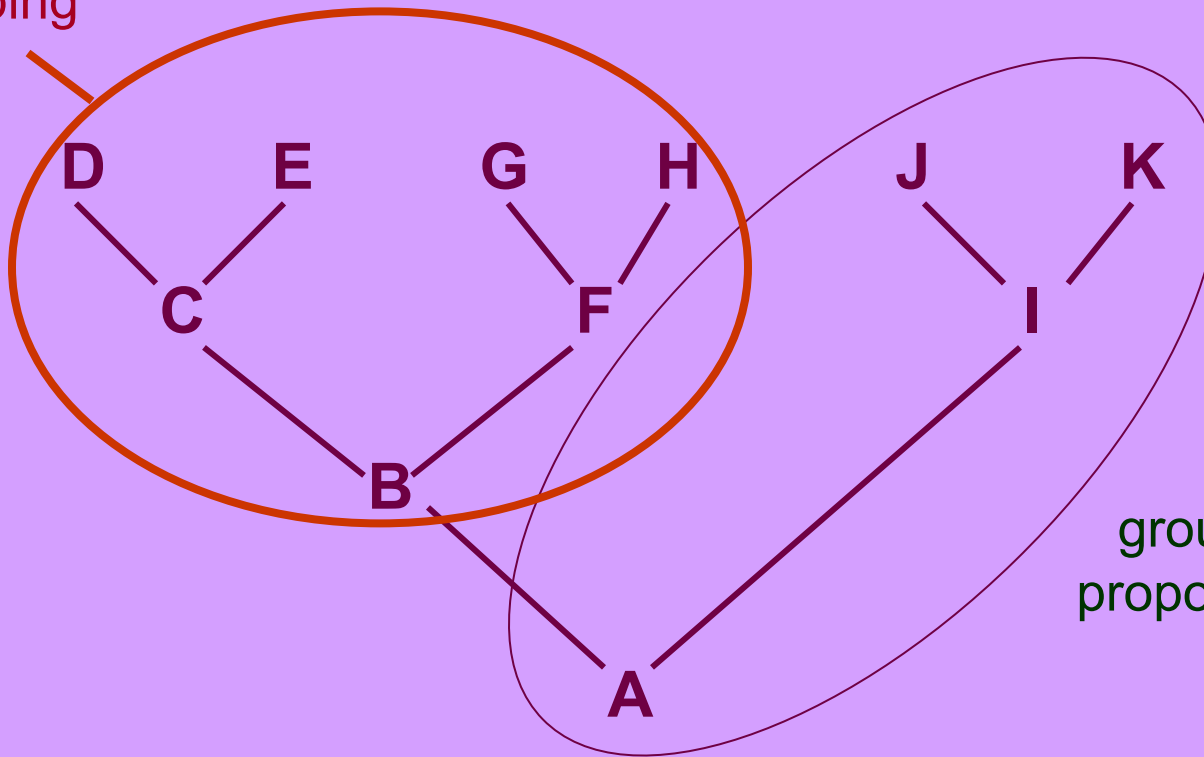
# Polyphyletic Groups



ancestral species, and also some  
of their descendants, excluded  
from taxa

# Paraphyletic Groups

descendants of **A**  
excluded from  
grouping



# Example

- A taxon including all pseudocoelomates would be polyphyletic
- The most recent common ancestor of all pseudocoelomates was the original protostome animal
  - It was also the ancestor of many acoelomate and eucoelomate phyla
  - And may well have been acoelomate, itself

# Species concept

- Typological (morphological) (Before Darwin)
  - Discarded by evolutionists
  - Type specimen deposited in museum
- Biological species concept (Dobzhansky and Mayr)
  - "a species is a reproductive community of populations (reproductively isolated from others) that occupies a specific niche in nature"
- Evolutionary species concept (Simpson)
  - A single lineage of ancestrodescendent populations that maintains its identity from other such lineages and has its own evolutionary tendencies and historical fate.
- Phylogenetic species
  - A monophyletic unit

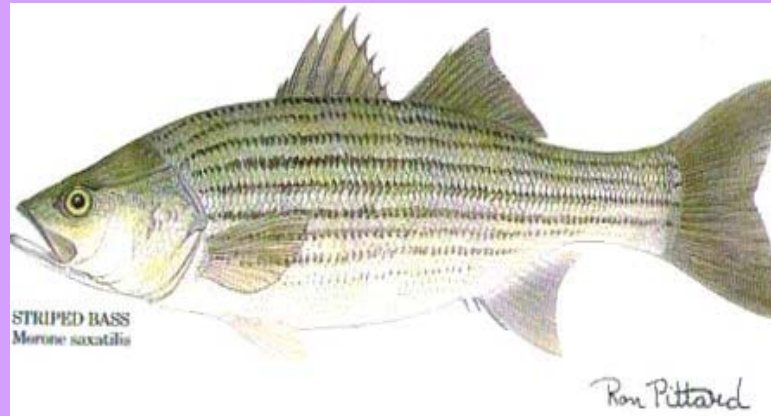
# Biological Species concept

- Based on reproductive compatibility not morphology.
- “Niche” ties in ecological properties
- Breeding experiments necessary
- Molecular studies can differentiate organisms with similar morphology

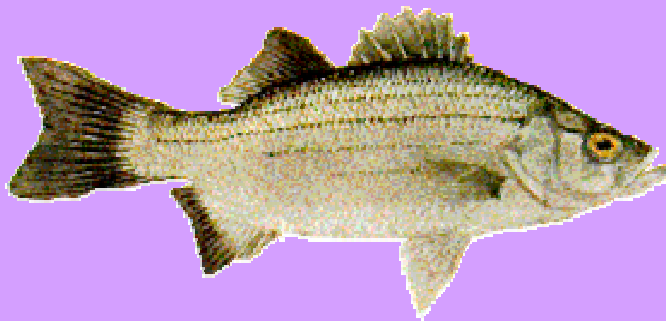


A Fishy Example!

# Some Representatives of the Genus *Morone*



Striped Bass



White Bass



White Perch

Ecologically Significant  
Fisheries and Aquaculture

# Other Terms

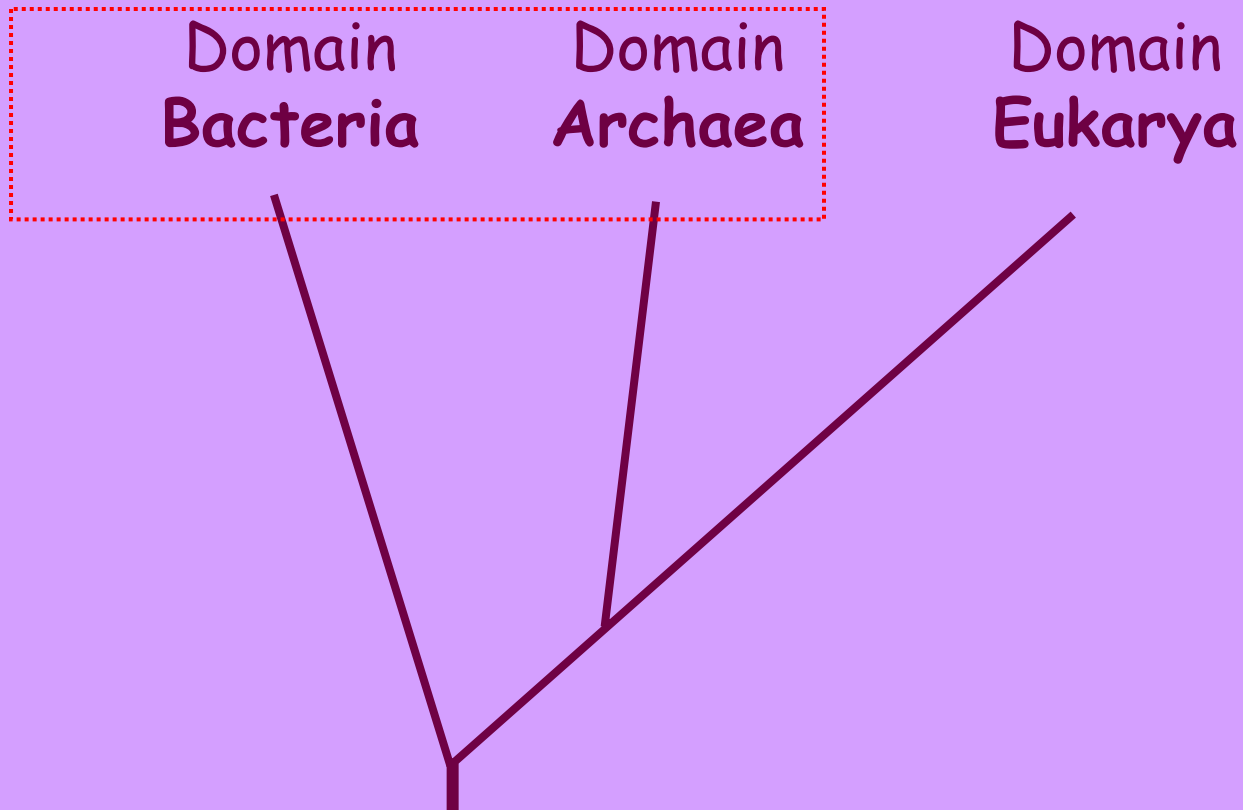
- Geographic Range
- Evolutionary duration
- Cosmopolitan vs. Endemic
  - Ranges can change through duration



# Phylogeny of Domains

compare Fig. 10-11

*prokaryotes*



Hickman pgs 202-204

How many kingdoms are there?

# History

- Aristotle (1800's)
  - Plants/Animals
- Haeckel (1866)
  - Plants/Animals/Protista
- Whittaker (1969)
  - Fungi/Plants/Animals/Protists/Monerans
- Woese, Kandler, Wheelis (1990)
  - Domain system  
(Archea, Bacteria, Eucarya)

# Domain Eukarya - 8 Kingdoms

- Archezoa
- Euglenozoa
- Stramenopila
- Alveolata
- Rhodophyta
- Plantae
- Fungi
- Animalia



# Eukarya Kingdom Contrasts

- Mode of nutrition
  - Photoautotrophic
  - Absorptive heterotrophic
  - Ingestive heterotrophic
  - mixotrophic
- Uni- or multi-cellular
- Special organelles or locomotion

# Uni- and Multi-Cellular

- A unicellular organisms may be 1-celled
  - Or colonial - many cells living together, all identical (except reproductive cells)
- A multicellular organism is composed of several different kinds of cells
  - besides those involved in reproduction

# Archezoa

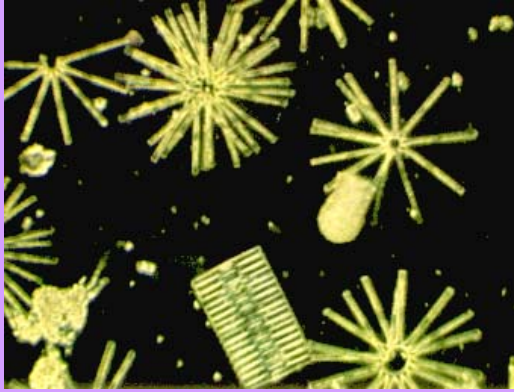
- Proper nucleus
- No mitochondria
  - all other eukaryotes have mitochondria
- Unicellular, ingestive and absorptive heterotrophs
- Locomotion: ameboid and flagellar

Fig. 11.14



Giardia

diatoms



# Kingdom Stramenopila

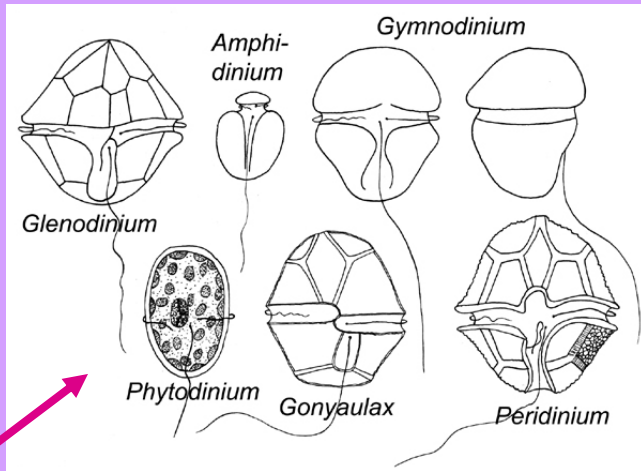
compare Campbell Fig. 16.25 A,B

- flagellum, if present, "hairy"
- photoautotrophic (diatoms, sea weeds)
- mixotrophic (golden-brown algae)
- absorptive heterotrophic (water molds)
- mostly unicellular, but kelps are multicellular

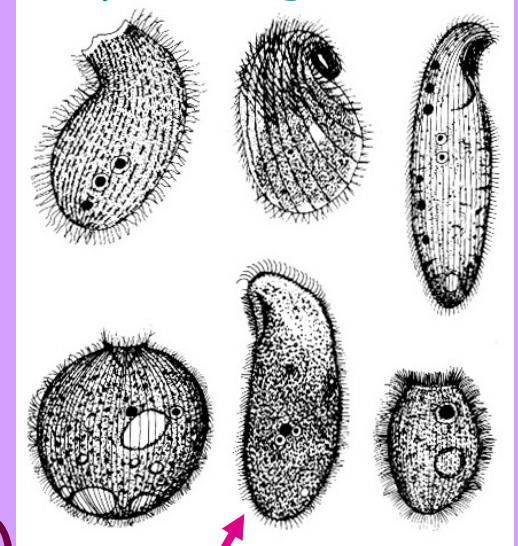


kelp - brown seaweed  
Campbell Fig. 16.26A

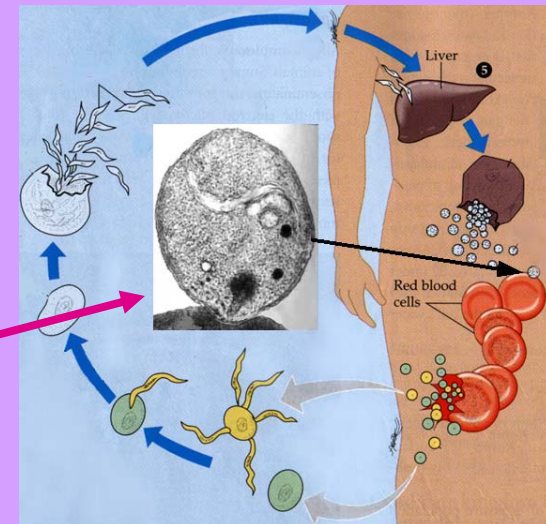
compare Campbell Fig.16.22 D



# Alveolata

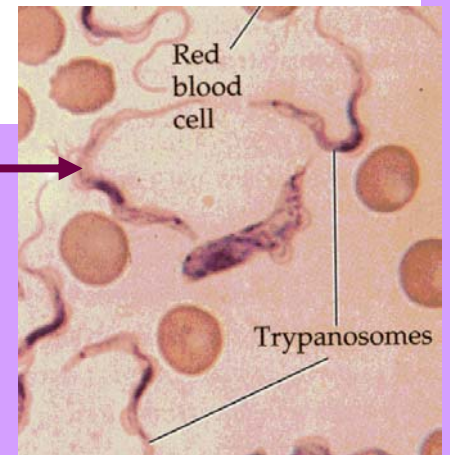
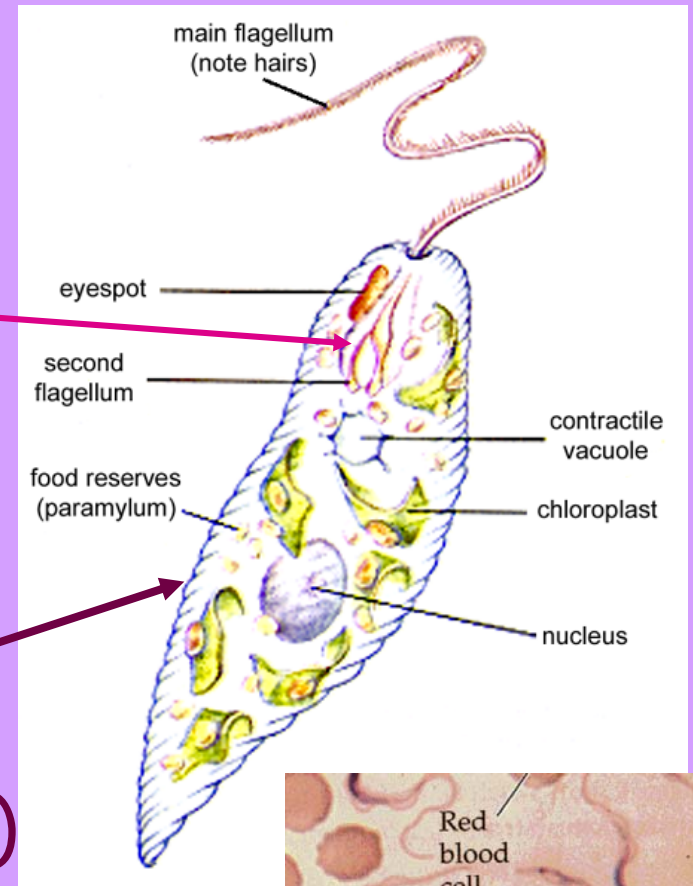


- internal layers of vacuoles (alveolae)
- cilia, flagella, or ameboid locomotion
- ingestive heterotrophs (ciliates)
- mixotrophs (dinoflagellates)
- absorptive heterotrophs (malaria organism)



# Euglenozoa

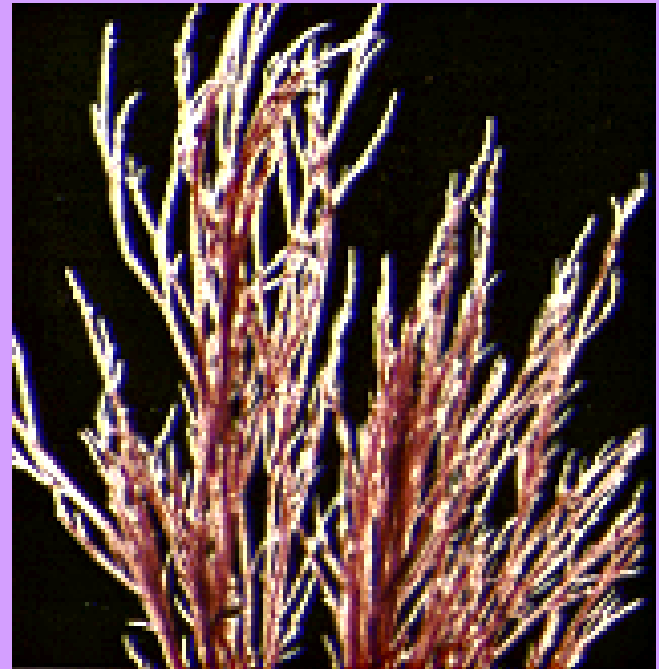
- organelles or pits close to flagellum
- nutrition varied
  - mixotrophs (Euglena)
  - ingestive heterotrophs
  - parasites (Trypanosoma)
  - some amebas
- entirely unicellular, not colonial



Campbell Fig. 16.22 A

# Rhodophyta

- no flagella
- photoautotrophic
- double-membraned chloroplasts
- reddish pigments

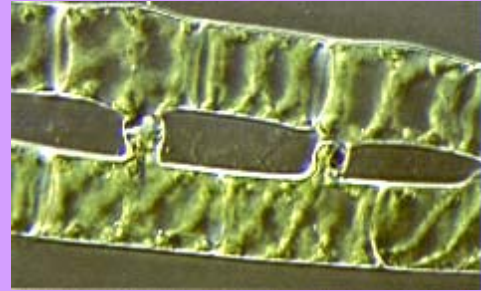


Campbell Fig. 16.26 b



# Plantae

- photoautotrophic
- cellulose cell walls
- unicellular ones called green algae
- multicellular ones called plants



compare Campbell Fig. 17.3 C



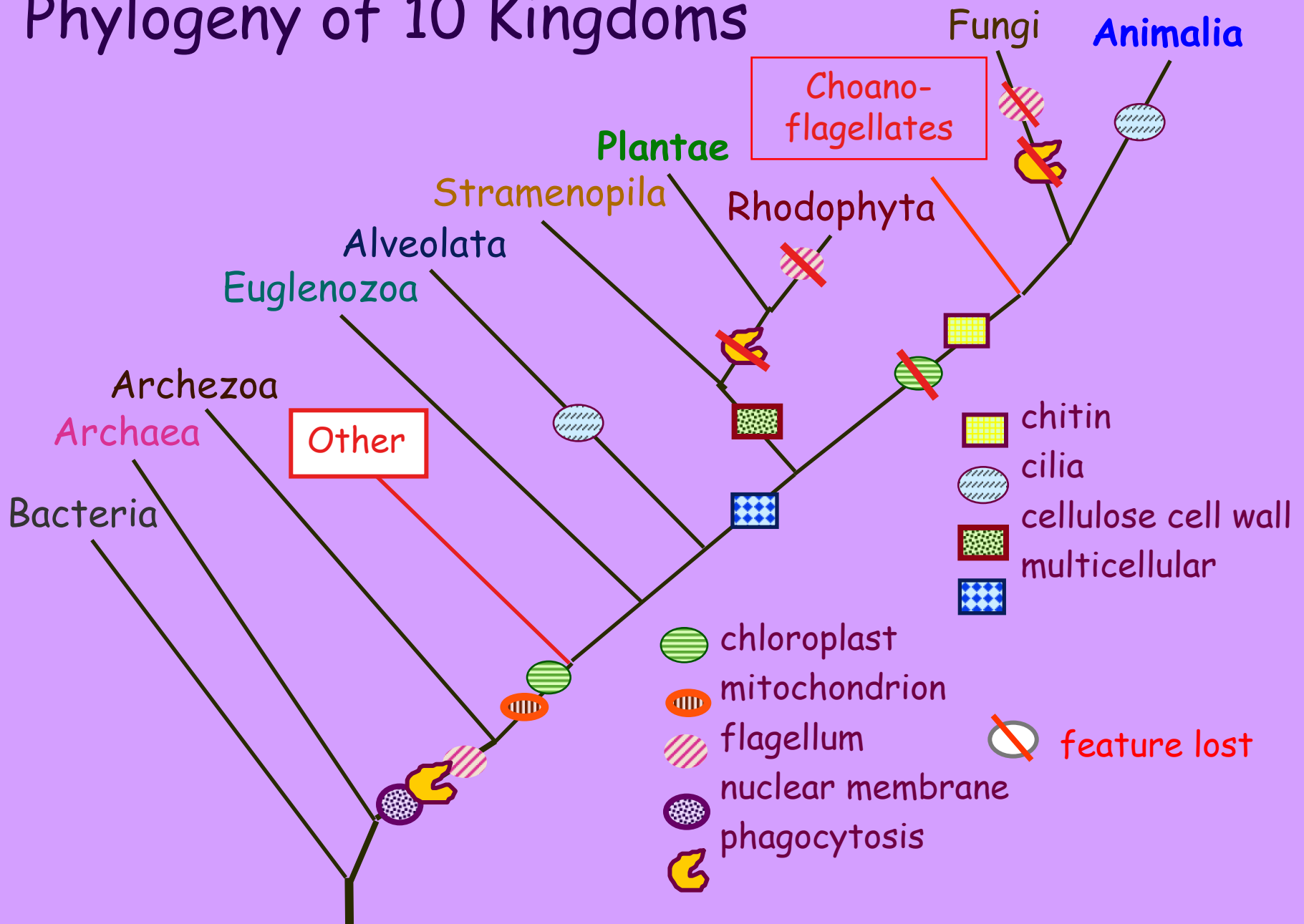
# Fungi

- multicellular, coenocytic, absorptive heterotrophs with chitinous cell walls
- most lack flagella

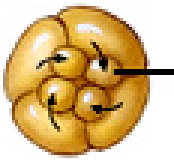
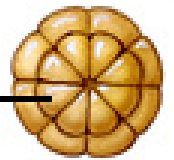
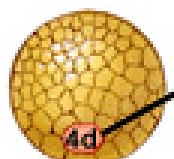
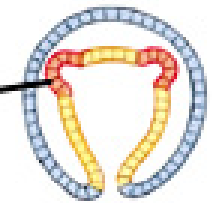
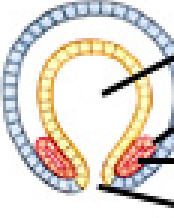
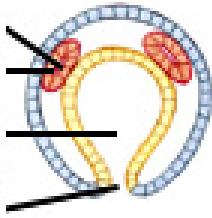

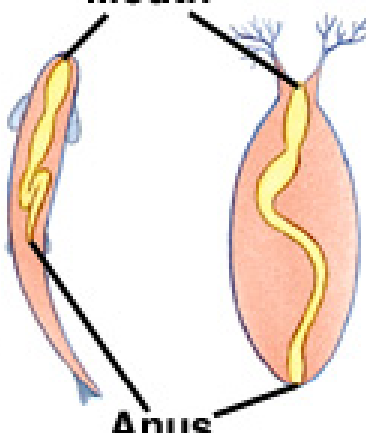
# Animalia

- multicellular, ingestive heterotrophs without cell walls
- many have flagella and cilia

# Phylogeny of 10 Kingdoms



# Protostome and deuterostome comparison

PROTOSTOMES	DEUTEROSTOMES
 <p><b>Spiral cleavage</b></p> <p>Cleavage mostly spiral</p>	<p>Cleavage mostly radial</p>  <p><b>Radial cleavage</b></p>
 <p>Cell from which mesoderm will derive</p> <p>Endomesoderm usually from a particular blastomere designated 4d</p>	<p>Endomesoderm from pouches from primitive gut</p>  <p>Endomesoderm from enterocoelous pouching (except chordates)</p>
 <p><b>Primitive gut</b></p> <p><b>Mesoderm</b></p> <p><b>Coelom</b></p> <p><b>Blastopore</b></p> <p>In coelomate protostomes the coelom forms as a split in mesodermal bands (schizocoelous)</p>	<p>All coelomate, coelom from fusion of enterocoelous pouches (except chordates, which are schizocoelous)</p>  <p><b>Coelom</b></p> <p><b>Mesoderm</b></p> <p><b>Primitive gut</b></p> <p><b>Blastopore</b></p>
 <p><b>Anus</b></p> <p><b>Annelid (earthworm)</b></p> <p><b>Mouth</b></p> <p>Mouth from, at, or near blastopore; anus a new formation</p> <p>Embryology mostly determinate (mosaic)</p> <p>Includes phyla Platyhelminthes, Nemertea, Annelida, Mollusca, Arthropoda, minor phyla</p>	<p>Anus from, at, or near blastopore, mouth a new formation</p> <p>Embryology usually indeterminate (regulative)</p>  <p><b>Mouth</b></p> <p><b>Anus</b></p> <p>Includes phyla Echinodermata, Hemichordata, Chaetognatha, Phoronida, Ectoprocta, Brachiopoda, Chordata</p>