Classification – WHY?

TAXONOMY FAIL
Classification

• : Finding Order in Diversity
  • How living things are organized
  • Binominal Nomenclature
  • Linnaeus’s System of Classification
• : Modern Evolutionary Classification
  • Evolutionary relationships
  • Cladistics
  • Comparing dissimilar organisms
• : Kingdoms and Domains
  • 6 kingdoms of Life
  • 3 Domain system of classification
Finding Order In Diversity

• What is a species?
  – A population of organisms that share similar characteristics and can interbreed freely and produce fertile offspring

• Biologists have identified 1.5 million species, and they estimate 2-100 million species have yet to be identified

• Order out of chaos?

• Classification
  – A system to name and group organisms in a logical order, used to study diversity of life

• Taxonomy
  – Classifying organisms and giving them a universally accepted name
Scientific Name? Common Name?

- Using common names is confusing
  - Mountain lion, cougar, catamount, puma, panther

- 18th century scientists agreed to use a single name for each species, and to use Latin as the common language

- Carolus Linnaeus- a Swedish botanist (mid 1700’s) who developed the binominal nomenclature system of naming organisms
  - Binominal Nomenclature = 2 word naming system we still use today

Grrrrrr.

Say my name, say my name.
Rules of the Binomial Nomenclature System

1. Written in italics or underlined
2. First word is Genus which is capitalized, second word is species which is lower case

Panthera leo 

Drosophila melanogaster 

Canis lupus 

Lion 

Fruit fly 

Wolf
## Scientific Names of Bears:

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grizzly Bear</strong></td>
<td>Ursidae Ursus arctos</td>
</tr>
<tr>
<td><strong>Polar Bear</strong></td>
<td>Ursidae Ursus maritimus</td>
</tr>
<tr>
<td><strong>Black Bear</strong></td>
<td>Ursidae Ursus americanus</td>
</tr>
<tr>
<td><strong>Panda Bear</strong></td>
<td>Ursidae Ailuropoda melanoleuca</td>
</tr>
<tr>
<td><strong>Sloth Bear</strong></td>
<td>Ursidae Melursus ursinus</td>
</tr>
</tbody>
</table>

All bears are NOT alike - but they are all bears.
Scientific Names

- For a grizzly bear, **Ursus** is the *genus* name and **arctos** is the *species* name.
- Species names are unique to that individual group of organisms and are usually a description of an important trait or an indication of *where that organism lives*.

- **Ursus maritimus**, where does he live?
  - *Maritim* means to live near the sea.

- **Felis domesticus**, cat.
  - What does “domesticus” mean? *Domesticus = “of the house”*
The Wood Lice, *Armadillidium vulgare*, is most closely related to the

A  Head Lice, *Pediculus humanus*

B  Wood cockroach, *Parcoblatta pensylvanica*

C  Roly Poly, *Armadillidium pallidum*
8 taxa of classification

- Linnaeus’s system is hierarchical, it now includes 8 levels (largest to smallest)
Linnaeus’s System of Classification

Example: Humans

- **Domain**: Eukarya
- **Kingdom**: Animalia
- **Phylum**: Chordata
- **Class**: Mammalia
- **Order**: Primates
- **Family**: Hominidae
- **Genus**: Homo
- **Species**: sapiens

Smallest: Homo sapiens

Example: Humans

Did Katy Perry Come Over For Group Singing?

FUN!
Bear Classification as an Example

Question:
Which organism is more closely related to the polar bear, the squirrel or the fox?

Duh, it’s the fox.
How Can You Remember the 8 Taxon levels?

- Dumb King Philip Came Over For Good Soup
- Diva Katy Perry Can Order Fresh Green Salad

Or you can combine the two OR

😊 you come up with your own pneumonic

Evolutionary Classification

• Linnaeus grouped organisms based on physical similarities, but Darwin’s concept of Descent with Modification changed all that.

• **Phylogeny** = grouping organisms into categories that represent lines of evolutionary descent instead of physical similarities.

If you had to group these 3 based on what they look like, who is more related?
Actually, **crabs** and **barnacles** are more closely related evolutionarily.

This branching shows that **crabs and barnacles** share a more recent common ancestor.

Derived characteristics in crustaceans =
- Segmented bodies
- Hard external skeleton shed during growth

**Cladogram** = shows the evolutionary relationships among a group of organisms
Which of these classifications is most specific?
A  Family
B  Genus
C  Phylum
D  Order
The chart above shows the classification of three organisms. Certain categories are not shown. Which two organisms are most closely related?

<table>
<thead>
<tr>
<th>Organism A</th>
<th>Organism B</th>
<th>Organism C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animalia</td>
<td>Animalia</td>
<td>Animalia</td>
</tr>
<tr>
<td>Insecta</td>
<td>Mammalia</td>
<td>Mammalia</td>
</tr>
<tr>
<td>Diptera</td>
<td>Carnivora</td>
<td>Carnivora</td>
</tr>
<tr>
<td>Musca domestica</td>
<td>Canis lupus</td>
<td>Felis domestica</td>
</tr>
</tbody>
</table>

A  A and B  
B  B and C  
C  C and A  
D  Not enough information is given
Similarities in DNA and RNA

- Genes of many organisms share important similarities at the molecular level
- Similarities in DNA and RNA can help determine classification and evolutionary relationships (who are the vultures most closely related to?)

American vulture
African Vulture
Storks
Falcon
Molecular Clocks

- DNA comparisons can also be used to mark the passage of **evolutionary time**
- **Molecular Clock** model uses DNA comparisons to estimate the length of time that 2 species have been evolving independently
  - Looks for mutations that separate 2 species
  - Other changes in DNA
  - Compares DNA sequences between species

Which organisms are more closely related?

<table>
<thead>
<tr>
<th></th>
<th>Human</th>
<th>Pig</th>
<th>Chimpanzee</th>
<th>Cricket</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA</td>
<td>CCA</td>
<td>CCA</td>
<td>CCA</td>
<td>CCT</td>
</tr>
<tr>
<td></td>
<td>TAG</td>
<td>TGG</td>
<td>TAA</td>
<td>AAA</td>
</tr>
<tr>
<td></td>
<td>CAC</td>
<td>AAA</td>
<td>CAC</td>
<td>GGG</td>
</tr>
<tr>
<td></td>
<td>CTA</td>
<td>CGA</td>
<td>CTA</td>
<td>ACG</td>
</tr>
</tbody>
</table>

Only 1 mutation separates human and chimp in this portion of the gene.
Kingdoms and Domains

• In Linnaeus’s time, life was much simpler. Either you were a plant or an animal.
• Today, classification is more complicated.
  – Protists? Bacteria? Viruses?
• Tree of Life (www.tolweb.org)
• Life is full of Diversity
  – Robert Hooke and Van Leewenhoek – showed us the microscopic world, bacteria, protists, microorganisms
  – Discovering all these microscopic life forms, added branches to the Tree of Life
Three Domain System

• Using a molecular clock, scientists group organisms according to how long they have been evolving independently.

• Linnaeus’s 7 level system became 8 levels when Domain was added.

• Today, we have 3 Domains:
  – Bacteria = all bacteria in the kingdom Eubacteria, unicellular, members are Prokaryotes
  – Archaebacteria = includes the kingdom Archaebacteria
  – Eukarya = protists, fungi, plants and animals
Domain Bacteria

• Members of Kingdom Bacteria are Prokaryotes

• Prokaryotes = lack a nucleus, no membrane-bound organelles (HAVE RIBOSOMES)
  – So, no mitochondria, chloroplasts, endoplasmic reticulum, golgi apparatus, vacuole

Some microbes live on our skin and protect us from many harmful agents. The drier areas, like the back, have few microbes; moist areas, such as under the arm, have many more.

Examples of Bacteria:

*Lactobacillus bulgaricus* helps turn milk into cheese, yogurt, and other dairy products. Lactose intolerant anyone?

*Mycobacterium tuberculosis* causes tuberculosis

*Staphylococcus* (a.k.a. *staph*) can cause serious infections and is one of the most drug-resistant bacteria

*Escherichia coli* (a.k.a. *E. coli*) lives in the gut, where it helps digest food
Domain Archaea

- Archaebacteria are **CRAZY** bacteria
- **Unicellular, Prokaryotic**
- Live in the most **extreme** environments, where only crazy things live
  - Would you live in a swamp or marsh?
  - Or in the boiling water of a hot spring (over 163 °F)?
  - Or in a “black smoker” (deep sea air vents (very hot!))
  - Or in brine (water with 9X amount of salt as the ocean) and in salt crust?
  - Or how about Mars?? Yes, Mars!

1. Methanogens (methane-producers)--responsible for swamp gas and farts.
2. Extreme Thermophiles--live in hot springs and black smokers.
3. Extreme Halophiles--live in saturated brine and salt crust.
Domain Eukarya

• All organisms whose cells have a nucleus
• Everything that is NOT a bacteria- including YOU!
• Now we get to the last 4 kingdoms in the 6 Kingdom system

3. Protista — if it’s not a bacteria, plant, fungi or animal, it’s a protist, remember that! Live in moist places, like ponds
   Keywords: eukaryote, lives in moist places, hard to classify

4. Fungi — heterotrophs that feed on dead or decaying organic matter (organic = from living organisms), saprophytes — they secrete enzymes that digest and then absorb (not eat) the smaller food molecules, cell walls of chitin
   Keywords: heterotroph, saprophyte (feeds on dead or decaying matter), secretes enzymes, chitin cell walls
Plantae and Animalia

5. **Plantae** – multicellular, photosynthetic autotrophs, that don’t move, have cell walls with cellulose

   **Keywords**: autotroph, photosynthesis, cell walls, cellulose

6. **Animalia** – multicellular and heterotrophic, do not have cell walls, motile (can move), can live almost everywhere

   **Keywords**: multicellular, heterotrophic, motile, no cell walls
### Key Characteristics of Kingdoms and Domains

#### Classification of Living Things

<table>
<thead>
<tr>
<th>DOMAIN</th>
<th>Bacteria</th>
<th>Archaea</th>
<th>Eukarya</th>
<th>Fungi</th>
<th>Plantae</th>
<th>Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>KINGDOM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KINGDOM</td>
<td><strong>Eubacteria</strong></td>
<td><strong>Archaebacteria</strong></td>
<td><strong>Protista</strong></td>
<td><strong>Fungi</strong></td>
<td><strong>Plantae</strong></td>
<td><strong>Animalia</strong></td>
</tr>
<tr>
<td>CELL TYPE</td>
<td><strong>Prokaryote</strong></td>
<td><strong>Prokaryote</strong></td>
<td><strong>Eukaryote</strong></td>
<td><strong>Eukaryote</strong></td>
<td><strong>Eukaryote</strong></td>
<td><strong>Eukaryote</strong></td>
</tr>
<tr>
<td>CELL STRUCTURES</td>
<td>Cell walls with peptidoglycan has ribosomes</td>
<td>Cell walls without peptidoglycan has ribosomes</td>
<td>May have cell walls of cellulose and/or chloroplasts</td>
<td>Cell walls of chitin</td>
<td>Cell walls of cellulose; chloroplasts</td>
<td>No cell walls or chloroplasts</td>
</tr>
<tr>
<td>NUMBER OF CELLS</td>
<td><strong>Unicellular</strong></td>
<td><strong>Unicellular</strong></td>
<td>Most unicellular; some colonial; some multicellular</td>
<td>one unicellular; most multicellular</td>
<td><strong>Multicellular</strong></td>
<td><strong>Multicellular</strong></td>
</tr>
<tr>
<td>MODE OF NUTRITION</td>
<td><strong>Autotroph or heterotroph</strong></td>
<td><strong>Autotroph or heterotroph</strong></td>
<td><strong>Autotroph or heterotroph</strong></td>
<td><strong>Heterotroph</strong></td>
<td><strong>Autotroph</strong></td>
<td><strong>Heterotroph</strong></td>
</tr>
<tr>
<td>EXAMPLES</td>
<td>Streptococcus, <em>Escherichia coli</em></td>
<td>Methanogens, halophiles</td>
<td><em>Amoeba, Paramecium</em>, slime molds, giant kelp</td>
<td><em>Mushrooms, yeasts</em></td>
<td><em>Mosses, ferns, flowering plants</em></td>
<td><em>Sponges, worms, insects, fishes</em></td>
</tr>
</tbody>
</table>

### Fill in the table

- **Kingdoms**
  - **Bacteria**
  - **Archaea**
  - **Protista**
  - **Fungi**
  - **Plantae**
  - **Animalia**

- **Domains**
  - **Eubacteria**
  - **Archaebacteria**
  - **Eukaryotes**

- **Cell Types**
  - **Prokaryotes**
  - **Eukaryotes**

- **Cell Structures**
  - Cell walls with peptidoglycan
  - Cell walls without peptidoglycan

- **Number of Cells**
  - Unicellular
  - Multicellular

- **Mode of Nutrition**
  - Autotroph or heterotroph

- **Examples**
  - *Streptococcus, Escherichia coli*
  - Methanogens, halophiles
  - *Amoeba, Paramecium*, slime molds, giant kelp
  - *Mushrooms, yeasts*
  - *Mosses, ferns, flowering plants*
  - *Sponges, worms, insects, fishes*
Kingdoms
- Eubacteria
- Archaebacteria
- Protista
- Plantae
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