Announcements
• First lab this week - make sure you have read the handout
• First Quiz next Monday at beginning of lecture

Last lecture
• Significance of Cells
• Science as a process
• Magnitude of biological diversity
• Organizing diversity

Hierarchical classification
• Species constitute the lowest taxonomic level and are based on reproductive isolation or morphological distinction
• Similar species are grouped together into a ‘genus’
• Similar genera (plural) grouped into a ‘family’
• Additional groupings occur at higher levels (order, class, phylum, kingdom, domain)
• Each species is named by genus and species name (binomial classification)
Some terms

- Taxonomy- naming and classifying organisms
- Taxon- taxonomic unit at a given level
- Category- any level in classification system (i.e. Kingdom, Class, Family).
- Phylogeny- evolutionary history of a species or group of related species
- Systematics- evolutionary study of biological diversity, with the goal of retracing the phylogeny of a group

Major lineages of life

- Recognizable differences
  - Cell type (nucleus + organelles or lacking these)
  - Body complexity (uni- versus multicellular)
  - Mode of nutrition (autotroph versus heterotroph)

Five kingdom system

- Monera- no nucleus or organelles
- Protista- unicellular or forming filaments or colonies of similar cells
- Plantae- autotrophic, produce food by photosynthesis
- Fungi- heterotrophs that absorb nutrients from organic matter (external digestion)
- Animalia- heterotrophs, ingest food and digest internally
Problems with five kingdom system

- Phylogenetic evidence suggests that many separate lineages of ‘Monera’ exist
  - Differences in proteins and DNA sequences
  - Differences in metabolism
- Becoming multicellular evolved multiple times, so the division of protista, plantae, fungi, and animals does not reflect phylogeny

Three Domain system

- Divides Monera into Archaea, Bacteria
- Includes other four kingdoms into Eucarya

Classification represents a hypothesis/work in progress

- Phylogenies are still poorly known
- Scientists debate number of kingdoms and the use of the Linnaean taxonomic system we used today.
- We will use the three domain, five kingdom system in this course.
Phylogenetic classification

- Used to recognize groups used in classification
- Also determines evolutionary relationships among groups
- Corresponds, to some degree, to Linnean hierarchical classification.

Characters in phylogenetics

- Character - feature of an organism.
- Character state - alternative conditions of a character.
- Variable character - one with at least two character states.
- Ancestral character state - original character state
- Derived character state - 'modified' character state

Examples of variable characters

- Body covering in lizards, crocodiles, birds
  - Ancestral state = scales, derived state = feathers
- Digestion in flatworms and tapeworms
  - Ancestral = digestive organs, derived = no digestive organs
Homology

• Homology- similarity in characteristics resulting from descent from a common ancestor (shared ancestry).
• Derived homology-
  – two groups share a derived character state because they inherited it from their most recent common ancestor.
  – Example- salamanders and horses have legs (not fins)

Analogy

• Analogy- similarity in character state resulting from convergent evolution
• Derived character state evolved more than once
• Groups formed by analogies are polyphyletic, i.e. using these characters for classification does not retrace phylogeny.

Phylogenetic classification

• The classification should reflect evolutionary history (phylogeny of groups)
• We must use existing taxa to develop a phylogenetic hypothesis (no time machine available)
• Monophyletic groups formed by identifying shared derived homologies
Steps in phylogenetic classification I

• Choose species in ‘ingroup’ and ‘outgroup’
  – The ingroup consists of species you want to classify
  – The outgroup consists of a close relative to the ingroup
• Collect information about characters in all taxa
  – Characters should show ancestral state in outgroup.
  – Ingroup species may show derived or ancestral state

Steps in phylogenetic classification II

• Use derived homologies to define monophyletic groups
• Draw tree to represent ‘nested’ monophyletic groups
• When characters disagree,
  – Study characters and eliminate those that seem to arise through convergent evolution
  – Construct multiple trees that fit the data and determine which one is the ‘simplest,’ which requires the fewest evolutionary steps- parsimony principle

Character matrix:

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<tr>
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<tr>
<td>taxon D</td>
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<td>0</td>
<td>1</td>
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</table>

Autapomorphy - a derived character found in only one group (not shared).

Monophyletic groups:

- BD
- AC
- ABCD