

Classification and Taxonomy

Classification → the grouping of objects or organisms based on a set of criteria

Early Classification Ideas

1. Aristotle (394 - 322 B.C.)

- classified organisms as either animals or plants
- Animals were classified according to the presence of red blood
 - red blood present = vertebrate
 - red blood absent = invertebrate
- Animals were further grouped according to habit and morphology
- Plants were classified by average size (tree, shrub, herb)

Flaws

- based on his view that species are distinct and unchanging
- his views did not look at evolutionary relationships
- some organisms did not fit into a category of Aristotle's

Plants

Herbs

violets
rosemary
onions

Shrubs

blackberry bush
honeysuckle
flannelbush

Trees

apple
oak
maple

Animals

Land

wolf
cat
bear

Water

dolphin
eel
sea bass

Air

owl
bat
crow

2. Carolus Linnaeus (1707-1778)

- based his system on observational studies of the morphology and the behavior of the organisms

ex. grouped birds into 3 groups depending on their behavior and habitat

1. eagle - bird of prey
2. heron - wading bird
3. cedar waxwing - perching birds

- First formal system of Taxonomy

discipline of biology that deals with identifying, naming, and classifying species based on natural relationships

Binomial Nomenclature

- Linnaeus's method of naming organisms

- Each species has a scientific name that is 2 parts

Part 1 ----- Genus Homo

Part 2 ----- Species sapien

Black Bird
crow

- Use scientific names because common name vary in their use
- Use scientific names because common name can be misleading

How to write scientific name

1. Write the genus first. The first letter of the genus is capital and the rest of the letters in the genus are lower case
2. Write the species next. ALL letters of the species name are lower case
3. If the name is written by hand, both names need to be underlined or italicized
4. The genus may or may not be shortened to just one letter

ex. Homo sapien or *Homo sapien* or *H. sapien*

3. Modern Classification → scientists now look at not only morphological and behavioral characteristics but also evolutionary relationships in their classification systems

Taxonomic Categories

Taxon - a named group of organisms

- based on characteristics
- the broader the characteristics, the larger the taxa
- the more specific the characteristics, the smaller the taxa

Species - a group of organisms that can interbreed and produce fertile offspring

Genus - a group of species that are closely related and share a common ancestor

Family - the next higher taxa consisting of similar or related genera (genus)

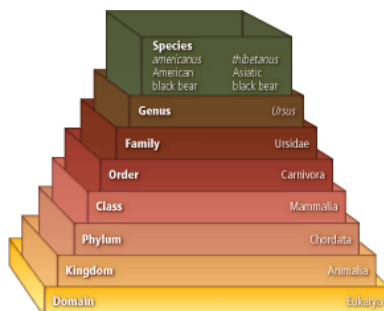
Order - contains related families

Class - contains related orders

Phylum - contains related classes

Kingdom - contains related phylum

Domain - the broadest of all taxa and contains one or more kingdom



King Phil Came Over From Geneva Switzerland

Kings Play Chess On Fine Glass Stools

Modern Classification

Typological Species Concept

- Classification is determined by the comparison of physical characteristics with a type of specimen
- Based on the idea that species are unchanging, distinct, and natural types

Limitations - alleles produce a wide variety of features within a species



Benefits - descriptions of type specimens provide detailed records of the physical characteristics of many organisms

Biological Species Concept

- Classification is determined by similar characteristics and the ability to interbreed and produce fertile offspring

Limitations - 1) some organisms such as wolves and dogs that are different species interbreed occasionally.

2) It does not account for extinct species

Benefits - The working definition applies in most cases, so it is still used frequently

Phylogenetic Species Concept

- Classification is determined by evolutionary history

Phylogeny - the evolutionary history of a species

- a species is a cluster of organisms that is distinct from other clusters and show evidence of a pattern of ancestry and descent

Limitations - Evolutionary histories are not known for all species

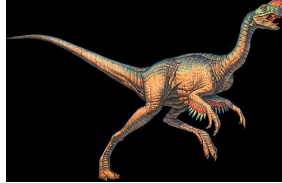
Benefits - Accounts for extinct species and considers molecular data

Characters

- inherited features that vary among species
 - can be morphological or biochemical
- DNA, protein, chromosomes*
→ what you see

Morphological Characters

- shared morphological characters suggest that species are related closely and evolved from a recent common ancestor
- ex. hawks and eagles (keen eyesight, talons, hooked beaks)
- Analogous characters DO NOT indicate close evolutionary relationship
- ex. sparrows and oviraptors



Morphological Similarities

- Birds have hollow bones and oviraptors have bones with hollow spaces in them
- Oviraptors have hip, leg, wrist, and shoulder structures that are more similar to birds than other reptiles
- Some fossils suggest that oviraptors had feathers

Biochemical Characters

- amino acid sequences, nucleotides, chromosome structure and number

ex. broccoli, cauliflower, cabbage, kale have almost identical chromosome structures



- the greater number of shared DNA sequences between species, the greater number of shared genes --- the greater the evidence that the species share a common ancestor
- find genomes of organisms

Phylogenetic Reconstruction

- ★ Cladistics - a method that classifies organisms according to the order that they diverged from a common ancestor

- it reconstructs phylogenies based on shared characteristics

- Cladogram -

2 Main Character Types

- 1) an ancestral character is found within the entire line of descent of a group of organisms
- 2) derived characters are present in members of one group of the line but not in the common ancestor

ex. birds and mammals, *reptiles, fish, amphibians*

ancestral character = *Backbone*

derived character = *wings, lungs, webbed feet, fur, lays eggs*

Cladograms

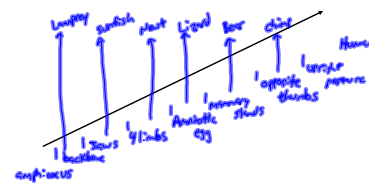
- a branching diagram that represents the proposed phylogeny or evolutionary history of a species or group
- similar to a pedigree to show direct ancestry

TAXA	CHARACTERISTICS
Bear	Mammals, jaws, four limbs, amniotic egg, mammary glands
Human	Mammals, jaws, four limbs, amniotic egg, mammary glands, opposable thumb, upright posture
Lemmy	Mammals, jaws, four limbs, amniotic egg, mammary glands
Shrimp	Mammals, jaws, four limbs, amniotic egg, mammary glands, opposable thumb
Neat	Mammals, jaws, four limbs, amniotic egg, mammary glands, opposable thumb
Chimpanzee	Mammals, jaws, four limbs, amniotic egg, mammary glands, opposable thumb
Lizard	Mammals, jaws, four limbs, amniotic egg, mammary glands, opposable thumb

- 1) draw a diagonal line up and to the right
- 2) choose an *outgroup* - a group that shares a primitive character, but does not exhibit any derived characters
- 3) construct a character table based on the information given to you (above)

TAXA	CHARACTERISTICS	CHARACTERISTICS	CHARACTERISTICS	CHARACTERISTICS	CHARACTERISTICS	CHARACTERISTICS	CHARACTERISTICS
Amniotes (outgroup)							
Lemmy							
Neat							
Shrimp							
Lizard							
Human							
Chimpanzee							
Bear							

- 4) The organism with the least number of derived characteristics will be placed on the cladogram first (after the outgroup)
- 5) Repeat with the organism with the second least number of derived characteristics, and so on...
- 6) In between the placement of each organism create a node that states what derived characteristic shows up.



Derived Characters							
	segmented	jaws	hair	placenta	multicellular	limbs	
5 kangaroo	+	+	+	-	+	+	+
2 earthworm	+	-	-	-	+	+	+
0 amoeba	+	-	-	-	-	-	-
4 lizard	+	+	-	-	+	+	+
6 cat	+	+	+	+	+	+	+
14 sponge	+	-	-	-	+	+	+
3 salmon	+	+	-	-	+	+	+

Domains

3 Main Domains

- 1) Bacteria 2) Archaea 3) Eukarya

6 Kingdoms

- 1) Eubacteria 2) Archaea 3) Protists 4) Fungi 5) Plantae 6) Animalia

Domain Bacteria

Domain = Bacteria
Kingdom = Eubacteria

- prokaryotes whose cell walls contain peptidoglycan
- unicellular
- can survive in many environments

Domain Archaea

Domain = archaea
Kingdom = archaea

- cell walls do not contain peptidoglycan
- have some of the same proteins as eukaryotes
- unicellular
- * - can live in extreme environments (hot springs, salty lakes, thermal vents)

Domain Eukarya

Domain = Eukarya
Kingdoms = protista, fungi, plantae, animalia

- eukaryotic organisms

Protista - protists

- cell walls with cellulose in some
- * - unicellular, multicellular, or colonial
- autotrophs or heterotrophs

Fungi - fungus

- multicellular
- absorb nutrients from organic materials in its environment
- heterotrophs
- lack mobility
- cell walls contain chitin

Plantae - Plants

- more than 250,000 species of plant
- multicellular
- cell walls composed of cellulose
- most contain chloroplasts for photosynthesis
- autotrophs

Animalia - Animals

- multicellular
- heterotrophic
- do not have cell walls
- cells → tissues → organ → organ system
- wide range of sizes
- can live in land, water, or air