the goal is to try and reconstruct the evolution of life on Earth

phylogeny - evolutionary history of a species or closely related set of species common ancestry

systematics - study of biological diversity in an evolutionary context
phylogeny . . . 

(b) The Galápagos finches

Common ancestor from South American mainland
questions of relatedness . . .

1) what do they have in common?
2) how long ago did they share a common ancestor?

. . . putting the what they had in common, with the how long ago they had it in common is systematics
evidences for phylogenies . . .

fossil record

homologies

morphological

molecular
fossils and sedimentary rock formation . . .

1. Rivers carry sediment to the ocean. Sedimentary rock layers containing fossils form on the ocean floor.

2. Over time, new strata are deposited, containing fossils from each time period.

3. As sea levels change and the seafloor is pushed upward, sedimentary rocks are exposed. Erosion reveals strata and fossils.

Younger stratum with more recent fossils

Older stratum with older fossils
fossil types . . .

there are several ways in which a fossil may be formed:

1) permineralization
2) molds and casts
3) impressions
4) whole organism preservation
fossil types . . .

permineralization

pores of plant or animal remains impregnated by minerals; retains original shape

petrified wood
fossil types . . .

**mold & casts**

3-D physical characteristics of organisms impressed onto rocks; mud, clay, etc. form around trapped organism which subsequently decays

*internal & external*
fossil types . . .

**impressions**

2-D imprints of an organism; contains no organic matter; most form in fine grained sediment

pores & veins in plants

footprints or trails which provide unique data on possible size and modes of locomotion

animal skeleton or skin!
fossil types . . .

whole organism preservation

RARE!

occasionally tree trunks when buried by volcanic mud
→ petrified forests

best known are the eggs!
evidences for phylogenies . . .

fossil record

homologies

morphological

molecular
homologous vs. analogous . . .

**homologous structures** - similarity in structure due to common descent, irrespective of the diverse uses to which they may be put

* e.g. mammalian forelimbs

**analogous structures** - similarity in structure based on adaptation for the same function, not common descent

* e.g. wings in insects, reptiles, birds, and bats
morphological homologies . . .
vs. analogous structures . . .

analogous structures are potential pitfalls in phylogenetic reconstruction
a problem with analogous structures . . .

convergent evolution
evidences for phylogenies . . .

fossil record

homologies

morphological

molecular
steve is king

babasstevelknmqqonnpiswerbabkingionm
reviewing taxonomy . . .

**goal is simple classification**

**Species:** Canis lupus

**Genus:** Canis

**Family:** Canidae

**Order:** Carnivora

**Class:** Mammalia

**Phylum:** Chordata

**Kingdom:** Animalia

**Species:** Panthera pardus

**Genus:** Panthera

**Family:** Felidae

**Order:** Carnivora

**Class:** Mammalia

**Phylum:** Chordata

**Kingdom:** Animalia

**Domain:** Eukarya
relating taxonomy to systematics . . .

goal is connecting life
clades . . .

*cladistics* is the study of grouping life; tool

*valid clade* = group of species with *ancestor* and all descendants

- **monophyletic**
- **paraphyletic**
- **polyphyletic**
cladograms . . .

shared primitive characteristic 
(*plesiomorph*)

shared beyond taxon

shared derived characteristic 
(*synapomorph*)

unique to a clade

outgroup
distantly related taxon
e.g. cladograms . . .
e.g. cladograms . . .
e.g. cladograms . . .
e.g. cladograms . . .
questions of relatedness . . .

1) what do they have in common?

2) how long ago did they share a common ancestor?

. . .putting the what they had in common, with the how long ago they had it in common is systematics
molecular homologies and the molecular clock . . .

the rate of change in nucleotide sequences among orthologous genes (genes from two or more species traced to a common ancestor)

average rate of genetic mutation in plants and animals = 1/100,000 genes / generation

so more changes = more time since common ancestry
molecular homologies . . .

fewer . . . . . . . . . . . . . . . changes . . . . . . . . . . . . . . . . . . . . . . . . . . . . more

less . . . . . . . . . . . . . . . . . time . . . . . . . . . . . . . . . . . . . . . . more
phylogeny + timing = systematics

phylogram
branch length = how many changes

ultrametric tree
when did branching occur