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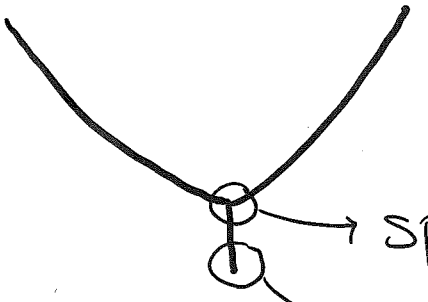
Cladograms

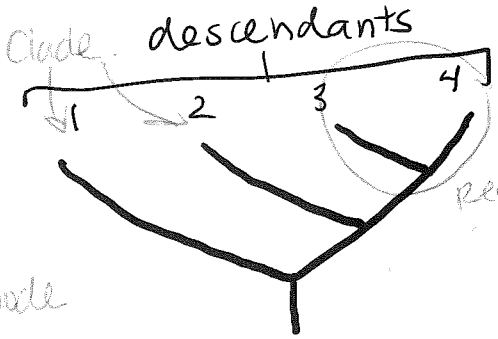
- Diagrams that show the evolutionary relationships among a group of organisms based on their **derived characteristics**.
- A **derived character** is a trait that arose in the common ancestor of a lineage and is shared by all members of a **clade**. We find these between the **nodes** on a cladogram.
- **Root** is the common ancestor of all following organisms. The root is at the very bottom.
- **Node** is a speciation event, or a point at which the organism was now different from the following organisms
- **Clade** is a group of organisms such as a species, whose members share homologous features derived from a common ancestor



splitting event node

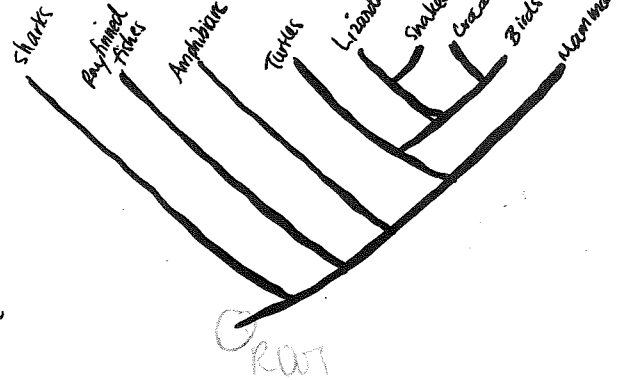
ancestral lineage ROOT

splitting is called a "node"



3 and 4 are more closely related to each other than any of them is to any other lineage.

This shows the evolutionary relationship among vertebrates — animals with backbones.



Cladistics gets its name from the branches of a family tree, which are called **clades**. A **cladogram** is a stylized diagram that looks like a series of Y's or forks in a road. At each branch, or "Y" junction, unique characters of evolutionary origin are used to separate off one group from the rest.

Using these patterns of **shared derived characteristics**, a cladogram can be constructed as a series of Y's or branches. At every branch, one of the organisms that does not share a common character with the rest of the group is "branched off" into its own **clade**. The order, or sequence of these branches depends on how many characters are left within the larger group.

Close relationships in a cladogram are shown by recent forks from the supporting branch. The closer the fork, the closer the relationship.

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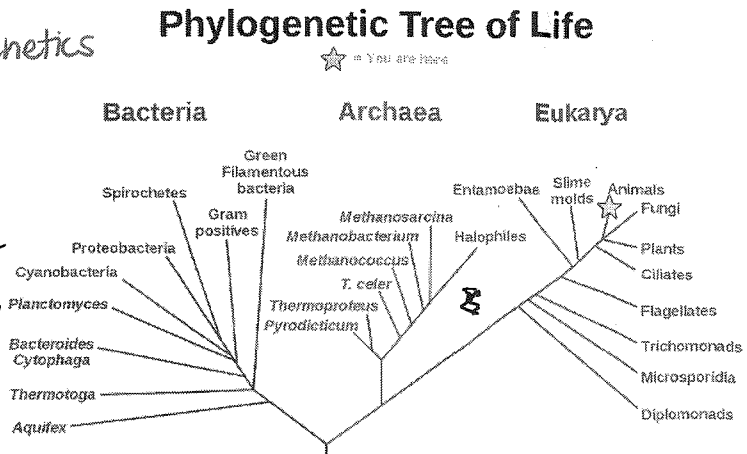
Taxonomy is also used to make connections. The following below are used to help make connections.

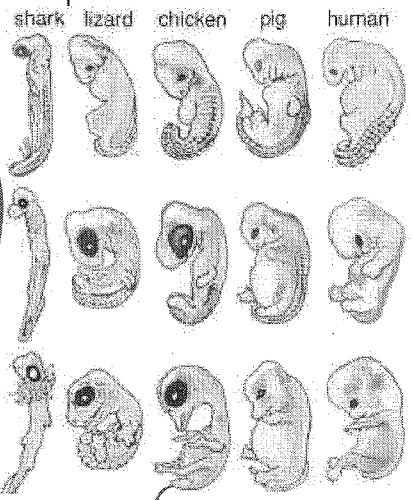
a. **Evolution:** organisms change over time A change in the genetics of a species.

Genetic (DNA) distance: degree of distance vs. similarity among organisms

It is the measure of genetic divergence between species or between populations of a species.



b. **Embryology:** degree of similarity of embryonic development that provides pattern for relatedness



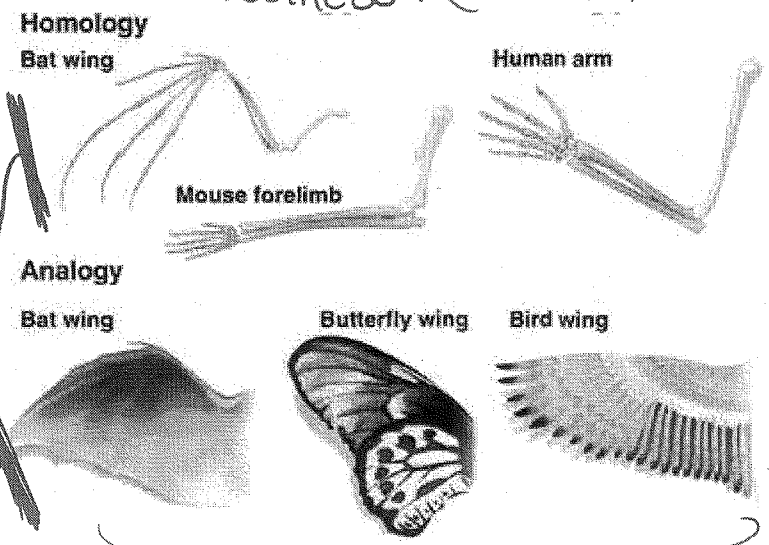
★ considers similarities and differences among embryos

★ Because we see similarities at various stages means there is genetic relatedness. (i.e. cat + dog)

c. **Homology:** Study of similarities, particularly

<u>homologous structures</u>: similar anatomically, but specialized for different use

<u>Analogous</u>: correspond to each other (i.e. can fly) but have different anatomy



Similar "bones" but different functions

Different anatomy but similar functions

Can all fly

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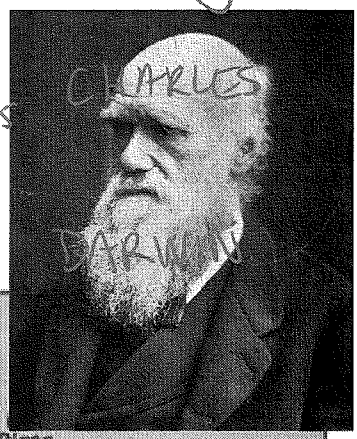
The role of DNA in Evolution → carries all genetic information needed to make an organism.

1. Genome contains instructions to make an organism (AA Aa)
   a. Allele is a variation of a particular gene (alleles makeup genotypes of genome)
   b. Gene Pool – ratio of all alleles of a gene in a species
      i. Allele frequency determined by members of the species
   ★ c. Evolution occurs when the ratio of genes in a gene pool changes
      i. Change in the genetics of a species

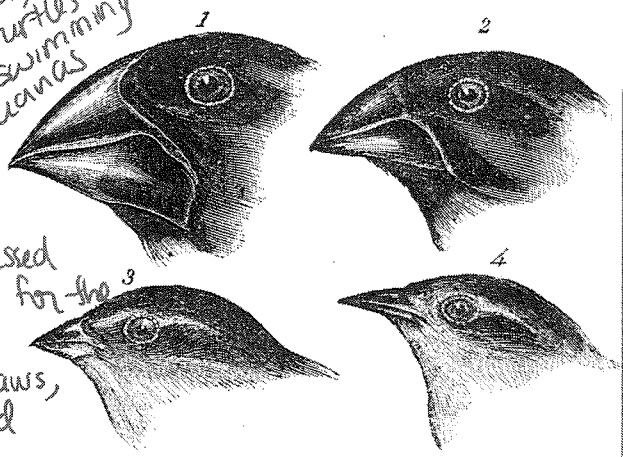
Reproduction + Death can affect ratio. Smaller populations are more likely to evolve.

Agents of Evolution

1. Natural Selection – Charles Darwin 1830's.
   a. Galapagos Islands and the finches – new volcanic islands
   b. Variation among the organisms of the same species

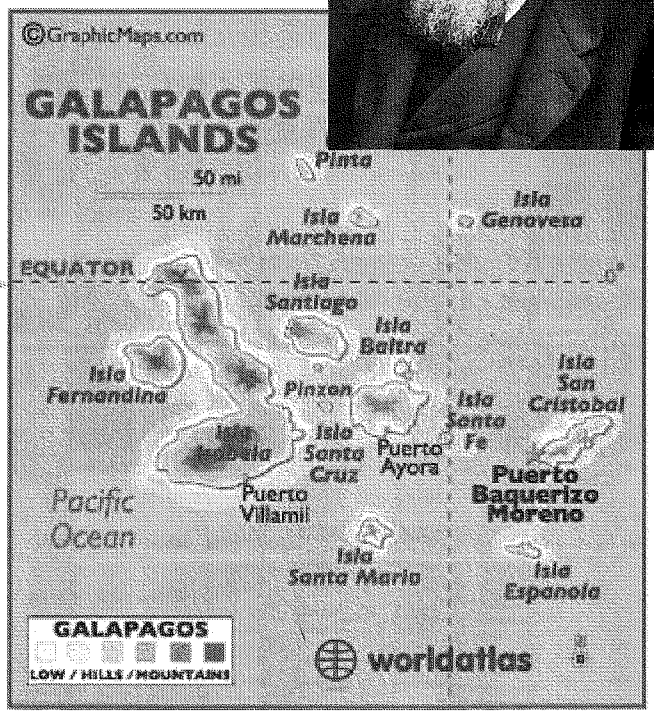


★ he saw finches, giant turtles and swimming iguanas



1. Geospiza magnirostris. 2. Geospiza fortis.
3. Geospiza parvula. 4. Certhidea olivacea.

most impressed by finches for the variety in colour, claws, size and BEAK SHAPE → Saw more than 12 beak variations and reasoned they were all related and likely descendent from same ancestral bird.



There are 5 distinct ideas of Natural Selection:

all can occur in N.S.

a. Overproduction: # of species produced is greater than can survive.

b. Struggle for existence: essential resources are limited (food, water).

c. Variation: differences in traits among members of same species.

d. Survival of the fittest: better adapted will tend to survive to reproduce (pass on "fitness")

e. Accumulation of variation: traits from parents are passed to offspring.

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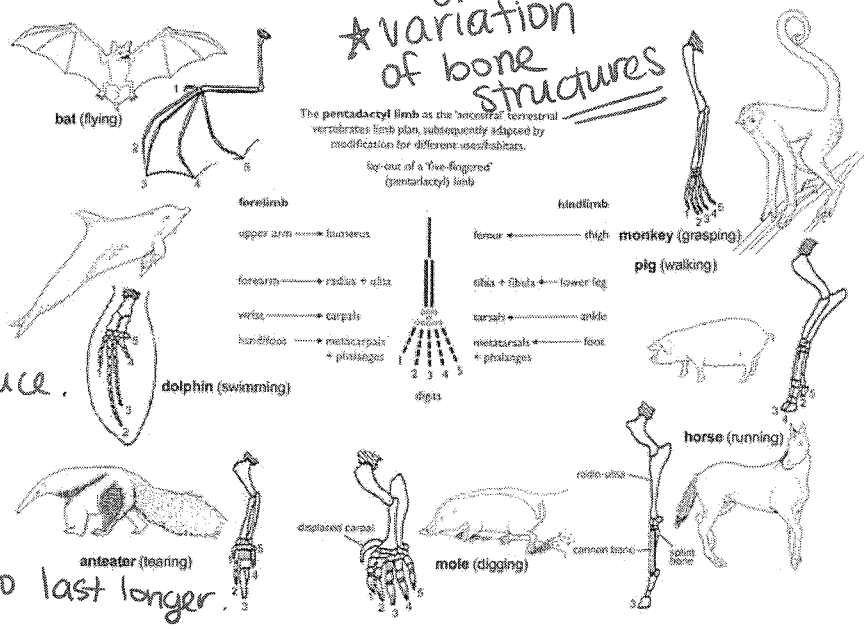
There are also types of Adaptation:

e.g. ★variation of bone structures



a. Structural: modification of structures to suit different functions.

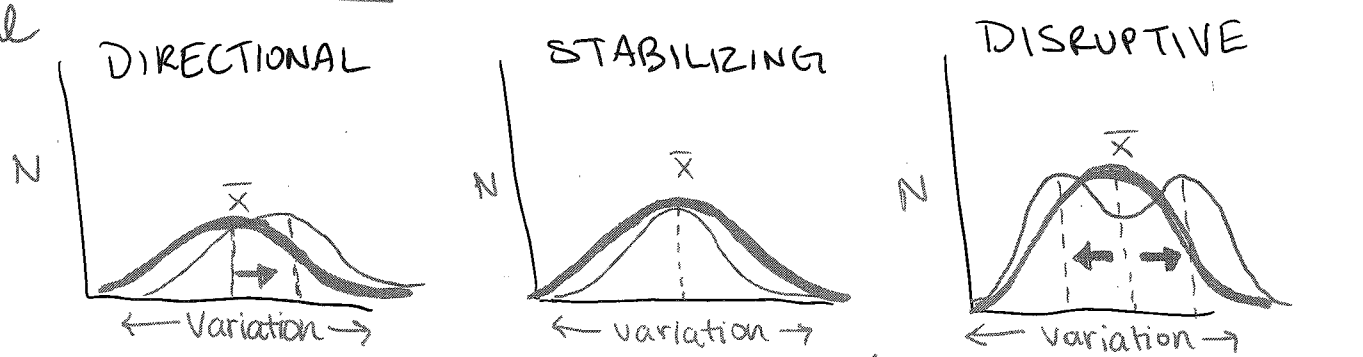
b. Physiological: a body process that helps an organism survive/reproduce.

snakes: poisonous venom

emperor penguin: slow down RHR to conserve O_2 during a dive. to last longer.

There are also types of Selection:

= original
– after



a change in a constant direction.
e.g. increasing size

Removes members of a species w extreme variations in order to reinforce the average phenotype.

selects against most common features to promote phenotypic variation.

2. Artificial Selection

a. Selective Breeding: purposeful mating to get something beneficial (racehorses, dogs, livestock, vegetables)

b. Accidental selection: human activity puts survival of organisms in jeopardy. unintentionally.

e.g. humans use pesticides and herbicides for improving or protecting crops, but bee populations are currently at risk because of the use of this.

look up peppered moth of England example.

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Patterns of Evolution

1. Speciation development of a new species
   a. Population become isolated and must adapt to new environment
      i. Geographic isolation: physical barrier (ie. volcano)
         → gene flow stops
         → differences prevent interbreeding.
      ii. Reproductive isolation: organisms in a population no longer interbreed. (e.g. courtship patterns are different)
   b. Long term changes to gene frequencies cause species to become more similar or dissimilar to physical features
      i. Divergent evolution: 2 separate species evolve differently from a common ancestor
         a. Homologous structures: similar origin or anatomy but for different uses.

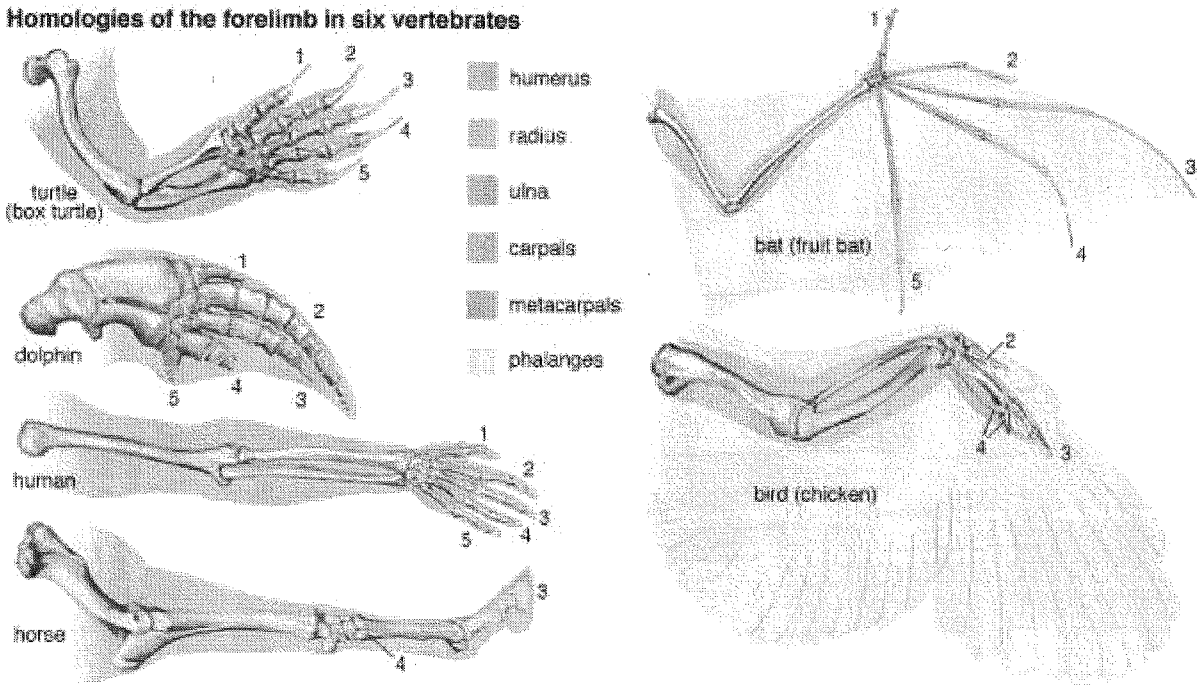
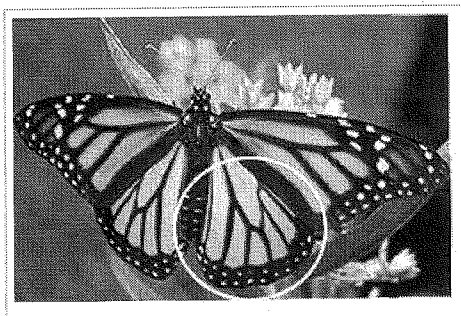


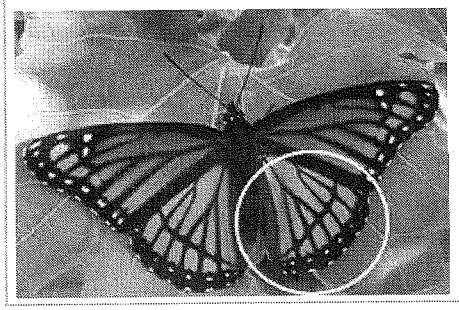
Figure 1 The forelimbs of a human and four animals showing the similarity in construction. This similarity was offered by Darwin as evidence that evolution has occurred.

ii. Convergent evolution: when species have different ancestral origins but developed similar features

a. Analogous structures: organisms perform similar functions but are different anatomically/internally.



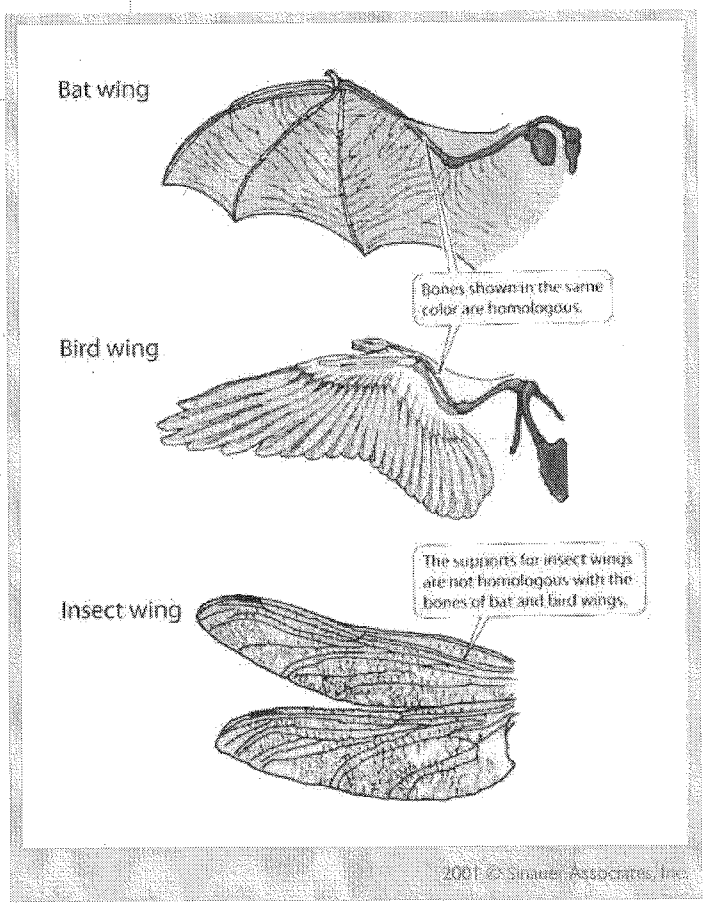
Monarch
Danaus plexippus



Viceroy
Limenitis archippus

Birds find Monarch yucky..

Birds want to eat Viceroy



Birds mistake moths for butterflies so moths eaten less and over many generations the 2 species features have converged.

☆Take-away: N.S. types, cladogram, evolution