Principles of Evolution - Origin of Species

Theories of Organic Evolution

X Multiple Centers of Creation (de Buffon)

- developed the concept of "centers of creation”
- throughout the world organisms had arisen, which other species had evolved from

X Catastrophism (Georges Cuvier)

- suggestion that a succession of catastrophies periodically destroyed all life and necessitated the repopulation of the world by successive acts of special creation

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X Acquired characteristics (Jean Baptiste de Lamarck)

- change that occurs during a lifetime of an organism are the result of the use or disuse of parts which can be passed on to the next generation

theory is not valid … acquired characteristics cannot be inherited

no experimental evidence has been found to support this theory

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Natural Selection (C. Darwin / A. Wallace / T. Malthus)

Basic idea of natural selection:

- organisms that are better adapted to an environment in which they live produce more viable offspring, increasing their proportion to the population
- therefore, they are being selected for

Result of natural selection:

- **evolutionary adaptation** - a population's increase in the frequency of traits that are suited to the environment

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Evidence for Organic Evolution

Paleontology - the study of fossils

- **fossils** - preserved remains or impressions left by once- living organisms

- **fossil record** - reveals through the years, a general change and increase in the diversity and complexity of life
  - proves that organisms have appeared in historical sequences

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Evidence for Organic Evolution

Comparative Anatomy

- **homologous organs**
  - derived from same basic evolutionary origin
  - similarities are seen best in embryonic development
  - organisms are classified on the basis of shared homologies

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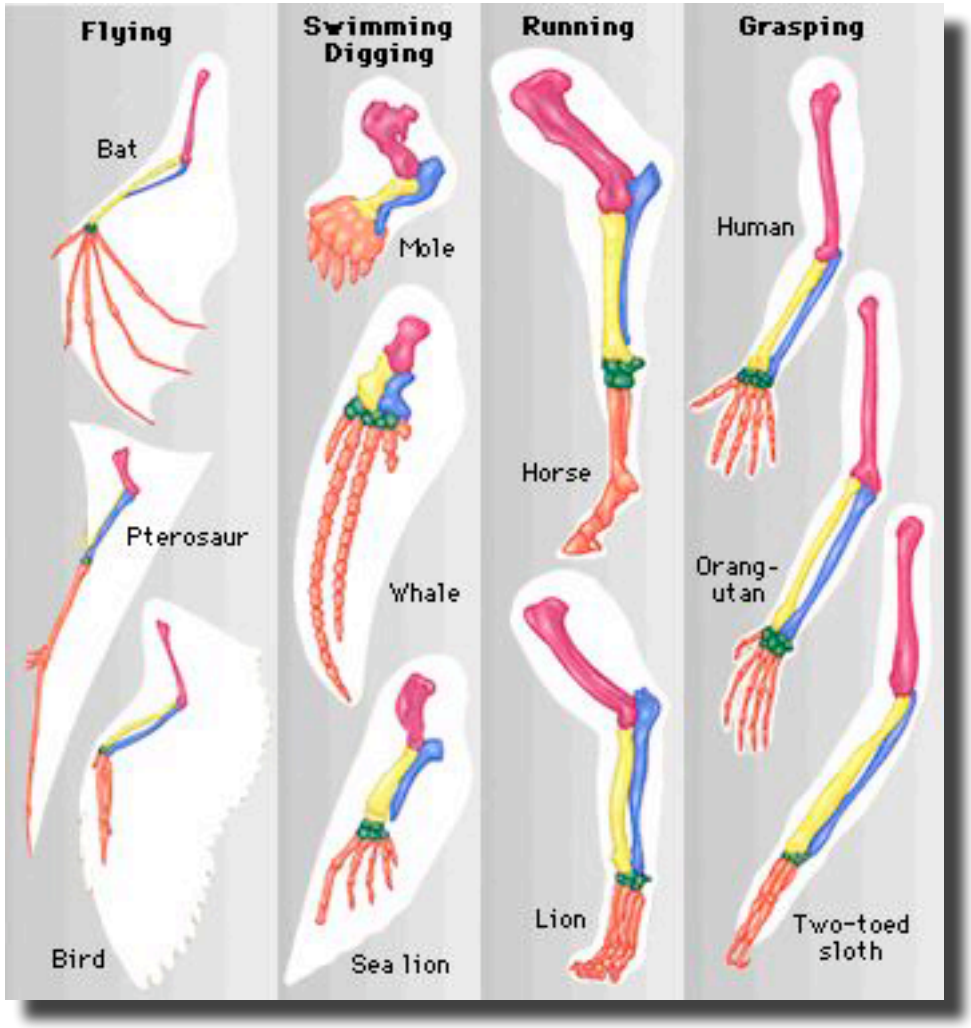
Homologous v. Analogous

homologous structures

- features that have different functions, but are structurally similar



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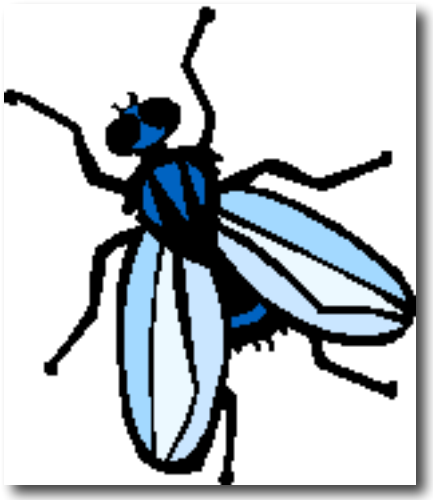
Homologous v. Analogous

analogous structures

- features that have similar functions, but have evolved independently and have entirely different structures



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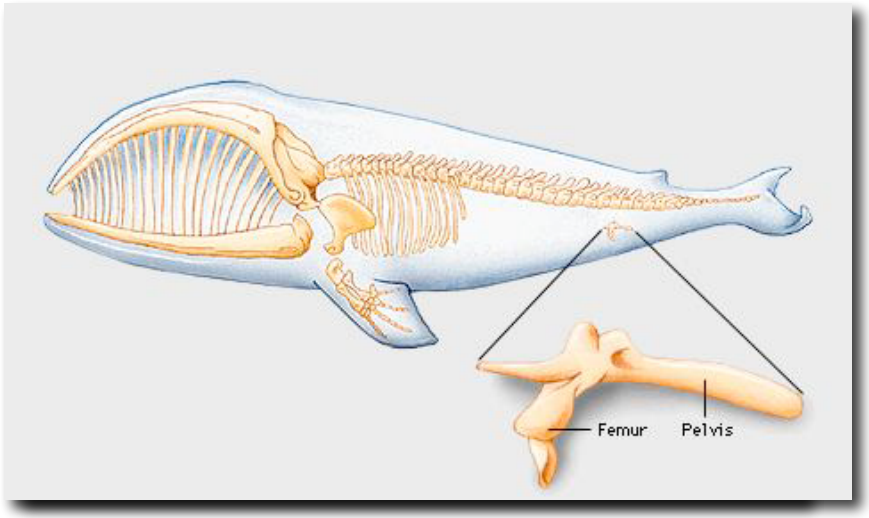
Evidence for Organic Evolution

vestigial organs

- humans (muscles to move their ears, vestigial tailbone)
- vestigial toes in the horse

- vestigial limbs in whales and snakes



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Evidence for Organic Evolution

Embryology

comparative embryology

- comparison of structures that appear during the development of different organisms
- similarities in embryonic development gives evidence for evolutionary relationships

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Evidence for Organic Evolution

Comparative Biochemistry

- similarities and differences in molecules (structure and function)
- "structure defines function"

example:

antigen-antibody technique reveals a basic similarity between blood proteins of organisms

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Evidence for Organic Evolution

Molecular Biology

- evolutionary relationships among species leaves signs in DNA and proteins (genes and gene products)
- matching sequences of genes and proteins reveal common ancestors

Species pairs	% difference in nucleotide sequence between species pairs
Human - human	.05 - 1.0
Human - chimpanzee	2.5
Human - gibbon	5.1
Human - Old world monkey	9.0
Human - New world monkey	15.8
Human - lemur	42.0

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Basic Principles of Natural Selection

Overpopulation - organisms produce an excessive numbers of offspring

- natural resources are limited
- excessive offspring --> struggle for existence among individuals of a population
- only a small percentage of offspring will survive in each generation

Variation - offspring possess different characteristics (inheritable)

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Basic Principles of Natural Selection

… putting it together …

"Survival of the fittest"

- offspring with inherited traits that are best suited to the habitat (adaptation) are more likely to survive and reproduce than less fit individuals.

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Terminology

organic evolution

- the change in gene frequency

population

- a group of individuals of the same species living in the same area at the same time
- the smallest biological unit that can evolve

evolutionary impact of natural selection is only apparent in tracking how a population changes over time
(individual organisms do not evolve during their lifetime)

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Population Genetics

Field of science

- emphasizes the genetic variation within populations
- tracks the genetic makeup of populations over time

Principles of Evolution

Sources of Genetic Change (variation) in populations

mutations

- random changes in genetic material

bacteria
- short generation spans
- evolve rapidly by mutations alone

animals / plants
- long generation times
- depend on sexual reproduction (recombination) for genetic variation

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How can we tell if a population is evolving?

- understanding through defining what is *not evolving*

  non-evolving = genetic equilibrium

- gene pool remains constant over time

  gene pool is the sum total of all genes in the population

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Microevolution

The generation-to-generation change in a population's frequency of alleles (alternate forms of genes)

Four mechanisms of microevolution

- mutations - random changes in genetic material
- natural selection
- genetic drift
- gene flow

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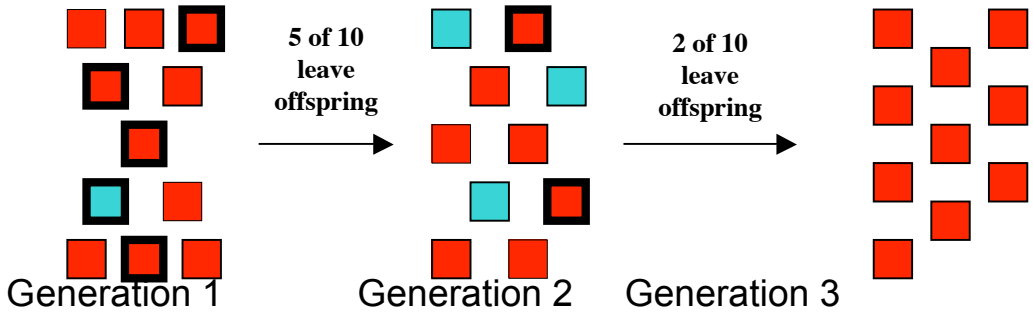
Four mechanisms of microevolution

- genetic drift - random effects of chance on a gene pool of a small population



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Four mechanisms of microevolution

gene flow

- genetic exchange (gain or loss of genes) with another population

- via migration or immigration

  - organism enters (leaves) a population, introducing (removing) genes into (from) gene pool

Principles of Evolution

Microevolution v. Macroevolution

Microevolution is a change in the gene pool of a population.

- changes within a species

If this is all that happens then we would find only one specialized population,
but there exist many populations of organisms …

Macroevolution is a change in life-form, the origin of a new taxonomic groups (new species, new genera, new kingdoms)

- formation of new species

Principles of Evolution - Effects of Evolution

Adaptation

- the inherited change of form, function and behavior

- natural selection exerts positive selection pressures
  --> producing the patterns in a population

Principles of Evolution - Effects of Evolution

Diversification

adaptive radiation

- offspring of a population already adapted to one habitat, radiate out into newly available habitats

convergent adaptations (convergent evolution)

- independent development of similar features in organisms in response to similar environmental factors
- fish and whales have evolved similar stream-lined bodies and fins

divergent adaptations (divergent evolution)

- independent development of different features as a result of different selective pressures

Principles of Evolution - Effects of Evolution

Speciation

- formation of a new species