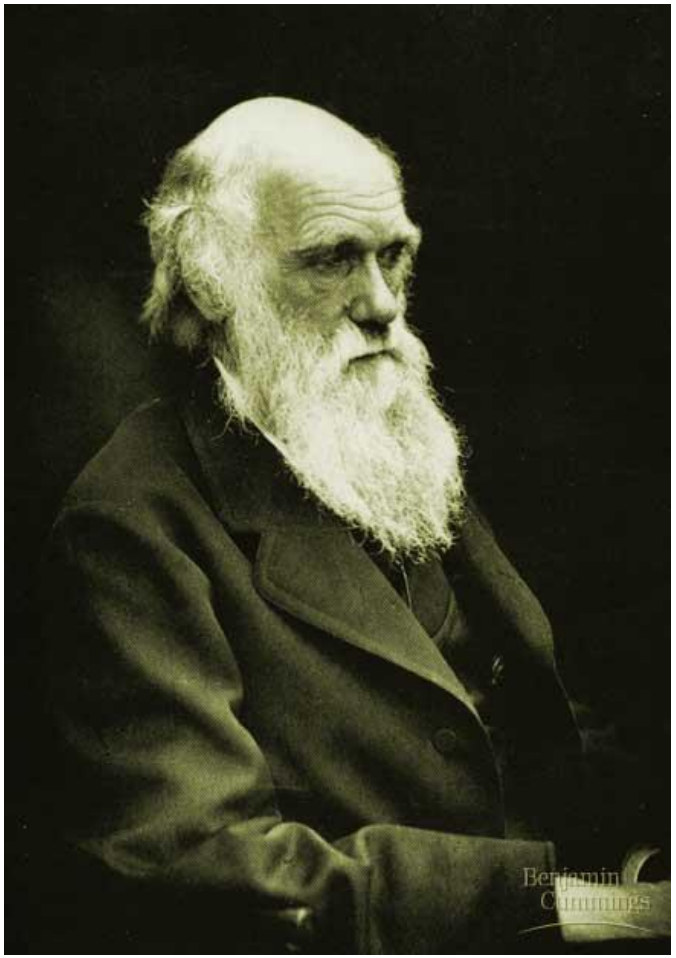


- Chapter 22

  Descent with Modification: A Darwinian View of Life

Essential Knowledge

- 1.A.1 – Natural selection is a major mechanism of evolution
- 1.A.2 – Natural selection acts on phenotypic variations in populations
- 1.A.3 – Evolutionary change is also driven by random processes
- 1.A.4 – Biological evolution is supported by scientific evidence from many disciplines, including mathematics
- 1.C.3 – Populations of organisms continue to evolve

Essential Knowledge

- 1.D.2 – Scientific evidence from many different disciplines supports models of the origin of life
- 2.E.3 – Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection
- 3.C.1 – Changes in genotype can result in changes in phenotype
- 3.E.1 – Individuals can act on information and communicate it to others

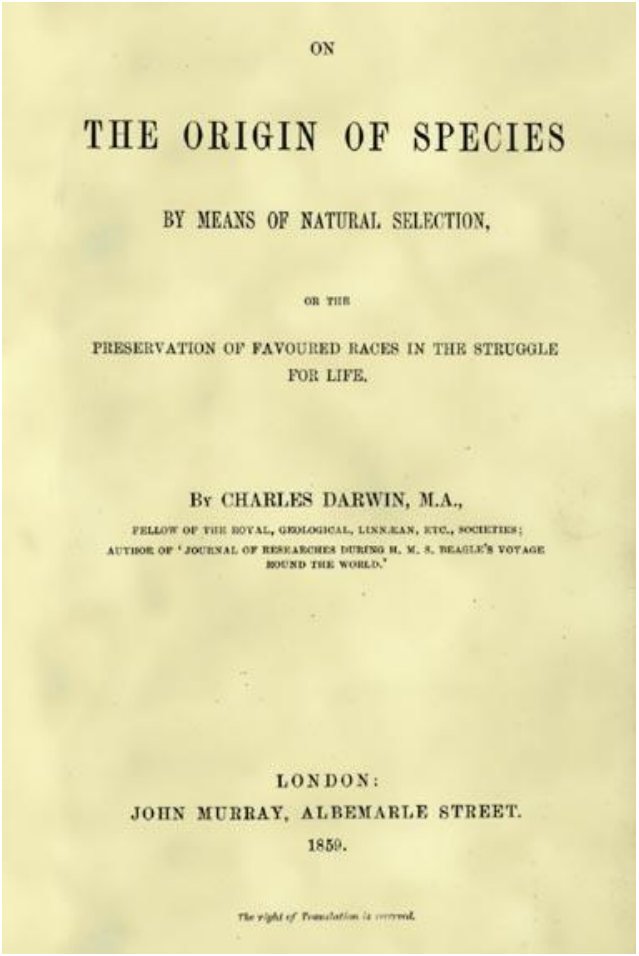
Observations of Life

- Striking ways in which organisms are suited for life in their environments
- The many shared characteristics (unity) of life
- The rich diversity of life

Evolution

- Evolution: the change in the genetic composition of populations over time

- Natural selection: populations of organisms can change over the generations if individuals having certain heritable traits leave more offspring than others (differential reproductive success)



ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

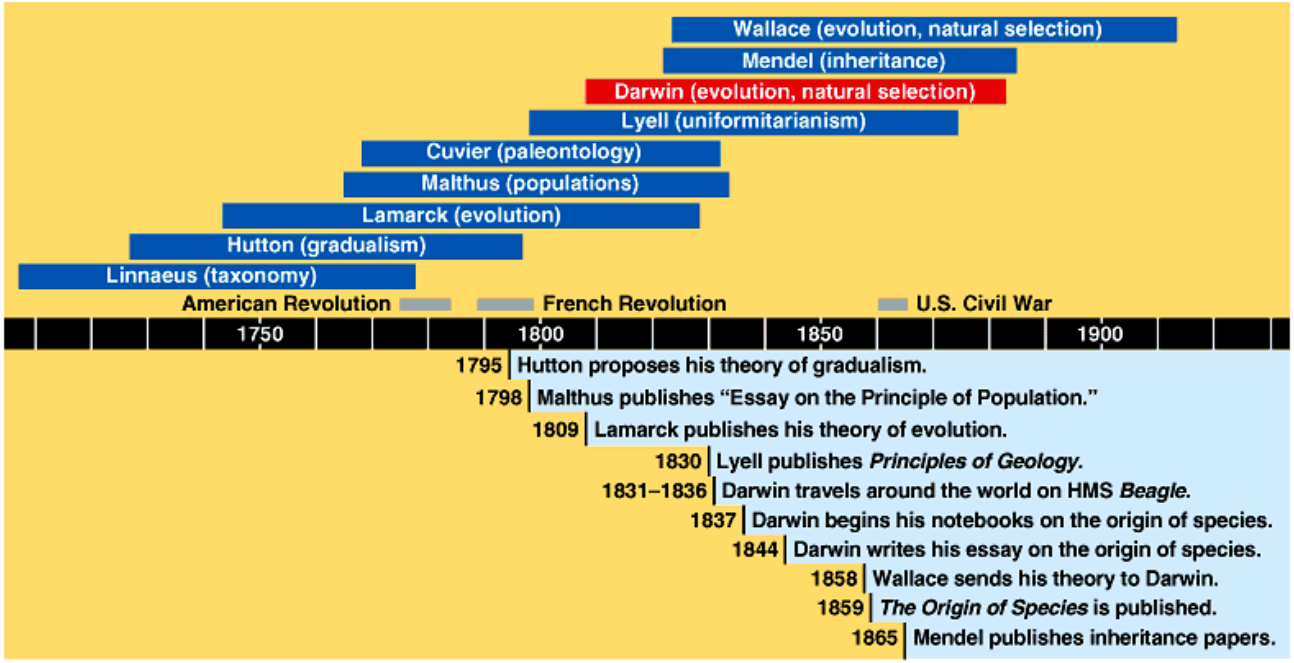
The right of Translation is reserved.

November 24, 1859

- Evolutionary adaptations: genetic variation that is favored by selection and is manifested as a trait that provides an advantage to an organism in a particular environment

I. Historical Setting

- Aristotle: scala naturae
- Linnaeus: taxonomy / classification
- Hutton: gradualism
- Lamarck: evolution
- Malthus: populations
- Cuvier: paleontology / catastrophism
- Lyell: uniformitarianism
- Darwin: evolution
- Mendel: inheritance
- Wallace: evolution



Lamarckian Views

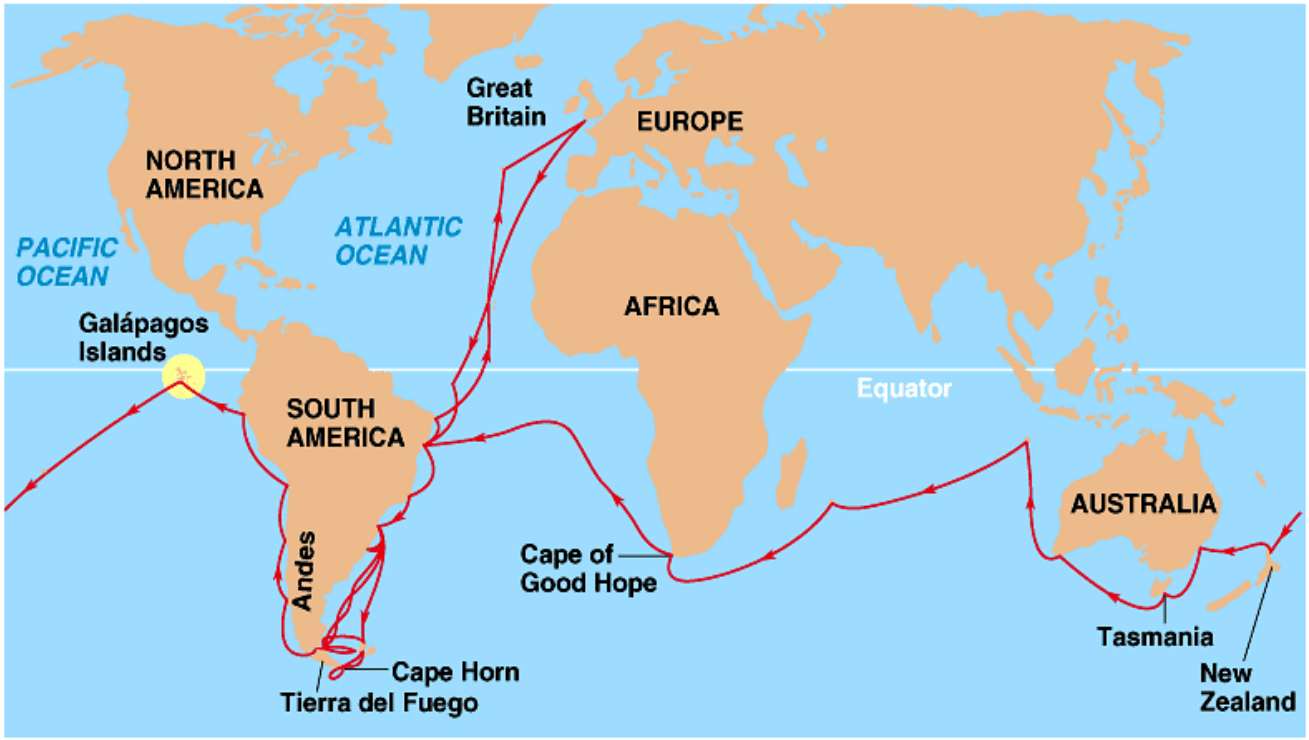
- **Use and disuse** = parts of the body that are used extensively become larger and stronger, while those that are not used deteriorate
- Inheritance of **acquired characteristics** = an organism could pass these modifications to its offspring

- Thought that organisms have an innate drive to become more complex
- Even though he was incorrect, Lamarck should get credit for explaining the match of organisms to their environment is a slow gradual process and for proposing a testable mechanism of change

II. Descent with Modification

Darwin's 4 Observations:

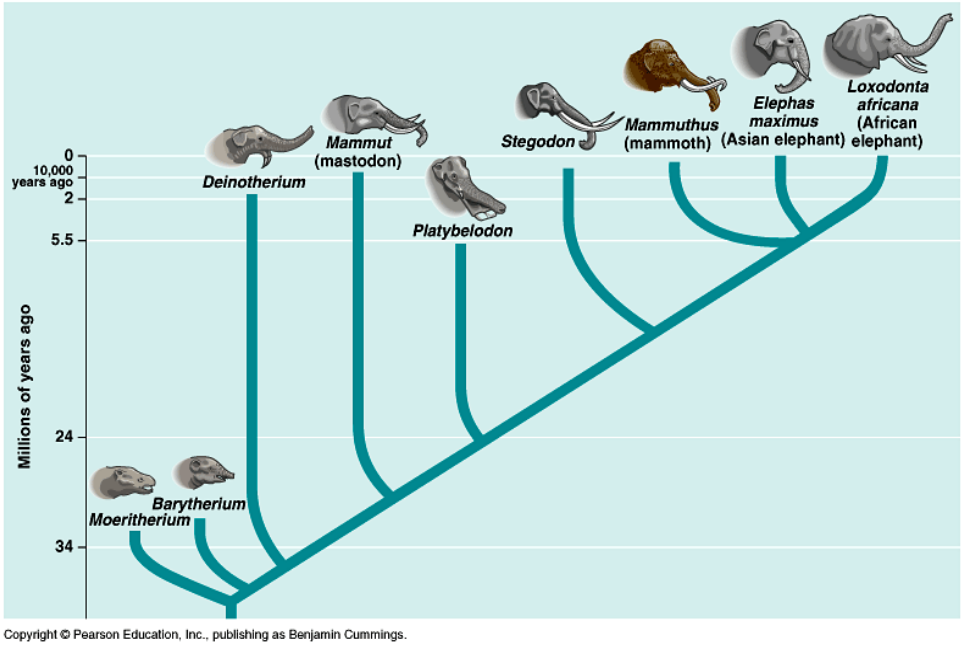
1. Species are capable of producing more offspring than the environment can support
2. Populations vary in their traits (variation)
3. Traits are inherited from parents and are random and not specifically directed toward any preferential adaptation
4. Competition leads to some offspring not surviving and others being able to pass on their traits



II. Descent with Modification

3 Inferences:

1. Struggle for existence
2. Non-random survival
3. Natural selection occurs – unequal ability to survive leads to accumulation of favorable traits



- Put in modern terms, Darwin explained that random events create changes in the genotype of the organisms. These changes are then reflected in variations in the phenotype.

- Combinations of these variations, distributed among large numbers of offspring and expressed as different phenotypes, are in competition for survival.

- Nature and the natural environment "select" the most fit phenotype and discard the least fit phenotypes. Darwin, therefore, viewed evolution as the gradual accumulation of genotypic change in a population of organisms to the point that the population becomes a new species.

Causes of Evolution

- Natural Selection: differential success in reproduction based on environmental conditions
  - Results in alleles being passed to the next generation in proportions different from their relative frequencies in the present generation
  - **Genetic variation and mutation play roles in natural selection**

Natural selection

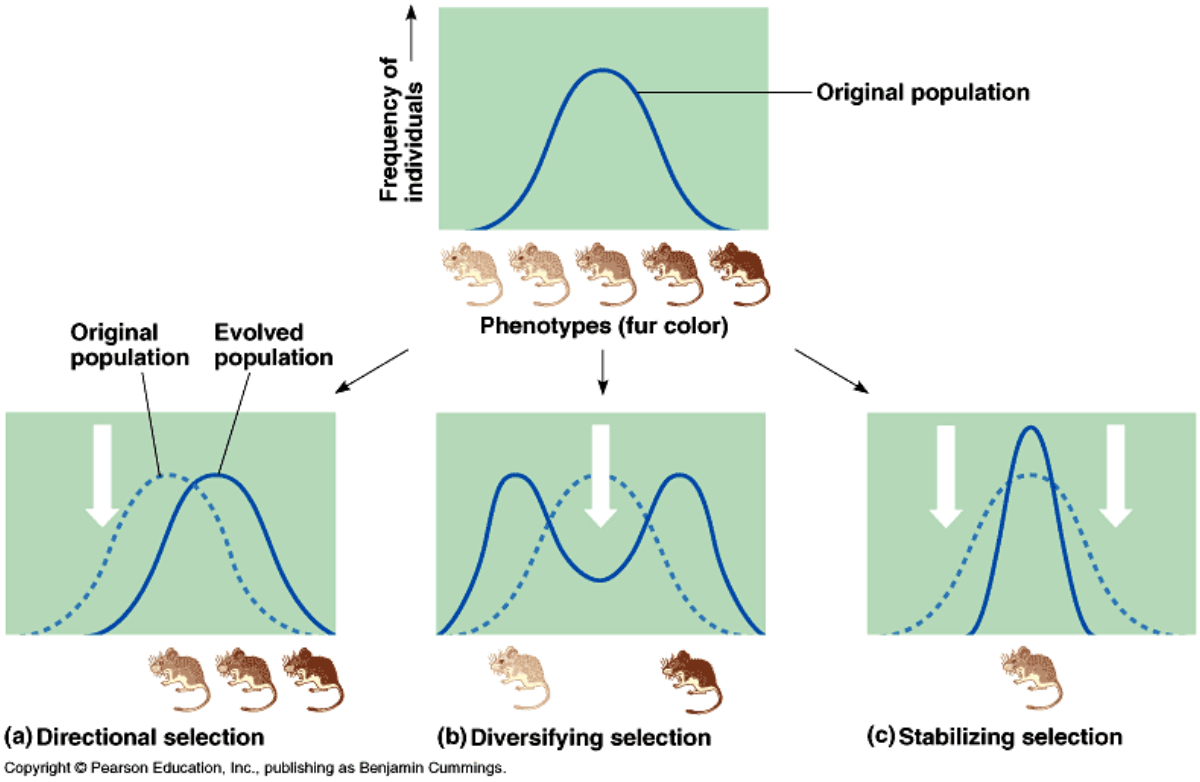
- Fitness: *contribution an individual makes to the gene pool of* the next generation
  - Measured by reproductive success

<u>3 Types</u>:

A. Directional

B. Disruptive

C. Stabilizing



- Artificial Selection - process by which species are modified by humans and are purposefully selecting for traits during breeding

Sexual selection

- Sexual dimorphism: secondary sex characteristic distinction

- Sexual selection: selection towards secondary sex characteristics that leads to sexual dimorphism

Summary

- Evolution is change in species over time
- Heritable variations exist within a population
- These variations can result in differential reproductive success
- Over generations, this can result in changes in the genetic composition of the population
- INDIVIDUALS DO NOT EVOLVE, POPULATIONS EVOLVE

III. Evolution evidence

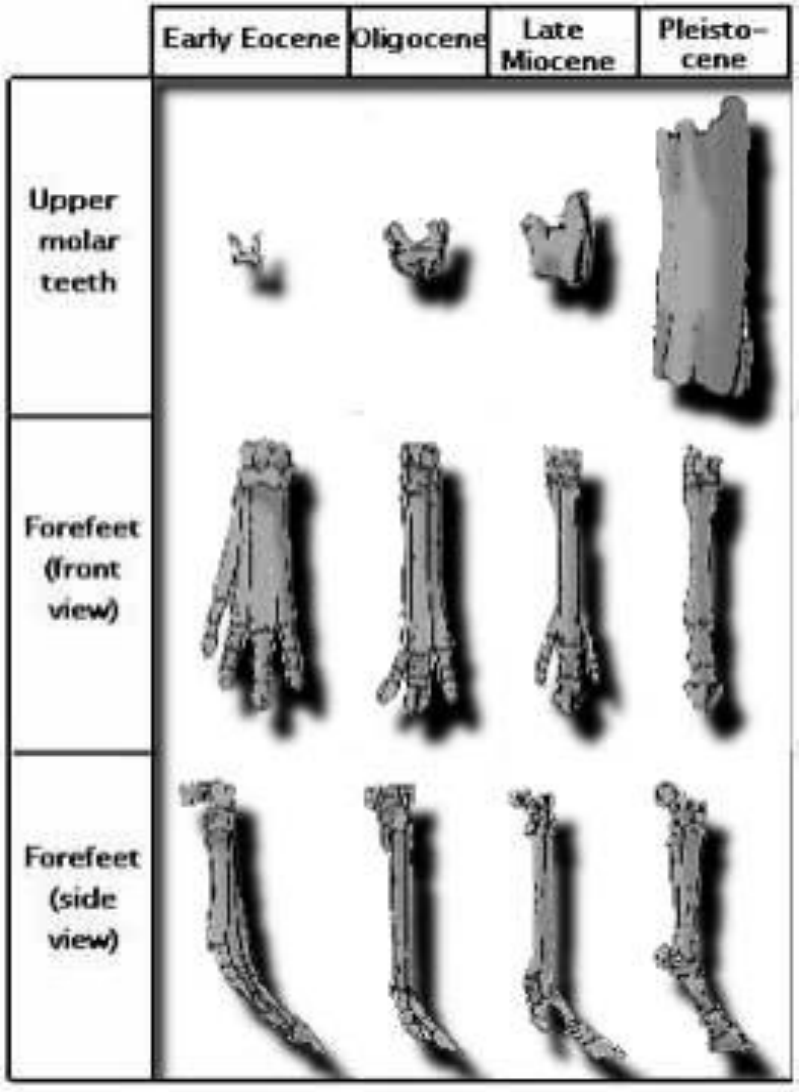
- Scientific evidence of biological evolution uses information from geographical, geological, physical, chemical, and mathematical applications

III. Evolution evidence: Direct Observation

- Evolution of antibiotic-resistant bacteria or pesticide resistant insects
  - Mutation occurred for the resistance to become apart of the gene pool
- Emergent diseases – viruses continue to evolve and new diseases show up in the population
- Intense predation of wild guppies results in more drably colored males

Evolution evidence: The Fossil Record

- Fossils = remains or traces of organisms form the past
- Succession of forms over time and the origin of major new groups of organisms
- Transitional links
- Paleontology = study of fossils



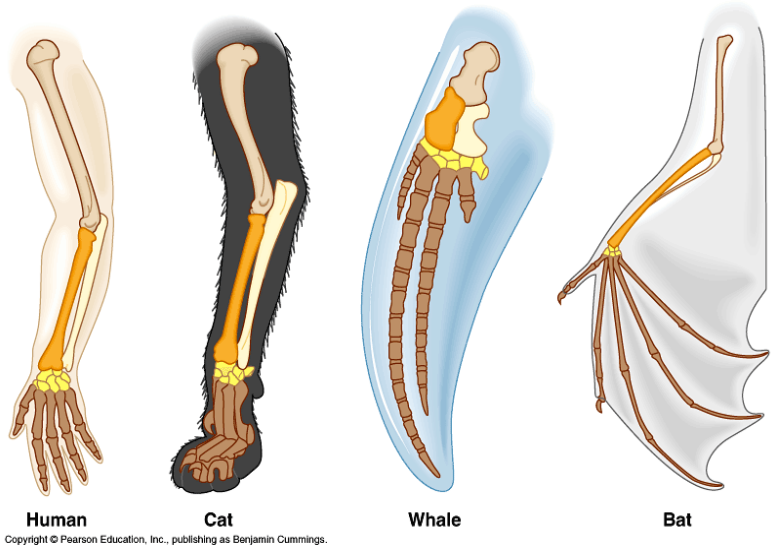
Evolution evidence: The Fossil Record

- Fossils can be dated by a variety of methods that provide evidence for evolution
- Methods include:
  - Determining age of rocks where a fossil is found
  - Rate of decay of isotopes (Carbon-14)
  - Relationships within phylogenetic trees
  - Mathematical calculations that take into account information from chemical properties and/or geographical data

Evolution evidence: Comparative Anatomy

- Homologous structures (homology) = characteristics in related species even though the structures have different functions
  - Descent from a common ancestor

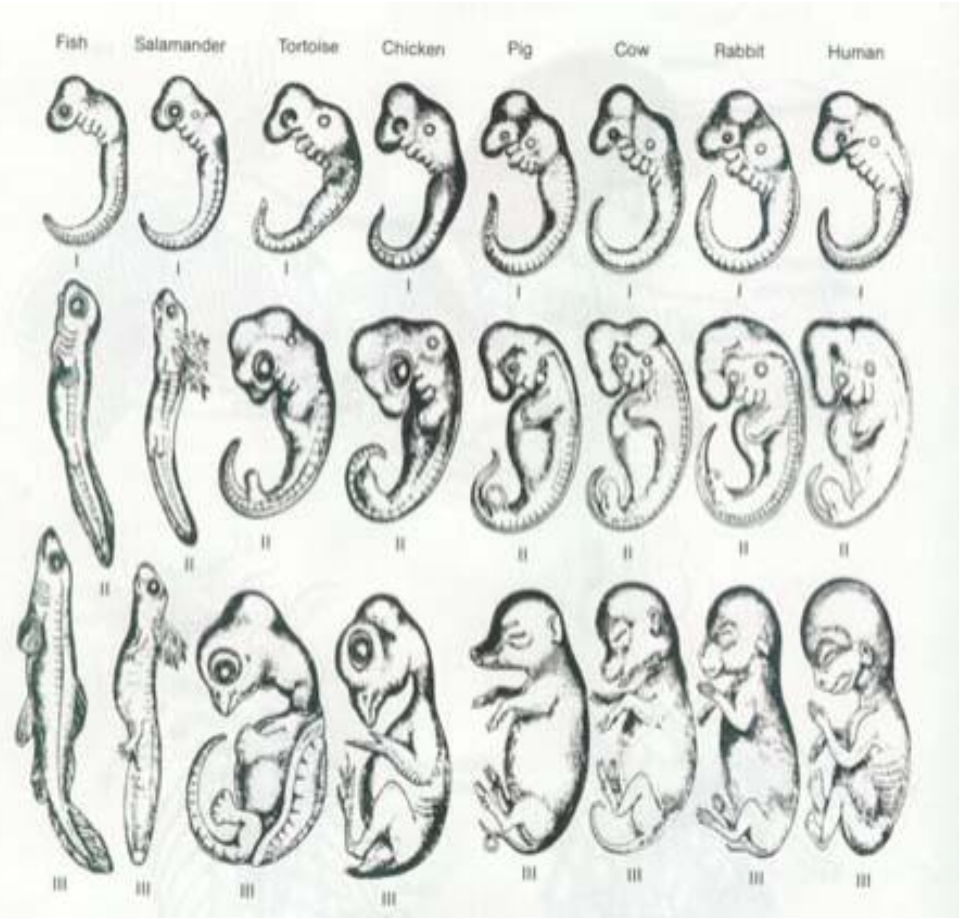
- Vestigial structures = remnants of structures that functioned in the past
  - Can be compared to fossils
  - Ex: whale/snake hindlimbs; wings on flightless birds



Evolution evidence: Comparative Embryology

- Comparison of early stages of animal development

- All vertebrates have pharyngeal pouches and post-anal tails as embryos



Evolution evidence: Molecular Biology

- Biochemical and genetic similarities, such as DNA nucleotide and protein sequences, genes, and gene products, provide evidence for common ancestry

- Ex: All life forms use the same genetic code

Table 22.1 Molecular Data and the Evolutionary Relationships of Vertebrates

Species	Number of Amino Acids That Differ from a Human Hemoglobin Polypeptide (Total Chain Length = 146 Amino Acids)
Human	0
Rhesus monkey	8
Mouse	27
Chicken	45
Frog	67
Lamprey	125

Evolution evidence: Convergent Evolution

- Explains why distantly related species can resemble one another

- Analogous structures = develop when organisms share similar environments and under go similar selective pressures not because they evolved from a common ancestor

Evolution evidence: Biogeography

- Geographical distribution of species
  - Organisms in discrete geographic areas tend to be more closely related to each other than to species in distant geographic areas

- Endemic species = found in only one location
  - Ex: marine iguanas, lemurs