In 1159, John of Salisbury wrote: “Bernard of Chartres used to say that we are like dwarfs on the shoulders of giants, so that we can see more than they, and things at a greater distance, not by virtue of any sharpness of sight on our part, or any physical distinction, but because we are carried high and raised up by their giant size.”

Aristotle’s Scala naturae

- Fixed species, progress toward perfection.
- Exploration of the relationships among living things.

A History of Giants

Dr. Erica Bree Rosenblum

Greek Thinkers

Aristotle

384-322 BC

Linnaeus

Carl Linnaeus

1707-1778

Established the binomial classification system we use today.

Lamarck - Inheritance of Acquired Characteristics

Jean-Baptist Lamarck

1744-1829

Lamarck - Inheritance of Acquired Characteristics

Jean-Baptist Lamarck

1744-1829

Did NOT originate the idea of inheritance of acquired characteristics - prevailing view for most of antiquity.

However, DID develop a cohesive theory of evolution based on a “complexifying force” (making organisms more complex) and an “environmental force” (making organisms better adapted due to “use and disuse” of traits).

Wrong about mechanisms but a proponent of biological evolution.
Malthus and the struggle for existence

**An Essay on the Principle of Population**

- There is a tendency toward population growth
- There are limited resources (e.g., food) which are stressed by population growth
- Epidemics can cause catastrophic population declines

Thomas Robert Malthus 1766-1834

Established the idea of “struggle for existence” that influenced evolutionary thinkers like Darwin.

Geology and Inorganic Evolution

Uniformitarianism: earth is ancient and changing under slow uniform action of geological forces over time

Inorganic evolution: earth changes through time

*The Principles of Geology* - 1831

Established the geological backdrop for organic evolution and greatly influenced evolutionary thinkers like Darwin.

Charles Lyell 1797-1875

Wallace 1858

Wallace sends Darwin his essay “On the Tendency of Varieties to Depart Indefinitely From the Original Type”. Describes mechanics of species formation due to environmental pressures similar to Darwin’s idea of “natural selection” that he had been working on for 20 years.

Charles Lyell decides to make joint presentation of Wallace’s essay and Darwin’s unpublished writings to the Linnean Society of London.

The president of the Linnean Society remarks that the year was not marked by any striking discoveries. Then...

Darwin and the Publication of “Origin”: 1859

Charles Darwin 1809-1882

Many modern concepts in evolutionary biology can be traced back to Darwin.

Darwin’s legacy

Many modern concepts in evolutionary biology can be traced back to Darwin.
Darwin’s postulates

**Individual variation:** Individuals in a population vary in their characteristics

**Correspondence/Heredity:** There is a mechanism for offspring to resemble parents (genes were not yet described)

**Overproduction:** More young are produced each generation than survive to reproduce

**Struggle for existence:** Not all individuals survive (population explosions are not often observed)

**Survival of the fittest:** Individuals with favorable traits survive and reproduce

**Gradual change over generations:** Evolution happens!

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After the Origin...

By 1900 two factions had emerged that disagreed about the chief mechanism of evolution:

- **Neo-Darwinians:** natural selection
- **Neo-Lamarckians:** inheritance of acquired traits

Remember these factions did not have anything to do with animosity between the two men!

What lead to the dissolution of the Neo-Lamarckians? GENETICS!

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Mendel

Between 1856 - 1863, cultivated 29,000 pea plants in his monastery’s garden.

Between 1856 - 1863, cultivated 29,000 pea plants in his monastery’s garden.

- **P1**
  - AA
  - aa
  - All yellow

- **F1**
  - Aa

- **F2**
  - AA
  - Aa
  - aa

1:2:1 ratio

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Mendel’s Laws of Inheritance

**Law of Segregation:**
- a) There is allelic variation
- b) One allele comes from each parent
- c) Alleles segregate during gamete production

**Law of Independent Assortment:**
- a) Inheritance pattern at one trait will not affect that of another.

Set foundation for modern genetics

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A long way from Mendel to...

History of DNA Discovery

In 1869 DNA was isolated from pus on surgical bandages. Dubbed “nuclein” because it was found in nuclei of cells.

Not until 1940s and 1950s were experiments done that demonstrated DNA’s role as primary heredity material.

In 1953 Watson and Crick described the first accurate model of DNA double helix structure based on Franklin’s X-ray diffraction images.
Evolutionary “Modern” Synthesis

1930s-40s the Modern Synthesis
Integration of Genetics and Darwinian Theory

Some of the Major Players:
- Fisher, Haldane, Wright - statistical population genetics
- Dobzhansky - genetics in natural populations
- Simpson - paleontology
- Mayr - speciation

Some of the Major Tenets:

a) Evolutionary phenomena can be explained by existing genetic and naturalist knowledge
b) Evolution is gradual and relies on small genetic changes
c) Selection is the primary process driving evolution
d) The population level is the the primary level for thinking about evolutionary processes
e) Micro and macro evolutionary explanations are fundamentally compatible

Times of turmoil: 1950s and 1960s

Struggle between evolutionary and molecular biologists, with evolutionary biologists needing to justify the importance of an organismal perspective (referred to by E.O. Wilson as the “molecular wars”).

Also conflicts among evolutionary biologist with the neutralist-selectionist debates.

“Nothing in biology makes sense, except in the light of evolution. Without that light it becomes a pile of sundry facts - some of them interesting or curious but making no meaningful picture as a whole.”

- Dobzhansky’s 1964

Formalization of the field: 1970s

The field of Molecular Evolutionary Biology “grew up” and now plays a central role in our understanding of the living world.

1971 the Journal of Molecular Evolution founded.

Volume 1, 1971

On the rate of molecular evolution
Motosu Kanamaru and Tomoko Ohta

On the constancy of the evolutionary rate of cistrons
Tomoko Ohta and Motoo Kimura

The structure of cytochrome c and the rates of molecular evolution
Richard E. Dickerson

Comparisons of the polypeptide chains of globins
Thomas H. Jukes

Experimental investigation on the origin of the genetic code
Carl Sieringer and Cyril Ponnamperuma

Homologous evolution as judged by the polypeptide structure
R. F. Dobzhansky, L. W. Godding, Y. Lin and M. Riley

Rate of change of concomitantly variable codons
W. M. Fitch

Toward a molecular taxonomy
Thomas A. Reichert and Andrew K. C. Wong

Volume 72, 2011

Fusion and Retrotransposition Events in the Evolution of the Sea Anemone
Anemonia viridis Strainestia Genes
Yehia Menas, Hagar Weinberger, Nimrod Lazarov, Maya Gur, Roy Kohn, Dalia Gordon and Michael Granville

Aplysia cDNA Glutamate-Gated Chloride Channels Reveal Convergent Evolution of Ligand Specificity
Sarah Kalles, Svetlana Bokhovkina, Françoise Acher, Joseph Dest, Piet Breugstevski and Jonathan Bradley

Adaptive Evolution Involving Gene Duplication and Insertion of a Novel Tyrosine-Like Retrotransposon in Soybean
Akira Kurokawa, Shouchi Liu, Fungting Kong, Sachiko Arase and Jun Abe

Acyl-CoA Dehydrogenases: Dynamic History of Protein Family Evolution
Zuzana Szigovszki, Al-Wahdi Moheen and Jerry Vokaty

Oxygen and Guanine–Cytosine Profiles in Marine Environments
Héctor Romero, Emiliano Piredda, Hugo Naya and Héctor Muñoz
## Timeline of major advances in molecular tools

- **1950s** Protein sequencing
- **1960s** Protein electrophoresis
- **1970s** RNA sequencing
- **1980s** DNA sequencing
- **1990s** Whole genome sequencing
- **2000s** Genomics, transcriptomics, proteomics and beyond

*Rapid advances - shoot at a moving target.*

## Dobzhansky reading

“Dobzhansky once defined evolution as "a change in the genetic composition of populations", an epigram that should not be mistaken for the claim that everything worth saying about evolution is contained in statements about genes”

- Lewontin