



# Chapter 16: Darwin's Theory of Evolution



Class

Biology

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# 16.1 — Darwin's Voyage of Discovery

## Darwin's Journey

Darwin was invited to join the *HMS Beagle* in 1831 for a five-year voyage.

- At the time when scientists had revolutionary ideas
  - **Evolution:** scientific idea that life had changed as Earth did over time

Darwin → Theory of *biological evolution* (scientific explanation for the unity and diversity of life)

- The living world changes continuously

## Observations Aboard the *Beagle*

Darwin found diversity in life.

- Found how organisms were suited to their environments

Darwin focused on three patterns of diversity.

1. Species vary globally.
2. Species vary locally.
3. Species vary over time.

## Species Vary Globally

Different species (similar, ecologically) occupied separate but **ecologically-similar habitats** across space.

### Species Vary Locally

Different (still related) species occupied **different habitats in local areas**.

### Species Vary Over Time

Darwin collected living species & **fossils** (preserved remains or traces of ancient organisms).

- Formed a record that told a story of organisms no longer living

Fossils included distinct animals that were different, but similar to living species (ex. glyptodonts & armadillos).

After returning from the voyage on the *Beagle*, Darwin put together the different pieces he had found.

- Began thinking about natural processes for organisms to change over time

## 16.2 — Ideas that Shaped Darwin's Thinking

### Hutton and Lyell's Ideas

James Hutton & Charles Lyell → Earth is very old and the same ancient natural processes exist in the present

### Hutton's Ideas of Geological Change

Hutton connected different geological processes & features.

- Hutton looked at natural forces below Earth's surface

Hutton conclude that Earth must be older than a thousand years.

- Introduced *deep time* (the concept that Earth's history stretches back over a period of time that the human mind cannot image)

## Lyell's *Principles of Geology*

Lyell → the laws of nature are constant over time & scientists must explain past events in terms of processes observable in the present

- Lyell's way of thinking was called *uniformitarianism*

Darwin read Lyell's books while on the *Beagle*.

- Geological events repeated to build up over many years

## Lamarck's Evolutionary Hypothesis

Darwin was **NOT** the first person to suggest that species could evolve.

- Fossil record already showed that species changed over time

Lamarck → organisms could change during their lifetimes and pass the traits onto their offspring

- Explains how species can change over time

## Lamarck's Ideas

Lamarck → all organisms have an innate urge to become more complex and perfect

- Thus, organisms change or acquire features to live more successfully in their environments

**Acquired Characteristics:** traits altered by an individual organism during its life

## Evaluating Lamarck's Hypotheses

Organisms do **NOT** have an inborn drive to become more perfect.

- Evolution does not progress in a predetermined direction

## Theories about Population Growth

Thomas Malthus → people were being born faster than people were dying (overpopulation)

- Theorized that there wouldn't be enough resources for unchecked growth on human population

**Differential Reproductive Success** → Competition between new offspring leads some to die and some to reproduce

- Darwin needed a scientific explanation to explain how certain individuals survived

## Artificial Selection

**Inherited Variation:** changes in traits passed down from parents to offspring

- Breeders would select the best performing organisms to make more of (*selective breeding*)
  - Darwin called it **artificial selection** → nature provides variation & humans select the most useful ones

## 16.3 — Darwin Presents His Case

### Evolution through Natural Selection

Darwin described a natural process to operate like *artificial selection*.

- Used arguments from Malthus and Lamarck to support his ideas in *On the Origin of Species*

Based on Malthus' theories, Darwin suggested that increased offspring will have to struggle for existence with limited supply of environmental resources.

- Those with variation or adaptations to their environment would succeed
  - **Adaptation:** any heritable characteristic that increases an organism's ability to survive and reproduce in its environment

## Survival of the Fittest

**Fitness:** how well an organism can survive and reproduce in its environment

- Adaptations suited to an environment increase an organism's fitness
- Those not well suited die without reproducing / have less offspring

**Survival:** reproducing and passing adaptations on to the next generation

## Natural Selection

**Natural Selection:** the process by which organisms in nature with variations most suited to their local environment survive and leave more offspring

- Well-adapted individuals survive and reproduce

The **environment** influences *fitness*.

## Common Ancestry

*Descent with modification* → living species are descended from common ancestors with changes over time

- A single tree of life links all living things

## 16.4 — Evidence of Evolution

Natural selection can be observed in labs / controlled outdoor environments.

# Biogeography

**Biogeography:** the study of where organisms live now and where they and their ancestors lived in the past

- Patterns in the distribution of specific organisms with geological information → how modern organisms evolved from ancestors
1. Closely-related species evolve diverse adaptations in slightly different environments.
  2. Very distantly-related species develop similar adaptations in similar environments.

# The Age of Earth

Radioactive dating shows that Earth is about 4.5 billion years old.

- Time for evolution & natural selection to occur

Many recently-discovered fossils today form sequences that trace evolution of modern species.

# Comparing Anatomy & Development

Basic structures appear for different purposes.

- Animals with similar structures evolved from a common ancestor

## Homologous Structures

**Homologous Structures / Anatomies:** similar structures that are shared by related species and have been inherited from a common ancestor

**Analogous Structures:** body parts of an organism that share *common* functions, but **not common structure and development** (ex. wings of bees & birds)

**Vestigial Structures:** structures inherited from ancestors which have lost size and function but retain anatomical homologies to functional versions of the same structure

## Development

For most vertebrates, the same groups of embryonic cells develop in the same order.

- Produce multiple homologous tissues & organs in the same patterns

Similar patterns of embryological development provide further evidence that organisms have descended from a common ancestor.

## Genetics & Molecular Biology

Darwin was unaware how heredity functioned.

- Genetics is now the strongest evidence to support evolutionary theory
  - Overwhelming similarities in genomes across different species show evidence of common ancestry

## Life's Genetic Code

All living cells code genetic information in DNA or RNA.

- Directs protein synthesis
- Sends genetic information from one generation to the next

## Molecular Homology

Homologous proteins share extensive similarities in structure and chemical makeup.

- Genes can also be homologous → common throughout multiple organisms

## Evaluating Evolutionary Theory



Evolutionary theory provides insight into other branches of biology.

- Called the *grand unifying theory of the life sciences*

There are still questions about **how life began**.