Historical Background

Plato (427-347 BC) – Believed in 2 worlds: the real world (ideal and eternal), and an illusionary world (imperfect and perceived through the senses). Typological view of nature - individual variation as the imperfect manifestation of ethos.

Aristotle (384-322 BC) – Believed that all living organisms could be arranged in a "scale of nature" or Great Chain of Being. The ladder of life consists of graduation from inanimate material through plants, through lower animals and humans to other spiritual beings.







modern system of taxonomy in an attempt to discover order in the diversity of life "for the greater glory of God".

- Groupings based on similarity
- Hierarchal relationships of organisms

Early Ideas About Evolution

- Earth formed according to laws of physics and chemistry
 - Older than previously thought
- Life emerged as distinct types
 - Transformed when environment changed



Georges Buffon (1707-88)



Jean-Baptiste Pierre Antoine de Monet, Chevalier de Lamarck

1809 Philosophie Zoologique

First articulated theory of evolution:

- Organisms continually arise by spontaneous generation.
- Organisms continually arise by spontaneous generation.
 "Nervous fluid" acts to move each species up the "great chain of being".
 Organisms develop adaptations to changing environment through the use and disuse of organs. (Heavy use attracts more "nervous fluid".)
 Acquired characteristics are inherited.











Geologists recognized that change was gradual

- James Hutton
 - Observable processes produce small changes that accumulate over time
- The earth must be old · William Smith
- Different rock layers contain distinct fossils



Smith's first Geological Map

Emerging field of GEOLOGY lead to a new concept of the age of the Earth.

- The history of the earth extends back through vast time periods.
- The processes at work today are the same as those that have been operating throughout the entire history of Earth.

These concepts became known as UNIFORMITARIANISM or ACTUALISM.



Charles Lyell Principles of Geology

Paleontology provided evidence that life changed

- Georges Cuvier (1769-1832)
- Fossils resemble but are not exactly the same as modern species
 - Many past species are extinct





Mary Anning discovered several species of extinct marine reptiles

Charles Robert Darwin (1809-1882)

- Briefly studied medicine at Edinburgh.
- Studied for the clergy at Christ's College, Cambridge University.
- Interacted with some natural scientists (John Henslow and Adam Sedgwick) at Cambridge.
- Offered a position (in 1831) as the ship's naturalist on the H.M.S. *Beagle*, which was going on an expedition to chart the waters of South America.















OBSERVATIONS FROM DOMESTIC ANIMALS:

- High levels of variability within a species (SPORTS).
- Variants can pass these characteristics to offspring.
- Artificial selection can rapidly alter the characteristics of a breed.



Essay on the Principle of Populations 1798

- Populations reproduce exponentially.
- Natural populations have a large capacity to reproduce and if left unchecked they will increase at a rapid rate.
- MANY MORE ORGANISMS ARE BORN THAN CAN POSSIBLY SURVIVE.



Thomas Malthus 1766-1834



Charles Darwin

As more individuals ...are born than can possibly survive, and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in a manner profitable to itself, will have a better chance of surviving, and thus be *naturally selected.* – *The Origin of Species* 1859

SEPTEMBER 28, 1838:

"... it at once struck me that under these circumstances favourable variations would tend to be preserved and unfavourable ones to be destroyed."

"Then it suddenly flashed upon me that this self-acting process would necessarily improve the race, because in every generation the inferior would inevitably be killed off and the superior would remain – that is, *the fittest would survive.*"



Alfred Russell Wallace (1823-1913)

DARWIN'S FOUR "THEORIES" OF EVOLUTION

- 1. Evolution has occurred. Species are not unchanging entities, but evolve over time. All species derive from very different species living in the past. This theory was not entirely new, but Darwin provided convincing evidence for it.
- 2. The primary cause of evolutionary change is natural selection. Species change over time because bearers of different traits have different probabilities of contributing offspring to the next generation.

DARWIN'S FOUR "THEORIES" OF EVOLUTION

3. Splitting of single species into two or more species has occurred. Darwin postulated that all life originated with one or a few species. Because many species exist today, there must have been a process whereby one species can split into at least two species.

The necessary conclusion from this view is:

All species share common ancestors.

4. Evolutionary change is gradual. Evolution occurs by the gradual transformation of populations over long periods of time (hundreds to millions of years) rather than by a species changing nearly instantaneously into something different.

WHAT ARE THE ELEMENTS OF EVOLUTION BY NATURAL SELECTION?

- Many more individuals are born than survive (COMPETITION).
- Individuals vary in traits directly related to their ability to survive and reproduce (VARIATION).
- These advantageous traits are passed on to offspring (HERITABILITY).
- This process is repeated generation after generation over long periods of time (ITERATION).

















"If I were to give a prize for the single best idea anybody ever had, I'd give it to Darwin for the idea of natural selection. Ahead of Newton, ahead of Einstein, because his idea unites the two most disparate features of our universe: the world of purposeless, meaningless matter in motion on the one side, and the world of meaning and purpose and design on the other. He understood that what he was proposing was a truly revolutionary idea."

Daniel Dennett, philosopher, 2001

BIOLOGY'S LAW

EVOLUTION BY NATURAL SELECTION – a necessary outcome of differential survival and reproduction, provided the characteristics that caused those differences are heritable.

- A mechanism, as mechanical as any physical law.
- Acts on individuals, but only populations evolve.
- Opportunistic, not goal seeking backward-looking, not anticipatory.
- Not the only mechanism of evolution.

What is the Evidence for Evolution?

Principles of Homology and Common Descent

- Evolution can be viewed as a series of bifurcations in a phylogenetic tree – all life can be traced back to a common ancestor.
- Groups of species that share a common ancestor derive attributes from that ancestor through common descent.
- Once related lineages are reproductively isolated, evolution can lead to modifications of the basic plan.
- Nevertheless, future evolutionary paths are *constrained* by past history.











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 Transplant experiments from closely related fish show that the genes for eye development are *still present and fully functional*.























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nature

















MAJOR LINES OF EVIDENCE FOR EVOLUTION

- The proposed genetic mechanisms of evolution have all been documented experimentally.
- Just as erosion is a fact in physical geology, natural selection is a fact in biology – it is a necessary outcome of heredity and variation.
- HOMOLOGY AND COMMON DESCENT-
- Vestigial characters
- Different sets of data yield similar phylogenetic trees.

MAJOR LINES OF EVIDENCE FOR EVOLUTION

THE FOSSIL RECORD-

- "Intermediate types" are being reported continually from the fossil record.
- Different dating methods yield similar ages for fossil deposits, and they all indicate that the earth is "old".
- Stratification in the fossil record life forms that we believe to be more recently evolved only appear in more recent fossil deposits.

MAJOR LINES OF EVIDENCE FOR EVOLUTION

DIRECT OBSERVATION OF EVOLUTIONARY CHANGE THROUGH TIME

- Through artificial selection experiments, the mean phenotype can be rapidly advanced, and phenotypes can be produced that are well beyond the range of variation in a base population.
- Direct observation of change in the fossil record.
- Evolutionary change in response to changing environmental conditions. Often referred to as "Contemporary Evolution" or "Evolution in Ecological Time".











Chapter 1...

- Biological evolution is a process by which populations of organisms change over time.
- Mutations are changes in the genome of an organism. They can be neutral, detrimental, or beneficial.
- Natural selection occurs when heritable characteristics cause some individuals to survive and reproduce more successfully than others.
- Natural selection is a mechanism of evolution that can cause the genetic composition of a population to shift from generation to generation.
- Evolutionary biologists use many different lines of evidence to test hypotheses about evolution.
- Evolutionary theory explains the patterns of life observable in the natural world and the processes by which that life has evolved.