

EVOLUTION, LECTURE 1: HISTORY OF EVOLUTIONARY THOUGHT (1–8, 12–17, 452–458)

Course structure and logistics. Biology 1B is an integrated course that includes lecture, lab, and discussion section. Lectures are held in 2050 VLSB, **Monday–Thursday, from 12:10–1:30 PM**. Midterms are held in the same room during class time on 13 July, 27 July, and 13 August. There is no final exam.

Office hours. My office hours will follow class, from **1:30–2:15 PM**, in **3095 VLSB**. Please make sure you are up-to-date on the reading (caught up to the previous day), so that office hours is productive for everyone. All of the GSIs will hold office hours each week as well.

Lecture format. The lecture series is divided into three modules: (1) Evolution, (2) Ecology, and (3) Plants & Fungi. Each module has a review scheduled before its midterm. On the day of the review, I will tie up loose ends, review the entire module, and answer questions.

Assigned readings. Note that the assigned readings for each day (from the 8th edition of Campbell's *Biology*) are given after the lecture title (at the top of this page).

BIODIVERSITY: THE UNITY AND DIVERSITY OF LIFE

The extraordinary variety of living forms has always amazed and inspired humankind. Our ancestors were apparently as fascinated by nature as we are today, and ancient rock paintings, such as in the recently discovered cave of Chauvet, in southern France, show the exquisite attention to detail paid by human observers of wild animals (32,000 years ago).

The biological knowledge and wisdom of indigenous cultures worldwide attest to the universal affinity of humans for other organisms. Psychologists have called the attraction of humans to living systems (evident in children from an early age), *biophilia*, and E. O. Wilson defined this phenomenon in terms of “the connections that human beings subconsciously seek with the rest of life.”

The attention paid to nature by our ancestors was partly motivated by practical needs, and some of it was motivated by curiosity, awe, and respect. A similar mix of motives typifies the best scientists of the 21st century.

THE DARWINIAN REVOLUTION, AND THE MODERN CONCEPT OF EVOLUTION.

It is natural to begin this course with the topic of **Evolution**, because, in the famous words of Theodosius Dobzhansky, “Nothing in biology makes sense except in the light of evolution.”

The modern theory of evolution has a long history, elements of which we will cover in this first lecture. An initial and obvious starting point for our discussion of evolution is the work of Charles Robert Darwin. After an introduction to Darwin's life and work in the 19th century, we will work back to the foundations of modern biological thought in ancient Greek philosophy.

A deep historical perspective will allow us to more fully appreciate the significance of the Darwinian revolution following the publication of *On the Origin of Species* in 1859.

Please note the title of Darwin's great work. There is no “the” before “Species,” and the book was not about us (humans), at least not directly. The full title of the book is actually, *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*.

The *Origin* was written after a long period of gestation (or procrastination, if you prefer). Darwin was actually catalyzed to publish after receiving a short essay from the British naturalist, Alfred Russell Wallace (1823–1913).

What is most remarkable about this turn of events was that the evolutionary arguments of Darwin and Wallace were basically similar: both authors emphasized the importance of variation and a process of natural selection in the transformation of species over time.

The similarity in the arguments of Darwin and Wallace can be seen as a sort of convergence of thought in a common intellectual milieu. Darwin and Wallace were steeped in many of the same scientific, social, and philosophical traditions, and they arrived at a similar theory of species evolution.

PRE-DARWINIAN EVOLUTIONISTS

Many workers before Darwin had foreshadowed the modern concept of evolution, dating back to ancient Ionian, Greek, and Roman philosophers, such as Anaximander (c. 611–546 BCE), Empedocles (c. 490–430 BCE), and Lucretius (c. 99–55 BCE).

Later authors—including Darwin’s grandfather, the physician, **Erasmus Darwin** (1731–1802), as well as the somewhat infamous French biologist, **Jean-Baptiste Lamarck** (1744–1829)—had advanced more complete evolutionary hypotheses.

Erasmus Darwin wrote in verse and was widely read, but his influence (including his influence on his grandson) is difficult to assess. His most famous works are *Zoonomia, or the Laws of Organic Life* (1794), and his last long poem, *The Temple of Nature* (published posthumously).

Lamarck was a curator of invertebrates at the Museum of Natural History in Paris, and he seems to have coined the word “biology” around 1800. Lamarck’s evolutionary model was based on his concept of **use and disuse** and the **inheritance of acquired characteristics**.

Lamarck’s evolutionary ideas were not widely accepted by his contemporaries. The two mechanisms that he proposed to explain the evolutionary process are known to be wrong today. We will look at his ideas more closely in the next lecture.

NATURAL THEOLOGY

Although there were occasional speculations on organic evolutionary change throughout history, most thinkers assumed that species were immutable (fixed) and specially created by God. A primary motivation for the study of nature, for many scholars, was to better understand the divine plan of the Creator, and one could accomplish this by studying nature and living organisms.

William Paley (1743–1805) and **Carl Linnaeus** (1707–1778) were both motivated by a natural theology.

THE AGE OF EXPLORATION

From the 15th to the 17th centuries—a period sometimes call the Age of Exploration or the Age of Discovery—European ships sailed around the world on various political and military expeditions. In many cases, these ships took on board a naturalist who made observations and collections that had a profound influence back home.

James Cook (1728–1779) visited Australia and Hawaii, sometimes accompanied by the botanist, Joseph Banks (1743–1820).

Alexander von Humboldt (1769–1859) made a famous 5-year voyage to the Americas that inspired Darwin and other naturalists of that era.

The Lewis & Clark Expedition (1803–1806) was, in part, motivated by the biological curiosity of its primary sponsor, Thomas Jefferson, who admonished: “Scour the western landscape for mastodons, living or dead.”

These expeditions helped to reveal the extraordinary extent of nature’s variety.

THE AGE OF THE EARTH, GRADUALISM, UNIFORMITARIANISM

The problem of the age of our planet was difficult and unresolved before the 20th century discovery that radioactive decay could be used to estimate time.

James Ussher (1581–1656) estimated the age of the earth by studying ancient texts and human genealogies, and he concluded that Earth was created on 26 October, 4004 BCE.

James Hutton (1726–1797) advanced a philosophy of *gradualism*, the idea that profound change can result from the cumulative effect of slow, continuous processes. Hutton’s ideas greatly expanded our notion of time, opening up the possibility that the earth was millions of years old.

Charles Lyell (1797–1875) and *uniformitarianism*, the assumption that the rules governing natural processes in the past are the same as those acting today. Note that this does not specify the rate of change in the past (it could be slow, or it could be sudden). But it does specify that all change was, and is, natural (not supernatural).

William Thomson Kelvin (1824–1907) assumed that the earth was originally molten and that it had gradually cooled since that time. On that basis, he estimated that earth was 20–400 Ma.

PALEONTOLOGY, FOSSILS, AND THE REALITY OF EXTINCTION

Georges Cuvier (1769–1832) established the field of vertebrate paleontology as a legitimate (and exciting) field of scientific inquiry. Cuvier’s research revealed that the ancient world was populated by organisms that no longer exist. He established that species could go *extinct*. Cuvier argued that the world had undergone a series of catastrophes as a result of natural processes such as floods and droughts, and his philosophy is known as *catastrophism*.

Richard Owen (1804–1892) was the pre-eminent paleontologist of Victorian England, and he was an older contemporary of Darwin’s. Owen described the lost faunas of Australia and New Zealand, and he speculated that early human colonists were responsible for the extinction of the giant flightless moas, and the other megafauna, of that region.

Owen was the first to clearly distinguish *homology* from *analogy* in the comparative study of organismal morphology. Homology was defined as “the same organ in different animals under every variety of form and function.” Analogy, on the other hand, referred to organs that served a similar function but that were constructed in accordance with different underlying plans (today we call this convergence or parallelism).