

Outline of lectures 1-3

History of genetics in evolution

1. History's persistent influence in biology. Monster movies are a major example of the survival of Victorian ideas about evolution. (e.g. *The Lost World* by Conan Doyle). Generally a recent movie is a remake of a '50's version, which was based on a novel from at least 50 years before (and the author's exposure to biology was even earlier).
2. Aristotle. Categorized natural entities into "genus" and "species" (and did this not just for living things). This was typological thinking – it assumed that the real organisms were imperfect examples of idealized "types".
3. The Great Chain of Being. A linear order of animal species from worms up to us (and on to angels). Influential to this day when people think of "higher" and "lower" species. It is not per se evolutionary, as the linear order can be static. It goes back at least to the 1600's.
4. (Mentioned John Greene's *The Death of Adam*). From the 1500's on, developments in astronomy, anthropology, geology, linguistics that led to people being more ready to consider evolutionary ideas. Especially since the success of Isaac Newton's laws of motion in explaining orbits in astronomy, people became interested in simple laws that would generate natural phenomena, rather than arbitrary patterns (such as planets arranged on rotating celestial crystal spheres).
5. Karl Linné (Carolus Linnaeus). Swedish botanist of the mid-1700's. Invented hierarchical classification (also the "type specimen" system, and codified binomial nomenclature). The system was presented as disclosing the true (static) order of nature as laid down at creation. It became widely used, as it succeeded in summarizing biological diversity better than many other systems present at the time, which were based on geometric or numerological schemes.
6. If the groups we made in a classification system were entirely genealogical (so that each group was a branch of the tree and all its descendants – a *monophyletic* group), then we would expect a hierarchical classification system that was predicted by the phylogeny (evolutionary tree). Many textbook writers unthinkingly assume that this is the kind of classification system we have had. The success of hierarchical classification then becomes a simple, neat story. But this isn't the kind of classification system we have had.
7. However, the Linnean classification of organisms that has been in use most of the time since Linnaeus has many groups that are not monophyletic. (A group is *monophyletic*

when it has its own common ancestor which is not the ancestor of anything else under discussion). Within the vertebrates, groups like Osteichthyes (bony fishes), and Reptilia (reptiles) are not monophyletic (the tetrapods are other descendants of the common ancestor of Osteichthyes, and the mammals and birds are other descendants of the common ancestor of reptiles). There has been a trend away from this, toward a purely monophyletic classification system, called “phylogenetic systematics”, since the 1960’s.

8. George-Louis Leclerc, Comte de Buffon (d. 1788). *Historie Naturelle*. Described animal species as graded into each other along a continuum. Also said that organisms changed and environment affected this. He primarily envisaged change by degeneration. (He also said earth was much older than 6000 years). Did not give much of a mechanism for this evolutionary change.
9. Jean Baptiste Pierre Antoine de Monet (Chevalier de Lamarck) (1744-1829). The first true evolutionary biologist. Worked on invertebrates at the Natural History Museum in Paris. He was a great pioneer of invertebrate systematics, rearranging and clarifying it greatly. In his *Philosophie Zoologique* (1809) Held that organisms had evolved, and that the mechanism was the effects of use and disuse, passed on by inheritance of acquired characters. He did not invent the latter, which was “common knowledge” at the time. “Lamarckian inheritance” was not invented by Lamarck or even promoted by him, as it was widely believed in by everybody at that time.
10. Controversies between Lamarckians and others in the early 1800’s partly owing to political implications of Lamarckian views in medicine. Etienne Geoffroy Saint-Hilaire (1772-1844). Major supporter of Lamarck who tried to use anatomy to connect vertebrates, invertebrates.
11. Georges Cuvier (1769-1832). Geoffroy’s great oponent, and the great founder of comparative anatomy. Also a central figure in purging French academia, in the period after the defeat of Napoleon, of supporters of republican views. Debunked Geoffroy’s assertions of homology rather effectively (for example Geoffroy’s “homologies” between crustaceans and fish). Lamarckian views inspired many reformers and radicals of the early 1800’s (especially in medicine). Adrian Desmond’s book *The Politics of Evolution* goes over this in detail, explains how Cuvier and others played a major role in defending the establishment, and how Darwin probably delayed publishing his work because he didn’t want to be associated with the Lamarckian position in these controversies.
12. The *Naturphilosophen*. Group of romantic philosophers (centered in Germany in the early 1800’s) who asserted a unity of all life and that different life forms were explained by different amounts of development (but not evolution) along one common course. Johann Wolfgang von Goethe (1749-1832), acknowledged since then as the central figure in German literature, was allied with them and was also the first person to connect the flower parts with leaves (by a developmental argument). He invented the term “morphology”. He argued that flowers arose by the same developmental pathway that leads to leaves, but gave flowers if continued further.

13. Charles Darwin (1809-1882). Journey on the *Beagle*. Came up with natural selection, in about 1837, as the mechanism to explain the adaptations of organisms. Alfred Russel Wallace (1823-1913) was the co-discoverer of natural selection (1858). This forced Darwin to publish. Darwin's book was published in 1859 and was a sensation – it sold out the same day. Later Darwin tried to explain heredity as well. His theory of heredity was called Pangenesis (the units were gemmules).
14. Fleeming Jenkin (1867) had an incisive criticism of Darwin. A pioneering electrical engineer and buddy of the famous physicist William Thompson (Lord Kelvin). Kelvin thought he had a fatal physical objection to Darwin's work based on the length of time the sun could remain hot, which he calculated meant that it could not be very old. It turns out that nuclear fusion within the sun creates heat, and that invalidates his calculation. Jenkin had a different objection than his friend Kelvin. It was based on blending inheritance. In blending inheritance, which was commonly assumed to be true, the offspring's hereditary substances ("blood") was a mixture of the parent's, and hence intermediate between theirs. This would cause progress to stall, as blending of phenotypes would eliminate half of the variance of the population every generation. Kelvin encouraged Jenkin to publish this. The criticism worried Darwin, who coped by increasing his emphasis on inheritance of acquired characters as a source of variability.
15. Gregor Mendel (1822-1884). Under Mendelian inheritance (1864) there is no "blending" of different alleles. The variability does not disappear as it does with blending inheritance. A heterozygote Aa does not produce gametes with medium-sized A 's in them, but instead half A and half a gametes.
16. Mendel's laws were rediscovered by Karl Correns, Hugo de Vries, and Erich von Tschermak-Seysenegg in 1900. Maybe only Correns really discovered them independently, the others from finding Mendel's paper first (though that is not what they claimed).
17. Controversy between the "Biometricians" (Francis Galton and Karl Pearson) and the Mendelians over evolution. The Mendelians put forward mutation (discovered by De Vries) against natural selection. The Biometricians (from the 1880's through about 1920) put forward statistical formulas predicting the distribution of offspring phenotypes, and developed many regression and correlation methods, having a great effect on the development of statistics.
18. Population genetics theory was developed in the 1910's-1940's largely by three people: R. A. Fisher (1890-1962), Sewall Wright (1889-1988 (!)) and J. B. S. Haldane (1892-1964). Fisher also was the major figure in the development of modern mathematical statistics. Wright carried out years of work on the "physiological genetics" of guinea pig coat colors, and many of his graduate students became noted mammalian geneticists. Haldane made contributions to many fields, including physiology of diving, and produced popular writings on science, but did most of his work in human genetics.

19. Fisher developed the theory of variance components and correlations among relatives in quantitative genetics (among many other things). Wright developed inbreeding coefficients and the methods of calculating them. He and Fisher both developed the theory of the way genetic drift and other evolutionary forces interact in small populations. Haldane published a series of papers in the 1920s setting forth the equations for gene frequency change in natural selection in many cases. Between them they dominated the field well into the 1950's, when a new generation of theorists such as Motoo Kimura, Richard Lewontin, James Crow, Oscar Kempthorne, and C. Clark Cockerham emerged.
20. Their work was the theoretical basis for the Neodarwinian Synthesis, the combination of Mendelian genetics and evolutionary theory that emerged in the 1920's and was widely publicized in the 1940's in books by zoologists and botanists applying the theory to systematics and paleontology, notably Ernst Mayr, George Gaylord Simpson, Theodosius Dobzhansky, G. Ledyard Stebbins, and Julian Huxley (all but the last one published by Columbia University Press!).
21. The Neodarwinian Synthesis combined genetics with evolution. It enabled quantitative arguments to be made about how fast natural selection would change phenotypes (if you knew their genetic basis), and how strong forces such as genetic drift, gene flow due to migration, and mutation would be. This will be the subject of the next lectures in this course.