

Evolution, Heredity, and the History of Biology Syllabus

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This course will chart the history of biology from Darwin's proposal of evolution to Watson and Crick's discovery of the structure of DNA. We will examine the debates over the nature of heredity and evolution in this period as a set of 'natural responses' to the theory of evolution – many of which can still be found in our classrooms and biology textbooks. The development of these ideas will bring us into contact with methodological concerns in science, the role of experiment and theory in scientific discovery, and the process by which new scientific theories are developed, tested, and rejected. We will conclude with a brief overview of current issues regarding science and religion, creationism and intelligent design, and the prospect of teaching evolution to students in today's cultural environment.

In an unusual development for our summer school, we are in fact overlapping with the [IHPST 2009](#) conference. Allowance will be made in the last few days of the schedule for you to attend some of these meetings if you'd like – conference registration fees and the Saturday banquet cost will be covered for students attending this course.

Assessment

The main assignment for the course is the preparation of two detailed lesson plans for use in the classroom. Further, participation in discussions and readings for the various sessions are required.

Readings

Our reading will be heavily focused on primary sources – original documents dating from the 19th and early 20th centuries. Occasionally we will supplement these with secondary sources – synthetic, scholarly overviews from recent historical and philosophical work. All but two of the readings (on the following pages) will be available electronically on the course website. Two books will need to be purchased and read before the course.

Pre-Course Reading

The following books should be purchased and read before the course.

Darwin, Charles. *On Natural Selection (Penguin Great Ideas)*. Penguin, 2005.

A selection of four chapters from the first edition of the *Origin of Species*. The best of the central argument of the *Origin*, unabridged.

Bowler, Peter. *Charles Darwin: The Man and his Influence*. Oxford: Basil Blackwell, 1990.

A really nice biography of Darwin, shorter than many of the scholarly works produced by the 'Darwin industry.' Covers the environment in which Darwin developed his theories, Darwin's life, and the fate of his theory immediately after his death.

As an optional reading, the best full, unabridged edition of the *Origin of Species* is *On the Origin of Species: A Facsimile of the First Edition (Harvard Paperbacks)*, introduction by Ernst Mayr, Harvard Univ. Press (though any *first edition* copy of the *Origin*, including those by Penguin Classics and Barnes & Noble, are just fine). It's available in a recent (2001) edition, as well as several older printings, which are all identical. Darwin famously said that the *Origin* was an 'abstract' which could best be read in a single sitting, but at some 600pp., he's probably not to be trusted.

If you do purchase your own copy of the complete *Origin*, the chapters in the short selected volume (on which we will focus) are those titled 'Struggle for Existence' (Ch. 3), 'Natural Selection' (Ch. 4), 'Difficulties on Theory' (Ch. 6), and 'Conclusion' (Ch. 14).

Readings

All other readings are available digitized, online at [the course website](#). This is the master bibliography; individual sessions below have specific readings listed.

- Bowler, Peter J. 2003. *Evolution: The History of an Idea*. Selections from Ch. 7. [[PDF link, requires password](#); page numbers for excerpts listed in sessions below]
- Butler, Samuel. 1879. *Evolution, Old and New*. London: Hardwicke and Bogue. Selections from Chh. XXI and XXII. [[PDF link](#)]
- Cope, Edward Drinker. 1887 [1867]. "On the Origin of Genera." In *The Origin of the Fittest*. New York: D. Appleton and Company. Selections. [[PDF link](#)]
- Darwin, Charles. 1900 [1868]. *Variation of Plants and Animals Under Domestication*, vol. 2. Selections from Ch. XXVII. [[PDF link](#)]
- Fisher, R.A. 1922. "Darwinian Evolution by Mutations," *Eugenics Review* 14:31-34. [[PDF link](#)]

- Gould, Stephen Jay. 2002. *The Structure of Evolutionary Theory*. Belknap. Selections from Chapter 2. [[PDF link, requires password](#); read pp. 93–116, 125–end, and read quickly]
- Gould, Stephen Jay and Richard Lewontin. 1979. “The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme.” *Proceedings of the Royal Society of London. Series B, Biological Sciences* 205(1161):581–598. [[PDF link, requires password](#)]
- Griffiths, Paul E. and Russell D. Gray. 1994. “Developmental Systems and Evolutionary Biology.” *Journal of Philosophy* 91(6):277–304. [[PDF link, requires password](#); read pp. 277–279, 283–285, 298–end]
- Lamarck, Jean-Baptiste. 1914 [1809]. *Zoological Philosophy*, trans. and ed. H. Elliot. Macmillan. Selections from Chh. VI and VII. [[PDF link](#); skim Table of Contents and read excerpts]
- Largent, Mark A. 2008. “Darwin’s Analogy Between Artificial and Natural Selection in the Origin of Species.” In *Cambridge Companion to the “Origin of Species,”* ed. M. Ruse and R.J. Richards. Cambridge Univ. Press. [[PDF link, requires password](#)]
- Lankester, E. Ray. 1896. “Are Specific Characters Useful? [Letter of July 16, 1896].” *Nature* 54(1394):245–246. [[PDF link, requires password](#)]
- Lyell, Charles. 1837 [1830]. *Principles of Geology*, 5th ed. Philadelphia: James Kay. Selections from Ch. IX. [[PDF link](#)]
- Malthus, Thomas R. 1890 [1798]. *An Essay on the Principle of Population*, 9th ed. London: Ward, Lock, and Co. Chapter I. [[PDF link](#)]
- Mayr, Ernst. 1997 [1959]. “Agassiz, Darwin, and Evolution.” In *Evolution and the Diversity of Life: Selected Essays*. Harvard Univ. Press. [[PDF link, requires password](#)]
- Mendel, Gregor [communicated by C.T. Druery and W. Bateson]. 1901 [1865]. “Experiments in Plant Hybridization.” *Journal of the Royal Horticultural Society* 26:1–32. [[PDF link](#); read through p. 7, carefully, skim to p. 14 or so]
- Morgan, Thomas Hunt. 1908. *Evolution and Adaptation*. Macmillan. Selections from Preface and Ch. XIII. [[PDF link](#)]
- Morgan, Thomas Hunt. 1916. *A Critique of the Theory of Evolution*. Princeton Univ. Press. Selections. [[PDF link](#); apologies for the broken pictures]
- Nagel, Thomas. 2008. “Public Education and Intelligent Design.” *Philosophy & Public Affairs* 36(2):187–205. [[PDF link, requires password](#)]
- Osborn, Henry Fairfield. 1934. “Aristogenesis, the Creative Principle in the Origin of Species,” *Science* 79(2038):41–45. [[PDF link, requires password](#)]

- Radick, Gregory. 2003. “Is the Theory of Natural Selection Independent of its History?” In *Cambridge Companion to Darwin*, ed. J. Hodge. Cambridge Univ. Press. [\[PDF link, requires password\]](#)
- Ruse, Michael. 1982. “Creation Science is Not Science.” *Science, Technology, & Human Values* 7(40):72–78. [\[PDF link, requires password\]](#)
- Safina, C. 2009. “Darwinism Must Die So That Evolution May Live.” *The New York Times*, Feb. 10, 2009. [\[PDF link\]](#)
- Sloan, Phillip R. 2009. “Bringing Evolution to Notre Dame: Father John Zahm, C.S.C. and Theistic Evolution.” *American Midland Naturalist* 161(2):189–205. [\[PDF link, requires password\]](#)
- Tax, Sol. 1960. “Panel Two: The Evolution of Life.” In *Evolution After Darwin*. Univ. of Chicago Press. [\[PDF link, requires password\]](#)
- Watson, James D. and Francis H.C. Crick. 1953. “Molecular Structure of Nucleic Acids.” *Nature* 171(4356):737–738. [\[PDF link, requires password\]](#)
- Whewell, William. 1847 [1840]. *The Philosophy of the Inductive Sciences*, vol. 2. London: John W. Parker. Selections from Ch. VI. [\[PDF link\]](#)
- Weldon, W.F.R. 1893. “On Certain Correlated Variations in *Carcinus moenas*,” *Proceedings of the Royal Society of London* 54:318–329. [\[PDF link, requires password\]](#); skim pp. 318–324, read pp. 329–end beginning “It cannot be too strongly urged. . .”]

Schedule

Here's the detailed schedule that we'll try to stick to for the five days.

Day 1: Darwin and his Predecessors

Today's class is designed to get us up to speed on the historical background of Darwin's theory and Darwin's main theses. Why study the history of biology? What was the environment in which Darwin worked, and how did it influence his theory? Did Darwin do anything original, or did he just synthesize material that was available to him at the time?

Session	Material
9–10:30 AM	<p>Why are we here? <i>Discussion.</i> Introduce the course, discuss the history of biology. Importance of studying science in a historical context. Discussion about (1) the meaning of 'Darwinism' or evolution, (2) the importance of evolution in the classroom, (3) whether anyone has ever taken direct fire over teaching evolution, and (4) whether the resistance to evolution is constructive or destructive.</p> <p>Readings: None.</p>
12–2:30 PM	<p>Lamarck, Lyell, Whewell, and Malthus. <i>Lecture.</i> My pick for the four most substantial influences on Darwin. Who was Lamarck? What is his theory (and what <i>isn't</i> his theory)? What was Lyell's uniformitarian theory in geology, and how did it influence Darwin? What was Whewell's notion of consilience, and how might we profitably read the <i>Origin</i> as a consilience of inductions? What was Malthus's theory of population growth, and is it central to Darwin's theory?</p> <p>Readings: Lamarck (1914 [1809]), Lyell (1837 [1830]), Whewell (1847 [1840]), Malthus (1890 [1798]), Radick (2003).</p>
3:30–5:30 PM	<p>Darwin's Origin of Species. <i>Discussion.</i> What's the structure of the <i>Origin</i>? Is this a useful way of presenting evolution to students? Does it still feel current, or not?</p> <p>Readings: Darwin (1859, prior reading), Largent (2008)</p>

Day 2: Darwin, Mendel, Heredity; Non-Darwinian Theories of Evolution

We'll spend today setting up the most important problem for evolutionary theory in the time period immediately after the death of Darwin: theories of heredity. What did Darwin think was the mechanism of heredity? How did the 'rediscovery' of the work of Mendel influence the reception of evolutionary theory? What was the substance of the conflict between biometry

and Mendelism in the early 1900s? We'll also deal with the two largest non-Darwinian theories of evolution, which posited “extra machinery” as necessary in evolution. The first is a resurgence of the progressivist ideas of Lamarck, and the second posits linear driving forces internal to organisms.

Session	Material
9-11:30 AM	<p>Darwin, Mendel, and Biometry. <i>Discussion / Lecture.</i> What was Darwin's theory of heredity? What can we learn from Mendel's original paper? Mendel is a stock figure in secondary biology courses – why? How might Mendel's theory be seen as contradicting Darwin? After the rediscovery of Mendel's work, how was it taken up by the biological community? Can we understand the push-back offered by the 'biometrical' school?</p> <p>Readings: Darwin (1900 [1868]), Mendel (1901 [1856]), Weldon (1893), Lankester (1896), Bowler (2003) [pp. 256–273].</p>
1-2:30 PM	<p>Neo-Lamarckism and Orthogenesis. <i>Discussion.</i> Is Lamarckism a natural response to evolution? How can we help students grasp the slow but steady pace of Darwinian evolution? How is neo-Lamarckism related to the historical work of Lamarck we read at the beginning of the semester? What was the theory of orthogenesis? How does it relate to biology and, more importantly, paleontology?</p> <p>Readings: Cope (1887 [1867]), Butler (1879), Osborn (1934), Bowler (2003) [pp. 236–250]</p>
5-7 PM	<p>Teaching Evolution. <i>Dinner at the Pences.</i> How are we supposed to teach evolution these days, anyway? Can it be done in a sensitive way? How can you build this historical material into a lesson plan?</p> <p>Readings: None</p>

Day 3: The 'Darwinian Revolution' and the New Synthesis

From here, we move into the terrain of the “New” or “Modern” Synthesis, the marriage of evolutionary theory and the cellular picture that took place between around 1930 and 1950. Our goal today is to look at two issues. First, was there a genuine Darwinian Revolution? We frequently talk as if there were, but we have seen quite a bit of opposition to the theory over the decades after its proposal. Finally, we will see how this New Synthesis was achieved. To what extent did the New Synthesis rewrite the history of biology? What was ‘New’ about the New Synthesis? How did the New Synthesis pave the way for the discovery of DNA and the current state of modern biology?

Session	Material
9–10:30 AM	<p>The ‘Eclipse’ of Darwinism and the Darwinian Revolution. <i>Lecture / Discussion.</i> Was Darwinism ever really ‘eclipsed’? If so, how do we teach that? Was there a ‘Darwinian Revolution’? This history seems more convoluted than is generally acknowledged. Why is that? Does it constitute a failing of the “traditional narrative?”</p> <p>Readings: Bowler (2003) [pp. 224–236, 251–256]</p>
12–1:30 PM	<p>The Rise of Genetics and the Start of the Synthesis. <i>Lecture / Discussion.</i> How did the modern theory of genetics develop? What is its relationship to Darwinism? What needed to be synthesized at this point? How could such a synthesis develop?</p> <p>Readings: Morgan (1908), Morgan (1916), Fisher (1922)</p>
3–5 PM	<p>Retelling History: The New Synthesis. <i>Discussion.</i> What was the result of the New Synthesis? Who brought it about? What was brought into it from previous biology? What was left out?</p> <p>Readings: Tax (1960), Mayr (1959), Watson and Crick (1953).</p>
7–8:30 PM	<p>IHPST 2009 Presidential Address. Michael Matthews, “Joseph Priestley and the Possibility of Grand Narratives in Science Education.” Held in connection with the IHPST conference.</p>

Day 4: Today’s Biology: Prospects and Problems

We’ll begin today – allowing time for you to attend some of the IHPST conference – by talking about the most recent developments and “challenges” to evolutionary theory from within the scientific community. Despite the claims to the contrary by creationists, evolutionary biology has been a rapidly changing field in the last forty years – with punctuated equilibrium, the neutral theory, critiques of adaptationism, and evolutionary developmental biology (or ‘evo-devo’) all drastically changing the way in which we see the progress of evolution. We’ll spend some time this morning looking at how this has come to pass, and what it might mean for biology instruction.

Session	Material
9–11 AM	<p>Neo-Darwinism: A Glimpse. <i>Discussion.</i> What parts of ‘orthodox’ Darwinism have been challenged in the last 40 years? Are we on our way to a ‘New New Synthesis’? Can any of this cutting-edge material (evo-devo, adaptationism, punctuated equilibrium) be brought into the classroom? How?</p>

Readings: Gould (2002), Gould and Lewontin (1979), Griffiths and Gray (1994).

11 AM–4 PM

Time to attend the IHPST conference. This should permit attendance at the 11 AM and 2 PM sessions of IHPST.

4–6 PM

Presentation and Discussion of Lesson Plans.

Readings: None.

Day 5: Evolution Today: Teaching and Controversy

We'll close our with a brief discussion of the current socio-cultural climate surrounding the teaching of evolution. How can we respond to critics of evolution? I've included the most reasonable pro-intelligent-design argument I've ever found (the Nagel article) – can we make any sense of it? Clearly some (Richard Dawkins, &c.) consider science and religion flatly incompatible, while some have developed detailed theories of theistic evolution. How much consideration should be given to science-religion issues in the classroom?

Session	Material
8:30–11 AM	Darwinism, Theistic Evolution, and Intelligent Design. <i>Discussion.</i> How are we to talk about science and religion issues in the classroom? Is ID a genuine threat to Darwinism? Why or why not? How about the term 'Darwinism'? Must we 'kill the Buddha'? Readings: Sloan (2009), Nagel (2008), Ruse (1982), Safina (2009).
11 AM–6 PM	The rest of the day is open for your attendance at the IHPST conference.

Further Reading

Here's a smattering of other readings that might interest you, on the various topics we've dealt with this week. Sadly, there are fewer readings here than I would like to present – but many of the historical works I would like to see have yet to be written.

Historical Influences on Darwin

- Burkhardt, R. 1995. *The Spirit of System: Lamarck and Evolutionary Biology*. Harvard Univ. Press. [[One of the only nice scholarly sources for Lamarck, who faces a surprising dearth of scholarship.]]
- Whewell, W. 1840. *The Philosophy of the Inductive Sciences, Founded upon their History*. 2 vols. and Whewell, W. 1857. *History of the Inductive Sciences, from the Earliest to the Present Time*. 2 vols. [[I can do no better than to point toward the *massive* four volumes of Whewell's writing in awe. They repay immense and careful study, as a masterful portrait of the history and philosophy of science in the mid-nineteenth century.]]
- Lyell, C. Introduction by M.J.S. Rudwick. 1990 [1830]. *Principles of Geology*, vol. 1. Univ. of Chicago Press. [[The introduction to this volume by Rudwick is probably the best concise source for Lyell and his impact.]]

Darwin and the Origin

- Richards, R.J. and Ruse, M., eds. 2008. *The Cambridge Companion to the 'Origin of Species'*. Cambridge Univ. Press. [[We read one piece of this collection on our first day; the rest is quite good. The piece by Richards is doubly-recommended.]]
- Hodge, J. and Radick, G., eds. 2009. *The Cambridge Companion to Darwin*, 2nd. ed. Cambridge Univ. Press. [[Another great collection, pointed less at the origin and more toward the broader historical influences on Darwin.]]
- Desmond, A. and Moore, J. 1994. *Darwin: The Life of a Tormented Evolutionist*. W.W. Norton. [[Despite the 'sexed-up' title for the American release of this book, it remains a scholarly masterpiece, and probably the best single biography of Darwin available.]]
- Desmond, A. and Moore, J. 2009. *Darwin's Sacred Cause: How A Hatred of Slavery Shaped Darwin's Views on Human Evolution*. Houghton Mifflin. [[Desmond and Moore's newest offering, which has created quite a stir. I can't comment on its scholarly merit, but given D&M's track record, it's probably quite good.]]
- Browne, J. 1996. *Charles Darwin: Voyaging*. Princeton Univ. Press. and Browne, J. 2003. *Charles Darwin: The Power of Place*. Princeton Univ. Press. [[Another two-volume biography of Darwin by Janet Browne, whose work is quite good.]]
- Richards, R.J. 2002. *The Romantic Conception of Life*. Chicago Univ. Press. [[A great work detailing the context into which the *Origin* entered into in Germany.]]

The Origin's Reception and the Eclipse of Darwinism

- Ellegard, A. 1990. *Darwin and the General Reader*. Univ. of Chicago Press. [[A really interesting study of how Darwin's work was received in the popular magazines and newspapers. The first step toward answering how Darwinism could have so rapidly been well-received.]]
- Bowler, P.J. 1992. *The Eclipse of Darwinism*. J.H.U. Press. [[The leading, if occasionally slanted, reference on the period surrounding 1900. I've consulted this work extensively in developing the course.]]
- Gliboff, S. 2008. *H.G. Bronn, Ernst Haeckel, and the Origins of German Darwinism*. The MIT Press. [[A good new work detailing early German reception of Darwin.]]
- Richards, R.J. 2008. *The Tragic Sense of Life: Ernst Haeckel and the Struggle over Evolutionary Thought*. Univ. of Chicago Press. [[A spectacular work on Haeckel, whose influence is not to be underestimated.]]
- Gayon, J. 1998. *Darwin's Struggle for Survival: Heredity and the Hypothesis of Natural Selection*. Cambridge Univ. Press. [[A wonderfully historically sensitive treatment of this period, highly recommended.]]

The New Synthesis; Current Science-Religion Work

- Provine, W. 1971. *The Origins of Theoretical Population Genetics*. Univ. of Chicago Press. [[A deeply slanted, but nonetheless invaluable work on the development of population genetics from Galton to Fisher.]]
- Smocovitis, V.B. 1996. *Unifying Biology*. Princeton Univ. Press. [[A great, if controversial, take on the unification produced by the New Synthesis.]]
- Larson, E. 1997. *Summer for the Gods: The Scopes Trial and America's Ongoing Debate between Science and Religion*. Basic Books. [[What has become the standard source for the history of the Scopes trial.]]
- McMullin, E. 1985. *Evolution and Creation*. Univ. of Notre Dame Press. [[The proceedings of a conference which took place at Notre Dame; all papers in the collection well-reviewed.]]