

History of Science 333: History of Modern Biology
Spring 2010
Prof. Lynn Nyhart
TR 11-12:15 in 6112 Social Science

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Office Hours (207 Bradley Memorial Building): Tuesdays 1:30-3:30 pm and by appt.

The word "biology" was coined in 1800, to describe a science of life that would be more than "mere" natural history - a science that would unite all the living world into a single scheme. From then to now, the desire to find a single "key" to life has been a powerful motivator. In this year's course, we focus on a series of efforts to unify the study of life around a single theme or idea, including Lamarck and Treviranus' "Biologie" of 1800; the cell theory; Darwinian evolution; the theory of the gene ("classical" genetics); the "modern" evolutionary synthesis of the 1940s; DNA and molecular biology; recombinant DNA and genomics; and the newest evolutionary synthesis, evo-devo. Across these topics, we will grapple with biologists' ideas about reductionism, holism, and levels of biological organization; analyze different modes of scientific practice (fieldwork, lab work, theorizing); and consider the institutional and broader politics of biology as it has developed over the last century or so. Finally, we will also consider how these various themes are reflected in the ways that the history of biology has been written, by critically examining primary sources in context, historical biology textbooks, and scientists' and historians' ways of reconstructing the past.

There are 2 required books, available for purchase at University Book Store:

*Jan Sapp, *Genesis: The Evolution of Biology* (Oxford University Press, 2003)

*James D. Watson, *The Double Helix* (Norton Critical Edition, 1980)

The bulk of the readings are articles and chapters available online via Learn@UW. It is expected that you will either print these up to bring to class, bring extensive notes, or bring your laptop to consult the readings in class (but NOT surf the web, check email or do other homework!).

Undergraduate Course Requirements:

- 20% 1st essay (textual/contextual analysis, approx. 1500 words, covering beginning of course thru 2/14), due Tuesday, Feb. 18, in class
- 20% Biology textbook analysis
- 30% Final essay, covering Units 3 and 4 (approx. 1500 words), due Tuesday, May 11 @ 2:30 pm.
- 30% Class participation: includes preparing 10 questions/comments for class and 3 analytical discussion pieces—see addendum on class participation and preparation. Attendance is mandatory; participation means talking intelligently based on your active engagement with readings, lecture material, and classmates).

All formal writing assignments are take-home essays and should be word-processed and stapled with your name on the back of the last page. Please be sure to include a title.

Honors students may either 1) extend your textbook analysis into a 10-12-page research paper, due the last class day. Or 2) write a research paper on a history of biology topic of your choice, in consultation with me.. The honors project will count as 15% of your overall grade, with 5% taken away from each of your other written assignments.

Graduate Student Course Requirements:

Grades will be based on a combination of discussion of readings, including any informal writing

(40%) and formal writing (60%). See separate Graduate Syllabus.

Course Website. We will be using "Learn@UW," an interactive course website, for distributing all writing assignments and handouts and for important website links and other information. To access the Learn@UW site for HS/MedHist 333, follow these two steps:

1. Open up an Internet browser and go to this website (which you should then save in your "favorites" file): <https://learnuw.wisc.edu/> (You can reach it from the UW home page, too, under "Learn@UW.") This is your login page for Learn@UW. You will need to type in your WiscWorld username and password to get to your "portal page."
2. Once on your Learn @UW portal page, you will see "My Madison Courses" which will list all your UW courses that have a Learn@UW website. Click on the link for this semester for "History of Science 333" (or "Medical History and Bioethics 333") and you'll arrive at the course website. Notice that on this page there is information about the "Help Desk" if you have any trouble navigating to the site or getting any of the information.

Schedule of Topics and Readings

T 1/19: Course Introduction: Unifying the Study of Life

Unit I: Unifying Life in the 19th Century: Unity of Type, the Cell, and Evolution

Analytical focus: Analyzing primary-source texts, placing them in context

Note: All readings marked with * are posted under "Content" on Learn@UW.

A. Life at the Paris Museum, 1790s-1830s: Unity of Type

Issues for 1/21-1/26: Around what principles--methodological, organizational, epistemological, and metaphysical-- did Lamarck, Cuvier, and Geoffroy organize their sciences of animal life ca. 1800-1830? If you had been a student at the Paris Museum ca. 1829, with whom would you have wanted to work and why?

R 1/21: Studying "Life" in Paris ca. 1800.

Sapp 3-13;

*Lamarck, *Zoological Philosophy* (1809), translated by Hugh Elliott (Chicago: Univ. Of Chicago Press, 1984), 181-210

*Toby Appel, *The Cuvier-Geoffroy Debate* (NY: Oxford U. Press, 1987), 11-19, 246-248

T 1/26: The Cuvier-Geoffroy Debate

Sapp, 13-15

*Toby Appel, *The Cuvier-Geoffroy Debate*, 34-39, 251-252

*Georges Cuvier, *The Animal Kingdom Arranged in Conformity with Its Organization* (orig. French publ. 1817; English translation New York: Carvill, 1831), "Introduction," 1-32

*Hervé Le Guyader, *Étienne Geoffroy Saint-Hilaire 1772-1844: A Visionary Naturalist* (U. of Chicago Press, 2004), 1-19, 135-146 [Cuvier], 152-165 [Geoffroy]

B. Cell Studies as the Key to Life in Germany, 1830s-1840s

Issues for 1/28 and 2/2: what characterized the upswing in interest in microscopy and cell theory in Germany in the 1830s and 1840s? What might have caused it? (Consider different levels of causation.)

R 1/28: Microscopy and cell theory

Sapp, 75-81

*Frederic L. Holmes, "The Microscopic Organization of Plants and Animals," (unpublished ms.), 11-42 (note: this is not all of the selection)

*Theodor Schwann, *Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants*, tr. Henry Smith (London: Sydenham Society, 1847; orig. 1838), 154-168 (top), Plates I-IV.

T 2/2: Cellular physiology: Johannes Müller and microscopy in Berlin

*Laura Otis, *Müller's Lab* (Oxford U. Press, 2007), 14-34, 42-75

*Theodor Schwann, *Microscopical Researches*, 186-193

*Holmes, "Microscopic Organization," 42-55 (still not quite the rest of the reading)

R 2/4: Generation and individuality

How did the problematic nature of individuality extend beyond cell theory? To what realms? What scientific questions were seen as belonging together and needing common solutions?

Sapp, 82-84

*Thomas Henry Huxley, "Report upon the Researches of Prof. Müller into the Anatomy and Development of the Echinoderms," *Annals and Magazine of Natural History*, 2nd ser., 8 (July 1851), selections on pp. 11-19, 1 plate.

*Rudolf Leuckart, *On the Polymorphism of Individuals* (1851), tr. LK Nyhart

C. "Darwin's" Theory, 1830-59: A British Imperial Solution to Unifying Nature?

How is it that both Darwin and Wallace came up with "the same" theory? What practices did the two men have in common? What problems in natural history did the theory of descent with modification through natural selection solve? How did it do so?

T 2/9: Darwin, Wallace, and British (Imperial?) Culture

Sapp, 16-30

*Jane Camerini, "Remains of the Day," in Bernard Lightman, *Victorian Science in Context* (Chicago: University of Chicago Press, 1997), 354-377

*Charles Darwin, *On the Origin of Species* (London: John Murray, 1859; reprint ed. Harvard University Press, 1964), 1-7, 80-96, 109-130.

Receive first essay question

R 2/11: The *Origin* as a Solution to the Problem of Unity of Type

*Darwin, *Origin*, 456-90.

Sapp, 36-40

****Saturday, 2/13: Darwin Day**** Extra credit (class part.) for attending events and sending me a one-page commentary on what you learned.

Unit II: The Unity and Disunity of Biology, 1870-1945

Analytical focus: Textbooks as a way in to understanding the unity and disunity of biology.

A. Unifying Biology through Pedagogy and Professionalization

Why was pedagogy an important route to unifying biology? What can the study of biology teaching tell us about the history of biology as a discipline?

T 2/16: T. H. Huxley's Program: Bringing Nature into the Lab

Sapp: 31-35

- *Graeme Gooday, "'Nature' in the Laboratory: Domestication and Discipline with the Microscope in Victorian Life," *British Journal for the History of Science*, 1991, 24: 307-41.
- *Thomas Henry Huxley, "On the Study of Biology" (1876) in *idem*, *Science and Education. Essays*. (New York: Appleton, 1896), 262-293.

R 2/18: "Biologie" in Germany: an ecological approach to unifying the study of living nature

Unit I essay due

- *Lynn K. Nyhart, "From Biology to Ecology," chapter 8 in *idem*, *Modern Nature* (Chicago: University of Chicago Press, 2009), 293-322.
- Intro to Unit II textbook project

B. The Vicissitudes of Uniting Evolution, Development, and Heredity

How were development, heredity, and evolution understood to be united in Haeckel's program? Why didn't this unity persist?

T 2/23: Haeckel's Program: Combining Ontogeny and Phylogeny

Sapp, 36-42

- *Ernst Haeckel, *The History of Creation* (trans. 1874) (New York: Appleton, 1887), pp. 1-23.
- *Churchill, "Living with the Biogenetic Law," in *From Embryology to Evo-Devo: A History of Developmental Evolution*, edited by Manfred D. Laubichler and Jane Maienschein (Cambridge, MA: MIT Press, 2007), 37-81.

R 2/25: The "Divorce" of the Studies of Heredity and Ontogeny and the Fragmentation of American Biology

- *Holmes, "Microscopic Organization," 55-59

Sapp, 130-135

- *Garland Allen, "A Century of Evo-Devo: The Dialectics of Analysis and Synthesis in Twentieth-Century Life Science," in *From Embryology to Evo-Devo: A History of Developmental Evolution*, edited by Manfred D. Laubichler and Jane Maienschein (Cambridge, MA: MIT Press, 2007), 123-167.

- *C. Hart Merriam, "Biology in Our Colleges: A Plea for a Broader and More Liberal Biology," *Science*, 21 (June 30, 1893), 352-355.

C. Genetics as a New Unifying Device

What made Morgan's gene theory so powerful? What consequences did this have for evolution in the early twentieth century?

T 3/2: Classical Genetics: Morgan's School

Sapp, 135-140

- *T. H. Morgan, "The Theory of the Gene," *American Naturalist* 51 (1917): 513-44
- *Robert E. Kohler, "Drosophila: A Life in the Lab" *J. Hist. Biol.* 1993, 26: 281-310

R: 3/4: From Population Genetics to the Evolutionary Synthesis

Sapp, 143-152

- *Robert E. Kohler, "Drosophila and Evolutionary Genetics: The Moral Economy of Scientific Practice," *History of Science*, 1991, 29(4): 335-74
- *Julian Huxley, *Evolution: The Modern Synthesis* (New York: Harper, 1942), 13-46

D. A Shift toward Synthesis? Evolution and Ecology

Both evolution and ecology are approaches to living things that view organisms as parts of complex

causal systems. Both rapidly developed new and powerful anchoring theories in the first half of the twentieth century. What sorts of questions was each emerging research community seeking to answer? What concepts helped structure their thinking? What seem to have been the crucial objects or levels of analysis?

T 3/9: The "Modern Evolutionary Synthesis"

Sapp, 151-156

*Ernst Mayr, Ch. 5, "The Systematic Categories and the New Species Concept," pp. 102-122
in idem, *Systematics and the Origin of Species* (Columbia Univ. Pr., 1942)

*Stephen Jay Gould, *The Structure of Evolutionary Theory* (Belknap/Harvard, 2002), 503-508, 518-21, 524-28, 533-43

R 3/11: Ecology

*Joel Hagen, *An Entangled Bank: The Origins of Ecosystem Ecology* (New Brunswick, NJ: Rutgers University Press, 1992), chapters 2 and 4, "A Rational Field Physiology" and "The Metabolic Imperative," 15-32, 50-77

*Robert E. Kohler, "Plants and Pigeonholes: Classification as a Practice in American Ecology" *Historical Studies in the Natural Sciences* 38(1), 2008: 77-108

T 3/16: Biology Textbook Project: What have we learned about biology in this period?

Textbook project due; small group discussions.

Unit 3: "The Episode Described as Molecular Biology," 1950s-2003

Analytical focus: Scientists' histories and historians' histories. What do we learn from scientists' retrospective accounts of events? How do we treat them critically and place them into larger pictures?

A. Situating Watson and Crick

R 3/18: The Genetics of Little Tiny Things: Viruses and Genes

Sapp, 168-79, 187-194

Watson, *The Double Helix*, front matter-78

T 3/23: The Path(s) to the Double Helix

Sapp, 187-194

Watson, *Double Helix*, 78-133, plus essays by Pauling (146-153), Klug (153-58), Perutz, Wilson, and Watson (207-212)

*Erwin Chargaff, "A Quick Climb Up Mount Olympus," *Science*, vol. 159, 29 March 1968: 1448-1449

R 3/25: The Genetic Code: Crick's Story and Its Context

Sapp, 194-200

*Francis Crick, *What Mad Pursuit: A Personal View of Scientific Discovery* (Basic Books, 1988), 15-23, 116-136

*Gunter Stent, "That Was the Molecular Biology That Was," *Science*, 160, 26 April 1968: 390-95

*Soraya de Chadarevian, *Designs for Life: Molecular Biology after World War II* (Cambridge University Press, 2002), 164-198

March 27-April 4: SPRING BREAK

B. From Molecular Biology to Genomics

T 4/6: Recombinant DNA: The Privatization of Molecular Biology

What institutional, cultural, and technical factors allowed the further development of recombinant DNA research beginning in the early 1970s? What were the peculiar cultural features of Cetus Corp. that contributed to its success?

*Sally Smith Hughes, "Making Dollars out of DNA: The First Major Patent in Biotechnology and the Commercialization of Molecular Biology, 1974-1980," *Isis* 2001, 92: 541-575

*Paul Rabinow, Chapter One, "Toward Biotechnology," in idem, *Making PCR: A Story of Biotechnology* (Chicago: University of Chicago Press, 1996), 19-45, 178-179.

R 4/8: The Human Genome Project and its Outcomes

Why was (is?) the Human Genome Project controversial? What has it accomplished? How did it grow out of pre-existing ideas, institutions, and expectations? What unexpected consequences grew out of it?

Sapp, 201-202

*Robert Mullan Cook-Deegan, "Origins of the Human Genome Project," *Risk: Health, Safety, and Environment*, Spring 1994, 5: 97-118

*Maynard V. Olson, "The Human Genome Project: A Player's Perspective," *Journal of Molecular Biology*, 319 (4) 17 June 2002, 931-942

T 4/13: Genomics and the Problem of the Gene

What has happened to the "gene" concept?

Sapp, 203-206, 214-216

*Evelyn Fox Keller, *The Century of the Gene* (Cambridge, MA: Harvard University Press, 2000), 1-10, 46-72

*Barry Barnes and John Dupré, *Genomes and What to Make of Them* (Chicago: University of Chicago Press, 2008), chapter 2, 47-74

R 4/15: Placing Molecular Biology into a Larger Narrative

*Bruno Strasser, "GenBank—Natural History in the 21st Century?" *Science* 322, 24 October 2008: 537-38.

*Michel Morange, "The Death of Molecular Biology?" *History and Philosophy of the Life Sciences* 30 (2008), 31-42.

Unit 4: Some New "Synthetic" Biologies

Analytical focus: How do historians and scientists construct histories for new fields? How are images of biology's past and future connected?

A. Cross-Species Blending

T 4/20: Nature: Lateral Gene Transfer, Endosymbiosis and "Symbiomics"

How has the study of bacteria and viruses changed evolutionary theory in recent years? How does Sapp's recounting of the history of endosymbiosis change the trajectory we think of as "the" history of biology?

Sapp, 234-251

*Margaret McFall-Ngai, "Love the One You're With: Vertebrate Guts Shape Their Microbiota," *Cell*, 20 October 2006, 127: 247-249.

*Michael Specter, "Darwin's Surprise; Annals of Science" *The New Yorker*, 3 December 2007 (downloaded 12/30/07), 1-14.

R 4/22: Culture: From Bioengineering to "Synthetic" Biology

- *Allison Snow, "Genetic Modification and Gene Flow: An Overview," in Daniel Lee Kleinman et al., *Controversies in Science and Technology: From Maize to Menopause* (Madison: University of Wisconsin Press, 2005), 107-11
- *Kenneth A. Worthy, et al., "Agricultural Biotechnology Science Compromised: The Case of Quist and Chapela," in *ibid.*, 135-149
- *Luis Campos, "That Was the Synthetic Biology That Was," in *Synthetic Biology: The Technoscience and Its Societal Consequences*, edited by Markus Schmidt et al. (Dordrecht: Springer, 2009), 5-22.

B. Evo-Devo: A "New New" Evolutionary Synthesis?

4/27: Evo-Devo

- *Seán Carroll, *Endless Forms Most Beautiful: The New Science of Evo-Devo*, selections
- *Gerd B. Müller, "Six Memos for Evo-Devo," in *From Embryology to Evo-Devo: A History of Developmental Evolution*, edited by Manfred D. Laubichler and Jane Maienschein (Cambridge, MA: MIT Press, 2007), 499-524.

4/29: Modularity: A New Mediating Concept?

- *Rasmus Winther, "Varieties of Modules: Kinds, Levels, Origins, and Behaviors," *Journal of Experimental Zoology (Mol. Dev. Evol.)*, 2001, 291: 116-129
- *another reading to be determined.

5/4: Historicizing Evo-Devo

- *Manfred Laubichler, "Does History Recapitulate Itself? Epistemological Reflections on the Origins of Evolutionary Developmental Biology," in *From Embryology to Evo-Devo: A History of Developmental Evolution*, edited by Manfred D. Laubichler and Jane Maienschein (Cambridge, MA: MIT Press, 2007), 14-33.
- *Günter P. Wagner, "The Current State and the Future of Developmental Evolution" in *From Embryology to Evo-Devo: A History of Developmental Evolution*, edited by Manfred D. Laubichler and Jane Maienschein (Cambridge, MA: MIT Press, 2007), 525-545

5/6: Wrap-Up

Final Paper due Tuesday, May 11, at 2:30 pm in my mailbox in Bradley Memorial Building.

Academic Performance and Accommodation:

Essays: Every essay you write should take the form of an argument supporting a thesis. Since all essays are open-book, grading will NOT depend solely or even primarily on the correctness of the facts marshaled for your argument; this correctness is assumed as a base-point. Rather, much of your grade will be based on the persuasive power, sophistication, originality, and succinctness of your argument. (More on this during the course.)

Extensions are only granted if requested before the due date, and only in case of illness or other serious emergency. All extensions will have a definite new due date established. Papers received after the new due date will be subject to late paper penalties.

Late paper policy: any piece of writing that you hand in late without an extension will have the following penalties assessed: a quarter of a grade for every working day late. For example, if the paper on its merits deserves a B, after one day it would receive a B/BC, after two days a BC, after three a BC/C, after four a C. NOTE: LATE FINAL ESSAYS (due May 11) WILL NOT BE ACCEPTED.

Academic Credit and Plagiarism: Students may not copy sentences or ideas from others (including authors, websites, or other students) without giving credit to those sources; if someone else's words are so wonderful that you cannot substantially rephrase them, you must put them inside quotation marks, using the exact same words. If you omit the quotation marks or the credit, you are plagiarizing. Plagiarism is grounds for failure on the assignment plagiarized; repeated plagiarism is ground for failure in the course. If you use 3 or more words in a row from another source, they must be placed in quotation marks and footnoted. Otherwise, it is plagiarism. For more details on what plagiarism is and how to avoid it, consult a style manual or the Writing Lab.

Appealing a Grade: If you have questions about a grade, come speak to me. If the problem is not resolved, speak with the Undergraduate Chair, Prof. Florence Hsia. She will attempt to resolve the issue informally and inform you of the Appeals Procedures if no resolution is reached informally.

Access and Accommodation: I will make every effort to honor requests for reasonable accommodations made by individuals with disabilities. (If you think you qualify for accommodation, please contact the McBurney Disability Resource Center [263-2741; <http://jumpgate.acadsvcs.wisc.edu/~mcburney/>] to establish your eligibility for services.) Requests for accommodation can be responded to more effectively if I receive them as far in advance as possible, preferably at the beginning of the semester. Such requests are confidential.

Religious Observance: If religious holidays or observances conflict with your participation in this course, please come talk to me **well in advance** for us to work out alternative arrangements. If any other problems arise, either academic or personal, which might jeopardize your performance in the course, you must try to inform me after class or by the soonest available office hour, by email (lknyhart@facstaff.wisc.edu), or by leaving a message with the History of Science department administrator (262-1406).

Grading Scale for Take-Home Essays:

[note: papers involving research will also be graded on quality and quantity of research effort.]

- A: For outstanding essays only. Thesis and argument are clear, thought-provoking, and based on correctly understood facts; material used to support the argument synthesizes ideas from different parts of the course (readings, lectures, discussions from different weeks); relationships drawn between facts and ideas are sophisticated, subtle, and/or original. Writing is grammatically correct and succinct. The argument flows well from point to point, without any puffery or wasted words.
- AB: For very good essays that for some reason fall short of the criteria listed above. For example, the argument may be murky in one place; information may be presented that doesn't directly or clearly contribute to the argument; writing style may be awkward here and there, or flawed by one or two consistent (if minor) grammatical errors.
- B: Your basic okay grade. The essay may pursue a straightforward but not especially deep or sophisticated argument; it is okay as far as it goes, but doesn't penetrate the material very far. It may have a flash of brilliance that is unfulfilled, counterbalanced by minor grammatical problems, a weakness in argumentation, and/or a significant misunderstanding of events or chronology.
- BC: The essay shows some of the basics of the ideal essay, but is weakened by a lack of serious think-work or writing problems. It may make superficial connections without offering sufficient evidence to make the connections plausible or persuasive, or it may have what is in principle a good argument supported by incorrect facts or chronology. Alternatively, it may provide a fairly solid argument with minor flaws, from which the reader is repeatedly distracted by awkward or ungrammatical prose.
- C: A grade signifying some serious problem in essay-writing. It may deliver facts without a recognizable thesis or argument; it may wander away from the point; or it may be a thoughtful attempt so weakened by writing problems (grammar, punctuation, word choice) that it is difficult for the reader to understand a crucial point you are trying to make.
- D: A marginal grade. There may be enough in here to show you have attended a few lectures and/or done some of the reading, but the essay indicates no effort at synthesis or thinking on your own, or else shows a serious misunderstanding of the nature of the material and/or the assignment. Also used for essays that are just barely coherent.
- F: For unacceptable essays. An essay may be judged unacceptable if it contains plagiarism (see below); if it consists primarily in content inappropriate to the question or the material for this course; if it shows a complete misunderstanding of the course content; or if the writing fails to meet standard college-level requirements of basic communication in English.

