

History of Science 333: History of Modern Biology
Spring 2008
Prof. Lynn Nyhart
TR 11-12:15 in 6112 Social Science

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Office Hours: Tuesdays 12:45-2:30 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 the study of all the living world into a single scheme under a small number of unifying laws. From then to now, the desire to find a single key to understanding life has been a powerful motivator. In this year’s course, we examine scientists’ efforts to unify the study of life around a single theme or idea, including Lamarck’s “Biologie” of 1800; unity of type; the cell theory; Darwinian evolution; the “classical” theory of the gene; the “modern” evolutionary synthesis of the 1940s; DNA and molecular biology. Recognizing that life is complicated, some biologists have also worked across these levels of analysis, seeking to integrate them, and we will also study some of these efforts for more complex syntheses, such as the unification of cell studies and evolution in the late nineteenth century and the “modern” evolutionary synthesis of the 1940s. We will situate these topics in relation to particular scientific and social practices in particular locations as scientists sought to advance biology.

We will also pay self-conscious attention to the different kinds of sources historians have to work with for understanding the history of biology, concentrating sequentially on texts and images in the first part of the course; objects in the second part; and experimental systems and scientists’ own accounts in the last part.

There are 4 required texts:

- *Jan Sapp, *Genesis: The Evolution of Biology* (Oxford University Press, 2003)
- *Robert E. Kohler, *Lords of the Fly* (University of Chicago Press, 1993)
- *James D. Watson, *The Double Helix* (Norton Critical Edition, 1980)

(books available for purchase at University Book Store and at Underground Textbook Exchange)

*HS 333 Course Reader, on sale at History of Science Department office, 7143 Social Science, 8 a.m.-3:00 pm M-F (open to 5 pm the first week of class). Course readers are NOT refundable, even if you drop the course!

A copy of all readings is on reserve at College Library. A copy of the first week’s reading from the reader is on the Learn@UW course website, in case it takes some time for the reader to come back from the bindery.

Undergraduate Course Requirements:

- 20% five analytical discussion pieces responding to the readings for a particular day (each approximately 400-500 words long). You may do one or two in Units I and III, as you choose; you **MUST** do two in Unit II. Discussion pieces are to be emailed to me no later than 8 a.m. on the day of the class; you must also turn in a hard copy in class.
- 20% 1st essay (textual analysis, approx. 1500 words, covering beginning of course thru 2/14), due Tuesday, Feb. 21, in class
- 20% 2nd essay and display text (object analysis from zoology museum, approx 1000 words, plus 1-page display text), due Tuesday, April 1, in class.
- 20% 3rd essay (historiographic analysis, approx. 1500 words), due Tuesday, May 13 @ 2:30 pm.
- 20% class participation (includes preparing questions for class—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 have two choices: 1) You may extend your object analysis into a 10-page research paper, due the last class day. Or 2) you may research one of the topics on the schedule from 4/17 to 5/6; make a 20 minute presentation to the class during the appropriate lecture time that week; and hand in a 5-7 page paper describing your research process and results. It is expected that you and I will be in close consultation during the semester as you develop your research and whittle it down to a workable size. The honors project will count as 15% of your overall grade, with 5% taken away from each of your other written assignments. See Honors Handout for more details.

Graduate Student Course Requirements:

Grades will be based on a combination of discussion of readings, including informal writing (40%) and formal writing (60%).

Readings/discussions: There will be additions to the undergraduate readings, which will be discussed during our separate discussion section on Wednesdays. We will read all of Toby Appel, *The Cuvier-Geoffroy Debate*; Laura Otis, *Müller's Lab*; selections from Angela Creager at al., *Science without Laws*; Angela Creager, *Life of a Virus*; and Kaushik Sunder Rajan, *Biocapital*. Shorter additional graduate readings will be made available a week in advance in the seminar room for photocopying. Graduate students are **NOT** expected to do reading responses for the common course readings, but you are expected to supply brief (1-page) critical summaries of the grad student readings to bring to discussion.

Writing: Graduate students will normally produce a minimum of 20-25 pages of scholarly prose, in a form appropriate to your stage in grad school and your interest in the material. This could be a research paper (especially recommended for first-year students); a series of book reviews (due the week the book in question is relevant to the discussion); an historiographic/bibliographic essay; a dissertation or grant proposal; or some other form of writing that we agree upon. Each graduate student's writing schedule will be tailored to their project, in consultation with me.

Schedule of Topics

Week 1: Introductions

T 1/22: Course intro: Unifying the study of life; opening discussion and ice breaker

W 1/23: first grad discussion: come to meet each other, discuss projects for semester

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

Note: All readings marked with * are in the course reader.

Weeks 1-2: Life at the Paris Museum, 1790s-1830s: Comparative Anatomy and Classification

Issues for 1/24-1/31: 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 1/24: Studying “Life” in Paris ca. 1800.

Sapp 3-11;

*Lamarck, *Zoological Philosophy*, 181-210

*Toby Appel, *The Cuvier-Geoffroy Debate*, 11-19, 246-248

T 1/29: Georges Cuvier, Legislator of Science

Sapp, 11-13

*Toby Appel, *The Cuvier-Geoffroy Debate* (New York: Oxford University Press, 1987), 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), 10-17 [n.b. this begins partway into this reading]

W 1/30: Grads: read all of Appel

R 1/31: The Cuvier-Geoffroy debate

What divided Cuvier and Geoffroy?

Sapp, 13-15

*Hervé Le Guyader, *Étienne Geoffroy Saint-Hilaire 1772-1844: A Visionary Naturalist*, 1-10, 17-19; 135-146 [Cuvier], 152-165 [Geoffroy]

Week 3: The Cell as the Key to Life in Germany, 1830s-1840s

What was the character of microscopical science in Germany in the 1830s and 1840s? What did scientists think they could learn about with the microscope? What might have caused the upswing in interest? (Consider different levels of causation.)

T 2/5: 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 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.

W 2/6: Grads read Laura Otis, *Müller's Lab* (all)

R 2/7: Cell 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)

Saturday, 2/9: Darwin Day Extra credit (class part.) for attending events and sending me a one-page commentary on what you learned.

Week 4: "Darwin's" Theory, 1830-59: A British Imperial Solution to Unifying Nature?

For this week: 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 2/12: Darwin, Wallace, and British (Imperial?) Culture

Sapp, 16-30

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

*Charles Darwin, *On the Origin of Species* (1859; reprint ed. 1964), 1-7, 80-96, 109-130.

Receive first essay question

W 2/13: Grads read Melinda Fagan, "Wallace, Darwin, and the Practice of Natural History," *J. Hist. Biol.*, Winter 2007, 40(4): 601-635.

R 2/14: The *Origin* as a Solution to the Problem of Unity of Type

*Darwin, *Origin*, 456-90.

*Lynn K. Nyhart, "Embryology and Morphology" in Michael Ruse and Robert J. Richards, *The Cambridge Companion to the Origin of Species*, forthcoming 2008

Sapp, 36-40

Unit II: Making Biology a Discipline, 1870-1945

Week 5: Inventing the Discipline of Biology

How did the popular science of "natural history" turn into the professionalized discipline of "biology" in late nineteenth-century Britain and America?

T 2/19: T. H. Huxley's program

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.

W 2/20: Grads read Joseph Caron, "'Biology' in the Life Sciences: A Historiographical Contribution," *History of Science*, 1988, 26: 223-268; Nyhart, "Natural history and the 'new' biology" in *Cultures of Natural History*

R 2/21: Building Biology in the U.S.

*Keith Benson, "From Museum Research to Laboratory Research: The Transformation of Natural History into Academic Biology," in Ronald Rainger, Keith Benson, and Jane Maienschein, eds., *The American Development of Biology* (Rutgers University Press, 1991), 49-83

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

*Lowell E. Noland, "History of the Department of Zoology, University of Wisconsin," *Bios* 21(2), 1950, 83-109.

Week 6: The Many Foci of Biology in the Late Nineteenth Century

T 2/26: Introduction to Zoology Object Project

(**Meet at Zoology Museum, 4th Floor, Noland Hall**)

first essay due

W: Grad choice for discussion

R 2/28: Late Nineteenth-Century Heredity

How did the scientists view the cell as simultaneously answering questions about generation, development, and evolution? What had changed since the mid-nineteenth century?

*Holmes, "Microscopic Organization," 55-59 (filed earlier in reader)

Sapp, 82-94

*August Weismann, *The Germ-Plasm. A Theory of Heredity*. Trans. W. Newton Parker and Harriet Rönfeldt. (New York: Charles Scribner's Sons, 1893), 1-35, 75-77

Week 7: Breeding, Heredity, and the Emergence of Genetics

What practical and ideological considerations shaped the understanding and development of genetics after the "rediscovery" of Mendel's laws in 1900? How did they do so?

T 3/4: Mendelism and the Mutation Theory of de Vries

Sapp 117-129

*Hugo de Vries, "Evolution and Mutation," in idem, *Plant Breeding* (Chicago: Open Court, 1907), 1-26.

W 3/5: Grad choice for discussion

R 3/6: Genetics, Eugenics, and the Shape of Biology in the U.S.

Sapp, 130-135

*Barbara Kimmelman, "The American Breeders' Association: Genetics and Eugenics in an Agricultural Context, 1903-1913," *Social Studies of Science*, 1983, 13: 163-204.

*Michael Guyer, *Being Well-Born: An Introduction to Heredity and Eugenics* (Bobbs-Merrill, 1916, 2nd ed., 1927), front matter, 412-441.

Week 8: “Classical” Genetics

What made Morgan’s gene theory so powerful? What consequences did this have for the overall shape of biology as a scientific discipline in the early twentieth century?

T 3/11: Establishing the Reality of the Gene

Sapp, 135-140

*T. H. Morgan, “The Theory of the Gene,” *American Naturalist* 51 (1917): 513-44

W 3/12: Grad choice for discussion

R 3/13: *Drosophila* and the Production of Genetic Knowledge

Robert E. Kohler, *Lords of the Fly* (University of Chicago Press, 1994), 19-56, 87-132

SPRING BREAK

Week 9: The “Modern” Evolutionary Synthesis

What did the “modern synthesis” synthesize? What did it accept, and what did it reject? Which problems and organisms (and their researchers) were privileged in this process, and which were marginalized?

T 3/25: Developing the “Modern” Evolutionary Synthesis

Sapp, 143-152

Kohler, *Lords*, 250-286

*Julian Huxley, *Evolution: The Modern Synthesis* (New York: Harper, 1942), 13-46

W 3/26: Grad choice for discussion

R 3/27: The Synthesis triumphant: Inclusions and Exclusions

Sapp, 152-156

*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), 503-543

Week 10: Transition to Models and Systems

T 4/1: Zoology Object Project Displays (**Meet in Zoology Museum Lab, 4th Floor Noland Hall)

*object analysis due; one-page write-up to be displayed with object

W 4/2: Grads read selections from Angela N. H. Creager, Elizabeth Lunbeck, and M. Norton Wise,

Science without Laws: Model Systems, Cases, Exemplary Narratives (Duke University Press, 2007)

Part III: The Molecularization of Biology

R 4/3: Genes and Development: From *Drosophila* to *Neurospora*

Kohler, *Lords*, 208-249

Sapp, 157-170

Week 11: Studying Genetics through Micro-organisms

T 4/8: Tobacco Mosaic Virus vs. Phage

*Angela N. H. Creager, *The Life of a Virus: Tobacco Mosaic Virus as an Experimental Model*, 1930-1965, pp. 1-16, 185-248

Come hear Angela Creager's public lecture, "After the Double Helix: Rosalind Franklin's Research on Tobacco Mosaic Virus," Tuesday at 3:30 pm (room TBD).

W 4/9: Graduate students: Creager, *Life of a Virus*, all

R 4/10: Analyzing the Rise of Molecular Biology: A Discussion with Angela Creager
James Watson, *The Double Helix*, Front matter to p. 78
Sapp, 187-194

Week 12: DNA and the Genetic Code: Founders' Tales

T 4/15: Watson's Tale and its Vicissitudes

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

W 4/16: Grad discussion: Pnina Abir-Am, "The First American and French Commemorations in Molecular Biology: From Collective Memory to Comparative History," *Osiris*, 2nd ser., 14 (1999): 324-370

R 4/17: Information and 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

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

Week 13: Biotechnology and Genomics

T 4/22: 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.

W 4/23: Grads read: Susan Wright, "Recombinant DNA Technology and its Social Transformation, 1972-1982," *Osiris*, 2nd ser., 1986, 2: 303-60

R 4/24: The Human Genome Project

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

Week 14: Re-Introducing Complexity into Biology

The natural world is characterized by complexity, whereas scientists usually seek simple unifying laws. How have biologists in recent decades dealt with this tension? Both intellectually and culturally, why is complexity such a big problem?

T 4/29: Structure, Function, and the Genome

Sapp, 203-206, 214-16

*Tom Bethell, "A Map to Nowhere: The Genome Isn't a Code and We Can't Read It," *The American Spectator*, 34 (3), April 2001: 51-56.

*Evelyn Fox Keller, *The Century of the Gene*, 1-10, 46-72

W 4/30: Grads: Kaushik Sunder Rajan, *Biocapital: The Constitution of Post-Genomic Life*

R 5/1: Carl Woese and archaea

Sapp, 217-233

*Carl Woese, "The universal ancestor," *PNAS* 95, June 1998, 6854-6859

*Ernst Mayr, "Two empires or three?" *PNAS* 95, August 1998, 9720-9723

*Carl Woese, "Default taxonomy," *PNAS* 95, September 1998, 11043-11046

Week 15: New Horizons and (Re-)Writing the History of Biology

T 5/6: Bacteria, Viruses, and Evolution Today

How has the study of bacteria and viruses changed evolutionary theory in recent years? How does Sapp's recounting of this history 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.

W 5/7: Grads: wrap-up discussion

R 5/8: Biology Present, Past, and Future

Sapp, 267-271

*Stephen P. Rose, "The Biology of the Future and the Future of Biology," *Journal of Molecular Biology*, 17 June 2002, 319 (4): 877-884 (ScienceDirect)

Final Essay due Tuesday May 13, at 2:30 pm.

Course Website. We will be using “Learn@UW,” an interactive course website, for posting assignments and your discussion pieces and questions. 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:
<https://uwmad.courses.wisconsin.edu/> (You can reach it from the UW home page, too, under “My UW Madison.”) This is your Learn@UW login page. 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,” 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.

Academic Performance and Accommodation:

Essays: The essay questions ask you to think synthetically, drawing material from different weeks together into a unified picture. 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 13) 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 (take-home exam or paper); 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. Michael Shank. He 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).

Essay Grading Scale:

- 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, 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.