

History of Science 333: History of Modern Biology

Spring 2006

MWF 9:55 (grad student discussion section meets 8:30 R)

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Office Hours: Weds. 1:30-3:15 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. 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 focus on a series of 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; the “modern” evolutionary synthesis of the 1940s; and “evo-devo.” Across these topics, we will grapple with biologists’ ideas about the nature of life, individuality, and levels of biological organization; analyze a variety of scientific practices and methods; and consider the institutional and broader politics of biology as it has developed over the last two centuries.

There are 3 required texts:

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

*Francis Crick, *What Mad Pursuit: A Personal View of Scientific Discovery* (Basic Books, 1990)

(both available for purchase at University Book Store and at Underground Textbook Exchange, temporarily located in the basement of the Varsity building, 401 N. Lake St.)

*HS 333 Course Reader (\$42, check or cash only, exact change preferred), on sale at History of Science Department office, 7143 Social Science, 8 a.m.-3:00 pm M-F (open to 5 pm this week. 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:

- 35% seven analytical reading responses (approximately 400-500 words long, 5% each), to be framed around the weekly discussion questions. At least three must be from weeks 2-7. You may do more for extra credit. Responses are to be emailed to me no later than 8 a.m. Friday; please also turn in a hard copy in class.
- 20% midterm essay (approx. 1500 words), due Friday, March 10 in class (or before)
- 30% final essay (1800-2000 words), due Monday, May 8 @ 2:30 pm.
- 15% class participation (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 will research one of the topics from weeks 13 and 14 (the Human Genome Project; What has happened to the gene concept?; Carl Woese and Archaea; the rise of Evo-Devo; Intelligent Design) and make a 20 minute presentation during the appropriate lecture time that week. In addition, you will 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 20% of your overall grade, with 5% taken away from each other item of the grade. (You will do only 6 reading responses, 3 from weeks 2-7 and 3 from weeks 9-12 and whichever week is not your week to present.) See Honors Handout for more details.

Graduate Student Course Requirements:

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

Reading: There will be occasional additions to the undergraduate readings, including all of Hervé Le Guyader, *Etienne Geoffroy St. Hilaire: A Visionary Naturalist*, Robert E. Kohler, *Lords of the Fly* (to be ordered), and Angela Creager, *Life of a Virus*. 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, though you may want to think about the questions posed in them.

Writing: Graduate students will 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. Each graduate student's writing schedule will be tailored to their project, in consultation with me.

Academic Performance and Accommodation:

Take-home 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.

Plagiarism: plagiarism is grounds for failure on the assignment plagiarized (take-home exam or paper). If you use 3 or more words in a row from another source, it 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).

See also Grading Scale, appended to the last page of this 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 “favorite” file): <https://uwmad.courses.wisconsin.edu/> (You can reach it from the UW home page, too.) 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,” 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.

Topics Week by Week

Week 1: Introductions

Wed. 1/18: Course intro: Unifying the study of life

1/19-1/20: Opening discussion and ice breaker- BE THERE!

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

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

Week 2: "Life" in Paris, 1796-1832: Unity of type and the comparative method

1/23: What did it mean to study "life" ca. 1800?

Sapp 3-13;

*Lamarck, *Zoological Philosophy*, 181-210

1/25: The Cuvier-Geoffroy debate

Sapp, 13-15

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

Grad students: read all of Le Guyader; also Caron, "Biology," 223-237. Check in with me this week or next re: what type of writing work you want to do this semester; set schedule.

1/26-1/27: Discussion: Around what principles--methodological, 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?

Week 3: Other Versions of Unity

1/30: Biology and development in Germany

* Stephen Jay Gould, *Ontogeny and Phylogeny*, pp. 35-45, 52-63, 415-19

2/1: British responses to Continental morphologies

Sapp, 35-36

*Nicholas Rupke, *Richard Owen*, 162-173, 188-196, 376-380

Graduate students: Caron, "Biology," 237-247

2/2-2/3: Discussion: 1) Consider the differences between Oken and von Baer. How do they compare to the differences between Geoffroy and Cuvier? 2) Compare the ideas of unity of type expressed by Oken and Owen. How might they reflect their settings? In particular, to what local situations might Owen's integration of German and French approaches have been a response?

Week 4: Darwinian Evolution and the Tree of Life

2/6: The development of Darwin's theory

Sapp, 16-30

*Charles Darwin, *On the Origin of Species* (1859), ch. 4 excerpts, from *The Darwin Reader*, ed. Mark Ridley (W.W. Norton, 1996), 101-126

2/8: The *Origin* and responses

Sapp, 43-54, 63-72

2/9-10: Discussion: Analyze Darwin's diagram of divergence. How does this illustrate how Darwin solved the problem of unity of type? What new problems did his solution present in its wake? What were the social and cultural implications of the unity that Darwin's theory presented?

***extra credit: Attend "Darwin Day" public events on Saturday, 2/11 and write up your notes.

"Darwin Day" organizers are looking for volunteers to help out! If you are interested, please contact me as soon as possible

Week 5: Cell theory and the problem of individuality

2/13: Schleiden and Schwann's cell theory

Sapp, 75-81

*Frederic L. Holmes, "The Microscopic Organization of Plants and Animals," (unpublished ms.), 11-55 (note this is not quite all the selection)

2/15: Individuality and the organism as a "state"

*Rudolf Virchow, "Atoms and Individuals" (1859), from *Disease, Life, and Man: Selected Essays by Rudolf Virchow*, tr. Leland J. Rather (Stanford University Press, 1958), 120-141

*Andrew Reynolds, "Metazoic Politics and Unicellular Citizens: The Cell State Metaphor in Nineteenth and early Twentieth Century Biology" (unpublished ms.)

Grad student additional reading: James Elwick, "Habits of Reasoning in early- to mid-Victorian Life Research: Analysis and Palaetiology," unpublished ms. (subject to receiving permission)

2/16-17: Discussion: How did metaphor and visual images shape the conceptions of cellular and organic individuality in the nineteenth century? Compare the approaches of Sapp, Holmes and Reynolds in analyzing ideas about research and theorizing on cells and individuals.

Week 6: "Biology" after Darwin: New Bases for Unity?

2/20: Huxley's program

Sapp: 31-36

*Thomas Henry Huxley, "On the Study of Biology" (1876) in *idem, Science and Education. Essays*. (New York: Appleton, 1896), 262-293.

*Joseph Caron, "'Biology' in the Life Sciences: A Historiographical Contribution," *History of Science* 26 (1988), excerpt: 247-255, 265-268

2/22: "Biology" in Germany

Sapp: review 36-42

Haeckel's program, *Biologie in museums and schools*; "allgemeine Biologie"

*Ernst Haeckel, The History of Creation (trans. 1874) (New York: Appleton, 1887), pp. 1-23.

*Lynn K. Nyhart, "Natural History and the 'New' Biology," pp. 426-443, 490-491 in

Cultures of Natural History, ed. N. Jardine, J.A. Secord and E.C. Spary (Cambridge University Press, 1996)

Graduate student additional reading: Lynn K. Nyhart, *Modern Nature* (ms.), chapters 5 and 6

2/23-24: Discussion: On what ideas and resources did Huxley and Haeckel draw in developing their programs for “biology” in the late 19th century? How did the situations differ in Britain and Germany? To what causes might we attribute those differences?

Week 7: The Activities of the Cell: Generation and Development

2/27: The cell in development, heredity, and evolution

Sapp, 82-94

*August Weismann, *The Germ-Plasm. A Theory of Heredity*. Trans. W. Newton Parker and Harriet Rönnfeldt. (New York: Charles Scribner's Sons, 1893), pp. 1-35, 75-77, 392-409.

3/1: Getting inside the cell

**Receive midterm essay question

Sapp, 95-108

*Frederic L. Holmes, “Microscopic Organization” (filed earlier in reader), 55-59

*Ariane Droescher, “E.B. Wilson’s *The Cell* and Cell Theory between 1896 and 1925,” *Hist. Phil. Life Sci.*, 2002, 24: 347-389

3/2-3: Discussion: How did cell theorists Weismann and Wilson think their subject unified biology at the turn of the twentieth century? How did the scientists view the cell as simultaneously answering questions about generation, development, and evolution? What had changed since the mid-nineteenth century? Review/discussion of midterm essay

Part II: The Century of the Gene

Week 8: The Theory of the Gene

3/6: The rediscovery of Mendel’s laws

Sapp 117-124

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

3/8: The Morgan School and “classical” genetics

Sapp, ch. 12, 130-142

*T. H. Morgan, “The Theory of the Gene,” *American Naturalist* 51 (1917): 513-54

* Robert E. Kohler, “Drosophila: A Life in the Lab” *J. Hist. Biol.* 1993, 26: 281-310

Graduate student reading: Kohler, *Lords of the Fly*

3/9-10: Discussion: Consider the experimental work of Hugo de Vries as compared to Morgan and his school. How did the theory of the gene develop? How did it change the playing field of biology?

**Midterm essay due

SPRING BREAK

Week 9: The Evolutionary Synthesis: Integrating Genetics and Evolution

3/20: Developing the “modern” evolutionary synthesis

Sapp, 143-152

*Mark B. Adams, “Sergei Chetverikov, the Kol’tsov Institute, and the Evolutionary Synthesis,” pp. 242-278 in Ernst Mayr and William Provine, *The Evolutionary Synthesis: Perspectives on the Unification of Biology* (reprint edition, Harvard U. Press, 1998)

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

3/22: The Synthesis triumphant: inclusions and exclusions

*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

3/23-24: Discussion: 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?

Week 10: The Genetics of Little Tiny Things

3/27: Using bacteria to study genes

Sapp, 157-170

*Roberta Bivins, “Sex Cells: Gender and the Language of Bacterial Genetics,” *J. Hist. Biol.* 33 (2000): 113-139

3/31: Viruses and Genes

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

Graduate students: Creager, *Life*, chs. 1-3, 5 (n.b. skip Creager selection in reader)

3/30-31: Discussion: How were viruses and bacteria used to study genetics between the 1920s and the 1950s? What technologies and techniques were developed to make this possible? What assumptions did scientists working on these creatures make about the relations between the study of little tiny things and more familiar realms of biological existence, such as people?

Week 11: Molecularizing Biology

4/3: The Path(s) to the Double Helix

Sapp, 187-194

Francis Crick, *What Mad Pursuit: A Personal View of Scientific Discovery* (Basic Books, 1988), 1-79

4/5: Information as an Organizing Concept in the Postwar Period: The Genetic Code, 1952-1966

Sapp, 194-200

Crick, *What Mad Pursuit*, 89-142

Graduate students: Creager, *Life*, chs. 4, 6-8

4/6-7: Discussion: Crick calls his book “a personal view of scientific discovery.” What is his view of discovery? What is personal about it, do you think? What issues should a reader keep in mind when using a memoir or autobiography to reconstruct history?

Week 12: From Recombinant DNA to Biotechnology

4/10: Recombinant DNA (1): The Debate, ca. 1975

*Science for the People, “Biological, Social and Political Issues in Genetic Engineering,” pp. 99-126 in David A. Jackson and Stephen P. Stich, eds., *The Recombinant DNA Debate* (Englewood Cliffs, N.J.: Prentice-Hall, 1979)

*Joshua Lederberg, “DNA Splicing: Will Fear Rob Us of Its Benefits?” (1975) reprinted in *ibid.*, pp. 173-180.

*Susan Wright, “Recombinant DNA Technology and its Social Transformation, 1972-1982,” *Osiris*, 2nd ser., 1986, 2: 303-325 (=Parts I-III)

4/12: Recombinant DNA (2): The (Re)Entry of Industry

*Susan Wright, “Recombinant DNA Technology and its Social Transformation, 1972-1982,” *Osiris*, 2nd ser., 1986, 2: 325-60 (Part IV-end)

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

4/13-14: Discussion: Gauge your gut reactions to the first two readings. With the hindsight of 30 years, do the various worries expressed there seem to you to have been reasonable? Why or why not? What has happened in the meantime to make these worries seem so dated? For the other two readings: 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?

Week 13: Genomics and Beyond (possible honors projects)

4/17: The Human Genome Project

Sapp, 201-202

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

*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. (This reading is NOT IN THE READER; you may find it on the course Learn@UW website.)

4/19: Genomics and the Problem of the Gene

Sapp, 203-216

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

4/21: Discussion: 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?

Week 14: New models for Evolution: Unity and Complexity (possible honors projects)

4/24: 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

4/26: Explaining order and complexity: Evo-Devo and Intelligent Design

Sapp, 234-251

*Scott F. Gilbert, John M. Opitz, and Rudolf A. Raff, "Resynthesizing Evolutionary and Developmental Biology," *Developmental Biology* 173 (1996), 357-372

*Kitzmiller v. Dover Area School District, "Memorandum Opinion" by Judge John E. Jones III, pp. 64-89

4/27-28: *Discussion: The natural world is characterized by complexity, whereas scientists seek simple unifying laws. How have evolutionary scientists in recent decades dealt with this tension? Both intellectually and culturally, why is complexity such a big problem?*

Week 15: Retrospect and Prospect

5/1: What is Biology now?

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

possible other reading TBA

Receive final essay question

5/3: Final Overview

5/5: Optional Review/Q&A (no grad discussion)

Final Essay due Monday May 8 @ 12:25 pm.

Grading Scale for Essays:

- 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.