

History of Science 203

Science in the 20th Century: A Historical Overview

Fall 2009

3 Credits; Z (Humanities or Social Studies)

2 hours lecture (1:20pm MW, 5231 Social Sciences), 1 hour discussion.

Instructor

Richard Staley, 226 Bradley Memorial

Tel: 262-3978, (h): 231-9940

Email: rastaley@wisc.edu

Office Hours: 2:25 M, 10:30 F

TA

Scott Prinster, 324 Bradley Memorial

Tel: 262-3999

Email: prinster@wisc.edu

Office Hours: 2:30 W, and by appt.

This course surveys the history of science in the twentieth century, from the discovery of x-rays and radioactivity in the 1890s through to the complex of scientific and social questions raised by the human genome project and stem cell research circa 2000. The period has seen spectacular transformations in the reach of modern science and technology, accompanied by the increasing specialization and fragmentation of knowledge. Here we explore the changing dimensions of science in an age of unprecedented promise and conflict. Tracing the evolution of physics and biology and exploring the emergence of environmentalism through the course of the century, we examine major conceptual developments, the interaction of science and society, and the impact of war on science and technology.

Book List (*University Bookstore and other Madison bookstores*)

Diane B. Paul, *Controlling Human Heredity: 1865 to the Present* (Humanities Press, 1995). Required.

Daniel J. Kevles and Leroy Hood, eds. *The Code of Codes: Scientific and Social Issues in the Human Genome Project* (Harvard University Press, 1992). Required.

Arthur I. Miller, *Einstein, Picasso: Space, Time, and the Beauty that Causes Havoc* (Basic Books, 2001). Required.

Jeff Hughes, *The Manhattan Project: Big Science and the Atomic Bomb* (Columbia Univ. Press and Icon Books, 2003). Required.

James D. Watson, *The Double Helix*, ed. Gunther S. Stent, (Norton, 1980). Required.

Course Reader Available for \$22.00 by cash or check from the History of Science Department Office (210 Bradley Memorial); note that returns are not possible.

All reading materials are also available on reserve at the College Library.

Assessment

Assessment is through three take-home essay exams written on selected topics (75% of the total grade), and section participation (25%). The section participation grade will test your comprehension of both lectures and readings, and some informal writing will be required for discussion sections.

First Take-Home Exam (20%): Distributed Sept. 30; due Oct. 12.

Second Take-Home Exam (25%): Distributed Nov. 4; due Nov. 16.

Final Take-Home Exam (30%): Distributed Dec. 14; due Tues. Dec. 22.

Honors Assessment

Honors students will submit in addition a presentation and paper on a topic of their own choice (worth 20% of their overall grade), to be completed by Mon. Dec. 14.

Participation and Performance

If you have a conflict between an academic requirement and any religious observance, please notify me of the specific dates concerned within the first two weeks of the course and I will find an alternative means for you to fulfill the requirement. Such requests are confidential.

In compliance with the Americans with Disabilities Act, 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://www.mcburney.wisc.edu/>] 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.

If any problems arise, either academic or personal, that might jeopardize your performance in the course, you must try to inform me of the problem at the next available office hour, by email or telephone, or by leaving a message with the Department of the History of Science (262-1406).

To limit the spread of disease due to H1N1 influenza, everyone on campus must consider it prudent to stay home from work and class at the first sign of influenza symptoms (fever of 100 degrees F/37.8 degrees C or higher with cough or sore throat) until at least 24 hours after they have been completely fever-free (without fever-reducing medication). For most people, this takes three to five days. If I am in that situation I will communicate via email and the course website on Learn@UW. Please communicate by email or telephone if you have to miss classes or a deadline due to illness.

Syllabus

Items on the Book List are referred to by name (eg. **Paul**, chaps. 1-2). The other material is in the Course Packet. The readings listed are core material and ideally should be read before the relevant lecture.

Part I: Time and Space Machines: New Views of Man and Matter, circa 1900

1. Introduction: Time Machines (*Sept. 2*)

H.G. Wells, *The Time Machine*, in *The Works of H.G. Wells*, Atlantic Edn., vol. 1 (New York: Charles Scribner's Sons, 1924), pp. 3-15. On its background see Jim Bennett, et al. *1900: The New Age. A Guide to the Exhibition* (Cambridge: Whipple Museum of the History of Science, 1993), "The Time Machine," pp. 13-16.

Discussion Section: Introductions

2. The Discovery of X-rays and Science at the 1900 World's Fair (*Sept. 9*)

W.C. Roentgen, "On a New Kind of Rays," *Nature* 53 (23.1.1896), 274-276 and A.A.C. Swinton, "Professor Röntgen's Discovery," *Nature* 53 (23.1.1896), 276-277.

Bettyann Holtzmann Kevles, *Naked to the Bone: Medical Imaging in the Twentieth Century* (New Brunswick: Rutgers Univ. Press, 1997), pp. 9-32.

Discussion Section: From the Laboratory to the Living Room: Science and Society

Part II: Biology and Society: Eugenics and Genetics

3. Darwin's Legacy: Biology and Society circa 1900 (*Sept. 14*)

Paul describes those facets of 19th century biology particularly concerned with heredity. Read chaps. 1-2.

4. Theories of Heredity (*Sept. 16*)

For a contemporary (neo Lamarckian) perspective on evolution read Wells, *The Time Machine*, pp. 59-66. Continue reading **Paul**, chap. 3.

Note: Lailatul-Qadr; Rosh Hashanah, Sept. 19

Discussion Section: Heredity and Eugenics

5. Mendel's Work and its Rediscovery (*Sept. 21*)

A useful overview of the development of genetic mapping from the nineteenth century right through to 1990 is provided in Horace Freeland Judson, "A History of the Science and Technology Behind Gene Mapping and Sequencing," in **Kevles and Hood**, eds., pp. 37-80. For now only read up to his discussion of *Drosophila*, pp. 37-49 (we return to this text later).

Note: Eid-al-Fitr

6. The Fruit Fly and the Rise of Experimental Genetics (Sept. 23)

Robert E. Kohler, "Drosophila: A Life in the Laboratory," *Journal of the History of Biology* 26 (1993), 281-310.

Discussion Section: The Rise of the Experimental Life Sciences

7. Mendelism and the Eugenic Problematic (Sept. 28)

Henry Herbert Goddard, *The Kallikak Family* (Arno Press: New York, 1973, reprint of the 1912 Macmillan edn.), pp. 101-117. **Paul**, chaps. 4-6.

Pnina G. Abir-Am, "The Molecular Transformation of Twentieth-Century Biology," in John Krige and Dominique Pestre, eds. *Science in the Twentieth Century* (Amsterdam: Harwood Academic, 1997), pp. 495-524.

Note: Yom Kippur

Part III: The New Physics and the Birth of the Atomic Age

8. Albert Einstein and the Rise of Theoretical Physics I (Sept. 30)

For Poincaré on space and time and an excerpt of his speech to the 1900 Congress of Physicists read Henri Poincaré, *Science and Hypothesis* in idem, *The Value of Science*, edited by Stephen Jay Gould (New York: Modern Library, 2001), pp. 73-74 and 109-117.

Miller, chaps. 1 and 3.

Note: First Take-Home Exam Distributed

Discussion Section: Einstein and the Development of Theoretical Physics

9. Einstein and Theoretical Physics II (Oct. 5)

Miller, Intermezzo and chap. 6 (pp. 173-213).

10. Scientists and the Great War (Oct. 7)

Hughes, pp. 1-30.

Discussion Section: Physics, Politics, Philosophy and War

11. Physics, Politics, and Philosophy (Oct. 12)

Matthew Stanley, "'An Expedition to Heal the Wounds of War': The 1919 Eclipse and Eddington as Quaker Adventurer," *Isis* 94 (2003): 57-89.

On Bohr's philosophy read Aage Petersen, "The Philosophy of Niels Bohr," in *Niels Bohr: A Centenary Volume*, eds. A.P. French and P.J. Kennedy (Cambridge, MA and London: Harvard University Press, 1985), pp. 299-310. On the abandonment of classical imagery see **Miller**, pp. 253-267.

Note: First Take-Home Exam Due

12. Science and Fiction: Nuclear Physics and the Concept of the Atomic Bomb (*Oct. 14*)

Hughes, pp. 30-63.

Discussion Section: The Atomic Bomb as Organized Science

13. "The Greatest Achievement of Organized Science in History" (*Oct. 19*)

Hughes, pp. 64-104.

J. Robert Oppenheimer, "Speech to the Association of Los Alamos Scientists, November 2, 1945," in Alice Kimball Smith and Charles Weiner, eds. *Robert Oppenheimer: Letters and Recollections* (Cambridge: Harvard University Press, 1980), pp. 315-25.

Part IV: Cold War Sciences

14. Nuclear Things and Nuclear States (*Oct. 21*)

Gabrielle Hecht, "A Cosmogram for Nuclear Things," *Isis* 98 (2007): 100-08.

Discussion Section: Science and the State in the Cold War

15. Computers and Cybernetics across Cultures: Humans, Machines and Society (*Oct. 26*)

David Mindell, Jérôme Segal, and Slava Gerovitch. "From Communications Engineering to Communications Science: Cybernetics and Information Theory in the United States, France, and the Soviet Union," in Mark Walker, ed. *Science and Ideology: A Comparative History* (London/New York: Routledge, 2003), pp. 66-96.

For perspectives on present computer use read Sherry Turkle, "Multiple Subjectivity and Virtual Community at the End of the Freudian Century," *Sociological Inquiry* 67:1 (1997), 72-84 and "Can You Hear Me Now?" *Forbes Magazine* (May 2007).

16. Molecular Genetics: Pathways to the Double Helix (*Oct. 28*)

Reading for this and the following two lectures comes from **Watson**, a book that has been influential in shaping popular images of the post-war scientist. Read as much of the book as you can, for this first lecture focusing on pp. 1-48. For a brief overview read further in Judson, "A History of Gene Mapping," in **Kevles and Hood**, eds. pp. 49-60.

Discussion Section: Man, Mind & Machine; The Discovery of the Structure of DNA

17. "A Personal Account" in Context: Discovering the Double Helix (*Nov. 2*)

Watson, rest of the book. For Watson's account of the discovery, see pp. 87-133.

18. Molecular Biology, 1950s-70s: The Era of Prokaryotes (*Nov. 4*)

Watson's account drew vigorous responses from other scientists and commentators. Read in particular the letters from Klug, Lewontin, Ellman, Sinsheimer, Perutz, Wilkins and Watson, and Merton in **Watson**, pp. 153-158, 185-194, 200-207, 213-218.

Note: Second Take-Home Exam Distributed

Discussion Section: DNA and Molecular Biology

19. Nature Management and the Rise of Environmentalism (Nov. 9)

For excerpts from two classics of environmentalism read Aldo Leopold, *A Sand County Almanac and Sketches Here and There* (London, Oxford and New York: Oxford University Press, 1949), pp. 6-18 and Rachel Carson, *Silent Spring* (Boston and New York, Houghton Mifflin, 1962), pp. 1-13, 85-100.

Linda J. Lear, "Bombshell in Beltsville: The USDA and the Challenge of 'Silent Spring'," *Agricultural History* 66:2 (1992), 151-170.

20. Test, Protest and the Radical Critique of Science in the 1960s (Nov. 11)

J.R. Ravetz, "Orthodoxies, Critiques and Alternatives," in R.C. Olby, et al. *Companion to the History of Modern Science* (London: Routledge, 1990), pp. 898-908.

Discussion Section: Nature Management, Environmentalism, and Test and Protest

21. Geophysics, the Global Perspective, and Global Warming (Nov. 16)

R.E. Doel, "The Earth Sciences and Geophysics," in Krige and Pestre, eds. *Science in the Twentieth Century*, pp. 391-416.

Spencer R. Weart, "Reflections" and "Milestones" in *The Discovery of Global Warming* (Cambridge, MA: Harvard Univ. Press, 2003), pp. 193-206.

Note: Second Take-Home Exam Due

22. Big Science and the Challenges facing Post Cold War Physics (Nov. 18)

On big science, read **Hughes**, pp. 105-163.

For political challenges see Daniel J. Kevles, "The Death of the Superconducting Super Collider in the Life of American Physics," 1995 Preface to *The Physicists: The History of a Modern Scientific Community in America* (Cambridge, MA and London: Harvard University Press, 1995), pp. ix-xlii. On the challenges nature poses read Harry Collins and Trevor Pinch, "Set the Controls for the Heart of the Sun: The Strange Story of the Missing Solar Neutrinos," in idem, *The Golem: What You Should Know about Science* (Cambridge: Canto, 2nd ed. 1998), pp. 121-138.

Discussion Section: The Challenges of Scale: Big Physics and Global Warming

Part V: Beyond the Cold War

23. Genetic Engineering and Biotechnology (Nov. 23)

Sally Smith Hughes, "Making Dollars Out of DNA: The First Major Patent in Biotechnology and the Commercialization of Molecular Biology, 1974-1980," *Isis* 92 (2001), 541-75. Read also the final part of Judson, "A History of Gene Mapping," in **Kevles and Hood** eds., pp. 60-80.

24. Film: "Gattaca" (Nov. 25)

Written and directed by Andrew Niccol, Columbia Pictures, 1997.

Thanksgiving: No Discussion Section

25. The Formation of the Human Genome Project (Nov. 30)

On the background to the project read Daniel J. Kevles, "Out of Eugenics: The Historical Politics of the Human Genome," in Kevles and Hood eds., pp. 3-36. For contrasting perspectives read James D. Watson, "A Personal View of the Project," *ibid*, pp. 164-173, and Evelyn Fox Keller, "Nature, Nurture, and the Human Genome Project," *ibid*, pp. 281-299.

The Human Genome Project is coordinated by the U.S. Department of Energy and the National Institutes of Health. Information on it, including its own historical timeline, can be found at its web-site: http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml

26. The Human Genome Project and the Future of Biology (Dec. 2)

Reading as for Nov. 30. Note in particular the way the DOE has responded to criticism of the HGP in the formation of its next program, Genomics: GTL.

Claude Alvares, "Does the Real World Need 'Modern' Science?" in Tom Wakeford and Martin Walters, eds. *Science for the Earth: Can Science Make the World a Better Place?* (Chichester, NY: John Wiley, 1995), pp. 65-86.

Discussion Section: Genetic Engineering and the Human Genome Project

27. Stem Cell Research (Dec. 7)

On James Thomson at UW-Madison read Katherine Esposito, "The Cell Scientist," *Isthmus*, 09/08/00, pp. 9-10.

Junying Yu and James A. Thomson, "Embryonic Stem Cells," in *Regenerative Medicine*, Department of Health and Human Services, August 2006, </info/scireport/2006report>, pp. 1-17. See also the NIH website <http://stemcells.nih.gov/index.asp>.

Robert Best and George Khushf, "The Stem Cell Controversy in the United States: Scientific, Philosophical, Political and Theological Aspects," in *Grenzüberschreitungen/Crossing Borders: Kulturelle, religiöse und politische Differenzen im Kontext der Stammzellenforschung weltweit/Cultural, Religious, and Political Differences Concerning Stem Cell Research. A Global Approach*, eds. Wolfgang Bender, Christine Hauskeller and Alexandra Manzei, (Münster: agenda, 2005) pp. 241-261.

28. Of Mice and Men and Missiles: Perspectives on the Present (Dec. 9)

Donald Mackenzie, "Nuclear Missile Testing and the Social Construction of Accuracy," in Mario Biagioli, ed. *The Science Studies Reader* (New York and London: Routledge, 1999), pp. 342-357.

Discussion Section: Stem Cells and Science in the 21st Century

29. Of Mice and Men and Missiles: Concluding Thoughts (Dec. 14)

Junying Yu, Maxim A. Vodyanik, Kim Smuga-Otto, Jessica Antosiewicz-Bourget, Jennifer L. Frane, Shulan Tian, Jeff Nie, Gudrun A. Jonsdottir, Victor Ruotti, Ron Stewart, Igor I. Slukvin and James A. Thomson, "Induced Pluripotent Stem Cell Lines Derived from Human Somatic Cells," *Science* (2007): 1151526 (8pp.).

Note: Final Take-Home Exam Distributed

Tuesday Dec. 22 Final Examination Due (by 12:05 PM)

Grading Criteria

- A: For outstanding essays only. The 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). The relationships drawn between facts and ideas are sophisticated, subtle, and/or original. The writing is grammatically correct and succinct, and the argument flows well from point to point. Not a word is wasted!
- AB: For very good essays that for some reason fall short of the criteria described above. The argument may be murky at one point; information may be presented that doesn't directly or clearly contribute to the argument; the writing style may be awkward occasionally, or flawed by one or two consistent (if minor) grammatical errors.
- B: The basic good grade. The essay may pursue a straightforward but not particularly deep or sophisticated argument; it is okay as far as it goes, but doesn't penetrate into the material very far. It may have a flash of brilliance that isn't brought to fruition, because it is counterbalanced by a weakness in argumentation, minor grammatical problems, 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 thinking, or by 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 continually 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 here to show that you have attended a few lectures and/or done some of the reading, but the essay indicates no attempt at synthesis or thinking on your own, or 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 of 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.

Note that **plagiarism** is grounds for automatic failure on the assignment. If you use three or more words in a row from another source, the phrase must be placed in quotation marks and footnoted. Otherwise it is plagiarism. For more on what constitutes plagiarism and how to avoid it, consult *A Pocket Style Manual* by Diana Hacker, or the UW-Madison Writing Center website.