

History of Science 203
Science in the 20th Century: A Historical Overview
Fall 2001

3 Credits; Z (Humanities or Social Studies)
2 hours lecture (1:20pm MW, 6203 Social Sciences), 1 hour discussion
Prerequisites: None

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Book List (University Bookstore)

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

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

Richard Rhodes, *The Making of the Atomic Bomb* (Simon and Schuster, 1988) Required

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

Steven Weinberg, *Dreams of a Final Theory* (Vintage, 1993) Required

Course Reader

Available for \$15.50 from the History of Science Department Office, 7143 Social Science. Note that the office is open from 7:30am-3:15pm daily.

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.

First Take-Home Exam (20%): Distributed Oct. 3; due Oct. 10.

Second Take-Home Exam (25%): Distributed Nov. 7; due Nov. 14.

Final Take-Home Exam (30%): Distributed Dec. 10; due Monday, December 17.

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. 3.

Syllabus

Items on the Book List are referred to by name (eg. Miller, pp. 1-8). The other material is in the Course Reader. The readings listed are core material and ideally should be read before the relevant lecture.

Sept. 5 Introduction

For a description of science at the World's Fair in Paris see Jim Bennett, et al. *1900: The New Age. A Guide to the Exhibition* (Cambridge: Whipple Museum of the History of Science, 1993), pp. 1-12.

Discussion Section: Introduction (1900: The New Age)

Discussing Bennett, et al.

Sept. 10 The Century in Prospect and Retrospect: Science at the 1900 Worlds Fair

For a survey of physics in 1900, see Erwin N. Hiebert, "Fin-de-Siecle Physics," in Mario Bunge and William R. Shea, eds. *Rutherford and Physics at the Turn of the Century* (New York: Dawson and Science History Publications, 1979), pp. 3-22.

Sept. 12 The Discoveries: X-rays, Radioactivity and the Electron

Primary Sources:

- 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.
- Henri Becquerel, excerpt on "The Radiation from Uranium," *Comptes Rendus* 122 (1896), p. 420 as translated in W.F. Magie, *A Source Book in Physics* (Cambridge, MA: Harvard University Press, 1963), pp. 610-613
- P. and M.S. Curie, excerpts on "Polonium," and "Radium," *Comptes Rendus* 127 (1898), pp. 175 and 1215, as translated in Magie, *Source Book*, pp. 613-616.

On Marie Curie's collaboration with her husband Pierre, Helena Pycior, "Reaping the Benefits of Collaboration while Avoiding Its Pitfalls: Marie Curie's rise to Scientific Prominence," *Social Studies of Science* 23 (1993), 301-323.

Discussion Section: Experimental Discoveries

Discussing primary and secondary material on radioactivity

Sept. 17 The New Theories, I: Einstein's Quantum Theory

Miller, pp. 1-8 and 41-83.

Sept. 19 The New Theories, II: Einstein's Relativity

Miller, pp. 171-213. For a modern physicist's view of Einstein's achievement see Weinberg, pp. 90-107.

Discussion Section: Einstein and the Development of Theoretical Physics

Focusing on Einstein's work on relativity.

Sept. 24 Scientists and World War I

On World War I see Rhodes, pp. 86-103, and for Einstein's response to his social environment see Fritz Stern, "Einstein's Germany," in *Albert Einstein: Historical and Philosophical Perspectives*, ed. G. Holton and Y. Elkana (Princeton, NJ: Princeton University Press, 1982), pp. 319-343.

Sept. 26 Quantum Mechanics

Primary Source:

- W. Heisenberg, "Quantum Theory and its Interpretations," in *Niels Bohr: His Life and Work as Seen by his Friends and Colleagues*, ed. S. Rozental (New York: Interscience Publishers, 1967, 1st Danish ed., 1964), pp. 94-108.

For a more detailed account of Bohr's work see Rhodes, pp. 53-85. On his philosophy more generally see Aage Petersen, "The Philosophy of Niels Bohr," in *Niels Bohr: A Centenary Volume*, eds. French and Kennedy, pp. 299-310. For a modern physicist's perspective on the interpretation of quantum mechanics see Weinberg, pp. 65-89.

On science and ideology in Nazi Germany and the Soviet Union, see P.R. Josephson, *Totalitarian Science and Technology* (New Jersey: Humanities Press, 1996), pp. 39-66 (read 66-74 if possible).

Discussion Section: Physics, Philosophy and War

Discussing Rhodes on the war and Stern, Heisenberg and Petersen on the philosophical and social commitments of different physicists.

Oct. 1 19th Century Biology: The Morphological Tradition

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

Oct. 3 Heredity in Man

Paul, chaps. 3-4.

Note: First Take-Home Exam Distributed

Discussion Section: Science and Society

Discussing the role of theories of evolution in changing views of the nature/nurture issue and the social implications of biology, and Josephson on physics in totalitarian Germany and the Soviet Union.

Oct. 8 The Biometricians and Mendelians

Paul, rest of book, especially chaps. 5 and 7.

Oct. 10 Model Organisms and the Formation of Genetics, Part 1

For an overview of the development of genetic mapping see Horace Freeland Judson, "A History of the Science and Technology Behind Gene Mapping and Sequencing," in Daniel J. Kevles and Leroy Hood, eds. *The Code of Codes: Scientific and Social Issues in the Human Genome Project* (Cambridge, MA: Harvard University Press, 1992), pp. 37-80. He takes us up to the role of *Drosophila* in the development of the first genetic maps on pp. 37-49. On model organisms, see Jean-Paul Gaudilliere, "Biologists at Work: Experimental Practices in the Twentieth-Century Life Sciences," in John Krige and Dominique Pestre, eds. *Science in the Twentieth Century* (Amsterdam: Harwood Academic, 1997), pp. 683-700.

Note: First Take-Home Exam Due

Discussion Section: Evolution and Eugenics in American Society

Discussing Paul, Controlling Human Evolution.

Oct. 15 Genetics and Model Organisms, Part 2

Reading as for Oct 10.

Oct. 17 Post World War I Biochemistry

Pnina G. Abir-Am, "The Molecular Transformation of Twentieth-Century Biology," in Krige and Pestre, eds. *Science in the Twentieth Century*, pp. 495-524.

Discussion Section: Model Organisms and the Rise of the Experimental Life Sciences

Discussing the development of genetics and biochemistry up to World War 2, focusing on articles by Gaudilliere and Abir-Am.

Oct. 22 Nuclear Physics and the Idea of an Atomic Bomb

Reading for this and the following lecture comes from Rhodes, a complex book interweaving several narrative and thematic threads in each chapter. Ideal would be to read the whole, but I can suggest a number of excerpts that are particularly relevant. On the discovery of fission, pp. 247-264; on the US decision to build the bomb, and German research, pp. 367-393; and on the appointment of Groves to head the Manhattan Project and the building of the first atomic pile in Chicago, pp. 422-442.

Oct. 24 "The Greatest Achievement of Organized Science in History"

On moving from experiment to production of U235 through electromagnetic isotope separation and gaseous diffusion, and on the pile for plutonium, see Rhodes, pp. 486-512; for an example (one amongst many) of work at Los Alamos, pp. 573-578; on the Trinity explosion, pp. 651-678.

Discussion Section: Mobilizing Science for Bombs

Discussing Rhodes, paying particular attention to the relationships between physicists, chemists, engineers and the military.

Oct. 29 Cold-War Computing

On the development of the computer see Martin Campbell-Kelly and William Aspray, *Computer: A History of the Information Machine* (New York: Basic Books, 1996), chapter 4 "Inventing the Computer," pp. 79-104.

Oct. 31 Cybernetics

Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, MA and London: MIT Press, 1996), chapter 6, "The Machine in the Middle: Cybernetic Psychology and World War II," pp. 175-206.

Discussion Section: Mind-Man-Machine

Discussing selections from Campbell-Kelly and Aspray, and Edwards.

Nov. 5 The Structural, Informational and Biochemical Approaches to Molecular Genetics

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 see Judson, "A History of Gene Mapping," pp. 49-60.

Nov. 7 Watson and Crick's Double Helix

For Watson's account of the discovery, see pp. 87-133, and the responses to the book from other scientists and reviewers, pp. 153-158, 185-194, 200-207, 213-218.

Note: Second Take-Home Exam Distributed

Discussion Section: Watson and Crick's Discovery of the Double Helix Structure of DNA

Focus on Watson's account of the discovery, his description of the relations with Rosalind Franklin and her work, and responses to the book.

Nov. 12 Molecular Biology

Reading as for Nov. 5 and 7.

Nov. 14 The Radical Critique of Science in the 1960s

For an account linking the power of Rachel Carson's argument on pesticides to pervasive public concern with radioactive fallout, see Ralph Lutts, "Chemical Fallout: Rachel Carson's *Silent Spring*, Radioactive Fallout and the Environmental Movement," *Environmental Review* 9 (Fall 1985), 211-225. On the background to Carson's argument and the Department of Agriculture's complacent response, see Linda J. Lear, "Bombshell in Beltsville: The USDA and the Challenge of 'Silent Spring'," *Agricultural History* 66:2 (1992), 151-170. For an overview of new perspectives on science in the second half of the century see 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.

Note: Second Take-Home Exam Due

Discussion Section: The Environmental Sciences

Focus your reading on one of Lutts or Lear, and the general articles by Ravetz and Doel (see next lecture).

Nov. 19 Geophysics and the Global Perspective

For a discussion of global perspectives and scientific exploration of the earth's atmosphere, crust and sea bed, see R.E. Doel, "The Earth Sciences and Geophysics," in Krige and Pestre, eds. *Science in the Twentieth Century*, pp. 391-416.

Nov. 21 Film: "Gattaca"

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

Thanksgiving: No Discussion Section

Nov. 26 Particle Physics and the Search for a Final Theory

Weinberg, his discussion of the physics, chemistry and biology of a piece of chalk, especially pp. 19-39; defense of reductionism, pp. 51-64; and the challenges facing particle physics, pp. 191-210.

Nov. 28 Post Cold War Physics

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.

Discussion Section: Particles and Politics

Discussing Weinberg, Dreams, and Kevles on the death of the SSC.

Dec. 3 Genetic Engineering and Biotechnology

On the development of PCR and biotechnology see Paul Rabinow, *Making PCR: A Story of Biotechnology* (Chicago and London: University of Chicago Press, 1996), Introduction and chapter 1, "Toward Biotechnology," pp. 1-45. See also Judson, "A History of Gene Mapping," pp. 60-80.

Dec. 5 The Human Genome Project

See Daniel J. Kevles, "Out of Eugenics: The Historical Politics of the Human Genome," in Kevles and Hood, *Code of Codes*, pp. 3-36. For contrasting perspectives see James D. Watson, "A Personal View of the Project," in Kevles and Hood, *Code of Codes*, pp. 164-173 and R.C. Lewontin, "The Dream of the Human Genome," in *Biology as Ideology: The Doctrine of DNA* (New York: Harper Perennial, 1992), pp. 61-83.

Information on the Human Genome Project coordinated by the U.S. Department of Energy and the National Institutes of Health can be found at its web-site:

http://www.ornl.gov/TechResources/Human_Genome/home.html

Discussion Section: The Human Genome Project

Discussing Rabinow's account of biotechnology and Watson and Lewontin's contrasting views on the value of the Human Genome Project.

Dec. 10 Stem Cell Research

See Katherine Esposito, "The Cell Scientist," *Isthmus*, 09/08/00, pp. 9-10. And watch the media!

Note: Final Take-Home Exam Distributed

Dec. 12 How Political is Accuracy? Missile Testing

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. For an overview of historical approaches to understanding the century see Charles S. Maier, "Consigning the Twentieth Century to History," *The American Historical Review* 105 (2000), 807-831.

Discussion Section: Perspectives on Projections: The Dependence of Scientific Research on Future Scenarios

Dec. 17 Final Examination Due