

History of Science 203
Science in the 20th Century: A Historical Overview
Fall 2000

3 Credits; Z (Humanities or Social Studies)
2 hours lecture (1:20pm MW, 5106 Social Science), 1 hour discussion
Prerequisites: None

Instructor: Richard Staley, 7131 Social Science
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Book List (University Bookstore)

H.G. Wells, *The Time Machine* (1895) Recommended
Mary Jo Nye, *Before Big Science: The Pursuit of Modern Chemistry and Physics, 1800-1940* (Harvard University Press, 1999) Required
Richard Rhodes, *The Making of the Atomic Bomb* (Simon and Schuster, 1988) Required
Steven Weinberg, *Dreams of a Final Theory* (Vintage, 1993) Required
James D. Watson, *The Double Helix*, ed. Gunther S. Stent, (Norton, 1980) Required
Diane B. Paul, *Controlling Human Heredity: 1865 to the Present* (Humanities Press, 1995) Required
Harry Collins and Trevor Pinch, *The Golem: What You Should Know about Science*, 2nd ed., (Canto, 1998) Recommended

Course Reader, Part I (Available from 7143 Social Science)

Assessment

Assessment will be through three take-home examinations (each worth 28% of the total grade) and section participation (16%).

First Take-Home Exam

Write a 3-4 page, typewritten, double spaced essay on one of three topics. Questions will be distributed in the lecture on October 4; the essay will be due on October 11.
Late papers will be penalized a grade if turned in by October 16, and 2 grades thereafter.

Syllabus, Part I

Items on the Book List are referred to by name (eg. Nye, pp. 147-158). The other material is in the Course Reader.

Sept. 6 Introduction

Discussion Section: Introduction (1900: The New Age)

Sept. 11 The Century in Prospect and Retrospect: Science at the 1900 Worlds Fair

For an overview of “moral” and “structural” historical approaches to understanding the century see Charles S. Maier, “Consigning the Twentieth Century to History,” *The American Historical Review* 105 (2000), 807-831. For a survey of physics in 1900, discerning a “descriptionism” pervading scientists views, see J.L. Heilbron, “Fin-de-Siecle Physics,” in C.G. Bernhard et al., eds. *Science, Technology and Society in the Time of Alfred Nobel* (Oxford: Nobel Foundation, 1982), pp. 51-73.

Sept. 13 The Discoveries: X-rays and Radioactivity

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.

Nye, pp. 147-158, and 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: Gaining Perspective, Raising Questions

Sept. 18 The Electron

Primary Source:

- J.J. Thomson, excerpt on “The Electron,” *Philosophical Magazine* 44 (1897), 293 ff. as cited in Magie, *Source Book*, pp. 583-597. Note that Thomson’s own title for the paper was “Cathode Rays.”

Nye, pp. 82-87 (on cathode rays in the late nineteenth century) and pp. 159-164 (on Thomson’s discoveries).

Sept. 20 Radiation Physics and the Quantum Theory

Nye, pp. 109-119. On the practical origins of experiments at the foundations of quantum theory see David Cahan, “High Temperatures and High Science,” in *An Institute for an Empire: The Physikalisch-Technische Reichsanstalt, 1871-1918* (Cambridge: CUP, 1989), pp. 143-157.

Discussion Section: Experimental Discoveries

Sept. 25 Einstein’s Relativity

Primary Source:

- Albert Einstein, “Autobiographical Notes,” in *Albert Einstein: Philosopher-Scientist*, ed. P.A. Schilpp (La Salle, IL: Open Court, 1969, 1st ed. 1949), pp. 2-94 on pp. 51-65.

For a brief survey of the history of relativity see John Stachel, "The Theory of Relativity," in R.C. Olby, et al. *Companion to the History of Modern Science* (London: Routledge, 1990), pp. 442-457, and for an account of 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).

Sept. 27 Bohr's Quantum Theory of the Atom

Nye, pp. 164-171, For a more detailed account of Bohr's work see Rhodes, pp. 53-85 and/or J.L. Heilbron, "Bohr's First Theories of the Atom," in *Niels Bohr: A Centenary Volume*, eds. A.P. French and P.J. Kennedy (Cambridge, MA: Harvard University Press, 1985), 33-49. 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.

Discussion Section: The New Theories: Relativity and Quantum Theory

Oct. 2 Scientists and World War I

On World War I see Rhodes, pp. 86-103, and 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).

Oct. 4 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.

Discussion Section: Physics and Ideology

Syllabus, Part 2

Items on the Book List are referred to by name (eg. Paul, chaps. 1-3). The other material is in the Course Reader, Part 2.

Oct. 9 Quantum Mechanics in America / The Morphological Tradition in 19th Century Biology

On quantum mechanics see readings for lecture on Oct. 4. Paul describes those facets of 19th century biology particularly concerned with heredity.

Oct. 11 Heredity in Man

Paul, chaps. 1-3.

Discussion Section: Review and Preview, Discussion of Mid-Term Essays

Oct. 16 The Biometricians and Mendelians

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

Oct. 18 Model Organisms and the Formation of Genetics, Part 1

Reading as for Oct. 16, and 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.

Discussion Section: Evolution and Eugenics in American Society

Discussing Paul, Controlling Human Evolution.

Oct. 23 Genetics and Model Organisms, Part 2

Reading as for Oct 18.

Oct. 25 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. 30 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.

Nov. 1 "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.

Nov. 6 Laboratory Physics in the Post-War Era

On the Physics Department at UW-Madison, see selections from Peter Galison, *Image & Logic: A Material Culture of Microphysics* (Chicago and London: The University of Chicago Press, 1997), pp. 239-243, 281-288, 303-311.

Nov. 8 The H-Bomb and Cold-War Physics

On the Hydrogen bomb see Peter Galison and Barton Bernstein, "In any Light: Scientists and the Decision to Build the Superbomb, 1952-1954," *Historical Studies in the Physical and Biological Sciences* 19 (1989), 267-347.

Note: Second Take-Home Exam Distributed

Discussion Section: Cold-War Physics and the Military-Industrial Complex

Discussing selections from Galison, Image & Logic, and the article from Galison and Bernstein.

Nov. 13 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.

Nov. 15 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 Due

Discussion Section: Watson and Crick

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. 20 Molecular Biology

Reading as for Nov. 13.

Nov. 22 Film: "Gattica"

Thanksgiving: No Discussion Section

Nov. 27 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.

Nov. 29 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.

Discussion Section: The Environmental Sciences

Focus your reading on one of Lutts or Lear, and the general articles by Ravetz and Doel.

Dec. 4 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.

Dec. 6 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. 11 Biotechnology and the Human Genome Project

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. (For those interested, 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.)

Note: Final Take-Home Exam Distributed

Dec. 13 Perspectives on Projections

For contrasting perspectives on the human genome project 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.

Discussion Section: The Human Genome Project

Discussing Judson's scientific and technological history and Watson and Lewontin's contrasting views on the value of the project.

Dec. 19 Final Examination Due

Assessment

Assessment is through three take-home examinations (each worth 28% of the total grade) and section participation (16%).

Second Take-Home Exam

Distributed in the lecture on November 8; due on November 15.

Final Take-Home Exam

Distributed in the lecture on December 11; due on December 19.