HPSC0010

History of Modern Science

Course Syllabus

2019-20 session | Professor Jon Agar | jonathan.agar@ucl.ac.uk

Course Information

This module provides an overview of the development of the sciences from 1800 to the present, with particular emphasis on the twentieth century. The development of science will be considered in its social, political and cultural contexts. Topics include science in different national contexts (Germany, United States, Soviet Union), science and war (Second World War and Cold War), the emergence of new specialties and disciplines (such as geology, quantum physics, psychology, relativity, genetics, particle physics) as well as the development of older ones, and major intellectual and social themes (the discovery of deep time, evolution, diversity in science). Emphasis will be on the physical and life sciences..

Basic course information

Course website:	See Moodle
Moodle Web site:	moodle.ucl.ac.uk
Assessment:	Essay and Exam
Timetable:	See online timetable
Prerequisites:	None
Required texts:	Readings listed below
Course tutor(s):	Professor Jon Agar PGTA: Santiago Guzman Gamez santiago.gamez.15@ucl.ac.uk
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Schedule

	UCL Wk	Date	Topic	Activity
1	21	13.1	Discovery of Deep Time	
2	21	14.1	Darwin and the Professionals	
3	21	17.1	Week 1 Seminar	Read: Turner
4	22	20.1	Energy and Invention	
5	22	21.1	Germs	
6	22	24.1	Week 2 Seminar	Read: Kohler
7	23	27.1	New Physics	
8	23	28.1	Genetics and Eugenics	
9	23	31.1	Week 3 Seminar	Read: Stepan
10	24	3.2	New Sciences of the Self Essay advice	
11	24	4.2	Science in the First World War	
12	24	7.2	Week 4 Seminar	Read: Manifesto of the 93
13	25	10.2	Science and Germany	
14	25	11.2	Ecology and Empire	
15	25	14.2	Week 5 Seminar	Read: Cueto, Quintero
	26		**Reading Week**	**no lectures**
16	27	24.2	Science and the United States	
17	27	25.2	Science and the Soviet Union	
18	27	28.2	Week 7 Seminar	Read: Graham

19	28	2.3	From Lab to Los Alamos	
20	28	3.3	Radar Sciences	
21	28	5.3	Week 8 Seminar	Read: Science, the Endless Frontier
22	29	9.3	Big Science and the Cold War	
23	29	10.3	The Standard Model	
24	29	13.3	Week 9 Seminar	Read: Edwards
25	30	16.3	Science in Social Movements	
26	30	17.3	DNA to Biotech	
27	30	20.3	Week 10 Seminar	Read: Carson
28	31	23.3	Diversity of Science	
29	31	24.3	New Ends	
30	31	27.3	Week 11 Seminar	Watch: Oreskes

Assessments

Summary

	Description	**Deadline**	**Word limit**	**Deadline for Tutors to provide Feedback**
50%	Essay	31 March 2020	2,500	As advised
50%	Exam	n/a	n/a	n/a

Assignments

The essay is designed so that you explore the recent academic scholarship on the history of nineteenth or twentieth century science.

Further detailed instructions will be given in class.

Specific Criteria for Assessment for this Module:

To be discussed in class.

Aims & objectives

aims

The aims of this course are to provide students with the knowledge of an overview history of modern science (particularly science in the twentieth century) and skills necessary to begin further study if twentieth century science as a historical topic.

objectives

By the end of this module students should be able to:

- Knowledge of an overview of the development of modern science, with particular emphasis on science in the twentieth century
- Skills for further study of twentieth century science as a historical topic

Reading list

Best General Introductions:

Bowler, Peter J. and Iwan Rhys Morus (2005), *Making Modern Science: a Historical Survey*. Chicago: University of Chicago Press,

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity

John Krige and Dominique Pestre (eds.), *Science in the Twentieth Century*, Amsterdam: Harwood Academic Publishers, 1997

Week 1 Session 1 13 January 2020

Discovery of Deep Time

Introduction to the course. The discovery of 'deep time' in the late 18th-early 19th centuries.

Background Reading

Bowler, Peter J. and Iwan Rhys Morus (2005), *Making Modern Science: a Historical Survey*. Chicago: University of Chicago Press, pp. 103-127.

Martin J.S. Rudwick, *Bursting the Limits of Time: the Reconstruction of Geohistory in the Age of Revolution*, Chicago: University of Chicago Press, 2005.

Week 1 Session 2 14 January 2020

Darwin and the Professionals

The career and ideas of Charles Darwin, and his followers, captures many interesting features of 19th century science: travel and exploration, gentlemanly and amateur cultures, supposed conflicts with religion, and the growing professionalisation of science.

Key scientists: Charles Darwin, Ernst Haeckel, T.H. Huxley

Background Reading

Bowler, Peter J. and Iwan Rhys Morus (2005), *Making Modern Science: a Historical Survey*. Chicago: University of Chicago Press, pp. 129-164.

Peter Bowler, *History of the Environmental Sciences*, London: Fontana, 1992, chapters 8 and 10

Adrian Desmond and James Moore, *Darwin*, London: Penguin, 1991

Week 1 Session 3 17 January 2020

Seminar: Science vs Religion

Frank Turner's argument about understanding the science vs religion conflict.

Essential Reading

Turner, Frank M. (1978) 'The Victorian conflict between science and religion: a professional dimension', *Isis* 69, pp.356-376.

Week 2 Session 4 20 January 2020

Energy and Invention

The 19th century saw the construction of technological systems that transformed Victorian time and space. Examples include railways, land and submarine telegraphs, and electrical systems of power and lighting. This lectures explores the involvement and consequences for the physical sciences. Conservation of energy.

Key scientists: James Clerk Maxwell, Lord Kelvin, Thomas Edison, Charles Steinmetz, Herman von Helmholtz, James Joule

Background Reading

Bowler, Peter J. and Iwan Rhys Morus (2005), *Making Modern Science: a Historical Survey*. Chicago: University of Chicago Press, pp.79-102.

Schivelbusch, Wolfgang (1986) *The Railway Journey: the Industrialization of Time and Space in the 19th Century*. Berkeley: University of California Press.

Dennis, Michael Aaron (1987) 'Accounting for research: new histories of corporate laboratories and the social history of American science', *Social Studies of Science* 17, pp.479-518.

Hughes, Thomas P. (1989) *American Genesis: a Century of Invention and Technological Enthusiasm, 1870-1970*, New York: Penguin, pp.13-52, pp. 138-183.

Nye, Mary Jo (1996) *Before Big Science: the Pursuit of Modern Chemistry and Physics, 1800-1940*. Cambridge, MA: Harvard University Press.

Schaffer, Simon (1992) 'Late Victorian metrology and its instrumentation: a manufactory of

ohms', in Robert Bud and Susan E. Cozzens (eds.), *Invisible Connections: Instruments, Institutions, and Science*, Bellingham, WA: SPIE Optical Engineering Press, pp.23-56.

Mary Jo Nye (ed.) *The Cambridge History of Science. Volume 5: The Modern Physical and Mathematical Sciences*, Cambridge: Cambridge University Press, pp.311-327, p. 317.

Week 2 Session 5 21 January 2020

Germs

In the late 19th century a new germ theory of disease challenged and (mostly) replaced older theories. The theoretical change was accompanied by changes in scientific practice, not least the expansion of laboratories for the life and medical sciences.

Key scientists: Louis Pasteur, Robert Koch, Claude Bernard

Background Reading

Bowler, Peter J. and Iwan Rhys Morus (2005), *Making Modern Science: a Historical Survey*. Chicago: University of Chicago Press, pp. 439-461.

Roy Porter, *The Greatest Benefit to Mankind*, London: Fontana, 1997, chapter 14, pp. 428-461.

W.F. Bynum, *Science and the Practice of Medicine in the Nineteenth Century*, Cambridge: Cambridge University Press, 1994

Gerald L. Geison, 'Louis Pasteur, in *Dictionary of Scientific Biography*.

Nancy Tomes, *The Gospel of Germs*, Cambridge, MA: Harvard University Press, 1998

Week 2 Session 6 24 January 2020

Seminar: Model Organisms and the Life Sciences

The modern life sciences focus to a very great extent on model organisms, such as the mouse, rat, *Arabidopsis* plant, and so on. This seminar examines one of the most important and productive: the fruit fly *Drosophila*. How does the historian Robert Kohler explain the extraordinary productiveness of the fruit fly as a model organism?

Essential Reading: Kohler, Robert (1999) 'Moral economy, material culture, and community in Drosophila genetics', in Mario Biagioli (ed), *Science Studies Reader*, London: Routledge, pp. 243-257.

Week 3 Session 7 27 January 2020

New Physics

Around 1900 physicists discovered a series of new phenomena that would ultimately lead to a new physics, as well as new industries. Examples of such phenomena include X-rays, radioactivity and the electron. This lecture looks at how experimentalists and theoreticians argued and made sense of the phenomena.

Key scientists: Wilhelm Röntgen, J.J. Thomson, Marie Curie, Albert Einstein, Niels Bohr

Background Reading

Cassidy, David (1995) *Einstein and Our World*, Atlantic Highlands: Humanities Press.

Bowler, Peter J. and Iwan Rhys Morus (2005), *Making Modern Science: a Historical Survey*. Chicago: University of Chicago Press, pp. 253-276.

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 15-43.

Nye, Mary Jo (1996) *Before Big Science: the Pursuit of Modern Chemistry and Physics, 1800-1940*. Cambridge, MA: Harvard University Press.

Hughes, Jeff (2003) 'Radioactivity and nuclear physics', in Mary Jo Nye (ed.) *The Cambridge History of Science. Volume 5: The Modern Physical and Mathematical Sciences*, Cambridge: Cambridge University Press, pp.350-374.

Darrigol, Olivier (2003) 'Quantum theory and atomic structure, 1900-1927', in Mary Jo Nye (ed.), *The Cambridge History of Science. Volume 5: The Modern Physical and Mathematical Sciences*, Cambridge: Cambridge University Press, pp.331-349.

Galison, Peter (2003) *Einstein's Clocks, Poincaré's Maps: Empires of Time*, London: Hodder and Stoughton.

Kuhn, Thomas S. (1978) *Black-body Theory and the Quantum Discontinuity, 1894-1912*, Oxford: Oxford University Press.

Week 3 Session 8 28 January 2020

Genetics and Eugenics

Around 1900 the scientific claims of Gregor Mendel were "rediscovered". The result eventually would be a new science of genetics, developed both in theory and in practice. This lecture traces the history of genetics in the context of an interest in better breeding, both in livestock and in humans ("eugenics").

Key scientists: Gregor Mendel, Hugo de Vries, William Bateson, Francis Galton, Karl Pearson, Thomas Hunt Morgan

Background Reading

Bowler, Peter J. and Iwan Rhys Morus (2005), *Making Modern Science: a Historical Survey*. Chicago: University of Chicago Press, pp. 189-212.

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 44-62.

Brannigan, Augustine (1981) *The Social Basis of Scientific Discoveries*, Cambridge: Cambridge University Press.

Kimmelman, Barbara A.(1983) 'The American Breeders' Association: genetics and eugenics in an agricultural context, 1903-13' *Social Studies of Science* 13, pp.163-204

Kevles, Daniel J. (1992) 'Out of eugenics: the historical politics of the Human Genome', in Kevles and Hood (eds.), *Code of Codes: Scientific and Social Issues in the Human Genome Project*, Cambridge MA: Harvard University Press, pp.3-36

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

Kohler, Robert E. (1994) *Lords of the Fly:* Drosophila *Genetics and the Experimental Life*, Chicago: University of Chicago Press.

Week 3 Session 9 31 January 2020

Seminar: 'Race' and Science

Nancy Stepan argues that '"race science", although undergoing many changes in the course of its history, nevertheless is best understood not in terms of changing stages, but in terms of an underlying continuity'. Read the three excerpts, one introductory and the other two on eugenics, and make notes about what this continuity might be.

Essential reading:

Nancy Stepan (1982) 'Introduction', 'Eugenics and race, 1900-25', and 'A period of doubt', in *The Idea of Race in Science: Great Britain 1800-1960*. London: Macmillan, pp. ix-xxi, pp. 111-139, and pp. 140-169.

Week 4 Session 10 3 February 2020

New Sciences of the Self + Essay Advice

This lecture compares and contrasts new sciences of human self of the late 19th century and early 20th century: the psychoanalysis of Freud, the psychological programmes of Binet in France, and of Watson in the United States, and immunology.

Key scientists: Sigmund Freud, Alfred Binet, Ivan Petrovich Pavlov, John B. Watson, Ilya Ilyich Mechnikov, Paul Ehrlich

This session will also outline the expectations for the assessed essay, and hold a Q&A.

Background Reading

Roy Porter, *The Greatest Benefit to Mankind*, London: Fontana, 1997, chapter 16, pp. 493-524.

Watson, John Broadus (1913) 'Psychology as the behaviorist views it', *Psychological Review* 20, pp.158-177.

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 63-85.

Sulloway, Frank J. (1979) *Freud, Biologist of the Mind: Beyond the Psychoanalytic Legend*, London: Burnett Books.

Smith, Roger (1997) *The Fontana History of the Human Sciences*, London: HarperCollins

Todes, Daniel P. (1997) 'Pavlov's physiological factory', *Isis* 88, pp.205-246

Soderqvist, Thomas, Craig Stillwell and Mark Jackson (2009) 'Immunity and immunology', in Peter J. Bowler and John V. Pickstone (eds.), *The Cambridge History of Science, Volume 6, The Modern Biological and Earth Sciences*, Cambridge: Cambridge University Press.

Week 4 Session 11 4 February 2020

Science in the First World War

The sciences were mobilised for action in the First World War. This lecture assesses the cliché of the resulting 'chemist's war', and looks at how chemists, physicists, engineers and psychologists both contributed their expertise and sought to change the fortunes of their disciplines during the global conflict.

Key scientists: Fritz Haber, Albert Einstein, George Ellery Hale, Thomas Edison

Background Reading

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 89-117.

Kevles, Daniel J. (1971) The Physicists: the History of a Scientific Community in Modern America. Cambridge MA: Harvard University Press, p. 113.

Hughes, Thomas P. (1989) *American Genesis: a Century of Invention and Technological Enthusiasm, 1870-1970*, New York: Penguin, p. 109, p. 137.

Charles, Daniel (2005) *Master Mind: the Rise and Fall of Fritz Haber, the Nobel Laureate Who Launched the Age of Chemical Warfare*. New York: Ecco

Nye, Mary Jo (1996) *Before Big Science: the Pursuit of Modern Chemistry and Physics, 1800-1940*. Cambridge, MA: Harvard University Press

Kevles, Daniel J. (1968) 'Testing the Army's intelligence: psychologists and the military in World War I', *Journal of American History* 55, pp.565-581

Roland, Alex (2003) 'Science, technology, and war', in Mary Jo Nye (ed.), *The Cambridge History of Science. Volume 5: The Modern Physical and Mathematical Sciences*, Cambridge: Cambridge University Press, pp.561-578

Week 4 Session 12 7 February 2020

SEMINAR: Manifesto of the 93

This seminar looks at who signed, and why, two very different manifestos on science and war in 1914. Read both manifestos. Pick three names of signatories of the Manifesto of the 93 and use internet resources to construct a brief biography of each person. Make notes about what kind of expert they were, what they did before, during and after the First World War, and consider why they might have signed the Manifesto.

'Manifesto of the 93'.
Available in translation at:
http://en.wikipedia.org/wiki/Manifesto_of_the_Ninety-Three

'Manifesto to the Europeans'
Available in translation at:
http://being.publicradio.org/programs/einsteinsethics/einstein-manifesto.shtml

Week 5 Session 13 10 February 2020

Science and Germany

German science was in the ascendant in the late nineteenth and early twentieth century. This lecture reviews the developments in German science after the First World War, comparing and contrasting sciences in the context of the Weimar republic and the Nazi regime.

Key scientists: Niels Bohr, Wolfgang Pauli, Werner Heisenberg, Erwin Schrödinger, Johannes Stark, Philipp Lenard, Max Wertheimer, Wolfgang Köhler, Otto Neurath, Pascual Jordan, Fritz Haber

Background Reading

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 118-141 and pp. 211-228.

Forman, Paul (1971) 'Weimar culture, causality, and quantum theory, 1918-1927: adaptation by German physicists and mathematicians to a hostile intellectual environment', *Historical Studies in the Physical Sciences* 3, pp.1-116

Darrigol, Olivier (2003) 'Quantum theory and atomic structure, 1900-1927', in Mary Jo Nye (ed.) *The Cambridge History of Science. Volume 5: The Modern Physical and Mathematical Sciences*, Cambridge: Cambridge University Press, pp. 331-349

Ash, Mitchell (1995) *Gestalt Psychology in German Culture, 1890-1967: Holism and the Quest for Objectivity*. Cambridge: Cambridge University Press

Proctor, Robert N. (1988) *Racial Hygiene: Medicine under the Nazis*, Cambridge, MA: Harvard University Press

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Week 5 Session 14 11 February 2020

Ecology and Empire

This lecture examines the growth of ecological ideas in an imperial context. The British Empire provided a global context for science, while at the same time science provided crucial techniques and knowledge for colonial administration and Imperial rule.

Key scientists: Ronald Ross, Arthur George Tansley, Charles Elton, Jan Smuts, Julian Huxley

Background Reading

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 142-160.

Mark Harrison, 'Science and the British Empire', *Isis* (2005) 96, pp. 56-63

Anker, Peder (2001) *Imperial Ecology: Environmental Order in the British Empire, 1895-1945*. Cambridge, MA: Harvard University Press

Basalla, George (1967) 'The spread of Western science', *Science* 156, pp611-622

Palladino, Paolo and Michael Worboys (1993) 'Science and imperialism', *Isis* 84, pp.91-102

Bynum, W.F. et al, *The Western Medical Tradition: 1800 to 2000*, Cambridge: Cambridge University Press, 2006, pp. 229-239.

Week 5 Session 15 14 February 2020

SEMINAR: Latin American early twentieth-century science

Up to this point, the course has explored the configuration of science within the European and North American contexts. Yet, it is not possible to understand the development of twentieth-century science without taking into account the techno-scientific relationships between the global north and Latin America. This seminar explores the science that was produced in Latin American, its relation with nationalistic views on science in the region, and the neo-colonialism proposed by the United States.

Essential reading:

Cueto, Marcos. "Andean Biology in Peru: Scientific Styles on the Periphery" in *Isis*, Vol. 80, No. 4, 1989. pp. 640-658.

Quintero, Camilo. "Trading in birds: imperial power, national pride, and the place of nature in the U.S. – Colombia relations" in *Isis*, Vol. 102. pp. 421 – 455.

Week 6

**** READING WEEK ****

Week 7 Session 16 24 February 2020

Science and the United States

American science was extraordinarily successful in the twentieth century, but how can such success be explained? One clue is the American approach to philanthropy, and the recycling of new industrial wealth to support science. Another set of clues can be found in the demands of American industries and markets, and relationships of citizens to government.

Key scientists: George Ellery Hale, Andrew Carnegie, John D. Rockefeller, Sr., Max Mason, Edwin Hubble, Alfred Wegener, Frederick Winslow Taylor, Lillian Gilbreth, John Scopes

Background Reading

Hughes, Thomas P. (1989) *American Genesis: a Century of Invention and Technological Enthusiasm, 1870-1970*, New York: Penguin, pp. 184-248.

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 161-185.

Smith, Robert W. (1982) *The Expanding Universe: Astronomy's 'Great Debate', 1900-1931*. Cambridge: Cambridge University Press

Kay, Lily E. (1993) *The Molecular Vision of Life: Caltech, the Rockefeller Foundation, and the Rise of the New Biology*. Oxford: Oxford University Press

Kevles, Daniel J. (1971) *The Physicists: the History of a Scientific Community in Modern America*. Cambridge MA: Harvard University Press

Owens, Larry (1997) 'Science in the United States' in John Krige and Dominique Pestre (eds.) *Science in the Twentieth Century*, Amsterdam: Harwood Academic Press, pp.821-837

Kanigel, Robert (1997) *The One Best Way: Frederick Winslow Taylor and the Enigma of Efficiency*, London: Viking

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Week 7 Session 17 25 February 2020

Science and the Soviet Union

The Soviet Union began in 1917 and lasted until the end of the Cold War. The regime, which on one hand was based on supposedly scientific foundations and on the other hand was intensely suspicious of the rival form of authority found in science, offers an unparalleled opportunity to examine the relationships between politics and science.

Key scientists: Vladimir Ivanovich Vernadsky, Lev Semeovich Vygotsky, Aleksandr Ivanovich Oparin, J.B.S. Haldane, Sergei Chetverikov, Nikolai Ivanovich Vavilov, Trofim Denisovich Lysenko, Theodosius Dobzhansky

Background Reading

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 186-210.

Graham, Loren R. (1993a) *Science in Russia and the Soviet Union*. Cambridge: Cambridge University Press.

Graham, Loren R. (1993b) *The Ghost of the Executed Engineer: Technology and the Fall of the Soviet Union*, Cambridge, MA: Harvard University Press

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Week 7 Session 18 28 February 2020

SEMINAR: Money or Freedom?

Loren Graham, a historian of Russian and Soviet science, asks a very interesting question: which is more important to science, money or freedom? In Soviet times, some sciences had plenty of resources but little freedom. In post-Cold War Russia, scientists found themselves with more freedom, but also much less money. A comparison of the two periods, in the same land, therefore provides clues to how Graham's question might be answered.

Graham, Loren R. (1998) 'Chapter 3: How robust in science under stress?', in *What Have We Learned about Science and Technology from the Russian Experience?* Stanford: Stanford University Press, pp. 52-73.

Week 8 Session 19 2 March 2020

From Lab to Los Alamos

One of the important themes of research and development before the Second World War was the search for methods of scaling up research, from the increasing the scale of instrumentation in physics to the science of macromolecules and polymers in chemistry. In this lecture we explore this theme by looking at the scale of physics from small labs to the Manhattan Project.

Key scientists: Ernest O. Lawrence, J. Robert Oppenheimer, Linus Pauling, Patrick Blackett, Ernest Walton, John Cockcroft, Hideki Yukawa, Theodor Svedberg, Warren Weaver, Max Delbrück, Salvador Luria, Frederick Banting, Wallace H. Carothers, Vannevar Bush, James Bryant Conant, Howard Florey, Leo Szilard, Enrico Fermi, Robert Oppenheimer, Leslie Groves, Werner Heisenberg, Albert Einstein

<u>Background Reading</u>

Hughes, Jeff (2002) *The Manhattan Project: Big Science and the Atom Bomb*. Cambridge: Icon

Books

Hughes, Thomas P. (1989) *American Genesis: a Century of Invention and Technological Enthusiasm, 1870-1970*, New York: Penguin, pp. 353-442.

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 229-259, pp. 283-300.

Seidel, Robert (1992) 'The origins of the Lawrence Berkeley Laboratory', in Peter Galison and Bruce Hevly (eds.) *Big Science: the Growth of Large-Scale Research*. Stanford: Stanford University Press, pp.21-45

Bird, Kai and Martin J. Sherwin (2005) *American Prometheus: the Triumph and Tragedy of J. Robert Oppenheimer*. London: Atlantic Books

Hounshell, David A. (1992) 'Du Pont and the management of large-scale research and development' in Galison and Hevly, op. cit., pp.236-261

Week 8 Session 20 3 March 2020

Radar Sciences

The mobilisation of science for the Second World War had many consequences for post-war science and technology. This lecture examines the development of radar and its post-war influence, not least for astronomy, electronics and computing.

Key scientists: Bernard Lovell, Martin Ryle, Norbert Wiener, Patrick Blackett, William Shockley, Tom Kilburn.

Background Reading:

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 229-259, pp. 367-387.

Galison, Peter (1994) 'The ontology of the enemy: Norbert Wiener and the cybernetic vision', *Critical Inquiry*, pp.228-266.

Kirby, Maurice W. (2003) *Operational Research in War and Peace: the British Experience from the 1930s to 1970*. London: Imperial College

Campbell-Kelly, Martin and William Aspray (1996) *Computer: a History of the Information Machine*. New York: Basic Books.

Week 8 Session 21 6 March 2020

SEMINAR: Science policy

Seminar Reading:

Just before the end of the Second World War, President Roosevelt asked his science adviser, Vannevar Bush, to make recommendations for the role and organisation of science in the post-war world. The result was 'Science: the Endless Frontier'.

Read Bush's report online, via:
http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm

Week 9 Session 22 9 March 2020

Big Science and the Cold War

The permanent mobilisation of science in the Cold War. Scientists and the question of control of nuclear weapons. The Soviet bomb. McCarthyism and the Oppenheimer trial. Atoms for Peace. Big Science. Space Race. Plate tectonics. Green Revolution.

Key scientists: Vannevar Bush, Robert Oppenheimer, Igor Kurchatov, Peter Kapitsa, Wernher von Braun, Sergei Korolev, Norman E. Borlaug

Background Reading

James H. Capshew and Karen A. Rader, 'Big Science: Price to the present', *Osiris* (1992) 7, pp. 3-25

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 301-353.

Leslie, Stuart W. (1993) *The Cold War and American Science: the Military-Industrial-Academic Complex at MIT and Stanford*. New York: Columbia University Press

Paul Forman (1987) 'Beyond quantum electronics: national security as basis for physical research in the United States', *Historical Studies in the Physical Sciences* 18. pp. 149-229

Holloway, David, (1994) *Stalin and the Bomb: the Soviet Union and Atomic Energy, 1939-1956*, New Haven: Yale University Press

Van Keuren, David K. (2001) 'Cold War science in black and white', *Social Studies of Science* 31, pp.207-252

Oreskes, Naomi and Ronald E. Doel 'The physics and chemistry of the earth', in Mary Jo Nye (ed.), *The Cambridge History of Science. Volume 5: The Modern Physical and Mathematical Sciences*, Cambridge: Cambridge University Press, pp.538-557

Frankel, Henry (2009) 'Plate tectonics' in Peter J. Bowler and John V. Pickstone, *The Cambridge History of Science, Volume 6, The Modern Biological and Earth Sciences*, Cambridge: Cambridge University Press, pp. 385-394

Perkins, John H. (1997) *Geopolitics and the Green Revolution: Wheat, Genes and the Cold War*. Oxford: Oxford University Press

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Week 9 Session 23 10 March 2020

The Standard Model

This lecture looks at the development of the 'Standard Model', the nearest approximation we have to a unified theory of physics. The Standard Model is one of the great modern milestones, partly a product of 'Big Science', a collaborative achievement of experimenters and theorists, and relies on evidence from measurements made on the tiniest to the largest scales.

Hans Bethe, Julian Schwinger, Richard Feynman, Tsung Dao Lee and Chen Ning Yang, Abdus Salam, Murray Gell-Mann, George Gamow

Background Reading

Schweber, Silvan S. (2003) 'Quantum field theory: from QED to the Standard Model', in Mary Jo Nye (ed.), *The Cambridge History of Science. Volume 5: The Modern Physical and Mathematical Sciences*, Cambridge: Cambridge University Press, pp.375-393

Kragh, Helge (2002) *Quantum Generations: a History of Physics in the Twentieth Century*, Princeton: Princeton University Press.

Week 9 Session 24 13 March 2020

SEMINAR: Edwards

What are the relationships between computers and the Cold War? Is 'discourse' a useful term for historians of science and technology?

Seminar Reading:

Edwards, Paul N. (1996) 'Chapter 1: "We defend every place": building the Cold War world' (part) *The Closed World: Computers and the Politics of Discourse in Cold War America*. Cambridge, MA: MIT Press, pp. 1-30.

Week 10 Session 25 16 March 2020

Science in Social Movements

The long 1960s as a period of transition. Social movements and the sciences. New environmentalism. Pills and the biomedicalisation of everyday life. Cybernetics, the *Limits to Growth* and China's One Child Per Family policy. Neo-catastrophism.

Key scientists: Rachel Carson, Barry Commoner, Maurice Wilkins, Margaret Sanger, Qian Xuesen, Song Jian, Niles Eldredge, Stephen Jay Gould, Luis and Walter Alvarez, Cesare Emiliani, Edward Lorenz

Background Reading

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 403-432.

Agar, Jon (2008) 'What happened in the Sixties?', *British Journal for the History of Science* 41, pp.567-600

Mendelsohn, Everett (1994) 'The politics of pessimism: science and technology circa 1968', in Yaron Ezrahi, Mendelsohn, and Howard Segal (eds.) *Technology, Pessimism and Postmodernism*, London: Kluwer Academic Publishers, pp.151-173

Ravetz, Jerome R. (1990) 'Orthodoxies, critiques and alternatives', in Robert Olby et al (ed.) *The Companion to the History of Modern Science*, London: Routledge, 1990, pp.898-908

Lear, Linda (1997) *Rachel Carson: Witness for Nature*. New York: Henry Holt

Watkins, Elizabeth Siegel (1998) *On the Pill: a Social History of Oral Contraceptives, 1950-1970*. Baltimore: Johns Hopkins University Press

Greenhalgh, Susan (2008) *Just One Child: Science and Policy in Deng's China*. Berkeley: University of California Press

Weart, Spencer R. (2003) *The Discovery of Global Warming*. Cambridge MA: Harvard University Press

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Week 10 Session 26 17 March 2020

DNA to Biotech

Discovery of the structure of DNA. Breaking the code. New biotechnology and entrepreneurial science. Intellectual property. Big Pharma. Discovery of Archaea. Bio-collecting. Sequencing and Human Genome Projects.

Key scientists: James Watson, Francis Crick, Rosalind Franklin, Paul Berg, Herbert Boyer, Stanley Cohen, Ananda Chakrabarty, Carl Woese, Frederick Sanger, John Sulston, Craig Venter, Kary Mullis

Background Reading

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp. 433-465.

Judson, Horace Freeland (1979) *The Eighth Day of Creation: Makers of the Revolution in Biology*. London: Penguin Books

Bowler, Peter J. and Iwan Rhys Morus (2005), *Making Modern Science: a Historical Survey*. Chicago: University of Chicago Press, pp. 205-209

de Chadarevian, Soraya (2003), 'Portrait of a Discovery: Watson, Crick, and the Double Helix' *Isis* 94(1), pp. 90-105

Wright, Susan (1986) 'Recombinant DNA technology and its social transformation, 1972-1982', *Osiris* 2, pp.303-360

Bud, Robert (2009) 'History of biotechnology', in Peter J. Bowler and John V. Pickstone (eds.) *The Cambridge History of Science, Volume 6, The Modern Biological and Earth Sciences*, Cambridge: Cambridge University Press, pp. 524-538

Sulston, John and Georgina Ferry (2002) *The Common Thread: a Story of Science, Politics, Ethics and the Human Genome*. London: Bantam Press

Kevles, Daniel J. and Leroy Hood (eds.), *The Code of Codes: Scientific and Social Issues in the Human Genome Project*. Cambridge, MA: Harvard University Press. (See in particular the essays by Kevles, 'Out of eugenics' and Judson, 'A history of gene mapping and sequencing')

Cook-Deegan, Robert (1994) *The Gene Wars: Science, Politics, and the Human Genome*. New York: W.W. Norton

Judson, Horace Freeland (1979) *The Eighth Day of Creation: Makers of the Revolution in Biology*. London: Penguin Books

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Week 10 Session 27 20 March 2020

SEMINAR: Rachel Carson

Rachel Carson was one of the finest science writers. In Silent Spring (1962) she achieved something else: a dramatic account of what chemicals might be doing to living organisms, and call to arms for environmental action. In this seminar, read the excerpts of Silent Spring, and make notes on how Carson presents the science and moves the reader. Read, too, how reviewers responded.

Seminar Reading:

Rachel Carson, *Silent Spring*. Excerpts available via moodle.

Reviewers' responses to Silent Spring. Excerpts via moodle.

Week 11 Session 28 23 March 2020

Diversity in Science

Diversity in science in terms of language and gender. How and why did English emerge as the most common language of science? How have the patterns of gender diversity in science changed over time and why?

Background Reading

Pnina G. Abir-Am, Dorinda Outram (eds.), *Uneasy Careers and Intimate Lives: Women in Science, 1789-1979*, News Brunswick: Rutgers University Press, 1987
Henry Etzkowitz, Carol Kemelgor, Brian Uzzi, Brian, *Athena Unbound: the Advancement of Women in Science and Technology*, Cambridge: Cambridge University Press, 2000.

Michael D. Gordin, *Scientific Babel: How Science Was Done Before and After Global English*, Chicago: University of Chicago Press, 2015.

Wendy Faulkner and E.A. Kerr, 'On seeing brockenspectres: sex and gender in twentieth century science', in John Krige and Dominique Pestre (eds.), *Science in the Twentieth Century*, Amsterdam: Harwood Academic Publishers, 1997, pp. 43-60

Angela Saini, Inferior: *How Science Got Women Wrong and the New Research That's Rewriting the Story*, London: Fourth Estate, 2017

Ruth Watts, *Women in Science: a Social and Cultural History*, London: Routledge, 2007.

Mary R S Creese and Thomas M Creese, *Ladies in the Laboratory: American and British Women in Science, 1800-1900, a Survey of their Contributions to Research*, London: Scarecrow Press, 1998.

Week 11 Session 29 24 March 2020

New Ends

Physical sciences and the end of the Cold War. CERN and the SSC. Science and global climate change. Trends in disease and health.

Background Reading

Agar, Jon (2012) *Science in the Twentieth Century and Beyond*, Cambridge: Polity, pp.466-496.

Royal Society and Royal Academy of Engineering (2004) *Nanoscience and Nanotechnologies: Opportunities and Uncertainties*. London: Royal Society

Riordan, Michael (2001) 'A tale of two cultures: building the Superconducting Super Collider, 1988-1993', *Historical Studies in the Physical and Biological Sciences* 32, pp.125-144.

Kevles, Daniel J. (1997) 'Big Science and big politics in the United States: Reflections on the death of the SSC and the life of the Human Genome Project', *Historical Studies in the Physical and Biological Sciences* 27, pp.269-297

Gieryn, Thomas F. (1991) 'The events stemming from Utah', *Science* 252, pp.994-995

Weart, Spencer R. (2003) *The Discovery of Global Warming*. Cambridge MA: Harvard University Press,

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Week 11 Session 30 27 March 2020

Seminar: Merchants of Doubt

Watch and make notes of historian of science, Naomi Oreskes' lecture on the sources of doubt and skepticism in the debate on global warming:

https://www.youtube.com/watch?v=XXyTpY0NCp0