HPSC0010

History of Modern Science

Course Syllabus

2022-23 session | Professor Jon Agar and Dr Jenny Bulstrode

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, India, China), 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:	https://moodle.ucl.ac.uk/course/view.php?id=28015
Assessment:	Two essays
Timetable:	See online timetable
Prerequisites:	None
Required texts:	Readings listed below
Course tutor(s):	Professor Jon Agar; Dr Jenny Bulstrode PGTA: TBC
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Schedule

	UCL Wk	Topic	Tutorial Reading
1	21	Introduction to Course; Deep Time (JB) and Evolution (JA)	Read: Turner
2	22	Science and industry (JB)	Read: Hunt Read: Prasad
3	23	New Sciences c.1900 (JA)	Read: Kohler Read: Galison
4	25	Sciences and empires (JB)	Activity – see group instructions
5	24	Science and the World Wars (JA)	Read: Manifesto of the 93, Manifesto to the Europeans Read: Science: the Endless Frontier
6	26	Reading Week	
7	27	Capitalism, Communism and the Cold War (JA)	Read: Polanyi Read: Capshew and Rader
8	28	Winds of Change (JA)	Read: BSSRS documents and publications – instructions given in class
9	29	Science, Commerce and Innovation (JA)	Read: Wright
10	30	Diversity in Science (JA)	Read: Carson and Responses
11	31	Climate Change (JB)	Watch: Oreskes

Assessments

Summary

	Description	Deadline	Word limit	Deadline for Tutors to provide Feedback
50%	Essay (3 paper summary)	27 March 2023	1,000	As advised
50%	Essay (exhibition design)	24 April 2023	2,500	As advised

The first essay – critical summaries of three academic history of science journal articles - is designed so that you explore the recent academic scholarship on the history of nineteenth or twentieth century science.

The second essay – a guide to an exhibition, designed by you, on science in the 19th and 20th centuries – is designed so that you consider and interpret the topic as a whole, guided and referenced in good history of science secondary literature.

Further detailed instructions will be given during the course, see Moodle page for further information.

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.

Mary Jo Nye (ed.) *The Cambridge History of Science. Volume 5: The Modern Physical and Mathematical Sciences*, Cambridge: Cambridge University Press, 2003.

Peter Bowler and John Pickstone (eds.), *The Cambridge History of Science. Volume 6: The Modern Biological and Earth Sciences*, Cambridge: Cambridge University Press, 2009.

Other Good Books and Papers (organized in order of the topic being discussed in class)

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

Bulstrode, Jenny, 2016, The industrial archaeology of deep time, British Journal for the History of Science, 49 (1) 1-25.

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

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

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.

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, 2003.
Peter Bowler and John Pickstone (eds.), *The Cambridge History of Science. Volume 6: The Modern Biological and Earth Sciences*, Cambridge: Cambridge University Press, 2009.

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

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

Roy Porter, *The Greatest Benefit to Mankind*, London: Fontana, 1997

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

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

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

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

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

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

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

Peter Galison and Bruce Hevly (eds.) *Big Science: the Growth of Large-Scale Research*. Stanford: Stanford University Press, 1992

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

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

Kapil Raj, 'Beyond Postcolonialism . . . and Postpositivism: Circulation and the Global History of Science', *Isis* (2013) 104, pp. 337–347.

David Arnold, 'Nehruvian Science and Postcolonial India', *Isis* (2013) 104, pp. 360 –370.

Graham, Loren R. (1998) *What Have We Learned about Science and Technology from the Russian Experience?* Stanford: Stanford University Press.

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

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

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

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

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

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

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

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

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

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

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.

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.

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

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

Naomi Oreskes and Erik M. Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*, London: Bloomsbury Press, 2010

Week 1

Introduction to Course; Deep Time (JB) and Evolution (JA)

Introduction to the course: how the course works; how the course in assessed

The age of the earth and the ages of man: concepts of 'deep time' in the late 18th to mid 19th centuries. The career and ideas of Charles Darwin, and his followers, captures many interesting features of nineteenth century science: travel and exploration, gentlemanly and amateur cultures, supposed conflicts with religion, and the growing professionalisation of science.

The tutorial reading this week is a journal paper by the historian Frank Turner examining the deeper causes of the science and religion debates.

Essential Tutorial Reading

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

Week 2

Science and industry (JB)

In the wake of the Napoleonic Wars, (1803-1815), Britain expanded its aggressive system of global capitalism to become the workshop of the world. In the middle of this industrial revolution, technological transformations changed the way people saw the world and how they went about their daily lives. Out of these new ways of seeing and doing, people developed new ways of knowing.

Essential Tutorial Reading

Hunt, Bruce, 2008, 'Doing Science in a Global Empire: Cable Telegraphy and Electrical Physics in Victorian Britain' in Lightman (ed) *Victorian Science in Context*, pp.312-333

Prasad, Ritika, 2013. 'Time-sense': Railways and temporality in colonial India. *Modern Asian Studies*, 47(4), 1252-1282.

Week 3

New Sciences, c.1900 (JA)

The late 19th and early 20th centuries were tremendously productive of new science and sciences. 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. Also 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"). We will also explore the new 'germ' theory (bacteriology), new instruments and discoveries in astronomy and new theories of psychology.

The tutorial readings this week are two interesting papers by leading historians of science: Peter Galison on Einstein and Robert Kohler on Thomas Hunt Morgan's Fly Group.

Essential Tutorial 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.

Peter Galison, 'Einstein's Clocks: The Place of Time', *Critical Inquiry* (2000) 26, pp. 355-389

Week 4

Sciences and empires (JB)

The British Museum's collections are principally associated with 18th and 19th centuries and there is little mention of 20th century collecting on the British Museum website. Yet in the first half of the 20th century, the British Museum collections doubled in size. In a recent exchange with the British Museum curatorial team, staff were unaware of any connection with 20th century science and technology, yet a closer look at how these cultural artefacts came to the British Museum tells a different story. This session supports you to carry out your own mini research project, working in groups to explore the entangled projects of 20th century science and empire instantiated in British Museum collections. By putting British Museum collections in context, we see how the British empire provided context and resources for science; and science provided context and resources for the British empire.

Activity

In place of an essential tutorial reading, students work in groups to complete an activity. Each group activity will involve visiting the British Museum to see a specified object on gallery, and using the materials assigned to that group to prepare a group presentation for whole class discussion in the tutorial session.

Week 5

Science and the World Wars (JA)

The sciences were mobilised for action in the First and Second World Wars. We examine how chemists, physicists, engineers and psychologists all contributed their expertise and sought to change the fortunes of their disciplines during the First World War. We will trace the aftermath of the First World War in Germany, and explore the sciences both in the Weimar Republic and under the Nazi regime. We examine science in the Second World War, especially the project to build atomic weapons.

The tutorial readings this week are primary sources: two manifestos signed in Germany at the beginning of the First World War, and a science policy document drawing lessons from the Second World War.

Essential Tutorial Reading (and Activity)

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

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 6

**** READING WEEK ****

Week 7

Capitalism, Communism and the Cold War (JA)

The great ideological battle of the twentieth century was between capitalism and communism. What do such terms mean? Was science different in capitalist and communist systems? We examine science in the United States (especially in regard to industrial capitalism), the Soviet Union, and the People's Republic of China. American science was extraordinarily successful in the twentieth century, but how can such success be explained? We have seen that 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. 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. Loren Graham, a historian of Russian and Soviet science, asks a very interesting question: which is more important to science, money or freedom? China's communist revolution was completed in 1949, and a study of science in China reveals further insights. Finally we look at the permanent mobilisation of science in the Cold War.

There are two tutorial readings this week. Michael Polanyi's 'The republic of science' argues for freedom in science. Karen Rader and John Capshew's 'Big Science: from Price to present' analyses a term for a type of large-scale science that flourished in the Cold War.

<u>Essential Tutorial Reading:</u>

Michael Polanyi, 'The Republic of Science: Its Political and Economic Theory', *Minerva* (1962) 1, pp. 54-74.

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

Week 8

Winds of Change (JA)

The twentieth century saw the break up of European imperial systems and, through decolonisation, the establishment of independent nations. 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. Science was also important, sometimes central, for new, independent, post-colonial nations, such as India.

The long 1960s was also a period of transition everywhere. Social movements and the sciences. New environmentalism. The contraceptive pill and the biomedicalisation of everyday life (including psychopharmacology). DSM III and cognitive therapies.

Essential Tutorial Reading

The tutorial readings this week are documents and publications by the activist group the British Society for Social Responsibility in Science. More information about accessing them will be given in class.

Week 9

Science, Commerce and Innovation (JA)

From the 1970s, with the discovery of genetic engineering techniques a dramatic transformation of the life sciences involved a new commercial focus, the new 'biotechnology' boom. The lectures will trace the longer history of molecular biology, including the discovery of the structure of DNA. the breaking of the code, and the rise of the new biotechnology and entrepreneurial science. Other topics include intellectual property, the continuing role of Big Pharma, the discovery of Archaea, and the sequencing projects that culminated in the Human Genome Projects. We will also take a quantitative, statistical look at science and science funding.

The tutorial readings are Susan Wright on the transformations of the life sciences associated with genetic engineering, and Benoît Godin on the history of the term 'innovation'.

Essential Tutorial Reading

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

Week 10

Diversity in Science (JA)

The lectures examine 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?

In the tutorial we revisit the work of Rachel Carson, 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.

Essential Tutorial Reading

For 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, not least to her as a woman.

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

Reviewers' responses to Silent Spring. Excerpts via moodle.

Week 11

Climate Change (JB)

In the last week we look at one of the great issues of the 20th and early 21st century: climate change. As we finalize this syllabus in November 2022 Wikipedia quotes authoritative sources to claim that “Climate change first emerged as a political issue in the 1970s.” Is this true? What can we learn from past disputes about how to understand climate? How did these disputes translate (and not) into international political action? What were the strategies taken by opponents to climate change action, and where were those strategies learned? How can the history of climate science as a political issue help us to engage with questions of climate justice today?

In the tutorial we will discuss a lecture presentation by one of the leading historians of the 'merchants of doubt', Naomi Oreskes.

Essential Tutorial Activity

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