UNIVERSITY OF OXFORD

Modern History Faculty

Hilary Term 2004

Science and Learned Culture in Victorian Britain

Science and learned culture in Victorian Britain

Lecture programme for Hilary Term 2004

Lecture 1 (Week I: Thursday 22 January
The common context: Genesis, geology, and natural theology

Lecture 2 (Week II: Thursday 29 January
Darwin and natural selection

Lecture 3 (Week III: Thursday 5 February):
Science, criticism, and the crisis of faith

Lecture 4 (Week IV: Thursday 12 February)
The roots of human history: archaeology, anthropology, and the evolutionary model

Lecture 5 (Week V: Thursday 19 February)
Scholarship and the liberal ideal in education

Lecture 6 *(Week VII: Thursday 4 March)*
Culture and the industrial spirit

These six one-hour lectures will take place at 11.00 on the Thursdays indicated. They will be given in the History of Science and Technology Seminar Room on the top floor of the Modern History Faculty. Note that there will be no lecture in Sixth Week.

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For an electronic version of this booklet, look under the *Courses and reading lists* section of the History of Science, Medicine, and Technology website at **http://www.history.ox.ac.uk/hsmt**

Science and learned culture in Victorian Britain

There are few periods in which science has been as prominent in public debate as it was in the nineteenth century. The controversy surrounding Darwin's theory of evolution by natural selection is a particularly well known instance of a scientific confrontation that captivated the Victorian reading public. But the Darwinian affair was the tip of an exceedingly capacious iceberg. By the 1850s, the faltering of natural theology – a theology based on the use of natural reason (in the manner of William Paley) – raised the spectre that science might, after all, be at odds with belief and hence that the modernizing call for an extension of science teaching at all levels in society and for the reinvigoration of British industry through science might carry with it a threat to the established order of religion and even of society.

The purpose of these lectures is to set Victorian science in the context of broader movements in the intellectual, social, and economic history of the period. A central episode, inevitably, is the debate that followed the publication of Darwin's *Origin of species* in 1859, epitomized in the famous confrontation of 1860 between T. H. Huxley and Samuel Wilberforce, the Bishop of Oxford. And there is recurring reference to attempts to modernize both thought and public policy. The emphasis throughout is on those aspects of Victorian science that impinged most forcefully on the general intellectual affairs of the day. The increasingly abstruse 'professional' disciplines of mathematics and the physical sciences are therefore given less prominence than developments in geology and the life sciences, social theory, educational reform, and industry, all of which fired the imagination of the reading public. What emerges is a state of intimacy between general culture and at least the more accessible areas of science of which few traces have survived into our own day.

Lectures and reading

The summary of each lecture is followed by suggestions for reading. It cannot be stressed too strongly that the suggestions are no more than that. For essay writing, they are insufficient, and for general background reading, too numerous. They are certainly no substitute for the guidance of your tutor.

An obvious problem with these lectures is that there is no satisfactory general text covering all the material, even superficially. Nevertheless, certain works, many of them surprisingly elderly, do provide partial starting points. For a perceptive general introduction to Victorian cultural history, Walter E. Houghton's *The Victorian frame of mind 1830–1870* (New Haven and London, 1957) is still dependable, and T. W. Heyck's *The transformation of intellectual life in Victorian England* (London, 1982), especially chapters 3–5, provides a brief overview. For more detailed studies, it is necessary to refer to journals, specialized monographs, or collections of essays, among which Bernard Lightman (ed.), *Victorian science in context* (Chicago and London, 1997), is especially useful.

Of a daunting literature on the Darwinian revolution and the associated issues in geology and palaeontology, a useful introduction is Charles Gillispie's *Genesis and geology. A study in the relations of scientific thought, natural theology, and social opinion in Great Britain, 1790–1850* (Cambridge, Mass., 1951). In the same general area, a collection of essays of generally high quality is David Kohn (ed.), *The Darwinian heritage* (Princeton, N.J., 1985). Other general books on Darwin's hypothesis and its origins and consequences include David R. Oldroyd's *Darwinian impacts. An introduction to the Darwinian revolution* (Milton Keynes, 1980) and Peter J. Bowler's *Evolution. The history of an idea* (Berkeley, Calif., 1984), but Loren Eiseley's *Darwin's century. Evolution and the men who discovered it* (New York, 1958) is still useful. Despite some questionable interpretations, Gertrude Himmelfarb's *Darwin and the Darwinian revolution* (New York, 1959) remains an exceptionally rich source, and no study of the age of Darwin can ignore Robert M. Young's collection of essays: *Darwin's metaphor. Nature's place in Victorian culture* (Cambridge, 1985). Recent writing on Darwin, however, has tended to be overshadowed by the readable and reliable biographies by Adrian Desmond and James Moore – *Darwin* (London, 1991) – and Janet Browne – *Charles Darwin. Voyaging* (London, 1995), and *Charles Darwin. The power of place* (London, 2002). Huxley has been similarly well served by Adrian Desmond: see Desmond's two volumes of biography, *Huxley. The devil's disciple* (London, 1994) and *Huxley. Evolution's high priest* (London, 1997).

For a well-chosen selection of primary sources on the relations between science and religion, Tess Cosslett's *Science and religion in the nineteenth century* (Cambridge, 1984) can be recommended. On this subject, John Hedley Brooke's *Science and religion. Some historical perspectives* (Cambridge, 1991), especially chapters 6–8, is incomparable and is strongly recommended for purchase. Very important too is John Hedley Brooke and Geoffrey N. Cantor, *Reconstructing nature. The engagement of science and religion* [Gifford Lectures, 1995–6] (Edinburgh, 1998).

The themes of educational reform and the rise and decline of British industry are treated in another vast literature. Here, David Landes's *The unbound Prometheus*, first published as volume VI, part 1 of the *Cambridge economic history of Europe* in 1965, remains an untarnished classic, unrivalled in its integration of the history of technology with economic history. Donald Cardwell's *The organisation of science in England* (2nd edn., London, 1972) is still a remarkable and dependable survey. Though not primarily a work of historical scholarship, Martin J. Wiener's *English culture and the decline of the industrial spirit* (Cambridge, 1981) has attracted much attention and, for all its faults, is a stimulus for discussion. For some useful primary sources, see George Basalla, William Coleman, and Robert H. Kargon (eds.), *Victorian science. A self-portrait from the presidential addresses to the British Association for the Advancement of Science* (New York, 1970), especially sections II and III.

In these introductory notes, I have suggested readily available (usually paperback) items that provide a wide basic coverage. In this way, unfortunately, some of the most exciting modern literature in the field is ignored. If you are particularly interested in geology, for example, you will want to come to grips with the writings of Martin Rudwick, in particular his acclaimed book *The great Devonian controversy. The shaping of scientific knowledge among gentlemanly specialists* (Chicago and London, 1985). Geology and natural history can also be well studied through the interesting collection of essays, edited by Nicholas Jardine, J. A. Secord, and E. C. Spary, *Cultures of natural history* (Cambridge, 1996), while Victorian practices of reading and conversation about such subjects are fascinatingly treated in Secord's *Victorian sensation* (Chicago, 2001), a magisterial study of the publishing and reception of Robert Chambers's *Vestiges of the natural history of creation* (1844). Finally, on religion, no serious work is possible without reference to Owen Chadwick's two volumes on *The Victorian church* (London, 1966–70), and on Victorian social theory, John W. Burrow, *Evolution and society. A study in Victorian social theory* (Cambridge, 1966), remains indispensable.

January 2004 Robert Fox

The caricature on the front cover is of Thomas Henry Huxley. It is by Carlo Pellegrini ('Ape'), who began a famous series of portraits of public figures in Vanity Fair *in 1862. The tradition was continued in a similar style in the same magazine by Leslie Ward ('Spy').*

LECTURE 1
The common context: Genesis, geology, and natural theology

About 1800, the interests of religion and science seemed to have converged most satisfactorily in the broad, mainly Anglican consensus known as natural theology. Even the most devoted advocates of natural theology, including William Paley and the Oxford geologist William Buckland, insisted that the role of natural theology was as a complement to revealed theology, not as a substitute for it. But that point was easily overlooked in the thirty years or so that separated the publication of Paley's *Natural theology* in 1802 from that of the 'Bridgewater treatises' in the early 1830s. In this lecture, both intellectual and social contexts are discussed in an attempt to explain the rise of natural theology and its subsequent faltering in the years just before the appearance of Darwin's *Origin*, years in which evolutionary ideas were common currency in advanced and intellectual circles.

Primary source:

Baden Powell, *Essays on the spirit of the inductive philosophy, the unity of worlds and the philosophy of creation* (1855). Essay I, chaps. I, II and V, pp. 3–81 and 133–68

Key reading:

John Hedley Brooke, *Science and religion. Some historical perspectives* (Cambridge, 1991), chapters 6 and 7

Other reading:

John Hedley Brooke and Geoffrey N. Cantor, *Reconstructing nature. The engagement of science and religion* (Edinburgh, 1998), chapters 5 and 6

Pietro Corsi, *Science and religion. Baden Powell and the Anglican debate, 1800–1860* (Cambridge, 1988), Parts II and III, especially chapters 9–12

Charles Coulston Gillispie, *Genesis and geology. A study in the relations of scientific thought, natural theology, and social opinion in Great Britain, 1790–1850* (Cambridge, Mass., 1950), chapters 4 and 5

Dov Ospovat, *The development of Darwin's theory. Natural history, natural theology, and natural selection, 1838–1859* (Cambridge, 1981)

Martin J. S. Rudwick, *The great Devonian controversy. The shaping of scientific knowledge among gentlemanly specialists* (Chicago and London, 1985)

Nicolaas A. Rupke, *The great chain of history. William Buckland and the English school of geology (1814–1849)* (Oxford, 1983), esp. the later chapters

James A. Secord, 'Introduction', in Secord (ed.), *Vestiges of the natural history of creation and other evolutionary writings by Robert Chambers* (Chicago, 1994), pp. ix–xlv

James A. Secord, *Victorian sensation. The extraordinary publication, reception, and secret authorship of Vestiges of the Natural History of Creation* (Chicago and London, 2000)

Michael Shortland (ed.), *Hugh Miller and the controversies of Victorian science* (Oxford, 1996), especially the contributions by Shortland, John Hedley Brooke, and Donald Macleod

LECTURE 2
Darwin and natural selection

Darwin's forebodings about the likely repercussions of the *Origin* proved fully justified. For although evolutionary theories of the history of life were familiar enough by 1859, the notion of natural selection as the mechanism of evolution was new and disturbing. Above all, natural selection undermined the tradition of providentialist teaching which saw the exquisite adaptation of animals to their environment (an inevitable consequence of natural selection) as explicable only by God's creative activity, either at the Creation (in the deistic version) or at intervals in the subsequent history of the world (as theists believed). The theory was inevitably divisive, but the lines of the division are often misapprehended. The confrontation between Huxley and Wilberforce at the Oxford meeting of the British Association in 1860, in particular, is a snare, since it suggests that the forces of atheism and science (personified in Huxley) were pitted quite straightforwardly against religion, represented by the Bishop of Oxford. In reality, there were profound internal conflicts within both the scientific and the religious camps, conflicts that set England's leading anatomist Richard Owen against Darwin, for example, and Broad Church Anglicans against Wilberforce.

Primary sources:

Charles Darwin, *On the origin of species* (London, 1859), chapter 14 (chapter 15 in the Everyman edition). The text is in the volume of texts edited by Tess Cosslett, *Science and religion in the nineteenth century* (Cambridge, 1984), pp. 88–109. Another useful version is the Penguin Classics edition of the *Origin*, which has a perceptive and informative introduction by John Burrow.

'Autobiography of Charles Darwin' (1876), in Sir Francis Darwin (ed.), *The life and letters of Charles Darwin*, vol. I (1888), chap. II, 26–107

Key reading:

Either Adrian J. Desmond and James R. Moore, *Darwin* (London, 1891), at least chapters 30–34

Or as much as you can manage of Janet Browne's two volumes: *Charles Darwin. Voyaging* (London, 1995) and *Charles Darwin. The power of place* (London, 2002)

Other reading:

Janet Browne, *Charles Darwin. Voyaging* (London, 1995), and *Charles Darwin. The power of place* (London, 2002)

Walter F. [Susan F.] Cannon, 'The bases of Darwin's achievement: a revaluation', *Victorian studies*, 5 (1962 – 2), 109–34

Adrian J. Desmond, *Huxley. The devil's disciple* (London, 1994) and *Huxley. Evolution's high priest* (London, 1997)

John Durant (ed.), *Darwinism and divinity. Essays on evolution and religious belief* (Oxford, 1985), especially the contributions by John Hedley Brooke and Durant

Richard Keynes, *Fossils, finches, and Fuegians. Charles Darwin's adventure and discoveries on the Beagle, 1832–1836* (London, 2002)

H. L. McKinney, 'Alfred Russell Wallace and the discovery of natural selection', *Journal of the history of medicine*, 21 (1966), 333–57; also McKinney's book *Wallace and natural selection* (New Haven, Conn., 1972)

Charles Moore, 'Wallace's Malthusian moment: the common context revisited', in Bernard Lightman (ed.), *Victorian science in context* (Chicago and London, 1997), pp. 290–311

Nicolaas A. Rupke, *Richard Owen. Victorian naturalist* (New Haven, Conn., 1994)

Michael Shermer, *In Darwin's shadow. The life of Alfred Rusel Wallace* (Chicago and London, 2002)

Phillip R. Sloan, 'Whewell's philosophy of discovery and the archetype of the vertebrate skeleton: the role of German philosophy of science in Richard Owen's biology', *Annals of science*, 60 (2003), 39–61

S. M. Walters and E. A. Stow, *Darwin's mentor. John Stevens Henslow 1796–1861* (Cambridge, 2001)

Robert M. Young, 'The impact of Darwin on conventional thought', in Young, *Darwin's metaphor. Nature's place in Victorian culture* (Cambridge, 1985), pp. 4–22; originally published in A. J. Symondson (ed.), *The Victorian crisis of faith* (London, 1970), pp. 13–35

Robert M. Young, 'Darwin's metaphor: does Nature select?' in Young, *Darwin's metaphor*, pp. 79–125; originally published in *The monist* (1971)

LECTURE 3
Science, criticism, and the crisis of faith

The religious doubts that lay at the heart of the Victorian crisis of faith had intellectual roots not only in science but also, and more forcibly, in the emerging tradition of German biblical scholarship. By presenting the Bible as a fallible source, comparable with any other ancient text, German scholars cast doubt not only on its divine origin but also on the supposedly historical events of the Old Testament and even of the lives of Christ and the Apostles. The works of David

Strauss (*The life of Jesus*, 1835) and others provoked conflicting waves of revulsion and admiration throughout the Christian world. In Britain, the 'higher criticism' reinforced the scepticism of those who were ready to turn away from traditional religion: the success of the positivist Religion of Humanity was one manifestation of this. But many leading Christians too were captivated by the ideas emanating from the German universities, and it was a group of liberal Anglicans who produced the most constructive response to new perceptions of the Bible and to the rising tide of scientific naturalism in a collection of seven essays published in 1860 as *Essays and reviews*. The history of *Essays and reviews* is a microcosm of the Anglican Church's struggle to come to terms with the modern world. It has many echoes in our own time.

Primary sources:

Thomas Henry Huxley, *Evolution and ethics* [Romanes Lecture] (London, 1893)

William Thomson, Baron Kelvin, Presidential address delivered to the British Association meeting at Edinburgh in 1871, reprinted as 'The structure of matter and the unity of science', in G. Basalla, W. Coleman, and R. Kargon (eds.), *Victorian Science* (New York, 1970), pp. 101–28

John Tyndall, 'Address', *Report of the Forty-Fourth Meeting of the British Association for the Advancement of Science, held at Belfast, August 1874* (1875), pp. 87–97

Key reading:

Brooke, *Science and religion*, chapter 8

Other reading:

Ruth Barton, 'John Tyndall, pantheist: a rereading of the Belfast Address', *Osiris*, 2nd ser. 3 (1987), 111–34

W. H. Brock and R. M. MacLeod, 'The scientists' declaration: reflexions on science and belief in the wake of *Essays and reviews*, 1864–5', *The British journal for the history of science*, 9 (1976), 39–66

Brook and Cantor, *Reconstructing nature*, pp. 48–57 and chapter 8

Owen Chadwick, *The Victorian church* (2 vols., London, 1966–70), vol. 2, section II, especially pp. 75–97 (on *Essays and reviews*); also pp. 1–75 (on 'Science and religion' and 'History and the Bible')

Owen Chadwick, *The secularization of the European mind in the nineteenth century* (Cambridge, 1975), chapters 7 and 8

Ieuan Ellis, *Seven against Christ. A study of 'Essays and reviews'* (Leiden, 1980)

Peter Hinchcliff, *Frederick Temple, Archbishop of Canterbury. A life* (Oxford, 1998), especially chapter 3 (on *Essays and reviews*) and chapter 7 (on religion and science)

Victor Shea and William Whitla (eds.), *Essays and reviews. The 1860 text and its reading* (Charlottesville and London, 2000)

Anne Thwaite, *Glimpses of the wonderful. The life of Philip Henry Gosse 1810–1888* (London, 2002)

Frank Miller Turner, *Between science and religion. The reaction to scientific naturalism in late Victorian England* (New Haven and London, 1974), especially chapters 2, 4, and 6

Basil Willey, *More nineteenth-century studies. A group of honest doubters* (London, 1956), chapter 4

Terence R. Wright, *The religion of humanity. The impact of Comtean positivism on Victorian Britain* (Cambridge, 1986)

LECTURE 4
The roots of human history: archaeology, anthropology, and the evolutionary model

In mid-Victorian Britain, Herbert Spencer was the best-known theorist of social evolution. He saw human history as exemplifying a transition from the homogeneity of primitive societies to the heterogeneity of complex modern societies. Supporting his analysis by scientific theories drawn in particular from Lamarck's doctrine of the inheritance of acquired characteristics and recent developments in embryology, he brought the biological and social realms of evolutionary thought together in a synthesis that broke sharply and deliberately with the view of society as an artefact capable of virtually infinite manipulation. The latter view, espoused in the early nineteenth century by Bentham and other 'philosophic radicals', duly lost ground as Spencer's stock rose and as social Darwinism incorporated many of the principles that in reality were Spencerian in origin. It is no coincidence that the debates of this period also made their mark in the rise of archaeology and anthropology.

Primary sources:

Herbert Spencer, 'Progress: its law and cause', *Westminster Review*, new ser. 11 (April 1857), 445–85

Herbert Spencer, *The study of sociology* (1873), chapters 1–3 (pp. 1–71)

Alfred Russel Wallace, 'Darwinism applied to man', in *Darwinism. An exposition of the theory of natural selection with some of its applications* (London, 1889), chapter 15 (pp. 445–78)

Key reading:

Robert M. Young, 'Malthus and the evolutionists: the common context of biological and social theory', in Young, *Darwin's metaphor*, pp. 23–55; originally published in *Past and present*, no. 43 (1969), 109–45

Other reading:

Peter J. Bowler, *Evolution. The history of an idea* (Berkeley, Calif., 1984), chapter 10

Peter J. Bowler, *Theories of human evolution. A century of debate, 1844–1944* (Oxford, 1987)

Peter J. Bowler, *Biology and social thought, 1850–1914* (Berkeley, Ca., 1993)

John W. Burrow, *Evolution and society. A study in Victorian social theory* (Cambridge, 1966), especially chapter 6 (on Spencer)

John C. Greene, 'Biology and social theory in the nineteenth century: Auguste Comte and Herbert Spencer', in Marshall Clagett (ed.), *Critical problems in the history of science* (Madison, Wisc., 1959), pp. 419–46; also the commentaries on pp. 447–66

Elie Halévy, *The growth of philosophic radicalism*, trans. by Mary Morris (1928; reprinted as a Faber paperback, London, 1972)

T. W. Heyck, *The transformation of intellectual life in Victorian England* (London, 1982), chapter 5

Greta Jones, *Social Darwinism and English thought. The interaction between biological and social theory* (Brighton, 1980), chapters 2–4

Benjamin Kidd, *Social evolution* (London, 1894)

Roger Smith, *The Fontana history of the human sciences* (London, 1997), chapter 13

George W. Stocking, Jr., 'From chronology to ethnology: James Cowles Prichard and British anthropology 1800–1850', in Prichard, *Researches into the physical history of man* (facsimile reprint of 1813 edition; Chicago and London, 1973), ix–cx

LECTURE 5
Scholarship and the liberal ideal in education

The danger of seeking a single characterization of a period has led historians to be suspicious of such notions as the 'spirit of the age' and 'the Victorian mind'. The reality is almost invariably one of diversity and tension. The Victorian period is no exception. Much of this lecture will be devoted to one such tension: that between the Victorian admiration for classical antiquity and the parallel interest in the Middle Ages. For Lord Acton, writing in 1859, this was 'the great dualism that runs through our society'. The two cultural tendencies bore rich scholarly fruit. Britain (though never quite the equal of Germany) was among the leaders in classical scholarship, while a variety of devotees of medieval art and culture, from Pugin to Ruskin, expounded their views in a tradition of writing broadly associated with the movement that, with caution, we can designate as the Gothic Revival. Ideas emanating from these loftier regions of 'high' culture permeated the worlds of education and the reading public. Here, in a recurring debate, attempts were made to determine the way in which professional scholarship and refined taste should be integrated in the formation of the young mind. William Whewell, John Henry Newman, Henry Sidgwick, Thomas Henry Huxley, and Mark Pattison were just a few of those whose views on a liberal education will be touched on. The debate was one in which the emergence of our own discipline of modern history (in Oxford from the 1850s) also became involved.

Primary sources

J. Bryce, Preface to J. Conrad (ed.), *The German universities for the last fifty years*, trans. John Hutchison (Glasgow, 1885), xiii–xxx

J. Ruskin, 'The nature of Gothic', from *The stones of Venice* (1851–3); 'The two boyhoods', from *Modern painters*, vol. 5 (1860); 'Traffic', from *The crown of wild olive* (1866) – all reprinted in *Unto this last and other writings* (Penguin, 1985), ed. C. Wilmer, pp. 77–109, 144–53, 233–49.

Schools Inquiry Commission [Taunton], (P.P. 1867–8, xxviii, part 1): 'Of the kinds of education which appear to be desirable and attainable', pp. 14–49, and 'Girls' schools', pp. 546–70

H. Sidgwick, 'The theory of classical education', in F. W. Farrar (ed.), *Essays on a liberal education*

Key reading:

Arthur J. Engel, *From clergyman to don. The rise of the academic profession in nineteenth-century Oxford* (Oxford, 1983)

Other reading:

Paul Atterbury and Clive Wainwright (eds), *Pugin. A Gothic passion* (New Haven and London, 1994)

Kenneth Clark, *The gothic revival. An essay in the history of taste* (London, 1928, and many subsequent editions)

Thomas Henry Huxley, 'A liberal education and where to find it' and 'Scientific education: notes of an after-dinner speech', in Huxley, *Lay sermons, essays and reviews* (London, 1895), pp. 24–61

Richard Jenkyns, *The Victorians and ancient Greece* (Cambridge, Mass., 1980)

Peter Slee, *Learning and a liberal education. The study of modern history in the universities of Oxford, Cambridge and Manchester 1800-1914* (Manchester, 1986)

John Sparrow, *Mark Pattison and the idea of a university* (Cambridge, 1967), especially chapters 3 and 4

Frank M. Turner, *The Greek heritage in Victorian Britain* (New Haven and London, 1981), chapters 1–3

LECTURE 6
Culture and the industrial spirit

The publication of Martin Wiener's *English culture and the decline of the industrial spirit* in 1981 caused a stir that spread far beyond the world of historical scholarship. Wiener's contention that England has been the victim of anti-utilitarian cultural prejudices that have gravely inhibited her industrial performance since the mid-nineteenth century was greeted in many circles as a revelation of blinding originality. In reality, Wiener was simply rehearsing in a provocative form a thesis that has been current in England since the days of Lyon Playfair. In this lecture, it is argued that although cultural conservatism did indeed have an effect on British industrial performance, similar attitudes can be identified in virtually all industrialized countries. Hence, in itself, Britain's allegiance to classical values and traditional forms of literate culture cannot explain the country's economic decline relative to, say, Germany. Moreover, it has to be borne in mind that the lofty cultural values of which Wiener speaks were very much those of a social elite centred on London and the ancient universities, to which he seems to give undue weight. As I shall argue, things looked very different in Manchester or Glasgow.

Primary sources:

Matthew Arnold, *Culture and anarchy* (1869); University of Michigan edition (1969), pp. 85–229.

Lyon Playfair, 'The chemical principles involved in the manufacturers of the exhibition', in *Lectures on the results of the Great Exhibition of 1851* (London, 1852), pp. 159–75, 189–208

Key reading:

Martin J. Wiener, *English culture and the decline of the industrial spirit, 1850–1980* (Cambridge, 1981)

Other reading:

Michael Argles, *South Kensington to Robbins. An account of English technical and scientific education since 1851* (London, 1964), chapters 1–6

Eric Ashby, *Technology and the academics. An essay on universities and the scientific revolution* (London, 1958), chapters 1–4

Corelli Barnett, *The audit of war. The illusion & reality of Britain as a great nation* (London, 1986), chapter 11

Donald S. L. Cardwell, *The organisation of science in England* (2nd edn., London, 1972); much of relevance in chapters 4–7, but see especially chapter 6

David Edgerton, *Science, technology and the British industrial 'decline', 1870–1970* (Cambridge, 1996), pp. 2–28

Robert Fox and Anna Guagnini, 'Britain in perspective: the European context of industrial training and innovation, 1880–1914', *History and technology*, 2 (1985), 133–50

Margaret Gowing, 'Science, technology, and education: England in 1870', *Notes and records of the Royal Society of London*, 32 (1977–8), 71–90

Sidney Pollard, *Britain's prime and Britain's decline. The British economy, 1870–1914* (London, 1989), chapter 3

Michael Sanderson, *The universities and British industry 1850–1970* (London, 1972), chapters 1–4

Julia Wrigley, 'Technical education and industry in the nineteenth century', in Bernard Elbaum and William Lazonick (eds.), *The decline of the British economy* (Oxford, 1986), pp. 162–88

The University Museum in the late nineteenth century. The museum, which was designed to provide facilities for all the sciences on a single site, reflected the vision of a unified body of scientific knowledge in accordance with the principles of Charles Daubeny and Henry Acland. It was on the first floor of the building, in what was then the library, that Thomas Huxley and the Bishop of Oxford, Samuel Wilberforce, engaged in their heated debate about Darwin's theory of evolution by natural selection in June 1860.