

# *The laboratory revolution in medicine*

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*Edited by*

ANDREW CUNNINGHAM

*and*

PERRY WILLIAMS

*Wellcome Unit for the History of Medicine,  
University of Cambridge*



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## *Introduction*

ANDREW CUNNINGHAM AND PERRY WILLIAMS

If you feel unwell and go to see a doctor or are admitted to hospital, the chances are that the physicians will take a sample of your body – generally blood, tissue or urine – and send it away to another place for testing; in such cases the decision as to whether you are ill or not, and if you are, what disease you have, will be primarily taken not by you and not by your doctor but by a laboratory test. If you require treatment, this will probably involve the administration of medicinal substances prepared not by you nor by your doctor but in a highly specialised factory-like laboratory. If you decide to become a doctor yourself, your formal professional training will begin not with general practice, nor with hospital work, but with study of the medical sciences, in lecture rooms, libraries and laboratories. If you have already qualified as a doctor and are trying to decide which field of medicine to enter, you will find that the highest professional prestige is attached not to saving large numbers of lives through preventative medicine in the Third World, not to providing service to the community through general practice, nor even to hospital consultancy, but to medical research in scientific laboratories.

Why should the laboratory have become so dominant in modern medicine?

It has taken historians a long time to begin addressing this question. A start was made, one might think, over twenty years ago, when Erwin Ackerknecht posited a threefold distinction between the ‘bedside medicine’ which held sway in Western Europe from the Middle Ages to the eighteenth century, the ‘hospital medicine’ especially associated with Paris between 1794 and 1848, and the



'laboratory medicine' which predominated thereafter, right up to our own time.<sup>1</sup>

In fact, of these three categories, neither 'bedside medicine' nor 'laboratory medicine' were much taken up at first by historians.<sup>2</sup> Rather it was 'hospital medicine' that was studied, largely because of its suitability for making comment – complimentary or critical – on certain features of modern medicine, of which it was seen as marking the origin. There was certainly plenty of justification for this view. For as is now generally accepted, following the work of Ackerknecht, Foucault and others, the rise of 'hospital medicine' involved a dramatic transformation in both the *location* of medicine and its *content*. The hospital became the centre of medical teaching and research and the arbiter of medical knowledge. Teaching at the bedside of hospital patients became the norm – an essential part of a medical education, and not just an optional extra if one had the time and the money. The patients became a resource for medical research – something only made possible by the increased power of doctors within hospitals. In the realm of medical knowledge, humoral pathology was replaced by anatomical pathology, in which disease was primarily identified with lesions. As a result, post-mortem examinations became routine, in order to identify pathological changes after death, and distinctive diagnostic techniques (such as percussion, palpation and auscultation) were developed for identifying the same changes before death – techniques which were pointless to anyone not within the clinical system of thought.<sup>3</sup> All of

<sup>1</sup> Erwin H. Ackerknecht, *Medicine at the Paris Hospital 1794–1848* (Baltimore, 1967), pp. vii and xi. 'Hospital medicine' is sometimes also referred to as 'clinical medicine', following Foucault's terminology (see note 3) and the modern practice of referring to the hospital part of medical education as 'clinical'. This can be confusing; originally the term 'clinical' meant no more than 'at the bedside', so that there would have been no distinction with 'bedside medicine'. It was only after the rise of hospital medicine that 'clinical' was identified with 'hospital', so that for us an 'out-patient clinic' is not a self-contradiction.

<sup>2</sup> One notable use of 'bedside medicine' is N. D. Jewson, 'The disappearance of the sick-man from medical cosmology, 1770–1870', *Sociology*, 10 (1978), pp. 225–44.

<sup>3</sup> The classic works on this subject are Ackerknecht, *Medicine at the Paris Hospital*; and Michel Foucault, *The Birth of the Clinic: An Archaeology of Medical Perception*, trans. A. M. Sheridan (London, 1976; original French edn, 1963). Different perspectives are provided by David M. Vess, *Medical Revolution in France 1789–1796* (Gainesville, Fla., 1975), who emphasises the role of army surgeons; Toby Gelfand, *Professionalizing Modern Medicine: Paris Surgeons and Medical Science and Institutions in the 18th Century* (Westport, Conn., 1980), who emphasises the role of pre-revolutionary surgeon reformers; Russell C. Maulitz, *Morbid Appearances: The Anatomy of Pathology in the Early Nineteenth Century* (Cambridge, 1987), who concentrates on the development of pathological anatomy; and Robert Kilpatrick, 'Nature's schools: the Hunterian revolution in London hospital medicine 1780–1825', unpublished Ph.D. thesis (University of Cambridge, 1989), who argues that hospital medicine developed independently in London.

these features of early nineteenth-century ‘hospital medicine’ are of course fundamental to the medicine of our own culture.

By thus identifying modern medicine’s origin with the rise of hospital medicine, historians have inadvertently minimised and obscured from view the later change from hospital medicine to laboratory medicine; it was as though the rise of the laboratory was simply the addition of another resource, the possibility of doing the same thing better. What we are now appreciating is that the claim that medicine should be based on the laboratory actually involved demoting the importance of the hospital. Claude Bernard’s famous statement of the claim in 1865 makes this clear:

I consider hospitals only as the entrance to scientific medicine: they are the first field of observation which a physician enters; but the true sanctuary of medical science is a laboratory; only there can he seek explanations of life in the normal and pathological states by means of experimental analysis. I shall not concern myself here with the clinical side of medicine; I assume it as known or as still being perfected in hospitals by the new methods of diagnosis which physics and chemistry are constantly giving to symptomatology. In my opinion, medicine does not end in hospitals, as is often believed, but merely begins there. In leaving the hospital, a physician, jealous of the title in its scientific sense, must go into his laboratory; and there, by experiments on animals, he will seek to account for what he has observed in his patients, whether about the action of drugs or about the origin of morbid lesions in organs or tissues. There, in a word, he will achieve true medical science.<sup>4</sup>

From a perspective in which the primary site of medical teaching, medical research and medical knowledge and authority was the *hospital*, Bernard’s claim that to be a true physician one had to pass through the *laboratory* was a staggering one. What this suggests is that the transition to laboratory medicine was a revolution at least as great as the transition to hospital medicine which preceded it.

In the English-speaking world, we are now beginning to get a picture of that revolution as a result of work in a number of different traditions. Historians of the medical sciences are examining the creation in the nineteenth century of new disciplines such as bacteriology, and identifying fundamental changes in old disciplines such as physiology – which only in the time of Magendie and Müller went from being a study concerned with *organs* and other parts serving the animal soul, a discipline closely associated with anatomy, to a study of the *processes* of living bodies.<sup>5</sup> Historians of the

<sup>4</sup> Claude Bernard, *Introduction to the Study of Experimental Medicine*, trans. Henry Copley Greene (New York, 1957; original French edn, 1865), pp. 146–7.

<sup>5</sup> *Physiology*: Frederic Lawrence Holmes, *Claude Bernard and Animal Chemistry: The Emergence of a Scientist* (Cambridge, Mass., 1974); W. R. Albury, ‘Experiment and explanation in the physiology of Bichat and Magendie’, *Studies in the History of Biology*,

antivivisection movements are reminding us that one consequence of this new concern with living processes and experimental control was that most of the new life sciences were based to a quite unprecedented extent on experiments on living animals.<sup>6</sup> Historians of scientific institutions, interested in the social organisation of science, are charting the rise of the laboratory from the private chemical workrooms of the start of the century to the university-based research schools of mid-century to the huge state-funded institutes of the end of the century.<sup>7</sup> Historians of medical education and the medical profession are studying the rise of the elementary teaching laboratory in the middle of the century, and the increasingly dominant role of laboratory science in medical practice.<sup>8</sup> Historians of epidemiology

1 (1977), pp. 47–131; Gerald L. Geison, *Michael Foster and the Cambridge School of Physiology* (Princeton, 1978); John V. Pickstone, 'Bureaucracy, liberalism and the body in post-Revolutionary France: Bichat's physiology and the Paris School of Medicine', *History of Science*, 19 (1981), pp. 115–42; Timothy Lenoir, *The Strategy of Life: Teleology and Mechanism in Nineteenth-Century German Biology* (Dordrecht, 1982; reprinted Chicago, 1989); John Lesch, *Science and Medicine in France: The Emergence of Experimental Physiology 1790–1855* (Cambridge, Mass., 1984); W. Bruce Fye, *The Development of American Physiology: Scientific Medicine in the Nineteenth Century* (Baltimore, 1987); Gerald L. Geison (ed.), *Physiology in the American Context 1850–1940* (Bethesda, Md, 1987); L. S. Jacyna, 'Medical science and moral science: the cultural relations of physiology in Restoration France', *History of Science*, 25 (1987), pp. 111–46; William Coleman and Frederic L. Holmes (eds), *The Investigative Enterprise: Experimental Physiology in Nineteenth-Century Medicine* (Berkeley, 1988); Stephen Jacyna (ed.), *A Tale of Three Cities: The Correspondence of William Sharpey and Allen Thomson* (London, 1989). Pathology: Russell C. Maulitz, 'Rudolf Virchow, Julius Cohnheim and the program of pathology', *Bulletin of the History of Medicine*, 52 (1978), pp. 162–82; L. S. Jacyna, 'The laboratory and the clinic: the impact of pathology on surgical diagnosis in the Glasgow Western Infirmary, 1875–1910', *Bulletin of the History of Medicine*, 62 (1988), pp. 384–406. Bacteriology: K. Codell Carter, 'The Koch–Pasteur dispute on establishing the cause of anthrax', *Bulletin of the History of Medicine*, 62 (1988), pp. 42–57; Thomas D. Brock, *Robert Koch: A Life in Medicine and Bacteriology* (Madison, Wis., 1988); Bruno Latour, *The Pasteurization of France*, trans. Alan Sheridan and John Law (Cambridge, Mass., 1988; original French edn, 1984).

<sup>6</sup> Richard D. French, *Antivivisection and Medical Science in Victorian Society* (Princeton, 1975); Coral Lansbury, *The Old Brown Dog: Women, Workers, and Vivisection in Edwardian England* (Madison, Wis., 1985); Nicolaas A. Rupke (ed.), *Vivisection in Historical Perspective* (London, 1987); E. M. Tansey, 'The Wellcome Physiological Research Laboratories 1894–1904: the Home Office, pharmaceutical firms, and animal experiments', *Medical History*, 33 (1989), pp. 1–41.

<sup>7</sup> The classic study of the social organisation of scientific work is Joseph Ben-David, *The Scientist's Role in Society: A Comparative Study* (Englewood Cliffs, 1971). Major recent works include: Robert Fox and George Weisz, *The Organization of Science and Technology in France, 1808–1914* (Cambridge, 1980); David Cahan, *An Institute for an Empire: The Physikalisches-Technische Reichsanstalt 1871–1918* (Cambridge, 1989); Jeffrey Allan Johnson, *The Kaiser's Chemists: Science and Modernization in Imperial Germany* (Chapel Hill, 1990).

<sup>8</sup> Arleen M. Tuchman, 'Science, medicine and the state: the institutionalization of scientific medicine at the University of Heidelberg', unpublished Ph.D. thesis (University of Wisconsin, 1988); 'Experimental physiology, medical reform, and the politics of education

and public health are pointing to the importance of the laboratory-based germ theory of disease in establishing the basis of disease-management in the colonies of the European imperial powers at the end of the nineteenth century, and in shaping modern attitudes to cleanliness and hygiene.<sup>9</sup> Historians of instruments are studying the rapid development of new investigative techniques, especially in microscopy and in the graphic recording of changing physiological quantities, and the increasing application of such research instruments to clinical use.<sup>10</sup> Historians of business are drawing attention to the increasing industrial role of the laboratory, especially in the drug

at the University of Heidelberg: a case study', *Bulletin of the History of Medicine*, 61 (1987), pp. 203–15; 'From the lecture to the laboratory: the institutionalization of scientific medicine at the University of Heidelberg' in Coleman and Holmes (eds), *The Investigative Enterprise*, pp. 65–99; S. V. F. Butler, 'Science and the education of doctors in the 19th century: a study of British medical schools with particular reference to the development and uses of physiology', unpublished Ph.D. thesis (Manchester University, 1982); 'A transformation in training: the formation of university medical faculties in Manchester, Leeds and Liverpool, 1830–1884', *Medical History*, 30 (1986), pp. 115–32; Russell C. Maulitz, "'Physician versus bacteriologist": the ideology of science in clinical medicine' in Morris J. Vogel and Charles E. Rosenberg (eds), *The Therapeutic Revolution: Essays in the Social History of American Medicine* (Philadelphia, 1979), pp. 91–107.

<sup>9</sup> Michael Warboys, 'The emergence of tropical medicine: a study in the establishment of a scientific speciality' in G. Lemaire *et al.* (eds), *Perspectives on the Emergence of Scientific Disciplines* (The Hague, 1976); Charles E. Rosenberg, 'Florence Nightingale on contagion: the hospital as moral universe', in his (ed.), *Healing and History: Essays for George Rosen* (London, 1979); William Coleman, *Death is a Social Disease: Public Health and Political Economy in Early Industrial France* (Madison, Wis., 1982); C. E. Gordon Smith and Mary F. Gibson, 'Yellow fever in South Wales, 1865', *Medical History*, 30 (1985), pp. 322–40; James Trostle, 'Early work in anthropology and epidemiology: from social medicine to the germ theory, 1840 to 1920', in Craig R. Jones (ed.), *Anthropology and Epidemiology: Interdisciplinary Approaches to the Study of Health and Disease* (Dordrecht, 1986), pp. 35–57; William Coleman, *Yellow Fever in the North: The Methods of Early Epidemiology* (Madison, Wis., 1987); Richard J. Evans, *Death in Hamburg: Society and Politics in the Cholera Years 1830–1910* (Oxford, 1987); Roy MacLeod and Milton Lewis (eds), *Disease, Medicine and Empire: Perspectives on Western Medicine and the Experience of European Expansion* (London, 1988); Paul Weindling, *Health, Race and German Politics Between National Unification and Nazism, 1870–1945* (Cambridge, 1989).

<sup>10</sup> Merrile Borell, 'Extending the senses: the graphic method', *Medical Heritage*, 2 (1986), pp. 114–21; 'Instrumentation and the rise of modern physiology', *Science and Technology Studies*, 5 (1987), pp. 53–62; 'Instruments and an independent physiology: the Harvard Physiological Laboratory, 1871–1906', in Geison (ed.), *Physiology in the American Context*, pp. 293–321; 'Marey and d'Arsonval: the exact sciences in late 19th-century French medicine', in J. L. Berggren and B. R. Goldstein (eds), *From Ancient Omens to Statistical Mechanics: Essays on the Exact Sciences Presented to Asger Aabae* (Copenhagen, 1987), pp. 225–37; Robert G. Frank, Jr, 'The telltale heart: physiological instruments, graphic methods, and clinical hopes, 1854–1914' in Coleman and Holmes, *The Investigative Enterprise*, pp. 211–90; Stella Butler, R. H. Buttall and Olivia Brown, *The Social History of the Microscope* (Cambridge, n.d.); Brian Bracegirdle, *A History of Micro-Technique: The Evolution of the Microtome and the Development of Tissue Preparation* (London, 1978).

industry.<sup>11</sup> Finally, sociologists and anthropologists are offering a new perspective from which to study laboratories, by examining their role in the construction of knowledge and technology through the building of social alliances.<sup>12</sup>

To bring these different perspectives together for an examination of the whole subject of the origins and nature of the laboratory revolution in medicine we organised a conference on 'Medicine and the Laboratory'. This book contains revised versions of some of the papers given there, together with others. Rather than focusing on the personalities and work of a few celebrated laboratory scientists such as Bernard, Pasteur and Koch, to which discussion of the laboratory in medicine has conventionally been limited, we have tried to cover issues of more general importance about the bringing into existence of laboratories in medicine, about the power they came to wield, and about what precisely goes on inside them. Our aim has been to open up a wider discussion of 'the laboratory revolution in medicine'.

Thus Timothy Lenoir raises the questions: why did teaching and research laboratories, especially those for experimental physiology, become institutionalised in German medical education before their benefits to the practice of medicine were visible? It was not a simple matter of growth, he argues, but was closely related to a shift in ideology: what he calls the 'discourse of practical interest'. This new discourse provided the ideological foundations for the second wave of institute building, which brought regular education in experimental physiology to the mass of doctors. He traces the connections of this ideology with the concept of Progress and with the material improvement and the industrialisation of Germany. The promotion

<sup>11</sup> Jonathan Liebenau, *Medical Science and Medical Industry: The Formation of the American Pharmaceutical Industry* (Basingstoke, 1987); 'Paul Ehrlich as a commercial scientist and research administrator', *Medical History*, 34 (1990), pp. 65–78.

<sup>12</sup> H. M. Collins and T. J. Pinch, *Frames of Meaning: The Social Construction of Extraordinary Science* (London, 1982); G. Nigel Gilbert and Michael Mulkay, *Opening Pandora's Box: A Sociological Analysis of Scientists' Discourse* (Cambridge, 1984); H. M. Collins, *Changing Order: Replication and Induction in Scientific Practice* (London, 1985); Michael Lynch, *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk in a Research Laboratory* (London, 1985); David Gooding, "'In Nature's School": Faraday as an experimentalist' in David Gooding and Frank A. J. L. James (eds), *Faraday Rediscovered: Essays on the Life and Work of Michael Faraday, 1791–1867* (Basingstoke, 1985), pp. 105–35; Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton, 1985); Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts*, 2nd edn (Princeton, 1986); Peter Galison, *How Experiments End* (Chicago, 1987); Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Milton Keynes, 1987); David Gooding, Trevor Pinch and Simon Schaffer (eds), *The Uses of Experiment: Studies in the Natural Sciences* (Cambridge, 1989).

of the practical (as opposed to *Wissenschaft*, knowledge for its own sake) was part and parcel of this movement, he argues, and hence laboratories, which now taught the practical, were made central to the training of doctors. 'Physicalism' too was part of this movement, and he examines the rise of physicalism in German physiology with a study of the early careers of Emil du Bois-Reymond and Hermann Helmholtz and their associates in the 1840s, through to their involvement in the Berlin Physical Society and the training offered by Magnus in the 1850s and '60s, in which physiology was treated as a branch of physics and as an essential practical science.

The laboratories themselves are the focus of the chapters by Richard Kremer and Paul Weindling. Kremer discusses three attempts to set up physiological institutes in Prussia in the early period, with a detailed analysis of the negotiation process involved in persuading (or failing to persuade) the state officials that such facilities needed to be built and funded: that future physicians need an experimental and experiential education in physiology was still not yet accepted as obvious. Weindling compares the funding, location and internal organisation of two of the great institutes of the late nineteenth century, the Pasteur Institute in Paris, more pluralist in its organisation and flexible in its relations, and Robert Koch's more centralist and hierarchical Institute for Infectious Diseases in Berlin. These two institutes were the germ theory put into bricks and mortar, and with their different structures and emphases they provided the great centres for the dissemination of the germ theory and of belief in the centrality of the laboratory to medicine, through their training of an international corps of researchers and teachers.

The chapters by John Harley Warner, Michael Osborne and Stewart Richards serve to illustrate the long process which was necessary to convince ordinary practitioners and members of the public to accept the authority of the laboratory. Warner describes how American physicians before the Civil War had become committed to the Parisian model of medical science in which authority was based on clinical experience, so that laboratory medical science was initially resisted as a theoretical, mystifying and elitist form of knowledge; the eventual acceptance of the claims of the laboratory towards the end of the century, he argues, thus involved a change in the form of knowledge supposed to carry authority. Osborne explores the considerable resistance to Pasteurian views on disease causation put up by Louis-Félix-Achille Kelsch, a French military physician and epidemiologist at the Val-de-Grâce hospital who, though knowl-

edgeable about and interested in bacteriology, consistently minimised its significance for military medicine; even while admitting the aetiological role of germs, he maintained that environmental factors were crucial for their virulence, and they were therefore not sufficient to account for the outbreak of epidemics. A concern with disease causation was not enough, in itself, to convert one to Pasteurian views, for Kelsch was very concerned with disease causation; but his view of what this involved was wider than that of the bacteriologists. As a believer in medical geography, Kelsch preferred 'that great laboratory of nature' (as he called it) to the laboratory of the microbiologists.

The existence and practice of the medical laboratory, particularly the experimental physiological laboratory but also the microbiological and pharmaceutical laboratories, depend crucially on the experimental use of animals. When these laboratories became more common, both for teaching and research, more and more animals were regularly (to use the technical term) 'sacrificed' in them in the cause of science. This vastly extended use of experimental animals necessitated a profound change in sensibility on the part of the practitioners of laboratory medicine. The live animal had to be transformed into, and be perceived as, simply a neutral object of scientific investigation and not as a perceptive pain-feeling fellow-creature being put to the torture.<sup>13</sup> There were loud objections to this attempted transformation in perception and sensibility, especially in Britain, and the medical laboratory was thus the site of struggle between the antivivisectionists and the advocates of experimental research. Stewart Richards discusses these disputes about the regulation of vivisection in late nineteenth-century Britain and makes an important distinction between ethical and aesthetic objections to the physiological laboratory, observing that while the use of anaesthetics to relieve the suffering of the animal greatly weakened the ethical argument against vivisection, yet the aesthetic objection was left untouched: attitudes for or against vivisection, he concludes, depended as much on feeling (aesthetics), in particular that of revulsion, as they did in the scientific argument that the animals were safely anaesthetised and therefore free from suffering.

Two chapters deal with the role of the laboratory in the actual construction of medical knowledge, and how it determines the form

<sup>13</sup> On this transformation see Michael E. Lynch, 'Sacrifice and the transformation of the animal body into a scientific object: laboratory culture and ritual practice in the neurosciences', *Social Studies of Science* 18 (1988), pp. 265–89.

and authority of such knowledge. Andrew Cunningham studies the case of plague to examine how concepts of infectious disease were transformed by the laboratory, showing how a disease which was formerly identified by symptoms was turned into a disease which could only be identified in a laboratory through determining there the presence or absence of a specific micro-organism or pathogen. Wai Chen examines the Inoculation Unit at St Mary's Hospital, London, founded by Sir Almroth Wright, and argues that its entire programme of medical research was shaped by the laboratory's role as a commercial vaccine factory; he argues that even the most famous product of that laboratory – penicillin (which was not a vaccine, of course) – was given an identity constructed by the requirements of the laboratory's vaccine programme.

In the final section of the book, three scholars with different theoretical perspectives offer their reflexions on the subject of laboratory medicine. Bruno Latour, whose work has done so much to suggest new perspectives on the historical investigation of the role and importance of laboratories in medicine, writes from the perspective of the anthropology of science. In a revised version of the talk which he gave in the final session of the original conference, he encourages us to move away from sociological concepts like professionalisation and institutionalisation when trying to understand the origin and power of the laboratory in medicine, and instead to look at the opposition to the laboratory and how it was overcome; to pursue the analogy between the laboratory and the factory, and the simultaneous production of both goods (or facts) and a market for them; and to revive Foucault's notion of 'discipline' as applying both to what happens inside the laboratory, say to microbes or experimental animals, and outside the laboratory, to professional colleagues. From the perspective of the philosophy of science, Nicholas Jardine observes that the traditional presentist historiography of the laboratory was created by the nineteenth-century laboratory-propagandists to legitimate their own enterprise, and he looks towards the creation of a new historiography which would combine the insights of the historiographies of texts and discourses, of networks, and of social interests, while supporting a commonsense ontology and engaging with the content of science through the investigation of specific laboratory practices. From the perspective of gender studies, Hilary Rose calls for us to ask how far the laboratory vision, the particular manual and mental skills taught by the teaching laboratory, was the product not merely of a specific class but of a specific gender within that class.



Reflecting on how the original conference (and indeed this book) not only suffered from a gender imbalance in its participants, but scarcely touched on gender issues at all – the significant exception being the session devoted to Stewart Richards’s chapter on vivisection, where feelings and sensibility for the first time were discussed – she speculates on how a conference in a feminist utopia might see the laboratory revolution of the nineteenth century and patriarchal studies of it, such as (for the most part) this book.

Taking all these contributions together, we can see certain common themes. One is that the claims made on behalf of the laboratory – both the cognitive claims of representing nature more accurately and authentically and in an unmediated way, and the practical claims of delivering clinical benefits – were not in themselves self-evident or naturally compelling. Admittedly, these claims were propounded with enormous confidence. For example, it was frequently stated and assumed by advocates of the medical laboratory that the new techniques and instruments of the laboratory had had the human element totally removed, so that they were completely objective, and in the laboratory Nature was most herself and spoke clearly in her own voice. Thus Robert Koch said that by the use of photographic techniques in the laboratory ‘the microscopical object copies itself’, and there could therefore be no doubt as to what Nature was saying; an editor of the *Lancet* wrote that with the invention of the sphygmograph ‘the pulse... writes its own diagram, and registers its own characters’, and Almroth Wright said that his laboratory techniques of the capillary pipette ‘evolved themselves’.<sup>14</sup> Those who made claims for the practical benefits of the laboratory were no less assertive. Famously, Claude Bernard looked forward to a time when experimental physiology would have made the aetiology of every disease as well-known as that of scabies (caused by a mite), and the cure of every disease no less certain: ‘we cure it *always* without any exception, when we place ourselves in the known experimental conditions for reaching this goal’.<sup>15</sup> Nevertheless, the conclusion of our contributors is that such claims had little justification. The new techniques and tests were not obviously objective; for example, Almroth Wright’s sophisticated, much-used and supposedly ‘self-

<sup>14</sup> R. Koch, ‘On the investigation of pathogenic organisms’, trans. Victor Horsley, in W. Watson Cheyne (ed.), *Recent Essays by Various Authors on Bacteria in Relation to Disease* (London, 1886), pp. 1–64, at p. 20; *Lancet* editorial, quoted in Frank, ‘The telltale heart’, p. 211; A. E. Wright, *Handbook of the Technique of the Teat and Capillary Glass Tube: And its Applications in Medicine and Bacteriology* (London, 1912), p. v.

<sup>15</sup> Bernard, *Introduction to the Study of Experimental Medicine*, p. 214.