Medicine Studies (2009) 1:3–10
DOI 10.1007/s12376-009-0006-8

EDITORIAL NOTES

Medicine Studies: Exploring the Interplays of Medicine, Science and Societies beyond Disciplinary Boundaries

Norbert W. Paul

Received: 23 December 2008 / Accepted: 19 January 2009 / Published online: 5 February 2009
© Springer Science & Business Media BV 2009

Abstract Taking into account how much modern medicine is a function of—and at the same time has a function in—science and technology, it is hardly surprising that both the approach of science studies and the idea of the social and cultural construction of health, disease, and bodies overlap, generally and specifically, in the realm of the novel field of MEDICINE STUDIES. The work already done in science and technology studies as well as in social studies of medicine, together with the rich tradition of medical history and philosophy of medicine, may be considered a solid base and a good vantage point for further analysis. By exploring the shifts of knowledge production in medicine we may be able to see the driving forces behind the ongoing development of medicine and the associated transformation of its social functions in a new light. Based on historiographical reconstructions we may come up with a much more broadly contextualized understanding of the ways in which science, technology, medicine and society interact and in what regard their mutual interdependencies have been undergoing profound changes for a number of decades. By tracing the channels through which key concepts defining the relationship of medicine and its social context are negotiated, we may further explore how our notions of health, disease, and humanity are continuously morphing alongside the incessant transformations of medicine. This editorial explores the aims and scope of MEDICINE STUDIES as a truly transdisciplinary endeavor.

Keywords Medicine studies · Science studies · History and philosophy of science · Medicine, science, technology and culture · Ethical analysis

N. W. Paul (✉)
Institute for History, Philosophy and Ethics of Medicine,
Johannes Gutenberg University Medical School,
Am Pulverturm 13, 55131 Mainz, Germany
e-mail: npaul@uni-mainz.de

Why Medicine Studies?

When scientific medicine started to flourish in the nineteenth century, no one could have anticipated that reports from the clinical ward or the biomedical lab would regularly hit the headlines of leading news media. Even more unlikely would have been the idea that explanatory tools of biomedicine would be routinely extended into those cultural spheres in which we negotiate what it means to be human. Early developments of this kind—such as the public impact of bacteriology and its expansion into ideas of social order in the nineteenth century or the ideas of bio-engineering formulated at the turn of the twentieth century—could have been mistaken for events symptomatic only for the rise of modern scientific medicine. As such, they inevitably would catch general attention

and trigger public interest. However, since the second half of the twenty-first century we are facing an incessant stream of news about fresh biomedical knowledge, novel biomedical applications, and brand new technologies increasingly challenging not only our view of the world but also the view of ourselves.

One of the dominant discourses of the twentieth and twenty-first century has been to negotiate the justifications of the venture of biomedicine with its related experimental sciences and biotechnologies with regard to the certainty of our beliefs and theories concerning the biological foundations of humanity on the one hand and, on the other, in terms of the search for tools to control those risks and uncertainties inevitably coming with our biological makeup. In the wake of this discourse, disciplines such as bioethics and practices like clinical ethics have emerged as part of a cultural immune response. What would constitute an appropriate reaction to the news that our biological future is apparently set up in our genes? How are we to understand the message that our autonomy is a projection generated by our neurons? How should we decide about the new options, provided by biomedicine, to shape the processes of our lives technologically, from their very beginning to our very end?

Justified as these concerns may be, they are but one specific way of tackling some truly mind-boggling questions brought about by medicine and its allied sciences. A broader, much more contextualized image of the interplay between medicine, science, and society has recently become increasingly invisible because of what the philosopher and ethicist Henk ten Have has called the "ethicalization" of the philosophy of medicine and the "technicalization" of ethics (ten Have 1997). While the former is responding to the need for instant orientation in an increasingly fragmented world, the latter is addressing the wish for an operational, "practical" apparatus for concrete decision making in unclear and thus confusing situations. What seems to be missing, though, is a perspective, which may provide some reference points for mapping the metamorphoses of medicine onto our social and cultural coordinates. This is an endeavor worthwhile undertaking, because medicine since long has become the most immediate interface between new explanatory models generated in the experimental sciences, novel technologies, and the daily life of humans. How will these new technologies be implemented and how much will they change medicine? How will medicine alter our understanding and perception of health, disease, and the human body? What are the driving forces behind the expansion of biomedical explanations into almost every cultural sphere? With MEDICINE STUDIES, we are striving to provide an "evolutionary" platform for addressing these crucial questions. We do not take up a particular theoretical position, because we are convinced that the interplay of medicine, science, and technology with our culture and our selves must be explored outside disciplinary boundaries. Nevertheless, studies in the philosophy and recent history of science have been a vital source of inspiration for the establishment of this journal. As William E. Stempsey put it in 2004:

> It may be that a new vision of the philosophy of medicine will emerge, consisting of a wedding of historical, philosophical and social studies of medicine. Perhaps, similar to science studies or science and technology studies, this will eventually come to be known as 'medicine studies' (Stempsey 2004, p. 250).

What is in the Name?

Taking into account how much modern medicine is a function of—and at the same time has a function in—science and technology, it is hardly surprising that both the approach of science studies and the idea of the social and cultural construction of health, disease, and bodies overlap, generally and specifically, in the realm of MEDICINE STUDIES (Knorr-Cetina 1981; Latour 1987; Woolgar 1988; Haraway 1990; Nelkin et al. 1991; Clarke and Fujimura 1992; Cole 1992; Pickering 1992; Gibbons et al. 1994; Nelkin and Tancredi 1994; Jordanova 1995; Sassower 1995; Epstein 1996; Fujimura 1996; Keller and Longino 1996; Radder 1996; Sismondo 1996; Haraway 1997; Rheinberger 1997; Schlich 1998; Biagioli 1999; Gieryn 1999; Knorr-Cetina 1999; Kay 2000; Layne 2000; Nowotny et al. 2001).[1] The work already done in science and technology studies as well as in social

[1] The references selected represent only a small part of scholarly work in these fields and are meant to illustrate the overlap in the realm of MEDICINE STUDIES only.

studies of medicine, together with the rich tradition of medical history and philosophy of medicine, may be considered a solid base and a good vantage point for further analysis. By exploring the shifts of knowledge production in medicine, we may be able to see the driving forces behind the ongoing development of medicine and the associated transformation of its social functions in a new light (Hacking 1983, 1999, 2002). Based on historiographical reconstructions, we may come up with a much more broadly contextualized understanding of the ways in which science, technology, medicine, and society interact and in what regard their mutual interdependencies have been undergoing profound changes for a number of decades. By tracing the channels through which key concepts defining the relationship of medicine and its social context are negotiated, we may further explore how our notions of health, disease, and humanity are continuously morphing alongside the incessant transformations of medicine (Borck et al. 2005).

At first sight, and maybe especially from the perspective of applied, "technicalized" bioethics, this may look like a rather theoretical enterprise, if not a moot case. What is not always remembered, however, is that, as with all social or constructs or cultural concepts, "health" "disease", and "body" are constantly in flux. Hence, principal goals and the scope of "legitimate" medical intervention are continually readjusted to the respective social setting (Paul 2002, 2003). Nowadays, this setting is predominantly molded by science and technology. Again, it is important to keep in mind that modern medicine is—in addition to its social function—a scientific and technological endeavor. It may appear that the daily work of general practitioners and family physicians and the everyday experience of patients as well as our current understanding of our bodies and our selves are relatively far removed from hardcore knowledge production and technological innovation in biomedicine. And yet, medical science and technology are constantly bleeding into these areas of practice, in accelerated cycles of innovation.

Medicine, Technology, and Science

There is a basic assumption here: scientific theories with their derived applications in biomedicine and its allied sciences are becoming increasingly technology-based. It is interesting to note that for sometime now single sets of technological tools—for example, those of recombinant DNA technology or the tools of neuro-imaging—support observations, theories, explanatory models, as well as their presentation and application all at the same time. Thus, external criteria—that is, references to "natural" objects and processes evidenced by classical empirical studies—are losing the normative function they traditionally were assigned in science. Objectivity is at stake (Daston and Galison 2007). As a result, the classical criteria of scientific verification and falsification and the often invoked "scientific truth" are in question and the meaning of empirical evidence changes fundamentally. In a subtle way, technology-based biomedicine generates its own objects and evaluates them with the same tools it has used to generate them (Sassower 1995). Knowledge is, no longer based on empirical evidence mediated by observation, but technologically constructed by using the tools of the particular domain in and for which they were created (Clarke 1992; Fujimura 1996; Rheinberger 1997; Chadarevian 2002; Rabinow 1996). To put it in a provocative way: Biomedical knowledge production in the mode of a techno-science, can be self-referential. The same holds true for its subdisciplines such as genomics or the neurosciences.

However, if we neither want to admit that the cheerful slogan "anything goes" applies to techno-science and biotechnological medicine nor want to subscribe to a neopragmatism of the sort "only if you can spray it, it's real," (Lenoir 1999, p. 295), we have to ask how technologically constructed knowledge is now validated. The concept of "performability" might give us a first idea and help getting a provisional handle on this complex question. The distinction between accepted and rejected techno-scientific knowledge in medicine is made according to how it performs, how far it contributes to the construction of tools for problem-solving, and how far it leads to new and useful applications. It is obvious that the term "usefulness" reflects a social consensus. Hence, issues of "quality control" inevitably have to shift from types of internal scientific accountability (e.g., institutionalized as procedures of peer review) to much broader, socially embedded types of accountability (Gibbons et al. 1994; Nowotny et al. 2001). Against this background, debates such as the one on

the relative predictive power of genetic information and the uses and usefulness of predictive genetic testing as an amalgamate of a scientific, a biomedical, an ethical, and a societal discourse may serve as an example for recent types of social accountability of biomedicine. The phenomenon is not restricted to our recent history, however. Historically, the concept of bioengineering formulated at the end of the nineteenth century by Jacques Loeb in the context of regeneration research triggered a fierce debate on the technological malleability of fundamental processes of life. The normative and cultural undertow of these debates is now inherent to current disputes on regenerative medicine, stem cell research, and the technological co-construction of human life (Pauly 1987). It is through the path of usefulness, efficiency and convincingness that realities of biomedicine—such as those of genomics, regenerative medicine, or the neurosciences—migrate into our lives on a daily basis.

There is widespread consensus that contemporary Western societies are ruled by knowledge and run by technology. In this milieu, scientific medicine is an essential component of societal self-preservation. Beyond its classic function of disease prevention and restoration of health, modern medicine is one of the focal points of knowledge production and technological innovation, and therefore a vital element of modern society. The strong relations between medicine, science, and technology are likely to reinforce medicine's productive role by creating new applications, new markets, and finally by transforming familiar forms of medical prevention and intervention and expanding them into new fields like the enhancement of human capabilities. In this respect, economics and the medical market have to be regarded as two influential factors in motivating the endeavors of biomedicine.

The move toward a technology-based production of biomedical knowledge privileges a highly application-oriented type of knowledge. This move is mirrored by the transition from disciplinarily organized scientific medicine, driven by the search for explanations for health and disease in order to apply this knowledge to clinical problems, to the current biomedicine resembling techno-science and turning more and more into techno-medicine. Evidently, this transition is dependent on specific modes of knowledge production.

Distributed Knowledge Production

For decades, scientific knowledge production has been grouped around specific loci of expertise built and provided with resources according to the needs of knowledge production and quality control in a well-defined discipline or academic specialty. Scientific problems, approaches, methods, models, and theories were formulated according to the interests of a given discipline because, especially in the medical field, only disciplines and their subspecialties seemed to be sufficiently congruent with the required differentiation of knowledge. In "disciplinary science", methods and tools at hand were used to tackle problems in the field of expertise, and to come up with solutions that either confirmed or challenged disciplinary knowledge. Accordingly, quality control was in the hands of the discipline, implemented by peer review of related publications and by intra-disciplinary competition for funding of knowledge development and institutionalization.

In the disciplinary mode of medical research and development, novel approaches were—and still are—viewed as misfits of a discipline and were either completely dismissed and forgotten or accepted and rewarded only after major generational shifts of "scientific revolutions" within a discipline (Fleck 1935, 1979; Kuhn 1996). Nevertheless, following arguments of a different strand, we may very well contrast disciplinary science with the production and processing of knowledge in the context of modern medicine that takes place in a distributed, non-disciplinary mode. Rooted in and growing out of disciplinary science, a distributed and non-disciplinary mode of knowledge production has long since co-existed. In this mode, new knowledge becomes primarily a product of the design of research tools and applications, performed in a de-centered fashion. This means, scientific activities are diffused through different groups of researchers and practitioners and explicitly embedded into the societal context brought about both by reference to the societal relevance of research and development and by competition for public and political recognition. Unsurprisingly, non-disciplinary modes of research and development tend to follow the rules of performability rather than those of disciplinarity.

Is this a recent phenomenon? After turning into a clinically oriented pragma-science, the crisscrossing

of disciplinary boundaries became part of the developmental history of modern medicine. In one way or another, physics, chemistry, biochemistry, biology, mathematics, social sciences, etc. became involved in medical problem-solving. Already in the pre-history of modern medicine—as in the discourse on public health entertained by physicians in the period of the European Enlightenment—and during the early developments of modern medicine—as in the discourses on vaccination or infection in the nineteenth century—we could observe how societal relevance played a crucial role in the justification of medicine. However, the approaches and goals of a multidisciplinary research approach were never set as clearly by the factor of performability, societal relevance, and public recognition as in the twentieth and twenty-first centuries. For a long period in the history of modern medicine, interdisciplinarity primarily served the purpose of knowledge transfer—i.e., the import of explanatory models from the so-called basic sciences or allied sciences into the realm of medicine. These "infusions of knowledge" followed the top-down approach of disciplinary science: In general, these approaches show a pattern in which explanatory models are accepted before their potential for clinical problem-solving, that is, the "performance", can be validated (Martin Michael and Fangerau 2007). The quarrel of bacteriology and microbiology with earlier theories of "contagionists" provides a good historical example of this theory-driven top-down type of medicine. In the twentieth and twenty-first centuries, this model has been shored up by a much more problem-focused, pragmatic strategy in which knowledge is much more a product of the design of clinical solutions than of the search for an explanation of the processes of life, health, and disease. The program of evidence-based medicine dedicated to the use of knowledge for a mere justification of standardized pathways of intervention vividly illustrates how functionality and performability take precedence over the search for the scientifically most adequate explanation of a given condition.

In this regard, objects, artifacts, and knowledge generated through biomedical research are similar functions of, and have functions in, the distributed production of application-oriented knowledge. Acknowledging that techno-scientific and techno-medical explanations are theoretically and empirically underdetermined does not mean to take commonly accepted solutions in techno-science as mere products of social consensus. Evidently, they are also very much dependent on their material generation and representation through the apparatus of techno-science. Therefore, keeping in mind that the ways in which science, technology, and medicine produce and apply knowledge are socially constructed, accepted techno-scientific knowledge becomes a product of a context as a whole. This context explicitly includes material objects, all kinds of artifacts, and technological tools as non-human agents (Latour 1987).

Given that judgments of performability are based on social consensus, social accountability permeates the knowledge production process much more intensely. "It [social accountability] is reflected not only in interpretation and diffusion of results but also in the definition of the problem and the setting of research priorities" (Gibbons et al. 1994, p. 7). From the de-centered and transdisciplinary character of its distributed production, knowledge thus becomes heterogeneous and organizationally diverse. Moreover, distributed knowledge production is highly dynamic; it is "problem solving capability on the move" (Gibbons et al. 1994, p. 5). Generating knowledge in the context of application rather than in a disciplinary context helps to avoid problems of knowledge transfer from theoretical models to application. Simultaneously, various medical problems are redefined by technologically constructed findings, applications are re-designed and tools technologically fixed. When this process of innovation results in solutions performable in the manifold fields of medical application, we will certainly not witness a "paradigm shift" or a redefinition of the theoretical foundations of medicine.[2] Innovation based on distributed knowledge production in a bottom-up mode is much more likely to initiate an inexorable and incessant morphing of the whole medical domain, including the principles of health and disease.

[2] Most of the current disciplines of medicine represent fields of application and fields of basic science. Historically, fields of application were first defined by anatomical region and the type of intervention. Cf. also Foucault (1994).

An invitation to "Undisciplined" Thinking

Heterogeneity, organizational diversity, and the particular ways in which knowledge production and social accountability are increasingly intertwined do not encourage a clear and simple overview of the current changes in medicine. The proliferation of "hybrids"—as Bruno Latour put it—into our daily life, consisting of bits and pieces of diverse, sometimes contradictory yet amalgamated elements and "weird chunks" of information, is a symptom of some sort of postmodern puzzlement (Latour 1999). Social diffusion of knowledge combined with the enormous pace of innovation leaves us all too often with a lack of familiar reference points. Our existing intellectual charts are mainly based on disciplinarily produced knowledge. This knowledge forms our culture of understanding. Now that new knowledge and new applications swiftly traverse disciplines as well as boundaries between science, technology, and society, it becomes difficult to map novelties onto the available intellectual and cultural charts.

By and large, science and technology have reached a point where they produce cultural uncertainty rather than cultural certainty—as they did in the Golden Age of "classic" scientific medicine deeply rooted in the ideals of enlightenment. Whereas in the "Golden Age" the public demand for a science and technology based medicine even overcame professional resistance put forward by traditionally oriented physicians, we now face the situation that "biomedicine" stimulates reactions from our cultural immune system, which in the case of medicine becomes apparent in thriving public debates and even in the emergence of a discipline devoted to dealing with the normative impact of these uncertainties: the discipline of bioethics. Cultural uncertainty and a lack of orientation may at first appear as a threat or at least an enormous challenge. However, judging the situation favorably, one might perceive it as an option to rethink those intellectual conventions, which more and more fail to have a bearing on our culture of understanding.

At this point, it seems appropriate to acknowledge the enormous dynamics and the impact of the distributed and application-oriented production of knowledge by trying to define some new reference points. Therefore, MEDICINE STUDIES does not follow the paradigm, scope, or the methods of any specific discipline. It is one of the joys of undisciplined thinking that the approaches can be problem-oriented and ignore disciplinary boundaries. The subject determines the approach. As a consequence, MEDICINE STUDIES welcomes contributions from theoretical, empirical, and practical backgrounds generating insights into the ways in which medicine, science, technology, and society interact, and how historical, cultural, and social processes have molded these interactions. Medicine will be approached as a phenomenon emerging from the matrix of distributed knowledge, new technologies, shifts in the economics of health care, the politics of medicine and a variety of related interests.

The subject is sometimes confusing, even mind-boggling. Rather than trying to provide an exhaustive analysis of the ongoing processes in biomedicine and its preconditions, MEDICINE STUDIES brings some of the prominent themes of modern medicine into a kaleidoscopic vision. The journal will attempt to plot directions of developments within the background of preexisting circumstances and historically contingent social settings. Thus, questions asked and methods used derive from the heterogeneous field of science studies as well as from history and philosophy of science and medicine—a sufficiently transdisciplinary project in itself. The reader will also encounter a wealth of cultural, anthropological, and ethical issues. By doing so, the journal is hoping to come up with some new insights that may be useful for decision making in the real world and help in co-constructing the frames of biomedical research and clinical practice.

Hence, we cordially invite our readers to join us in this discourse and to contribute their expertise relevant to the transdisciplinary field of medicine studies. We strongly encourage the scientific community to submit original research and we will gladly accept open submission of articles not falling into the specific focus of a themed issue. We will also announce calls for articles for themed issues on a regular basis and invite you to submit your work preferably within the framework of these issues. All submissions—open or as part of a themed issue—will have to pass a double-blinded review process. This way we will keep a high scientific standard of undisciplined but coherent scientific thinking. Last but not least we will also gladly accept suggestions for themed issues and offer—under well-defined circumstances—the role of a guest editor.

References

Biagioli, M. (ed.). 1999. *The science studies reader*, vol. xviii, 590. Routledge: New York.

Borck, C., V. Hess, and H. Schmidgen (eds.). 2005. *Maß und Eigensinn: Studien im Anschluß an Georges Ganguilhem*. München: Wilhelm Fink Verlag.

Chadarevian, S.d. 2002. *Designs for life. Molecular biology after World War II*. Cambridge UK; New York: Cambridge University Press.

Clarke, A., and J.H. Fujimura (eds.). 1992. *The right tools for the job: At work in twentieth-century life sciences*, vol. xi, 365. Princeton, NJ: Princeton University Press.

Cole, S. 1992. *Making science: Between nature, society*. Cambridge, MA: Harvard University Press.

Daston, L., and P. Galison (eds.). 2007. *Objectivity*. New York: Zone.

Epstein, S. 1996. *Impure science: AIDS, activism, and the politics of knowledge*, vol. xiii, 466. Berkeley: University of California Press. *Medicine and Society.*

Fleck, L. 1935. *Entstehung und Entwicklung einer wissenschaftlichen Tatsache: Einführung in die Lehre vom Denkstil und Denkkollectiv*, 150. Basel: B. Schwabe.

Fleck, L. 1979. *Genesis and development of a scientific fact*, vol. xxviii, 203. Chicago: University of Chicago Press.

Foucault, M. 1994. *The birth of the clinic: An archaeology of medical perception*, vol. xix, 215 (1st edition 1973). New York: Vintage Books.

Fujimura, J. 1996. *Crafting science. A sociohistory of the quest for the genetics of cancer*. Cambridge, MA: Harvard University Press.

Gibbons, M., et al. 1994. *The new production of knowledge. The dynamics of science and research in contemporary societies*. London: Sage.

Gieryn, T.F. 1999. *Cultural boundaries of science: Credibility on the line*. Chicago: The University of Chicago Press.

Hacking, I. 1983. *Representing and intervening: Introductory topics in the philosophy of natural science*, vol. xv, 287. Cambridge (Cambridgeshire), New York: Cambridge University Press.

Hacking, I. 1999. *The social construction of what?*, vol. x, 261. Cambridge, Mass: Harvard University Press.

Hacking, I. 2002. *Historical ontology*, vol. vii, 279. Cambridge, Mass: Harvard University Press.

Haraway, D.J. 1990. *Simians, Cyborgs, and women: The re-invention of nature*, vol. x, 287. London: Free Association.

Haraway, D.J. 1997. *Modest_Witness@Second_Millennium.FemaleMan_Meets_OncoMouse: Feminism and technoscience*, vol. xi, 361. New York: Routledge.

Jordanova, L. 1995. The social construction of medical knowledge. *Social History of Medicine* 8(3): 361–381.

Kay, L.E. 2000. Who wrote the book of life? A history of the genetic code. In *Writing science*, ed. T. Lenoir, and H.U. Gumbrecht. Stanford: Stanford University Press.

Keller, E.F., and H.E. Longino (eds.). 1996. *Feminism and science*, vol. vii, 289. Oxford readings in feminism. Oxford University Press: Oxford; New York.

Knorr-Cetina, K. 1981. *The manufacture of knowledge: An essay on the constructivist and contextual nature of science*, vol. xiv, 189. Pergamon international library of science, technology, engineering, and social studies. Oxford, New York: Pergamon Press.

Knorr-Cetina, K. 1999. *Epistemic cultures: How the sciences make knowledge*, vol. xiii, 329. Cambridge, MA: Harvard University Press.

Kuhn, T.S. 1996. *The structure of scientific revolutions*. (3rd ed.) (1st edition 1962). Chicago: The University of Chicago Press.

Latour, B. 1987. *Science in action: How to follow scientists, engineers through society*. Cambridge, MA: Harvard University Press.

Latour, B. 1999. *We have never been modern* (1st edition 1993). Cambridge, MA: Harvard University Press.

Layne, L.L. 2000. The cultural fix: An anthropological contribution to science and technology studies. *Science, Technology, & Human Values* 25(3): 352–379.

Lenoir, T. 1999. Was the last turn the right turn? The semiotic turn and A.J. Greimas. In *The science studies reader*, ed. M. Biagioli, 290–301 (published first in 1994). Routledge: New York.

Martin Michael, and H. Fangerau. 2007. Listening to the heart's power: Designing blood pressure measurement. *ICON: Journal of the international organization for the history of technology* 13: 86–107.

Nelkin, D., and L.R. Tancredi. 1994. *Dangerous diagnostics: The social power of biological information* (1st edition 1989), vol. xxiv, 207. Chicago: University of Chicago Press.

Nelkin, D., D.P. Willis, and S. Parris (eds.). 1991. *A disease of society: Cultural and institutional responses to AIDS*, vol. vii, 287. Cambridge, England; New York: Cambridge University Press.

Nowotny, H., P. Scott, and M. Gibbons. 2001. *Re-thinking science: Knowledge and the public in an age of uncertainty*. Cambridge/Oxford: Polity.

Paul, N.W. 2002. Genes, information, volatile bodies. In *Health and quality of life. Philosophical, medical, and cultural aspects*, ed. A. Gimmler, C. Lenk, and G. Aumüller, 187–198. Münster: Lit.

Paul, N.W. 2003. The representational framework of health and disease. In *Tradtitions of pathology in Western Europe. Theories, institutions and their cultural setting*, ed. C.-R. Prüll, 123–138. Centaurus: Pfaffenweiler.

Pauly, P.J. 1987. *Controlling life: Jacques Loeb and the engineering ideal in biology*. Monographs on the history and philosophy of biology, 252. New York: Oxford University Press. ([12] of plates).

Pickering, A. (ed.). 1992. *Science as practice and culture*, vol. viii, 474. University of Chicago Press: Chicago.

Rabinow, P. 1996. *Making PCR: A story of biotechnology*, vol. vii, 190. Chicago: University of Chicago Press.

Radder, H. 1996. *In and about the world: Philosophical studies of science and technology*. Albany: State University of New York Press.

Rheinberger, H.-J. 1997. *Toward a history of epistemic things: Synthesizing proteins in the test tube*. Stanford, CA: Stanford University Press.

Sassower, R. 1995. *Cultural collisions: Postmodern technoscience*. New York: Routledge.

Schlich, T. 1998. Wissenschaft: Die Herstellung wissenschaftlicher Fakten als Thema der Geschichtsforschung. In *Medizingeschichte: Aufgaben, Probleme, Perspektiven*,

ed. N.W. Paul, and T. Schlich, 107–129. Campus: Frankfurt/M.

Sismondo, S. 1996. *Social knowledge: Constructivism, realism, and the politics of science*. Albany: State University of New York Press.

Stempsey, W.E. 2004. The philosophy of medicine: Development of a discipline. *Medicine, Health Care and Philosophy* 7: 243–251.

ten Have, H. 1997. From synthesis and system to morals and procedure: The development of philosophy of medicine. In *Philosophy of medicine and bioethics: A twenty-year retrospective and critical appraisal*, ed. R. Carson, and C. Burn, 19–36. Dordrecht: Kluwer Academic Publishers.

Woolgar, S. 1988. *Science, the very idea*, 119. Chichester; London, New York: Tavistock Publications.