mistakes and unrealized possibilities, is always worthwhile in history; and here it pays off too, and allows authors to raise the question whether (as biographers of Lavoisier have wondered) the honor and glory goes to the ambitious bastards. We also meet conservatism about innovations, theoretical or instrumental, which historians have learned to expect at all times and places. One unsurprising feature is that whereas (as Wurtz in fact ruefully realized) nineteenth-century chemistry was a German science, the twentieth was the American century – important things happened elsewhere, but it was the research schools in the American universities and their links with industry, brought out particularly by Nicolas Rasmussen, that were dominant.

We look at the rise of cosmochemistry, at radiochemistry, polymer science, and biotechnology, with authors who are good guides into these territories – though some of the papers would have benefited from a read-through by a native speaker of English. And we end with BERNADETTE BENSAUDE-VINCENT looking at materials science and raising the question whether chemists have a future in this new world. Chemistry has such a long past that it would be surprising if like some dinosaur it were to become extinct; but while sciences are not social constructions, the boundaries between them clearly are – and 'chemistry' might cease to be a useful label. But we can infer from these studies that chemists are likely to continue to be crucial figures in the research teams which, to the continuing bafflement of lay people, will carry science forward as an intellectual, a practical, and a social activity.

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ALLEN G. DEBUS: *Chemistry and Medical Debate. Van Helmont to Boerhaave*, Science History Publications, Canton MA, 2001, xvii + 277 pp. [ISBN 0-88135-285-3].

In the field of the history of science Allen G. Debus deserves to be ranked among the innovators. In his pioneering studies, he has presented such figures as Paracelsus and Robert Fludd as subjects worthy of study. Within a domain that was dominated by physics and astronomy, he saw a space for chemistry. He has placed the history of medicine within a wider scientific, religious, and philosophical context and has characterized the 'chemical philosophy' as a third force between the declining Aristotelianism and the rising mechanical philosophy. He has always highlighted the close relationship between the spread of humanistic ideals, the increase in philological skill, and scientific progress in the early-modern period (from this point of view, his *Man and Nature in the Renaissance* is exemplary). He has never missed the opportunity to emphasize the connections among such cultural factors as religious humanism, biblical studies, and textual authority in the making of the scientific enterprise, most of all the cross-referencing of the great book of nature and the Scriptures. Last but not least, he has never undermined the role of the educational establishment and the pedagogical implications of the new science.

In this volume, Debus retraces the principal results of his studies, specifically focusing on the debate between chemistry and medicine, a debate that was triggered in the 16th century by the appearance of the Paracelsian œuvre and that was far from concluded at the end of the eighteenth century. One of the great merits of Debus' book is its far-ranging scope and the attention to long-term developments in the history of science. It is indeed the case that teleology has become anathema in the field of historical studies of late. One ought to ask

whether teleology implies, as it is supposed, a linear account of history. One might ask whether teleology may be used to indicate instead a tension toward a potential meaning in the unfolding of human events. (The question whether this meaning is inherent in history or it is only a reasonable projection by the historian can here be left aside being a matter of metaphysics and philosophy of history rather than of historiography.) The philosopher may be content with a view of history as the domain of chance, arbitrariness, and irrationality, but the historian, in recounting a meaningful story, looks for a sequence of events, that is, a plot. And plots have prologues and aftermath. This is quite apparent, for example, when dealing with Jan Baptiste van Helmont's work and its fortunes through the 17th and 18th centuries. Debus tells us that if we want to follow the *Wirkungsgeschichte* of Helmont's chemical and medical thought we need to bear well in mind the writings of Hermann Boerhaave, Georg Ernst Stahl, Joseph Black, Gabriel François Venel, Antoine Lavoisier, and Xavier Bichat, and not confine ourselves to the parochial setting of late 17th-century English medicine. Big pictures, macro-histories, and the widening of geographical horizons produce sense. And not only that: in van Helmont's case, the diachronic pattern is more reliable than the typical synchronic, contextual device traditionally adopted by historians, namely, the battle between mechanists and vitalists.

The rich historical reconstruction provided by Debus' book makes the reader question more than once the legitimacy of the hackneyed polarization between mechanism and vitalism in early modern medicine. Can we still label Boerhaave a mechanist when we learn that, especially in the last part of his life, he devoted so much energy to understanding the alchemical legacy? Can we refer to Stahl as a vitalist when his belief in the inertia of matter and the mechanical arrangement of the body has the same clarity and presumption as Descartes' advocacy of dualism? Was chemistry a Trojan horse in the philosophical citadel of the mechanical philosophy (especially when dealing with such elusive topics as respiration, combustion, and digestion)? Was the mechanical philosophy so unmoved by the chemical philosophy? Borelli, Malpighi, and Bellini, for instance, were sincere believers in the validity of the iatrophysical approach in medicine, and yet they made frequent use of the chemical armory – both from a theoretical and an experimental point of view – to explain the origin and maintenance of life within the bodily engine.

By way of dialectical counterpoint, the establishing of the mechanical medicine is an important component of Debus' book. Iatrophysics was a complex and variegated phenomenon. It could represent the introduction of quantification and measurement into the domain of physiology up to the most refined use of the calculus in matters of animal economy. It could advocate reliance on mathematics and on the universal laws of motion, fluids and solids for the study of the life processes. Albeit reluctantly, some iatrophysicists agreed to reserve some space for chemical applications in the medical field, but even savants like Boerhaave and Stahl were interested in what we would call inorganic chemistry rather than the chemical interpretation of life; that is to say, they did not embark on any attempt to understand the vital functions of the body and the processes of living matter in chemical terms. Referring to Boerhaave's and Stahl's position, Debus rightly notes that it was "a fundamental break with the Paracelsian-Helmontian tradition" (p. 222). Before Lavoisier's grand synthesis, the separation between chemistry and medicine, apart from the specific section of materia medica, remained common among medical and chemical practitioners. It may seem a paradox, but the division between medicine and chemistry – medicine and chemistry being understood as the respective domains of the ensouled body

and inert matter – could be justified as the result of a far-fetched interpretation of Helmont's philosophy. In the Helmontian system, life and matter were incommensurable entities, and the vital spark was a transcendent accident superimposed on prime matter by a divine command. Whilst the contingent nature of the manifestations of life in the created world had not prevented Helmont from viewing chemistry as the privileged access to knowledge of life in the new foundation of medicine, the great majority of physicians and anatomists, in keeping with the more reassuring tenets of the chemical Galenism à la Sennert, preferred to maintain the foundations of medicine and chemistry separated and to relegate the chemical contribution to the manufacture of metallic-based remedies. We have to wait for the medical theoreticians of the Montpellier school (a renowned center of vital medicine) such as François Bossier de Sauvages, Théophile Bordeu, and Paul-Joseph Barthez, to find a deliberate attempt to bridge the speculative gap between Helmont's vital philosophy and Stahl's animism.

The conflictual nature of the relationship between chemistry and medicine notwithstanding, the history of chemistry from the 16th to the 18th century can be seen as part of the history of medicine. But it is not just a history of the salient events and discoveries of the respective disciplines. Another merit of Debus' volume is the constant attention to the meta-historical and ideological aspects of the early modern chemists' and physicians' self-understanding and self-portraying. Throughout the book we can follow a fascinating 'history of histories', that is, a narrative of the succeeding 16th-, 17th-, and 18th-century views concerning the beginnings of both the medical art and the chemical practice. The debate between Hermann Conring and Olaus Borrichius in the second half of the 17th century, for instance, was a clash between a secularized and philologically-reliable reconstruction of the medical origins of chemistry on the one hand, and the idea of chemistry as a product of the Egyptian wisdom on the other. With an eye for the technological side of the chemical practice, Boerhaave argued that chemical theorizing originated from the fabulous stories made up by miners eager to make sense of the terrifying and inexplicable sides of their job. Platonic and Hermetic elements were added later to give an aura of mysticism and philosophy. Depending on the specific idelogical need, the Arabs (Rhazes and Avicenna, in particular) were extolled to the detriment of Paracelsus' contribution, or vice versa. In his *Histoire de la médicine* (1696) Daniel LeClerc restated the belief that "Hermes, or Mercury, or Toth" was the "Inventor of Physick" and repeated the traditional genealogy from the Arabic alchemists to Paracelsus via Roger Bacon and Arnald of Villanova. John Freind replied to LeClerc's alchemically-biased account with his *History of Physick* (1744) in which he presented medicine and chemistry as evolving toward a fully realized Newtonian system.

In this sketch of successive views of medico-chemical history, Debus devotes a certain attention to the figure of Hippocrates, and deservedly so. Independently of all the theoretical differences, everyone agreed that the Hippocratic tradition represented a mature instance of clinical medicine and experimental natural philosophy. Significantly, Hippocrates was the only author in the medical canon to be appreciated even by the iconoclastic iatrochemists. In medicine, the revival of the pre-Galenic natural philosophy had the same meaning and function as the recovery of the pre-Socratic wisdom in philosophy. A clear example of Hippocratic renaissance at mid-17th century is Otto Tachenius, who in 1666 published his influential *Hippocrates Redivivus*. But Debus also remembers the different meanings that Hippocratism could convey for such different people as Helmont, Sydenham, or the Spanish physicians who between the 17th and the 18th century sought to introduce new ideas into their conservative medical setting. Even Boerhaave, in

his 1701 inaugural address for his appointment as lecturer in medicine at the University of Leiden, reconfirmed the need to return to Hippocrates for the advancement of medical studies in an experimental direction.

The early modern appropriations of Hippocrates lay bare the ideological uses of history. The hermeneutical pliability of the Hippocratic figure made it possible for the legendary Greek physician to become at once the champion of iatrophysics and the original iatrochemist. But the variegated gallery of the early modern Hippocrates reminds us once more that dealing with the medico-chemical debate in terms of a polarization between vitalism and mechanism is unsatisfactory and misleading. In medicine, the adoption of the reassuring dichotomy between Aristotelian naturalism and mechanical philosophy is not so easy as in the physical sciences. Debus' introduction of the notion of 'chemical philosophy' was timely and it still is because it aids the development of a more complex historical panorama. But precisely because of this complexity, the category of chemical philosophy, not merely a heading for spagiric naturalism, turns out to be more varied than the Paracelso-Helmontian one: one has only to think of reluctant alchemists like Robert Boyle, of 'chymical Galenists' like George Castle and Francis Glisson, and of chemical iatrophysicists like Giovanni Alfonso Borelli and Marcello Malpighi. The principal merit of Debus' book lies precisely in relieving readers of their 'isms' and exposing them to the complexity of the early modern interplay between medicine and chemistry, rising mechanical philosophies and still influential naturalisms.

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The German Chemical Industry in the Twentieth Century, ed. by JOHN E. LESCH, Kluwer Academic Publisher, Dordrecht, 2000, viii + 472 pp., EUR 163.50 [ISBN 0-7923-6487-2].

One of the interesting issues for the philosophy of chemistry is identifying the forces that have shaped chemical development. Why is one type of research pursued vigorously while at the same time a similar topic is largely ignored? In the late 19th and early 20th centuries, interactions involving industry, government, the public, and academic research were responsible for creating the modern discipline of chemistry. Academics often focus mainly on research discoveries, even though it can be argued that these other influences were as important as the success or failure of research programs. Only by giving appropriate weight to each of these constituents is it possible to gain a balanced understanding of the forces that have created modern chemistry.

The German chemical industry in the 20th century provides an excellent opportunity to see all these forces at work. The inorganic chemical industry that developed in Britain in the late 19th century did not place a strong emphasis on research and development. The dyestuffs and pharmaceutical companies that were established later on in Germany emphasized research in order to respond to a public demand for new colors and drugs. Germany depended heavily upon imports for basic raw materials, so during the two World Wars the chemical industry had to respond to governmental needs for alternative sources of raw materials. Thus, it was Germany that first displayed the strong interactions among industry, government, public demand, and academic research that are typical of the modern chemical industry. Research on Germany is also informative because the aftermath of the two world wars made a great deal of documentation available,