expressed in poetic texts as opposed to illustrations. This method allows for the use of the same word to mean different objects in different contexts, but always related to the same basic concept. For example, the metaphor for "oven" can also stand in for "womb." The Greeks and Romans have left us copious detailed images of practitioners of the chemical arts in fresco paintings and on pottery. Representations include blacksmiths, potters, fullers, perfumers and various types of metalworkers, sometimes in mythological contexts and sometimes in actual chemical workshops.

Some general comments. One thing to note is that for each essay, the authors do not seem to feel that it is necessary to give the reader a beginning, a middle and an end. Often an essay plunges right into the subject matter *sans* context, and after a lengthy disquisition in which each item is given equal importance, comes to an abrupt end. This may be the product of the volume's structure. Also, this reviewer would have been helped if dates had accompanied some major protagonists or commentators such as Maria the Jewess (e.g. ~1st-3rd C. CE) and Zosimos of Panopolis (e.g. 3rd-4th C. CE). Also, the chapter figures all carried informative captions but sometimes they were not called out in the text. The careful reader might be nonplussed by the substitution of "tenants" for "tenets" (p 27), "goodness" for "goddess" (p 32), "dying" for "dyeing" (pp 69 and 160), and a few more—strange typos or quirky spellcheck artifacts?

Overall this volume is a unique, comprehensive and rich treatise that encompasses thousands of years and a vast geographical swath of civilizations. It deals in detail with an all-encompassing latent chemistry that touched every aspect of human life. It is replete with references (over 50 pages) and contains a detailed and helpful index.

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1. B. Jaffe, *Crucibles: The Story of Chemistry*, Dover Publications, New York, 1976 (first published in 1930 as *Crucibles: the Lives and Achievements of the Great Chemists*).
2. A. Ihde, *The Development of Modern Chemistry*, Dover Publications, New York, 1984 (first published 1964).
3. J. R. Partington, *A History of Chemistry*, Macmillan, Ltd.; St. Martin's Press, 1961-1970.
4. S. Drake and C. D. O'Malley, Eds., *The Controversy of the Comets of 1618*, Philadelphia, University of Pennsylvania Press, 1960, pp 183-184, quoting Galileo Galilei, *Il Saggiatore* (*The Assayer*).
5. J. R. Partington, "Chemistry as Rationalised Alchemy," *Bull. Br. Soc. Hist. Sci.*, **1951**, *1*(6), 129-135.

Vol 2: *A Cultural History of Chemistry in the Middle Ages*, Charles Burnett and Sébastien Moureau, Eds., xiii+221 pp

A Cultural History of Chemistry in the Middle Ages, is a small but ambitious volume in this large and ambitious series. It succeeded in giving an orientation to the occult science of alchemy to this novice. I feel the need to add a disclaimer here. The review for this volume is written not by a scholar in the period but by a tyro. It contains no expert insights, but rather an account of what a chemist knowledgeable about some aspects of the discipline's later history can make of the volume as a first step in learning about medieval alchemy.

The Introduction by Sébastien Moureau, one of the volume's editors, provides an excellent overview both of the scope of the book and of the history of alchemy in the Middle Ages. What medieval natural philosophers called *chimia* or *alchimia*—the terms were synonymous—was "the science of matter, its composition and changes," including some changes (such as phase changes) a modern scientist would classify as physical. For the most part, the history of chemistry in the Middle Ages is the history of alchemy and the history of chemical crafts; this volume emphasizes the former, but does not neglect the latter.

Moureau explains that during this period, alchemy was pursued in the Islamicate world and in Latin Europe. (Islamicate refers to cultures in which Muslims predominate, avoiding the identification of such cultures with a single language (*e.g.*, Arabic), ethnic group (*e.g.*, Arab) or religion (*e.g.*, Islamic).) This volume is the first attempt at presenting an overview of alchemy in both the Islamicate and Latin worlds. Indeed, many of the chapters are co-written by scholars expert in each of those civilizations. Moureau's introduction describes the periods into which scholars of alchemy usually divide the study of the field: Egyptian and Hellenic, Arabic, and Latin. The scope of this volume spans these periods, including some work of late antiquity (Byzantine alchemy), of the medieval Islamicate, and of early Latin alchemy (before Paracelsus). One suspects that this scope was imposed, at least in part, by the periodization of the wider Bloomsbury Cultural History series. Whatever its origin, the resulting text emphasizes the transmission of alchemical ideas and traditions from Byzantine to Islamicate and later from Islamicate to Latin writers and practitioners.

Transmission is particularly emphasized in the first chapter (theory and concepts), subtitled "The Shared Heritage of Byzantine, Arabo-Muslim, and Latin Alchemy," by Matteo Martelli, Moureau, and Jennifer Rampling. Transmission took place via translations as well as by pseudotranslations—works falsely attributed to a prestigious figure. Two very broad theoretical topics are treated in this chapter, namely the composition and classification of matter, as well as two more specific ones, transmutation of metals and the quintessence.

The next two chapters are co-authored by Moureau and Nicolas Thomas, and they describe alchemical operations and apparatus, respectively. The processes and equipment of alchemy have considerable overlap with those used in chemical crafts. What distinguishes alchemy from industry is theory; their operations were often similar and their tools even more so. Alchemical operations were performed on a body (base metal), spirit (often mercury) and soul (elixir)—the theoretical framework is evident in the terminology—whereas craft operations were carried out to make a useful product. Some operations described here are still used in chemistry, such as distillation—or at least distillation *per ascensum*, in which vapors rise from a liquid heated in a cucurbit to be condensed on an alembic and collected. There was also a less common distillation *per decensum*, in which solid plant matter was heated in a perforated vessel set atop another vessel which collected liquids that separated from the heated material. Others do not correspond to any single modern chemical operation; ceration (literally to make waxy) is an example. Some alchemical manuscripts contain informative diagrams of alchemical apparatus. But some of the most striking depictions of alchemy and alchemists, such as paintings by Pieter Brueghel the Elder and David Teniers the Younger, are anachronistic.

Some of the same processes mentioned in chapter 2 are also treated in chapter 6, on chemical crafts and technology, written by Justine Bayley with Spike Bucklow. Many of the technologies discussed were known in antiquity; there was little incentive to change processes once a practical one was found. The chapter focuses on two inorganic products, metals and glass. Medieval craftsmen made few innovations in metalworking, but several in glassmaking.

Chapter 4, written by Regula Forster and Jean-Marc Mandosio with Antoine Calvet and Gabriele Ferrario, examines attitudes toward alchemy by contemporary scholars. In the Islamicate world, it was classified as a foreign science. Some religious scholars defended alchemy and others criticized it. There seems to have been more of an affinity for alchemy among Sufi and Shiite scholars than Sunnī scholars. In the Latin world, philosophers who were not alchemists regarded alchemy as a mechanical art, but its practitioners considered it a branch of natural philosophy.

Forster and Mandosio, with Calvert, also wrote chapter 7, on learning alchemy. Alchemy itself was not taught in European universities, although questions about the development of metals likely were included in some courses of natural philosophy. In the Islamicate world, oral transmission was the preferred form of teaching, and it is likely that this was true for alchemy. The *madrasa* was the cultural institution of the Islamicate milieu most comparable to the European university. Some alchemical manuscripts seem to have been read in some *madrasas*, probably for philosophical content, but it is unlikely that any had an alchemical laboratory.

Chapter 5, written by co-editor Charles Burnett with Calvet and Bayley, examines the place of alchemy in society. That position was highly variable: the notion of alchemy as a "culmination of intellectual study" could be found in both Islamicate and Latin contexts, but so could opinions that alchemists were charlatans or deluded. In the Islamicate world, alchemy was associated with royalty from its origins, as tradition attributed its first text to prince Khālid b. Yazīd. In Christian Europe, several religious orders prohibited the practice of alchemy within the order. Pope John XXII condemned alchemists who did not deliver what they promised, so what the religious legal system denounced was fraud, not alchemy itself.

The final chapter, by Rampling, treats images in alchemical manuscripts from simple diagrams found in the margins to elaborate allegorical tableaus. About the latter, Rampling writes, "One of the most distinctive and remarkable features of European alchemical imagery is its fusion of Arabic alchemical tropes with Christian iconography." The images discussed in this chapter all accompany texts, but the images and texts do not necessarily illustrate each other. The images are reproduced in greyscale in the print book but in color in the ebook.

For an alchemical tyro, this book succeeds in presenting an overview of the subject as well as numerous references to more detailed information. It provides an overview of many of the most important names in medieval alchemy as well as frequent reminders that many of those names must not be taken at face value. Pseudepigraphy (the attribution of texts to people who did not write them) pervades medieval alchemy. Many such texts were attributed to writers who had little interest

in alchemy or opposed it. Other texts purporting to be from the Middle Ages were written later, and some were attributed to fictional authors.

In addition to instructing novices, I suspect that the book will also serve scholars of alchemy as syntheses and sources of references in much the same way as scientific review articles assist both experts and beginners.

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Vol 3: *A Cultural History of Chemistry in the Early Modern Age*, Bruce T. Moran, Ed., xiii+275 pp

What is chemistry? Where did it belong? With these questions, editor Bruce Moran opens his splendid introduction to *The Early Modern Age*, the third volume in Bloomsbury's *Cultural History of Chemistry*. The same questions provide a constant refrain throughout the volume. While the eight individual chapters cover a host of chemical applications—from transmutational alchemy to mining, gunpowder-making to medicinal distillation—the fundamental problem of defining early modern "chemistry" remains at the fore of each. After all, as Moran notes, "the experience of what gets lumped together as chymistry was never one experience, and never reflected a unified structure of meaning" (p 9).

This range of experiences is both examined and embodied by a highly-qualified assembly of contributing authors, who include, besides tenured and emeritus professors, early career researchers, independent scholars, and museum and library curators. These authors bring multiple perspectives to bear on their subject, including the intellectual history of alchemy, art history, history of the book, institutional history, and the social history of secrets. Despite a few nods to the Atlantic world (notably in Donna Bilak's chapter on "Laboratories and Technology"), this is nonetheless a history that focuses overwhelmingly on the European experience, with Europe providing the stage on which the modern, Western discipline of academic chemistry gradually arose from a tangle of ideas and practices that historians are still attempting to unsnarl.

Chemistry in sixteenth- and seventeenth-century Europe—the scope of this volume—had not yet crystallized as a discipline, posing terminological difficulties both for early modern Europeans and present-day scholars. One solution has been to adopt "chymistry" (a term championed by William Newman and Lawrence Principe in an oft-quoted article) as an umbrella term for the pre-modern chemical sciences, intended to avoid the anachronistic separation of "alchemy" from "chemistry." Scholars of recipes, secrets, and artisanal knowledge have argued for adopting even broader definitions to represent the full range of arts and techniques in which chemical knowledge is implicated. Chemistry's borders with medicine and pharmacy were also highly permeable—but not all medicine was chemical, and not all chemical medicine was "alchemical." Given the profusion and imprecision of available terminology, it hardly surprising that six out of the eight chapters in *The Early Modern Age* devote space to such complications. Definitional questions are important, and newcomers to the subject will certainly be left in no doubt of their ongoing importance. At times, however, I found myself skipping over passages that reprised issues already presented clearly and well in Moran's introduction.

A more engaging method for slicing and dicing chemical culture is supplied by the chapter titles themselves. These eight general headings, consistent across all six volumes in the series, invite readers to examine the topic from different vantage points. As these studies show, chemistry's place in European culture indeed looks very different depending on whether we view it as technology, economic enterprise, experimental philosophy, or literary genre. Its protagonists also change across cultural outlets—so, in some chapters we meet physicians and university-educated scholars; in others, painters, craftsmen, and charlatans. Women make walk-on appearances, especially in craft contexts, although the few to be mentioned by name (Martine de Bertereau, Margaret Cavendish) hail from the upper classes.

All of the contributors to this volume provide solid surveys of their designated topics, although the fixed chapter titles are still not quite enough on their own to corral chemistry's sprawling and invasive character. There is, for instance, considerable topical overlap between William Eamon's chapter on "Society and Environment" and Tillmann Taape's on "Trade and Industry," each of which includes sections on print, secrets, and women distillers. On the other hand, such duplications do allow contributions to function as freestanding units—a feature that doubtless accords well with Bloomsbury's strategy of making chapters available for individual download for subscribers to the online "Cultural History" database. Read on its own terms, Eamon's chapter makes a strong case for the diversity of chemical practices within a bustling marketplace of craft knowledge, medical secrets, and printed books—the contexts in which most early modern people would have experienced "chemis-