

# The Oxford Handbook of Science and Medicine in the Classical World edited by Paul T. Keyser and John Scarborough

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*The Oxford Handbook of Science and Medicine in the Classical World* edited by Paul T. Keyser and John Scarborough

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The volume under review is a recent addition to the Oxford Handbooks series, which

offer[s] authoritative and up-to-date surveys of original research in a particular subject area. Specially commissioned essays from leading figures in the discipline give critical examinations of the progress and direction of debates, as well as a foundation for future research. [dustcover]

This review is written from the standpoint of someone fairly new to the fields of ancient science and medicine, who teaches an undergraduate survey of them and would like to be brought up to date on recent discoveries, interpretations, and approaches. To that end, this book is a fantastic resource and a major achievement. And at just over 1,000 pages, there is a lot in it: much that readers might reasonably anticipate, but a lot that they might not. The title suggests a broad scope—science and medicine in the classical world—but we get considerably more.

Core topics—cosmology, astronomy, mathematics, geography, anatomy, pathology, and pharmacy—receive ample coverage. But so do topics that are less commonly treated in handbooks or overviews, such as harmonics, optics, surgical tools, and physiognomy. Most strikingly, the volume opens with four groups of chapters treating Mesopotamian, Egyptian, Indian, and Chinese science and medicine. The scholarship on Greek science and medicine has often looked beyond the Greek world to understand precursors and influence. Yet handbooks (or even monographs) rarely look beyond the ancient Greek and Roman worlds for their own sake.

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Contributors to the volume frequently cite the *Encyclopedia of Ancient Natural Scientists* (EANS), of which Keyser is also an editor;<sup>1</sup> and we might understand this volume to be a companion that offers context for the entries in EANS. It is, similarly, a collaborative effort: for this volume, Keyser and Scarborough have gathered an international team of 44 contributors. The editors are well-placed to have taken on this project: Keyser has also co-edited Routledge's *Greek Science of the Hellenistic Era: A Sourcebook* [Irby-Massie and Keyser 2002], while Scarborough is the contributor to, and editor of, multiple volumes as well as a leading figure in ancient pharmacology and medicine more generally. Their contributors are a mix of established figures with long records of research and up-and-coming scholars. The volume is also a natural companion to *The Oxford Handbook of Engineering and Technology in the Classical World*, edited by John Peter Oleson [2009].

Keyser and Scarborough have structured their volume around broad disciplines or spheres of activity, much more so than the *Companion to Science, Technology, and Medicine in Ancient Greece and Rome*, edited by Georgia Irby [2016], whose 60 chapters each have a narrower focus. While the two books have much in common—they are comparable in length and temporal coverage, and even share some contributors—importantly, Irby's *Companion* also includes chapters on technology. Keyser and Scarborough's inclusion of chapters on areas outside the classical world (notwithstanding Irby's chapter 56) signal their awareness of future directions in the study of classical science and medicine.

Keyser's introduction sets up some helpful parameters and guiding principles for the volume. It is here that we learn the volume's chronological divisions: excepting part A, in which the timespan for each contribution is less fixed, science and medicine are considered from Homer through AD 650, divided into four rough periods at what Keyser terms "natural joints" [5]. Part B runs from Homer through Plato; part C, through the Hellenistic period; part D, the Greco-Roman period; and part E, late antiquity and early Byzantium.

Since each chapter offers a summary of its topic—and given that there are 49 chapters, plus an introduction—I will simply pick out highlights of each. Most chapters include the following elements: the major source material for their topic, key players, ancient and modern approaches, and essential bibliography.

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<sup>1</sup> See Keyser and Irby-Massie 2008.

Part A, “Ancient Scientific Traditions beyond Greece and Rome”, contains 10 essays on ancient scientific and medical traditions outside Greece and Rome. As Keyser acknowledges in his introduction, these contextualizing essays on Mesopotamia, Egypt, India, and China are not comprehensive, largely because of a lack of contributors. The gaps signal areas for future scholarship. Other parts of the world had science too, as Keyser acknowledges; but their lack of texts, or the difficulty of working with them, made comparable essays impossible.

Jens Høyrup’s contribution, “Mesopotamian Mathematics”, introduces the key themes of the volume: the tension between theory and practice; the importance of scribal activity and textual transmission; and the social and cultural prestige of the topic. The close of the essay, which problematizes the Greek inheritance of Near Eastern mathematics, provides a useful corrective to often oversimplified and misleading presentations of intellectual inheritance. In “Astral Sciences of Ancient Mesopotamia”, Francesca Rochberg points out that astronomy and astrology were not distinguished as a science and a pseudo-science, a theme picked up several times later in the volume. There are helpful summaries of key compendia, including *Enūma Anu Enlil* and *MUL.APIN*, and here, as elsewhere, mathematics is emphasized as a key underpinning of other sciences. JoAnn Scurlock’s lively essay, “Mesopotamian Beginnings for Greek Science?”, focuses on medical practitioners and remedies. In rationalizing and psychologizing the role of magical practices as part of healing, she argues that Mesopotamian healing was more rational and effective than Greek. Scurlock also discusses the Greco-Babyloniaca: texts in Akkadian that used the Greek alphabet to give Greek-language scholars access to Akkadian literary and scientific texts and that reflect significant cultural encounters between the Greek and Mesopotamian worlds.

Moving to Egypt, Annette Imhausen’s “Mathematics in Egypt”, which emphasizes textual transmission and our lack of sources, includes the sobering statistic that “only six chance finds of mathematical texts have survived” [54]. This essay is a model of clarity; her explanation of Egyptian fractions [51–52] is admirably lucid. Joachim Friedrich Quack’s “Astronomy in Ancient Egypt” surveys star-clocks, the *Book of Nut*, and simple formulae for calculation. Quack occasionally looks forward in time to the Greco-Roman period and helpfully anticipates the later chapters of the volume. In her survey of Egyptian medicine, Rosemary David emphasizes current and recent research. She argues for a greater presence of rational elements than irrational, citing preliminary findings from the University of Manchester’s

Pharmacy in Ancient Egypt project. In a long section on sources, she surveys the possibilities offered by physical remains, as well as their current limitations.

Much of the material on Mesopotamia and Egypt is well known to experts on the Greek and Roman side. But India and China will be less familiar, and the essays that follow are a real boon to all classicists, pointing us to possibilities for comparative work and alerting us to a multiplicity of ancient sciences and medicines.

Toke Lindegaard Knudsen's accessible "Mathematics in India until 650 CE" picks out just a few elements of interest, including large numbers, the place-value decimal system, Indians' use of the Pythagorean Theorem, and Pascal's Triangle. While classicists should avoid the temptation to approach science and medicine outside the ancient Mediterranean by looking for relative chronologies in discovery, Knudsen does provide details for ancient texts (and translations) that will help classicists track contemporary modes of thought. "Sanskrit Medical Literature" by Tsutomu Yamashita takes a source-based approach to argue that rational medicine originated in irrational religious texts. In the final section, Yamashita provides a careful and lucid introduction to physiology and pathology and points up the distorting tendency among scholars to fit Āyurvedic theories to those of Greek sources.

Moving to China, we are made aware of an enormous and complex scholarly tradition. In "Ancient Chinese Mathematics", Alexei Volkov supplies specific examples of problems that interested Chinese mathematicians, including the "remainder theorem" and calculations of pi and the volume of a sphere. According to Xu Fengxian's "Astral Sciences in Ancient China", there were two driving forces: calendar-making and astrology. Fengxian's discussion of how the Chinese conceptualized and observed the structure of the heavens (with 28 constellations or *xiu*) reminds us that core conceptualizing frameworks, such as the zodiac, are not inevitable.

These opening contributions give a sense of universal themes, which are helpful for the instructor trying to guide undergraduate students away from notions of Greece and Rome being special or different. The essays on Egypt and Mesopotamia attend to influences on and between peoples, and it would have been helpful to have some discussion on external influences—or the lack of them—on Indian and Chinese science and medicine (for example, the influence of Hellenistic texts on Indian astronomy).

Part B, “Early Greek Science”, takes us from Homer to Plato in four chapters. In “Pythagoras and Plato”, Andrew Gregory takes a biographical approach—the essays in the volume arrange their material biographically, topically, chronologically, and around key texts—to explore early Greek treatments of a few topics. Other chapters, too, will be selective, favoring depth over coverage. Investigation is a key theme of Gregory’s chapter, and indeed approach—theoretical *vs* empiricist—is important in the volume overall. Mention of Philolaus is welcome; his pyrocentric model of the universe can be presented to students alongside Aristarchus’ heliocentric model as alternatives to the dominant geocentrism.

Leonid Zhmud’s “Early Mathematics and Astronomy” is a dense chapter. We learn that competition existed among early Greek scientists—giving rise to proofs as evidence of excellence—but emphasis on “firsts” comes later from Eudemus of Rhodes, who exerted enormous influence on the form and focus of the history of Greek science. The terminology employed in this chapter could have been clearer: “astronomy” is not clearly defined, and *mathemata*, a term used throughout the chapter, is not defined until the final section. Zhmud’s clear explanations of various mathematicians’ attempts to square a circle are valuable.

In “Early Greek Geography”, Philip G. Kaplan surveys Homer’s and Hesiod’s approaches to space through early cosmogonies and genealogies, and traces the shift in Greeks’ conceptions of space from itinerary-based to cartographic, as apparent in Herodotus. Kaplan presents Herodotus as a geographical innovator who describes distance using units of measurement, not time (stades *vs* days’ walk). This section of the chapter is especially helpful to graduate students, providing them with another context in which to think about a writer otherwise approached as a historian.

“Hippocrates and Early Greek Medicine” by Elizabeth Clark contains a broad introduction to the Hippocratic Corpus and early medical thought. Clark also briefly considers similarities between Āyurvedic medicine and early Greek medicine, and raises the possibility of the movement of ideas, along with people and goods, especially around the Black Sea. She notes that Greek mechanical views of the body (as containing fluids that might need to be unblocked when gathered in excess in one place) are also identified in contemporary Chinese medicine.

Moving to Part C, “Hellenistic Greek Science”, which receives the most attention of any period (16 essays), we pick up with Aristotle, whom Joachim Althoff suggests we should regard as a scientist first and philosopher second.

His “Aristotle, the Inventor of Natural Science” is a well-written chapter that does an admirable job of connecting Aristotle’s key areas of inquiry and approaches. Little is said about Aristotle’s intellectual context, though Althoff stresses Aristotle’s towering influence on the Hellenistic period (and later). Teun Tieleman’s brief essay “Epicurus and His Circle” can be regarded as something of a companion piece that similarly treats Epicurus and his successors.

Fabio Acerbi’s “Hellenistic Mathematics” is one of the most imaginatively presented essays in the volume. He opens with an intriguing section on the stylistics of mathematical writing (which might be a nice addition to graduate-level courses on Greek prose style). Acerbi summarizes Hellenistic mathematics—no mean feat—by characterizing it as concerned with lines, and then goes on to define those various lines and to sketch various individuals’ concern with them. The survey is highly technical and condensed, but offers a neat approach to what might otherwise have been a long and unwieldy section. Acerbi helpfully points out that the notion of a collective endeavor to solve the classic three problems (duplication of the cube, squaring of the circle, and trisection of an angle) has arisen from succeeding traditions of commentary and compilation that have downplayed the breadth and independence of mathematicians’ work.

In “Hellenistic Astronomy”, Alan C. Bowen surveys ancient conceptions of *astrologia*, or work on the heavens (which encompasses modern astronomy and astrology). He stresses the need to acknowledge the literary nature of Hellenistic astronomical texts, of the “facts” chosen and presented to support their author’s literary intent. For Bowen, the Hellenistic period’s main contribution to *astrologia* lies in its establishment of a framework for the work that is to follow.

Duane Roller’s “Hellenistic Geography from Ephorus through Strabo” is a masterly and fascinating survey of the development of geography as a discipline. Roller points out that Polybius viewed himself more as an “explorer” than a historian (another useful corrective, to set aside that concerning Herodotus). It is good to see mention of Hestiaia of Alexandria, who wrote on topography [330].

T. E. Rihll’s essay on “Mechanics and Pneumatics in the Classical World”, a *tour de force*, marks an important shift in the volume, to the immediately practical and sometimes utilitarian. But as Rihll notes, “Academic subjects and the world of work were less separated in antiquity than they are today” [339]. Despite the reputation of Greeks and Romans for engineering,

Rihll points out that the erroneous notion of “natural motion”, deriving from Aristotle, hampered progress in mechanics for many centuries, though practical applications of the mechanics of moving objects were not altogether stymied. Rihll matches descriptions of catapults and other machines with archaeological finds, arguing against labeling devices not immediately realizable as “armchair devices” and noting that the gap between written explanations and final execution has always existed. This chapter, which is more accessible than most because of the familiarity of so many of the devices being described, could be assigned to a senior undergraduate interested in the topic. There is also a survey of ancient theoretical explanations for machines, many of which were unsuccessful—a nice counterpoint to the positive impression of ancient mechanical understanding given by the archaeological record.

Fabio Stok’s “Medical Sects” surveys and carefully differentiates Hero-phileans, Erasistrateans, and Empiricists, stressing the development of their approaches over time. This essay nicely anticipates that of Lauren Caldwell later in the volume.

Glen M. Cooper’s chapter, “Astrology (The Science of Signs in the Heavens)” provides an introduction to its subject. There is a significant section on skepticism (along with astrologers’ rejoinders), and a brief but fascinating section on Christianity’s uneasy but sometimes accommodating relationship with astrology. The essay closes with an analysis of Hadrian’s horoscope, a neat way to explain facets of prediction and to introduce key explanatory texts (and their contradictions), including Ptolemy’s.

In “The Longue Durée of Alchemy”, Paul Keyser defines his subject as the “science of materials” [409], a definition which he acknowledges as broad, and which enables consideration of alchemy both as a precursor to chemistry and also as a philosophically driven set of practical and spiritual practices. Claiming the former as alchemy’s primary goal through the Hellenistic period, Keyser focuses on work with pigments and metals. Readers will benefit from his explanation that modern categories based on physical properties (e.g., metals vs minerals) did not exist in the ancient world.

Klaus Geus and Colin Guthrie King’s chapter, “Paradoxography”, is a fascinating survey of Greek and Latin accounts of phenomena considered outside what is normal or expected. Paradoxographical accounts of phenomena rely on their sources for credibility, not the judgment of their collector. As such, they demonstrate the broad point that ancient epistemological premises differ from those of today. The chapter exemplifies the volume’s emphasis on



the otherness of ancient science and medicine, and its concern to consider ancient areas of interest according to their ancient definitions and goals.

The inclusion of the chapter “Music and Harmonic Theory” is likewise in keeping with the editors’ concern to conform to ancient definitions and conceptualizations. This a highly technical chapter, one that is hard to penetrate without some familiarity with music theory. Stefan Hagel helpfully reviews Aristoxenus’ main achievements, including his attempts to reconcile musicians’ and mathematicians’ ratios, as well as Ptolemy’s attempts to do the same, which were apparently too technical or difficult to be picked up by either fellow theorists or musicians.

Philip Thibodeau’s chapter, “Ancient Agronomy as a Literature of Best Practices”, marks a significant shift for the volume. His focus is not on archaeological evidence but on texts that communicate the most economically beneficial practices and share marvels of farming. This chapter might sit more obviously in a volume on ancient technology, though Thibodeau points out that some agronomers organized their material around the calendar and basic astronomical observations, and, as Keyser points out in the introduction, the editors have used a broad definition of science.

“Optics and Vision” raises the intriguing question, What is vision? In this chapter, Colin Webster tracks the various ancient definitions that came into vogue and their proponents. Most of the names are ones already encountered in the volume, and Webster briefly connects their thoughts on vision to their wider concerns with issues of matter, perception, astronomy, and geometry.

“Pharmacology in the Early Roman Empire: Dioscorides and his Multicultural Leanings” is a compelling chapter. In it, John Scarborough has arranged his material by simples, which he has chosen to reflect both the contemporary empire in which Dioscorides worked and traveled, with its varied geography and flora, and the history of pharmacology. There is plenty in this chapter for the instructor: information on pharmaceutical uses of silphium, castoreum, and sea urchins, as well as poisons and narcotics. While authors of other chapters have tried to avoid applying modern definitions or explanations lest they seem to be making judgments from a modern sensibility or knowledge, Scarborough does supply modern explanations for ancient remedies which help the reader to understand better that remedies were often the result of empiricism. Scarborough’s description of Pliny’s *Natural History* [520–521] is delightful.

A chapter devoted to dietetics, “Dietetics: Regimen for Life and Health”, is a welcome surprise, opening with a nod to the importance of experimental archaeology to some scholars of ancient food and diet. Most compelling in this chapter is Mark Grant’s survey of ancient understanding regarding food’s interaction with the body, e.g., in digestion and in cures for madness; he sets out the connections between qualities (hot, dry, cold, moist) and the foods that were believed able to correct the imbalance that had caused illness.

“Greco-Roman Surgical Instruments: The Tools of the Trade”, with its interest in archaeology, follows neatly from the previous chapter. Lawrence J. Bliquez organizes some of his material by tool and notes the consistency between archaeological finds and written descriptions of instruments.

Moving to Part D, “Greco-Roman Science”, and Philip Thibodeau’s “Traditionalism and Originality in Roman Science”, we might ask whether there was such a thing as Roman science. Thibodeau answers by defining it as science written in Latin and identifying some of its achievements. Those are often hard to recognize because Romans liked to place themselves in traditions and credit discoveries to early figures, notably Numa Pompilius and Pythagoras, rather than single themselves out as originators or significant developers. Thibodeau surveys such figures as the Elder Cato, Nigidius Figulus, and Varro.

By invoking Pythagoras, Roman scientists acknowledge their debt to the Greeks, a theme picked up by Pamela Gordon in “Science for Happiness: Epicureanism in Rome, the Bay of Naples, and Beyond”. Gordon explores the extent to which Lucretius, Philodemus, and others developed Epicureanism, in a broad survey that brings together medicine, physics, and evolution. This essay reflects well the scope of the volume, encompassing theory and philosophers alongside physical evidence and practitioners.

Lauren Caldwell picks up on Stok’s earlier essay in her “Roman Medical Sects: The Asclepiadeans, the Methodists, and the Pneumatists”. She offers a sketch of the sects and their key positions or approaches, acknowledging the problem of scholars’ necessary over-reliance on one source: Galen. Highlights of this chapter include Caldwell’s overview of what Empiricist and Methodist doctors might offer patients—carefully considered plans of treatment from the former, efficiency and value for money from the latter—and her consideration of medical education (the first chapter in the volume to do so). She also explores the extent to which doctors consciously

adhered to a sect and how united those sects were. This is a lucid, well-written, and highly readable chapter that brings together scholarship and carefully chosen ancient sources, such as Aelius Aristides' *Sacred Tales*.

In "Science and Medicine in the Roman Encyclopedists: Patronage for Praxis", Mary Beagon tackles the importance of polymathy for ancient scientists. In her treatment of Vitruvius, Beagon identifies a "Roman holistic attitude to learning, whereby human need, utility, and aesthetics make the study of nature more than the literal sum of its elemental parts" [666]. Her discussion of Pliny works towards a definition of a Roman approach to science, with its emphasis on practicality, utilitarianism (in support of profit), personal authority, and a "medico-magico-religious" approach from a Roman tradition that can be set alongside the Greek tradition [673]. Added to that is the Roman attitude towards knowledge as a corollary to power, which is exemplified in the encyclopedists.

Teun Tieleman's "Stoicism and the Natural World: Philosophy and Science" focuses more on philosophy than on science, though a highlight is his discussion of Stoic responses to developments in medical thought.

John Scarborough's "Scribonius Largus and Friends" is the companion to his earlier chapter on Dioscorides. According to Scarborough, the precision and complexity of Largus' recipes for remedies ensured that they would become neglected, in contrast to Dioscorides' far simpler text. (Scarborough's acknowledgment of the importance of the reader complements Caldwell's earlier discussion of patient experience.) In addition, as Scarborough notes, Galen favored Dioscorides. Scarborough analyzes one of Scribonius' recipes, carefully presenting how it was (and was not) efficacious—a powerful example of Scarborough's training in pharmacy and history. The final section of the chapter, which describes the effects wrought by the recipe (including, alarmingly, kidney poisoning) is a salutary reminder of what the capabilities of ancient medicine were.

In "Distilling Nature's Secrets: The Sacred Art of Alchemy", Kyle Fraser revisits the history of alchemy in order to correct and complicate Festugière's influential claim that alchemy became less scientific and more mystical over the centuries. The section on Maria, a figure often mentioned only in passing, is a significant contribution. Presented usually as a designer of apparatus, Maria developed her *kerotakis*, a sealed still used to collect heated gases, with the goal of transmutating a base metal by complete transformation of all its properties.

Mariska Leunissen's "Physiognomy" is an excellent addition to the volume. Though no longer a modern science, thanks especially to its notorious employment in the early 20th century, physiognomy nevertheless has a long and important history. As Leunissen points out, Greek and Roman philosophers used the body to understand character, while physicians used character to understand the body.

Galen has appeared throughout the volume thus far, but Ian Johnston's "Galen and His System of Medicine" is devoted entirely to him. Galen's predecessors are identified as chiefly Hippocrates and Plato. The chapter emphasizes his philosophical training and interests as an intentional basis for thinking about methods of diagnosis. He wrote on philosophical topics, an aspect of his work that this volume could have overlooked but happily did not. There are excellent accounts of Galen's positions on, for example, elemental vs atomistic views of anatomy and his classifications of disease. At the close of the chapter, Johnston sets out his list of answers to the question, "What relevance does the study of Galen have today?" This should be a go-to list for anyone teaching a course on ancient science or medicine.

James Evans' chapter is an elegant introduction to the wide-ranging work of Ptolemy. A standout from this long chapter is the discussion of Ptolemy's claim that the Earth cannot be moving because items thrown into the air do not continue to move along with it—a helpful example of ancient explanations for what we understand as Earth's gravitational pull. The section on Ptolemy's geography provides an example of one of the strengths of this volume: Evans' discussion, focused on cartography, is oriented quite differently from that of Duane Roller, which focuses on explorers and historical writers. (Compare also Evans' discussion of refraction with that of Colin Webster, and his less technical treatment of harmonics with Hagel's.) The closing section is one of the most important in the volume, raising the issue of instrumentalist vs realist approaches to science among the ancients.

Paul Keyser's "Science in the 2nd and 3rd Centuries CE: An Aporetic Age", which closes this part of the volume, helpfully puts Ptolemy and Galen in context and affords their contemporaries some attention. According to Keyser, there are three characteristics of science writing in this period: adoration of the past, a tendency to produce compendia or summaries rather than wholly original work, and the cultural importance of claiming wide intellectual authority, all of which will be important in the last part of the volume. In Part E, "Late Antique and Early Byzantine Science", the volume continues through the sixth century AD. This editorial decision was made, perhaps, in

the spirit of inclusivity, and I hope classicists will pay it due attention. They should certainly read “Plotinus and Neoplatonism”, for as Lucas Siorvanes reminds us, Neoplatonist texts make up about 58% of all extant Greek philosophical texts. With scholars increasingly relabeling those texts as simply Platonist, perhaps familiarity with them will increase. The importance of (Neo)platonism is underlined in the closing summary of its influence on later scientists, most notably Kepler.

The brief and clearly demarcated sections of Alain Bernard’s “Greek Mathematics and Astronomy in Late Antiquity” are a good fit for a handbook and make his arguments easy to find and follow. Unlike most other chapters, Bernard emphasizes his subject’s social and intellectual contexts, which are far different from those in previous parts of the volume; for example, mathematics’ newly increased importance to late antique philosophy would justify its importance in the future. Commentaries are emphasized, as indeed they are through the remaining chapters, as gatekeepers for the mathematical tradition and venues for new ideas.

Commentaries are the focus of Michael Griffin’s “Greek Neoplatonist Commentators on Aristotle”. Griffin emphasizes the originality of late antique commentators on Aristotle, who were concerned with reconciling those of his texts that are in contradiction and picking out shared ideas. They also refined Aristotelian thought and approaches. Griffin supplies the example of Philoponus, who develops Aristotle’s notion that a javelin thrower imparts movement to the air that then propels the javelin; Philoponus posits that the thrower is giving force to the javelin.

In “Byzantine Geography”, Andreas Kuelzer reminds us that information was drawn not only from older Greek authorities, most notably Strabo and Ptolemy, but also from texts from Nisibis and from Jewish and Christian texts of the third century and later—a salutary reminder of the strands of thought that should stand alongside the more familiar (to us) texts of Ptolemy *et al.* Especially helpful in this connection is Kuelzer’s discussion of Christian opposition to notions of the Earth and universe as spherical.

In “Byzantine Alchemy, or the Era of Systematization”, the focus returns to commentaries and collections and the processes of compiling and editing. A notable feature of Cristina Viano’s chapter is the section on material evidence for alchemy, including the black patina on some statues that may be the famed “black bronze” of some alchemical recipes, and the remains of gold mining sites at Samut in Egypt. Here, the emphasis on the practical work of alchemy nicely echoes Keyser’s earlier chapter.

Svetla Slaveva-Griffin describes a new area for research in her “Byzantine Medical Encyclopedias and Education”. These encyclopedias are little mentioned in regular scholarly surveys of the period, but medical practitioners and medical historians are drawing attention to their significance, especially as syntheses that were of immediate use to medical practitioners.

In “Late Encyclopedic Approaches to Knowledge in Latin Literature”, David Panagua surveys those works in Latin, from the third century AD to Isidore, that present *omne scibile*, everything knowable, such as Lucius Ampelius’ *Liber memorialis*. But what is worth knowing? The example of Augustine’s abandonment of secular learning as incompatible with Christian education highlights one of the myriad threats to the later transmission of ancient science. Yet Cassiodorus’ educational program provides an encouraging counterpoint.

Louise Cilliers’ “Medical Writing in the Late Roman West” provides a fitting end to the volume; this is the period in which, as Cilliers points out, the majority of Latin medical texts were produced. Cilliers describes how Greek scientific and medical texts were being translated into Latin for a Roman West that was in the fourth to seventh centuries—and onwards—increasingly Latin-speaking rather than bilingual. The philosophical and theoretical aspects of translated texts were excised, leaving only practical instruction. The chapter would have benefited from a longer discussion of Alexander of Tralleis, who, as Cilliers acknowledges, is termed by modern doctors “the third Hippocrates”.

As these summaries indicate, in this volume there is a wealth of information and analysis, far in excess of what one might expect from a handbook or introduction. However, in several chapters, especially those by Rochberg, Zhmud, and Hagel, the information has been presented so densely that a reader unfamiliar with the topic would need to do some background reading in order to understand it fully. Other chapters (most notably that by Rihll) are accessible to the non-specialist.

There is an inconsistency in references to Pythagoras’ theorem: it is thus named in Volkov’s and Gregory’s chapters, but in Lindegaard Knudsen’s it is the “Pythagorean theorem”. The difference is important: the theorem was not Pythagoras’, though it was perhaps proven by him. “Pythagorean theorem” more elegantly reflects that fact and might have been adopted through the volume. Another inconsistency is that Maria, the alchemical authority discussed in Fraser, has become Mary the Jewess in Viano.

In 49 chapters, there are, inevitably, overlaps in subject matter (for example, between Zhmud's and Gregory's discussions of Pythagoras). When those are treated with different approaches, appropriate cross references would benefit the reader. Some chapters do contain cross references, most notably those of Gordon, Cooper, and especially Bernard, who seems to have read other chapters carefully and taken pains to engage with them. The paucity of cross references in some chapters is not a source of criticism, rather a missed opportunity. Johnston's treatment of the medical sects does not refer to similar treatments in Stok and Caldwell, and Grant and Caldwell do not refer to each other's contributions, despite the overlap in their material. Scarborough, in his chapter on Scribonius, discusses Philodemus and Epicureanism at Herculaneum, but does not reference Gordon's chapter. Given that Scarborough is one of the volume's editors, it seems likely that contributors were not encouraged to reference others' essays.

Division of the Greek and Roman material into four parts (early Greek, Hellenistic, Greco-Roman, and late antique and early Byzantine) broadly reflects intellectual developments, along with developments in politics and culture. As Keyser notes in his Introduction, Part C, "Hellenistic Greek Science", covers "the long Hellenistic era generally", and Part D, "Greco-Roman Science", is "somewhat overlapping" [5]. As a result, chapters in the same part of the volume might not have the same temporal bounds, an inconsistency that was disconcerting to this reader. For example, in Part C, while Althoff and Tieleman focus on the fourth and third centuries BC, the chapter that follows by Acerbi ranges as late as the first century AD. The title of Scarborough's chapter on Dioscorides, "Pharmacology in the Early Roman Empire", was a confusing choice for a chapter included in Part C. Similarly, Bliquez's "Greco-Roman Surgical Instruments: The Tools of the Trade" surveys instruments that date to the late Republic/early Empire, yet because, as Bliquez notes, they were used by Greek doctors, the chapter was included in Part C. In Part D, Thibodeau has an end point of the first century AD, but Gordon and Caldwell, in the chapters that follow, span as far as the third century. Finally, in Part E, the distinction between late antique and early Byzantine is hard to determine: for example, Kuelzer's "Byzantine Geography" references texts dating as early as the second century AD and written in Latin, but also ranges as late as the 11th. While some contributors (such as Bowen, Viano, and Cilliers) do an excellent job of stating clearly their beginning and end dates, others (including Rochberg) are less clear.

A handbook on science and medicine will, quite reasonably, offer only brief historical narrative or supporting detail, but sometimes supporting evidence

or references were needed for them. For example, Cooper presents assertions about the emperors' use of astrology and astrologers without textual references that would have helped the reader evaluate those claims. Cilliers, in an otherwise excellent chapter, refers to "the deposition of the last Roman emperor in the West in 476" [1013], though, as some scholars are keen to point out, Julius Nepos clung to his imperial title until 480. Her characterization of the fourth to the seventh centuries as "the twilight years of the western Roman Empire, passing over into the Dark Ages" [1030] catches the reader's attention, but feels dated.

Readers of handbooks are often looking for good bibliographies, and this volume does an excellent job of providing judicious lists of editions (and, where necessary, translations) and of seminal and recent scholarship. The bibliographies of Panagua and Webster are even divided helpfully into sections (though the latter does not key his in-text references to those sections), and Volkov offers two lists of publications, in "oriental languages" and "western languages". Acerbi's "Onomasticon" is a boon to the reader, though a reference to it early in the chapter would have made it more useful. In addition, the contributors do an admirable job discussing important individual works of scholarship.

Editors of handbooks are faced with the difficult choice between, on the one hand, sacrificing space for the sake of clarity in presenting complex material and, on the other, keeping discussions short and relying on references to relevant detailed discussions elsewhere. The editors and their contributors have achieved an effective balance, largely through judicious selection of exemplary material. The volume would have benefited from a full discussion (perhaps not a chapter) somewhere of atomism as treated by Leucippus, Democritus, and others. Also desirable would have been a rigorous discussion of where scholars have stood and currently stand on the role and status of magic in ancient science and medicine, a topic that admittedly exercises non-specialist classicists more than it might the volume's contributors.

To the classicist who must incorporate them into teaching or research, ancient science and medicine can seem impenetrable and intimidating, largely because the sources are unfamiliar and rarely available in the usual collections. Keyser and Scarborough are therefore to be commended for the fact that their contributors emphasize sources—both textual and material—throughout the volume.



In his introduction, Keyser tackles the issue of definitions of science. He acknowledges that what qualifies as science develops over time and, in viewing science as a broad church, hopes to encompass both ancient and modern definitions. This seems a reasonable approach, especially for a handbook that must somehow divide its material to suit ancient conceptions, modern expectations, and scholars' areas of expertise. There are some significant, perhaps unintended, consequences for the volume. For example, Keyser himself, in his chapter on alchemy, takes a modern scientific approach to the topic by privileging the exoteric over the esoteric (and, in so doing, can argue for its success in modern scientific terms). By contrast, Fraser acknowledges that a modern distinction between what is science and what is not threatens an anachronistic and misleading view of alchemy.

The inclusion of both Bowen's chapter, which doggedly sticks with ancient conceptions of *astrologia* (in which astronomy and astrology are often enmeshed), and Cooper's, which focuses on astrology, suggests that the editors had either not sought to impose definitions and approaches or wanted contributions that would reflect different definitions and approaches. Some contributors question definitions in such a way that justifies their choices. For example, Beagon opens by wondering whether there is such a thing as an ancient encyclopedia or even encyclopedic writing; the chapter that follows suggests she has established criteria that suggest there are. Beagon's anxiety over generic definitions is modern, though the parameters of her chapter are then structured around the very definitions she questions.

The classicist new to the fields of ancient science and medicine will benefit from the questioning of long-standing assumptions and over-simplifications in many of the chapters—for example, that Greek science simply emerged from and continued Near Eastern work. The following, from Zhmud's chapter on mathematics, might stand as a programmatic statement on how to deal with transmission of ideas across space and the problem of parallel evolution of scientific ideas: "Real or assumed isomorphism between two mathematical theories, formulas, or methods often gives rise to common-origin hypotheses, but only the theories placed in a specific historical setting with identifiable ways of transmission survive the tests" [184]. Another assumption—that the canons of authors and authorities passed down to us are historical—is also widely tackled. For example, Scarborough reminds us that Dioscorides enjoys a higher reputation than does Scribonius Largus thanks to Galen; and Galen himself dominates discussions of Roman-era medicine simply because he wrote so much (and so much survives).

There are a few typographical errors: p. 89, “patters” for “patterns”; p. 120, “(Needham and Wang 1959)” for “Needham and Wang (1959)”; p. 152, *testmonia* for *testimonia*; p. 391, “though” for “through”; p. 466, “Xenophon” for “Xenophon’s”; p. 615, “Laërtius, Major scholars” for “Laërtius. Major scholars”. There are some proofing errors too: p. 322, “Aethiopia ~~E~~thiopia”; p. 486, “have attempted harmonize”; p. 629, “Furley1999”; p. 682, “Craftsmancraftsman”; p. 822: “Ptolemy’s regarded his theories”; p. 937 “(see”. (a reference has dropped out); p. 945, “soma” should be italicized; p. 951, “he would also commented”. Clagett 2000 (cited on p. 54) and Schürmann 1991 (cited on p. 340) are not included in the relevant bibliographies. But these errors are few in a book of over 1,000 pages, and the overall production quality is high. The editors are to be commended that all Greek text presented in the volume has been transliterated, and all Greek and Latin text is translated.

There is a wealth of information in this volume, much more than I anticipated. It comes at a literal cost: the list price for the volume is \$175, which is steep for a graduate student or the classicist looking for an introduction to science and medicine (though far less than Irby-Massie’s *Companion*). But should they take the plunge: this is a fascinating and absorbing volume that will expose them to aspects of the ancient world still too little considered by many in the field.

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