A COMPANION TO

SCIENCE, TECHNOLOGY, AND MEDICINE IN ANCIENT GREECE AND ROME

VOLUME I

EDITED BY

GEORGIA L. IRBY
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Volume I

Edited by
Georgia L. Irby

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Contributor Biographies

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**Hariclia Brecoulaki** is an archaeologist and holds a research position at the Institute of Historical Research, Department of Greek and Roman Antiquity (The National Hellenic Research Foundation). Her work mainly focuses on Greek painting from the Late Bronze Age to the Roman period, with a particular interest in the technological aspects of ancient polychromy. Her publications include the books *L’esperienza del colore nella pittura funeraria dell’Italia preromana V-III secolo a.C.* (Electa: Naples, 2001), *La peinture funéraire de Macédoine. Emplois et fonctions de la couleur, IV-IIème s. av. J.-C.* (The Institute of Historical Research: Athens, 2006) and *Mycenaean Painting in Context. New Discoveries, Old Finds Reconsidered* (co-editors J.L. Davis and S.R. Stocker) (The Institute of Historical Research: Athens, 2015).

**Sonja Brentjes** holds a doctorate in the history of mathematics from Karl Marx University in Leipzig. Her research interests include history of science (mathematics, mapmaking, institutions) in Islamicate societies; cross-cultural exchange of knowledge; portolan charts; early modern travel accounts about the Ottomans and Safavids; and narrative of science in Islamicate societies. She is now a researcher at the Max Planck Institute for the History of Science in Berlin.

**Lauren Caldwell** is Associate Professor of Classical Studies at Wesleyan University. Her research is in Roman history, Greco-Roman medicine, and Roman law. Her
book, *Roman Girlhood and the Fashioning of Femininity* (Cambridge 2014), investigates Roman medical perspectives on women’s health, particularly female adolescent health, and examines how medical perspectives were both influenced and shaped by social values.

**Gordon Campbell** is a lecturer in Ancient Classics at the National University of Ireland, Maynooth. He works on ancient philosophical poetry, anthropology, cosmology, and in particular on Lucretius and Empedocles.

**Paul T. Craddock** graduated in Chemistry from the University of Birmingham in 1966 and joined the British Museum Research Laboratory, where he remained for his whole career, currently in an emeritus role. While there he obtained further qualifications in prehistoric archaeology and metallurgy, obtaining his PhD from the Institute of Archaeology in 1975 on classical bronze alloys. Most of his work has been concerned with metals through all stages of their production, from mining and smelting the ores, as exemplified by Rio Tinto, through to their final embellishment, as exemplified by studies on Corinthian bronze. He is currently working on a monograph investigating the technology of large hollow lost wax castings in Egyptian and classical antiquity.

**Robert I. Curtis** is Professor Emeritus of Classics in the Department of Classics, University of Georgia. His primary research interests include food technology, Roman social and economic history, and Pompeii and Herculaneum.

**Raffaele D’Amato** is a Turin-based expert of the ancient and medieval military world. After achieving his first PhD in Romano-Byzantine law, he earned a second doctorate in Roman military archaeology. He is currently a visiting professor at the Fatih University of Istanbul, working for the Turkish government on a project upon the arms and armour of Byzantium in Turkey.

**Jean De Groot** is Associate Professor in the School of Philosophy at The Catholic University of America, where she teaches ancient science and philosophy, as well as twentieth-century philosophy and philosophy of science. Her present interests focus on the history of mechanics, particularly in pre-Classical and Classical antiquity. She is also interested in the materiality of scientific culture in western Magna Graecia. She has written articles and book chapters on Aristotle’s natural philosophy and on Eudoxan proportion theory in astronomy and mechanics. Her books include *Aristotle’s Empiricism: Experience and Mechanics in the Fourth Century BC* (Parmenides, 2014) and *Aristotle and Philoponus on Light* (1991, reprint by Routledge, Summer 2015).

**Nathalie de Haan** is Assistant Professor of Ancient History at Radboud University Nijmegen in the Netherlands. Her research focuses on Roman baths and bathing culture, Pompeii, Roman housing, and reception studies. She is the author of *Römische Privatbäder. Entwicklung, Verbreitung, Struktur und sozialer Status* (Peter Lang Verlag, 2010).

**John F. Donahue** is Professor in the Department of Classical Studies, College of William and Mary in Williamsburg, VA (USA). His works include *The Roman Community at Table during the Principate* (2004) and *Food and Drink in Antiquity: A Sourcebook of Readings from the Greco-Roman World* (2015), as well as various articles and reviews on ancient health and diet, Latin epigraphy, and Roman history.
Thorsten Fögen is Reader (Associate Professor) at Durham University (UK) and “Privatdozent” at Humboldt University of Berlin. He is the author of “Patrii sermonis egestas”: Einstellungen lateinischer Autoren zu ihrer Muttersprache (Munich & Leipzig 2000) and of Wissen, Kommunikation und Selbstdarstellung: Zur Struktur und Charakteristik römischer Fachtexte der frühen Kaiserzeit (Munich 2009). He has edited seven volumes, most recently Tears in the Graeco-Roman World (Berlin & New York 2009) and Bodies and Boundaries in Graeco-Roman Antiquity (Berlin & New York 2009).

Rafael Frankel began studying at Tel Aviv University 1969. He has taught at Tel Aviv and Haifa Universities and various colleges and has participated in excavations at Tel Bet Yerah (Khirbet Kerak), Tel Be’er Sheva, and Aphek- Antipatris. He has excavated a Persian period temple at Mount Mizpe Yammim and several oil and wine presses and aqueducts, and he has directed archaeological surveys of Western and Upper Galilee. His main fields of research are archaeology and history of Western and Upper Galilee and of wine, oil, and bread.

Laura Gawlinski is Associate Professor of Classical Studies at Loyola University Chicago. She is the author of The Sacred Law of Andania: A New Text with Commentary (de Gruyter, 2012), and her research generally focuses on combining epigraphy and archaeology to investigate how ancient Greek religion was practiced. She is active in fieldwork and has been associated with the excavations of the Athenian Agora since 1995.

Sophie Gibson is an independent scholar. She received her DPhil in Classics from Oxford University in 2002, and is the author of Aristoxenus of Tarentum and the Birth of Musicology (Routledge 2005). A holder of degrees also in law and music, she lives in Oxford.

Daniel W. Graham is A. O. Smoot Professor of Philosophy at Brigham Young University. He does research on history of philosophy and history of science, and has written, translated, or edited eight books on ancient philosophy and science. He has also published numerous scholarly articles on Aristotle, Plato, Socrates, and the Presocratic philosophers. He is president of the International Association for Presocratic Studies and a member of the editorial board of Apeiron. He has taught at Grinnell College and Rice University and been a visiting fellow at Clare Hall, Cambridge, and a visiting professor of philosophy at Yale University. He has been awarded two NEH fellowships.

Andrew D. Gregory is Professor of the History and Philosophy of Science in the Department of Science and Technology Studies at University College London. He has published widely on science in the ancient world, with books including Plato’s Philosophy of Science, Ancient Greek Cosmogony, and The Presocratics and the Supernatural.

Klaus Grewe trained as a surveyor and has worked as a surveying engineer. He is Associate Professor at RWTH Aachen University. He has worked extensively in the field and has published broadly on Roman infrastructure (especially in Cologne, Algeria, and Tunisia). In 1988, he was awarded the Frontinus-Medaille by the Frontinus Society.

Robert Hannah is Dean of Arts & Social Sciences at the University of Waikato, New Zealand. Before that he was a member of the Department of Classics at the University of Otago. He is a Fellow of the Society of Antiquaries of London, and a
Fellow of the Royal Society of New Zealand. He has written extensively on the use of astronomy in Greek and Roman cultures. His recent publications include the books *Greek and Roman Calendars: Constructions of Time in the Classical World* (London, 2005), and *Time in Antiquity* (London, 2009). His current interests are in calendars, the measurement and perception of time, and star-based navigation.

**Ellen Harlizius-Klück** is Marie Curie Research Fellow of the Gerda-Henkel Foundation at the Danish National Foundation’s Centre for Textile Research. She was Guest Professor in Textile Studies at the University of Osnabrück and Scholar in Residence at the Deutsches Museum in Munich. In her PhD thesis, she combined mathematics, philosophy, and textile studies and since then focuses on the question of how ancient textile technology has contributed to the advent of mathematics and sciences in ancient Greece. She studied fine arts, mathematics, and philosophy and has explored and experienced warp-weighted loom technology in several exhibitions in Germany (Penelope rekonstruiert, Munich; Gesponnen und Verwoben, Bramsche).

**Devin Henry** is Associate Professor of Philosophy at the University of Western Ontario. He received his PhD from King’s College London, where he wrote a dissertation on the metaphysical foundations of Aristotle’s theory of biological generation. He is the author of several articles on topics in Aristotle’s philosophy of science (including classification, teleology, inheritance, and sexism) as well as Plato’s late epistemology. His work has appeared in *Oxford Studies in Ancient Philosophy*, *The Monist*, *Phronesis*, *The Journal of the History of Biology*, as well as part of various collected volumes.

**Georgia L. Irby** is Associate Professor in the Department of Classical Studies at the College of William and Mary. She studied Mathematics and Latin at the University of Georgia, Athens, and she holds a PhD in Classical Philology from the University of Colorado at Boulder. She is the author of several articles on cartography in the ancient world, the interstices of science and culture, Greco-Roman medicine, astrology, and Greek pedagogy. Her books include *Encyclopedia of Ancient Natural Scientists: The Greek Tradition and Its Many Heirs* (with Paul T. Keyser; London, 2008); *Greek Science of the Hellenistic Era: A Sourcebook* (with Paul T. Keyser; London, 2002); and *A New Latin Primer* (with Mary C. English; Oxford, 2015).

**M. Eleanor Irwin** was a member of the Department of Humanities at the University of Toronto Scarborough until her retirement in 2001. She is presently a Dean’s Designate for academic integrity at UTSC. In addition to publications on color terms and plants in Classical literature, she has contributed articles on Classical scholars, most recently on Kathleen Freeman. She is working on the problem of identifying plants in a pre-Linnaean world while gaining practical knowledge by gardening in Haliburton, Ontario.

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**Kenneth F. Kitchell Jr.** is Professor Emeritus of Classics from Louisiana State University and University of Massachusetts Amherst. He has published on animals and animal lore from Minoan to Medieval times, most recently in *Animals in the Ancient World from A-Z*. 2014. London: Routledge.
Contributor Biographies

Jason König is Professor of Greek at the University of St Andrews. He works broadly on the Greek literature and culture of the Roman Empire. He is author of Athletics and Literature in the Roman Empire (2005) and Saints and Symposiasts: The Literature of Food and the Symposium in Greco-Roman and Early Christian Culture (2012), and editor, with Jeff Rusten, of Philostratus’ Heroicus and Gymnasticus in the Loeb Classical Library series (2014).

Anna Lagia is an independent anthropologist who has worked on human skeletal collections from diverse periods and sites in Greece on questions concerning mortuary practices, health and dietary conditions, socio-economic inequalities, and the expression of disease on the human skeleton.

Frédéric Le Blay is Associate Professor in the Department of Classics at the University of Nantes (France). He is a specialist of ancient medicine and meteorology. His research focuses on the relationship between sciences and philosophy in the classical world and the heritage of ancient sciences in modern and contemporary Europe. In 2009, he was the editor of Transmettre les savoirs dans les mondes hellénistique et romain, Collection Histoire, Presses Universitaires de Rennes, a collection of papers dealing with ancient sciences and philosophy.

Sarah Lepinski holds a PhD in Classical and Near Eastern Archaeology from Bryn Mawr College. She specializes in ancient and medieval surface decoration, and her research interests encompass ancient materials, artistic practices and processes, the historiography of ancient art, and cultural heritage conservation and preservation. Her publications include the edited volume Beyond Iconography: Methods, Materials and Meaning in Ancient Surface Decoration (Archaeological Institute of America/Kress Foundation, 2015).

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Efthymia Nikita is a postdoctoral researcher at the Fitch Laboratory (British School at Athens). Her work approaches diverse archaeological questions by means of a broad range of osteological methods, while she has also published papers re-evaluating the traditional statistical and osteological methods employed in bioarchaeology.

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Georgia Petridou is a research associate in the ERC-funded research project “Lived Ancient Religion” at the Max-Weber Kolleg (University of Erfurt) and works on Greek literature and epigraphy history of Greek and Roman religion and cultural history of Greco-Roman medicine. She is the author of Divine Epiphany in Greek Literature and Culture (2015, Oxford University Press) and co-editor (with Chiara Thumiger) of Homo Patiens-Approaches to the Patient in the Ancient World (2015, Brill).

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Abbreviations

AA: Archäologischer Anzeiger
ABSA: Annual of the British School at Athens
ABull: The Art Bulletin
AEA: Archivo Español de Arqueología
AGPh: Archiv für Geschichte der Philosophie
AHES: Archive for History of Exact Sciences
AIHS: Archives internationales d’histoire des sciences
AJA: American Journal of Archaeology
AJPh: American Journal of Philology
AncSoc: Ancient Society
AntCl: L’Antiquité classique
AS: Anatolian Studies
AW: Antike Welt
BABesch: Bulletin Antieke Beschaving
BAR: British Archaeological Reports
BAR-IS: British Archaeological Reports–International Series
BASP: Bulletin of the American Society of Papyrologists
BCH: Bulletin de correspondance hellénique
BCTH: Bulletin archéologique du Comité des travaux historique
BHM: Bulletin of the History of Medicine
BICS: Bulletin of the Institute of Classical Studies of the University of London
BJ: Bonner Jahrbücher des Rheinischen Landesmuseums in Bonn und des Vereins von Altertumsfreundem im Rheinlande
<table>
<thead>
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<th>Abbreviation</th>
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<tbody>
<tr>
<td>CCAG:</td>
<td>Catalogus Codicum Astrologorum Graecorum</td>
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<tr>
<td>CIL:</td>
<td>Corpus inscriptionum Latinarum. Berlin 1862–</td>
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<td>CJ:</td>
<td>The Classical Journal</td>
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<tr>
<td>CMG:</td>
<td>Corpus Medicorum Graecorum Berlin: Akademie-Verlag, 1908–</td>
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<tr>
<td>CP:</td>
<td>Theophrastus, De Causis Plantarum (On the Causes of Plants)</td>
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<tr>
<td>CPPh:</td>
<td>Classical Philology</td>
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<tr>
<td>CQ:</td>
<td>Classical Quarterly</td>
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<tr>
<td>CRAI:</td>
<td>Comptes rendus de l’Académie des inscriptions et belles-lettres</td>
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<tr>
<td>CW:</td>
<td>The Classical World</td>
</tr>
<tr>
<td>DHA:</td>
<td>Dialogues d’histoire ancienne</td>
</tr>
<tr>
<td>EMC:</td>
<td>Échos du monde classique</td>
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<tr>
<td>G&amp;R:</td>
<td>Greece and Rome</td>
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<tr>
<td>GA:</td>
<td>Aristotle, On the Generation of Animals</td>
</tr>
<tr>
<td>GC:</td>
<td>Aristotle, On Generation and Corruption</td>
</tr>
<tr>
<td>GeogrAnt:</td>
<td>Geographia Antiqua</td>
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<tr>
<td>GRBS:</td>
<td>Greek, Roman, and Byzantine Studies</td>
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<tr>
<td>HA:</td>
<td>Aristotle, De Historia Animalium (On the Enquiry into Animals)</td>
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<tr>
<td>HP:</td>
<td>Theophrastus, De Historia Plantarum (On the Enquiry into Plants)</td>
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<td>HR:</td>
<td>History of Religions</td>
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<td>HSPh:</td>
<td>Harvard Studies in Classical Philology</td>
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<tr>
<td>IEF:</td>
<td>Israel Exploration Journal</td>
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<tr>
<td>IG:</td>
<td>Inscriptiones Graecae, 3rd ed. 1981–. Berlin</td>
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<tr>
<td>IGUR:</td>
<td>Moretti, L., ed. 1968–. Inscriptiones Graecae Urbis Romae. Rome</td>
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<tr>
<td>IFNA:</td>
<td>International Journal of Nautical Archaeology</td>
</tr>
<tr>
<td>IFPP:</td>
<td>International Journal of Paleopathology</td>
</tr>
<tr>
<td>JAS:</td>
<td>Journal of the Royal Asiatic Society of Great Britain and Ireland</td>
</tr>
<tr>
<td>JDAI:</td>
<td>Jahrbuch des Deutschen Archäologischen Instituts</td>
</tr>
<tr>
<td>JESHO:</td>
<td>Journal of the Economic and Social History of the Orient</td>
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<tr>
<td>JGS:</td>
<td>Journal of Glass Studies</td>
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<tr>
<td>JHB:</td>
<td>Journal of the History of Biology</td>
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<td>JHS:</td>
<td>Journal of Hellenic Studies</td>
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<tr>
<td>JMA:</td>
<td>Journal of Mediterranean Archaeology</td>
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<tr>
<td>JNES:</td>
<td>Journal of Near Eastern Studies</td>
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<tr>
<td>JRA:</td>
<td>Journal of Roman Archaeology</td>
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<tr>
<td>JRS:</td>
<td>Journal of Roman Studies</td>
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<tr>
<td>JSAH:</td>
<td>Journal of the Society of Architectural Historians</td>
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<tr>
<td>Kf:</td>
<td>Kölner Jahrbuch</td>
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Abbreviations

MDAI(A): Mitteilungen des Deutschen Archäologischen Instituts
MEFRA: Mélanges d’Archéologie et d’Histoire de l’école Française de Rome, Antiquité
MNIR: Mededelingen van het Nederlandsch historisch Instituut te Rome
NH:  Pliny the Elder, Naturalis Historia (Natural History)
NQ:  Seneca the Younger, Naturales Quaestiones (Natural Questions)
OGIS: Orientis Gracci Inscriptiones Selectae. 1903–1905. Leipzig: Hildesheim
OJA:  Oxford Journal of Archaeology
ORom: Opuscula Romana
OSAPh: Oxford Studies in Ancient Philosophy
PA:  Aristotle, On the Parts of Animals
PAA: Praktika tes Akadémias Athenon
PAS: Proceedings of the Aristotelian Society
PBSR: Papers of the British School at Rome
PCPhS: Proceedings of the Cambridge Philological Society
PhR: Philosophical Review
POxy: The Oxyrhynchus Papyri. 1898–. London: Egypt Exploration Fund
RA: Revue archéologique
RBPh: Revue belge de philologie et d’histoire
RCCM: Rivista di cultura classica e medioevale
REA: Revue des études anciennes
REL: Revue des études latines
RUSCH: Rutgers University Studies in Classical Humanities
SHPS: Studies in History and Philosophy of Science
SMEA: Studi micenei ed egeo-anatolici
SMSR: Studi e materiali di storia delle religioni
TAPhA: Transactions and Proceedings of the American Philological Association
TAPhS: Transactions of the American Philosophical Society
VT: Vetus Testamentum
YCS: Yale Classical Studies
ZPE: Zeitschrift für Papyrologie und Epigraphik
ZWG: Sudhoff’s Archiv: Zeitschrift für Wissenschaftsgeschichte
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Introduction

Georgia L. Irby

1. “Science” in Antiquity

From Thales onward, Greek intellectuals sought to understand the world around them, and from this tradition we derive two very important scientific terms: *physics*, a Greek term for “the nature of things”; and *science*, the Latin word for “knowledge.” Science, as the ancients envisioned it, can hardly be separated from other intellectual pursuits, including technology (broadly, the application of scientific principles) and medicine (drawing on mathematical and natural sciences, technology, as well as religion and magic, often nearly indistinguishable). Spheres of knowledge in antiquity were understood as having more fluid boundaries. Thus seeking or imposing modern disciplinary compartmentalization on ancient initiatives does violence to the ancient thinkers and trivializes their accomplishments. “Science” in the ancient world, moreover, never lost its sense of wonder nor its intimate connection with ethics and the divine: even in the Aristotelian corpus (among the most “scientific” collections in the ancient world) matters of theology are considered (Barnes 1995, 67, 106; cf. *Nature and the Divine*). “Scientist,” furthermore, was not a recognized profession until the nineteenth century, and natural philosophers in the ancient world followed many paradigms: after the death of Alexander the Great (323 BCE), royal patronage enabled talented minds to pursue “science” full time (especially at Alexandria, whose Museum and Library attracted scholars from across the Greek-speaking world into the fifth century CE), but Pliny the Elder was a Roman statesman of broad learning and curiosity, like the nineteenth-century gentleman scholar. The notion of academic specialization, furthermore, would have been anathema to the ancients. For example, in addition to four-element theory to explain *phasis* (nature), Empedocles proposed hypotheses on optics, evolution, and theology; Democritus’ interests included mathematics, music, and ethics, as well as physics (atomic theory).

Scientific traditions cannot be separated from the culture which produced and employed them—any more than trends in literature or religion. And the methods and principles of Greek science were forged by the agonistic nature of Greek society, which
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prejudiced Greek investigations into the natural world and shaped the interrelationships between teacher and student as well as between competing schools. Greek science was an exercise in debate and persuasion. Given the state of the instrumentation, many scientific hypotheses were unprovable; thus, scholars aimed to persuade their audiences of the truth of a given theory. The Greeks also valued autonomy, and their philosophical schools were not so much “schools” in the modern sense as groups of like-minded thinkers. Many thinkers were autodidacts, and even those who studied under famous teachers were not altogether content to follow the direction of their predecessors, often carving out their own paths, citing predecessors’ views or ignoring them—whichever proved more convenient. This attitude, of course, varied from one author to another: Pliny the Elder, although more polemical than Vitruvius, nonetheless still relied largely on his predecessors (see Fögen 2009).

The methods of Greek science were largely theoretical owing to the limitations of equipment and technology. Experimentation was not a virtue, and this attitude reflects the contention between “art” and “skill” (or “doing”—the prejudice was against those who worked with their hands, such as the dirty, sweaty craftsmen; Galen tackled the question of whether medicine is an art or a skill, and he also argued that the best physicians were likewise philosophers). In the context of natural philosophy, Aristotle recognized and recommended empirical data and observation, long valued by medical practitioners and theorists (Mithridates’ notorious immunity to all known poisons and venoms was the result of a long program of research and development of antidotes by the toxicologists in his service combined with empirical trials on death-row prisoners). But theory almost always held sway, even in the light of empirical evidence (e.g., the rejection of Eratosthenes’ remarkably accurate estimate of the earth’s circumference, and the enduring theory of geocentrism: Astronomy, Geography).

Although most ancient Mediterranean science, technology, and medicine stems from the Greek intellectual praxis, the Romans fostered and advanced these conventions (Roman Responses to Greek Science and Scholarship as a Cultural and Political Phenomenon, Scientific Encyclopedias). Scholars living under the hegemony of the Roman Empire preserved and synthesized much of the Greek accomplishment in Latin (e.g., Pliny the Elder) and Greek (e.g., Athenaeus), new advances continued to be made on both sides of the Ionian Sea, and the Greco-Roman achievement was preserved and enhanced by later traditions (Translation and Transmission of Ancient Scientific Texts, The Reception of Greco-Roman Science in the Renaissance: Assimilation(s), Transformation(s), Rejection, Hybridization).

Preservation and transmission was a long process that began with the Greeks themselves. As thinkers distilled the work of their predecessors, usually in the interest of refuting them, original texts were lost, and much survives only in fragments, paraphrase, or redaction: for example, the Presocratic Natural Philosophers, culled by Aristotle and others, neatly collected, translated, and annotated in the TEGP, and the medical thinkers (third century BCE to second century CE), plundered by Galen who effectively silenced those voices with which he disagreed. Much of the surviving corpus is a distorted and often uncontextualized selection, but a selection nonetheless that was considered worthy to be copied numerous times over the span of 2500 years (and in many cases translated into Arabic and other languages, which thus accounts for their survival). Furthermore, ancient texts remain unedited and untranslated into modern languages (consequently, the works of Galen which survive only in Arabic transmission or translation still remain