

History of Science 322/Medieval Studies 322/History of Science 622
Ancient and Medieval Science (Spring 2013)

Michael H. Shank

Writing Fellows: Lauren Bocher, Tim Scallan

Lectures: 8:50 MW in Social Science 4308 (Fridays will usually be devoted to discussion of the readings—only occasionally to lectures)

Undergrad Discussion: Fridays in Social Science 4308; bring relevant books/reader

Graduate students taking HS/MS 322 must be enrolled concurrently in HS 622 (timetable discussion on Friday at 9:55 conflicts with my other class... need to move).

Shank office hours: Tuesdays 2:00-3:30 (326 Bradley Memorial) or by appointment (262-3972; mhshank@wisc.edu)

Writing Fellow emails: lbocher@wisc.edu, tscallon@wisc.edu

The following required books were posted and are available locally ordered at Underground Textbooks and University Bookstore:

David C. Lindberg, The Beginnings of Western Science: The European Scientific Tradition in Philosophical, Religious and Institutional Context, 600 B. C. to A. D. 1450 **2nd edition** (Chicago: University of Chicago Press, 2008) [=BWS below].

Plato, Timaeus, trans. Peter Kalkavage (Newburyport, Mass.: Focus, 2001).

Michael H. Shank, ed., The Scientific Enterprise in Antiquity and the Middle Ages (Chicago: University of Chicago Press, 2000).

Richard Dales, ed., The Scientific Achievement of the Middle Ages (Philadelphia: University of Pennsylvania Press, 1973).

Additional readings--articles and excerpts marked by an asterisk* below--are distributed in photocopy at cost (the per-page cost of your home printer is more expensive). \$21 (available in History of Science Dept, 210 Bradley Memorial Building). Cash, or checks payable to "History of Science Dept."

NOTE: The reader is not refundable if you drop the course.

Grad students (622 only), and in addition to the above:

G. E. R. Lloyd, The Ambitions of Curiosity (Cambridge: Cambridge University Press, 2002).

Edward Grant, A History of Natural Philosophy from Antiquity to the Nineteenth Century (Cambridge: Cambridge University Press, 2007).

George Saliba, Islamic Science and the Making of the European Renaissance (Cambridge, Mass. and London: The MIT Press, 2007).

622 Readings (electronic packet)

Requirements

General: attendance at two lectures per week; participation in the Friday discussion; completion of the readings in timely fashion (the undergraduate reading load averages about 85 pages per week, with some weeks lighter than others). Note that a short reading is not necessarily an easy reading. For this course (and most others), you should plan on spending on average a minimum of 2 hours outside of class for every hour in class.

Undergraduates: a take-home midterm essay exam (25%), two article analyses (4 pages each; 20% total), one final synthetic essay take-home exam (30%) with an in-class short-essay exam (15%); participation in discussion (10%). Extra-credit analyses or projects by special permission and consultation.

Honors work is individualized and by special arrangement. I will entertain proposals ranging from additional reading and a literature review of a special topic to a more concrete project (an experimental replication, an observational project, the construction of an instrument, etc.). Talk to me about your interests and ideas.

Graduate students: concurrent enrolment in HS 622; attendance at lectures; participation in 622 discussions (20%); two detailed reviews (5-6 pages) of Lloyd and Saliba (20% each); oral report on one review (10%); one take-home, 8-10-page final essay (35%). The readings listed under "Grad supplement" are to be completed in time for discussion on the following Friday.

The UW-Madison is committed to creating a dynamic, diverse and welcoming learning environment for all students and has a non-discrimination policy that reflects this philosophy. Disrespectful behaviors or comments addressed towards any group or individual, regardless of race/ethnicity, gender, sexuality, religion, ability, or any other difference are unacceptable in this class.

Note, however, that I have no tolerance for plagiarism or any other form of academic dishonesty, from unattributed borrowings to the purchase or resubmission of others' papers. All submitted work for this course must start as your work, develop as your work, and be your work when submitted. You must place the phrases of others in quotation marks and credit their ideas. If you are unsure about proper citation practice, look at Wayne Booth *et al.*, *The Craft of Research* (Chicago, 1995) or the latest edition of the *Chicago Manual of Style*. If questions remain, contact me (in person, by phone, or by email). When I have found academic dishonesty, I have sought the harshest sanctions available, including expulsion of the guilty from the university without a degree.

Course Schedule

Week 1: Where to begin?

W 1/23: Introduction to the course; "Science" in Antiquity as Problem and Hot Topic

F 1/25: Egypt and Mesopotamia (maybe some discussion, esp. Pingree and Bernal?).

From readings in first 7-8 weeks, choose the paper/chapter to analyze for Analytical Paper #1 (see end of syllabus for instructions).

Lindberg, Beginnings, ch. 1; *M. Clagett, "Science in Egypt and Mesopotamia," in Greek Science in Antiquity (Macmillan, 1955), pp. 3-20; O. Neugebauer, "The Study of Wretched Subjects;" D. Pingree, "Hellenophilia and the History of Science," and Martin Bernal, "Animadversions on the Origins of Ancient Science,"--all in Shank, Scientific Enterprise, pp. 21, 30-39, 72-83.

Grad supplement: *Jack Goody and Ian Watt, "The Consequences of Literacy," in Goody, ed., Literacy in Traditional Societies, pp. 27-68; Shank, "Introduction," and H. von Staden, "Affinities and Elisions: Helen and Hellenocentrism" in Shank, Scientific Enterprise, pp. 1-19, 54-71.

Week 2: Presocratics: Thales to Parmenides; Plato

M 1/28 : The Milesian natural philosophers and the Pythagoreans

W 1/30: The challenge of Parmenides; Plato. **Analytical paper #1 due in class**

F 2/1: Discussion: Excerpts from Ionians and Parmenides/Plato's Timaeus

Lindberg, BWS, ch. 2; *Thales, Anaximander, Anaximenes, Parmenides from K. Freeman, Ancilla to the Presocratic Philosophers (Harvard UP, 1957), 18-19, 41-46; *B. Farrington, "The Character of Early Greek Science," from Farrington, Head and Hand in Ancient Greece (London: Watts, 1947) *Jean-Pierre Vernant, "The New Image of the World," The Origins of Greek Thought (Ithaca: Cornell UP, 1968); Plato, Timaeus [read #17-#46 middle]=pp. 47-77; skim 52D-57D, 90A-92C, pp. 84-90, 125-130 in Focus edition of the Kalkavage translation.

Grad supplement: Grant, ch. 1; *A. A. Long, "The Principles of Parmenides's Cosmology," *G. Vlastos, "Theology and Philosophy in Early Greek Thought," in Furley and Allen, eds., Studies in Presocratic Philosophy, vol. 1. (New York: Humanities Press, 1970), pp. 92-129.

Week 3: Aristotle

M 2/4: Aristotle: Logic, Method, and Biology

W 2/6: Aristotle: Solving the Problem of Change

F 2/8 Discussion: Aristotle readings and Horowitz article

Lindberg, BWS, ch. 3; *Marjorie Grene, "On Interpreting Aristotle," A Portrait of Aristotle (Chicago); *Aristotle, Physics, book I (trans. Apostle); *excerpts from Parts of Animals, History of Animals in Cohen and Drabkin, eds., Source Book in Greek Science (Cambridge: Harvard UP, 1948); *Maryann C. Horowitz, "Aristotle and Woman," Journal of the History of Biology 9 (1976) 183-213.

Grad supplement: Grant, ch. 2; *W. D. Ross, "The Development of Aristotle's Thought," in

Barnes, Schofield, Sorabji, eds., Articles on Aristotle: Science (London: Duckworth, 1975), pp. 1-13.

Week 4: Greek Mathematics and Proof

M 2/11: Arithmetic: Pythagorean ratios/irrational numbers

W 2/13: Geometry: Formal systems: Euclid to Apollonius

F 2/15: Substitute meeting and/or discussion: Mathematics readings

Lindberg, BWS, ch. 4-5; *"Incommensurables," and *"Proclus on the origins of geometry," from Cohen and Drabkin, eds., Source Book in Greek Science (Cambridge: Harvard UP, 1948), pp. 13-14, 33-38; *Euclid, Elements, definitions, postulates, common notions, Book 1, proposition 1.

Grad supplement: *W. Knorr, "Infinity and Continuity: The Interaction of Mathematics and Philosophy in Antiquity," in Kretzmann, ed., Infinity and Continuity in Ancient and Medieval Thought (Ithaca: Cornell UP, 1982).

Recommended: G. E. R. Lloyd, Magic, Reason, and Experience, ch. 2.

Week 5: Greek Astronomy and Cosmology

M 2/18: Athens: Plato, Eudoxus, Aristotle

W 2/20: Alexandria (Egypt): From Eratosthenes to Ptolemy. **Revised analytical paper #1 due in class.**

F 2/22: Discussion: Aristotle and Ptolemy selections. **Hand out mid-term essay questions**

Review Lindberg, BWS, ch. 5; *Aristotle, excerpts from On the Heavens (De caelo) and Physics, from Cohen and Drabkin, eds., A Source Book in Greek Science (Cambridge, Mass.: Harvard University Press, 1974), pp. 200-209; *Ptolemy, Almagest, Book I, pp. 1-9 (trans. G. J. Toomer); B. Goldstein and A. Bowen, "A New View of Early Greek Astronomy," in Shank, Scientific Enterprise, pp. 85-95.

Grad supplement: Grant, ch. 3; A. Jones, "The Adaptation of Babylonian Methods in Greek Numerical Astronomy," in Shank, Scientific Enterprise, pp. 97-109; *D. Furley, "The Cosmological Crisis in Classical Antiquity," from his Cosmic Problems: Essay on Greek and Roman Philosophy of Nature (Cambridge: Cambridge UP, 1989) pp. 223-35.

Week 6: Greek Medicine and Biology

M 2/25: The Hippocratic corpus

W 2/27: Alexandrian and Galenic medicine

F 3/1: Discussion: esp. "Sacred Disease," and Galen, "On sects."

Lindberg, BWS, ch. 6; *[Pseudo-Hippocrates], "The Sacred Disease;" *Galen, "On the sects: for beginners" (trans. Walzer and Frede); O. Temkin, "Greek Medicine as Science and Craft," in Shank, Scientific Enterprise, pp. 111-123.

Grad supplement: *G. E. R. Lloyd, "The Criticism of Magic and the Inquiry Concerning Nature," ch. 1 in his Magic, Reason and Experience, (Cambridge UP, 1979), pp. 10-58. **Review of Lloyd, Ambitions of Curiosity due.**

Week 7: Antiquity: Concluding Issues

M 3/4: The Roman Predicament: Greek Science in Decline?

W 3/6: Augustine/The Commentator Tradition. **Draft of mid-term essay due in class.**

F 3/8: Discussion of Philoponus and Lindberg.

Lindberg, BWS, ch. 7; *Philoponus excerpts in Cohen and Drabkin, eds., A Source Book in Greek Science (Harvard UP); D. Lindberg, "Science and the Early Church," in Shank, Scientific Enterprise, pp. 125-146; Shank and Lindberg, "Introduction," from Lindberg and Shank, ed., The Cambridge History of Science, vol. 2 (Cambridge: University Press, 2011)—to be emailed.

Grad suppl.: *Augustine, On Christian Doctrine, bk II, ch. 19-42 (trans. Robertson), pp. 55-78.

Week 8: The Emergence of Arabic Science

M 3/11: Arabic translation and appropriation of Greek science.

W 3/13: Appropriation of Greek Learning: Contexts and Effects

F 3/15: Discussion: Science in Arabic society (esp. Sabra, "Appropriation" article)

Lindberg, BWS, ch. 8; *A. I. Sabra, "The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam: A Preliminary Statement," History of Science 25 (1987) 223-243; *A. I. Sabra, "The Scientific Enterprise," in Bernard Lewis, ed., The World of Islam (Thames and Hudson); A. I. Sabra, "Situating Arabic Science: Locality versus Essence," in Shank, Scientific Enterprise, pp. 215-31.

Grads: Grant, ch. 4. **Start reading Saliba**

Week 9: Arabic Science

M 3/18: Medicine (around Avicenna)

W 3/20: The Mathematical Sciences in Islam: Optics and astronomy

F 3/22: Discussion of readings, esp. Musallam.

*Avicenna, excerpts from Canon in Grant, ed., A Source Book in Medieval Science, pp. 715-20; *excerpts from Alhacen, Avicenna and Averroes, from S. Sambursky, ed., Physical Thought from the Presocratics to the Quantum Physicists: An Anthology (London: Hutchinson, 1974); *Basim Musallam, Sex and Society in Islam: Birth Control Before the Nineteenth Century (Cambridge/New York: Cambridge UP, 1983), ch. 1 and 3: Why Islam Permitted Contraception; Conception Theory in Muslim Thought, pp. 10-27, 39-59.

Grad supplement: *G. Makdisi, "Madrasa and University in the Middle Ages," Studia Islamica 32 (1970) 255-264; V. Roberts, "The Solar and Lunar Theory of Ibn ash-Shatir: A Precopernican Copernican Model" in Shank, Scientific Enterprise, pp. 233-37. **Review of Saliba due**

Spring Break 3/23-3/31

Week 10: Early Latin Europe

M 4/1: Agriculture & Medieval Technology: The Lynn White thesis. **Revised mid-term essay due in class?**

W 4/3: Intellectual Struggles

F 4/5: Discussion: The Lynn White thesis

*L. White, "The Agricultural Revolution of the Early Middle Ages," from his Medieval Technology and Social Change (Oxford UP, 1958); *R. H. Hilton and P. H. Sawyer, "Technical Determinism: The Stirrup and the Plough," Past and Present 24 (1963) 90-100; *Alex Roland, "Once More into the Stirrups: Lynn White, Jr., Medieval Technology and Social Change," Technology and Culture 44 (2003) pp. 574-585; S. McCluskey, "Gregory of Tours, Monastic Timekeeping and Early Christian Attitudes to Astronomy," in Shank, Scientific Enterprise, pp. 147-61.

Grad supplement: Grant, ch. 5; Selections from *Isidore of Seville's Etymologiae, in Grant, Source Book in Medieval Science (Cambridge: Harvard UP, 1974); Linda Voigts, "Anglo-Saxon Plant Remedies and the Anglo Saxons," in Shank, Scientific Enterprise, pp. 163-181.

Week 11: The twelfth-century revival

M 4/8: The New Naturalism

W 4/10: From translation to the emerging universities

F 4/12: Discussion: Dales selections/Sweet

Lindberg, BWS, ch. 9; Dales, "The Twelfth Century," pp. 37-60; *Victoria Sweet, "Hildegard of Bingen and the Greening of Medieval Medicine," Bulletin of the History of Medicine 73 (1999) 381-403; *C. Burnett, "Scientific Speculations," from Peter Dronke, ed., A History of Twelfth-Century Philosophy (Cambridge: Cambridge UP, 1988), pp. 151-76.

Grad supplement: Grant, ch. 6; *M. D. Chenu, "Nature and Man: The Renaissance of the Twelfth Century" from his Nature, Man and Society in the Twelfth Century (Chicago: University of Chicago Press), pp. 1-48, and review reports.

Week 12: The Universities Respond

M 4/15: Oxford University and Robert Grosseteste

W 4/17: Natural Philosophy and Theology at Paris

F 4/19: Grosseteste (Dales)/Condemnations/Lindberg's "Handmaiden" article

Lindberg, BWS, ch. 10; Dales, "Grosseteste and Scientific Method," "The Tides," pp. 61-80; Lindberg, "Science as Handmaiden: Roger Bacon and the Patristic Tradition," in Shank, Scientific Enterprise, pp. 295-313; *Condemnations of 1277, in Grant, ed., Source Book in Medieval Science (Harvard); *Grant, "The Condemnation of 1277, God's Absolute Power, and Physical Thought in the Late Middle Ages," Viator 10 (1979) 211-243.

Grad supplement: *Edward Grant, "Science and the Medieval University," in Kittelson and Pamela Transue, eds., Rebirth, Reform and Resilience: Universities in Transition,

1300-1700 (Columbus: Ohio State University Press); *Shank, "A Female Student in Late Medieval Krakow," Signs 14 (1989) 373-80.

Week 13: Late Medieval Latin Natural Philosophy

M 4/22: Optics/Perspectiva

W 4/24: The Science of Motion

F 4/26: Discussion of Dales selections and Cadden

Begin Lindberg, BWS, ch. 12; Dales, "Studies of the Rainbow" and "Studies of Local Motion," pp. 81-124; M. McVaugh, "Arnald of Villanova and Bradwardine's Law," in Shank, Scientific Enterprise, pp. 363-71; *Joan Cadden, "Nothing Natural is Shameful": Vestiges of a Debate about Sex and Science in a Group of Late-Medieval Manuscripts," Speculum 76 (2001), p. 66-89.

Grad supplement: Grant, ch. 7-8; **NOT in reader:** Murdoch and Sylla, "The Science of Motion," in D. Lindberg, ed., Science in the Middle Ages (book in Hist. Sci. Dept library and other libraries; hold the book in your hands and leaf through it).

Week 14: Specialized Sciences in the Later Latin Middle Ages

M 4/29: Medicine and Life Sciences

W 5/1: Astronomy, Astrology, and Cosmology

F 5/3: Discussion: Selections in Dales; Green, Lemay

Finish Lindberg, BWS, ch. 11, 13; Dales, "Astronomy," pp. 125-138; *Monica Green, "Women's Medical Practice and Health Care in Medieval Europe," Signs 14 (1989) 39-78; Helen Lemay, "The Stars and Human Sexuality: Some Medieval Scientific Views," Nancy Siraisi, "Taddeo Alderotti and Bartolomeo da Varignana on the Nature of Medical Learning," and Thorndike, "The True Place of Astrology in the History of Science," in Shank, Scientific Enterprise, pp. 239-255, 349-61.

Grad supplement: Grant, ch. 9; B. Goldstein, "Theory and Observation in Medieval Astronomy;" and Pamela Long, "Power, Patronage, and the Authorship of Ars: From Mechanical Know-How to Mechanical Knowledge in the Last Scribal Age," in Shank, Scientific Enterprise, pp. 205-213, 395-435.

Week 15: An Assessment of Medieval Science

M 5/8: Character of late-medieval science

W 5/10: Manuscript & printed books (Special Collections, 9th fl. Mem. Library)

F 5/12: Discussion: Dales and Murdoch/Overview

Lindberg, BWS, ch. 14; Dales, "Conclusion," pp. 170-176; *John Murdoch, "The Analytic Character of Late Medieval Learning: Natural Philosophy Without Nature" from L. Robertson, ed., Approaches to Nature in the Middle Ages, pp. 171-213.

Grad supplement: Grant, ch. 10 and Conclusion; Dales, "Fringes of Science;" Brian Copenhaver, "Did Science Have A Renaissance?" in Shank, Scientific Enterprise, pp. 373-93.

Final exam: (but always double-check time and place!): 5/11/2011 at 5:05 p.m.

The short analytical papers that focus on articles

1. These assignments are **not** a research paper on the topic of the article to be analyzed. Rather, they focus on the article itself (pick one that you find interesting). The goal of the assignment is to have you discover and explain the main point/thesis of the assigned article, and to understand the author's subsidiary claims, arguments, and evidence. Your writing about these issues will clarify your own thinking and sharpen your analytical and critical skills. To do the job properly, you should (re)read the paper **at least two days before the paper is due** and think about it. Our brains work also while we sleep, but they tend to simmer rather than boil--and simmering requires time.

2. **Main thesis.** Both while you are reading and after you have read the piece, you should try to isolate the author's main thesis. In a well-written article, the introduction and conclusion often provide precious clues about the matter, but not always. What is the author trying to demonstrate? what is the one (or two) main idea(s) that the author wants you to remember? what are (if any) the two or three related subsidiary points?

In the opening section of your paper, express in clear and condensed form the author's own point of view. Get inside the author's head and outline/summarize/clarify in your own words the ideas and emphases expressed in the text. Ideally, your attitude at this point is one of understanding--you are representing someone else's views in your own words and as best you can, regardless of whether or not you disagree with them. Criticism is not appropriate at this stage.

3. **Analysis.** The second part of the paper will analyze the author's argument(s). This stage involves paying close attention to the structure and flow of the article. Among the questions you should consider (and perhaps address in your paper, if they help clarify what the author is trying to do):

How does the author defend the thesis? Is the author only making a positive case? or is the author also criticizing earlier literature on the subject?

What assumptions (implicit or explicit) does the author bring to bear on the argument?

How has the author structured/organized the case presented here?

What kind of evidence does the author use?

Finally, recognizing the difficulties that you face in trying to understand the article is an important part of the analysis. You may not understand everything. Think hard about the difficulties: you may solve some of them, but others may remain unsolved. That's OK. You may (or not) wish to bring up all of these difficulties in your write-up, but do think about them.

4. **Criticism/evaluation.** After you have gained increased understanding from analyzing the article, you are now in a position to go one step farther, and to evaluate the effectiveness of the argument. Does the article in fact do what the author intended it to do? Does it convince you that the thesis is plausible? correct? wholly correct? correct in part? correct, but not for the reasons the author provided? Partly wrong? Completely wrong? Be measured in your criticisms; avoid even the appearance of trying to "trash" the article when you strongly disagree with it; always give reasons for your disagreements. Remember that you are trying to convince your reader.

If you notice apparent inconsistencies, are they apparent only? are they traceable to hidden assumptions? if so, can you draw the latter out?

Note that, in writing, "analysis" and "criticism/evaluation" tend to overlap (they may or may not be separate sections in your paper).

5. Miscellaneous advice: When writing in the analytical vein, try to be clear and direct (rather than allusive or subtle). You are supposed to get behind/dissect the author's allusions or subtleties. Expository and analytical writing is one specific genre of writing that strives for transparency (unlike some poetry or creative writing, for example). Use the active voice whenever possible; avoid the unnecessary (or repeated) use of impersonal turns of phrase "There is/are..." "It is..." Sentences that you cannot read in one breath are too long. Pay attention to rhythm, and improve it.

In this kind of work, avoid quotations (they take up precious space); use restatement and paraphrase instead. The point of the assignment is to grapple with the author's viewpoint by presenting it in your own words. The analysis will, of course, be your own analysis. Paraphrases must be your own. (If a quotation is absolutely necessary, I am not suggesting that you eliminate quotation marks, on the contrary!) Because of the peculiar nature of the assignment, you may use page numbers in parentheses instead of footnotes.

Do not write the paper to your professor. Your audience should be an intelligent friend of yours who is unfamiliar with the article and the course. If possible, field-test your analysis with a friend or roommate. If s/he is able to understand some passages, revise them.

Add to READER

Victoria Sweet, "Hildegard of Bingen and the Greening of Medieval Medicine," Bulletin of the History of Medicine 73 (1999) 381-403 and substitute for Alic

Electronic copy is in "Others Papers" folder, and is called "Sweet-Hildegard.rtf"

Add Galen ureter article: Michael H. Shank, "From Galen's Ureters to Harvey's Veins," Journal of the History of Biology

After Hilton and Sawyer: Alex Roland, "Once More into the Stirrups: Lynn White Jr., Medieval Technology and Social Change," Technology and Culture – 44 (2003) pp. 574-585 Recommended

Look at/use in reader(?) Adriaan Verhulst, "The Agricultural Revolution of the Middle Ages Reconsidered," in Bernard Bachrach and David Nicholas, eds., Law, Custom, and the Social Fabric in Medieval Europe (Studies in Medieval Culture, 28 (Kalamazoo, 1990) , pp. 17-28.CB351.S83/35

week 1 Recommended: R. Palter, "Black Athena, Afrocentrism, and the History of Science," from Mary Lefkowitz et al., eds., Black Athena Revisited and M. Bernal, "Response to Robert Palter," History of Science 32 (1994), 445-468.

week 3 Recommended: G. E. R. Lloyd, Aristotle: The Growth and Structure of his Thought (Cambridge: Cambridge University Press, 1968); Jonathan Barnes, eds., The Cambridge Companion to Aristotle (Cambridge: Cambridge UP, 1995); Martha Nussbaum, "Aristotle, Feminism, and Needs for Functioning" in Cynthia A. Freeland, ed., Feminist Interpretations of Aristotle (University Park: University of Pennsylvania Press, 1998), pp. 248-59.

week 5 Recommended: D. R. Dicks, Early Greek Astronomy to Aristotle (Ithaca: Cornell UP, 1970); James Evans, The History and Practice of Ancient Astronomy (Oxford: Oxford UP, 1998).

Week 6 Recommended: Heinrich von Staden, Herophilus: the Art of Medicine in Early Alexandria: Edition, Translation, and Essays (Cambridge/New York: Cambridge UP, 1989).

Week 13 Recommended: Nicholas Steneck, Science and Creation in the Middle Ages: Henry of Langenstein on Genesis (Notre Dame: University of Notre Dame Press, 1976).

Week 14 Recommended: Grant, "Medieval Departures from Aristotelian Natural Philosophy," in S. Caroti, ed., Studies in Medieval Natural Philosophy (Florence: Olschki, 1989), pp. 237-256.