History 252-01: The History of Western Science: A Survey
(Second Semester; CRN 10440)

Tuesdays & Thursdays 9:30-10:45, MHRA 2211

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Office hours: Tuesdays & Thursdays 11:00-12:00, or by appointment. I'm available many other times, and I encourage you to come by if you're having trouble or if you just want to talk.

This course attempts to capture some of the major developments in the history of Western science from the end of the Scientific Revolution around 1700 till the end of the twentieth century. It is designed to give the student an understanding of the historical development of some of the principal ideas and discoveries that have gone into the making of the Western scientific tradition and hence of the modern scientific worldview. The approach it will take is to see scientific concepts and theories as attempts to explain certain striking phenomena in the context of particular beliefs and assumptions about nature and about the nature of scientific knowledge. Roughly speaking, one might say that science begins with the desire to explain particular phenomena, whereas philosophy begins with the desire to explain things in general. (As we'll see, John Dalton's chemical atomism of the nineteenth century differed crucially from early Greek atomism in just this regard.) In addition to looking at *what* things people thought needed explaining and *how* they then tried to explain them, we will pay particular attention to changing notions about the very nature of what counts as an "explanation," an issue closely related to the overall conception of the world put forth by scientists at different times.

For example, the world of Aristotelian science is pretty much as it *appears* to us, from the reality of basic qualities like heaviness, color, and hotness, to the naturalness of free-fall and the growth of a seed, to the structure of a universe centered on a motionless earth and bounded by a rotating sphere of stars. The world of seventeenth-century corpuscularians, on the other hand--which remained pretty much the generally accepted world of science until the end of the nineteenth century--was as we *imagine* it to be, from the assumption of invisible atoms in motion, to the positing of an idealized principle of inertia in Euclidean space, to its wildly counterintuitive claim that the earth spins as it revolves around the sun. And the world of modern science--of quantum mechanics and relativity, in particular--is radically *un*imaginable, from wave-particle duality, to mass-energy equivalence, to the curved space-time of a universe that expanded with unimaginable rapidity from an unimaginably small and dense space. The course assumes no prior exposure to either science or the history of science, though of course either would be useful! I will explain such scientific concepts as you need to know.

Since the scope of relevant and important topics is truly vast, severe selection is needed to produce a manageable syllabus. Unfortunately, few good elementary-level texts cover this period, none adequately. I've chosen Peter J. Bowler and Iwan Rhys Morus, *Making Modern Science* (Chicago & London: University of Chicago Press, 2005), as the best presently known to me. As with all such texts, it omits much I consider important and includes much I have no use for. As a supplementary *recommended* text I've asked the bookstores to make available a few copies of Charles C. Gillispie's *The Edge of Objectivity: An Essay in the History of Scientific Ideas* (Princeton: Princeton University Press, 1960; with a new preface 1990), from which I have also made a few specific assigned readings. The Library's two copies are on 1-day reserve.

Many additional required readings (marked **eR** on the syllabus) are accessible as e-Reserves via Blackboard, as described below. You should print out these readings for easier use. *You will get the most out of this class if you do the assigned readings before the scheduled class period, and then review them afterwards!* If you don't do the readings, you cannot expect to do well in this course. *Note that in some cases only selected pages are assigned from an e-Reserves reading*. Where no such pages are indicated, you should read the whole selection. *Supplementary readings* provide a fuller treatment of the topic for those who might want another take. Although the order of the assigned readings under any given topic may not necessarily be all that important, I've nevertheless put them into what I judge to be the most effective order for you to read. A parenthetic "(*recommended*)" refers only to the immediately preceding pages; thus with the assignment from Bowler & Morus for February 14, only pages 426-431 are recommended; the other pages from that work are required. The numbers in brackets give the approximate number of assigned page-equivalents; the average per class is 36.

My lectures will present some of the more important information but will emphasize explaining the basic concepts and the significance of the work. You'll need to do the assigned reading for much of the substance. If the coherence of my lecture notes allows it, I'll make copies of them available to you via e-Reserves on a timely basis. No promises here!

It has traditionally been reckoned that students should expect to spend around three hours outside of class for each hour of class time. Hence in this class if you're *not* devoting around eight hours a week to reading and studying, you're probably not going to do as well as you should.

The written work for the course consists of two exams and a final, each worth a third of your (unadjusted) final grade. The final will be cumulative, but will be weighted toward the last third of the material. I encourage you to ask questions, and significant class participation will be rewarded with an increase in the final grade (up to a full letter grade, though usually less). I expect regular attendance: more than three absences are considered excessive, and may result in a lowering of your final grade (up to a full letter grade, though usually less). I reserve the right to drop students after six absences. *Students who miss the first two classes will be dropped from the role*.

A few words about **Blackboard**, UNCG's online course management system. You can access it from the UNCG homepage by clicking "Current Students" on the horizontal yellow bar,

then “Blackboard” on the horizontal grey line just below it. Most of you will already have been exposed to Blackboard at one or another orientation session for incoming students. If not, you can familiarize yourself with it via the Blackboard Online Student Orientation at http://www.uncg.edu/aas/itc/bborient/. If you have specific problems–say with logging in or printing–you should call the Help Desk at 6-TECH (*i.e.*, 68324) on a University phone. *In order to gain access to Blackboard you will first need to have activated your student account*. If you haven’t, go to http://blackboard.uncg.edu/webapps/login Click on the yellow “Support” tab at top, then “Activate your accounts” under the Links at upper left, and follow the directions. What you need to know for this course is relatively simple. “Course Information” contains the syllabus and the handout “Most of the Foreign and a Few of the More Obscure Words from the Readings”–nothing new here. “e-Reserves” is a list of all the readings, arranged alphabetically by title. (Note that the Library includes initial “A” and “The” in its alphabetization.) That’s the principal feature you’ll need for this course. “Announcements” will alert you to things like cancellation of a class--unlikely, but you should check it regularly just in case.

I expect students to have read and understood the section of the *Policies for Students* handbook (or the equivalent on-line version at http://academicintegrity.uncg.edu/) relating to the UNCG Academic Integrity Policy. Submission of written work implies your acceptance of its provisions.

Student Learning Goals

• Basic knowledge of some of the principal episodes and developments in the history of Western science from the seventeenth through the twentieth century.

• Appreciation of the nature of scientific enquiry, in particular the relationship between phenomena and their explanation.

• In particular, an understanding of the changes in people’s conception of the material world (including the earth), of living things, of the erstwhile imponderables (*i.e.*, forces and energy), and of the structure of the cosmos.

Schedule of Topics and Readings

January 15: Introduction

January 17: The Enlightenment and the Newtonian Legacy: Bowler & Morus, 39-50; Silver, *The Ascent of Science*, Pt. A (**eR**) [28]

January 22: The Quantification of Heat in the 18th Century: Guerlac, “Black, Joseph” (**eR**); Heilbron, “Wilcke, Johan Carl” (**eR**); Gillispie, *The Edge of Objectivity*, Pt. A, 235-241 (**eR**; this selection is hard; give it a chance); Lavoisier & Laplace, *Memoir on Heat* (**eR**);

recommended: McKie & Heathcote, *The Discovery of Specific and Latent Heats*, 11-22, 78-86 (**eR**); the classic presentation of Lavoisier's calorimeter is Lavoisier, *Elements of Chemistry* (**eR**) [21 + 35]

January 24: Eighteenth-Century Chemistry: Bowler & Morus, 55-67; Perrin, "The Chemical Revolution," 264-270 (**eR**); Gillispie, *The Edge of Objectivity*, Pt. A, 202-209 (**eR**); Toulmin & Goodfield, *The Architecture of Matter*, Pt. A, 207-215 (**eR**) [32]

January 29: The Chemical Revolution: Bowler & Morus, 67-71; Perrin, "The Chemical Revolution," 270-276 (**eR**); Gillispie, *The Edge of Objectivity*, Pt. A, 209-235 (**eR**); Toulmin & Goodfield, *The Architecture of Matter*, Pt. A, 216-228 (**eR**) [48]

January 31: Chemical Atomism: Bowler & Morus, 71-77; Sharlin, *The Convergent Century*, Pt. B, 48-58, 66-67 (**eR**); Gillispie, *The Edge of Objectivity*, Pt. B (**eR**); Toulmin & Goodfield, *The Architecture of Matter*, Pt. A, 229-237, and Pt. B, 239-247 (**eR**) [41]

February 5: buffer day; no new reading

February 7: The Background to Darwin: Living Things: Bowler & Morus, 129-143, 350-354; Toulmin & Goodfield, *The Discovery of Time*, Pt. B, 171-188 (**eR**); *supplementary reading*: McClellan & Dorn, *Science and Technology in World History*, 316-318 (**eR**) [36 + 2]

February 12: The Background to Darwin: The Earth: Bowler & Morus, 103-124, 347-350; Toulmin & Goodfield, *The Discovery of Time*, Pt. A, 141-170, and Pt. B, 189-195 (**eR**) [54]

February 14: Darwin and the Theory of Evolution: Bowler & Morus, 143-157, 354-360, 426-431 (*recommended*); Toulmin & Goodfield, *The Discovery of Time*, Pt. C (**eR**); *supplementary reading*: McClellan & Dorn, *Science and Technology in World History*, 318-327 (**eR**) [49 + 19]

February 19: buffer day; no new reading

February 21: FIRST EXAM

February 26: The Wave Theory of Light: Gillispie, *The Edge of Objectivity*, Pt. D, 406-435 (**eR**); *recommended*: Silver, *The Ascent of Science*, Pt. B, 190-193 (**eR**); *supplementary reading*: Sharlin, *The Convergent Century*, Pt. C, 99-119 (**eR**) [29 + 3 + 20]

February 28: Heat Theory: Bowler & Morus, 398-403; Sharlin, *The Convergent Century*, Pt. A, 18-19, 32-35 (**eR**); Gillispie, *The Edge of Objectivity*, Pt. A, 235-241 (*review*); Pt. C, 357-370, 394-405 (*skim the math* on 396-400) (**eR**); *recommended*: Silver, *The Ascent of Science*, Pt. C (**eR**) [33 + 17]

March 4 & 6: The Conservation of Energy: Bowler & Morus, 79-101; Gillispie, *The Edge of Objectivity*, Pt. C, 370-394, *review* 400-402 (**eR**); Sharlin, *The Convergent Century*, Pt. A, 26-32, 35-37 (**eR**); Toulmin & Goodfield, *The Architecture of Matter*, Pt. B, 247-249, 259-260 (**eR**) [55]

March 11 & 13: Spring Break: no class

March 18: Radioactivity and Atomic Transmutation: Quinn, *Marie Curie: A Life* (**eR**); MacLachlan, *Children of Prometheus*, Pt. A, 362-366 (**eR**); Brush, *The History of Modern Science*, Pt. A (**eR**); Malley, "The Discovery of Atomic Transmutation" (**eR**); *optional*: Bowler & Morus, 496-499 [42 + 2]

[March 19: last day to drop a course without penalty]

March 20: Continental Drift: Bowler & Morus, 237-244; Hallam, *A Revolution in the Earth Sciences*, Pt. A (**eR**) [28]

March 25: Plate Tectonics: Bowler & Morus, 244-252; Hallam, *A Revolution in the Earth Sciences*, Pt. B (**eR**) [27]

March 27: buffer day; no new reading

April 1: SECOND EXAM

April 3: Relativity and Classical Physics: Bowler & Morus, 260-265; Silver, *The Ascent of Science*, Pt. F, 417-430 (**eR**); MacLachlan, *Children of Prometheus*, Pt. A, 361-362, 366-368 (**eR**); *supplementary reading*: Toulmin and Goodfield, *The Architecture of Matter*, Pt. B, 249-259, 261-268 (*recommended*) (**eR**); Gillispie, *The Edge of Objectivity*, Pt. E, 498-502 (*skim*), 502-520 (**eR**; this reading isn't easy, but it's worth the effort if you're so inclined) [10 + 45]

April 8: Atomic Structure and Nuclear Fission: Bowler & Morus, 255-260; Toulmin & Goodfield, *The Architecture of Matter*, Pt. C (**eR**); MacKenzie, *The Major Achievements of Science* (**eR**); MacLachlan, *Children of Prometheus*, Pt. A, 370-372, 375-380 (**eR**); Brush, *The History of Modern Science*, Pt. B, 350-352 (**eR**); Sime, "The Search for Transuranium Elements and the Discovery of Nuclear Fission" (**eR**); *recommended*: Silver, *The Ascent of Science*, Pt. D, 363-368 (**eR**) [59 + 5]

April 10: Nuclear Energy and the Atomic Bomb: Bowler & Morus, 471-479; Brush, *The History of Modern Science*, Pt. B, 352-361 (**eR**); MacLachlan, *Children of Prometheus*, Pt. A, 380-385 (**eR**) [19]

April 15: Quantum Mechanics: Bowler & Morus, 265-270; Toulmin & Goodfield, *The*

Architecture of Matter, Pt. D (**eR**); MacLachlan, *Children of Prometheus*, Pt. A, 368-370, 373-375 (**eR**); Silver, *The Ascent of Science*, Pt. D, 357-363 (**eR**) [28]

April 17: Paradoxes of Quantum Mechanics: Silver, *The Ascent of Science*, Pt. E (**eR**) [22]

[Astronomy and Cosmology: Bowler & Morus, 277-297; Silver, *The Ascent of Science*, Pt. G (**eR**) [29]. *This unit was omitted due to time constraints. Some of you may still wish to do the reading*.]

April 22: Physiology and the Explanation of Life: Bowler & Morus, 165-186, 360-362, 415-420; Toulmin & Goodfield, *The Architecture of Matter*, Pt. E (**eR**) [56]

April 24: Early Genetics: Bowler & Morus, 189-205; Toulmin & Goodfield, *The Architecture of Matter*, Pt. F, 358-368 (**eR**); Morange, *The Misunderstood Gene*, 8-14 (**eR**); MacLachlan, *Children of Prometheus*, Pt. B, 409-419 (**eR**) [41]

April 29: Modern Genetics: Bowler & Morus, 205-211; Toulmin & Goodfield, *The Architecture of Matter*, Pt. F, 369-372 (**eR**); Morange, *The Misunderstood Gene*, 1-7, 14-34 (**eR**); MacLachlan, *Children of Prometheus*, Pt. B, 420-430 (**eR**) [46]

May 1: buffer day; no new reading; course evaluation administered.

[If you have the interest and the stamina, I strongly recommend the two selections from Theodore Roszak's *The Making of a Counter Culture* and *Where the Wasteland Ends* (both **eR**), which we can discuss if there's interest and time.]

[May 6: Though a Tuesday, Friday's scheduled will be followed, hence we won't meet.]

May 7 (Wednesday): Reading Day

May 8 (Thursday): FINAL EXAM, 12:00-3:00