Hsci 1815/3815—Revolutions in Science: Lavoisier, Darwin, Einstein
Spring 2008

Time and Place. **Lecture:** MWF, 9:05 – 9:55 am, Physics 131
Discussion: 2 M, 12:20 – 1:10 pm, AkerH 211
3 Tu, 9:05 – 9:55 am, AkerH 215
4 W, 11:15 am – 12:05 pm, Phys 157

NOTE: here will be NO discussion sessions the first week of classes.

Instructors.

Lecture: **Michel Janssen**. 354B Physics; email: janss011@umn.edu; tel. 624 5880. Office Hours: M, 10:30–11:30 am; W, 1:30–2:30 pm; or by appointment.

Discussion: **Adrian Fischer**. 167 Social Sciences Building; email: fisch406@umn.edu; tel. 626 8722. Office Hours: Th, 1:30 –2:30 pm; or by appointment.

Course Description. This class is the second part of a two-semester introductory survey of the history of science. The two parts can be taken independently of one another. This class covers a selection of developments in chemistry, biology, geology, and physics from the 18th through the 20th century. We examine the reasoning of some of the leading scientists involved, while being sensitive to the broader social and cultural contexts in which they worked. To allow for meaningful analysis of the material, the course is clustered around a few pivotal episodes: the chemical revolution of the 1780s led by the Parisian Antoine Lavoisier, who lost his head to the guillotine; the publication of the *Origin of Species* in 1859 by the Victorian gentleman-scientist Charles Darwin; and the *annus mirabilis* 1905 of a Swiss civil servant, who started out a German and ended up an American—Albert Einstein. We also study the impact of these scientific developments on society. In particular, we shall look at the reception of Darwin's theory and at the development of nuclear weapons made possible by the development of modern physics. The lectures will cover and supplement the textbooks. The focus in the discussion section will be typically be on a passage from the work of a scientist covered in the lecture.

This course satisfies the **Historical Perspectives Diversified Core Requirement** and the **International Perspective Theme**. Given the important role of science in modern society, it is easy to forget that science does not lead a life of its own but that, like any other human endeavor, it is the product of and remains conditioned by historical processes. The number one goal of this class is to increase your awareness of this truism by examining some concrete examples of science practiced in historical environments very different from our own. At the same time, science appears to be different from other human pursuits. Even though you may personally prefer Van Gogh's paintings to Rembrandt's, you would probably not say that Van Gogh is better than Rembrandt. The same holds for literature, music, architecture, and even, depending on whom you ask, for religion, philosophy, and political systems. Yet, you probably would say that Einstein's theories are better than Newton's. I find this fascinating. There is no question that science is embedded in and constrained by the broader culture in which it is practiced. How do we square that with scientific ideals of objectivity (the idea that science produces results that hold completely independently of the historical circumstances under

which they were originally found) and progress (the image of an unstoppable march of modern science gaining more and more knowledge of the natural world that cuts right across both spatial and temporal boundaries between different cultures)? To what extent are scientific objectivity and progress just part of the ideology of our own science-dominated culture, reinforced by a history of science written from our own winners vantage point? How do we actually construct our narratives about the history of science? What sources do we have to go on? What pitfalls do we need to watch out for? Such questions form the background against which we examine some celebrated examples of fundamental change in our understanding of the natural world over the last three centuries.

Given our goals in this class, the episodes that we shall cover in some depth are chosen to represent different times and places. The section on chemistry will take us to 18th-century Paris, the section on biology to 19th-century London, and the section on physics to early-20th-century Berlin. This will also put us in a position to appreciate the increasingly international character of science during the period covered in this class, while emphasizing differences between the developments in various countries (notably Britain, Germany, France, and the United States). We shall also study the emergence of the United States as a scientific powerhouse in the 20th century. The objective of the course is to give you a better understanding not just of the historical development of scientific ideas but also of the role science plays in modern societies by tracing how it came to play that role.

Requirements. The main requirement of this class is that you keep up with the readings. It's especially important that, before coming to the discussion section, you read the material on the agenda that week. **If it turns out that *some of you* are not doing these readings, we may require *all of you* to turn in (at the beginning of the discussion section each week) a written statement that can serve as the starting point for discussion of the material.** In week 13 (April 21–25), the discussion sections are used for the 'Georgina Hoptroff Montgomery Mini-Conferences': you team up with one or two other students to give a short presentation on a physicist of your choice. Coffee and doughnuts are provided. This presentation counts toward your grade for participation in the discussion section. If you keep up with the material, you should have no trouble with the formal requirements of this class: a midterm, a cumulative final, and three take-home short-essay-questions (about a page and a half each) spread over the semester (see schedule below).

Additional requirement for Hsci 3815 students. In addition to the requirements listed above, you are required to write a term paper of about 2000–2500 words (7–10 pages). A list of possible topics will be passed out the week after the midterm. You need to clear it with me (Michel) if you want to write on a topic not on this list. A short proposal for your paper is due at the beginning of the lecture on **Friday, April 11**. **If you are considering a minor in History of Science and Technology, you are strongly advised to take 3815 rather than 1815**. The university rule is that you cannot count 1000-level credits toward a minor.

Grading. 85% of your grade will be based upon:

Hsci 1815 students: three take-home short-essay-questions (worth 15% each), midterm (worth 15%), and final (worth 25%);

Hsci 3815 students: three take-home short-essay-questions (worth 15% each), midterm (worth 10%), final (worth 10%), and term paper (worth 20%).

The remaining 15% of your grade will be based on attendance of the lectures (worth 5%) and attendance of and participation in the discussion sections (worth 5% each; you can boost

your participation grade with your class presentation in week 13). Your attendance grade is essentially the percentage of classes you attended. Those sitting in rows 1–5 during the lectures receive a bonus of 5%. You also receive a bonus of 5% for attending the lectures on Friday. If your cell phone rings (or, worse, plays some annoying jingle) during class, you forfeit all credit for attending that class. All grades will initially be given on a scale from 0 to 100 (110 for attendance of the lectures) and will only in the end be converted to letter grades. The conversion is roughly: 85–100: A; 70–85: B; 55–70: C; 40–55: D; less than 40: F.

Attendance. There tends to be a strong correlation between attending class (in a seat that optimizes oral and visual reception of the various offerings and without distractions) and doing well on the exams and the assignments. As an extra incentive to come to class, attendance makes up a small portion of your grade. There is a bonus for sitting in the front rows, a penalty for not switching off your cell phone, and another bonus for resisting the temptation to start your weekend on Fridays. It is especially important that you come to the discussion sections. This is reflected in the grading policy: attending the discussion section *once* a week is worth almost as much as coming to the lecture *three times* a week.

Office Hours. If you have difficulty with the material, do not wait too long and come see one of us during office hours. One of our office hours is by appointment, so there will always be a time that fits your schedule. We shall do our best to answer any questions you may have, from very specific ones to "I'm lost!"

WebVista Course Site. There is a website for this class, on which various readings, lecture notes, short essay questions, study guides etc. will be posted. There is also a page called "announcement" on which important information pertaining to this class will be posted (such as, if necessary, reminders about due dates of assignments or information about changes in the schedule). **Check the website, including the annoucement page, at least once a week for new material and/or messages. The line "I did not see that announcement" will not be accepted as an excuse for failing to meet any of the requirements of the course. Note that WebCT has a "big brother" function, which means that I can see who is logging in when.**

To log on to the WebVista course site for this class, go to www.myu.umn.edu. Sign in to "myu." You will be prompted for your UofM Internet ID (i.e., your username as in username@umn.edu) and password (if you do not know your Internet ID or have forgotten your password, call the ADCS helpline at 612-301-4357 [on campus, dial 1-HELP]). Go to the tab "my courses." There you will find a list of all WebVista sites for courses that you are currently enrolled in. Click on the link to this course. The first time you use WebVista, go to webvista.umn.edu and follow the instructions on configuring your browser (this site also provides an alternative path to WebVista course sites: go to WebVista B and log in). Only a few of the features of WebCT will be used for this class (e.g, the gradebook). The main purpose of the site is to make readings and handouts available to you on-line. Unfortunately, some scans of journal articles and book chapters are not very legible on screen, but they print out just fine. Let me remind you that copyright laws only allow you to make a copy for your own personal use. All files are in html- or pdf-format. To read and print pdf-files, you need (a reasonably recent version of) Adobe Acrobat Reader. For instructions on how to download this program (for free), go to www.adobe.com/products/acrobat/readstep2.html. There is a link to this site on the home page of the course site.

Required Texts.

Trevor H. Levere, *Transforming Matter: A History of Chemistry from Alchemy to the Buckyball*. Baltimore: Johns Hopkins University Press, 2000.

Edward J. Larson, *Evolution. The Remarkable History of a Scientific Theory.* New York: The Modern Library, 2004.

James D. Watson, *The Double Helix. A Personal Account of the Discovery of the Structure of DNA*. New York: New American Library, 1991.

Jeremy Bernstein, *Oppenheimer. Portrait of an Enigma*. Chicago: Ivan R. Dee Publisher, 2004.

These books are available at the U of M Bookstore in Coffman Union. Additional readings will be posted on the WebCT site for this class. Among these supplementary readings will be passages from the work of various scientists covered in the lectures that will serve as the focal points for the discussion sections. **You are expected to bring to discussion all readings for that week (including printouts of the readings posted on the web for that week). Failure to do so will be reflected in your participation grade for the discussion section.**

Schedule & Readings.

Week — Topic & Readings for Lecture and Discussion Section:*

CHEMISTRY

1 Jan. 23 — **Introduction; Alchemy.**
Lecture: Levere, ch. 1, pp. 1–13 [14 pages].
Note: There will be no discussion sections the first week of classes.

2 Jan. 28 — **Greek matter theory; Iatrochemistry (Van Helmont, Paracelsus); Boyle.**
Lecture: Levere, chs. 2–3, pp. 14–38 [25 pages].
Discussion: passages from Boyle's *Skeptical Chymist* (1661)

3 Feb. 4 — **The Chemistry of Airs: Priestley and Lavoisier.**
Lecture: Levere, chs. 5–6, pp. 51–79 [29 pages].
Discussion: passages from Priestley's *Experiments and Observations on Different Kinds of Air* (1775).

4 Feb. 11 — **Lavoisier's Chemical Revolution; Elements from Dalton to Mendeléev.**
Lecture: Levere, chs. 7 and 9, pp. 80–93 & pp. 107–120 [28 pages]
Discussion: introduction of Lavoisier's *Elements of Chemistry* (1789)
Friday, February 15: First take-home short-essay-question assigned.

*. Readings for discussion section are subject to change.

Week | Topic & Readings for Lecture and Discussion Section:

BIOLOGY

5 Feb. 18 **Natural History and Geology in the 18th Century: Linnaeus and Buffon on species, Werner and Hutton on geology (Neptunists vs. Vulcanists).**

Lecture: Larson, preface and ch. 1, pp. xiii–xiv & pp. 5–26 [24 pages]
Discussion: help you get started on the take-home short-essay question.

6 Feb. 25 **Early 19th Century. Three different reasons for opposing transmutation of species: Cuvier's Comparative Anatomy; Lyell's Uniformitarianism; Paley's Natural Theology.**

Lecture: Larson, ch. 2, pp. 29–51 [22 pages]
Discussion: Paley's appropriation of the mechanical philosophy's 'watch'-metaphor in his *Natural Theology* (1802).
Monday, February 25: First take-home short-essay-question due at the beginning of the lecture.

7 Mar. 3 **Darwin's Beagle Voyage and the development of his theory of evolution through natural selection.**

Lecture: Larson, ch. 3, pp. 55–75 [21 pages]
Discussion: passages from Darwin's *On the Origin of Species* (1859).

8 Mar. 10 **Wallace; Darwin's *The Origin* (1859)**

Lecture: Larson, ch. 4, pp. 79–101 [23 pages]
Discussion section: Review for the midterm.
Friday, March 14, 9:05 – 9:55 am, Physics 131: Midterm (on most of the material covered in weeks 1–8; a review sheet will be made available).
Friday, March 14: Second take-home short-essay-question assigned.

Mar. 17–21 **Spring Break**

9 Mar. 24 **Dinosaurs; Decline of Darwinism; Mendel.**

Lecture: Larson, chs. 5 and 7 (1st half), pp. 105–129 & pp. 153–165 [38 pages]
Discussion: passages from Whewell's *Philosophy of the Inductive Sciences* (1840s).
Friday, March 28: Second take-home short-essay-question due at the beginning of the lecture

10 Mar. 31 **Mendelians vs. Biometrists; Modern Synthesis; Scopes Trial; DNA.**

Lecture: Larson, chs. 7 (2nd half), 10, and 9, pp. 165–174 & 221–243 & pp. 201–218 [51 pages]
Discussion: Watson, foreword, preface, chs. 1–29, and epilogue, pp. *vii–x*, pp. 13–143 [135 pages]

Week | Topic & Readings for Lecture and Discussion Section:

PHYSICS

11 Apr. 7 **Einstein's miracle year (1905); Thermodynamics, kinetic theory and the Reality of Atoms.**

Lecture: lecture notes
Discussion: road map of the physics section of the course
Sign-up for presentations at mini-conference in week 13.
Friday, April 11 (for students in 3815 only): Short proposal for term paper due at the beginning of class

12 Apr. 14 **Electricity and magnetism from Coulomb forces to the electromagnetic field and special relativity (1785-1905); $E = mc^2$.**

Lecture: lecture notes
Discussion: review/preview of material covered in lecture in weeks 11–12.

13 Apr. 21 **General relativity and Einstein's later journey (1915–1955). Quantum theory: Planck, Einstein, and Bohr**

Lecture: lecture notes
Discussion: ***'Georgina Hoptroff Montgomery Mini-Conferences': student presentations on physicists covered in lecture in weeks 11–12.***
Friday, April 25: Third take-home short-essay-question assigned.

14 Apr. 28 **From the old quantum theory to matrix mechanics.**

Lecture: lecture notes
Discussion: Bernstein, preface, pp. vii–xi, Chs. 1–3, pp. 3–90
[93 pages]

15 May 5 **Nuclear Physics; Manhattan Project.**

Discussion: review for final exam.
Monday, May 5: Third take-home short-essay-question due at the beginning of the lecture.

Friday, May 16, 1:30–3:30 pm (place to be confirmed but probably Phys 131): Final Exam (cumulative; a review sheet will be made available);
Term paper for Hsci 3815 students due at the beginning of the exam period.