

SYLLABUS
Chemistry 150
Great Discoveries in Science
or
An Essential Unity: Humanities, Social Sciences, Sciences
Inclusion/Exclusion: The Nature of Scientific Discovery
Bodies That Matter: The Nature of Scientific Discovery
No Man Is an Island: The Nature of Scientific Discovery

Spring 2019

CLASS ATTENDANCE IS REQUIRED!!!

No man is an island,
entire of itself;
every man is a piece of the continent,
a part of the main.

If a clod be washed away by the sea,
Europe is the less,
as well as if a promontory were.

as well as if a manor of thy friend's
or of thine own were.

Any man's death diminishes me,
because I am involved in mankind;
and therefore never send to know for whom the bell tolls;
it tolls for thee.

(John Donne, 1572-1631, poem ca. 1623; Francis Bacon 1561-1626)

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Preamble--The perspective of the College for COLL 150 (Freshman Seminars) classes.

“COLL 150 courses are **seminars**, typically limited to an enrollment of fifteen, which explore deeply a particular topic via close readings of **texts, data**, or [and/or] **methods of inquiry**. The goal of COLL 150 is to initiate students into the culture of **critical thinking, persuasive writing**, and **independent inquiry**” (From the College catalog.)

Seminar - class, meeting, tutorial, assembly, discussion, conference, etc. Seminar often implies a limited number of people involved in the investigation of a particular subject matter.

Text - a book or other written work regarded in terms of its content rather than its physical form. The text communicates thoughts, ideas, observations, events, etc. via the process of interpretation. Since the text is a representation of a thought, idea, observation, event, etc., the text needs to be interpreted to obtain meaning. How one goes about interpreting text is the subject field of **hermeneutics**. **Is NATURE, i.e., the natural world, a form of text? Are scientists reading this text and interpreting this text to obtain meaning that is mirrored by or behind the text?** That is, there is event, and there is the meaning of event—or there is reality, and there is the reality behind the reality—or there is appearance, and there is essence.

Data - facts, information, figures, records, observations, events, concretes, sensate experience, etc.

Method of inquiry - a procedure or process for attaining a goal, purpose, objective, etc.: a systematic procedure, technique, or mode/method of inquiry employed by or proper to a particular discipline in order obtain knowledge.

Critical thinking - Critical thinking is that mode of thinking—about any subject, content, or problem—in which the thinker improves the quality of his or her thinking by skillfully analyzing, assessing, and reconstructing it. Critical thinking is self-directed, self-disciplined, self-monitored, and self-corrective thinking. (Self-corrective thinking occurs within a **hermeneutical cyclic** a la Gadamer.) It presupposes assent to rigorous standards of excellence and mindful command of their use. It entails effective communication and problem-solving abilities, as well as a commitment to overcome our native egocentrism and sociocentrism or as a la Gadamer our “historically effected consciousness.”

Persuasive writing - Persuasive writing is a form of writing in which the writer uses words to convince the reader that the writer's opinion is correct in regards to an issue. Persuasive writing sometimes involves

persuading the reader to perform an action, or it may simply consist of an argument or several arguments to align the reader with the writer's point of view. Persuasive writing is one of the most commonly used writing types in the world. Persuasive writers employ many techniques to improve their argument and show support for their claim.

Independent inquiry - not influenced or controlled by others in matters of opinion, conduct, and judgment; thinking or acting for oneself; not subject to another's authority or jurisdiction; autonomous; free.

I. General Information

Classroom Meeting Times: Tuesday Thursday 12:30 pm to 1:50 pm

Final Exam Date/Time: No final examination but a final paper(s) is due by the last exam day, 5 pm.

Required Books:

1. *The Annotated and Illustrated Double Helix* by James D. Watson, Alexander Gann, Jan Witkowski
 - ISBN-10: 0226458121
 - ISBN-13: 978-0226458120
 - Hardcover: 368 pages
 - Publisher: Simon & Schuster; annotated edition (November 6, 2012)
 - ISBN-10: 1476715491
 - ISBN-13: 978-1476715490
2. *The Alchemy of Air: A Jewish Genius, a Doomed Tycoon, and the Scientific Discovery That Fed the World but Fueled the Rise of Hitler* by Thomas Hager
 - Paperback: 336 pages
 - Publisher: Broadway Books (August 18, 2009)
 - ISBN-10: 0307351793
 - ISBN-13: 978-0307351791
3. *Marie Curie: A Life* (Radcliffe Biography Series) by Susan Quinn
 - Series: Radcliffe Biography Series
 - Paperback: 528 pages
 - Publisher: Da Capo Press (April 10, 1996)
 - ISBN-10: 0201887940
 - ISBN-13: 978-0201887945
4. *The Structure of Scientific Revolutions: 50th Anniversary Edition* by Thomas S. Kuhn, with an Introduction by Ian Hacking
 - Paperback: 264 pages
 - Publisher: University Of Chicago Press; Fourth Edition (April 30, 2012)
5. *Life Is a Miracle: An Essay Against Modern Superstition* by Wendell Berry
 - Paperback: 176 pages
 - Publisher: Counterpoint (May 15, 2001)
 - ISBN-10: 1582431418
 - ISBN-13: 978-1582431413
6. *The Elements of Style*, Fourth Edition by William Strunk Jr., E. B. White
 - Paperback: 105 pages
 - Publisher: Longman; 4th edition (1999)
 - ISBN-10: 020530902X
 - ISBN-13: 978-0205309023
7. *Whose Community? Which Interpretation?: Philosophical Hermeneutics ...* by Merold Westphal (Distinguished Professor of Philosophy, Fordham University), Baker Academic, 2009.
8. *Harvard Case Studies in Experimental Science—The Overthrow of the Phlogiston Theory: The Chemical Revolution of 1775-1789* by James Bryant Conant, Harvard University Press, 1948.

Other reading in the syllabus/schedule will be provided without charge.

II. Course Description:

This course will look at great discoveries in physics and chemistry including the structure of atoms, radioactivity and nuclear phenomena, the structure and significance of DNA, and chemicals with profound social consequences such as ammonia and their dominant place in chemistry, biology, and physics. Besides fundamental scientific and historical interest, these discoveries will be used to illumine the philosophical foundations of research in science. Several biographical works will be examined including those of Marie Curie, James Watson and Francis Crick, Henri Becquerel, Fritz Haber, Frederick Banting, etc. Philosophical works such as Thomas Kuhn's *The Structure of Scientific Revolutions*, Jacob Bronowski's *Science and Human Values*, and Wendell Berry's *Life is a Miracle* (the latter addressing the consilience of E. O. Wilson) will be examined. The syllabus may vary with regard to topics as time restraints dictate as determined by the instructor.

III. Grading and Student Responsibilities.

All assignments standard be done in standard English narrative/grammar/syntax, that is, sentences and paragraphs—no short answers. All assignments must be turned in as word processed documents. For assignments that require written answers to the assignment's questions, download the Word assignment and type in your answers after each question, so that the question and your answer are both contiguously visible. Thank you.

Time commitment: Excelling in college level course work typically requires on average three to four hours per credit per week. Since this is a four credit course, in addition to the time we meet as class each week, you should expect to spend nine to twelve hours on average reading, writing or otherwise preparing for this class on a weekly basis.

Grades will be assigned based on the following:

Class Participation	10%
Tests	35%
Writing/reading assignments of various sorts	31%
Final paper	25%

No one can receive an A grade for the course without writing at least a B+ final paper!

Absences and late assignments. Freshmen Seminars require group discussions, class participation, writing assignments, content mastery, etc. **Class attendance is required. Each student may miss one class for any reason.** You may not miss student *presentations*. In order to be excused from attendance beyond the one absence listed above, you must contact me before the absence or provide notification of illness or college-sponsored function. If you have any scheduled, college-sponsored travel that will cause you to miss a class, you need to notify me as soon as you find out about the trip. You will need to write a 150-word science news summary to turn in for each excused absence, for example, an illness or an out-of-town chess club tournament or a football trip. *Each unexcused absence will decrease your overall grade by one-third of a letter grade (e.g., A⁻ to B⁺)*. Your grade is ultimately your own responsibility. Make sure that you talk to me if you're having any difficulties, but do not wait until the end of the semester.

Films, movies, documentaries, and such like. During these types of presentations the departmental protocol is that all electronic devices be closed, e.g., computers, smart phones, cell phones, tablets, etc.

IV. Class Environment

Open. Lecture and discussion. There will be content lectures/presentations by the instructor, but you are free to interrupt during lectures with comments and questions. There are no trivial, bad, meaningless, or pointless comments or questions. The instructor welcomes all input, especially input disagreeing with or questioning the instructor and his conclusions.

V. Topics and schedule of class periods (continually tentative)

I. The Nature of Science—Ontological and Epistemological Dimensions

A. A traditional understanding of the scientific enterprise.

The “Scientific Method” as commonly presented in standard textbooks.
(Lecture notes only)

B. A non-traditional understanding of science

1. No such thing as the “scientific method.”
2. The essential homogeneity of human intellectual endeavor.
3. Science, art, and creativity.
4. The myth of biological evolution and the Big Bang.

(Lecture notes only.)

C. A Scientific Creed (Creedo - beliefs and purposes that guide someone's thoughts and actions.)

1. Robert Ingersoll, *The Creed of Science* (1995, American intellectual)
2. Bradley James Wogglund, *A Scientist's Creed* (2006, physicist and mathematician)
3. Edward East, *The Scientist's Creed*, Miami news, 1928
4. Craig Dilworth, *The Metaphysics of Science: An Account of Modern Science in Terms of Principles, Laws and Theories*
5. “And our guesses are guided by the unscientific, the metaphysical (though biologically explicable) faith in laws, in regularities which we can uncover—discover.” (Popper 2002, 278)

D. *The Structure of Scientific Revolutions* by Thomas Samuel Kuhn

(Whatever one may think of Kuhn, his view of science has become “a permanent part of the repertoire of historians and philosophers and people in science-studies in general,” as philosopher Ian Hacking, editor of the 50th anniversary edition of *Structure*, recently told Gary Stix of *Scientific American*.)

1. Hacking introduction
2. The main ideas in Kuhn's *The Structure of Scientific Revolution*

II. The Phlogiston and the Transition to Modern Chemistry: A Revolution in the Kuhnian sense?

- A. The Greek legacy
- B. The alchemical period
- C. One hundred years of phlogiston
- D. Lavoisier, Priestley, Dalton (and others) and the birth of modern chemistry
- E. A Kuhnian approach to the overthrow of phlogiston and embrace of oxygen as the paradigm for understanding combustion – a brief summary of Kuhn's ideas in *The Structure of Scientific Revolutions*.
- F. Readings:
 1. *The Overthrow of the Phlogiston Theory*, James Bryant Conant.
 2. *Phlogiston: The Rise and Fall of a Theory*, Jamie Wisniak.
 3. *Historical Structure of Scientific Discovery*, Thomas S. Kuhn.

III. Marie Curie and the Beginnings of Nuclear Science Culminating in The First Atomic Bombs and the Manhattan Project

IV. The Double Helix: A Personal Account of the Discovery of the Structure of DNA: An example of a Kuhnian revolution?

IV. The Alchemy of Air: A Jewish Genius, a Doomed Tycoon, and the Scientific Discovery That Fed the World but Fueled the Rise of Hitler: Science as an integral part of the whole of society and its culture.

V. Glory Enough for All: Frederick Banting and Charles Best—The Discovery of Insulin and Diabetes

VI. John Dalton and the Rebirth of an Atomic Theory Culminating in Mendeleev's Discovery of Periodicity Among the Elements

VII. Life Is a Miracle: An Essay Against Modern Superstition

VI. Great Discoveries in Science—What does this course title mean? To what is it referring?

The meaning of “great.” Synonyms: vast, large, distinguished, celebrated, wonderful, magnificent, paradigm changing, life changing, density of affect, etc.

The meaning of “discovery.” Synonyms: unearthing, uncovering, breakthrough, innovation, revelation, etc.

The meaning of “science.” Synonyms: discipline, knowledge, skill, art, learning, scholarship, physics, chemistry, biology, sociology, government, etc.

"Those who cannot remember the past are condemned to repeat it."

George Santayana, American philosopher.

VII. Where are we going in Chemistry 150?

We are heading to the suggestion—

1. that science is a thoroughly human activity. (Watson, Crick, the Curies, Banting, Haber, etc.)
2. that there is a unity and thus beauty within the domain of human intellectual achievement and that beauty is an essential criterion of truth. (Watson, Crick)
3. that beauty and myth are necessary and essential to understanding of all that is important. (Dirac, Chandrasekhar)
4. that there is no essential difference between the humanities and the sciences. (Berlin, Thompson)
5. that valid/true/compelling knowledge is discovered and created by the same human-centered foundational approach (a hermeneutical circle a la philosophers Schleiermacher, Heidegger, Ricoeur, Gadamer).
6. that science has limitations. (As Bacon wrote, "*ipsa scientia potestas est*" ("knowledge itself is power," *Meditationes Sacrae* (1597)); however, such power can be put to good or ill. (Curies, Haber, Einstein, Oppenheimer))
7. that the world is made of stories, not of atoms. (Rukeyser, Bagdassarian)
8. that there is a “fatal flaw” (harmatia-Greek: ἀμαρτία-missing the mark) within humans. (Koestler)
“We knew the world would not be the same. A few people laughed, a few people cried, most people were silent. I remembered the line from the Hindus scripture, the *Bhagavad-Gita*... "Now, I am become Death, the destroyer of worlds." (Oppenheimer)
“In some sort of crude sense which no vulgarity, no humor, no overstatement can quite extinguish, the physicists have known [sin](#); and this is a [knowledge](#) which they cannot lose.” (Oppenheimer)
9. that human knowledge results from “working up the raw material of sensation into the finished product of thought.” (Durant)

But then, do we always have to be going somewhere? Is destination the substance and joy of life? Is not joy in the journey as significant as the joy in the destination? Maybe at times more important because often we will not reach the destination for one reason or another? We are going “to travel farther north than anyone [has] ever gone, farther north than [our] people's stories went.” (Barry Lopez in Crow and Weasel)

VIII. Topics for Chem 150 final papers for Chem 150. You must write on one of these topics.

1. The marginalization of women in science throughout history such as Marie Curie, Rosalind Franklin,, Jocelyn Bell Burnell, Esther Lederberg, Lise Meitner, Clara Immerwarf, Emmy Noether (mathematician) or others that may come to your attention. **You may not write on Rosaline Franklin** as we have devoted much time to her story in the context of class material and assignments such as the 1000 word essay related to The Double Helix.

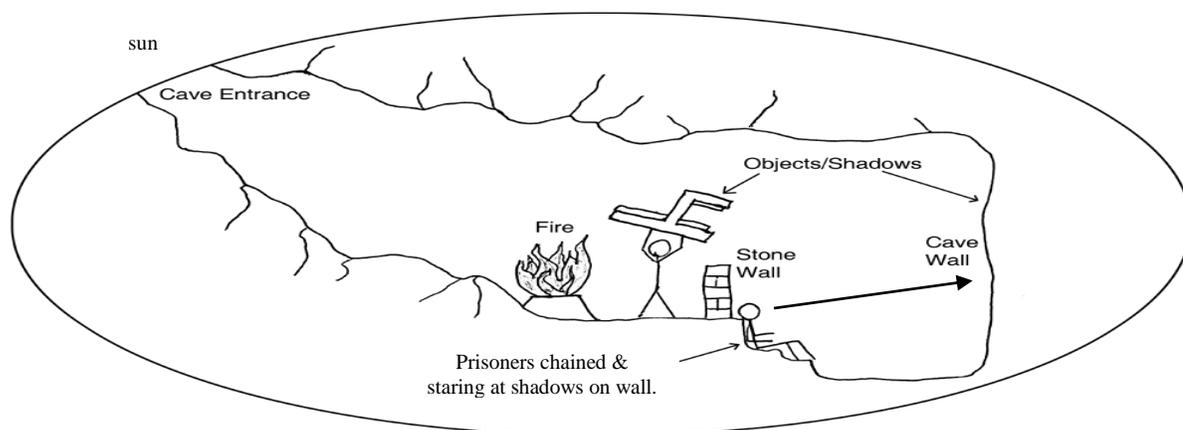
2. Should Nobel Prizes be awarded to scientists (1 to 3) or should they be awarded to discoveries, not to individuals? What are the limitations and even injustices at times to awarding Nobel Prizes to individual scientists limited in number? Here are two introductory pieces on this topic. There are several others as well.

http://www.slate.com/articles/health_and_science/science/2017/10/the_nobel_prize_does_science_a_serious_disservice.html

<https://www.theatlantic.com/science/archive/2017/10/the-absurdity-of-the-nobel-prizes-in-science/541863/> 1/6

3. Should the America government have used atomic bombs on Japan, Hiroshima and Nagasaki?

4. An essay on Plato's *Allegory of the Cave*. You will first need to read Plato's *Allegory of the Cave*. It is a short piece. It is found on Blackboard for Great Discoveries under Documents. Your task is to apply Plato's allegory of the cave to modern times, most particularly to natural science. However, you may apply the "cave" story to any aspect of modernity. For example, does the "cave" intersect with the film *The Matrix*? The Little Prince—"What is essential is invisible to the eye." What does the cave represent? How about the prisoners, the shadows on the wall, the marionette players, the fire, and the area outside the cave? In other words, explain the allegory from a modern perspective, particularly with regard to sciences. In no way do I want to limit your creativity here. A pictorial representation of the "cave" story is below. Plato's Cave is on Blackboard under "Documents Chem 150".



With regard to the final paper for Chem 150:

Please see the course syllabus for topics, length, etc. for the final paper. It is a typical research/response erudite paper. It is due by the last day of finals. It will be graded for coherence, fidelity, form, content, and style.

Please consult the Purdue Online Writing Lab resources listed below. Have your paper conform to this guidelines in the two sites below. Your paper must minimally have five cogent references formatted appropriately (see Purdue OWL site).

Please follow the Purdue Online Writing Lab resources for final COLL/CHEM 150 Great Discoveries papers.

1. Writing a research paper: <https://owl.english.purdue.edu/owl/owlprint/658/>

2. Formatting and style guide: <https://owl.english.purdue.edu/owl/resource/747/01/>