

History 89S / Chemistry 89S Syllabus (v. Jan 4, 2022)

Making and knowing the material world: Exploring the history of chemistry

Weds 3:30-6pm, West Duke 08A

Prof. Evan Hepler-Smith (evan.heplersmith@duke.edu)

Office Hours: Tues 2-4pm, Classroom Bldg 319 + via Zoom, and by appointment

Prof. Patrick Charbonneau (patrick.charbonneau@duke.edu)

Office Hours: Mon 4:30-5:30pm via Zoom

This course introduces students to the history of the chemical sciences: the rich and diverse ways of knowing, using, and making material substances that have shaped human societies and environments. Emphases are on understanding the chemistry of the past in its own terms, situating chemistry within history more broadly, and appreciating how historical perspectives can contribute to present-day chemistry. Topics may include alchemy, the Chemical Revolution, the development of the periodic system of elements, non-Western chemistry, the rise of theoretical chemistry, chemistry and the environment, and the relationship between chemical sciences and chemical industries.

Course requirements and grading:

- | | |
|---|-----|
| • Seminar participation | 40% |
| • Assignment 1: Thinking like a chemist in past and present | 30% |
| • Assignment 2: Cultures of chemistry in past and present | 30% |

Learning goals: By the end of this class, students will:

- Gain familiarity and interest in history, chemistry, their respective methods, and how they may relate to one another.
- Through in-class lectures and discussion, become familiar with key concepts and methods in chemistry and be able to compare them and/or apply them to examples of historical chemistry.
- Through in-class exercises and written assignments, be able to analyze examples of historical chemistry in their own terms, in relation to their cultural contexts, and in relation to present-day issues involving chemicals and chemistry.
- Through instructor-guided research, gain familiarity with a range of historical primary sources, including historical archives.
- Through readings, in-class discussion, and written assignments, be able to describe and apply the criteria for good historical argumentation: quality of evidence, engagement with historiography, and significance of argument.
- Through in-class exercises and assignments, learn to recognize and appropriately use primary, secondary, and tertiary sources in both history and chemistry.

Course logistics: A typical week of this course will include three to five hours of out-of-class reading, plus a short response to a discussion question or exercise (to be posted on Sakai by the evening before class). Each class meeting will include: 1) discussion of weekly readings and related historical topics, 2) short lecture and discussion of chemistry topics

Syllabus subject to change at instructors' discretion. See Sakai for latest version.

related to the week's readings, 3) a skill-building exercise focusing on some aspect of the historical study of chemistry, and 4) a brief lecture providing historical context for the following week's readings. For the first half of the course (before spring break), in-class discussions of chemistry will focus on familiarizing ourselves with some key concepts and methods in the present-day chemistry. The second half will focus on applying these concepts and methods in our studies of historical chemistry and in relating historical findings to issues in present-day chemistry.

Seminar participation: To do your part in making for a productive class (and earn full credit for participation), please:

- a) **read** each week's assigned texts;
- b) **post** your response to the weekly discussion question by the evening before class;
- c) **attend** class meetings, engaging in discussion as both **speaker** and **listener**;
- d) **present** an informal overview of findings from your assignments in our final class

Assignments: We will have two major assignments this term. Details at end of syllabus.

Late submissions: Except with prior consultation and written consent of instructor, a **half letter grade** (A to A-, A- to B+, etc.) will be deducted from assignments submitted after the deadline listed on the syllabus. An **additional half-letter grade** will be deducted for each additional two days of late submission (including weekends). Questions? Ask! (Please do ask; deadlines are there to support your progress through the course, not to burden you.)

Collegiality and mutual support: We all bring different perspectives, experiences, identities, and concerns to this class. Some topics may be a matter of positive personal experience to come, negative personal experience to others, and entirely unfamiliar to still others. You will all disagree (we hope!) with some of the arguments advanced by our authors, instructors, and each other. We ask that you join in supporting our mutual growth by posing frank questions, presenting sincere arguments, testing uncertain ideas, and listening and responding to each other in a tough-minded spirit of generosity. Please keep an eye on the syllabus and our communications regarding what's coming up; if you have any concerns, please let us know.

Unforeseen conflicts: We're committed to being flexible and making accommodations that are fair to all students in the course. If you anticipate trouble, please speak with your instructors as soon as possible. The more we can stay ahead of challenging circumstances, the better we'll be able to navigate them.

Collaboration and academic integrity: Group presentations will be evaluated as the collective work of all group members. Individual problem sets and essays should reflect your own research, thinking, and writing. You are warmly encouraged to consult with

Syllabus subject to change at instructors' discretion. Latest version posted on Sakai.

others in and outside of class on all aspects of coursework. As a matter of intellectual generosity, please acknowledge substantial assistance you receive from anyone other than course instructors by including an “acknowledgements” note in your assignment submission. This course is subject to the [Duke Community Standard](#). If you have questions on collaboration, [citation](#), or [appropriate use of sources](#), please ask!

Electronics, accommodations, and accessibility: We want to do all we can to ensure that this class is accessible, inclusive, and equitable for all students. Please notify us within the first two weeks of class (or as soon as possible for concerns arising mid-semester) with information about accommodations that we can provide to ensure accessibility, per the [Student Rights and Responsibilities](#) of the Duke accessibility office. If you have other concerns about classroom inclusiveness, please let us know. We will work with you!

Please join us in directing all in-meeting electronics use and multitasking toward activities that feed into our course rather than distract from it. Note-taking, consulting readings electronically, and searching online resources for discussion-relevant information are appropriate; social media, shopping, email, and other non-course-relevant activities are not. We strongly prefer that you stick with tablets or laptops during class meetings and keep phones away; however, we are happy to make any exceptions that will aid rather than impede full participation by all. Again: please ask!

Duke University is committed to providing equal access to students with documented disabilities. Students with disabilities may contact the Student Disability Access Office (SDAO) to ensure your access to this course and to the program. There you can engage in a confidential conversation about the process for requesting reasonable accommodations both in the classroom and in clinical settings. Students are encouraged to register with the SDAO as soon as they begin the program. Please note that accommodations are not provided retroactively. More information can be found online at access.duke.edu or by contacting SDAO at 919-668-1267, SDAO@duke.edu.

Week 1 (Jan 12): Introduction: What is chemistry? What is history?

Week 2 (Jan 19): The alchemical laboratory

The chemistry of distillation and separations***Readings***

- Lawrence Principe, *The Secrets of Alchemy* (Chicago: University of Chicago Press, 2013), introduction, chapters 2 & 6 (1-7, 27-50, 137-171).
 - Plus: “Inside the Mind of an Alchemist – Featuring Larry Principe” (2013), <https://www.youtube.com/watch?v=7ealYU2ICnU>

Syllabus subject to change at instructors’ discretion. Latest version posted on Sakai.

- Bruce T. Moran, *Distilling Knowledge: Alchemy, Chemistry, and the Scientific Revolution* (Cambridge, MA: Harvard University Press, 2005), chapter 2 (37-66).

Week 3 (Jan 26): Chemical substances

The chemistry of acids, bases, & salts

Readings

- Hasok Chang, *Is Water H₂O?: Evidence, Realism and Pluralism* (New York: Springer, 2012), introduction & selections from chapter 1 (xv-xxi, 1-14, 29-50).
- Antoine Laurent Lavoisier, *Elements of Chemistry, in a New Systematic Order, Containing All the Modern Discoveries: Illustrated with Thirteen Copperplates*, trans. Robert Kerr (Edinburgh: William Creech, 1790), 83-96.
- Joseph Priestley, "Experiments and Observations Relating to the Principle of Acidity, the Composition of Water, and Phlogiston," *Philosophical Transactions of the Royal Society of London* 78 (January 1, 1788): 147-57, <https://doi.org/10.1098/rstl.1788.0012>.

Week 4 (Feb 2): Metals, minerals, and mining

Electrochemistry: oxidation & reduction

Readings:

- Jöns Jakob Berzelius, *An Attempt to Establish a Pure Scientific System of Mineralogy, by the Application of the Electro-Chemical Theory and the Chemical Proportions*, trans. John Black (London: Robert Baldwin, 1814), <http://hdl.handle.net/2027/mdp.39015008100003>, 5-27, 43-50, 109-118, 122-124.
- Gabrielle Hecht, "An Elemental Force: Uranium Production in Africa, and What It Means to Be Nuclear," *Bulletin of the Atomic Scientists* 68, no. 2 (March 1, 2012): 22-33.
- Additionally, each student will read ONE of the following:
 - Shadreck Chirikure, *Metals in Past Societies: A Global Perspective on Indigenous African Metallurgy* (Cham: Springer, 2015), selections.
 - Allison Margaret Bigelow, *Mining Language: Racial Thinking, Indigenous Knowledge, and Colonial Metallurgy in the Early Modern Iberian World* (Chapel Hill: Omohundro Institute and UNC Press, 2020), selections.
 - Sung Ying-Hsing (Song Yingxing), *T'ien-Kung k'ai-Wu [Tiangong Kaiwu]*, trans. Shiou-chuan Sun and E.-tu Zen Sun (University Park, PA: Pennsylvania State University Press, 1966), chapter 14 (235-259) AND Dagmar Schäfer, *The Crafting of the 10,000 Things: Knowledge and Technology in Seventeenth-Century China* (Chicago: University of Chicago Press, 2011), introduction (1-18)

Week 5 (Feb 9): Chemical atomism: Hypothesizing, visualizing, classifying, and splitting atoms

Stoichiometry, the periodic system, & periodic trends

Readings

Syllabus subject to change at instructors' discretion. Latest version posted on Sakai.

- Michael D. Gordin, "The Textbook Case of a Priority Dispute: D. I. Mendeleev, Lothar Meyer, and the Periodic System," in Jessica Riskin and Mario Biagioli, *Nature Engaged: Science in Practice from the Renaissance to the Present* (New York: Palgrave Macmillan, 2012), 59-82.
- Dmitri Mendeleev, "How I Discovered the Periodic Law," in *Mendeleev on the Periodic Law*, ed. William B. Jensen, 192-226.
- Marie Sklodowska Curie, "Radium and Radioactivity," *The Century* 67 (Jan 1904), 461-466.
- Lise Meitner and O. R. Frisch, "Disintegration of Uranium by Neutrons: A New Type of Nuclear Reaction," *Nature* 143, no. 3615 (February 1939): 239-40.

Week 6 (Feb 16): Quantum chemistry & Fritz London (meet in Rubenstein)

The structure of the atom & electron configurations

Readings

- Kostas Gavroglu, *Fritz London : A Scientific Biography* (New York: Cambridge University Press, 1995), <https://find.library.duke.edu/catalog/DUKE005838811>, selections.
- AND/OR Kostas Gavroglu and Ana Simões, *Neither Physics nor Chemistry: A History of Quantum Chemistry* (Cambridge, Mass: MIT Press, 2012), selections

Week 7 (Feb 23): Coal-tar dyes & structural organic chemistry

The chemistry of color (basics of organic chemistry)

In-class workshop: bring Assignment 1 work in progress with you

Readings

- Anthony S. Travis, *The Rainbow Makers: The Origins of the Synthetic Dyestuffs Industry in Western Europe* (Bethlehem, PA: Lehigh University Press, 1993), selections.
- Carolyn Cobbold, *A Rainbow Palette : How Chemical Dyes Changed the West's Relationship with Food* (Chicago: University of Chicago Press, 2020), <https://find.library.duke.edu/catalog/DUKE010138554>, selections.

Assignment 1 due by 5pm on Monday, Feb 28

Week 8 (Mar 2): Drugs, biomolecules, & the chemical structure of life

The chemistry of biopolymers

Readings

- Paul Ehrlich, *Experimental Researches on Specific Therapeutics* (New York: Hoeber, 1909), <http://www.biodiversitylibrary.org/bibliography/28293>, selections.
- Jane S. Richardson, "The Anatomy and Taxonomy of Protein Structure," in *Advances in Protein Chemistry*, vol. 34 (Academic Press, 1981), 167-339, [https://doi.org/10.1016/S0065-3233\(08\)60520-3](https://doi.org/10.1016/S0065-3233(08)60520-3), brief selections.

Syllabus subject to change at instructors' discretion. Latest version posted on Sakai.

SPRING BREAK**Week 9 (Mar 16): The natural and the synthetic**

Readings

- Bernadette Bensaude-Vincent, "Reconfiguring Nature through Syntheses: From Plastics to Biomimetics," in *The Artificial and the Natural: An Evolving Polarity*, ed. William Royall Newman and Bernadette Bensaude-Vincent, (Cambridge, MA: MIT Press, 2007), 293-312.
- Tara E. Nummedal, "The Lion's Blood," in *Anna Zieglerin and the Lion's Blood: Alchemy and End Times in Reformation Germany* (Philadelphia: University of Pennsylvania Press, 2019), 70-100.
- G. P. Hoff, "Nylon as a Textile Fiber," *Industrial & Engineering Chemistry* 32, no. 12 (December 1, 1940): 1560-64, <https://doi.org/10.1021/ie50372a007>.

Week 10 (Mar 23): Chemistry at war

Readings

- Edmund Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (New York: Cambridge University Press, 2001), introduction, chapters 5-6.
- Pap A. Ndiaye, *Nylon and Bombs: DuPont and the March of Modern America*, trans. Elborg Forster (Baltimore : Johns Hopkins University Press, 2007), chapter 4, 141-178.
<https://find.library.duke.edu/catalog/DUKE008561568>.
- Amos Alfred Fries and Clarence Jay West, *Chemical Warfare* (New York: McGraw-Hill, 1921), 427-439.

Week 11 (Mar 30): Chemistry in the environment

Readings

- Rachel Carson, *Silent Spring* (Boston: Houghton Mifflin, 1962), chapters 1-4.
- "The Desolate Year," *Monsanto Magazine*, October 1962.
- Reena Shadaan and Michelle Murphy, "EDC's as Industrial Chemicals and Settler Colonial Structures: Towards a Decolonial Feminist Approach," *Catalyst: Feminism, Theory, Technoscience* 6, no. 1 (May 15, 2020): 1-36, <https://doi.org/10.28968/cftt.v6i1.32089>.

Week 12 (Apr 6): Chemistry at home

In-class workshop: bring Assignment 2 work in progress with you*Readings*

- Linda Civitello, *Baking Powder Wars* (Urbana: University of Illinois Press, 2017), chapter 1-4.
- Ellen Henrietta (Swallow) Richards, *Food materials and their adulterations* (Boston: Home Science Publishing, 1898), selections.
<https://archive.org/details/foodmaterialsthe00rich>

Assignment 2 due by 5pm on Monday, April 11

Syllabus subject to change at instructors' discretion. Latest version posted on Sakai.

Week 13 (Apr 13): Chemistry on the farm

Readings

- George Washington Carver, *Twelve Ways to Meet the New Economic Conditions Here in the South*, Experiment Station Bulletin no. 33 (Tuskegee, Ala.: Tuskegee Normal and Industrial Institute, 1917), <https://catalog.hathitrust.org/Record/101642572>.
- Adam Romero, *Economic Poisoning: Industrial Waste and the Chemicalization of American Agriculture* (Oakland: University of California Press, 2022), selections.

Week 14 (Apr 20): Presentations and wrap-up

Readings

- Film or fiction, TBD

* * *

Assignment 1 (due Mon Feb 28) will analyze a historical primary source for its approach to chemical ideas and/or experimental practice. The goals of this assignment are 1) to explain how the author and readers of this source would have understood the chemical phenomena it discusses, 2) to explain how present-day chemists understand these phenomena, and 3) to suggest some possible reasons for differences (and/or for surprising similarities!) between these examples of chemical thinking in the past and in the present.

Assignment 2 (due Mon Apr 11) will present an argument regarding how some development in the history of chemistry related to its cultural context. You may use a range of different sources as primary-source evidence in this assignment: textual sources, an interview of a scientist, images, instruments, materials, films, and more! For information about historical contexts and the ways they may have affected the practice of chemistry, we will ask you to draw on one or more secondary sources (books or articles of historical scholarship), either from our syllabus or elsewhere.

Good historical arguments come in many formats, and we are flexible about the form and length of these assignments. For example, you may find it easiest to describe some aspects of historical and present-day chemistry using appropriate diagrams, formulas, or reaction equations, supplemented by explanation of the meanings of these symbols. The foundation of all good historical scholarship is accurate citation of all sources, for reasons of transparency in use of evidence and academic integrity. Whatever form your assignments take, we will ask that you cite all sources and provide a bibliography of works cited.

We will make ample time in-class, including during a dedicated workshop session for each assignment, to work with you on choosing a topic of appropriate scope, finding appropriate sources, and crafting your arguments. (We encourage you to bring additional questions to office hours!)

Syllabus subject to change at instructors' discretion. Latest version posted on Sakai.

