ENTOMOL 7910: Nature and Practice of Science SP 2023 (2 credits)

Time: Mondays, Noon - 2:00 PM

Location: 244 Kottman Hall (Columbus) & 244 Wooster Science Building (via Zoom)

Instructor:

Professor Carol Anelli
Department of Entomology
253 Howlett Hall, Columbus
Anelli.7@osu.edu
Office hours-- by appointment (email Carol)

Text book (required)

Eisley, Loren. 1961. Darwin's Century: Evolution and the Men Who Discovered It.

Required readings— see Carmen modules for selected excerpts

Appleman, Philip. 2001. Darwin: A Norton Critical Edition. Selected and edited by P. Appleman. 3rd Edition. WW Norton & Company, ISBN-0-393-05849-3

Gauch, Jr. Hugh G. 2014. Scientific Method in Brief. Cambridge University Press. ISBN-13: 978- 1107666726

Institute of Medicine. 2009. On Being a Scientist: A guide to responsible conduct in Research, 3rd ed. National Academies Press. Washington, DC https://doi.org/10.17226/12192

Mayr, Ernst. 1982. The Growth of Biological Thought: Diversity, Evolution, and Inheritance. The Belknap Press. ISBN-13: 978-0674364462

Moore, John A. 1993. Science as a Way of Knowing: The Foundations of Modern Biology. Harvard University Press. ISBN-13: 978-0674794825

Recommended for further reading

Graf, Chris., et al. 2007. Best practice guidelines on publication ethics: a publisher's perspective. *Int. J. Clin. Pract.* 61 (Suppl. 152), 1-26.

Lee, Jeffrey A. 2016. The Scientific Endeavor: A Primer of Scientific Principles and Practice. 2nd Edition. CreateSpace Independent Publishing, ISBN-13: 978-1536893830

Magner, Lois N. 2002. A History of the Life Sciences. CRC Press. 3rd Edition. ISBN 13: 978-0824708245

Root-Bernstein, Robert and Michèle. 1999. Sparks of Genius: The Thirteen Thinking Tools of the World's Most Creative People. Houghton Mifflin Co., ISBN-0-395-90771-3

Woodward, J. and D. Goodstein. 1996. Conduct, misconduct and the structure of science. *American Scientist*, 84(5):479-490

Course Description

We begin with an overview of the history of biological thought, starting with Aristotle and the ancient Greeks. After consideration of St. Augustine and Scholasticism we turn attention to the Scientific Revolution, highlighting key people and advances in science and medicine including Bacon, Leeuwenhoek, DaVinci, and Hooke. We review key advances in geological science in the 18th and 19th centuries that proved critical for Darwin's theory of species origin *via* the mechanism of natural selection. This theory countered the earlier view popularized by Paley. We discuss Darwin's life, influences, critics, and contributions and examine his approach to science as an exemplar of the hypothetico-deductive method. Writings by key philosophers of science provide additional foundational context.

In the second portion of the course we discuss the scientific endeavor, including best practices, integrity in research, the value of diversity and inclusion, and the ethical obligations and social responsibilities of scientists.

Course Goals & Learning Outcomes

Upon completion of this course, successful students will:

A. *Discuss the growth of science as a way of knowing*
   - A1. Identify key people, concepts, schools of thought, and advances in the history of biological science
   - A2. Explain and provide examples of paradigm shifts
   - A3. Cite examples of technological advances and their impact on science
   - A4. Conduct a literature search demonstrating the growth of scientific knowledge and approaches relevant to their own research program
   - A5. Discuss how historians of science evaluate and interpret historical sources to create historiography and why it can change over time

B. *Critically examine science and its methodology as a way of knowing*
   - B1. Discuss the role of theory and the refinement of theory in the advancement of scientific knowledge
   - B2. Distinguish science as a way of knowing and the roles of observation, and inductive and deductive logic, in scientific reasoning and hypothesis testing
   - B3. Identify key people and ideas in the philosophy of science

C. *Explain and evaluate science as a human endeavor*
   - C1. Explain the significance of communal review of findings, and justification for reporting scientific findings, errors, and fraud
   - C2. Discuss ethical dilemmas in research and scholarship and justify the value of diversity and inclusion in the scientific enterprise
   - C3. Explain the importance of scientific integrity and be able to identify forms of scientific misconduct.
   - C4. Discuss and evaluate the ethical and social obligations of scientists

D. *Prepare a manuscript per author guidelines for American Entomologist (AE)*
   D1. Present context for and significance of the topic
   D2. Support the thesis/argument being presented in the manuscript
   D3. Cite relevant literature
   D4. Write (~800 words) in a style appropriate for column submission to *AE*

Assignments

To help you meet the course goals and achieve the learning outcomes, Carol will comment on your submitted discussion questions, participation, and mid-term exam and provide feedback on your manuscript assignment. Please check your work after submission to review her comments and feedback; email her with any follow-up questions or concerns.

Recorded lecture segments. Check Carmen modules for Carol's PowerPoint recordings on the topics listed for weekly class discussions. View the recordings before class time and take notes. Come to class prepared to contribute to discussion of each topic and set of readings.

Discussion questions. The goal of this activity is to create and share questions to enliven our discussions and deepen your comprehension. Post a total of at least 3 thoughtful questions per set of weekly readings to Carmen *before class time* and use them as a springboard for class discussion. Your questions should demonstrate that you have completed the readings *and* pondered their significance.

Participation. Come to every class prepared to contribute thoughtfully to discussion.

Manuscript for *American Entomologist (AE)*. *AE* is the flagship publication of the Entomological Society of America (ESA). The manuscript you will write is a semester-long assignment worth *50% of your final grade;* its several mini-deadlines are intended to help you produce a publication-worthy column for *AE.* My hope is that you will eventually submit your MS for publication in *AE.* (I have had students do this in the past, including Dr. Jamie Strange, so it is an achievable goal!) Ideas for potential topics are posted in the Carmen module; alternatively, you can come up with your own topic.

Your *AE* manuscript (MS) of *ca.* 800 words (excluding References) must be written for one of these *American Entomologist* columns: Musings, Signals, Student Life, or Zyzzyva. Each *AE* column has its own focus; select the one that best suits your topic. Follow carefully the Instructions for Authors of *AE*.

Deadlines for *AE* manuscript assignment

Please be cognizant of these deadlines, as last assignments are subject to point reduction of 10% per day it is late:

- Jan 16— Peruse potential MS topics in Carmen module (or conceive your own topic)
- Jan 25— Email Carol no later than this date for Zoom meeting to discuss your topic(s)

- Feb 13—Submit your MS topic (approved by Carol in Zoom meeting) to Carmen
- Mar 6— Submit your MS abstract (*ca.* 50 words) plus at least 3 references to Carmen
- Apr 3— Submit *well edited, near final version* draft of your MS (~800 words) to Carmen
- Apr 26—Submit final version (*it should be in excellent shape!*) of your MS to Carmen

Mid-term Exam. There is one closed-book exam, completed during class time, worth 30% of your final grade. Format is short answer identification questions (each ID will focus on a key person or concept) selected from a list of IDs; plus one or two essay questions, typically selected from a choice of two or three questions.

Assignments and Percentage Allocations

Discussion questions (~ 3 per class, upload to Carmen before class)	10%
Participation in class discussion	10%
American Entomologist MS (see various deadlines for Carmen uploads)	50%
Mid-term Exam	30%
	100%

Grade Distribution

A 93-100%	C..... 71-74
A-.....89-92	C-.....68-70
B+.....85-88	D+.....65-67
B 81-84	D.....60-64
B- 78-80	F .....< 60
C+. 75-77	

Attendance, Participation, Late Work Policy

Plan to attend all classes. For missed classes, notify Carol *via* email before class and provide a reason for your absence. View the Zoom recording of the class discussion.

Your participation and contributions to class discussions should demonstrate that you have completed the readings and have applied critical, deep thought vis-à-vis the context and content of the assignment. Come prepared to contribute to every class discussion.

Late work is subject to grade reduction (10% per late day). Consult Carmen for all assignments and due dates. Any unanticipated changes will be announced *via* Carmen.

Course Schedule, Assigned Readings, Assignments

Take substantive notes on all readings and recorded lecture segments.

Jan 9: Welcome; Historiography; Science of Ancient Greece

Readings

- Andrews & Burke. 2007. What does it mean to think historically? *Perspectives on History*, Jan 1 issues, pp. 1-6.
- Moore: Chapters 2 & 3, pp. 30-58

Assignments due before class:

1. Read syllabus; come prepared with any questions regarding it.
2. View recorded lecture segments posted in Carmen module and take notes.
3. In Carmen, submit ~3 questions relevant to the readings.

Jan 16: No class; Celebrate MLK

Readings

- Peruse *American Entomologist* journal articles posted at Carmen and identify potential topic(s) for your MS. Email Carol with any questions or request for Zoom meeting.

Assignment due by Jan 25:

- Email Carol for a Zoom meeting to discuss your potential topic(s).

Jan 23: St. Augustine & Judeo-Christian Worldview

Reading

- Moore: Chapter 4, pp. 59-76

Assignments due before class:

1. Email Carol for a Zoom meeting to discuss your potential topic(s) (due date Jan 25).
2. View recorded lecture segments posted in Carmen module and take notes.
3. In Carmen, submit ~3 questions relevant to the readings.

Jan 30: Revival of Science—Vesalius, Harvey, Bacon, Leeuwenhoek, Hooke; *Scala Naturae*, Ray, Linnaeus & *Systema Naturae*, Fixity of Species

Readings

- Moore: Chapter 5, pp. 77-101
- Eisley: Chapter 1--The Age of Discovery

Assignments due before class:

1. View recorded lecture segments posted in Carmen module and take notes.
2. In Carmen, post answers to questions relevant to the readings.

Feb 6: 18th Century Naturalists: De Maillet, Buffon, Erasmus Darwin, Lamarck

Readings

- Eisley: Chapter 2-- The Time Voyagers

Assignments due before class:

1. View recorded lecture segments posted in Carmen module and take notes.
2. In Carmen, post answers to questions relevant to the readings.

Feb 13: Geology, Part 1: Figur'd Stones & Plastick Virtue; Time (Age of Earth); Hooke; Hutton; Cuvier & Catastrophism

Readings

- Moore: Chapter 6, pp. 102-115
- Eisley: Chapter 3—The Pirate Chart, *except* Part VI, on William Smith

Assignments due before class:

1. Submit your MS topic (approved by Carol in Zoom) to Carmen before midnight.
2. View video(s) posted in Carmen module and take notes.
3. In Carmen, post answers to questions relevant to the readings.

Feb 20: Geology, Part 2: Quarries of Paris Basin; Lyell & Uniformitarianism; Smith & Geological Column; Understanding Nature in 1850

Readings

- Moore: Chapter 6, pp. 115-127
- Eisley: Chapter 3, part VI, William Smith; Chapter 4— on Lyell, Uniformitarianism, & Non-Progressionism
- De Beer. 1964. Biology before the *Beagle.* In Appleman, pp. 33-39.

Assignments due before class:

1. View recorded lecture segments posted in Carmen module and take notes.
2. In Carmen, post answers to questions relevant to the readings.

Feb 27: Darwin— Brief Bio, Intellectual Influences, *Beagle* Voyage

Readings

- Mayr. 1991. Who is Darwin? In Appleman (2001), pp. 23-29
- Eisley: Chapter 6— The Voyage of the *Beagle*
- *Links at Carmen:* View Darwin's Notebooks while listening to Darwin historian David Kohn comment on the significance of eight Notebook entries.

Assignments due before class:

1. View recorded lecture segments posted in Carmen module and take notes.
2. In Carmen, post answers to questions relevant to the readings.

Mar 6: Paley & Natural Theology; Bridgewater Treatises; *Beagle* Voyage revisited; Malthus; Law of Divergence; First Essay; Darwin & Lamarck

Readings:

- Eisley: Chapter 7— The Making of the *Origin*
- Malthus; Paley: Excerpts in Appleman, pp. 39-41
- Moore: Chapter 7, pp. 136-147

Assignments due before class:

1. Submit your MS abstract (*ca.* 50 words) plus at least 3 references to Carmen.
2. View recorded lecture segments posted in Carmen module and take notes.
3. In Carmen, post answers to questions relevant to the readings.

SPRING BREAK Mar 13-17

Mar 20: MIDTERM EXAM (closed book; lockdown browser online)—To prepare, review recorded video segments, notes on readings, notes on discussions through 6 Mar.

Mar 27: Darwin as Exemplar for Use of the Hypothetico-Deductive Method; Scientific Contributions;

Readings:

- Ruse, M. 1975. Darwin's debt to philosophy: An examination of the influence of the philosophical ideas of John F.W. Herschel and William Whewell on the development of Charles Darwin's theory of evolution. *Studies in the History and Philosophy of Science* Part A 6:159-181.
- Herschel excerpt, w/annotations. In Appleman, pp. 52-57
- Appleman. 2000. Darwin: On Changing the Mind. In Appleman, pp. 3-17
- Moore: Chapter 7, pp. 131-136

April 3: Dr. Kayla Perry-- Defining Science, Part 1. Methodology; Deductive and Inductive Logic; Kuhn, Popper; Science *vs.* Other Ways of Knowing

Potential Readings:

- Shrake et al. 2006. What is Science? *Ohio Journal of Science,* 106:130-135.
- National Academy of Sciences. 1999. Evolution.
- Gauch, pp. 21-51 (skim); 112-115; 123-129
- Lawson, A.E. 2015. Hypothetico-deductive Method. In Gunstone R. (eds) Encyclopedia of Science Education. Springer, Dordrecht, pp. 471-472.
- Kuhn, T.S. 1982. Logic of discovery or psychology of research. In P. Grime, ed.*Philosophy of Science and the Occult.* SUNY Press, Albany, New York.
- Popper, K.R. 1982. Science: conjectures and refutations. In P. Grime, ed.*Philosophy of Science and the Occult.* SUNY Press, Albany, New York.

- Naughton, J. 2012. The man who changed the way the world looked at science. 18 Aug. *The Guardian* (UK newspaper)

Assignment due before class:

1. In Carmen, submit *well edited, near final version* draft of your MS (~800 words).
2. In Carmen, look for assignment from Dr. Perry relevant to the readings.

April 10: Darwin's Influence on Science; Historical Criticism of Darwinism

Readings:

- Ayala, F.J. 2009. Darwin and the scientific method. *PNAS* 106:10033-10039.
- Wallace, A.R. 1883. Debt of science to Darwin (excerpt). Appleman, pp. 287-288.
- Quotes from various scientists. Appleman, p. 255.
- Hull, D.L. 1983. *Darwin and his Critics* (excerpt). Appleman, pp. 257-265.
- Bowler, P. 1984. *The Evolutionary Synthesis* (excerpt). Appleman, pp. 319-325

Assignment due before class:

1. In Carmen, post answers to questions relevant to the readings.

April 17: Dr. Bruce McPheron-- On Being a Scientist; Scientific Integrity

Potential Readings:

- Committee on the Conduct of Science. 1989. On Being a Scientist. National Academies Press. Washington, DC
- O'Connor C. and Weatherall J.O. 2019. What is truth? Excerpt from *The Misinformation Age: How False Beliefs Spread*, pp. 19-45.
- Weinberg, S. 2003. Four golden lessons. *Nature* 426:389.

Assignment due before class:

1. In Carmen, look for assignment from Dr. McPheron relevant to the readings.

April 24: Dr. Leo Taylor-- Equity, Diversity, and Inclusion in Science

Potential Readings:

- Brower A., James, A. 2020. Research performance and age explain less than half of the gender pay gap in New Zealand universities. *PLoS ONE* 15(1): e0226392.
- Budden, A.E. et al. 2008. Double-blind review favours increased representation of female authors. *Trends in Ecology and Evolution*, 23(1):4-6.
- Cameron, E.Z. et al. 2016. Solving the productivity and impact puzzle: Do men outperform women, or are metrics biased? *BioScience*, 66(3):245-252.
- Griffin, K.A. 2019. Race and ethnicity in Higher Education: A Status Report.
- Li D., Koedel, C. 2017. Representation and salary gaps by race-ethnicity and gender at selective public universities. *Educational Researcher* 46(7);343-354
- Moss-Racusin, C.A. et al. 2014. Scientific diversity interventions. *Science* 343:615-616.
- Peifer, J.S. 2019. Context and reasons for bolstering diversity in undergraduate research. *Frontiers in psychology* 10:1-3.
- Shen, H. 2013. Mind the gender gap. *Nature*, 495(7439):22-24.

Assignment due before class:

1. Submit final version (*it should be in excellent shape!*) of your MS by Apr 26.

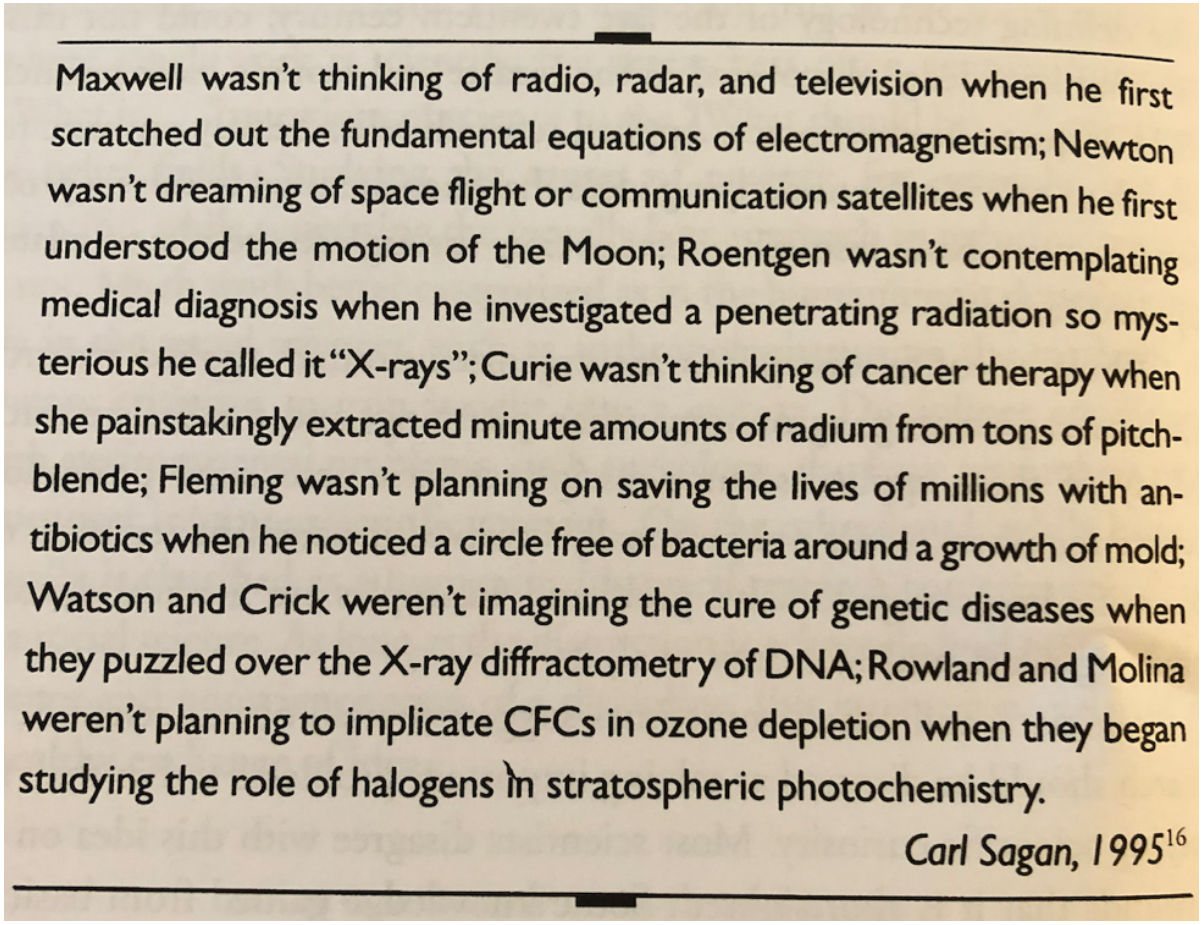
2. In Carmen, look for assignment from Dr. Taylor relevant to the readings.

Academic Misconduct Statement

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

Academic Disabilities Statement

Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/



Maxwell wasn't thinking of radio, radar, and television when he first scratched out the fundamental equations of electromagnetism; Newton wasn't dreaming of space flight or communication satellites when he first understood the motion of the Moon; Roentgen wasn't contemplating medical diagnosis when he investigated a penetrating radiation so mysterious he called it "X-rays"; Curie wasn't thinking of cancer therapy when she painstakingly extracted minute amounts of radium from tons of pitchblende; Fleming wasn't planning on saving the lives of millions with antibiotics when he noticed a circle free of bacteria around a growth of mold; Watson and Crick weren't imagining the cure of genetic diseases when they puzzled over the X-ray diffractometry of DNA; Rowland and Molina weren't planning to implicate CFCs in ozone depletion when they began studying the role of halogens in stratospheric photochemistry.

Carl Sagan, 1995[16]

Quote from Sagan, C. 1995. **The Demon-Haunted World: Science as a Candle in the Dark**, p. 398 Random House: New York