

Philosophy of Science

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Course summary

What is science? How does it work? And where did it come from? These are the three central questions we will consider throughout the course. We will draw on historical, philosophical, and sociological resources in answering these questions. We will consider philosophical attempts to define a method that distinguishes scientific and non-scientific inquiry. We will also investigate how our collective understanding of science has changed over time by looking at debates over the nature of heat, gravitation, the age of the earth, and the organization of the solar system. Finally, we will examine how the social organization of science structures empirical inquiry and assess what that means for “following the science” with respect to difficult questions of climate change and public health policy.

Course texts

Three books are required for this course:

- Strevens, M. 2020. *The Knowledge Machine* (Liveright)
- Bowler, P.J. and Morus, I.R. 2020. *Making Modern Science*, 2nd ed. (Chicago)
- Kuhn, T. 2012. *The Structure of Scientific Revolutions*, 4th ed. (Chicago)

Other readings will be made available on the Canvas page for the course.

Grading

*All rubrics are available on Canvas. I will provide feedback on any assignment, but drafts must be submitted within 72 hours of the assigned due date.

Participation (0%): There is no formal attendance policy. More than 4 unexcused absences could result in an F, as per the College’s policy.

Short responses (15%; *Due before class*): Prior to class, please submit a 100-word summary of the reading for class that day (if there are multiple readings, please summarize just *one* of the readings). These can be submitted on Canvas.

Science and public engagement (20%; *Due before end of semester but not before February 27*): You will identify a portrayal of science in popular media and write 500-750 words about what this portrayal of science indicates about some underlying assumptions of popular conceptualizations of science. This could be a clip from a TV show, an op-ed from a nationally circulated newspaper, or a popular science book (but this list is not exhaustive). I will provide some examples in the early part of the semester to help you think about the assignment.

Paper 1 (15%; *Due 2/24*): You will write one short paper on the Scientific Revolution, the subjectivity of scientific inquiry, the nature of scientific paradigms, or whether falsification demarcates scientific claims from non-scientific claims.

Paper 2 (20%; *Due 3/24*): You will write one short paper on either feminist or sociological critiques of scientific objectivity and how seriously we should take these critiques as indictments of scientific rationality.

Final exam (30%; *Exam date TBD*): There will be one cumulative final at the end of the term. A study guide will be made available before the end of the semester.

Academic Integrity

All students pledge to abide by the guidelines on academic integrity outlined in the *Undergraduate Catalogue* (in the aptly titled section “Academic Integrity”).

Boilerplate

Student Success Center: The Student Success Center (Phillips Memorial Library, Room 250) offers a wide variety of support services for all students, including group and individual tutoring, academic skills mentoring, disability support, and writing assistance. *Note:* Students who may need academic accommodation based on a documented disability should make the necessary arrangements as soon as possible. All accommodations must be arranged through the Student Success Center.

Mental Health and Well-Being: As a student, you may experience a range of challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, depression, difficulty concentration, or lack of motivation. These mental health concerns or stressful events may affect your ability to attend class, concentrate, complete work, take an exam, or participate in daily activities. If mental health and adjustment concerns are causing distress, please speak to me and/or reach out for personal support. Remember that asking for help is a sign of strength and courage. Additional resources can be found at the Personal Counseling Center, Dean Of Students, CARE team, Chaplain’s Office, Title IX Office, PC/Day One Advocate, and the Student Health Center.

Diversity & Inclusion: It is my intent that students from all backgrounds be well-served by this course, that their learning needs be addressed both in and out of class, and that the diversity they bring into the classroom be viewed as a resource, strength, and benefit. I will make every effort to present material and activities that are respectful of your various identities, including (but not limited to) those tied to ethnicity, race, gender, religion, sexuality, disability, age, socioeconomic status, and culture. Please let me know if something said or done in the classroom, either by myself or other students, is particularly troubling or upsetting. While our intention may not be to cause distress or offense, the impact of what happens throughout the course should not be ignored and deserves proper attention. It is critical that we work together to create a safe and bias-free learning environment in which all students can thrive and succeed. I take this mission very seriously and your suggestions on how to best accomplish it are always encouraged and appreciated.

Schedule

(*This schedule is subject to change; all modifications will be announced in class)

- 1/18 Introduction and Syllabus
No reading

Grasping towards science

- 1/20 **The Ancient world**
o Lloyd, *Early Greek Science* (on Canvas)
- 1/23 **The Medieval era**
o Tihon, "Science in the Byzantine Empire" (on Canvas)
o Finger, *Origins of Neuroscience*, pp. 69-72
- 1/25 **The Renaissance**
o Boas, *The Scientific Renaissance 1450-1600* (on Canvas)

The Scientific Revolution

- 1/27 **The basics of modern science**
o Godfrey-Smith, *Theory and reality* (Introduction) (on Canvas)
- 1/30 **The history of the Scientific Revolution**
o Bowler and Morus, *Making Modern Science*, ch. 2 (pp. 25-55)
- 2/1 **Was there a Scientific Revolution?**
o Strevens, *Knowledge Machine*, Introduction (pp. 1-10)

Falsification and the logic of science

- 2/3 **Scientific claims are falsifiable**
o Strevens, *Knowledge Machine*, pp. 13-22
o Popper, *The logic of scientific discovery* (pp. 3-24, 27-29, 57, 60-67)
- 2/6 **The "decisive" eclipse experiment**
o Stanley, "An expedition to heal the wounds of war" (on Canvas)
o Dyson, Eddington, and Davidson, "A Determination of the Deflection of Light by the Sun's Gravitational Field, from Observations made at the Total Eclipse of May 29, 1919" (on Canvas)
- 2/8 **Auxiliary assumptions and observation**
o Popper, *Logic of Scientific Discovery* (pp. 264-73, 278-82; on Canvas)
o Strevens, *Knowledge Machine*, pp. 67-74

- 2/10 **Induction and values**
 o Douglas, “Inductive risk and values in science” (on Canvas)
- 2/13 **The age of the Earth controversy**
 o Burnet, *The sacred theory of the earth*, vol. 1 (pp. 152-58; on Canvas)
 o Bowler and Morus, *Making Modern Science*, pp. 108-33
- 2/15 **Subjectivity and falsification**
 o Strevens, *Knowledge Machine*, pp. 74-86

Paradigms and paradigm shifts

- 2/17 **Kuhn on normal science**
 o Kuhn, *Structure*, chapters 2-4 (pp. 10-42)
- *2/21 **Science within the paradigm**
 o Kuhn, *Structure*, chapter 4-6 (pp. 35-65)
 o Strevens, *Knowledge Machine*, pp. 32-38
 o Waldrop, “Of politics, pulsars, death spirals—and LIGO” (on Canvas)

Feel free to consult the following resources:

- o Daw, “How does an experiment at LIGO actually work?”
<https://phys.org/news/2016-02-ligo.html>
- o “Gravitational waves detected 100 years after Einstein’s prediction”
<https://www.ligo.caltech.edu/news/ligo20160211>

Note: Due to honoring our presidents, we will have class on Tuesday

- 2/22 **Crisis and revolution**
 Kuhn, *Structure*, chapters 7-9, 12 (skip pp. 96-103)
- 2/24 **Revolution and progress**
 Kuhn, *Structure*, chapter 13 and postscript (pp. 159-208)
 Strevens, *Knowledge Machine* (pp. 22-32, 38-40)
****PAPER 1 DUE**

The sociological critique of science

- 2/27 **What the lab is like**
 Latour and Woolgar, *Laboratory life*, pp. 15-21, 45-56, 142-49, 151-59 (on Canvas)
- 3/1 **Feminist critiques of science**
 Richardson, “Sexes, species, and genomes” (on Canvas)
- 3/3 **Feminist critiques continued**
 Okruhlik, “Gender and the biological sciences” (on Canvas)

3/6 Spring break

3/8 Spring break

3/10 Spring break

3/13 **The revolution in geology**

Bowler and Morus, *Making Modern Science*, pp. 245 – 261

3/15 **Continental drift and subjectivity in science**

Strevens, *Knowledge Machine*, pp. 41 – 65

Bekelman et al., “Scope and impact of financial conflicts of interest in biomedical research” (On Canvas)

The Baconian vision of science

3/17 **The new organon**

Bacon, *The New Organon* I.38 – 65 and II.10 – 20 (on Canvas)

Strevens, *Knowledge Machine*, 105 – 109

3/20 **Darwinism (I)**

Bowler and Morus, *Making Modern Science*, pp. 134 – 154

3/22 **Darwinism (II)**

Bowler and Morus, *Making Modern Science*, pp. 155 – 171

3/24 **The chemical revolution**

Bowler and Morus, *Making Modern Science*, pp. 58-82

Strevens, *Knowledge Machine*, 89 – 104, 109 – 119

***Paper 2 due**

The Newtonian Turn

3/27 **The theory of gravitation**

Weinberg, *To Explain the World*, pp. 255 – 47 (on Canvas)

Newton, *The Principia*, pp. 585 – 90 (on Canvas)

3/29 **Norms of explanation**

Dear, *The Intelligibility of Nature*, pp. 15 – 28

3/31 **Explanatory pluralism**

Strevens, *Knowledge Machine*, pp. 120 – 42

4/3 **Explanation in quantum mechanics**

Strevens, *Knowledge Machines*, pp. 142 – 151

- 4/5 **What's the evidence?**
Strevens, *Knowledge Machine*, pp. 183 – 97
Christianson, *Isaac Newton*, pp. 24 -33, 63 – 76

4/7 *Good Friday; no class*

4/10 *Easter break; no class*

- 4/12 **Sterilization in science**
Strevens, *Knowledge Machine*, pp. 152 – 72

- 4/14 **Is science broken?**
Ioannides, “Why most published research findings are false”
Aschwanden, “Science isn’t broken”
(link: <https://fivethirtyeight.com/features/science-isnt-broken/>)

Religion and beauty in science

- 4/17 **Religion in science?**
Strevens, *Knowledge Machine*, pp. 173 – 83
Bolwer and Morus, *Making Modern Science*, pp. 386 – 96
Whewell, *History of the Inductive Sciences*, pp. 569 – 70, 580 – 88)
- 4/19 **Is truth beautiful?**
Strevens, *Knowledge Machine*, pp. 227 – 238
Hossenfelder, *Lost in Math*, pp. 17 – 41
Gell-Mann, “Symmetries of baryons and mesons” (on Canvas)
- 4/21 **No class**

The social organization of science

- 4/24 **Rewards in science**
Merton, “Priorities in scientific discovery” (pp. 635 – 43, 658 – 59)
Latour and Woolgar, *Laboratory life*, pp. 200 - 208
- 4/26 **Fixing science?**
Casadevall and Fang, “Reforming Science”
Crick and Watson, “A structure for deoxyribose nucleic acid
- 4/28 **Data socialism**
Merton, “The normative structure of science”

- 5/1 **Information sharing in science**
Louis, Jones, and Campbell, “Sharing in Science”
Strevens, “Scientific sharing”
- 5/3 **Interpreting science for the public**
Strevens, *Knowledge Machine*, pp. 278 – 90
- 5/5 **Following the science**
Schneider, “Confidence, consensus and the uncertainty cops: Tackling risk management in climate change”
IPCC Fifth Assessment Report – Synthesis