HOW SCIENCE WORKS

Time & Place  Mondays and Wednesdays, 9.30 to 10.45 AM
             Kimmel 808

  ■ The Structure of Scientific Revolutions, Thomas Kuhn, University of Chicago Press, 2012. (Any edition that contains Kuhn’s postscript will work. The pagination is just very slightly different in the latest edition.)
  ■ Readings distributed via NYU Brightspace

Topics  What is science? How does it work? Is there a scientific method? We will use a mix of logical argument, history, and sociology to investigate these questions. We will read the philosophers of science Karl Popper and Thomas Kuhn, as well as the early modern thinker Francis Bacon, and we will look at the history of scientific inquiry into the structure of the solar system, gravitation, the nature of heat, the question of the age of the earth, evolutionary theory, continental drift, and some modern physics including quantum theory. We’ll travel into the lab with sociologists of science such as Harry Collins and Bruno Latour, as well as taking a more high-level look at the social organization of science and at the problems involved in “following the science” when formulating public policy to deal with climate change and covid-19.

Objectives  Understand the debate about the nature of the scientific method;
             acquire familiarity with the ideas of some major thinkers about method

             Learn to think critically about what is subjective and what is objective in scientific reasoning and argument

             Appreciate the complexities and complications of scientific inquiry, both in conducting experiments and in evaluating the resulting evidence

             Acquire some familiarity with a variety of illuminating episodes in the history of science

             Learn some of the techniques used by sociologists to investigate science at both the micro and the macro level

             Understand some aspects of the large-scale social organization of science; consider some proposals for reform
Understand some of the problems involved in applying scientific knowledge when formulating public policy
And finally: find out how science really works!

**Evaluation**

Your total grade will be made up of:

- First paper (due Mar 9) 20%
- Second paper (due Apr 25) 20%
- Exercises (due Feb 14, Mar 23, Apr 13, May 4) 20%
- Class participation 10%
- Take-home exam (due May 16) 30%

Papers should be about 1200 words long (roughly four pages). No extensions will be granted (except for medical emergencies).

Answers should be 300 to 500 words long (roughly a page to a page and a half). Don’t write more than a page and a half. No extensions will be granted (except for medical emergencies).

The take-home exam will be distributed in the final class (May 9). You will choose three questions from a longer list, and write answers of about 600 words each (roughly two pages; six pages total).

Participation means some combination of: turning up for class and recitations; making useful remarks or asking valuable questions in class and recitations; finding interesting and relevant examples in the science news or elsewhere to share with the class.

Attendance at lectures and recitations is not required, but absence or lateness will be noted, and will have a major impact on your participation grade.

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**Moses**
Academic accommodations are available for students with disabilities. The Moses Center website is [www.nyu.edu/csd](http://www.nyu.edu/csd). Please contact the Moses Center for Student Accessibility (212-998-4980 or mosesscd@nyu.edu) for further information. Students who are requesting academic accommodations are advised to reach out to the
Moses Center as early as possible in the semester for assistance.

*Integrity*  Academic integrity means that the work you submit is original. Bringing answers into an examination or copying all or part of a paper straight from a book, the Internet, or a fellow student is a violation of this principle. But there are other forms of cheating or plagiarizing which are just as serious—for example, presenting an oral report drawn without attribution from other sources (oral or written); writing a sentence or paragraph which, despite being in different words, expresses someone else’s ideas without a reference to the source of the ideas; or submitting essentially the same paper in two different courses (unless both instructors have given their permission in advance). Receiving or giving help on a take-home paper, examination, or quiz is also cheating, unless expressly permitted by the instructor (as in collaborative projects).
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READINGS

Sources identified as “resources” (and itemized with a ⬤) are to be examined rather than read. It should be obvious what level of engagement is feasible, but we will give you some guidance in the course of the semester.

Introduction

Jan 24 Science and the Scientific Revolution
  ▶ Strevens, Knowledge Machine, Introduction
  ▶ Bowler & Morus, Making Modern Science, chapter 2 (pp. 25–57)
  Read both at your leisure

Karl Popper’s Falsification

Jan 26 Falsificationism
  ▶ Strevens, Knowledge Machine, pp. 13–22
  ▶ Popper, Logic of Scientific Discovery, pp. 3–24, 27–29, 57 (intro to chapter 4), 60–67 (starting at “Thus my conflict. . .”)

Jan 31 Eddington’s eclipse experiment
  ▶ Stanley, “An expedition to heal the wounds of war”
  ◤ Resource: Dyson, Eddington, and Davidson, “A determination of the deflection of light”

Feb 2 Auxiliary assumptions
  ▶ Popper, Logic of Scientific Discovery, pp. 264–273, 278–282
  ▶ Strevens, Knowledge Machine, chapter 3, pp. 66–74
  ▶ Douglas, “Inductive risk and values in science”

Feb 7 The age of the earth
  ▶ Bowler & Morus, Making Modern Science, chapter 5 (pp. 108–133)
  ▶ Strevens, Knowledge Machine, chapter 3, pp. 74–86

Thomas Kuhn’s Paradigms

Feb 9 Kuhn on normal science
  ▶ Kuhn, Structure, chapters 1 through 6
Feb 14  “A detail and depth that would otherwise be unimaginable”
▷ Strevens, Knowledge Machine, chapter 1, pp. 32–38
▷ Wade, The Nobel Duel, chapter 8 (pp. 102–118)
▷ Waldrop, “Of politics, pulsars, death spirals—and LIGO”
◊ Resource: Daw, “How does an experiment at LIGO actually work?”,
◊ Resource: “Gravitational waves detected 100 years after Einstein’s
  prediction” (LIGO press release),
  https://www.ligo.caltech.edu/news/ligo20160211
■ First exercise due

Feb 16  Kuhn on crisis and revolution
▷ Kuhn, Structure, chapters 7 through 9, 12 (omit pp. 96–103)

Feb 21  President’s Day – no class
Feb 23  Kuhn on revolution and progress
▷ Kuhn, Structure, Postscript
▷ Strevens, Knowledge Machine, rest of chapter 1 (pp. 22–32, 38–40)

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The Sociological Eye

Feb 28  Into the laboratory
▷ Latour and Woolgar, Laboratory Life, 15–21, 45–56, 142–149,
  151–159
▷ Collins, “The seven sexes”, 208–216

Mar 2  No class
Mar 7  Feminist critiques
▷ Richardson, “Sexes, species, and genomes”
▷ Okruhlik, “Gender and the biological sciences”

Mar 9  No class
■ First paper due

Mar 21 Continental drift & subjectivity in science
▷ Bowler & Morus, Making Modern Science, chapter 10 (pp. 245–261)
▷ Strevens, Knowledge Machine, chapter 2 (pp. 41–65)
◊ Resource: Bekelman, Li, and Gross, “Scope and impact of financial
  conflicts of interest in biomedical research: A systematic review”

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Science’s Iron Rule

Mar 23  Bacon’s new method
▷ Strevens, Knowledge Machine, pp. 105–109 (optional)
■ Second exercise due
Mar 28  The iron rule
  ▲ Bowler & Morus, Making Modern Science, chapter 3, “The chemical revolution” (pp. 58–82)
  ▲ Strevens, Knowledge Machine, chapter 4 (pp. 89–104); chapter 5, pp. 109–119

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**The Newtonian Revolution**

Mar 30  Newton’s theory of gravitation
  ▲ Weinberg, To Explain the World, pp. 225–247
  ◊ Resource: Newton, The Principia, General Scholium to the second edition (pp. 585–590)

Apr 4  Explanatory relativism and shallow explanation
  ▲ Dear, The Intelligibility of Nature, chapter 1, pp. 15–28
  ▲ Aristotle, Physics, II.8
  ▲ Strevens, Knowledge Machine, chapter 6, pp. 120–142

Apr 6  The quantum shallows; Whewell’s God
  ▲ Strevens, Knowledge Machine, chapter 6, pp. 142–151
  ▲ Strevens, Knowledge Machine, chapter 8, pp. 173–183
  ▲ Whewell, History of the Inductive Sciences, volume III, Book 18, Chapter 6, §§1, 5 (pp. 569–570, 580–588)

Apr 11  Only empirical evidence counts!
  ▲ Strevens, Knowledge Machine, chapter 8, pp. 183–197
  ▲ Christianson, Isaac Newton, chapters 3, 7 (pp. 24–33, 63–76)

Apr 13  Sterilizing the public record; The replication crisis
  ▲ Strevens, Knowledge Machine, chapter 7 (pp. 152–172)
  ◊ Resource: Try out the p-hacking simulator in the Aschwanden piece
  ■ Third exercise due

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**Religion, Beauty, and Irrationality in Science**

Apr 18  Religion and science
  ▲ Bowler & Morus, Making Modern Science, chapter 6 “The Darwinian Revolution” (pp. 134–171)
  ▲ Bowler & Morus, Making Modern Science, chapter 16, pp. 391–396

Apr 20  Is non-empirical thinking irrational?
  Or is science irrationally narrow?
  ▲ Strevens, Knowledge Machine, chapter 9 (pp. 201–208)
  ▲ Strevens, Knowledge Machine, chapter 10, pp. 209–227
Apr 25  Beauty as a guide to truth
▷ Strevens, Knowledge Machine, chapter 10, pp. 227–238
▷ Hossenfelder, Lost in Math, chapter 2 (pp. 17–41)
▷ Baggott, “But is it science?”, https://aeon.co/essays/post-empirical-science-is-an-octymoron-and-it-is-dangerous
◊ Resource: Gell-Mann, “Symmetries of baryons and mesons”
■ Second paper due

The Social Organization of Science

Apr 27  Credit capitalism
The reward system in science: who gets how much credit for what discoveries
▷ Merton, “Priorities in scientific discovery”, pp. 635–646 (stop before Humility), 658–659
▷ Latour and Woolgar, Laboratory Life, pp. 200–208
▷ Casadevall and Fang, “Reforming science”
◊ Resource: Crick and Watson, “A structure for deoxyribose nucleic acid”

May 2  Data socialism
Merton’s “communist” norm and information sharing in science
▷ Merton, “The normative structure of science”
▷ Louis, Jones, and Campbell, “Sharing in science”
▷ Strevens, “Scientific sharing: Communism and the social contract”, first 9 pages (pp. 3–11)

Science and Public Policy

May 4  The voice of science
Methods for deciding when science has reached a consensus, given that it never reaches a consensus
▷ Oreskes, “The scientific consensus on climate change”
■ Fourth exercise due

May 9  How to “follow the science”
The job of interpreting science for politicians, policy-makers, and the public
▷ Strevens, Knowledge Machine, chapter 14 (pp. 278–290)
▷ Schneider, “Confidence, consensus and the uncertainty cops: Tackling risk management in climate change”

Papers are due on Mar 9 and Apr 25
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REFERENCES


