Biomedical Graduate Studies
The Science of Science and Innovation

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Wednesdays 1pm – 4pm, Spring 2024

“I fully agree with you about the significance and educational value of history and philosophy of science. So many people today - even professional scientists - seem to me like somebody who has seen thousands of trees but has never seen a forest.”

– Albert Einstein

The increasing burden of knowledge in biomedical science has led training and coursework to focus on the many trees within a specific area of research. While understandable, this narrowed scope means that scientists themselves are often unaware of historical, economic, and social forces that structure the enterprise in which they work. This course aims to illuminate these dynamics. Tapping into the many emerging metasciences—the science of science, economics of science, philosophy of science, etc—we will embark on a slow zoom from a thousand-foot view, moving gradually from the perspective of governments, to funders, to practitioners, to trainees. The course will progress as follows:

Structuring the scientific enterprise
- Week 1: A (very) brief history of biomedical science in the US
- Week 2: Design of scientific institutions, from Bell’s Lab to yours
- Week 3: The legal structures shaping research and translation
- Week 4: Presentations of student case studies

Evaluating and funding scientific projects
- Week 5: Mechanisms for funding people, projects, and products
- Week 6: How grant peer review works, and doesn’t
- Week 7: Capturing lightning (science) in a bottle (metric)

Conducting scientific research
- Week 8: Open science - never let a good (replication) crisis go to waste
- Week 9: How we publish scientific research, and how we might
- Week 10: Mapping the flow of citations, collaborations, and careers

Becoming a scientist
- Week 11: Perspectives on STEM education and training
- Week 12: How bias and prestige warp the scientific workforce
- Week 13: Career paths beyond the academia/industry binary

Science futures
- Week 14: Where are we headed, and how should we steer?
- Week 15: Presentations for final project

Combining lecture and seminar styles, this course will explore the many hidden corners of the US scientific apparatus. Students will come away with both (1) a better understanding of the policies and incentives that shape scientific practice, and (2) actionable insight into the process of obtaining funding, producing rigorous science, disseminating and translating work, and taking next steps in their career.
Books
This course will primarily rely on academic papers; however, we will use excerpts from the following books, which are recommended but not required:
- Kuhn, TS (1962). The Structure of Scientific Revolutions.

Requirements
This section provides an overview of the main requirements of the course. More details about the requirements will be provided later.

Class participation (30%) 
Attendance is required. Everyone’s learning can benefit from informed discussion. After the first few sessions, students will have extra responsibility for particular papers, for which they will help guide the discussion. This will apply to approximately 4 to 6 of the class sessions. The number of people in the class will affect the nature of this requirement.

Project 1 (15%) 
A short in-class presentation on a topic within the history, philosophy, or sociology of science, broadly defined. These areas are rich with research and case studies about science and innovation; find something that sparks your interest and tell your classmates about it. A list of examples and motivating ideas will be provided in class.
Presentations: Wednesday, March 6

Assignments (15%) 
There will be small weekly assignments throughout the course. Students will be asked to respond to readings or write up short case studies of relevant topics.
Assignments due 10pm the night before each class

Final project (40%) 
The final exam will take the form of a term paper/project. Students will initially write a short proposal for their chosen project, which will be due Monday, April 1st. They will get feedback on the proposal before moving forward with the full project, which will be due Friday, May 10th.

The format of the project is not specified. A few possible formats are (1) a policy proposal for a government agency or legislative body, related to the support and structure of scientific research, (2) a formal design for a quasi-experimental or experimental study that could be conducted to fill a knowledge gap in science policy or metascience, (3) a small research project using publicly available data on scientific papers, grants, researchers, etc. This is absolutely not a comprehensive list; students are encouraged to be creative with their project, and the initial proposal period is intended to ensure that ideas are feasible and relevant.
Rigor and reproducibility
This course is deeply committed to exploring and encouraging rigor and reproducibility as foundational characteristics of good scientific practice. Through critical examination of mechanisms for funding, evaluation, and the conduct of scientific research, students will gain insights into the standards and practices that ensure trustworthy and accurate scientific outcomes. During Week 8 — in a session titled, "Open science - never let a good (replication) crisis go to waste" — we will discuss modern developments and debates surrounding replication in biomedical research, examining the value of open science practices, transparency, and new methodologies.

Moreover, the theme of rigor will be interwoven throughout the course, including the examination of funding models in Week 5, the discussion of metrics and evaluation in Week 7, and the exploration of scientific publication in Week 9. Students will also have the opportunity to engage with these principles in their final projects — potentially through a research project that embodies them directly, or a policy proposal that identifies an institutional lever for advancing them.

Contact and questions
Students and potential students are encouraged to contact me with any questions or comments at jdworkin@fas.org. During the course’s run, I will hold in-person office hours on Wednesday mornings from 10:00–10:30 am, and virtual office hours on Friday mornings from 10:00–10:30 am.