

# FYSM 153: Science

## Intersections of Money and Discovery

Trinity College

Fall 2019

### Class Meetings:

WF 2:40-3:55 pm  
Clement 210

### Instructor:

Prof. Michelle Kovarik  
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### Office Hours:

Clement 129  
M 1-2 pm  
R 9-10 am  
and by appointment

### First-Year Mentor:

RJ Chadha  
[rahuljeet.chadha@trincoll.edu](mailto:rahuljeet.chadha@trincoll.edu)

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### Course Description & Objectives

Although scientific inquiry strives to be objective, financial and economic concerns inevitably influence human endeavors. This course will address key issues concerning how we pay for science, what science we fund, and who benefits when researchers' results are successfully commercialized. What proportion of our funding dollars should go to basic scientific research versus practical applications and technology development? Should the government receive royalties when publicly funded research leads to commercialization by a successful start-up company? Should pharmaceutical companies price new drugs to make them accessible to those in need despite high initial investment costs? Through readings, case studies, interviews, and hands-on research, we will explore these and other questions in the context of current scientific research and on-going policy debates.

After completing this course, students should be able to

- Articulate a framework for the relationship between curiosity-driven and utility-driven research, and classify specific research projects and funding priorities according to this framework
- Compare and contrast a variety of mechanisms for funding scientific research
- Describe the processes by which intellectual property is developed, protected, and commercialized
- Debate the high costs associated with new pharmaceuticals from the perspectives of multiple stakeholders

### Course Format

Typically you will need to complete one or more reading assignments before class. These readings will be accompanied by a short, informal writing assignment due at or before the start of class to ensure that you've prepared thoughtfully for our discussions. In class we will discuss the readings with short breaks for lectures to clarify factual content as needed. Your active participation in class discussions is required for this course format to succeed. We will also do informal writing in class. Other class periods will be dedicated to introducing you to academic resources at Trinity. Finally, you will complete three longer, formal writing assignments and a presentation. These formal writing assignments will be completed in stages, allowing you to incorporate multiple course topics and to refine your final manuscript over several weeks.

## Required Course Materials

- **Text**  
Paula E. Stephan, *How Economics Shapes Science*, 2012, Harvard University Press.  
Available as hardcover, paperback, or Kindle or free through the library (see Moodle links).
- **Other Readings**  
Posted on Moodle or distributed in class.

## Moodle & Email

Moodle and e-mail will be used extensively in this course. All students are required to have an active e-mail account. Students will be expected to consult the Moodle site on a daily basis for assignment info, announcements, schedule changes, lecture materials, supplementary course materials and external links.

## Formal Writing/Presentation

We will have three formal writing assignments and a final presentation assignment in this course. These four assignments will be weighted equally and will account for 45% of your grade in the course. A brief sketch of each assignment is below; detailed instructions are available on Moodle.

- 1) **Comparing crowd-funding to traditional federal funding (~6-8 page paper)**  
Identify two proposals with related goals funded through a crowd-funding site and the federal government, then compare and contrast the two proposals.
- 2) **Profiling a researcher at Trinity College (~6-7 page paper)**  
Interview a research-active faculty member in the natural or social sciences and evaluate their research in terms of one or more of the models of basic and applied research discussed in class.
- 3) **Critiquing a source of information on the patent system (~two 1 page papers+bibliog.)**  
Write a reflection on what factors make a source credible and useful, use an annotated bibliography to fact-check a potential source, then write a brief evaluation of the source.
- 4) **Charting the development of a pharmaceutical (5-10 min presentation)**  
Working with a partner, chart the history of an FDA-approved drug from lab to routine prescription.

## Informal Writing

At the start of each class period, you should hand in a short (1-3 p.), informal, writing assignment about the day's readings. Often these assignments will take the form of a worksheet with short answer questions and longer essay prompts. If no worksheet is provided, then you should do a free write that demonstrates that you read all of the assigned readings, related them to each other, and related them to our ongoing class discussion. The goal is to synthesize concepts and examples from class, practice making use of evidence, and generate ideas for formal writing assignments. In general, these assignments will be assessed with an emphasis on content rather than structure or grammar. For these assignments, no late work or make-up assignments will be accepted; however, I will drop the lowest of your informal writing assignment grades.

## How do you earn your grade?

Assessment	% of Grade
Formal Writing / Presentation	45
Informal Writing	45
Participation	10

### Grading Scale

	+		-
A	98.00+	93.00+	90.00%+
B	87.00+	83.00+	80.00%+
C	77.00+	73.00+	70.00%+
D	67.00+	63.00+	60.00%+
F	<60.00%		

## Participation

Active participation in class discussion will allow you to refine your ideas about course topics and practice articulating and supporting ideas for your writing assignments. As a result, participation is integral to your success and will be assessed accordingly using the rubric posted on Moodle. Participation is worth 10% of your grade. You will receive feedback on your participation at midterm from the mentor and from me. If you feel uncomfortable speaking up in class or have other concerns about participation, please arrange to meet with me as soon as possible to discuss ways to be an active member of the class.

Sometimes unexpected (and often unwelcome) events intrude on our plans – mental and physical illness, family needs, etc. may affect your class performance this semester. To the extent that you are comfortable sharing this information with me, I would like to know as soon as possible so that we can make a plan to minimize disruption of your academic work. If you miss a major deadline due to illness, injury, or a family emergency, you should provide some confirmation of the event directly to me or to the Dean of Students office. If you will miss class for a scheduled, College-sanctioned event (e.g., religious observance, athletics), you should discuss your absence with me in advance (at least 3 days prior).

## Classroom Citizenship

Please familiarize yourself with the College's policies on attendance, absences, academic honesty, and classroom behavior as outlined in the Student Handbook. This course will be conducted in strict agreement with these policies.

## Academic Integrity

Each student should be familiar with the Trinity College Student Integrity Contract and the section on Intellectual Honesty in the Student Handbook.

**References.** Any ideas in written assignments that (i) did not spring from your own mind and (ii) are not common knowledge to high school students should be cited at the end of each assignment. Rewrite all ideas in your own words *and* cite them.

If you have a question about whether or not your rewording is acceptable, ask me! Use the *ACS Style Guide* to format your references. Plagiarism and academic dishonesty – copying from another student, copying from another source including the internet, failing to cite a reference, etc – will be subject to the strictest penalties.

**Collaboration.** I encourage you to discuss your writing with classmates and to help one another to edit and revise assignments. That said, I expect each of you to do your own work. If you have any questions about whether or not your collaboration with a classmate complies with my expectations, please talk to me about it *before* turning in an assignment.

## Resources

### First-Year Mentor

RJ Chadha is the first-year mentor for our seminar. You should feel free to reach out to him to discuss course requirements or assignments as well as any aspect of academic and intellectual life at Trinity.  
([rahuljeet.chadha@trincoll.edu](mailto:rahuljeet.chadha@trincoll.edu))

### First-Year Librarian

Jennifer van Sickle  
Appointments available through the library homepage.  
[www.trincoll.edu/LITC/Library/](http://www.trincoll.edu/LITC/Library/)

### The Writing Center

115 Vernon St.  
M-R 3-10 pm  
Sundays 7-10 pm

To schedule an appointment, call 297-2468 or visit  
<http://trincoll.mywconline.com/>

### ACS Style Guide

You can refer to this reference for citation formatting online at [pubs.acs.org](http://pubs.acs.org), and copies are available in the main library and the Chemistry library.

### Accessibility Requests

Please let me know if there are circumstances that might affect your full participation in class. If you need accommodations, talk with me as soon as possible and contact Lori Clapis in the Student Accessibility Resource Center at 860-297-4025 or  
[Lori.Clapis@trincoll.edu](mailto:Lori.Clapis@trincoll.edu).

## Frequently Asked Questions (FAQs)

### *What should I do if I have to miss class?*

Class attendance is mandatory and will be taken at the beginning of each class, so please be on time and do not miss class if at all possible. If you will be absent, please do the following:

- (1) Notify me as soon as possible, preferably before class and by email.
- (2) Email me any assignments that are due, drop them in CT208, or send them to class with a friend.
- (3) Contact a classmate to get notes and consult Moodle for any handouts that you missed.

### *Can I turn an assignment in late? May I have an extension?*

Informal writing assignments will not be accepted late for credit, but you may turn them in late for feedback. Formal writing assignments and components of those assignments will be accepted late with a penalty of one letter grade per day. You may request an extension of up to 48 hours by email. All requests for extensions must be received at least 24 hours before the original deadline and be accompanied by evidence of progress on the assignment, e.g., a Word document showing your current draft or outline.

### *Can I do extra credit?*

There will be no extra credit in this class. Please don't ask! My philosophy is that you should spend your valuable time succeeding at the primary objectives for the course. If you have not completed the assignments designed to help you do this, you should not be spending time on additional work. If you have completed them, your grade should not be in need of a boost.

### *How can I tell what my current grade is?*

Your grades for individual assignments and your overall course grade will always be available in the grade book in Moodle. If you have any questions or would like to discuss your performance in the class at any time, please come by office hours or make an appointment.

### *Whom should I contact for help with Moodle?*

If you are having general technical problems logging on or using Moodle, you should contact the Help Desk at 860-297-2007 or [helpdesk@trincoll.edu](mailto:helpdesk@trincoll.edu). If you are having specific problems with a file, link, or other content on our class site, you may want to contact me first so I can make sure it's not a mistake I've made in preparing the content. Our first-year mentor, RJ Chadha, will also be a good resource for navigating Trinity's online systems, including Moodle and TCOonline.

### *How can I be successful in this course?*

Come to class prepared and complete all of the readings on time. Come to office hours and meet with the mentor regularly. Use College resources, like our librarian contact and the writing center. Be sure to reach out with concerns or small problems before they begin to affect your performance in class. You should expect to spend 6-12 h per week outside of class reading, completing informal writing assignments, and making progress on your formal writing assignments and presentation, in order to be successful in this course.

### Important Dates

Mandatory Library Tour.....	TBA
Drop/Add Deadline .....	9/10
Proposal Comparison .....	10/2
Withdraw Deadline .....	10/21
Researcher Profile.....	10/25
Podcast Critique .....	11/13
Pharma Presentations .....	12/4

## Tentative Schedule

*Check Moodle regularly for updated versions.*

Date	Topic	Readings / Preparation	Important Deadlines
<i>Week 1</i>			
Aug 30	intro to the course and Trinity		
Sept 4	intro to money and science	<p>Paula Stephan, "Chapter 1: What does economics have to do with science?" <i>How Economics Shapes Science</i>, Harvard University Press: Cambridge, MA, 2012.</p> <p>Yudhijit Bhattacharjee, "Anatomy of a grant," <i>Science</i>, <b>2014</b>, 344, 33.</p>	
Sept 6	costs of scientific research	<p>Andrea Widener, "The underlying costs of research," <i>C&amp;E News</i>, <b>2015</b>, 93, 26.</p> <p>Paula Stephan, "Chapter 5: The production of research: equipment and materials," <i>How Economics Shapes Science</i>, Harvard University Press: Cambridge, MA, 2012.</p>	
<i>Week 2</i>			
Sept 11	funding mechanisms	<p>Paula Stephan, "Chapter 6: Funding for research," <i>How Economics Shapes Science</i>, Harvard University Press: Cambridge, MA, 2012.</p> <p>Art Jahnke, "Who picks up the tab for science?" <i>Boston University Research</i></p>	<b>Add/drop ends Tuesday, Sept 10</b>
Sept 13	proposal searching workshop	<p>Review crowd-funded research proposal using links to funding sites on Moodle. Come with an idea of 2-3 proposals that interest you.</p> <p>Bring a laptop to class. If needed, Chromebooks can be checked out from the main Information Services desk on level A of the library.</p>	(F1) Identify your proposals

Week 3			
Sept 18	crowd-funding	<p>Neel V. Patel, "Crowdfunded science is here. But is it legit science?" <i>Wired</i>, 24 Apr 2015.</p> <p>Listen: Richard Harris, "Breast cancer patients seek more control over research agenda," All Things Considered (NPR), 16 Sept 2014.</p> <p>Matthew Motta, "Teaching the public more science likely won't boost support for funding, but sparking their curiosity might," <i>The Conversation</i></p>	
Sept 20	library visit	<p>Come with ideas about what topics you need to research to develop more background knowledge for your proposal comparison paper.</p> <p>Before the library session, you should register for SciFinder using the link on Moodle and your Trinity email address and download Zotero onto your computer along with the plug-in for Microsoft Word.</p>	(F1) Outline of proposal comparison
Week 4			
Sept 25	writing workshop	<p>Upload your completed draft to Moodle and bring a hard copy to class for self-and/or peer-review.</p> <p>George Gopen and Judith Swan, "The science of scientific writing," <i>American Scientist</i>, Nov-Dec 1990.</p>	(F1) Proposal comparison draft
Sept 27	private funding and prizes	<p>William J. Broad, "Billionaires with big ideas are privatizing American science," <i>New York Times</i>, 14 Mar 2014, A1.</p> <p>Andrea Widener, "The power of prizes," <i>C&amp;E News</i>, <b>2014</b>, 92, 23-25.</p> <p>Kelsey Piper, "Science funding is a mess. Could grant lotteries make it better?" <i>Vox</i>, 18 Jan 2019.</p>	



Week 5			
Oct 2	funding levels	<p>Listen: Richard Harris and Robert Benincasa, "U.S. science suffering from booms and busts in funding," Morning Edition (NPR), 9 Sept 2014.</p> <p>Bruce Alberts, Marc W. Kirschner, Shirley Tilghman, and Harold Varmus, "Rescuing US biomedical research from its systemic flaws," <i>Proceedings of the National Academy of Sciences</i>, <b>2014</b>, 111, 5773-5777.</p> <p>Jennifer Couzin-Frankel, "Chasing the money," <i>Science</i>, 2014, 344, 24-25.</p>	(F1) Proposal comparison final
Oct 4	basic vs. applied research	Vannevar Bush, Summary and Chapters 1-3 in <i>Science, the Endless Frontier: A Report to the President</i> , U.S. Government Printing Office, 1945.	
Week 6			
Oct 9	curiosity and application	Donald E. Stokes, "Chapter 3: Transforming the paradigm" in <i>Pasteur's Quadrant: Basic Science and Technological Innovation</i> , Brookings Institute Press, 1997.	(F2) Email draft
Oct 11	writing center visit	Brainstorm at least 3 areas where you would like feedback from a writing associate on your researcher profile.	
Week 7			
Oct 16	funding priorities	<p>Robert Irion, "What Proxmire's golden fleece did for--and to--science," <i>The Scientist</i>, 12 Dec 1988.</p> <p>Jeffrey Mervis, "Malware and search engines," <i>Science</i>, 18 Feb 2015.</p>	

Oct 18	research and economic development	<p>Paula Stephan, "Chapter 9: The relationship of science to economic growth," <i>How Economics Shapes Science</i>, Harvard University Press: Cambridge, MA, 2012.</p> <p>Patrick Collison and Michael Nielsen, "Science is getting less bang for its buck," <i>The Atlantic</i>, 16 Nov 2018.</p> <p>L. Fleming, <i>et al.</i> "Government-funded research increasingly fuels innovation," <i>Science</i>, <b>2019</b>, 364, 1139-1141.</p>	<p>(F2) Interview complete</p> <p><b>Last day to withdraw is Oct 21</b></p>
<i>Week 8</i>			
Oct 23	scientific publishing	<p>Stephen Buranyi, "Is the staggeringly profitable business of scientific publishing bad for science?" <i>The Guardian</i>, 27 Jun 2017.</p> <p>Brian Resnick and Julia Belluz, "The war to free science," <i>Vox</i>, 3 Jun 2019.</p>	
Oct 25	patents	<p>Listen: Stuff You Should Know, "How patents work," 11 Nov 2014.</p> <p>Charles Duan, "A century-old debate over science patents is repeating itself today," <i>Slate</i>, 25 Feb 2019.</p>	(F2) Researcher profile
<i>Week 9</i>			
Oct 30	researchers and IP	Pages 44-55 of Paula Stephan, "Chapter 3: Money" <i>How Economics Shapes Science</i> , Harvard University Press: Cambridge, MA, 2012.	(F3) Reflection on sources
Nov 1	Bayh-Dole Act	<p>V Loise and AJ Stevens, "The Bayh-Dole Act turns 30," <i>Sci. Transl. Med.</i> <b>2010</b>, 52, 1-5.</p> <p>S Boettiger and AB Bennett, "Bayh-Dole: if we knew then what we know now," <i>Nat. Biotechnol.</i> <b>2006</b>, 24, 320-323.</p> <p>Jeffrey Mervis, "When the payoff for academics drops, commercialization suffers," <i>Science</i>, <b>2016</b>, 352, 396.</p>	



Week 10			
Nov 6	pre-registration info session	Print and complete the pre-advising worksheet posted on Moodle.	(F3) Thesis statement and annotated bibliography
Nov 8	start-ups	Robert Langer, "A personal account of translating discoveries in an academic lab," <i>Nat Biotechnol.</i> <b>2013</b> , 31, 487-489.  Jeffrey Mervis, "Business decisions," <i>Science</i> , <b>2015</b> , 348, 1190-1193.  Jon Cohen, "Give us your best pitch," <i>Science</i> , <b>2015</b> , 348, 1194-1195.	
Week 11			
Nov 13	drug discovery and development	AA Ciociola, LB Cohen, and P Kulkarni, "How drugs are developed and approved by the FDA: Current process and future directions," <i>Am. J. Gastroenterol.</i> <b>2014</b> , 109, 620-623.  "The price of failure," <i>The Economist</i> , Nov. 29, 2014.	(F3) Evaluation of podcast as source
Nov 15	generics and open source drug discovery	Ann M. Thayer, "30 years of generics," <i>C&amp;E News</i> , <b>2014</b> , 8-16.  SM Maurer, A Rai, and A Sali, "Finding cures for tropical diseases: Is open source an answer?" <i>PLoS Med.</i> , <b>2004</b> , 1, e56.	
Week 12			
Nov 20	ethical drug pricing	Listen: Radiolab, "How much would you pay for a year of life?" from Worth, Season 13, Episode 3.  Brian Palmer, "Jonas Salk: Good at virology, bad at economics," <i>Slate</i> , April 2014.  HM Kantarjian, T Fojom, M Mathisen, and LA Zwelling, "Cancer drugs in the United States: Justum pretium -- the just price," <i>J. Clin. Oncol.</i> <b>2013</b> , 31, 3600-3604.  Laurie McGinley, "Low prices of some lifesaving drugs make them impossible to get," <i>Washington Post</i> , June 18, 2019.	(F4) Partner and drug selected, partial bibliography

Nov 22	presentation workshop	Patricia Gosling and Bart Noordam, "Giving a great presentation," <i>ScienceCareers</i> (Blog), 20 Oct 2006.	(F4) Full annotated bibliography
<i>Week 13</i>			
Nov 21	<b><i>Thanksgiving Break</i></b>		
Nov 23			
<i>Week 14</i>			
Dec 4	drug case studies	Self-selected readings to prepare for your presentation	(F4) Presentations on drug development
Dec 6	course wrap-up	<b>Listen:</b> Where We Live, "Science's 'Creativity Crisis'," Aug. 20, 2015.	