

Title: Interpreting Scientific Evidence

Course number: 2300

Maximum number of students: 25

Course format: lecture & discussion

Number of points: 3

Instructor: **Molly Przeworski** (Professor of Biological Sciences & Systems Biology)

Email address: mp3284@columbia.edu

Office location: 602A Fairchild, door code 21209#

Office hours: M 3-4PM

Term taught: Fall

Class days/times: W 2:10PM-4:00PM

Classroom location: Fairchild 800

Teaching Assistant: **Carla Hoge**

Email address: crh2152@columbia.edu

Office location: 602B Fairchild

Office hours: Mon 12-1PM, door code 21209#

Course description and objectives:

This class focuses on how we gather reliable scientific evidence, with a focus on human biology and health. The aim is to help students better interpret and evaluate the scientific evidence that they will encounter throughout their lifetime, in primary papers but also as presented in news, advertisement, and politics. To these ends, students will be introduced to basic definitions and concepts in statistics and epidemiology, including point estimates and measures of uncertainty, error rates, association and causation, different study designs, and selection bias. The second part of the course will turn to dissecting the representation and misrepresentation of scientific evidence presented in different venues. The main readings will draw from a textbook (referred to as "Gordis" below) and a book ("Bergstrom & West"); additional reading will be provided as PDFs or URLs on the course website.

Learning objectives are to be able to:

- Define some basic concepts in statistics and epidemiology
- Identify key epidemiological study designs and their strengths and weaknesses
- Articulate how error, bias, and confounding can affect study results
- Call out common problems with data representation
- Evaluate the communication of scientific results by comparison to primary sources

Textbooks/Readings:

Gordis, Sixth Edition and Calling Bullshit, by Bergstrom & West are available for purchase at the University bookstore. Used or rental copies can also be purchased from a variety of sellers; just be sure the edition number is correct. The books are also on reserve at the library, and are viewable at the following link: <https://www1.columbia.edu/sec-cgi-bin/cul/respac/respac?CRSE=20233BIOL2300W001>

Schedule:

Week 1: Sept 6

Truth, lies & bullshit. Why interpreting scientific evidence matters. How some studies provide more reliable evidence than others. Class organization, evaluations, expectations.

Readings:

Frankfurt, On Truth, Introduction, Chapters 1 & 2 (through p. 37)

Bergstrom & West, Chapter 2

Week 2: Sept 13

*last week to add class

15 min in class reading quiz on readings for weeks 1 & 2

Distributions. Means, medians and modes. Measures of dispersion. Some basic plots.

Readings:

Taking the Medicine, Chapters 13, 14 & 16

Week 3: Sept 20

Screening and diagnostic test error rates. Null model & hypothesis testing. Statistical power. Intro to p-values.

Readings:

Gordis, Chapter 5, p. 94-99

<https://apnews.com/article/winter-olympics-sports-tokyo-doping-eugene-85dc632c6578ebdb7e71303b1c335345>

<https://www.npr.org/templates/story/story.php?storyId=93424870>

Assignment due Tues 5 pm.

Week 4: Sept 27

Recap on p-values. Correlation & causation. Confounders.

Readings:

Bergstrom & West, Chapter 4

No assignment due.

Week 5: Oct 4

* last week to drop class

Observations studies (case control & cohort). Selection bias, recall bias.

Readings:

Gordis, Chapter 7 (149-172, no need to read "case-crossover design" section)

Gordis, Chapter 8 (178-187, through "When is a case-control study warranted?")

Optional: Bergstrom & West, Chapter 6

Assignment due Tues 5 pm.

Week 6: Oct 11

Control groups, randomization and randomized trials. Placebos. Natural experiments.

Readings:

Gordis, Chapter 10, p. 197-208 (until the section "Crossover")

Gordis, Chapter 11, p. 223-230 (until the section "Study of breast cancer...") + p. 234-235 (until the epilogue).

Please also listen to:

<https://freakonomics.com/podcast/does-health-insurance-make-you-healthier/>

Assignment due Mon 5 pm.

Week 7: Oct 18

15 min in class quiz on study designs. Recap of concepts/study designs covered to date.

Discussion: Is epidemiology unreliable, hard or both?

Readings:

Taubes: <https://www.science.org/doi/10.1126/science.7618077>

https://fivethirtyeight.com/features/science-isnt-broken/?ex_cid=endlink#part4

(Optional) <https://pubmed.ncbi.nlm.nih.gov/35675391/>

Assignment due Tues 5 pm.

Week 8: Oct 25

In class mid-term

Discussion: How to evaluate the legitimacy of a scientific claim?

Readings:

Bergstrom & West, Chapter 10

Week 9: Nov 1

Class presentations: Science in the news

Readings:

https://callingbullshit.org/tools/tools_legit.html

<https://www.theopennotebook.com/2018/11/06/how-to-read-a-scientific-paper/>

<https://www.theopennotebook.com/2021/04/13/a-getting-started-guide-for-newcomers-to-science-writing-2/>

Week 10: Nov 8

(i) Q&A with Amy Harmon (Journalist, NY Times)

(ii) Review of midterm & in class quiz

Readings:

<https://www.nytimes.com/2014/01/05/us/on-hawaii-a-lonely-quest-for-facts-about-gmos.html>

<https://www.nytimes.com/2013/08/25/sunday-review/golden-rice-lifesaver.html>

https://archives.cjr.org/the_observatory/michael_pollan_and_amy_harmon.php

(Optional) <https://rameznaam.com/2013/04/28/the-evidence-on-gmo-safety/>

Assignment due Mon 5 pm.

Week 11: Nov 15

(i) Misinformation, disinformation, mal-information

(ii) Misleading with numbers, data visualization

Readings:

Bergstrom & West, Calling Bullshit, Chapter 5

https://callingbullshit.org/tools/tools_misleading_axes.html

https://en.wikipedia.org/wiki/Misleading_graph#Truncated_graph

https://callingbullshit.org/tools/tools_proportional_ink.html

Assignment due Mon 5 pm.

Week 12: Nov 22

No class. Thanksgiving Holiday

Week 13: Nov 29

i) In class quiz

ii) How much of a solution is “Big Data”?

Readings:

Bergstrom & West, Chapters 7 & 8

Week 14: Dec 6

i) Guest speaker: Katrina Armstrong (Chief Executive Officer, Columbia University Irving Medical School)

ii) Class recap

Readings:

<https://jamanetwork.com/journals/jama/fullarticle/2781943>

<https://www-acpjournals-org.ezproxy.cul.columbia.edu/doi/full/10.7326/M19-3496>

Assignment due Mon 5 pm.

Final assignment due any time before 5 pm on Dec 15th

General class plan:

Class structure will include lecturing, group exercises and all-class discussion

Requirements:

- (1) Attend class.
- (2) Read all assigned material. Have the assigned readings (in virtual or hard copy format) easily to hand for every class session.
- (3) Unless otherwise noted, the weekly assignment is due by 5 pm on Monday. Skipped assignments will be assigned an F, late assignments will automatically receive a D.
- (4) A midterm exam in class.
- (5) A final assignment to complete by Dec 15th.

Course evaluation:

Class participation and attendance: 20%

Twelve weekly assignments (including two in class quizzes): 20% (to accommodate illness and other intervening circumstances, the two lowest grades will be dropped)

Midterm exam (in class): 30%

Final assignment: 30%

Class participation and attendance:

Your class participation grade depends upon your attendance for each of the lectures following the first. Absences due to illness or that are excused for a different reason can be made up by students emailing a one page written response to the readings within a week of the missed class (or their return, if longer).

Academic Integrity:

As members of an academic community, each one of us bears the responsibility to participate in scholarly discourse and research in a manner characterized by intellectual honesty and scholarly integrity. Scholarship, by its very nature, is an iterative process, with ideas and insights building one upon the other. Collaborative scholarship requires the study of other scholars' work, the free discussion of such work, and the explicit acknowledgement of those ideas in any work that inform our own. This exchange of ideas relies upon a mutual trust that sources, opinions, facts, and insights will be properly noted and carefully credited.

In practical terms, this means that, as students, you must be responsible for the full citations of others' ideas in all of your research papers and projects; you must be scrupulously honest when taking your examinations; you must always submit your own work and not that of another student, scholar, or internet agent, including artificial intelligence chatbots such as Chat GPT. Any breach of this intellectual responsibility is a breach of faith with the rest of our academic community. It undermines our shared intellectual culture, and it cannot be tolerated. Students failing to meet these responsibilities should anticipate being asked to leave Columbia.

Resources and Policies for Students with Disabilities:

If you are a student with a disability and have an DS-certified "Accommodation Letter" please come to office hours to confirm your accommodation needs. If you believe that you might have a disability that requires accommodation, you should contact [Disability Services](#) at 212-854-2388 and disability@columbia.edu.