

# **Ethics in Biostatistics and Data Science**

(M21 512)

Spring 2019 Syllabus

Mondays 4:00 – 6:00 pm

January 14 – May 6

TAB Classroom B

## **Instructor and Teaching Assistant**

Alison L. Antes, PhD, [aantes@wustl.edu](mailto:aantes@wustl.edu), 314-362-6006

Tim Rubbelke, PhD, [trubbelke@wustl.edu](mailto:trubbelke@wustl.edu)

## **Office Hours**

Both the instructor and teaching assistant are glad to schedule meetings with students at a mutually convenient time and location. Please email or speak with us in class.

## **Course Description**

This course prepares data scientists/biostatisticians to analyze and address ethical and professional issues across the range of their professional roles and responsibilities. The primary goals are for data scientists/biostatisticians to recognize complex situational dynamics and ethical issues and to develop professional and ethical problem-solving skills. The course specifically examines ethical challenges related to research design, data collection, data management, ownership, security, and sharing, data analysis and interpretation, and data reporting and provides practical guidance on these issues. The course also examines fundamentals of the broader research environment, including principles of ethics in human and animal subjects research, regulatory issues in biomedical research, publication and authorship, and collaboration in science.

## **Course Competencies**

By the conclusion of this course, students will be able to:

- Promote ethical standards and practices in data management, research design, and statistical analysis and reporting
- Analyze ethical problems using a systematic decision-making framework
- Communicate about ethical and professional issues to address challenges and facilitate research integrity
- Contribute to collaborations with professionalism and personal integrity

## **Course Format and Learning Environment**

This course is interactive; it will include short didactic lectures, discussion of literature, case studies, and activities. Activities and case analyses will allow us to engage in dialogue about ethics in research, to share perspectives, and to discuss strategies for solving professional and ethical problems. It is important that the learning environment is open, engaged, and collaborative. The course incorporates essential content and readings to establish knowledge, and it focuses on building skills related to professional and ethical thinking, problem-solving, and working effectively with others. Students are expected to participate actively and contribute each week by coming to class prepared to share ideas and discuss with classmates.

## **Readings**

Readings include a collection of articles and books chapters available. The readings are provided via ARES, the Washington University Library eReserves system. There are 2 ways to access these readings: 1) Links to the readings will be provided in the “Reading” assignment posted for each course module on Canvas or 2) A link to the ARES page for the course, which contains an index of all readings, is posted at the top of the Canvas Home Page. Please access the articles early each week to ensure that you have them for the weekly assignment. The readings provide content related to each week’s topic and journal assignment. Please read

for key ideas and lessons important to your career as a biostatistician. As noted on the course calendar, some readings are *required* and some are *optional*.

### Canvas Course Management

Assignments, readings, and grades will be posted via Canvas (<https://mycanvas.wustl.edu>). Important course updates and announcements will be sent to students via Canvas as well. The home page is the main course page with weekly modules showing the readings and assignments. You will also find links to the weekly “current issue” on the home page.

### Assignments

The assignments are described below, in addition to grading criteria. Assignments will also be discussed in class, and students are encouraged to ask questions about assignments and grading criteria.

Assignment		Percentage	Grading Scale	
1	Weekly Journal Entry	20%	A+ (98%-100%)	B- (80%-82%)
2	Weekly Participation	25%	A (93%-97%)	C+ (78%-79%)
4	Group Case Analysis	25%	A- (90%-92%)	C (73%-77%)
5	“Top 5” Final Paper	30%	B+ (88%-89%)	C- (70%-72%)
		100%	B (83%-87%)	D+ (68%-69%)

### Weekly Journal Entry

Each week a writing prompt or question will be available on Canvas. The prompt or question will relate to the week’s topic and readings. Students should write a response that is about one single-spaced page in length that is informed by the readings and personal perspective. The writing will be approximately 500-650 words in length, or about 4-5 paragraphs. **The depth of critical thought is more important than the specific length. The purpose of the assignment is to encourage critical thinking and reflection on the weekly topic, which will provide a “warm-up” for the course session each week.** Students may utilize the thoughts articulated in their journal entries to contribute to the in-class discussions.

- **Submission:** Submit entries under the assignment in that week’s module by **12pm (noon) each Sunday**. After Clicking the “Submit Assignment” button, you will be presented with the option to either upload a document (.doc or PDF) or directly enter text on Canvas.
- **“Freebie” Journal:** You may skip ONE of the journals without losing credit. If a student completes all of the journal entries, the lowest journal grade will be dropped.
- **“Redo” Option:** During the first four weeks of class, as students are becoming familiar with the journal writing assignment, students are permitted to “redo” and resubmit up to one journal entry and have it re-graded. The re-graded score will be the final score received for the journal. If a student elects to re-submit a journal entry, it is due by Friday at 12am (midnight) the week it was originally due.
- **Referencing Sources:** When referring to information contained in the **assigned readings**, students should refer to these resources in their writing in the following fashion: “According to Williams (1999)...”, “Miller and colleagues (2003) discuss...” Or, you can include a reference at the end of a sentence like this (Baker 2010). The teaching assistant and instructor will know which references from the reading list you are citing.

If students utilize **outside resources** of any kind, they must reference the resource in their writing using the author name and date, such as “Self et al. (1998) stated...”, AND provide the full reference at the bottom of their writing. For example, the full reference for a journal article and website are provided below. Students must put quotation marks (“”) around direct, word-for-word quotes taken from a reference. It is imperative that proper credit is given for information that students obtain from resources. Without this credit, the student has engaged in plagiarism, a serious form of academic misconduct. Outside references are encouraged but not required. Please ask if you have any questions about appropriate citation practices. This is an essential skill, and we are glad to help clarify.

Self DJ, Olivarez M, Baldwin DCJ. The amount of small-group case-study discussion needed to improve moral reasoning skills of medical students. *Acad Med.* 1998;73:521-523.

University of Illinois at Urbana-Champaign Library. *Why Should You Cite?* Available at <http://guides.library.illinois.edu/citingsources>. Accessed January 15, 2018.

**Grading Criteria:** Grades will be based on (a) relevance to the question/topic, (b) depth and diligence of critical thinking, (c) writing clarity, and (d) timeliness.

### ***Weekly Participation***

Class meetings will be interactive. Please arrive in class prepared to engage and discuss. Students will be rewarded with participation points for active participation in class. Students are encouraged to actively ask questions of the instructor and classmates. Students are encouraged to share their perspective or challenge the ideas discussed in class. The classroom will be a safe place for students to engage in discussion. All dialogue is expected to be collegial and open. If classroom discussion happens to elicit differences in opinion, these differing views will *focus on the issue or problem, rather than on the person* challenging us to consider different views. In addition to in-class discussion, active participation in all in-class activities (for example, analysis of case scenarios or quizzes to review material) will count as participation. Students are also welcome to share links or online resources to their classmates using the Canvas Discussion tool. If a student would like *feedback* on his/her progress regarding course participation, he/she should please feel welcome to ask the instructor.

**Grading Criteria:** Grades will be based on contributions such as the following: sharing ideas and raising points during class discussions, asking questions, bringing examples and/or resources to class (or sharing via Canvas), participating in individual and group in-class activities, and paying attention actively in class—**ultimately participation means that students are actively engaged in their learning. Active learners are willing to share and learn from others, contribute to the learning of their classmates, and try to apply what they are learning to their life outside of the class.**

### ***Current Issue***

As part of the reading assignments, students will be given an article detailing a current issue or current event facing science and biostatistics. Most articles involve professional or ethical issues, and all feature real-world issues in the news. The article (or a link to it) will be posted on the Canvas site for that week. All students are expected to read the assigned article before class. At the beginning of class, the professor will call on one or two students to provide ***their perspective*** on the issue(s) discussed in the article. Throughout the semester, all students will be called on at least once for this assignment. Grading for this assignment will be part of the participation grade for the semester.

### ***Group Case Analysis***

Students will be assigned to small teams for this assignment. The small groups will review, analyze, and present a case to their classmates. The goal of the assignment is to practice ethical reasoning, professional problem-solving, and discussion of ethical issues with colleagues. Additional instructions will be provided to structure the assignment, and we will discuss the assignment expectations in class. Students will be expected to identify time out of class to discuss the case and prepare their presentation. The small teams should keep in mind the importance of engaging their classmates. Please consider this an opportunity for your own learning, but also as an important opportunity to contribute to the learning of your classmates. The small teams should present the case for about 10 minutes and then engage the class in discussion for about 10 minutes. The teams should have a planned activity or planned questions for classmates to stimulate discussion. In a way, the team members should think of themselves as the “teachers” for the 20 minutes that they present their case to their classmates. The team should plan and coordinate the case assignment so that every member of the group participates in presenting the case to the class.

**Grading Criteria:** Grades will be based on (a) depth and diligence of critical thinking about the case, (b) clarity of ideas, arguments, and points, (c) engagement of classmates/contribution to classmates’ learning,

and (d) coordination of the presentation given by group members. These four elements of the grade will be scored for the entire group collectively.

### ***“Top 5” Final Paper***

The final assignment will be a culminating paper reflecting on the student’s learning in the course. Students will consider the *5 most important things* that they have learned in the course and explain (a) what each point or lesson is, and (b) why it is important, including specifically commenting on why or how it will be useful to them in their career. The 5 points may be anything at all from the course, however, one point must include something you learned about yourself. The key aspects of this assignment are that the student explains each item clearly and convincingly describes why each item was selected. The length should be approximately 4-6 double-spaced pages with 1 inch margins. Please include an introduction paragraph and a conclusion paragraph in your paper.

- **Submission:** The paper should be submitted on Canvas under the Top 5 Paper Assignment in the final week’s module by **12pm (noon) on Sunday, May 5**. Please upload your paper as a Word document.
- **Referencing Sources:** Please follow the same instructions as described for the Weekly Journal Entry.

**Grading Criteria:** Grades will be based on (a) depth and diligence of critical thinking, (b) demonstration of learning from the course (i.e., sophistication of reasoning about course topics), and (c) writing clarity.

### **Course Policies, Expectations, and Wash U Resources**

By participating in this course, students agree to the policies and expectations outlined in the syllabus. If questions arise at any point in the course, students are encouraged and expected to ask the instructor.

**Writing and Speaking Skills:** This course offers students the opportunity to enhance their writing and speaking skills. Students interested in taking additional initiative to improve their writing skills are encouraged to consult the Wash U Writing Center (<http://writingcenter.wustl.edu/>) for assistance. In the instructor’s experience, writing center assistance significantly enhances students’ writing and their grades. Additionally, for non-native English speakers in the Wash U community, the English Language Programs (<https://oiss.wustl.edu/english-language-programs/>) located in the Office of International Students and Scholars (<https://oiss.wustl.edu/>) offers some outstanding courses, tutorials, and events for students (including ones that are free); to find out more, contact [elp@wustl.edu](mailto:elp@wustl.edu).

**Attendance:** Attendance in this course is expected and essential to meet the learning objectives. Students may miss one class (for any reason) without penalty. After one missed class, students will lose participation points for missing a second and third class (for any reason). Missing a fourth class will result in one full letter grade deduction of the final course grade. Missing more than four classes would result in failing the course. Please make the most of your learning opportunity in this course.

**Professionalism:** Classmates are expected to treat each other with dignity and respect. In this course, all opinions and perspectives are valued and encouraged.

**Academic Integrity:** Students are responsible for completing their own work, and academic dishonesty of any kind will not be tolerated and will be dealt with seriously by the instructor. Penalties range from receiving a zero on the assignment to failure of the course. Violations of academic integrity include but are not limited to:

1. Submitting material written by another person but represented as the student’s own work;
2. Copying a passage or text directly from a book, journal, website, etc., or using extensive paraphrasing, without indicating the source using a citation for referencing material;
3. Writing a paper or completing an assignment for another student;
4. Submitting an assignment as new work when the assignment was completed for another course.

The Master of Science in Biostatistics program expects students to adhere to the academic and research integrity policies published by Washington University. In particular, students should consult the [Graduate Student Academic Integrity Policy](#) regarding academic and professional integrity.

Students must understand that being unaware or lacking knowledge about exactly what constitutes cheating or academic dishonesty is not an acceptable justification. College students are responsible for educating themselves about cheating and academic dishonesty. They are also responsible for maintaining an open dialogue with their instructors if they have questions. Cheating and dishonesty in the college classroom are similar to issues encountered in the work world; responsible students and professionals must learn about these issues and address them appropriately.

**Late Assignment Policy:** All assignments must be turned in by their due dates. Incomplete assignments or assignments less than 24 hours late will receive partial credit. Assignments turned in more than 24 hours late receive no credit. Reasonable requests for assignment deadline extensions due to extenuating circumstances will be considered by the instructor; please speak with the instructor as far in advance as possible.

**Changes to Course Plan:** Any changes to the course schedule or plan will be communicated in class and via Canvas.

**Academic Accommodations:** Washington University is committed to providing accommodations and/or services to students with documented disabilities. Students who are seeking support for a disability should contact Disability Resources at [disabilityresources@wustl.edu](mailto:disabilityresources@wustl.edu). Disability Resources is responsible for approving all disability-related accommodations for WU students, and students are responsible for providing faculty members with formal documentation of their approved accommodations at least two weeks prior to using those accommodations.

## Course Calendar

Date	Topic	Readings
<b><u>Foundations of Ethics and Professionalism in Research</u></b>		
Week 1 January 14	Introduction to Ethics and Professionalism	
Week 2 January 28	Principles of Ethics and Professionalism in Biostatistics	<p>Vardeman SB, Morris MD. Statistics and ethics: Some advice for young statisticians. <i>The American Statistician</i>. 2003;57:21-26.</p> <p>Hurwitz S, Gardenier JS. Ethical guidelines for statistical practice: The first 60 years and beyond. <i>The American Statistician</i>. 2012;66:99-103.</p> <p>American Statistical Association. Ethical Guidelines for Statistical Practice (1999). Available at: <a href="http://www.amstat.org/about/ethicalguidelines.cfm">http://www.amstat.org/about/ethicalguidelines.cfm</a></p> <p>International Statistical Institute. Declaration on professional ethics. Available at: <a href="http://www.isi-web.org/images/about/Declaration-EN2010.pdf">http://www.isi-web.org/images/about/Declaration-EN2010.pdf</a></p> <p>Finney DJ. Ethical aspects of statistical practice. <i>Biometrics</i>. 1991;47:331-339.</p>
Week 3 February 4	Protecting Human and Animal Research Participants	<p>Emanuel EJ, Wendler D, Grady C. What makes clinical research ethical? <i>JAMA</i>. 2000;283:2701-2711.</p> <p>Grady C. Enduring and emerging challenges in informed consent. <i>New England Journal of Medicine</i>. 2015;372:855-862.</p> <p>Annas GJ. HIPAA regulations—a new era of medical-record privacy. <i>New England Journal of Medicine</i>. 2003;348:1486-1490.</p> <p>Steneck NH. <i>ORI Introduction to the responsible conduct of research</i>. Chapter 4: The Welfare of Laboratory Animals (pgs. 51-65). Washington DC: U.S. Government Printing Office.</p>
Week 4 February 11	Ethical Decision-Making	<p>Hammond JS, Keeney RL, Raiffa H. The hidden traps in decision making. <i>Harvard Business Review</i>. 1998; 76: 47-58.*</p> <p>Gunsalus CK. The integrity mindset: An obligation ourselves and others. <i>Journal of Microbiology and Biology Education</i>. 2014;15:120-123.</p> <p>Moore, DA, Loewenstein, G. Self-interest, automaticity, and the psychology of conflict of interest. <i>Social Justice Research</i>. 2004;17:189-202.</p> <p>Tenbrunsel AE, Messick DM. Ethical fading: The role of self-deception in unethical behavior. <i>Social Justice Research</i>. 2004;17:223-236.</p>
Week 5 February 18	Defining “Research Misconduct” and Conflicts of Interest	<p>Shamoo AE, Resnik DB. <i>Responsible conduct of research</i> (3<sup>rd</sup> edition). Chapter 2: Misconduct in research (pps. 28-59). 2015. New York: Oxford University Press.</p> <p>De Vries R, Anderson MS, Martinson BC. Normal misbehavior: Scientists talk about the ethics of research. <i>Journal of Empirical Research on Human Research Ethics</i>. 2006;1:43-50.</p> <p>WUSTL Research integrity policy. Available at: <a href="http://research.wustl.edu/PoliciesGuidelines/Pages/ResearchIntegrityPolicy.aspx">http://research.wustl.edu/PoliciesGuidelines/Pages/ResearchIntegrityPolicy.aspx</a></p> <p>Bekelman JE, Yan L, Gross CP. Scope and impact of financial conflicts of interest in biomedical research: A systematic review. <i>JAMA</i>. 2003; 289: 454-465.</p> <p>Fanelli D (2010) Do Pressures to Publish Increase Scientists’ Bias? An Empirical Support from US States Data. <i>PLoS ONE</i>. 5(4): e10271. doi:10.1371/journal.pone.0010271</p> <p><i>Optional (However, please download and save as a resource):</i></p> <ul style="list-style-type: none"> <li>Keith-Spiegel P, Sieber J, Koocher GP. Responding to research wrongdoing: A user-friendly guide. 2010.</li> </ul>

## **Ethics in Research Design and Data Analysis, Interpretation, Reporting, and Management**

Week 6 February 25	Ethics in Clinical Trial Design	<p>Halpern SD, Karlawich JHT, Berlin JA. The continuing unethical conduct of underpowered clinical trials. <i>JAMA</i>. 2002;288:358-362.</p> <p>Kimmelman J, London AJ. Predicting harms and benefits in translational trials: Ethics, evidence, and uncertainty. <i>PLoS Medicine</i>. 2011;8(3): e1001010. doi:10.1371/journal.pmed.1001010</p> <p>Ellenberg SS. Protecting clinical trial participants and protecting data integrity: Are we meeting the challenges? <i>PLoS Medicine</i>. 2012;9(6):e1001234. doi:10.1371/journal.pmed.1001234</p> <p>Hey SP, Kimmelman J. Are outcome-adaptive allocation trials ethical? <i>Clinical Trials</i>. 2015;12(2):102-106.</p> <p>Optional:</p> <ul style="list-style-type: none"> <li>• Miller LE, Stewart ME. The blind leading the blind: Use and misuse of blinding in randomized controlled trials. <i>Contemporary Clinical Trials</i>. 2011;32:240-243.</li> <li>• Cassel CK. Statistics and ethics: Models for strengthening protection of human subjects in clinical research. <i>Proceedings of the National Academy of Sciences</i>. 2009;106:22037-22038. doi: 10.1073/pnas.0912882107</li> <li>• Press WH. Bandit solutions provide unified ethical models for randomized clinical trials and comparative effectiveness research. <i>Proceedings of the National Academy of Sciences</i>. 2009;106:22387-92.</li> <li>• Gill RD. Statistics, ethics and probiotics. <i>Statistica Neerlandica</i>. 2009;63:1-12.</li> </ul>
Week 7 March 4	Ethical Issues in Data Analysis	<p>Gelfond, JAL, Heitman, E, Pollock, BH, Klugman, CM. Principles for the ethical analysis of clinical and translational research. <i>Statistics in Medicine</i>. 2011;30:2785-2792.</p> <p>DeMets DL. Statistics and ethics in medical research. <i>Science and Engineering Ethics</i>. 1999;5:97-117.</p> <p>Young SS, Karr A. Deming, data and observational studies: A process out of control and needing fixing. <i>Significance</i>. 2011:116-120.</p> <p>Leek JT, Peng RD. P values are just the tip of the iceberg. <i>Nature</i>. 2015;520:612.</p> <p>MacCoun, R, Perlmutter, S. Hide results to seek the truth. <i>Nature</i>. 2015;526:187-189.</p> <p>Optional:</p> <ul style="list-style-type: none"> <li>• Hoenig JM, Heisey DM. The abuse of power: The pervasive fallacy of power calculations for data analysis. <i>The American Statistician</i>. 2001;55(1):19-24.</li> </ul>
<b>March 11—Spring Break—No class</b>		
Week 8 March 18	Reproducibility in Science	<p>Nuzzo, R. How scientists fool themselves – and how they can stop. <i>Nature</i>. 2015;526:182-185.</p> <p>Munafò, M. R., Nosek, B. A., Bishop, D. V. M., Button, K. S., Chambers, C. D., Percie du Sert, N., . . . Ioannidis, J. P. A. (2017). A manifesto for reproducible science. <i>Nature Human Behaviour</i>, 1(1). doi:10.1038/s41562-016-0021</p> <p>Collins FS, Tabak LA. NIH plans to enhance reproducibility. <i>Nature</i>. 2014;505:612-613.</p> <p>Kaiser, J. The cancer test: A nonprofit's effort to replicate 50 top cancer papers is shaking up labs. <i>Science</i>. 2015;348:1411-1413.</p> <p>Freedman LP, Cockburn IM, Simcoe TS. The Economics of Reproducibility in Preclinical Research. <i>PLoS Biology</i>. 2015;13(6): e1002165. doi:10.1371/journal.pbio.1002165</p>
Week 9 March 25	Ethics in Big Data and Genetic Research	<p>Mittelstadt BD, Floridi L. The ethics of big data: Current and foreseeable issues in biomedical contexts. <i>Science and engineering ethics</i>. 2015. doi: 10.1007/s11948-015-9652-2</p> <p>Tabor HK, Berkman BE, Hull SC, Bamshad MJ. Genomics really gets personal: How exome and whole genome sequencing challenge the ethical framework of human genetics research. <i>Am J Med Genet Part A</i>. 2011;155:2916-2924.</p> <p>Article on returning genetic results. (To be determined and announced.)</p>

Week 10 April 1	Data Integrity and Data Stewardship  (Managing, Storing, Sharing, and Securing Data and Research Records)	<p>Bloomrosen M, Detmer D. Advancing the framework: Use of health data—A report of a working conference of the American Medical Informatics Association. <i>Journal of the American Medical Informatics Association</i>. 2008;15:715-722.</p> <p>Schreier AA, Wilson K, Resnik D. Academic research record-keeping: Best practices for individuals, group leaders, and institutions. <i>Academic Medicine</i>. 2006;81:42-47. Mitka M.</p> <p>Clinical trial data: Share and share alike? <i>JAMA</i>. 2015;313:881-882.</p> <p>Gelman A. Ethics and statistics—Open data and open methods. <i>Chance</i>. 2011:51-53.</p> <p>Buck S. Solving reproducibility. <i>Science</i>. 2015;348:1403.</p> <p><i>Optional:</i></p> <ul style="list-style-type: none"> <li>• Mospan GA, Wargo KA. Researchers' experience with clinical data sharing. <i>The Journal of the American Board of Family Medicine</i>. 2016;29(6):805-807.</li> </ul>
--------------------	---	---

### **Ethics and Professionalism in the Workplace**

Week 11 April 8	Collaboration, Communication, and Authorship	<p>Chapter 12: Setting up collaborations (pps. 201-210). <i>Making the right moves: A practical guide to scientific management for postdocs and new faculty (2<sup>nd</sup> edition)</i>. 2006. Howard Hughes Medical Institute and Burroughs Wellcome Fund. Available at: <a href="http://www.hhmi.org/labmanagement">http://www.hhmi.org/labmanagement</a>.</p> <p>Cohen CM, Cohen SL. <i>Lab dynamics: Management and leadership skills for scientists (2<sup>nd</sup> edition)</i>. Chapter 7—Win/win with peers: Make allies, not enemies (pps. 137-159). 2012. New York: Cold Spring Harbor Laboratory Press.</p> <p>Parker, RA, Berman NG. Criteria for authorship for statisticians in medical papers. <i>Statistics in Medicine</i>. 1998;17:2289-2299.</p> <p>WUSTL Policy for authorship on scientific and scholarly publications. Available at: <a href="http://www.wustl.edu/policies/authorship.html">http://www.wustl.edu/policies/authorship.html</a></p> <p><i>Optional:</i></p> <ul style="list-style-type: none"> <li>• Kempers RD. Ethical issues in biomedical publications. <i>Fertility and sterility</i>. 2002;77:883-888.</li> </ul>
Week 12 April 15	Group Case Presentations	
Week 13 April 22	Leadership and Professional Development	<p>Cohen CM, Cohen SL. <i>Lab dynamics: Management and leadership skills for scientists (2<sup>nd</sup> edition)</i>. Chapter 1—People who do science: Who they are and who they can be (pps. 1-16). 2012. New York: Cold Spring Harbor Laboratory Press.</p> <p>Cohen CM, Cohen SL. <i>Lab dynamics: Management and leadership skills for scientists (2<sup>nd</sup> edition)</i>. Chapter 2—The mote in your own eye: Manage yourself first (pps. 17-33). 2012. New York: Cold Spring Harbor Laboratory Press.</p> <p>Ashford SJ, DeRue DS. Developing as a leader: The power of mindful engagement. <i>Organizational Dynamics</i>. 2012;41:146-154.</p> <p><i>Optional:</i></p> <ul style="list-style-type: none"> <li>• Robledo IC, Peterson DR, Mumford MD. Leadership of scientists and engineers: A three-vector model. <i>Journal of Organizational Behavior</i>. 2012;33:140-147.</li> <li>• Hogan R, Kaiser RB. What we know about leadership. <i>Review of General Psychology</i>. 2005;9:169-180.</li> <li>• Goffee R, Jones G. Creating the best workplace on earth: What employees really require to be their most productive. <i>Harvard Business Review</i>. 2013:98-106.*</li> <li>• Groysberg B, Abrahams R. Manage your work, manage your life: Zero in on what really matters. <i>Harvard Business Review</i>. 2014:58-66.*</li> </ul>

<p>Week 14 April 29</p>	<p>Working in Industry and Commercializing Science</p>	<p>Cohen CM, Cohen SL. <i>Lab dynamics: Management and leadership skills for scientists</i> (2<sup>nd</sup> edition). Chapter 9—Science, Inc.: Make a smooth transition to industry (pps. 179-198). 2012. New York: Cold Spring Harbor Laboratory Press.</p> <p>Kotha R, Kim PH, Alexy O. Turn your science into a business. <i>Harvard Business Review</i>. 2014;92(11):106-114. *</p> <p>Malakoff D. The many ways of making academic research pay off. <i>Science</i>. 2013;339(6121):750-753.</p>
-----------------------------	--	---

<p>Week 15 May 6</p>	<p>Course Review and Reflections</p>
--------------------------	--

\*Note: Typically to access the *Harvard Business Review* articles, students will need to search for the article title within the database.