

Instructors:

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Room: Life Sciences 310**Course Objectives:**

The ability to identify important biological questions, develop testable hypotheses, design experiments tailored to particular questions, and evaluate results is critical for scientific research success. Presenting data clearly and concisely both in written and oral formats is critical for a successful career in research.

At the end of the course students will be able to formulate testable hypotheses, design practical ways to address scientific problems, and organize and present scientific data and insights to a professional audience.

Course Description

This course takes advantage of research articles—old and new—to highlight different approaches for problem solving in biology and, in doing so, develop skills for the critical analysis of the primary literature. The last three weeks of class will be devoted to student presentations on topics related to these landmark papers, providing students the opportunity to hone their public speaking skills.

Class will meet for two hours once a week, Mondays 2PM. While most of our meetings will be remote, we hope to hold a few classes outside weather permitting. In this case, we will let you know that class will be held outside by 5pm on the Friday before that class.

Landmark Research Articles

Landmark papers were selected for their excellence and their impact on the field, and represent the best of the best. They are thus also not representative of the majority of articles you will read during the course of your studies. Of course, despite their status as landmark articles, these papers are also not without flaws. While we encourage you to look for these flaws, we prefer you focus on honing your ability to recognize 1) clever strategies; 2) the logical progression from the initial observation to the last experiment; and 3) the use of multiple approaches, combined with published background data, to reach sound conclusions.

All research is constrained by available methodologies and on-going paradigms; many important papers introduce new technologies or paradigms. As you read the “old” papers, consider how the research might have been done or interpreted differently in present times. How have the “new” papers addressed questions first raised by the “old” papers?

Expectations:

Students are expected to work independently unless otherwise instructed.

Read and Participate:

- Each week, students will be assigned landmark and current papers in prokaryotic and eukaryotic microbiology. Papers will be available to download from the course website on Canvas.
- Discussions will focus on analysis of the biological question(s) addressed in the week's reading material and the approaches used to answer the question. Possible alternative approaches will be evaluated.
- Every student is expected to come to class prepared to discuss the entire paper. Students should be able to: 1) identify the biological question(s) being addressed; 2) describe the approaches used to address the question; 3) summarize the data presenting in figures and tables; 4) assess the significance and/or validity of the authors' conclusions; and where appropriate, 5) propose follow-on experiments.
- Class participation will count towards 40% of the final grade.

Write:

- With the exception of the first class meeting, three days prior to class (i.e. by midnight Friday), students are expected to upload a one-page "Specific Aims" document that includes: i) a 250-word summary of relevant background; ii) a statement of the question to be addressed and their hypothesis; and iii) three experimental approaches (Aims) designed to test their hypothesis. These will be evaluated by the instructors and returned with constructive feedback. Students should expect to receive comments by the following Tuesday giving them a few days to revise and resubmit.
- We will be using the plagiarism checker "turn-it-in" to avoid accidental copying and pasting from primary research papers.
- The first class will include a discussion of what makes a good set of specific aims, how to structure your specific aims page etc. Examples of specific aims pages will be available on blackboard.
- The first set of specific aims will focus on a topic of the student's choosing. The remaining three sets of aims will be based on an assigned topic.
- After receiving the aims, the instructors will provide constructive criticism on the first set of aims. Students are then expected to revise their specific aims page based on this critique for submission three days prior to the following class (i.e. by midnight Friday) by email to appropriate instructor as above. As per the schedule below, submission of new specific aims will alternate with submission of revised specific aims.
- Performance on specific aims and revisions will count towards 40% of the final grade.

Present:

◦The last few weeks of the course will be devoted to student led presentations. Students will select one set of their specific aims for a 20-minute in-class presentation. The student will be expected to complete an extensive literature review on the topic and, in consultation with Dr. Levin and Dr. Bose, develop a 20-minute PowerPoint lecture, including graphics, that establishes the significance of the biological problem they are seeking to address and describing the approaches they propose to use.

◦Revising is an essential part of speaking as well as writing. To help students hone their public speaking skills, students will submit a detailed outline and list of slides to Drs. Bose and Levin and for critique two weeks before their scheduled presentation.

◦Peer review is an essential component of modern science. To this end, students will be expected to fill out a brief evaluation for each of their colleagues' talks. The evaluation form will ask students to briefly address overall performance as well as organization, clarity, and slide "aesthetics." As a final project, the presenting student will write a one page summary detailing their "response to reviewers" and noting how they would modify their talk for future presentations, being as specific as possible.

◦ Oral Presentation will count towards 20% of the final grade (10% content; 10% presentation design and implementation)

Course Web Site:

All materials will be available on Canvas.

Rules to Read By: Reading and evaluating a scientific research article in four simple steps

1) Read through the Abstract and Introduction to ascertain background, premises, and major conclusions.

At the end of this step you should be able to succinctly state the question being addressed or hypothesis being tested.

2) Look through all Figures and Tables and their legends, consulting Methods if those used are unfamiliar, to get a sense of the kind and quality of the data.

3) Read Results carefully in conjunction with Figures and Tables, comparing claims about what the data is showing with what the data actually shows, again consulting Methods when necessary.

After completing steps 2 and 3 you should be able to summarize the important findings of the paper in four or five sentences.

4) Read Discussion, evaluating whether the conclusions drawn are supported by the data or whether some are tenuous; where tenuous, do the authors acknowledge this and indicate that further experiments are needed?

Other criteria for evaluation. 1) Have previous published articles been adequately acknowledged? If the results refute previous publications, are explanations offered for the discrepancies? 2) Are Methods sufficiently detailed that you believe you could repeat the experiments?

You should also take note of what you like and don't like about the presentation style. 1) Is some of the data presented in an informative fashion (e.g. accessible graphics) that you might wish to emulate in your own publications? Reciprocally, is some of the data presented in a confusing fashion that you would want to avoid? 2) If you find the writing particularly lucid and engaging, try to identify what goes into that for future emulation. If it's turgid and boring, notice what generates that outcome for future avoidance.

At the end of Step 4 you should be able to summarize the merit of the paper both experimentally (i.e. are the experiments well designed and properly controlled) and in terms of contribution to the field (i.e. what are the implication of the authors' findings for the field) in one or two sentences.

Washington University COVID Policy Information:

While on campus, it is imperative that students follow all public health guidelines established to reduce the risk of COVID-19 transmission within our community. The full set of University protocols can be found at <https://covid19.wustl.edu/health-safety/>. This includes:

- Completing a self-screening using the [WashU COVID-19 Screening](#) app every day before coming to campus or leaving your residence hall room. If you do not receive a green check and pass the screening, you are not permitted to come to campus or leave your residence hall room. You must contact the COVID Call Center (314-362-5056) or the Habif Health and Wellness Center (314 935-6666) immediately. Note: In addition to the symptoms listed in the screening tool, everyone also should pay attention to symptoms that are new or different for you, including things like headache and congestion, particularly in combination with diarrhea. These can also be signs of COVID-19. Call the COVID Call Center or Habif to report these symptoms.
- Complying with universal masking. All individuals on campus must wear disposable masks or cloth face coverings while occupying indoor public settings, including: multi-person offices, hallways, stairwells, elevators, meeting rooms, classrooms and restrooms. Masks are encouraged but not required for outdoor activities, particularly at large events or in crowded settings. Students with disabilities for whom masked instructors or classmates create a communication barrier are encouraged to contact Disability Resources (www.disability.wustl.edu) or talk to their instructor for assistance in determining reasonable adjustments. Adjustments may involve amplification devices, captioning, or clear masks but will not allow for the disregard of mask policies.
- Maintaining physical distancing as needed. While distancing requirements have been removed for vaccinated students, those who are not fully vaccinated are strongly encouraged, for their own health, to maintain a distance of 6 ft from others in the classroom. If you are not able to be vaccinated or have conditions that may put you at increased risk of failed immunity and classroom activities would bring you in frequent proximity to other students, contact your instructor to discuss alternatives.
- Practicing healthy personal hygiene, including frequent handwashing with soap and warm water for at least 20 seconds and/or using hand sanitizer with at least 60% alcohol.

University-Wide Policies:**Reporting Sexual Harassment**

If a student discusses or discloses an instance of sexual assault, sex discrimination, sexual harassment, dating violence, domestic violence or stalking, or if a faculty member otherwise observes or becomes aware of such an allegation, the faculty member will keep the information as private as possible, but as a faculty member of Washington University, they are required to immediately report it to the Department Chair or Dean or directly to Ms. Cynthia Copeland, the University's Associate Title IX Coordinator, at (314) 935-3411, cmcopeland@wustl.edu. Additionally, you can report incidents or complaints to the Office of Student Conduct and Community Standards or by contacting WUPD at (314) 935-5555 or your local law enforcement agency. See: [Title IX](#)

Reasonable Accommodations for Disabled Students

Washington University in St. Louis supports the rights of enrolled students to a full and equal educational opportunity and, in compliance with federal, state, and local requirements, is committed to reasonable accommodations for individuals with documented disabilities. Disabled students for whom accommodations may be necessary must be registered with, and provide their instructors official notification through, WUSTL's Disability Resources (www.disability.wustl.edu). Once established, responsibility for disability-related accommodations and access is shared by DR, faculty, and the student. Please contact Disability Resources at 314.935.5970 or disabilityresources@wustl.edu.

Statement on Military Service Leave

Washington University recognizes that students serving in the U.S. Armed Forces and their family members may encounter situations where military service forces them to withdraw from a course of study, sometimes with little notice. Students may contact the Office of Military and Veteran Services at (314) 935-2609 or veterans@wustl.edu and their academic dean for guidance and assistance. See: <https://veterans.wustl.edu/policies/policy-for-military-students/>.

Preferred Name and Gender Inclusive Pronouns

In order to affirm each person's gender identity and lived experiences, it is important that we ask and check in with others about pronouns. This simple effort can make a profound difference in a person's experience of safety, respect, and support. See: <https://students.wustl.edu/gender-pronouns-information/>, <https://registrar.wustl.edu/student-records/ssn-name-changes/preferred-name/>.

Emergency Preparedness

Before an emergency, familiarize yourself with the building(s) that you frequent. Know the layout, including exit locations, stairwells and the Emergency Assembly Point (EAP). Review the "Quick Guide for Emergencies" that is found near the door in many classrooms for specific emergency information and instructions. For additional Information and EAP maps, visit emergency.wustl.edu. To ensure that you receive emergency notifications, make sure your information and cell phone number is updated in SIS, and/or download. The WUSTL app and enable notifications.

To report an emergency: Danforth Campus: (314) 935-5555 School of Medicine Campus: (314) 362-4357 North/West/South and Off Campus: 911 then (314) 935-5555

Resources for Students:**Disability Resources**

At Washington University we strive to make the academic experience accessible and inclusive. If you anticipate or experience barriers based on disability, please contact Disability Resources at 314.935.5970, disabilityresources@wustl.edu, or visit our website for information about requesting academic accommodations. See: <https://students.wustl.edu/disability-resources/>.

Confidential Resources for Instances of Sexual Assault, Sex Discrimination, Sexual Harassment, Dating Violence, Domestic Violence, or Stalking

The University is committed to offering reasonable academic accommodations (e.g. a no-contact order, course changes) to students who are victims of relationship or sexual violence, regardless of whether they seek criminal or disciplinary action. If a student needs to explore options for medical care, protections, or reporting, or would like to receive individual counseling services, there are free, confidential support resources and professional counseling services available through the Relationship and Sexual Violence Prevention (RSVP) Center. If you need to request such accommodations, please contact RSVP to schedule an appointment with a confidential and licensed counselor. Although information shared with counselors is confidential, requests for accommodations will be coordinated with the appropriate University administrators and faculty. The RSVP Center is in Seigle Hall, Suite 435, and can be reached at resvpcenter@wustl.edu or (314) 935-3445. For after-hours emergency response, call (314) 935-6666 or (314) 935-5555 and ask to speak with an RSVP Counselor on call.

Bias Reporting and Support System (BRSS)

The University has a process through which students, faculty, staff, and community members who have experienced or witnessed incidents of bias, prejudice, or discrimination against a student can report their experiences to the University's Bias Report and Support System (BRSS) team. See: brss.wustl.edu.

Mental Health Services

Mental Health Services' professional staff members work with students to resolve personal and interpersonal difficulties, many of which can affect a student's academic experience. These include

conflicts with or worry about friends or family, concerns about eating or drinking patterns, and feelings of anxiety, depression, and thoughts of suicide. See: <https://students.wustl.edu/mental-health-services/>. Additionally, see the mental health services offered through the RSVP Center listed above.

WashU Cares

WashU Cares specializes in connecting students to mental, medical, financial and academic resources by using supportive case management. We seek to empower students to be successful through life's challenges and to have ownership of their own experiences. Our services are designed to support Danforth Campus students. If you feel concerned about a student who may need help connecting to resources we accept referrals from all students, faculty, and staff. If you are concerned about a student, you can file a report here: <https://washucares.wustl.edu/> and a WashU Cares Case Manager will reach out to you to get more information about your concern.

The Writing Center

The Writing Center, located in Olin Library, offers free one-on-one writing tutorials to WashU students, as well as workshops designed to help students become better writers. The Writing Center staff can assist by providing feedback on the strength of an argument, clarity, and organization. Contact them at 935-4981 or writing@wustl.edu. Visit them at: <https://writingcenter.wustl.edu/>.

The Learning Center

The Learning Center works collaboratively with University partners to provide undergraduate students key resources, like academic peer mentoring, to enhance their academic progress. Contact them at <https://ctl.wustl.edu/learningcenter/> to find out what support they may offer for your classes.

Date	Topic	Reading
8/30	<p align="center">DNA as the molecule of heredity (Petra)</p>	<p>Avery, O. T., Macleod, C. M., & McCarty, M. (1944). Studies on the chemical nature of the substance inducing transformation of pneumococcal types. Inductions of transformation by a desoxyribonucleic acid fraction isolated from pneumococcus type III. <i>J. Ex. Med.</i> 149: 297–326.</p> <p>Hershey, A. D. and Martha Chase, (1952) Independent functions of viral protein and nucleic acid in growth of a bacteriophage, <i>The Journal of General Physiology</i>, 36: 39-56.</p>
9/4	<p align="center">To both Petra and Arpita</p>	<p align="center">Specific Aims 1 Due</p>
9/13	<p align="center">Prokaryotic Gene Regulation (Arpita)</p>	<p>Pardee, Arthur B., François Jacob, and Jacques Monod. (1959) The genetic control and cytoplasmic expression of “inducibility” in the synthesis of β-galactosidase by <i>E. coli</i>. <i>J. Mol. Biol.</i> 1: 165-178.</p> <p>Somvanshi, Vishal S., et al. (2012) A single promoter inversion switches <i>Photobacterium</i> between pathogenic and mutualistic states." <i>Science</i> 337: 88-93.</p>
9/17	<p align="center">To both Petra and Arpita</p>	<p align="center">Specific Aims 1 REVISED Due</p>
9/20	<p align="center">Antibiotic Discovery (Petra)</p>	<p>Fleming, A. (1929). On the Antibacterial Action of Cultures of a <i>Penicillium</i>, with Special Reference to their Use in the Isolation of <i>B. influenzae</i>. <i>British Journal of Experimental Pathology</i>, 10(3), 226.</p> <p>Stokes et al (2020) A Deep Learning Approach to Antibiotic Discovery. <i>Cell</i> 180: 688-702.</p>
9/24	<p align="center">To both Petra and Arpita</p>	<p align="center">Specific Aims 2 Due</p> <p align="center">TOPIC: Genetic and biochemical analysis of a molecular machine</p>
9/27	<p align="center">Prokaryotic Secretion (Arpita)</p>	<p>Oliver, Donald B., and Jon Beckwith. (1981)<i>E. coli</i> mutant pleiotropically defective in the export of secreted proteins. <i>Cell</i> 25: 765-772.</p> <p>Guttman, David S., et al. (2002) A functional screen for the type III (Hrp) secretome of the plant pathogen <i>Pseudomonas syringae</i>." <i>Science</i> 295: 1722-1726.</p>
10/1	<p align="center">To both Petra and Arpita</p>	<p align="center">Specific Aims 2 REVISED Due</p>

10/4	Genetics for the win! (Petra)	<p>Luria, S. E., & Delbruck, M. (1943). Mutations of Bacteria from Virus Sensitivity to Virus Resistance. <i>Genetics</i>, 28(6), 491–511.</p> <p>Lederberg, J. and E. M. Lederberg (1951) Replica plating and the indirect selection of bacterial mutants, <i>J. Bacteriol.</i>, 63:399-406.</p> <p>Giver et al (1998) Directed evolution of a thermostable esterase, <i>Proc, Nat. Acad. Sci.</i> 95: 12809–12813.</p>
10/8	To both Petra and Arpita	<p style="text-align: center;">Specific Aims 3 Due</p> <p style="text-align: center;">Topic: Genetic and Molecular Analysis of an Essential Process in Bacteria</p>
10/11	FALL BREAK	Wheeeeeee!
10/18	Characterization of essential processes (Petra)	<p>Hirota, Y., Ryter, A., & Jacob, F. (1968). Thermosensitive Mutants of <i>E. coli</i> Affected in the Processes of DNA Synthesis and Cellular Division. <i>Cold Spring Harbor Symposia on Quantitative Biology</i>, 33(0), 677–693. doi:10.1101/SQB.1968.033.01.077</p> <p>Schekman et al (1973) Initiation of DNA Synthesis: Synthesis of oX174 Replicative Form Requires RNA Synthesis Resistant to Rifampicin <i>PNAS</i> 69: 2691-2695</p>
10/22	To both Petra and Arpita	Specific Aims 3 REVISED Due
10/25	One gene one enzyme (Arpita)	<p>Beadle, G. W., & Tatum, E. L. (1941). Genetic control of biochemical reactions in <i>Neurospora</i>. <i>Proc Natl Acad Sci U S A</i>, 27: 499-506</p> <p>Helliwell K.E., Wheeler G.L. & Smith A.G. (2013). Widespread decay of vitamin-related pathways: coincidence or consequence? <i>Trends Genetics</i> 29: 469-478. [Note: This is a review article, so discussion will focus on concepts rather than on data interpretation.]</p>

10/29	To both Petra and Arpita	Specific Aims 4 Due Topic: Microbe-host interaction
11/1	CRISPr (Petra)	Horvath and Barrangou (2010) CRISPR/Cas, the Immune System of Bacteria and Archaea (REVIEW), <i>Science</i> 327: 167-170 Marraffini, L. A., & Sontheimer, E. J. (2008). CRISPR Interference Limits Horizontal Gene Transfer in <i>Staphylococci</i> by Targeting DNA. <i>Science</i> , 322(5909), 1843–1845. doi:10.1126/science.1165771 Jinek et al, (2013) RNA-programmed genome editing in human cells, <i>eLife</i> 2013;2:e00471 DOI: 10.7554/eLife.00471
11/5	To both Petra and Arpita	Specific Aims 4 Revised Due
11/8	Microbial Physiology (Arpita)	Bryant, M. P., et al. (1967) <i>Methanobacillus omelianskii</i> , a symbiotic association of two species of bacteria." <i>Archives of microbiology</i> 59: 20-31. Boetius, Antje, et al. (2000) A marine microbial consortium apparently mediating anaerobic oxidation of methane." <i>Nature</i> 407: 623.
11/12	To both Petra and Arpita	Slide List for Final Presentation Due
11/15	Three kingdoms and eukaryotic origins (Arpita)	Woese, C.R., & Fox, G.E. (1977). Phylogenetic structure of the prokaryotic domain: The primary kingdoms. <i>Proc Natl Acad Sci U S A</i> , 74:, 5088-5090. Alvarez-Ponce, D., Lopez, P., Baptiste, E., & McNemey, O. (2013). Gene similarity networks provide tools for understanding eukaryotic origins and evolution. <i>Proc Natl Acad Sci U S A</i> , 110: E1594-E1603.
11/22	STUDENT PRESENTATIONS	
11/29	STUDENT PRESENTATIONS	
12/6	STUDENT PRESENTATIONS	