ENVH 444/544 • Course Syllabus

Antibiotic Resistant Bacteria/Genes Impact on the Environment and Public Health

Course Number: ENVH 444/544 (Fall 2016, 4 credits)

Course Title: Antibiotic Resistant Bacteria/Genes Impact on the Environment and Public Health

Course Times: T/Th 1:30 – 3:20

Course Location: T473

Instructor:

Marilyn C. Roberts, PhD
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Office Hours: By arrangement

Course Website: https://canvas.uw.edu/courses/1065260

Course Description: Addressing issues of antibiotic resistant bacteria and genes through an interdisciplinary "One Health" approach that integrates human, animal and environmental health. This course explores how the global use and abuse of antibiotics has profound consequences on the health of humans, animals, and the environment.

Prerequisites: Either EPI 320, BIOL 220 or MICROM 301 or approval by Dr. Roberts

Learning Objectives – Upon completing the course, both undergraduate (444) and graduate (544) students will be able to:

1. Explain what antibiotic resistance genes (ARGs) and antibiotic resistant bacteria (ARBs) are and the origins of ARGs (the resistome).
2. Describe the various mechanisms for resistance and important classes of resistance genes.
3. Compare and analyze diverse viewpoints on controversial issues related to sources of ARGs/ARBs in relationship to humans, animals, and the environment (One Health).
4. Summarize how several different human practices influence the evolution/ecology of ARGs/ARBs.
5. Explain how the evolution of resistance differs between developed and developing countries, how the two are interconnected, and how ARGs/ARBs are transmitted around the world.
6. Discuss the role that agriculture, aquaculture, food animals and food play in the transmission of ARGs/ARBs and give specific examples to illustrate this.

7. Describe how various modes of horizontal gene transfer occur and compare/contrast how they impact the evolution of ARGs/ARBs.
8. Communicate effectively with both scientific and non-scientific audiences about the topic of ARGs/ARBs using risk communication
9. Describe the role that sub-therapeutic use of antibiotics for "growth promotion" in agriculture plays in contaminating environments, municipal wastewaters, receiving water streams, recreational waters, etc.

In addition to the learning objectives above, graduate (544) students will be able to:

10. Critically evaluate papers in the scientific literature and identify strengths and weaknesses of the science presented.
11. Develop and compose a literature review on a topic related to ARGs/ARBs.

Course Overview and Format: This course is designed to combine lectures by the instructor and invited guest lecturers with opportunities for students to engage in active, investigative learning through active learning. Students are expected to do the assigned readings prior to each class session and submit reflections from the reading through the course website. Three quizzes and one final exam will assess learning throughout the course.

Course Requirements:

Textbook**:** There is no textbook for this course. Instead, a list of required readings will be provided on the course website for each class session. In addition, the following general readings for the course will provide good background knowledge on the topics we will be discussing:

- Antibiotic Resistant Threats in the United States, CDC 2013
  http://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf
- CDC National Antimicrobial Resistance Monitoring System: Enteric Bacteria (NARMS), 2012 Report
  http://www.cdc.gov/narms/pdf/2012-annual-report-narms-508c.pdf
- WHO Antibiotic Resistance global Report of Surveillance 2014
  http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748_eng.pdf?ua=1

Preparing for Class: Reading and viewing assignments for each class session will be available through the course website. These will include readings, such as scientific articles, reports and articles from the popular press, as well as documentary videos. Students are expected to read/view the materials, then respond to questions on the reading assignments. Responses will be submitted via the course website prior to the applicable class session and will be reviewed and graded (complete/incomplete) by the instructor and/or the TA for the course.

Risk Communication Exercise:
There will be discussion throughout the course on what risk communication is and how it can be used to communicate science to specific stakeholders. The last week in class each student will present their risk communication project. Identification of stakeholder and type of document to be produced **is due Oct 13th by noon. The final project is due Nov 28 by Noon**.

1. Each student will prepare a communication document or video which can include, but is not limited to, a fact sheet, an informational pamphlet, poster or a public service announcement.
2. Students need to identify a specific stakeholder and method of communication and submit these to the instructor for approval by Oct 11, 2016.
3. Completed assignments will be turned in online via Canvas website by noon Nov. 28, 2016. The assignment needs to be a pdf, u-tube video, or power point presentation (2007 format)

Research (Graduate/544 Students and 444 undergraduate honors): Graduate students enrolled in **the 544 section and undergraduates in 444 that are doing honors for the course will research and** write a literature review paper on a topic related to ARGs/ARB. The paper should be double-spaced, paginated, and no fewer than 6 and no more than 10 pages long, not including references. A minimum or 10 references must be included, up to three of which can be reputable websites (e.g., CDC, WHO, US State Department, etc.). The remaining works referenced should be from relevant, peer-reviewed scientific journals. Paper topics must be submitted to the instructor for approval by **Oct. 11, 2016 at noon** and due by **Nov. 21, 2016 at noon.**

Exams: There will be three quizzes and one final exam for this course. The first two quizzes will be in-class and the last quiz and the final will be take-home.

For undergraduate (444) students, grades will be based on the following:

20%	Reflections on reading (will include questions about reading assignments each week on Canvas)
20%	Risk Communication Exercise (each student will create a risk communication brochure, fact sheet, or poster) for specific stakeholders and present the last week in class
20%	Quizzes
5%	Class Participation: Answers questions in class for active learning exercises and general questions during class
35%	Final Exam

For graduate (544) students, grades will be based on the following:

10%	Reflections on reading (will include questions about reading assignments each week on Canvas
25%	Risk Communication Exercise (each student will create a risk communication brochure, fact sheet, or poster) for specific stakeholders
15%	Quizzes
25%	Final Exam
5%	Class Participation: Answers questions in class for active learning exercises and general questions during class
20%	Research Paper

Course Outline (number of sessions will be adjusted as needed based on holidays):

Week 1: Course Overview, Introduction to ARGs/ARBs	
Readings: • PBS Frontline episode, *Hunting the Nightmare Bacteria.* *http://www.pbs.org/wgbh/pages/frontline/hunting-the-nightmare-bacteria/* • Davies J, Davies D. 2010. Origins and evolution of antibiotic resistance. Microbiol. Mole Biol. Rev. 74:417-433 http://mmbr.asm.org/content/74/3/417.full.pdf+html • Levy SB, Marshall B. 2004. Antibacterial resistance worldwide: causes, challenges and responses. Nature Med. 10:S122-S139. http://www.nature.com/nm/journal/v10/n12s/pdf/nm1145.pdf • FACT SHEET: Obama Administration Takes Actions to Combat Antibiotic-Resistant Bacteria http://www.whitehouse.gov/the-press-office/2014/09/18/fact-sheet-obama-administration-takes-actions-combat-antibiotic-resistan Reflections on PBS Frontline and readings: • **Due by 1 pm on Monday Oct 3rd**	
Sept 29	• Introductions and overview of student responsibilities and instructor expectations • Small group warm-up activity and in-class discussion

Week 2: Overview of Antibiotic Resistance	
Readings: • Marinez JK, Baquero F. 2014. Emergence and spread of antibiotic resistance: setting parameter space. Upsala J Med Sciences. 119:68-77. http://informahealthcare.com/doi/pdf/10.3109/03009734.2014.901444 • Heuer H., Smalla K. 2007. Horizontal gene transfer between bacteria. Environ Biosafety Res. 6:3-13. http://dx.doi.org/10.1051/ebr:2007034 • Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations http://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations_1.pdf	
Oct 4, 2016	• History of antibiotic use since 1945 • Mobile elements [plasmids, transposons, integrons] • Bacterial gene exchange [conjugation, transformation, transduction]
Oct 6, 2016	• Basic overview of antibiotic resistance, differences between bacteria, viruses, fungi, parasites

Week 3: Antibiotic Classes and Mechanisms of Resistance	
Readings: • Roberts MC, Schwarz S, Aarts H 2012. Acquired antibiotic resistance genes: an overview. Frontier in Microbiol: Antimicrobials Resistance & Chemotherapy 2012 http://www.frontiersin.org/Antimicrobials,_Resistance_and_Chemotherapy/10.3389/fmicb.2012.00384/full • Farias P et al., 2015. Natural hot spots for gain of multiple resistance: http://aem.asm.org/content/81/7/2534.full.pdf+html Reflections on Reading: • Due by 1 pm on Tuesday October 11th	
Oct 11, 2016	• Linkage between antibiotic/heavy metal resistance genes and virulence • **Paper topics approved by instructor (544 students and 444 honor students only) by noon**
Oct 13, 2016	• Antibiotic classes and how they are targeted specifically for bacterial pathways • Mechanism of antibiotic resistance genes [ARGs] and antibiotics resistant bacteria [ARBs] • **In-class quiz on content covered during the first 2 weeks of class** • **Risk Communication identification of stakeholder and type of document to be produced (all students) by noon.**

Week 4: Antibiotic Resistome	
Readings: • Dantas G, Sommer MOA. 2014. How to fight back against antibiotic resistance. American Scientist 102:42-51. http://www.americanscientist.org/issues/id.16136/issue.aspx • Mao D, Luo Y, Mathieu J et al. Persistence of extracellular DNA in river sediment facilitates antibiotic resistance gene propagation. Environ Sci Technol. 48:71-78. http://pubs.acs.org/doi/pdf/10.1021/es404280v • Forsberg K et al., 2012. The shared antibiotic resistome of soil bacteria and human pathogens. Science. 337:1107-1111. http://www.sciencemag.org/content/337/6098/1107.full.pdf Reflections on Reading: • Due by 1 pm on Tuesday October 18th	
Oct 18, 2016	• What is the antibiotic resistome?
Oct 20, 2016	• Sources of ARGs (tentative)

Week 5: ARGs/ARBs the role of the popular press and Why are ARGs/ARBs a Global Issue?

Readings:

- Find 2 recent (last 2 years) articles in the popular press talking about antibiotic resistant bacteria. Post the urls to canvas site by 1 pm on Tuesday October 27th. Provide a 1 paragraph finding on how this article could influence thinking in the general population and is this accurate or not.
- Be prepare to discuss one of your articles in class Nov. 1, 2016 (2 min presentation on who the audience was and what the message was of the article)
- Roberts et al., 2009. Hospital and societal costs of AR infections in a Chicago teaching hospital: http://cid.oxfordjournals.org/content/49/8/1175.full.pdf+html
- Casey JA, Curriero FC, Cosgrove SE et al. 2013. High-density livestock operations, crop field application of manure, and risk of community-associated methicillin-resistant Staphylococcus aureus infection in Pennsylvania. JAMA Intern Med. 173:1980-1990. http://archinte.jamanetwork.com/article.aspx?articleid=1738717
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Reflections on Reading:

- Due by 1 pm on Tuesday October 25th

Oct 25, 2016	• How the popular press impacts the science
Oct 27, 2016	• Guest Lecturer: Dr. Peter Rabinowitz - One Health; how animals, humans, environment, and ARGs/ARBs interconnect

Week 6: One Health spread of ARGs/ARB

Readings:

- Gedik H, Voss TA, Voss A. 2013. Money and transmission of bacteria. Antimicrob Resist Infect Control 2:22 http://www.aricjournal.com/content/pdf/2047-2994-2-22.pdf
- Walsh, TR. 2010. Emerging carbapenemase: a global perspective. Internation. J Antimicrob Agents http://ac.els-cdn.com/S0924857910700042/1-s2.0-S0924857910700042-main.pdf?_tid=876e0e3a-4014-11e4-8ac4-00000aacb362&acdnat=1411141944_34d3c9f87c6513d1348c622e61d8358e
- Singer RS, Ward MP, Maldonado. 2006. Can landscape ecology untangle the complexity of antibiotic resistance? Nature Rev: Microb 4:943-952, http://www.nature.com/nrmicro/journal/v4/n12/pdf/nrmicro1553.pdf
- Berkner S, Konradi S, Schonfeld J. 2014. Antibiotic resistance and the environment-there and back again. EMBO reports http://embor.embopress.org/content/embor/15/7/740.full.pdf

Nov 1, 2016	• Student presentation on popular press and science • **In class quiz on content covered during the first 5 weeks of class**
Nov 3, 2016	• Examples of ARGs/ARB spread between animals, environment and humans • VRE in the US vs EU • Ciprofloxacin resistant *Campylobacter*

Week 7: Why are ARGs/ARBs a Global Issue?

Readings:

- Gedik H, Voss TA, Voss A. 2013. Money and transmission of bacteria. Antimicrob Resist Infect Control 2:22 http://www.aricjournal.com/content/pdf/2047-2994-2-22.pdf
- Walsh, TR. 2010. Emerging carbapenemase: a global perspective. Internation. J Antimicrob Agents http://ac.els-cdn.com/S0924857910700042/1-s2.0-S0924857910700042-main.pdf?_tid=876e0e3a-4014-11e4-8ac4-00000aacb362&acdnat=1411141944_34d3c9f87c6513d1348c622e61d8358e
- Rahube TO et al., 2014. Impact of fertilizing with raw or anaerobically digested sewage sludge on the abundance of AR coliforms, ARG, and pathogenic bacteria in soil and on vegetables at harvest. Appl Environ Microb. http://aem.asm.org/content/80/22/6898.full.pdf+html

Reflections on Reading:

- Due by 1 pm on Tuesday November 8th

Nov 8, 2016	• The environment and its role in ARG/ARB evolution and spread • Location of ARGs/ARBs
Nov 10, 2016	• Guest Lecturer: Dr. Scott Weissman - International spread of KPC, NDM, OXA-48

Week 8: Alternative therapies to antibiotics

Readings:

- Nakonieczna A, Cooper CJ, Gryko R. 2015 Bacteriophages and bacteriophage-derived endolysins as potential therapeutics to combat Gram-positive spore forming bacteria. J App Microbiol 110:620-631http://onlinelibrary.wiley.com/doi/10.1111/jam.12881/pdf
- McFarland LV. 2015: From yaks to yogurt: The history, development, and current use of probiotics. CID 60(suppl) S85-S90. http://www.ncbi.nlm.nih.gov/pubmed/25922406
- Ferrero et al. 2015. Efficacy and safety of a decision rule for using antibiotics in children with pneumonia and vaccinated against pneumococcus. A randomized controlled trial. Arch Argent Pediatr. 113:397-403

http://www.sap.org.ar/docs/publicaciones/archivosarg/2015/v113n5a04e.pdf • Ho HJ. In press. Am J Infect Cont Alcohol handrubbing and chlorhexidine handwashing are equally effective in removing methicillin-resistant *Staphylococcus aureus* from health care workers' hands: A randomized controlled trial http://www.sciencedirect.com/science/article/pii/S0196655315006653 Reflections on Reading: • Due by 1 pm on Tuesday November 15th	
Nov 15, 2016	• Alternative therapies, phage, probiotics
Nov 17, 2016	• Vaccines, behavior changes.

Week 9: The Role of Agriculture (in the Spread of ARGs/ARBs)	
Readings: • Millman JM, Waits K, Grande et al., 2014. Prevalence of antibiotic-resistant *E. coli* in retail chicken: comparing conventional, organic, kosher, and raised without antibiotics. [v2] 2:155 http://f1000research.com/articles/10.12688/f1000research.2-155.v2/doi • Zurek, L, Ghosh A. 2014.. Insects present a link between food animals, farms and the urban environment for antibiotic resistance traits. Appl Environ Microbiol. 80:3562-3567. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4054130/ • 2012 Summary Report on Antimicrobials Sold or Distributed for Use in Food-Producing Animals http://www.fda.gov/downloads/ForIndustry/UserFees/AnimalDrugUserFeeActADUFA/UCM416983.pdf [Look at the highlights in this report] • Nilsson O. 2012. Vancomycin resistant enterococci in farm animals-occurrence and importance. Infect Ecol Epidem. 2:16969-http://www.infectionecologyandepidemiology.net/index.php/iee/article/view/16959. Reflections on Reading: • Due by 1pm on Tuesday November 22th • **Research papers due Nov. 21st by noon**	
Nov 22, 2016	• **Guest Lecturer: Dr. Doug Call [WSU]** - Why does antimicrobial resistance persist? • **Take-home quiz on content covered during the first 8 weeks of class is distributed (due on Nov. 29th)**

Week 10: ARGs/ARB influenced by man
Readings: • LaPara TM, Burch TR, McNamara PJ et al. 2011. *Tertiary-treated municipal wastewater is a significant point source of antibiotic resistance genes into Duluth-Superior Harbor*. Environ Sci Technol. 45:9543-9549. http://pubs.acs.org/doi/pdf/10.1021/es202775r

• Andersson DI, Hughes D. 2011. *Persistence of antibiotic resistance in bacterial populations*. FEMS Microbiol Rev. 35:901-911. http://onlinelibrary.wiley.com/doi/10.1111/j.1574-6976.2011.00289.x/pdf **Risk project due by noon Nov. 28 to Canvas** **Quiz due by noon Nov. 29th**	
Nov 29, 2016	• Built environments like waste water treatment plants and their influence on transmission of ARGs/ARB around the world
Dec 1, 2016	• How do different human practices influence the evolution/ecology of ARGs/ARBs? **Summary**

Week 11: Student Presentations	
Dec 6, 2016 Dr. Roberts Out	• Present risk analysis project • Half the students will present their risk analysis project
Dec 8, 2016 Dr. Roberts Out	• Present risk analysis project • Half the students will present their risk analysis project • Take home exam given out. **Due 9 AM Dec 14, 2016**

UW Disability Statement:

Access and Accommodation (http://depts.washington.edu/uwdrs/faculty-resources/syllabus-statement/):

Your experience in this class is important to me. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course.

If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 206-543-8924 or uwdrs@uw.edu or disability.uw.edu. DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between you, your instructor(s) and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

UW Academic Integrity Statement: (http://sph.washington.edu/students/academicintegrity/) Students at the University of Washington (UW) are expected to maintain the highest standards of academic conduct, professional honesty, and personal integrity.

The UW School of Public Health (SPH) is committed to upholding standards of academic integrity consistent with the academic and professional communities of which it is a part. Plagiarism, cheating, and other misconduct are serious violations of the University of Washington **Student Conduct Code** (WAC 478-120). We expect you to know and follow the university's policies on cheating and plagiarism, and the **SPH Academic Integrity Policy**. Any suspected cases of academic misconduct will be handled according to University of Washington regulations. For more information, see the University of Washington **Community Standards and Student Conduct** website.