

Course Syllabus, First Half to Midterm
Biology 524
Strategies of Host-Microbe Interactions
Fall Semester, 2020 M,W 2.00-3.15 Coker 119

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office hours by appointment, please email

Powerpoint shows and primary readings are on Blackboard.

Textbook (SW) chapters are available on e-reserve, UNC library:

To view your paper reserve items, click:

<http://webcat.lib.unc.edu/search/a?searchtype=r&searcharg=biol524.001&submit=Search>

To view your electronic reserve items, click:

<http://eres.lib.unc.edu/eres/coursepage.aspx?page=pm&cid=3093>

Lecture:

1 W Aug 25 Class Introduction: Review of Bacterial Genetics, Genomics, Molecular Biology.

In this first, very short week, please review your Bio 202 text. If you sold it, go find one in the library. There are several on Reserve for Bio 202 and they all have a Bacterial Genetics chapter. Review plasmids, gene transfer (conjugation, transformation, phage transduction), mechanisms of Gene Regulation in prokaryotes, recombinant DNA methods and genomics chapters. NOTE these lectures will be part of the mid-term exam.

2 M Aug 30 Continuation of Lecture 1.

3 W Sept. 1 Infection mechanisms of bacterial pathogens and methods of analysis.

SW chapters 2 and 3 (skim), e-reserves.

M Sept. 6 Labor Day Holiday

4 W Sept 8 Strategies for identification of microbial virulence genes.

Heithoff, D. M., et al. (1997) Dissecting the biology of a pathogen infection *Trends in Microbiol.* 5, 509-513. (an excellent systems review).

Valdivia, R. H., and Falkow, S. (1997) Fluorescence-based isolation of bacterial genes within host cells. *Science* 277, 2001-2011.

5 M Sept. 13 Comparative Genomics and Understanding Virulence in *E. coli*

SW chapters 28 and 29 (skim), e-reserve

Medini, D. et al. (2005) The microbial pan-genome. *Current Opin. In Genet. and Develop.* 15, 589-594.

Dobrint, U. et al. (2004) Genomic islands in pathogenic and environmental microorganisms. *Nature Rev. Microbiol.* 2, 414-424.

Brzuszkiewicz, E. et al. (2007) How to become a uropathogen: Comparative genomic analysis of extraintestinal pathogenic *Escherichia coli* strains. *Proc. Natl. Acad. Sci., USA* 103, 12879-12884.

6 W Sept. 15 Commonalities in bacterial pathogenesis: Type III secretion systems and delivery of virulence factors.

Galan JE (2009) Common themes in the design and function of bacterial effectors. *Cell Host Microbe* 5, 571-579.

Marlovits TC & Stebbins CE (2010) Type III secretion systems shape up as they ship out. *Curr Opin Microbiol* 13, 47-52.

He, S.-Y., et al. (2001) The Hrp pilus in Type III protein secretion in *Pseudomonas syringae*. *Science* 294, 2556-2558.

7 M Sept 20 Recognizing pathogens by recognizing virulence factor action: the plant immune system.

Jones, JDG and JL Dangl (2006) The Plant Immune System. *Nature* 444, 323-329.

Shao, F. et al. (2003) Cleavage of *Arabidopsis* PBS1 by a bacterial type III effector. *Science* 301, 1230-1233.

Ade. J. et al. (2007) Indirect activation of a plant nucleotide binding site-leucine-rich repeat protein by a bacterial protease. *Proc. Natl. Acad. Sci., USA* 104, 2531-2536.

8 W Sept. 22 The plant immune system, part 2.

[Reading assignment as above for Lecture 7.]

9 M Sept. 27 Comparative Genomics and Fungal Virulence

Kamper J, Kahmann R, et al. (2006) Insights from the genome of the biotrophic fungal plant pathogen *Ustilago maydis*. *Nature* 444, 97-101.

And a news story about this paper by Dr. Ralph Dean from *Nature Biotechnology* which is appended to the paper.

Skibbe DS, Doehlemann G, Fernandes J, & Walbot V (2010) Maize tumors caused by *Ustilago maydis* require organ-specific genes in host and pathogen. *Science* 328, 89-92.

10 W Sept. 29 Comparative Genomics and Fungal Virulence.

[Reading assignment as above for Lecture 9]

11 M Oct. 4 Cholera

SW Chapter 25, on Cholera (skim!), e-reserve.

Faruque, S. H. and Mekalanos, J. J. (2004) Pathogenicity islands and phages in *Vibrio cholerae* evolution. *Trends Microbiol.* 11, 505-1510.

Waldor, M. K. and Mekalanos, J. J. (1996) Lysogenic conversion by a filamentous phage encoding cholera toxin. *Science*, 272, 1910-1914.

Faruque, S. H. et al. (2004) Genetic diversity and virulence potential of environmental *Vibrio cholerae* population in a cholera-endemic area. *Proc. Natl. Acad. Sci., USA* 101, 2123-2128.

12 W Oct. 6 Mutualism and Glowing Squid:

Nyholm, S. and McFall-Ngai, M. J. (2004) The winnowing: Establishing the squid-*Vibrio* symbiosis. *Nature Rev. Microbiol.* 2, 632-642.

Koropatnick, T. A. et al. (2004). Microbial factor-mediated development in a host-bacterial mutualism. *Science* 306,1186-1188.

Lupp, C and Ruby, EG (2005) *Vibrio fischeri* Uses Two Quorum-Sensing Systems for the Regulation of Early and Late Colonization Factors. *J. Bacteriol.* 187, 3620-3629.

13 M Oct 11 Intracellular entry, growth and spread: How Salmonella usurps host cell biology.

SW Chapter 26 (skim!), e-reserves.

Hansen-Wester, I. and Hensel, M. (2001) Salmonella pathogenicity islands encoding type III secretion systems. *Microbes and Infection* 3, 549-559.

Cirillo, et al. (1998) Macrophage-dependent induction of the *Salmonella* pathogenicity island 2 type III secretion system and its role in intracellular survival. *Mol. Microbiol.* 30, 175-188.

Note: Review the FACS methodology in the Valdivia and Falkow paper from Sept. 8, first.

14 W Oct. 13 **2 hour in class midterm**, covers papers read and lectures through Lecture 13, Oct. 11.

15 M Oct 18 The gut microbiome and gut development.

Ley, RE, et al. (2006) Ecological and Evolutionary Forces Shaping Microbial Diversity in the Human Intestine. *Cell* 124, 837-848.

Stappenback, T. S. et al., (2002) Developmental regulation of intestinal angiogenesis by indigenous microbes via Paneth cells. *Proc. Natl. Acad. Sci., USA* 99, 15451-15455.

W Oct 20 No class. Fall Break.

16 M Oct 25 Guest Lecturer, Dr. Sarah Lebeis, Dangl Lab, UNC Dept. of Biology

The battle for your gut: How pathogens trick hosts into helping them in the gut niche.

<http://www.nytimes.com/2010/07/13/science/13micro.html>

Stecher, B and Hardt, W.-D. (2008) the role of microbiota in infectious disease. *Trends in Microbiology* 535, 1-8 epub ahead of print.

Stecher, B. et al. (2007) *Salmonella enterica* serovar *typhimurium* exploits inflammation to compete with the intestinal microbiota. *PLoS Biology* 5(10): e244. doi:10.1371/journal.pbio.0050244

[Note: You will need to go to the PLoS Biology web site and download or study the Supplemental Figures and Tables. This is a good exercise. PLoS is open source, so you can access it from anywhere]

17 W Oct. 27 The gut microbiome and obesity.

Ley, RE, et al. (2005) Obesity alters gut microbial ecology. *PNAS* 102, 11070-11075.

Turnbaugh, PJ, et al., (2006) An obesity-associated gut microbiome with increased capacity for energy harvest. *Nature* 444, 1027-1031. (and, at the end of this pdf is a short research communication from the same group on humans)

18 M Nov 1 Microbial community assembly and host-microbe interactions in the vertebrate intestine

Guest Lecturer, Dr. John Rawls, Assistant Professor, Dept. of Cell and Molecular Physiology, UCM-School of Medicine

McFall-Ngai, M (2006) Love the One You're with: vertebrate guts shape their microbiota. *Cell* 127, 247-249.

Rawls, JF, et al. (2006) Reciprocal gut microbiota transplants from Zebrafish and Mice to germ-free-recipients reveal host habitat selection. *Cell* 127, 423-433.

19 W Nov. 3 Pathogenesis of *Mycobacterium tuberculosis*: life inside a macrophage

Guest Lecturer, Dr. Jenny Hayden, Braunstein Lab, UNC Dept. of Microbiology and Immunology

Russell, DC (2007) Who puts the tubercle in tuberculosis? *Nature Rev. Microbiol.* 5, 39-45.

Vandal, OH, et al. (2008) A membrane protein preserves intrabacterial pH in intraphagosomal *Mycobacterium tuberculosis*. *Nature Medicine* 14, 849-854.

20 M Nov. 8 Mutualism and fungus farming ants I.

Herre, E. A., et al. (1999) The evolution of mutualisms: exploring the paths between conflict and cooperation. *Trends in Ecology and Evolution* 14, 49-53.

Currie, C. R., et al. (1999) Fungus-growing ants use antibiotic-producing bacteria to control garden parasites. *Nature* 398, 701-704.

21 W Nov. 10 Mutualism and fungus farming ants II

Currie, C. R., et al. (2003) Ancient tripartite coevolution in the Attine ant-microbe symbiosis. *Science* 299, 386-388.

Currie, C. R. et al. (2006) Coevolved crypts and exocrine glands support mutualistic bacteria in fungus-growing ants. *Science* 311, 81-83.

Gerardo, NM et al. (2006) Ancient Host–Pathogen Associations Maintained by Specificity of Chemotaxis and Antibiosis. *PLoS Biology* 4, 1358-1363.

M Nov 15, W Nov 17, M Nov 22

NO CLASSES, but TUTORIALS to be scheduled with Dr. Dangl by email. You must schedule a tutorial.

For the tutorial, FOCUS on your Research Proposal and Presentation. Read the course outline for tips. Also, focus on your outline, reading, preparing a detailed outline and even a rough draft of the Introduction section. Then prepare your list of experimental aims and predicted outcomes. Remember to include all necessary control experiments to help you make your predicted outcomes interpretable. Each of you must schedule with me at least one 30 minute appointment to discuss your progress. Come prepared, bring you laptop, pdfs of the papers you are using, and outline/current progress.

Class presentations (in the order of presentation):

M Nov 29

W Dec 1

M Dec 6

W Dec 8

4 student presentations per class period; 15-20 minutes each and 5 minutes discussion. The rest of you will be graded on how well you listen synthesize the information and ask good questions. Try to think of, and write down, at least two questions for each talk during the presentation.

Term papers as pdf files Friday December 17 at 5pm by email at the latest—NO EXCEPTIONS.