Syllabus of Microbial Evolution

This is an enquiry-based, writing intensive senior seminar that introduces seniors to the primary literature on microbial evolution. Teams of 4 students will be expected to develop Wiki pages on one of the topics below as well as handing in a weekly summary on the topics selected below. The unifying theme of the topics below is genetic networks and how they are organized and linked to fitness in microbial systems.

1. **Evolution of antibiotic resistance**
    a. **Walkiewicz, K, ASB Cardenas, C Sun, C Bacorn, G Saxer, & Y Shamoo** 2012. Small changes in enzyme function can lead to surprisingly large fitness effects during adaptive evolution of antibiotic resistance. *PNAS USA* 109: 21408-21413
2. **Adaptive immunity in bacteria**
    a. **Hale, CR, P Zhao, S Olson, MO Duff, BR Graveley, L Wells, RM Terns, & MP Terns** 2009. RNA-guided RNA cleavage by a CRISPR RNA-Cas Protein Complex. *Cell* 139: 945-956
3. **Genetic capacitors**
    a. **Levy, SF & ML Siegal** 2008. Network hubs buffer environmental variation in *Saccharomyces cerevisiae*. *PLoS Biology* 6: e264
4. **Constraints on evolution**
    a. **Miller, SP, M Lunzer, & AM Dean** 2006. Direct demonstration of an adaptive constraint. *Science* 314: 458-461
5. **physiological laws**
    a. **Scott, M, CW Gunderson, EM Mateescu, Z Zhang, & T Haw** 2010. Interdependence of cell growth and gene expression: origins and consequences. *Science* **330**: 1099-1102
6. **microbial longevity**
    a. **Jazwinski, M** 2012. The retrograde response and other pathways of interorganelle communication in yeast replicative aging. In *Aging Research in Yeast, Subcellular Biochemistry* (M Breitenbach et al. (ed.s) **57**. Springer-Verlag, NY, pp. 79-100
7. **bet hedging in a variable environment**
    a. **Levy, SA, N Ziv, & ML Siegal** 2012. Bet hedging in yeast by heterogeneous, age-correlated expression of a stress protectant. *PLoS Biology* 10: e1001325
8. **modularity**
    a. **Segre, D, A DeLuna, GM Church, & R Kishony** 2005. Modular epistasis in yeast metabolism. *Nature Genetics* 37: 77-83
    b. **Roguev, A, S Bandyopadhyay, M Zofall, K Zhang, T Fischer, SR Collins, H Qu, M Shales, H-O Park, J Hayles, K-L Hoe, D-U Kim, T Ideker, SI Grewal, JS Weissman & NJ Krogan** 2008. Conservation and rewiring of function modules revealed by an epistasis map in fission yeast. *Science* 322: 405-410
9. **evolution of robustness**
    a. **Lehner, B** 2010. Genes confer similar robustness to environmental, stochastic and genetic perturbation. *PLoS ONE* 5: e9035

10. **microevolution of genetic networks**
    a. **Covert, MW, CH Schilling & B Palsson** 2001. Integrating high-throughput and computational data elucidates bacterial networks. *Nature* 429: 92-96
11. **balanced polymorphisms in gene networks**
    a. **Hittinger, CT, P Goncalves, JP Sampaio, J Dover & M Johnston** 2010. Remarkably ancient balanced polymorphisms in a multi-locus gene network. *Nature* 464: 54-60
12. **macroevolution of genetic networks**
    a. **Tuch, BB, DJ Galgoczy, AD Hernday, H Li, AD Johnson** 2008. Evolution of combinatorial gene regulation in fungi. *PLoS Biology* 6: e38
13. **evolution of epistasis and adaptive walks**
    a. **Chou, H-H, H-C Chiu, NF Delaney, D Segre, & CJ Marx** 2011. Diminishing returns epistasis among beneficial mutates decelerates adaptation. *Science* 332: 1190-1192
14. **coevolution of host and parasite on omics scale**
    a. **Bonneaud, C, SL Balenger, AF Russell, J Zhang, GE Hill, & SV Edwards** 2011. Rapid evolution of disease resistance is accompanied by functional changes in gene expression. *PNAS USA* 108: 7866-7871
    b. **Delaney, NF, S Balenger, C Bonneaud, CJ Marx, GE Hill, N Ferguson-Noel, P Tsai *et al*.** 2012. Ultrafast Evolution and Loss of CRISPRs Following a Host Shift in a Novel Wildlife Pathogen, *Mycoplasma gallisepticum*. *PLoS Genetics* **8**:e1002511.
15. **evolution of multi-cellularity**
    a. **Koschwanze, JH, KR Foster, & JR Murray** 2011. Sucrose utilization in budding yeast as a model for the origin of undifferentiated multicellularity. *PLoS Biology* 9: e1001122
16. **evolution of sex, negative epistasis, and robustness**
    a. **Azevedo, RBR, R Lohaus, S Srinivasan, KK Dang, & CL Burch** 2006. Sexual reproduction selects for robustness and negative epistasis in artificial genetic networks. *Nature* 44: 87-90
17. **horizontal gene transfer in protists**
    a. **Kissinger, JC & J DeBarry** 2011. Genome cartography: charting the apicomplexan genome. *Trends in Parasitology* 27: 345-354

Each week a student will turn in a summary of the reading for the week according to the format described in a separate attached page. There will be 13 assignments, each of equal value. The value of each will be 100 pts.

In addition there will be a semester project for each student to develop their own Wiki page on one of the 10 topics above. The purpose of Wiki page is to allow a group to work on a common project. You will be divided into groups, each consisting of 4 students, to develop the Wiki page. The last class will be reserved for presentation of your Wiki page. The software CATME will be used to assess the contribution of each team member to the Wiki. The value of your Wiki page will be 200 pts.