Syllabus BIBC 194: Advanced Topics in Biochemistry

(**with 13 highly recommended research/review references)

Professor Milton Saier (msaier@ucsd.edu; 858-534-4084)

References marked with ** are highly recommended research/review articles.

Class schedule:

- Class: Thursdays 1:00-2:20 pm (Room: York 3010)
- Office hours: Thursdays 2:20-3:00 pm (Room: York 3010)

I. Prokaryotic Diversity

a. Classical prokaryotes and eukaryotes – an overview

b. The three laws of Biology

**Trevors JT, Saier MH, "Three Laws of Biology", WASP, 2010.

c. Evolution of the Genetic Code according to biochemical laws

**Saier M. H., Jr (2019). Understanding the Genetic Code. *Journal of bacteriology*, *201*(15), e00091-19. [PMID: 31010904]

d. CPR nanobacteria – symbionts (and pathogens)?

e. Asgard archaea – the eukaryotic cell precursor?

Comparative population genomic analyses of transporters within the Asgard archaeal superphylum, Russum S et al., 2021, PLoS One [PMID: 33770091]

**Castelle, C. J., & Banfield, J. F. (2018). Major New Microbial Groups Expand Diversity and Alter our Understanding of the Tree of Life. *Cell*, *172*(6), 1181–1197 [PMID: 29522741]

f. The Human systemic microbiome:
   i. A multiplicity of microbiomes
   ii. The effects of oral microbiota on health
   iii. Modulating brain function with microbiota
   iv. Microbiota and maintenance of skin barrier function

g. Actin cytoskeleton and complex cell architecture in an Asgard archaeon

h. Eating animal products, a common cause of human diseases

**Saier MH et al., (2022) Eating Animal Products, a Common Cause of Human Diseases, Microbial Physiology 32 (5-6) 146 - 157 [PMID 35952632].

II Prokaryotic Molecular Machines

a. Bacterial cytoskeleton and cell coordination

**Govindarajan, S., & Amster-Choder, O. (2016). Where are things inside a bacterial cell? *Current opinion in microbiology*, *33*, 83–90. [PMID: 27450542].

b. Bacteriorhodopsin and photosynthesis: light driven ion pumps

c. Reversible rotary ATP synthetases: F-, V-, and A-types

d. 'Switching' rotary flagella – organelles of motility

e. Poorly characterized types of prokaryotic motility:
   i. Archaeal flagella: rotary type IV pili;
   ii. social gliding via retractable pili – Myxobacteria;
   iii. Adventurous gliding motility – Myxobacteria;
   iv. Ratchet structure involvement – Cytophaga/Flavobacteria;
   v. Internal fiber-dependent motility – Mycoplasma

f. Chemotaxis – involving *mot*, *fla* and *che* genes

g. Sensing physical forces

h. Bioelectricity and bacterial nanowires

i. Protein secretion systems (>24 distinct types)

j. Chaparonins and proteosomes

k. Carboxysomes, cellulosomes and metabolomes

l. Circadian clocks in Cyanobacteria

m. Sulfur granuoles and gas vacuoles

**Saier M. H., Jr (2013). Microcompartments and protein machines in prokaryotes. *Journal of molecular microbiology and biotechnology*, *23*(4-5), 243–269. [PMID: 23920489]

III. Prokaryotic Membrane-bounded Organelles

a. Intracellular membranes in *E. coli* and other bacteria (mitochondrial precursors)

b. Chromatophores in photosynthetic bacteria (chloroplast precursors)

c. Magnetosomes in magneto-tactic bacteria, archaea and eukaryotes

d. Anammoxosomes in planctomycetes

e. Universal Acidocalcisomes – for H^+, Ca^{2+}, polyphosphate and energy storage

f. Outer membrane vesicles for communication and trafficking

**Saier, M. H., Jr, & Bogdanov, M. V. (2013). Membranous organelles in bacteria. *Journal of molecular microbiology and biotechnology*, *23*(1-2), 5–12. [PMID: 23615191]

IV. Cooperativity, Metastability and Stochasticity

a. Cell polarity

b. Bacterial adhesins

c. Molecular beacons

d. Quorum sensing: group-dependent external chemical signaling

**Striednig, B., & Hilbi, H. (2021). Bacterial quorum sensing and phenotypic heterogeneity: how the collective shapes the individual. *Trends in microbiology* 30(4):379-389 [PMID: 34598862]

e. Biological warfare – use of protein toxins and lytic strategies

**Hu, H., Liu, M., & Sun, S. (2021). Pore-Forming Toxins During Bacterial Infection: Molecular Mechanisms and Potential Therapeutic Targets. *Drug design, development and therapy*, *15*, 3773– 3781. [PMID: 34522083]

f. Persisters- formation and resuscitation

**Wainwright, J., Hobbs, G., & Nakouti, I. (2021). Persister cells: formation, resuscitation and combative therapies. *Archives of microbiology*, *203*(10), 5899–5906. [PMID: 34739553]

g. Prokaryotic differentiation: *Bacillus*, Myxobacteria, *Streptomyces*

**Riley, E. P., Schwarz, C., Derman, A. I., & Lopez-Garrido, J. (2020). Milestones in *Bacillus subtilis* sporulation research. Microbial cell (Graz, Austria), 8(1), 1–16. [PMID: 33490228]

**Kroos L. (2017). Highly Signal-Responsive Gene Regulatory Network Governing *Myxococcus* Development. *Trends in genetics: TIG*, *33*(1), 3–1 [PMID: 27916428]

Ladwig, N., Mayer, C., Macek, B., Mitousis, L., Sigle, S., Walter, A., Wohlleben, W., & Muth, G. (2019). Role of the *Streptomyces* spore wall synthesizing complex SSSC in differentiation of *Streptomyces coelicolor* A3(2). *International journal of medical microbiology : IJMM*, *309*(6), 151327. [PMID: 31324525]

h. Myxobacterial differentiation

i. Cell-cell interactions in embryogenesis and myxobacteria

j. Social microbes

k. Mighty microbes: Viruses of bacteria and eukaryotes – including coronaviruses

**Reddy, B. L., & Saier, M. (2020). The Causal Relationship between Eating Animals and Viral Epidemics. *Microbial physiology*, *30*(1-6), 2–8. [PMID: 32957108]

Wong, N. A., & Saier, M. H., Jr (2021). The SARS-Coronavirus Infection Cycle: A Survey of Viral Membrane Proteins, Their Functional Interactions and Pathogenesis. *International journal of molecular sciences*, *22*(3), 1308. [PMID: 33525632]

V. Mutagenesis, Evolution and Mobile Genetic Elements

**Saier, M. H., Jr, Kukita, C., & Zhang, Z. (2017). Transposon-mediated directed mutation in bacteria and eukaryotes. *Frontiers in bioscience (Landmark edition)*, *22*, 1458–1468. [PMID: 28199212].

Getting Help

Questions are essential in science and you must never be afraid to ask them. You can ask during my office hours, send me an email, submit your question via Canvas.

Academic Honesty and Plagiarism

There is a zero tolerance policy regarding academic dishonesty. See the Academic Integrity Agreement (which you must sign to receive a passing grade in the class) for more details on the topic. Violators of these policies may be subject to UCSD rules for academic integrity. Plagiarism is the unacknowledged presentation of the work of another person as one's own. To present someone else's work as one's own is dishonest and academically worthless. Plagiarism is unethical and will be treated as a serious offense. If a student is uncertain whether a course of action might constitute plagiarism or cheating, they should consult the instructor in advance.