BILD 130: Microbial Physiology

This class will be given online via zoom.

Syllabus (** indicates required readings)

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.

d. CPR nanobacteria – symbionts and pathogens?

e. Asgard archaea – the eukaryotic precursor?

**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.

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.

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 bacterial 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 (actin/myosin?)-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. Chaperonins 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.

III. Prokaryotic membrane-bounded organelles

a. Intracellular membranes in E. coli and other bacteria (mitochondria 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+, Ca2+, 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.

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*, S0966-842X(21)00212-2.

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.f. Persister cells: formation, resuscitation and combative therapies

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.

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.

Kroos L. (2017). Highly Signal-Responsive Gene Regulatory Network Governing Myxococcus Development. *Trends in genetics : TIG*, *33*(1), 3–15.

Vollmer, B., Steblau, N., 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.

h. Myxobacterial Differentiation

i. Cell-cell interactions in embryogenesis and myxobacteria

j. Social Microbes

k. Mighty Microbes

l. 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.

Baird, S. (2022). Three Pandemics and Human Behavior.

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.

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.