Hebe Guardiola-Diaz May 15, 2014
CTL Teaching Fellow Report

Flipping Biochemistry

Proposed Teaching Project

The traditional lecture approach to teaching biochemistry works like this: the instructor delivers information during scheduled class time while students passively take notes. Students leave lecture and attempt to work on problems or papers outside of class time. As a CTL teaching fellow, I plan to flip this around. In some institutions, instructors of a “flipped” course post online lectures that constitute their sole activity outside the classroom. I do not intend to do that. My approach has been to develop paired resources that will enhance learning about Biochemistry. Each pair will consist of (1) a preparatory resource to be completed before class and (2) in-class problems or activities.

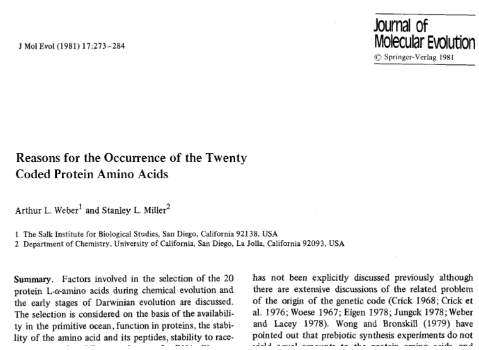
The preparatory resources will reduce the need for extensive lectures and will include:
1. Video tutorials
2. Animations
3. Article bank (popular press and scientific literature)

The paired in-class activities will take up some of the time normally spent lecturing and will include:
1. Problems
2. Model building
3. Data analysis

Examples of Paired Resources under Development:

1. <u>Amino Acids and Proteins</u>

   I will ask students to read a review article on the topic of the evolutionary basis for selection of 20 specific amino acids for protein synthesis. I will also ask them to consider



J Mol Evol (1981) 17:273–284

Journal of Molecular Evolution
© Springer-Verlag 1981

Reasons for the Occurrence of the Twenty Coded Protein Amino Acids

Arthur L. Weber[1] and Stanley L. Miller[2]

1 The Salk Institute for Biological Studies, San Diego, California 92138, USA
2 Department of Chemistry, University of California, San Diego, La Jolla, California 92093, USA

Summary. Factors involved in the selection of the 20 protein L-α-amino acids during chemical evolution and the early stages of Darwinian evolution are discussed. The selection is considered on the basis of the availability in the primitive ocean, function in proteins, the stability of the amino acid and its peptides, stability to race-

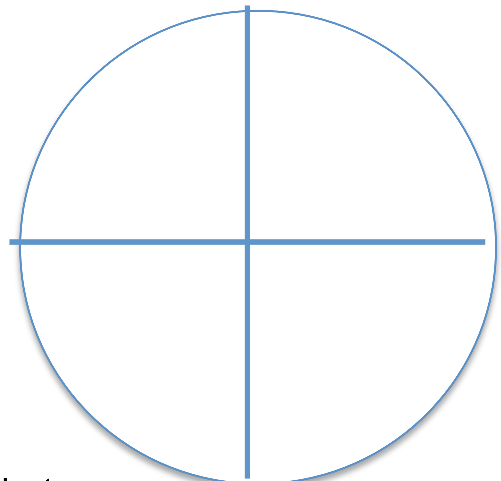
has not been explicitly discussed previously although there are extensive discussions of the related problem of the origin of the genetic code (Crick 1968; Crick et al. 1976; Woese 1967; Eigen 1978; Jungck 1978; Weber and Lacey 1978). Wong and Bronskill (1979) have pointed out that prebiotic synthesis experiments do not

the following peptide sequence and to carry out tasks (a) and (b) before class:
Leu-Glu-Glu-Val-Phe-Ser-Gln-Leu-Cys-Thr-His-Val-Glu-Thr-Leu-Lys

a. Identify hydrophobic, hydrophilic and ionizable residues.

b. This sequence forms an a helix. Construct a visual picture of the types of secondary and tertiary structures of proteins. Explain the molecular interactions that control protein structure formation and stability.

The paired in-class activity in this case will be to work with a partner to determine how to space out the amino acids in a helical plot.



This will enable students to better understand molecular interactions that control protein structure formation and stability.

Students will then work in teams to build a model of this peptide using either molecular models or a styrofoal cylinder and pipe cleaners.

2. <u>Enzyme Kinetics</u>

Prior to our enzyme kinetics lab, students will be asked to carry out a virtual lab (http://www.wiley.com/college/pratt/0471393878/student/animations/enzyme_kinetics) and to bring their results to class. It has been my experience that a significant number of students do not understand concepts of chemical equilibrium. This out-of–class activity will help students visualize the data and come to class better prepared for level-appropriate concepts. The paired in-class activity in this case will be to work with the data they collected virtually so that they can calculate kinetic parameters such as:

a. K_M and V_{MAX}

b. Kcat and the catalytic efficiency (Kcat/ K_M)

I expect to be able to discuss the meaning of these parameters in depth and how these parameters serve as a basis for physiological adaptations and even for drug development.

3. Energy: Mechanism for ATP synthesis

The mechanism for ATP synthesis is not easy to illustrate in a diagram. This is an example of the diagram from a popular Biochemistry textbook:

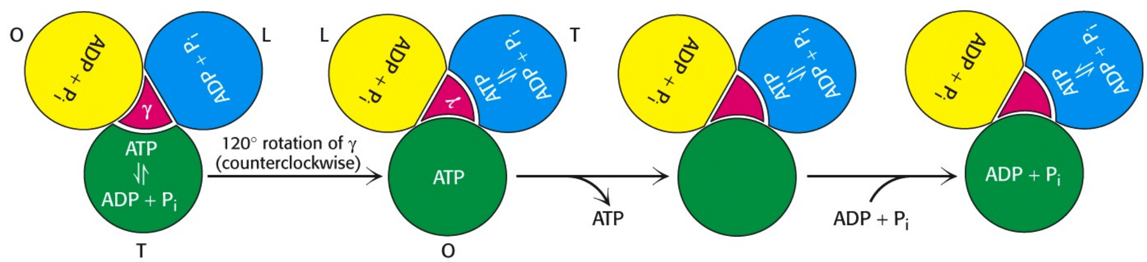


Figure borrowed from the 6th edition of Berg's Biochemistry

I have found several videos that students can watch prior to class to foster a better understanding of this elegant mechanism. One example can be viewed at:

- http://www.youtube.com/watch?v=PjdPTY1wHdQ

I expect to couple this effort to an in-class discussion of the clinical significance of energy metabolism. One possible article we may discuss would be:

The role of mitochondria in aging, neurodegenerative disease, and future therapeutic options

Issue: BCMJ, Vol. 53, No. 4, May 2011, page(s) 188-192 Articles
Shahul Hameed, MD, Ging-Yuek Robin Hsiung, MD, MHSc, FRCPC

Therapies based on agents that enhance mitochondrial health may eventually play a role in the treatment of Alzheimer disease and other neurodegenerative conditions.

ABSTRACT: The mitochondrion is an essential organelle central to a number of biochemical processes in the cell. Since we know the functional efficiency of mitochondria declines with age, and since aging is a risk factor common to a number of neurodegenerative diseases, including Alzheimer disease, Parkinson disease, and amyotrophic lateral sclerosis, researchers have proposed that secondary mitochondrial failure may be the common pathway in-volved in degenerative processes. Given the evidence suggesting that mitochondrial dysfunction and oxidative damage play a role in neurodegeneration, researchers are looking at antioxidant therapies. Although there is no evidence supporting the use of common over-the-counter antioxidants such as vitamins C and E in the treatment or prevention of neurodegenerative diseases, other therapeutic agents aimed at restoring or preserving mitochondrial health hold promise for treating these diseases in the future.

Aging is natural to all of us, and can be defined as a time-dependent degenerative process that ultimately leads to death. The idea that free radicals and oxidative damage might lead to aging and premature cell death has been around since our early understanding of the biochemistry involved in energy production in organisms.

Harman first suggested that oxidative damage to cellular components produced by free radicals is the underlying cause of aging, based on the observation that ionizing radiation and oxygen pressures decrease life span.[1]

4. Energy: Q-cycle

The Q-cycle provides a framework for understanding the relationship between electron transport and H^+ ion translocation. It is also not easy to develop images that do it justice. Here is an example of an image from a popular Biochemistry textbook:

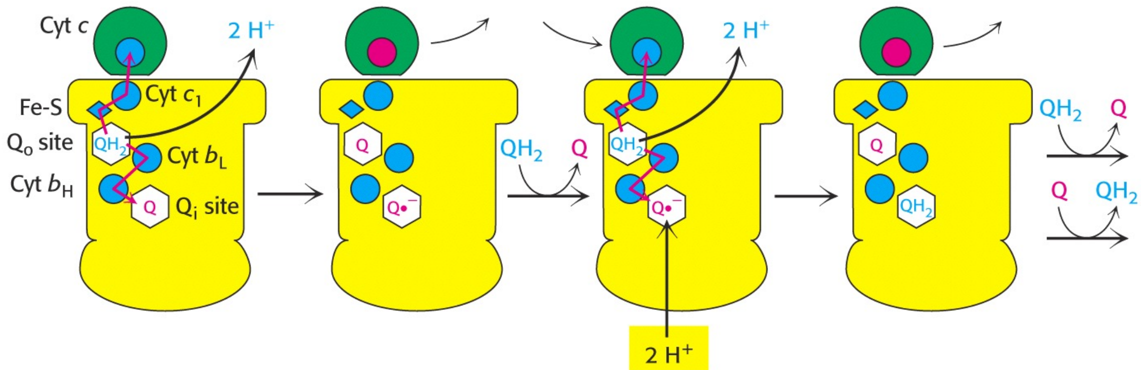


Figure borrowed from the 6th edition of Berg's Biochemistry

I am still searching for an effective task for students to complete prior to class. The two videos available online are not satisfactory. These videos are available at:
http://www.youtube.com/watch?v=rTrLWGQDB0Q

http://www.youtube.com/watch?v=GaWM6yTE1Wg

I am considering developing my own animation to help students better understand this important concept.

Impact on Teaching and Concluding Remarks

The redesigned biochemistry course will launch in the fall of 2014. The four examples above will be expanded during the summer with the goal of developing more independence and confidence in the students as they carry on work outside the classroom. This will open up time in class to discuss topics in depth and help students understand their significance and applications.

The Center for Teaching and Learning has provided a great setting to discuss ideas about teaching and to discuss our teaching projects plans. I feel part of a community that cares about teaching and about providing the best possible experience for our students.