Translating the Central Dogma: Biochemical Models of Protein Translation

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Audience:
24 undergraduate students transferred to UC Santa Cruz

Venue:
Biochemistry WEST from September 12^{th} -14^{th}, 2016 at UC Santa Cruz.

Description:

This activity was designed to engage transfer students to UC Santa Cruz from STEM backgrounds participating in the WEST program. Although targeted to students with backgrounds in **chemistry and biochemistry**, students participated with educational interests as diverse as electrical engineering, evolutionary biology, and physics. The primary content objectives were firmly rooted in chemistry and biochemistry, exploring the identification, character, and cumulative consequences of **weak intermolecular forces in protein structure and function**. Our students pursued this content by applying authentic (albeit simulated) experimental techniques toward the development of a “back-of-the-envelope” **functional model** of prokaryotic protein translation. This simulated the ubiquitous practice in real research environments of extemporaneous model development; using coarse and apparently simplistic model depictions to explain complex and nuanced experimental detail.

Students began **with short discussions** on the importance and challenge of using models in scientific endeavors, leading into an introductory activity proposing the forces at play in a related biomolecule, tRNA synthetase. Provided with its known chemical transformation, students proposed the reasonable location and nature of intermolecular chemical forces necessary for reactivity, binding, and selective recognition. Following this thought exercise, students were separated into "**expert groups**" to discuss readings about authentic biochemical experimental techniques that were randomly assigned a few days prior to our activity. These groups allowed students to imagine the scientific potential of their respective techniques, clarify confusion, highlight caveats, and build excitement and ownership for the upcoming challenge. **Students from each expertise were divided into new groups** that relied upon each other over the course of 5 hours (over 2 days) to apply their experiments to solve the function of the biomolecules involved in protein translation, beginning with nothing more than crude paper cut-outs.

Entrance to a research laboratory can be daunting to first-generation college students, or to any student unfamiliar with a perceived culture of white-coated experts. In reality, scientific progress rests in our ability to recruit minds and hands capable of applying uniquely creative abilities to the next generation of scientific challenges. This activity recreated many elements innate to a research environment (amateur backgrounds, scientific reading, multidisciplinary expertise, communication, collaborative labor, and truly difficult problems), giving students an opportunity to develop ownership and identity in the process of research. Teams were allowed to choose particular **human disease states as the ultimate object of their model development**, furthering supporting individuals' ownership in the activity. With such a dynamically complex biochemical apparatus, teams were assessed not on their ability to reproduce a fully complete model, but on their ability to apply chemical explanation upon only the model components relevant to their chosen disease state. Due to the effort and commitment applied by the students on small details of the translation system, any incomplete knowledge was rapidly sated during the final consensus model reveal; they were able to grasp this as the culmination of years of experimental labor, rather than yet another page in a textbook.