367d Development of a Molecular and Systems Biotechnology Course

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As part of an overall bioengineering initiative in the Department of Chemical Engineering at the University of Massachusetts Amherst, we offered a graduate elective course in Molecular and Systems Biotechnology this spring semester. The goal of the course was to provide an introduction to both experimental methods and computational modeling. In the experimental methods part, we focused on the following topics: (1) genetic screen and selection in E. coli and S. cerevisiae and their applications; (2) protein engineering by directed evolution and rational design and their applications; (3) DNA-templated organic synthesis; (4) mass spectrometry-based proteomics; (5) metabolic pathway engineering and its application; and (6) synthetic biology. In the computational modeling section, we introduced the following topics: (1) nonlinear dynamic systems and their analysis; (2) theory and applications of metabolic flux analysis; (3) theory and applications of metabolic control analysis; (4) metabolic network modeling and analysis; and (5) gene and signaling network modeling and analysis. Although these topics can be viewed independently, we utilized an integrated approach that focused on common themes in E. coli and S. cerevisiae metabolic and protein engineering. Advantages of this approach are that existing topics can be extended and new topics can be added as warranted by recent developments in the field. This course provides a unique starting point for the development of two distinct graduate elective courses in molecular biotechnology and systems biology to diversify and enrich our bioengineering education in the UMass-Amherst Department of Chemical Engineering.