

Hands-on Laboratory Exercises in Biotechnology / Bioprocess Engineering

Dhinakar S. Kompala, *Department of Chemical Engineering, University of Colorado, Boulder, CO 80309-0424, U.S.A.,*
/ Ph: 303-492-6350, \ Fax: 303-492-4341, e-mail: kompala@colorado.edu

At the Senior-level in the Biotechnology option of our Chemical Engineering curriculum, we offer a capstone course on Bioprocess Engineering, dealing with bioreactor design and operation with recombinant microbial and mammalian cells. Building on prior coursework (including lab) on Biology and Biochemistry, which are part of our Biotechnology option, we have been able to address advanced issues in modern biotechnology in our Bioprocess Engineering course. An integral part of this course is a set of four laboratory exercises focusing on: (1) enzyme kinetics with and without inhibition, (2) batch diauxic growth of yeast on glucose, galactose and ethanol, (3) recombinant bacterial cultures with and without induction of foreign protein expression, and (4) recombinant mammalian cell cultures in batch and continuous bioreactor cultures. Through this sequence of laboratory exercises interspersed with lecture materials on these evolving technologies, we provide a more systematic introduction to the modern laboratory techniques as well as current industrial practice. Within this general framework, we typically update these experiments based on the current activities in our research laboratory. For example, with the increasing use of polymerase chain reaction (PCR) in my research laboratory, we are introducing a new laboratory exercise on PCR, illustrating the utility of thermostable enzymes in this modern biological technique. Similarly, with our research laboratory's emphasis on high cell density bioreactors, we illustrate these efficient bioreactors in operation with recombinant mammalian cells. The undergraduate and entering graduate students take hands-on measurements of viable and dead cell numbers and recombinant protein concentration in the culture medium. Other universities have been able to duplicate several of these experiments (with our step by step instructions posted on the web) in their courses, using their own available equipment.