# Cell biology education: where's the math?

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The Bio2010 Report from the National Research Council prompted college and university educators to consider effective ways to integrate quantitative thinking and practice into their biology curricula. None questions the need for training cell biology students who can do the quantitative analysis required for substantive discoveries. Quantitation is an essential feature of biological thinking, and thus math is used on a daily basis in the cell biology lab.

In this Minisymposium, biologists from various levels of experience proffered philosophy and assorted tools to infuse quantitative analyses into biology classes and laboratories. The take- home lessons are as follows: 1) The time factor in biology curriculum development can be especially daunting and frequently becomes a justification for inertia. Minisymposium speakers belied this justification by presenting many resources in websites and people willing to help. Examples are listed later in this review (Marsteller, 2010; BioQUEST Curriculum Consortium, n.d.). 2) Mathematicians and cell biologists seldom talk to each other, remaining comfortably siloed in their respective departments. Yet experts at quantitative modeling can be the best resource to help biologists select among hypotheses generated by experimental data or to design experiments that are better able to clearly test their hypotheses (Berro *et al.*, 2010; Sirotkin *et al.*, 2010). Biologists could invite mathematicians into the laboratory to do experiments or analyze data; mathematicians could invite biologists to try modeling experimental data to see whether a model predicts things that might never have occurred to the cell biologist. So take a mathematician to lunch! 3) Undergraduates can drive quantitative curriculum development, especially in the laboratory. Under faculty supervision, a student team can generate new knowledge while developing lab exercises, work out the bugs of presentation (talking with peers before and during the course), gain comfort in quantitative approaches, and get course credit simultaneously. Undergraduates thus engage in research and teaching, and faculty have a built-in team of collaborators more enthusiastic about the process of science.

**John Jungck** (Beloit College) and **Pat Marsteller** (Emory University) focused on resources for faculty, including ready-to-use curricular material and faculty pedagogical development opportunities (Marsteller, 2010; BioQUEST Curriculum Consortium, n.d.). **Omar Quintero** (Pennsylvania State University Medical School) reported on development of a "semiwet lab" approach that utilizes short video clips to introduce the students to advanced research approaches that might be prohibitively expensive or technically difficult. The students get exposure to some wet-lab techniques in a larger context, but the major goal of the project is to shift the students' time and focus toward quantitative data analysis in context and away from cookbook lab methods without context.

Postdoctoral fellow **Julien Berro** (Yale University) provided a specific example of how a mathematical model suggests experiments and how the experimental results lead to model revision—much like the course of science (Berro *et al.*, 2010; Sirotkin *et al.*, 2010).

Graduate student **Julia Philip** (University of Notre Dame) described a protein binding simulation that reinforces why thermodynamics and kinetics both describe the regulation of microtubule binding parameters. This tool is freely accessible and useful in upper division coursework and research (Philip *et al.*, 2010).

Finally, undergraduate **Samantha Lindemann** (University of Minnesota, Duluth) reported on her development of learning modules using statistics to evaluate Mendelian genetics of zebrafish and to demystify the statistical approach for her peers; this effort allowed her undergraduate research to couple the science and the math.

Cell biology education: where's the math? The math is here and always has been. Its use has become more critical and even more fun as the complexities of cellular processes continue to be explained in an ever more quantitative manner. From the research lab to the classroom, mathematics is part and parcel of how scientists describe how biology works.

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