Enhancing the understanding of dynamic cellular processes and microbial diversity: a proposal to integrate Tablet PCs / DyKnow in a sophomore-level microbiology course

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Course to be modified

AB220 Prokaryotic Cell and Molecular Biology (Microbiology) This course discusses the essential properties of Eubacteria and Archaea. Bacterial nutrition, growth, genetics and structural and metabolic diversity are discussed in detail. Fundamental laboratory methodologies are covered in lab. Typical enrollment is ~20 students, including majors from Applied Biology, Biomedical Engineering, Chemistry, Chemical Engineering, Math, and Physics.

Course objectives

1. Understand the structure, function, and cellular physiology of bacteria.
2. Understand how bacteria impact all aspects of life on Earth, including health and the environment, biotechnology, and applied microbiology.

Ideas for Implementation of Tablet PCs / DyKnow

(1) Combine unlabeled figures, pen-based hardware, and DyKnow "replay content" feature to facilitate student learning of dynamic cellular processes.

For Rose-Hulman students pursuing careers in biotechnology, biochemical engineering, and medicine, AB220 (Microbiology) is a foundational course in the biology curriculum. For students, the most challenging aspect of this course is understanding the bewildering assortment of maze-like physiological processes, biochemical feedback loops, and genetic pathways (*course objective 1*). In my experience, learning difficulties arise *not* from the volume of material, but from 1) an inability of students to identify patterns and similarities that unite all physiological processes, and 2) the failure to recognize that physiological processes are dynamic.

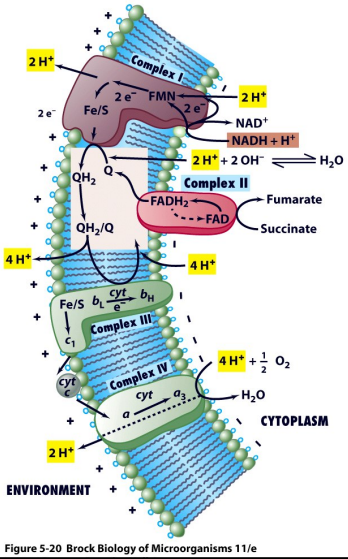

Figure 1. At the end of the day, complicated biochemical pathways such as respiration (depicted here) become a stagnant array of lines and arrows. The fluidity of metabolism is lost upon the students.

Following a traditional lecture format, students must resort to memorizing static notes and diagrams. For these students, biochemical pathways cease being fluid processes and simply become a motionless hodgepodge of enzymes, electrons, and arrows (Figure 1). Although students are able to regurgitate information on an exam, they seem to lack a fundamental understanding of *how* the system works. Furthermore, failure to view physiological processes as dynamic can contribute to failure in recognizing important similarities among biochemical pathways.

Using a combination of unlabeled figures and pen-based hardware, I propose designing lectures that effectively capture the flow of biochemical pathways. Most microbiology textbooks, including the text used in this course (*Brock Biology of Microorganisms, 11th Ed.*) provide unlabeled figures that are ideal for use with pen-based hardware. (Figure 2). Using the drawing function, the class will also be able to construct hypothetical biochemical pathways of their own. The "replay content" feature of DyKnow will

allow students to follow my pen strokes as I trace biochemical pathways on unlabeled figures during lecture. More importantly, students will be able to review these "active" pathways after class.

Contributions to learning → Students can study animated lecture diagrams, including figures identical to those found in the textbook. Students can focus on how biochemical pathways actually function, and construct "working" hypothetical biochemical pathways during group exercises.

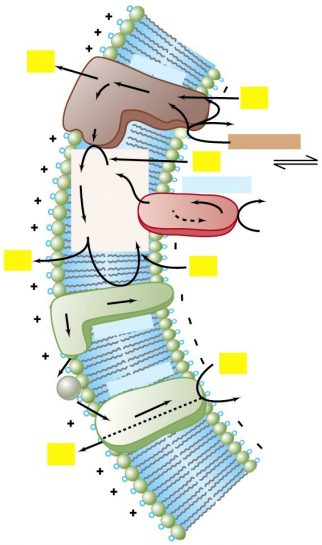

Figure 2. Combining unlabeled figures with the DyKnow "replay" feature will allow students to follow my pen strokes as I trace the flow of biochemical pathways.

(2) Encourage collaborative learning of microbial diversity through shared whiteboards and student teams.

An essential component of any microbiology course is a survey of microbial diversity (*course objective 2*). During a typical semester, fifty or more species of microbes are discussed in a variety of contexts. Not surprisingly, students have a difficult time managing the shear number of organisms discussed in class. As a result, students seem to retain very little information with respect to individual microbes.

Using shared whiteboards, I propose assigning teams of students that are responsible for collating and sharing information *during lab and lecture* on important groups of microbes covered in class. For example, whenever the lecture topic turns to *Escherichia coli*, whether that be environmental features, cellular structures, or pathogenicity, the "*E. coli*" team will update a course file pertaining to this organism. Members of this team will share this continually-updated file with the class, and will be responsible for leading discussions pertaining to this microbe. All files will be kept in an online class repository that can be accessed by any student. During 9th and 10th weeks, student teams will summarize and present their microbes to the class in a series of 30-minute presentations.

Contributions to learning → Students will become experts on specific groups of microbes. Students will also learn how to organize information as a team and effectively communicate data to their peers.

(3) Implement classroom assessment techniques with instant polling and shared whiteboards.

AB220 has historically been a diverse course. In 2007, enrollment consisted of 1 freshman, 8 sophomores, 2 juniors, and 2 seniors representing *five* different majors. Moreover, the biology background of the students varied widely, from students having only completed one previous biology course to many. The diversity has a noticeable impact on classroom dynamics: underclassman / less experienced students often remain quiet during class activities. Consequently, I have the tendency to rush through topics that are familiar only to advanced students.

DyKnow provides tools to rapidly assess the learning of students. Using the instant polling feature, I plan to implement a misconception/preconception check at the beginning of every new topic. Likewise, the instant polling feature will allow me to gauge learning of *all* students in real-time. To facilitate peer instruction and encourage the asking of questions, students will formulate weekly sample test questions to be shared electronically. Questions will be divided among student teams, and answers will be shared with the class.

Contributions to learning → Through the use of anonymous polling features, student misconceptions are immediately apparent. Less experienced / timid students will also have a safe forum in which to pose questions to the class. Student-generated test questions will empower the students to take responsibility over their own learning, as well as identify challenging lecture topics. Finally, students will learn to formulate accurate and articulate responses to peer questions.