

First Year Seminar Proposal in Entrepreneurship—Spring 2007

**Harnessing Life's Molecular Machines:
From AIDS Tests to Hydrogen Cars**

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Department Chair's Approval

Abstract:

In this First Year Seminar (FYS) students will explore the submicroscopic resources found inside living cells: tiny machines made up of amino acids and DNA. These molecular machines undergird every living system and nearly all biotechnological devices and methods. The goal of this class will be to learn how these machines perform their manifold functions and how biotechnologists harness them to make useful innovations. After culling ideas from Wake Forest University professors and off-campus entrepreneurs, students will draft proposals that leverage those ideas in order to create value. Particular emphasis will be placed on the value of “appropriate technology”—inexpensive AIDS tests for developing countries, for example—and on energy conscious technology, such as hydrogen producing molecular machines.

Motivation:

Thomas Friedman in his book *The World is Flat*, urges young Americans to get involved in science and technology in order to keep their jobs from going overseas. Friedman and many futurists believe that our innovative spirit is what made our country great and is what will keep America from sliding towards oblivion. Indeed, the 21st century, with its enormous potential in biotechnology, offers young people the exciting prospect of understanding and tapping into life's greatest secrets.

At an even deeper level, entrepreneurship in biotechnology has the potential to harness resources and generate value for people who have so little of value in their lives. Clean water. Sustainable harvests. Affordable medicines. These are hallmarks of value in the developing world. But who will seize the opportunity to mobilize resources for these valuable services, while those who need them struggle to make it through each day?

On the global playing field, breakthroughs in biotechnology can address the world's pressing need for environmental protection, energy conservation, and fuel alternatives. Oil reserves dwindle and global warming threatens to cartwheel our ecosystem. Our obligation to future generations is clear: we must find a way to curtail consumption and develop new technologies. But who will live proactively today, taking initiative to marshal the technical know-how, while our cold tomorrow still seems so far away?

The Kauffman Campus Initiative, and its FYS emphasis on entrepreneurship topics provides students with tools they will need to use technology “in service to humanity”. University students are an essential facet of the resources needed to initiate change to create global value. In this FYS, students will be motivated to see their responsibility in the world at large and will gain confidence in their ability to understand and utilize the molecular machines that are at the heart of biotechnology.

Specific Goals:

Reading—Foremost among the goals of the class is to broaden students' horizons. To that end, students will read *Bionanotechnology: Lessons from Nature* by David Goodsell and *The World is Flat* by Thomas Friedman. All too often, students will either be trained as a “technobot”, able to understand science but unable to contextualize it, or they will be educated in ideas and ideals, without the technological backing to make those ideas reality. By integrating these two aspects and juxtaposing these two books, students will avoid either extreme in favor of a more balanced and productive middle ground.

Writing—Clear thinking accompanies clear writing. Thus, a key aspect of this FYS will be for students to compose carefully written **5-page** essays on each the four segments of the class: the Science, the Academy, the Business, and the Responsibility. **Drafts of these essays will be critiqued at least one week prior to their due date, and outlines will be proofed at least two weeks prior.** In addition, students will continue in class discussion on the course blog site. By interacting with the blogosphere and the global internet community, students will have an opportunity to test the mettle of their ideas.

Discussion—Discussions and presentations will comprise the bulk of in-class time, as well it should for a course, such as this one, which seeks to motivate students from the bottom up rather than from the top down. To obtain full credit in this FYS, students will be required to actively participate in class discussions and in the course blog site. In doing so, students will hone their speaking and persuasive skills—essential ingredients in initiating change and managing resources.

Research—This course will culminate in students presenting their own entrepreneurial plans for actualizing a molecular machine based technology. Though at the beginning of the semester, this prospect may sound daunting, by interviewing professors, visiting biotech companies, and researching the ideas gleaned from these encounters, student will be able to confidently explain how a particular biological machine can be utilized. Topics could run the gamut, from commercializing a professor's high-efficiency solar cells to partnering with *Engineers Without Borders* in order to harvest AIDS antibodies from genetically modified bacteria grown inside ripening coconuts. The point that will be stressed in these proposals is not so much that their ideas must come to fruition (though with the help of the course development stipend, some might) but, rather, that the students see the possibility of creating value from the resources locked up inside each living cell and that they understand their responsibility to do so in a way that will benefit humanity.

Schedule:

I will divide the course in four segments, which parallel the FYS taught by Bill Conner in the spring of 2005, *Biological Innovation and Entrepreneurship* (see attached example schedule from this course). These three-week segments are:

- Science: What are molecular machines? How do they work? What do they do?
- Academy: Who are Wake Forest's entrepreneurs? What ideas do they have?
- Business: Is the Triad home to any biotech companies? Who runs them? How?
- Responsibility: What *can* we do with molecular machines? What *ought* we to do?

The writing assignments will coincide with these four segments. For example, the students' first 5-page essay will focus on a molecular machine of their choosing. The required format for each essay will allow students to practice different writing styles. For instance, the style for the first essay will follow the format of a scientific review article (with accompanying figures, references and glossary of terms), while the second essay will be a biographical sketch, with a more narrative style.

Appendix A: Biotechnology in a Coconut Shell

Guest Lectures:

In addition to the Wake Forest professors and local biotechnologists who will be interviewed as part of this class, I plan to include at least one guest lecture in the curriculum. A colleague of mine, Walter Bradley, Distinguished Professor of Engineering at Baylor University, has agreed to present (contingent on the approval of this course) his research team's innovative work on appropriate technologies. Dr. Bradley and coworkers are developing some exceptionally creative ways to help developing countries utilize their limited resources to create social and economic value. In particular, Dr. Bradley, with his expertise in material science and polymer chemistry, is exploring alternative use for indigenous plants such as coconuts. Though reminiscent of a scene from *Gilligan's Island*, Dr. Bradley has found a way to take a \$0.06 coconut, and with \$0.08 of processing costs convert it into products that can be sold by villagers for \$0.53. For example, the outer husks can be hot pressed, without additional binders, into particle board. In addition, the inner shells, which are harder than any aluminum alloy, can be ground into tiny pellets and exported to developed countries for use in high-end polymer composites; the shells are also denser than any hardwood and can be converted into high quality charcoal for heating. Finally, the coconut meat can be separated into diesel-generator-compatible oil and high protein livestock feed. Dr. Bradley's visit is sure to be a highlight of the class and a catalyst for exciting final proposals.

Appendix B: Qualifications of Instructor

I have had the privilege of working for two biotech start-up companies. For one, I helped design a low-cost CD4/CD8 cell sorting platform for AIDS patients in developing countries. The device was based on molecular "grappling hooks" (antibodies) and a standard optical disk reader. I am currently consulting for the second company, which makes an inexpensive asthma monitoring system that uses a submicroscopic "laughing gas sniffer" (cytochrome c.) to measure the nitric oxide in patients' lungs. In addition to harnessing molecular machines for these products, I have spent over a decade investigating molecular machines as an academic and lecturing to laymen about how they work. One tool I have found extremely helpful in describing these tiny machines is the computer animated video *Voyage Inside the Cell* by Christian Sardet *et al.* at Digital Studio in Paris, France. I will show this 15 minute DVD at the beginning of the course

and use it throughout in order to give students a taste of how molecular machines work in their native environment.

Appendix C: Example Schedule (courtesy of Prof. Bill Conner)

Biological Innovation and Entrepreneurship – FYS100 – Spring-2005

Instructor: William E. Conner (Rm. 030) Winston, Telephone 5315, conner@wfu.edu)

Lecture: MWF 10:00-10:50 Winston 221

Texts: Biotechnology: Demystifying the Concepts. 2000. Bourgaize, D., Jewell,

T. R., and Bruiser, R. G. Addison Wesley Longman (required).

Startup: A silicon valley adventure. 1994. Kaplan, J, Penguin Books
(required).

MouseDriver chronicles. 2002. Lusk, J. and Harrison, K. Perseus
Publishing (required)

Lecture and Reading Assignments

Jan. 12 Introduction: Ground Rules and Biology's Greatest Hits

Jan. 14 Introduction: The Sources of Entrepreneurship

Jan. 17 MLK Jr. Holiday – No Class

Jan. 19 Student Presentations – Biology's Greatest Hits

Gretchen Elder – Stem Cell Research

Bill D'Alessandro - Nanotechnology

Text: Chapter 1 and 2 Biotechnology

Jan. 21 Student Presentations – Biology's Greatest Hits

Becca Red – Hemoglobin

David Gaffney – Genetic Engineering of Plants

Text: Chapter 3 and 4 Biotechnology

Jan. 24 Student Presentations – Biology's Greatest Hits

Van Nguyen – Tuberculosis virus

Annie Lutin – Genetic Immunity

Text: Chapters 5 and 6 Biotechnology

Jan. 26 Student Presentations – Biology's Greatest Hits

Hadley Wilson – Animal Cloning Techniques

Veronica Jarvinen – Radiation Therapy

Text: Chapters 7 and 8 Biotechnology

Jan. 28 Student Presentations – Biology's Greatest Hits

Shane Ahlers – Parkinson's Disease

Ted Sensor – Organ transplants

Text: Chapters 9 and 10 Biotechnology

Jan. 31 Student Presentations – Biology's Greatest Hits

Jun Yang – Insulin
Kathlene Skarbek – The Human Genome Project
Text: Chapters 11 and 12 Biotechnology
Feb. 02 Student Presentations – Biology’s Greatest Hits
Ashley Burney - Antibiotics
Ashley Spooner – Vaccines

Text: Chapters 13 and 14 Biotechnology
Feb. 04 Student Presentations – Biology’s Greatest Hits
Charles Sartor – Performance Enhancing Drugs
Text: Chapters 15 and 16 Biotechnology

Feb. 07 Field Trip Paper 1 DUE – Biology’s Greatest Hit
Text: Chapter 17
Feb. 09 Introduction to Entrepreneurship – Page West
Reading: Mousedriver Chronicles
Feb. 11 Student Presentations on Local Discovery– Dr. Christa Colyer, Dr. Bruce King

Feb. 14 Student Presentations on Local Discovery – Dr. Rebecca Alexander
Feb. 16 Student Presentations on Local Discovery – Dr. Ray Kuhn
Feb. 18 Student Presentations on Local Discovery – Dr. Mike Morykwas

Feb. 21 Student Presentations on Local Discovery – Dr. Dale Browne,
Dr. Anthony Marsh
Feb. 23 Student Presentations on Local Discovery – Dr. Richard Williams,
Dr. Zheng Cui
Feb. 25 Student Presentations on Local Discovery – Dr. Danni Kim Shapiro,
Dr. Jacque Fetrow

Feb. 28 Student Presentations on Local Discovery – Dr. Jennifer Burg,
Dr. Bob Swofford
Mar. 02 Student Presentations on Local Discovery – Dr. Susan Fahrback
Mar. 04 Paper 2 DUE – The Art of Discovery

Mar. 14 NO CLASS
Reading: Start-up
Mar. 16 NO CLASS
Reading: Start-up
Mar. 18 NO CLASS
Reading: Start-up

Mar. 21 Student Presentation – Local Business
Mar. 23 Student Presentation – Local Business
Mar. 25 Good Friday Recess

Mar. 28 Student Presentation – Local Business

Mar. 30 Student Presentation – Local Business

Apr. 01 Student Presentation – Local Business

Apr. 04 Student Presentation – Local Business

Apr. 06 Student Presentation – Local Business

Apr. 08 Student Presentation – Local Business

Apr. 11 Introduction to Business Plans – Dr. Betsy Gatewood

Apr. 13 Group Work Session

Apr. 15 Field Trip – Paper 3 DUE – The Makings of an Entrepreneur

Apr. 18 Business Plan 1 Presentation

Apr. 20 Business Plan 2 Presentation

Apr. 22 Business Plan 3 Presentation

Apr. 25 Business Plan 4 Presentation

Apr. 27 End of the Semester Celebration – Paper 4 DUE – The Plan