Synthetic Biology Anthropology 112B

Professor Paul Rabinow

Tuesday-Thursday: 3:30-5:00, Room 115 Kroeber Hall

Teaching Assistants:
Anthony Stavrianakis and Gaymon L. Bennett

The first goal of the class is to equip students to be able to think about the relations among three registers: Synthetic Biology, Concepts and Cases.

The second goal is to equip students to work on problems collaboratively in a mode of human practices.

In view of these goals the course is designed such that the student will be prepared to address the question of what is *distinctive* about the synthetic biology approaches to *problem areas* such as malaria, biofuels, security, tumor killing bacteria, intellectual property and what are some of the associated *human practices challenges*?

The class is to produce a casebook of 4 group projects which will focus on topic areas central to synthetic biology. These 4 topic areas are; "environment", "IP", "health" and "safety, security, preparedness". The projects themselves will focus on specific cases and questions within these broader topic areas. Examples of specific cases would include tumor killing bacteria in "health", biofuels in "environment", the biobricks registry in "IP" and so-called 'experiments of concern' within "safety, security, preparedness".

The class will be divided into four research teams corresponding to these topic areas.

The first responsibility of each team will be to select a specific case within their topic area. This case will provide the basis on which group research will be done and a group project will develop. The first purpose of the group projects is to analyze specific technological developments in their human practices context. This means that selected cases must involve research into both technical and non-technical aspects of synthetic biology. The second purpose of the group projects is to learn how to do collaborative research on common problems across specializations. Each group will be expected to present their research findings both in writing and in class at the end of the semester. The in class presentations should be given in power point format for a duration of approximately 20 minutes. The written presentation should be about 10 pages and no more than 15 pages. One of the challenges of this assignment is concise synthesis of complex materials

Schedule.

Tuesday 28th / Thursday 30th August: **Introduction**

Tuesday 4th Sept / Thursday 6th: **Synthetic Biology – Guest lecturer J. Goler (UCB)**

Baker, et al. "Engineering Life: Building a FAB for Biology" *Scientific American*. June 2006. 44-51.
Knight , Thomas F "Engineering novel life", *Mol Syst Biol.* 2005; 1, 2005
Watson and Crick, "Molecular structure of nucleic acids", *Nature* 1953
Rabinow and Caduff, "'Life' – after Canguilhem", *Theory, Culture & Society*, Vol. 23, No. 2-3, 329-331, 2006
Chan LY, Kosuri S, Endy D, "Refactoring bacteriophage T7". *Mol Syst Biol* 13 September 2005; 2005.0018
Website: http://parts.mit.edu/registry/index.php/Help:Contents

Tuesday 11th Sept (No Class Thursday 13th): **Synthetic Biology and Human Practices Common Problems**

Weber, Max "Science as a vocation"

Foucault, Michel "What is Enlightenment?"

Tuesday 18th Sep / Thursday 20th Sept: **"Science and Society: three modes"**

Snow, CP "The Two Cultures, A Second Look", Cambridge University Press; 1963
Rabinow and Bennett, Paul Rabinow and Gaymon Bennett "The Work of Equipment: 3 Modes" ARC Working Paper #10. Anthropology of the Contemporary Research Collaboratory 2007

Tuesday 25th Sept / Thursday 27th Sept: **Malaria – Guest lecturer Prof. J Keasling (UCB)**

Chaitan Khosla and Jay D. Keasling "Metabolic engineering for drug discovery and development", *Nature Reviews Drug Discovery* 2, 1019-1025 (December 2003)
Ro et al, "Production of the anti-malarial drug precursor artemisinic acid in engineered yeast", *Nature* 440, 940-943, 13 April 2006
Laurie Garrett, "the challenge of global health", *Foreign Affairs*, January/February 2007
Websites: One World Health http://www.oneworldhealth.org/
Keasling lab UCB http://keaslinglab.lbl.gov/wiki/index.php/Main_Page
Amyris biotechnology http://www.amyrisbiotech.com/
Gates foundation http://www.gatesfoundation.org/default.htm

Tuesday 2nd Oct: **Security**

Zuckerman, M J "Biosecurity: a 21st Century Challenge", Carnegie Corporation of New York, 2005
S. Maurer, K. Lucas & S. Terrell, "From Understanding to Action: Community-Based Options for Increasing Safety and Security in Synthetic Biology," (2006). White Paper
Buegl et al, "DNA synthesis and biological security", *Nature Biotechnology* 25, 627 - 629 (2007)
Rogers, Michael "The Pandora's Box Congress", *Rolling Stone*, June 19th, 1975
Tucker, Jonathan B. and Zilinskas, Raymond A., "The Promise and Perils of Synthetic Biology, *The New Atlantis", Spring 2006*

Thursday 4th Oct. **Security**

Caduff, Carlo "The futures of risk", unpublished paper
Rabinow, Paul "Safety, security, preparedness", Power point presentation

Tuesday 9th Oct: **Group project work**

Thursday 11th Oct : **Biofuels** – **Guest lecturer Dr. John Dueber (UCB)**

Kavanagh, Etta "Looking at biofuels and bioenergy" , *Science*, Vol 312 23, June 2006
Websites:
Stop BP http://www.stopbp-berkeley.org/
Amyris http://www.amyrisbiotech.com/
EBI http://www.energybiosciencesinstitute.org/index.php
JBEI http://jbei.lbl.gov/

Tuesday 16th Oct : **Biofuels - Guest lecturer Prof. Tad Patzek (UCB)**

Patzek, Tad "How we can outlive our way of life?", OECD paper, Paper prepared for the 20th Round Table on Sustainable Development of Biofuels: Is the Cure Worse than the Disease? OECD Headquarters, Chateau de la Muette, Paris, 11-12 September 2007

Patzek, T "A First-Law Thermodynamic Analysis of the Corn-Ethanol Cycle" *Natural Resources Research*, Vol. 15, No. 4, December 2006

Thursday 18th Oct: **Tumor Killing Bacteria – Guest lecturer Prof. Chris Anderson (UCB)**

Anderson et al, "Environmentally Controlled Invasion of Cancer Cells by Engineered Bacteria", *J Mol Biol*. 2006 Jan 27;355(4):619-27
SynBERC TKB testbed:
http://synberc.org/testbed_integration.html http://synberc.org/testbeds.html#cancerkiller

Tuesday 23rd Oct: **Midterm review**

Thursday 25th Oct : **Biofuels discussion with Prof Jay Keasling (UCB)**

Tuesday 30th Oct: **Tumor Killing Bacteria – discussion session**

Baker, Monya "Better living through microbes", *Nature*, Volume 23, number 6 , June 2006

Thursday 1st Nov: Midterm

Tuesday 6th Nov. **iGEM - Berkeley iGEM team**

Thursday 8th Nov: **Guest lecturer Dr Leonard Katz (SynBERC) - IP and Industry Relations**

Maurer, S and Henkel J "The economics of synthetic biology", *Molecular Systems Biology* 3: 117
Rai, A, Boyle J "Synthetic Biology: Caught between Property Rights, the Public Domain, and the Commons" *PLoS*, March 2007 | Volume 5 | Issue 3
Glass, J et al, "Minimal Bacterial Genome Patent Application", US2007/0122826 A1, May 31 2007

Tuesday 13th Nov: **Student Project Workshops**

Thursday 15th Nov : **Student Project Workshops**

Tuesday 20th / 23rd Nov: Thanksgiving

Tuesday 27th Nov : **workshop**

Thursday 29th Nov : **workshop**

Tuesday 4th Dec: **Presentations**

Thursday 6th Dec: **Presentations – Papers due**

Appendix A

Project Orientation Sheet

112B Synthetic Biology

The aim of the class is to produce a casebook of 4 group projects which will focus on topic areas central to synthetic biology. These 4 topic areas are; "environment", "IP", "health" and "safety, security, preparedness". The projects themselves will focus on specific cases and questions within these broader topic areas. Examples of specific cases would include tumor killing bacteria in "health", biofuels in "environment", the biobricks registry in "IP" and so-called 'experiments of concern' within "safety, security, preparedness".

The class will be divided into four research teams corresponding to these topic areas.

The first responsibility of each team will be to select a specific case within their topic area. This case will provide the basis on which group research will be done and a group project will develop. The first purpose of the group projects is to analyze specific technological developments in their human practices context. This means that selected cases must involve research into both technical and non-technical aspects of synthetic biology. The second purpose of the group projects is to learn how to do collaborative research on common problems across specializations. Each group will be expected to present their research findings both in writing and in class at the end of the semester. The in class presentations should be given in power point format for a duration of approximately 20 minutes. The written presentation should be about 10 pages and no more than 15 pages. One of the challenges of this assignment is concise synthesis of complex materials.

Below are some orienting questions to help you think through specific case material within topic areas.

What cases will allow for the identification of a shared problem space?

- Who besides technical engineers have a stake in the technical projects and on what basis?
- What kinds of questions are the scientists and other stakeholders asking?
- What is the relation between the research being done on a specific project and the real world problems that justify the pursuit of that project?
- Are they biological questions? "We're helping solve a biological question", so are biologists interested relative to the pursuit of fundamental scientific understanding?
- "We're contributing to an application" so bioengineers and industry could be interested?
- "The engineers are making biological machines", will people who think DNA is the 'essence' of the human going to be angry?
- Within each topic area what kind of interest groups / end users/ stakeholders are associated with projects within that area?
- In the topic area "environment"; who has a stake in biofuels? At what scale?

Deadlines

Thursday 20th September: Project Groups discussed (start thinking about which topic you are most excited about.)

Tuesday 2nd Oct: Groups divided in class

Tuesday 9th October : Groups hand in project proposal

Tuesday 23rd October: Progress report, blockages, adjusted timeline, division of labor?

Thursday 1st November : Midterm

13th / 15th November: Student Project Workshops

Tuesday 4th/ 6th December: Project Presentations

Thursday 6th Dec: Project Papers due

Appendix B

112B Synthetic Biology midterm examination

Professor Paul Rabinow

The exam consists of 4 short answer ID questions (section 1) and one essay (section 2)

Section 1: Identification of terms

Select two terms from group A and two from group B.

For each term provide an explanation with a worked through example indicating how the term relates to synthetic biology. Marks will be given for both conceptual understanding and the ability to work through the concept in relation to examples from course material.

A	B
Parts	Collaboration
Metabolic Pathways	Preparedness
Biobricks assembly	3 modes
Chassis	Wissenschaft
Engineering Principles and Analogy	Two cultures

Section 2: Essay

All questions should be answered with reference to understandings of synthetic biology, human practices concepts and topical examples.

From the list of questions choose one:

A

"The richness and versatility of biological systems make them ideally suited to solve some of the world's most significant challenges, such as converting cheap, renewable resources into energy-rich molecules; producing high-quality, inexpensive drugs to fight disease; detecting and destroying chemical or biological agents; and remediating polluted sites."

This is a vision statement from a grant proposal. From what you have learned in the course, critically assess this statement using specific examples and concepts.

B

What is the problem to which collaboration is the solution?

Answer the question with reference to Snow, Weber and the three modes of engagement using topical examples.

C

"Technology will solve our problems."

What are the critical limitations to this statement? Answer with reference to synthetic biology.