

Chemical Engineering/Bioengineering 163
Introduction to Engineering Biological Molecules and Systems
Spring, 2007

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Important course information (office hours, homeworks, solutions, etc.) will be available at <http://cheme.che.caltech.edu/courses/che163/home.htm>

Grading:

Homework: 40%

Quizzes: 20%

Final exam: 40%

Homework policy/honor code:

In general and unless otherwise noted, if you run into difficulty with homework, you may discuss it with others. The work, however, should be substantially your own--you may not copy solutions from classmates or previous years' homeworks or exams. When a specific collaboration policy is given for an assignment, that given policy supersedes the general policy. Credit will be subtracted from all work handed in late, unless you have arranged it beforehand (with a good excuse!) with Prof. Arnold.

All Homework is due Thursday at the beginning of class.

No homework will be accepted after the solutions have been posted.

Syllabus: ChE/BE 163 Spring, 2007

- Week 1 The biological design problem—Nature as designer
Sequence spaces
Evolution as an adaptive walk on fitness landscapes
Sequence and functional variation between homologous proteins
- Week 2 Protein design: design is hard and details matter
How nature re-engineers enzymes for new function
Jensen and Horowitz models for functional protein evolution
- Week 3 Evolution as an optimization problem
General optimization algorithms (Monte Carlo, genetic algorithms, etc.)
Random mutagenesis vs. recombination
- Week 4 Natural protein evolution: is nature optimizing?
Thermodynamics of protein neutrality
Neutral networks and neutral evolution
- Week 5 Exploiting biochemical knowledge in evolutionary protein engineering:
Designing ‘targeted protein libraries
“Consensus” engineering: using sequence information
- Week 6 Design by directed evolution
Convergent evolution of a cytochrome P450 propane monooxygenase:
exploring what is physically possible versus what is biologically relevant
Generating genetic diversity for evolution
- Week 7 Engineering by recombination
SCHEMA and structure-guided recombination
Sequence and stability relationships of chimeric P450s
- Week 8 Rational biomolecular design
Free energy landscape perspective of biomolecular structures
Partition functions of nucleic acid structure
- Week 9 Determining/designing nucleic acid structure from partition functions
Self-assembling nucleic acid structures and functional biomolecules
- Week 10 Designing biological circuits: parts, modules, and control diagrams
Design tour of a biological device
On Beyond Zebra: engineering with nonnatural amino acids