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## Molecular Modeling Spring 02 Syllabus

*Please Note:* Article numbers in the Homework column refer to items in the course reading list. Students should also read text chapters (in boldface letters) before and after the material is discussed in class. [Update March 2, 2002]

Class	Subject	Homework
1 Jan. 23	Course and Field Overview: <ul style="list-style-type: none"> <li>• What is molecular modeling and how has it evolved?</li> <li>• What are the practical applications and important questions?</li> </ul> <p style="text-align: center;"><b>(Preface and Chapter 1)</b></p>	<b>1:</b> Introduction to sequence and structural databases and to the early molecular modeling literature. <i>Read papers 1,2,3,20,33.</i>
2 Jan. 30	<ul style="list-style-type: none"> <li>• Continuation of the overview on biomolecular modeling and simulation, from drug design to new materials.</li> <li>• Discussion of the 1959 paper of Alder &amp; Wainwright and 1971 work of Rahman Stillinger: difficulties then and now.</li> <li>• Introduction to interesting biomolecular modeling problems: protein folding, protein misfolding, nucleic acid/protein interactions, and RNA folding.</li> </ul> <p style="text-align: center;"><b>(Chapter 2)</b></p>	<b>2:</b> Retrieval of structural information from the Protein Data Bank (PDB), and the display, manipulation, and analysis of three-dimensional biomolecular structures with the Insight II molecular graphics package. Explore kinemage tutorials. <i>Read papers 5,8,30,31,34.</i>
3 Feb. 6	<ul style="list-style-type: none"> <li>• Minitutorial on protein structure: amino acid repertoire, primary to quaternary structure, protein structure classification.</li> </ul> <p style="text-align: center;"><b>(Chapters 3 &amp; 4)</b></p>	<b>3:</b> Construction and analysis of the pentapeptide Met-enkephalin with the Insight II program. <i>Read papers 2,4,6.</i>
4 Feb. 13	Guest Lecturer: <i>Protein Structure Modeling</i> , Dr. Andrej Sali (Rockefeller University).	<b>4:</b> Generation and analysis of Ramachandran plots for proteins and introduction to the NDB. <i>Read papers 23, 29.</i>
5 Feb. 20 (substitute)	<ul style="list-style-type: none"> <li>• Minitutorial on nucleic acid structure: building blocks, backbone conformational flexibility, helical parameters, and DNA supercoiling.</li> </ul> <p style="text-align: center;"><b>(Chapters 5 &amp; 6)</b></p>	<b>5:</b> Analysis of Protein/DNA Complexes with Insight and NDB. <i>Read papers 7, 21.</i>
6 Feb. 27	<ul style="list-style-type: none"> <li>• Computational and theoretical approaches to structure prediction (from the quantum-mechanical to the molecular mechanical description).</li> </ul> <p style="text-align: center;"><b>(Chapters 7 &amp; 8)</b></p>	<b>6 (MIDTERM):</b> Sequence/Structure/Function Relationships in Proteins, A Contest! <i>Read papers 22, 35.</i>

## 2 1. Syllabus

## Syllabus (continued)

Week	Subject	Homework
7 Mar. 6	Guest Lecturer: <i>Ab Initio Calculation of Protein Structure by Global Optimization of Potential Energy</i> , Prof. Harold Scheraga (Cornell University, Department of Chemistry), pioneer of protein force fields and computation of protein structure.	<b>7:</b> Molecular mechanics force fields: approximations, variations, and the assessment of results with respect to experiment and other simulations ( <i>papers 10,11,15,16</i> ). <i>Read papers 13,14,17,24.</i>
8 Mar. 20	<ul style="list-style-type: none"> <li>• Continue molecular mechanics force fields.</li> <li>• Begin MIDTERM class presentations.</li> </ul>	<b>8:</b> A bit of programming: non-bonded versus bonded energy computations.
9 Mar. 27 (Seder)	Amer. Chem. Soc. 1990 videotapes: <i>Molecular Modeling in Biological Systems</i> : 1 – Peter Kollman, “Methods in Molecular Modeling”, 4 – Panel Discussion.	
10 Apr. 3	<ul style="list-style-type: none"> <li>• Continue Midterm presentations.</li> <li>• <b>Force Field Debate!</b></li> </ul>	<b>9 (TERM PROJECT):</b> The Successes (Failures?) of Molecular Modeling. <i>Read papers 9,18,19.</i>
11 Apr. 10	<ul style="list-style-type: none"> <li>• Molecular mechanics force fields — origin, variations, and parameterization.</li> <li>• Special topics — molecular topology: book-keeping and data structures, potential energy differentiation.</li> <li>• Special issues in nonbonded energy computations — spherical cutoffs, fast electrostatics by the multipole method, periodic boundary conditions, and the Ewald summation.</li> </ul> <p style="text-align: center;"><b>(Chapter 9)</b></p>	<b>10:</b> Experiments in Geometry Structure Optimization: Minimization of Biphenyl with Insight II/Discover. <i>Read paper 12.</i>
12 Apr.17	<ul style="list-style-type: none"> <li>• Optimization techniques for multivariate functions in computational chemistry.</li> </ul> <p style="text-align: center;"><b>(Chapter 10).</b></p>	<b>11:</b> A global optimization contest for a pentapeptide! <i>Read papers 25, 26.</i>
13 Apr. 24	Monte Carlo Simulations. <p style="text-align: center;"><b>(Chapter 11)</b></p>	<b>12:</b> An exercise in Monte Carlo. <i>Read papers 27,28,32.</i>
14 May 1	Molecular dynamics simulations — theory and practice. <p style="text-align: center;"><b>(Chapters 12 &amp; 13)</b></p>	<b>13, 14:</b> Advanced exercises in minimization and dynamics.