STB 533. Crystallographic Methods of Structural Biology
Course Syllabus and Class Schedule
Fall Semester 2014. Class meetings 10:30-11:45 am Tuesdays and Fridays

The goal of the course is that students acquire sufficient knowledge and understanding of the basic principles of biomolecular crystal structure analysis that they will be able to comfortably, and with interest and insight, read and comprehend the articles in Volume F of the *International Tables for Crystallography: Crystallography of Biological Macromolecules*, and articles in the current and recent literature reporting research in structural molecular biology by diffraction methods.

Textbooks for the course are:

Eaton E. Lattman and Patrick J. Loll (2008). *Protein Crystallography: A Concise Guide.* Baltimore, Maryland: Johns Hopkins University Press.

Bernhard Rupp (2010). *Biomolecular Crystallography. Principles, Practice, and Applications to Structural Biology*. New York: Garland Science, Taylor and Francis Group, LLC. See also http://www.ruppweb.org/ for valuable supplementary materials.

Dates	Topics	Instructor
26, 29 Aug.	Introduction Protein structural elements 1° aa sequence; 2° α-helix, β strand, β sheet, loop; 3° domain fold; 4° domain assembly. Overview of biomacromolecular crystallography **Rupp, chs. 1-4** (Only §§ 1.1-1.5 and 3.2)	**Blessing**
2, 5 Sept. 9, 12	**Geometrical crystallography** Laws of classical crystallography Lattices, point groups, space groups Crystal faces, lattice planes, and Miller indices The Bragg equation and the Ewald construction Reciprocal space and the reciprocal lattice **Rupp, ch. 5**	**Blessing**
16, 19 Sept. 23, 26	**X-Ray diffraction physics** X-Ray sources Wave nature of X-rays X-Ray scattering by an electron, an atom, a molecule by a lattice row, a lattice plane by a crystal – Laue diffraction / Bragg reflection The crystal structure factor **Rupp, ch. 6**	**Blessing**
30 Sept, 3 Oct. 7, 10	**Statistics and probability in crystallography** Descriptive statistics – error propagation Probability distributions – joint, marginal, and conditional Likelihood and Bayesian inference **Rupp, ch. 7** Mid-term exam	**Blessing**

14, 17 Oct. 21, (24)	**Diffraction measurements** Crystal classes and Laue groups Diffraction symmetry – Friedel and Bijvoet pairs Space group determination – Systematic extinctions Reading the *International Tables* Non-crystallographic symmetry **Rupp, chs. 8, 6** (§6.5)**, and 5** (§5.2)	**Snell** **(Blessing)**
(28), 31 Oct. 4, (7) (Fri., 7 Nov. BHT meeting)	**Diffraction measurements (cont'd)** Instrumentation – robotic sample handling, pixel detectors Data collection – local and remote control software Data processing – data reduction and error analysis **Rupp, chs. 8 and 6** (§6.4 and §6.5)	**Snell** **(Blessing)**
11, 14 Nov. 18, 21	**Structure determination – the phase problem** The "fundamental theorem" of structural crystallography $F_{hkl} = \lvert F_{hkl} \rvert \mathrm{e}^{i\varphi_{hkl}} \underset{\mathcal{F}^{-1}}{\overset{\mathcal{F}}{\rightleftarrows}} \rho(x,y,z)$ Fourier theory The Patterson function Patterson maps, Harker sections Molecular replacement methods **Rupp, chs. 9, 10**	**Blessing**
25, (28) Nov. 2, 5 Dec. (Fri., 28 Nov. Thanksgiving recess)	**Structure modeling and refinement** SIR, MIR, SAD, SIR/SAD, MAD methods Stereochemical restraints NCS averaging and constraints Fourier methods Least-squares methods Maximum likelihood methods Energy minimization methods **Rupp, chs. 11, 12**	**Blessing**
9, 12 Dec.	**Structure refinement and validation** Precision indices Uncertainty estimates Ramachandran plots Richardson MolProbity analysis Real-space density residual **Rupp, ch. 13**	**Blessing**
16 Dec.	Final exam	

STB 533. Crystallographic Methods of Structural Biology

Bibliography of Teaching and Learning Materials

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The following books and Internet sites provide very good teaching and learning materials for biocrystallography. Especially good websites, very well worth the time for extended and repeated visits, are those of Gervais Chapuis, Nicolas Schoeni, and Wes Hardecker (Lausanne); Martín Martínez Ripoll and Félix Hernández Cano (CSIC, Madrid); Gerard Kleywegt (Uppsala); Thomas Proffen (ORNL) and Reinhard Neder (Erlangen); Randy Read (Cambridge); Bernard Rupp (q.e.d. life sciences discoveries, inc.); Michael Sawya and Duilio Casico (UCLA); Bob Sweet (NSLS/BNL); and Joe Wedekind (U of R). The sites were accessible and functioning as of Sunday, 3rd August 2014.

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