

Structural Biology: Practical NMR Applications

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Preface

Over the years since NMR was first applied to solve problems in structural biology, it has undergone dramatic developments in both NMR instrument hardware and methodology. While it is established that NMR is one of the most powerful tools for understanding biological processes at the atomic level, it has become increasingly difficult for authors and instructors to make valid decisions concerning the content and level for a graduate course of NMR in structural biology. Because many of the details in practical NMR are not documented systematically, students entering the field have to learn the experiments and methods through communication with other experienced students or experts. Often such a learning process is incomplete and unsystematic. This book is meant to be not only a textbook, but also a handbook for those who routinely use NMR to study various biological systems. Thus, the book is organized with experimentalists in mind, whether they are instructors or students. For those who have a little or no background in NMR structural biology, it is hoped that this book will provide sufficient perspective and insight. Those who are already experienced in NMR research may find new information or different methods that are useful to their research.

Because understanding fundamental principles and concepts of NMR spectroscopy is essential for the application of NMR methods to research projects, the book begins with an introduction to basic NMR principles. While detailed mathematics and quantum mechanics dealing with NMR theory have been addressed in several well-known NMR books, Chapter 1 illustrates some of the fundamental principles and concepts of NMR spectroscopy in a more descriptive and straightforward manner. Such questions as, “How is the NMR signal generated? How do nuclear spins behave during and after different RF pulses? What is the rotating frame? And why do we need it?” are addressed in Chapter 1. Next, NMR instrumentation is discussed starting with hardware components. Topics include magnetic field homogeneity and stability, signal generation and detection, probe circuits, cryogenic probes, analog-to-digital conversion, and test equipment. A typical specification for an NMR spectrometer is also included in the chapter. There is also a chapter covering NMR sample preparation, a process that is often the bottleneck for the success of the NMR projects. Several routine strategies for preparing samples for macromolecules as well as complexes are dealt with in detail.

Chapter 4 discusses the practical aspects of NMR, including probe tuning, magnet shimming and locking, instrument calibrations, pulse field gradients, solvent suppression, data acquisition and processing, and some homonuclear two-dimensional experiments. In Chapter 5, experiments that are routinely used in studying biological molecules are discussed. Questions to be addressed include how the experiments are setup and what kind of information we can obtain from the experiments.

The next chapter focuses on the application of NMR techniques for the study of biological molecules. The use of NMR in studying small biological molecules such as ligands, drugs, and amino acids involved in different biological pathways is covered. Then, applications in studies of macromolecules such as proteins, protein–peptide, and protein–protein complexes are discussed. The last chapter deals with dynamics of macromolecules, important information that can be uniquely obtained by NMR methods.

I would like to thank my colleagues who have contributed both directly and indirectly to this book. I am particularly grateful to Dr. Jun Qin for writing sections of Chapter 3 and 7, and for numerous discussions, and Drs. Kristen Mayer, Weidong Hu, Steve Unger, Fang Tian, John Glushka, and Chalet Tan for reviewing all or part of this manuscript and providing corrections, valuable comments, and encouragement. I am also grateful to the authors and publishers who have given permission to use their figures. Finally, I am indebted to the staff at Kluwer Academic/Plenum Publishers, especially to Senior Editor Andrea Macaluso and Production Editor Felix Fortnoy for their constant support and encouragement.

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