PREFACE

Life is a sea of electrons that when in the state of equilibrium thrives but causes havoc when perturbed. But this oversimplistic analogy leaves a multitude of unanswered questions and is ridden with complexities. It is encouraging that current advancements in biochemistry and biological chemistry have allowed modern-day biomedical investigators to understand some of these complexities and get ever closer to unraveling some of the most fundamental questions in disease development. Most often overlooked are the analytical tools employed to probe these mysteries. A research area by itself, it owes its modern progress to chemists, biologists, engineers, and biomedical researchers for the development of innovative molecular probes and imaging agents, efficient methodologies, and state-of-the-art instrumentation. This book is therefore a tribute to them: without their tireless dedication, our understanding of disease pathogenesis would not be in the state it is today. At the heart of this perturbation of a sea of electrons is the reduction and oxidation chemistry that involves a variety of players, the most important of which is molecular oxygen; when not properly metabolized, it results in the production of reactive species. These reactive species are like an army of destructive forces that destroy, inactivate, or cause only partial functioning of key biomolecular systems essential for normal functions of living systems. Knowledge of reactive species' location, their origin, and their identity as well as their target molecules and molecular trails they leave as biomarkers are critical and can only be accomplished through the use of both earlier and modern sophisticated analytical tools. Reactive species detection is therefore important for identifying specific molecular and cellular pathways leading to oxidative stress that could lead the way to the development of genetic, molecular, and pharmacological approaches, as well as diagnostic tools to prevent or ameliorate free radical–mediated diseases.

This book is basically divided into four major parts: introduction, chemistry of reactive species, their biology, and their modes of detection. Chapter 1, Introduction, provides a historical account of how oxygen and its reactive metabolites have been implicated in the pathogenesis of diseases. It also describes how important discoveries of the last century were aided by the use of analytical tools to characterize reactive species as important biological mediators and how bioassays can complement such findings. Chapter 2, Chemistry of Reactive Species, will only present biologically relevant reactions of reactive species in an effort to give readers a sense of their relative reactivity, specificity, and selectivity to various biomolecules. In Chapter 3, Reactive Species in Biological Systems, shows various sources of reactive species in biological settings, either from exogenous sources or as generated from enzymes, and it will

discuss various sources of reactive species production from cellular compartments. Lastly, Chapters 4, Fluorescence Technique; Chapter 5, EPR Spin Trapping; Chapter 6, UV–Vis Absorption and Chemiluminescence Techniques; Chapter 7, Electrochemical, Mass Spectroscopic, Immunochemical, and Nuclear Magnetic Resonance Techniques; showcase conventional and modern analytical techniques that are often if not widely employed in the detection of biological reactive species such as fluorescence, electron paramagnetic resonance (EPR) spin trapping, UV–Vis light and chemiluminescence, and electrochemical, mass spectrometric, immunochemical, and other magnetic resonance techniques with the exception of some techniques that are too specialized (e.g., EPR and positron emission tomography imaging) or redundant in their principles and chemistry to those already discussed here.

I hope readers will find this first edition a one-stop kind of reference material for fundamental principles, limitations, and applications of the various analytical technique used in reactive species detection. Since this book will only cover so much information, readers are encouraged to consult the references cited herein for more detailed discussions and descriptions of the topics discussed.

This book would not have been possible without the dedication and passion of investigators working in the field of free radical research, whether in the synthesis of new molecules or the development of methodologies and instrumentations, as well as biomedical researchers who continuously validate these tools for their effective application in biological systems.

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