Preface

The interfacing of man-made electronics with redox proteins and enzymes not only tells us a great deal about the, often humbling, levels of sophistication active in biology, but also paths the way to utilising exactly this in derived sensory devices. Some of these have already had a profound impact on both clinical diagnostics and the quality of life enjoyed by those unfortunate enough to live with disease. Though much remains to be learnt about controlling and optimising these interfacial interactions, their potential utilisation is, if anything, growing.

This book outlines a selection of some of the recent advances made in controllably engineering the bioelectronic interface, establishing robust communication with proteins and enzymes, characterising these surfaces and potentially important derived clinical applications. It is not intended to be in any way exhaustive but to give readers a flavour of the possibilities, challenges, tools and potential applications.

The book begins with a discussion by Paul Bernhardt of the fascinating properties and chemical transformation abilities of molybdenum-containing oxidoreductase enzymes (with potential applications in environmental and clinical sensing). The demands associated with establishing reliable electrochemical communication with these molecules are those familiar to many in the bioelectrochemistry field. As such, this chapter sets the stage for some of the leaders in this field to discuss a range of interfacial design and analysis tools now available to the electrochemist. This begins in Chapter 2, with a discussion of scanning probe technology, its application to biomolecular imaging and the proximal probe resolution of single metalloprotein redox characteristics.

In Chapter 3 the group of Willner discuss their recent pioneering work in using molecular wires, electron relays, nanoparticles and novel reconstitution protocols in improving electrode-protein/enzyme coupling and the preliminary applications of this to amperometric biosensing and fuel cell technology. In a continuing theme, the group of James Rusling detail the considerable progress

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they have made in utilising carbon nanotube modified surfaces in biosensing configurations (including those which are vertically aligned) in Chapter 4. The unique electrical and topological characteristics of these structures facilitate a considerable increase in Faradaic current and analyte sensitivity over bare electrodes.

In Chapter 5, Heering and Canters describe the covalent or crystallised association of protein and enzymes and the information this provides about their natural electron transfer dynamics. These analyses highlight the often tremendously sensitive nature of these processes to interfacial interactions (information of great value in establishing comparable levels of communication at man-made surfaces). The importance of electrode surface preparation, pre-modification and the use of π-delocalised surface linkers in facilitating robust electron transfer are also discussed.

The Cytochrome P450 enzymes play a critical role in the human body by catalysing reactions involved in xenobiotic metabolism, biosynthesis of steroid hormones, oxidation of unsaturated fatty acids and stereo-specific and regio-specific metabolism. There exists considerable interest in both engineering their specific characteristics and interfacing them with electrode surfaces. In Chapter 6, Gilardi and Dodhia describe the fascinating catalytic properties of these molecules, their engineering by mutagenesis and progress made controllably interfacing with electrode surfaces (including the use of "Molecular Lego" approaches).

One's ability to precisely engineer the bioelectrochemical interface can be applied to the sensitive electronic detection of protein (arguably the most demanding and important medical challenge of the next decade). In Chapter 7 the Davis group survey the importance, requirements and methods of ultra-sensitive protein detection, a particular focus being the establishment of highly sensitive, specific, field effect detection of target protein in complex mixtures. Finally, in Chapter 8, the applications of biosensors are discussed from a clinical perspective by Ko Ferrigno, where the complexities and demands of screening cell and bodily fluid composition are, in particular, highlighted.

Jason J. Davis
Oxford