The Biology of Oligodendrocytes

Traditionally, oligodendrocytes have been considered to play a supporting role in the central nervous system and their importance has generally been overlooked. For the first time, this book provides a dedicated review of all of the major aspects of oligodendrocyte biology, including development, organization, genetics, and immunobiology. Later chapters emphasize the importance of this often overlooked cell to the mammalian central nervous system by exploring the role of its primary function, myelin synthesis and maintenance, in neural disease and repair. Particular attention is paid to multiple sclerosis, arguably the prime example of an acquired demyelinating disease, with detailed examinations of the current concepts regarding demyelination, oligodendroglial damage, and remyelination in multiple sclerosis lesions.

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This book is dedicated to Jonathon Pembroke and Jarrod Glasson.

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Preface

For a long time neurons have blinded neuroscientists with their dazzling array of impulses and synapses. In thrall to these complex neural networks neuroscientists have often concentrated almost exclusively on neurons while the role of the macroglia – the oligodendrocytes and astrocytes – has remained in the shadows. We hope that this book will present a more integrated view of the relationship between oligodendrocytes and neurons and the critical role both cell types play in the central nervous system (CNS).

We aim to set out major aspects of the biology of the oligodendrocyte – a very large, very complex and dynamic cell – highlighting its extraordinarily unique organization and its multiple functions. For example, each oligodendrocyte can produce a plethora of up to 50 elongated paddle-like processes, each of which spirals around an internode of a different CNS axon. This spiraling process forms the compacted myelin lamellae and the associated uncompacted inner mesaxon, lateral paranodal regions and the outer mesaxons so often overlooked. The metabolic requirements and maintenance of such an elaborate organization of membranes depend on the uncompacted and compacted myelin compartments remaining in continuity. This continuity is achieved via the transverse processes and Schmidt–Lanterman incisures and ensures that vital cytoplasmic components have access to the compact myelin membranes. The orchestration of oligodendrocyte interaction with the neurons and other CNS cells is dependent on the precision of developmental processes including cell division, differentiation and migration to exact locations. Damage to this organization or an

individual cell type is a major focus of medical research because of the serious consequences of any perturbation of the CNS. We thank Dr. Martin Griffiths, CUP, for his assistance, Professor John Prineas and Dr. Michael Barnett for review of Chapter 9 and all our colleagues who assisted us in the production of this book.

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