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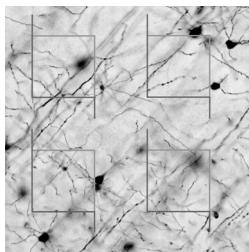
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BASIC STEREOLOGY
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COLD SPRING HARBOR LABORATORY PRESS
Cold Spring Harbor, New York • www.cshlpress.org

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Front Cover: Series of unbiased sampling frames, superimposed on a Golgi-Cox–stained section of neocortex, that can be used to perform stereological analyses of various three-dimensional structural features of the tissue. (Image courtesy of Mark J. West.)

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To Maryam

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Preface

MORPHOLOGY (HISTOLOGY) HAS HISTORICALLY BEEN a qualitative descriptive discipline. It has provided us with a wealth of names and definitions of a multitude of structural features that have provided valuable insight into numerous cell and tissue functions. Attempts to quantify morphological features, in order to make four-dimensional comparative statements about cell and tissue function, have been mired in controversy, however, due to lack of concordance in the data, disagreement about quantitative methodology, and a general lack of appreciation of rational practical approaches to the quantitation of histological features. During the past two decades, a large number of scientific papers have been published that collectively represent a paradigm shift in thinking about how to derive meaningful quantitative data about structural features in biological tissues; these are design-based, unbiased stereological methods.

The unique aspect of the new design-based stereology is that, unlike previously available methods, these methods involve no prerequisite information about the structural features being quantified. These new methods have a strong foundation in stochastic geometry and sampling theory and result in meaningful reproducible data. This book is an attempt to present a number of the concepts and principles of the new stereology in one coherent discussion of what these methods involve in terms of their application, with the goal of providing the reader with the knowledge necessary to design, supervise, and critically evaluate design-based stereological studies. Although sufficient detail regarding the theoretical basis of these methods is provided, along with numerous references to the original papers, the primary emphasis of the book is on the application of design-based stereology to the structure of the nervous system and how this would be extended to other tissues. The nervous system provides a wealth of structural features that can be used to exemplify modern stereological methods for estimating number, length, number, surface, and volume. The book does not exhaustively cover the full range of stereological methods, but it does, however, present detailed descriptions of methods for obtaining data regarding the fundamental structural organization of organs, tissues, cells, and subcellular structures.

This book is based on a series of lectures held at the NeuroStereology Workshops, together with Lutz Slomianka, between 2000 and 2011. Readers who are new to design-based stereology are advised to proceed to read the chapters in sequence, because there are numerous references to concepts and terms presented in earlier chapters and because some of the practical exercises build upon the results of earlier exercises. In addition to describing stereological methods (Chapters 2–5), practical issues that must be dealt with when applying these methods are presented and discussed in detail. These include descriptions about how to get started (Chapter 9), designing pilot studies (Chapter 10), and getting to know your tissue, tissue preparation, and tissue shrinkage (Chapter 11). Numerous examples of applications of the methods are based on the author's own work in the central nervous system, although the book is written in general terms for those interested in applying modern, design-based stereology to other tissues, as mentioned above.

I thank my colleague and coauthor on many stereology papers, Lutz Slomianka, for his helpful assistance in the preparation of this book; Hans Jørgen Gundersen, Luis Cruz-Orive, Adrian Baddeley, and Eva Bjørn Jensen for enriching my view of the structure of the world; and Albert Meier for his expert assistance with many of the illustrations and figures in this book and in the earlier papers upon which this book is based.

MARK J. WEST
Aarhus, October 1, 2011