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Foreword

This book is meant to be a companion to our atlas of the adult rat brain (*Brain Maps: Structure of the Rat Brain, Elsevier, 1992*), using a consistent approach to nomenclature and graphical representation. The immediate stimulus for its production was the need for maps to display patterns of homeobox gene expression in the developing rat brain, work done in collaboration with Michael G. Rosenfeld of San Diego. In a broader sense, however, it provides a histological foundation for, and major extension of, the schematic outline of early brain development presented in the earlier volume.

Once again, we are indebted to Dr. Nello Spiteri of Elsevier for his unfailing support and encouragement.

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Alicante and Los Angeles

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I. Overview

Preparing an atlas of brain development is more challenging and less satisfying than doing so for the adult brain—more challenging because the geometry of the developing neural plate and tube changes so dramatically over time, and less satisfying because so little is known with any degree of certainty about the disposition of particular cell groups and fiber tracts during embryogenesis.

The two goals of the approach used here, and in our atlas of the adult rat brain, are to clarify the basic structural plan of the mammalian brain, and to generate computer graphics maps for summarizing related information, using the rat as a particularly convenient model. The advantages of the adult rat brain for neuroanatomical research are well-known: it is relatively small (about 2 $cm.^2$ vs. 1500 $cm.^2$ for the human); its cerebral cortex is much less convoluted than that of most carnivores and primates; and much more is known about the organization and chemistry of its circuitry than any other mammal. The major disadvantage of the rat at the present time is that the even smaller mouse is much more convenient, and is used almost exclusively, for genetic analysis in mammals. However, the rat and mouse are closely related species, and we have included a discussion of how similar the development of their brains may be, and thus how useful our maps may be as a guide to mouse brain development (section VI).

The heart of this book is, of course, the atlases of the rat brain at progressive stages of embryogenesis (section VIII). Nine representative ages have been selected to demonstrate the appearance of the prenatal brain from the simple neural plate stage to a time just before birth, when most of the major cell groups and fiber tracts of the adult are finally recognizable. At each age, enough levels are presented to illustrate the major known structural features, and at five ages two planes of section are presented to help clarify difficult topological relationships. At all ages,

each level is represented by a photomicrograph of the right side of the brain, and our interpretation of the underlying structure is presented as a drawing on the left side.

A second part of the book discusses our approach to interpreting the gross structure of the developing brain (sections II and III). The approach is classical and based on the fundamental work of Malphigi (1673) and Baer (1828), who characterized the significance of the vertebrate neural plate and brain vesicles; and of His (1887), who drew attention to the cellular differentiation of the neural tube wall. A summary of what has been learned since then is presented, as a framework for modern cellular and molecular investigation of mechanisms responsible for the construction of neural circuits, and for the design of useful maps for summarizing neuroanatomical information.

A third component of the book is more theoretical and deals with methods to produce flattened maps or footprints of the central nervous system (section IV), much like familiar wall maps of the earth. Our approach to this problem was outlined in the adult brain atlas, and has now been refined considerably by a systematic histological examination of the developing brain.

And finally, we have discussed problems associated with identifying specific structures in the embryonic brain, and with the many inconsistencies found in nomenclature associated with the developing and adult brain (section V). Based on this, we have adopted a conservative approach to the drawings accompanying the photomicrographs—only major structures that are relatively easy to identify under the microscope in Nissl-stained sections have been indicated. Nevertheless, because of the relatively small amount of information currently available in the literature, we have undoubtedly failed to identify many important subdivisions or transitory structures, and even misplaced important boundaries. The maps of gross structural features

presented here will undergo considerably greater modifications in the future than those we have published for the adult brain.