Imaging Dopamine

Since its discovery 50 years ago, brain dopamine has been implicated in the control of movement and cognition, and has emerged as a key factor in diverse brain diseases such as Parkinson's disease, schizophrenia, and drug addiction. This book is an illustrated biography of the dopamine molecule, beginning with an account of its synthesis in brain, and then describing its storage, release and signalling mechanisms, and its ultimate metabolic breakdown. Using color illustrations of positron emission tomography (PET) scans, each chapter presents a specific stage in the biochemical pathway for dopamine. Writing for researchers and graduate students, Paul Cumming presents an overview of all that has been learned about dopamine through molecular imaging, a technology which allows the measurement of formerly invisible processes in the living brain. He reviews current technical controversies in the interpretation of dopamine imaging and presents key results illuminating the roles of brain dopamine in illness and health.

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"But as if a magic lantern threw the nerves in patterns on a screen."

T. S. Eliot

To the remembrance of
Professor George Leslie Cumming (1930–1994)

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The color plates are between pages 28 and 29, and pages 224 and 225.

Foreword

This book is timely and will prove useful for many researchers interested not only in the specific topic, "Imaging Dopamine," but also in more general aspects of dopamine. In neurotransmitter research, dopamine has served a spearhead function ever since its discovery in the brain half a century ago. Dopamine has also played a key role in molecular imaging research; the imaging of dopamine receptors started very early in the history of positron emission tomography.

Although this book has its focus on imaging, the full utilization of imaging techniques depends on the background knowledge gained from other methodologies, a theme that has been duly considered by the author. Thus, the various aspects of dopamine, dealing, for example, with its synthesis, storage, release, and metabolism, as well as with the enzymes and transporter proteins involved in these processes, are treated in sufficient detail to provide a well-integrated and reasonably complete picture of the very complex dopamine transmission machinery.

It should go without saying that the growth of knowledge regarding the various aspects of neurotransmission has not taken place without intervals of considerable disagreement and controversy. In the course of the past half century's intense research, many issues have been resolved, whereas others are still being debated. I am pleased to find that the author has devoted some space to historical aspects, starting out with a scheme of the dopamine nerve terminal published by me in 1966. Indeed, our first experiments made in 1957 and the following years initially led to a considerable controversy, based largely on the belief prevailing at the time that the nerve cells in the brain communicated mainly by electric signaling. Thus, our proposal that the catecholamines dopamine and noradrenaline served important neurotransmitter functions in the brain was at the time hard to accept by most leaders in the field. This was evident at an international meeting in London in 1960. But only five years later, at a subsequent international meeting in Stockholm, the concept of

chemical transmission in the brain had already gained considerable acceptance. This was largely due to the development of histochemical techniques, by means of which Swedish research groups had been able to visualize the neuronal localization of monoamines in the central nervous system, thus providing further evidence of their neurotransmitter function. However, very soon other controversies followed. For example, there arose a debate on whether synaptic vesicles were essential in the physiological release process or were just serving as "garbage cans."

Since those early days, the field of dopamine research has moved a long way, largely thanks to the advent of an array of powerful techniques. The early pharmacological work proposing the existence of several subtypes of dopamine receptors, "autoreceptors," and transporter proteins could be confirmed by molecular biology techniques, and their roles further elucidated by, for example, knockout techniques. The ongoing development of molecular imaging will clearly play a key role. It will continue to bridge the gap between animal and human research, and more sophisticated techniques will make it possible to record the processes underlying even the highest integrative functions of the brain. The present book will serve as an important guide for many researchers in this endeavor.

Arvid Carlsson

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