Handbook of
Neurochemistry

SECOND EDITION

Volume 1
CHEMICAL AND CELLULAR ARCHITECTURE

Edited by
Abel Lajtha

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Preface

After the completion of the first edition of this series, this editor thought that a new edition would not be warranted in less than 15, perhaps 20, years, but it seems that we live in a time in which rapid changes are the norm and findings in a field such as neurochemistry develop exponentially. The task of a future editor attempting to get a comprehensive neurochemical handbook for the year 2000 would be even less enviable, but by then information processing may be very different.

The approach, the design, and the areas covered by each volume and each chapter are necessarily arbitrary, and it is likely that other editors or authors would have approached the coverage or the organization in a different manner. It is hoped, however, that readers will find the series helpful for beginning or for continuing work. There may be some overlap among the various chapters, but insisting on single coverage of an area would at times have restricted treatment to only one point of view and might have truncated and hurt the logical flow of some of the chapters.

Chapters in this series do not cover small areas in detail, but each covers a subject that could have been expanded to a book or could have been discussed in a week-long symposium. Still, one definition of a handbook is that it can be lifted and carried by hand. This series may be on the borderline of such a definition, but perhaps it fits "that by being brief it is of more help." Although they facilitate the finding of information and directions, such short presentations always gravely restrict details or background of the information presented. For these restrictions authors are not to be blamed. Clearly, full coverage is not possible, but the emphasis is on good chapters that are of support to those who turn to the book.

Most important, the editor wishes to thank the authors whose hard work is presented here; they are busy, have deadlines and unexpected emergencies, and, no doubt, this series has added just another difficult task to the long list. For their excellent contributions and cooperation we all are indeed grateful. The Handbook reflects not only the excitement of past findings but also, through the rapidly expanding present, the exciting possibilities of the future in our field.

Abel Lajtha

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Cation Transport

László Latzkovits and Csaba Fajszi

1. INTRODUCTION

1.1. Basic Concepts of Cation Transport

According to the traditional concept[1–3] of cation transport, there are "active" and "passive" fluxes: the former drives cations uphill (against an electrochemical gradient) at the expense of ATP consumption, whereas the latter moves cations downhill (in the direction of the electrochemical gradient) by simple diffusion across membrane "imperfections" or "pores." This traditional concept of active and passive cation fluxes has proved to be inadequate for two main reasons.[4–11] (1) It has been demonstrated that the "active" pump transporting both Na^+ and K^+, usually uphill, by direct consumption of ATP can also drive cation movements "on the level" (i.e., in the absence of any concentration gradient) or even downhill.[4,5] (2) Evidence has been collected that demonstrates that "passive" fluxes of cations are highly organized and are closely associated with important physiological functions[6]: many of them take place as part of counter- or cotransport mechanisms.[5–9] Thus, the energy of the electrochemical gradient of the cation actually moving downhill is not dissipated but is mostly consumed in promotion of the transport of different compounds (e.g., sugars, amino acids, other cations), in some cases even against a concentration gradient. In this way, "passive" fluxes of cations moving downhill can build up a concentration gradient for other cations without any waste of ATP.[5–9] Selectivity of the membrane for some "passive" cation fluxes enables it to convert the energy of primary ionic gradients into the energy needed for the maintenance of resting membrane potential as well as for cell excitation.[6,10,11]

The above facts gave the impetus for the construction of more appropriate new concepts and models of cation transport, but the various attempts have introduced quite divergent operational definitions of rather fictitious entities

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