

# Central Regulation of Autonomic Functions

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*Edited by*

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## PREFACE

The importance of the autonomic nervous system in regulating body functions has been appreciated for many years. The anatomy and, to a lesser extent, the physiology of the system were cogently described in Langley's monograph entitled *The Autonomic Nervous System* (Heffer & Sons, Cambridge), which was published in 1921. His book had an immense impact on the field.

With the development and application of a wide range of new experimental techniques in anatomy, physiology, and pharmacology, many traditionally held beliefs about autonomic function have changed or are in the process of being revised. Several excellent discussions of such advances have been published. The textbook by D. Purves and J. W. Lichtman (1985), *Principles of Neural Development* (Sinauer, Sunderland, MA), summarizes current knowledge of the development of the autonomic nervous system, and the 1987 monograph by J. B. Furness and M. Costa, *The Enteric Nervous System* (Churchill Livingstone, Edinburgh), surveys what is now known about the anatomical and neurochemical organization of the enteric nervous system. In addition, the issue of chemical cotransmission in the autonomic nervous system has been recognized through the outstanding contributions of a number of scientists, and these have been reviewed by G. Burnstock (1986) in his article "The Changing Face of Autonomic Neurotransmission," published in *Acta Physiologica Scandinavica* 126, 67–91, and by J. M. Lundberg and T. Hökfelt (1986) in a review article, "Multiple Coexistence of Peptides and Classical Transmitters in Peripheral Autonomic and Sensory Neuron-Functional and Pharmacological Implications," published in *Progress in Brain Research* 68, 241–262.

The idea that a wide spectrum of chemical transmitters operates at the level of the neuroeffector, the autonomic ganglia, and the central nervous system (CNS) has been clearly established. At many of these sites, the physiological actions of the various neurotransmitters and modulators have been studied at the cellular level. At the other end of the spectrum, the physiological description of autonomic reflexes has established that visceral afferents function not solely in transmitting nociceptive sensations but also as an integral part of the control mechanisms for homeostatic regulation of virtually all visceral functions.

In light of these exciting developments, it is perhaps surprising that so little appears to have changed over the last 20 or so years in the general appreciation within the medical and scientific communities of the role of the CNS in regulating autonomic functions. In many ways the prejudices and misconceptions that have grown out of this ignorance seem to have been perpetuated in typical textbook accounts of the autonomic nervous system. This is un-

fortunate in view of the dramatic advances in neuroanatomical techniques involving immunohistochemistry and axoplasmic transport tracing that have provided abundant new information on regions of the brain and the spinal cord that control the autonomic nervous system. Neurophysiological studies at the single cell level have also contributed significantly to a greater understanding of the role of the CNS in aspects of autonomic nervous system control.

The purpose of this volume is to redress this imbalance. Our initial intention was to be comprehensive, but we concluded that it was better to concentrate on the areas in which enough new ideas had developed to justify a revision of classical concepts. In doing so, we were convinced that a mildly didactic approach was required rather than a traditional scholarly review as presented in volumes such as the *Handbook of Physiology* (American Physiological Society, Oxford University Press). Clearly, certain features of autonomic control are underrepresented as a consequence, but our chapters include references to many reviews that can provide supplemental information on most of these topics.

Our aim has been to review the central neuronal components involved in autonomic control, and it is in this context that the book should be judged. We asked our contributors to provide both historical and contemporary accounts of their fields of interest while making their chapters accessible in style and level of detail to graduate students, medical students, interested clinicians, and neuroscientists in general. We hope that the material is of sufficient value to benefit autonomic aficionados as well since this is probably the first text to focus on the CNS aspects of the subject.

The first six chapters provide a comprehensive review of the basic anatomy, physiology, and pharmacology of the autonomic nervous system. The organization and control of the autonomic preganglionic neurons (Chapters 4 and 5) are emphasized, and an overview of the complex central autonomic pathways (Chapter 6) is given. These topics are amplified at several stages throughout the book. The early chapters are intended to familiarize readers with the essential background for an analysis of the more detailed material provided in subsequent chapters. In particular, the role of the autonomic nervous system in cardiovascular homeostasis is discussed in some depth in Chapters 8, 9, 10, and 11, as well as in Chapters 13, 18, 19, and 20, where it is placed in the context of behavioral activities. The relationship between the autonomic regulation of the fluid and ionic composition of the extracellular environment of the body and cardiovascular control is explored in Chapters 13 and 14. The sensory information arising from the viscera is outlined in Chapter 7, and the role of the cerebral cortex in autonomic function is considered in Chapter 12. The latter two chapters give an indication of the perceptual qualities of autonomic sensation and their potential in modifying behavior. The importance of the autonomic nervous system in the expression of affective behavior is reviewed in Chapter 19. The changes that occur in autonomic function during sleep provide considerable insight into the neural organization of this state (see Chapter 20). Together with the understanding of affective behavior, these changes indicate the widespread role of the autonomic nervous system in natural activity. The more direct effects of the system in regulating visceral and endocrine function are addressed in Chapters 15, 16, and 17, although in each case there is an attempt to draw behavioral significance from the fundamental observations of functional control.

We have been fortunate in persuading a number of distinguished scientists to contribute to this endeavor. They have sustained their interest in the project through the protracted editorial process that allowed us to use a great number of independent reviewers. Each chapter

has undergone a number of revisions, and the final form in many cases reflects the expert and constructive comments of the reviewers. Their role cannot be overemphasized and our thanks to them are sincere and deeply felt. Many of these experts could easily have contributed valuable chapters themselves, but space constraints prevented us from expanding the text further.

For the two editors, the challenge posed by this venture has been stimulating, at times difficult, but also entertaining. The editorial process often operates at an interface between scientific fact and opinion, and this is always fraught with difficulties. We have insisted on balanced and accurate summaries of each field covered in this book by making stringent demands on our contributors and ourselves, and we believe that we have provided a critical review of each of the fields while preserving our friendships with our collaborators and with each other.

It is a pleasure to acknowledge our debts to colleagues, past and present, who have contributed, often unknowingly, to the development of our ideas and have supported our activities in many ways. A special note of thanks must go to Jeffrey House of Oxford University Press, who encouraged us to undertake the task and provided many constructive comments at all stages of this project. It has been an interesting experience and one that will ultimately be judged by its success, or otherwise, in fostering more interest in this field of neuroscience.

We wish to thank the many publishers who have permitted us to reproduce illustrations. A particular note of appreciation is due to George Paxinos and Charles Watson, and Jeremy Fisher the Managing Editor of Academic Press, for allowing us to use, often in modified form, several drawings from their atlas *The Rat Brain in Stereotaxic Coordinates*, 2nd ed. (Academic Press, Sydney, 1986).

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*St. Louis*  
*London*

A. D. Loewy  
K. M. Spyer

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