

An Overview of Chemical Bioregulation in Vertebrates

Fifty years ago, I read two new books that shaped my professional life. The first was *A Textbook of Comparative Endocrinology* by Aubrey Gorbman and Howard A. Bern (1962) that contained virtually everything known about invertebrate and vertebrate endocrinology at that time. The second book was *Silent Spring* by Rachel Carson. Thus began my development as an "environmental endocrinologist" long before the term appeared in print. Since that time there has been exponential growth in our knowledge and it would take many volumes to adequately summarize it today. We thought the old lines drawn between the disciplines of endocrinology, neurobiology, and immunology were relatively clear 50 years ago but now they have become indistinct. All three fields employ chemical messengers affecting target cells through specific receptors, often involving the same messengers and receptors, and we now recognize that the nervous, endocrine, and immune systems each influence the activities of the others. Thus, a broader, integrated concept of chemical bioregulation for physiology and behavior has emerged that incorporates these three disciplines. Furthermore, a great variety of man-made chemicals related to products we use every day are appearing in aquatic and terrestrial environments at extremely low concentrations. These same chemicals are associated with endocrine, immunological, and neural disorders in laboratory rodents and very likely in humans. Similar impacts are being described for aquatic and terrestrial wildlife. Consequently, an understanding of endocrinology and other chemical regulatory mechanisms and their interactions is essential for our future on Earth.

Vertebrate or comparative "endocrinology" (i.e., bioregulation) has become too broad a field for any one person to keep abreast of, with hundreds of new publications appearing each year in the clinical and non-clinical

literature. For example, in one month there may be (1) information about bioregulation in new species that influences our understanding of the evolution of endocrine systems, (2) discovery of new bioregulatory chemicals that contribute to coordination of activities within cells, between cells, and among organs and organ systems and even between organisms, (3) new understandings or treatments for a specific clinical disorder, and (4) new evidence of disruption of endocrine functions in humans and wildlife by chemicals previously believed to be safe.

In an attempt to make the content of *Vertebrate Endocrinology* more representative of this vast and rapidly changing field, I have added a co-author, Dr. James A. Carr, Professor of Biological Sciences at Texas Tech University to help with this task. Additionally, the illustrations (mostly in full color) have been completely redone to help students better conceptualize the major concepts. Rather than produce a compendium, we have attempted to provide a current overview and interpretation of chemical bioregulation of vertebrates with a basic framework for helping students access and understand the primary bioregulation literature. *Vertebrate Endocrinology* is organized to challenge advanced undergraduates and graduate students interested not only in mammalian or human endocrinology but those wishing to examine comparative vertebrate endocrinology as well.

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FIGURE 1-1 Chemical Bioregulation of
Physiology and Behavior: The Integrated
Function of the Nervous, Endocrine, and Immune
Systems

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