Stanley Jacobson · Elliott M. Marcus

# Neuroanatomy for the Neuroscientist

*Second Edition*

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*To our wives: Avis Jacobson and Nuran Turksoy.*
*To our children: Arthur Jacobson, Robin Seidman,*
*Erin Marcus, and Robert Letson, and*
*to our grandchildren: Ross Jacobson, Zachary Letson,*
*and Amelia Letson.*
*To our teachers, students, and colleagues.*

# About the Author

Dr. Elliott Marcus, Professor of Neurology at University of Massachusetts (Emeritus). At 78, Dr. Marcus – a neurologist and educator for five decades at Tufts Medical Center, Tufts University School of Medicine, and the University of Massachusetts Medical School at Saint Vincent Hospital – died on July 25, 2011 in Massachusetts General Hospital in Boston.

Even as the end drew near, Dr. Elliott Marcus pressed on with his life's work: sharing the knowledge he had gleaned through a lifetime of dedicated study and teaching neuroscience. He received his undergraduate education at Yale University and earned an MD from Tufts University School of Medicine. He was trained in neurology at Tufts Medical Center and also served with distinction for two years in the US Army. He taught at Tufts University School of Medicine from 1964 to 1976 where he was the "father" of neuroscience teaching to medical students. He then moved to St. Vincent's Hospital in Worcester Massachusetts in 1976 where he was Chief of Neurology. He also was a Professor of Neurology at the University of Massachusetts and an active member of that department. He was a clinical neurologist and he published many papers on diagnosis and treatment of seizure disorders. He retired in 1998 and continued active teaching of neurology residents and medical students at UMass until just before his death.

Even as non-Hodgkin's lymphoma took its toll on Dr. Marcus, he pushed himself, discussing his contributions to a forthcoming book that he and Dr. Stanley Jacobson, a Professor of Anatomy and Cellular Biology at Tufts Medical School and a friend and colleague for over 40 years, were collaborating on and telling friends to make sure the work continued beyond the span of his limited days. He wanted to live and be there to teach and to be there for his grandchildren.

Friends and colleagues said he was dedicated to his work, loved his family, and inspired generations of doctors. Dr. Thomas Sabin, a Professor of Neurology at Tufts Medical School described Dr. Marcus as a superb neurologist and someone with a brilliant intellect. Dr. David

Chad, a Professor of Neurology and Pathology at UMass Medical School, said Dr. Marcus's passion for neurology and teaching was always evident. Dr. Marcus often traveled from Florida more than a decade after his official retirement in 1998 to work with neurology students. He would talk with them, letting them learn through conversations, rather than just giving the answers, Chad said.

"He had a Socratic method of teaching; he let students sort of find the truth," Chad said. "He would open the subject up. He would bring out the key issues to be discussed. He wouldn't stand up and give the answers. He'd ask questions and give feedback. He was an excellent communicator. He loved sharing what he knew. He brought scholarship to his teaching."

Dr. Cynthia Brown, who first met Dr. Marcus in 1980 as a resident neurologist at UMass Medical School and Saint Vincent's Hospital, described neurology as a "very intellectual specialty." "To have someone as bright and inspiring as Dr. Marcus helps to validate one's choice to be a neurologist," she said. "He's really a doctor's doctor, and it is very sad to think that the upcoming classes of medical students will not be able to have his tutorials."

Boston Globe
Boston, MA

Melvin Mason
Stanley Jacobson

# Preface

## Neuroanatomy for the Neuroscientist

The purpose of this textbook is to enable a Neuroscientist to discuss the structure and function of the brain at a level appropriate for students at many levels of study including undergraduate, graduate, dental, or medical school level. It is truer in neurology than in any other system of medicine that a firm knowledge of basic science material, that is, the anatomy, physiology, and pathology of the nervous system, enables one to readily arrive at the diagnosis of where the disease process is located and to apply their knowledge at solving problems in clinical situations.

The two authors have a long experience in teaching neuroscience courses at the first or second year level to medical and dental students in which clinical information and clinical problem-solving are integral to the course. In addition, the first author has taught for many years an upper level biology course on the Central Nervous System to undergraduates at Tufts University in Medford, MA utilizing many of Dr. Marcus' cases to help engage the students. The second author has developed a case history of problem-solving sessions in the book "Integrated Neurosciences" by E.M. Marcus and S. Jacobson, Kluwer 2003 and he also conducted a problem-solving seminar in which all medical students at the University of Massachusetts participated during their clinical neurology clerkship rotation. This provides the students an opportunity to refresh their problem-solving skills and to review that basic science material is essential for clinical neurology. At both levels, we have observed that this inclusion of case history materials reinforces the subject matter learned by markedly increasing the interest of the students in both basic and clinical science material. This text is a modified version of "Integrated Neurosciences" published by Kluwer in 2003. This book is also an updated version of an earlier integrated textbook originally developed by the authors along with Dr. Brian Curtis and published by W.B. Saunders in 1972 as "An Introduction to the Neurosciences." The text provides an updated approach to lesion localization in neurology, utilizing the techniques of computerized axial tomography (CT scanning), magnetic resonance imaging (MRI), and magnetic resonance angiography (MRA). Multiple illustrations demonstrating the value of these techniques in clinical neurology and Neuroanatomical localization have been provided. The clinical cases illustrations have been utilized in the body of the text.

In this, the second edition, decisions had to be made so that the size of the textbook remained within limits that could be managed in most of today's neuroscience courses and we could respond to some of the very worthwhile suggestions from our colleagues. The printed book contains the core topics concerned with the central nervous system. We have divided this book into four sections: I: Introduction to the Central Nervous System (Chaps. 1–10), II: The Systems (Chaps. 11–17), and III: The Non-Nervous Elements (Chaps. 18–21). We have added a chapter with case histories, Chap. 20, and following suggestions from our colleagues have been added as an Atlas (Chap. 22). We have updated "Movies on the Brain", Chap. 21, and we have used several of these movies as an adjunct to the course ("Young Dr. Frankenstein" directed by Mel

Brooks has a wonderful scene introducing the CNS, and "Little Shop of Horrors" directed by Frank Oz features Steve Martin as a dentist. Making a great introduction to the trigeminal nerve). There are many movies in the science fiction genre that are also useful for discussion, and Star Trek with its many episodes and its Medical Manual are at the top of our list!

We have added Chap. 20 with representative cases of disease within the CNS to add in the students, 'understanding of the disease process within the CNS. We have also included a discussion on the eighth nerve in the cranial nerve chapter and a discussion on the olfactory system in the limbic system chapter. In addition, we have added material in the form of an Atlas at the end of the spinal cord chapter, the brain stem, and thalamic chapters and finally we have included a separate chapter, Chap. 21 as an Atlas with labeled gross sections and myelin stained sections of the brain to aid in identifying the regions within the brain. A number of other topics including cell biology, cell physiology, embryology, nerve, and muscle are usually covered in other courses and the students should examine these topics in those courses. The anatomy of the peripheral nervous system and autonomic nervous system should be reviewed in one of the standard gross anatomy texts.

Most of the case histories utilized in the chapters, have been drawn from the files of Dr. Marcus. For a number of the cases, our associates at the New England Medical Center, St. Vincent Hospital, Fallon Clinic, and the University of Massachusetts School of Medicine either requested our opinion or brought the case to our attention, and provided information from their case files. These individual neurologists and neurosurgeons are identified in the specific case histories. We are also indebted to the many referring physicians of those institutions. Medical house officers at St. Vincent Hospital presented some of the cases to Dr. Marcus during morning report. In particular, our thanks are due to our associates in Worcester: Drs. Bernard Stone, Alex Danylevich, Robin Davidson, Harold Wilkinson, and Gerry McGillicuddy. Drs. Sandra Horowitz, Tom Mullins, Steve Donhowe, Martha Fehr, and Carl Rosenberg provided clinical information from their files for some of the case histories. Our associates at the New England Medical Center, Drs. John Sullivan, Sam Brendler, Peter Carney, John Hills, Huntington Porter, Thomas Sabin, Bertram Selverstone, Thomas Twitchell, C.W. Watson, and Robert Yuan likewise provided some of the clinical material. Dr. Milton Weiner at St. Vincent Hospital was particularly helpful in providing many of the modern neuroradiological images. Dr. Sam Wolpert and Dr. Bertram Selverstone provided this material for the earlier version of the text. Dr. Val Runge from the Imaging Center at Texas A&M provided the normal MRIs. Dr. Anja Bergman (left handed) had the patience to be our normal case and the images from her brain form the normal MRIs in the basic science chapters and Atlas. Dr. Tom Smith and his associates in pathology provided much of the recent neuropathological material. Drs. John Hills and Jose Segaraa provided access to neuropathological material for the earlier version of the text. Drs. Sandra Horowitz and David Chad provided critic of particular chapters.

Dr. Sarah B. Cairo MD, MPH while still a medical student at Tufts Medical School developed the illustrated drawings that have been used throughout the second edition of this book to illustrate the retina, pathways, levels of the spinal cord, levels of the brain stem, and levels of the thalamus. Dr. Mary Gauthier Delaplane while a medical student at Boston University School of Medicine provided the anatomical drawings illustrating the cranial nerves, and the Neuroembryology chapter. Anne Que, Paul Ning, Tiffany Mellott, Elizabeth Haskins, and Tal Delman aided Dr. Delaplane. Dr. Marc Bard provided drawings for the earlier version of this text while a student at Tufts University School of Medicine. In many of the clinical chapters, various medications are recorded. Before utilizing these medications, the reader should check dosage and indications with other sources. It is with great pleasure we extend our thanks to our publishers and particularly our editors Ann Avouris and Joseph Burns for all their help. Any faults or errors are those of the authors and we would therefore appreciate any suggestions or comments from our colleagues.

Boston, MA — Stanley Jacobson
Worcester, MA — Elliott M. Marcus

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