Pied Piper of Neuroscience

Principles of Neurobiology
Author: Liqun Luo
New York, NY, USA: Garland Science (2015).
645 pp. $100.00

Forgive us for not disclosing the year, but when one of us was excited about the brain at a young age (and the other just born), neuroscience as an integrated discipline was still so new that one could hardly find a textbook.

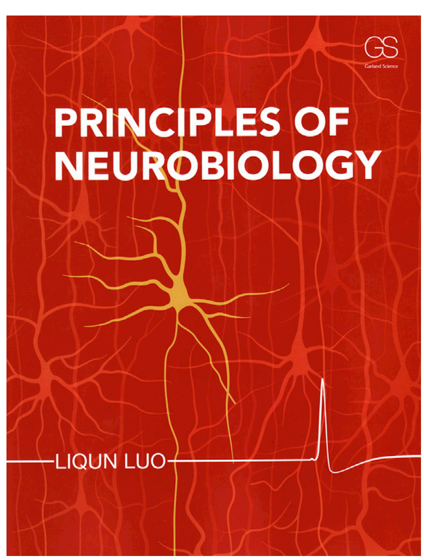
Neuroscience was then scattered in the standard medical curriculum of anatomy, embryology, histology, biochemistry, physiology, pharmacology, pathology, neurology, and psychiatry. Some teachers literally extracted relevant materials from those traditional disciplines before adding a prefix "neuro-" to most of them. The exception was Harvard University, where Steve Kuffler and John Nicholls published *From Neuron to Brain* in 1976, basically using their teaching notes. For the progeny of Harvard who worshiped Kuffler, *From Neuron to Brain* was automatically embraced, though its style was highly personal and its content highly selective. Kuffler and Nicholls imprinted what they liked onto their students, who later spread the book when they established laboratories or departments of neurobiology outside Harvard.

When Eric Kandel and James Schwartz published *Principles of Neural Science* in 1981, it solved the problem of comprehensiveness and became the standard neuroscience textbook. In its third edition in 1991, Tom Jessell strengthened the coverage on neural development, which, at that time, was taught mainly from *Principles of Neural Development* by Dale Purves and Jeff Lichtman (1985). More textbooks, including *Fundamental Neuroscience* by Squire et al., *Neuroscience* by Purves et al., and *Neuroscience Exploring the Brain* by Bear et al., followed and each has been used by a significant readership.

Why should anyone read Dr. Liqun Luo's *Principles of Neurobiology*? Isn't it suicidal to write a textbook in an already crowded market?

The new book is distinct in its philosophy and authorship, which makes it valuable for teaching and a pleasure to read. Luo shares with us the belief that students should not be taught just facts and knowledge but also how knowledge is obtained and how principles are derived. He advocates discovery-based teaching in his own course at Stanford and Peking Universities. This book is the product of his hard work to offer discovery-based teaching to more students. The target readership is senior undergraduate students interested in research, graduate students interested in neuroscience, and the minority of medical students who still intend to pursue research alongside clinical practice.

It is an immense task for any individual to write a textbook for a discipline so large now that each recent annual meeting for the Society for Neuroscience in the United States alone has more than 30,000 attendees. If one wants to be sane and preserve one's own time for research, one should ask others to join in writing a book. These partially explain why all major neuroscience textbooks are multi-authored. Multiple authors also ensure expertise in diverse fields. Nevertheless, the advantage of single authorship is also obvious, as long as the author has the intellectual breadth and depth to cover different areas. A consistent writing style and a coherent, logical flow will certainly be helpful to readers. Luo has been heroic in writing the book over 5 years as a single author. In 13 chapters and 645 pages, he provides a masterpiece highlighting principles of how the nervous system transforms and governs our sensation, action, memory, and thought.



Reading *Principles of Neurobiology* is like enjoying a beautiful piece of music. Luo often begins each section with interesting stories or classic experiments and ends with his comments on important but unsolved questions. We include a few stories here.

Chapter 1 showcases nature versus nurture: a young chick exhibits innate escape behavior if an object flies toward it resembling a hawk but not when the same object flies toward it resembling a goose; juvenile barn owls, after wearing artificial prisms, could adjust their auditory map to match an altered visual map. Luo uses these stories to entice students to explore neurobiological mechanisms of behavior: how experiences remodel and sculpt neural circuits formed by genetic instruction.

Chapters 2 to 11 form the core: signaling within neurons and across synapses, sensory/motor systems and how they wire together, sexual behavior, learning/memory and synaptic plasticity, and brain disorders. Unlike other neuroscience textbooks in which molecular, cellular, systems, and developmental neurobiology are treated separately, most topics in this book are question oriented with interdisciplinary approaches intertwined to address the same question. For example, in the section on olfaction, the author starts with an intriguing and remarkable story of salmon homing. A 1976 field study demonstrates that adult salmon rely on the imprinted memory of smell to guide their homing to streams even after they have migrated many miles away. How are odor stimuli transformed into electrical signals? How do these signals get processed, organized, and transmitted to the brain to form internal representation? How can some odors evoke stereotypic innate behaviors while others can be flexibly associated with learned

Image credit: Zhi Ye, Peking University.

behaviors? How do distinct neural maps form during development and then how are they shaped by experiences? The author logically takes readers through the journey of major discoveries, colorfully filled with chemistry, molecular biology, genetics, electrophysiology, optical imaging, and behavioral assays. Instead of simply remembering facts or conclusions, students can have fun deriving conclusions from the original data. The pied piper is getting the student to follow with action.

All sensory systems convert external stimuli into an internal representation in the brain, but they differ dramatically in the physical nature of the stimuli and the required processing. For example, vision has to convey color, as well as spatial information, while the auditory system requires frequency separation and temporal precision. Are there the general principles shared between olfactory, visual, auditory, taste, and somatosensory systems? What are their unique mechanisms? Again, the discovery-based approach encourages the reader to solve the puzzles one by one and arrive at a general understanding of the sensory systems. This is but one of the many storylines that are thought provoking and enjoyable to read.

The book ends with "evolution of the nervous system" (Chapter 12) and "ways of exploring" (Chapter 13). The evolution section asks how ion channels or sensory GPCRs evolved and when and how the mammalian neocortex underwent rapid expansion. It places neurobiology in a perspective where diverse and independent strategies in different organisms were created to solve the common problem.

The last chapter centers on technologies in neurobiology. As Sydney Brenner remarked in 1980, "progress in science depends on new techniques, new discoveries, and new ideas, probably in that order." In fact, the career of the author himself partly echoes the comment. From the late 1990s to now, Luo has invented genetic methods in flies and mice to label and manipulate single neurons and to trace *trans*-synaptic connections, thus in an excellent position to provide an authoritative summary of neurotechniques, beyond those of optogenetics and CRISPR/Cas9. Regrettably, however, a bias is shown by the absence of biochemical approaches to neurobiology, which have played an important role in neuroscience such as the discoveries of the nerve growth factor and netrin.

Taken together, Luo's book is a pied piper's flute for neuroscience students. As a single author taking up the challenge of discovery-based teaching, Luo has included a judicious choice of materials and achieved a fine balance of breadth and depth. *Principle of Neurobiology* will help teachers to inspire curious students. Once the students find neurobiology irresistible, they will find that no one can cover neuroscience in a single textbook, and motivated students can go on his/her own path of learning more about neuroscience by reading other books that have upward of 1,700 pages and nearly 80 authors, specialized books such as *Cognitive Neuroscience* by Michael Gazzaniga, or better still original research papers.

Most scientists are afraid of writing textbooks, both because precious time can be spent on doing research and writing grants and because the reputation of authors of textbooks in the natural sciences almost always precedes, rather than follows, a textbook. Luo, through his *Principles of Neurobiology*, has set an example of how an outstanding scientist cares about education and writes a textbook to inspire students to pursue discoveries. We hope that students will follow this pied piper, happily and fruitfully.

Yulong Li[1,2,3,*] and Yi Rao[1,2,3,*]
[1]State Key Laboratory of Membrane Biology, Peking University School of Life Sciences, Beijing 100871, China
[2]PKU-IDG/McGovern Institute for Brain Research, Beijing 100871, China
[3]Peking-Tsinghua Center for Life Sciences, Beijing 100871, China
*Correspondence: yulongli@pku.edu.cn (Y.L.), yrao@pku.edu.cn (Y.R.)
http://dx.doi.org/10.1016/j.cell.2015.09.039

