

# FOUNDATIONAL CONCEPTS IN NEUROSCIENCE

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A Brain–Mind Odyssey

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# Preface: From Molecules to Consciousness

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Neuroscience—the science of brain and behavior—is one of the most exciting fields in the landscape of contemporary science. Its rapid growth over the last several decades has spawned many discoveries and a large number of popular books. Contemporary news is filled with stories about the brain, brain chemistry, and behavior. Photos and drawings of brains and nerve cells grace the pages of newspapers and magazines. Neuroplasticity—the capacity of neural connections to change and reorganize—has become a buzzword. The notion that your mind can change your brain is pervasive.

We read that drugs used to treat mental conditions such as depression, anxiety, and psychosis are among the best-selling pharmaceuticals in history. Ads for these drugs depict neurons and neurotransmitter molecules. One hears that brain science is being used increasingly in the courtroom—that brain structure and functional activity are used in arguing for guilt or innocence in accusations of criminal behavior. It is said that advertising agencies are spending millions of dollars to study the neural activity in people's brains when they look at ads or use products. What is going on with all of this? How are we to understand fact from fiction?

My intention in this book is to provide the backstory—a description of how nervous systems work and how the workings of our nervous system relate to our mind and our behavior. My description is concise yet thorough, rigorous yet easy to follow (and, I hope, fun to read).

For more than twenty years I have taught a class on introductory neuroscience at the University of California, Berkeley. Hundreds of students take this class every year. Many are freshmen in their first year of college. Some are seniors just before graduation. Students having every sort of disciplinary interest take the class—biological and physical sciences, social sciences, engineering, economics, business, arts, and humanities. Some come to the class already having a passion for science. Others are afraid of science and sometimes have particularly strong aversive reactions to chemistry. Occasionally a few high school students or a few graduate students take the class. And there are generally a few retired professionals and other folks from the Berkeley community sitting in on lectures.

My aim as instructor is to provide a comprehensive overview of brain structure and function—beginning with atoms and molecules, building up to membranes and cells, progressing to neurons, neural circuits, and sensory organs, and then on to perception, memory, language, emotion, sleep, and dreams. A theme throughout the



semester is the mystery of how mental experience (which is all we ever truly are able to know) is related to the workings of our brain and body—the deep mystery of mind and consciousness.

That class is the framework for this book. As such, the book is comprehensive enough to use as a text in an introductory course on neuroscience. It gives quite a bit of detail about the structure and function—largely at the molecular and cellular levels—of the human nervous system. Most of the material in this book is basic enough that it will not readily be outdated. Textbooks that endeavor to keep up with the very latest developments need to be rewritten and updated frequently. An instructor using this book for a class can always keep things current by supplementing with additional material drawn from contemporary neuroscience research. This book provides the foundation.

I have taught this subject not only in university classrooms but also in a variety of continuing-education workshop settings for interested individuals of all kinds. I have taught various components of this material in workshops held in the unique setting of the Esalen Institute on the California coast, and I have been privileged to teach neuroscience to Tibetan Buddhist monks and nuns in India as part of a science-education program initiated by the Dalai Lama. In all these diverse settings, this approach to the subject—exacting yet affable—has been well received.

Not just for use in the classroom, this book is also meant for *anyone* interested in learning about how the brain works. It is for those of you who wish to understand just where that news article on brain scans is coming from, or how to appreciate a story about antidepressant drugs. I develop everything as much as possible from the ground up, so that no specific technical background is required to read this book. For those not familiar with molecular structure diagrams, I hope you will quickly come to appreciate their simplicity, beauty, and utility. My intention is to make even the most complex material easy and fun to understand, at least in its essential features.

A goal is for readers to come away with some intuition about how the brain works, to appreciate the beauty and power of molecular and cellular explanations, and at the same time to appreciate that the unfathomable complexity of living systems places substantial limits on any sort of seemingly simple explanation. This last point is frequently forgotten.

Contemporary physical, chemical, and biological sciences have enjoyed awesome success over the last several centuries in accounting for a great deal of what we observe. From the farthest reaches of the universe, billions of light years away, to the inner structure of atomic nuclei, physical theories provide a stunningly powerful and coherent explanatory framework. Living systems, even with their extraordinary complexity, appear to be falling nicely within this remarkable explanatory framework. However, scientific understanding of the human mind—and how our capacity for conscious awareness relates not only to the brain but also to everything else we believe we know about the physical universe—is considered to be among the greatest mysteries in modern science, perhaps *the* greatest mystery. It is my hope that this book will provide the foundation from which to more deeply appreciate this awesome subject.