Public Health. He is also the author of *Complications: A Surgeon's Notes on an Imperfect Science,* which was a finalist for the 2002 National Book Award for Nonfiction.

"The learning curve is something you think about from the very first day you put on a white coat," he explains, "and for good reason. It has terrors, important consequences, and vexing moral dilemmas. A perfect subject for an essay, I thought. I was nervous taking on the topic, though. There are only untidy solutions to the dilemmas. And no matter how carefully I explain why the opportunity to practice upon human beings is vital to good medicine, I (and many of my colleagues) feared the essay would just increase the number of people turning up in doctors' offices insisting that only the most experienced take care of them. But in truth, people have already figured out that experience matters. And offering an understanding of where it comes from and how seemed to me the only chance of leading anyone to accept the limits inherent in what we do and also our constant need to learn."

Marcelo Gleiser holds the Appleton Professorship of Natural Philosophy and is professor of physics and astronomy at Dartmouth College, where he leads an active research group in theoretical physics. To date, he has published over sixty-five papers in refereed journals and has participated in many domestic and international conferences as an invited speaker. He is the recipient of the Presidential Faculty Fellows Award (PFF) from the White House and the National Science Foundation and is a Fellow of the American Physical Society. His first book, *The Dancing Universe: From Creation Myths to the Big Bang* (Dutton, 1997), received the 1998 Jabuti Award, the highest literary award in Brazil. He has appeared in several science documentaries, including the PBS/BBC *Stephen Hawking's Universe.* He received the 2001 José Reis Award for the Popularization of Science, offered every two years by the Brazilian Research Council (CNPq). His second book, *The Prophet and the Astronomer: A Scientific Journey to the End of Time* (W. W. Norton, 2002), received the 2002 Jabuti Award. Since September 1997, he has written a widely popular weekly column in *Folha de São Paulo,* one of the top newspapers in his native Brazil.

He writes, "When Charles Harper invited me to contribute an essay to the volume celebrating Sir John Templeton's ninetieth birthday, I was elated. He suggested I write on the general topic of 'emergence' from the point of view of a physicist. Nothing could be more appropriate; the emergence of form from substance, be it of living matter from inorganic molecules, of mind from brain, or of the universe itself (from nothing?), is a topic at the forefront of scientific research. And it is also a very old question, much older than what we today call

science. As such, it represents very uniquely the drive we all have to ask questions about Nature's mysteries and to try and answer them as best we can. This essay is an effort to communicate my own personal drive, a scientific drive fueled by a sense of awe which is also much older than science."

Roald Hoffmann was born in 1937 in Zloczow, Poland. Having survived the war, he came to the United States in 1949 and studied chemistry at Columbia and Harvard Universities. Since 1965 he has been at Cornell University, now as the Frank H.T. Rhodes Professor of Humane Letters. He has received many of the honors of his profession, including the 1981 Nobel Prize in Chemistry (shared with Kenichi Fukui). "Applied theoretical chemistry" is the way Roald Hoffmann likes to characterize the particular blend of computations stimulated by experiment and the construction of generalized models, of frameworks for understanding, that is his contribution to chemistry. Dr. Hoffmann is also a writer of essays, nonfiction, poems, and plays. The latest of his four poetry collections is *Soliton,* published in 2002. His nonfiction writing includes a unique art/science/literature collaboration with artist Vivian Torrence, *Chemistry Imagined: The Same and Not the Same,* a thoughtful account of the dualities that lie under the surface of chemistry; and, with Shira Leibowitz Schmidt, *Old Wine, New Flasks: Reflections on Science and Jewish Tradition,* a book of the intertwined voices of science and religion. Dr. Hoffmann is also the presenter of a television course, *The World of Chemistry,* aired on many PBS stations and abroad. A play, *Oxygen,* by Carl Djerassi and Roald Hoffmann premiered at the San Diego Repertory Theatre in 2001, and has had several productions since.

"This one was easy," he comments. "Have I not been peddling theories all my life? I should know what I preach.

"It was easy, but not for that reason. Scientists are mostly unreflective about what they do as they do it. Oh, they're very good at spotting lack of logic, obfuscation, and hype in other scientists. But not in their own work. And perhaps it's just as well—we all know too much thinking and talking about the process undermines creation. There is cognition and thought, mind working with hands, in the heat of making the new, yes. But not all that much stand-back-and-ponder-why thinking. At some point, it's just 'do it!'; as other theorists, I did what comes naturally. Does the reflective tone of this article then mean that I am through doing real science?

"I am not going to answer that question.

"I have been fortunate to have to rise to the occasion of writing *American Scientist* columns for a dozen years, alternating between popularized chemistry, chemical stories with a point, history or social issues, and amateur philosophy

of science. 'Why Buy That Theory?' belongs to the last category. Michael Weisberg, a young philosopher of science and a friend, invited me to a symposium at the Philosophy of Science Association meeting in 2002, on the theme 'Causation and Explanation in Chemistry.' It was also high time for my next *American Scientist* column. I wrote 'Why Buy This Theory?' to . . . see where it would take me, as I had trouble beginning my talk. And because I was inclined to fight a little with all too rational ways of looking at science by philosophers and scientists.

"What may not be so obvious is the personal conflict (read: inconsistency) revealed in this article. First of all, the success of my early theoretical work with Woodward was based in substantial part on some risky predictions. Second, I have made a good living teaching people in chemistry simple orbital pictures of the driving forces for shape and reactivity. Respectful of complexity, I've still simplified—some would say oversimplified—the world.

"But in 'Why Buy This Theory?' I set off, bang, by dismissing the importance of risky predictions in theory acceptance. And I come out, desperately trying to restrain myself, for complexity.

"Why am I fighting myself? Is it that I've just gotten older? And as one ages one loses (some people do) the simple, strong convictions of the young? And sees shades of gray, the shadows that lurk around simple worldviews.

"No doubt that's part of it. But also that I've learned something from the ambiguity that gives a poem (or prose) meaning beyond simple meaning. That I just know more chemistry, more stories. And more people, who make wonderful molecules and build ornate theories, blissfully ignoring the Ockham's razor they idolize. People who give us the gift of new means of looking. Their way there is rife with tension, paved with inconsistencies as they craft provisional (all the while subtly claiming absolute) knowledge. Telling stories, not fessing up to it, telling them anyway, because they have. Just people, perforce fallible, relentlessly curious, driven to create the new."

JENNIFER KAHN writes about science and other subjects for *Discover, Harper's Magazine,* and *Wired* magazine, where she is also a contributing editor. She is based in Berkeley, California, and was recently awarded the American Academy of Neurology's 2003 journalism fellowship.

"A decade ago," she writes, "as an undergrad in the Princeton physics department, I remember seeing a crank letter pinned to the basement bulletin board. It was a long letter, written entirely in capitals and very neat, asking whether anyone knew about the government's ability to transmit radio messages through silver fillings. What struck me at the time was how reasonable the question was. Why couldn't fillings act like antennae at some frequency? I

mean, how would *you* account for voices that seemed to originate inside your own head? Because I was in lab at the time, and struggling to explain the bizarre data that my experiments inevitably generated, I had a lot of sympathy for the idea that rogue electromagnetic waves permeated the universe. They had to be mostly undetectable, of course—but really, it would have explained a lot."

MICHAEL KLESIUS is a staff writer at *National Geographic* magazine, where he has spent the last ten years researching and writing science articles. He holds a master's degree from the Johns Hopkins science writing program in Washington, D.C. During his undergraduate years at the College of William and Mary, he excelled at languages and the written word, but found himself continually drawn to science courses and lectures for their mind-bending facts, theories, and controversies. During his junior year in France he crisscrossed much of the European continent and has returned to it a dozen times. On assignment for *National Geographic,* he has worked in China, Russia, South Africa, Syria, Thailand, Turkey, and Zambia. Haiti counts as one of his most rewarding stops, due to the limitless spirit of its people amid abject poverty. Topics he has covered for *National Geographic* include Neolithic cultures, the global AIDS pandemic, Iron Age ships excavated from Danish peat bogs, and new technologies in aviation, for which he flew aerobatics in the F-16 and F-18. Among his most memorable experiences, was trekking above Mount Everest's base camp to the peak of Nepal's Kala Pattar. Michael and his wife, Giuliana, live in Arlington, Virginia.

"Writing about science offers me a constant lesson in humility," he says, "both because the people I interview are orders of magnitude smarter than I am, and because I'm always left with the reminder of humanity's brevity and unremarkable place in the cosmos. I've always shared *National Geographic*'s fascination with things ancient. So I eagerly accepted this assignment chronicling the rise of the angiosperms, or flowering plants. Reporting the story from Sweden to China to Wyoming's Big Horn Basin, I encountered paleobotanists as passionate about their calling as any scientists I've known. They showed me how flowering plants, extant and extinct, have played a critical role in the rise and sustenance of humans, and not just physiologically. As a flower dealer in the Netherlands said, 'People have been fascinated by flowers as long as we've existed. It's an emotional product. People are attracted to living things. Smell, sight, beauty are all combined in a flower. Every Monday a florist delivers fresh flowers to this office. It is a necessary luxury.' "

BRENDAN I. KOERNER is a contributing writer for *Mother Jones,* a contributing editor at *Wired,* and a fellow at the New America Foundation. He was for-