Marc’s life work is mapping the infinitely complex circuitry of the retina, a monumental task he says is “a challenge that spans many lifetimes and many individuals, so I’ve been privileged to make some headway—with the help of a lot of mentors. The Kayser Award is a very big deal for me. So many people who I admire tremendously have won in the past, and to be put on the same list with them is pretty challenging. It also means that the body of work I’ve done impacts our understanding of vision in ways I didn’t anticipate it would.”

Marc joined the Moran Eye Center in 1993, arriving by way of the University of Texas Houston where he held an endowed chair and was widely known for his discoveries in color vision. The first of his many notable achievements was mapping the color receptors of the retina. Together with his graduate mentor, Harry Sperling, he produced the first complete color maps of retinal cone arrays. Postdoctoral work with William Stell at UCLA launched a career-long interest in tracing neural pathways with molecular markers and electron microscopy, providing the first frameworks for neurochemically defined feedback systems in the retina.

Visualizing Change
A decade ago, the Marc Lab at Moran demonstrated that diseases such as age-related macular degeneration and retinitis pigmentosa began by rewiring the neural circuits in the eye, but no one had a complete idea what that circuitry looked like or how it worked. To begin to understand those diseases, he and his team needed to create what was then a “dream” of a photo map, called a connectome. It would be the first complete interactive digital image of the network of nerves and neurons that make up the retina—a map so dense it could zoom down to the level of an individual synapse and track exactly how it sparked with the others—and then zoom out to larger patterns made by thousands of synapses together.
But, given the technology available at the time, it was basically impossible. A single 3D connectome map can require more storage space than 100 desktop computers. Marc and his team began assembling the images anyway, with Marc insisting “technology will catch up with us.” Moran donor Martha Ann Healy believed in them and bought a top-of-the-line electron microscope, which they repurposed for high-speed imaging, collaborating, all the while, with the University of Utah’s Scientific Computing and Imaging Institute to write entirely new code to manage the data. A few years later, “technology caught up.” In 2011, the Marc lab unveiled a retinal map of unprecedented completeness and resolution. Today, they are the lead team in discovering the nature and scope of retinal remodeling and in searching for mechanisms to control it. “Why should we focus on biological details when the need for cures is so pressing?” Marc asks. “Because the answers are in those details.”

Apples & Algorithms

Wriry, silver-haired, with a deep boom of a voice, the El Paso native sometimes sports a ponytail and well-worn jeans with a Texas-sized belt buckle. More than one colleague has described him as a “renaissance” man. One of his passions is the heirloom apple orchard he and his wife, Ann Torrance, have planted in the tiny town of Torrey, in Central Utah. “Science is child’s play compared to farming,” he says. “Computers don’t lift shovels. But I am happiest outdoors.” However, once a scientist, always a scientist: “The genetics, physiology, and chemistry of apples and plant biology and animal husbandry all overlap with my interests in mapping metabolic networks. Indeed, I think many of the tools we’ve developed for studying retinal metabolism and mapping retinal degenerations have powerful applications in agronomy. To my eyes, it’s all the same problem: interacting networks of cells carrying out genetic programs in changing environments. I could talk for hours on the organization of the retina or the evolution of apples.”
“Robert works harder than most. Part of that is because of his passion for understanding how the retina is wired. He geeks out on it, digs in, and gets really excited when we discover something new. And with the connectomics project, we discover something new almost daily.”

—Bryan W. Jones, PhD, Marc Lab Researcher