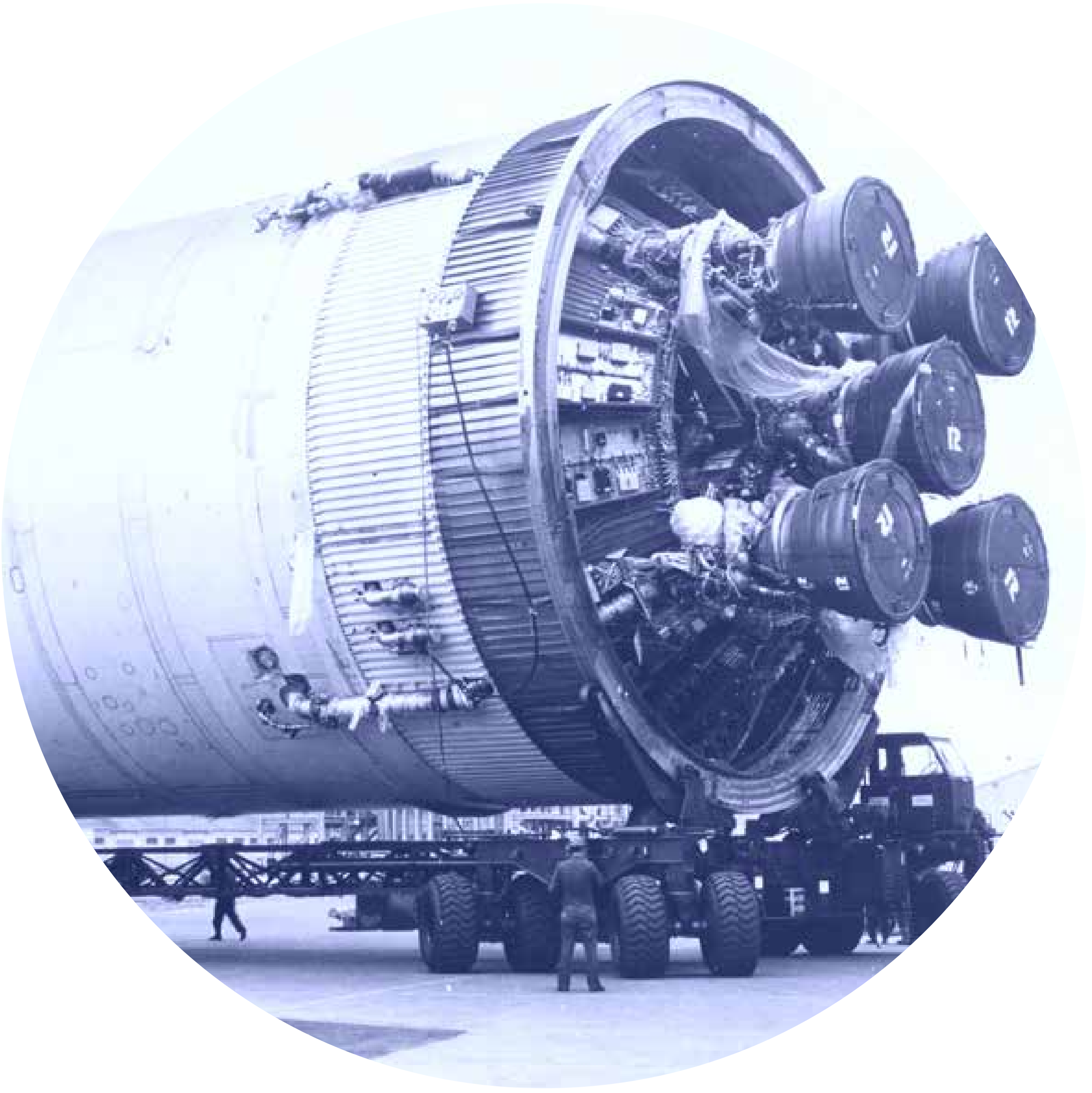

*Techn*Ozarks:

Essays in Technology, Regional Economy, and Culture

Edited
by
Thomas A. Peters
Paul L. Durham

Foreword
by
Greg Burris
Former Springfield City Manager
President and CEO of the
United Way of the Ozarks

The Ozarks Studies Institute of
Missouri State University
Springfield, Missouri
2019

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Book cover and layout design by Jesse Nickles.
Cover photo: The Chadwick Flyer stopping in Ozark, Missouri (*ca.* 1909).
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Image facing Notes on Contributors (p. 282): Panorama at West Shops in Springfield, Missouri (1927). *Thomas Railroad Collection, MSU Special Collections and Archives.*

ISBN-13: 978-1-7321222-2-2
Library of Congress Cataloging-in-Publication Data:
Names: Peters, Thomas A. 1957- editor. | Durham, Paul L., editor.
Burris, Greg, writer of foreword.
Title: TechnOzarks : essays in technology, regional economy, and culture / edited by Thomas A. Peters, Paul L. Durham ; foreword by Greg Burris.
Description: Springfield, Missouri : The Ozarks Studies Institute of Missouri State University, 2019.
Notes: Includes bibliographical references.
Identifiers: ISBN 978-1-7321222-2-2
Subjects: LCSH: Technology—Ozark Mountains Region. | Technology—Social aspects—Ozark Mountains Region. | Technology—Economic aspects—Ozark Mountains Region. | Ozark Mountains Region—Social life and customs. | Ozark Mountains Region—History.
Classification: LCC T14.5.T43 2019 | DDC 303.483—dc23

Introducing The OSI Publications Series in Ozarks History and Culture

The Ozarks Studies Institute (OSI) of Missouri State University seeks to preserve the heritage of the Ozarks, its culture, environment, and history by fostering a comprehensive knowledge of Ozarks' peoples, places, characteristics, and dynamics. The Institute promotes a sense of place for residents and visitors alike and serves as an educational resource by collecting existing—and discovering new—knowledge about the Ozarks and by providing access to that knowledge.

Following *Living Ozarks: The Ecology and Culture of a Natural Place* (2018), *Techn*Ozarks is the second volume in the OSI series. Along with its companion journal, *OzarksWatch*, the series aims "to introduce the Ozarks to the world," and vice versa.

What readers have said of the first volume, *Living Ozarks:*

> Authors in this anthology are aware of tourism's fantasies that overlay geology's reality and that the Ozarks' fragile natural landscape requires stewardship. We know that the environment shapes all creatures that live within it, including us. We must be prepared to address our presence as part of the natural—what is the cost to absorb our footprint?
>
> —Lynn Morrow, editor, *Ozarks in Missouri History: Discoveries in an American Region*

> Any discussion of sustainability in the Ozarks must involve not only the natural environment, but also elements not commonly thought of as natural resources: the history, the heritage, and the people. These are key elements that make this region unique and attractive to outsiders and tourists and give the Ozarks its unique identity. *Living Ozarks: The Ecology and Culture of a Natural Place* brings this point home in a decisive and definitive work.
>
> —Paul W. Johns, author, *Unto These Hills: True Tales of the Ozarks*

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Silica granule, scanning electron microscope (630x magnification). *Courtesy of Austin O'Reilly, Dynamic DNA Laboratories, Inc.*

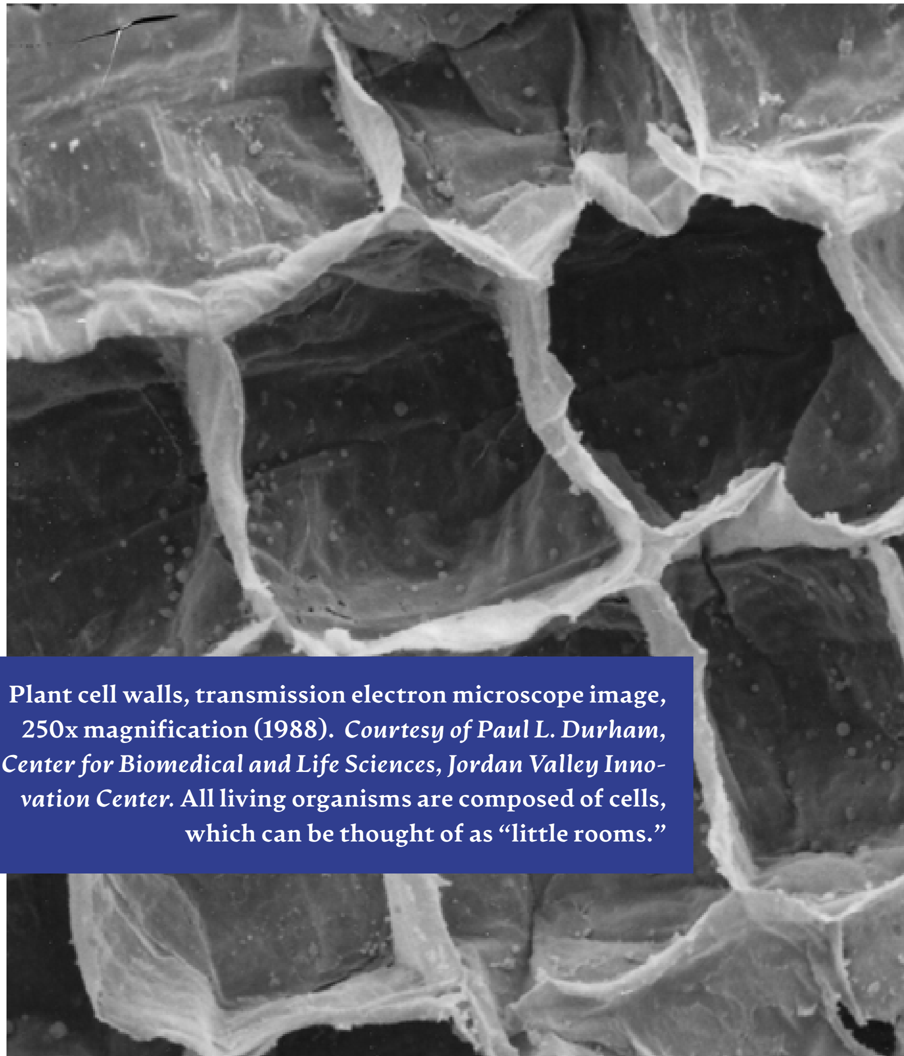
A Different Perspective on Life:

A Cell Biologist Looks Through the Microscope

Paul L. Durham

Recently I was asked what I do as a profession. Without much thought I responded, "I'm a cell and molecular neuroscientist and director for the Center for Biomedical and Life Sciences at Missouri State University." What I should probably have said to prevent the blank stare was, "I'm a biology professor," which typically elicits the response, "Oh, so you study animals—that's cool." I don't think too much about what it means to be a scientist. There really aren't many of us in the Ozarks. Unfortunately, most of the time the word "mad" is included in our titles, since Hollywood has done a good job making money on movies portraying (and promoting) the "mad scientist" character type. My personal feeling is that these films were produced by students who didn't do so well in their high school or college science courses. In truth, I am a biological scientist who studies how nerve cells get excited and then send pain signals to your brain. I work to discover ways to quiet the nerve cells involved in causing migraine, trigeminal neuralgia, and jaw pain—known as temporomandibular disorders or TMD, mistakenly referred to as TMJ (which is actually the name of the joint).

Being a scientist takes perseverance and a deep desire to want to know the answers to important questions; however, I've found that being a scientist also requires humility and a sense of humor, given how little we really know and understand about the natural world and even about the functioning of our own cells. As a cell biologist, I want to understand how cells perform their myriad tasks; to do this, I have to use the lab instruments available to me, including—and especially—the varieties of microscopes. The naked eye is a powerful instrument in itself, but it needs help peering into the smallest structures of life. The cells that I study are so small, hundreds of them can fit on the sharpened tip of a pin; the pinhead can hold many thousands. Fortunately, each innovation in microscopy has multiplied our vision: fivefold at first, soon tenfold, then more than a hundredfold, now many thousands of times more than before. English scientist Robert Hooke (1635-1703) was among the first to describe the "little worlds" or *microcosmi* revealed by means of the earliest microscopes; the etchings in

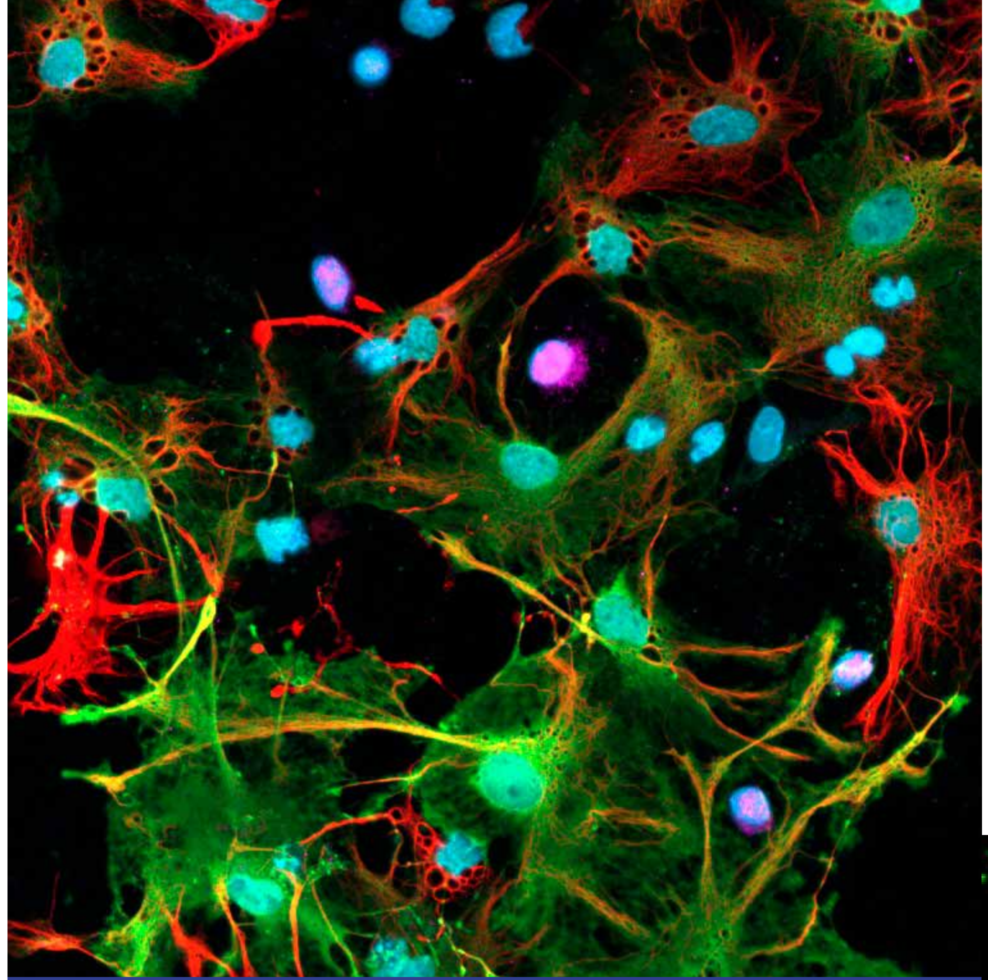


Plant cell walls, transmission electron microscope image, 250x magnification (1988). *Courtesy of Paul L. Durham, Center for Biomedical and Life Sciences, Jordan Valley Innovation Center.* All living organisms are composed of cells, which can be thought of as "little rooms."

his *Micrographia* (1665) remain monuments of early technoscience and are admired still for their artistry and accuracy. Aided by a single-lens candle-lit microscope, Hooke's drawing of the plant material cork reinvented our understanding of biological structure: He is credited with using the word "cell" to describe what appeared to be "little rooms" or *cellulae*, similar to those inhabited by monks. In comparison, here's an image that I captured early in my career, using a scanning electron microscope (SEM) far more powerful than Hooke's old instrument: Clearly it illustrates why the term "cell" is used in biology.

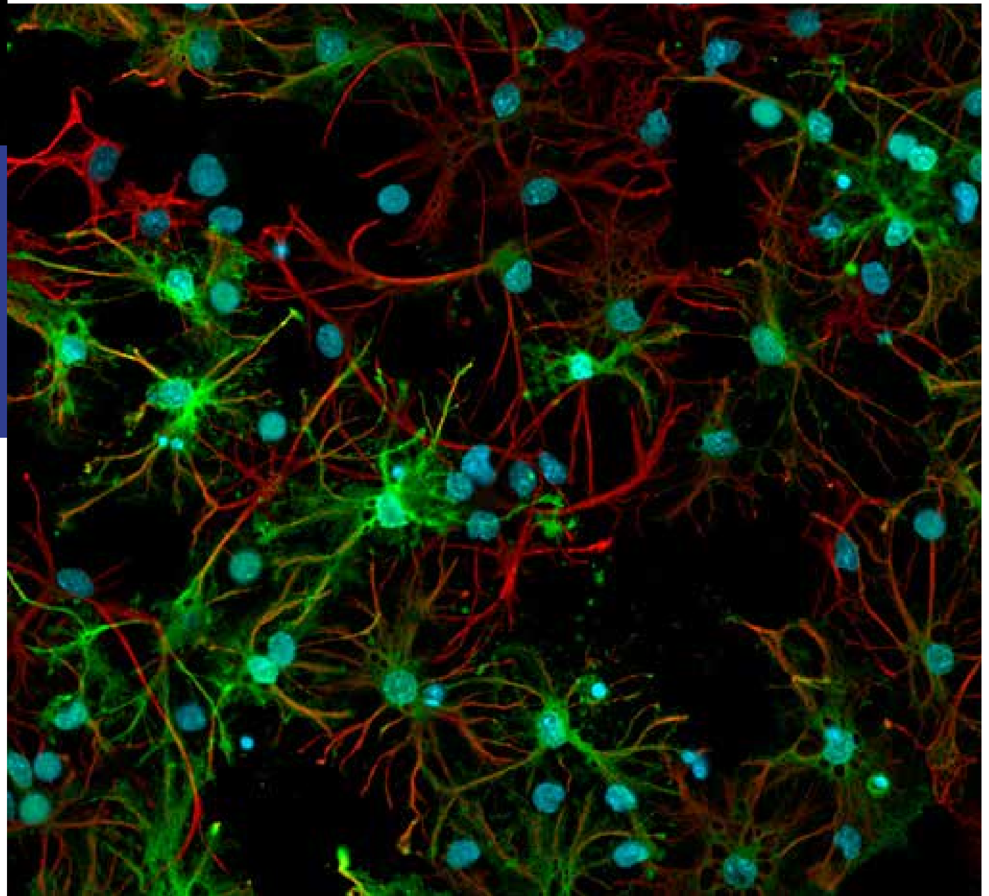
In my laboratory today, I study the activity of cells with the aid of a fluorescent microscope, which allows me to see changes in the level of proteins; these are the molecules that "perform the work" in a cell. To give you some sense of the challenge and excitement of understanding how cells perform their myriad tasks, here's an analogy from the game of baseball. In this model, proteins are the players, each assigned specific functions that allow the team as a whole to perform efficiently. Now, pretend that you have to describe to a total novice the essence of baseball in all of its rules and strategies, but you can only show that person single pictures (snapshots) of the dynamic, ever-changing game. How many pictures would it take to ensure that someone unfamiliar with the game of baseball understands the overall goal and how each individual player contributes to the team effort? In a typical major league game, there are nine position players on the field at any one time, along with several umpires. Honestly, is there a single person alive who knows *all* the rules that govern major league baseball? As complex as the game of baseball is for the average fan to understand, in our world of cells, the game of life is infinitely more complicated; and that's because there are literally thousands of players (remember, we're calling them proteins) in each cell.

Adding to the complexity of our analogy, let's say



▲ Cultured hippocampal cells, fluorescent microscope images, 200x magnification (2016). *Courtesy of Paul L. Durham.* Cells have been stained with fluorescent dyes to visualize internal cellular structures. Information gained from these images allows us literally to see changes in response to a neurological disease or in response to a novel drug. ▶

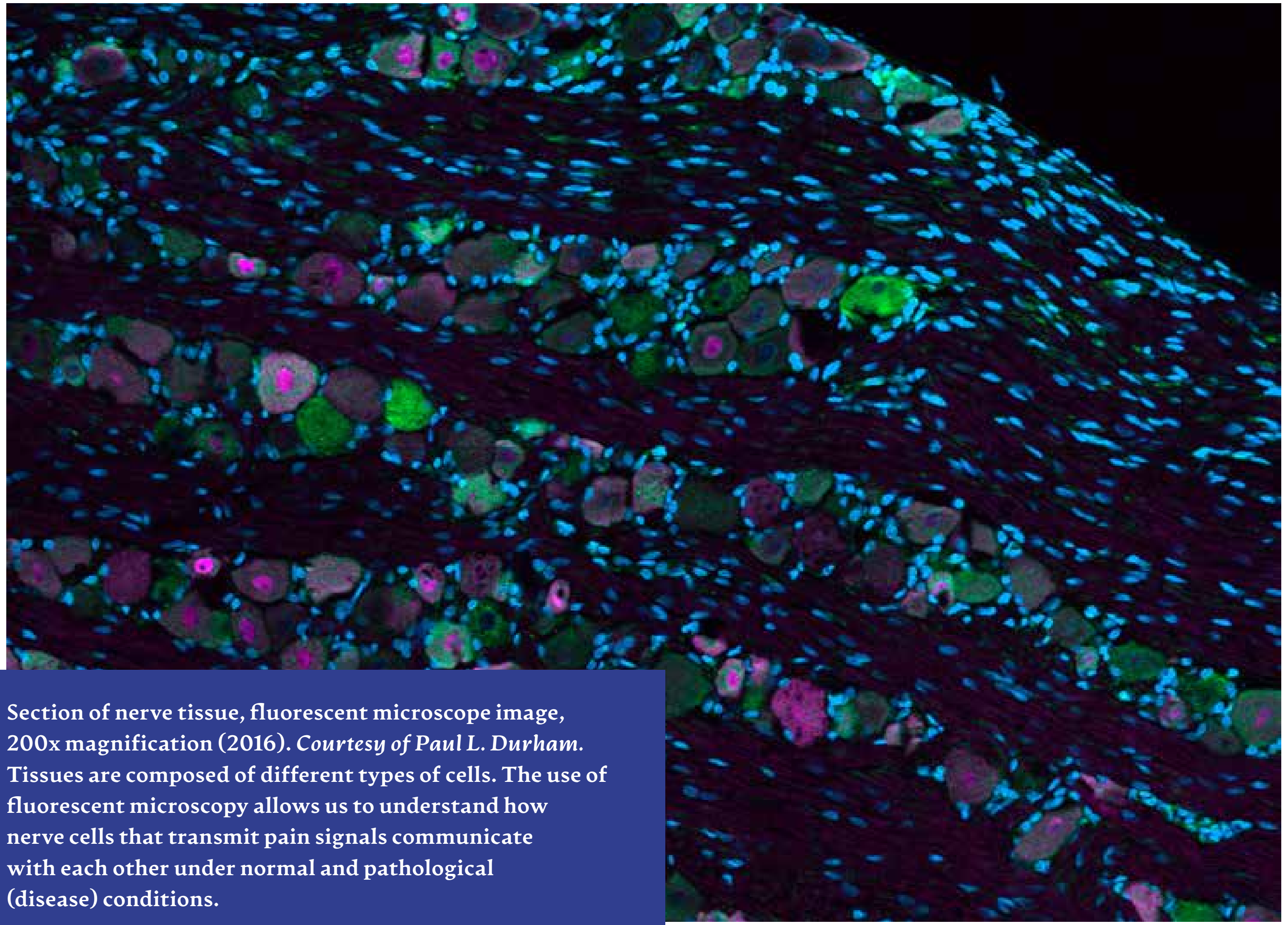
that you've been successful in helping your friend understand the rules and teamwork involved in the game of baseball; in which case, you've managed to describe *how one single cell functions in your body*. There are, however, several hundred different kinds of cells in the human body. So, now you have to explain how each cell is uniquely different from other cells—which is like explaining how baseball is different from basketball, cricket, hockey, soccer, football, etc. And all of these teams (cells) with their specialized players (proteins) are using the same field—basically, you! And they're all playing at the same time, though they have to coordinate their games—that is, their cellular activities. Hence, all the different cells of the body are all talking to each other to coordinate their functions to maintain your health and allow you to perform the myriad activities involved in your daily life. This is the challenge that cell biologists face every day: By observation and experiment, we have learned many of the actions and functions involved in biological life at the cellular level. We're in better shape than that novice, whom you tried to teach baseball. But, going back to the early history of microbiology, *we scientists were the novices* trying to learn "the rules of the game" by mere snapshots. And we're still learning. To state the obvious, our world of cells is very complicated. But that is what makes studying them so exciting: For a cell biologist, discovering a new function of a protein is like discovering a new planet—or *microcosmos*, as Robert Hooke might have termed it.



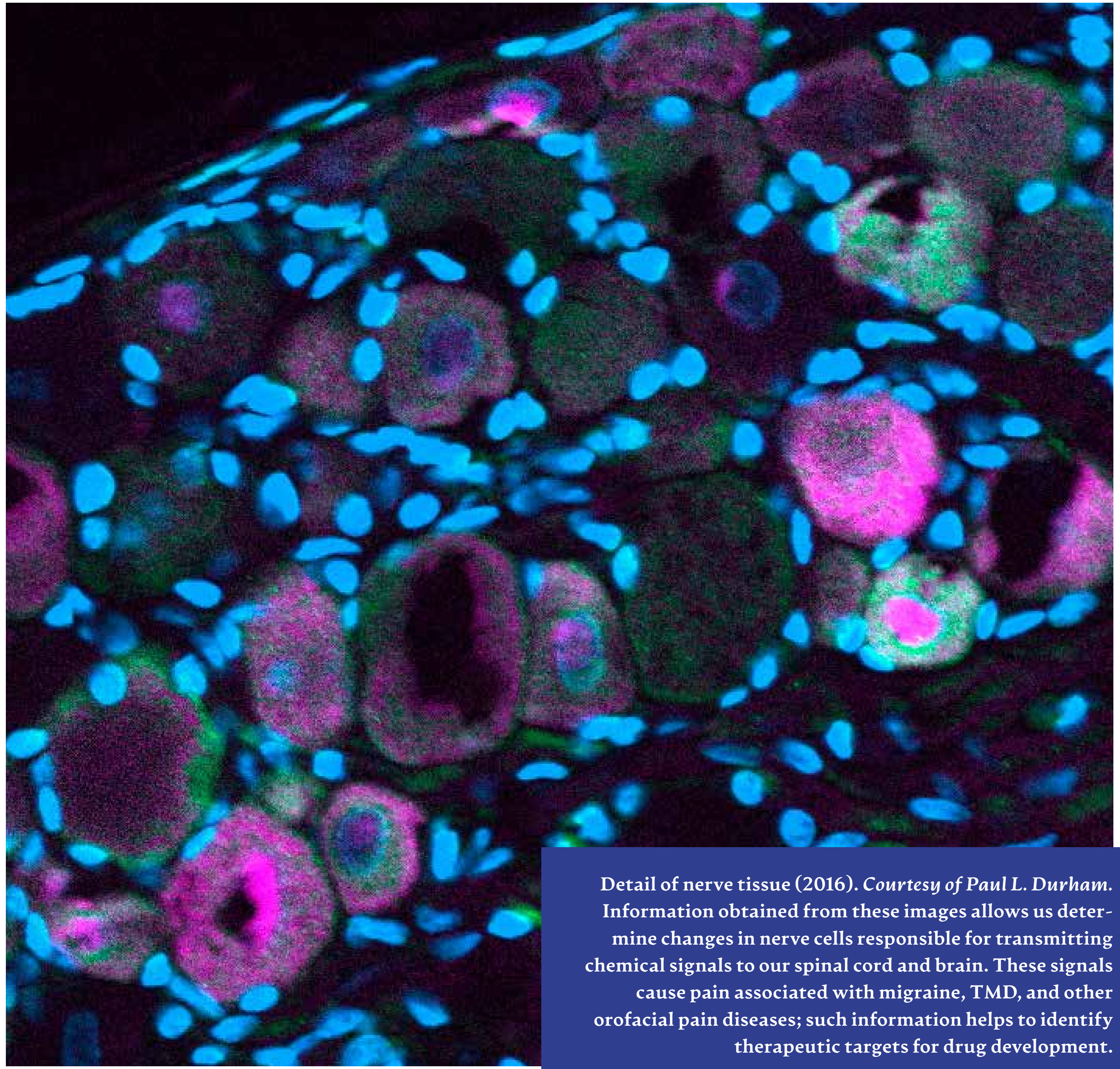
Much has changed in the thirty years that I have been photographing cells. Back in 1984, when I first became a researcher at the University of Iowa, there was not a computer in every lab and I did not own a personal computer. In fact, I did not even own an electric typewriter but used the manual typewriter that my mom had used in the 1960s. To capture images of cells, I made use of a manual-focus microscope and F200 and F400 Kodak black-and-white film. Sometimes I used color; either way, the film had to be developed. I'd take the photos based on manual settings for aperture and exposure time and then have someone from a local camera shop pick up the film and develop it within twenty-four hours (there was an upcharge for faster processing). I still remember the excitement of holding the roll of negatives up to the light to see if any of the images were usable. The process was incredibly laborious, since you could spend hours taking photographs of cells only to discover that the exposure time was not correct and the images were either too bright or too dark. After viewing the film negatives and determining whether there were some useful images, I'd then spend hours in the darkroom perfecting the art of "burning and dodging" to get the textbook 4" x 6" print for publication.

Thankfully, my days of having to capture images of cells manually were short-lived. Today, our laboratories in Temple Hall and in the JVIC Center for Biomedical and Life Sciences are equipped with state-of-the-art digital microscopes; these allow us to capture amazing images and greatly aid in our understanding of how cells in our nervous system function to cause disease and respond to therapies.

Similar to scientists in other disciplines, I am, first and foremost, an adventure seeker who is driven to discover and learn something new each day. I want to unlock the mystery of how cells in the nervous system function so that I can better understand the pathways that lead to development of chronic pain and identify novel ways to prevent, manage, and possibly cure the incredible burden—physical, emotional, social, economic—caused by diseases of the head and face. After thirty years of being a trained cell biologist, I still get a natural high from learning something that no else knows and then sharing that information with scientific communities via conferences, lectures, posters, and publications and then on to the general public, oftentimes with help from public media. I hope that these images help you to appreciate the beauty and mystery of the incredible cellular world that I have the privilege of studying each day.



Section of nerve tissue, fluorescent microscope image, 200x magnification (2016). *Courtesy of Paul L. Durham.* Tissues are composed of different types of cells. The use of fluorescent microscopy allows us to understand how nerve cells that transmit pain signals communicate with each other under normal and pathological (disease) conditions.



Detail of nerve tissue (2016). *Courtesy of Paul L. Durham.* Information obtained from these images allows us determine changes in nerve cells responsible for transmitting chemical signals to our spinal cord and brain. These signals cause pain associated with migraine, TMD, and other orofacial pain diseases; such information helps to identify therapeutic targets for drug development.

dicted developments is an anticipation of their arrival: We look forward to the advances and potential of these products and technologies.

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