

PREPARING FOR
THE NEXT

50 | YEARS

OF NEUROSCIENCE
PROGRESS

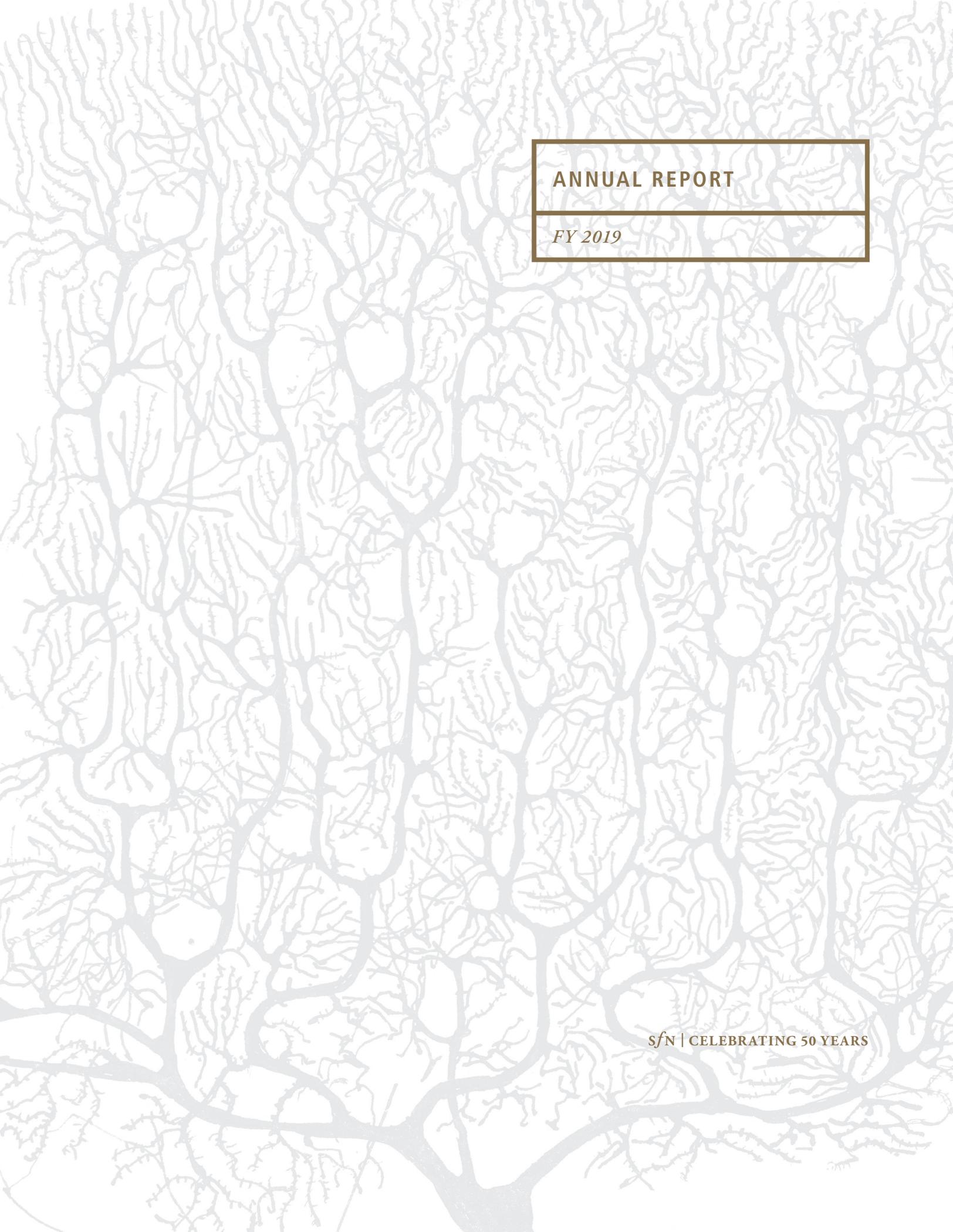


1969–2019



ANNUAL
REPORT

FY
2019



ANNUAL REPORT

FY 2019

sfN | CELEBRATING 50 YEARS

SfN Mission

Advancing Scientific Exchange

Advance the understanding of the brain and the nervous system by bringing together scientists of diverse backgrounds, by facilitating the integration of research directed at all levels of biological organization, and by encouraging translational research and the application of new scientific knowledge to develop improved disease treatments and cures.

Supporting the Neuroscience Community

Provide professional development activities, information, and educational resources for neuroscientists at all stages of their careers, including undergraduates, graduates, and postdoctoral fellows, and increase participation of scientists from a diversity of cultural and ethnic backgrounds.

Educating and Engaging the Public

Promote public information and general education about the nature of scientific discovery and the results and implications of the latest neuroscience research. Support active and continuing discussions on ethical issues relating to the conduct and outcomes of neuroscience research.

Advocating for the Field

Inform legislators and other policymakers about new scientific knowledge and recent developments in neuroscience research and their implications for public policy, societal benefit, and continued scientific progress.

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DIANE LIPSCOMBE
SfN President

Message From the President



We are incredibly fortunate. Neuroscience is arguably the most exciting field of biomedical research today, but that is no accident. Neuroscience emerged from foundational discoveries that depended on the integration of, and deep expertise in, several disciplines. The seminal research of Hodgkin and Huxley in the early 1950s and their quantitative model of the ionic basis of excitability depended on their integration of mathematics, physics, and physiology and the application of voltage-clamp technology. That scientific openness in neuroscience promotes the exchange of ideas and mirrors the core values of the founding members of SfN.

In the 50 years since the founding of the Society for Neuroscience, the field has advanced at a remarkable pace, and if history is the best predictor of the future — take a deep breath. In parallel, SfN has developed high-quality programming to promote training, funding, public engagement, advocacy, exchange of ideas, global partnerships, and rapid dissemination of discoveries. As we celebrate 50 years of SfN, we will also continue to communicate the work of the volunteer leadership and the investments made to fulfill the core missions of SfN — advance the understanding of the brain and nervous system; provide professional development, information, and education; promote public outreach; and inform legislators and policymakers about neuroscience research and discovery.

QUALITY SCIENCE

SfN's Program Committee comprises 51 neuroscientists from across the world who represent the breadth of our field. They are an incredible group, led by Patricia Janak in collaboration with incoming chair Sheena Josselyn, who are responsible for the content of the annual meeting including abstract sessioning, selecting and inviting special lecturers, exploring creative ways to enhance the exchange of ideas, and much more. In 2018, the Program Committee introduced the Dual Perspectives session, which was standing room only, and ran the extremely popular Storytelling session for a second year. Strongly endorsed by SfN Council and Program Committee, SfN staff ensured that attendees to the annual meeting had access to high quality, enhanced infant-care facilities.

Under the leadership of our talented Editors-in-Chief Marina Picciotto

and Christophe Bernard, and in collaboration with the Scientific Publications Committee and dedicated staff, the SfN journals *JNeurosci* and *eNeuro* continue to grow their readership. Publications from our journals are now regularly featured on the homepage of the Society's website, and the weekly highlights to the press under embargo have resulted in SfN journals and the science we publish being featured in major news outlets worldwide. A new blog hosted by *eNeuro* regularly promotes scientific discourse on current topics in neuroscience, and an ongoing series of editorials from the *JNeurosci* editorial board have highlighted methods in scientific rigor specifically related to neuroscience. Further, the SfN Reviewer Mentoring program pairs trainees with editorial board members to open up the review process, provide training, and enhance the pool of skilled reviewers.

SUPPORTING NEUROSCIENTISTS

SfN's elected Council — eight councilors, treasurers, secretaries, and presidents (elect, current and outgoing) — continue to focus on enhanced opportunities for the next generation of neuroscientists. In collaboration with the energetic committees for Neuroscience Training, Trainee Advisory, and Professional Development, we have invested

substantial resources in year-round neuroscience training and professional development opportunities that extend beyond the annual meeting.

The Society hosted quarterly virtual conferences on current topics of optogenetics, implicit bias, neuroethology, and machine learning. Our partnership with the Federation of European Neuroscience Societies (FENS) also resulted in SfN member access to a European-based training webinar. We plan to expand these exchanges leading to additional content. A new grant funded by the National Institute of Neurological Disorders and Stroke (NINDS) provides resources to create a three-year training program on the sociology of science — addressing cultural factors that impact the rigor of neuroscience research. With support from the Dana Foundation, which matched SfN funds, SfN created the Leadership Development Program (LDP), a year-long professional development opportunity for exceptional trainees. SfN also worked toward developing a set of skills and curricula for undergraduate, graduate, and post-doctoral neuroscience programs relevant to SfN's Institutional Program members.

The training resources are accessible through Neuronline, SfN's learning and discussion website. Members can access all content, but SfN also gives open access to a significant portion of trainee material. With more than 1,000 pieces of content, enhancements are underway to improve discoverability of content on Neuronline.

COMMUNICATING DISCOVERIES

A new editor-in-chief, Richard Wingate, and associate editor, Charles Yokoyama, took the helm at *BrainFacts.org* in January from John Morrison. *BrainFacts.org*, a public information initiative of the Kavli Foundation,

the Gatsby Charitable Foundation, and SfN, has been an unqualified success, filling a need for trustworthy and authoritative information about neuroscience. Building on this success in FY 2019 includes expanding accessibility, increasing use by educators and the general public, and involving members of SfN on a more regular basis. *BrainFacts.org* has reached more than 10.5 million users across the world since its launch and creates a phenomenal opportunity for SfN to continue to offer the public insight into discoveries, explanations of current topics, and inspiration for even more students to study neuroscience.

Our continued focus on advocacy and communicating the critical importance of basic research to policymakers saw tangible outcomes this year, with both NIH and NSF receiving increases to their budgets in FY 2019. SfN worked in coalition with the science community to advocate for this investment in biomedical research funding. Forty-eight neuroscientists attended Capitol Hill Day in the spring, and SfN collaborated with its international partners to develop culturally appropriate advocacy programs. Work with FENS focused on building support for the use of animals in biomedical research, and a renewed Memorandum of Understanding with the Canadian Association for Neuroscience led to an increased number of neuroscientists communicating with members of the Canadian Parliament. New this year, the Society is expanding its advocacy reach to neuroscience funding opportunities offered by the U.S. Department of Defense and Department of Veterans Affairs. The foundation of all these efforts remains our Society's engaged NeuroAdvocates, including our public outreach committees. Their efforts — in the form of traveling to Capitol Hill,

hosting lab tours, writing opinion pieces in their local papers, and more — share the value of our field to those who fund so much of our work. Alongside other organizations, SfN celebrated the 5th anniversary of the BRAIN Initiative, which has supported transformative science by our colleagues in tandem with large neuroscience initiatives around the globe.

50 YEARS AND 50 MORE

SfN is a remarkable society because of the dedication of countless volunteer leaders, SfN staff, and our donors. In my year as president, I have had the great honor to help guide our organization's efforts in 2019 and I am enormously grateful to work with so many amazing scientists who are giving back to the SfN community. We are members of a 50-year young Society that values a culture of openness, quality, and fairness. These values should not be taken for granted, they require the participation of you all to serve the community — visit a student's poster, become a committee volunteer, present at a virtual conference, contribute to Neuronline, share your love of neuroscience with students and your community, advocate for neuroscience at the national or local level of government, or be a mentor. It took the collective contributions of many individuals to bring our Society to the threshold of success, and it will take even more to maintain the openness, quality, and fairness to remain current and significant. I hope you will contribute.



Diane Lipscombe, SfN President

SfN Kicks Off 50th Anniversary Celebration with Series of Special Activities

In 2019, the Society for Neuroscience (SfN) celebrates its 50th anniversary, and a variety of special activities are being planned to recognize this milestone during the annual meeting and the months to come in 2020. The anniversary represents a golden opportunity to reflect on half a century of neuroscience and the efforts of the Society and its volunteers in supporting the field.

THEN AND NOW

SfN has grown significantly since its founding in 1969 (see sidebar). The Society now represents more than 37,000 neuroscientists from 80+ countries around the world. According to the History of SfN, the first annual meeting in 1971 gathered 1,395 attendees in Washington, D.C. Today, Neuroscience 2019 is expected to draw close to 30,000 attendees to discuss more than 14,000 abstracts, representing the largest gathering of neuroscientists at one of the world's largest annual scientific meetings.

As its membership has grown, so have the Society's efforts to pursue its mission. SfN has long advocated for neuroscience funding by engaging policymakers in discussions around new discoveries and emerging opportunities in neuroscience research and their implications for societal benefit and continued scientific progress. As many of these new advancements and emerging opportunities rely on the ethical use of animals in research, SfN is committed to informing policymakers and the public of the value and necessity of this work, while simultaneously pushing back against misconceptions about animal research.

An expansion of the Society's goal to advance the field came in 1981 with the founding of *The Journal of Neuroscience*. *JNeurosci* reflected SfN's membership in that it accepted manuscripts from a broad array of disciplines, helping to integrate the diverse field under the "neuroscience" umbrella. In 2014, SfN launched the open-access journal *eNeuro* as a continuation of SfN's commitment to serving the field.

SfN's mission pillar to support the neuroscience community has expanded into a number of programs over the Society's history, serving different segments of the community. The Neuroscience Scholars Program (NSP) originated in 1981 as an annual meeting travel grant for trainees underrepresented in science. Funded through a grant from the National Institute of Neurological Disorders and Stroke (NINDS), NSP has since expanded into a two-year, award-winning training program. More broadly, the Trainee Professional Development Award (TPDA) has become a significant initiative supporting trainees in attending the annual meeting to present and network, with more than 200 young neuroscientists attending Neuroscience 2019 through the program. Additionally, the Increasing

Women in Neuroscience initiative, originally funded under a grant from NSF, focuses on developing resources for individuals and institutions to recruit and retain women, minorities, and young investigators. SfN has grown its investment in scientific training and professional development programming, much of which can be found on Neuronline, the Society's digital learning and discussion website, launched in 2015. Neuronline offers content members can access on demand from anywhere in the world, on any device.

Educating the public has evolved alongside the changing preferences for content. The Society first hired a science writer in 1989 to produce the first *Brain Facts* book, a scientifically accurate educational booklet focused on brain and nervous system anatomy for students, journalists, and the brain-curious public. The publication has since received regular updates in print, alongside newer digital and audio formats. Adapting to the online age, *BrainFacts.org* launched in 2012 to provide a constant stream of neuroscience content to the world.

A GOLDEN YEAR OF CELEBRATIONS

As SfN kicks off its 50th anniversary year at the 2019 annual meeting with a series of celebratory events and activities, the organization is inviting its members to both recognize all that they have achieved together over the last half century and look forward to the opportunities that lay ahead.

50TH ANNIVERSARY HIGHLIGHTED

► Content will be coordinated and created for sharing across the Society's platforms including SfN.org; Neuronline, *BrainFacts.org*, SfN's social media channels, and included in *JNeurosci* and *eNeuro*.

► A limited-run podcast series will launch in fall 2019 to tell some of the stories of SfN's 50 years.

► Past, present, future of the field sessions will be hosted at Neuroscience 2019 and Neuroscience 2020 along with a Professional Development Workshop at Neuroscience 2019 focused on how the field has changed over the past 50 years.

► A second History of SfN essay describing the Society's 1995-2019 milestones will be published. When combined with the first historical essay covering SfN's 1969-1995 creation and growth, they chronicle the Society's first 50 years.

► An interactive digital art experience that will highlight the beauty and wonders of the brain will take place at Neuroscience 2020.

► Ongoing special advocacy activities will engage more members with science policy and outreach to lawmakers in their communities.

► A Chapter public engagement interactive challenge invited chapters to create videos on a neuroscience concept and the winner will be announced at Neuroscience 2019.

As the members of SfN celebrate this milestone with these activities, events, and more, it is an opportunity to honor the achievements of their Society, reflect on how far the broad field has come, and to look ahead to the next 50 years of neuroscience progress with excitement.

FOUNDING AN INTER-DISCIPLINARY SOCIETY

The Society for Neuroscience was formally created on July 11, 1969, at the National Academy of Sciences (NAS) building in Washington, D.C. The first acting Board of Directors of the Society consisted of 11 individuals, according to the SfN Articles of Incorporation:

John M. Brookhart, University of Oregon Medical School

Robert W. Doty, University of Rochester

Ralph W. Gerard, University of California, Irvine

Louise H. Marshall, National Academy of Science-National Research Council

Neal E. Miller, Rockefeller University

Edward R. Perl, University of Utah College of Medicine

Alfred Pope, McLean Hospital

Vernon Rowland, Case Western Reserve University School of Medicine

James M. Sprague, University of Pennsylvania Medical School

Robert L. Thompson, Hunter College

John E. Wilson, University of North Carolina School of Medicine

The name "Society for Neuroscience" was consciously chosen in order to define "neuroscience" in the broadest possible terms as a unified field, encouraging interdisciplinary approaches to studying the brain — or as SfN Past President Vernon Mountcastle described in his opening remarks at the first SfN annual meeting in 1971, "what makes Man human."

MARKING A 50 YEAR MILESTONE

To celebrate the 50th anniversary of the Society's founding and the 50th annual meeting in 2020, SfN's Council formed a working group of volunteers devoted to reflecting on and reaffirming the mission of the Society. The working group consists of a diverse, international group of members that reflect the Society's membership today:

Magda Giordano, Universidad Nacional Autonoma de Mexico (co-chair)

Larry Swanson, University of Southern California (co-chair)

Bernice Grafstein, Weill Cornell Medicine

Yevgenia Kozorovitskiy, Northwestern University

Alexxai Kravitz, National Institute of Diabetes and Digestive and Kidney Diseases

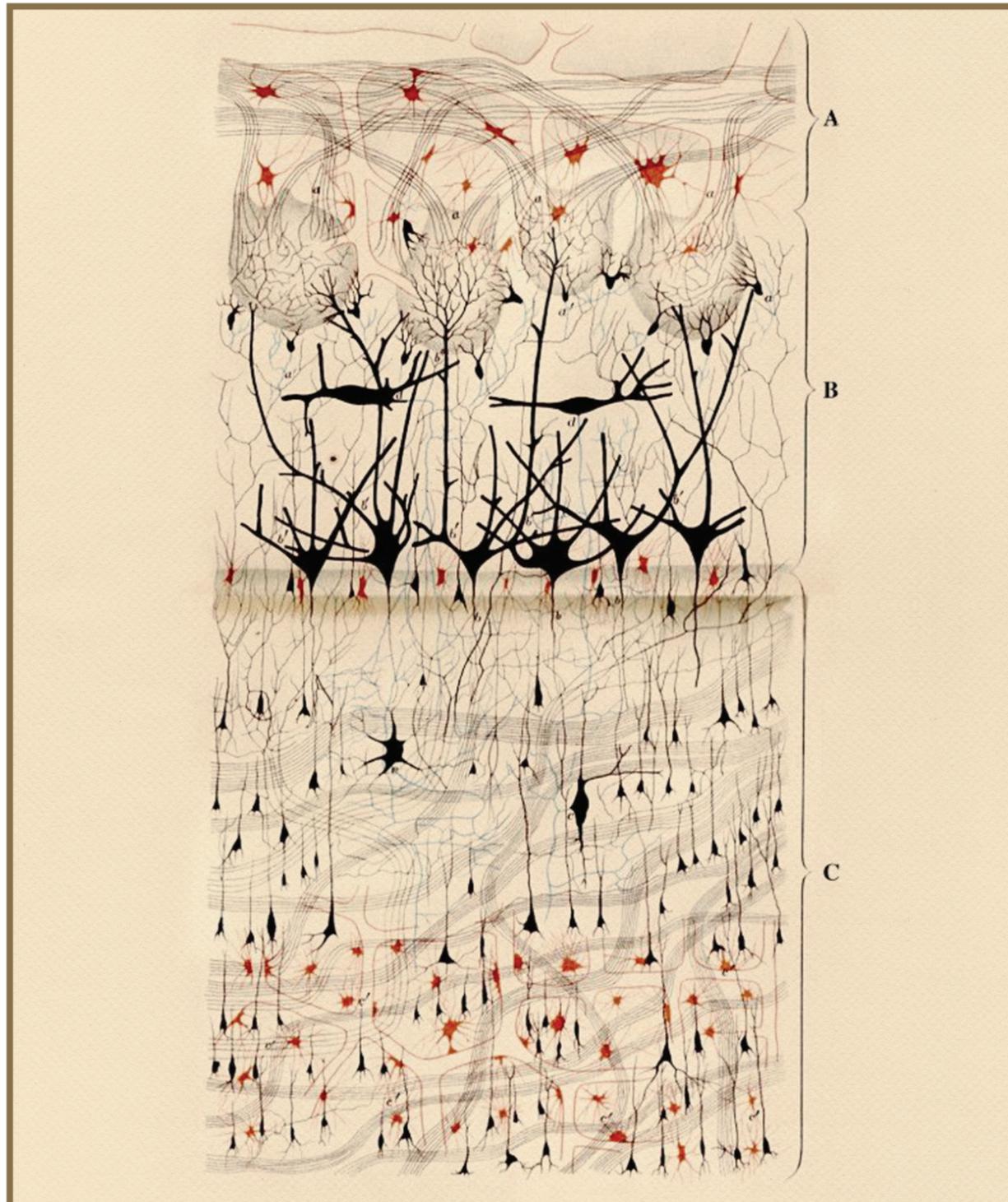
Brian MacVicar, University of British Columbia

Gordon Shepherd, Yale University

The working group encouraged all SfN committees to develop special initiatives that collectively offer perspective on the past, present, and future of neuroscience and the Society (see main text). The initiatives include highlighting scientific advances, celebrating the increasingly global and demographically diverse nature of neuroscience, and enticing the next generation of researchers to the field.

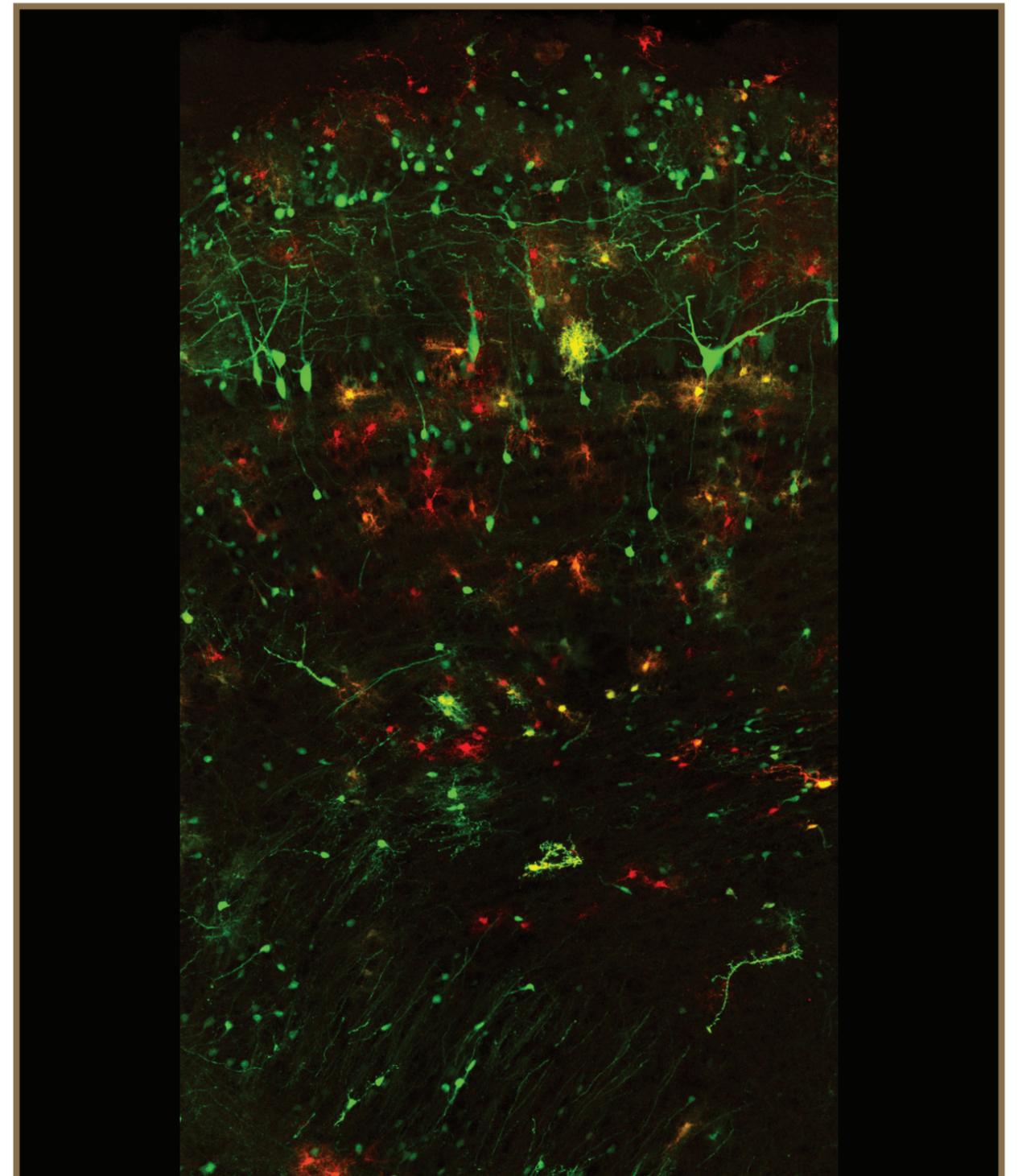
“I think how the modern period of scientific research, whose developments I have had the good fortune to witness, has really enlarged, in a surprising way, our knowledge of the organization of the nervous system...”

CAMILLO GOLGI | 1906
Nobel Lecture



Hand drawn image by Camillo Golgi of a dog's olfactory bulb.

1875



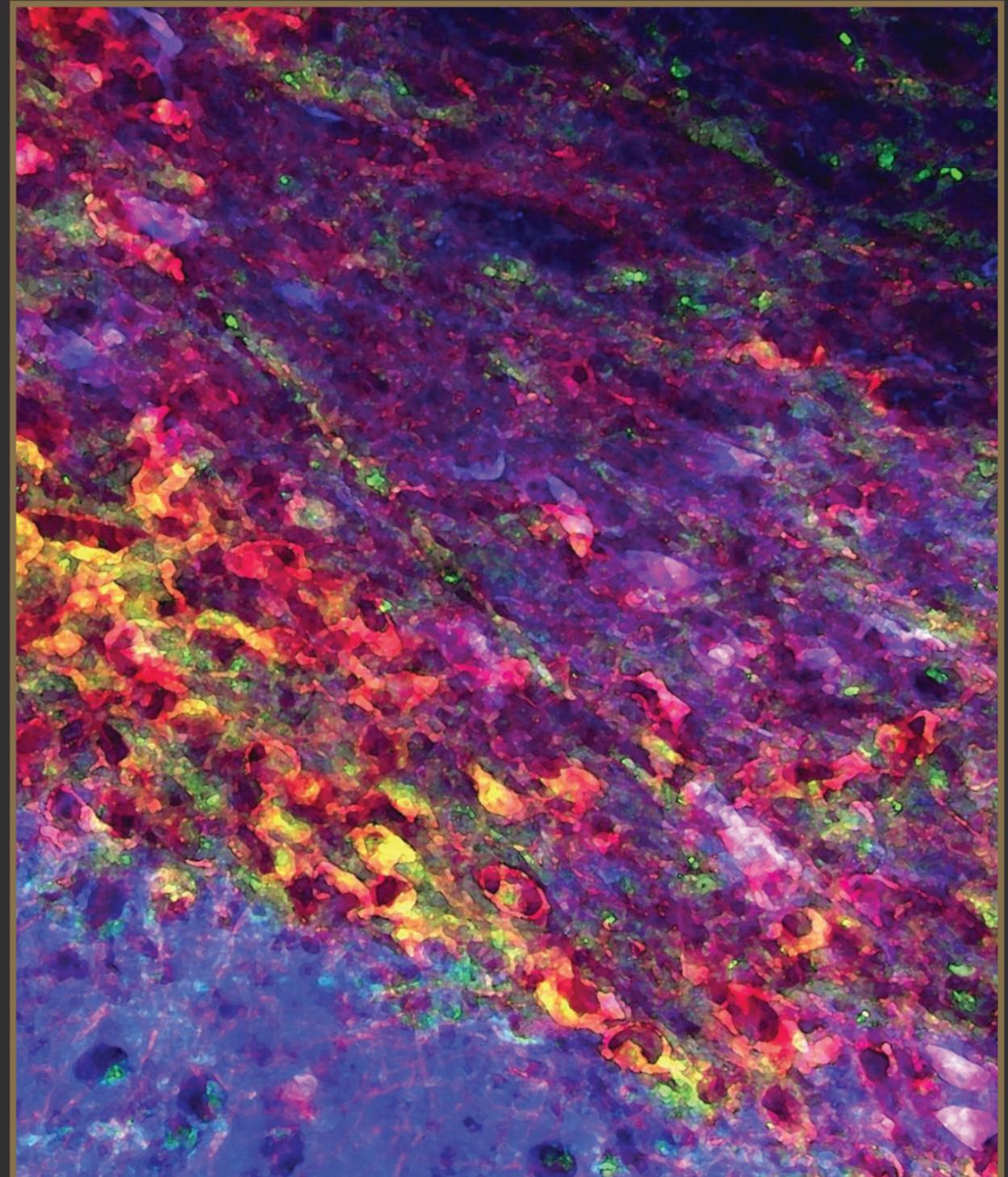
Olfactory bulb of adult mouse brain cells. Mitral cells and interneurons are labeled in green. Groups of glial cell are labeled in red.

2017

OLFACTORY BULB

1875 / 2017

sfN | CELEBRATING 50 YEARS



Immunostaining of dopaminergic neurons, which are known to be at most risk of death in Parkinson's disease. The image was processed to provide a watercolor effect.

2006

Neuroscience 2018 Shares Diverse Perspectives, Provides for Dynamic Needs

“This is where I find ideas, where I start conversations, where I see which direction my science is going.”

SERGIO I. VALDES-FERRER,
assistant professor, Instituto Nacional de
Ciencias Médicas y Nutrición, Mexico

Neuroscience 2018 brought together 28,691 attendees from 73 countries in San Diego, to once again create the largest gathering of neuroscientists in the world. Like the densely clustered neurons of the human brain, attendees reached out to form connections with those around them, strengthening their individual careers through contact with world-renowned researchers, new scientific knowledge, and the inspiration waiting to be found in and around the convention center.

As the methods of neuroscience continue to evolve in the 21st century, so has the Society’s annual meeting. Neuroscience 2018 featured new formats and the reimagining of familiar sessions. In addition to programming, the annual meeting continues to find ways to open its doors to increasingly diverse attendees with different needs.

NEW SESSIONS DRAW CROWDS

A new perspectives-sharing session made its debut to a standing-room only crowd at Neuroscience 2018 — Dual Perspectives. The Program Committee’s Innovative Learning Working Group modeled the Dual Perspectives session after the feature in *JNeurosci*. The format featured two researchers representing different views for a respectful one-hour discussion. The overwhelmingly positive response

to Dual Perspectives ensured that the session will return to Neuroscience 2019.

Bringing new energy to a longstanding tradition, SfN-Sponsored Socials shifted to a submission-based system similar to the selection of symposia and minisymposia. Giving members the ability to propose social ideas resulted in popular new gatherings such as “Breaking Barriers for Young Women in Science,” which created a space for up-and-coming female scientists to interact with mentors in a relaxed environment. The Storytelling Session, which debuted at Neuroscience 2017 and enjoyed large crowds for its second year, also shifted to accepting member proposals for the 2019 annual meeting to provide members a greater ability to suggest the programming they wish to experience.

“What draws me to the SfN meeting is the fact that I am able to learn so much from people around here.”

MUSTAFA MITHAIWALA, doctoral candidate,
University of Texas Health San Antonio



To support attendees with young children, Neuroscience 2018 offered enhanced infant care resources.

With the annual meeting continuing to evolve, SfN’s 50th anniversary (page six) offers an opportunity for members to reflect on the changing nature of neuroscience. Several sessions at Neuroscience 2019 will be structured to look at the past, present, and future of specific areas of interest in the field.

DRIVING ACCESSIBILITY FOR DYNAMIC MEMBER NEEDS

As the largest gathering of neuroscientists in the world, SfN takes seriously its responsibility to ensure that the annual meeting is accessible to all neuroscientists. In response to more restrictive travel visa policies in the U.S. and elsewhere, some SfN members were unable to attend Neuroscience 2018 to share their science with peers. In order to better serve members, in 2019 SfN’s Program Committee launched the Science Knows No Borders program with the support of SfN Council. The initiative will enable Neuroscience 2019 presenters facing

visa or travel restrictions to share their science. Program participants provide their poster or pre-recorded nanosymposium, symposium, or minisymposium presentations to SfN prior to the annual meeting and assistance will be provided on-site by attendee volunteers. Poster presenters are encouraged to host online chats during their presentation and symposia time. While the Science Knows No Borders program cannot replace the experience of attending the annual meeting in person, it reflects the neuroscience community’s commitment to supporting the needs of colleagues worldwide.

New action by Council in 2018 through the Trainee Professional Development Award (TPDA) offered an expanded avenue of support for trainees interested in attending the annual meeting. Council matched \$30,170 in individual donations given to the Friends of SfN Fund in support of the TPDA program, along

with an additional \$55,000 that matched gifts of \$25,000 or more from private foundations and corporate contributors. Council also provided \$100,000 in direct support. Because of the generosity of the neuroscience community, 261 trainees from 22 countries received awards and benefited from funds that helped them travel to Neuroscience 2018. Building on this momentum, FY 2019 includes the creation of a year-round Leadership Development Program, co-funded by the Dana Foundation, where 15 high-performing TPDA recipients will receive additional training in leadership, strategic thinking, and more to help position them for success. The inaugural class will meet for the first time at Neuroscience 2019.

Neuroscience 2018 included other expanded accessibility efforts. In response to the needs of neuroscientists with young families, SfN communicated with the convention centers in San Diego,

Chicago, and Washington, D.C., to encourage their facilities to either create or expand spaces for infant care. SfN enhanced its own Neuroscience 2018 infant care space to offer both new and improved resources. These offerings complement the childcare program that has been offered for many years with the goal of making the annual meeting experience more supportive for attendees with young children.

On-site scooter rentals, providing immediate mobility enhancement for members in need, were again offered after an enthusiastic reception in 2017.

The mobile app also provided increased accessibility options via two new features guided by SfN's Neuroscience Meeting Software Test Group. First, a recommendations tool presented session suggestions to those who created an itinerary and performed searches in the app. Second, the "contact" feature allowed attendees to create a personal profile. Attendees could then connect

and swap profile information with others, much like a digital business card. These new app-based resources aid attendees in deriving more value from their time at the annual meeting.

Adapting to the evolving use of technology, Council has adopted a new policy, recommended by the Program Committee, regarding the use of photography and recording devices during SfN meetings. Developed in FY 2019 to be implemented at Neuroscience 2019, presenters and exhibitors can indicate whether they agree to their materials being photographed or recorded under a Creative Commons license by displaying graphics with a red (no recording) or green (recording allowed) camera icon.

MAJOR PRESS COVER NEUROSCIENCE 2018

Every year, the SfN annual meeting offers the first glimpse of cutting-edge science to the world, guaranteeing coverage by the media. The press

program, directed by the Public Education and Communication Committee and aimed at generating news coverage of abstracts submitted to the annual meeting, created 11 press conferences and a Hot Topics book consisting of roughly 100 newsworthy abstracts. Through these efforts, Neuroscience 2018 attracted 207 registered journalists from 13 countries, produced more than 150 original English-language stories, and earned 1,229 news hits and mentions from across the globe. Articles appeared in high-profile media outlets including *NPR*, *MSN*, *The Washington Post*, *Forbes*, *Daily Mail*, and *The San Diego Union-Tribune*. Respected scientific publications such as *Nature*, *Scientific American*, *Popular Science*, and *Science* also published articles with science presented at the meeting.

New SfN-Sponsored Socials created opportunities for trainees to meet and learn from established neuroscientists.





Nearly 30,000 attendees connected at Neuroscience 2018, exchanging ideas, insights, and inspiration to channel their science and careers across new frontiers.

2018

SAN DIEGO
CA

Neuroscience 2018

By the Numbers

NOVEMBER 3-7
2018

13,884

ABSTRACT
PRESENTATIONS

795

SCIENTIFIC SESSIONS

28,691

ATTENDEES

from
73 COUNTRIES

25,808

MOBILE APP
DOWNLOADS

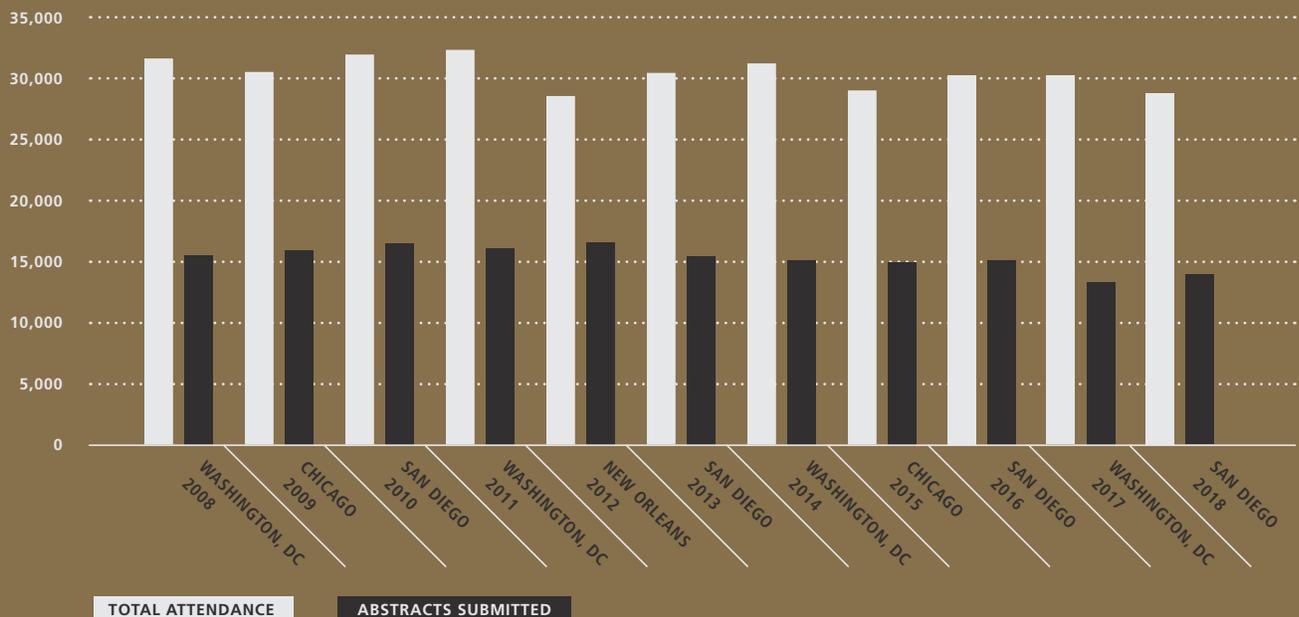
536

EXHIBITORS

PERCENT OF ABSTRACT SUBMISSIONS in EACH THEME

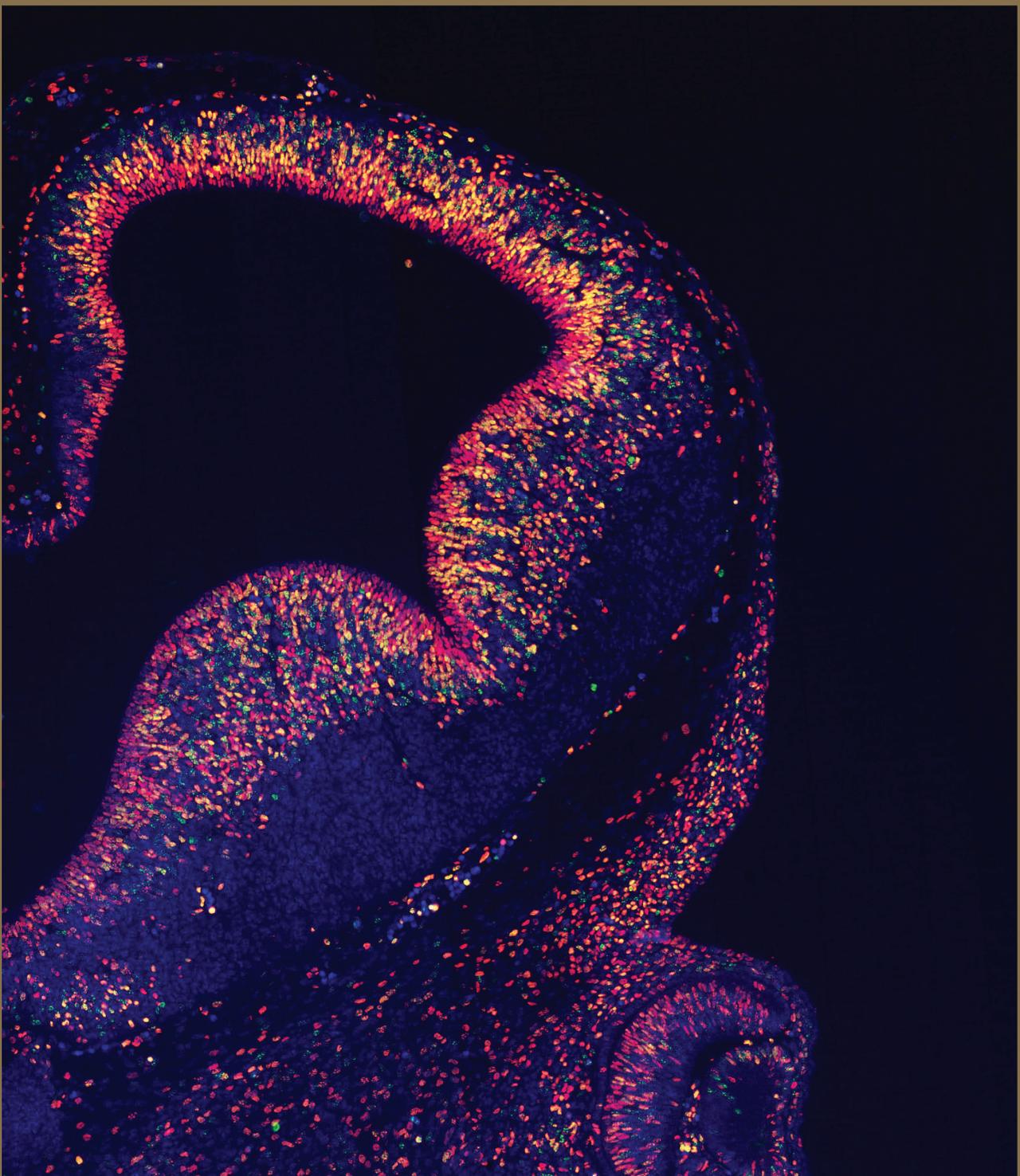
THEME A: Development 9%
THEME B: Neural Excitability, Synapses, and Glia 11%
THEME C: Neurodegenerative Disorders and Injury 20%
THEME D: Sensory Systems 11%
THEME E: Motor Systems 8%

THEME F: Integrative Physiology and Behavior 8%
THEME G: Motivation and Emotion 10%
THEME H: Cognition 16%
THEME I: Techniques 7%
THEME J: History and Education 1%



TOTAL ATTENDANCE

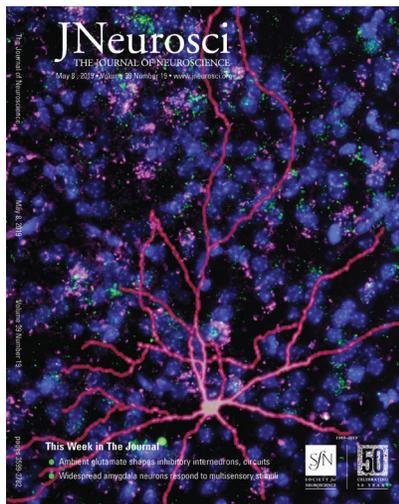
ABSTRACTS SUBMITTED



A mouse embryo forebrain on day 11 of development. Nuclei labeled green are daughter cells produced by cell division of neural progenitor cells. Other nuclei are labeled red; double-labeled nuclei are yellow.

2016

Shaping the Field



The cover of *JNeurosci* provides a canvas to display the beauty of cutting-edge neuroscience.

While neuroscientists network and share the latest science in-person at the annual meeting, they exchange knowledge about the brain and nervous system every day through SfN’s scientific journals. Published since 1981, *JNeurosci* is home to some of the most highly cited research in neuroscience. *eNeuro*, the leading open-access neuroscience journal, provides the community a needed venue to publish important scientific findings, such as negative results and replication studies, that might otherwise not be considered for review. Both journals publish research that readers can trust will remain reliable and relevant over time.

SUPPORTING STRONG SCIENCE

Scientific journals have historically been inclined toward novel, positive results, which has unintentionally contributed to a “reproducibility crisis” in science. One way to mitigate such publication bias is to have authors preregister their research question and methodology before conducting any experiments. *eNeuro* has joined a growing number of journals in offering Registered Reports. If the research proposal is accepted and the authors have adhered to the research plan, *eNeuro* agrees to publish their results regardless of the outcome.

In 2018, *JNeurosci* began a series of editorials addressing issues of experimental design unique to neuroscience. So far the editorial board has covered human

neuroimaging, electrophysiology, and model organism behavior.

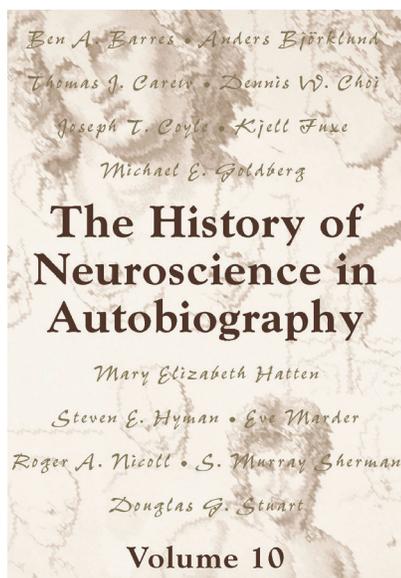
PROMOTING DIVERSITY AND INCLUSION

As authors themselves, the editorial boards of both journals represent the geographic, ethnic, and gender diversity of the field. In 2018, *JNeurosci* welcomed four new Reviewing Editors: Jonas Obleser, Hans Op de Beeck, Daniela Schiller, and Kevin Staley. Senior Editors Jeff Diamond and Jay Gottfried also joined the *JNeurosci* Editorial Board. *eNeuro* added Reviewing Editors Julie Bakker, Yavin Shaham, and Katalin Toth; Sabine Kastner was added to the *eNeuro* Advisory Board.

As part of its commitment to early-career researchers, SfN’s Reviewer

“eNeuro is the first journal that I ever published in. They accepted my first project that I did as a graduate student. So, thank you eNeuro — you started my career.”

JAIME WILLET, graduate student, North Carolina State University



The 10th volume of The History of Neuroscience in Autobiography details the lives and discoveries of eminent neuroscientists, including Ben A. Barres, Steven E. Hyman, and Eve Marder.

Mentor Program has paired more than 50 trainees with volunteers from both journals' editorial boards. Through these partnerships, trainees practice reviewing preprints on bioRxiv and learn from editors how to thoroughly and constructively evaluate a peer's manuscript. Following successful completion of the program, participants are included in a reviewer pool from which *eNeuro* editors are encouraged to draw.

ACCELERATING PUBLICATION

Both *JNeurosci* and *eNeuro* publish new research as quickly as possible by making articles available prior to formatting and copyediting. Publishing these “early release” articles means new, citable findings are delivered quickly to the community. In 2018, the median time to first decision was 31 days for *JNeurosci* and 27 days for *eNeuro*.

eNeuro has published more than 1,000 papers in just five years. Submissions to *eNeuro* continue to rise each year, increasing by nine percent in 2018 to a total of 471 submissions.

JNeurosci accepted 29 percent of research manuscript submissions in FY 2019. In response to the needs of authors, *JNeurosci* has taken decisive steps to simplify and streamline the submission process.

“Aside from the fact that a lot of really interesting work is published in *JN*, we all need to support a journal that is run by scientists, rather than by companies,” said George Augustine of Nanyang Technological University.

INCREASING READERSHIP

SfN's journals are read by a global audience of neuroscientists from more than 200 countries and territories. *eNeuro*'s readership has grown rapidly since launching in 2014, increasing by 50 percent in the last year. *JNeurosci*'s established online readership also continues to grow, increasing by seven percent in 2018.

Twitter has become an important channel for the scientific community to discover research, and SfN helps to promote research through this venue by tweeting about every article published in both journals. The @SfNJournals Twitter account is followed by more than 6,000 scientists and members of the media and acquired nearly 1,800 new followers in FY 2019. SfN sent 1,300 tweets from this channel, which were retweeted close to 4,000 times and liked 6,600 times, increasing readership and the impact of the manuscripts — and authors — published in the journals.

eNeuro's custom electronic Table of Contents, which is emailed biweekly to both SfN members and authors, has effectively referred 12 percent of the traffic to *eNeuro* in 2018, an increase of seven percent from the previous year.

DISSEMINATING RESEARCH TO THE FIELD AND THE PUBLIC

To promote important advances in neuroscience and ensure wider exposure of articles among the science-interested public, SfN alerts a growing list of science reporters and communications staff at authors'

institutions of new research coming out in *JNeurosci* and *eNeuro*. In turn, the media and public information officers disseminate research to the public. SfN issued more than 100 research summaries to the media in FY 2019, while public information officers issued more than 60 additional press releases further promoting the work of their students and faculty.

In addition to press promotion, SfN uses its communications channels to share research with the scientific community. Neuronline, SfN's digital learning and discussion website, invites *JNeurosci* and *eNeuro* authors to write a broad summary of their recent article for SfN's membership. With its August 2018 relaunch, SfN.org spotlights recently published research in SfN's journals on the homepage, which is regularly updated each week. In October 2018, *eNeuro* launched a blog to highlight research, promote discussion about peer review and publishing practices, and facilitate an open dialogue between Editor-in-

Chief Christophe Bernard and the author community. The *eNeuro* blog complements the journal by publishing a variety of content types, including Editor's Picks, Reader's Picks, Featured Findings, and Beyond the Paper.

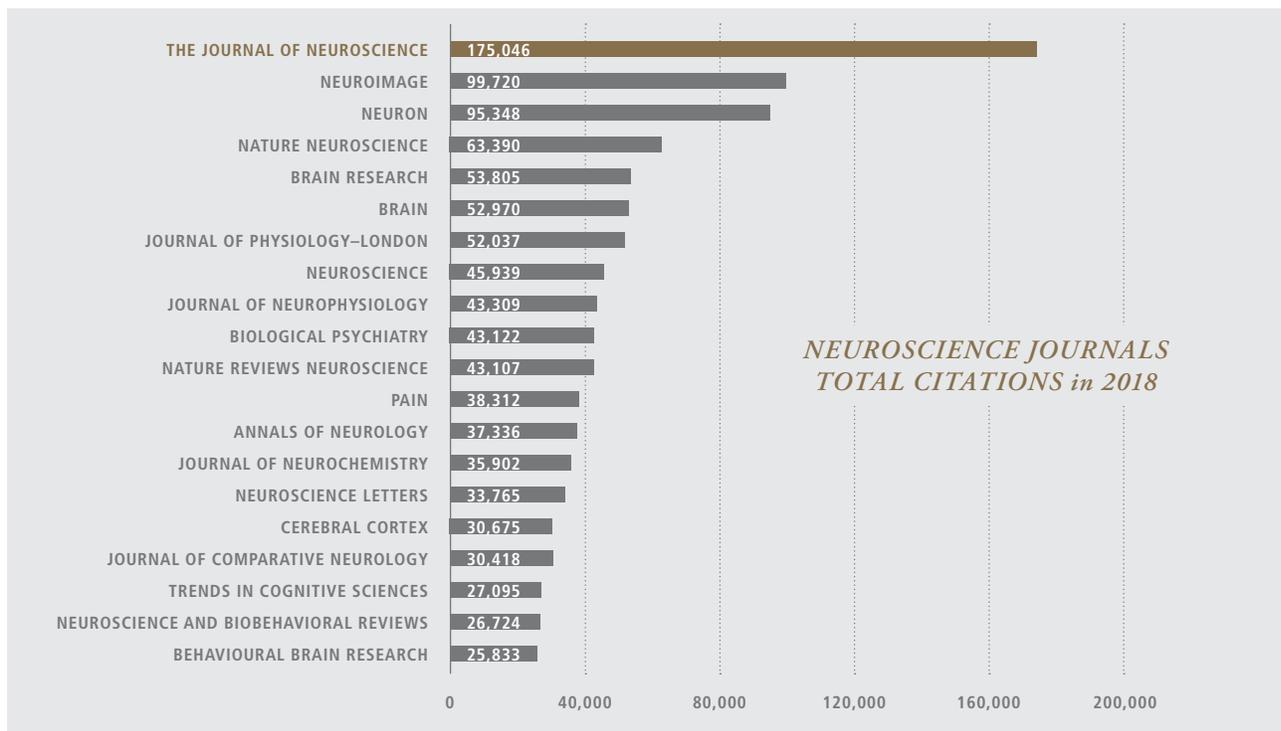
Stemming from an SfN Council strategic opportunity investment, planning for a new SfN-produced podcast series began in FY 2019. The podcasts will feature discussions about research in both journals, highlighting content being published in both *JNeurosci* and *eNeuro* through in-depth interviews with authors, with the goal of expanding into the stories behind the research.

SfN helps readers navigate the ever-growing neuroscience literature by curating lists of recommended articles through new "featured research" pages, the scholarly recommendation engine TrendMD, the all-member digital publications *Nexus* and *Neuroscience Quarterly*, and e-Alerts. All of these efforts refer readers directly to journal

articles. SfN will continue to leverage new ways to publish, read, and share research.

LOOKING FORWARD: THE NEXT 50 YEARS

Neuroscience has come a long way since the Society was founded in 1969. Reflecting on this progress in the Neuroscience 2018 issue of *JNeurosci*, Douglas Fields writes: "The challenge of understanding the brain, mind, behavior, and dysfunction cannot be met without bringing to bear the full arsenal of scientific power and technology in an attempt to comprehend it, from mathematics to psychology." Like the SfN annual meeting, SfN's scientific journals bring together scientists of diverse backgrounds around a common scientific mission to continually advance our understanding of the brain and nervous system.



SCIENCE *in* PROGRESS

Giving Name to an Unruly Brain Syndrome

It's estimated that one percent of all intellectual disability not explained by a known syndrome is caused by these mutations.

RICHARD HUGANIR, SfN president

MOST INFANTS FUSS and cry when they get sick, but Landen showed little sign of pain. Instead, when illness struck, Landen simply slowed down a bit.

"By the time I connected the dots and realized he was sleeping 15 minutes longer," his mother Lisa says, "he'd have bilateral ear infections."

In addition to his insensitivity to discomfort, Landen gets seizures, has an autism diagnosis, and at 12 years old knows about 100 words.

When he was born in 2006, Landen's disorder had no name — just a constellation of symptoms that Lisa and her husband managed the best they could. It took genome sequencing in 2015 to match his condition to a recently discovered syndrome. Because of a small mutation in a gene called SYNGAP1—possibly a single additional letter in the DNA code — Landen's brain cannot make enough of a protein that both keeps neural wiring in check as we grow and promotes learning and memory in adults.

As it turns out, Landen is not alone. Researchers now know of hundreds of children like him thanks to an

online organization of affected families. "It's estimated that one percent of all intellectual disability not explained by a known syndrome is caused by these mutations," says SfN Past President Richard Haganir, a neuroscientist at John Hopkins University and co-discoverer of the gene-protein duo. "That's lots and lots of kids."

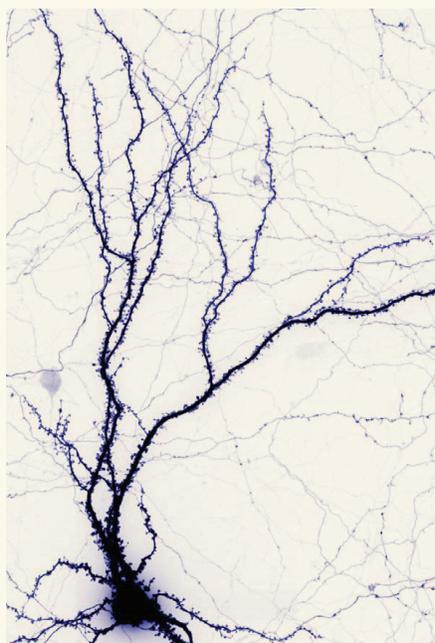
And as result, neuroscientists like Haganir — who began their careers studying basic brain function — find themselves thrust toward the front lines of clinical research, turning neuroscience theory toward the search for treatments, and perhaps even cures.

Mutations in the SYNGAP1 gene occur randomly in sperm or eggs, leaving developing brains with half the amount of a crucial protein it needs for normal development. This protein, termed the SYNGAP1 protein, stops neurons from sprouting too many connections. Without enough of this protein, young brains grow wild and unruly. Their brain circuits become extra sensitive to stimulus, impeding learning by failing to extract much useful information about the world. These overly connected brains are

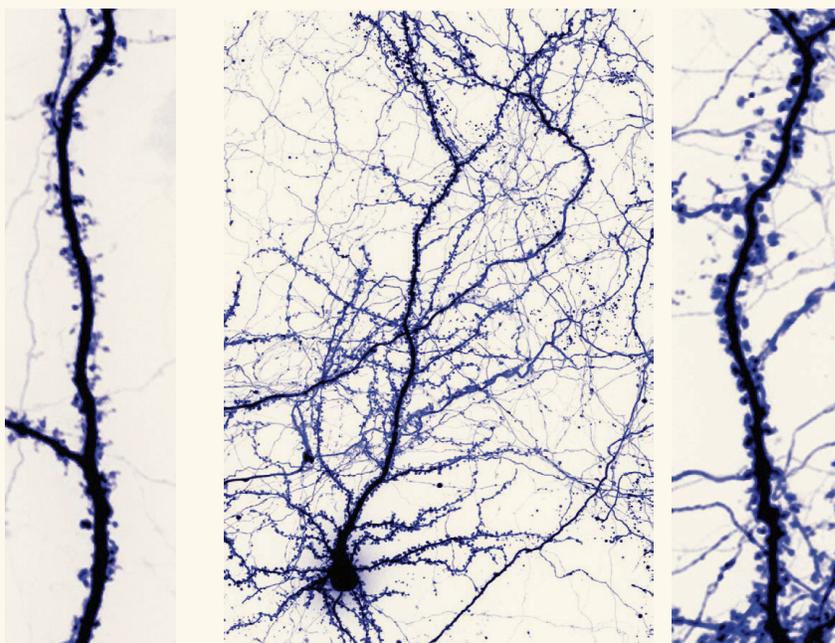
prone to epilepsy and a host of other symptoms.

Yet, how SYNGAP1 gene mutations affect specific circuits remains an active area of inquiry, says Gavin Rumbaugh, a neuroscientist at Scripps Research who has worked with Hagan. Rumbaugh's research suggests the condition mutes rather than intensifies the response of sensory circuits such as touch. If that were true, it could explain why Landen doesn't outwardly show distress. In fact, Rumbaugh speculates that intellectual disability may arise from a distortion of sensory information. "They may not experience the world in the same way as neurotypical children," he says.

The story of SYNGAP1 began with Hagan and Caltech neuroscientist Mary Kennedy independently discovering the SYNGAP1 gene and protein in 1998 while trying to work out how the brain develops during infancy and how it processes information in adults. About a decade later, their work leapt from lab to clinic when a genetic analysis of three individuals linked their intellectual disability with mutations in their SYNGAP1 gene. At that moment, Rumbaugh decided to take his recently formed neuroscience lab in a more clinical direction. "That day I said, 'let's model this in mice and try to understand what happens to brain development when you lose one copy of SYNGAP1,'" he recalls.



NORMAL NEURONS



SYNGAP MUTATION NEURONS

Images above show normal neurons (left) and the enlarged dendritic spine of neurons with SYNGAP1 mutations.



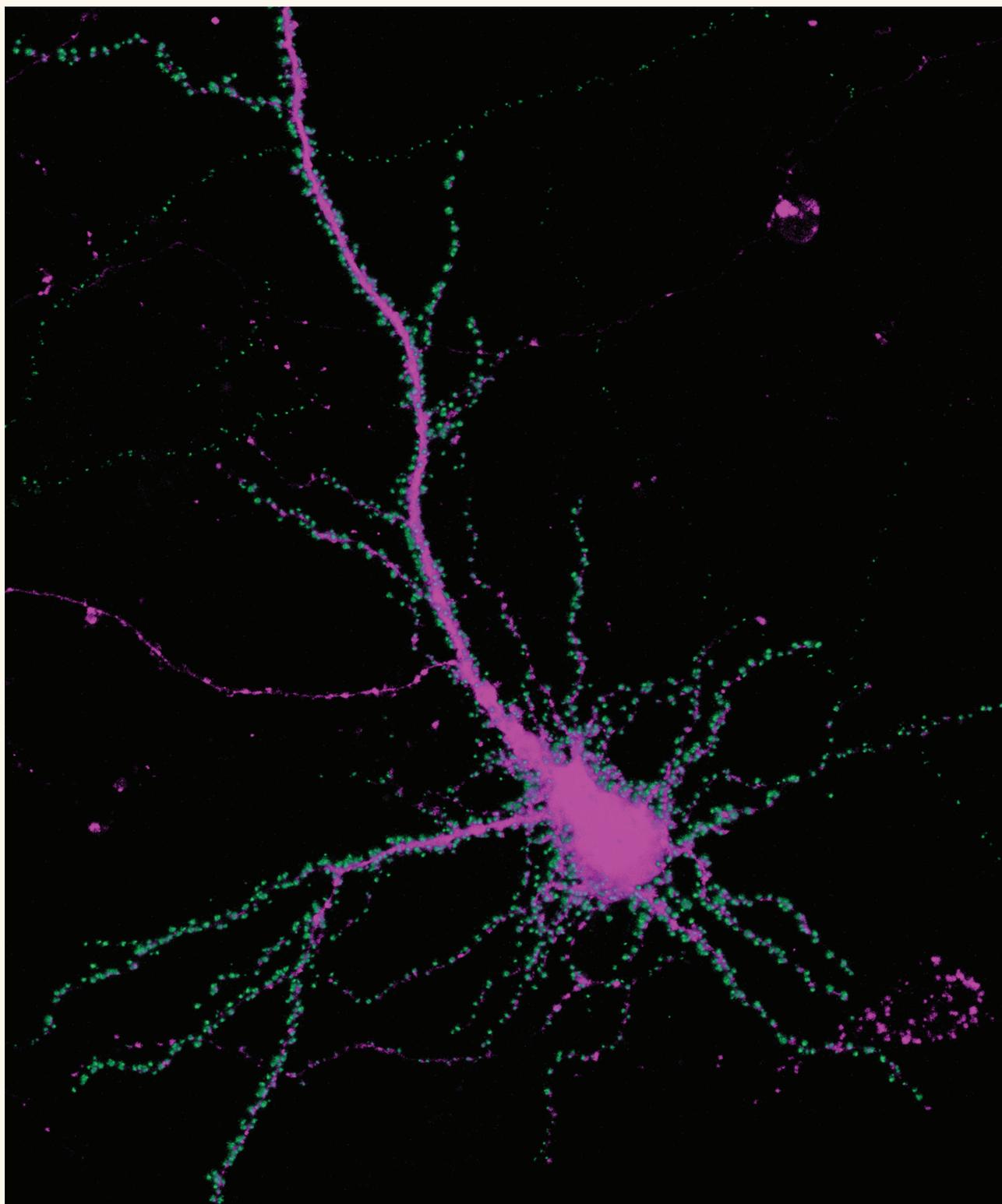
The SYNGAP1 Family Meet Up at Johns Hopkins University gathered patients and families living with the syndrome with researchers, including Richard Haganir (far left).

From the patient side, increased accessibility to genetic sequencing gave families a name for their children's disorders but little else. One parent, Monica Weldon, grew a Facebook group into Bridge the Gap, a foundation that keeps families updated on research and maintains a patient registry to connect SYNGAP1 children with researchers. The database, where parents log symptoms and other information, helps researchers connect dots that would otherwise be hard to see from the relatively small number of published case studies. Database reports of children like Landen not responding to pain, for instance, inspired Rumbaugh to investigate sensory circuits.

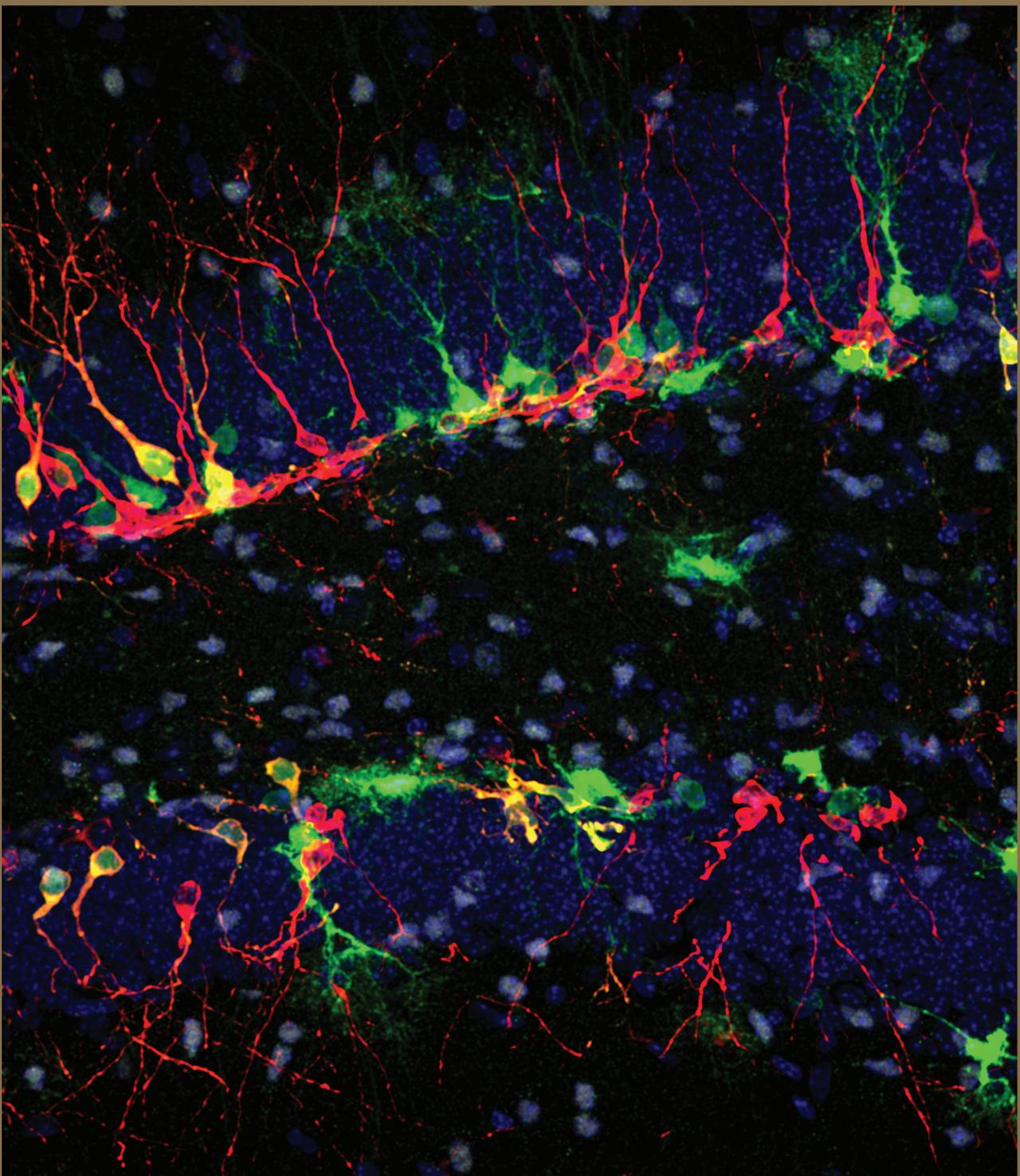
Recently Rumbaugh and Haganir have taken complementary approaches to improving the lives of people with SYNGAP1 gene mutations. Rumbaugh seeks a drug that will restore normal levels of the SYNGAP1 protein. Such a treatment could help infants with SYNGAP1 mutations develop more normal neural wiring, and recent research in mice suggests that boosting the SYNGAP1 protein could also decrease seizure rates in older children and adults.

Haganir is looking at ways to curb the activity of a protein group called RAS. SYNGAP1 gene mutations activate RAS proteins. Inhibiting the activity of RAS proteins could stop neurons from getting so overdeveloped. Unpublished work and two case studies suggest that the statin drugs used to lower cholesterol may interfere with RAS activity and diminish the havoc cause by SYNGAP1 gene mutations. Haganir is also looking at ways to restore normal SYNGAP1 protein expression.

Longer term, Haganir hopes gene editing tools will mature to the point where they can correct the genetic typo from the very beginning, sidestepping the need to fiddle with proteins in developing brains. "Those are approaches that lots of people are thinking about," he says, "and probably will be viable in the next five to ten years."



Researchers can track the movement of the protein SYNGAP1 (green) within brain cells.



An adult mouse hippocampus with neurogenesis markers. Radial glia-like neural stem cells and their progenies are labeled green. Adult-born neurons and neural stem cells/neural progenitors are stained red and white, respectively. Nuclei are labeled blue.

2018

SUPPORTING THE
NEUROSCIENCE
COMMUNITY

Year-round Global Initiatives

“The optogenetic virtual conference was very good because I could gather everyone in our lab to watch the presentation.”

ALEXANDRE MAGNO, postdoctoral fellow,
Federal University of Minas Gerais, Brazil

Serving more than 37,000 neuroscientists around the globe, SfN offers programs to strengthen the neuroscience community all year. Alongside SfN-created programming, the Society partners with a variety of organizations to extend the size and scope of training and professional development opportunities available to its global membership.

DIGITAL LEARNING AND DISCUSSION

Complementing the once-a-year, in-person convening that is the SfN annual meeting, Neuronline is SfN’s year-round home for digital learning and discussion. Since launching in 2015, the website has generated over 1,000 pieces of content on topics ranging from career advice to scientific research to select sessions from annual meetings, in formats as wide-ranging as written articles and webinars. All of these resources are available to offer SfN’s global membership access to valuable programming at their convenience. An example of content unique to Neuronline, and created in celebration of SfN’s 50th anniversary (page six), is a series of video interviews with SfN past presidents; these prominent neuroscientists explore how the field of neuroscience, and its culture, has changed over the length of their careers. Alongside SfN-produced content are resources from Neuronline content partners, including

workshops organized by the Federation of European Neuroscience Societies (FENS), articles from the Neuroethics Blog, and videos by the International Neuroinformatics Coordinating Facility. In addition, the Neuronline community forums offer a platform for members to communicate directly with each other on any topic, with popular posts around finding roommates for the annual meeting and blog-style posts written by those who attended Neuroscience 2018.

With Council investment, SfN achieved its goal of hosting one virtual conference per quarter in FY 2019 on both scientific training and professional development topics important to the field. September 2018 featured “Next Generation Optogenetics — Tools and Applications,” which served as a component of SfN’s inaugural training series on optogenetics. In January 2019, the professional development virtual conference on “Mitigating Implicit Bias — Tools for the



NINDS is funding a new SfN training program to enhance scientific rigor in neuroscience.

Neuroscientist” focused on recognizing and overcoming behavioral biases in members’ labs, institutions, and wider communities. The April 2019 virtual conference, “From Behavior to Brain — The Neuroethological Way to Neuroscience” dove into novel techniques and model organisms to study how nervous systems generate natural behaviors. “Machine Learning in Neuroscience — Fundamentals and Possibilities” in June 2019 revealed the many ways machine learning and neuroscience intersect in the context of data analysis and modeling brain function. These virtual conferences allowed members and nonmembers to benefit from rich content and gain access to leading scientific experts.

As the content on Neuronline continues to grow, so has the need for new, efficient methods for members to find content they are interested in. For that reason, Council made a strategic opportunity investment to modernize the website. Neuronline relaunched

in fall 2019 with an improved look and feel, enhanced navigation, and improved search functionality.

INDIVIDUAL AND INSTITUTIONAL TRAINING RESOURCES

A new grant awarded by the National Institute of Neurological Disorders and Stroke (NINDS) was initiated in 2019 to carry on an important training program on scientific rigor. The grant-funded program, Foundations of Rigorous Neuroscience Research, is focused on the sociology of science and the cultural factors that underlie the rigor of neuroscience research. The new funding enables SfN to develop and deliver in-person workshops, a virtual conference, digital toolkits, and online programming to the world-wide neuroscience community over the next three years. Topics will include biases that can influence experimentation and interpretation; practices related to data collection, management, and sharing; and incentives that underlie career advancement and the stability

“Any sort of instruction on implicit bias in our work is important for making sure that neuroscience is a community that is open and agreeable to everyone.”

HANNAH BAUMGARTNER, graduate student, University of Michigan

of scientists’ research programs. This type of training strategy that encompasses numerous opportunities for year-round learning and exchange in various formats aligns with the vision the Neuroscience Training Committee (NTC) holds for future training strategies organized by SfN.

The support from NINDS builds on a previous three-year grant-funded program titled Training Modules to Enhance Data Reproducibility. Supported by the National Institute on Drug Abuse (NIDA), the program produced a collection of training resources, including training modules and a virtual conference, for the global neuroscience community.

A key international partnership continued in 2019 with FENS organizing a European-based training webinar on networking. The event featured European scientists and examples of networks throughout Europe. Additional FENS digital content and events are scheduled

for FY 2020. FENS members enjoy select access to Neuronline content, including FENS-organized webinars, articles, and videos.

For SfN's Institutional Program members, the NTC developed a set of Core Competencies in Neuroscience Training, specific skills undergraduate, graduate, and postdoctoral neuroscience programs should consider when developing curricula and learning outcomes. The postdoctoral fellow-focused resource built on previous work by the National Postdoctoral Association, while the Core Competency for undergraduates received input from the Faculty for Undergraduate Neuroscience. Core competencies appropriate for European training programs were also developed in cooperation with the FENS Committee on Higher Education and Training, reflecting yet another facet of SfN's strong relationship with the organization.

A FOUNDATION FOR FUTURE LEADERS

SfN widened its already broad offerings in professional development programming by launching a Leadership Development Program (LDP) in 2019. The idea for the new program, a two-year pilot, emerged from volunteer-leader recognition of the need for a year-long professional development experience for motivated trainees. Combining an investment from Council with significant core support from the Dana Foundation, the first class of 15 LDP members were selected from high-performing graduate student and postdoctoral fellow Trainee Professional Development Award (TPDA) recipients. The LDP class can look forward to in-person meetings at Neuroscience 2019 and in Washington, D.C. in February 2020, as well as year-round online programming focused on topics such as adaptive leadership, strategic thinking,

effective teamwork, and cultural competencies and inclusion.

Another area of expansion was in support of women in neuroscience. Stemming from a conversation between SfN President Diane Lipscombe and FENS President Carmen Sandi at Neuroscience 2018, SfN agreed to support the activities of a new organization called the ALBA Network. Meaning "sunrise" in several languages, this network of European neuroscientists will focus on addressing gender disparity issues. Much like SfN's Increasing Women in Neuroscience initiative, the ALBA Network looks to develop resources for individuals and neuroscience departments across Europe. As part of the celebrations surrounding SfN's 50th anniversary, the Celebrating Women in Neuroscience (CWiN) luncheon at Neuroscience 2019 will feature three of SfN's female past presidents. Together, they will share their personal stories on how the practice and culture of neuroscience has changed over their distinguished careers.

The longstanding Neuroscience Scholars Program (NSP), a two-year training program supporting underrepresented neuroscience trainees, earned special recognition in 2018 when it received a Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. The award recognizes outstanding efforts of mentors in encouraging the next generation of innovators and developing a science and engineering workforce that reflects the diverse talent of America. NSP has been funded by NIH for almost 40 years.

Representing SfN's growing ability to support international neuroscience communities, two new chapters were approved in 2018 — LX-Portugal and Macau. Enabling the new chapters' creation was the Chapters Workshop at Neuroscience 2018, which featured,

in part, an interactive roundtable discussion on how to start a chapter. The new workshop format, which helped to double the attendance of past years' workshops, will be repeated at Neuroscience 2019, where participants will have small group discussions around hosting a successful Brain Bee. This workshop will serve as the capstone of the SfN 50th Anniversary Chapter Video Challenge, where chapters competed to make the best video to answer the question, "why is brain science so important?" Videos were judged by recent Brain Bee participants, who are part of the student-run International Youth Neuroscience Association.



The new Leadership Development Program will offer a year-long experience to exceptional trainees.

SCIENCE in PROGRESS

Reversing the Course of Spinal Muscular Atrophy



Danyelle Sun and her family at the 2019 Annual SMA Conference.

“A lot of the basic science that’s needed to lead to new treatments and cures for neurological and psychiatric illnesses is paying off now.”

DIANE LIPSCOMBE, director of the Carney Institute for Brain Science at Brown University and president of the Society for Neuroscience

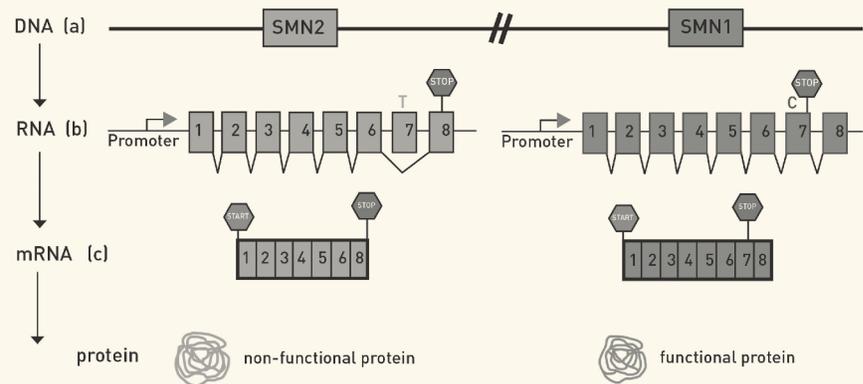
DANYELLE SUN’S daughter began walking when she was around 12 months old, but instead of growing ever more confident in her steps, she began to hesitate, falling more and more.

It took the better part of a year for doctors to identify the problem: spinal muscular atrophy (SMA). This progressive muscle wasting disease strips away mobility over time and in severe cases causes complete paralysis and even death in infancy. Sun’s daughter was diagnosed near age two, around the time the girl last walked. Sun noticed symptoms in her son at 10 months old, when he stopped pushing himself up with his legs to stand on her lap. For years, the young family was buffeted by lost abilities. “Every time you think you have a good handle on accommodations like the bathroom or their play area, they would lose another skill,” said Sun.

That pattern reversed itself after Sun’s kids began taking a new synthetic DNA drug called Spinraza (nusinersen) at ages six and three. Through regular injections, the drug is delivered directly into the cerebrospinal fluid to access the spinal cord and other nervous tissues.

Within months of the initial doses, Sun’s son regained trunk control and motor skills. “He was reaching out and giving me high-fives. I hadn’t seen that since he was nine months old,” said Sun. Her daughter, who started treatment at age six, gets less fatigued and can now independently use the restroom at school. “Anything that lets them do things like everyone else is a miracle,” says Sun. “We’d do anything for that.”

Spinraza was approved by the U.S. Food and Drug Administration (FDA) in December 2016. Over recent decades, there have been few new drugs for patients with nervous



The difference of a single nucleotide — or letter in the genetic code — is what separates the fully functional SMN1 gene from the less functional SMN2 gene. SMA results from mutations in the SMN1 gene.

system disorders, but optimism is growing that a greater understanding of the genetics behind neurological diseases and improved gene-based technology will change that.

“A lot of the basic science that’s needed to lead to new treatments and cures for neurological and psychiatric illnesses is paying off now,” said Diane Lipscombe, director of the Carney Institute for Brain Science at Brown University and president of the Society for Neuroscience.

Around 1 in 10,000 infants are born with SMA. The range of disability and life expectancy vary by genetics and access to care. Before Spinraza, no treatment stopped the inexorable loss of muscle strength in patients. Care options included walkers and wheelchairs, breathing machines, and spinal fusions to straighten a collapsing trunk. Research funding and patient advocacy efforts helped push the treatment into existence.

“Spinraza changed the entire course of history in SMA,” said Jill Jarecki, chief scientific officer of Cure SMA, a patient organization that has invested \$75 million in research since 1984. That research included early studies on the unique genetics of SMA.

People with the disease are missing the gene that produces the survival motor neuron (SMN) protein, which is necessary for healthy motor neurons. But everyone, whether affected by SMA or not, has a near-perfect, mostly silent “backup” copy of that SMN gene. Some people have multiple copies. The broken gene copies produce a small amount of SMN protein. The more copies, the more backup SMN protein and the less severe the effects of the disease tend to be. In 2003, Cure SMA first funded researchers attempting to understand why the gene copies produced only a little SMN protein. It was not clear at the time that a treatment would emerge. “The funding of that science is a perfect illustration of how basic research can lead to therapy in ways that you may not anticipate,” said Jarecki.

Over the next decade, research on how to rouse the backup gene copies to produce more SMN protein would move from academic labs to biotechnology companies and into clinical trials. In tests with infants with SMA type I, half of the babies receiving the drug hit motor skill milestones such as head control and rolling over compared to none of

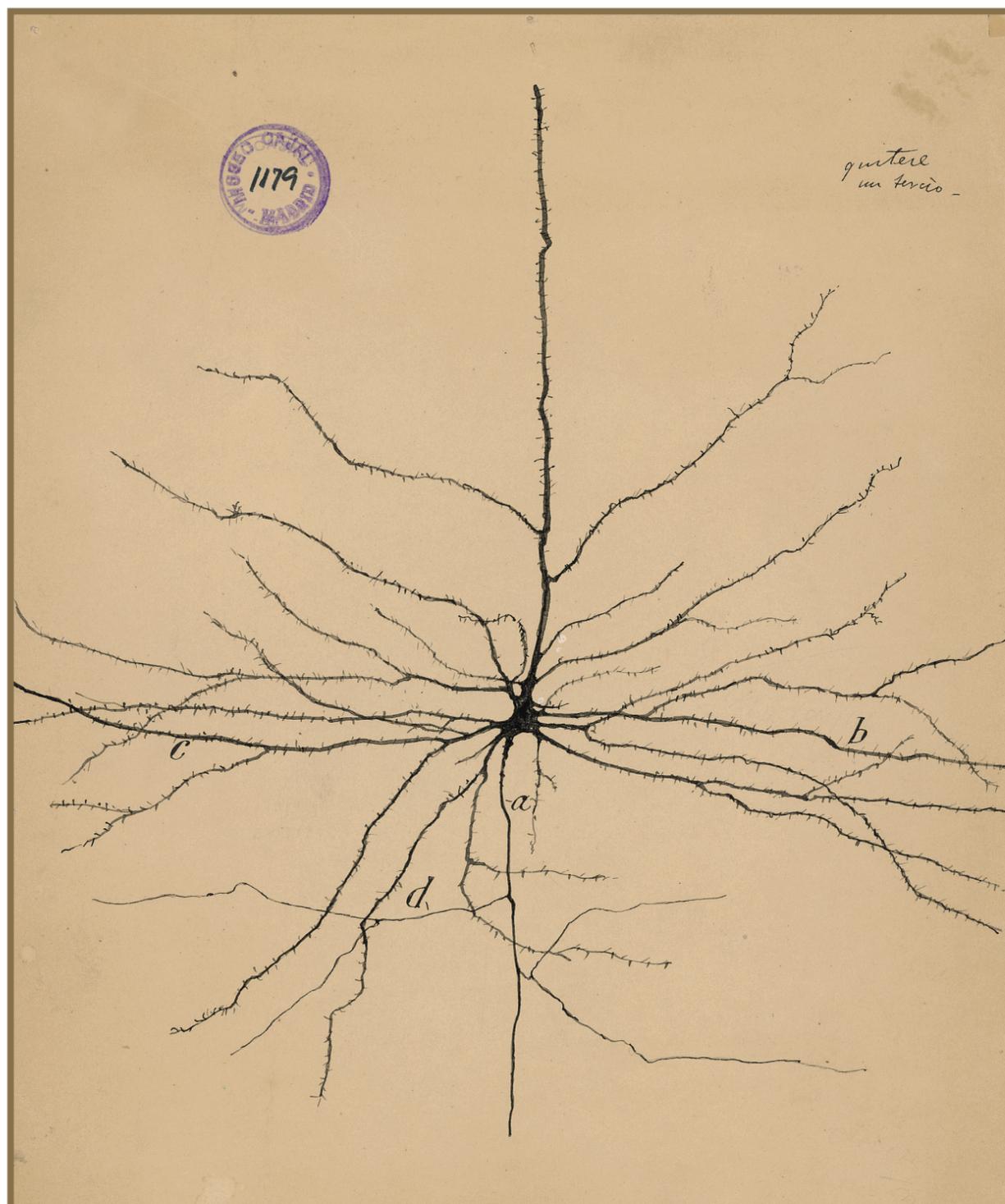
the untreated babies. Older patients with SMA type II and III also saw improvements in trials.

The approval of Spinraza has been incredibly meaningful to patients, said Jarecki. Families now have options and more are expected. In May 2019, the FDA approved a gene therapy for SMA patients under two years of age. This single-dose treatment is delivered intravenously and provides a functional copy of the main SMN gene into patient nervous systems. Clinical researchers are also testing two oral drugs that can boost the activity of the ordinarily silent SMN copy genes. (One of the drugs was developed with funding from another patient group, the SMA Foundation.) Jarecki says in the future, patients may be able to combine therapies to optimize treatment depending on age and stage.

“Even granting that the genius subjected to the test of critical inspection emerges free from all error, we should consider that everything he has discovered in a given domain is almost nothing in comparison with what is left to be discovered.”

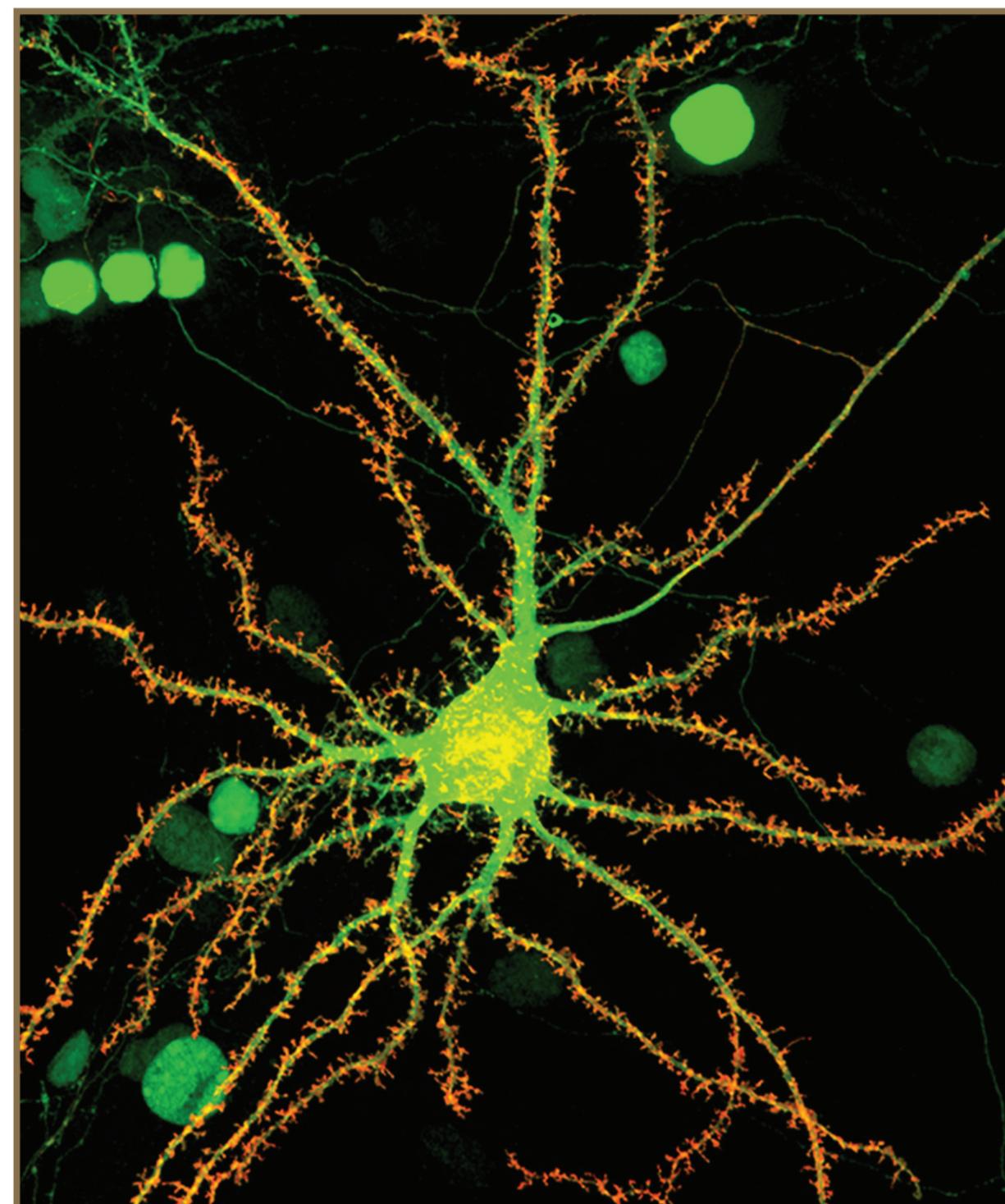
SANTIAGO RAMÓN Y CAJAL | 1951

Precepts and Counsels on Scientific Investigation: Stimulants of the Spirit



Hand drawn image by Santiago Ramón Y Cajal of a pyramidal neuron of the cerebral cortex.

1913



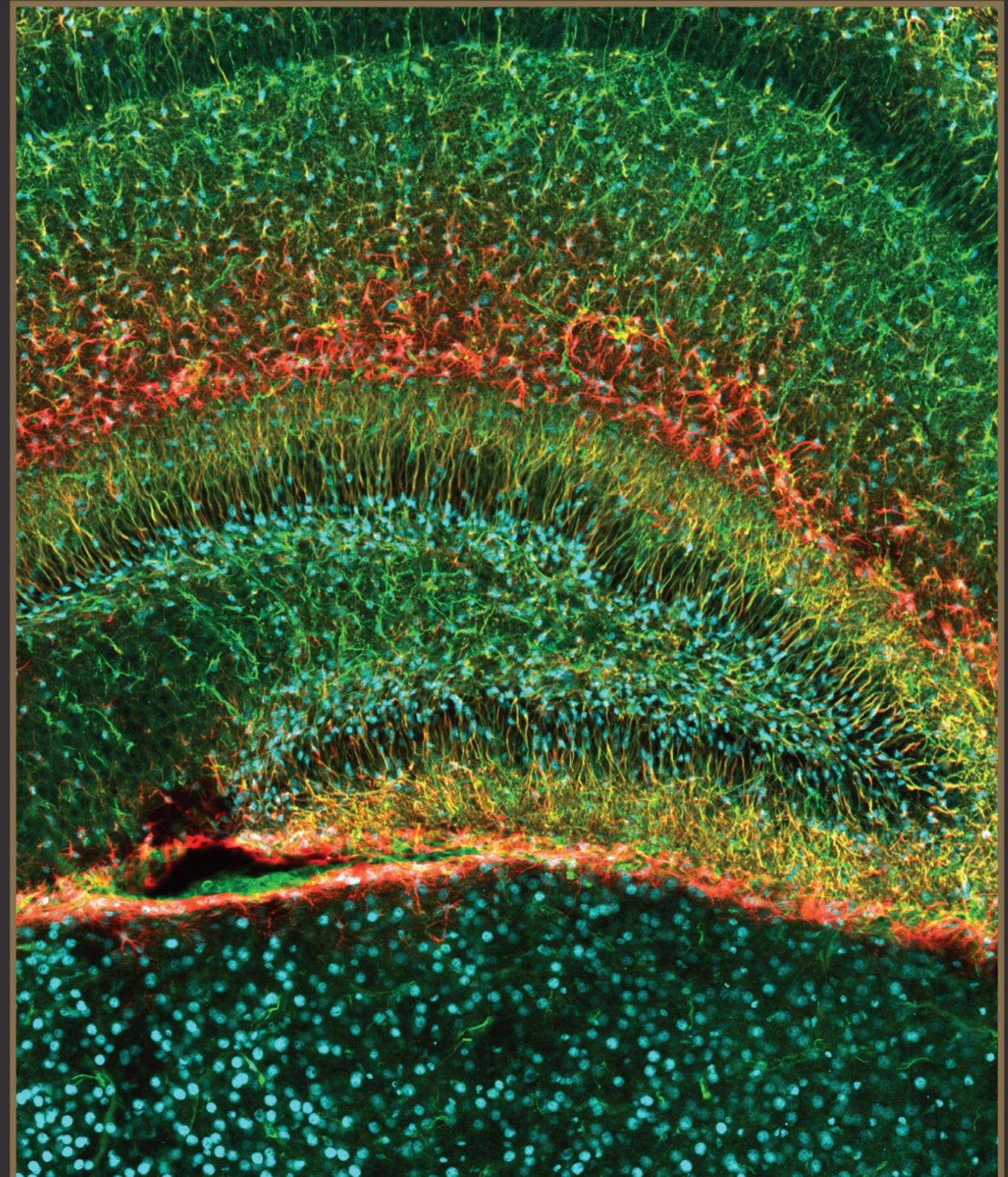
Hippocampal neurons (green) cultured from a mouse model overexpressing Neuroligin-1 (red).

2017

PYRAMIDAL CELL

1913 / 2017

sfN | CELEBRATING 50 YEARS



Immunostaining of neural stem cells having a unique morphology called "secondary radial scaffold" (labeled green and red) in the dentate gyrus of a juvenile mouse. Nuclei of neural stem cells are labeled cyan.

2006

EDUCATING AND
ENGAGING THE PUBLIC

Transforming Brain Science Stories to Inform the Community

One of the most important lessons that I've learned from SfN is to tell stories when you communicate science to the public."

TIMOTHY SHEA, graduate student,
University of California, Merced

The roughly 86 billion neurons comprising the brain encased in our heads is complexity come to life. Intricate communications between neurons fuel all our thoughts, actions, memories, and emotions. For seven years, *BrainFacts.org* has been reliably telling the story of how our brains compel us to explore and understand our world, all the while gaining a public audience and private support.

NEW LEADERSHIP, NEW DIRECTIONS

In January 2018, Richard Wingate took the helm of *BrainFacts.org* from outgoing Editor-in-Chief John Morrison. Wingate, a reader (professor) in the MRC Centre for Neurodevelopmental Disorders at Kings College, London, is bringing his passion for communicating science to non-scientific audiences to help guide *BrainFacts.org* as it continues to deploy multimedia storytelling. Working with Wingate is new Associate Editor Charles Yokoyama, executive director of the Research Center for Neurointelligence at the University of Tokyo. Yokoyama's scientific interests have been studying connections between structures in the brain and Yokoyama's role with *BrainFacts.org* will enable him to connect a wider audience to brain science.

Wingate and Yokoyama defined three specific goals for *BrainFacts.org*. First, they will explore ways to increase the range of audiences who can access the resources available online. Wingate and Yokoyama are committed to expanding *BrainFacts.org*'s readership outside the U.S. Over 55 percent of the site's readers already come from non-U.S. countries, with India having the second most users of the site (14 percent) after the U.S. The second goal is to further promote *BrainFacts.org* as a scientifically accurate resource for educators and the general public. The site regularly publishes "Classroom Resources" developed as activities for educators to engage their classes on brain science. A robust content plan for 2019 will create reasons for the public to return to the site almost every day. Third, *BrainFacts.org* looks to more consistently engage SfN members.



Colorful, interactive activities, like building neurons out of pipe cleaners, are an effective way to engage audiences with neuroscience.

“It’s important to share what we learn because our findings shape what we know about the brain — and therefore what we know about ourselves.”

BENEDICT WILD, graduate student, German Primate Center, Germany

Whether agreeing to participate as a subject in a “Meet the Researcher” video, answer questions in the “Ask an Expert” series, or serve as a resource for local schools by joining the “Find a Neuroscientist” database, Wingate and his colleagues on the editorial board are seeking to have SfN members understand that *BrainFacts.org* can be an outlet to help neuroscientists reach and speak to a non-scientific audience. As a whole, these goals bring together the neuroscience community and the public in support of curiosity about the brain.

EXPANDING BEYOND TEXT

BrainFacts.org began in 2012 as a public information initiative of founding partners The Kavli Foundation, the Gatsby Charitable Foundation, and SfN. Each partner has renewed their support, recognizing the importance

of providing people with easy and free access to scientifically accurate, engaging, and accessible information about the brain. In 2018, The Lundbeck Foundation awarded SfN a five-year grant worth \$150,000 per year to provide core funding to *BrainFacts.org*, enhancing the Society’s ability to employ innovative digital formats to develop engaging neuroscience narratives. The Stanley Center for Psychiatric Research also generously supports mental health content under a three-year grant.

The most popular content on *BrainFacts.org* continues to be the 3D Brain, which was funded with a 2016 grant from the Wellcome Trust. Since its launch in October 2017, the scientifically accurate and interactive model has offered users the opportunity to explore the human

brain. This year, the accessibility of the model for visually impaired users was enhanced by adding audio labels of the written descriptions. Other top *BrainFacts.org* stories of 2018 examined how pregnancy, anxiety, and fasting affect the brain, highlighting how the site provides its audience with answers to everyday questions in everyday language.

Moving beyond text-driven articles, *BrainFacts.org* employs neuroscience storytelling in videos, infographics, quizzes, podcasts, and interactive games to engage the audience in new learning mediums. The Build-a-Neuron game provides users the opportunity to build individual neurons and then connect multiple neurons to form a circuit. In 2018, SfN published the 8th edition of the *Brain Facts* book. In 2019, the book was converted to digital and audio formats enabling more students, teachers, and the public access to this instructional tool.

Looking forward, *BrainFacts.org* is developing a podcast series made possible through SfN Council strategic opportunity funding. In the coming year, the editorial team is gearing up to celebrate SfN's 50th anniversary (page six) with a series of 50 Brain Facts designed to be visually engaging and easily sharable on social media, expanding the reach of *BrainFacts.org*.

INSPIRING GENERATIONS

Complementing *BrainFacts.org*'s online content are SfN's efforts to bring together neuroscientists and the non-science public via in-person outreach. Using the *Brain Facts* book as a source of questions, Brain Bees provide a competitive opportunity for secondary school students around the world to prove their knowledge of neuroscience. Starting with local-level gatherings hosted by many SfN chapters, the competition culminates with national

Brain Bee winners competing at the International Brain Bee (IBB), hosted during an international neuroscience conference. This year, the IBB took place at the International Brain Research Organization (IBRO) World Congress in Daegu, South Korea September 20–21, 2019. SfN has partnered with IBRO, the Federation of European Neuroscience Societies (FENS), the American Psychological Association, and the Dana Foundation to create a formal IBB organization to sustain the IBB in the future. SfN also hosts the Washington, D.C., Brain Bee each year and sent its winner to Hershey, PA for the U.S. National Brain Bee competition.

Brain Awareness Week (BAW) represents another international opportunity for members to share brain science with the public. Launched in 1995 by The Dana Foundation, BAW sees neuroscientists connect with students, teachers, and communities to celebrate the excitement and benefits of brain research. In addition to many in-person events scattered across the globe, SfN hosted a webinar on *BrainFacts.org* revealing the origins of insight that lead to an “aha!” moment. An educator-focused webinar in December 2018 discussed the impact of technology on attention in students. For those looking to make use of their creative insight, the annual Brain Awareness Video Contest again offered the opportunity to explain a favorite neuroscience topic. The winner earned a trip to the SfN annual meeting and videos judged to be both rigorously accurate and entertaining were shared with the world on *BrainFacts.org*.

In FY 2019, SfN returned to the National Association of Biology Teachers meeting to increase awareness of the *Brain Facts* book and resources on *BrainFacts.org* among this key group of educators. SfN maintained its longstanding presence at the National

Science Teachers Association National Meeting to introduce the many ways science teachers can incorporate brain science into their lesson plans. In addition to public outreach events at Neuroscience 2018, SfN hosted a booth at the Family Science Days, held in conjunction with the annual meeting of the American Association for the Advancement of Science.



Brain Awareness Week connects current and future generations of neuroscientists around their shared curiosity of the brain.

Digging to the Heart of Human Creativity — in the Brain

JAZZ GUITARIST Pat Metheny is famous for his exceptional skill with improvisation, but when he first got his hands on a guitar at the age of 12, he didn't really know what to do with it. Born into a family of trumpet players, Metheny had to learn the basics of guitar on his own.

"Within the first few days of getting a guitar, I couldn't play an F chord," which requires holding down two strings with one finger, Metheny recalled. "But I remember realizing, 'Oh, if I don't push down the two strings, I actually liked the way that sounds even more,' which of course is an F major 7 chord, instead of an F. I had no idea of knowing that. That was my first moment of improvising."

Musical improvisation — making up music on the spot — isn't that different from "every single thing we all do, every day," said the 20-time Grammy award winner. However, the jazz improvisation and musicianship that Metheny is known for allows musicians to wordlessly express stories and emotions — an area of interest for neuroscientists who want to understand the origins of creativity in the brain.

"If you want to understand something as complicated as music, perception, performance, or emotion, whatever it might be, you may have to understand the ear and the process of hearing, but you also have to understand the brain."

CHARLES LIMB, professor of otolaryngology (ear, nose, and throat medicine) at the University of California, San Francisco

Exploring improvisation was the topic of the Neuroscience 2018 Dialogues Between Neuroscience and Society lecture, featuring Metheny and moderated by 2018 SfN President Richard Haganir and Charles Limb, professor of otolaryngology (ear, nose, and throat medicine) at the University of California, San Francisco.

Limb grew up immersed in music, like Metheny, but opted for a career in medicine as his way of "contributing to the world" after college. Fittingly, his chosen field allowed him to help people with their hearing.

As his medical career progressed, however, Limb maintained his passion for music by pioneering the study of improvisation and the brain.

"If you want to understand something as complicated as music, perception,

performance, or emotion, whatever it might be, you may have to understand the ear and the process of hearing, but you also have to understand the brain," said Limb.

Driven by this curiosity about how the brain enables improvisation, Limb designed a system that allowed musicians to play a plastic keyboard while strapped inside an MRI machine. He recorded their brain activity while they played a memorized song and then compared it to their brain activity during improvisation.

The experiment revealed that during improvisation, but not while playing memorized music, the brain of a trained expert decreases its activity in the prefrontal cortex, a region that's "responsible for conscious self-monitoring and effortful planning,"

said Limb. “You can view that as the brain surrendering ... its conscious control during creative improvisation.”

Furthermore, the brain dedicated more of its resources to regions responsible for listening (temporal lobe) and for playing an instrument (sensorimotor cortex) during improvisation, “even though there was not more sound being heard or more notes being played,” Limb explained. The results implied that the brain could be focusing more purely on the experience of making music when a musician is improvising, as opposed to consciously thinking through each successive note.

“That first jazz study was important for me because it showed that the way I was asking this question about creativity was [scientifically] reasonable,” Limb said. “It was a musically natural behavior and we were able to approach it the same way you approach any other complicated biological activity. [It showed that creativity] doesn’t have to just remain in the realm of the mystical.”

In 2014, Limb followed up on this work by looking at how jazz musicians “trade fours,” or swap short, improvised solos that build off one another, and discovered that this type of improvisation depends on areas of the brain that are responsible for language production and comprehension, such as Broca’s and Wernicke’s areas.

That sort of finding is quite familiar to Metheny, whose decades of experience playing jazz with hundreds of musicians have given him a keen sense of the purpose of improvisation: communication and connection.

“Improvisation manifests itself like storytelling to me,” said Metheny. “There’s a strong correlation to a narrative, in a positional way of presenting information, of taking ideas, following them, letting them run their course. This connection between improvisation and everyday life grows and grows as the years go by, and as my fluency as an improvising musician has increased.”

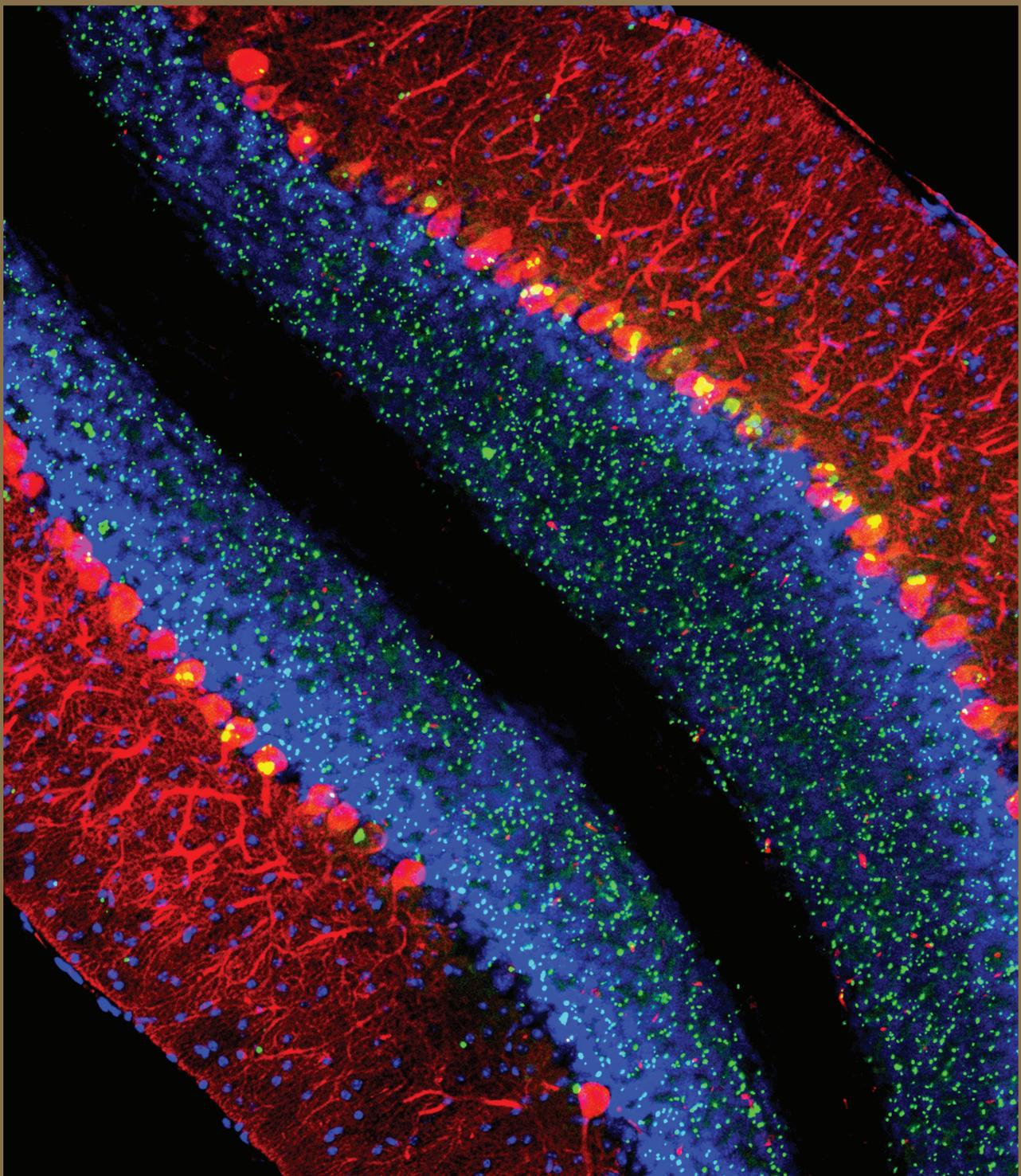
Although Metheny tours the world with his guitar while Limb works with hearing-loss patients, ultimately their interests intersect at the heart of what it means to be human.

Limb is now pursuing an even more ambitious project: An investigation, funded by the National Endowment for the Arts, of the brain activity of “transformative artists who have really defined the way we hear music and the way we see the world,” said Limb. By “literally peering into the minds of creative geniuses,” on an individual basis, Limb hopes to illuminate broader truths about human creativity — and potentially identify ways to boost that creativity.

“There’s maybe nothing more important to understand than how humans create new ideas,” said Limb, “because this is how we evolve and survive and advance as a society.”

Grammy award-winning jazz guitarist Pat Metheny explored the topic of improvisation during the Dialogues Between Neuroscience and Society lecture at Neuroscience 2018.





Cerebellum of a mouse modeling the lysosomal disease late-infantile neuronal ceroid lipofuscinosis (CLN2 disease). Purkinje cells are labeled red, nuclei are blue, and abnormal clumps of the protein p62/Sqstm1 are green.

2018

ADVOCATING FOR
THE FIELD

Expanding NeuroAdvocate Engagement

“Since my time [as an ECPA], I’ve met several times with my senators, congressmen, and even locally with the governor.”

RACHEL HENDRIX, postdoctoral fellow,
Washington University School of Medicine

Now in its third year of strategic opportunity investment, SfN’s commitment to expanded advocacy continued to see increased return via new legislative accomplishments, a growing cadre of passionate advocates, and stronger relationships with policymakers.

AN EXPANDING LEGISLATIVE FOOTPRINT

Funding levels increased by \$2 billion for NIH in FY 2019. The FY 2019 increase not only represented the fourth year in a row of funding increases for the agency, but the first time in 22 years that NIH funding was secured prior to the start of the new fiscal year. The consistent increases to the NIH budget speaks to the bipartisan nature of scientific research.

The FY 2019 increase included \$429 million for the BRAIN Initiative to continue its sixth year of providing neuroscientists the tools and technologies necessary to explore the inner workings of the brain. SfN celebrated the fifth anniversary of the BRAIN Initiative by co-hosting a Congressional BRAIN Investigators Reception on Capitol Hill, along with the Simons Foundation, Allen Brain Institute, American Brain Coalition, and Kavli Foundation. The reception gathered over 30 BRAIN Initiative-funded investigators, the

Congressional Neuroscience Caucus, and representatives from NIH and NSF to share stories about their work to untangle the complexities of our body’s most complex organ.

The NSF received a four percent increase to its budget, but only after a 35-day government shutdown shuttered the agency. NeuroAdvocates responded to the shutdown via an action alert urging their representatives to fulfill their public service responsibilities and provide funding for NSF. At the organizational level, SfN partnered with a large community of science advocacy groups, including Research!America, the American Academy for the Advancement of Science (AAAS), and the Coalition for the National Science Foundation to emphasize the costs of the unnecessary shutdown on scientists across the country.

The Government and Public Affairs Committee approved SfN’s expansion of its advocacy efforts to include the



A simple handshake between a policymaker and NeuroAdvocate can be the beginning of a strong relationship in support of neuroscience.

“If we really, really want the public to engage with us and be willing to fund research, then we need to tell them what it is that we’re doing.”

SARAH HUTTER, graduate student,
Princeton University

Congressionally Directed Medical Research Programs (CDMRP) under the Department of Defense, as well as neuroscience research supported by the Department of Veterans Affairs (VA). The CDMRP provides research funding with the goal of improving health care for members of the military and the American public. VA research focuses on issues impacting military veterans, such as prosthetics and post-traumatic stress disorder.

NURTURING ADVOCATES AROUND THE GLOBE

Effective advocacy is best achieved when there are strong relationships with policymakers and numerous voices all calling for the same action. Through a multi-year strategic opportunity investment, SfN has built a vocal, well-positioned, and powerful cohort of NeuroAdvocates.

At the core of this cohort are the Early Career Policy Ambassadors (ECPAs) and Key Contacts. ECPAs

are a select group of trainee and early career neuroscientists committed to advocating on behalf of the field at their home institution, in their state, and on Capitol Hill. SfN’s Key Contacts program consists of SfN members at all career stages who are represented by lawmakers identified as being particularly important to funding scientific research agencies. Together, their collective action via direct communication to their members of Congress, inviting policymakers to lab tours, conducting poster floor tours at the annual meeting, or writing op-ed pieces in local publications, sustain the steady drumbeat of support for neuroscience funding.

Two additional efforts are also building the number of advocates calling for action. A strategic opportunity investment by SfN Council offers neuroscientists the opportunity to invite SfN staff to their chapter or institution to host seminars on how to affect change through advocacy. Through the Advocacy Training Program, SfN members in New York City; Baltimore, Maryland; Birmingham, Alabama; Toronto, Canada; and Washington, D.C. explored the inner workings of the policymaking process and identified key methods and moments for shifting policymaker opinion on issues critical to research. The strategic opportunity investment also looks to scale up the availability of these seminars by training SfN members on how to conduct them, enabling members to educate their departments on the practice of effective advocacy.

Two prominent North American advocacy partners, the SfN Mexico City Chapter and the Canadian Association for Neuroscience (CAN), renewed their memorandum of understanding with SfN to further develop their own culturally

appropriate advocacy programs. For CAN, these efforts focus on increasing the number of neuroscientists communicating with members of the Canadian Parliament, while the SfN Mexico City Chapter is developing additional outreach resources to share the power and wonder of neuroscience research with the public.

Beyond North America, SfN continued to support global engagement seed grants offered by the International Brain Research Organization (IBRO) through IBRO's Global Advocacy Committee. These grants funded 11 projects to advance advocacy in four geographic areas: Africa, Latin America, Pan-Europe, and the Asia/Pacific region. The projects support lectures, symposia, and other educational content for global NeuroAdvocates looking to engage in local advocacy initiatives. SfN continues to develop resources in collaboration with the Federation of European Neuroscience Societies (FENS) continuing of the strong, longstanding partnership between the two organizations. Areas of focus include the support of transparency in the use of animals for biomedical research, advocacy, and a range of training resources developed in partnership between the SfN and FENS scientific training committees.

CAPITOL HILL ADVOCACY YIELDS RESULTS

SfN's annual Capitol Hill Day is one of the most effective events on the neuroscience advocacy calendar, as it offers members the unique opportunity to discuss neuroscience research face-to-face with members of Congress and their staff. The 13th annual Hill Day held in March 2019 hosted 48 neuroscientists, including representatives from SfN's Council, Government and Public Affairs Committee, Global Membership Committee, Key Contacts, and

the new class of ECPAs, as well as members from Canada, Mexico, the United Kingdom, Egypt, and India. Rep. Jerry McNerney (D-CA) opened the day with a speech on the floor of the U.S. House of Representatives welcoming SfN members to Capitol Hill and encouraging all House members to support robust funding for NIH and the BRAIN Initiative. Representatives Earl Blumenauer (D-OR) and Cathy McMorris Rogers (R-WA), co-chairs of the Congressional Neuroscience Caucus, introduced a resolution declaring support for Brain Awareness Week and neuroscience research. Such public statements by elected officials are further evidence of SfN's multi-year effort to build strong, trusted relationships with members of Congress.

On behalf of the SfN membership, SfN President Diane Lipscombe submitted congressional testimony urging increases to the NIH and NSF budget for FY 2020. Lipscombe's experience with being funded by both agencies meant her testimony shared how her research and career have been impacted by each agency's funding and how those experiences reflect similar stories from tens of thousands of neuroscientists across the country.

PROACTIVE COMMUNICATION OF ANIMAL RESEARCH

SfN members rely on well-regulated animal experiments to reveal how the human brain and nervous system function; SfN works to ensure the continued responsible and ethical use of animals in research. A key aspect of that work is to build public support and understanding of animals in scientific discovery through open communication. The Neuroscience 2018 Animals in Research (AiR) panel featured speakers from three organizations that proactively undertake public communication efforts to clarify when, how, and why

they use animals in research. These examples of frequent and accessible communication to the public have been shown to be effective in counteracting the misleading messaging surrounding animal research.

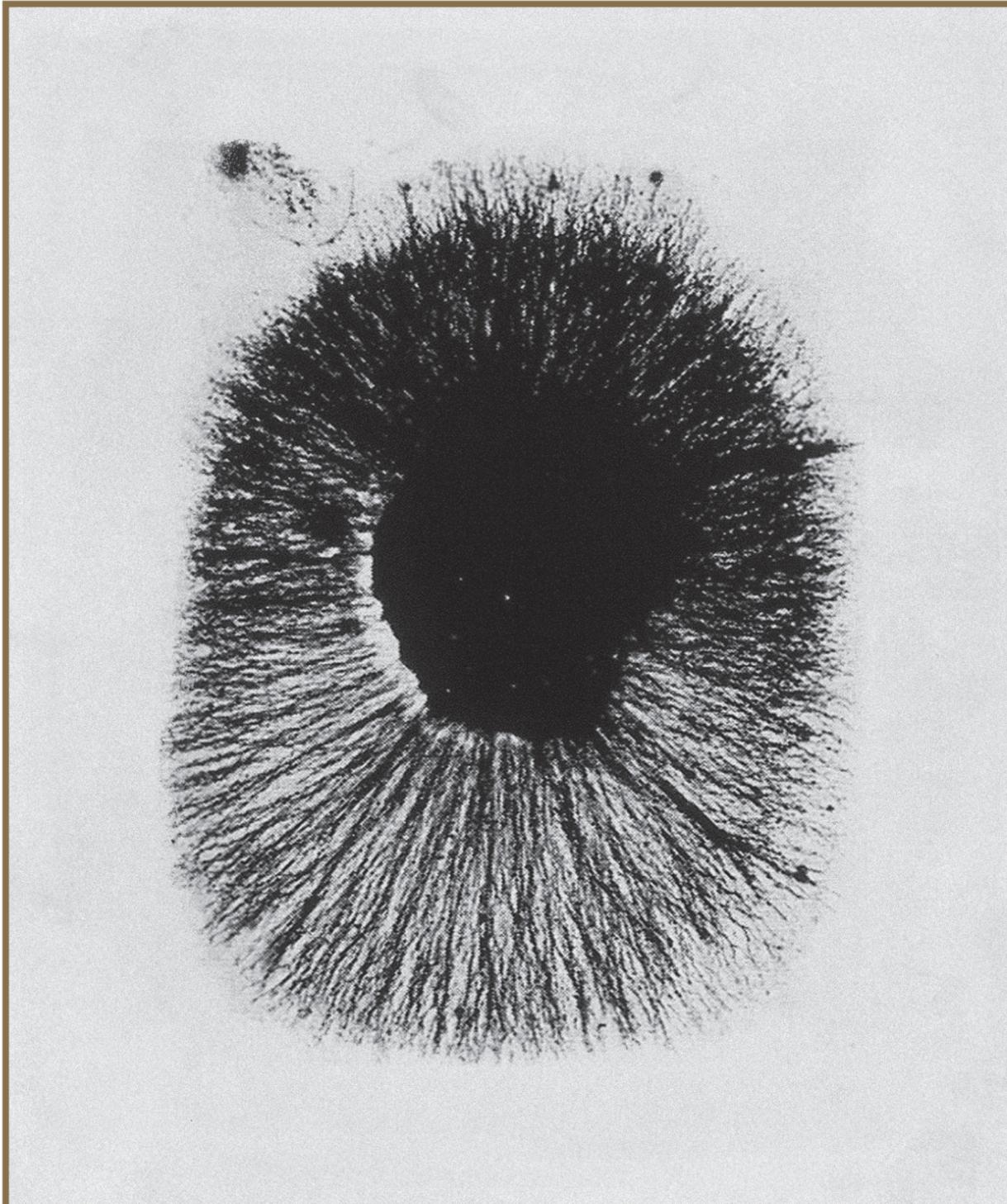
Outside of the annual meeting, the European Animal Research Association, with support from FENS and SfN, hosted a series of in-person workshops for European scientists on proactively and positively sharing research conducted with animals. Through these efforts and others, SfN and its members continue to identify opportunities to describe why animals are vital in research, how they are responsibly treated, and the life-saving benefits that result from their inclusion in the process of scientific discovery.



NeuroAdvocates spoke to their representatives about the needs of the neuroscience community during SfN's annual Capitol Hill Day.

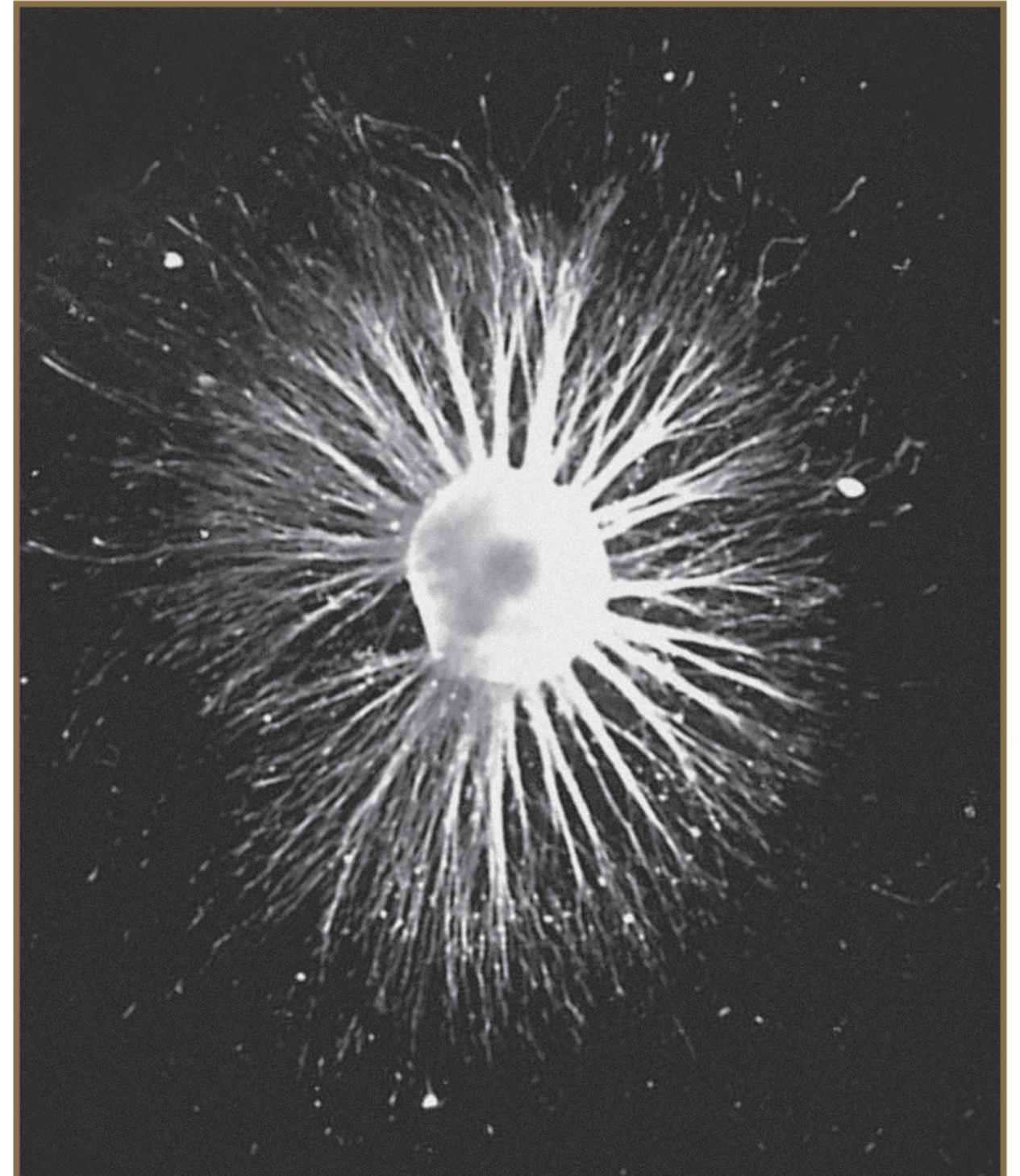
“Scientists and artists both have a drive to create and they share the passion and imagination in creating something.”

RITA LEVI-MONTALCINI | 2010
Neuroscience Quarterly



Experiment by Rita Levi-Montalcini observing the effects on a chick embryo 24 hours after exposure to nerve growth factor.

1952



A dorsal root ganglion neuron 24 hours after exposure to nerve growth factor.

2003

NERVE GROWTH FACTOR

1952 / 2003

FINANCIAL &
ORGANIZATIONAL
HIGHLIGHTS

50 Years of Neuroscience Community Investment

To advance breakthrough discoveries in neuroscience and promote innovative translation of scientific advances to improve the health of people everywhere: This vision of SfN is as meaningful and relevant today as it was when the Society was founded July 11, 1969. Throughout the past 50 years, SfN has remained committed to serving as a financial steward to support the pillars of the mission: providing exceptional programming, service, scientific training opportunities, professional development, and avenues and resources for public outreach to neuroscientists worldwide.

FISCALLY RESPONSIBLE STEWARDSHIP

Steady growth of SfN’s annual meeting, the largest gathering of neuroscientists in the world, and SfN’s two scientific journals, *JNeurosci* and *eNeuro*, helped to ensure financial support for a vast array of programming, reinforcing the value of SfN membership. Revenue also supported programming that fueled greater awareness of neuroscience: the Society engaged the public in the need for basic research funding that may lead to new breakthroughs for human health.

After years of strong performance within the organization’s investment portfolio, the SfN Council established an annual draw of \$2 million from reserves dedicated to the support of key programs and mission-driven activities including professional

development, advocacy, and training programs important to membership and the field.

PURSUING STRATEGIC OPPORTUNITIES

Initiated in 2016 by Council, the Strategic Opportunities Fund and its approach to directed investment in the Society’s mission have continued to fund priorities in FY 2019.

ACCELERATING CAREERS

Council continued its commitment to the Trainee Professional Development Award (TPDA) with base funding of \$100,000 in addition to donations made by the Friends of SfN Fund. Fifteen high performing TPDA recipients this year will form the inaugural cohort of the Leadership Development Program, a year-round pilot initiative focused on building

the skills, knowledge, and confidence of trainees so that they can effectively perform as leaders.

SCIENTIFIC TRAINING

FY 2019 also saw an increase in training programs, with a series of three scientific training-focused virtual conferences on the topics of optogenetics, neuroethology, and machine learning in neuroscience. In connection with optogenetics, SfN piloted a series of scientific training content on Neuronline. This model will be repeated in FY 2020.

PUBLISHING

Further investment to evaluate and refine scientific journal publishing strategies emerged as a key priority in FY 2019 to ensure SfN’s journals evolve to meet the growing needs of authors and the Society’s membership. Efforts have been focused on improving accessibility and exposure of content, recognizing authors and reviewers for their contributions, and enhancing the overall experience for contributors to both *JNeurosci* and *eNeuro*.

SCIENCE ADVOCACY

Council also provided strategic investment into SfN’s advocacy efforts with the broadening of member engagement activities and a scalable, modular advocacy training program that is available in seminar format for chapters, departments and programs, and other groups of SfN members interested in learning more about effective advocacy.

DIGITAL LEARNING AND PUBLIC EDUCATION

Ongoing investments in digital learning and strategy were another leading priority in FY 2019, including Neuronline, which underwent a modernization and improvement project during FY 2019 and FY 2020 to enhance the user experience and

discoverability of content. The updated site relaunched in September.

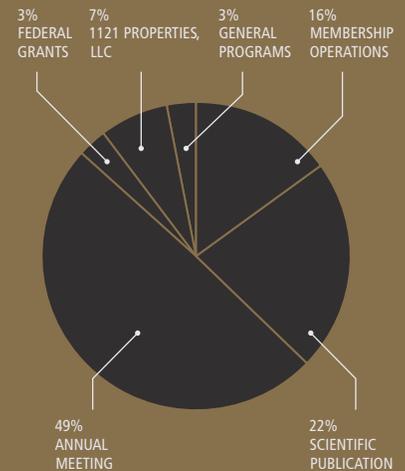
Additionally, SfN planned three podcast series: *BrainFacts.org*, SfN’s public information initiative, will begin a podcast series bringing to life neuroscience topics of interest to the general public through storytelling. A podcast series tied to *JNeurosci* and *eNeuro* will focus on in-depth interviews from recent authors the stories behind the science. Additionally, a limited-run 50th anniversary podcast will release featuring eight episodes showcasing vignettes from notable SfN members.

Other digital investments include converting all historical abstracts back to 1971 into easily accessible digital files for preservation, also making them searchable on SfN.org.

As SfN looks ahead to FY 2020, which includes SfN’s 50th annual meeting, it will continue to practice responsible investment strategies and carefully evaluate new opportunities to invest in mission and drive innovative programming for members of the global neuroscience community.

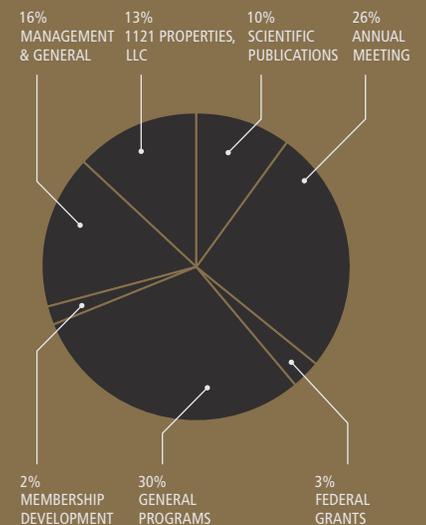
\$30,909,237*

REVENUE



\$34,689,992*

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* UNAUDITED

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The Society for Neuroscience (SfN) gratefully acknowledges the generous donations to SfN from the following contributors in FY 2019 (July 1, 2018–June 30, 2019).

Donations to the FRIENDS OF SfN FUND support the Society's mission of advancing the understanding of the brain and nervous system. Visit sfn.org/Support-SfN or contact development@sfn.org to learn more about the Fund and becoming a donor.

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SfN Council gratefully acknowledges the following organizations and individuals who contributed support to SfN's programs and annual meeting in FY 2019:

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COVER: Santiago Ramón y Cajal, A Purkinje neuron from the human cerebellum, 1899. Ink and pencil on paper. Courtesy of the Cajal Institute, "Cajal Legacy," Spanish National Research Council (CSIC), Madrid, Spain.

PAGE 9 (LEFT): Published in: Golgi, C. (1875). Sulla Fina Struttura del Bulbi Olfattorii. Reggio-Emilia: Printer Stefano Calderini.

PAGE 9 (RIGHT): Olfactory bulb of adult mouse brain cells after UbC-StarTrack targeting of progenitors cells at E12.5. Mitral cells and interneurons are labelled in green. Groups of glial cell are labelled in red. Courtesy, with permission: Rebeca Sánchez-González and Laura López-Mascaraque, Instituto Cajal-CSIC, Madrid (Spain).

PAGE 10: Fibroblast growth factor (FGF) receptor 1 is highly expressed in calbindin-negative dopaminergic neurons in adult ventral midbrain. The image shows the immunostaining of tyrosine hydroxylase (red), FGF receptor 1 (green), and calbindin (blue), supporting the result that FGF-20 is preferentially acting on calbindin-negative dopaminergic neurons, which are known to be at most risk in Parkinson's disease. The image was processed to provide a watercolor effect. Courtesy, with permission: Murase et al., 2006, *JNeurosci*, 26 (38) 9750-9760.

PAGE 16: Coronal section of a mouse embryonic forebrain labeled on embryonic day 11 with iododeoxyuridine (green) and bromodeoxyuridine (red). Double-labeled nuclei are yellow. The green (IdU-labeled only) nuclei are daughter cells produced by cell division of neural progenitor cells. Courtesy, with permission: Fujimura et al., 2016, *JNeurosci*, 36 (42) 10908-10919.

PAGE 17: A parvalbumin-expressing interneuron overlaid on a two-color fluorescent in situ hybridization image showing expression of NMDA receptor GluN2D in GAD-expressing GABAergic interneurons. Courtesy, with permission: Hanson et al., 2019, *JNeurosci*, 39 (19) 3611-3626.

PAGE 21: Courtesy of Richard Huganir.

PAGE 22: Courtesy of Richard Huganir.

PAGE 23: Courtesy of Yoichi Araki.

PAGE 24: The mouse adult hippocampus with neurogenesis markers. EYFP (green) is expressed in radial glia-like neural stem cells and their progenies. Adult-born neurons and neural stem cells/neural progenitors are stained with Doublecortin (red)

and Sox2 (white), respectively. DAPI labeling is blue. Courtesy, with permission: Kuhn et al., 2018, *JNeurosci*, 38 (49) 10401-10410.

PAGE 28: Courtesy of Danyelle Sun.

PAGE 29: Schematic of a portion of chromosome five that contains the two SMN genes. The major difference between the two SMN gene copies is the C (SMN1) to T (SMN2) nucleotide change in exon seven in their DNA. Because of this difference, SMN2 mostly makes mRNA that excludes exon seven and produces a smaller, unstable SMN protein. SMN1 makes mRNA that includes exon seven and makes functioning full-length SMN protein. Courtesy of Cure SMA, 2019.

PAGE 31 (LEFT): Santiago Ramón y Cajal, The pyramidal neuron of the cerebral cortex, 1904. Ink and pencil on paper. Courtesy of the Cajal Institute, "Cajal Legacy," Spanish National Research Council (CSIC), Madrid, Spain.

PAGE 31 (RIGHT): Hippocampal neurons (green) cultured from a mouse model overexpressing Neuroigin-1 (red). Overexpressed Neuroigin-1 is recruited at the postsynaptic clusters formed on dendritic spine. Modified from Chanda et al., 2017, *JNeurosci*, 37 (29) 6816-6836. Courtesy of Soham Chanda.

PAGE 32: This confocal image shows neural stem cells in the dentate gyrus of a seven-day-old mouse. Neural stem cells migrate toward the hilus of the dentate gyrus and form a proliferative zone, called the subgranular zone, at the border between the hilus and the granule cell layer. While neural stem cells are migrating into the subgranular zone, they establish a radial process that extends across the granule cell layer, called the secondary radial scaffold (labeled with Nestin (green) and GFAP (red)). Neural stem cell nuclei are labeled with Sox2 (cyan). Courtesy, with permission: Noguchi et al., 2016, *JNeurosci*, 36 (22) 6050-6068.

PAGE 38: Portion of lobule VII of cerebellum from the mouse model of the lysosomal disease, late-infantile neuronal ceroid lipofuscinosis (CLN2 disease). Immunofluorescence labeling shows calbindin-positive Purkinje cells (red) and DAPI-labeled nuclei (blue) in relation to aberrant accumulation of the macroautophagy adapter protein p62/Sqstm1 (green) in protein aggregates. p62 responds to lysosomal membrane permeability in CLN2 disease by sequestering released lysosomal content in intraneuronal aggregates. Courtesy, with permission: Micsenyi et al., 2013, *JNeurosci*, 33(26) 10815-10827.

PAGE 43 (LEFT): Photomicrograph of a seven-day chick embryo after 24 hours of culture in a medium supplemented with the salivary nerve growth factor. Silver impregnation. With permission: Levi-Montalcini, 1964, *Science*, 143 (3602) 105-110.

PAGE 43 (RIGHT): Representative explants of DRG neurons with neurofilament labeled neurites after 24 hours. Courtesy, with permission: Mills et al., 2003, *JNeurosci*, 23 (5) 1638-1648.

PAGE 50: Ependymal cell basal bodies, labeled by γ -tubulin staining in red, are clustered in a patch on the apical surface of ependymal cells, outlined by β -catenin staining in green. The position of the basal body patch on the apical surface is planar-polarized, with neighboring cells having their basal body patch displaced to the same side, which corresponds to the downstream side with respect to cerebrospinal fluid flow. Courtesy, with permission: Mirzadeh et al., 2010, *JNeurosci*, 30 (7) 2600-2610.

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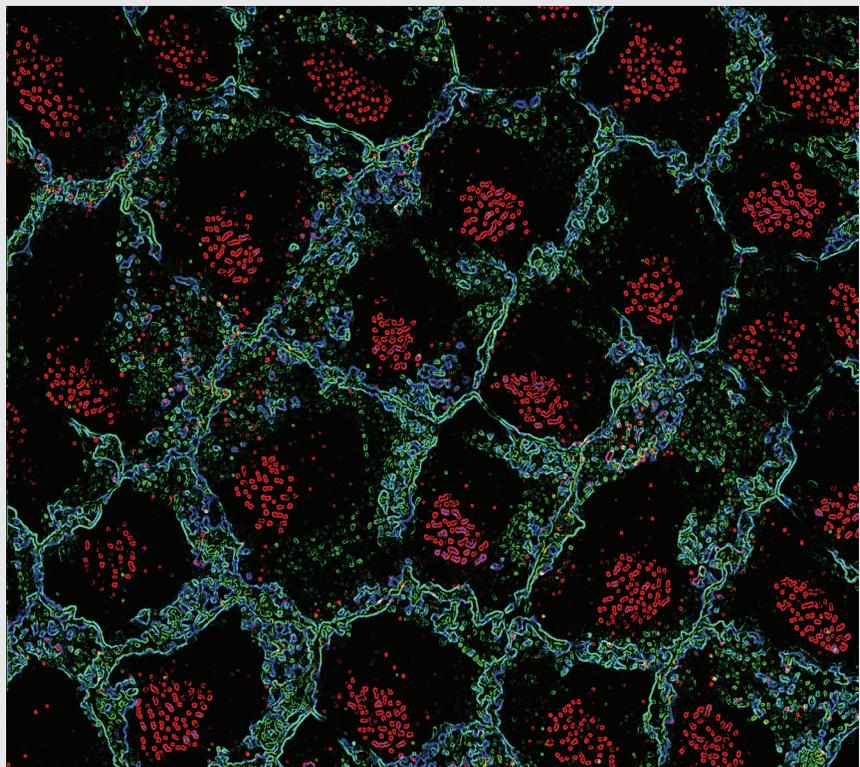
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Ependymal cell basal bodies (red) are clustered in a patch just below the surface of ependymal cells outlined in green.



1969–2019

ADDRESS

1121 14th Street NW
Suite 1010
Washington, DC 20005
Tel: 202.962.4000
Fax: 202.962.4941

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