### Sunday, April 28

<table>
<thead>
<tr>
<th>Event</th>
<th>Location</th>
<th>Time</th>
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<tbody>
<tr>
<td>Registration/Badge Printing</td>
<td>Main Lobby</td>
<td>7am–6pm</td>
</tr>
<tr>
<td>ARVO Central</td>
<td>Exhibit Hall</td>
<td>7am–6pm</td>
</tr>
<tr>
<td>Basic Clinical Lecture</td>
<td>East Ballroom B</td>
<td>8–10am</td>
</tr>
<tr>
<td>Symposia</td>
<td>See program listing</td>
<td>8–10am</td>
</tr>
<tr>
<td>Posters</td>
<td>See program listing</td>
<td>8–9:45am</td>
</tr>
<tr>
<td>Exhibits</td>
<td>Exhibit Hall</td>
<td>8:30am–5pm</td>
</tr>
<tr>
<td>ARVO/Alcon Keynote Session</td>
<td>ARVO Ballroom</td>
<td>10:15–11:45am</td>
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<tr>
<td>Proctor Award Lecture</td>
<td>ARVO Ballroom</td>
<td>12noon–12:45pm</td>
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<tr>
<td>China-ARVO Networking Forum</td>
<td>West 301</td>
<td>1–2:30pm</td>
</tr>
<tr>
<td>Low Vision Cross-sectional Group</td>
<td>West 223/224</td>
<td>1–2:30pm</td>
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<tr>
<td>Papers</td>
<td>See program listing</td>
<td>3–4:45pm</td>
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<tr>
<td>Sunday Social</td>
<td>Vancouver Aquarium</td>
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### Monday, April 29

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<tr>
<td>Registration/Badge Printing</td>
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<td>ARVO Central</td>
<td>Exhibit Hall</td>
<td>7am–6pm</td>
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<tr>
<td>NAEVR Defense Briefing</td>
<td>West 109/110</td>
<td>7–8am</td>
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<tr>
<td>Posters</td>
<td>See program listing</td>
<td>8:15–10am</td>
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<tr>
<td>Papers/Minisymposia</td>
<td>See program listing</td>
<td>8:15–10am</td>
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<tr>
<td>Exhibits</td>
<td>Exhibit Hall</td>
<td>8:30am–5pm</td>
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<tr>
<td>Section Business Meetings</td>
<td>See program listing</td>
<td>10:15–11:15am</td>
</tr>
<tr>
<td>Workshops</td>
<td>See program listing</td>
<td>1:15–2:45pm</td>
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<tr>
<td>SIGs/Workshops</td>
<td>See program listing</td>
<td>1:15–2:45pm</td>
</tr>
<tr>
<td>Multi-Disciplinary Ophthalmic Imaging Cross-sectional Group</td>
<td>East Ballroom B</td>
<td>1:15–2:45pm</td>
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<tr>
<td>WEAVR Luncheon</td>
<td>Harbour Ballroom</td>
<td>1:15–2:45pm</td>
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<tr>
<td>Friedenwald Award Lecture</td>
<td>ARVO Ballroom</td>
<td>3–3:45pm</td>
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<tr>
<td>Special Sessions</td>
<td>See program listing</td>
<td>7:30–9pm</td>
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<tr>
<td>Student/Trainee Social</td>
<td>West Ballroom Foyer</td>
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### Tuesday, April 30

<table>
<thead>
<tr>
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<tr>
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<tr>
<td>ARVO Central</td>
<td>Exhibit Hall</td>
<td>7am–6pm</td>
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<tr>
<td>Breakfast with the Experts†</td>
<td>Harbour Ballroom</td>
<td>7–8:30am</td>
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<td>Exhibits</td>
<td>Exhibit Hall</td>
<td>8:30am–5pm</td>
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<tr>
<td>Posters</td>
<td>See program listing</td>
<td>8:45–10:30am</td>
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<tr>
<td>Papers/Minisymposia</td>
<td>See program listing</td>
<td>8:45–10:30am</td>
</tr>
<tr>
<td>General Business Meeting</td>
<td>West 211</td>
<td>10:45–11:30am</td>
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<tr>
<td>Weisenfeld Award Lecture</td>
<td>ARVO Ballroom</td>
<td>1:45–2:30pm</td>
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<tr>
<td>MIT Outstanding Poster Award Competition</td>
<td>Exhibit Hall</td>
<td>4:15–6:30pm</td>
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<tr>
<td>ARVO/Champalimaud Award Lecture</td>
<td>ARVO Ballroom</td>
<td>5:45–6:45pm</td>
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### Wednesday, May 1

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<td>Exhibit Hall</td>
<td>7am–6pm</td>
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<tr>
<td>Posters</td>
<td>See program listing</td>
<td>8:15–10am</td>
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<tr>
<td>Papers/Minisymposia</td>
<td>See program listing</td>
<td>8:15–10am</td>
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<tr>
<td>Exhibits</td>
<td>Exhibit Hall</td>
<td>8:30am–5pm</td>
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<tr>
<td>Genetics Cross-sectional Group</td>
<td>East Ballroom B</td>
<td>12:15–1:45pm</td>
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<tr>
<td>Workshops</td>
<td>See program listing</td>
<td>12:15–1:45pm</td>
</tr>
<tr>
<td>SIGs/Workshops</td>
<td>See program listing</td>
<td>12:15–1:45pm</td>
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<tr>
<td>Cogan Award Lecture</td>
<td>ARVO Ballroom</td>
<td>2–2:45pm</td>
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<tr>
<td>Special Sessions</td>
<td>See program listing</td>
<td>6:15–7:45pm</td>
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<tr>
<td>Classical Concert</td>
<td>West 301</td>
<td>8–10pm</td>
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<tr>
<td>Karaoke Night†</td>
<td>Blackbird Public House</td>
<td>9pm–12midnight</td>
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### Thursday, May 2

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<tr>
<td>Registration</td>
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<tr>
<td>ARVO Central</td>
<td>Exhibit Hall</td>
<td>7am–3pm</td>
</tr>
<tr>
<td>Symposia</td>
<td>See program listing</td>
<td>8–10am</td>
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<tr>
<td>Posters</td>
<td>See program listing</td>
<td>8–9:45am</td>
</tr>
<tr>
<td>Papers</td>
<td>See program listing</td>
<td>10:15am–12noon</td>
</tr>
<tr>
<td>SIGs/Workshops</td>
<td>See program listing</td>
<td>12:15–1:45pm</td>
</tr>
<tr>
<td>ARVO 2020 Kickoff Reception</td>
<td>Exhibit Hall</td>
<td>2–3pm</td>
</tr>
<tr>
<td>Beckman Argyros Award Lecture</td>
<td>ARVO Ballroom</td>
<td>3:15–4:15pm</td>
</tr>
<tr>
<td>ARVO/Alcon Keynote Session</td>
<td>ARVO Ballroom</td>
<td>4:30–6pm</td>
</tr>
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</table>

* All Poster Session (all first authors must be present at their poster)
† Separate registration required
Important Policies

Use of recording/photography/audiotape/video equipment: Recording by any means (photographing, audiocaping, videoaping) of any presentations or sessions at any ARVO Meeting is prohibited, except by an ARVO-authorized agent for official purposes or by First Authors who wish to photograph their own poster presentations. Violators risk confiscation of their equipment and/or dismissal from the Annual Meeting as deemed appropriate by ARVO.

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Clinical Trials Registration Policy: All clinical trials that will be reported in ARVO Annual Meeting abstracts must be registered on a publicly available database. The required acknowledgement of the First Author, acting as the authorized agent for all authors, certifies that any research presented in the abstract that reports on a clinical trial is registered, and the registration location and number are included on the abstract, in compliance with the ARVO Statement on Registering Clinical Trials, arvo.org/About/policies/statement-on-registering-clinical-trials. For more information on this policy, refer to the Clinical Trials Registration Index at arvo.org/program-summary.

Program Summary

Program Summary: Online at arvo.org/program-summary. Abstracts are referred to in the Program Summary by program number (not page number) and session number.

Online Planner: Abstracts may be viewed and printed from the online planner at arvo.org/annual-meeting/program/online-planner.

ARVO 2019 Mobile App: Offers complete search functionality for the Annual Meeting Program. Plan your schedule or sync with your schedule in the Online Planner. Download from the App Store, Google Play and elsewhere.

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ARVO is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

ARVO designates this live activity for a maximum of 23.75 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Please refer to the Pocket Guide for the complete CME information.

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See arvo.org/program-summary for:
- ARVO Commercial Relationships Policy
- Commercial Relationships Index
- Statement on Registering Clinical Trials
- Clinical Trials Index
- Moderator Index

Children in the Convention Center

Children under 18 years old must be accompanied by a parent or guardian at all times. Parents/guardians who bring children into paper sessions must remove them immediately if they become disruptive. Children are not allowed to accompany parents/guardians in sessions/events where tickets are required or food is provided, except events for which children’s tickets are available for purchase. Under no circumstances are children permitted in the exhibit hall during set-up or dismantle times.

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The Program Summary provides a summary of the ARVO 2019 Annual Meeting Scientific Program and information about other Meeting events and activities. Abstracts are not included. Abstracts are available online for viewing and printing. See below for details.

The scientific program is organized chronologically by day, session time and program number. All sessions scheduled within the same time slot are listed together (see thumb index at the side of each page).

A Program Daily Schedule is included for each day to provide a quick view of the scheduled paper and poster sessions, symposia, award lectures, business meetings, workshops and special interest groups (SIGs). These program schedules are located at the beginning of each scientific program day.

Page headers include the day, type of session and the program number range on each page.

There are four indices to assist you in locating sessions, moderators and presentations.

- **Author Index** — All authors are listed alphabetically by last name. Boldface type is used to indicate the program number and poster board number of the abstract for which the author is First (Presenting) Author. Bold and italic type indicates a symposium presentation. This index is located in the back of this book.

- **Moderator Index** — This is a listing of the session moderators alphabetically by last name. Included are the moderator’s name, session day, date, time, location, title and Commercial Relationships Disclosure, if applicable. This index can be found online at arvo.org/am/program-summary.

- **Clinical Trial Registration Index** (online only) — This is a listing by program number of the clinical trial registration information for each applicable presentation as indicated at the time of abstract submission. See ARVO Statement on Registering Clinical Trials in this Index. This index can be found online at arvo.org/am/program-summary.

- **Commercial Relationships Index** (online only) — This is a listing by program number of the commercial relationships and names of firms with which commercial relationships exist for each First Author and Co-author as indicated. First Authors or Co-authors who indicated “none” for commercial relationship are not included in this index. See Commercial Relationships Policy in the Index. This index can be found online at arvo.org/program-summary.

### Paper Sessions/Symposia/Minisymposia:

- **West 212-214**
  - **Monday, April 29, 2019 11:15 AM-1:00 PM**
  - **Visual Neuroscience / Anatomy and Pathology/Oncology / Retina / Retinal Cell Biology**
  - **Session number**: 233
  - **Session title**: Of mice and men: Comparing primate and rodent retina - Minisymposium
  - **Paper presentation time**: 11:44

### Poster Sessions:

- **West Exhibition Hall A0552-A0568**
  - **Monday, April 29, 2019 4:00 PM-5:45 PM**
  - **Glaucoma**
  - **Session number**: 283
  - **Session title**: Clinical Studies
  - **Program number**: 2388
  - **Poster board number for presentation**: A0552
  - **Poster title**: Making a correct diagnosis of glaucoma, the EMGT experience. Hanna Maria Öhnell, B. Bengtsson, A. Heijl. clinical sciences, Malmö, Lund University *CR, »

*CR refers to the program number in the Commercial Relationships (CR) Index for Disclosures.

» Refer to the Program Number in the Clinical Trial (CT) Registration Index.

Poster board numbers indicate the Exhibit Hall location of the presentation. For example, A0552 will be located in Poster Area A and B1098 will be located in Poster Area B.

Abstracts also will be available at iovs.arvojournals.org, the version of record, in summer 2019.
Vancouver Convention Centre
Entry Level — Registration/Offices/Main Ballrooms
West Building
Meeting Rooms/Convention Center

Vancouver Convention Centre
West Level 2
West Building

West 204
FARVO Lounge

West 301
Classical Concert

Vancouver Convention Centre
West Level 3
West Building
### ARVO Office Information

**Association for Research in Vision and Ophthalmology**  
1801 Rockville Pike, Suite 400  
Rockville, MD 20852–5622  
Tel: +1.240.221.2900  
Fax: +1.240.221.0370  
arvo.org

#### ARVO Staff

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<th>Executive Office</th>
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<tr>
<td>Iris M. Rush, CAE Executive Director</td>
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</table>
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Director, Human Resources |
| Stephen Willie  
Senior Manager, Executive & Committee Operations |
| Marisa Lavine, MS  
Chief Marketing and Communications Officer |
| John Saville  
Senior Graphic Designer |
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Assistant Director, Communications and Digital Strategy |
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Coordinator, Marketing and Communications |

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| Jason Spessard, MBA, CAE  
Chief Financial Officer |
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Senior Manager, Finance |
| Clarissa Portillo  
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<tr>
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| Tim Maxey  
Chief Information Officer |
| Kiah Culver  
Assistant Director, Customer Service |
| Jeremy McCravy  
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Customer Service |
| Mackenzie Wright  
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| Lancey Cowan, JD, CAE  
Chief Meetings Officer |
| Kathy Cox  
Assistant Director, Meetings |

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</table>
| Cathy Conley  
Senior Instructional Designer |
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| James Jorkasky  
Executive Director |
| David Epstein  
Director, Government Relations and Education |

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| Steven J. Fliesler, PhD, FARVO  
Retinal Cell Biology |

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<th>Vice President(s)</th>
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| Raymond A. Appleget, OD, PhD, FARVO  
Visual Psychophysics/Physiological Optics  
Andrew D. Dick, MBBS, MD, FMedSci, FARVO  
Immunology/Microbiology |

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| W. Daniel Stamer, PhD, FARVO  
Physiology/Pharmacology |

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| Jennifer J. Kang-Mieler, PhD, FARVO  
Retina |

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<th>Immediate Past President</th>
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| Claude Burgoyne, MD, FARVO  
Glaucoma |

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| Justine R. Smith, MBBS, PhD, FARVO  
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<th>Trustees</th>
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| T. Michael Redmond, PhD, FARVO  
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| Stephen C. Plugelder, MD, FARVO  
Cornea |

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The Ohio State University
Columbus, Ohio

Lisa A. Ostrin, OD, PhD
University of Houston
Houston, Texas

Jennifer J. Hunter, PhD
University of Rochester
Rochester, N.Y.

Andrew Carkeet, MS, PhD
OUT School of Optometry and Vision Science
Kelvin Grove, QLD, Australia

Ulrike Guntern, PhD (Chair)
University of Sydney
Sydney, NSW, Australia

Jan J. Kremers, PhD
University of Erlangen
Nuremberg, Germany

Erika D. Eggers, PhD
University of Arizona
Tucson, Ariz.

Low Vision Cross-sectional Group
Zi-Bing Jin, MD, PhD (Chair)
Wenzhou Medical University
Wenzhou, China

Yutao Liu, MD, PhD
Augusta University
Augusta, Ga.

Susanne Roosing, PhD
Radboud University Medical Center
Nijmegen, The Netherlands

Multidisciplinary Ophthalmic Imaging Cross-sectional Group
Yali Jia, PhD (Chair)
Oregon Health & Science University
Portland, Ore.

Stacey S. Choi, PhD
The Ohio State University
Columbus, Ohio

Kevin Chan, PhD
New York University
New York, N.Y.

Richard Rosen, MD
New York Eye and Ear Infirmary of Mount Sinai
New York, N.Y.

Ex Officio
Steven J. Fliesler, PhD, FARVO
SUNY-Buffalo / VA Medical Center – Buffalo
Buffalo, N.Y.

W. Daniel Stamer, PhD, FARVO
Duke University
Durham, N.C.

Claude F. Burgoyne, MD, FARVO
Devers Eye Institute
Portland, Ore.
In remembrance

ARVO recognizes and honors members who we lost in the last year. We’re proud of our members and their contributions to the vision and eye research community. If you know of a member who has passed, please let us know at arvo@arvo.org.

Satish K. Srivastava, PhD
Feb. 12, 2019
Dr. Srivastava passed away from complications of heart failure. He was Professor of Biochemistry & Molecular Biology at the University of Texas Medical Branch in Galveston, and was a long-time member of the LE section of ARVO. For over 50 years, Srivastava published his research on lens metabolism and molecular mechanisms leading to cataract formation. His many trainees now lead research teams worldwide.

R. Rand Allingham, MD, FARVO
Aug. 27, 2018
Internationally renowned in the field of glaucoma, Dr. Allingham received his MD from the University of Cincinnati, completed his residency at the Eastern Virginia Medical School and completed a glaucoma fellowship at Massachusetts Eye and Ear Infirmary. He was recruited by Duke Eye Center in 1983, and served as chief of the glaucoma service for 22 years. He has made seminal contributions to glaucoma clinical care and to understanding the most basic causes for several types of glaucoma, including a severe form of glaucoma that affects individuals with African ancestry. He was an ARVO member from 1986 until 2017.

Robert H. Webb, PhD
Aug. 23, 2018
Even with a strong academic background — studying physics at Rutgers and Stanford and teaching at Tufts University — Dr. Webb was mainly known for his affiliation with Schepens Eye Research Institute and Wellman Laboratory at Massachusetts General Hospital. While there, he invented diagnostic instrumentation, such as the Scanning laser ophthalmoscope, the pneumotonometer and several applications in confocal microscopy. He was also Associate Professor of Ophthalmology and Dermatology at Harvard Medical School. Webb was a member of the RE section.

Venkat Reddy, PhD, FARVO
June 30, 2018
Dr. Reddy was a recognized expert on the metabolism of the lens and formation of cataracts. He grew up near Hyderabad, India, and emigrated to the U.S. to obtain his MS and PhD degrees at Fordham University. He joined the faculty at Kresge Eye Institute and left there with a colleague to establish the Eye Research Institute (ERI) at Oakland University in Rochester Michigan. In 1998, he retired from ERI and joined the faculty of the University of Michigan Department of Ophthalmology and Visual Sciences. He returned to Oakland University in 2006 as Distinguished Professor of Biomedical Sciences. Emeritus, Reddy was an ARVO member from 1980 to 2017, earning his gold Fellow in 2009. He served on the editorial board of IOVS and as a trustee of the Physiology and Pharmacology section from 1995 to 2000.

Jean-Claude Hache
Oct. 12, 2018
Professor Hache was a neuro-ophthalmologist at Lille Regional University Hospital. He was a pioneer of electrophysiology, originally studying “de Beaupias,” the correlation between quality of vision and learning to read. With colleague Guy Charlot, Hache started the SILMO Academy, with the theme “Vision and growth, from 0 to 20 years,” and he remained their chairman to 2017. Hache was a member of the EY section and an ARVO member from 1992 to 2003.

Christopher A. Paterson, PhD, DSc, FARVO
March 30, 2018
Dr. Paterson was the Kentucky Lions Research Chair of Ophthalmology at the University of Louisville School of Medicine. Paterson’s research focused on the mechanisms of cataract development, ocular inflammation and corneal wound healing. In collaboration with colleagues, he published more than 200 peer-reviewed papers. Paterson was an active ARVO member; he was a gold Fellow, served as 1994–1995 ARVO president and was on the ARVO Foundation Board of Governors. He earned his PhD and DSc from the University of London Institute of Ophthalmology and completed a research fellowship at the Wilmer Eye Institute, Johns Hopkins University Hospital.

Paul Sheehy, PhD
Jan. 22, 2019
Dr. Sheehy most recently served as the NIH/National Eye Institute Director of Extramural Activities. He earned his MS in biophysics from the University of Maryland at Baltimore and completed his PhD at the Uniformed Services University of the Health Sciences. Prior to his position at NEI, Sheehy held positions at NIH/National Institute of General Medical Sciences and NIH/National Institute of Neurological Disorders and Stroke. He was a member of the ARVO AP section.

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David R. Pepperberg, PhD, FARVO
Sept. 2, 2018
Dr. Pepperberg has been a vision neuroscientist at the University of Illinois at Chicago since 1983. He was the Sears-Schenk Professor in the Department of Ophthalmology and Visual Science. In a career spanning more than 40 years, Pepperberg made many seminal contributions to ophthalmology, where his work focused on the molecular and cellular mechanisms of light and dark adaptation in retinal photoreceptors.

He published over 100 journal articles, most on photo transduction, and has been a long-time ARVO member.

Oscar Candia, MD, FARVO
Dec. 2018
Born in Argentina and earning his MD from the University of Buenos Aires School of Medical Sciences, Dr. Candia joined the Mount Sinai Departments of Ophthalmology and Physiology in 1968, ultimately serving as Director and Vice Chairman for Research in the Department of Ophthalmology. Candia’s work furthered the understanding of the physiological and biophysical features of the cornea, lens, and ciliary body, and appeared in more than 140 peer-reviewed publications. He was an ARVO member from 1980 to 2017, earning his gold Fellow in 2009. He served on the editorial board of IOVS and as a trustee of the Physiology and Pharmacology section from 1995 to 2000.

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ARVO Social Events: Everyone is Welcome!

**Sunday Social**
Sun., April 28, 7–10pm
An evening at the Vancouver Aquarium
845 Avision Way
Adults: $30 USD; 18 and under: $20 USD. Shuttles will be available.
This year’s Sunday Social features exhibits, animals, a dolphin and sea lion show and a 4-D movie experience. Ticket includes admission and two drinks.

**Student/Trainee Social**
Mon., April 29, 7:30–9pm
Vancouver Convention Centre
West Ballroom Foyer
All trainees attending the Meeting are invited to join us in honoring the 2019 Travel Grant Recipients. Come and mingle with your colleagues, make new acquaintances, and meet members of the ARVO Board of Trustees.

**ARVO Classical Concert**
Wed., May 1, 8–10pm
Vancouver Convention Centre
West 301
The popular ARVO Classical Concert is performed by multi-talented ARVO members. Relax and enjoy the music.

**ARVO Karaoke**
Wed., May 1, 9pm–12midnight
Blackbird Public House
905 Dunsmuir St.
Adults: $20 USD.
Show your vocal talents or cheer on your favorite performer at the ARVO karaoke night! Admission includes one drink. Cash bar and light snacks will also be available. You must be 21 years or older to attend this event.

**Visit Baltimore Welcomes ARVO 2020 Kick-Off Reception**
Thurs., May 2, 2–3pm
Vancouver Convention Centre
Exhibit Hall
Join ARVO and Visit Baltimore as we look forward to the ARVO 2020 Annual Meeting, May 3–7.

*Tickets required. Tickets may be purchased at the Gift Shop in ARVO Central.

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ARVO Learn is the name for ARVO’s education offerings and its new online education platform.

ARVO Learn offers education opportunities to vision researchers worldwide, with 24/7 access. Member and nonmember options available.

ARVOLearn.org
Visit NAEVR Central in the Exhibit Hall
Hours: Sun. – Wed.: 8:30am – 5pm

Hosted by NAEVR’s James Jorkasky and David Epstein
• Contact Congress to support vision research funding increases
• Learn about research funding resources, such as multiple
  Department of Defense (DoD) funding opportunities to meet critical
  vision research gaps

NAEVR’s Defense-Related Vision Research
Opportunities Session
Monday, April 29, 7 – 8am, West 109
NAEVR has invited DoD representatives to speak about funding
opportunities and past DoD awardees to offer insights into how
researchers can be most responsive to the funding Program
Announcement.

Future ARVO
Annual Meetings

May 3 – 7, 2020
Baltimore, Md.

May 2 – 6, 2021
San Francisco, Calif.

May 1 – 5, 2022
Denver, Colo.

April 23 – 27, 2023
New Orleans, La.

May 5 – 9, 2024
Seattle, Wash.

May 4 – 8, 2025
Austin, Texas

Connect with ARVO on your favorite social
networking site for the most up-to-date
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