

## KARA L. MARSHALL

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### EDUCATION

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- PhD** Columbia University, Cellular, Molecular & Biomedical Science 2016  
Dissertation: *The Functional Diversity of Mammalian Touch Receptors*  
Advisor: Ellen A. Lumpkin, Ph.D.
- MS** Baylor College of Medicine, Neuroscience (Ph.D. program) 2010  
Thesis: *Testing the Roles of TRPV1 and TRPV4 in Glucose Regulation*  
Advisor: Ellen A. Lumpkin, Ph.D.
- BS** Texas A&M University, Biology 2007  
Graduated *Magna Cum Laude* with University Honors  
Minored in Psychology  
Research Advisor: James Grau

### RESEARCH EXPERIENCE

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- Postdoctoral Fellow**, HHMI/ The Scripps Research Institute 2016–present  
La Jolla, CA  
Advisor: Ardem Patapoutian
- Identified the mechanotransduction ion channel PIEZO2 as essential for bladder filling sensation and urinary function in mice and humans. (Marshall et al., 2020, *Nature*)
  - Helped determine that both PIEZO1 and PIEZO2 are critical for neuronal blood pressure sensing and the baroreflex. (Zheng, Marshall et al., 2018, *Science*)
  - Contributed to understanding that PIEZO2 facilitates noxious mechanical pain in the context of injury or inflammation. (Murthy et al., 2018, *Sci. Translational Med*)
  - Investigating the mechanosensory ion channels in neurons that innervate the gastrointestinal tract and their role in mediating feeding behavior and digestion. (unpublished)
- Ph.D. Student**, Columbia University 2010–2016  
New York, NY  
Advisor: Ellen A. Lumpkin
- Discovered a new phenomenon of rapid touch-receptor remodeling in the context of healthy skin renewal. (Marshall & Clary et al., 2016, *Cell Reports*)
  - Described the anatomical and organizational structure of somatosensory neurons that innervate the bat wing to provide sensory feedback during flight. (Marshall et al., 2015, *Cell Reports*)
  - Identified the structural features of touch receptors that govern their firing properties in the skin. (Lesniak & Marshall et al., 2014, *eLife*)

**Ph.D. Student**, Baylor College of Medicine 2007–2010  
Houston, TX (transferred programs to move to Columbia with PI)  
Advisor: Ellen A. Lumpkin

- Determined that sensory neurons innervating the pancreas express TRP channels in higher proportion than other sensory neurons, and that these ion channels could contribute to blood glucose control. (unpublished)

**University Honors Research Fellow**, Texas A&M University 2006–2007  
College Station, TX  
Advisor: James Grau

**Research Assistant**, Texas A&M University 2005–2007  
College Station, TX  
Grau Lab

**Summer Undergraduate Research Fellow**, UT Health Science Center 2005  
San Antonio, TX  
Toney Lab

#### MENTORING AND TEACHING EXPERIENCE

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##### *Teaching*

“Scientific figure-making workshop” 2015  
Instructor & course designer  
Skin Disease Research Center, Columbia University, New York, NY

“Introduction to Confocal Microscopy” 2014  
Instructor  
Skin Disease Research Center, Columbia University, New York, NY

##### *Mentoring*

###### **Undergraduate Students**

Alexandra Salazar, San Jose State University  
Kaylee Shi Hui Lee, University of California San Diego  
Kelly Li, University of California San Diego  
Leroy Perez-Haddock, University of Puerto Rico

###### **Technicians**

Adam Coombs, University of California San Diego  
Current position: Incoming OHSU graduate student

###### **Graduate Students (advised under primary mentor)**

Yu Wang, Scripps Research  
Current position: Graduate student  
Blair Jenkins, Columbia University  
Current position: Dermatology resident, Columbia University

## PUBLICATIONS

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- Marshall KL**, Saade D, Ghitani G, Coombs AM, Szczot M, Keller J, Ogata T, Daou I, Stowers LT, Bonnemann CG, Chesler AT, Patapoutian A. (2020) PIEZO2 in sensory neurons and urothelial cells coordinates urination. *Nature* (online ahead of print) PMID: 33057202
- Marshall KL**, Patapoutian A. (2020) Getting a grip on touch receptors. *Science*. 368(6497):1311-1312. PMID: 32554582 [Commentary]
- Zeng W, **Marshall KL**, Min S, Daou I, Chapleau MW, Abboud FM, Liberles SD, Patapoutian A. (2018) PIEZO2 mediates neuronal sensing of blood pressure and the baroreceptor reflex. *Science*. 362(6413):464-467. PMID: 30361375
- Moayed Y, Greenberg SA, Jenkins BA, **Marshall KL**, Dimitrov LV, Nelson AM, Owens DM, Lumpkin EA. (2019) Camphor white oil induces tumor regression through cytotoxic T cell-dependent mechanisms. *Mol Carcinog*. 58(5):722-734. PMID: 30582219
- Murthy SE, Loud MC, Daou I, **Marshall KL**, Schwaller F, Kühnemund J, Francisco AG, Keenan WT, Dubin AE, Lewin GR, Patapoutian A. (2018) The mechanosensitive ion channel Piezo2 mediates sensitivity to mechanical pain in mice. *Science Translational Medicine*. 10(462). PMID:30305457
- Sterbing-D'Angelo, SJ, Chadha, M, **Marshall, KL**, Moss, CF. (2016) Functional role of airflow sensing hairs on the bat wing. *J Neurophysiol*. 117(2):705-712. PMID: 27852729
- Marshall, K.L.\***, Clary, R.C.\*, Baba, Y., Orlowsky, R.L., Gerling, G.J., Lumpkin, E.A. (2016) Touch receptors undergo rapid remodeling in healthy skin. *Cell Reports*. 17(7):1719-1727. PMID: 27829143 \*co-first authorship
- Marshall, K.L.**, Chadha, M., DeSouza, L.A., Sterbing-D'Angelo, S.J., Moss, C.F., Lumpkin, E.A. (2015) Somatosensory substrates of flight control in bats. *Cell Reports*. 11(6): 851-858. PMID: 25937277 [cover art]
- Wang, Y., **Marshall, K.L.**, Baba, Y., Lumpkin, E.A., Gerling, G.J. (2015) *PLoS One*. Compressive viscoelasticity of freshly excised mouse skin is dependent on specimen thickness, strain level and rate. 10(3):e0120897 PMID: 25803703
- Maksimovic, S., Nakatani, M., Baba, Y., Nelson, A.M., **Marshall, K.L.**, Wellnitz, S.A., Firozi, P., Woo, S.H., Ranade, S., Patapoutian, A., Lumpkin, E.A. (2014) Epidermal Merkel cells are mechanosensory cells that tune mammalian touch receptors. *Nature*. 509(7502):617-621 PMID: 24717432
- Lesniak, D.R.\*, **Marshall, K.L.\***, Wellnitz, S.A., Jenkins, B.A., Baba, Y., Rasband, M.N., Gerling, G.J., Lumpkin, E.A. (2014) Computation identifies structural features that govern neuronal firing properties in slowly adapting touch receptors. *Elife*. 2014;3:e01488 PMID: 24448409 \*co-first authorship
- Wang, Y., **Marshall, K.L.**, Baba, Y., Lumpkin, E.A., Gerling, G.J. (2013) Natural Variation in Skin Thickness Argues for Mechanical Stimulus Control by Force Instead of Displacement. *Joint Eurohaptics Conf Symp*. 2013:645-650. PMID: 24500653

- Wang, Y., **Marshall, K.L.**, Baba, Y., Gerling, G.J., Lumpkin, E.A. (2013) Hyperelastic material properties of mouse skin under compression. *PLoS One*. 8(6) PMID: 23825661
- Marshall, K.L.**, Lumpkin, E.A. (2012) The molecular basis of mechanosensory transduction. *Adv. Exp. Med. Biol.* 739:142-155. PMID: 22399400 [Book chapter]
- Nelson, A.M., **Marshall, K.L.**, Lumpkin, E.A. (2011) DEG/ENaCs lead by a nose: mechanotransduction in a polymodal sensory neuron. *Neuron*. 71(5):763-5 PMID: 21903069 [Commentary]
- Lumpkin, E.A., **Marshall, K.L.**, Nelson, A.M. (2010) The cell biology of touch. *Journal of Cell Biology*. 191(2): 237-248 PMID: 20956378 [Review]
- Washburn, SN, Patton, BS, Ferguson, AR, **Hudson, KL**, & Grau, JW. (2007). Exposure to intermittent nociceptive stimulation under pentobarbital anesthesia disrupts spinal cord function. *Psychopharmacology*. 192, 243-252 PMID: 17297638

## FUNDING

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K99 DK128621	Role: PI	04/2021–03/2022
Impact Score: 14 (Approval pending council review)		
<i>Molecular Mechanisms of Mechanosensing in the Urinary Tract</i>		
F32 DK121494	Role: PI	06/2019—5/2022
Ruth L. Kirschstein NRSA Postdoctoral Fellowship		
<i>Molecular Mechanisms of Stomach Stretch Sensing</i>		

## HONORS AND AWARDS

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Jared F. Purton Memorial Award, The Scripps Research Institute Winner of the Lightning Talks Competition	2020
Society of Fellows Travel Award, The Scripps Research Institute	2018
Dean's Award for Excellence in Research, Columbia University Awarded to two graduates per year from the entire graduate school for their PhD work.	2017
Symposium Award, Society of General Physiology Symposium on Sensory Transduction	2014
Grand prize for Best Platform Presentation (2 <sup>nd</sup> time in a row) Cellular, Molecular and Biomedical Sciences Biennial Retreat, Columbia University	2014
Travel Scholarship, Janelia Farm Research Center Conference on Mammalian Circuits Underlying Touch Sensation	2013
Society for Neuroscience Travel Award Kavli Institute for Brain Science	2012
Grand prize for Best Platform Presentation Cellular, Molecular and Biomedical Sciences Biennial Retreat, Columbia University	2012

Grand prize for Best Poster Presentation Physiology & Cellular Biophysics Annual Retreat, Columbia University	2012
Helen Record Predoctoral Fellowship Department of Neuroscience, Baylor College of Medicine	2009
Honorable Mention, NSF Graduate Research Fellowship	2009
Phi Beta Kappa, Texas A&M University Chapter	2007
University Undergraduate Research Fellow, Texas A&M	2006

## **PRESENTATIONS AND INVITED SEMINARS**

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**Under Pressure: PIEZO ion channels in interoception.** *Mount Sinai Neuroscience Seminar Series*, New York, NY. 2020 (virtual)

**Under Pressure: PIEZO ion channels in interoception.** *SPiNES Seminar Series*, NYU Langone Medical Center, New York, NY. 2020 (virtual)

**The role of PIEZO2 in urination.** *Annual Meeting*, Society for Urodynamics, Female Pelvic Medicine & Urogenital Reconstruction, Scottsdale, AZ. 2020

**PIEZO ion channels in mechanotransduction.** *Neuroscience in Urology Think Tank*, NIDDK, Bethesda, MD. 2019

**Under Pressure: The Role of Piezo2 in Urination,** *Somatosensation: From Detection to Perception*, Keystone Symposium Conference, Keystone, CO. 2020

**Molecular mechanisms of stomach stretch sensing.** *Force Gated Ion Channels*, Berlin, Germany. 2018.

**Bats have evolved unique sensorimotor circuitry to support mammalian flight.** *Society for Neuroscience*, Washington, D.C., 2014.

**How do touch receptors maintain reliable firing during normal target remodeling?** *Mammalian Circuits Underlying Touch Sensation*, Ashburn, VA: Janelia Farm Research Campus, 2013.

**Elucidating the electrical architecture of a mammalian touch receptor.** *Society for Neuroscience*, New Orleans, LA, 2012.

### ***Poster presentations***

**Marshall, K.L.,** Patapoutian, A. Molecular mechanisms of stomach stretch sensing. *Mammalian Sensory Systems*. Keystone Symposia Conference, Seattle, WA. 2019

**Marshall, K. L.,** B. A. Jenkins, Y. Baba, Y. Wang, D. R. Lesniak, G. J. Gerling, Lumpkin, E. A. Elucidating mechanisms of touch-receptor plasticity during target-organ remodeling. *Society of General Physiology, Symposium on Sensory Transduction*. Woods Hole, MA. 2014.

**Marshall, K. L.**, M. Chadha, L. A. deSouza, S. J. Sterbing-D'Angelo, C. F. Moss, E. A. Lumpkin. Tactile sensing in the bat's winged hand. *Northeast Regional Meeting of the Society for Developmental Biology*. Woods Hole, MA. 2014.

**Marshall, K. L.**, B. A. Jenkins, E. A. Lumpkin. What are the molecular mechanisms that govern mammalian touch receptor remodeling? *Northeast Regional Meeting of the Society for Developmental Biology*, Woods Hole, MA. 2014.

Lumpkin, E. A., **Marshall, K. L.\***, B. A. Jenkins, Y. Baba, Y. Wang, D. R. Lesniak, G. J. Gerling. Elucidating mechanisms of touch-receptor plasticity during target-organ remodeling. *Society for Neuroscience*, Washington, D.C., 2014. \*Presenter

**Marshall, KL**, Wellnitz, SW, Gerling, GJ, Lumpkin, EA. Elucidating the electrical architecture of a mammalian touch receptor. *Collaborative Research in Computational Neuroscience PI Meeting*. Princeton, NJ, 2011.

## **PROFESSIONAL TRAINING**

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### **Advanced Techniques in Molecular Neuroscience**

Cold Spring Harbor Laboratories, Cold Spring Harbor NY, 2017

## **PROFESSIONAL SERVICE**

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### **Co-Chair, Nanosymposium**

“The Cells and Molecules of Touch, Itch and Thermoreception”  
Society for Neuroscience, Annual Meeting, 2014

### **Peer-Reviewed Articles for:**

- Cell (co-reviewer)
- Nature (co-reviewer)
- Science (co-reviewer)
- Journal of Neurophysiology

## **COMMUNITY SERVICE**

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### **Fleet Science Center**

Speaker, Sharp Minds Lecture Series, San Diego, CA. 2020

Speaker, Suds and Science, San Diego, CA. 2020

### **Científico Latino**

Volunteer (mentor to Maribel Anguiano, UC Davis student). 2019-2020

### **Columbia University Neuroscience Outreach**

Brain Bee Organizer and Volunteer, New York, NY. 2011-2013

### **The Health Museum**

Public Programming Instructor, Houston, TX. 2008-2009

## REFERENCES

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**Dr. Ardem Patapoutian**, Professor  
Department of Neuroscience  
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**Dr. Ellen A. Lumpkin**, Professor  
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**Dr. Lisa Stowers**, Professor  
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**Dr. Alexander Chesler**, Senior Investigator  
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