

# Edward C. Cooper, M.D., Ph.D.

• Associate Professor of Neurology and Neuroscience



## Clinical Service Area

Neurology

## Board Certification

American Board of Psychiatry and Neurology, Neurology

## Medical School

M.D./Ph.D., Yale University, Conn.

## Internship

Internal Medicine, University of California, San Francisco, School of Medicine, San Francisco, Calif.

## Residency

Neurology, University of California, San Francisco, School of Medicine, San Francisco, Calif.

## Clinical Fellowship

Epilepsy Research, University of California, San Francisco, School of Medicine, San Francisco, Calif.

Molecular Neurobiology, Howard Hughes Medical Institute, University of California, San Francisco, School of Medicine, San Francisco, Calif.

## Clinical Interests

Epilepsy and seizures; family history of epilepsy

## Research Interests

As a laboratory physiologist and clinical neurologist, my goal is to speed the translation of basic brain science into better treatments, cures, and preventing interventions for epilepsy and related disorders that affect children and adults. I am focused on understanding the mechanisms underlying the brain's fast long-distance signal, known as the action potential. Action potentials carry signals from our sensory organs to the brain, from the brain to our muscles, and within the brain's circuits for thought, emotion, and memory. The key molecules for the action potential, called sodium and potassium channels, are very central to many issues in epilepsy. Sodium and potassium channel genes are frequently involved when epilepsy in a family occurs due to single-gene mutation. Sodium and potassium channels are also targets of many of the known anti-epileptic drugs. We helped to discover the role KCNQ potassium channels play in the action potentials of brain and nerve. We are continuing to research how KCNQ channels balance sodium channels and make action potentials and other signals stronger and more reliable. In fact, KCNQ channels seem to be a powerful, natural anti-seizure mechanism. We are studying novel anti-seizure drugs that increase the opening of KCNQ channels. Our research spans from very basic studies at the molecular level, to in vivo work in animal models of seizures, to human studies of hereditary disorders and drug treatments.

Funding from [The Jack Pribaz Foundation](#) has enabled our lab to begin studies of KCNQ2 mutations found in patients with neonatal-onset epileptic encephalopathy. KCNQ2 encephalopathy is a recently-described syndrome of seizures and marked developmental delay (for review, see [Millichap and Cooper, 2012](#)). We are working with families and treating pediatric neurologists to assess the pathogenicity of KCNQ2 mutations newly uncovered through genetic tests, and to develop novel early treatment approaches for these patients. Families and physicians are encouraged to contact Dr. Cooper with questions about these programs.

## Contact Information

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## Journal Publications

1. Millichap JJ, Cooper EC. KCNQ2 potassium channel epileptic encephalopathy syndrome: divorce of an electro-mechanical couple? *Epilepsy Curr.* 2012;12(4):150-2. [[View journal article](#)]
2. Cooper EC. Made for "anchordin": Kv7.2/7.3 (KCNQ2/KCNQ3) channels and the modulation of neuronal excitability in vertebrate axons. *Semin Cell Dev Biol.* 2011;22(2):185-92. [[View journal article](#)]
3. Cooper EC. The cadherin superfamily and epileptogenesis: end of the beginning? *Epilepsy Curr.* 2009;9(3):87-9. [[View journal article](#)]
4. Jin Z, Liang GH, Cooper EC, Jarlebark L. Expression and localization of K channels KCNQ2 and KCNQ3 in the mammalian cochlea. *Audiol Neurotol.* 2009;14(2):98-105. [[View journal article](#)]

5. Raol YH, Lapides DA, Keating JG, Brooks-Kayal AR, Cooper EC. A KCNQ channel opener for experimental neonatal seizures and status epilepticus. *Ann Neurol.* 2009;65(3):326-36. [[View journal article](#)]
6. Cooper EC. Funny team member makes key plays, but leaves the dendritic field when hit hard. *Epilepsy Curr.* 2008;8(4):103-5. [[View journal article](#)]
7. Hill AS, Nishino A, Nakajo K, Zhang G, Fineman JR, Selzer ME, et al. Ion channel clustering at the axon initial segment and node of Ranvier evolved sequentially in early chordates. *PLoS Genet.* 2008;4(12):e1000317. [[View journal article](#)]
8. Shah MM, Migliore M, Valencia I, Cooper EC, Brown DA. Functional significance of axonal Kv7 channels in hippocampal pyramidal neurons. *Proc Natl Acad Sci U S A.* 2008;105(22):7869-74. [[View journal article](#)]
9. Cooper EC, Pan Z. Putting an end to DEND: a severe neonatal-onset epilepsy is treatable if recognized early. *Neurology.* 2007;69(13):1310-1. [[View journal article](#)]
10. Cooper EC. (What to do) when epilepsy gene mutations stop making sense. *Epilepsy Curr.* 2007;7(1):23-5. [[View journal article](#)]
11. Cooper EC. Exploiting the other inhibitory ion: KCNQ potassium channels and regulation of excitability in developing and mature brain. *Epilepsy Curr.* 2006;6(4):133-5. [[View journal article](#)]
12. Pan Z, Kao T, Horvath Z, Lemos J, Sul JY, Cranstoun SD, et al. A common ankyrin-G-based mechanism retains KCNQ and NaV channels at electrically active domains of the axon. *J Neurosci.* 2006;26(10):2599-613. [[View journal article](#)]
13. Schwarz JR, Glassmeier G, Cooper EC, Kao TC, Nodera H, Tabuena D, et al. KCNQ channels mediate IKs, a slow K+ current regulating excitability in the rat node of Ranvier. *J Physiol.* 2006;573(Pt 1):17-34. [[View journal article](#)]
14. Surti TS, Huang L, Jan YN, Jan LY, Cooper EC. Identification by mass spectrometry and functional characterization of two phosphorylation sites of KCNQ2/KCNQ3 channels. *Proc Natl Acad Sci U S A.* 2005;102(49):17828-33. [[View journal article](#)]
15. Cooper EC, Baraban SC. Pain without gain (of function): sodium channel dysfunction in epilepsy. *Epilepsy Curr.* 2004;4(4):158-9. [[View journal article](#)]
16. Devaux JJ, Kleopa KA, Cooper EC, Scherer SS. KCNQ2 is a nodal K+ channel. *J Neurosci.* 2004;24(5):1236-44. [[View journal article](#)]
17. Cooper EC, Jan LY. M-channels: neurological diseases, neuromodulation, and drug development. *Arch Neurol.* 2003;60(4):496-500. [[View journal article](#)]
18. Tsao JW, Cooper EC. Reflex-sensitive spinal segmental myoclonus associated with vitamin B12 deficiency. *Neurology.* 2003;61(6):867-8. [[View journal article](#)]
19. Castro PA, Cooper EC, Lowenstein DH, Baraban SC. Hippocampal heterotopia lack functional Kv4.2 potassium channels in the methylazoxymethanol model of cortical malformations and epilepsy. *J Neurosci.* 2001;21(17):6626-34. [[View journal article](#)]
20. Cooper EC, Harrington E, Jan YN, Jan LY. M channel KCNQ2 subunits are localized to key sites for control of neuronal network oscillations and synchronization in mouse brain. *J Neurosci.* 2001;21(24):9529-40. [[View journal article](#)]
21. Cooper EC. Potassium channels: how genetic studies of epileptic syndromes open paths to new therapeutic targets and drugs. *Epilepsia.* 2001;42 Suppl 5:49-54. [[View journal article](#)]
22. Cooper EC, Aldape KD, Abosch A, Barbaro NM, Berger MS, Peacock WS, et al. Colocalization and coassembly of two human brain M-type potassium channel subunits that are mutated in epilepsy. *Proc Natl Acad Sci U S A.* 2000;97(9):4914-9. [[View journal article](#)]
23. Cooper EC, Jan LY. Ion channel genes and human neurological disease: recent progress, prospects, and challenges. *Proc Natl Acad Sci U S A.* 1999;96(9):4759-66. [[View journal article](#)]
24. Gleeson JG, Minnerath SR, Fox JW, Allen KM, Luo RF, Hong SE, et al. Characterization of mutations in the gene doublecortin in patients with double cortex syndrome. *Ann Neurol.* 1999;45(2):146-53. [[View journal article](#)]
25. Brennan JE, Topinka JR, Cooper EC, McGee AW, Rosen J, Milroy T, et al. Localization of postsynaptic density-93 to dendritic microtubules and interaction with microtubule-associated protein 1A. *J Neurosci.* 1998;18(21):8805-13. [[View journal article](#)]
26. Cooper EC, Milroy A, Jan YN, Jan LY, Lowenstein DH. Presynaptic localization of Kv1.4-containing A-type potassium channels near excitatory synapses in the hippocampus. *J Neurosci.* 1998;18(3):965-74. [[View journal article](#)]
27. Gleeson JG, Allen KM, Fox JW, Lamperti ED, Berkovic S, Scheffer I, et al. Doublecortin, a brain-specific gene mutated in human X-linked lissencephaly and double cortex syndrome, encodes a putative signaling protein. *Cell.* 1998;92(1):63-72. [[View journal article](#)]
28. Agnew WS, Cooper EC, Shenko S, Correa AM, James WM, Ukomadu C, et al. Voltage-sensitive sodium channels: agents that perturb inactivation gating. *Ann N Y Acad Sci.* 1991;625:200-23. [[View journal article](#)]
29. Cooper EC, Agnew WS. Reconstituted voltage-sensitive sodium channels from eel electroplax: activation of permeability by quaternary lidocaine, N-bromoacetamide, and N-bromosuccinimide. *J Membr Biol.* 1989;111(3):253-64. [[View journal article](#)]
30. Shenko S, Cooper EC, James W, Agnew WS, Sigworth FJ. Purified, modified eel sodium channels are active in planar bilayers in the absence of activating neurotoxins. *Proc Natl Acad Sci U S A.* 1989;86(23):9592-6. [[View journal article](#)]
31. Cooper EC, Tomiko SA, Agnew WS. Reconstituted voltage-sensitive sodium channel from electrophorus electricus: chemical modifications that alter regulation of ion permeability. *Proc Natl Acad Sci U S A.* 1987;84(17):6282-6. [[View journal article](#)]
32. Agnew WS, Tomiko SA, Rosenberg RL, Emerick MC, Cooper EC. The structure and function of the voltage-sensitive Na channel. *Ann N Y Acad Sci.* 1986;479:238-56. [[View journal article](#)]
33. Greenberg DA, Carpenter CL, Cooper EC. Stimulation of calcium uptake in PC12 cells by the dihydropyridine agonist BAY K 8644. *J Neurochem.* 1985;45(3):990-3. [[View journal article](#)]
34. Greenberg DA, Cooper EC, Carpenter CL. Reversible dihydropyridine isothiocyanate binding to brain calcium channels. *J Neurochem.* 1985;44(1):319-21. [[View journal article](#)]
35. Greenberg DA, Cooper EC, Carpenter CL. Calcium channel 'agonist' BAY K 8644 inhibits calcium antagonist binding to brain and PC12 cell membranes. *Brain Res.* 1984;305(2):365-8. [[View journal article](#)]
36. Greenberg DA, Cooper EC, Carpenter CL. Calcium entry activators: distinct sites of dihydropyridine and aminopyridine action. *Neurosci Lett.* 1984;50(1-3):279-82. [[View journal article](#)]
37. Greenberg DA, Cooper EC, Carpenter CL. Phenytoin interacts with calcium channels in brain membranes. *Ann Neurol.* 1984;16(5):616-7. [[View journal article](#)]
38. Greenberg DA, Cooper EC, Gordon A, Diamond I. Ethanol and the gamma-aminobutyric acid-benzodiazepine receptor complex. *J Neurochem.* 1984;42(4):1062-8. [[View journal article](#)]
39. Greenberg DA, Cooper EC. Effect of ethanol on [3H]nitrendipine binding to calcium channels in brain membranes. *Alcohol Clin Exp Res.* 1984;8(6):568-71. [[View journal article](#)]

#### **Book Chapters and Other Publications**

1. Cooper EC. Potassium channels (including KCNQ) and epilepsy. In: Noebels JL, Avoli M, Rogawski MA, Olsen R, W, Delgado-Escueta AV, editors. Jasper's basic mechanisms of the epilepsies. 4th ed. New York: Oxford University Press; 2012. p.

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[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list\\_uids=22787644](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=22787644).  
[\[View book section\]](#)

**Poster and Platform Presentations**

1. Chang K-J, Zollinger DR, Susuki K, Ho TS, Cooper EC, Bennett V, et al. Paranodal ankyrins: Enigmatic glial anchors. Program No. 699.05. 2013 Neuroscience Meeting Planner. San Diego, CA: Society for Neuroscience, 2013. Online.
2. Ho T, Zollinger DR, Xu M, Cooper EC, Stankewich MC, Bennett V, et al. The roles of ankyrin-G in node of Ranvier formation in vivo. Program No. 699.17. 2013 Neuroscience Meeting Planner. San Diego, CA: Society for Neuroscience, 2013. Online.
3. Cooper E. Ion channel modifications in epilepsy. Presented at the American Academy of Neurology (AAN), 64th Annual Meeting in New Orleans, La. (April 21-28, 2012).