Voltage-gated Calcium Channels
February 24, 2005
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1. **Catterall, W.A. 2000. Structure and regulation of voltage-gated Ca2+ channels. *Annu. Rev. Cell Dev. Biol*. 16: 521-555.** Review. Highly cited article concerning the three different families of voltage-gated Ca^{2+} channels, $Ca_v1.x$, $Ca_v2.x$, and $Ca_v3.x$. Concentrates on the mechanisms of modulation governing their activity, including phosphorylation, G proteins, and calcium itself.

2. **Altier, C. and G.W. Zamponi. 2004. Targeting Ca^{2+} channels to treat pain: T-type versus N-type. *TIPS* 25(9): 465-470.** Review discussing the roles of voltage-gated calcium channels in the reception of painful stimuli, and the possiblities for the targeting of drugs against these channels in order to pharmacologically block such painful stimuli.

3. **Striessnig, J., Hoda, J.-C., Koschak, A., Zaghetto, F., Ilner, C.M., Sinnegger-Brauns, M.J., Wild, C., Watschinger, K., Trockenbacher, A., and G. Pelster. 2004. L-type Ca2+ channels in Ca^{2+} channelopathies. *Biochem Biophys Res Comm* 322: 1341-1346.** Review concerning the channelopathies known to have a source in L-type channel dysfunction. Discusses stationary night blindness, hypokalemic periodic paralysis, and malignant hyperthermia susceptibility (the latter entails strong adverse reactions to anesthetics or muscle relaxants).

4. **McGee, A.W., Nunzaito, D.A. Maltez, J.M., Prehoda, K.E., Pitt, G.S., and D.S. Bredt. 2004. Calcium channel function regulated by the SH3-GK module in β subunits. *Neuron*. 42: 89-99.** Original research article. The authors align sequences in the β subunit that resemble protein-interaction motifs, termed Src Homology 3 (SH3) and guanylate kinase (GK) domains. Disruption of these domains alters channel inactivation kinetics, as well as the disruption of binding between the α and β subunits.

5. **Kim, J., Ghosh, S., Nunzaito, D.A. and G.S. Pitt. 2004. Identification of the components controlling inactivation of voltage-gated Ca^{2+} channels. *Neuron*. 41: 745-754.** Original research article. The authors describe the purification of the Ca^{2+} sensor complex, and how the intracellular linker between domains I and II is likely to occlude the pore of the calcium channel subunit, α_{1C}.

6. **Cibulsky, S.M. and W.A. Sather. 2003. Control of ion conduction in L-type Ca^{2+} channels by the concerted action of S5-6 regions. *Biophys J*. 84: 1709-1719.** Original research article investigating the role of the pore and the entire S5-6 region (containing the pore) in unitary conduction. Interesting discussion concerning the dichotomy between ion channel conduction and selectivity.

7. **Badou A., Basavappa, S., Desai, R., Peng, Y-Q., Matza, D., Mehal, W.Z., Kaczmarek, L.K., Boulpaep, E.L., R.A. Flavell. 2005. Requirement of Voltage-Gated Calcium Channel β4 Subunit for T Lymphocyte Functions. *Science*. 307:117-121.** Original research article discussing the role of voltage-gated calcium channels in a nonexcitable cell,

the T lymphocyte. T lymphocytes lacking Ca_v channels demonstrate an altered calcium response and cytokine release.

8. **Chen, Y., Li, M., Zhang, Y., He, L., Yamada, Y., Fitzmaurice, A., Shen, Y., Zhang, H., Tong, L. and J. Yang. 2004. Structural basis of the α_1–β subunit interaction of voltage-gated Ca^{2+} channels. *Nature*. 429: 675-680.** Original research article describing the crystal structures of β subunits of voltage-gated Ca^{2+} channels, both in the presence and absence of binding to the α subunit.

9. **Serysheva., I.I., Ludtke, S.J., Baker, M.R., Chiu, W., and S.L. Hamilton. 2002. Structure of the voltage-gated L-type Ca^{2+} channel by electron cryomicroscopy. *PNAS* 99: 10370-10375.** Original research article. Structural model of the L-type channel by electron cryomicroscopy; determined that channel is composed of two major regions, resulting in an asymmetrical protein. 30 Å resolution.

10. **Wolf., M. Eberhart, A., Glossmann, H., Striessnig, J. and N. Grigorieff. 2003. Visualization of the domain structure of an L-type Ca^{2+} channel using electron cryo-microscopy. *J. Mol. Biol*. 332: 171-182.** Original research article. 23 Å resolution structure of same L type channel as in #10, but appears to offer a more complete picture of the interaction between the dihydropyridine receptor ($Ca_v1.1$; DHPR) and the ryanodine receptor (RyR) complex in muscle necessary for excitation-contraction coupling.

Websites:

1. http://www.iuphar-db.org/iuphar-ic/calcium.html - an International Union of Pharmacology (IUPHAR) website, with information on many types of ion channels, including unitary conductance, types of blockers, histories, and references.

2. http://grimwade.biochem.unimelb.edu.au/cone/omega.html - website describing the conotoxins known to block some types (N type in particular) of voltage-gated calcium channels.

3. http://www.neuro.wustl.edu/neuromuscular/mother/chan.html - informative website detailing diseases associated with ion channels or channelopathies.

4. http://www.geocities.com/ionchannels/ - index website listing major labs and other websites dedicated to ion channels.

5. http://langevin.anu.edu.au/bac/calcium/contents.html - website concerning the permeation and selectivity of the calcium channel, with interesting pictures and mini-tutorials on how ions move through solution or "Brownian dynamics simulations." In addition, the webpage has a link to "comparisions with experimental results" to compare the accuracy of Brownian simulations.

6. http://www.americanheart.org/presenter.jhtml?identifier=4460 - an American Heart webpage that defines calcium channel blockers and their role in heart disease treatment.

For more detail on calcium channel antagonists, see http://www.aafp.org/afp/980401ap/straka.html.

7. http://www.ionadventure.com/ - an "interesting" website – who knew that this kind of stuff was out there? This website is attempting to sell a powerpoint-esque cartoon book of ion channels and electrophysiology, with the added bonus of a portrait of the author (as a child) as a guide.

8. http://www.cellml.org/examples/repository/mitochondria_and_Ca_signaling_2001_doc.html - a model repository for all sorts of signaling events in the cell, including Ca^{2+} signaling.

9. http://www.science.mcmaster.ca/biochem/faculty/ananthanarayanan/ananth/chandesc.htm - a small website dedicated to graphical depictions of the calcium channel.

10. http://www.signaling-gateway.org/molecule/query?afcsid=A000441&type=family&adv=latest - an interesting site hosted through Nature; gives a quick abstract describing the ion channel, as well as its gene ontology

11. http://opal.msu.montana.edu/cftr/ion_channel_glossary.htm - although not relating specifically to calcium channels, this webpage is dedicated to a glossary of terms commonly used in electrophysiology.