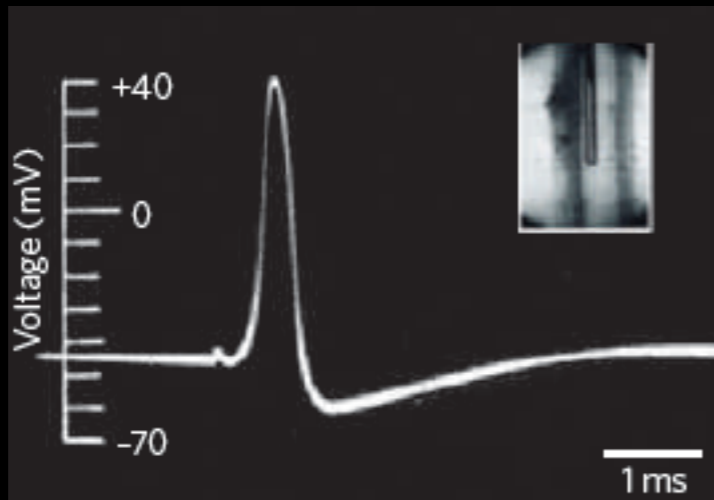
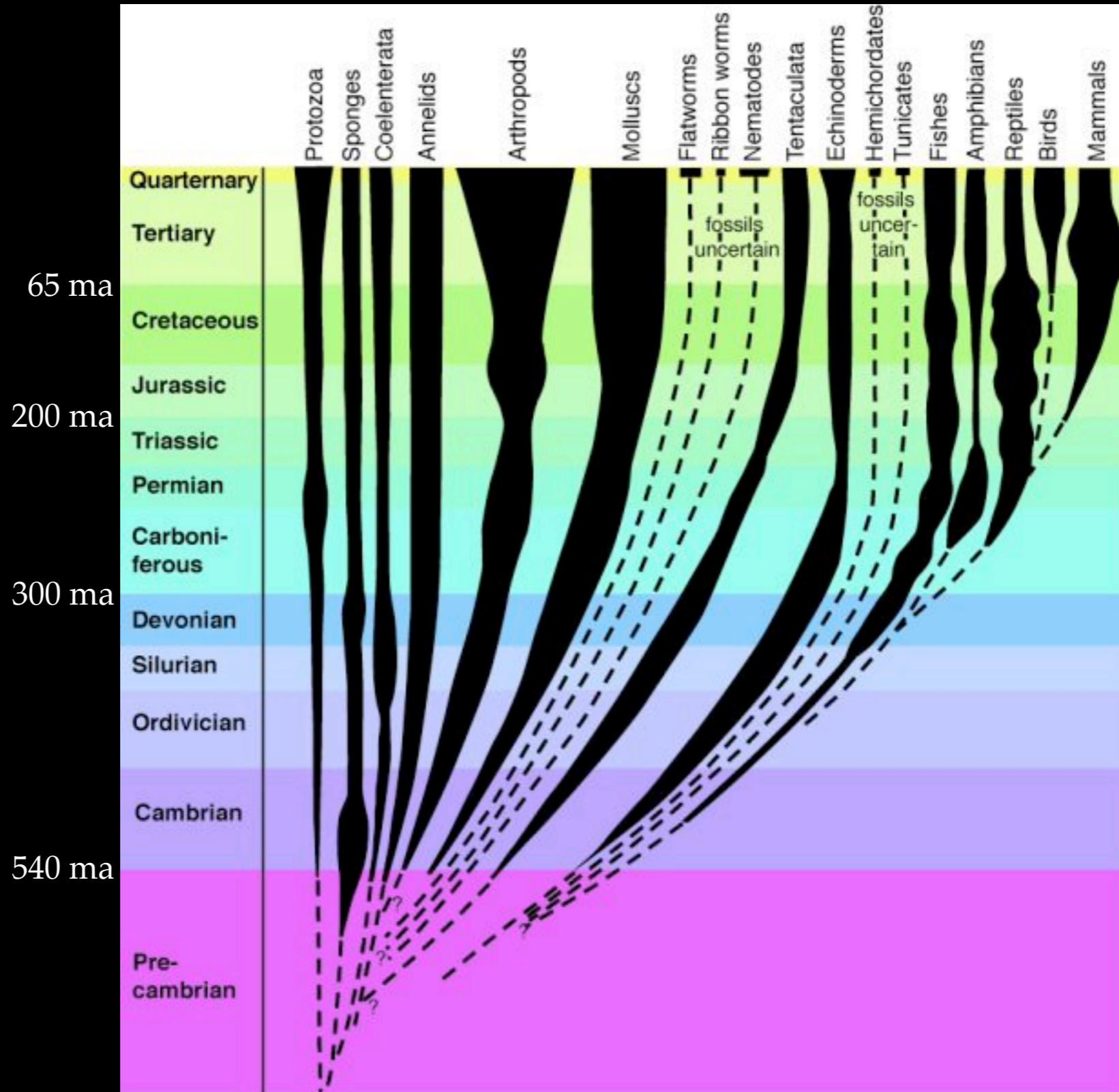


Evolution of the Spike



Arash Afraz June 2013

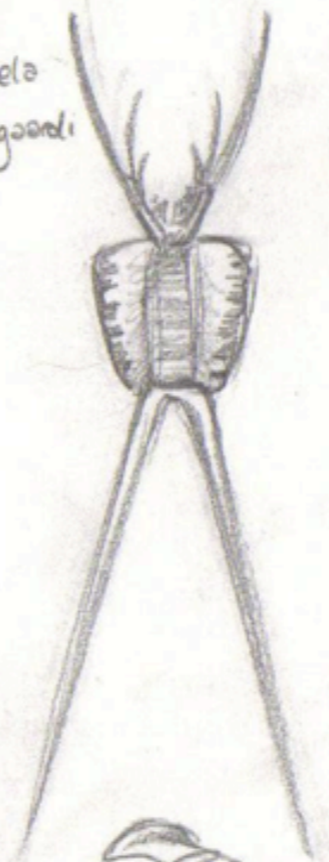
Cambrian Explosion



Anomalocaris
Sarsii



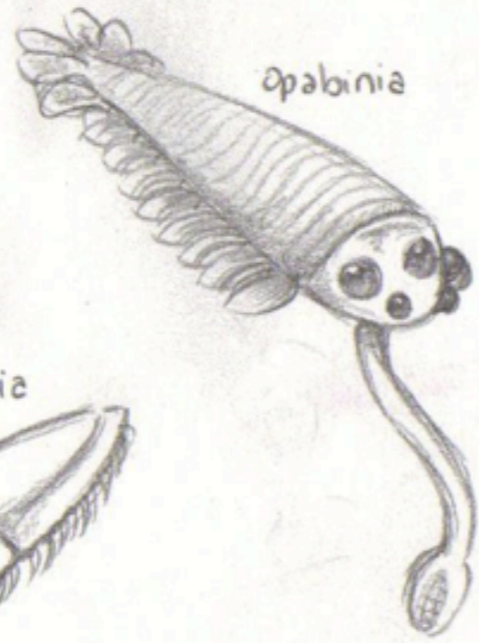
Kongmachela
ku erkegaardi



Laggania
Cambria



Opabinia



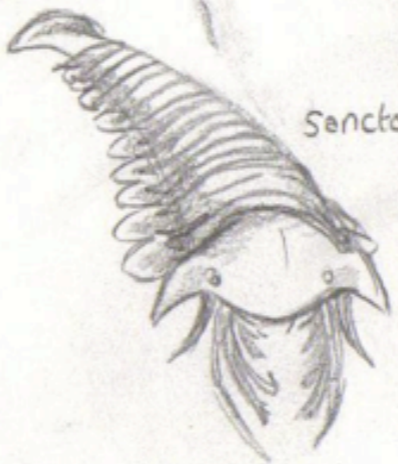
Pikeia



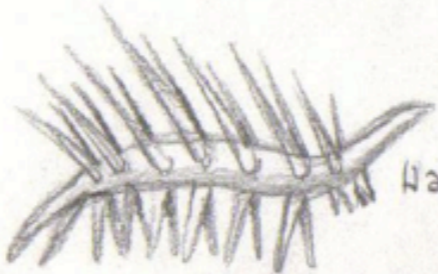
Naraoia



Sanctocaris



Hallucigenia



Amplectobelua
Symbrochiata



Anomalocaris
canadensis



Sharzy
22/11/08

Parapeyrola
yunnanensis



Cambrian Explosion

Cambrian Explosion

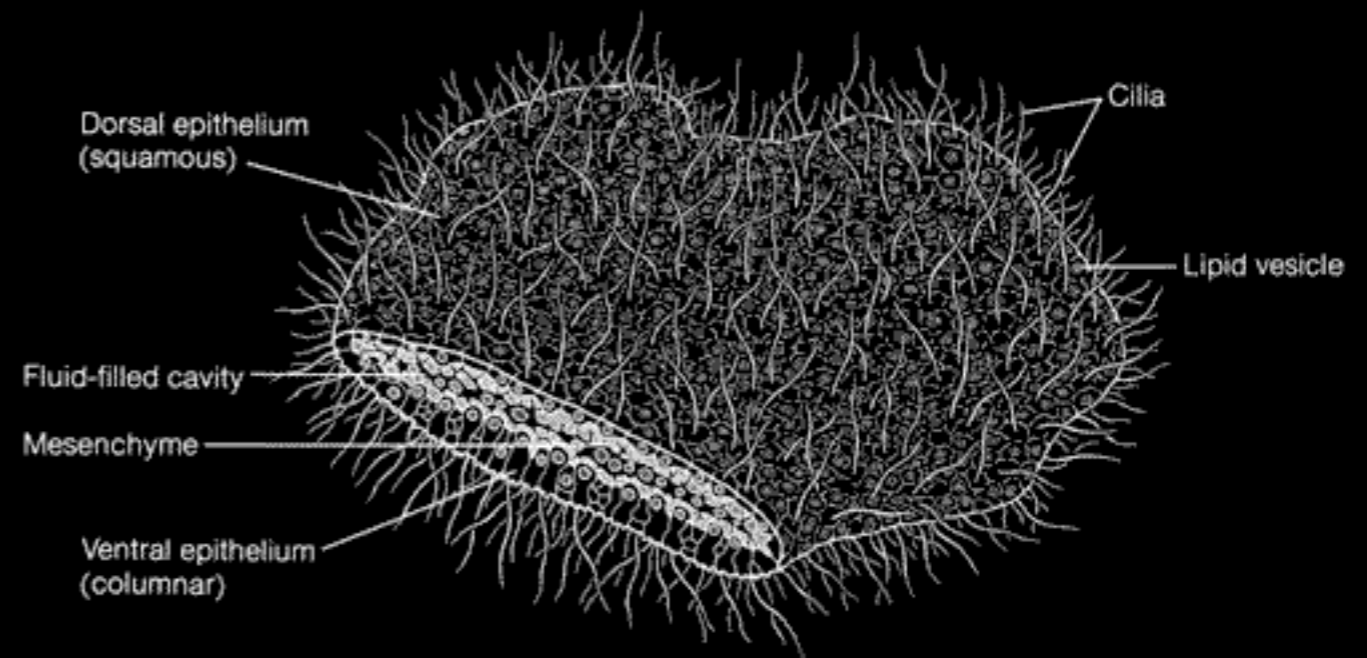
- Evolution of cell adhesion genes (allowed multicellularity)

Cambrian Explosion

- Evolution of cell adhesion genes (allowed multicellularity)
- Evolution of voltage-dependent sodium channel (allows evolution of the nervous system)

Cambrian Explosion

- Evolution of cell adhesion genes (allowed multicellularity)
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All animals except for Sponges and Placozoans have nervous system

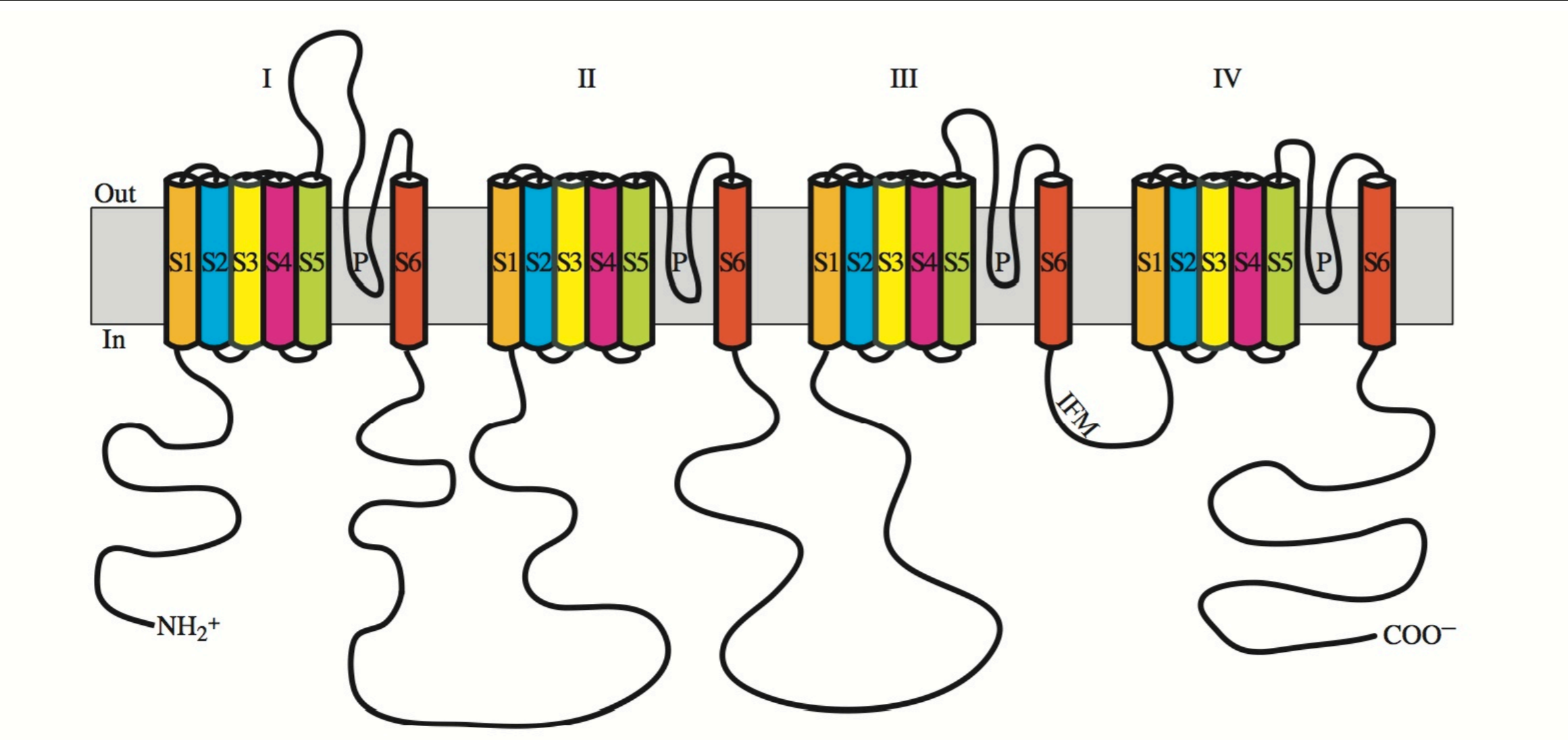
Evolution of voltage-gated Na⁺ channels

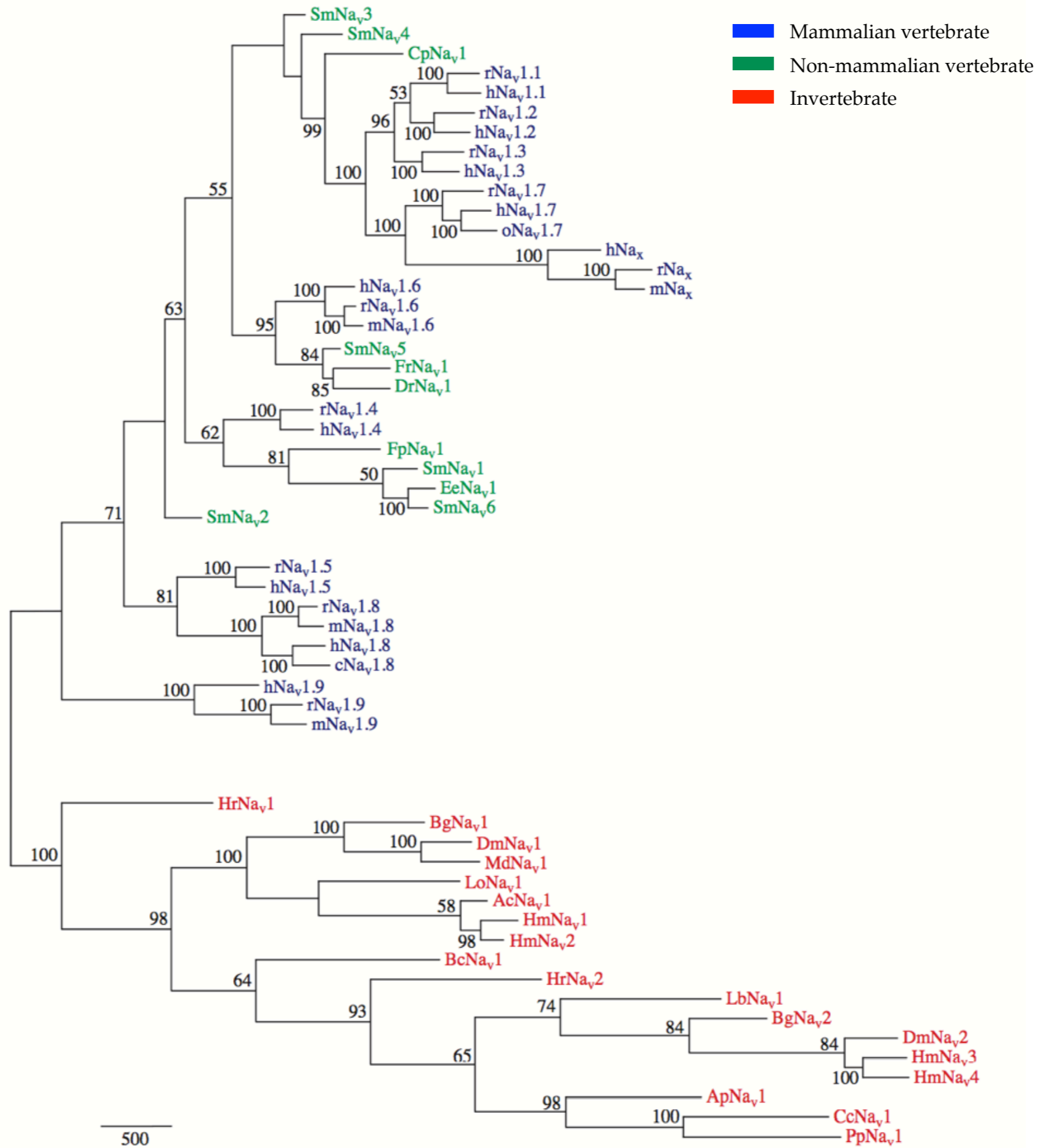
Alan L. Goldin*

Department of Microbiology and Molecular Genetics, University of California, Irvine, CA 92697-4025, USA

*e-mail: agoldin@uci.edu

Voltage-dependent sodium channel

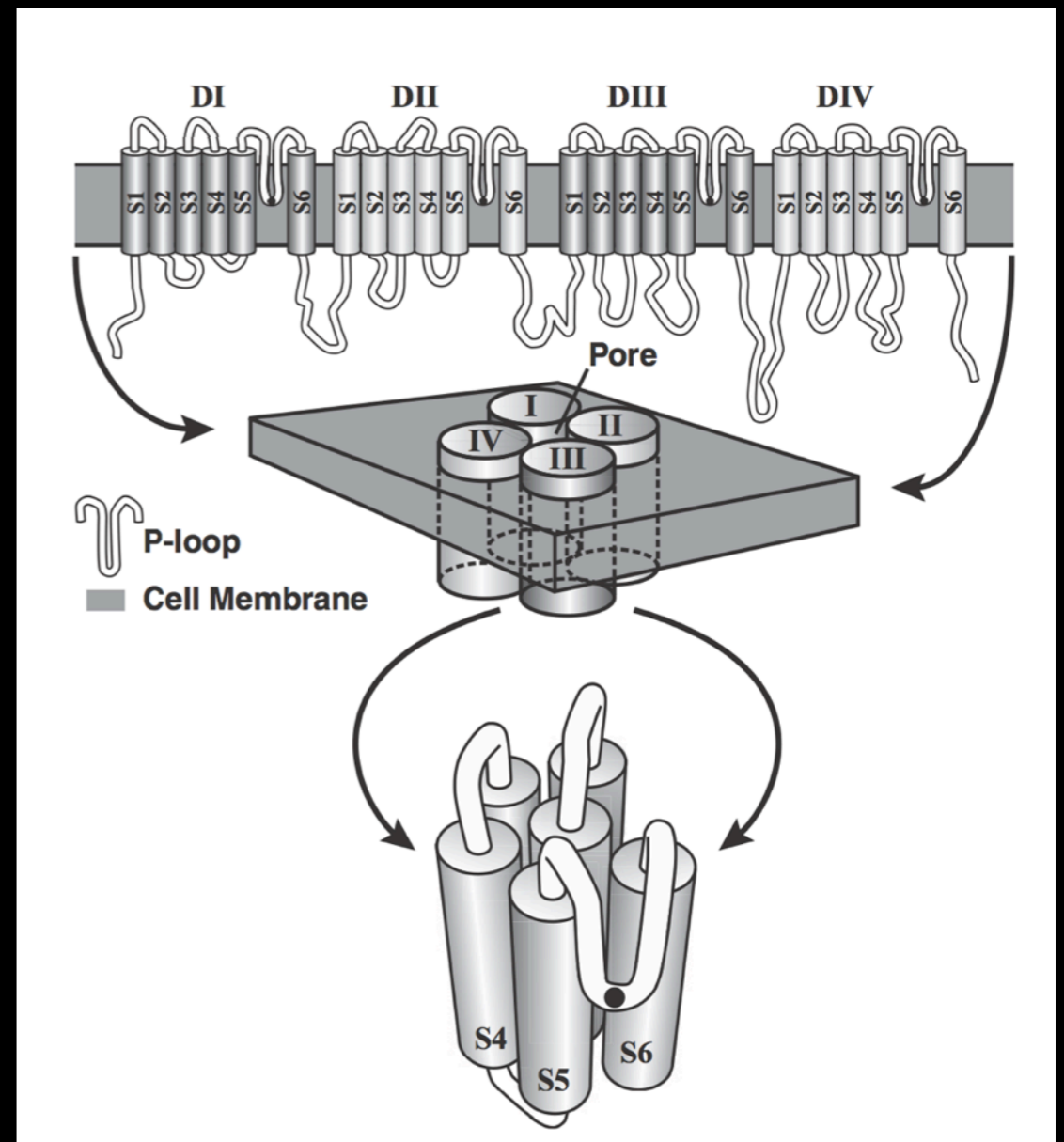




Evolution of sodium channels predates the origin of nervous systems in animals

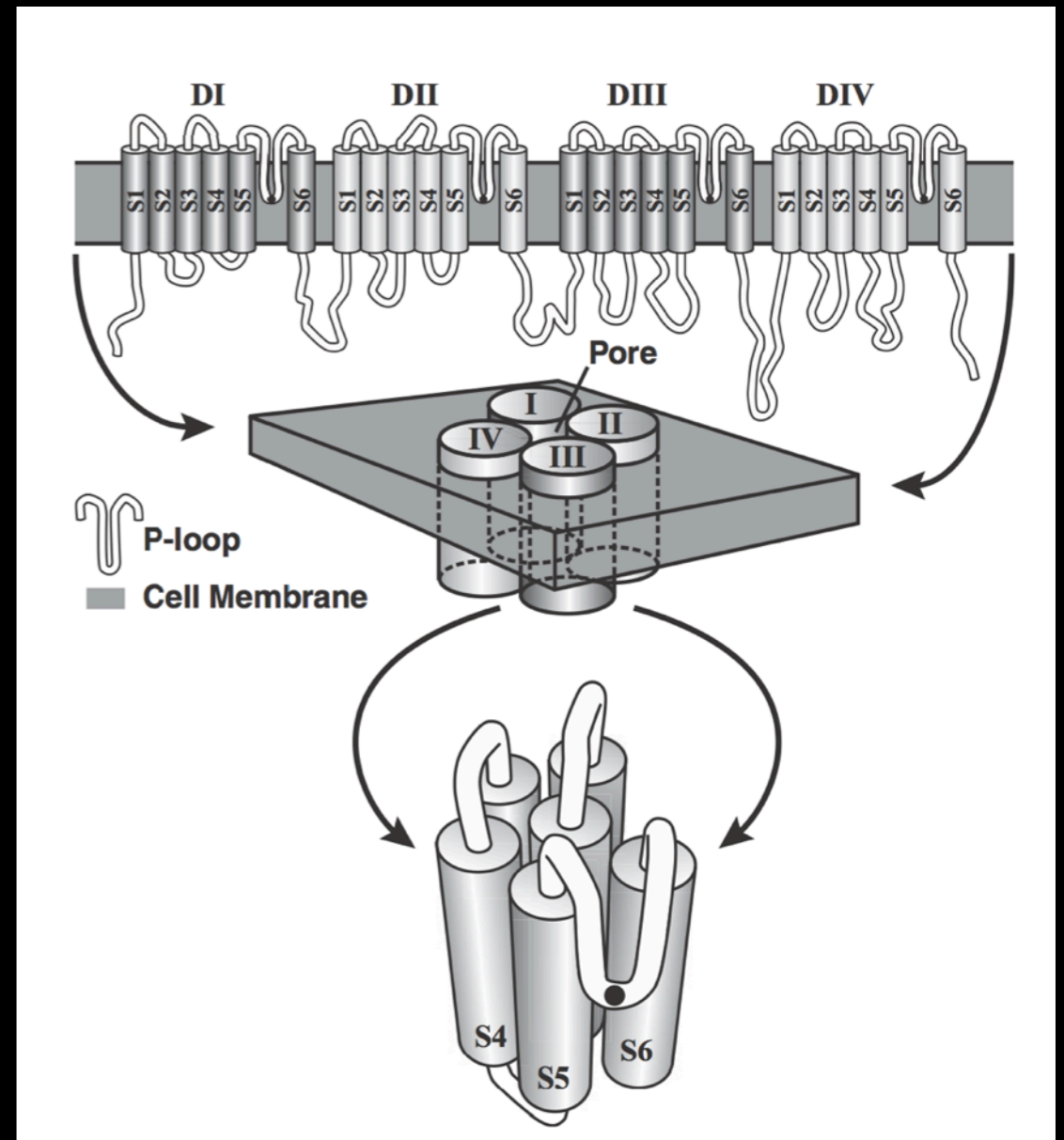
Benjamin J. Liebeskind^a, David M. Hillis^{a,1}, and Harold H. Zakon^{a,b,c,1}

Voltage dependent sodium channel (Na_v)



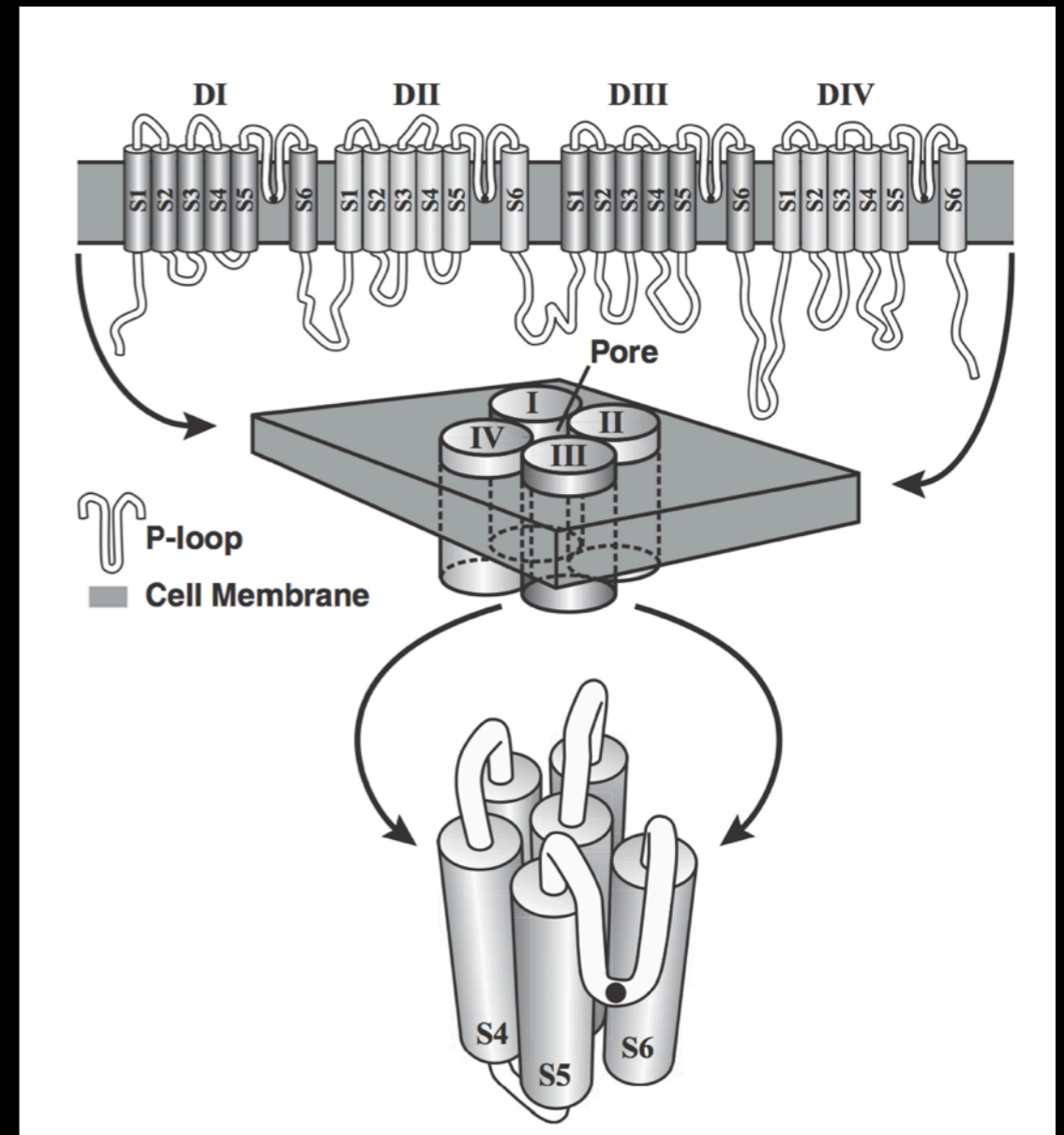
Voltage dependent sodium channel (Na_v)

- Rapid long-distance communication among excitable cells is achieved in bilaterian animals and a few jellyfish (cnidarians) through the use of action potentials (APs)



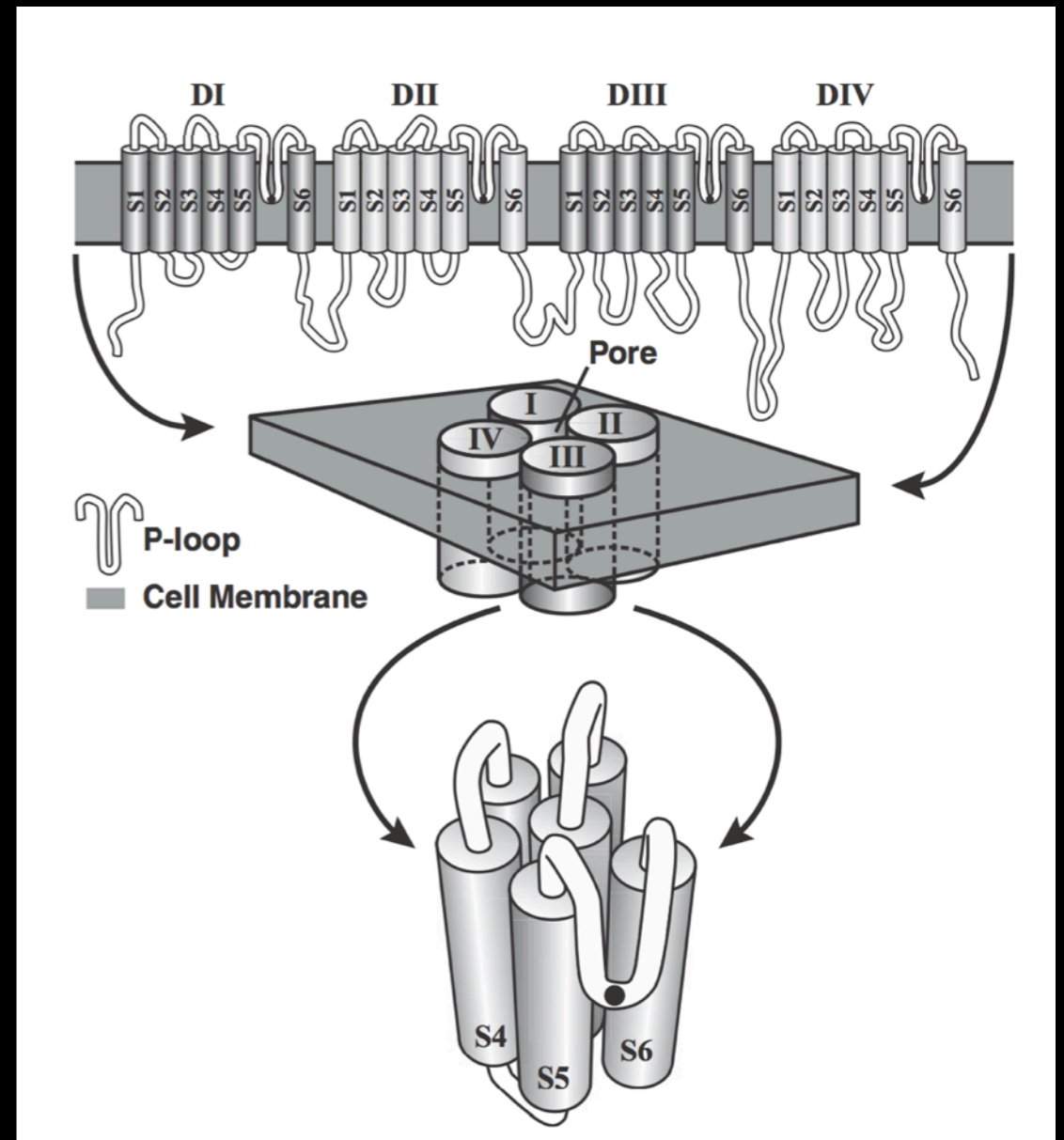
Voltage dependent sodium channel (Na_v)

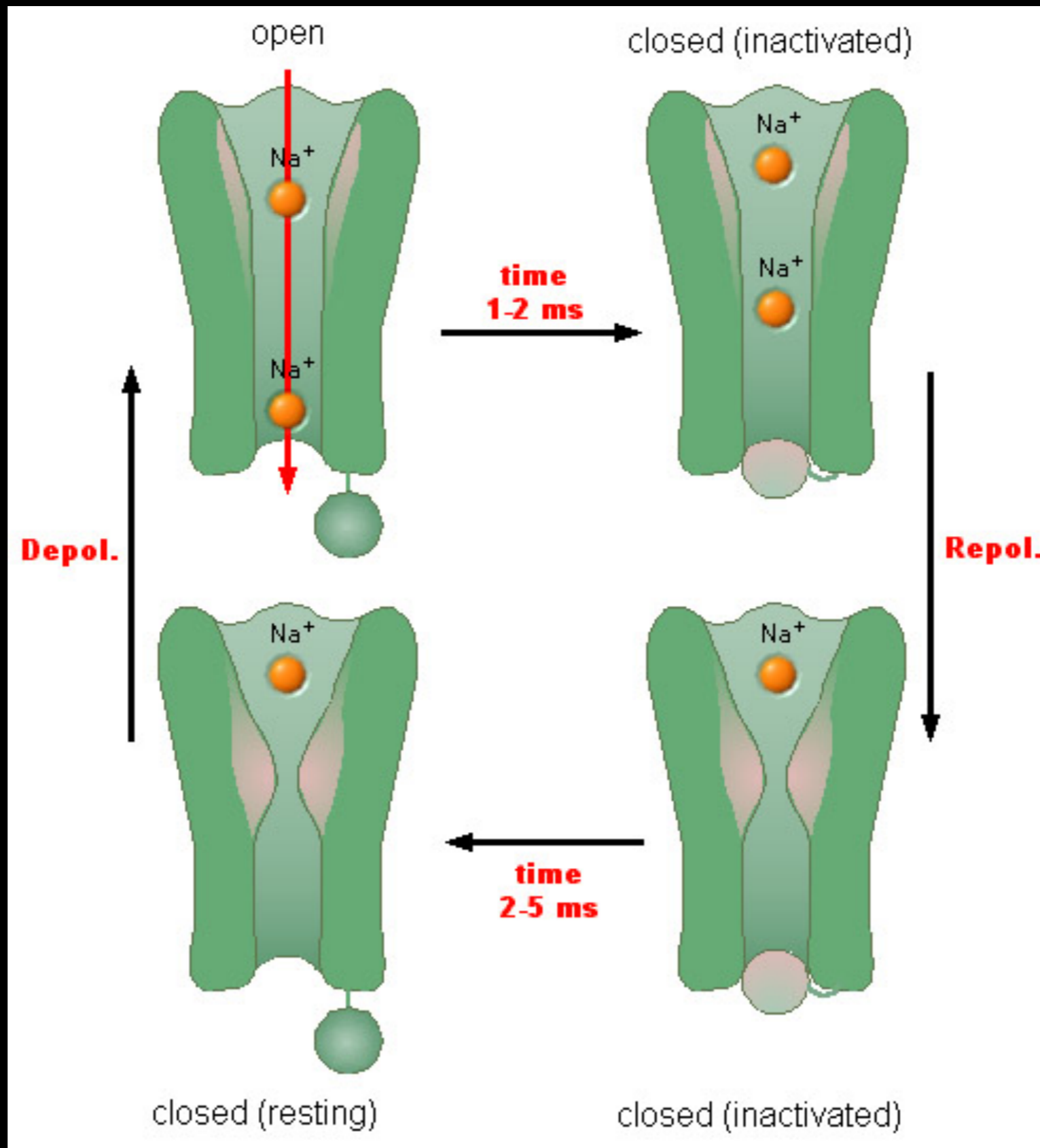
- Rapid long-distance communication among excitable cells is achieved in bilaterian animals and a few jellyfish (cnidarians) through the use of action potentials (APs)
- Na_v is thought to have evolved from Ca_v channel (evolved earlier in single-celled eukaryotes for intracellular signaling)

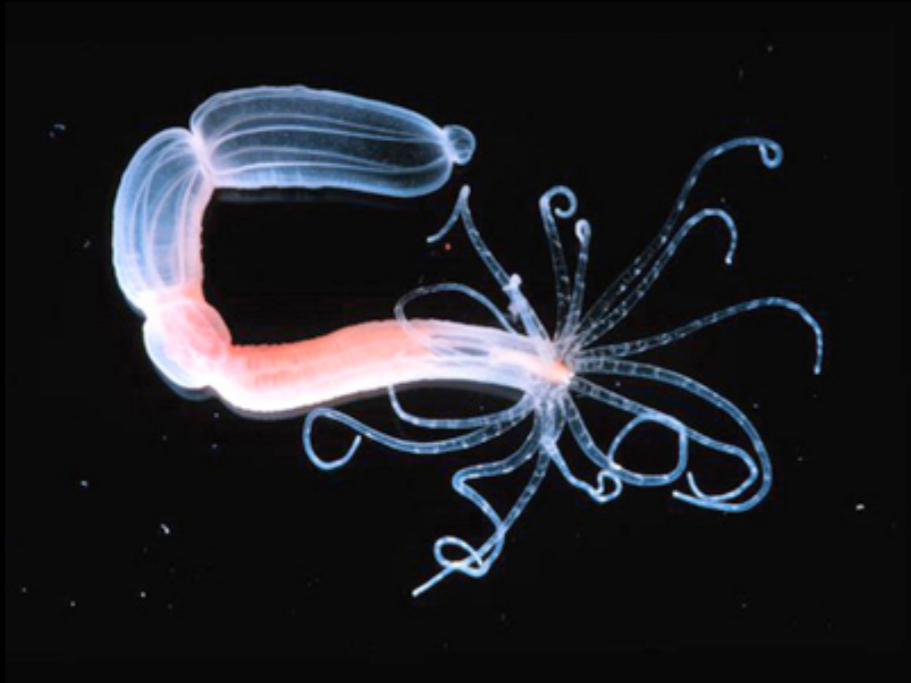


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- The ability to conduct action potentials without interfering with intracellular calcium (lack of sodium currents in sponges)



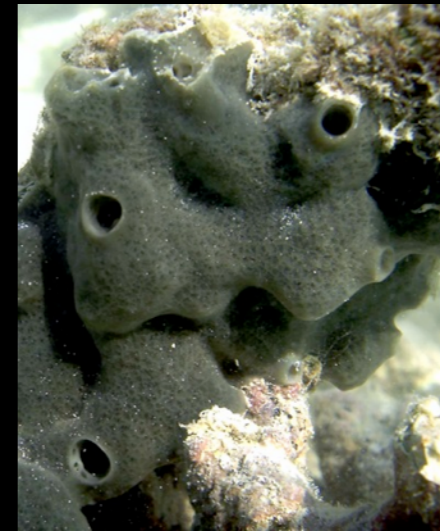




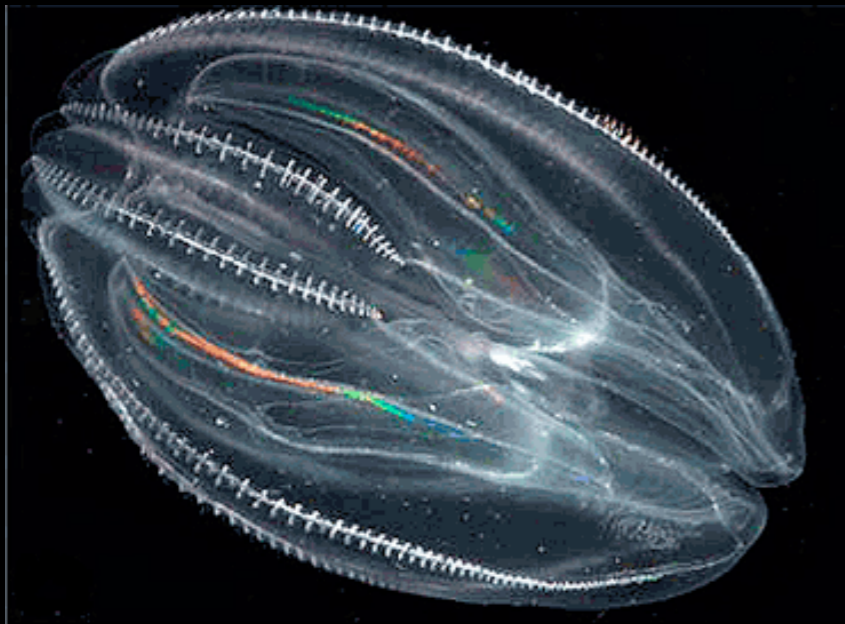
Nematostella vectensis



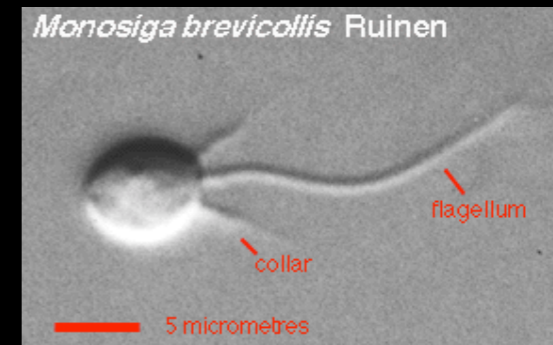
Trichoplax adhaerens (placozoan)



Amphimedon queenslandica (sponge)



Mnemiopsis leidyi



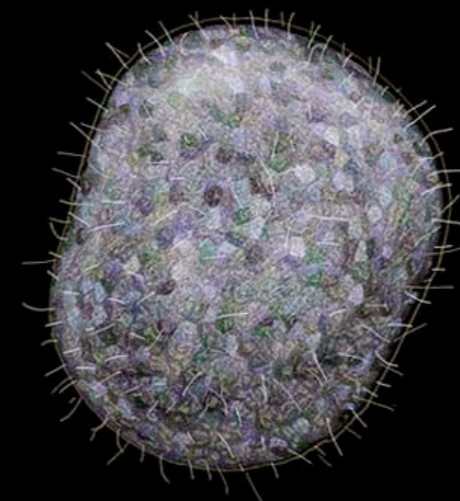
Monosiga brevicollis (choanoflagellate)

With nerve nets

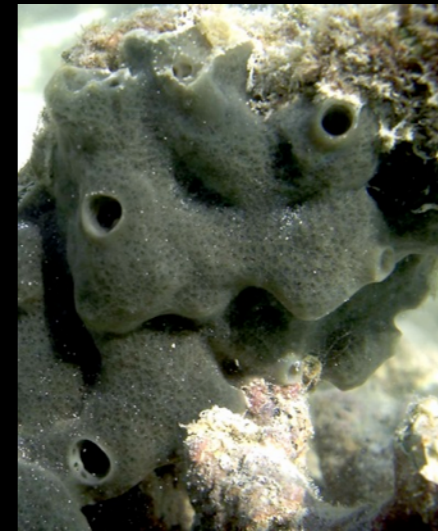
Without nerve nets



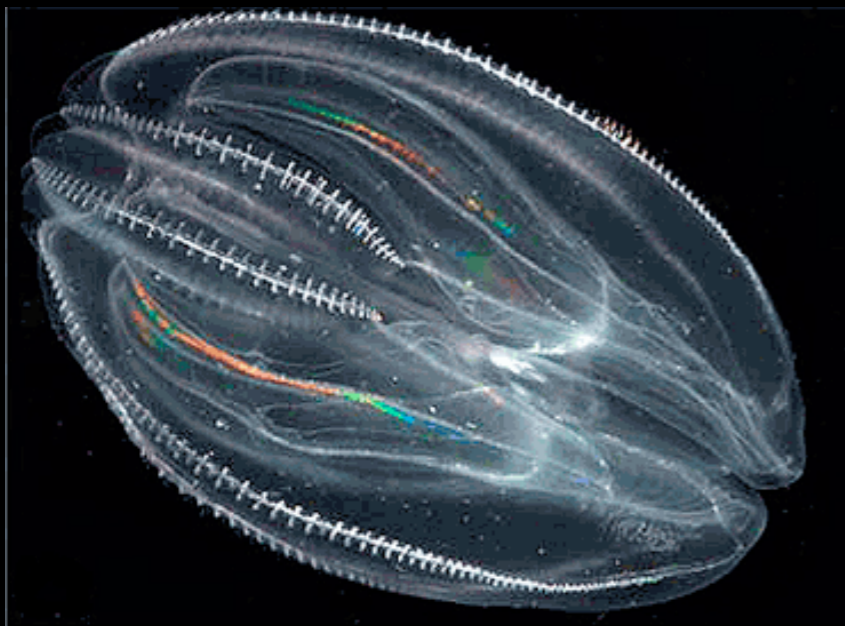
Nematostella vectensis



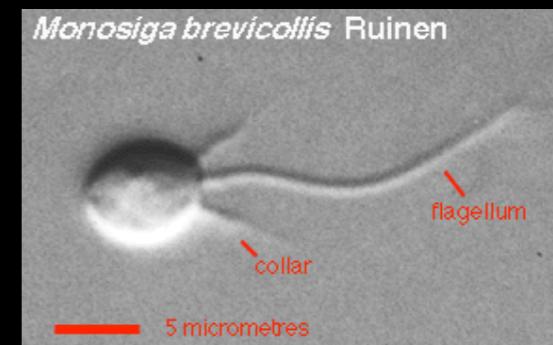
Trichoplax adhaerens (placozoan)



Amphimedon queenslandica (sponge)



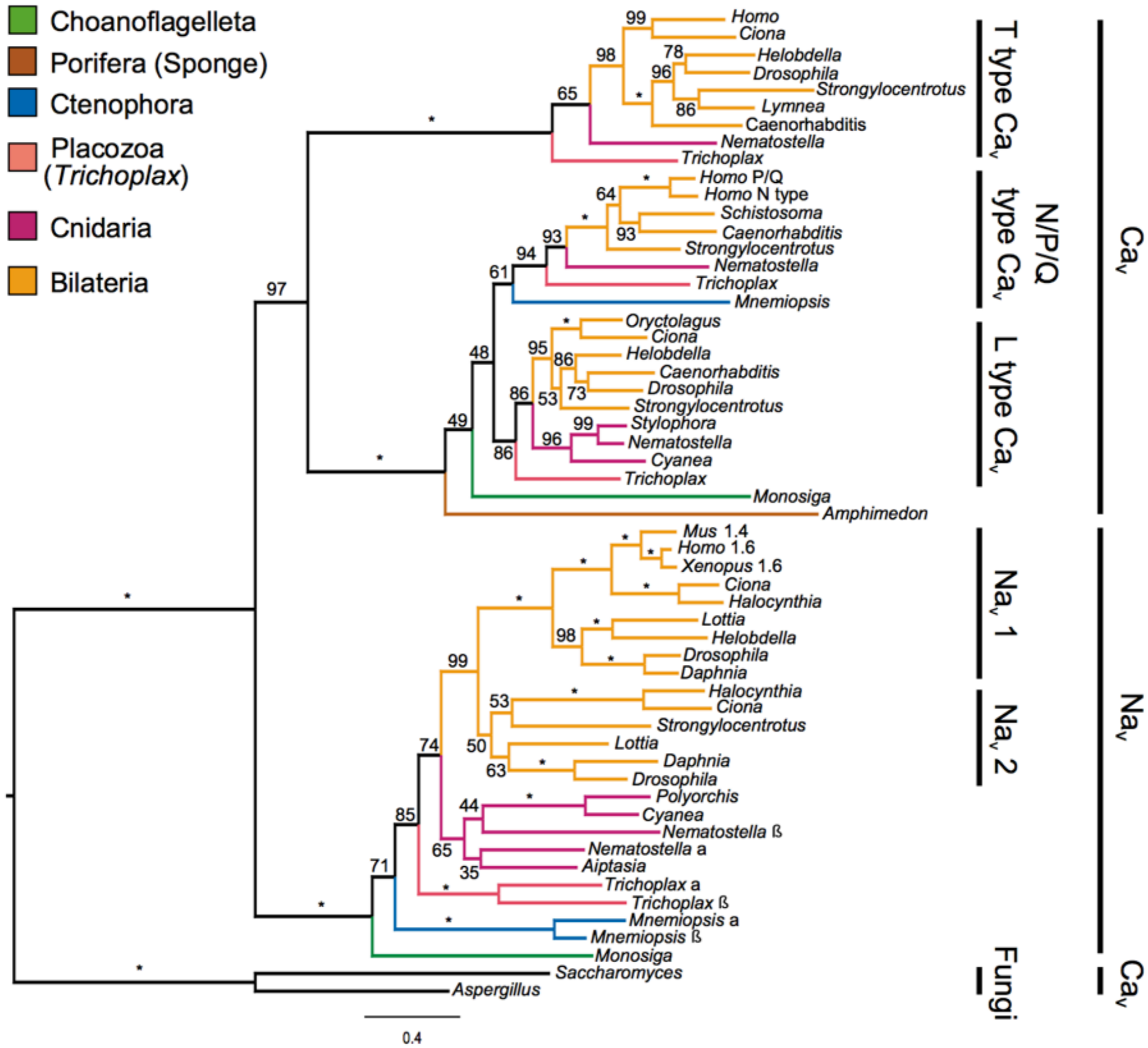
Mnemiopsis leidyi



Monosiga brevicollis (choanoflagellate)

With nerve nets

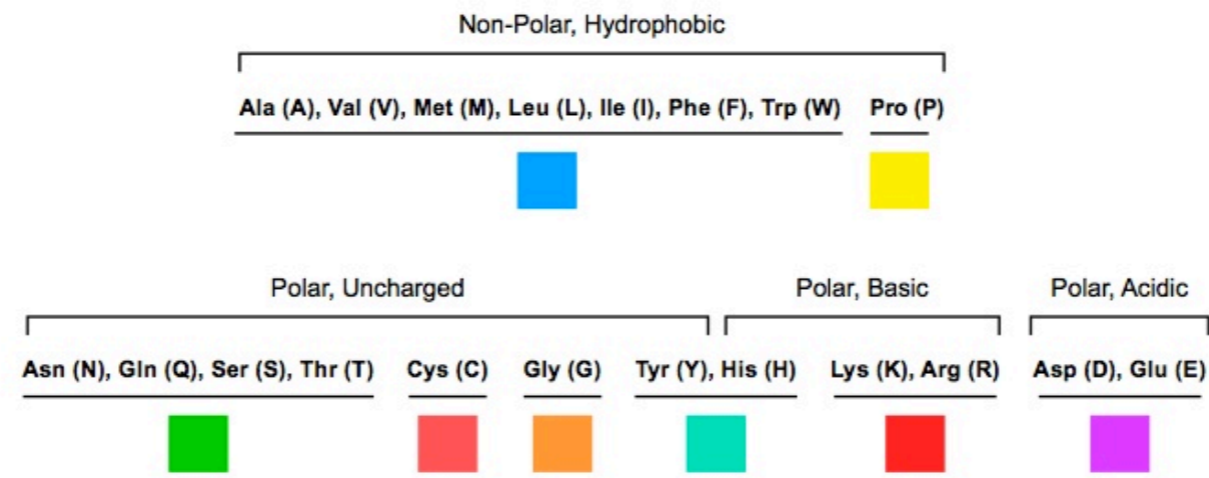
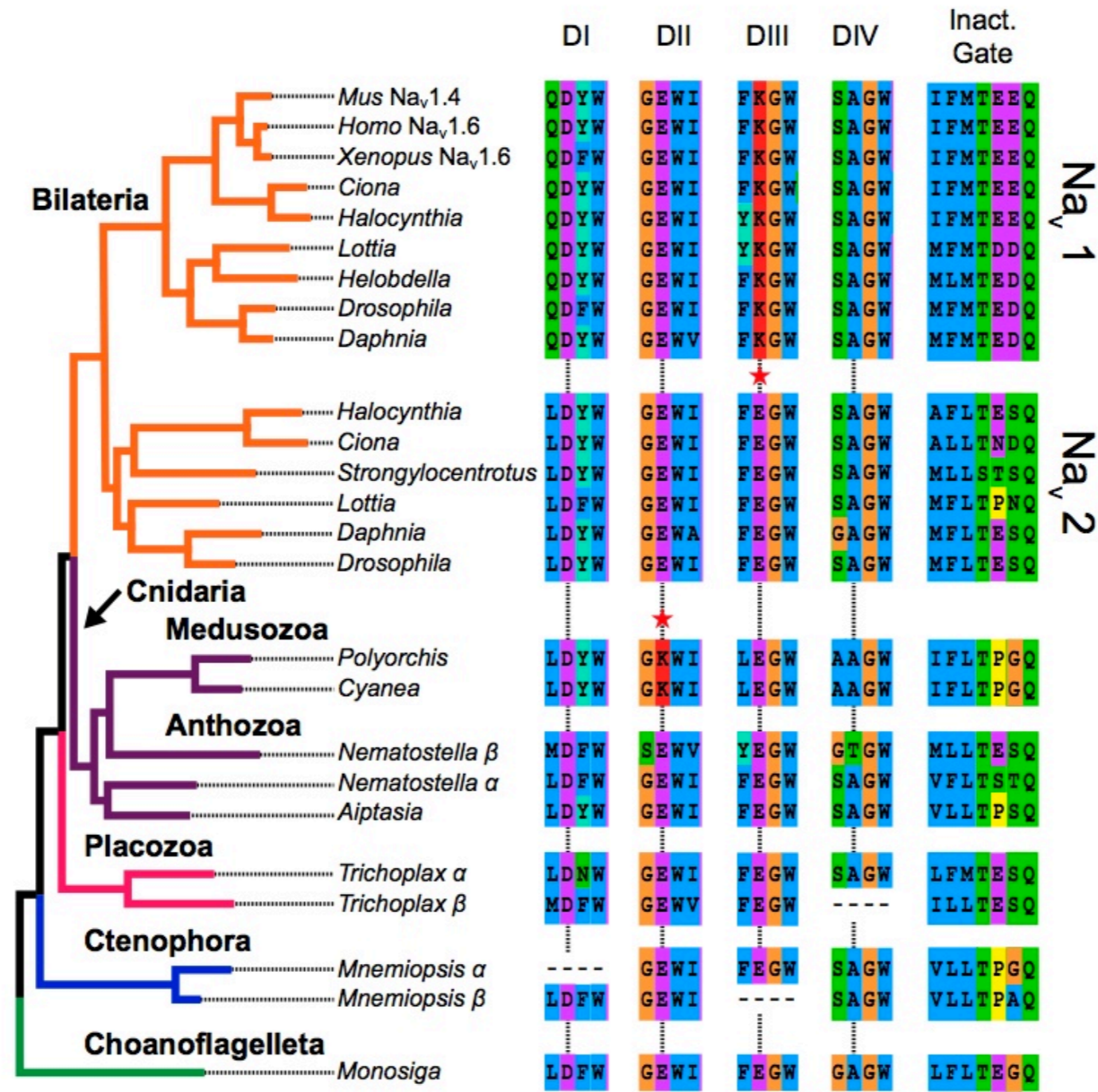
Without nerve nets



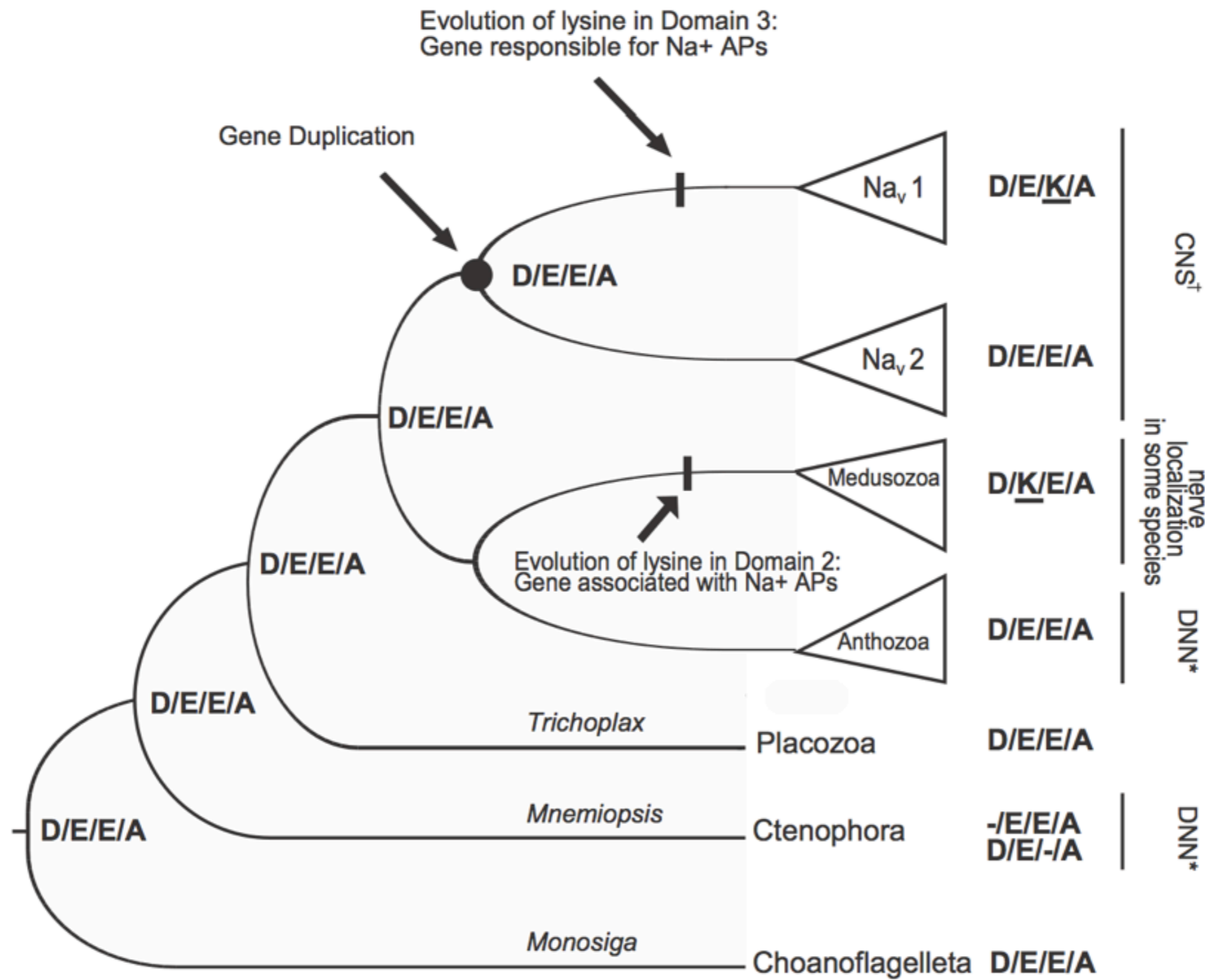
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- These results support the idea that Na_v channels arose from Ca_v channels, but push back this divergence date to at least the common ancestor of animals and choanoflagellates
- This demonstrates that complex systems like excitable tissues can evolve by coopting existing genes for new functions, rather than by de novo evolution of new genes.



Bilateria Cnidaria



† - Central Nervous System (CNS)

* - Diffuse Nerve Net (DNN)

Thanks

