Electric eels can generate an electrical charge of up to 600 volts in order to stun prey and keep predators at bay. What role does membrane transport play in producing such large voltages in eels?

Electric wels have specialized cells, *electrocytes*, which are charged in parallel (lower resistance) and linked in series to produce a very high voltage (Electric eels can emit in pulses or in a wave-like discharge). An electrocyte has two distinct membranes, one of them, called *innervated* membrane, contains acetylcholine (Ach) receptors, and voltage-gated Na+ channels. When an electric eel spots a prey, pacemaker neurons fire, and subsequently, the neurotransmitter Ach is released in the synaptic cleft. Ach binds to Ach receptors which become more permeable to ions Na^+ and K^+. This depolarizes the innervated membrane, and voltage-gated Na^+ channels start opening. Depolarization causes the innervated cell membrane potential to become positive, with Na^+ flowing into the cell, membrane potential increases further, and simultaneously more voltage-gated Na^+ channels keep opening. The strong inward flow of Na^+ ions result into an action potential. The other side of the cell, referred as non-innervated membrane, remains in or close to the resting state, its concentration gradient is sustained by ATPase pumps, and by both potassium (K^+) and chloride (Cl-) channels. The difference of voltage between innervated and non-innervated results into a net electric current from the innervated to the non-innervated membrane.

References:

[1] "Electric organ (biology)," *Wikipedia*. Nov. 22, 2021. Accessed: Feb. 23, 2022. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Electric_organ_(biology)&oldid=1056511111

[2] M. R. Markham, "Electrocyte physiology: 50 years later," *Journal of Experimental Biology*, vol. 216, no. 13, pp. 2451–2458, Jul. 2013, doi: 10.1242/jeb.082628.

[3] "Electrophorus electricus - an overview | ScienceDirect Topics." https://www-sciencedirect-com.proxy1.library.jhu.edu/topics/biochemistry-genetics-and-molecular-biology/electrophorus-electricus (accessed Feb. 21, 2022).

[4] C. D. S. Mermelstein, M. L. Costa, and V. Moura Neto, "The cytoskeleton of the electric tissue of Electrophorus electricus, L.," *An. Acad. Bras. Ciênc.*, vol. 72, pp. 341–351, Sep. 2000, doi: 10.1590/S0001-37652000000300008.

[5] K. C. Catania, "The Astonishing Behavior of Electric Eels," *Frontiers in Integrative Neuroscience*, vol. 13, 2019, Accessed: Feb. 21, 2022. [Online]. Available: https://www.frontiersin.org/article/10.3389/fnint.2019.00023