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Synchronization modulation of Na/K pumps on Xenopus oocytes

PENGFEI LIANG, JASON MAST, WEI CHEN, Univ of South Florida — We developed a new technique named synchronization modulation to electrically synchronize and modulate the Na/K pump molecules by a specially designed oscillating electric field. This technique is based on the theory of energy-trap in quantum physics as well as the concept of electronic synchrotron accelerator. As a result, the Na-transports are all entrapped into the positive half-cycle of the applied electric field and consequently, all of the K-transports are entrapped into the negative half cycle of the field. To demonstrate the process of the pump synchronization and modulation, we use Xenopus oocytes as a platform and introduce two-electrode whole-cell voltage clamp in measurement of pump current. Practically, we first synchronize the pump molecules running at the same pace (rate and phase) by a specially designed oscillation electric field. Then, we carefully maintain the pump synchronization status and gradually change the field frequency (decrease and increase) to modulate the pump molecules to newer pumping rate. The result shows a separation of the inward K current from the outward Na current, and about 10 time increase of the total (inward plus outward) pump current from the net outward current from the random paced pump molecules. Also, the ratio of the modulated total pump current with synchronized total pump current is consistent with the ratio of their field frequencies.

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