Sodium-potassium pump cycle

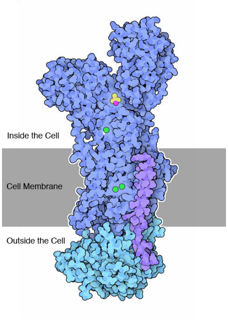
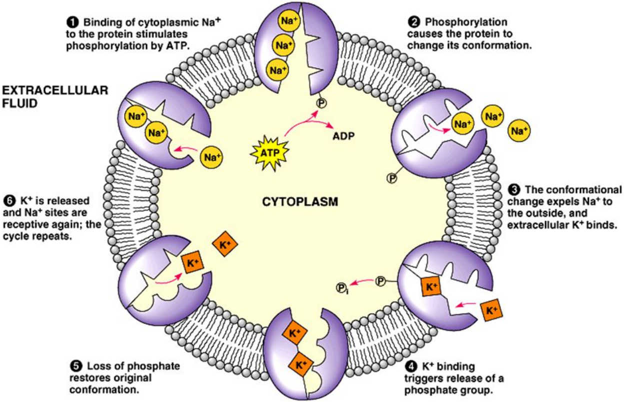
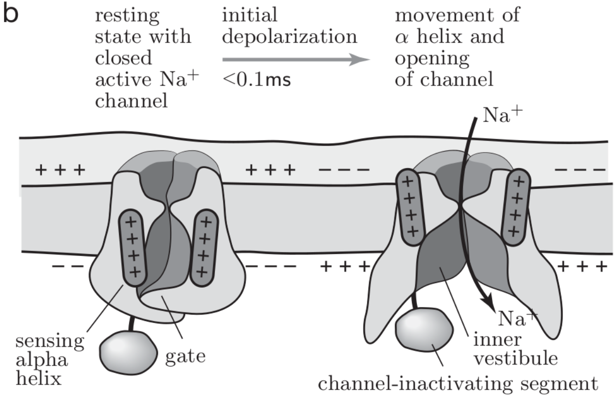


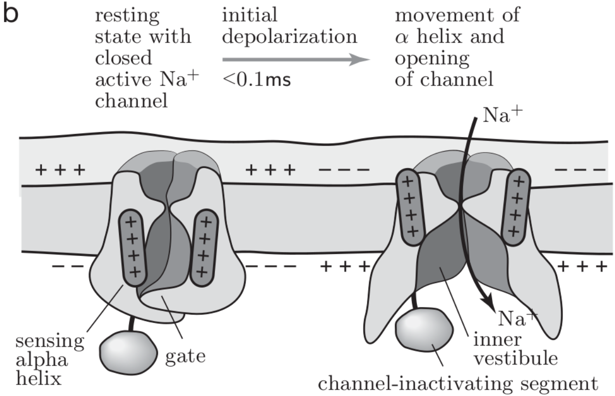
Figure 8.15 The sodium-potassium pump: a specific case of active transport



Voltage-gated Na^+ channel



Voltage-gated Na^+ channel



Simple thermodynamic model: state 1 = **closed**, state 2 = **open**

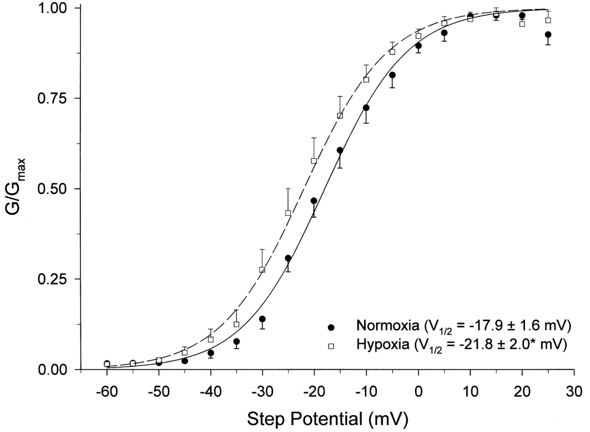
$$\frac{k_{21}}{k_{12}} = e^{-\beta(H_2 - H_1 - Q\ell\Delta V/d)}$$

where Q is the "gating charge", ℓ is the distance it moves, and $\Delta V/d$ is the electric field ($d = 4$ nm is membrane thickness).

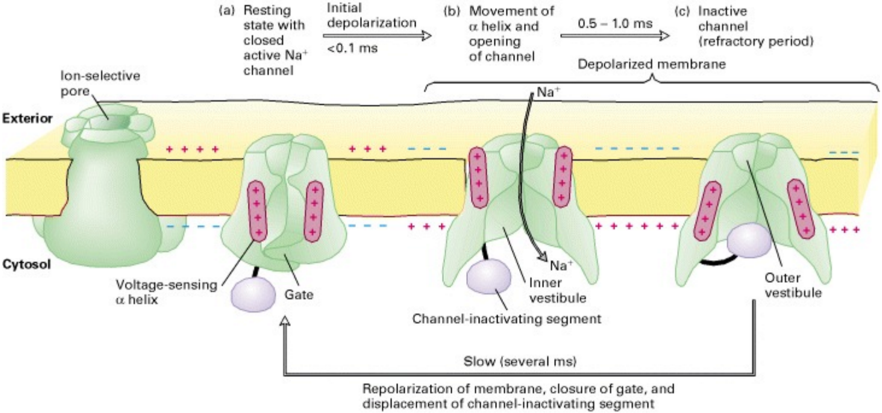
Voltage-gated Na^+ channel

Probability for channel to be open in stationary state at given V:

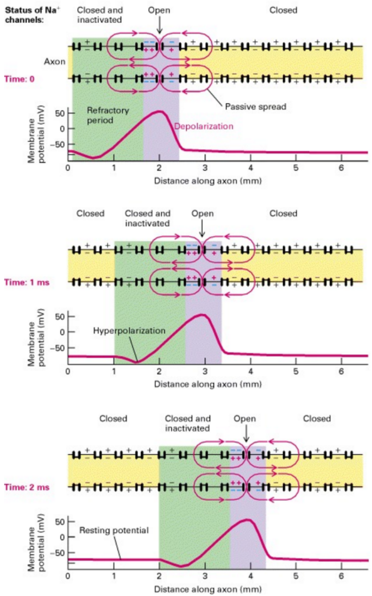
$$p_{Na}(V) = p_2^s = \frac{k_{21}}{k_{21} + k_{12}} = \frac{1}{1 + e^{\beta(H_2 - H_1 - Q\ell\Delta V/d)}}$$



Channel inactivation

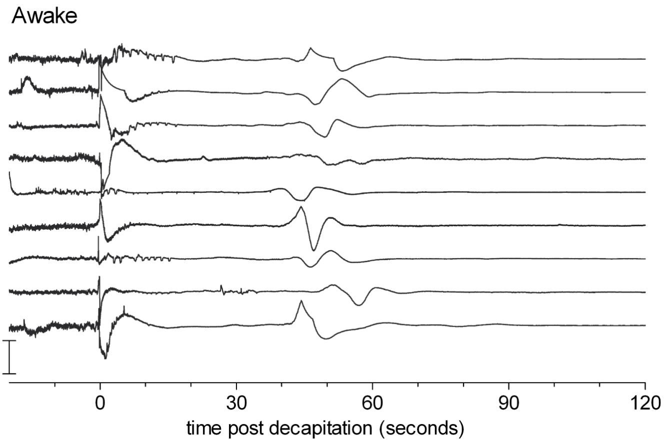


Action potential



Wave of death

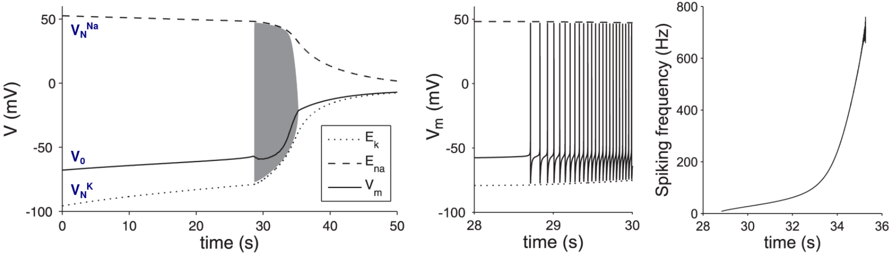
Slow depolarization in the absence of ATP driving the membrane pumps eventually triggers opening of Na^+ channels:



B. Zandt *et al.*, PLoS ONE 6, e22127 (2011)

Wave of death

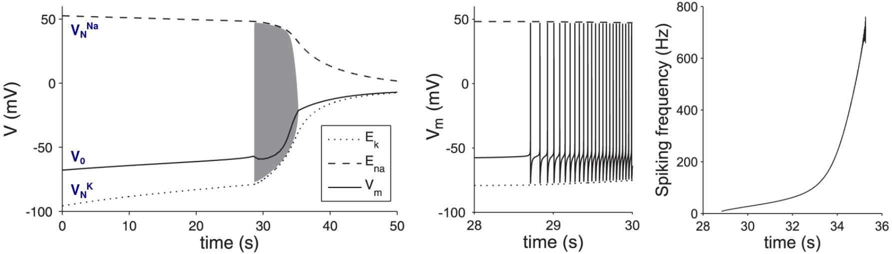
Simulation:



B. Zandt *et al.*, PLoS ONE 6, e22127 (2011)

Wave of death

Simulation:



B. Zandt *et al.*, PLoS ONE 6, e22127 (2011)

Warning: the next slide contains graphic imagery of a dead squid

Triggering squid action potentials with soy sauce

See movie on course website.