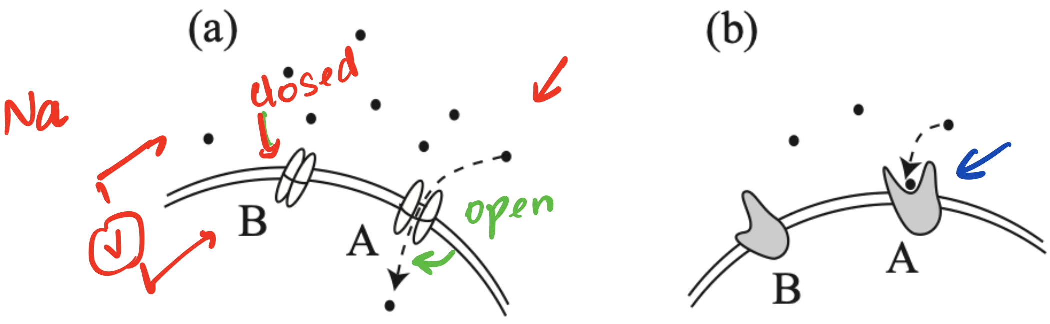
Introduction to chemical Kinetics

Transition between 2 states "Switch"



"The Primer"

cyclic AMP receptor.

open $\quad k_1(V) \quad$ close

$$A \underset{k_{-1}}{\overset{k_1(V)}{\rightleftharpoons}} B$$

rate constants.

Receptive

$$A \rightleftharpoons B$$

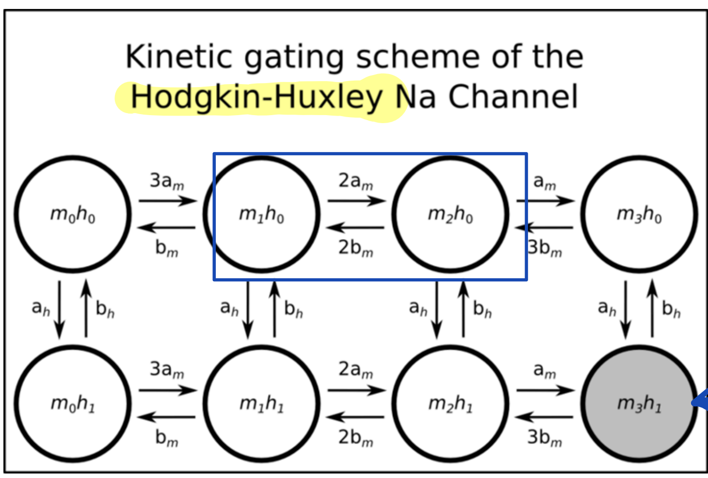
resistant.

$A, B \rightarrow$ concentration of ion channels / receptors

$k_1, k_{-1} \rightarrow$ rate constants

open $\quad$ closed

$$O \rightleftharpoons C$$



Open,

Consider the channel is in state A at time t
at $t + \Delta t$

1. Channel remains in A
2. —"— switches to B and stays there.

$|\Delta t|$

$$\underbrace{\text{Prob}(A \to B \text{ in } \Delta t)}_{\text{dimensionless}} = \underbrace{k_1}_{1/\text{time}} \overbrace{\Delta t}^{\text{time}}$$

absolute error

$$P(A \to B \text{ in } \Delta t) = K_1 \Delta t + \boxed{\varepsilon(\Delta t)}$$

$$= K_1 \Delta t \left(1 + \boxed{\frac{\varepsilon(\Delta t)}{K_1 \Delta t}}\right)$$

relative error.

$$P(B \to A \to B) = \underset{K_{-1}\Delta t}{P(B \to A)}\ \underset{K_1 \Delta t}{P(A \to B)}$$

$$P(A \to B) \gg P(B \to A \to B)$$

$$K_1 \Delta t \gg K_{-1} K_1 \Delta t^2$$

$$\Delta t \ll \left(\frac{1}{K_{-1}}\right) \quad \text{time}$$

Markov Properties

1. Transitions are random
2. Prob. of transitions is independent of history
3. If all conditions are fixed, P(transitions) is independent of time.

Concentration of open channels at time t $A(t)$

$A(t+\Delta t)$?

$$A \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} B$$

$$A(t+\Delta t) = A(t) - K_1 \Delta t\, A(t) + (K_{-1}\Delta t) B(t)$$

$P(A \to B)$ $P(B \to A)$

$$\boxed{\lim_{\Delta t \to 0} \frac{A(t+\Delta t) - A(t)}{\Delta t}} = -K_1 A(t) + K_{-1} B(t)$$

$$\boxed{\begin{aligned} \frac{dA}{dt} &= -K_1 A + K_{-1} B \\ \frac{dB}{dt} &= K_1 A - K_{-1} B \end{aligned}}$$

$$A \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} B$$

Simplification $\frac{dA}{dt} + \frac{dB}{dt} = 0$

$$\frac{d}{dt}(A+B) = 0 \qquad A+B = M$$

constant conservation statement.

$$B = M - A$$

$$\frac{dA}{dt} = -\left(k_1 + k_{-1}\right) A + k_{-1} M$$

$$A(t) \qquad A(t = \overset{0}{\overset{\shortparallel}{t_0}}) = A_0$$