Week 2 – part 2: Reversal potential and Nernst equation

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Neuronal Dynamics:
Computational Neuroscience of Single Neurons

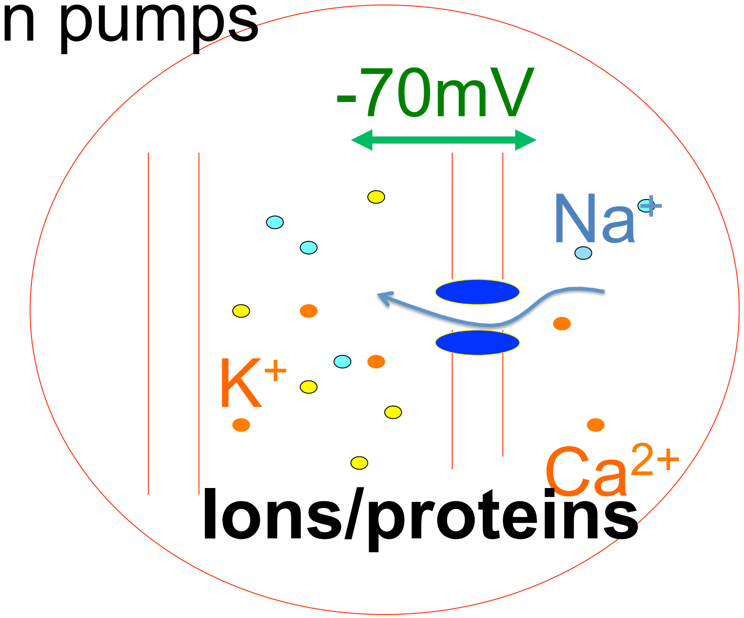
Week 2 – Biophysical modeling:
The Hodgkin-Huxley model

Wulfram Gerstner
EPFL, Lausanne, Switzerland

Neuronal Dynamics – 2.2. Resting potential

Cell surrounded by membrane

Membrane contains
- ion channels
- ion pumps



Resting potential -70mV
→ how does it arise?

Ions flow through channel
→ in which direction?

Neuron emits action potentials
→ why?

Neuronal Dynamics – 2. 2. Resting potential

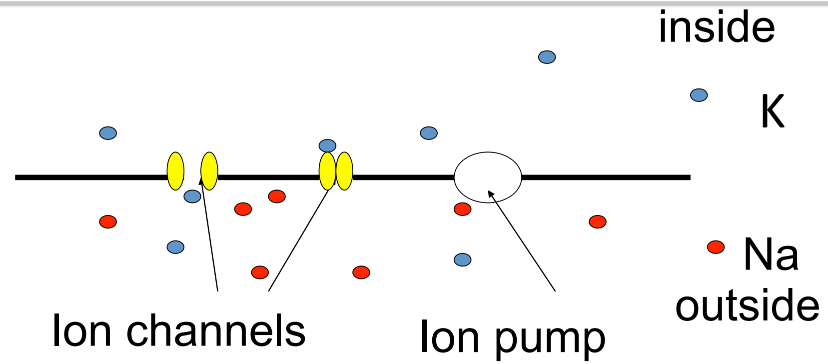
Resting potential -70mV
→ how does it arise?

Ions flow through channel
→ in which direction?

Neuron emits action potentials
→ why?
→Hodgkin-Huxley model

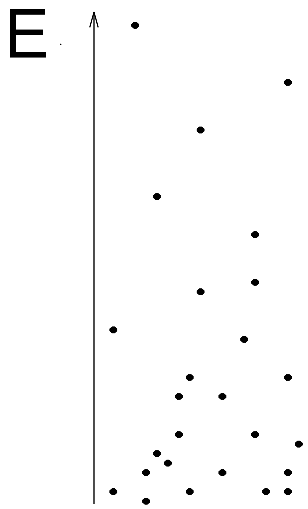
Hodgkin&Huxley (1952)
Nobel Prize 1963

Neuronal Dynamics – 2. 2. Reversal potential



density

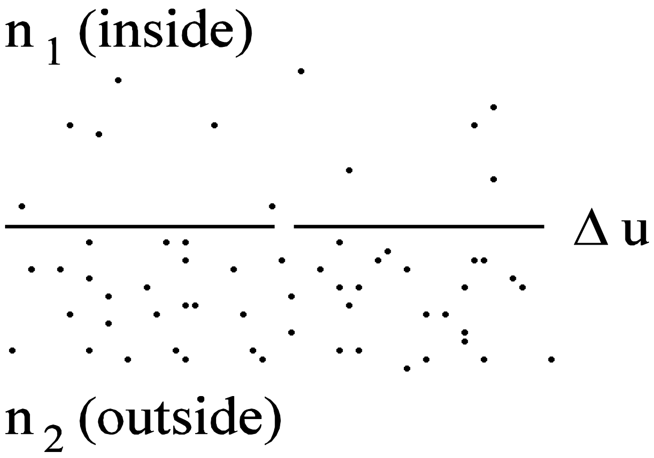
$$n \propto e^{-\frac{E}{kT}}$$



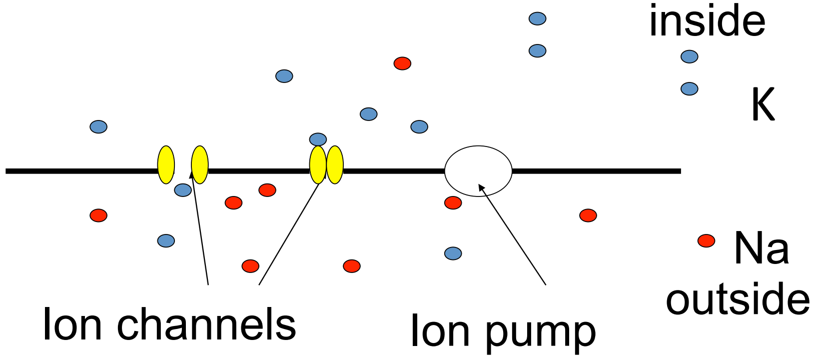
Ion pump ⇔ Concentration difference

Mathetical derivation

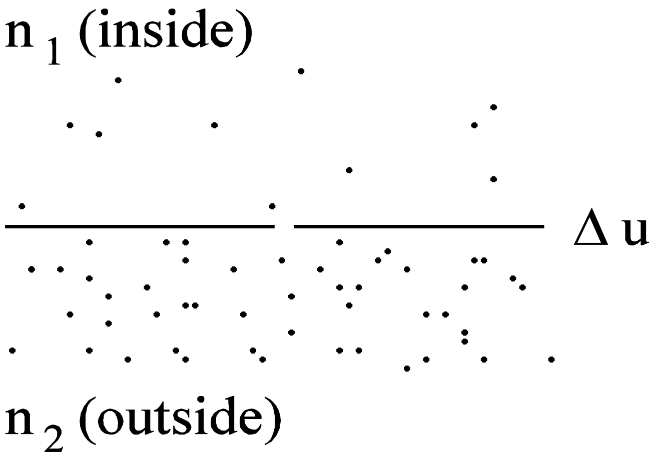
Neuronal Dynamics – 2. 2. Nernst equation

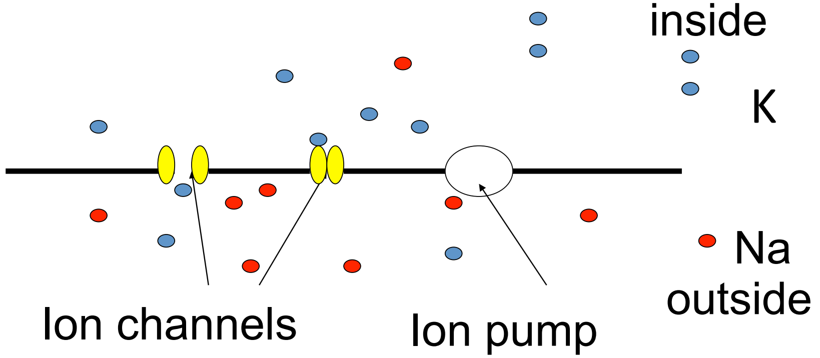


$$n \propto e^{-\frac{E}{kT}}$$



Neuronal Dynamics – 2. 2. Nernst equation



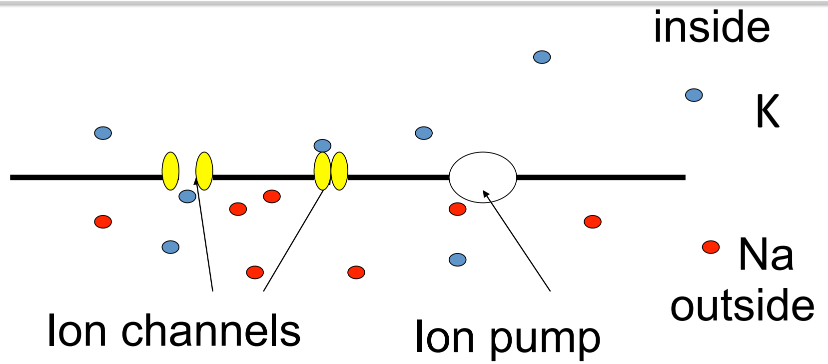


$$\Delta u = u_1 - u_2 = \frac{-kT}{q} \ln \frac{n(u_1)}{n(u_2)}$$

Reversal potential

Concentration difference ⇔ voltage difference

Neuronal Dynamics – 2. 2. Reversal potential



Ion pump → Concentration difference

Concentration difference ⇔ voltage difference

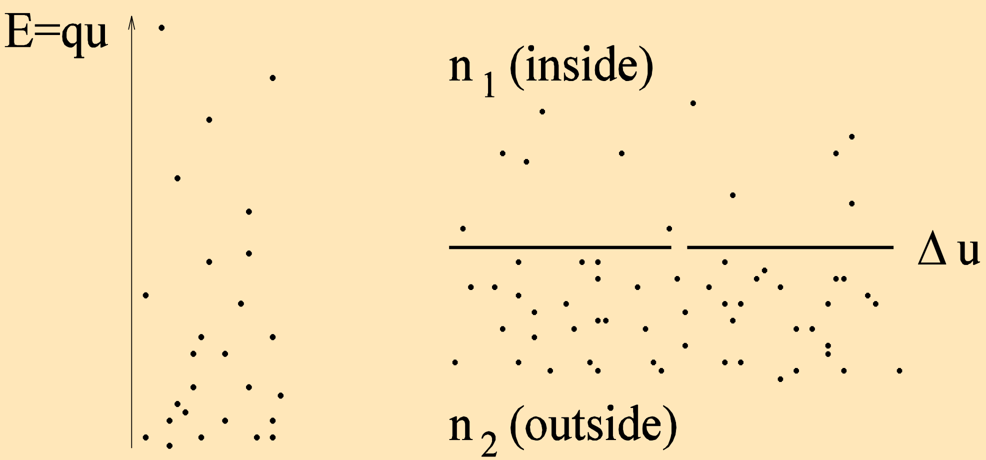
Reversal potential

Nernst equation

Exercise – 2. 2. Reversal potential of ion channels

Reversal potential

$$\Delta u = u_1 - u_2 = -\frac{kT}{q} \ln \frac{n(u_1)}{n(u_2)}$$



Calculate the reversal potential
for Sodium
Postassium
Calcium
given the concentrations

What happens if you change the temperature T from 37 to 18.5 degree?