# Ions demo

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This is a demo for simulating the buildup of the equilibrium potential in a simple neuron. We use the package deSolve to simulate the differential equations.

```
source('demos/ions_sim.R', chdir=T)
```

Both electric and chemical changes are simulated. The goal is to compare the time course and magnitude of the changes under different conditions.

There are two simulations in this demo: 1: Nernst potential 2: equilibrium potential

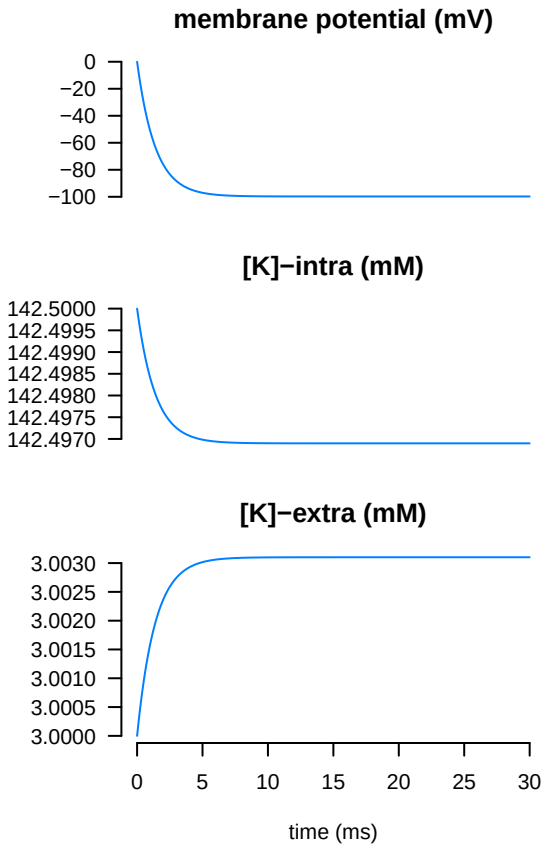
## 1. Simulating the Nernst equation

We will simulate the flux of K ions through a simple membrane permeable only to K ions. Initially there are no electric potential difference between the two sides of the membrane but there is a difference in the ionic concentrations

```
params <- c(gK=gK*2, cm=cm, vi=vi, ve=ve) # parameters of the system. Parameters are:
# gK: K conductance in mS,
# cm: membrane capacitance in uF
# vi and ve: the intracellular and extracellular volume in cm3.
# For more details, see the demos/ions_consts.R file
state <- c(v=0, C.Ki=C.Ki.init, C.Ke=C.Ke.init) # initial state of the system. State variables are:
# v - membrane potential - mV
# C.Ki - intracellular K concentration in mM
# C.Ke - extracellular K concentration in mM

times <-  seq(0,30, by=1/10) # the time axis of the simulations
out <- ode(y = state, times = times, func = sim.Nernst, parms = params) # the function ode solves the s
```

Now, we plot the results



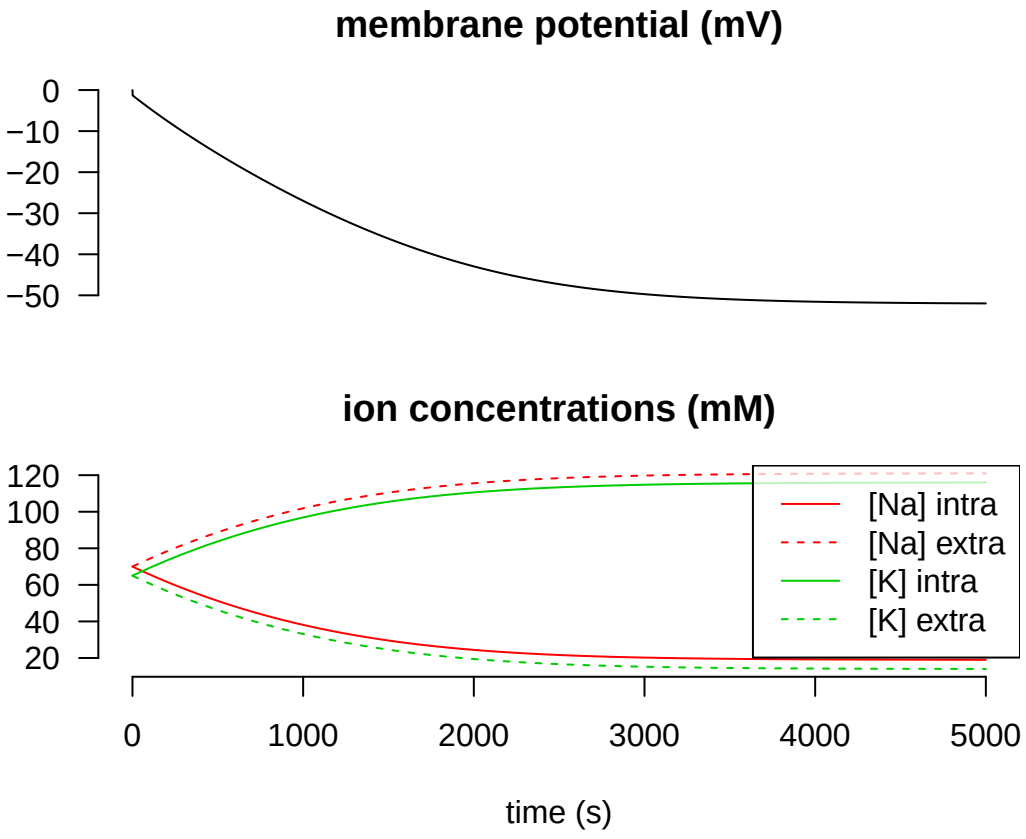

## 2. Equilibrium potential

We will simulate the buildup of the resting potantial of a neuron. Initially there are no electric or chemical gradients. At t=0, we switch on the Na/K exchanger, that starts transporting ions. Both Na and K ions are simulated, the permeability is assumed to be constant.

```
# simulation
params <- c(gK=gK, gNa=gNa, cm=cm, vi=vi, ve=ve, I.pump.K=I.pump.K, I.pump.Na=I.pump.Na)# simulation pa
# gK, gNa: K and Na conductance in mS,
# cm: membrane capacitance in uF
# vi and ve: the intracellular and extracellular volume in cm3.
# I.pump.K, I.pump.Na: the current mediated by the Na/K exchanger in uA
# For more details, see the demos/ions_consts.R file
state <- c(v=0, C.Nai=70, C.Nae=70, C.Ki=65, C.Ke=65)
# initial state of the system. State variables are:
# v - membrane potential - mV
# C.Ki, C.Nai - intracellular K and Na concentration in mM
# C.Ke, C.Nae - extracellular K and Na concentration in mM

times <-  seq(0, 5000000, by=1000) # in ms!
out2 <- ode(y = state, times = times, func = sim.equilibrium, parms = params)
```

Now look at the results


membrane potential (mV)
0
−10
−20
−30
−40
−50
ion concentrations (mM)
120
100
80
60
40
20
0
1000
2000
3000
4000
5000
time (s)
[Na] intra
[Na] extra
[K] intra
[K] extra