# Hodgkin and Huxley model

library(deSolve)

library(tidyverse)

HH\_model <- function(time, states, params){

C\_m <- 1

CL <- 1

if (time%%CL >= 0.010 & time%%CL <= 0.0105)

I\_Stim <- 20000

else

I\_Stim <- 0

# == I\_Na ==

E\_Na <- 40

G\_Na <- 120000

I\_Na <- G\_Na\*states['m']^3\*states['h']\*(states['V']-E\_Na);

alpha\_m <- -100\*(states['V']+50)/(exp(-(states['V']+50)/10)-1)

beta\_m <- 4000\*exp(-(states['V']+75)/18)

dm <- alpha\_m\*(1-states['m'])-beta\_m\*states['m'];

alpha\_h <- 70\*exp(-(states['V']+75)/20);

beta\_h <- 1000/(exp(-(states['V']+45)/10)+1);

dh <- alpha\_h\*(1-states['h'])-beta\_h\*states['h'];

# == I\_K ==

E\_K <- -87

G\_K <- 36000

I\_K <- G\_K\*states['n']^4\*(states['V']-E\_K)

alpha\_n <- -10\*(states['V']+65)/(exp(-(states['V']+65)/10)-1);

beta\_n <- 125\*exp((states['V']+75)/80);

dn <- alpha\_n\*(1-states['n'])-beta\_n\*states['n'];

# == I\_L ==

E\_L <- -64.387

G\_L <- 300

I\_L <- G\_L\*(states['V']-E\_L);

dV <- -(-I\_Stim+I\_Na+I\_K+I\_L)/C\_m

rates <- list(c('V'=dV,'m'=dm,'h'=dh, 'n'=dn))

return(rates)

}

init\_values <- c('V'=-75,'m'=0.05,'h'=0.6, 'n'=0.325)

dt <- 0.00001 # in seconds

time <- seq(0,2,dt) # in seconds

out <- ode(init\_values, time, HH\_model)

print(

out %>%

as\_tibble() %>%

ggplot(aes(x=time,y=V)) +

geom\_line(color="DarkBlue")+

labs(title="Action Potential of the Squid Giant Axon (Hodgkin-Huxley model)",

x="time (s)",

y="V (mV)") +

theme(plot.title = element\_text(face="bold"))

)