# 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"))

)