Compulsory exercise in INF-5610

Deadline: 1. October, kl 14.00

The exercises must be satisfactory solved in order to take the exam. You are suppose to solve them individually. Your report must not be handwritten, but typeset using e.g. Latex or Word.

- Red blood cells have a passive exchanger that exchanges a single Cl^- ion for a bicarbonate (HCO_3^-) ion. Develop a model for this exchanger and find the flux.

  Hint: What sort of transport is this an example of?

- Consider the model of the Na^+ channel shown in Fig. 3.14 on page 79(107) in the compendium. Show that if α and β are large compared to γ and δ, then x_{21} is given (approximately) by

$$x_{21} = \left(\frac{\alpha}{\alpha+\beta}\right)^2 h, \tag{1}$$

$$\frac{dh}{dt} = \gamma(1-h) - \delta h, \tag{2}$$

  while conversely, if γ and δ are large compared to α and β, then (approximately)

$$x_{21} = m^2 \left(\frac{\gamma}{\gamma+\delta}\right), \tag{3}$$

$$\frac{dm}{dt} = \alpha(1-m) - \beta m. \tag{4}$$

  Hint: Use the assumption of equilibrium.

- Explain why replacing the extracellular sodium with choline has little effect on the resting potential of an axon. Why is the same not true if potassium is replaced?

- The Hodkin-Huxley equations are for the squid axon at 6.3^oC. The absolute temperature enters the equations through the Nernst equation. Simulate the equations at 0^oC and 30^oC to determine whether the equations become more or less excitable with an increase in temperature. Use the Matlab code from `http://folk.uio.no/glennli/INF-5610/oblig.m`. The figure below shows a phase-plot for the reduced system. Trajectories for different temperatures are shown. Relate this plot to your conclusions from the simulations.