Ragnar Granit Institute
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71210 Bioelektroniikka - Bioelectromagnetism
Laskuharjoitus 2 – Exercise 2, 22.9.2004

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1. In KCl solution the mobilities of the K^+ and Cl^- are approximately $\omega_K = 4.6\times10^{11}\,\frac{\mathrm{m}}{\mathrm{Ns}}$ and $\omega_{Cl} = 4.9\times10^{11}\,\frac{\mathrm{m}}{\mathrm{Ns}}$. Determine the resistivity of the electrolyte solution, when 17 g of solid KCl is combined with 2 l of distilled water and KCl is fully dissolved.

2. What would be the whole-body impedance (measured between the arms and the legs) of a person consisting solely of mentioned KCl solution? What would the value be if 70 % of the volume consisted of the KCl solution and the rest of various nonconducting tissues? Dimensions of the extremities are:
   Length: arms 60 cm, legs 85 cm, trunk 60 cm.
   Average circumference: arms 29 cm, legs 45 cm, trunk 100 cm.

3. In an actual whole-body impedance measurement at 30 kHz, a 200 Ohm reading was obtained. What is the average resistivity of all the body tissues? What would be the current passing through the person, if s/he wanted to test the conductivity by grabbing 230 Vac with his/her hands? Assume zero contact impedance between the ac and the hands, and the legs and the GND.

4. What is Nernst equation? What phenomena does it explain?

5. Cylindric muscle cell (length 40 µm) is at rest. Potassium ion flow from the cell is $10\ \frac{\mathrm{p\ mol}}{\mathrm{cm^2 s}}$. Calculate the corresponding electrical current when the cell diameter is 10 µm. What is the potassium ion conductance of the cell membrane?
   (V_K = -90 mV, resting membrane voltave V = -70 mV)

6. In nerve and muscle cells the concentration ratios of the chloride and potassium ions between intracellular and extracellular fluids are approximately 1:30 (that is, for example $4\times10^{-6}\,\frac{\mathrm{mol}}{\mathrm{cm^3}} : 120\times10^{-6}\,\frac{\mathrm{mol}}{\mathrm{cm^3}}$) and 38.8:1. What are the corresponding equilibrium voltages for chloride and potassium ions? (The value of the potential difference across the cell membrane that clamps the specific ionic flow)