Instruction for exercise 5

Title: Testing electrical potentials in membrane systems.

Theoretical topics

1.Diffusion phenomenon, diffusion in membrane systems.

2. Electrical potentials. The difference in the potential of two oppositely charged plane

3. Mechanisms of transport of substances in biological cells

4. Nernst and Goldman equations for membrane potentials

5. Membrane potentials – resting and functional

The purpose of the exercise: Get acquainted with the phenomena of ion diffusion and Nerst – equilibrium issue formed in the solution of ions separated by selective membrane. Generating electrical potential in membrane systems.

The practical task is to carry out measurements of electrical potential difference appearing on the ion-selective (cationic) membrane at several selected concentrations of KCl or NaCl solutions.

Then compare the measured values of membrane potentials - E_z with the calculated values - E_o based on the Nernst-Planck equation.

The equation for electrical potential difference using a cation-selective membrane has the following form:

$$\mathbf{E_0 = 0.2mV/K \times T \times \log_{10}(a_1/a_2)}$$

where: $\mathbf{a_1=f_1 \cdot C_1}$, $\mathbf{a_2=f_2 \cdot C_2}$ are solution activities at concentrations: $\mathbf{C_1}$ and $\mathbf{C_2}$. $\mathbf{F_1}$, $\mathbf{f_2}$ are the activity coefficients of concentrations $\mathbf{C_1}$ and $\mathbf{C_2}$ respectively, while T represents measured temperature (in the Kelvin scale) of solutions in the Ussing chamber.

Note that the values of the coefficients **"f"** can be found in the table at the end of the manual.

Instruments:

1.Digital Multimeter - Peak Tech 2005, 2. Cobra 4 Interface - Chemistry PHYWE, 3. Ussing chamber storage tanks separated by a cation-selective membrane, 4. Silver chloride electrode (Ag/AgCl),

5. Temperature sensor - Pt 100, 6. Solutions of NaCl, KCl: 1 mol / dm^3, 0.1 mol / dm^3, 0.01 mol / dm^3, 0.001mol / dm^3

Technical Introduction:

Ussing chamber tanks are filled with salt solutions (NaCl or KCl) of various concentrations, separated by cation-selective membrane. Two identical Silver chloride electrodes placed in both solutions are connected to the multimeter (Millivoltmeter). In this setup, the millivoltmeter display the electrical potential difference between the membrane surfaces.

Measurements and reporting:

1. Using the cylinder measure 85 ml of 0.01 molar NaCl solution - then fill left tank (L) of the Ussing chamber with the solution (concentration $\mathbf{C_1}$). Fill the right tank (P) with 85 ml - 0.001 molar NaCl solution (this is $\mathbf{C_2}$ concentration).

2. Wash the electrodes with distilled water and dry them with lignin.

3. Immerse the electrode in solutions through the holes in the tanks. Check that the electrodes are not touching bottom of chambers.

4. Connect the electrodes to the multimeter sockets - COM (left electrode) and V / Ω (right electrode) - check if the meter is turned off.

5. Set the measuring range of the meter to: **200 mV DCV**.

6. Turn on the meter and read out the potential difference (mV).

7. Read the value of the potential difference at 0.5 minute intervals until you reach the fixed value. Enter the data into measuring table (3 values)

8. Connect the temperature sensor PT 100 to the Cobra 4 interface and measure the solution temperature in the Ussing Chamber tanks. Enter the temperature value T in the measurement table.

9. Turn off the meter, lift the electrodes, rinse them with distilled water and drain using lignin.

10. Make potential difference measurements for solutions with different concentrations e.g.: C_1 = 0.1M, and C_2 = 0.01M or C_1 = 0.1M and C_2 = 0.001M, repeat steps 1 - 8.
11. After the measurements have been completed, disconnect the electrodes from the meter (the meter must be switched off at this time) and immerse them in a 0.1 mol / dm^3 KCl solution and turn off the Cobra interface.
12. The solutions from the Ussing chamber should be poured out. Containers should be rinsed several times and then filled with distilled water.

Measurement table:
(values of membrane potential; measured and calculated, and temperature)

No.	**Concentration ratio between NaCl and KCl solution** [mol/dm^3]	**E_{z1}** [mV]	**E_{z2}** [mV]	**E_{z3}** [mV]	**$E_{z\ Avg.}$** [mV]	**T** [K]
1	1/0.1					
2	0.1/0.01					
3	0.01/0.001					
4	0.1/0.001					
5	1/0.01					

Table of activity coefficients - f

Solution	1 mol/dm^3	0.1 mol/dm^3	0.01 mol/dm^3	0.001 mol/dm^3
NaCl	0.664	0.786	0.906	0.966
KCl	0.611	0.771	0.902	0.965