Experiment GB-2: Membrane Permeability

Exercise 1: Movement of Small Positive Ions Across a Membrane

Aim: To determine if small, positively charged, hydrogen ions can move across a membrane from a region of higher concentration (1.0M HCl) to a region of lower concentration (deionized water).

Procedure

1. Using the equipment from the calibration exercise, place 100 mL of room temperature deionized (DI) water in a clean 250 ml beaker. Add a stir bar to the beaker and place the beaker on the magnetic stirrer. Turn on the stirrer and position the stir bar to one side of the beaker bottom.
2. Remove the ISE-100 pH electrode from the beaker of deionized water used at the end of calibration. Blot the drops of DI water from the electrode. Mount the electrode in a clamp on the ringstand and position it over the new beaker of deionized water. Carefully lower the tip of the electrode into the beaker.
3. Turn on the stirrer so that the stir bar rotates slowly and evenly.
4. Click Record on the LabScribe Main window to begin recording. When the recording on the channel reaches a stable baseline, type DI Water in the Mark box to the right of the Mark button. Press the Enter key on the keyboard to mark the recording.
5. After recording at least fifteen seconds of stable baseline, type the words Dialysis Tube w/ 1.0M HCl in the Mark box to the right of the Mark button.
6. Lower the dialysis tube into the deionized water and press the Enter key on the keyboard to mark the recording. Clamp the dialysis tube to the edge of the beaker so that about half the solution in the tube is below the surface of the deionized water. Make sure the bottom of the dialysis tube is not touching the stir bar.
7. Record the pH of the deionized water for five minutes.
8. Mark the recording at the 1 minute interval, type 1 minute in the Mark box to the right of the Mark button and press the Enter key on the keyboard to mark the recording.
9. Repeat Step 8 for the 2, 3, 4, and 5 minute intervals.
10. At the end of five minutes, click Stop to halt the recording.
11. Select Save in the File menu.
12. Turn off the magnetic stirrer. Remove the dialysis tube with the 1.0M HCl from the beaker and discard the dialysis sac as directed.
13. Remove the pH electrode from the beaker. Hold the electrode over the beaker used for collecting waste liquid, and rinse it with deionized water from a wash bottle. Blot any drops of water from the electrode and place it in a beaker of deionized water.
14. Remove the stir bar from the beaker of deionized water and rinse it with deionized water from a wash bottle. Discard the deionized water.

Data Analysis

1. Scroll to the section of data recorded in which the pH changes of deionized water treated with the 1.0M HCl dialysis tubing were recorded as shown in Figure GB-2-L1.

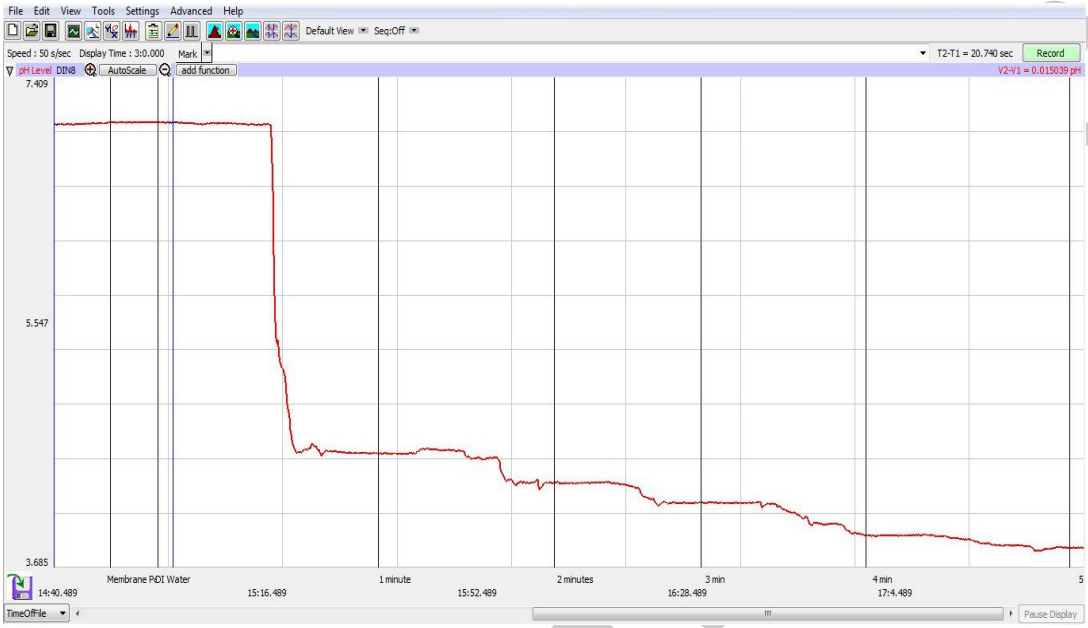

Figure GB-2-L1: Recording of the changes in pH over a 5 minute period with the 1.0 M HCl dialysis tubing in deionized water.

2. Use the Display Time icons on the LabScribe toolbar to position the complete recording on the Main window. The required data can also be selected by:
    - Placing the cursors on either side of the section of data needed. Place one cursor on the stable pH level recorded from pure deionized water. Place the second cursor on the stable pH level recorded after a total 5 minutes with the 1.0M HCl dialysis sac immersed in the deionized water
    - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment of data to the width of the Main window.
3. Click on the Analysis window icon in the toolbar or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window (Figure GB-2-L2).
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions that are listed should include Title, Value1, Value2, and V2-V1. The values for these parameters from each channel are seen in the table across the top margin of each channel.
5. Once the cursors are placed in the correct positions for determining the pH, the values for pH can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the Journal.

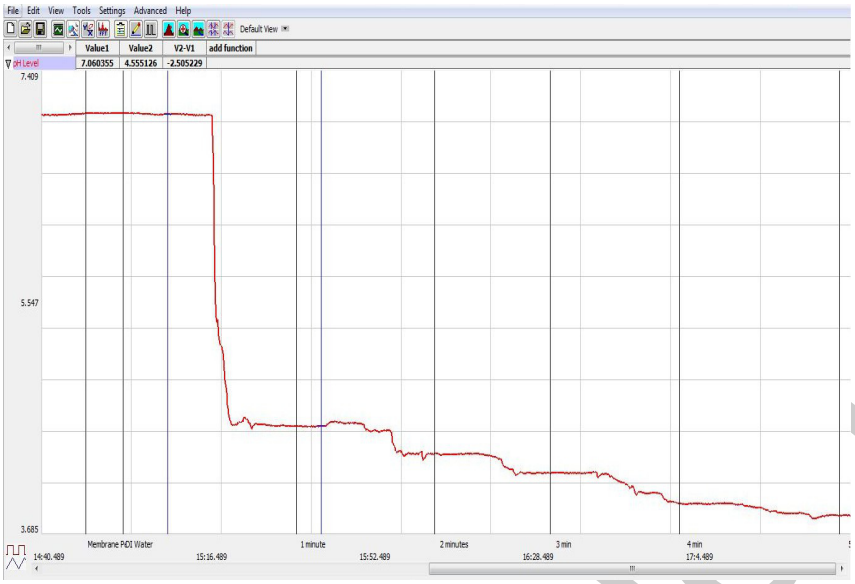

Figure GB-2-L2: The membrane permeability data displayed in the Analysis window, showing the values at each cursor and the pH change over time with the addition on a dialysis tube of 1.0 M HCl.

6. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters from the recording to the Journal. To use these functions:
    - Place the cursors at the locations used to measure the pH from the pH channel.
    - Transfer the name of the mathematical function used to determine the pH to the Journal using the Add Title to Journal function in the pH channel pull-down menu.
    - Transfer the value for the pH to the Journal using the Add Ch. Data to Journal function in the pH channel pull-down menu.
7. Place a cursor on the stable baseline recorded just before the dialysis tubing containing 1.0M HCl was lowered into the beaker of deionized water. Place the second cursor at the point in the recording that is five minutes after the dialysis tubing was placed in the water.
8. Measure the values for the following parameters from the pH channel for the region of data selected:
    - pH-DI Water, which is Value1 on the pH channel.
    - 5 minutes, which is Value2 on the pH channel.
9. Record the values for these parameters in the Journal using one of the procedures described in Step 6, and in Table GB-2-L1.
10. Measure the Overall Change in pH using the parameter, V2-V1, from the Function Table in the Analysis window.
11. Divide the Overall Change in pH by the initial pH of the DI water to determine the percent change in pH.
12. Click Save in the File menu

Exercise 2: Movement of Small Negative Ions Across a Membrane

Aim: To determine if small, negatively charged, hydroxide ions can move across a membrane from a region of higher concentration (1.0M NaOH) to a region of lower concentration (deionized water).

Procedure

1. Repeat Exercise 1 using the 1.0M NaOH dialysis sac in place of the 1.0M HCl.
2. Mark the recording with appropriate labels to indicate the length of time the 1.0M NaOH dialysis sac was in the beaker of deionized water.
3. Select Save in the File menu to add this data to the existing data file.
4. Turn off the magnetic stirrer. Remove the dialysis tube with the 1.0M NaOH from the beaker and discard as directed.
5. Remove the pH electrode from the beaker. Hold the electrode over the beaker used for collecting waste liquid, and rinse it with deionized water from a wash bottle. Blot any drops of water from the electrode and place it in a beaker of deionized water.
6. Remove the stir bar from the beaker of deionized water and rinse it with deionized water from a wash bottle. Discard the deionized water.

Data Analysis

1. Use the same techniques used in Exercise 1 to measure the pH levels of the DI water after the 1.0M NaOH dialysis sac was immersed in the deionized water.
2. Use the same techniques explained in Exercise 1 to record the values of the pH levels in the Journal, and in Table GB-2-L1.
3. Click Save in the File menu.

Exercise 3: Movement of Large Ions Across a Membrane

Aim: To determine if large, negatively charged, acetate ions can move across a membrane from a region of higher concentration (1.0M Na Acetate) to a region of lower concentration.

Procedure

1. Repeat Exercise 1 using the 1.0M Na Acetate dialysis sac in place of the 1.0M HCl.
2. Mark the recording with appropriate labels to indicate the length of time the 1.0M Na Acetate dialysis sac was in the beaker of deionized water.
3. Select Save in the File menu to add this data to the existing data file.
4. Turn off the magnetic stirrer. Remove the dialysis tube with the 1.0M Na Acetate from the beaker and discard as directed.
5. Remove the pH electrode from the beaker. Hold the electrode over the beaker used for collecting waste liquid, and rinse it with deionized water from a wash bottle. Blot any drops of water from the electrode and place it in a beaker of deionized water.

6. Remove the stir bar from the beaker of deionized water and rinse it with deionized water from a wash bottle. Discard the deionized water.

Data Analysis

1. Use the same techniques used in Exercise 1 to measure the pH levels of the DI water after the 1.0M Na Acetate dialysis sac was immersed in the deionized water.
2. Use the same techniques explained in Exercise 1 to record the values of the pH levels in the Journal, and in the data table.
3. Click Save in the File menu.

Table GB-2-L1: Changes in pH during Movement of Ions.

Solution in Dialysis Tubing	pH Level		
	T=0 Mins	T=5 Mins	Change (Δ)
1.0M HCl			
1.0M NaOH			
1.0M Na Acetate			

Questions

1. During the five minutes that the dialysis sac containing 1.0M HCl was placed in the beaker of deionized water, what happened to the pH of the water? What caused the result that you recorded?
2. During the five minutes that the dialysis sac containing 1.0M NaOH was placed in the beaker of deionized water, what happened to the pH of the water? What caused this result?
3. During the five minutes that the dialysis sac containing 1.0M Na Acetate was placed in the beaker of deionized water, what happened to the pH of the water?
4. Explain how the movement of large particles causes a change in pH.
5. If any of the ions diffused across the membrane, which one diffused more quickly?
6. What factors could increase the rate of diffusion of an ion across a membrane?