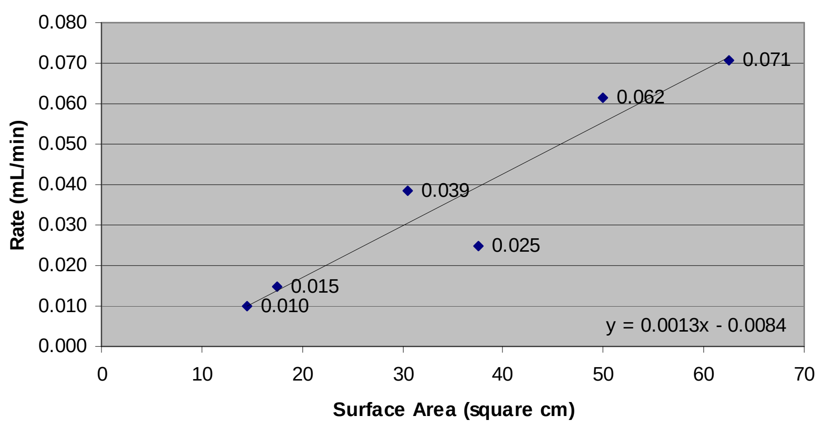
Rates of Osmosis and Membrane Surface Areas

Summary: My group and I tested the osmotic rate through a differentially permeable membrane with a specifically measured surface area. We accomplished this by constructing a simple osmometer from dialysis tubing, filled with sucrose solution and secured to a pipette, and submerged into a beaker filled with H_2O. Measurements of diffused liquid were then taken over an interval of time to find the rate of change. Other groups within our class performed the same experiment, the only difference being that each had a unique measurement for the total surface area of the permeable membrane. Individual results from all the groups were then pooled together to assist in making generalizations and determinations. Our collective data shows that the surface area does indeed have an effect on osmotic rates, with larger surface areas attributed as having higher rates. These results are supported by other experiments in which the flow rates were found to increase or decrease linearly with variations in surface area *(Chamberlain & Moore, 1982).* The direction of diffusion of H_2O is also confirmed by the fact that a lower concentration of water molecules exists in the sucrose solution, given that regions of higher concentration diffuse to regions of lower concentration. *(Raven et al., 2008)*.

Methods & Results: My group and I filled a beaker with H_2O and obtained an 8cm x 2.5cm piece of dialysis tubing. The tubing was measured to be approximately 4cm in length for the experiment, so we made the necessary adjustments when clamping shut one side of the tubing so that it would contain a liquid. We then filled the tubing with a 2.0M sucrose solution, which also contained the dye Congo Red, and affixed the top open portion of the tubing to a pipette with a rubber band. The final measurement from the clamp to the rubber band was 3.5cm which represented a total surface area of 17.5cm^2 (3.5cm x 2.5cm x 2 sides).

The pipette was then attached to a ring stand and the tubing with sucrose solution was submerged into the beaker containing H_2O. For an hour we took measurements every ten minutes to observe how much water had diffused into the sucrose solution. Other groups within the class performed the same experiment with different measured surface areas. Upon completion of all the experiments, all of our results were shared. This produced the following graph of data:



With only one exception, each group's results appear to be rather consistent. Applying a regression line to the data produces the linear equation $y = 0.0013x – 0.0084$, which represents the relationship of surface area (x-variable) to the rate in mL/min (y-variable).

References:
Chamberlain, Jr., J.A. & Moore, Jr., W.A., 1982. Rupture Strength and Flow Rate of Nautilus Siphuncular Tube, *Paleobiology*, 8(4), pp. 408-425.
Raven, P. & Johnson, G. & Losos, J. & Mason, K. & Singer, S., 2008. *Biology*, 8th ed., McGraw-Hill.