International Journal of Basic and Applied Medical Sciences ISSN: 2277-2103 (Online)
An Online International Journal Available at http://www.cibtech.org/jms.htm
2012 Vol. 2 (2) May-August pp. 271-278/Shukla and Shukla
Research Article

EFFECT ON POLARIZABILITY AND EFFECTIVE PRESSURE ACROSS URINARY BLADDER MEMBRANES OF GOAT USING AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE AND SODIUM CHLORIDE RESPECTIVELY

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ABSTRACT
Urine is a multi component system. Constituents of urine are collectively responsible for micturition phenomena. High protein food items are generally acid forming. Acid forming foods and their continuous use increases ammonia output in the urine. The objective of this paper is to assess the role of increasing ammonia and sodium chloride across urinary bladder as regards polarizability and pressure are concerned. Methodology of non-equilibrium thermodynamics have been used to explain the data. Hydrodynamic and electro-osmotic permeability of different aqueous solutions of ammonium chloride and sodium chloride have been carried out. Kinetic energy term (α_1) which is equivalent to velocity head which decreases effective pressure across the bladder membrane and polarizability term (α_2) which is related with distention power of the bladder have been computed for all the permeants. It has been found that ammonium chloride and sodium chloride behave differently with bladder surface. Such studies are expected to be of very great use as regards frequency of urination and physiological behavior of membranes in diverse situation is concerned.

Key Words: *Polarizability, Effective Pressure, Non-equilibrium Thermodynamics, Hydrodynamics and Electro-Osmotic Permeability*

INTRODUCTION
We are designed alkaline and function acidic (Murray 2000; Izquierdo, 1991). Each minute of each day, the body's metabolic process produce enormous quantities of acids even through in order to do that job properly the cells and tissues require a slightly alkaline environment. Healthy bodies require a narrow range of pH, blood and tissue balance at all times. Kidneys, Lung and skin are capable of eliminating undesirable substances.
The Biological kidney performs numerous regulatory functions in addition to manufacturing important bio-chemicals. Preliminary, the kidney's function to (Allen, 1987) (i) remove nitrogenous metabolic waste product, (ii) regulate volume of the body water, (iii) maintain acid base and electrolytic composition, (iv) assist in regulation of blood pressure and (v) assist in red blood cell production (erythropoiesis).
Kidneys provide the major control of electrolyte and acid-base balance (Westentood, 1974) of the body and this is achieved principally through H ± Na^+ exchange mechanism, ammonia formation and the kidney threshold for bicarbonate while the chief cation concerned in regulation of electrolytic concentration and acid-base balance is Na^+, in severe acidosis, the K^+, Ca^{++} and Mg^{++} concentration in plasma are elevated which leads to excessive excretion in urine.
The quantity of ammonia in urine may be enormously increased through hydrolysis of urea by bacteria in the bladder or other parts of urinary tract. Urinary ammonia may be marked by decreased in the case of severe nephritis, in which capacity of kidney to form it has been impaired.
Next to urea, chlorides make up the chief solid constituent (Oser, 1979) of urine. Daily excretion varies widely with dietary intake. Urine chlorides may be extremely low in case of severe diabetes insipidus.

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Excessive amount of sodium and chlorides are excreted in the urine in the case of Addison's disease (Adrenal cortical in sufficiency/while the excretion of these substances is decreased in cortical hyper function (Cushing Syndrome).

Urinary frequency is most common urological symptoms. To evaluate frequency, it is essential to know normal voiding pattern. Continuous increase or decrease of these substances may have prolonged effect on the bladder characteristic. Change of polarizability and pressure for aqueous urea solution (Shukla and Mishra, 1989). Urea-glucose mixture (Shukla and Mishra, 1992) Urea increasing glucose constant and urine-urea mixture (Shukla and Chaubey, 1995) (Decreasing Urea in urine) have already been studies. In view of the physiological effects and its importance, attempts have been made to analyse the effect of pressure and polarizability across urinary bladder by aqueous ammonium chloride and sodium chloride. Methodology of non-equilibrium thermodynamics have been used to explain the data.

Using methodology of non-equilibrium thermodynamics, volume flow and current flow may be expressed as (Lakshminariah 1984; Shukla and Chaubey, 1994)

$$J_v = L_{11}\Delta P + L_{12}\Delta\psi + L_{112}\Delta P\Delta\psi + \frac{1}{2}L_{111}(\Delta P)^2 + \frac{1}{2}L_{122}(\Delta\psi)^2 + \frac{1}{6}L_{1111}(\Delta P)^3 + \frac{1}{2}L_{1112}(\Delta P)^2\Delta\psi + \frac{1}{2}L_{1122}\Delta P(\Delta\psi)^2 + \frac{1}{6}L_{1212}(\Delta\psi)^3 \quad \text{..........} \quad (1)$$

$$I = L_{21}\Delta P + L_{22}\Delta\psi + \frac{1}{2}L_{211}(\Delta P)^2 + L_{212}\Delta P\,\Delta\psi + \frac{1}{2}L_{222}(\Delta\psi)^2 + \frac{1}{2}L_{2122}\Delta P\,(\Delta\psi)^2 + \quad \text{.........} \quad (2)$$

Where ΔP and $\Delta\Psi$ are differences of pressure and electrical potentials respectively. When $\Delta\Psi$ is zero, volume flow may be expressed as

$$J_v = L_{11}\Delta P + \frac{1}{2}L_{111}(\Delta P)^2 + \frac{1}{6}L_{1111}(\Delta P)^3 + \quad \text{......} \quad (3)$$

When $\Delta P = 0$, volume flow may be expressed as

$$J_v = L_{12}\,\Delta\psi + \frac{1}{2}L_{122}(\Delta\psi)^2 + \frac{1}{6}L_{1222}(\Delta\psi)^3 + \quad \text{.......} \quad (4)$$

Effective pressure term (α_1) and polarizability term (α_2) may be expressed as (Lorimer, 1985)

$$\alpha_1 = \frac{L_{111}A^2}{\rho L_{11}^{\ 3}} = \frac{-L_{1111}A^4}{(3\rho^2 L_{11}^{\ 5})} \qquad (5)$$

and

$$\alpha_2 = \frac{-L_{1222}A^2}{3\rho L_{11}^{\ 2} L_{12}\,\alpha_1} \quad \frac{-\alpha_1\rho L_{12}^{\ 2}}{2A^2}$$

$$= \frac{-L_{1122}\,A^2}{\alpha_1\rho L_{11}^{\ 3}} \quad \frac{-3\alpha_1\rho L_{12}^{\ 2}}{A^2} \qquad (6)$$

Where L_{1122} and L_{1222} are higher order phenomenological co-efficients.

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MATERIALS AND METHODS

Choice of Membrane

The membrane used for experimental study was goat bladder, which is a smooth muscle chamber having different layers. It was chosen due to its easy availability and capacity to withstand high pressure. The membrane was isolated from the animal and then immediately dipped in 0.7% sodium chloride solution. Care was taken to ensure that the bladder contained some urine. After keeping the bladder in brine for 2 to 3 hrs, it was treated with formaline-alcohol solution (100 parts water, 95% alcohol and 10 parts 40% formaldehyde) as described earlier (Shukla and Mishra, 1986).

Choice of Permeant

Aqueous solutions of sodium and ammonium chlorides have been chosen as permeant. These are the constituents of urine and their concentration varies according to the diet taken. The veterinary indication for ammonium chloride is as a urinary acidifying agent to help, prevent and dissolve certain type of urolith, to enhance renal excretion of some type of toxins or drugs or to enhance the efficiency of certain anti microbial.

Table 1: Values of Phenomenological Coefficient of Aqueous Solution of Ammonium Chloride

Conc. (Moles/Liter)	**L_{11} X 10^{-13} $m^5s^{-}N^{-1}$**	**L_{12} X 10^{-11} $m^3s^{-}volt^{-1}$**	**L_{111} X 10^{-16} $m^7s^{-1}N^{-2}$**	**L_{1222} x 10^{-13} $m^3s^{-1}v^{-3}$**	**$\square_1$ X 10^{12} $m^{-1}Ns^2Kg^{-1}$**	**$\square_2$ $m^{-3}v^{-2}J$**
0.02	3.60	3.50	6.00	4.00	1.2	-6.3
0.04	3.00	2.65	5.00	3.00	1.6	-6.5
0.06	2.40	1.90	4.06	2.50	2.34	-7.7
0.08	2.00	1.62	3.00	1.95	3.3	-8.3
0.10	0.90	1.34	2.20	1.50	3.7	-8.6

Table 2: Values of Phenomenological Coefficient of Aqueous Solution of Sodium Chloride

Conc. (Moles/Liter)	**L_{11} X 10^{-13} $m^5s^{-}N^{-1}$**	**L_{12} X 10^{-11} $m^3s^{-}volt^{-1}$**	**L_{111} X 10^{-16} $m^7s^{-1}N^{-2}$**	**L_{1222} x 10^{-13} $m^3s^{-1}v^{-3}$**	**$\square_1$ X 10^{12} $m^{-1}Ns^2Kg^{-1}$**	**$\square_2$ $m^{-3}v^{-2}J$**
0.02	0.15	0.12	1.00	0.96	392.50	-27.0
0.04	0.40	0.30	1.67	1.08	257.50	-14.55
0.06	0.90	0.70	2.35	1.38	31.75	-10.39
0.08	1.60	1.00	2.69	1.44	6.44	-6.06
0.10	3.00	1.80	3.44	1.80	0.89	-5.46

Experimental Procedure

A solution to be studied was placed in the experimental setup 8 to 10 hrs before observation were made so as to acclimate the membrane with the permeating material. Hydrodynamic permeability is measured by noting the rate of advancement of liquid in a horizontal capillary tube. Electro-osmotic permeability (Shukla and Mishra, 1987) is measured by noting the rate of advancement of liquid column as a result of application of electrical potential across the membrane. Ammonium chloride has also been used intra venously for correction of metabolic alkalosis.

RESULTS AND DISCUSSION

Urinary process is the development of pressure (Guytoon, 1971), sustenance of pressure and finally release of pressure. Development of pressure gives rise to streaming potential, which in turn produces streaming current which is nothing but micturition wave (Shukla and Chaubey, 1994-1995)

Proper excretion of urine is dependent upon proper functioning of the bladder. Stasis or sluggish flow of urine may be a factor in stone formation. When the bladder fails to empty it self (Wyper and Glimwater, 1977), the resting pressure within the bladder is higher than normal, disturbing the ureter bladder pressure gradient and making it more difficult for urine to reach the bladder. Back pressure produces hydro ureter and hydro nephrosis with resultant loss of renal function.

Next to urea, ammonia is quantitatively the most important of the nitrogenous end product of protein metabolism. Ammonia content of the urine appears to be related primarily to the acid-base balance of the body. Acid forming foods and copious water drinking also increase ammonia output. Pathological increase in output of ammonia is observed in disease accompanied by an increased and imperfect protein metabolism. In diabetes mellitus, increased excretion of ammonia occurs. With increase in urine acidity more ammonia becomes available to the urine and less to the venous blood. The ammonia is excreted in performance to fixed base, as follows-

$NaCl$	+	NH_4^+	NH_4Cl	+	Na^+
(from blood)		(from kidney)	(to urine)		(to blood)

Chlorides make up the chief solid constituents of urine. Daily excretion varies widely with dietary intake. Urine chlorides may be extremely low in case of severe diabetes insipidus.

The results of hydrodynamic and electro-osmotic permeability of aqueous solutions of ammonium chlorides and sodium chlorides may be summarized as follows -

(i) Hydrodynamic permeability increases with increase in concentration of sodium chloride whereas in the case of ammonium chloride, it decreases with increase in concentration as shown Figureure 1 & 2.

(ii) Electro-osmotic permeability increases with increase in concentration in case of sodium chloride solution whereas in case of ammonium chloride, it decreases with increase in concentration as shown in Figureure 3 & 4.

(iii) In the case of aqueous solutions of sodium chloride, α_1 decreases with increase in concentration while it increases with increase in concentration of ammonium chlorides.

(iv) Polarizability term (α_2) increases with increase in concentration of sodium chloride while it decreases with increase in concentration of ammonium chloride.

The ammonia content of urine appears to be related primarily to the acid-base balance of the body. If ammonia is fed in the form of oxidizable organic salt such as ammonium acetate or lactate, no extra ammonia appears in the urine. The organic portion of the salt is oxidized and the ammonia is excreted as urea. If, however, a non oxidizable salt such as ammonium salt is administered, while the ammonia portion is probabbly also converted into urea, the excretion of extra chloride ion requires simultaneous secretion of equivalent amount of base. This base must be sodium, potassium or ammonia salt, since these are the only forms of base available to the kidney.

The values of phenomenological co-efficient are evaluated by extra polation technique and their values are given in table 1 and table 2. Higher value of α_1 and lower value of α_2 produce same effect on the bladder surface. It is evident from table 1 and table 2 that ammonium chloride and sodium chloride behave differently with bladder membrane.

Frequency of urination has its effect on metabolism (Kedlubar, 1991). Frequent urination can signal underlying health problems (Sarkar Mohammad, 2003). Low urine pH may be important risk factor for bladder cancer (Margret, 2005).

A high roughage/concentration ratio decreases the effect of ammonium chloride on acid-base balance in horses (Kiengle, 2006). Ammonium chloride inhibits incidence of bladder tumor (Melton Vanotta, 1996, Flask, 1973) and sodium chloride promotes (Shihata, 1986).

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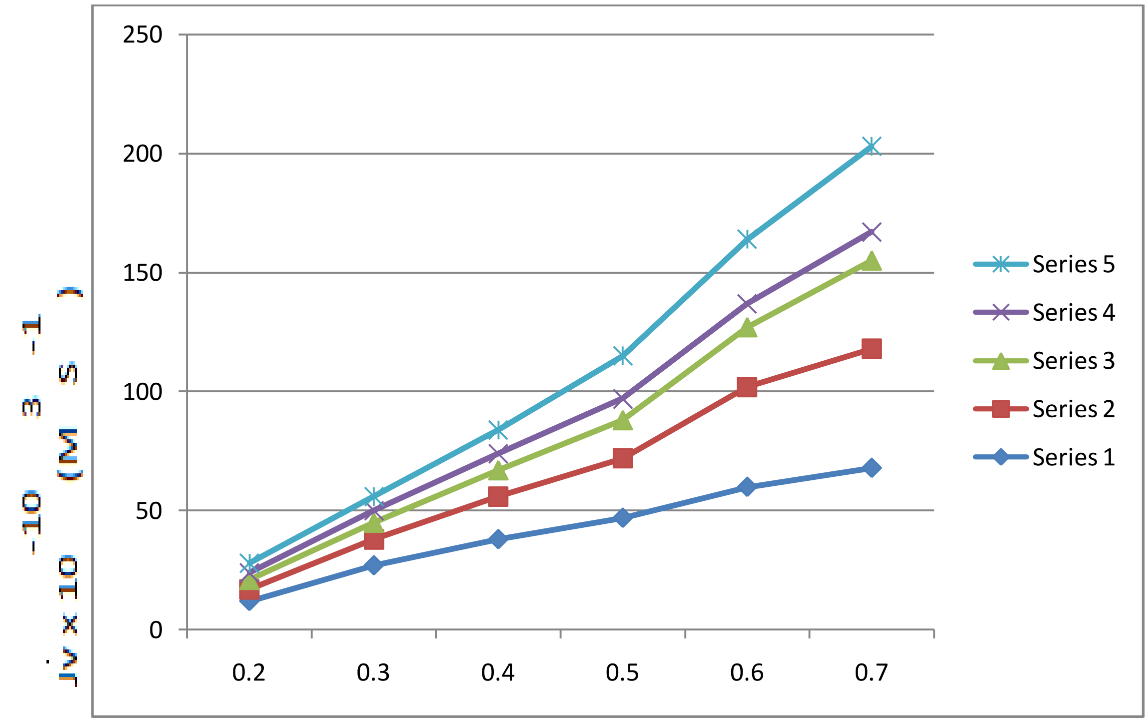
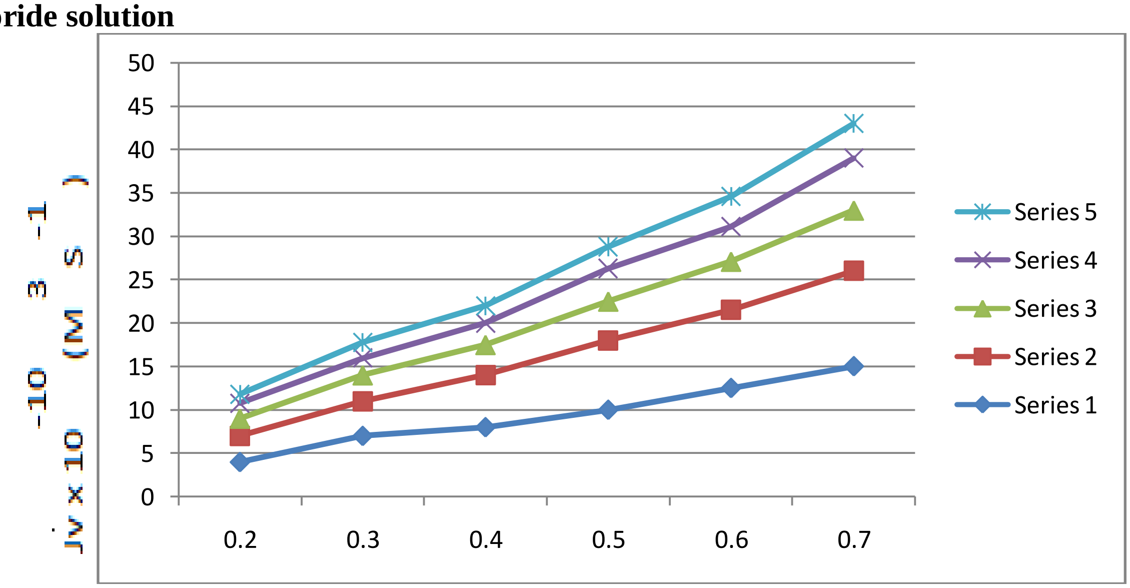
Effect of oral ammonium chloride on urinary excretion of Ca, Mg & Na in man has been studied recently (Lavan, 2008).



ΔP(m)

Figure 1: Dependence of volume flow (Jv) against pressure difference of aqueous sodium chloride solution



ΔP(m)

Figure 2: Dependence of volume flow (Jv) against pressure difference of aqueous ammonium chloride solution

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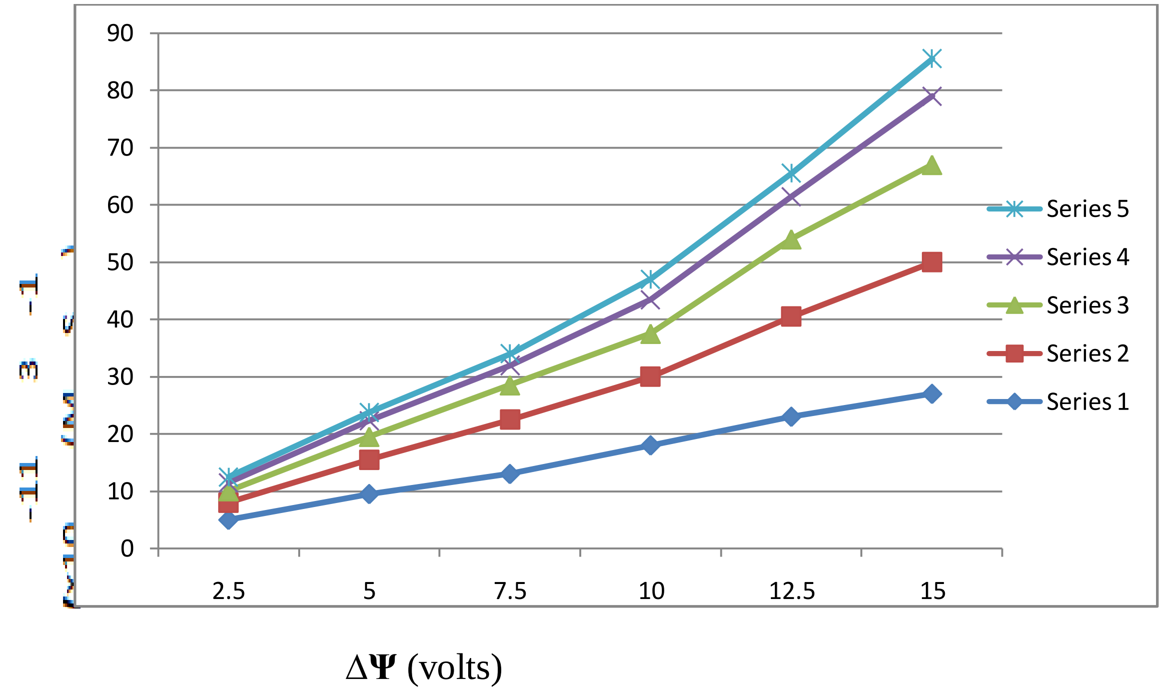

Figure 3: Dependence of volume flow (Jv) against electrical potential difference of aqueous sodium chloride solution

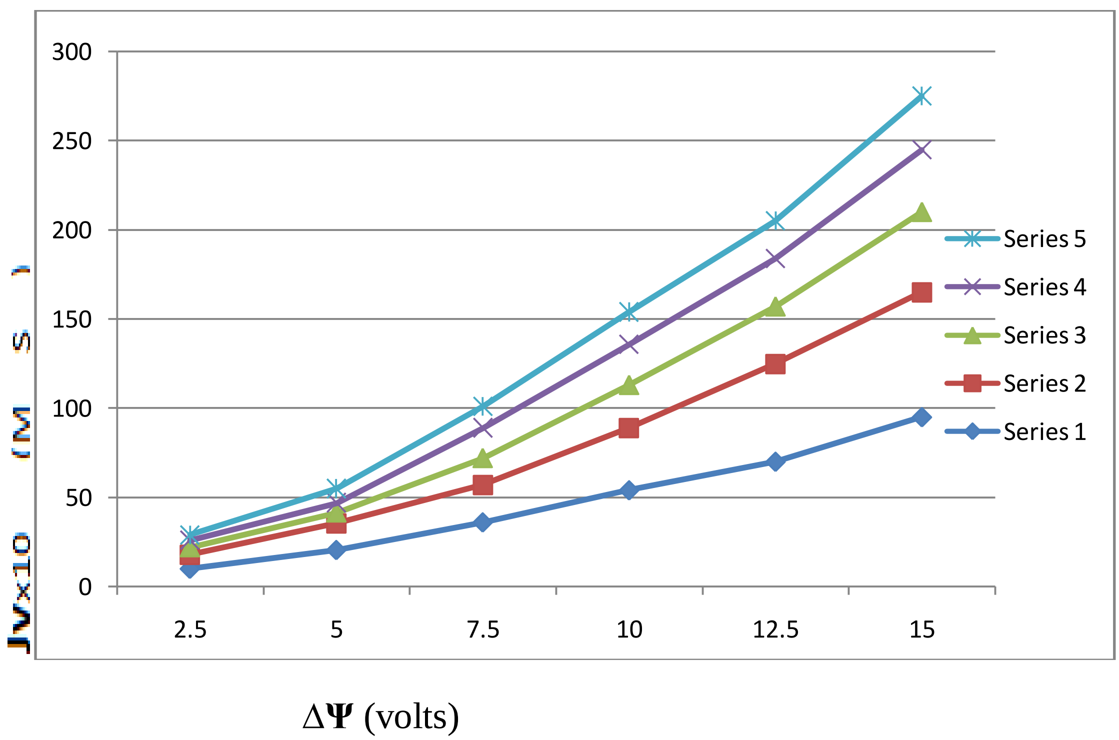

Figure 4: Dependence of volume flow (Jv) against electrical potential difference of aqueous ammonium chloride solution

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Conclusion

Hydrodynamic and electro-osmotic permeability of aqueous solution of sodium chloride and ammonium chloride have been carried out across urinary bladder membranes of goat kinetic energy term (α_1) which is equivalent to velocity head which decreases effective pressure of the membrane and polarizability term (α_2) which is related with distention power of the bladder have been calculated for all the permeants. α_1 decreases with increase in concentration of sodium chloride and increases with increase in concentration of ammonium chloride. Polarizability term (α_2) increases with increase in concentration of sodium chloride and decreases with increase in concentration of ammonium chloride. Such studies are expected to be of very great use in predicting physiological behavior of membranes in diverse situation.

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