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Movement of Water Against a Gradient in Models.

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In certain models employed to imitate living cells the behavior of water appears to be the opposite of what is expected. If it acts similarly *in vivo* it is not hard to understand why the living cell often fails to behave as a perfect osmometer.

In these models water moves through liquid layers against a gradient, passing from a region where its activity is low to one where its activity is high. This depends upon the fact that certain substances traversing these layers appear to carry water with them.

The simplest form of model is made as follows: In a U-tube (Fig. 1) we place guaiacol* (B) to imitate the action of the protoplasm.[1] Resting on the guaiacol (which forms a separate phase in contact with water) at the left is an aqueous solution (A) representing the external solution, and at the right an aqueous solution (C) representing the cell sap.

We may begin by putting in B some guaiacol which has been shaken with distilled water until equilibrium has been attained: in A and C we place equal amounts of the water which has been shaken with guaiacol. The system is therefore in equilibrium throughout and no movement of water occurs.

When we lower the activity of the water in A by adding trichloroacetic acid we might expect water to move from C to A, but just the opposite occurs. Acid and water move from A to B and from B to C. The higher the concentration of acid in A the greater the movement of water into C.

Evidently the water moves from A to C because acid does so and hence it would appear as though the acid carries water with it. This could be easily understood if the acid formed a hydrate (or a series of hydrates) so that it could not pass into C without carrying water with it. But it is not necessary to make such an assumption, for it is easily shown by shaking A and B together that acid increases the solubility of water in B (a "salting in" process). But when the acid moves from B to C the solubility of water in B decreases and in consequence water goes from B to C.

As the freezing point of A is lower than that of C it is evident

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* O-methoxyphenol.

[1] *Cf.* Osterhout, W. J. V., and Stanley, W. M., *J. Gen. Physiol.*, 1931-32, **15**, 667.

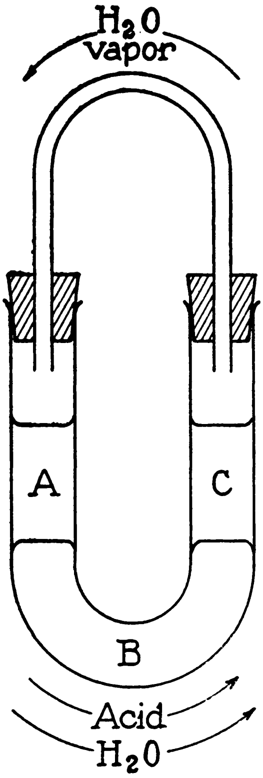

FIG. 1.
A contains an aqueous solution of trichloroacetic acid. B contains guaiacol. C is water saturated with guaiacol at the start. Acid and water move from A through B to C. In the air above the solutions water vapor moves from C to A.

that water moves from A where the activity of water is low to C where its activity is high. The movement of water vapor through the air above the solutions is from C to A. This apparent "perpetual motion" can go on for months, ceasing only when A and C become identical in volume and in composition.

The increase of water in C may amount to 40% or more. In view of this result we thought it desirable to test it in another way, namely by shaking A with B and then shaking B with C (in both cases the shaking was continued until equilibrium was attained). The result shows an increase of water in C which may amount to more than 400%.

It seems possible that any substance which causes guaiacol to take up water may act to some extent like trichloroacetic acid in these experiments. This has been found to be true of acetone, but the results are much less striking.

The behavior of water here described seems to be a different phenomenon from "anomalous osmosis" through solid membranes which appears to require the presence of pores and of electrolytes.[2] The gain in water in C is obviously only temporary. If left to itself the system would undoubtedly reach equilibrium with A and C identical in composition and in volume.

Since in certain respects guaiacol acts like some protoplasmic surfaces[1] it seems possible that similar phenomena may occur in living cells. If so these results have an obvious bearing on the movement of water in the organism and on methods of studying permeability. It becomes necessary to know to what extent a substance entering or leaving the cell carries water with it in the manner here indicated.

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"Acid" Phosphatase Activity of the Serum of Normal Human Subjects.

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Though the optimum for phosphatase activity of normal serum is in a distinctly alkaline range, pH-activity curves indicate slight but definite activity on the acid side of neutrality.[1] It has not been made clear whether these curves reflect the operation of a single enzyme over an unusually wide range in pH, or whether they are really composite curves representing the activities of 2 or more enzymes. Data to be presented suggest that the phosphatase activity of normal serum in the acid range is due largely to the presence of minute amounts of one or more phosphatases falling within the group classified by Folley and Kay[2, 3] as phosphomonoesterase A_2.

The method of King and Armstrong[4] proved adaptable to the estimation of "acid" serum phosphatase activity under conditions of hydrolysis most likely to approximate initial reaction velocities. The buffer-substrate employed was M/200 disodium monophenylphos-

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[2] *Cf.* Söllner, K., *Kolloid-Z.*, 1933, **62**, 31.

[1] Roche, J., *Biochem. J.*, 1931, **25**, 1724.

[2] Folley, S. J., and Kay, H. D., *Ergebn. d. Enzymforsch.*, 1936, **5**, 159.

[3] Folley, S. J., and Kay, H. D., *Tabulæ biol. period.*, 1937, **6**, 268.

[4] King, E. J., and Armstrong, A. R., *Canad. M. A. J.*, 1934, **31**, 376.