AN OPTICAL TORSION MICROLEVER FOR MEASURING CELL PERMEABILITY[1]

SAMUEL A. CORSON,

Department of Physiology, University of Oklahoma School of Medicine, Oklahoma City

In view of the inadequacy of available methods of measuring permeability and the desirability of using a greater variety of living material, a new quantitative method was developed for use with filamentous algae. The method involves the measurement of the tension of the cell, T, which is a function of the concentration gradient across the cell membrane, so that $T=K(P-p)$, where P is the osmotic pressure of the cell contents, p is the osmotic pressure of the external solution, and K is a constant depending on the diameter of the cell and the thickness of the cell wall. T is measured by means of an optical torsion microlever consisting of a tungsten wire 25 micra in diameter stretched across a duNouy surface tension apparatus. The method is unusually well adapted for the investigation of permeability to rapidly penetrating substances because the optical lever has very little inertia and thus permits the continuous recording of im-

[1] Most of the experimental work was conducted at the Physiology and Biophysics Laboratories of the University of Texas under the direction of Prof. E. J. Lund.

mediate responses to environmental osmotic or chemical changes of a population of similar cells. It permits the use of nonplasmolysing solutions, thus avoiding cell injury and any significant changes in the surface area of the cells during the experiments and simplifying calculations of permeability constants. Since the diffusing substances do not have to penetrate thru different layers of cells, equilibrium is attained within a short period of time, thus avoiding long exposures to the experimental solutions and possible injury. The method permits accurate comparative measurements of end- and exosmosis and lends itself to photographic recording made under very high magnification. Permeability properties of *Rhizoclonium*, a fresh-water filamentous alga, were investigated. These cells approached the behavior of perfect reversible osmometers in accordance with the Avogadro-van't Hoff law. Repeated exposure to solutions of various nonpenetrating solutes gave reproducible curves indicating that the cells did not lose osmotically active substances during the experiments. The cells were impermeable to strong electrolytes as ion pairs, were not freely permeable to anions, anu were probably permeable to cations. The permeability to a series of ammonium salts of organic acids was in the following order: ammonium bicarbonate > valerate > butyrate > propionate > acetate > formate. The same order of penetration was demonstrated for the free acid series by staining the cells with pH indicators in immersion and microinjection experiments. The order of penetration was inversely proportional to the molecular weights of the electrolytes and directly proportional to the lipoid solubility. It thus emphasizes the role of lipoid solubility in cell permeability, though molecular size as an important factor is not excluded. The order of penetration of the ammonium salts indicated that the salts penetrate not as ions but as free ammonia and undissociated acids which recombine within the cell, thus producing the observed osmotic effects.