Uranyl Nitrate Inhibition of Transport Systems in 
*Saccharomyces cerevisiae*

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Uranyl nitrate inhibited the transport of several amino acids, a vitamin, and a disaccharide into yeast.

Since the initial work of Rothstein et al. (15) which showed that uranyl ions inhibit hexose transport in yeast, numerous reports have been published which employ uranyl ions as specific inhibitors of sugar transport in these cells (1–3, 14, 18; V. P. Cirillo, Bacteriol. Proc., p. 189, 1960). But it has been observed that uranyl ions also inhibit sugar utilization in *Neurospora* (5) and sugar and amino acid uptake in bacteria (6; P. O. Wilkins and D. J. O’Kane, Bacteriol. Proc., p. 189, 1961). As a consequence, Cirillo has noted that uranyl ions may be generally useful in blocking transport systems in microorganisms (4). The data reported below contribute additional specific instances of inhibition consistent with the idea that uranyl ions affect a variety of cellular transport systems.

The results presented in Fig. 1 show that uranyl nitrate, at concentrations similar to those which inhibit hexose transport (15), effectively reduced the uptake of an amino acid-glycine, a vitamin-biotin, and a disaccharide-maltose. Transport of serine, another amino acid, was inhibited to the same extent as glycine. Uranyl nitrate also strongly inhibits the uptake of mannitol, recently shown to be transported into yeast cells (11). Although mannitol uptake requires energy, uranyl ions are effective inhibitors when no exogenous energy source is supplied. Inhibition of maltose uptake is consistent with the concept that uranyl ions block sugar transport. However, maltose has a transport system separate from that of the hexoses (10). Entry of amino acids and biotin into yeast has been characterized as involving specific transport systems (7–9, 12, 13, 17). Although glucose was not included in the above experiments, its addition as an energy source greatly increases the uptake of amino acids and biotin. Uranyl ions inhibit with or without glucose, thus eliminating an inhibition of glucose transport as the mechanism by which they block uptake of glycine, serine, and biotin.

Uranyl nitrate inhibits ethanol utilization much less than it does sugar transport as reported by Rothstein et al. (15) and confirmed in our laboratory. By using 10⁻² M uranyl nitrate, we observed a 50% decrease in O₂ utilization with ethanol as substrate. Similarly, glycerol, presumed to enter the yeast cell by diffusion (16), is affected by uranyl ions at higher concentrations and in a manner different from compounds which enter by transport systems. Our observations indicate a reduced total uptake, although initial rates of uptake are not decreased. It is suggested that uranyl ions at high concentrations may alter the plasmalemma nonspecifically, whereas at low concentrations transport systems are selectively inhibited.

Our results indicate that uranyl ions may block the entry of any compound carried into the yeast cell by a transport system, facilitated or active. Blocking the entry of compounds which may be taken up actively, whether an exogenous energy source is added or energy is provided endogenously, could result from binding some component of an energy coupling process. However, such an effect, supposedly occurring at the external surface of the cell (14, 15), suggests what might be considered an unusual uniformity in energy coupling mechanisms for the transport of a variety of different compounds. In the case of facilitated entry, an additional ligand may be involved (18), as suggested by the higher concentrations of uranyl ions required to block sorbose entry. Thus, it appears that mechanisms of transport in yeast are either markedly similar for a variety of compounds or that more sites of action for uranyl ions exist.

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LITERATURE CITED


FIG. 1. Uranyl nitrate inhibition of yeast transport systems. Aerobically grown cells were harvested during the stationary phase of growth, washed twice, and suspended (4 x 10⁸ cells/ml) in 5.0 ml of water (adjusted to pH 3.5 with HCl) containing 0.1 M maltose-U⁻¹⁴C, 0.1 M glycine-L⁻¹⁴C, or 0.2 nM D-biotin (¹⁵C-carbonyl) (all from American-Searle) and uranyl nitrate as indicated. Suspensions were shaken at 30 C. Samples (0.5 ml) were collected on membrane filters (Millipore Corp.) and washed with cold water. Cells and filter were placed in Bray’s scintillator fluid and counted in a scintillation spectrometer.