studies argue against the involvement of glycosidic, hemiacetal and acetal linkages and their thiol analogs as intermediates in the transport of monosaccharides.

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2-Deoxyglucose transfer in rabbit intestine

KLEINZELLER *et al.*[1] have recently reported that the sugars, 2-deoxyglucose and 2-deoxygalactose, are accumulated by rabbit kidney slices to concentrations in excess of those in the bathing medium. The accumulation of these sugars is not dependent on the presence of Na^+ in the medium and is unaffected by ouabain. However, the ability of the slices to accumulate other sugars such as glucose, galactose and 3-*O*-methylglucose was found to be entirely Na^+ dependent. These observations clearly suggest that sugar transport in kidney is not necessarily a function of the Na^+ concentration in the medium and raises questions concerning the concept of a sugar transport system driven by differences in Na^+ concentration between extra- and intracellular fluid. Since the existence of a Na^+-independent sugar transport system in the intestine would have important implications regarding the "Na^+ gradient hypothesis"[2], we felt it worthwhile to examine the transport of 2-deoxyglucose in rabbit intestine. It has been reported[3] that neither 2-deoxyglucose nor 2-deoxygalactose is actively transported by hamster intestine, but there is the possibility of a species difference.

Transmural fluxes of 2-deoxyglucose were determined with the apparatus described by SCHULTZ AND ZALUSKY[4]. Distal ileum from New Zealand White Rabbits (sacrificed by intravenous injection of pentobarbital) was mounted as a flat sheet between two chambers with identical bathing solutions containing 5 mM 2-deoxy-

glucose. [^{14}C]2-Deoxyglucose was added to one solution, and after a 40-min equilibration period, the rate of tracer appearance in the unlabeled solution was determined. Mucosal-to-serosal flux (J_{ms}) and serosal-to-mucosal flux (J_{sm}) were determined at the same time in adjacent pieces of tissue from the same animal. The bathing solution contained 140 mM NaCl, 10 mM $KHCO_3$, 1.2 mM $CaCl_2$, 1.2 mM $MgCl_2$, 1.2 mM K_2HPO_4, and 0.2 mM KH_2PO_4 and was maintained at pH 7.2 by bubbling continuously with O_2–CO_2 (95:5, v/v). In some experiments all the NaCl was replaced by choline chloride.

Unidirectional influx of 2-deoxyglucose from mucosal solution into the cell was determined with the method described by SCHULTZ *et al.*[5]. The mucosal surface of rabbit distal ileum is exposed for 60 sec to a solution containing [^{14}C]2-deoxyglucose in a special chamber and influx is estimated by determining the amount of [^{14}C]sugar uptake. [^{3}H]Inulin is used to measure the contamination of the surface by labeled test solution. Tissues were preincubated for 30 min in either normal Na^+-containing medium or in Na^+-free choline medium, and influx was measured from a solution containing 140 mM Na^+ or from Na^+-free solution. The concentration of 2-deoxyglucose was 20 mM in the test solution but the preincubation solution contained no sugar.

Transmural fluxes of 2-deoxyglucose observed in the presence and absence of Na^+ are summarized in Table I. There is no significant net flux of 2-deoxyglucose across rabbit ileum in the absence of a concentration difference, and the unidirectional fluxes are not altered when all the Na^+ is replaced by choline. In contrast, there is a substantial net transport of 3-*O*-methylglucose from mucosa to serosa in rabbit

TABLE I

TRANSMURAL FLUXES OF 2-DEOXYGLUCOSE

Fluxes are mean ± S.E. 2-Deoxyglucose concentration was 5 mM.

Principle cation	*Flux* ($nmoles \cdot h^{-1} \cdot cm^{-2}$)			*Number of observations*
	J_{ms}	J_{sm}	J_{net}*	
Na^+	60 ± 6	47 ± 3	13 ± 7	8
Choline	72 ± 9	58 ± 4	14 ± 10	8

* $J_{net} = J_{ms} - J_{sm}$.

TABLE II

INFLUX OF SUGARS ACROSS THE MUCOSAL BORDER

Influx is given as mean ± S.E. Sugar concentration was 20 mM.

Sugar	*Influx* ($\mu equiv \cdot h^{-1} \cdot cm^{-2}$)		*Number of observations*
	Na^+	*Choline*	
2-Deoxyglucose	0.19 ± 0.02	0.20 ± 0.03	10
3-*O*-Methylglucose*	2.53 ± 0.23	0.25 ± 0.04	12

* Data from GOLDNER *et al.*[6].

ileum. When Na^+ is replaced by choline, this net flux is completely abolished, primarily as a result of an 80% decrease in the mucosa-to-serosa flux (J_{ms})[6].

Experiments on the influx of 2-deoxyglucose (from mucosal solution to the cell) together with some observations on 3-*O*-methylglucose are summarized in Table II. The influx of 2-deoxyglucose is low and unaffected by the removal of Na^+ from the solutions. In the absence of Na^+, influx of 3-*O*-methylglucose is approximately the same as that of 2-deoxyglucose but the influx of this actively transported sugar is stimulated approx. 10-fold by the presence of Na^+.

These results indicate that 2-deoxyglucose is not actively transported by rabbit ileum. Although the fluxes of this sugar are not Na^+ dependent, 2-deoxyglucose does not appear to utilize the carrier system involved in the active transport of other sugars. Recent studies[6] have suggested that sugar influx into rabbit ileum in the absence of Na^+ does not involve a mediated process, whereas such a process is involved in the presence of Na^+. Thus, the observations that 2-deoxyglucose influx is unaffected by the presence or absence of Na^+ and is approximately the same magnitude as the influx of 3-*O*-methylglucose in the absence of Na^+, suggests that this sugar enters the cell by a relatively nonspecific process, possibly simple diffusion. Since 2-deoxyglucose is not actively transported, the fact that its movement is Na^+ independent does not conflict with the "Na^+ gradient hypothesis" for active sugar transport.

There is at present no simple explanation for the different ways in which the kidney and intestine handle 2-deoxyglucose. The techniques used in the two studies are different and experiments of the type carried out in the present work are difficult if not impossible to do on the kidney. Further study on the behavior of both Na^+-dependent and Na^+-independent sugars in kidney will be of interest in determining the mechanism of sugar transport in that tissue. There are certainly suggestions that the mechanism may be different, at least in some respects, from that postulated for sugar transport in the intestine.

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