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Absorption of Glucose, Galactose, and Xylose in the Dog* (32873)

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In a previous investigation, glucose reduced the intestinal absorption of galactose in the conscious dog but no effect of galactose on glucose absorption was demonstrated (1). Since only glucose was measured by a specific enzyme, the present study reinvestigates the effects of these sugars on one another. This study also tests the possible inhibitory effects between glucose and xylose in the dog since glucose reduced xylose absorption in the rat (2) and xylose reduced glucose uptake by hamster intestinal mucosa (3).

Methods. Solutions containing 10–150 m*M* of test sugar alone or with 10–75 m*M* of inhibitor sugar, plus NaCl to adjust the total osmolarity to about 325 milliosmols/liter, were perfused without recirculation through upper jejunal Thiry-Vella fistulas for 1 hour. [Glucose (Glucostat), galactose (Galactostat), xylose (4), and chloride (5), were measured in the input and the effluent solutions.] After perfusion, loops were flushed with 100 ml of H_2O and the residual unabsorbed solute was measured. Residual loop volume was estimated as the amount of flushed solute divided by the solute concentration in the effluent solution. Net absorption of fluid or solute was considered to be the amount infused minus the sum of effluent and loop residual amounts.

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Two series of experiments were done. In the first, 5 concentrations of glucose, 5 of galactose, and 7 combinations of glucose and galactose concentrations were presented in random order using random number tables, and the 17 test solutions were repeated according to a second randomization. Glucose or xylose alone, and 5 combinations of the two sugars were tested similarly in the second series. Five dogs were used for both series, each tested on alternate days after 18 hours' fasting.

Results. The experimental data are summarized in Table I. The means were calculated by averaging duplicate tests on each dog, then averaging the results obtained in all 5 dogs. The first two columns for each pair of sugars estimate the average concentration to which the loops were exposed for 1 hour; this was calculated as the average of input and effluent concentrations. Table I shows that the addition of glucose reduced galactose absorption rates whether concomitant net fluid absorption rates increased or decreased. In the other combinations, the addition of a second sugar had inconsistent effects on the absorption of the test sugar and usually altered net fluid absorption rates.

Since a previous similar study has shown that hexose absorption is correlated positively with the rate of net fluid absorption (6), the

TABLE I. Sugar and Water Absorption; Means of 5 Dogs.

Input		Absorbed	
mM/liter		mM/hour	ml/hour
galact.	glucose	galact.	H_2O
7	0	1.04	20
9	36	.45	39
11	136	.04	27
11	0	1.30	27
17	0	2.12	30
38	0	3.33	31
47	41	1.66	33
46	144	.85	26
120	0	5.32	32
glucose	galact.	glucose	H_2O
6	0	1.02	24
7	42	1.02	32
8	127	1.04	28
9	0	1.70	27
17	0	2.67	28
37	0	4.48	36
41	47	3.45	33
40	138	2.90	20
145	0	5.80	22
glucose	xylose	glucose	H_2O
6	0	1.22	25
6	47	1.29	38
6	68	1.20	24
15	0	2.24	33
13	14	2.40	41
30	0	3.59	47
28	7	4.10	52
66	0	5.90	62
60	84	4.46	31
135	0	5.17	32
xylose	glucose	xylose	H_2O
9	0	.32	14
7	28	.27	52
11	65	.66	51
21	0	.62	14
14	13	.72	41
40	0	1.04	17
47	6	2.65	38
71	0	3.08	17
84	60	2.41	31
141	0	3.59	15

data from all individual tests on each dog were analyzed by multiple linear regression (7). The dependent variable, Y, is the absorption rate of test sugar expressed in mM/hour. The assigned independent variables are the concentration of test sugar (mM/liter), X_1; the concentration of inhibitor sugar (mM/liter), X_2; and the net absorption rate of fluid (ml/hour), X_3. Thus,

$$Y = a + b_{1.23}X_1 + b_{2.13}X_2 + b_{3.12}X_3$$

the b constants indicate the increment or decrement in Y resulting from changes in X_1, X_2, and X_3.

The statistical analyses for each pair of sugars on each dog are summarized in Table II. Thus, test sugar absorption rates always increased with increasing lumen test sugar concentrations as shown by the $b_{1.23}$ constants, and nearly always increased with increasing net fluid absorption rates as indicated by the $b_{3.12}$ constants. Also, the $b_{2.13}$ constants for all dogs show that glucose absorption rates decreased as galactose concentrations increased, and both galactose and xylose absorption rates decreased as glucose concentration increased. However, the effect of increasing xylose concentration on glucose absorption rate was inconsistent among the dogs. The average regression coefficients were tested to see if they differed from zero. As shown in Table II, glucose reduced galactose absorption ($p<.01$), glucose reduced xylose absorption ($p<.05$), and galactose reduced glucose absorption ($p<.05$). The lowest initial concentration of NaCl in the perfusates was 50 mM when a second sugar was substituted for NaCl (150 mM of test sugar, 75 mM of inhibitor sugar). However, since xylose did not reduce glucose absorption, the decrease in sodium concentration does not seem to account for the observed reductions in sugar absorption rates. The multiple correlation coefficients, R in Table II, indicate the degree to which the 3 assigned independent variables account for the observed test sugar absorption rates.

Discussion. An earlier study (1) showed that galactose absorption decreased when glucose was added to intestinal perfusates in conscious dogs, but failed to show that galactose affected glucose absorption. Galactose was estimated as the difference between total reducing sugar and glucose, and any effect of changes in the concomitant rate of fluid absorption on sugar absorption was not controlled statistically. In this study, the specific

TABLE II. Multiple Linear Regression Analysis of Absorption Data. $Y = a + b_{1.23} X_1 + b_{2.13} X_2 + b_{3.12} X_3$. ($X_3$ = ml/hour of net fluid absorbed)

(mM/hour)	(mM/liter)								
Y	X_1	X_2	Dog	No. of tests	a	$b_{1.23}$	$b_{2.13}$	$b_{3.12}$	R
glucose	glucose	galact.	A	34	.60	.013	—.003	—.009	.74
			B	34	— .47	.052	—.003	.044	.91
			C	34	.39	.050	—.009	.030	.87
			D	33	.83	.046	—.009	.020	.88
			E	33	.82	.028	—.006	.019	.82
			av	5		.038[a]	—.006[b]	.021	
galact.	galact.	glucose	A	34	— .09	.022	—.005	.032	.79
			B	34	.34	.045	—.011	.014	.90
			C	34	— .05	.042	—.014	.032	.83
			D	33	— .40	.053	—.009	.027	.94
			E	33	— .29	.033	—.006	.037	.82
			av	5		.039[a]	—.009[a]	.028[a]	
glucose	glucose	xylose	A	30	.09	.016	—.003	.021	.78
			B	30	— .81	.047	.002	.066	.97
			C	30	— .58	.038	.000	.072	.93
			D	30	—1.57	.042	—.002	.081	.98
			E	30	.95	.021	.012	.113	.93
			av	5		.033[a]	.002	.071[a]	
xylose	xylose	glucose	A	30	— .18	.008	—.001	.019	.52
			B	30	— .18	.032	—.007	.017	.82
			C	30	.15	.028	—.005	.009	.88
			D	30	— .04	.044	—.006	.012	.92
			E	30	.03	.025	—.004	.009	.91
			av	5		.027[a]	—.005[b]	.013[a]	

[a] $p < .01$, 4 df.

[b] $p < .05$, 4 df.

measurement of both sugars probably permitted demonstration of mutual inhibitory effects since the rates of net fluid absorption did not vary widely in the glucose–galactose series (Table I). The mean inhibitory effect of glucose on galactose absorption, —.009 mM of galactose per hour/mM of glucose per liter, does not differ significantly from the effect of galactose on glucose absorption, —.006 mM per hour glucose/mM galactose per liter (paired comparison).

The results described in this paper confirm in part those of previous investigations by other workers on the inhibitory effect that glucose and xylose have on each other's intestinal absorption. Thus, xylose reduced the uptake of glucose by hamster mucosal tissue when the molar ratio of xylose/glucose was about 16 (3), and a glucose/xylose molar ratio of 45 reduced xylose absorption in the perfused rat intestine (2). The molar ratio of inhibitory/test sugar ranged from 1 to 10 in the present study. Although glucose inhibition of xylose absorption seems probable, no effect of xylose on glucose absorption was found.

Summary. Jejunal fistulas of conscious dogs were perfused with mixtures containing NaCl, and a test sugar at concentrations up to 150 mM and an inhibitor sugar at concentrations between 0 and 75 mM. The absorption rates of glucose, galactose, and xylose increased with increasing bowel lumen concentrations of each sugar, and increased with increasing net rates of fluid absorption. Glucose reduced the absorption rates of galactose and of xylose, and galactose reduced glucose absorption. Xylose did not have a consistent effect on glucose absorption.

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The Influence of Serotonin on Oxidative Metabolism of Brain Mitochondria (32874)

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It has been stated that serotonin functions as a neurohormone in the brain(1,2). Although this role is not well defined the concept is strengthened by the findings which show that serotonin potentiates hexobarbital hypnosis (3,4). Subsequent reports have verified this but found that the metabolism of serotonin rather than its concentration in the nervous system was the cause of this potentiation(5). It was further determined that the succinoxidase activity of rat brain homogenates was inhibited by the carbonyl derivative of serotonin (6). From this it is suggested that the serotonin metabolites which depress nervous tissue metabolism might be a contributing factor in the potentiation of hypnosis. Additional studies of the effect of serotonin and its metabolites on energy transformation, particularly of the brain mitochondria, might prove helpful in determining the mechanism of action of serotonin.

Various reports have dealt with the effect of drugs and chemicals on mitochondrial function because of mitochondria's role in bioenergetics. Drugs such as thyroxine, dinitrophenol (DNP), and salicylates have been reported to uncouple phosphorylation from oxidation(7–11). The DNP also stimulates mitochondrial adenosine triphosphatase(12–15); as do salicylates(16). Mitochondrial swelling has been reported to be caused by thyroxine and Ca^{2+}(8), by tris (hydroxymethyl) amino methane(17) and by salicylates (11). Thus it can be seen that a variety of agents that influence physiological functions have an effect on mitochondria. Therefore, this study has been carried out to determine what effect serotonin and its metabolites have on oxidative phosphorylation and the function of electron transport by brain mitochondria since this could have a net effect on physiological function of the nervous system.

Methods. Mitochondria were prepared from adult Sprague-Dawley rats by homogenization of the brain in 0.25 *M* sucrose (1:10 w/v) using a glass homogenizer with a teflon pestle (Arthur H. Thomas Co., Philadelphia, Pa.). The homogenate was centrifuged 10 min at 800*g* and the major portion of the supernatant was removed without disturbing the precipitate. The precipitate was washed with sucrose (1:5 w/v) and recentrifuged. The combined supernatants were centrifuged at 10,000*g* for 10 min. This supernatant was removed by decanting and the inverted tube, was allowed to drain momentarily. The mitochondria adhering to the bottom of the tube were resuspended in sucrose solution, at a concentration equivalent to 500 mg original weight per ml of sucrose solution. The entire process was carried out at 0–4°C.

The quality of the mitochondrial preparation was determined by evaluation of their adenosine triphosphatase activity according to the method of Recknagel and Anthony (15), with the addition of KCl 0.075 *M*(12). Only those mitochondria showing a high re-

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