OSMOTIC EFFECTS ON SECRETION BY RAJA ERINACEA GASTRIC MUCOSA

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The gastric mucosa secretes acid into the gastric pits as isotonic HCl with little secretion of other ions. Therefore in principle the pH of the secreted fluid can be altered by changing the tonicity of the serosal bathing solution and therefore of the cell cytoplasm. In dogfish, adding urea to the serosal solution decreases the secretory rate (J_H) to zero at 1500 mOsM. (Kidder, Bull. MDIBL 20:39-42, 1980) The pH of the secreted fluid under these limiting conditions is 0.13 on the assumption that only H^+ and Cl^- are present. At high J_H, bulk flow delivers HCl from the pits to the bulk solution, and the solution in contact with the oxyntic cells contains only H^+ and Cl^-, preserving this assumption. At low J_H, diffusion becomes important, and can result in delivery of other substances (principally Na^+ and urea) to the depths of the pits, raising the pH. In frog the mucosal bathing solution can be replaced by distilled water with only a minimal effect on JH. Under these conditions there can be no diffusion of osmoticaly-active substances into the pits. It was desired to employ these conditions in the elasmobranch, which with its high plasma osmolarity should provide low limiting pH for gastric secretion, but this experiment is only possible if secretion is independent of the osmolarity of the mucosal bathing solution.

The gastric mucosa of the skate was mounted in an Ussing chamber, using Forster's solution on the serosal surface and an unbuffered modification of this solution on the mucosal surface. Each tissue was exposed to standard and altered mucosal solutions; test periods were one hour in length and were alternated with one hour in standard conditions. The average J_H was measured (by pH-stat) during the last 15 minutes of the one hour period. Transepithelial voltage (PD) was recorded, and transepithelial resistance (R) was determined by periodically passing a small (10-20 uA/cm^2) 1-second current pulse and recording the voltage deflection. Table I shows these results, expressed as mean ± SE of the percentage of the test rate to that during the adjacent control periods (J_H and R) or of the difference between test and standard conditions (PD), for N such comparisons. ** = $0.01>P$, * = $0.05>P>0.01$, ns = $P>0.05$, by t-test.

Both PD and R changed consistently during the one hour equilibration in standard solutions following mounting the tissue, as seen in Table II.

Regression analysis was performed between the steady state PD, the steady state R, and J_H at the end of one hour. These data are greatly scattered, with low correlation coefficients and regression coefficients (slopes) not significantly different from zero, although the relationship between J_H and R is close to significance at the 5% level (for $R = a + b \cdot J_H$, $b = -50.11 \pm 24.60$, $t = 2.037$ for 26 degrees of freedom.)

The secretion by skate gastric mucosa decreases when a hypotonic mucosal bathing solution is produced by elimination of electrolytes or non-electrolytes. This may be an effect on the surface epithelial cells, which swell and occlude the openings of the gastric pits. Alternatively, it may be an effect on the pit border cells (Kidder and Blankemeyer, Bull. MDIBL 26:67-69, 1986). However, isotonicity alone does not support full JH, as shown by the reduced rate in an isotonic urea solution. In marine elasmobranchs the lumen contents are never hypotonic, so their surface cells need not be water-impermeable. These data may reflect a higher water permeability of the elasmobranch cells conditioned by their evolutionary history.

While transepithelial resistance in skate (as in dogfish) is approximately the same as in frog, the PD is low but finite. Thus while there are consistent changes in PD and R which occur as acid secretion starts, there seem to be factors other than acid secretory rate that determine the absolute values of these parameters.

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TABLE I - Effect of mucosal solution changes on J_H, PD and R

MUCOSAL SOLUTIONS	STANDARD Isotonic	WATER Hypotonic	- UREA Hypotonic	++ UREA Hypertonic	SALTS ONLY Isotonic	UREA ONLY Isotonic
MUCOSAL (mOsM)						
Salts	541	0	541	541	891	0
Urea	350	0	0	1000	0	850
TOTAL	891	0	541	1541	891	850
RELATIVE J_H (% of STD)						
Mean	100.0	22.0	74.6	137.7	129.5	46.4
SE	-	3.8	5.7	32.8	20.7	18.3
N	-	17	18	16	8	8
P dif 100	-	**	**	ns	ns	*
CHANGE IN PD (Exp-Std)						
Mean		19.24	-.99	1.93	-4.09	30.90
SE		1.29	0.36	0.38	0.97	3.60
N		14	14	12	9	8
P dif 0		**	*	**	**	**
RELATIVE R (% of STD)						
Mean	100	253.9	97.6	105	85.8	262.2
SE	-	30.4	4.8	4.8	8.7	51.2
N	-	14	18	15	7	6
P dif 100	-	**	ns	ns	ns	*

"Salts" indicates the ionic components of the standard mucosal solution; the "Salts Only" solution replaces urea with an osmotic equivalent of NaCl.

TABLE II - Changes in J_H, PD and R during equilibration in the chamber

	J_H (uEq·cm^2·hr)				PD (mV)					R (ohm·cm2)				
Time (min)	15	30	45	60	0	15	30	45	60	0	15	30	45	60
Mean	0.52	0.96	1.30	1.51	6.51	8.81	5.56	3.42	3.13	840	631	476	377	338
SE	0.07	0.11	0.14	0.15	0.84	0.83	0.75	0.85	0.87	48	34	29	21	19
N	29	29	29	29	27	27	27	26	26	27	27	27	27	26
P dif 60 min	**	**	ns	-	**	**	*	ns	-	**	**	**	ns	-