on standard aerobic media and appeared as monotrichate polar-flagellated vibrio-like bacteria. Three that grew abundantly manifested characteristics that suggest relationship to but not identity with *Vibrio fetus*. Cultures of 6 spinal fluid samples, 5 from multiple sclerosis, remained sterile during 46 days.

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Response of Cartilage Sodium to Changes in Extracellular Fluid.* (26036)

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In recent years a number of investigators have explored the possibility that bone could serve as a reservoir for sodium. (For references see(1).) Infant skeleton differs from adult in that a sizeable portion (up to 30%) of the skeletal mass is composed of cartilage, and it is estimated that as much as one-third of total skeletal sodium in infants is present in the cartilaginous portion(2). It was of interest, therefore, to determine whether or not sodium content of cartilage would change with changes in serum sodium concentration.

Methods. Rabbits between 6 and 10 weeks of age were used. Anesthesia consisted of Dial with Urethane (Ciba) in dose of 0.7 cc/kg body weight. In the *control* series, opposite pieces of costal cartilage were removed following a 2-hour period of anesthesia. In the *hyponatremic* series, one cartilage sample was removed after 2 hours of anesthesia, and at the same time a sample of venous blood was obtained. Immediately following this procedure, a sodium-free isosmolar solution (Table I) equal in volume to 20% of body weight of the animal was injected intraperitoneally. Four hours later, a second blood sample was obtained, and the opposite piece of costal cartilage removed. In the *hypernatremic* series, initial blood and cartilage samples were obtained as above, followed by intravenous infusion of fluid of high sodium content (Table I) in an amount equal to 5% of the body weight. Infusion time varied from 45 to 180 minutes. Thereupon a second sample of cartilage and of blood was obtained.

Upon removal from the animal, the cartilage samples were immediately stripped of perichondrium and placed in tared stoppered weighing bottles. Cartilage samples averaged 20 mg in weight.

Cartilage water was determined by drying overnight in a vacuum oven at 70°C. The samples were then digested with concentrated nitric acid (0.1-0.3 cc) on a steam bath, and resulting solutions made up to volume for sodium analysis by flame photometry and chloride analysis by Volhard titration. Serum analyses were made by standard methods, whole blood pH by glass electrode.

Results. Control series. In 39 experiments, sodium content of opposite pieces of costal cartilage was determined. The mean difference in sodium content was 0.0082 meq/g wet weight, and standard error 0.0016 meq/

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TABLE I. Composition of Infused Solutions.

	mM/liter						g/liter	
	NaCl	$NaHCO_3$	KCl	$CaCl_2$	KH_2PO_4	$MgSO_4$	Sucrose	Glucose
Solution I*	—	—	3.5	5.1	1.2	2.5	96.16	1.00
" II†	600	300	3	5	1	3	—	—

* Equiosmolar with serum.
† Designed to give sodium load of 45 meq/kg body wt.

TABLE II. Results of Hyponatremia Experiments.

	Pre-infusion			Post-infusion		
Cartilage Na, meq/g	46*	.292†	(.245- .349)‡	46*	.253†	(.214- .305)‡
" H_2O, %	37	69	(63 - 75)	37	69	(60 - 73)
Serum Na, meq/l	46	150	(139 -168)	45	106	(73 -131)
" K, "	13	3.6	(2.0 - 4.4)	5	5.5	(4.4 - 6.2)
" Cl, "	13	96	(83 -103)	5	71	(60 - 78)
" CO_2 content, meq/l	13	31	(25 - 40)	5	22	(20 - 25)
Whole blood pH	20	7.38	(7.26 - 7.64)	6	7.23	(7.01 - 7.32)
Hematocrit	21	42	(33 - 48)	11	43	(39 - 49)

* No. of samples. † S.E. difference = .0037. ‡ Range.

g. It was thus apparent that opposite pieces of costal cartilage could be used with one serving as control for the other.

Hyponatremic series. The results of these experiments are summarized in Table II. Intraperitoneal infusion of the sodium-free solution produced a profound fall in serum sodium and chloride concentrations. Carbon dioxide content and pH also fell, and there was a slight rise in serum potassium concentration. Cartilage water did not change. Average cartilage sodium content fell from a pre-treatment value of 0.292 to a post-treatment value of 0.253 meq/g wet weight, a decrease of 0.039 meq, or 13.3%. This decrease is approximately 10 times the standard error of the difference, and can thus be considered statistically significant. The 13% decrease in cartilage sodium content can be contrasted to the fall in serum sodium of 29%.

Hypernatremic series. The results are summarized in Table III. Serum sodium rose as did serum chloride and carbon dioxide content. There was a slight fall in blood pH. The magnitude of the induced hypervolemia is evident from the marked fall in hematocrit. Average cartilage sodium content increased from a pre-treatment value of 0.291 to a post-treatment value of 0.323 meq/g, an absolute increase of 0.032 or 11%. This increase can be considered statistically significant inasmuch as it is approximately 7 times the standard error of the difference. The 11% increase in cartilage sodium can be contrasted to the 39% increase in serum sodium concentration.

Discussion. It is evident that changes in serum sodium concentration were associated with a change in cartilage sodium content under the conditions of these experiments. However, the magnitude of these changes could not be correlated with the magnitude of the change in serum sodium, nor degree of acidosis produced. The observed changes in whole blood pH may reflect inadequate ventilation

TABLE III. Results of Hypernatremia Experiments.

	Pre-infusion			Post-infusion		
Cartilage Na, meq/g	28*	.291†	(.241- .330)‡	28	.323†	(.297- .360)‡
" H_2O, %	28	69	(63 - 73)	28	69	(64 - 73)
Serum Na, meq/l	28	145	(132 -157)	28	202	(179 -273)
" K, "	28	3.8	(2.5 - 5.7)	28	3.4	(1.8 - 5.6)
" Cl, "	28	96	(84 -103)	28	142	(125 -183)
" CO_2 content, meq/l	28	32	(24 - 40)	28	38	(30 - 62)
Whole blood pH	27	7.38	(7.31 - 7.52)	24	7.29	(7.08 - 7.45)
Hematocrit	27	42	(36 - 49)	27	20	(16 - 32)

* No. of samples. † S.E. difference = .0046. ‡ Range.

or circulatory changes due to the large volumes of fluid infused.

It should be noted that the reduction in cartilage sodium (13%) was larger than we have ever been able to produce in bone(1), although others have found greater changes in response to acidosis and/or salt depletion. Furthermore, we have not been able to produce an increase in bone sodium by infusing sodium-containing solutions, though an increase amounting to about one-half that which we found to occur in cartilage (11%) has been observed by others following chronic sodium loading(3). In this respect the infant skeleton by virtue of its cartilage component would be expected to provide a larger reservoir of sodium relatively speaking, than that of the adult.

An attempt was made to find out whether the observed changes in cartilage sodium could be accounted for in the chloride space of this tissue. Eight samples of rabbit costal cartilage were analyzed for chloride; average value was 0.039 meq/g (range 0.033 to 0.044). The calculated chloride space was therefore 35% of the wet weight, or about half of the total water.† In the hyponatremic series, the change which could be ascribed to that occurring in the chloride space is (.150-.106) x 0.35 = 0.015 meq Na/g, whereas the total observed change was 0.039 meq/g. For the hypernatremic series the change in chloride space sodium was (.202-.145) x 0.35 = 0.020 meq/g, whereas the total change was 0.032 meq/g. In the first instance chloride space sodium accounted for only 39% of the change, in the latter 62% of the total change. Thus the observed changes in cartilage sodium cannot be accounted for solely by "extracellular" fluid, but must have involved some alteration in the component of sodium outside the chloride space.

Recently Farber(4) reported studies similar to ours. Using the ear cartilage of rabbits he was able to show a decrease in cartilage sodium of 16% following induction of hyponatremia. Only 40% of observed change could be ascribed to the chloride space. He further demonstrated that cartilage which has been partly depleted of sodium took up radiosulfur (S^{35}) somewhat less readily, suggesting an alteration in chondroitin sulfate metabolism.

Summary. Induction of hyponatremia by intraperitoneal injection of a sodium-free solution resulted in an appreciable fall (13%) in sodium content of rabbit costal cartilage. Induction of hypernatremia by intravenous injection of a sodium-rich solution caused an 11% increase in cartilage sodium content. These changes cannot be accounted for solely in the chloride space of cartilage. About one-half of the change must be ascribed to alterations in that portion of the cartilage sodium which is outside of the chloride space. The observed changes are larger than we have been able to produce in bone.

† Cl space $= \frac{\text{Cartilage Cl}}{\text{Serum Cl}} \times 0.92 \times 0.95$.

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