only a particular phase in the latent period of viral development(9). Although our experiments illustrated in Fig. 2 suggest that abalone fraction 10 may also act on some specific phase of influenza virus replication, it is too early to discuss, at present, the mechanism of inhibition by abalone material. However, it appears unlikely that the inhibition is dependent on failure of virus to attach to or penetrate the host cell.

Recently, Jensen *et al.*(10) reported that inhibition of influenza virus in tissue culture systems exhibited by chemical compounds could be due to trace amounts of ammonium ion. In our study, the amount of ammonium ion in 2 aliquots of MKTC fluids at the 4th day of incubation—one in 199 medium with 50 mg% abalone fraction 10 and the other without it—was determined‖ and practically no difference was found. Therefore, inhibition of influenza virus in our case apparently was not due to ammonium ion.

Conclusion. The present experiments indicate that the antibacterial and antiviral activities of untreated abalone juice are readily separable by ion exchange chromatography.

‖ Determination of ammonium ion was kindly performed by Mr. H. G. McCann in the Laboratory of Chemistry, Nat. Inst. of Arthritis and Metab. Dis., N.I.H.

1. Li, C. P., PROC. SOC. BIOL. AND MED., 1960, v103, 522.
2. ———, *ibid,* 1960, v104, 366.
3. Prescott, B., Li, C. P., *ibid,* 1960, v105, 498.
4. Li, C. P., Jahnes, W. G., *Virology,* 1959, v9, 489.
5. Reed, R. J., Muench, H., *Am. J. Hyg.,* 1938, v27, 493.
6. Lum, G. S., Smith, P. K., *J. Pharm. and Exp. Therap.,* 1957, v119, 284.
7. Dickson, L., Thompson, M. J., *Brit. J. Pharmacol. and Chemotherap.,* 1957, v12, 66.
8. Tamm, I., 1959, In *Viral and Rickettsial Infections of Man,* Rivers, T. M. and Horsfall, F. L. (ed.), J. B. Lippincott Co., Philadelphia, p156.
9. Ackermann, W. W., Maassab, H. F., *J. Exp. Med.,* 1954, v100, 329; 1955, v102, 393.
10. Jensen, E. M., Force, E. E., Unger, J. B., PROC. SOC. EXP. BIOL. AND MED., 1961, v107, 447.

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Depletion of Splenic Norepinephrine in Rat by Celiac Ganglionectomy. (27260)

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It has been shown that surgical denervation of the spleen in the sheep(1), cat(2), and dog(3) depletes tissue norepinephrine. This report describes a technic for celiac ganglionectomy which results in depletion of splenic norepinephrine in the rat. The ability of tissues to store norepinephrine has been related to functioning sympathetic innervation(4). How the storage and metabolism of norepinephrine are dependent on innervation is not clear, nor is it certain that all tissues in which norepinephrine can be measured are directly innervated(5). In attempting to study these problems, particularly with isotopic tracer technics, such factors as size of the animal and the ease with which a specific tissue may be studied became important considerations. The spleen of the rat seems suitable in these respects.

Methods. Albino male rats of the Osborne-Mendel strain, weighing 200-250 g, were used. Surgical denervation of the spleen was carried out in 14 animals; a sham operation was performed in 11 animals. Anesthesia consisted of ether or intraperitoneal sodium pentobarbital (25 mg/kg). Spleens from 22 unoperated animals served as normal controls. At the time of study the animals were killed by decapitation, asphyxia or with an overdose of sodium pentobarbital. The methods of sacrifice did not significantly influence the results. Rats subjected to denervation or sham procedures were sacrificed on the fourth postoperative day. Tissue nor-

TABLE I. Norepinephrine Contents of Rat Spleens.

Group	No. of animals	Norepinephrine content, μg/g Mean & S.E.*	Range
Control	22	.57 ± .04	.24-.91
Sham	11	.50 ± .03	.24-.67
Denervated	14	.03 ± .015	.00-.19

(Individual values for 14 animals were as follows: .00; .04; .03; .19; .10; .02; .00; .00; .00; .00; .00; .00; .00; .00)

* Stand. error of mean.

epinephrine levels were determined fluorometrically as described by Crout and associates(6) or by the method of Shore and Olin (7). Method of assay did not significantly influence the results. Quantities of 0.02 μg/g or more can be detected by these assay methods although values less than 0.05 μg/g are of doubtful accuracy.

Description of operations. Denervation of the spleen: The anesthetized rat was placed in supine position. The skin of the abdomen was washed, shaved and prepared with iodine and alcohol. The peritoneal cavity was entered through a ventral midline incision. The aorta was exposed at the root of the mesentery and was freed of fascia from its emergence at the diaphragm to the origin of the anterior mesenteric artery. The proximal 5-10 mm of the celiac artery and the anterior mesenteric artery were also exposed and their fascia removed. The intervening soft tissue which includes the celiac ganglion was excised. The incision was closed with silk sutures.

Sham operation: These animals were anesthetized and prepared as described above. The abdomen was entered through a ventral midline incision and the aorta was exposed at the root of the mesentery. The vessels were not stripped nor was tissue excised. The incision was closed with silk suture.

Results. All animals appeared vigorous at sacrifice. There was no evidence of infection secondary to the operative procedure. The data are summarized in Table I. Differences between control and sham groups are not statistically significant ($p>0.4$); differences between denervated and control groups and denervated and sham groups are highly significant ($p<0.01$).

Discussion. These data indicate that the rat spleen can be completely depleted of norepinephrine by surgical interruption of its sympathetic innervation. (The relatively high values in 2 animals after operation for denervation (0.19 and 0.10 μmg/g) probably represent failure to excise completely the celiac ganglion.) The sympathetic innervation of the spleen of the rat was described by Utterback(8). The dissection described accomplishes interruption of innervation without endangering the blood supply to the spleen. However, it undoubtedly effects denervation of other structures as well. The accessibility of the spleen and its well documented participation in cardiovascular adjustments has made it useful to the study of sympathetic mediated vascular reactions(3, 9). Since the catecholamine content of the spleen of the rat is clearly related to the integrity of its innervation, further studies of the mechanisms of sympathetically mediated reactions of the spleen of this species would seem to be justified.

Summary. Excision of the celiac ganglion of the rat results in total depletion of splenic norepinephrine, indicating the necessity of an intact sympathetic innervation for maintenance of normal levels of catecholamines in the spleen of this species.

1. Von Euler, U. S., Purkhold, A., *Acta Physiol. Scand.*, 1951, v24, 212.

2. Rehn, N. O., *ibid.*, 1958, v42, 309.

3. Brandon, K. W., Rand, M. J., *J. Physiol.*, 1961, v157, 18.

4. Hagen, P. M., in *Symposium on Catecholamines*, Williams and Wilkins Co., Baltimore, Md., 1959, p361.

5. Augustinsson, K. B., Fänge, R., Johnels, A., Ostlund, E., *J. Physiol.*, 1956, v131, 257.

6. Crout, J. R., Creveling, C. R., Udenfriend, S., *J. Pharmacol. Exp. Therap.*, 1961, v132, 269.

7. Shore, P. A., Olin, J. S., *J. Pharmacol.*, 1958, v122, 295.

8. Utterback, R. A., *J. Comp. Neurol.*, 1944, v81, 55.

9. Burn, J. H., Rand, J. J., *J. Physiol.*, 1959, v147, 135.

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