($y - y' = 20.2$ mm, $p > 0.05$). Only 4 cases had preoperative renal blood flows above 800 cc per minute. Resistance values were calculated from the publications of these authors, using pressures at the time of the tests wherever designated by them, and without modification of data. Where hematocrit was not given, a value of 0.43 was assumed.

Conclusion. A relation of the preoperative renal resistance to the postoperative blood pressure has been demonstrated in patients with hypertension subjected to sympathectomy. A complete test of the reliability of this relation in predicting the result of sympathectomy requires additional data.

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Antagonism by Cellular Extracts of Effects of Respiratory Poisons on Onion Roots and Sea Urchin Eggs.

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Aqueous yeast extract has been shown to antagonize the deleterious effects of potassium cyanide, basic phenylmercuric nitrate and sodium azide upon respiration[1,2,3,4] and of basic phenylmercuric nitrate on the growth[1,5,6] of unicellular organisms and fragments of mammalian tissues. Study of the antagonism of yeast extract against the effects of these respiratory poisons has now been extended to intact multicellular structures, namely, the roots of the onion and the eggs of the sea urchin.

Onion Roots. Onions (*Allium cepa*) of approximately 5 cm in diameter, purchased in market, were germinated over water in the dark at room temperature. When the roots were approximately 4-7 cm in length they were reduced in number to 10-25 of uniform appearance. The normal rate of growth was 1 cm to 1.5 cm per day. The poisons employed were basic phenylmercuric nitrate (PMN) in concentrations of 1:200,000 to 1:24,000 (7.5×10^{-6} to 6.3×10^{-5} M); potassium cyanide, 0.4% (0.06 M); mercuric chloride, 1:72,000 (5.1×10^{-5} M), and urethane, 3 and 5% (0.34 M and 0.56 M).

The crude yeast extract, in dilutions of 0.8 to 2.5%, was an alcoholic extract corresponding to Sample A as described by Cook, Kreke, and Nutini.[7] In a few experiments beef spleen extract[8] was used in concentrations of 0.4 and 0.2% with concentrations of 1.6×10^{-5} PMN. The onion roots were immersed about half their total length in the test solutions for 1 hour and were thoroughly rinsed before replacement in tap water. The lethal dose of the poison was established as the amount which would lead to the death of all of the roots as a consequence of 1 hour of exposure. On surviving roots, enlarged tips, if they developed, usually did so in the 24 hours following exposure to the test solutions.

1 Cook, E. S., and Kreke, C. W., PROC. SOC. EXP. BIOL. AND MED., 1943, **53**, 222.

2 Cook, E. S., Kreke, C. W., Eilert, Sr. M. R., and Sawyer, M. A., PROC. SOC. EXP. BIOL. AND MED., 1942, **50**, 210.

3 Kreke, C. W., and Suter, Sr. M. St. A., *J. Biol. Chem.*, 1945, **160**, 105.

4 Kreke, C. W., and Suter, Sr. M. St. A., *Studies Inst. Divi Thomae*, 1945, **4**, 85.

5 Cook, E. S., and Kreke, C. W., *Nature*, 1940, **146**, 688.

6 Thomas, G. W., Fardon, J. C., Baker, S. L., and Cook, E. S., *J. Am. Pharm. Assn., Sci. Ed.*, 1945, **34**, 143.

7 Cook, E. S., Kreke, C. W., and Nutini, L. G., *Studies Inst. Divi Thomae*, 1938, **2**, 23.

8 Staff, I. D. T., *Studies Inst. Divi Thomae*, 1947, **5**, 55.

TABLE I.
Gross Effects on Onion Roots After One Hour of Exposure to Respiratory Poisons and Yeast Extract.

Concentrations		Dead	Terminal	Growth	Total growth
Poison	Yeast extract, %	roots, %	swellings, %	arrest, hr	4 days, cm
0	0	0	0	0	4-6
		Basic Phenylmercuric Nitrate.			
1:200,000	—	0	100	24	2-3
(7.5 x 10-6 M)	1.0	0	100	24	2-3
1:96,000	—	100	—	—	—
(1.6 x 10-5 M)	0.8	0	100	24	2-3
1:70,000	—	100	—	—	—
(2.1 x 10-5 M)	1.0	0	100	12-24	2-4
1:50,000	1.2	0	76	12-24	2-3
(3.0 x 10-5 M)	2.5	0	100	48*	1-1.5
1:48,000†	—	100	—	—	—
(3.1 x 10-5 M)	0.5	0	100	12-48	2-3
1:30,000	—	100	—	—	—
(5.0 x 10-5 M)	0.5	100	—	—	—
	1.0	80	20	72	1
1:24,000	—	100	—	—	—
(6.3 x 10-5 M)	1.0	100	—	—	—
	2.0	21	0	Indef.	?
	2.5	0	100	12-72	0.2-3.5
		Potassium Cyanide.			
0.4%	—	100	—	—	—
(0.06 M)	1.0	0	0	Slight	3.5-4
		Mercuric Chloride.			
1:72.000	—	100	—	—	—
(5.1 x 10-5 M)	1.0	0	0	Slight	4-4.5‡

* Only 50% resumed growth.
† Only 30 minutes exposure.
‡ Secondary roots developed, after 5 days, from root tips and along entire immersed length.

The results are summarized in Table I. When the effects of the test solutions were sublethal, growth by elongation, in many instances was arrested in the succeeding 24-hour interval. During this time small swellings developed just behind the meristematic tip which were similar in appearance to those produced by exposure to colchicine and to various organic salts.[9] Growth was usually resumed at a reduced rate on the second day and distal to the terminal swelling (Table I).

Yeast extract in no way modified the effects of a sublethal concentration of PMN, but prevented the lethal action of concentrations of the poison as high as 6.3 x 10^{-5} M, with the subsequent production of terminal swellings. In one experiment (PMN, 3 x 10^{-5} M, and yeast extract, 2.5%) only 50% of the roots resumed growth within 4 days. To determine if this was in part due to the high concentration of the yeast extract, onion roots were exposed to a 2.5% concentration of the extract alone. In the next 4 days their average growth was only 5 cm while that of control roots on the same bulb which had been in water throughout, was 6 cm. By the 4th day the daily increment was equivalent to that of the control roots.

Against lethal amounts of KCN and $HgCl_2$, a 1% concentration of yeast extract entirely protected the roots with no swellings or irregularities in form developing.

The action of urethane on onion roots differed from that of the PMN, KCN, and $HgCl_2$. A 5% solution (0.56 M) acting for 1 hour was not lethal. Growth was arrested for 48 hours but no swellings developed. Exposure for as long as 6 hours to a 3% (0.34 M) solution was not lethal at the end of that time and elongation continued for the next 24 hours, but was arrested on the second day, during which time terminal swellings developed. By the 4th day the tiny meristematic tip distal to the swollen zone was dead.

[9] Levan, A., *Nature*, 1945, **156**, 751.

Twenty-four hours after exposure to 3% urethane and 1% yeast extract the roots were flaccid and dead in a zone 1 cm in length immediately behind the meristematic tip; no terminal swellings developed during the interval.

Two experiments with aqueous beef spleen extract in concentrations of 0.4 and 0.2% were made using 1:96,000 PMN (1.6×10^{-5} M), for an hour of exposure. With 0.4% beef spleen extract none of the roots was dead at the end of the exposure period. Growth was arrested for 24 hours, during which time 2 of the 12 roots developed small terminal swellings. Very slight growth (1-2 cm) resulted during the 5 days following exposure. With 0.2% spleen extract, 4 roots were dead at the end of 48 hours; the remaining 10 continued to grow very slowly, 2 developing swollen tips and the others becoming curved and irregular in form.

Sea Urchin Embryos. Fertilized eggs in the 2- to 4-cell stage of the sea urchin (*Tripneustes esculentus*) were exposed for 1 hour to basic PMN and to mixtures of PMN and yeast extract and of PMN and beef spleen extract. Suspensions of fertilized eggs were prepared according to Just's method.[10] About 10 ml of thick egg suspensions containing a few hundred eggs were diluted to 30 ml with fresh sea water and used for each experiment. In control experiments the developing eggs were ciliated motile blastulae within 20 hours. The concentrations of PMN used were 1:144,000 (1×10^{-5} M), 1:1.5 million (1×10^{-6} M), and 1:2 million (7.5×10^{-6} M); 1:3.2 million (4.7×10^{-7} M) and 1:4 million (3.8×10^{-7} M). The crude yeast extract was diluted to 0.5, 0.8, and 1.0%.

With all of the concentrations of PMN, except the most dilute solution, 95 to 100% of the eggs were dead at the end of 20 hours after exposure to the poison for 1 hour. Some of the eggs (43, 30 and 95%) resumed growth after removal from the more concentrated solutions of PMN (1×10^{-5} M, 1×10^{-6} M, 7.5×10^{-7} M), but only 2% of those in 1×10^{-6} M reached the blastula stage and became motile. Most of the embryos treated divided but once more. Many of the embryos were anomalous in form and some of the cells cytolyzed. In the weakest dilution (3.8×10^{-7} M) the eggs were undamaged after 1 hour of exposure to the poison, resuming a normal rate of growth and development except for the slowing of the rate of absorption of the yolk.

Yeast extract (0.8%) did not protect the eggs against the lethal action of PMN 1×10^{-5} M, although a larger percentage resumed growth for a short period, after removal to seawater, than was the case with eggs exposed to PMN of the same concentration alone. None of the cells was cytolyzed. All of the eggs exposed to PMN 1×10^{-6} M and 1% yeast extract resumed growth, and half reached the motile blastula stage as contrasted with the 30% resuming growth, and 2% reaching the blastula stage after exposure to the poison alone. Mortality at 20 hours with yeast extract and the poison was 50% as compared to 95% without extract. There were also fewer anomalous forms and less cytolysis among the eggs exposed to the mixture of poison and yeast extract than among those exposed to the poison alone. At a PMN concentration of 4.7×10^{-7} M, yeast extract (0.8%) completely overcame the deleterious effects of PMN.

Evidence of a retarding action of the yeast extract itself lies in the observation that there was a more nearly normal rate of yolk absorption after exposure to PMN 3.8×10^{-7} M with 0.5% extract than with 1.0% of extract. Beef spleen extract at 0.8% concentration was less effective than yeast extract in antagonizing the deleterious effects of PMN on sea urchin eggs.

Discussion. It has been shown that, while basic phenylmercuric nitrate inhibits enzymes dependent upon the –SH group for their activity, it also inhibits iron porphyrin enzymes such as catalase and cytochrome oxidase;[11,12,13] azide and cyanide likewise inhibit

[10] Just, E. E., *Basic Methods on Eggs of Marine Animals*, Philadelphia, P. Blakiston's Son and Co., 1939.

[11] Cook, E. S., Kreke, C. W., McDevitt, Sr. M. of L., and Bartlett, Sr. M. D., *J. Biol. Chem.*, 1946, **162**, 43.

[12] Cook, E. S., and Perisutti, G., *J. Biol. Chem.*, 1947, **167**, 827.

the iron porphyrin enzymes.[14] Yeast extract has accelerated the activity of cytochrome oxidase and offset the effects of PMN (Cook and Kreke, unpublished) and poisons specific for this enzyme.[3,4] Moreover, yeast extract fails to antagonize poisoning of the respiration of yeast and mammalian tissue by urethane which inhibits the dehydrogenases.[3,4] In the present work, the action of urethane on onion roots differed from that of cyanide and PMN in 2 respects, in that (a) the meristematic cells were first killed and (b) this effect could not be offset with the concentrations of yeast extract used.

The effects of respiratory poisons and yeast extract on multicellular structures appear to resemble those described for unicellular organisms and mammalian tissue fragments. Cytologic studies are now in progress to determine if the toxic action is also evident in intracellular modifications. In these experiments reaction of the extracts with the poisons can not be excluded nor can possible direct effects of the extract on the enzyme systems or on the cell membranes. Further experiments will be undertaken to obtain information on these points.

Summary. The lethal and sub-lethal effects of basic phenylmercuric nitrate, potassium cyanide and mercuric chloride on onion roots and sea urchin embryos can be antagonized by yeast and beef spleen extract. These observations are in agreement with reports that yeast extract can offset the action of respiratory poisons on some enzyme systems.

[13] Cook, E. S., Kreke, C. W., and Walsh, Sr. T. M., *J. Biol. Chem.*, 1946, **162**, 51.

[14] McElroy, W. D., *Quart. Rev. Biol.*, 1947, **22**, 25.