calcifying system when lower concentrations of surface active compounds are present during the actual process of mineralization. The existence of an essential lipid factor secreted by the cells as calcification proceeds would help explain the observed effect of the above surface active agents on the calcifying mechanism.

Summary. Calcification *in vitro* of the hypertrophic epiphyseal cartilage was found to be inhibited by 4.8 x 10^{-4} M sodium desoxycholate, 1.9 x 10^{-3} M sodium cholate, 1.4 x 10^{-3} M Duponal C, and .08% Tween-20. By preliminary treatment of rachitic sections with higher concentrations of these surface active agents for a short time interval, it was possible to demonstrate inhibition only with the bile salts and Duponal C.

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The Effect of X Radiation on Antibody Formation.* (18127)

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Hektoen(1) conclusively demonstrated that total-body exposure of experimental animals to ionizing radiation suppressed the usual antibody response to antigens injected shortly before or shortly after irradiation. Hektoen's observations led him to ascribe this suppression to the destructive effect of irradiation on lymphatic tissue and bone marrow. These findings have been corroborated by a number of workers and have recently been reviewed by Taliaferro(2). Craddock and Lawrence(3) reported that total-body exposure of rabbits to 250 r X radiation effectively suppressed the formation of antibodies to antigens (typhoid vaccine and washed red cells from sheep) administered 8 hours after irradiation.

This communication relates a study on the capacity of the rabbit to form antibodies after the whole body, except for the spleen or appendix, has been exposed to 800 r X radiation. A preliminary report on this work was described elsewhere(4).

Materials and methods. Young adult rabbits (Swift's snuffle-free), weighing approximately 2 kg were used in this study. The rabbits were divided into groups and the experiments carried out as indicated in Tables I and II.

The rabbits of all groups, including the control animals, were anesthetized with Nembutal (38 mg per kg total-body weight) administered intravenously in the first experiments; later only those were given anesthetic which were subjected to irradiation, surgical exteriorization of the spleen, or both. Under anaesthesia, the spleen of each animal of Groups 3, 7, 8, and 9 was withdrawn from the abdominal cavity through a left upper quadrant incision. In the animals in Group 3, which were not irradiated, the spleen was exteriorized, wrapped in moist gauze, and left for one hour (the approximate time required to deliver the radiation to the exposure groups). In Group 7 the spleens were placed in lead shields during irradiation. The lead shields consist of two parts that fit together by means of overlapping flanges with a baffle type slit 3/16-inch wide and measuring 3¼ inches along the long axis. The wall of the

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1. Hektoen, Ludvig, *J. Infect. Dis.*, 1915, v17, 415.

2. Taliaferro, W. H., and Taliaferro, Lucy G., The Effect of X-rays on Immunity, Metallurgy Lab., University of Chicago, AECU-240, CH-3891, June 1946.

3. Craddock, C. G., and Lawrence, J. S., *J. Immunol.*, 1948, v60, 241.

4. Jacobson, L. O., Robson, M. J., Marks, E. K., and Goldman, M. O., *J. Lab. Clin. Med.*, 1949, v34, 1612.

TABLE I. Effect of Lead Shielding of the Surgically Mobilized Spleen on Antibody Response.

Group	Rabbit No.	Preparation	Antigen	Hemolysis titer at intervals after immunization: Control	7 days	10 days	14 days	21 days	28 days	35 days
1	1	None	1 cc 2%	0	40	5120	5120	640	—	—
	2		sheep cells	10	40	1280	160	80	20	
	3		I.V.	0	0	1280	1280	320	320	
	4			0	640	640	640	320	80	80
	5			10	2560	5120	5120	1280	640	
	6			10	640	640	640	320	320	
	7			40	1280	2560	1280	320	640	
2	1	None	None	0	0	0	20	0	0	
	2			0	10	0	0	0	10	
	3			0	80	20	10	20	10	
	4			0	20	20	20	10	0	
	5			0	0	0	10	0	0	
3	1	Spleen exteriorization only	1 cc 2%	0	0	80	40	0	0	
	2		sheep cells	0	1280	2560	5120	5120	2560	
	3		I.V.	0	2560	5120	640	320	320	160
	4			0	1280	1280	2560	1280	160	
	5			10	1280	2560	320	—	—	—
	6			0	1280	640	1280	1280	—	—
	7			20	320	—	—	—	—	—
4	1	Splenectomy only 24 hr prior to antigen injection	1 cc 2%	0	40	5120	5120	320	—	—
	2		sheep cells	0	2560	2560	5120	5120	2560	—
	3		I.V.	0	10	20	40	40	40	10
5	1	800 r total-body irradiation only	1 cc 2%	0	0	0	0	0	—	—
	2		sheep cells	0	0	0	0	20	40	
	3		I.V.	0	0	0	0	80	—	—
	4			0	10	*	10	40	40	80
	5			*	0	0	0	10	0	0
6	1	800 r total-body irradiation	None	20	0	—	—	—	—	—
	2			0	0	0	0	0	0	0
7	1	800 r total-body irradiation with spleen shielding	1 cc 2%	0	0	320	—	—	—	—
	2		sheep cells	0	0	40	80	5120	20	
	3		I.V.	0	40	160	640	0	0	
	4			0	80	160	320	20	80	
	5			0	0	80	1280	5120	80	
	6			0	40	80	40	0	0	0
	7			0	0	160	160	20	20	20
	8			0	0	20	40	*	80	10
	9			0	640	320	320	160	160	
	10			0	0	10	*	160	160	
	11			10	10	20	—	—	—	—
	12			10	0	160	—	—	—	—
	13			0	0	320	2560	1280	—	—
	14			10	160	—	—	—	—	—
	15			0	20	640	640	160	160	
	16			0	0	10	40	—	—	—
	17			0	0	20	40	40	40	
	18			0	10	20	40	40	20	
8	1	800 r total-body irradiation with spleen exteriorization but no shielding	1 cc 2%	0	0	20	—	—	—	—
	2		sheep cells	0	0	0	0	—	—	—
	3		I.V.	10	10	0	—	—	—	—
	4			0	0	0	0	0	0	
	5			0	0	0	0	0	0	
	6			0	0	0	0	80	80	40
	7			0	0	0	10	10	10	10
	8			0	0	0	0	0	0	
	9			0	0	0	0	0	0	
	10			0	0	0	0	—	—	—
	11			0	0	0	0	0	0	

TABLE I. (Continued).

Group	Rabbit No.	Preparation	Antigen	Hemolysis titer at intervals after immunization: Control	7 days	10 days	14 days	21 days	28 days	35 days
9	1	800 r total-body irradiation with spleen shielding, splenectomy 3 days after irradiation	1 cc 2% sheep cells I.V.	0	20	160	320	—	—	—
	2	Same as above except splenectomy 4 days after irradiation	1 cc 2% sheep cells I.V.	0	40	40	20	40	20	
	3			0	40	320	640	640	320	
	4	800 r total-body irradiation with spleen exteriorization but no shielding, splenectomy 3 days after irradiation	1 cc 2% sheep cells I.V.	0	0	0	0	0	0	
	5			10	0	0	—	—	—	—
	6	Same as above except splenectomy 4 days after irradiation	1 cc 2% sheep cells I.V.	0	0	0	0	0	0	
	7	Spleen exteriorization, no radiation, splenectomy 3 days after exteriorization	1 cc 2% sheep cells I.V.	0	1280	5120	2560	1280	1280	
	8	Same as above 4 days after exteriorization	1 cc 2% sheep cells I.V.	0	320	640	1280	640	320	
	9	No preparation, but splenectomized same as above	1 cc 2% sheep cells I.V.	10	80	160	160	160	160	

— Death of animal.
* Serum not obtained.

cylinder is ¼-inch thick. This arrangement prevents compression of the splenic pedicle and minimizes the penetration of X rays or scatter of X rays into the cylinder.

Twenty-four hours after operation and X irradiation, each animal in groups 1, 3, 4, 5, 7, 8, and 9 received 1 cc of a 2% suspension of washed sheep cells intravenously. Blood specimens were obtained from all rabbits before treatment ("Control" in Tables I and II) and on those which still survived at 7, 10, 14, 21, and 28 days after immunization. Blood was drawn for study at the 35-day interval in only a few animals.

After it was established, as described in the results below, that antibody production was not universally suppressed when the spleen was shielded during irradiation, an additional experiment was performed (Group 9). On the third and fourth days following irradiation and spleen shielding (2 and 3 days after immunization) splenectomies were done on 12 rabbits—2 from each of the irradiated groups (protected and not protected) on each day and one each from the control animals (normal and operation only). Streptomycin (75 mg/rabbit) was given to all animals (control included) on the day of irradiation and spleen exteriorization and was continued through the sixth day in a dose of 225 mg/day in three divided doses. None of the other groups of rabbits received an antibiotic. Splenectomy was performed on these animals using Nembutal anesthesia. The healed incision of the original surgery was reopened using clean surgical technic. The blood supply of the pedicle was tied off and the spleen removed. Any accessory spleens

TABLE II. Effect of Lead Shielding of the Surgically Mobilized Appendix on Antibody Response.

Group	Rabbit No.	Preparation	Antigen	Hemolysis titer at intervals after immunization: Control	7 days	10 days	14 days	21 days	28 days	35 days
10	1	None	1 cc 2%	0	40	640	640	640	40	
	2		sheep cells	0	1280	640	640	640	320	
	3		I.V.	10	2560	5120	5120	5120	1280	320
	4			0	320	640	320	160	160	
	5			10	5120	1280	1280	1280	320	
11	1	None	None	0	0	0	0	0	—	—
	2			0	0	*	0	0	0	—
	3			0	0	0	0	0	0	0
12	1	Appendix exteriorization only	1 cc 2%	10	2560	5120	5120	1280	640	
	2		sheep cells	0	1280	5120	2560	640	320	160
	3		I.V.	0	20	160	320	40	40	
	4			0	640	640	640	—	—	—
	5			0	160	320	320	160	80	
	6			10	640	—	—	—	—	—
	7			0	1280	1280	640	320	320	
	8			0	1280	640	320	160	160	
	9			0	640	320	320	320	320	
	10			0	2560	5120	5120	1280	630	
13	1	800 r total-body irradiation only	1 cc 2%	0	0	0	0	0	0	0
	2		sheep cells	0	0	0	0	0	—	—
	3		I.V.	0	0	0	—	—	—	—
14	1	800 r total-body irradiation only	None	0	0	0	0	0	0	0
15	1	800 r total-body irradiation with appendix shielding	1 cc 2%	0	0	0	0	640	—	—
	2		sheep cells	0	0	40	320	80	80	
	3		I.V.	0	40	320	320	320	160	80
	4			20	80	2560	5120	640	320	640
	5			0	0	20	640	640	80	
	6			0	0	160	1280	320	320	
	7			0	0	80	320	160	80	
	8			0	0	—	—	—	—	—
	9			0	20	320	320	—	—	—
	10			0	0	20	80	40	20	
	11			10	10	20	—	—	—	—
	12			0	0	20	40	20	—	—
	13			0	0	80	40	80	80	
	14			10	0	320	640	320	160	
	15			0	0	40	80	40	40	
	16			10	0	20	80	160	160	
	17			0	0	5120	5120	2560	320	
	18			0	40	640	640	640	320	
16	1	800 r total-body irradiation with appendix exteriorization but no shielding	1 cc 2%	0	0	0	—	—	—	—
	2		sheep cells	0	0	0	0	10	40	
	3		I.V.	0	0	0	0	0	10	
	4			0	0	0	0	0	0	0
	5			0	0	0	0	0	0	10
	6			0	0	0	0	0	0	0
	7			0	0	0	0	0	0	
	8			0	0	0	—	—	—	—
	9			0	0	0	—	—	—	—
	10			10	80	40	20	80	40	
	11			40	0	0	0	40	40	
17	1	800 r total-body irradiation with appendix shielding. appendectomy 5 days after irradiation	1 cc 2% sheep cells I.V.	0	40	5120	5120	5120	5120	

TABLE II. (Continued).

Group	Rabbit No.	Preparation	Antigen	Hemolysis titer at intervals after immunization: Control	7 days	10 days	14 days	21 days	28 days	35 days
17	2	Appendix exteriorization, appendectomy 5 days later	1 cc 2% sheep cells I.V.	40	320	640	160	80	80	
	3	No preparation but appendectomy same as above	1 cc 2% sheep cells I.V.	0	160	160	160	320	160	
	4			0	5120	5120	5120	2560	—	—

— Death of animal.
* Serum not obtained.

that were found were also removed. Blood samples for titrations were taken just prior to surgery.

The hemolysin titers were determined by making serial dilutions of the rabbit sera (1:10, 1:20, 1:40, etc., to 1:5120) in 0.5 cc amounts, adding 0.5 cc of lyophil guinea pig complement and 0.5 cc of a 2% suspension of washed sheep red cells, incubating 1 hour at 37°C, and refrigerating overnight. The hemolysin titrations on each series (those animals treated and immunized on the same day) were done at the same time to eliminate differences in complement or sheep cell suspension. The titer of each particular serum was that dilution that gave complete macroscopic hemolysis.

Experiments involving the appendix. In the experiments involving lead shielding of the surgically exteriorized appendix (Table II, Groups 10-17) the same general technics were employed as were used in the experiments involving spleen shielding. A surgical incision was made in the right lower quadrant of the abdomen and the appendix was brought out and placed in a cylindrical lead container (¼-inch thick throughout). This shield had an opening at one end for the proximal end of the appendix and a narrow baffletype slit with overlapping flanges to allow the blood supply of the appendix to remain intact during this procedure. The antigen was given 24 hours after irradiation.

On the fourth day following irradiation (third after immunization) appendectomy was done on 5 rabbits (Group 17). Two of these had lead shielding of the exteriorized appendix during irradiation, two had appendix exteriorization during irradiation, but no shielding, and one had had its appendix exteriorized but received no radiation. These rabbits were anesthetized with Nembutal, and sterile surgical technic was employed. The incision of the original surgery was reopened. The blood supply to the appendix was tied off and a purse string suture was used to close the stump of the appendix. Only one animal which was irradiated in Group 17 (Table II, No. 1) survived the procedure. No antibiotics were used on these animals.

Dosimetry. The X rays were generated in a 250-kv machine operating at 15 ma. A 1.0-mm Cu filter and a 3.0-mm Bakelite filter were used. The half-value layer in copper of the filtered beam was 2.0 mm. The exposures were measured with a Victoreen condenser r-meter equipped with a 100-r chamber. Measurements were made in air at the position occupied by the center of the animal's body. The dose rate averaged 15.5 r per minute at 33 inches; a total dose of 800 r was delivered.

The amount of X radiation that the lead-protected appendix received has not been accurately measured. One-quarter inch of lead effectively eliminates appreciable penetration of X rays. Scatter through the slit opening of the appendix shield is probably minimal but some radiation enters the open end of the appendix shield.

Histologic studies. Groups of rabbits paralleling the spleen- and appendix-protected animals were set up in order to determine the effect of lead shielding of the appendix and immunization upon the cell population of these lead-shielded tissues. At least two ani-

mals from each group were sacrificed at intervals of 2, 7, 14, 21, 28, and 35 days after immunization. These sacrifice intervals were chosen since they represented the intervals at which blood was drawn for antibody titer studies. The 3-day interval was chosen since previous experience(5,6) had shown that at this interval destruction and atrophy of the hematopoietic tissues was generally at its maximum after this dose of X radiation. In this report, only the histologic findings at 3 days after irradiation are reported. In another experiment, to be reported (7), rabbits exposed to 800 r or 1000 r total-body X radiation with lead protection of spleen or appendix were sacrificed for histologic study at intervals beginning at one day after irradiation through 35 days after irradiation. The histologic findings were identical with those observed in animals sacrificed in this present study of antibody formation. The tissues taken at autopsy for study were spleen, appendix, thymus, mesenteric lymph nodes, liver, kidney, adrenals, bone marrow (sternum and one femur), and intestine. These were fixed in Zenker-formol, embedded in 20% nitrocellulose, sectioned at 6 or 8 μ, and stained with hematoxylin-eosin-azure II.

Results. A dose of 800 r total-body X irradiation is followed by death of approximately one-half of the animals exposed to this dosage (LD_{50}). The mortality of the irradiated animals which had surgery was not as high as in animals irradiated without surgery. Mortality was higher in our early experiments but as our surgical technic improved so did survival. No significance should be attached to these survival data because of this latter fact.

Experiments involving lead-shielding of the spleen. Animals given 800 r total-body X radiation without spleen shielding but which were immunized one day later (Groups 5 and 8, Table I) either developed no demonstrable hemolysin titer, or titers of 1:80 or 1:40 were demonstrated on the twenty-first day, the twenty-eighth day, or thirty-fifth day, respectively, after immunization. In the normal animals (Group 1) and in animals that were subjected to surgical exteriorization of the spleen (Group 3) or splenectomy (Group 4) hemolysin titers as high as 1:5120 were produced by the tenth day; the titers had diminished by the twenty-eighth day after immunization. The hemolysin titers of individual rabbits given 800 r total-body X radiation exclusive of the surgically-exteriorized, lead-shielded spleen (Group 7) likewise reached values of 1:5120 but only by the twenty-first day. In general, the hemolysin titers in this group (Group 7) were lower and reached a maximum titer later than did normal controls (Group 1) or the additional control Groups 3 and 4. It is perhaps worth emphasizing that whereas the hemolysin titers of the control groups reached fairly high values by 7 days the titers of the spleen-shielded group (Group 7) as well as the appendix-shielded group (Group 15) had usually not risen by this interval. Animals in Group 9 (total-body X irradiation and spleen shielding) which were splenectomized three days after irradiation (2 days after antigen injection) or four days after irradiation (3 days after antigen injection) retained the capacity to produce hemolysin titers significantly higher than control irradiated nonshielded animals.

Lead protection of the appendix. Individual rabbits given 800 r total-body X radiation exclusive of the surgically-mobilized appendix and immunized twenty-four hours later produced antibodies reaching titers essentially comparable to the control groups; others, though producing titers higher than animals without lead shielding, were in some instances rather low (Table II). In general, the maximum titers in Group 15 were reached at 14 days. In rabbits given total-body X radiation including the appendix, the formation of antibodies was suppressed during the period of observation with the exception of an occasional animal which attained titers of 1:80 by 21, 28, or 35 days. Only one animal from Group 17, which had an appendectomy on

5. Jacobson, L. O., Marks, E. K., and Lorenz, E., *Radiology*, 1949, v52, 371.

6. Jacobson, L. O., Marks, E. K., Gaston, E., and Block, M. H, *J. Lab. Clin. Med.*, 1949, v34, 902.

7. Unpublished data.

the fifth day after irradiation (4 days after antigen injection) survived but this animal, which originally had 800 r total-body X irradiation and appendix shielding, attained a hemolysin titer of 1:5120 on the tenth day.

Histologic studies. Previous reports by Bloom *et al.*(8) and Jacobson *et al.*(5,6) have described the effects of a dose of 800 r total-body X radiation on the hematopoietic tissues of the rabbit. The lymph nodes throughout the body, the thymus, the patches of Peyer in the intestine, the appendix, and the spleen pass through a phase in which there is disintegration of the lymphocytes and virtually complete phagocytosis of the resultant particulate debris within the first 24 hours after irradiation. By 3 days the lymph nodes and spleen are practically devoid of lymphocytes, and the nodules appear as shrunken nests of reticular cells. The thymus is reduced to a sheath of epithelial cells in the cortex and the medulla is usually atrophic and devoid of lymphocytes. The bone marrow reaches a largely atrophic stage by 3 days after irradiation. Although regeneration of the bone marrow begins at about the 9th to 12th day and is orderly, normal cellularity is not attained before 14 to 21 days. The lymphatic tissue is reconstituted more slowly. Nodules rarely appear in the lymph nodes and spleen before the 12th day and usually not before the 14th to 21st day. Aggregates of lymphocytes begin to appear about the blood vessels and in the diffuse lymphatic tissue of the cortex and medulla of the lymph nodes about the 7th to 8th day after irradiation and increase slowly in number thereafter. In the experiment here reported the lymphatic tissues and bone marrow of all the irradiated groups were atrophic at 3 days with the exception of the spleen and the appendix of the groups that had either one or the other of these organs lead-protected during irradiation. In other words, whereas the lead-shielded spleen of irradiated animals remained essentially normal in size and cellularity, the marked cellular destruction and reduced cellularity of the irradiated lymph nodes, thymus, intestinal lymphatic tissue, including the patches of Peyer and the appendix, and bone marrow observed at 3 days were indistinguishable from those observed in animals which received total-body exposure without lead-shielding of the spleen. Likewise, in animals which had lead-shielding of the appendix during irradiation, the appendix was qualitatively normal in size and its cellularity largely indistinguishable from the normal appendix of nonirradiated controls at 3 days; whereas, the hematopoietic tissue elsewhere was atrophic.

It is worthwhile emphasizing that no increase in plasma cells in the lead-shielded spleen or appendix was apparent at 3 days or at subsequent intervals. The irradiated lymphatic tissue of rabbits with lead-shielding of the spleen or appendix regenerated much more rapidly than the animals irradiated without spleen or appendix shielding(7). By 4 days active nodules were present in the lymph nodes of the irradiated animals with spleen or appendix protection. Recovery of the white pulp of the spleen was prominent by 4 days in animals with appendix protection; in animals with spleen protection, recovery of the appendicial lymphatic tissue was well underway by 4 days.

Discussion. In a previous communication(8) it was reported that the 28-day LD_{50} for mice exposed to total-body X radiation exclusive of the surgically exteriorized, lead-shielded spleen is nearly twice as great (1025 r) as the LD_{50} for mice exposed to total-body X radiation including the spleen (550 r). It has also been demonstrated (10,11) that lead protection of the surgically-exteriorized spleen of mice during the delivery of 600 r total-body X radiation obviated the development of anemia and significantly les-

8. Bloom, W. A., 1948. Histopathology of Irradiation from External and Internal Sources, ed., W. A. Bloom. NNES, Div. IV, 22 I. McGraw-Hill Book Co., New York. First edition.

9. Jacobson, L. O., Marks, E. K., Robson, M. J., Gaston, E., and Zirkle, R. E., *J. Lab. Clin. Med.*, 1949, v34, 1538.

10. Jacobson, L. O., Simmons, E. L., Bethard, W. F,. Marks, E. K., and Robson, M. J., PROC. SOC. EXP. BIOL. AND MED., 1950, v73, 455.

11. Jacobson, L. O., Simmons, E. L., Marks, E. K., Robson, M. J., Bethard, W. F., and Gaston, E. C., *J. Lab. Clin. Med.*, 1950, v35, 746.

sened the severity and duration of the leucopenia and thrombocytopenia that regularly follow total-body exposure at this level. In fact, no anemia of significance and only a transient leucopenia and thrombocytopenia occur after exposure of mice to 1025 r total-body X radiation if the surgically-exteriorized spleen is lead-shielded during delivery of the radiation. Regeneration of the bone marrow and lymph nodes of these mice is largely complete by eight days; whereas, no regeneration or a feeble attempt at regeneration characterizes animals exposed to this dose of irradiation without spleen shielding. It is apparent that the spleen, under these circumstances, assumes functions that are of signal importance in increasing survival following radiation exposure. The capacity of the spleens of these mice to compensate so quickly for the destruction of hematopoietic tissue elsewhere in the body as well as to hasten regeneration of the irradiated hematopoietic tissue may be the significant factor. On the other hand, the retention of the capacity to produce antibodies, as is demonstrated in this paper, may play a role also in increasing survival. It would be premature to attempt at this time to use these data to ascribe antibody formation to lymphocytes or other specific cellular constituents of these lead-shielded lymphatic tissues. The fact that the irradiated lymphatic tissue of the animals with either spleen or appendix shielding regenerates more rapidly than in animals without lead shielding may be as important in the achievement of high titers as the fact that an intact spleen or appendix is present.

The originally shielded spleen may be removed at 3 or 4 days after irradiation (2 or 3 days after antigen injection) or the originally shielded appendix may be removed 5 days after irradiation (4 days after antigen injection) and antibody formation still proceeds. These facts may indicate that the intact (lead-shielded) appendix or spleen initiates the process of antibody formation or makes it possible for the process to be initiated. By 4 to 5 days regeneration in these animals at sites other than the originally protected tissue is perhaps far enough advanced to take over antibody production, or antigen is still available to initiate antibody formation as the irradiated tissue regenerates. It will be interesting to determine how soon after antigen administration these lead-shielded tissues must be removed to prevent the attainment of significant antibody titers. It will also be interesting to determine the increment of the total-body dose which must be given to the exteriorized spleen or appendix to suppress antibody formation such as occurs without spleen or appendix shielding.

In a recent publication Rowley(12) presents evidence that after splenectomy rats fail to respond with high circulating antibody titers if the dosage of antigen is small. In the same publication he reviews other work supporting his findings. Probably no real discrepancy exists between the splenectomy work referred to above and the findings reported in this present communication since the conditions of the experiments were so different.

Conclusions. These experiments corroborate Hektoen's original classic findings that antibody formation is suppressed by total-body X radiation. It has been demonstrated, in addition, that if the spleen or appendix of the rabbit is protected by lead shielding during total-body irradiation, the capacity to produce antibodies to an injected particulate antigen is retained to a marked degree even though lymphatic tissue elsewhere in the body is temporarily destroyed.

12. Rowley, D. A., *J. Immunol.*, 1950, v64, 289.

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