fected. 3. Some cases of regressions in the growth of lymphoma were noted after neutron and X-ray irradiation. 4. When the doses at the 50% survival point were compared, the X-ray/neutron ratios of the 3 tumors, lymphoma, mammary carcinoma, and lymphosarcoma, were found to be 5.8, 6.1, and 7.5 respectively. These ratios do not seem to indicate a significant difference in the sensitivity of the tumors to the radiations, but do show that per unit of ionization neutrons are more biologically destructive than X-rays.

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Bone Fractures Due to Low Calcium Diets.

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Several years ago[1] we reported the observation that a diet, adequate with respect to vitamin D and phosphorus but deficient in calcium, will produce a skeletal structure which is hard but light and fragile, in young growing animals. The thin-walled bones, showing no evidence of rickets, do not bend easily, have a nearly normal bone ash, and are not enlarged at the ends. Spontaneous fractures are common and are located at the point of greatest stress which varies with different species. In calves and dogs the fractures usually occur in the femur. In rabbits we find the vertebrae are the common site of fracture. Boelter and Greenberg[2] recently reported that rats on a low calcium diet frequently have spontaneous fractures of the long bones. According to our interpretation of their observations the vertebrae of rats are also susceptible to fracture.

During our study of this problem we carried out an experiment, using 5 litters of rabbits. Four of the litters were divided at weaning (3-5 weeks of age) each into 2 groups. Half of each litter was placed on a basal diet composed of whole oats 60%, alfalfa 18%, molasses 2%, whole wheat 10%, cracked yellow corn 8.5%, NaCl 0.5%, Na_2HPO_4 1%, plus irradiated yeast to supply 6.5 U.S.P. units of vitamin D per gram of ration. The other half of each litter received this basal diet plus 1% $CaCO_3$. The basal ration contained

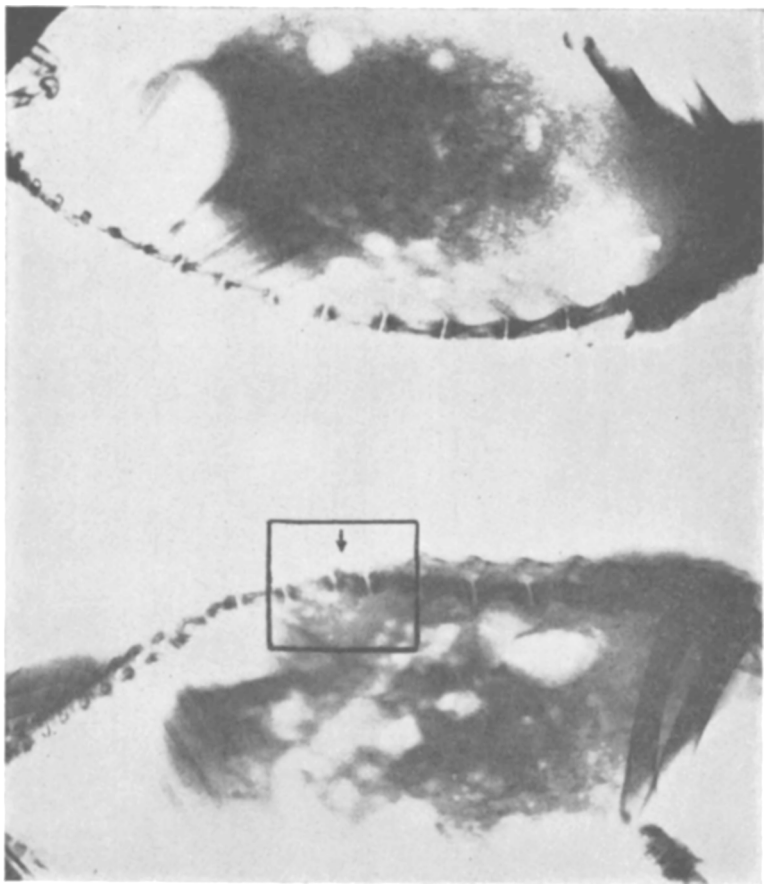
[1] Presented at the American Chemical Society meeting, Dallas, Texas, April, 1938.

[2] Boelter, M. D. D., and Greenberg, D. M., *J. Nutrition*, 1941, **21**, 61.

0.199% Ca and 0.513% P. The fifth litter was treated in the same manner, except that these animals were 8 weeks old when they were removed from their mother's pen where they had access to a commercial rabbit feed. This interval on a normal feed evidently carried the young past a critical period, since the animals of this litter placed on the basal ration remained healthy and their growth was equal to that of their litter mates fed the basal ration plus 1% $CaCO_3$.

Eight of the 9 animals from the first 4 litters on the basal low calcium diet died suddenly in 3 to 8 weeks. We X-rayed 4 of the

X-rays of Rabbits.
Comparison of Skeletal Development.
Basal diet + 1% $CaCO_3$, Group VIII.



Basal diet only, Group VII.
FIG. 1.

animals and found that one or more vertebrae had been fractured and collapsed in each instance, suggesting that vertebral fractures caused death in all cases. The crushed second lumbar vertebra of rabbit LEN, Group VII, can be seen in Fig. 1. On autopsy we found that the canal was definitely constricted on the left side. The animal showed a more complete paralysis of the left hind leg than of the right. The control litter mates fed the basal diet plus 1% $CaCO_3$ were normal throughout the experimental period, with no signs of paralysis. X-rays of several of these animals showed well developed, normal vertebral columns. (Fig. 1.)

The level of calcium in our basal diet was not drastically low (0.199%) when compared with the diets used by Boelter and Greenberg in their studies on the effect of calcium deficiency in growing rats. In their studies the rats were fed diets containing from 0.004 to 0.02% calcium. With these diets the authors describe the occurrence of paralytic symptoms which they attribute to "internal hemorrhages." The paralysis in their rats occurred suddenly, either spontaneously or following strong muscular contractions caused by galvanic shock or convulsive doses of strychnine. The paralysis always involved the hind quarters and not the forelimbs. They also noted that spontaneous fractures of the leg bones were common in the calcium-deficient animals.

It is evident from our data and that presented by Boelter and Greenberg that an X-ray study of their animals very probably would reveal that vertebral fractures resulting in compression of the spinal cord were the cause of paralysis.

Spontaneous fractures of the vertebrae in man are not uncommon. While no adequate explanation for these fractures has been given, the effects of low calcium intake may well be given consideration, especially since a diet containing as much as 0.2% calcium did not prevent poor bone development in experimental animals.