yet these rats just succeeded in attaining their original weights by the final week. This suggests that some factor in sulfanilamide did not permit the normal utilization of the diet in trichinous rats. McCoy noted that infected rats lost considerably more weight under sulfanilamide therapy than control rats and also more than other rats which were given the same amount of drug but were not infected with Trichinella. There is a possibility in our experiment that there was some loss of food among the shavings of the rat cage in the case of sulfanilamide due to dislike for the food. It is interesting that although the control rats carried a heavier parasitic infestation than any other group they made the greatest gain (20%) over their original weight. The rats on phenothiazine made a gain of 18%.

Conclusions. (1) A rather large amount of sulfanilamide, 0.96 g per kilo of body weight daily, used over a period of 6 weeks reduced the number of trichinella encysting in the muscles of rats by 55%. (2) The continuous use of phenothiazine, in a dosage approximately one-tenth that of sulfanilamide, over a period of 6 weeks reduced the severity of trichinous infection in rats by 74% and warrants further experimentation. (3) Thionol is of little use in reducing the severity of trichinous infestation in rats.

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Phosphorus Metabolism in Leukemic Blood.

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The fact that radioactive phosphorus is chemically like ordinary phosphorus and is "tagged," has made it valuable in following the exchange of phosphorus in biological systems.[1] The present study is concerned with the absorption, distribution, and excretion of labelled phosphorus (P^{32}) in 2 patients suffering from chronic myelogenous leukemia. The mixture of P^{31} (inactive) and P^{32} (radioactive) atoms were converted into Na_2HPO_4 and administered orally in an isotonic solution of this salt.

The first patient studied was a case of untreated chronic myelogenous leukemia, in fair clinical condition. The white blood count

[1] Lawrence, J. H., Artificial Radioactivity and Neutron Rays in Biology and Medicine, *Handbook of Physical Therapy*, Am. Med. Assn., 1938.

was 195,000 cells per mm^3, and the red cells numbered 3.7 million. The differential count was as follows: staff 40%, segmented 26%, metamyelocytes 9%, neutrophilic myelocytes 12%, eosinophilic myelocytes 1.5%, eosinophiles 1.5%, basophiles 0.5%, progranulocytes A 0.5%, S 0.5%, blasts 2.5%, lymphocytes 3.5%, mononuclears 2.5%. Under fasting conditions a tracer dose of 2.98 millicuries of radiophosphorus was given by mouth in an isotonic solution containing 0.8 g of Na_2HPO_4. Urinary and fecal excretion of radiophosphorus was determined daily for a period of 9 days. During the first 3 days 13.4% of the total activity administered was excreted in the feces and 8.1% in the urine. During the next 6 days, the daily urinary excretion was 0.90%, .99%, .84%, .80%, .83%, and .76% of the tagged phosphorus, while the daily fecal excretion was .30%, .17%, .22%, .21%, .10%, and .12%. At the end of 9 days 72.2% of the total dose was retained.*

The second patient, who was suffering from myelogenous leukemia of 2½ years' duration, and who had not received X-ray or other treatment for 4 months, was also in fair clinical condition. The white blood count was 163,000, and the red cells numbered 4.4 million. The differential count was as follows: staff 35%, segmented 16%, metamyelocytes 6.5%, neutrophilic myelocytes 12%, eosinophilic myelocytes 9.0%, staff eosinophiles 5.0%, basophiles 1.5%, eosinophiles 2.0%, blasts 2.5%, progranulocytes A 3.0%, lymphocytes 2.0%, mononuclears 3.0%, and unclassified 2.5%. Under fasting conditions a dose of 4.7 millicuries of radiophosphorus was given by mouth in an isotonic solution of 3.0 g Na_2HPO_4. During the first 3 days, 25.6% of the dose was excreted in the feces and 16.5% in the urine. During the next 9 days a total of 7.8% was excreted in the urine, and 1.48% in the feces. Of the dose given, 48% was retained at the end of 12 days.

The technic of separation of blood into its red and white cell fractions was as follows: In each case, 15 cc of blood were drawn, heparinized with 1 mg heparin† to 15 cc whole blood, and immediately centrifuged for exactly 20 minutes at a force of 1450 times gravity. Under this treatment, the blood separated into 3 distinct layers: plasma, white cells, and red cells. The plasma was removed and set aside for analysis. Next, a portion of the white cell layer was removed and suspended in isotonic Ringer's solution. Similarly, a portion of the red blood cell layer was suspended in Ringer's solution. Then both cell suspensions were again centri-

* All activities were corrected for decay.

† Connaught Laboratories, University of Toronto, Canada.

TABLE I.
Distribution of Radioactive Phosphorus in Leukemic Blood.

Days After Admin.	White Blood Cells			Red Blood Cells			Whole Blood			Plasma		
	% dose per 100 cc	Mg P per 100 cc	Microcuries* per 100 mg P	% dose per 100 cc	Mg P per 100 cc	Microcuries per 100 mg P	% dose per 100 cc	Mg P per 100 cc	Microcuries* per 100 mg P	% dose per 100 cc	Mg P per 100 cc	Microcuries per 100 mg P
Case I												
2	.230	234	2.94	.148	80.5	5.50	—	—	—	.021	12.2	5.22
4	.214	226	2.82	.105	83.0	3.78	.061	54.0	3.39	.015	12.6	3.42
9	.212	206	3.04	.053	84.0	1.90	.047	53.8	2.61	.012	12.5	2.96
14	.253	204	2.69	.053	85.0	1.87	.044	54.7	2.36	.0094	12.4	2.25
53	.136	227	1.79	.029	70.7	1.24	.022	52.0	1.26	.0075	15.0	1.51
Case II												
½	.20	261	3.58	.220	64.5	15.8	.125	64.5	9.11	.023	16.8	6.30
2	.23	262	4.17	.110	75.0	6.94	.078	—	—	.021	20.0	4.90
4	.29	—	—	.065	72.5	4.18	.060	62.2	4.52	.015	17.3	4.21
9	.30	257	5.53	.049	72.5	3.21	.059	67.6	4.08	.0115	16.9	3.22
14	.24	—	—	.042	70.0	2.80	.043	48.5	4.17	.0088	16.2	2.58

*All activities corrected for decay.

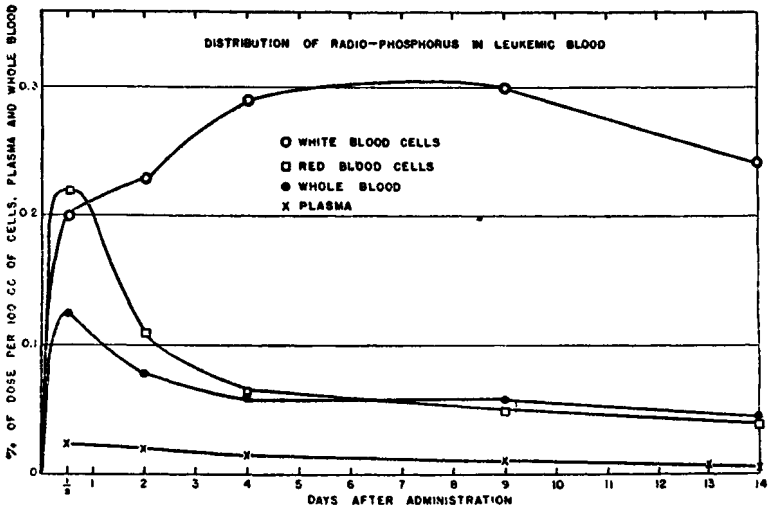

FIG. 1.

fuged for 20 minutes at 1450 times gravity under exactly the same conditions as before. The supernatant wash solution was removed from each cell fraction and set aside for an analysis. The washed red and white cells were then carefully aspirated into graduated capillary pipettes, and their volumes measured. After the samples were ashed at 450°C, the radioactivity of each was measured by means of a Lauritsen electroscope. Total phosphorus was determined by titration after precipitation as ammonium phosphomolybdate according to the method of Pregl.[2]

It should be emphasized that the values presented here do not pretend to be absolute, but do demonstrate the relative phosphorus metabolism of red and white cells that have been handled in an identical and reproducible manner. The technic was checked by means of blood counts on smears made from the final washed preparations. In the second case studied, counts made on the five successive white cell fractions indicated that white blood cells made up 59, 62, 57, 57, and 58%, respectively, of the total number of cells. Considering the relative sizes of red and white cells, this indicates that roughly 90% of the volume of the white cell fractions was composed of white cells. Similarly, it was established that the washed red cell fractions were contaminated with less than 1% white cells.

The amount of radioactivity found in the supernatant wash solution from each cell fraction in no case exceeded 10% of that found

2 Pregl, F., and Roth, H., *Quantitative Organische Mikroanalyse*, Julius Springer, Berlin, 1935.

in the cells themselves. The range for white cell washings was from 5.2% to 10%, averaging 7.0%, and for red cell washings 3.8% to 10.0%, averaging 7.3%. Thus it is seen that the cells lost no significant amount of their phosphorus as a result of washing.

The data are presented in Table I. In Fig. 1,‡ the amount of radioactive phosphorus found in equal volumes of cells, plasma and whole blood is expressed as percent of total dose and plotted against time in days.

During the hours soon after administration, red cells exchange phosphorus much more rapidly than do the white cells, indicating that the phosphorus is more concerned with function than with structure. In the case of the white cells, there is a rapid initial uptake, subsequent to which the activity curve rises slowly over a period of days, and then gradually falls off.

The high rate of metabolic turnover of phosphorus in red blood cells, best shown by Fig. 1, may be attributed: first, to the anion shift in neutrality regulation in which inorganic phosphate plays a rôle; second, to their function as a temporary storage vehicle for phosphate, as suggested by Buckman, *et al.*,[3] and third, to their function in glucose utilization in which phosphate is concerned, as shown by Halpern.[4]

The rapid initial uptake of phosphorus by the white cells is possibly due to their glycolytic function. The continued slower rise and retention of phosphorus over a long period of time is probably conditioned by the formation of new cells in which the phosphorus may be held in nucleoprotein in a relatively stable state.

The diet of the 2 patients, both of whom were able to pursue their normal occupations, was not controlled as to total phosphorus and calcium intake; neither were their total phosphorus and calcium excretions determined. The data are concerned only with the absorption, distribution and excretion of a single dose of "tagged" phosphorus taken by mouth under fasting conditions.

Three days after administration, the first patient had retained approximately 80% of the radioactive phosphorus given. The daily excretion thereafter averaged about 0.9% in the urine and 0.2% in the feces, a ratio of 4 to 1. The second patient, whose clinical condition was somewhat the better of the 2, had retained only 60% of the dose at the end of 3 days. The subsequent daily excretion was

‡ These curves are obtained from the data of Case 2. Case 1 gives similar curves.

3 Buckman, T. E., Daland, G. A., and Weld, M., *Arch. Int. Med.*, 1925, **35**, 389.

4 Halpern, L., *J. Biol. Chem.*, 1936, **114**, 747.

less than 1%; the urine-to-feces ratio being about 5 to 1. The lower absorption by the second patient may be ascribed to the fact that he was given a larger total dose (3 g) of Na_2HPO_4, which may have acted as a mild cathartic and hastened the passage of the ingested material through the small intestine.

It is to be noted that in the first patient 26% of the cells were young forms including metamyelocytes, myelocytes, and a few blasts. In the second patient, 33% of the cells were of such forms. Thus we are unable to state that the handling of phosphorus observed in these cases is characteristic of normal white cells, but the red cell findings may be assumed those of normal red cells.§

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Use of Liver Extract in Place of Yeast in Low Fat Diets.*

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During our studies on the B vitamins in liver extract, we found that definite retardation of growth and development of specific symptoms resulted when our synthetic diet was supplemented with liver extract without the addition of fat. The relation of fat to the normal development of the rat has been approached by several methods. Fats have been found to cure the dermatitis produced in rats on highly synthetic diets free of the B complex but containing B_1 and flavin.[1, 2] However, on such diets very little growth is obtained when the fat is added. With rations containing ether-extracted yeast to supply the B complex, symptoms of fat deficiency, namely scaly tail and paws, appear in 4-8 months. Upon addition of fat at

§ The radiophosphorus used in these studies was produced by the cyclotron, through the generous cooperation of the staff of the Radiation Laboratory. We acknowledge with thanks also grants-in-aid from the Josiah Macy, Jr., Foundation. Assistance from the W.P.A. is also acknowledged.

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1 Quackenbush, F. W., Platz, B. R., and Steenbock, H., *J. Nutrition*, 1939, **17**, 115.

2 Birch, T. W., *J. Biol. Chem.*, 1938, **124**, 775.