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Phosphorus Exchange in Tissues of Patients with Lymphoid Leukemia.*

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Methods and Materials. Radio-phosphorus (P^{32}) produced by the Berkeley cyclotron[1] was converted into sodium phosphate for oral and intravenous administration as therapy to patients with leukemia.[2]

Small pieces (about 5 g) of tissues obtained at the autopsy of 4 patients so treated were placed in crucibles and ashed at 400°C. The radioactivity of the ashes was measured by means of an ionization chamber. All measurements were calibrated by means of a uranium standard and the activities were corrected for rate of decay of radio-phosphorus (half-life, 14.3 days) to date of death. The total phosphorus (P^{31}) content of the ashes was determined by the method of Pregl.[3] By dividing the amount of radioactivity (microcuries) per gram wet weight of each tissue by the number of milligrams of phosphorus (P^{31}) per gram wet weight of the same tissue, one obtains the "specific radioactivity" of the tissue in μc/mg P^{31}.

Results. The results are listed in Table I. The notable but anticipated feature is that the "specific radioactivity" of the listed tissues was independent of the variations in type of disease, age of patient, quantity‡ or route of administration of radio-phosphorus, quantity of ingested nonradioactive phosphorus (including that in the diet) and quantity of P^{31} and P^{32} per gram of a specific tissue, but was apparently dependent upon the time interval between the last dose of radio-phosphorus and death. The quantity of P^{31} in some of the tissues of normal individuals[4] are also recorded in the table.

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1 Lawrence, E. O., and Cooksey, D., *Phys. Rev.*, 1936, **50**, 1131.

2 Lawrence, J. H., Scott, K. G., and Tuttle, L. W., *New International Clinics*, 1939, **3**, 33.

3 Pregl, F., and Roth, H., *Quantitative Organische Analyse*, Julius Springer, Berlin, 1935.

‡ The doses of radio-phosphorus administered were "therapeutic" and not "tracer" in quantity.

4 Schmidt, C. L. A., and Greenberg, D. M., *Physiol. Rev.*, 1935, **15**, 382.

TABLE I.

Case No.	1.	2.	3.	4.	Normal Individuals*
Age (yr)	4	11	67	24	
Type of lymphoid leukemia	acute leucopenic	acute leucopenic	chronic leucocythemic	chronic leucocythemic	
Avg white blood cell (per mm³)	3000	5000	100,000	60,000	
Dates, routes of adm.† and amts (Mc)‡ of P^{32} administered	2/13—1 Mc—I.V. 2/17—1 Mc—I.V.	1/4 to 3/9 14.09 Mc—I.V. 1.73 Mc—O.	10/20—20 Mc—O	12/14 to 2/24 44.1 Mc—O	
Total sodium phos. in which P^{32} was incorporated (g)	1.65	1.35	3.60	20.61	
Days bet. last adm. of P^{32} and death	11	18	19	2	

Tissues studied and results	Case 1.			Case 2.			Case 3.			Case 4.			Normal Individuals*	
(μc)§	μc/g wet wt	mg P^{31}/g wet wt	μc/mg P^{31}	μc/g wet wt	mg P^{31}/g wet wt	μc/mg P^{31}	μc/g wet wt	mg P^{31}/g wet wt	μc/mg P^{31}	μc/g wet wt	mg P^{31}/g wet wt	μc/mg P^{31}	mg P^{31}/g wet wt Min.	mg P^{31}/g wet wt Max.
1. Cerebellum				.058	3.37	.0174	.030	2.72	.0092	.053	2.78	.019	1.40	1.80
2. Kidney	.069	1.63	.043	.151	3.74	.0404	.065	1.21	.0446	.229	1.78	.127	1.27	1.92
3. Liver	.074	1.89	.039	.128	3.11	.0412	.088	1.57	.0467	.368	2.09	.176	1.84	3.05
4. Lung	.054	1.86	.029	.039	1.27	.0308	.042	1.20	.0297	.176	1.47	.119		
5. Lymph nodes	.058	1.78	.033	.154	3.96	.0389	.076	1.63	.0389	.320	2.67	.119		
6. Muscle														
a. Heart	.058	1.69	.034				.040	1.16	.0291	.155	1.41	.109	1.42	2.99
b. Skeletal	.039	1.40	.028				.046	1.77	.0221	.142	1.58	.090	1.00	2.00
7. Spleen	.075	.65	.116	.088	2.52	.0350	.066	1.60	.0348	.276	2.02	.136		
8. Sternum	.088	17.28	.005	.081	32.5	.0025	.078	19.9	.0032	.277	35.0	.0078		

*Bibliography, No. 4. †O = oral; I.V. = intravenous. ‡Mc = millicuries. §μc = microcuries.

Discussion. When one contrasts the "specific radioactivities" of Case 4 with those of the other 3 cases it becomes apparent that fairly large amounts of P^{32} have been retained by the various tissues at the end of the second day after administration. Apparently, however, a large part of the quantity leaves the tissues between the second and eleventh day. That retained is apparently specific for each type of tissue since the "specific radioactivities" of each tissue of the 3 cases were similar and were independent of the total amount (within the limits listed) of P^{32} administered and the other factors mentioned above. The quantities of phosphorus appearing in the tissue during the first few days probably take part in "carbohydrate" metabolism while those retained for longer periods of time may be involved in "nucleoprotein" and "phospholipid" metabolism.[5]

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Photoelectric Microdetermination of Calcium in Serum.

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A new microcolorimetric method has been developed for the determination of calcium by direct precipitation, in samples of 0.2 cc or less of serum. Although work is now in progress on a simplification of the technic and the use of smaller samples for analysis, the following procedure has given, for some time, such satisfactory results (accuracy within $\pm 2\%$) as to warrant its present description.

Procedure. In test tubes (10 x 75 mm), to 0.2 cc samples of serum are added 1.0 cc of water and 0.2 cc of saturated ammonium oxalate. Two *blank* samples, with water in place of serum, are treated in exactly the same way. After standing overnight, 0.2 cc of 0.1% Triton N E (Röhm and Haas) is added to each tube,[1] the contents stirred, then poured into a pyrex sintered glass filter funnel (No. 2 F, Buchner type) held by a rubber stopper in the mouth of a 500 cc suction flask. Three successive portions of 0.8 cc of 2% ammonia water are pipetted into the tube, agitated to pick up any remaining crystals of CaC_2O_4, then poured upon the filter. A receiving tube (7 x 7/8") is placed in the suction flask under the stem

[5] Tuttle, L. W., Erf, L. A., and Lawrence, J. H., *J. Clin. Invest.*, 1941, **20**, 57.

[1] Alter, C. M., and Thomas, D. S., Jr., *Ind. Eng. Chem., Anal. Ed.*, 1940, **12**, 525.