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Phosphorus Metabolism in Neoplastic Tissue.*

L. A. ERF† AND J. H. LAWRENCE.

From the Crocker Radiation Laboratory and the Department of Medicine, University of California.

Recent studies[1, 2, 3] (with the aid of radioactive phosphorus) on normal mice, leukemic mice and on mice carrying various neoplasms, have shown that wherever there is leukemic or neoplastic infiltration there is a higher uptake of labelled phosphorus than in uninvolved tissues and this uptake is found to be higher than that of any other soft tissue. These facts together with the knowledge that bone and bone marrow take up more phosphorus than any other tissue have led to the use of radio-phosphorus in the treatment of leukemia.[4, 5, 6] The studies here reported concern the uptake of radio-phosphorus in the tissues of a small group of patients suffering from various neoplastic diseases. Most of these patients were in the terminal stages of their diseases and were given radioactive phosphorus in the form of sodium phosphate shortly before death.

Methods. The phosphorus was prepared by bombarding red phosphorus with deuterons in the cyclotron, thereafter was converted to a neutral solution of sodium phosphate (isotonic); and was administered orally. The pieces of tissues assayed were those obtained at the surgical and the postmortem tables. None had been embalmed, nor was the blood removed from them. After weighing, each sample was ashed at 450°C, and the radioactivity measured by means of a Lauritsen electroscope.

Results and Discussion. The assays are recorded in Table I. With one exception, the tissues were obtained between the fifth and ninth days following the last administration of radio-phosphorus. The low assay values of the tissues of the patient receiving radio-

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† William R. Kenan, Jr., Fellow.

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TABLE I.
Radioactivity Assays of Autopsied (except Case 7) Tissues.
(Expressed in microcuries per gram wet weight.)

	Neuro-blastoma *Rich*	Seminoma *Gaa*	Melanoma *Hun*	Ewing's Sarcoma *L. Gre*	Hodgkins *Cla*	Hodgkins *Hor*	Lympho-sarcoma *Bea*	Fibro-sarcoma *A. Gre*
Oral admin. of P^{32} in Mc	5.3	6.0	7.0	1.68	4.0	1.7	5.1	7.1
Amt in g of Sod. Phos. in which P^{32} was inc.	2.8	1.05	1.5	.3	.5	.57	1.27	1.092
Days between ad. of P^{32} and Aut.	9	6	7	5	60	9	7	7
Tumor	.100	.138	1.480					.0108
Mesenteric lymph nodes	.093	.278*		.045 .038*	.006†	.024*	.020*	
Sternal marrow	.253				.016	.018		
Rib c marrow	.070	.070		.052		.015	.031	
Spleen	.084	.064	.232	.040	.012	.024*	.047	
Liver	.118	.094	.391	.032	.012	.036	.050	
Stomach	.053	.032		.025				
Kidney	.087	.076	.283	.033	.010	.020	.035	
Lung	.072		.090	.030 .042*	.006	.031	.039	
Heart muscle	.072	.057	.173	.028	.011	.008	.025	
Pancreas	.097	.054	.350	.043		.025	.038	
Cerebrum			.074	.004				
Skin		.025		.011		.0007		
Surrounding muscle								.001

*Infiltrated.
†Fibrotic.

phosphorus 60 days before death are due to the excretion and the decay of radio-phosphorus (half-life of P^{32} is 14.3 days). In the patients with seminoma and melanoma the malignant tissues or tissues infiltrated with malignant cells retained much more P^{32} than the other tissues assayed. And, in case 7, the biopsied piece of fibrosarcoma retained more radio-phosphorus than the surrounding muscle. In those patients with neuroblastoma, Ewing's sarcoma, and one with actively progressing Hodgkin's disease, the abnormal tissues retained as much radio-phosphorus as did those more rapidly metabolizing organs such as liver and kidney. In the other case of Hodgkin's disease the nodes involved were densely fibrosed and contained less P^{32} than most of the other tissues assayed. The lymphosarcoma tissue of one patient contained less P^{32} than other tissues assayed, but transplantable lymphosarcomas of mice do not have this characteristic.[1]

Conclusions. Of the tissues assayed the majority of the malignant tissues or those infiltrated with malignant cells retain as much or more radio-phosphorus per gram wet weight than other rapidly metabolizing tissues of the same patients.