need for cobalt, the relation of which to the internal microbiological synthesis of vitamin B_{12} is still not clear (*6*). Klosterman *et al.* (*7*) have found that Co stimulates the growth of pigs fed a soybean-corn ration, whereas in a recent report (*8*) Co has been stated to be ineffective in speeding the growth of rats fed a diet low in vitamin B_{12} and containing iodized casein. The different techniques used in this study and in our experiments make a comparison of the results difficult, but it seems possible that the effectiveness of Co supplements depends on the special microbiological flora prevalent in the experimental animals.

It should be kept in mind that a considerable part of the human population subsists on diets very poor in animal products and therefore probably low in vitamin B_{12}. In these people the possible dietary need for cobalt should be considered.

References

1. Jaffé, W. G. *Z. Vitamin-, Hormon-, Fermentforsch.*, **2**, 493 (1949).
2. ———. *Arch. Biochem.*, **27**, 464 (1950).
3. Underwood, E. J. *Nutrition Abstracts & Revs.*, **9**, 515 (1940).
4. Rickes, G. M., *et al. Science*, **108**, 134 (1948).
5. Hendlin, D., and Ruger, M. L. *Ibid.*, **111**, 541 (1950).
6. Becker, A. E., *et al. Ibid.*, **110**, 71 (1949).
7. Klosterman, E. W., *et al. Ibid.*, **112**, 168 (1950).
8. Tapan, D. V., *et al. Arch. Biochem.*, **29**, 408 (1950).

Manuscript received April 6, 1951.

The Szilard-Chalmers Process in Solid Phosphorus Salts

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The formation of electron-pair bonds is well known in organic systems where a nucleus has a high kinetic energy as a result of a nuclear reaction. In inorganic compounds processes of this type are more difficult to recognize, as it is often possible to explain the formation of polyatomic ions as a result of secondary reactions (*1*). For this reason the formation of radioactive pyrophosphates in different phosphorus salts under neutron irradiation may be of some interest, as pyrophosphate formation does not take place in dilute aqueous solutions.

The solids listed in Table 1 were exposed to slow neutrons. The materials were dissolved in water containing pyrophosphate, orthophosphate, phosphite, and hypophosphite ions and the pyrophosphate was precipitated as zinc pyrophosphate or as cadmium pyrophosphate. From the figures in Table 1 it is evident that the analytical technique has very little influence on the results obtained. The determination of the activities of the different ions is possible because no exchange of phosphorus occurs between orthophosphate and pyrophosphate (*2*) or between orthophosphate and phosphite (*3*).

TABLE 1

Compound irradiated	Ion used for pyrophosphate precipitation	Fraction of total activity found in			
		Orthophosphate	Phosphate from pyrophosphate	Phosphite + hypophosphite	Phosphite + hypophosphite from pyrophosphate
$Na_4P_2O_7 \cdot 10\ H_2O$	Zn	0.36	0.43	0.19	0.02
	Cd	.35	.43	.20	.02
$Na_4P_2O_7$	Zn	.11	.47	.28	.13
	Cd	.10	.48	.32	.10
$Na_2HPO_4 \cdot 2\ H_2O$	Zn	.22	.18	.51	.08
	Cd	.22	.18	.52	.06
Na_2HPO_4	Zn	.20	.25	.46	.09
	Cd	.26	.22	.46	.05
$Na_2HPO_3 \cdot 5\ H_2O$	Zn	.10	.07	.77	.06
	Cd	0.13	0.06	0.70	0.10

It is evident that radioactive phosphorus might very well occur in other ions than those listed as carriers. Radioactive pyrophosphites, pyrophosphatephosphite and other types must clearly be taken into account, but it is impossible to add carriers for all these species. In our experiments part of these materials may have followed the pyrophosphate and part may have gone with the orthophosphate and phosphite fractions. Therefore not only the filtrates of the pyrophosphate were separated into an orthophosphate and a phosphite + hypophosphite fraction (by ammonium magnesium phosphate precipitation), but the pyrophosphates were dissolved, hydrolyzed, and separated the same way.

The figures, which are (except in the first, second, and fourth lines) averages of two independent irradiations that were in good agreement, show clearly that in all cases an appreciable fraction of the total activity is present as pyrophosphate ions. There are indications that other radioactive ions containing two phosphorus atoms are formed, too.

It should be mentioned that if a pyrophosphate precipitate is not made but hydrolysis is performed, followed by a phosphate-phosphite separation, the fraction of the total activity found as pentavalent phosphorus is about 5% less than in Table 1. This may be due to absorption of carrier-free ion species or to exchange processes, but it does not detract from our general conclusions.

References

1. Libby, W. F. *J. Am. Chem. Soc.*, **62**, 1930 (1940).
2. Hull, D. *Ibid.*, **63**, 1269 (1941).
3. Wilson, J. *Ibid.*, **60**, 2697 (1938).

Manuscript received October 19, 1951.

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[1] We are glad to express our gratitude to the Nederlandse Organisatie voor Zuiver Wetenschappelijk Onderzoek and to the Stichting voor Fundamenteel Onderzoek der Materie for their support of this investigation. We also wish to thank the personnel of the Philips' cyclotron, who kindly performed the necessary irradiations.