LETTERS TO THE EDITORS

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Radioactive Phosphorus in Biochemical Research

IT is generally required in radioactive tracer procedure when applied to biochemical problems that the stable and radioactive molecules or ions possess identical configurations. Only when the two isotopic atoms are supplied in the same chemical form can it be assumed that living tissues will absorb them in the proportions applied. In experiments carried out here with phosphorus-32, it was found that this requirement was not satisfied, and since no information is available on the selectivity of the plants to isotopic elements in different chemical forms, our data cannot be interpreted.

A sample of radioactive disodium hydrogen phosphate with a phosphorus-32 activity of 0·1 millicurie, prepared by slow neutron bombardment of $Na_2HP^{31}O_4$ at the Atomic Energy Research Establishment, Harwell, was used. The irradiated salt was applied in aqueous solution to the roots of growing plants. At the end of the investigation, check experiments indicated that less than 50 per cent of the phosphorus-32 was present as orthophosphate. In other words, half the total phosphorus-32 was present in a different chemical form, or forms, from that of the main bulk of $Na_2HP^{31}O_4$. The analytical procedure used to establish the above fact was as follows: the orthophosphate was precipitated as magnesium ammonium phosphate, ignited to magnesium pyrophosphate, weighed to give 'total' phosphorus, and assayed for phosphorus-32 with a Geiger counter. This precipitate gave less than half the number of counts per minute given by the same volume of original radioactive solution evaporated to dryness in a counting dish. Only rigorous oxidation of the radioactive solution with concentrated nitric acid and 60 per cent perchloric acid prior to precipitation ensured the oxidation of all the phosphorus-32 to orthophosphate, and resulted in a pyrophosphate count comparable with that given by the evaporated aliquot.

Our attention was directed by the Atomic Energy Research Establishment to the work of Libby[1] in which effects of slow neutron bombardment on some inorganic compounds, including those of phosphorus, had been investigated. Libby confirmed that any molecule containing an atom absorbing a neutron would probably be decomposed by the initial recoil of the nucleus, resulting from the emission of the gamma quantum ($P^{31}_{15} + n^1_0 = P^{32} + \gamma$), in a general Szilard–Chalmers type of reaction[2]. In the case of orthophosphates, he suggested that this disruption would result in the ejection of oxygen, presumably the fragment containing the phosphorus-32 being in the form of a phosphite. By some process, however, which seemed to operate during irradiation, Libby found that in the final product about 50 per cent of the phosphorus-32 consisted of regenerated $Na_2HP^{32}O_4$ molecules.

In view of the increasing interest in the application of radioactive tracers to biochemical problems, it is desirable that prospective users of phosphorus-32 should be aware of the severe degradation of sodium orthophosphate which occurs during neutron irradiation in the atomic pile. If a material of a definite chemical form is required, it is essential to use phosphorus-32 prepared by pile irradiation of sulphur-32, and even then the identity of the active material should be confirmed before it is used.

W. D. E. THOMAS
D. J. D. NICHOLAS

Research Station,
Long Ashton,
Bristol.
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[1] *J. Amer. Chem. Soc.*, **62**, 1930 (1940).
[2] *Nature*, **134**, 462 (1934).

Effect of Enzyme Inhibitors on the Genesis of Phage

IT is generally agreed that the multiplication of viruses is intimately linked with the metabolism of the host cell[1]. It seemed, therefore, interesting to study the influence of enzyme inhibitors on the development of virus within the host cell. In this connexion we have launched an extensive investigation with regard to the influence of enzyme inhibitors on the growth of the bacterial cell and the development of 'bacterial virus' particles respectively.

For our first experiments we have used a coli-phage system. Tryptose medium cultures of *Escherichia coli*, strain *B*, were infected with suspension of T_2 phage. The following procedure was adopted: after two and a half hours growth the *E. coli* culture was split up into equal parts, which were treated with various inhibitors for one hour. The number of lytic particles used was calculated so as to assure infection of each bacterium by no more than a single phage particle, and plating out was done after 20 minutes incubation. Some details of the method used have already been reported[2].

Some of the substances examined had no effect on host cell or phage (sodium malonate, sodium fluoride 1/5,000–1/10,000); a second group inhibited both elements in the experimental system (penicillin, acriflavine, mapharside, malonic acid in higher con-

Inhibitor	Concentration (m*M*.)	Number of lytic particles (percentage of original inoculum)
Control		2,000–10,000
Hydroquinone	30	58
	15	78
	7·5	84·1
	50	61·9
	5	86
4-6-Dimethoxy-toluquinone	5·5	99·3
	0·55	124
Tetramethyl-*p*-phenylene diamine	3	83·4
	0·3	85·3
Malonic acid	100	0·27
	20	94·8
	10	81·7
	10	63·2
	5	142
Iodoacetic acid	25	44·6
	5	62
	1	78·6
Auramine	0·66	108
	0·066	72·3
Sodium cyanide	50	11·4
	10	60·5
	5	84·4
Sodium fluoride	24	114
Calcium chloride	10	160
Urethane	300	77·4
Colchicine	0·008	115
	0·004	180
	0·0004	159