CV. THE DISTRIBUTION OF PHOSPHORUS COMPOUNDS IN BLOOD.

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It follows from the work of numerous observers that phosphorus is to be found in blood as inorganic phosphate, as lipin phosphorus compounds and in other forms of combination unknown: the last is frequently referred to as the "unknown" P. Bloor [1918], using his nephelometric method, seems to have been the only one to attempt a general survey of the question. Other statements in the literature are of a more or less fragmentary and disjointed character. For various reasons we do not consider that the figures given by Bloor as a result of his extensive investigation can fairly be regarded as final.

After we had elaborated, therefore, the method with known limits of error described in the preceding paper we proceeded to investigate a few human bloods for purposes of orientation. Five individual bloods were obtained, and in each case the following estimations were made on the whole blood, the plasma and the corpuscles, namely, total P, inorganic P, lipin P and, by difference, "unknown" P. We also included the "acid soluble" P, because it has so frequently been the object of estimation by previous workers. The results are given in Table I (p. 707).

All figures are cmgm. (*i.e.* hundredths of a milligram) of P per cc.

Analysis of results.

From cases 1, 2, 3, 4 and 5 it appears that the phosphorus compounds of the blood are divided on the average as shown in Table II.

The calculations have been made on the basis of the calculated value for the whole blood "total" derived from the ascertained corpuscle percentage, and not on the experimentally determined whole blood "total." From Table I it will be seen that the agreement between the calculated and observed values is in most cases pretty good.

Lipin phosphorus. The "acid-soluble" P is the total P of the trichloroacetic acid filtrate. On the assumption that the lipin P compounds are precipitated with the proteins, and that no other P compounds are, and that any P in protein combination will be negligible in amount it follows that the figures for lipin P would be equal to the difference between total P and "acid-soluble" P. The figures relating to this point, calculated from the experimental results in Table I, are given in columns 6 and 7 of that table. The 7th column shows

Table I.
Distribution of P in Human Blood

	1	2	3	4	5	6	7
	Total	Inorganic	Lipin	"Unknown" by difference	"Acid- soluble"	Total minus "acid-soluble"	% difference
1 { Whole blood	40.5	2.7	11.0	26.8	Not estimated	—	—
{ Plasma	35.9	2.4	9.7	—	25.9	—	—
{ Corpuscles (49.2 %)	10.7	2.9	7.3	0.5	3.0	7.7	5
2 { Whole blood	62.0	1.9	12.2	47.9	49.5	12.5	2
{ Plasma	38.1	3.9	12.5	21.7	25.4	12.7	1
{ Corpuscles (42.4 %)	36.0	3.1	10.6	—	23.6	—	—
3 { Whole blood	12.6	3.7	8.9	0.0	3.7	8.9	0
{ Plasma	67.8	2.2	13.1	52.5	50.9	16.9	30
{ Corpuscles (47.1 %)	32.8	2.8	8.5	21.5	23.4	9.4	9
4 { Whole blood	31.6	2.2	8.3	—	—	—	—
{ Plasma	6.7	2.3	4.1	0.3	2.0	4.7	15
{ Corpuscles (43.8 %)	59.4	2.0	12.9	44.5	Not estimated	—	—
5 { Whole blood	39.5	3.8	11.5	24.2	25.0	14.5	25
{ Plasma	36.6	3.2	10.9	—	24.6	—	—
{ Corpuscles (43.8 %)	12.2	3.8	8.1	0.3	3.8	8.4	4
6 { Whole blood	68.0	2.4	14.5	51.1	51.3	16.7	15
{ Plasma	33.0	2.0	10.0	21.0	21.6	11.4	14
{ Corpuscles (49.0 %)	33.9	2.0	9.1	—	—	—	—
7 { Whole blood	7.9	1.8	5.6	0.5	Not estimated	—	—
{ Plasma	61.0	2.3	12.7	46.0	40.9	20.1	60
{ Corpuscles (49.0 %)							

Table II.

<i>In the plasma</i>	% of total P	Mean of
Inorganic	5	4, 6, 4, 6, 3
Lipin	10	10, 14, 7, 12, 9
"Unknown"	0	0.6, 0.0, 0.5, 0.8, 0.6
Total	15	15, 20, 11, 19, 13
<i>In the corpuscles</i>		
Inorganic	3	2, 3, 3, 3, 3
Lipin	17	17, 15, 19, 17, 18
"Unknown"	65	66, 62, 67, 61, 67
Total	85	85, 80, 89, 81, 88

the percentage difference between column 5 and column 3, the percentage being reckoned on the latter.

It will be seen that the total "acid-soluble" is never less than the experimentally determined lipin. The differences range from 0 % to + 30 % (in one case 60 %). Two explanations are possible for this. Whilst it was shown in the preceding paper that the methods employed have a probable error not exceeding 5 %, yet there is the limitation in the case of the lipin P that the extraction process with alcohol and ether, although customary, is empirical. It is assumed that it extracts the lipin P compounds completely, and nothing else. Apart from this, the extraction of a mass of protein precipitate with an alcohol-ether mixture excites suspicion as a quantitative procedure. It is therefore doubtful whether the differences found are due to incomplete extraction, or to the presence of P compounds which are precipitated by trichloroacetic acid, but are not soluble in an alcohol-ether mixture.

GENERAL CONCLUSIONS.

From the analysis of results in Table II it appears that the relative quantities of inorganic, lipin and "unknown" P in the blood are fairly constant. It is also interesting that the "unknown" P is almost if not entirely confined to the corpuscles. This has been frequently suspected before, but so far as we are aware, no very satisfactory evidence for the statement has been given.

THE PHOSPHORUS OF CEREBROSPINAL FLUID.

In the six experiments shown in Table III, the values obtained for inorganic and total P of cerebrospinal fluid (withdrawn from the living subject) are practically identical. It is curious that the "total" figures are in each case just greater than the inorganic, but the differences are really almost within the limits of experimental error (5 %) which we have shown to be attached to the methods of estimation. At least 95 % of the phosphorus of the cerebrospinal fluid is therefore present in the form of inorganic phosphate.

Table III.

Case No.	Inorganic	Total
1	1.47	1.54
2	1.27	1.33
3	1.52	1.65
4	1.51	1.61
5	1.68	1.81
6	1.57	1.62

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REFERENCE.

Bloor (1918). *J. Biol. Chem.* **36**, 49.