

low phosphorus "rickets-producing" diet. It was found that these rats were not refractory but developed rickets to the same extent as the five other stocks that had been tested. Evidently the alteration of the diet during the first four weeks of life was the determining feature. It will be noted that the diet throughout pregnancy was unchanged.

After about the tenth day of life young rats not only suckle but consume supplementary food. The acquired susceptibility may, therefore, have resulted from an inadequacy of the food consumed directly by the young, and not from an inadequacy of the mother's milk. Experiments seem to confirm this point of view. For example, a mother rat which was given 20 drops of cod liver oil daily in addition to our laboratory diet, gave birth to young which were not refractory to rickets. This would lead us to believe that it is difficult to furnish the young with an adequate amount of protective substance through the mother's milk. It seems certain that in young rats the character of the food during the first four weeks of life is of decisive importance regarding their later susceptibility to rickets. This probably indicates that protective anti-rachitic substances can be stored in the body. A discussion of the constitution of the various dietaries used in these tests is deferred until further experiments are carried out.

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The various forms of phosphoric acid in the blood. Findings in rickets.

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It is well known, that in rickets the inorganic phosphate in the blood is low. We have shown previously that in rachitic as well as in normal blood the inorganic phosphate is the same in the cells and in the plasma, and we have also given evidence

to show that there are three types of acid soluble phosphorus in mammalian blood, namely: inorganic, an organic phosphoric acid compound readily hydrolyzed in neutral or slightly acid solutions, and lastly the "nonhydrolysable phosphate," which cannot be broken down by boiling four hours in dilute acids, but can be determined as inorganic phosphate only after digestion with concentrated nitric and sulfuric acid. In order to complete the blood picture of rickets, we have done complete analyses of the acid soluble phosphorus according to the above scheme on rachitic and non-rachitic children. The results are shown in Tables I and II below.

Here we see that the total acid soluble phosphorus is not lower in rachitic than in normal children, except where the rickets is complicated by anemia. In these cases we would naturally expect a low total acid soluble phosphate since it has been known for some time that by far the greater part of the phosphorus of the blood occurs in the red cells. In anemia, however, the inorganic phosphate is not low.

In rachitic children the inorganic phosphate is not only lower in actual amount than the normal, (2.7 mg. against 4.6 mg.) but its percentage of the total is also lower. (13 per cent. against 22 per cent.).

The non-hydrolysable is increased above the normal (57.8 per cent. against the normal 48.5 per cent.).

Similar analyses were done on rachitic and non-rachitic rats (Table III). Here again we find in the rachitic animals a lowered inorganic phosphate (2.9 mg. or 15 per cent. as opposed to 6.2 mg. or 27 per cent. of the total acid soluble), and the increase of the non-hydrolysable. (60.7 per cent. against 42 per cent. in the normal). Owing to the fact that the blood phosphorus in rats can easily be influenced by the phosphorus level of the diet (not the case in human beings) the total acid soluble phosphate does not show the same constancy.

The significant facts shown by our data are:

1. In rickets the total acid soluble phosphate does not fall below the normal range.

2. The inorganic phosphate is reduced in rickets by an increase of the non-hydrolysable, the organic hydrolysable remaining the same.

3. In anemic blood the total acid soluble phosphate may be low without affecting the inorganic phosphate.

TABLE I. DISTRIBUTION OF PHOSPHORIC ACID IN RACHITIC BLOOD

Name	Age	Inorganic		Total acid sol. mg.	After boiling mg.	Org. Hydrolysable		Non-Hydrolysable	
		mg.	%			mg.	%	mg.	%
X. G.	17 mo.	2.9	11.6	25.0	10.6	7.7	30.8	14.4	57.6
W. R.	10 mo.	2.5	10.4	22.0	10.0	7.5	34.0	13.0	54.5
W. M.	7 mo.	2.9	14.2	21.1	9.3	6.4	30.5	12.3	57.0
E. G.	13 mo.	3.1	15.6	19.9	8.7	5.6	28.1	11.2	56.5
H. C.	15 mo.	3.4	15.2	21.7	8.7	5.3	24.5	13.0	60.0
J. M.	6 mo.	2.5	11.9	21.0	9.7	7.2	34.3	11.3	54.0
M. B.	12 mo.	2.8	10.0	28.6	12.3	9.5	33.2	16.3	57.0
A. G.	15 mo.	2.4	14.0	17.2	6.7	4.3	25.0	10.5	61.0
L. M.	8 mo.	2.2	12.5	17.6	7.4	5.2	29.6	10.2	58.0
Aver.		2.7	13.0	21.5			30.0		57.8

RICKETS WITH ANEMIA

S. Sc.	15 mo.	2.3	15.4%	14.9	5.7	3.4	23.0	9.2	62.0	cell volume 18%
S. Sc.	16 mo.	2.7	15.5%	17.4	8.5	5.8	33.3	9.0	51.5	cell volume 26%
S. H.	9 mo.	1.6	10. %	16.0	6.8	5.2	32.5	9.2	57.6	anemia

TABLE II. DISTRIBUTION OF PHOSPHORIC ACID IN NON-RACHITIC BLOOD

Name	Age	Inorganic		Total acid sol. mg.	After boiling mg.	Org. Hydrolysable		Non-Hydrolysable	
		mg.	%			mg.	%	mg.	%
J. R.	14 mo.	4.7	27.0	17.5	8.0	3.25	18.5	9.5	53.0
X. Ro.	1 mo.	4.2	15.8	26.6	13.3	9.1	34.1	13.3	50.0
L. F.	23 mo.	4.1	19.5	21.0	11.0	6.9	32.9	10.0	47.6
M. D.	6 yrs.	4.7	19.7	23.8	12.5	7.7	32.4	11.5	46.0
J. H.	4 y	4.1	19.0	21.6	11.0	6.8	31.6	10.6	49.0
J. T.	8 mo.	4.8	23.2	20.5	10.5	5.7	28.0	10.0	49.0
R. M.	7 yrs.	4.7	21.8	21.8	11.8	7.0	32.1	10.0	47.1
I. P.	18 mo.	5.0	21.3	23.5	13.0	8.0	34.0	10.5	44.5
N. T.	5 mo.	5.0	22.0	22.8	11.6	6.6	28.9	11.2	51.0
W. C.	4 yrs.	5.0	22.5	22.2	11.1	6.1	28.8	11.1	50.
W. A.	15 mo.	5.2	19.8	26.3	12.6	7.4	29.2	13.7	52.0
M. M.	8 yrs.	4.2	23.0	11.0	11.0	6.0	33.0	7.2	40.
H. K.	7 yrs.	4.6	19.5	23.6	11.6	7.0	29.6	12.0	51.
Aver.		4.6	22.0	22.2			30.3		48.5

WITH ANEMIA

M. Mag.	2½ yrs.	4.0	32.0	12.5	7.7	3.7	29.6	4.8	38.2	cell volume 14%
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TABLE III. DISTRIBUTION OF PHOSPHORIC ACID IN RAT BLOOD
NON-RACHITIC

Diet No.	Total acid sol. mg.	Inorganic		Org. Hydrolysable		Non-Hydrolysable	
		mg.	%	mg.	%	mg.	%
303D	23.0	6.0	26	8.3	36	8.7	38
303	20.6	5.4	26	7.6	37	7.6	37
303A	18.7	4.3	23	6.0	32	8.4	45
302C	22.3	6.1	27	5.3	24	10.8	48
302B	22.6	6.2	27	5.4	24	10.9	48
302A	20.0	6.7	33	6.7	34	6.6	33
302	19.5	7.6	39	5.9	30	6.0	31
301E	28.0	5.9	21	7.5	27	14.6	52
301	30.0	8.0	27	7.6	25	14.4	48
Aver.	22.7	6.2	27		30		42

RACHITIC

Diet No.	Total acid sol. mg.	Inorganic		Org. Hydrolysable		Non-Hydrolysable	
		mg.	%	mg.	%	mg.	%
303C	17.5	2.4	14	4.3	25	10.8	62
303B	17.4	2.7	15	6.4	37	8.3	48
302D	18.7	2.6	14	4.1	22	11.9	64
301A	20.0	2.6	13	3.7	18	13.7	69
301B	20.0	3.6	18	4.0	20	12.2	61
301C	19.2	3.1	16	4.0	21	12.0	63
301D	17.1	3.4	20	3.8	22	9.9	58
Aver.	18.6	2.9	15		24		60

The nature of these diets will be discussed elsewhere. In this table they are simply grouped as rachitic and non-rachitic, according to the X-ray and histological findings.

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Observations on the distribution of anti-rachitic substances.

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When Mellanby found that the rickets produced in dogs was prevented or cured by cod liver oil, he thought that since cod liver oil is extremely rich in the fat-soluble A vitamin, that this substance was responsible for the cure and that the deficiency of