

Further experiments are in progress to determine the limits of acid and base administration, in which the above observations hold, and to extend the study to various levels of Ca and P intake.

TABLE I.

Period.	Date Nov.	Vol. c.c.	D.	Ph.	NH ₃ gm.	Acidity c.c. N/10	P gm.	Ca gm.
I. Normal.	14	960	1.020	5.8	1.42	726	2.06	.394
	15	1620	1.021	5.9	.91	748	1.66	.376
	16	1320	1.023	5.7	1.20	815	1.99	.455
	17	1225	1.025	5.8	1.20	760	1.71	.446
II. 15 gm. NaHCO ₃ .	18	1950	1.019	6.5	.52	400	1.79	.389
	19	1850	1.021	7.2	.28	120	1.32	.307
	20	1700	1.022	7.3	.21	160	1.41	.297
III. 300 c.c. N/10HCl	21	1480	1.024	5.7	.61	508	1.68	.385
	22	1075	1.027	5.3	1.09	800	1.84	.467
	23	1250	1.023	4.9	1.44	850	1.86	.435
	24	1320	1.022	4.9	1.65	787	1.90	.512

TABLE II.

3 Last Days of Period.	P in Urine.	P in Feces.	Total P.	Per Cent. in Urine.	Ca in Urine.	Ca in Feces.	Total Ca.	Per Cent. in Urine.
I. Normal.	5.36	3.99	9.35	57	1.27	3.17	4.44	28.7
II. 15 gm. NaHCO ₃ . . .	4.52	4.72	9.24	44	.99	3.42	4.41	22.2
III. 300 c.c. N/10 HCl. .	5.60	3.53	9.13	61	1.41	2.94	4.35	32.4

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Studies on experimental rickets, IV.

Cod liver oil as contrasted with butter fat in the protection against the effects of insufficient calcium in the diet.

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In our experimental work we have made observations which demonstrate in a striking way the differences in the effectiveness

of cod liver oil as contrasted with butter fat in influencing the rate and extent of growth, and their effects on the histological structure of the bones. This is well illustrated by the results of restricting young rats to the following diet:

Wheat.....	30.0
Maize.....	19.5
Rice (polished).....	9.5
Rolled oats.....	8.5
Peas.....	8.5
Navy beans.....	8.5
Steak.....	10.0
NaCl.....	1.0
NaHCO ₃	1.5
Cod liver oil.....	3.0

This diet induces fairly good growth and fertility during at least 8 to 10 months, notwithstanding its deficiency in calcium. The calcium content of this food mixture is 0.059 gms. per 100. The optimum calcium content of this diet is reached when about 1.5 per cent. of calcium carbonate is added. The phosphorus content of this mixture is 0.3546 gms. per 100, and is not far from the optimum content. This food mixture is slightly alkaline owing to its content of sodium bicarbonate.

This food mixture with butter fat to the extent of 3, 10, or 20 per cent. of the food mixture fails to induce an appreciable amount of growth. With 20 per cent. of butter fat the animals gain but a few grams in weight, look very inferior, become short and stocky, and are rough coated. They usually die within a few months.

This diet when 10 per cent. of casein is added, but without the addition of either butter fat or cod liver oil, causes pathological changes characteristic of rickets. With small amounts of cod liver oil (3 per cent.) no rachitic changes are seen in the bones. Even 20 per cent. of butter fat fails to effectively direct the growth processes in the bones toward the normal condition.

This food mixture containing 3 per cent. of butter fat and 1.5 per cent. of calcium carbonate is a highly satisfactory diet for the promotion of growth to the full adult size, the maintenance of high fertility throughout the breeding period in the females and the successful nutrition of the young by the mothers. Even a fifth

generation in a family confined to this diet showed no signs of physical deterioration. Without the calcium addition, but with 3 per cent. of butter fat, very little growth can take place.

The striking differences between the nutritive properties of cod liver oil as contrasted with butter fat we have up to the present time been able to demonstrate in so satisfactory a manner only with diets in which the phosphorus content is approximately the optimum, and with the calcium content distinctly below the optimum. The results of feeding these two fats with a diet similar to that described but in which the phosphorus content is low and the calcium varies from low to high, we shall discuss in a forthcoming paper.

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**Studies on experimental rickets, V.
The production of rickets by means of a diet
faulty in only two respects.**

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The following diet, when fed to the young rat, in a comparatively short time (three to five weeks) produces rickets. The diet is composed of:

Rolled oats.....	40.0
Gelatin.....	10.0
Wheat gluten.....	7.0
Sodium chloride.....	1.0
Potassium chloride.....	1.0
Calcium carbonate.....	2.0
Dextrin.....	39.0

This diet is extremely poor in fat-soluble A, the anti-xerophthalmic substance. Young rats develop xerophthalmia when placed upon it in from four to five weeks. Its proteins are of good quality and are supplied in abundance (21 per cent.). The phosphorus content is relatively low (0.209 gms. per 100 gms. of the food mixture). The calcium content is approximately the optimum.