TABLE II.
B Vitamins in Corn and Beans at Different Stages of Development.
(γ/g on dry weight basis.)

	Corn (Golden Bantam)				Beans (Bush Lima)			
	Age I	Age II	Age III	Age IV	Age I	Age II	Age III	Age IV (Seeds)
Dry weight, %	15	7.8	26	70	31	21	82	92
No. specimens sampled	2 ears	3 ears	2 ears	1 ear	6 pods	6 pods	6 pods	1 lb
Avg wt per ear, g	5.7	26	87					
Wt corn per ear, g	3.6	12	31					
Length of pods, inches					1-1½	3	3	
Contents:								
Riboflavin	3.9	5.5	4.0	1.5	2.2	4.1	1.4	1.4
Nicotinic Acid	59	94	59	17	28	42	17	11
Pantothenic Acid	20	17	12		25	40	35	9.0
Pyridoxin	2.9	3.7	1.4	7.6	1.7	3.0	2.7	6.0
Biotin	1.3	1.4	0.35	0.21	0.25	0.39	0.41	0.11
Inositol	1500	2900	1500	1500	2000	4100	1600	1800
Folic Acid	5.0	7.9	2.8	1.6	13	18	5.7	3.6

second age of development, after which they decline steadily as the seeds mature. Pantothenic acid is seen to decline from the start in corn.

Pyridoxin is exceptional in that it is present in the highest concentration in the mature seeds. It is possible that pyridoxin may be a storage form of this vitamin and that pseudopyridoxin[8] may be the active form in the young plant.

Summary. Germination of seeds is accompanied by increases in the content of most B vitamins. The increases are greatest for nicotinic acid, followed by pyridoxin, pantothenic acid, riboflavin, inositol and biotin in approximately the order named. Thiamin is a borderline case. Folic acid is seen to decrease substantially in peas and in one sample of lima beans.

Contents of B vitamins in growing corn and beans are found to reach a peak at a relatively early stage of development, after which the amounts present decrease steadily as the seeds mature.

We wish to acknowledge, with thanks, the cooperation of Dr. Roger J. Williams, in whose laboratory this work was carried out. We are also indebted to Research Corporation of New York for financial support.

8 Snell, E. E., Guirard, B. M., and Williams, R. J., *J. Biol. Chem.*, 1942, **143**, 519.

14301

Pantoyltaurine and Growth of Rats.

KLAUS UNNA.

From the Merck Institute for Therapeutic Research, Rahway, N.J.

It has been shown by Snell[1] and by McIlwain[2] that N-(a-γ-dihydroxy-β-β-dimethyl butyryl Taurine (pantoyltaurine)) inhibits the growth of certain bacteria which require pantothenic acid as an essential nutrient. The inhibition was reversed by the addition of large amounts of pantothenic acid. In analogy to the relationship between pyridine-3-sulfonic acid and nicotinic acid[3] it was as-

1 Snell, E. E., *J. Biol. Chem.*, 1941, **141**, 121.

2 McIlwain, H., *Biochem. J.*, 1942, **36**, 417.

3 McIlwain, H., *Brit. J. Exp. Path.*, 1940, **21**, 136.

sumed by these authors that by virtue of its structural similarity pantoyltaurine competes with the utilization of pantothenic acid, particularly since the growth of bacteria which do not require pantothenic acid was not inhibited by pantoyltaurine. In connection with earlier studies on the utilization of pantothenic acid derivatives in bacteria and in animals[4] we became interested in the relationship between pantoyltaurine and pantothenic acid in their effect upon rats. Pantoyltaurine prepared from (+)a-hydroxy-β-β-dimethyl-γ-butyrolactone and the sodium salt of taurine according to the procedure of Snell[1] was obtained in pure crystalline form through the courtesy of Dr. J. R. Stevens of Merck & Co., Inc.

The experiments were conducted on young male albino rats. At 3 weeks of age the animals were placed on a diet consisting of dextrose 68%; vitamin-free casein 18%; hydrogenated vegetable oil (crisco) 8%; salt mixture U.S.P. XI No. 1 4%; cod liver oil 2%; supplemented with 0.8 mg each of thiamin, riboflavin and pyridoxine, 10 mg of nicotinamide, and 100 mg of choline chloride per 100 g of diet. Calcium pantothenate (dextrorotatory) and pantoyltaurine were fed separately to the animals by stomach tube.

The growth promoting effect of the daily administration of graded doses of calcium pantothenate, of pantoyltaurine or of a combination of both is illustrated in Fig. 1, each curve representing the average weight of 6 rats. The daily administration of 100 γ or of 1 mg pantoyltaurine (curve 2 and 3) did not influence the growth of the rats as compared with that of the control group (curve 1). The average survival time in these 3 groups was the same (21 days), and adrenal hemorrhages were found alike in these groups on gross examination at autopsy. Daily feeding of 1 mg pantoyltaurine to rats receiving 25 γ of pantothenic acid did not change the growth rate (curve 4 and 5) nor did it influence the development of signs of pantothenic acid deficiency; all rats maintained on 25 γ of pantothenic acid daily, exhibited to a comparable degree deficiency signs such as coarseness and rustiness of the fur and porphyrine deposits on their whisker. No deaths were observed in these groups over the period of 80 days. Likewise, no significant difference in weight nor in appearance was noted between rats maintained on a daily supplement of 100 γ of pantothenic acid and

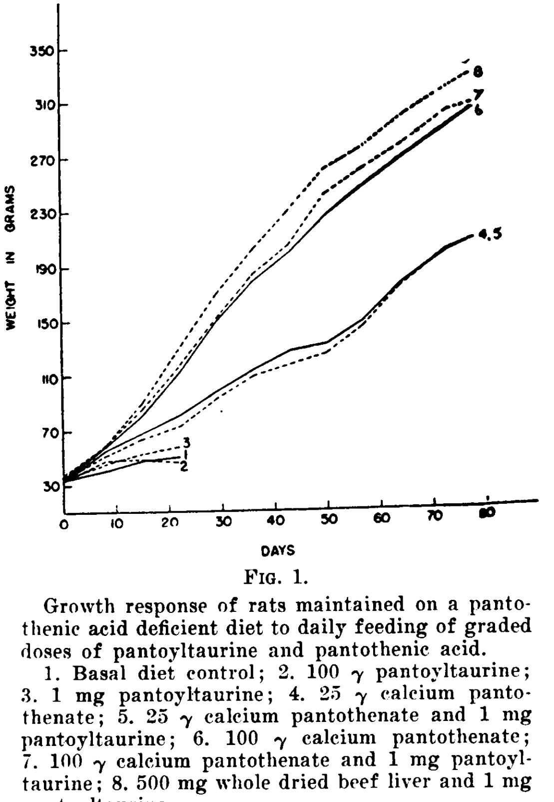

FIG. 1.

Growth response of rats maintained on a pantothenic acid deficient diet to daily feeding of graded doses of pantoyltaurine and pantothenic acid.

1. Basal diet control; 2. 100 γ pantoyltaurine; 3. 1 mg pantoyltaurine; 4. 25 γ calcium pantothenate; 5. 25 γ calcium pantothenate and 1 mg pantoyltaurine; 6. 100 γ calcium pantothenate; 7. 100 γ calcium pantothenate and 1 mg pantoyltaurine; 8. 500 mg whole dried beef liver and 1 mg pantoyltaurine.

those receiving 100 γ of pantothenic acid plus 1 mg pantoyltaurine (curve 6 and 7). A superior weight response to a supplement of dried whole beef liver was obtained even in the presence of 1 mg of pantoyltaurine (curve 8).

A second experiment was carried out in which a daily dose of 25 mg of pantoyltaurine per rat (corresponding to 500 mg per kg for the weanling rats) was fed over a period of 7 weeks. This amount of pantoyltaurine likewise had no effect on growth. In the absence of pantothenic acid it failed to enhance the

[4] Unna, Klaus, and Mushett, C. W., *Am. J. Physiol.*, 1942, **135**, 267.

deficiency symptoms or to accelerate death. When fed to rats receiving 25 γ and 100 γ of calcium pantothenate respectively, it failed to depress the weight curve or to precipitate symptoms of deficiency.

Discussion. The data presented demonstrate that feeding of pantoyltaurine to rats maintained on a diet free from pantothenic acid does not affect the growth nor the survival time. Daily administration of 1 and 25 mg of pantoyltaurine respectively to rats receiving graded doses of pantothenic acid did not influence significantly the growth of these animals. Our data, therefore, do not adduce evidence of an interference with the utilization of pantothenic acid by pantoyltaurine in animals.

While these experiments were in progress, two reports appeared on the effect of pantoyltaurine in mice. Snell *et al.*[5] reported that mice maintained on Purina Fox Chow and fed daily 200 mg per kg of pantoyltaurine showed after 3 weeks rough fur and porphyrin deposits on the whiskers. However, no attempt was made to correct these manifestations which were interpreted as symptoms of pantothenic acid deficiency, by the addition of pantothenic acid or the withdrawal of pantoyltaurine. On the other hand, Woolley and White[6] were unable to produce symptoms of pantothenic acid deficiency in weanling mice maintained on purified diets to which 1% of pantoyltaurine was added; their animals received pantoyltaurine at a level 2000 times greater than that of pantothenic acid. Likewise, hamsters fed pantoyltaurine failed to show pantothenic acid deficiency symptoms.[6] The results of our experiments on rats are in agreement with the findings of Woolley and White.[6]

Summary. Feeding of pantoyltaurine failed to produce symptoms of pantothenic acid deficiency in rats. An antagonism between the two substances similar to that established in studies on bacterial growth could not be demonstrated.

5 Snell, E. E., Chan, A., Spiridanoff, S., Way, E. L., and Leake, C. D., *Science*, 1943, **97**, 168.

6 Woolley, D. W., and White, A. G. C., PROC. SOC. EXP. BIOL. AND MED., 1943, **52**, 106.

14302

The Necessity of Additional B-Complex Factors in the Diet of the Chick.

H. J. ALMQUIST.

From the Division of Poultry Husbandry, University of California College of Agriculture, Berkeley.

Factor U, a chick growth factor, may be identical with a bacterial growth factor which occurs in an eluate fraction from norite adsorbate.[1-6] The name "folic acid" has been proposed for the bacterial factor.[6]

Identification of folic acid with a chick "eluate factor" appears to have been accomplished with the isolation of the former in crystalline state, and the demonstration of high growth-promoting activity for bacteria and for chicks, as well as an anemia-prevent-

1 Snell, E. E., and Peterson, W. H., *J. Bact.*, 1940, **39**, 273.

2 Hutchings, B. L., Bohonos, N., and Peterson, W. H., *J. Biol. Chem.*, 1941, **141**, 521.

3 Hutchings, B. L., Bohonos, N., Hegsted, D. M., Elvehjem, C. A., and Peterson, W. H., *J. Biol. Chem.*, 1941, **140**, 681.

4 Mills, R. C., Briggs, G. M., Jr., Elvehjem, C. A., and Hart, E. B., PROC. SOC. EXP. BIOL. AND MED., 1942, **49**, 186.

5 Stokstad, E. L. R., *J. Biol. Chem.*, 1941, **139**, 475.

6 Mitchell, H. K., Snell, E. E., and Williams, R. J., *J. Am. Chem. Soc.*, 1941, **63**, 2284.