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## Choline and Epithelial Hyperplasia in the Forestomach of Rats.

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In a recent study[1] of rats fed a white flour diet, supplements of cystine, lactoflavine, nicotinic acid, and rice polish concentrate prevented hyperplasia of the forestomach epithelium. Experiments with known factors of the rice polish concentrate have shown that choline is essential for prevention of lesions. The basal diet was composed of white flour 89.0%, salts 5.0%, butterfat 5.0%, nicotinic acid 0.5%, cystine 0.5%, riboflavin 0.4 mg %, thiamin hydrochloride 1.0 mg %, and pyridoxine hydrochloride* 2.0 mg %. Young rats weighing between 50 and 70 g were fed this diet for six weeks. They were then killed and their stomachs were examined for the papillomatous lesions that have been described.[1]

Eighteen of a group of 26 rats fed the basal diet had lesions. The changes varied from one small papillomatous area near the gastric orifice of the esophagus to a large number of individual areas distributed over the whole inner surface of the forestomach. Thirty-three rats, litter mates of those fed the basal diet, were fed the same diet supplemented by 0.15% choline hydrochloride. Only 5 of the 33 had lesions. Four of these had one and the fifth had only 2 small papillomatous areas. Choline was the only variable, which leads to the conclusion that it is one of the factors necessary to reduce the incidence of hyperplasia of epithelium in the forestomach of rats fed white flour.

The relation of choline to prevention of fatty livers is well known. More recently hemorrhagic degeneration of the kidneys has been obtained in young rats fed choline deficient diets[2] and Du Vigneaud[3] has shown that homocystine will substitute for methionine when choline is present. Demonstration of the essential nature of choline in prevention of epithelial hyperplasia is further evidence of the value of choline or substances with choline-like action in the rats' diet.

While the fundamental cause of the stomach changes remains obscure, proof that choline helps to maintain normal epithelium gives

1 Sharpless, George R., *J. Nutrition*, 1940, **19**, 31.

* The pyridoxine hydrochloride was kindly furnished by Merck and Co., Inc.

2 Griffith, Wendell H., and Wade, Nelson J., *J. Biol. Chem.*, 1940, **131**, 567.

3 Du Vigneaud, Vincent, Chandler, Joseph P., Moyer, A. W., and Keppel, Dorothy M., *J. Biol. Chem.*, 1940, **131**, 57.

a basis for correlation of two previous observations that had no apparent common relationship, namely protein tends to prevent and fat[5] tends to aggravate the lesions. In fact, Hoelzel and Da Costa[4] have maintained that the changes are produced by a protein deficiency. Since methionine and perhaps other amino acids have a choline-like action, protein would be expected to help prevent the lesions. Because choline is necessary for normal fat metabolism or transport a choline deficiency would tend to follow ingestion of a high fat diet.

*Summary.* Choline is necessary to help maintain normal squamous epithelium in the forestomach of rats fed white flour. This observation explains why protein tends to prevent and fat tends to increase hyperplasia of the forestomach epithelium.

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## Salt after Adrenalectomy. III. Carbohydrate Stores in Adrenalectomized Rats Given Various Levels of Sodium Chloride.*

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In a preceding communication[1] it was shown that giving 1% sodium chloride solution to adrenalectomized rats enabled them to grow and maintain a satisfactory state of health, and on the other hand, a larger amount of sodium chloride proved to be deleterious. The capacity of the adrenalectomized rats to store fed glucose has been studied under these 2 types of treatment. A group of 35 adrenalectomized rats and 21 "sham adrenalectomized" control rats were allowed to drink 1% sodium chloride solution in place of tap water. The average NaCl intake was 940 mg daily. Another group of 5 adrenalectomized rats and 4 controls were given tap water to drink. The NaCl intake was 339 mg daily for the former and 601 mg for the latter. The rats were kept in individual cages in a constant temper-

[4] Hoelzel, Frederick, and Da Costa, Esther, *Am. J. Digest. Dis. and Nutrition*, 1937, **4**, 325.

[5] Fujimaki, Yoshitomo, *Trans. Jap. Path. Soc.*, 1931, **21**, 708.

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[1] Anderson, E., Joseph, M., and Herring, V., Proc. Soc. Exp. Biol. and Med., 1940, **44**, 477.