

[CONTRIBUTION FROM THE DEPARTMENT OF BIOLOGICAL CHEMISTRY, GEORGETOWN MEDICAL SCHOOL]

The Rates of Absorption of and the Formation of Liver Glycogen by DL-Serine and DL-Threonine¹

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The rate of absorption of DL-serine from the gastrointestinal tract of the white rat was determined by Schofield and Lewis² by means of the Van Slyke amino nitrogen method to be 67.1 mg. per 100 g. of body weight per hour. Butts, Blunden and Dunn³ fed DL-serine to white rats and found that it caused an increase in liver glycogen. No reports were found on the rate of absorption of DL-threonine; however, Hall, Doty and Eaton⁴ have reported an increase in liver glycogen following the administration to rats of DL-threonine and also DL-allothreonine. The periodic acid methods of Nicolet and Shinn⁵ and of Shinn and Nicolet⁶ for the determination of serine and threonine have proven to be exceedingly accurate and they have been applied to an investigation of the rates of absorption of these two hydroxyamino acids. The amino nitrogen method of Pope and Stevens⁷ has been used to confirm the results obtained by the periodic acid methods. The formation of extra liver glycogen was followed at the same time that the rates of absorption were determined.

Experimental.—White rats, fasted for forty-eight hours, were fed the amino acids by stomach tube. The amino acids were administered, dissolved in water, at levels of 100, 200 and 300 mg. per 100 g. of body weight for the one-, two- and three-hour absorption periods, respectively.⁸ At the end of the period the animal was sacrificed and the entire gastrointestinal tract and the liver were removed. Glycogen was determined immediately in a portion of the liver by the method of Good, Kramer and Somogyi.⁹ The gastrointestinal tract was ground with 50 ml. of a 10% solution of trichloroacetic acid in a Waring blender, the extract was filtered through a Celite pad and aliquots of the filtrate taken for analysis. For each amino acid a series of experiments were conducted in which the amino acid was neutralized by the addition of the calculated amount of 5 N sodium hydroxide solution to the aqueous solution prior to administration. The results of the experiments are given in Tables I and II. All the results are corrected for the loss occurring in the procedure; the loss being 3.5% for DL-serine and 2.8% for DL-threonine. The loss was determined by adding the amino acid to the isolated gastrointestinal tract of a control rat and carrying out the procedure described above.

Discussion and Summary.—The rate of absorption of DL-serine fed as the sodium salt was higher than that for the free amino acid; a

(1) Presented in part before the Division of Biological Chemistry of the American Chemical Society, Atlantic City, September, 1949.

(2) Schofield and Lewis, *J. Biol. Chem.*, **163**, 439 (1947).

(3) Butts, Blunden and Dunn, *ibid.*, **124**, 709 (1938).

(4) Hall, Doty and Eaton, *Am. J. Physiol.*, **131**, 252 (1940).

(5) Nicolet and Shinn, *J. Biol. Chem.*, **139**, 687 (1941).

(6) Shinn and Nicolet, *ibid.*, **138**, 91 (1941).

(7) Pope and Stevens, *Biochem. J.*, **33**, 1070 (1939).

(8) The DL-serine and DL-threonine were obtained from Mann Fine Chemicals, Inc. The purity was determined by amino nitrogen analysis and also by estimation with the periodic acid methods. Both amino acids were at least 98.8% pure.

(9) Good, Kramer and Somogyi, *J. Biol. Chem.*, **100**, 485 (1933).

TABLE I

RATE OF ABSORPTION OF AND GLYCOGEN FORMATION BY DL-SERINE

No. of animals	Time, hours	Rate		Glyco- gen, %
		Mg. per 100 g. Periodate method	per hour Amino N method	
4	1	53.1	55.7	0.73 ^a
8	2	55.0	54.7	1.08
5	3	57.8	59.5	0.52
Av. 17		55.2 ± 4.0	56.4 ± 4.4	
4 ^b	1	84.2	89.2	0.71
5 ^b	2	87.1	87.5	0.98
4 ^b	3	86.5	85.5	0.50
Av. 13 ^b		86.0 ± 5.8	87.4 ± 5.2	

^a The glycogen content of the livers of 12 control rats averaged 0.02%. ^b Fed as the sodium salt.

TABLE II

RATE OF ABSORPTION OF AND GLYCOGEN FORMATION BY DL-THREONINE

No. of animals	Time, hours	Mg. per 100 g. per hour		Glyco- gen, %
		Periodate method	Amino N method	
3	1	63.2	64.3	0.88
3	2	64.8	63.5	1.13
6	3	65.0	63.7	1.84
Av. 12		64.5 ± 4.1	63.9 ± 4.5	
2 ^a	1	105.3	99.5	0.56
4 ^a	2	97.6	96.5	0.43
4 ^a	3	91.3	89.6	0.36
Av. 10 ^a		96.6 ± 5.7	94.3 ± 4.7	

^a Fed as the sodium salt.

similar result was obtained with the sodium salt of DL-threonine. Wilson and Lewis¹⁰ have reported that the rate of absorption of sodium glycinate was higher than that of free glycine and Hess¹¹ has found that the rate of absorption of sodium cysteinate is higher than that of cysteine hydrochloride. The rates determined from the estimation of the amino nitrogen content of the extracts of the gastrointestinal tracts were in good agreement with those calculated from the periodic acid determinations. No significant differences were found in the rates determined after absorption periods of one, two or three hours.

Both DL-serine and DL-threonine formed considerable extra liver glycogen within one hour after feeding the amino acids.

(10) Wilson and Lewis, *ibid.*, **84**, 511 (1929).

(11) Hess, *ibid.*, **131**, 23 (1949).

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Quinolinium Thiocyanate

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When benzoyl chloride, quinoline and potassium cyanide are combined in an aqueous medium, the product obtained² is 1-benzoyl-1,2-dihydro-

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(2) Reissert, *Ber.*, **38**, 1603 (1905).