relative to DNA. If this structural proposal is the correct one, it may be possible for ribonucleic acid, also, to assume a double-stranded configuration in solution through pairing of only the adenine nucleotides.[6]

(6) We are very much indebted to Mrs. Elizabeth Klemperer who was reponsible for many of the measurements in this investigation.

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INCORPORATION OF THE CARBON CHAIN OF METHIONINE INTO SPERMIDINE[1,2]

Sir:

The cumulative work of several laboratories has indicated the metabolic importance of the polyamines putrescine, spermidine and spermine in diverse biological systems. Tabor, *et al.*,[3] have shown that putrescine is the source of the four-carbon chain of spermidine and spermine. Recent results obtained by the author show that the side chain of methionine is an efficient precursor of the three carbon chain of spermidine in *Neurospora crassa*.

Neurospora crassa strains 74A-3b (wild type) and 38706 (blocked in the conversion of homocysteine to methionine) were grown at room temperature on Fries minimal medium supplemented with 50 μg./ml. of DL-methionine-2C^{14}. The spermidine was isolated by grinding the mold with sand and 5% TCA[4] and chromatography of the extract on 0.6 × 20 cm. columns of Dowex 50-X2 using an HCl gradient. The spermidine containing fractions were combined and dried; spermidine trihydrochloride was crystallized from methanolic hydrogen chloride and ethyl acetate. The specific activities of the added methionine and the isolated spermidine are compared in Table I. Amine concentrations were determined as described by Rosenthal and Tabor.[5] Radiopurity of the isolated spermidines was checked by paper ionophoresis in *p*H 8.2 borate buffer and by descending paper chromatography (3 parts 1-propanol:1 part 0.2*M* sodium acetate buffer). In all cases the radioactivity moved in one spot and was in the same position as added authentic spermidine trihydrochloride.

TABLE I

Strain	Specific Activities: Methionine (initial) c.p.m./μmole	Spermidine (isolated) c.p.m./μmole	Ratio Spermidine/ Methionine
74A-3b	6.36×10^4	3.38×10^4	0.53
38706	11.4×10^4	6.34×10^4	0.56

Spermidine was degraded by oxidation with alkaline permanganate. The small yield of succinate, from the four carbon chain, was isolated by chromatography on Dowex 1[6] and on paper using aqueous phenol.[7] The succinate isolated from the oxidation product of synthetic spermidine,[8] labeled in the four carbon chain, contained about 33% of the radioactivity put on the Dowex 1 column, while less than 0.5% of the radioactivity was found in the succinate from the oxidation products of isolated spermidine and synthetic spermidine[8] labeled in the three carbon chain. The low level of activity in the succinate shows that the isolated spermidine is not labeled in the four carbon chain and is consistent with labeling in the three carbon chain.

TABLE II

*p*H	Total radioactivity in spermidine fractions, c.p.m. + ATP	− ATP
7.2	2.1×10^4	520
8.2	2.5×10^3	795

Incubation, four hours at 37°; incubation mixture, 100 μg. 2C^{14}-DL-methionine (3.8×10^5 c.p.m.) per vessel, 0.01 *M* putrescine, 0.008 *M* glutathione, 0.003 *M* $MgCl_2$, 0.00001 *M* pyridoxal phosphate, 0.1 *M* buffer, 2.5 ml. 1:1 extract of 74A-3b, 0.02 *M* K_4ATP as indicated, total volume 5 ml.; buffers are *p*H 7.2, potassium phosphate + Tris hydrochloride (1:1), *p*H 8.2, Tris hydrochloride.

A possible mechanism for this reaction is the transfer of the methionine side chain from S-adenosyl methionine to putrescine in a manner similar to the transfer of the methyl group of this compound first observed by Cantoni.[9] The almost absolute ATP requirement for the incorporation of C^{14} methionine into spermidine by a cell free extract of 74A-3b as shown in Table II is consistent with this hypothesis. Further evidence for the presence of radioactivity in the spermidine from the *p*H 7.2 incubation mixture was obtained by paper ionophoresis in *p*H 8.2 borate buffer. Tabor, *et al.*,[10] have extended these studies in extracts of *E. coli* and have found further evidence that S-adenosylmethionine is an intermediate.

(1) A preliminary report of this work was presented before the American Society of Biological Chemists; *Federation Proc.*, **16**, 189 (1957).

(2) This work was supported in part by Research Grant C-3436(A) from the National Cancer Institute, National Institutes of Health, Bethesda 14, Md.

(3) H. Tabor, S. M. Rosenthal and C. W. Tabor, *Federation Proc.*, **15**, 367 (1956).

(4) Abbreviations used are: TCA, trichloroacetic acid; ATP, adenosine triphosphate; Tris, tris-hydroxymethylaminomethane.

(5) S. M. Rosenthal and C. W. Tabor, *J. Pharmacol. and Exptl. Ther.*, **116**, 131 (1956).

(6) J. K. Palmer, Bull. 589 Conn. Agric. Expt. Station (1955).

(7) H. K. Berry, H. E. Sutton, L. Cain and J. S. Berry, Biochemical Institute Studies IV, No. 5109, Univ. of Texas, Austin, Texas, 1951, p. 22.

(8) Kindly supplied by Dr. E. Jackson of the National Institute of Arthritis and Metabolic Diseases.

(9) G. L. Cantoni, "Phosphorus Metabolism," Vol. II, Johns Hopkins Press, Baltimore, Md., 1952, p. 129.

(10) H. Tabor, S. M. Rosenthal and C. W. Tabor, personal communication.

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THE HETEROGENEITY OF POLYSACCHARIDES AS REVEALED BY ELECTROPHORESIS ON GLASS-FIBER PAPER

Sir:

Glass-fiber paper[1] has been used in conjunction with a borate buffer *p*H 9–10 for the electrophoretic separation[2] of a wide variety of organic substances

(1) M. J. O'Leary, R. B. Hobbs, J. K. Missimer and J. J. Erving, *Tappi*, **37**, 446 (1954).

(2) D. R. Briggs, E. F. Garner, R. Montgomery and F. Smith, *Anal. Chem.*, **28**, 1333 (1956).