Studies on Amino-hexoses. III.[1]
A New Synthesis of 2-Deoxy-D-ribose

By Yoshio MATSUSHIMA and Yujiro IMANAGA

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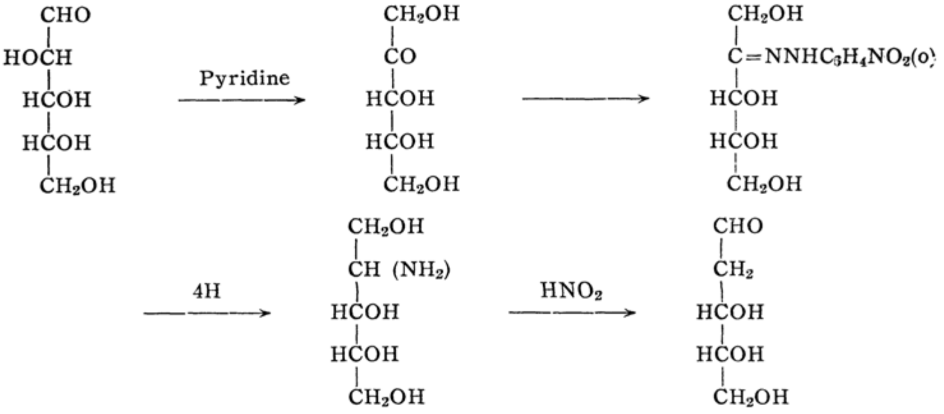
The synthesis of 2-deoxy-D-ribose, a constituent of deoxy-ribonucleic acid, has been a matter of interest from the biochemical point of view. Of several methods of synthesis which have hitherto been reported, the glycal method[2] and the more recently discovered nitro-glycitol method[3] are best in yields. Here is reported another method of synthesis which we tried recently.

D-Arabinose was isomerized in hot pyridine to ribulose which was isolated as o-nitrophenylhydrazone.[4] The ribulose-o-nitrophenyl hydrazone was reductively decomposed into o-phenylene diamine on the one hand and 2-amino-2-deoxy-pentitols on the other, using Raney nickel as catalyst. As one of the authors has demonstrated,[5] α-amino-alcohols in sugar series undergo "semi-pinacolinic deamination" when treated with nitrous acid, thus glucosamine and glucosaminol affording chitose and 2-deoxy-glucose respectively. The 2-amino-2-deoxy-pentitols, as expected, were converted by treating them with nitrous acid to 2-deoxy-ribose which was isolated as its benzylphenyl hydrazone. The reaction sequence is represented as follows:



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[1] Previous reports of this series: This Bulletin, **24**, 17 (1951); ibid., **24**, 144 (1951); Preliminary report of this article: *Nature*, **171**, 475 (1953).

[2] R. E. Deriaz, W. G. Overend, M. Stacey, E. G. Teece, L. F. Wiggins, *J. Chem. Soc.*, 1879 (1949); K. Ohta, *J. Biochem.* (Japan), **38**, 31 (1951).

[3] J. C. Sowden, *J. Am. Chem. Soc.*, **71**, 1897 (1949).

[4] C. Glatthaar, T. Reichstein, *Helv. Chim. Acta*, **18**, 80 (1935).

[5] Y. Matsushima, This Bulletin, **24**, 144 (1951).

Experimental

Ribulose-o-nitrophenyl Hydrazone—23 g. of D-arabinose is gently boiled with 190 cc of anhydrous pyridine for 4 hours. The dark brown reaction mixture is evaporated *in vacuo*, water is added to the residue and redistilled in vacuo. After several repetitions of this operation, the syrupy material is separated with absolute alcohol from the unreacted crystalline arabinose. The alcoholic solution is seeded with arabinose and kept in an ice box in order to separate arabinose as far as possible. 17 g. of arabinose are recovered in almost pure state. After evaporation *in vacuo* of the alcoholic solution 7.25 g. of dark brown syrup is obtained.

The syrup above obtained is dissolved in 190 cc. of absolute alcohol and is boiled with 6.0 g. of o-nitrophenyl hydrazine for 10 minutes. The reaction mixture is concentrated to 75 cc. a few drops of acetic acid are added and it is placed in an ice box. The reddish yellow crystal separates and it is washed with water, absolute alcohol and then with ether-ethyl acetate (I : I). Ribulose-o-nitrophenyl hydrazone thus obtained weighs 5.2 g. and melts at 150°.

2-Amino-2-deoxy-pentitols—5.2 g of the ribulose-hydrazone above obtained is finely powdered and suspended in 70 cc. of water, 5 g. of activated Raney nickel are added, and shaken in the atmosphere of hydrogen. When the velocity of hydrogen absorption diminishes, the catalyst is added anew. 14 g. in all of the catalyst are necessary and 1970 cc. of hydrogen are absorbed in 16 hours. After the catalyst is filtered off, the solution is extracted with ether automatically for 20 hours. The ether extract, after evaporation, leaves 1.7 g. of o-phenylene-diamine. 3.2 g. of brown syrup of the 2-amino-2-deoxy-pentitols are obtained when the water solution is evaporated *in vacuo*.

2-Deoxy-D-ribose-benzylphenyl Hydrazone—3.2 g. of the syrup above obtained are dissolved in 20 cc. of 50% acetic acid and the solution of 2 g. of sodium nitrite in 5 cc. of water is dropped under ice cooling and in the atmosphere of cabon dioxide. After 20 minutes the nitrous acid is driven off by the stream of carbon dioxide and the solution is concentrated *in vacuo* to a syrup which is dissolved in 10 cc. of absolute alcohol; 2.15 g of benzylphenyl hydrazine in 2 cc. of absolute alcohol are added. The mixture is kept at 70° for 30 minutes in the atmosphere of carbon dioxide and concentrated *in vacuo*. The syrup thus obtained is extracted 3 times with each 10 cc. of benzene and the residue is once more extracted with 10 cc. of benzene after dilution with water. The benzene extract, after drying with sodium sulfate, leaves on evaporation crystalline needles mixed with syrupy matter. The crystal is separated by washing away the syrupy matter with ether and benzene. After recrystallization from benzene isopropyl alcohol and 40% ethyl alcohol, it melts at 125.5∼126.5° and weighs 0.3 g. No melting point depression is observed when mixed with an authentic specimen. Colorless needle, $[\alpha]^{11}_{D}$ $-15.25°$ (in pyridine).

Calculated for $C_{18}H_{22}O_3N_2$: C, 68.79% ; H, 7.01% ; N, 8.92%
Found: C, 68.86% ; H, 6.56% ; N, 8.98%

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Department of Science, Nara Women's University, Nara