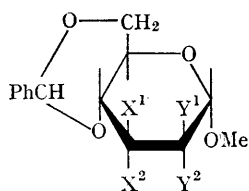


## Periodate Oxidation of Amino-sugars

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PERIODATE oxidation of vicinal diol systems in carbohydrates and their derivatives has been much studied and is of great use in structural investigation.<sup>1</sup> Little work has been done on amino-sugars, particularly from a mechanistic standpoint. The application of periodate oxidation to determination of ring-size is of doubtful value in view of the anomalous results of Weiss *et al.*<sup>2</sup> A detailed study of amino-sugar oxidation is being made in this Laboratory and preliminary results are here presented. Initial studies have been on the system (I) which exists in eight possible isomeric forms (1—8), all of which were either previously known, or have been prepared as part of this project.



(I) If an X=OH  
then a Y=NH<sub>2</sub>  
or *vice versa*;  
others are H

The effect of replacing a hydroxyl group in a vicinal diol by an amino-group is known<sup>3</sup> to increase the rate of oxidation: this has been observed here (*cf.* ref. 4) to an extent of 10<sup>2</sup> to 10<sup>4</sup>. Oxidation of compounds 1—6 was studied at 25° and pH 4 (acetate buffer). Under these conditions the rates of compounds 7 and 8 were too slow and measurements were made at pH 6.9 (phosphate buffer). The experimental technique of Honeyman and Shaw<sup>4</sup> was used to determine the rate constants ( $k_{\text{obs}}$ ). The true second-order rate constants  $k_2$

were calculated using the acid dissociation constants of the amino-sugars,<sup>5</sup> assuming that only the unprotonated form was oxidised.<sup>6</sup> The results are summarised in the Table.

TABLE

No.	Methyl 4,6- <i>O</i> -benzylidene- $\alpha$ -D-glycoside	$k_2$ in l.mole <sup>-1</sup> sec. <sup>-1</sup> pH 4 at 25°
1	2-Amino-mannoside	35.4
2	3-Amino-mannoside	149
3	2-Amino-alloside	22.6
4	3-Amino-alloside	5.13
5	2-Amino-glucoside	20.9
6	3-Amino-glucoside	18.0
7	2-Amino-altroside*	$3.67 \times 10^{-4}$
8	3-Amino-altroside*	$3.92 \times 10^{-3}$

\* at pH 6.9

The reaction was first order in both reactants for compounds 1—6 and obeyed the equation

$$\frac{d(\text{IO}_4^-)}{dt} = k_{\text{obs}} [\text{IO}_4^-][\text{AS}]$$

where [AS] is the concentration of the amino-sugar. Over-oxidation was very slow. For compounds 7 and 8 the second-order equation was obeyed only to 0.6 mole of periodate consumed; the rate curve then deviated considerably and extensive over-oxidation occurred. Since some periodate oxidations in phosphate buffer have been found to be anomalous,<sup>7</sup> oxidation of compounds 7 and 8 was studied at pH 6.8—7.1 in other buffer systems when similar behaviour was observed. Similar behaviour has been found for oxidation

(pH 6.9) of methyl 4,6-*O*-benzylidene-3-deoxy-3-methylamino- $\alpha$ -D-altroside. The corresponding 3-dimethylamino-altroside was oxidised extremely slowly; the unoxidised compound reacted with iodine to give a crystalline substance of, as yet, unknown structure. Oxidation of methyl 4,6-*O*-benzylidene-3-deoxy-3-methylamino- $\alpha$ -D-glucoside follows normal second-order kinetics (pH 4), the product, as in the case of compounds 1—8, being identical with that<sup>8</sup> from periodate oxidation of methyl 4,6-*O*-benzylidene- $\alpha$ -D-glucoside. Ammonia was detected quantitatively (Nessler) in the oxidation of compounds 1—6.

The rate constants obtained fit the general pattern of diol oxidations with *cis*-groups oxidised faster than *trans*-groups. The anomaly is compound 4 which had a rate much slower than would have been predicted. It is also of note that the *trans-ax,ax*-group in compounds 7 and 8 was oxidised (*cf.* refs. 1, 4), albeit slowly.

Work is in progress on rate measurements at other temperatures, on the oxidation of the corresponding  $\beta$ -series and on the stability of the copper complexes of compounds 1—8.

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<sup>2</sup> J. P. Joseph, H. M. Kissman, F. J. McEvoy, R. E. Schaub, A. M. Small, and M. J. Weiss, *J. Amer. Chem. Soc.*, 1959, **81**, 4050.

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<sup>4</sup> J. Honeyman and C. J. G. Shaw, *J. Chem. Soc.*, 1959, 2454.

<sup>5</sup> C. B. Barlow and R. D. Guthrie, unpublished work.

<sup>6</sup> G. E. McCasland and D. A. Smith, *J. Amer. Chem. Soc.*, 1951, **73**, 5164.

<sup>7</sup> D. J. Bell, *J. Chem. Soc.*, 1948, 992; D. J. Bell, A. T. Johns, and A. Palmer, *J. Chem. Soc.*, 1949, 1536.

<sup>8</sup> R. D. Guthrie and J. Honeyman, *J. Chem. Soc.*, 1959, 2441.