Efficient Syntheses of (*1R,2R*)- and (*1S,2S*)-2-Amino-1-alkyl(or aryl)-1,3-propanediols by Regioselective Ring Opening of Aziridine-2-methanols

Soo-Kyung Choi, Jin-Soo Lee, Jung-Ho Kim,† and Won Koo Lee*

Department of Chemistry, Sogang University, Seoul 121-742, Korea

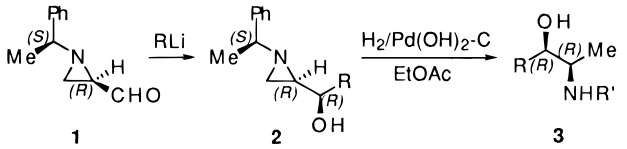
Received June 20, 1996

The asymmetric synthesis of 2-amino-1,3-propanediols[1] is of current interest and concern. Compounds containing a 2-amino-1,3-propanediol subunit are important constituents of broad-spectrum antibiotics, thiamphenicol[2] and florfenicol.[3] The amino diol is also found in sphingosines and dihydrosphingosines as the main structural unit.

The preparation of stereodefined β-hydroxy α-amino acids is an important area because some of the acids can be found in natural peptide antibiotics.[4] Since the carboxylic acid can be obtained from the corresponding primary alcohol, the efficient preparation of optically pure 2-amino-1-substituted-1,3-propanediols is the key step for the syntheses of β-hydroxy α-amino acids. A number of hydroxy amino acids have emerged as key components for pharmaceuticals[5] and various protease inhibitors.[6]

Substituted aziridines have been utilized as substrates in many important synthetic transformations.[7] The ring strain present in aziridines is responsible for the reactivity of *N*-activated aziridines toward nucleophiles.[8] Many examples of the regioselective ring opening by a variety of nucleophiles have been reported.[9] The products from the ring-opening reactions can readily be transformed to α- and β-amino acids as well as the more functionalized hydroxy amino acids.

Scheme 1. Reductive Cleavage of the Aziridine Ring



1 2 3

R = alkyl or aryl; R' = (*S*)-α-methylbenzyl

Recently, we reported that the C(3)−N bond in *N*-(*R*)-(+)-(α-methylbenzyl)aziridine-2-methanol derivatives could be reductively cleaved by catalytic hydrogenation with high regioselectivity (Scheme 1).[10a,b] We also found that the substrates **2** could be prepared by stereoselective addition of organolithiums to the configurationally stable *N*-(*S*)-(−)-(α-methylbenzyl)aziridine-2(*R*)-carboxaldehyde **1**. The C(3)−N bond of the aziridino secondary alcohols **2** could also be reductively cleaved by catalytic hydrogenation to provide β-amino alcohols **3** in high yields.[10c,d]

† Agrochemical Lab, Hanwha Group Research & Engineering Center, 6 Sinsung-Dong, Yusung-Ku, Taejon 305-345, Korea.

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S0022-3263(96)01168-1 CCC: $14.00

Scheme 2. Ring Opening of Aziridines by AcOH

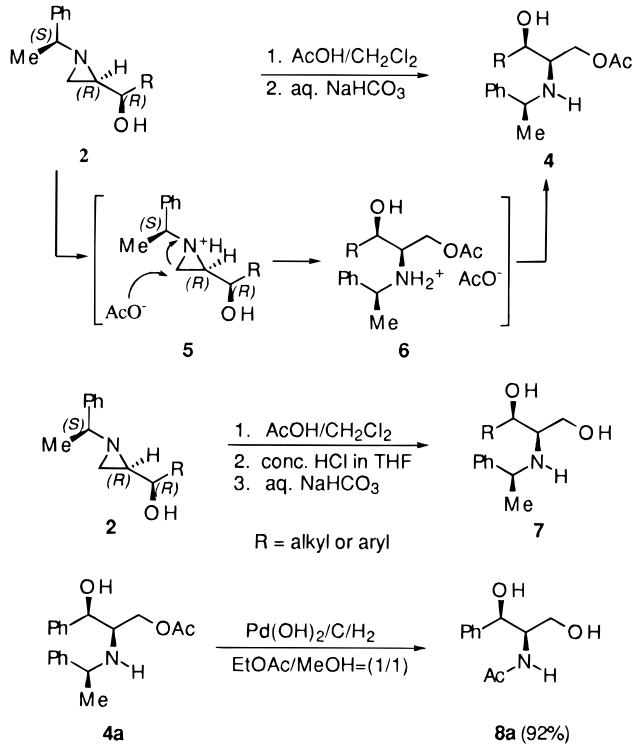


Table 1. Ring Opening of Aziridines 2 by AcOH

entry	R	yield of **4** (% isolated)	absolute configuration
2a	phenyl	91	*(1R,2R)*
2b	methyl	87	*(1R,2R)*
2c	*tert*-butyl	85	*(1R,2R)*
2d	1-naphthyl	85	*(1R,2R)*
2e	2-methylphenyl	85	*(1R,2R)*
2f	2-methoxyphenyl	95	*(1R,2R)*
2g[a]	2-naphthyl	88	*(1S,2S)*
2h	3-methylphenyl	87	*(1R,2R)*
2i[a]	4-chlorophenyl	89	*(1S,2S)*
2j[a]	4-fluorophenyl	91	*(1S,2S)*

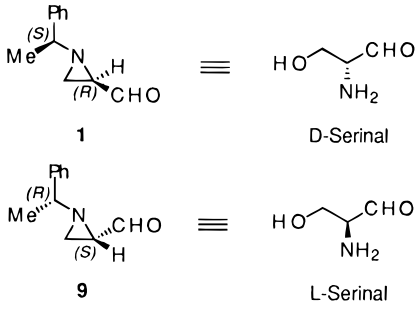
[a] **2g,i,j** are 1′(*S*)-aryl-*N*-[(*R*)-(+)-α-methylbenzyl]aziridine-2(*S*)-methanols which can be obtained from the reaction of *N*-[(*R*)-(+)-α-methylbenzyl]aziridine-2(*S*)-carboxaldehyde (**9**) with the corresponding aryllithiums. Therefore, the products **4g,i,j** have (*1S,2S*) absolute configuration after the ring cleavage.

In this note, we report that the C(3)−N bond of **2** could be cleaved by oxygen nucleophiles upon activating the aziridine nitrogen with a protonic acid regioselectively to provide 2-amino-1,3-propanediols as enantiomerically pure forms.

Results and Discussion

An efficient conversion of *N*-(*R* or *S*)-(α-methylbenzyl)-aziridine-2-methanol derivative **2** into [(*1S,2S*) or (*1R,-2R*)]-2-amino-1-alkyl(or aryl)-1,3-propanediols **4** by a straightforward reaction is shown in Scheme 2, and the results are summarized in Table 1. The ring-opening reaction seems to be accelerated upon protonation on the nitrogen atom of the aziridine ring by AcOH to form an aziridinium salt **5**. Then the nucleophile, AcO^-, attacks the aziridine ring at the less sterically hindered C(3) position to form an *O*-acetate as an ammonium salt **6**. The reaction proceeds smoothly at room temperature by treating the substrate **2** in CH_2Cl_2 with 3 equiv of AcOH, and refluxing the reaction mixture accelerates the ring-opening process. On treatment of the reaction mixture with saturated aqueous $NaHCO_3$ solution, isolation of the ring-opening product **4** was achieved in high yields. We were also able to isolate the regioisomer, C(2)−N opening product, in less than 4% yield. We expected that the acetyl group would readily migrate to the nitrogen upon treating the reaction mixture with a base. However, the acetyl group did not migrate and stayed on the oxygen. The IR stretching frequency of the carbonyl (1740 cm^{-1}) of **4a** clearly indicates that it is an ester carbonyl. We also tried to introduce the *tert*-butoxycarbonyl group on the nitrogen, but the reaction did not proceed. We think the steric bulkiness of the α-methylbenzyl group on the nitrogen precludes the migration of the acetyl group or the introduction of another electrophile. When we removed the α-methylbenzyl group from the nitrogen, we were able to isolate the acetyl-migrated *N*-acetamide **8a** which was indicated by the IR stretching frequency of the carbonyl group (1657 cm^{-1}). The acetyl protecting group in **4** can readily be removed by KOH in refluxing ethanol or by treating the compound with a catalytic amount of concd HCl in refluxing aqueous THF to provide **7**. The α-methylbenzyl group in **4** can also be removed by catalytic hydrogenation to provide the *N*-acetamide derivative **8**.

Scheme 3. Synthetic Equivalence between Aziridine-2-carboxaldehyde and Serinal



The above experimental results show that the aziridine-2(*R*)-carboxaldehyde **1** and its enantiomer **9** can readily be converted to 2-amino-1-alkyl(or aryl)-1,3-propanediols **7** and their enantiomers efficiently. Therefore, the aziridine-2(*R*)-carboxaldehyde **1** and its enantiomer **9** are synthetic equivalents of configurationally stable D- and L-serinal, respectively (Scheme 3).

Experimental Section

General. NMR spectra were recorded on spectrometers operating at 200 and 300 MHz (^1H) and at 50 and 75 MHz (^{13}C) in deuteriochloroform ($CDCl_3$). Tetrahydrofuran and diethyl ether were distilled from sodium−benzophenone ketyl at atmospheric pressure immediately prior to use. Methylene chloride was distilled from calcium hydride prior to use. All other reagents and solvents used were reagent grade.

General Procedure for Ring Cleavage. *(1R,2R)*-2-[*N*-[(*S*)-α-methylbenzyl]amino]-3-*O*-acetyl-1-phenyl-1,3-propanediol (4a). To a solution of 1′(*R*)-phenyl-*N*-[(*S*)-α-methylbenzyl]aziridine-2(*R*)-methanol (**2a**) (200 mg, 0.789 mmol) in 3.0 mL of methylene chloride was added 0.14 mL (2.37 mmol) of acetic acid. The mixture was refluxed for 4 h and cooled to room temperature. The mixture was then quenched with 0.5 mL of saturated $NaHCO_3$ solution. The organic layer was separated and the aqueous layer was extracted with methylene chloride (10 mL × 4). The combined organic extracts were dried over anhydrous $MgSO_4$, filtered, and concentrated in *vacuo*. Purification by silica gel flash chromatography (EtOAc/*n*-hexane, 3:7) provided 225 mg (91%) of *(1R,2R)*-2-[*N*-[(*S*)-α-methylbenzyl]-amino]-3-*O*-acetyl-1-phenyl-1,3-propanediol (**4a**) as a yellow oil. $[\alpha]^{22}_D = -201.7°$ (*c* 1.0, $CHCl_3$). IR (neat) 1740 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.37−7.13 (m, 10H) , 4.43 (d, J = 8.4 Hz, 1H), 4.27 (dd, J = 11.9, 4.0 Hz, 1H), 3.94 (q, J = 6.5 Hz, 1H), 3.73 (dd, J = 11.8, 3.3 Hz, 1H), 2.62 (m, 1H), 2.09 (s, 3H), 1.38 (d, J = 6.5

Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 170.6, 144.2, 141.3, 128.4, 128.1, 127.5, 127.1, 126.6, 61.8, 59.7, 55.2, 24.8, 20.5. Anal. Calcd for $C_{19}H_{23}NO_3$: C, 72.8; H, 7.4; N, 4.5. Found: C, 72.6; H, 7.5; N, 4.5.

(1*R*,2*R*)-2-[*N*-[(*S*)-α-Methylbenzyl]amino]-3-*O*-acetyl-1-methyl-1,3-propanediol (4b): $[\alpha]^{22}_D = -117.8°$ (*c* 1.0, $CHCl_3$). IR (neat) 1740 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.33−7.24 (m, 5H) , 4.31 (dd, *J* = 11.8, 4.1 Hz, 1H), 4.05 (dd, *J* = 11.3, 3.2 Hz, 1H), 4.05 (dd, *J* = 11.3, 3.2 Hz, 1H), 4.02 (q, *J* = 6.4 Hz, 1H), 3.56 (m, 1H), 2.29 (m, 1H), 2.09 (s, 3H), 1.36 (d, *J* = 6.5 Hz, 3H), 1.09 (d, *J* = 6.2 Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 171.3, 144.7, 128.7, 127.4, 127.0, 66.5, 61.8, 59.3, 55.0, 25.1, 20.6, 19.1. Anal. Calcd for $C_{14}H_{21}NO_3$: C, 66.9; H, 8.4; N, 5.6. Found: C, 66.7; H, 8.5; N, 5.6.

(1*R*,2*R*)-2-[*N*-[(*S*)-α-Methylbenzyl]amino]-3-*O*-acetyl-1-*tert*-butyl-1,3-propanediol (4c): $[\alpha]^{22}_D = -79.5°$ (*c* 1.0, $CHCl_3$). IR (CH_2Cl_2) 1738 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.32−7.23 (m, 5H), 4.25 (dd, *J* = 11.6, 4.3 Hz, 1H), 4.02 (dd, *J* = 11.8, 5.2 Hz, 1H), 3.95 (q, *J* = 6.6 Hz, 1H), 2.93 (d, *J* = 5.4Hz, 1H), 2.70 (m, 1H), 2.12 (s, 3H), 1.39 (d, *J* = 6.6 Hz, 3H), 0.67 (s, 9H). ^{13}C NMR ($CDCl_3$) δ 171.3, 144.2, 128.6, 127.5, 127.3, 75.2, 66.0, 56.0, 53.0, 34.7, 25.4, 24.2, 20.7. Anal. Calcd for $C_{17}H_{27}NO_3$: C, 69.6; H, 9.3; N, 4.8. Found: C, 69.7; H, 9.5; N, 4.8.

(1*R*,2*R*)-2-[*N*-[(*S*)-α-Methylbenzyl]amino]-3-*O*-acetyl-1-(1-naphthyl)-1,3-propanediol (4d): $[\alpha]^{22}_D = -148.5°$ (*c* 1.0, $CHCl_3$). IR (neat) 1740 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.81−7.72 (m, 3H), 7.48−7.15(m, 9H), 5.13 (d, *J* = 8.1 Hz, 1H), 4.27 (dd, *J* = 11.7, 4.4 Hz, 1H), 3.87 (q, *J* = 6.3 Hz, 1H), 3.69 (dd, *J* = 11.8, 3.6Hz, 1H), 3.07 (m, 1H), 2.09 (s, 3H), 1.38 (d, *J* = 6.5 Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 170.3, 144.1, 136.7, 133.6, 130.4, 128.4, 128.0,127.9, 126.7, 126.4, 125.3, 124.9, 124.7, 123.2, 70.6, 62.6, 58.0, 55.3, 24.2, 20.3. Anal. Calcd for $C_{23}H_{25}NO_3$: C, 76.0; H, 6.9; N, 3.9. Found: C, 75.9; H, 6.9; N, 3.8.

(1*R*,2*R*)-2-[*N*-[(*S*)-α-Methylbenzyl]amino]-3-*O*-acetyl-1-(2-methylphenyl)-1,3-propanediol (4e): $[\alpha]^{20}_D = -136.2°$ (*c* 1.0, $CHCl_3$). IR (CH_2Cl_2) 1740 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.34−7.04 (m, 9H) , 4.73 (d, *J* = 8.05 Hz, 1H), 4.29 (dd, *J* = 11.7, 4.5 Hz, 1H), 3.91 (q, *J* = 6.5 Hz, 1H), 3.67 (dd, *J* = 11.7, 3.3 Hz, 1H), 2.72 (m, 1H), 2.17 (s, 3H), 2.07 (s, 3H), 1.36 (d, *J* = 6.4 Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 171.2, 144.7, 139.6, 135.6, 130.7, 128.7, 127.5, 127.3, 127.2 127.0, 126.2, 69.4, 62.2, 58.3, 55.2, 24.8, 20.6, 18.7. Anal. Calcd for $C_{20}H_{25}NO_3$: C, 73.4; H, 7.7; N, 4.3. Found: C,73.0; H, 7.7; N, 4.2.

(1*R*,2*R*)-2-[*N*-[(*S*)-α-Methylbenzyl]amino]-3-*O*-acetyl-1-(2-methoxyphenyl)-1,3-propanediol (4f): $[\alpha]^{22}_D = -149.1°$ (*c* 1.0, $CHCl_3$). IR (CH_2Cl_2) 1738 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.34−7.13 (m, 7H) , 6.88 (t, *J* = 7.4Hz, 1H), 6.77 (d, *J* = 8.3 Hz, 1H), 4.82 (d, 7.32Hz, 1H), 4.15 (dd, *J* = 11.6, 4.7 Hz, 1H), 3.88 (dd, *J* = 8.0, 3.3 Hz, 1H), 3.86 (q, *J* = 6.2 Hz, 1H), 3.63 (s, 3H), 2.81 (dt,*J* = 7.3, 4.3Hz, 1H), 2.06 (s, 3H), 1.35 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 170.6, 156.5, 144.8, 129.8, 128.2, 127.8, 127.6, 126.7, 126.6, 120.5, 110.3, 68.1, 63.1, 58.2, 55.5, 54.9, 24.6, 20.6. Anal. Calcd for $C_{20}H_{25}NO_4$: C, 70.0; H, 7.3; N, 4.1. Found: C,69.7; H, 7.3; N, 4.0.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-3-*O*-acetyl-1-(2-naphthyl)-1,3-propanediol (4g): $[\alpha]^{22}_D = +113.7°$ (*c* 1.0, $CHCl_3$). IR (CH_2Cl_2) 1738 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.80−7.65 (m, 5H), 7.46−7.34(m, 3H), 7.28−7.20 (m, 6H), 4.60 (d, *J* = 8.1 Hz, 1H), 4.30 (dd, *J* = 11.8, 4.3 Hz, 1H), 3.94 (q, *J* = 6.6 Hz, 1H), 3.77 (dd, *J* = 11.8, 3.4Hz, 1H), 2.74 (m, 1H), 2.08 (s, 3H), 1.37 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 171.2, 144.4, 139.0, 133.3, 128.8, 128.3, 128.1, 127.8, 127.5, 127.1, 126.2, 126.0, 124.6, 73.1, 61.7, 59.6, 55.3, 24.9, 20.6. Anal. Calcd for $C_{23}H_{25}NO_3$: C, 76.0; H, 6.9; N, 3.9. Found: C, 76.0; H, 6.9; N, 3.8.

(1*R*,2*R*)-2-[*N*-[(*S*)-α-Methylbenzyl]amino]-3-*O*-acetyl-1-(3-methylphenyl)-1,3-propanediol (4h): $[\alpha]^{22}_D = -120.4°$ (*c* 0.98, $CHCl_3$). IR (CH_2Cl_2) 1738 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.37−6.95 (m, 9H) , 4.40 (d, *J* = 8.4 Hz, 1H), 4.27 (dd, *J* = 11.9, 4.0 Hz, 1H), 3.94 (q, *J* = 6.6 Hz, 1H), 3.74 (dd, *J* = 11.8, 3.3 Hz, 1H), 2.63 (m, 1H), 2.27 (s, 3H), 2.10 (s, 3H), 1.37 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 171.2, 144.4, 141.3, 138.1, 128.8, 128.7, 128.3, 127.5, 127.4, 127.0, 124.1, 73.0, 61.6, 59.7, 55.2, 24.9, 21.1, 20.6. Anal. Calcd for $C_{20}H_{25}NO_3$: C, 73.4; H, 7.7; N, 4.3. Found: C, 73.2; H, 7.8; N, 4.3.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-3-*O*-acetyl-1-(4-chlorophenyl)-1,3-propanediol (4i): $[\alpha]^{22}_D = +114.5°$ (*c* 1.0, $CHCl_3$). IR (CH_2Cl_2) 1740 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.40−7.06 (m, 9H), 4.39 (d, *J* = 8.1 Hz, 1H), 4.27 (dd, *J* = 12.0, 4.1 Hz, 1H), 3.93 (q, *J* = 6.6 Hz, 1H), 3.73 (dd, *J* = 11.8, 3.3Hz, 1H), 2.55 (m, 1H), 2.10 (s, 3H), 1.37 (d, *J* = 6.5 Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 171.1, 144.2, 140.0, 133.6, 128.8, 128.6, 128.3, 127.6, 127.0, 72.2, 61.3, 59.7, 55.2, 24.8, 20.6. Anal. Calcd for $C_{19}H_{22}ClNO_3$: C, 65.6; H, 6.4; N, 4.0. Found: C, 65.3; H, 6.4; N, 4.0.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-3-*O*-acetyl-1-(4-fluorophenyl)-1,3-propanediol (4j): $[\alpha]^{22}_D = +151.5°$ (*c* 0.99, $CHCl_3$). IR (CH_2Cl_2) 1740 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.38−7.22 (m, 5H), 7.16−7.02(m, 2H), 7.00−6.88 (m, 2H), 4.40 (d, *J* = 8.4 Hz, 1H), 4.27 (dd, *J* = 12.0, 4.0 Hz, 1H), 3.95 (q, *J* = 6.6 Hz, 1H), 3.71 (dd, *J* = 11.9, 3.1Hz, 1H), 2.55 (m, 1H), 2.11 (s, 3H), 1.39 (d, *J* = 6.5 Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 171.2, 164.2, 160.9, 144.3, 137.3, 128.8, 128.7, 128.6, 127.5, 127.0, 115.4, 115.1, 72.3, 61.4, 59.8, 55.2, 24.9, 20.5. Anal. Calcd for $C_{19}H_{22}FNO_3$: C, 68.9; H, 6.7; N, 4.2. Found: C, 68.6; H,6.7; N, 4.3.

(1*R*,2*R*)-2-[*N*-[(*S*)-α-Methylbenzyl]amino]-1-phenyl-1,3-propanediol (7a) To a solution of *(1R,2R)*-2-[*N*-[(*S*)-α-methylbenzyl]amino]-3-*O*-actyl-1-phenyl-1,3-propanediol **4a** (112 mg, 0.357 mmol) in 1.8 mL of EtOH was added 49 mg (0.873 mmol) of KOH. The mixture was refluxed for 2.5 h, concentrated in *vacuo*, dissolved in 2 mL of water, and then neutralized by the addition of 6 N HCl solution. The aqueous layer was extracted with methylene chloride (10 mL × 4). The combined organic extracts were dried over anhydrous $MgSO_4$, filtered, and concentrated in *vacuo*. Purification by silica gel flash chromatography (EtOAc/*n*-hexane, 7:3) provided 82 mg (85%) of (*1R,2R*)-2-[*N*-[(*S*)-α-methylbenzyl]amino]-1-phenyl-1,3-propanediol (**7a**) as a yellow oil. $[\alpha]^{22}_D = -138.7°$ (*c* 1.0, $CHCl_3$). ^{1}H NMR ($CDCl_3$) δ 7.42−7.03 (m, 10H), 4.63 (d, *J* = 7.4 Hz, 1H), 3.85 (q, *J* = 6.5 Hz, 1H), 3.67 (dd, *J* = 11.2, 3.8Hz, 1H), 3.31 (dd, *J* = 11.2, 2.3 Hz, 1H), 2.53 (m, 1H), 1.36 (d, *J* = 6.5 Hz, 3H). ^{13}C NMR ($CDCl_3$) δ 144.8, 141.9, 128.7, 128.5, 127.9, 127.3, 126.9, 126.8, 73.7, 61.0, 59.1, 54.8, 24.7. Anal. Calcd for $C_{17}H_{21}NO_2$: C, 75.3; H, 7.8; N, 5.2. Found: C, 75.5; H, 7.8; N, 5.0.

One-Pot Procedure from 2a. To a solution of 1′(*R*)-phenyl-*N*-[(*S*)-α-methylbenzyl]aziridine-2(*R*)-methanol (**2a**) (50 mg, 0.197 mmol) in 0.66 mL of methylene chloride was added 34 μL (0.592 mmol) of acetic acid. The mixture was refluxed for 4 h and then concentrated in *vacuo*. The residue was dissolved in aqueous THF (0.66 mL) and a catalytic amount of concd HCl was added. The mixture was refluxed for 8 h, and the reaction mixture was neutralized by the addition of saturated $NaHCO_3$ solution. The aqueous layer was extracted with EtOAc (10 mL × 4). The combined organic extracts were dried over anhydrous $MgSO_4$, filtered, and concentrated in *vacuo*. Purification by silica gel flash chromatography (EtOAc/*n*-hexane, 1:1) provided 41 mg (77%) of (*1R,2R*)-2-[*N*-[(*S*)-α-methylbenzyl]amino]-1-phenyl-1,3-propanediol (**7a**) as a yellow oil.

(1*R*,2*R*)-2-(*N*-Acetylamino)-1-phenyl-1,3-propanediol (8a). To a solution of *(1R,2R)*-2-[*N*-[(*S*)-α-methylbenzyl]amino]-3-*O*-acetyl-1-phenyl-1,3-propanediol (**4a**) (107 mg, 0.341 mmol) in 0.86 mL of EtOAc:MeOH (1:1) was added 22 mg of $Pd(OH)_2$. The mixture was stirred under a balloon pressure of hydrogen for 2 days at room temperature. The reaction mixture was filtered and concentrated. Purification by silica gel flash chromatography (MeOH/methylene chloride, 7:93) provided 65 mg (92%) of (*1R,2R*)-2-(*N*-acetylamino)-1-phenyl-1,3-propanediol (**8a**) as a white foam. $[\alpha]^{22}_D = -41.0°$ (*c* 1.0, $CHCl_3$). IR (CH_2Cl_2) 1657 cm^{-1}. ^{1}H NMR (CD_3OD) δ 7.42−7.23 (m, 5H) , 4.92 (d, *J* = 4.4 Hz, 1H), 4.09 (m,1H), 3.68 (dd, *J* = 10.9, 6.1 Hz, 1H), 3.46 (dd, *J* = 10.9, 5.9 Hz, 1H), 1.90 (s, 3H). ^{13}C NMR ($CDCl_3$) δ 171.8, 141.3, 128.6, 128.0, 126.0, 73.7, 63.4, 56.5, 22.9 Anal. Calcd for $C_{11}H_{15}NO_3$: C, 63.1; H, 7.2; N, 6.7. Found: C, 63.1; H, 7.4; N, 6.6.

Acknowledgment. This work was supported by the Korea Science and Engineering Foundation (through OCRC) and the Ministry of Education (BSRI-3412-96).

Supporting Information Available: IR, ^{1}H, and ^{13}C NMR spectra for **4a**−**j**, **7a**, and **8a** (35 pages). This material is contained in libraries on microfiche, immediately follows this article in the microfilm version of the journal, and can be ordered from the ACS; see any current masthead page for ordering information.

JO961168Z