Efficient Synthesis of *Ephedra* Alkaloid Analogues Using an Enantiomerically Pure *N*-[(*R*)-(+)-α-Methylbenzyl]aziridine-2-carboxaldehyde

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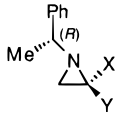
Efficient preparation of enantiomerically pure (2*S*)-aziridine-2-carboxaldehyde **9** and its 2(*R*) isomer and highly diastereoselective addition of organolithium reagents to the aldehyde **9** are described. The diastereoselectivity in additions of the lithium reagents seems to come from "chelation-controlled" carbon−carbon bond formation and is influenced by the source of the organometallic compound, solvent, and the presence of a Li salt. The C(3)−*N* bond of the aziridine ring of the addition products was regioselectively reduced by catalytic hydrogenation in the presence of Pearlman's catalyst to provide enantiomerically pure 1,2-amino alcohols. The absolute stereochemistries of the amino alcohol **13a** were assigned as (1*S*,2*S*) when the C-1 substituent was phenyl by comparison with those of commercially available norpseudoephedrine.

Introduction

The chemistry of enantiomerically pure substituted aziridines has been the target of extensive research.[1] Because of the ring strain of the aziridine many papers have appeared on regioselective ring-opening reactions by various nucleophiles including carbon and heteroatoms. In particular, the ring-opening reactions of enantiomerically pure aziridine-2-carboxylates have been the most popular since the reaction provides either enantiomerically pure α-amino or *β*-amino esters, many of which are considered biologically active and which also could be converted to biologically important compounds.[1a,2] Although most ring-opening reactions have focused on the *N*-activated aziridines that contain a functional group that conjugatively stabilizes the lone pair electrons on the nitrogen, few reports have been made on the ring-opening reactions of the *N*-alkylaziridines.

Recently, we reported the preparation of enantiomerically pure aziridine-2-carboxylates, **1** and **2**, and the corresponding alcohols, **3** and **4**, from readily available starting materials, *N*-(*R*)-(+)-α-methylbenzylamine and ethyl 2,3-dibromo propionate[3] and the regiospecific reductive ring cleavages of the aziridine ring via catalytic hydrogenation with a palladium catalyst.[4a] We found



1: X=CO_2Et, Y=H
2: X=H, Y=CO_2Et
3: X=CH_2OH, Y=H
4: X=H, Y=CH_2OH

that the catalytic hydrogenation of both 2(*R*)- and 2(*S*)-aziridine methanols provided only C(3)−*N* bond reduction products that corresponded to L- and D-alaninol, chiral *β*-amino alcohols.[4b] The above results encouraged us to investigate the preparation and the reduction characteristics of various aziridino alcohols.

Many *β*-amino alcohols are biologically active and play very important roles in living organisms.[5] Therefore, the syntheses of diastereo- and enantiomerically pure amino alcohols are becoming important areas of research. Among those, *Ephedra* alkaloids (**5**−**8**) are attractive because of their biological and medicinal activities. These compounds have long been used in China to treat bronchial asthma, hay fever, and other allergic reactions, and large quantities are produced in Western countries to relieve mucous membrane congestion.[6] Recently, *Ephedra* alkaloids have been used as chiral ligands or

† Warmly dedicated to Prof. Peter Beak on the occasion of his 60th birthday.

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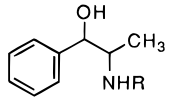
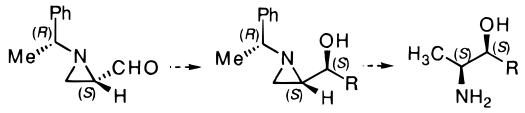
chiral auxiliaries in various stereoselective reactions.[7] As part of our continuing efforts to develop new strategies for the asymmetric syntheses of biologically active β-amino alcohols, we have investigated diastereoselective additions of organometallic reagents to the configurationally stable enantiomerically pure α-amino aldehydes prepared from **3** and **4** by Swern oxidation.[8]



5: R=CH_3 [(1*R*,2*S*)-(-)-ephedrine]
6: R=H [(1*R*,2*S*)-(-)-norephedrine]
7: R=CH_3 [(1*S*,2*S*)-(+)-pseudoephedrine]
8: R=H [(1*S*,2*S*)-(-)-norpseudoephedrine]

Usually, α-amino aldehydes are configurationally unstable, and careful handling is required for these compounds to keep their absolute configuration during chemical reactions with other reagents.[9] However, we were able to introduce configurational stability in the α-amino aldehyde by making a three-membered nitrogen heterocycle. The configurational stability of a similar system, aziridine-2-thiocarboxylate, was reported by Seebach, and the origin of the configurational stability came from the high inversion barrier of the three-membered heterocyclic ring system.[3] The problem of configurational stability and the lack of investigation on the additions of organometallic compounds to the enantiomerically pure aziridine-2-carboxaldehydes prompted us to investigate the addition reactions of organometallics to the above α-amino aldehydes (Scheme 1).

Scheme 1. Projected Syntheses of *β*-Amino Alcohols

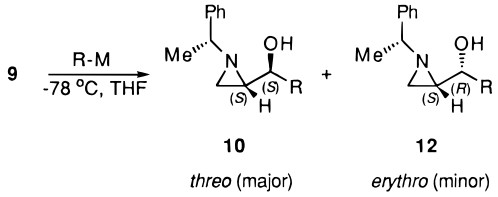


9 **10** **11**

Results and Discussion

The enantiomerically pure *N*-[(*R*)-(+)-α-methylbenzyl]-azirine-2(*S*)-carboxaldehyde (**9**) was prepared by Swern oxidation[8] of **3** in 91% yield. The absolute configuration at C-2 of the corresponding alcohol **3** was established by comparison with optically pure L- and D-alaninols after reductive ring cleavage and debenzylation.[4a] The configuration of the aldehyde **9** is stable due to the ring strain of the aziridine, and the compound can be chromatographed on silica gel and can be stored in a refrigerator for weeks without loss of optical purity.

Scheme 2. Diastereoselective Additions of Organometallics to 9



10 **12**

threo (major) *erythro* (minor)

Table 1. Diastereomer Ratio of Aziridino Alcohols in Phenyl Addition Reactions under Various Reaction Conditions

entry	RM (procedure[a])	solvent	ratio (**10:12**)	*T* (°C)	additive
1	PhMgBr (A)	THF	55:45	0	
2	PhMgBr (A)	Et_2O	79:21	0	
3	PhMgBr (A)	THF	65:35	−78	
4	PhMgBr (A)	Et_2O	82:18	−78	
5	PhLi (A)	THF	84:16	−78	
6	PhLi (A)	Et_2O	74:26	−78	
7	PhLi (A)	THF	91:9	−78	LiCl (5 equiv)
8	PhLi (A)	THF	93:7	−78	LiCl (15 equiv)
9	PhLi (B)	THF	91:9	−78	
10	PhLi (B)	THF	94:6	−78	LiCl (15 equiv)

[a] **Procedure A.** To a solution of **9** in THF (or Et_2O) (with LiCl when it was used), with stirring and cooling at −78 °C, was added phenyllithium (phenylmagnesium bromide). The mixture was stirred for 2 h at −78 °C and warmed to room temperature. **Procedure B.** To a solution of bromobenzene in THF under a nitrogen atmosphere at −78 °C was added 2 equiv of *t*-BuLi. The mixture was stirred for 30 min and then treated with **9** in THF via a canula at −78 °C. The mixture was stirred for 2 h at −78 °C and warmed to room temperature.

We found that the aldehyde **9** and its 2(*R*) isomer could be synthetic equivalents of L- and D-alaninal, respectively. The aldehyde **9** was reacted with various organometallic reagents, RM (M = Li, Mg, Ti), to give a diastereomeric mixture of two aziridine-2-methanol derivatives **10** and **12**. Alkyl or aromatic lithium reagents provided better diastereoselectivity in the addition reactions than other organometallics (Scheme 2), and the results are summarized in Table 1.

The above results show that phenyllithium provides better stereoselectivity than phenyl Grignard reagent and also that THF would be the reaction solvent of choice. The presence of a lithium salt also enhanced the stereoselectivity, and the salt effect was witnessed in many organic reactions.[10] Therefore, the best results can be obtained using aromatic bromides as starting materials so that the addition reactions are carried out in the presence of 1 equiv of LiBr, which is formed during lithium−bromine exchange. The diastereomeric alcohols were readily separable by flash chromatography, and isolated yields were above 81%. Under the standard reaction conditions (THF, 2 h, −78 °C, procedure B), various ArLi reagents, which were prepared by lithium−bromine exchange from the corresponding aromatic bromides, were reacted with *N*-[(*R*)-(+)-α-methylbenzyl]-aziridine-2(*S*)-carboxaldehyde to afford the corresponding aziridine-2-methanol derivatives (Table 2).

The above experimental results indicate that increasing steric requirement around the nucleophilic center also increases the diastereoselectivity. The assignment of the absolute stereochemistry of the product could be made by measuring the coupling constant between two neigh-

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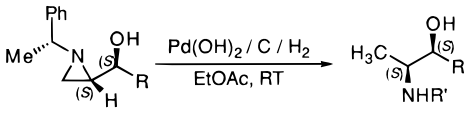
Table 2. Diastereoselective Additions of RLi Reagents to the Aldehyde 9

entry	ArLi	procedure	ratio **10:12** (*S,S*):(*S,R*)	yield (% isolated)
a	phenyl	B	91:9	83
b	*tert*-butyl	A	83:17	81
c	1-naphthyl	B	97:3	84
d	2-naphthyl	B	97:3	82
e	2-methylphenyl	B	94:6	89
f	2-furyl[a]	B	83:17	86
g	3-methoxyphenyl	B	92:8	84
h	4-chlorophenyl	B	86:14	85
i	4-fluorophenyl	B	91:9	84
j	9-phenanthryl	B	94:6	87

[a] The reaction was carried out in the presence of 10 equiv of LiCl.

Scheme 3. Highly Regioselective Reductive Ring Cleavage of Substituted Aziridines



10(a-j) **13(a-j)**

13 R' = (*R*)-(+)-α-Methylbenzyl
14 R' = H

boring methine protons or the chemical shift of the methine proton on the hydroxyl-bearing carbon. The coupling constants of the *threo (S,S)* isomers were always larger (J = 4.4−5.8 Hz) than those of *erythro (S,R)* isomers (J = 1.9−3.7 Hz),[4b,7a] and the chemical shifts of the methine proton on the hydroxyl-bearing carbon of the *threo* isomers were always in higher field than those of the *erythro* isomers.

Highly Regioselective Ring Reduction of the Aziridino Alcohols. With various secondary alcohols obtained from the organometallic additions, we studied the regioselective reductive cleavage of the aziridine ring on the basis of the previous results.[4a] To find the optimum reaction conditions, such as the amount of the catalyst, solvent, and concentration, the catalytic hydrogenation of the phenyl addition product, **10a**, was studied as a model reaction for the aziridino secondary alcohols.

We found that aziridine ring reduction proceeds much faster than debenzylation during the catalytic hydrogenation of the aziridino secondary alcohols. However, the catalytic hydrogenation provided a small amount (5−7%) of the debenzylation product **14**, which was resulted from the ring reduction product **13**. As the amount of Pearlman's catalyst, the concentration of the substrate, and the reaction time increased, more debenzylation product was formed. The best results of the reductive cleavage of the C(3)−*N* bond were obtained in the presence of 10 wt % of Pearlman's catalyst and when the concentration of the substrate was 0.1 M in EtOAc. Using Pd/C as a catalyst also provided the C(3)−*N* bond reduction product, but the reaction took more time to complete. The catalytic hydrogenations of **10a**−**j** in EtOAc with Pearlman's catalyst proceeded smoothly in 6 h at room temperature to provide a variety of *N-(R)*-(+)-α-methylbenzylamino alcohols **13a**−**j** in high yields (Scheme 3 and Table 3.

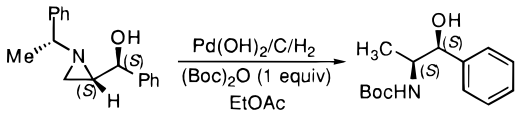
Confirmation of the Absolute Stereochemistry. To confirm the absolute configurations of the two diastereomers from the phenyl addition reaction, the major diastereomer **10a** was separated by flash column chromatography. The aziridine ring was reduced by catalytic

Table 3. Compound Data of the Reduction Products 13a−j

entry	R	yield[a]	$^3J_{[(H(1),H(2)]}$ Hz	abs confign
a (*threo*)	phenyl	85	8.4	(1*S*,2*S*)
a (*erythro*)	phenyl	84	4.3	(1*R*,2*S*)
b	*tert*-butyl	82	5.9	(1*S*,2*S*)
c	1-naphthyl	84	8.5	(1*S*,2*S*)
d	2-naphthyl	79	8.4	(1*S*,2*S*)
e	2-methylphenyl	83	8.5	(1*S*,2*S*)
f	2-furyl	70	8.0	(1*S*,2*S*)
g	3-methoxyphenyl	79	8.2	(1*S*,2*S*)
h	4-chlorophenyl	80	8.4	(1*S*,2*S*)
i	4-fluorophenyl	84	8.8	(1*S*,2*S*)
j	9-phenanthryl	85	8.0	(1*S*,2*S*)

[a] All yields are isolated % yields.

Scheme 4. Reductive Ring Cleavage and Successive Debenzylation



10a **15a**

hydrogenation to provide a β-amino alcohol.[4a] The α-methylbenzyl group of the crude product was removed by successive catalytic hydrogenation in the presence of 1.0 equiv of $(Boc)_2O$ to provide the *N*-Boc derivative **15a** in 85% yield (Scheme 4).[11] The spectrum and optical rotation data of **15a** were consistent with those of the *N*-Boc derivative of commercially available (1*S*,2*S*)-(+)-norpseudoephedrine.

Conclusions

We prepared the configurationally stable α-amino aldehyde **9** and its 2(*R*) isomer from readily available starting materials in simple steps, and the obtained aldehydes could be synthetic equivalents of configurationally stable L- and D-alaninals. The high diastereoselectivities in organolithium addition reactions to the aldehyde **9** can be explained by a "chelation-controlled" carbon−carbon bond formation. Using 2(*S*) aldehyde **9** in the addition reactions, we obtained (*S,S*) isomer **10** as the major product.[12] The C(3)−*N* bond of those aziridino secondary alcohols can be regioselectively reduced by catalytic hydrogenation in a mild reaction condition to yield (1*S*,2*S*) β-amino alcohols that can be readily derivatized to *Ephedra* alkaloid analogs.

Experimental Section

General Procedures. Melting points (mp) are uncorrected. Tetrahydrofuran and diethyl ether were distilled from sodium−benzophenone ketyl at atmospheric pressure immediately prior to use. Methylene chloride and DMSO were distilled from calcium hydride prior to use. Alkyllithium solutions (purchased from Aldrich) were assayed for active alkyl by titration using *N*-benzylbenzamide as an indicator. All other reagents and solvents used were reagent grade.

Preparation of *N*-[(*R*)-(+)-α-Methylbenzyl]aziridine-2(*S*)-carboxaldehyde (9). To a solution of oxalyl chloride (0.13 mL, 1.50 mmol) in 3.4 mL of CH_2Cl_2 under a nitrogen at −78 °C was added DMSO (0.21 mL, 2.98 mmol) in 3.0 mL of CH_2Cl_2. The solution was stirred for 30 min at −78 °C, and *N*-[(*R*)-(+)-α-methylbenzyl]aziridine-2(*S*)-methanol (**3**) (240

(11) The catalytic hydrogenation of the aziridine ring in the presence of $(Boc)_2O$ resulted in various side products.
(12) The manuscript is in preparation for the use of the 2(*R*) isomer.

mg, 1.36 mmol) in 1.4 mL of CH_2Cl_2 was added to the above solution and then the resulting mixture was stirred for 15 min at −78 °C. To the above reaction mixture was added Et_3N (0.95 mL, 6.80 mmol) at −78 °C. The mixture was stirred for another 15 min and warmed to room temperature. The mixture was treated with 5.0 mL of water, and the aqueous layer was separated and extracted with CH_2Cl_2 (5.0 mL × 5). The combined organic extracts were washed with 10 mL of brine, dried over anhydrous $MgSO_4$, filtered, and concentrated *in vacuo.* Purification by silica gel flash chromatography (EtOAc/hexane 40:60) provided 217 mg (91%) of **9** as a pale yellow oil: $[\alpha]^{28}_D = -30.0°$ (*c* 1.30, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 8.93 (d, J = 6.1 Hz, 1H), 7.32−7.24 (m, 5H), 2.62 (q, J = 6.6 Hz, 1H), 2.38 (d, J = 2.9 Hz, 1H), 2.08 (td, J = 6.5, 2.1 Hz, 1H), 1.94 (d, J = 6.9 Hz, 1H), 1.48 (d, J = 6.6 Hz, 3H); ^{13}C NMR (50.3 MHz, $CDCl_3$) δ 199.3, 143.6, 128.6, 127.4, 126.5, 69.0, 44.1, 33.0, 23.6. Anal. Calcd for $C_{11}H_{13}NO$: C, 75.40; H, 7.48; N, 7.99. Found: C, 75.17; H, 7.54; N, 7.98.

Representative Procedure of Organolithium Addition to the Aldehyde 9. To a solution of bromobenzene (345 mg, 2.2 mmol) in 4.0 mL of THF under nitrogen atmosphere at −78 °C was added *t*-BuLi (1.00 M, 2.05 mL, 2.05 mmol) in pentane. The mixture was stirred for 30 min and then treated with **9** (175 mg, 1.00 mmol) in 1.0 mL of THF via cannula at −78 °C. The mixture was stirred for 2 h at −78 °C, was warmed to room temperature, and then treated with 1 mL of water. The organic layer was separated, and the aqueous layer was extracted with EtOAc (5 mL × 5). The combined organic extracts were washed with brine, dried over anhydrous $MgSO_4$, filtered, and concentrated *in vacuo.* Purification by silica gel flash chromatography (EtOAc/hexane, 50:50) gave 196 mg (77%) of **10a** and 17 mg (7%) of **12a** as white solids.

10a: mp 53−55 °C; $[\alpha]^{25}_D = +131.5°$ (*c* 0.59, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.31−7.07 (m, 10H), 4.23 (d, J = 5.5 Hz, 1H), 2.52 (q, J = 6.6 Hz, 1H), 2.03 (d, J = 3.5 Hz, 1H), 1.78 (td, J = 6.0, 3.5 Hz, 1H), 1.57 (d, J = 6.5 Hz, 1H), 1.46 (d, J = 6.6 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.4, 142.1, 128.9, 128.3, 127.8, 127.5, 127.0, 125.9, 74.0, 69.3, 44.4, 31.8, 22.2. Anal. Calcd for $C_{17}H_{19}NO$: C, 80.60; H, 7.56; N, 5.53. Found: C, 80.44; H, 7.87; N, 5.54.

12a: mp 88−90 °C; $[\alpha]^{26}_D = +58.7°$ (*c* 0.95, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.31−7.26 (m, 10H), 4.66 (d, J = 3.2 Hz, 1H), 2.67 (q, J = 6.5 Hz, 1H), 2.12 (d, J = 3.4 Hz, 1H), 1.84 (m, 1H), 1.43 (d, J = 6.5 Hz, 3H) 1.41 (d, J = 6.2 Hz, 1H); ^{13}C NMR (50.3 MHz, $CDCl_3$) δ 144.4, 141.8, 128.5, 128.3, 128.0, 127.8, 127.5, 127.2, 126.6, 126.1, 70.1, 69.1, 43.0, 29.4, 23.3. Anal. Calcd for $C_{17}H_{19}NO$: C, 80.60; H, 7.56; N, 5.53. Found: C, 80.42; H, 7.80; N, 5.56.

Preparation of *N*-[(*R*)-α-Methylbenzyl]-1′(S)-*tert*-butylaziridine-2(*S*)-methanol (10b) and *N*-[(*R*)-α-methylbenzyl]-1′(*R*)-*tert*-butylaziridine-2(*S*)-methanol (12b). To a solution of **9** (175 mg, 1.00 mmol) in 5.0 mL of THF, with stirring and cooling at −78 °C, was added *t*-BuLi (1.00 M, 1.30 mL, 1.30 mmol) in pentane. The pale yellow mixture was stirred for 2 h at −78 °C and was warmed to room temperature and then treated with 1 mL of water. The organic layer was separated, and the aqueous layer was extracted with EtOAc (5 mL × 5). The combined organic extracts were washed with brine, dried over anhydrous $MgSO_4$, filtered, and concentrated *in vacuo.* Purification by silica gel flash chromatography (EtOAc/hexane, 45:55) gave 164 mg (70%) of **10b** as a white solid and 25 mg (11%) of **12b** as a colorless oil.

10b: mp 63−65 °C; $[\alpha]^{25}_D = +69.4°$ (*c* 0.72, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.35−7.23 (m, 5H), 2.73 (d, J = 5.5 Hz, 1H), 2.47 (q, J = 6.6 Hz, 1H), 1.86 (d, J = 2.0 Hz, 1H), 1.57 (d, J = 1.9 Hz, 1H), 1.44 (d, J = 6.5 Hz, 3H), 0.77 (s, 9H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.6, 128.9, 128.7, 127.8, 127.4, 127.3, 127.0, 80.0, 69.7, 40.1, 34.2, 33.2, 25.4, 25.1, 22.4. Anal. Calcd for $C_{15}H_{23}NO$: C, 77.21; H, 9.93; N, 6.00. Found: C, 77.04; H, 10.09; N, 5.96.

12b: $[\alpha]^{24}_D = +0.2°$ (*c* 0.50, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.33−7.22 (m, 5H), 3.31 (d, J = 2.2 Hz, 1H), 2.64 (q, J = 6.5 Hz, 1H), 2.03 (d, J = 3.6 Hz, 1H), 1.59 (m, 1H), 1.43 (d, J = 6.3 Hz, 1H), 1.41 (d, J = 6.5 Hz, 3H), 0.86 (s, 9H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.8, 128.5, 127.1, 126.6, 74.0, 69.0, 38.1, 34.2, 29.3, 25.6, 23.3. Anal. Calcd for $C_{15}H_{23}NO$: C, 77.21; H, 9.93; N, 6.00. Found: C, 77.24; H, 9.73; N, 5.94.

***N*-[(*R*)-α-Methylbenzyl]-1′(*S*)-(1-naphthyl)aziridine-2(*S*)-methanol (10c):** $[\alpha]^{24}_D = +131.2°$ (*c* 0.75, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 8.00−7.26 (m, 1H), 7.82−7.76 (m, 1H), 7.65 (dd, J = 6.9, 2.3 Hz, 1H), 7.46−7.37 (m, 3H), 7.25−7.16 (m, 6H), 5.04 (d, J = 4.6 Hz, 1H), 2.53 (q, J = 6.6 Hz, 1H), 2.12 (d, J = 3.5 Hz, 1H), 2.04 (m, 1H), 1.59 (d, J = 6.4 Hz, 1H) 1.46 (d, J = 6.6 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.5, 138.3, 134.2, 131.1, 129.2, 129.1, 128.2, 128.0, 127.4, 126.3, 125.8, 125.7, 123.9, 123.8, 70.3, 69.5, 43.7, 32.5, 22.3. Anal. Calcd for $C_{21}H_{21}NO$: C, 83.13; H, 6.98; N, 4.62. Found: C, 83.50; H, 7.01; N, 4.44.

***N*-[(*R*)-α-Methylbenzyl]-1′(*R*)-(1-naphthyl)aziridine-2(*S*)-methanol (12c):** mp 103−104 °C; $[\alpha]^{24}_D = +22.7°$ (*c* 0.87, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.85−7.22 (m, 12H), 5.46 (d, J = 2.1 Hz, 1H), 2.68 (q, J = 6.5 Hz, 1H), 2.12 (d, J = 2.7 Hz, 1H), 2.08 (m, 1H), 1.46 (d, J = 6.5 Hz, 3H), 1.43 (d, J = 6.6 Hz, 1H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.5, 137.3, 133.8, 130.8, 128.9, 128.7, 128.0, 127.4, 126.7, 126.1, 125.6, 125.5, 123.1, 123.0, 69.1, 66.2, 41.7, 29.7, 22.9. Anal. Calcd for $C_{21}H_{21}NO$: C, 83.13; H, 6.98; N, 4.62. Found: C, 83.43; H, 7.19; N, 4.44.

***N*-[(*R*)-α-Methylbenzyl]-1′(*S*)-(2-naphthyl)aziridine-2(*S*)-methanol (10d):** $[\alpha]^{26}_D = +159.9°$ (*c* 1.43, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.79−7.10 (m, 12H), 4.44 (d, J = 4.8 Hz, 1H), 2.65 (d, J = 4.0 Hz, 1H), 2.49 (q, J = 6.6 Hz, 1H), 2.11 (d, J = 3.3 Hz, 1H), 1.82 (m, 1H), 1.61 (d, J = 6.6 Hz, 1H), 1.48 (d, J = 6.6 Hz, 3H); ^{13}C NMR (50.3 MHz, $CDCl_3$) δ 144.0, 139.7, 133.1, 132.7, 128.4, 127.9, 127.7, 127.4, 127.3, 126.7, 126.1, 125.6, 125.4, 124.3, 124.0, 73.5, 69.1, 44.3, 31.6, 22.3. Anal. Calcd for $C_{21}H_{21}NO$: C, 83.13; H, 6.98; N, 4.62. Found: C, 83.40; H, 7.01; N, 4.44.

***N*-[(*R*)-α-Methylbenzyl]-1′(*R*)-(2-naphthyl)aziridine-2(*S*)-methanol (12d):** mp 65−67 °C; $[\alpha]^{23}_D = +55.0°$ (*c* 1.40, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.78−7.14 (m, 12H), 4.78 (d, J = 3.2 Hz, 1H), 3.28(br, 1H), 2.61 (q, J = 6.2 Hz, 1H), 2.15 (d, J = 3.0Hz, 1H), 1.87 (m, 1H), 1.40 (d, J = 6.5 Hz, 4H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.5, 139.3, 133.4, 133.2, 128.6, 128.1, 127.8, 127.3, 126.7, 126.1, 125.8, 125.0, 124.3, 77.2, 70.2, 69.0, 42.7, 29.3, 23.1. Anal. Calcd for $C_{21}H_{21}NO$: C, 83.13; H, 6.98; N, 4.62. Found: C, 83.46; H, 7.01; N, 4.44.

***N*-[(*R*)-α-Methylbenzyl]-1′(*S*)-(2-methylphenyl)aziridine-2(*S*)-methanol (10e):** $[\alpha]^{23}_D = +118.1°$ (*c* 1.1, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.36−7.00 (m, 9H), 4.52 (d, J = 5.5 Hz, 1H), 2.57 (q, J = 6.6 Hz, 1H), 2.30 (s, 3H), 2.06 (d, J = 3.5 Hz, 1H), 1.87 (td, J = 5.9, 3.6 Hz, 1H), 1.59 (d, J = 6.5 Hz, 1H), 1.51 (d, J = 6.6 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.3, 140.2, 134.9, 130.3, 128.9, 127.8, 127.3, 127.1, 126.1, 126.1, 70.4, 69.4, 43.6, 32.0, 22.1, 19.0. Anal. Calcd for $C_{18}H_{21}NO$: C, 80.86; H, 7.92; N, 5.24. Found: C, 80.52; H, 7.91; N, 5.63.

***N*-[(*R*)-α-Methylbenzyl]-1′(*R*)-(2-methylphenyl)aziridine-2(*S*)-methanol (12e):** mp 60−62 °C; $[\alpha]^{23}_D = +27.3°$ (*c* 1.0, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.49−7.05 (m, 9H), 4.88 (d, J = 2.6 Hz, 1H), 2.64 (q, J = 6.6 Hz, 1H), 2.17 (s, 3H), 2.13 (d, J = 3.6 Hz, 1H), 1.84 (td, J = 5.9, 3.6 Hz, 1H), 1.43 (d, J = 6.6 Hz, 3H), 1.41 (d, J = 6.5 Hz, 1H); ^{13}C NMR (50.3 MHz, $CDCl_3$) δ 144.2, 139.7, 134.8, 130.0, 128.4, 127.1, 126.5, 125.9, 125.7, 69.2, 66.5, 41.8, 29.8, 22.9, 18.8. Anal. Calcd for $C_{18}H_{21}NO$: C, 80.86; H, 7.92; N, 5.24. Found: C, 80.77; H, 8.18; N, 5.62.

***N*-[(*R*)-α-Methylbenzyl]-1′(*S*)-(2-furyl)aziridine-2(*S*)-methanol (10f):** mp 61−62 °C; $[\alpha]^{29}_D = +71.4°$ (*c* 0.77, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.32−7.17 (m, 6H), 6.15 (m, 1H), 5.83 (d, J = 3.2 Hz, 1H), 4.33 (d, J = 6.0 Hz, 1H), 2.60 (q, J = 6.5 Hz, 1H), 2.00 (m, 2H), 1.57 (d, J = 6.3 Hz, 1H), 1.46 (d, J = 6.6 Hz, 3H); ^{13}C NMR (50.3 MHz, $CDCl_3$) δ 155.0, 144.1, 141.8, 128.6, 128.3, 127.4, 126.9, 126.4, 109.9, 105.8, 69.3, 67.2, 41.2, 30.9, 22.6. Anal. Calcd for $C_{15}H_{17}NO$: C, 74.05; H, 7.04; N, 5.76. Found: C, 73.98; H, 6.96; N, 5.86.

***N*-[(*R*)-α-Methylbenzyl]-1′(*R*)-(2-furyl)aziridine-2(*S*)-methanol (12f):** mp 73−75 °C; $[\alpha]^{22}_D = +41.0°$ (*c* 1.00, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.30−7.20 (m, 6H), 6.26 (m, 1H), 6.17 (d, J = 2.7 Hz, 1H), 4.65 (d, J = 3.4 Hz, 1H), 3.00 (br, 1H), 2.68 (q, J = 6.5 Hz, 1H), 2.20 (d, J = 3.4Hz, 1H), 1.91 (m, 1H), 1.57 (d, J = 6.3 Hz, 1H), 1.45 (d, J = 6.6

Hz, 3H); ^{13}C NMR (50.3 MHz, $CDCl_3$) δ 154.3, 142.2, 128.5, 127.5, 127.2, 126.6, 110.0, 106.8, 69.1, 64.7, 40.1, 29.9, 23.2. Anal. Calcd for $C_{15}H_{17}NO$: C, 74.05; H, 7.04; N, 5.76. Found: C, 73.97; H, 6.86; N, 5.82.

***N*-[(*R*)-α-Methylbenzyl]-1′(*S*)-(3-methoxyphenyl)aziridine-2(*S*)-methanol (10g):** mp 43−45 °C; $[\alpha]^{24}_D$ = +116.9° (*c* 0.80, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.38−7.18 (m, 5H), 7.18−7.10 (m, 1H), 6.79−6.65 (m, 3H), 4.21 (d, *J* = 5.8 Hz, 1H), 3.73 (s, 3H), 2.52 (q, *J* = 6.5 Hz, 1H), 1.79 (td, *J* = 6.3, 3.3 Hz, 1H), 1.57 (d, *J* = 6.5 Hz, 1H), 1.45 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 159,8, 144.4, 143.9, 129.3, 128.8, 127.7, 127.0, 118.1, 113.0, 111.3, 74.0, 69.2, 55.1, 44.6, 31.9, 22.2. Anal. Calcd for $C_{18}H_{21}NO_2$: C, 76.30; H, 7.47; N, 4.94. Found: C, 76.28; H, 7.67; N, 5.02.

***N*-[(*R*)-α-Methylbenzyl]-1′(*R*)-(3-methoxyphenyl)aziridine-2(*S*)-methanol (12g):** mp 68−70 °C; $[\alpha]^{25}_D$ = +57.1° (*c* 1.00, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.40−7.00 (m, 6H), 6.85−6.74 (m, 3H), 4.64 (d, *J* = 3.2 Hz, 1H), 3.77 (s, 3H), 2.67 (q, *J* = 6.5 Hz, 1H), 2.11(d, *J* = 3.3 Hz, 1H), 1.83 (td, *J* = 6.5, 3.3 Hz, 1H) ,1.43 (d, *J* = 6.5 Hz, 3H), 1.42 (d, *J* = 6.3 Hz, 1H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 159,9, 144.5, 143.5, 129.4, 128.6, 127.3, 126.6, 118.5, 113.2, 111.6, 69.6, 68.9, 55.0, 42.6, 29.1, 23.0. Anal. Calcd for $C_{18}H_{21}NO_2$: C, 76.30; H, 7.47; N, 4.94. Found: C, 76.17; H, 7.46; N, 4.98.

***N*-[(*R*)-α-Methylbenzyl]-1′(*S*)-(4-chlorophenyl)aziridine-2(*S*)-methanol (10h):** mp 45−47 °C; $[\alpha]^{23}_D$ = +126.0° (*c* 0.80, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.44−7.12 (m, 5H), 7.03 (d, *J* = 5.5 Hz, 2H), 6.91 (d, *J* = 8.3 Hz, 2H), 4.24 (d, *J* = 4.4 Hz, 1H), 2.49 (q, *J* = 6.6 Hz, 1H), 2.00 (d, *J* = 3.6 Hz, 1H), 1.71 (m, 1H), 1.54 (d, *J* = 6.3 Hz, 1H), 1.44 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.1, 141.0, 133.0, 128.7, 128.3, 127.6, 127.1, 127.0, 72.5, 69.4, 44.2, 31.7, 22.2. Anal. Calcd for $C_{17}H_{18}ClNO$: C, 70.95; H, 6.30; N, 4.87. Found: C, 70.96; H, 6.30; N, 4.72.

***N*-[(*R*)-α-Methylbenzyl]-1′(*R*)-(4-chlorophenyl)aziridine-2(*S*)-methanol (12h):** mp 98−100 °C; $[\alpha]^{23}_D$ = +60.0° (*c* 0.23, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.45−7.00 (m, 9H), 4.60 (d, *J* = 3.6 Hz, 1H), 2.66 (q, *J* = 6.6 Hz, 1H), 2.07 (d, *J* = 3.6 Hz, 1H), 1.79 (m, 1H), 1.44 (d, *J* = 6.6 Hz, 1H), 1.44 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.3, 140.3, 133.4, 128.6, 128.5, 127.5, 127.3, 126.6, 69.5, 69.0, 42.5, 29.2, 23.0. Anal. Calcd for $C_{17}H_{18}ClNO$: C, 70.95; H, 6.30; N, 4.87. Found: C, 70.89; H, 6.30; N, 4.73.

***N*-[(*R*)-α-Methylbenzyl]-1′(*S*)-(4-fluorophenyl)aziridine-2(*S*)-methanol (10i):** $[\alpha]^{22}_D$ = +113.3° (*c* 0.86, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.29−7.26 (m, 5H), 7.02 (q, *J* = 5.5 Hz, 2H), 6.83 (t, *J* = 8.8 Hz, 2H), 4.24 (d, *J* = 4.9 Hz, 1H), 2.51 (q, *J* = 6.5 Hz, 1H), 2.00 (d, *J* = 3.5 Hz, 1H), 1.75 (ddd, *J* = 6.5, 4.9, 3.5 Hz, 1H), 1.56 (d, *J* = 6.5 Hz, 1H), 1.46 (d, *J* = 6.5 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 163.9, 160.6, 144.3, 138.3, 128.8, 127.7, 127.6, 127.5, 127.1, 115.1, 114.9, 72.7, 69.3, 44.2, 31.5, 22.1. Anal. Calcd for $C_{17}H_{18}FNO$: C, 75.25; H, 6.69; N, 5.16. Found: C, 75.10; H, 6.80; N, 5.17.

***N*-[(*R*)-α-Methylbenzyl]-1′(*R*)-(4-fluorophenyl)aziridine-2(*S*)-methanol (12i):** mp 86−88 °C; $[\alpha]_D^{24}$ = +54.5° (*c* 0.47, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.49−7.03 (m, 7H), 6.94 (t, *J* = 8.5 Hz, 2H), 4.61 (d, *J* = 3.3 Hz, 1H), 2.66 (q, *J* = 6.5 Hz, 1H), 2.11 (d, *J* = 3.4 Hz, 1H), 1.80 (m, 1H), 1.44 (d, *J* = 6.5 Hz, 4H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 164.1, 160.9, 144.4, 137.4, 128.6, 127.9, 127.8, 127.3, 126.6, 115.3, 115.0, 69.5, 69.0, 42.6, 29.2, 23.0. Anal. Calcd for $C_{17}H_{18}FNO$: C, 75.25; H, 6.69; N, 5.16. Found: C, 75.14; H, 6.82; N, 5.20.

***N*-[(*R*)-α-Methylbenzyl]-1′(*S*)-(9-phenanthryl)aziridine-2(*S*)-methanol (10j):** mp 118−120 °C; $[\alpha]^{27}_D$ = +9.9° (*c* 1.0, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 8.69 (d, *J* = 7.9 Hz, 1H), 8.59 (d, *J* = 8.0 Hz, 1H), 8.03 (d, *J* = 7.7 Hz, 1H), 7.67−7.52-(m, 6H), 7.17−6.94(m, 5H), 5.15 (d, *J* = 3.6 Hz, 1H), 2.53 (q, *J* = 6.4 Hz, 1H), 2.21 (d, *J* = 3.5 Hz, 1H), 2.14(m, 1H), 1.65 (d, *J* = 6.3 Hz, 1H), 1.46 (d, *J* = 6.5 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 143.8, 136.2, 131.6, 130.9, 130.1, 129.9, 129.1, 128.4, 127.5, 126.8, 126.5, 126.1, 124.2, 124.0, 123.4, 122.3, 69.0, 68.9, 42.7, 32.0, 21.9. Anal. Calcd for $C_{25}H_{23}NO$: C, 84.95; H, 6.52; N, 3.96. Found: C, 84.74; H, 6.52; N, 3.94.

***N*-[(*R*)-α-Methylbenzyl]-1′(*R*)-(9-phenanthryl)aziridine-2(*S*)-methanol (12j):** mp 83−85 °C.; $[\alpha]^{24}_D$ = +0.7° (*c* 0.77, $CHCl_3$); ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.74 (d, *J* = 8.0 Hz, 1H), 8.66 (d, *J* = 8.0 Hz, 1H), 7.95−7.49 (m, 7H), 7.36−7.28(m, 5H), 5.46 (d, *J* = 2.0 Hz, 1H), 2.65 (q, *J* = 6.4 Hz, 1H), 2.25 (d, *J* = 3.5 Hz, 1H), 2.18 (m, 1H), 1.46 (d, *J* = 6.4 Hz, 3H), 1.42 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR (50.3 MHz, $CDCl_3$) δ 144.3, 128.9, 128.5, 127.3, 126.6, 126.5, 126.1, 125.7, 123.8, 123.3, 123.1, 122.9, 122.8, 122.4, 69.3, 66.7, 41.9, 30.3, 23.0. Anal. Calcd for $C_{25}H_{23}NO$: C, 84.95; H, 6.52; N, 3.96. Found: C, 84.74; H, 6.52; N, 3.94.

Representative Procedure of Aziridine Ring Reduction. To a solution of **10a** (253 mg, 1.00 mmol) in 5.0 mL of EtOAc was added 51 mg of $Pd(OH)_2$. The mixture was stirred under a balloon pressure of hydrogen for 4 h at room temperature. The reaction mixture was filtered and concentrated *in vacuo*. Purification by silica gel flash chromatography (EtOAc/hexane, 50:50) gave 217 mg of **13a** (85%) as a colorless oil.

13a: $[\alpha]^{25}_D$ = +203.0° (*c* 0.66, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.38−7.15 (m, 10H), 4.12 (d, *J* = 8.4 Hz, 1H), 3.95 (q, *J* = 6.6 Hz, 1H), 2.47 (m, 1H), 1.38 (d, *J* = 6.6 Hz, 3H), 0.91 (d, *J* = 6.3 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.8, 142.4, 129.1, 128.7, 128.1, 127.8, 127.5, 127.3, 78.4, 57.0, 55.2, 25.4, 16.1. Anal. Calcd for $C_{17}H_{21}NO$: C, 79.96; H, 8.29; N, 5.49. Found: C, 79.73; H, 8.52; N, 5.42.

(3*S*,4*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-2,2-dimethyl-3-pentanol (13b): $[\alpha]^{25}_D$ = +111.2° (*c* 1.0, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.32−7.22 (m, 5H), 3.93 (q, *J* = 6.5 Hz, 1H), 2.80 (d, *J* = 5.9 Hz, 1H), 2.52−2.39 (m, 1H), 2.46 (m, 3H), 1.38 (d, *J* = 6.5 Hz, 3H), 1.16 (d, *J* = 6.5 Hz, 3H), 0.72 (s, 9H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.6, 128.6, 127.3, 127.1, 81.0, 55.3, 49.8, 34.6, 25.9, 24.7, 21.0. Anal. Calcd for $C_{15}H_{25}NO$: C, 76.55; H, 10.71; N, 5.95. Found: C, 76.47; H, 10.77; N, 5.93.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-1-(1-naphthyl)-1-propanol (13c): $[\alpha]^{23}_D$ = +185.3° (*c* 1.0, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.4 Hz, 1H), 7.79 (d, *J* = 8.0 Hz, 1H), 7.72 (dd, *J* = 7.1, 2.2 Hz, 1H), 7.69−7.21 (m, 10H), 4.81 (d, *J* = 8.5 Hz, 1H), 3.94 (q, *J* = 6.6 Hz, 1H), 2.92 (m, 1H), 2.75 (br, 1H), 1.42 (d, *J* = 6.6 Hz, 3H), 0.94 (d, *J* = 6.3 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.9, 137.6, 134.2, 131.3, 128.8, 128.4, 127.4, 127.1, 125.7, 125.4, 125.2, 124.4, 76.4, 55.4, 55.1, 24.9, 16.9. Anal. Calcd for $C_{21}H_{23}NO$: C, 82.59; H, 7.59; N, 4.59. Found: C, 82.23; H, 7.81; N, 4.55.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-1-(2-naphthyl)-1-propanol (13d): $[\alpha]^{23}_D$ = +191.0° (*c* 1.0, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.85−7.72(m, 4H), 7.68−7.27 (m, 8H), 4.36 (d, *J* = 7.3 Hz, 1H), 4.01 (q, *J* = 6.6 Hz, 1H), 3.09 (br, 2H), 2.66 (m, 1H), 1.44 (d, *J* = 6.6 Hz, 3H), 0.99 (d, *J* = 6.2 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.9, 139.8, 133.3, 128.8, 128.2, 128.1, 127.8, 127.4, 127.3, 127.0, 126.4, 126.1, 125.9, 125.0, 78.2, 56.3, 54.9, 25.2, 16.0. Anal. Calcd for $C_{21}H_{23}NO$: C, 82.59; H, 7.59; N, 4.59. Found: C, 82.27; H, 7.82; N, 4.55.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-1-(2-methylphenyl)-1-propanol (13e): mp 82−83 °C; $[\alpha]^{23}_D$ = +189.0° (*c* 0.93, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.33−7.23 (m, 5H), 7.14−7.07 (m, 4H), 4.46 (d, *J* = 8.5 Hz, 1H), 3.97 (q, *J* = 6.6 Hz, 1H), 2.65−2.42 (m, 1H), 2.25 (s, 3H), 1.40 (d, *J* = 6.3 Hz, 3H), 0.93 (d, *J* = 6.3 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.9, 140.2, 136.1, 130.5, 128.7, 127.3, 127.3, 127.0, 126.9, 74.1, 56.1, 54.8, 25.2, 19.3, 15.9. Anal. Calcd for $C_{18}H_{23}NO$: C, 80.26.; H, 8.61; N, 5.20. Found: C, 80.16; H, 8.42; N, 5.26.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-1-(2-furyl)-1-propanol (13f): mp 73−75 °C; $[\alpha]^{19}_D$ = +143.0° (*c* 1.0, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.38−7.22 (m, 6H), 6.25 (m, 2H), 4.23 (d, *J* = 8.4 Hz, 1H), 3.95 (q, *J* = 6.6 Hz, 1H), 2.78 (m, 1H), 1.38 (d, *J* = 6.3 Hz, 3H), 0.98 (d, *J* = 6.4 Hz, 3H); ^{13}C NMR (50.3 MHz, $CDCl_3$) δ 154.8, 144.8, 141.8, 128.5, 127.0, 126.6, 110.0, 107.3, 71.7, 54.9, 54.1, 25.2, 16.6. Anal. Calcd for $C_{15}H_{17}NO_2$: C, 73.44; H, 7.81; N, 5.71. Found: C, 73.48; H, 7.87; N, 5.75.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-1-(3-methoxyphenyl)-1-propanol (13g): mp 55−57 °C; $[\alpha]^{25}_D$ = +224.0° (*c* 0.93, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.38−7.11 (m, 6H), 6.92−6.74 (m, 3H), 4.17 (d, *J* = 8.2 Hz, 1H), 3.97 (q, *J* = 6.6 Hz, 1H), 3.72 (s, 3H), 2.58−2.44 (m, 1H) 1.41 (d, *J* = 6.6 Hz, 3H), 0.95 (d, *J* = 6.3, Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 159.8, 145.0, 144.1, 129.2, 128.7, 127.3, 127.0, 120.0, 113.3,

112.4, 78.0, 56.4, 55.0, 54.9, 25.2, 16.1. Anal. Calcd for $C_{18}H_{23}NO_2$: C, 75.76; H, 8.12; N, 4.91. Found: C, 75.62; H, 8.02; N, 5.10.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-1-(4-chlorophenyl)-1-propanol (13h): mp 88−90 °C; $[\alpha]^{23}_D = +172.1°$ (*c* 3.59, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.47−7.05 (m, 9H), 4.07 (d, J = 8.4 Hz, 1H), 3.92 (q, J = 6.5 Hz, 1H), 2.92 (br, 1H), 2.46−2.32 (m, 1H), 1.35 (d, J = 6.5 Hz, 3H), 0.88 (d, J = 6.3 Hz, 3H); ^{13}C NMR (50.3 MHz, $CDCl_3$) δ 144.6, 140.7, 133.1, 128.5, 128.3, 128.2, 127.1, 126.7, 77.4, 56.6, 55.0, 25.2, 16.2. Anal. Calcd for $C_{17}H_{20}ClNO$: C, 70.46; H, 6.96; N, 4.83. Found: C, 70.71; H, 7.01; N, 4.87.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino]-1-(4-fluorophenyl)-1-propanol (13i): $[\alpha]_D^{24} = +190.4°$ (*c* 2.15, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.39−7.35 (m, 5H), 7.27−7.14 (m, 2H), 7.00−6.91 (m, 2H), 4.41 (d, J = 8.8 Hz, 1H), 4.18 (q, J = 6.6 Hz, 1H), 2.73−2.60 (m, 1H), 1.57 (d, J = 6.6 Hz, 3H), 0.99 (d, J = 6.3 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 140.4, 136.7, 129.3, 128.8, 128.7, 128.5, 127.0, 115.5, 115.3, 75.9, 57.0, 55.3, 23.1, 14.0. Anal. Calcd for $C_{17}H_{20}FNO$: C, 74.70; H, 7.37; N, 5.12. Found: C, 74.61; H, 7.62; N, 5.02.

(1*S*,2*S*)-2-[*N*-[(*R*)-α-Methylbenzyl]amino-1-(9-phenanthryl)-1-propanol (13j): mp 120−122 °C.; $[\alpha]^{23}_D = +108.0°$ (*c* 2.0, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ 8.70−8.61 (m, 2H), 7.95−7.53 (m, 7H), 7.39−7.24 (m, 5H), 4.84 (d, J = 8.0 Hz, 1H), 3.92 (q, J = 6.6 Hz, 1H), 3.06 (m, 1H), 1.41 (d, J = 6.5 Hz, 3H), 1.02 (d, J = 6.2 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 144.8, 135.8, 131.2, 130.8, 130.2, 130.1, 128.6, 128.4, 127.0, 126.7, 126.5, 126.2, 126.1, 125.9, 125.0, 123.0, 122.3, 76.6, 55.3, 54.9, 24.9, 17.4. Anal. Calcd for $C_{25}H_{25}NO$: C, 84.47; H, 7.09; N, 3.94. Found: C, 84.44; H, 6.96; N, 3.90.

Preparation of (+)-(1*S*,2*S*)-2-[*N*-(*tert*-Butoxycarbonyl)-amino]-1-phenyl-1-propanol (15a). To a stirred solution of **10a** (311 mg, 1.23 mmol) in 12.3 mL of EtOAc was added Pearlman's catalyst (31 mg), and the mixture was stirred for 6 h under a balloon pressure of hydrogen. After complete consumption of **10a** the amount of the solvent was reduced to half and $(Boc)_2O$ (269 mg, 1.23 mmol) was added to the mixture. The mixture was stirred for another 6 h under a balloon pressure of hydrogen, and the catalyst was filtered. The solvent was removed, and the residue was chromatographed on silica gel to provide 262 mg of **15a** (85%) as a solid: mp 85−87 °C; $[\alpha]^{25}_D = +34.1°$ (*c* 0.05, $CHCl_3$); ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.38−7.27 (m, 5H), 4.68 (br, 1H), 4.57−4.54 (m, 1H), 3.86 (m, 1H), 3.24 (br, 1H), 1.41 (s, 9H), 1.07 (d, J = 6.7 Hz, 3H); ^{13}C NMR (75.4 MHz, $CDCl_3$) δ 157.1, 142.2, 128.8, 128.2, 127.1, 80.0, 52.7, 28.4, 17.7. Anal. Calcd for $C_{14}H_{21}NO_3$: C, 66.91; H, 8.42; N, 5.57. Found: C, 67.06; H, 8.63; N, 5.59.

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