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Asymmetric Synthesis of (+) and (-) *trans*-2,6-dimethylpiperidines.

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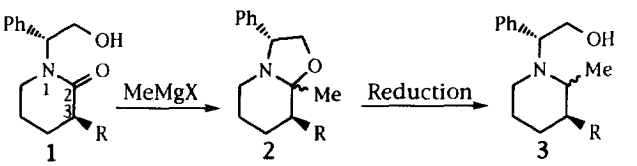
Abstract : (+) and (-) *trans*-2,6-dimethylpiperidines **9** have been prepared from diastereomeric lactams **6** and **11**, both available from (*R*)-(-)-phenylglycinol **4**. Diastereoselective C-2 alkylation afforded oxazolidines **7** and **12**. Reduction of **7** with $LiAlH_4$ or $NaBH_4$ led to *trans*-2,6-**8** with total retention of configuration. When **12** was reduced with $NaBH_4$, *trans* derivative **13a** was isolated as the major isomer. A mechanism is proposed to explain the different results. © 1997 Elsevier Science Ltd.

INTRODUCTION

Recently we described a method for the preparation of optically pure 2,3-disubstituted piperidines **3**, involving C-2 functionalization of chiral, non-racemic alkylated lactams **1**.[1] The intermediate oxazolidines **2** were obtained by addition of a Grignard reagent, followed by cyclization of the hydroxyl group onto the transient carbinolamine (Scheme 1). The diastereoselectivity observed during the formation of **2** was dependent on the nature of the organometallic species and the C-3 substituent. When $LiAlH_4$ was used, opening of the oxazolidine ring was diastereoselective and occurred with retention of configuration, as previously observed by Meyers.[2]



1 2 3

Scheme 1

At the same time, we developed two new methods for the preparation of (*R*)- and (*S*)-6-methyl lactams **6** and **11**, starting from (*R*)-(-)-phenylglycinol **4** (Scheme 2). One methodology[3] involved the formation of oxazolopiperidine **5**[2a], followed by a diastereoselective reduction. The other one[4] was based on the diastereoselective alkylation-reduction sequence of cyano-oxazolopiperidine **10** (CN(*R,S*) method[5]) leading to an oxazolidine intermediate which was submitted to an oxidation process (Br_2, HO^-) to furnish lactam **11**.

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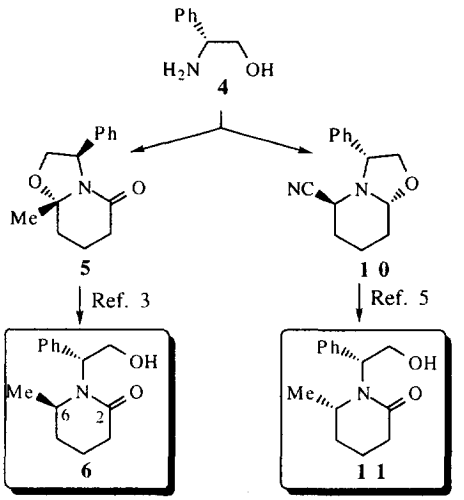


Scheme 2

At this point of our results, we considered applying the carbonyl functionalization method to **6** and **11** in order to get 2,6-disubstituted piperidines (Figure 1). It was particularly interesting to study the influence of the C-6 configuration on the diastereoselectivity of the alkylation and reduction steps. If the *cis-trans* ratio was observed to be different in the two series, one can expect to develop an alternative method to the preparation of *cis* and *trans* 2,6-disubstituted piperidines. The first results in the 2,6-dimethylpiperidine series are reported in this paper.

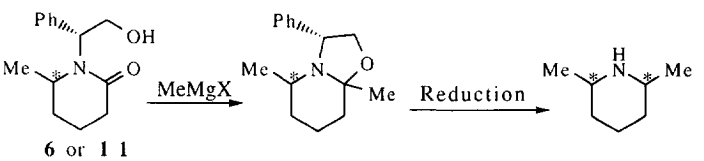


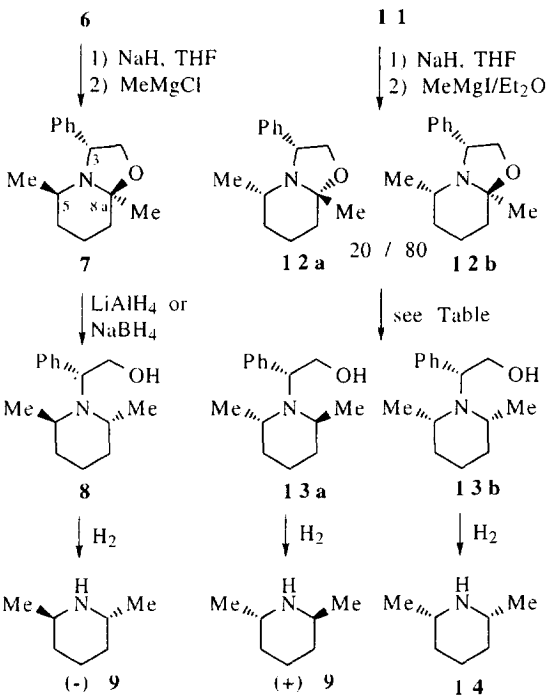
Figure 1

In the literature, numerous racemic approaches are described. Most of them consist in reducing 2,6-dimethylpyridine to lead to a mixture of *trans* and *cis* 2,6-dimethylpiperidines in 70-85 % yield[6].The diastereomeric excess depends on the reducing agents (H_2 in the presence of Ni-Al, Ru/C, Na/EtOH, Zn/AcOH/Ac_2O). Another strategy is based on reductive amination of a 2,6-diketone[7]. The major product is the *cis* isomer (70% yield). Few asymmetric syntheses were developed[8,9]. The most efficient consists in synthesizing a diol from an asymmetric sulfone[9b]. After tosylation, the product was cyclized with benzylamine and hydrogenolyzed to lead to *trans*-2,6-dimethylpiperidine in 89 % yield and with a high level of enantioselectivity. Recently, a short synthesis of *trans*-(2*S*, 6*S*)-lupetidine was achieved in four steps from a chiral pyridinium salt derived from (*R*)-(-)-phenylglycinol. A *trans*-2,6-dimethyl-Δ^3-piperideine was obtained in 50% d.e. after successive alkylations of the pyridinium salt and of the resultant tetrahydrooxazolopyridine[8].

RESULTS AND DISCUSSION

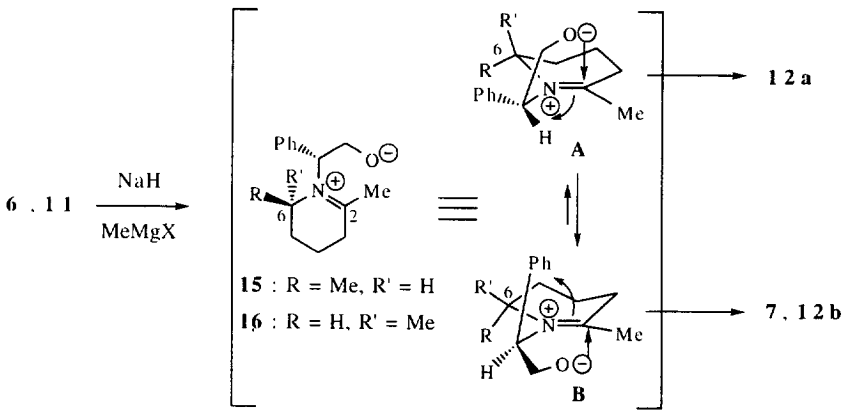
Oxazolidine **7** was obtained by cyclisation of the alcoholate of **6** in the presence of MeMgCl (7 eq., 3M/THF) in THF in 55% yield (Scheme 3). Only one diastereomer was detected by NMR, (d.e. superior to 98%). The stereochemistry of this compound was determined by nOe experiments; irradiation of C-8a methyl induced a nOe on H-5 and aromatic protons. Reduction of oxazolidine **7** with $LiAlH_4$ or $NaBH_4$ led to alcohol **8** in 82 % yield and a diastereomeric excess superior to 98 %. Hydrogenolysis (H_2, Pd/C 10 %) of **8** afforded (-) **9** in 60 % yield. The $[\alpha]_D$ value is in agreement with the previously reported value[10].

The same strategy was applied to lactam **11**. We first observed that this compound was less reactive towards MeMgCl than diastereomeric compound **6**. When the reaction was performed in THF, a equimolar mixture of **12a** and **12b** was obtained in poor yield; in Et_2O the alcoholate was not soluble and the reaction was very slow. Finally, we prepared the alcoholate in THF (NaH, 1.2 eq.), then added MeMgI (10 eq.) in Et_2O at rt. Under these conditions, the oxazolidines **12a** and **12b** were obtained in a 20/80 ratio in 45 % yield (70 % from reacting lactam).



Scheme 3

To explain the diastereoselectivity observed during formation of oxazolidines **7** and **12**, it is necessary to consider the intermediate iminium ions **15** and **16** (Scheme 4). They have to adopt one of the two conformations **A** or **B** in order to cyclize to oxazolidines. Strong interactions between phenyl ring and C-6 substituents disfavour conformation **A**. Cyclization can then occur via intermediate **B** by a stereoelectronically controlled attack of the nucleophile leading to compounds **7** and **12b**. The poorest diastereoselectivity observed for **12** (60 %) is the result of an increased allylic interaction between chiral auxilary and C-6 methyl which adopted a pseudo equatorial position (**16B**, R' = Me).



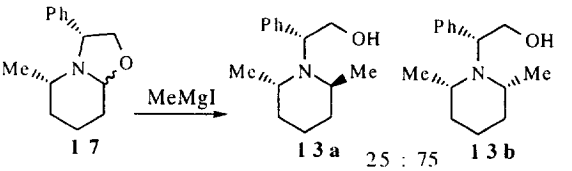
Scheme 4

As the two diastereomers **12a** and **12b** turned out to be difficult to separate, the reduction step was conducted on the mixture of oxazolidines. When $LiAlH_4$ was used, the disubstituted piperidines **13a** and **13b** were obtained in 68 % yield with the same 20:80 ratio (Table).

Table : Reduction of oxazolidines **12a,b**.

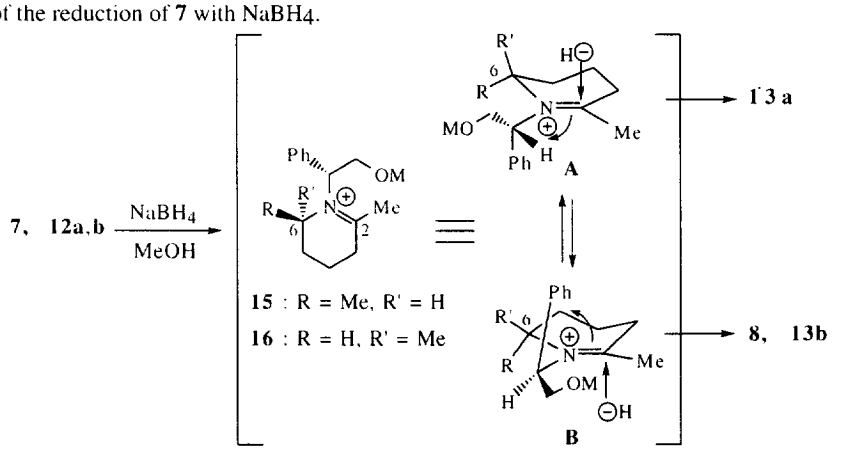
Reducing agent	Yield (%)	**13a**	**13b**
$LiAlH_4$ / THF	68	20	80
$NaBH_4$ / MeOH	72	85	15

This result, reflecting the stereochemical homogenity of the oxazolidines, is in agreement with Meyers' report[2], and is a consequence of the virtually complete retention of configuration at the C-2 position when various aluminium hydride were used. The *cis* relationship of C-2 and C-6 substituents of the major isomer was confirmed by the preparation of *trans*-2,6-dimethylpiperidine **13a** (vide infra) and by comparison with the products obtained by reaction of oxazolidine **17**[4] with MeMgI (Scheme 5). Indeed, it is known that such a reaction is stereoselective producing the *cis*-2,6- diastereomer **13b** as the major product[12].



Scheme 5

By analogy with our earlier results[11], treatment of **12** with $NaBH_4$ in methanol led to formation of a 85 : 15 mixture of the *trans* compound **13a** and its *cis* isomer **13b**. This result has been explained by a mechanism involving prior formation of the iminium ion **16** (Scheme 6). In this case, and in contrast with the mechanism proposed in Scheme 4, the N-phenylethanol chain can adopt a conformation in which the steric hindrance between the aromatic ring and the C-6 substituent is minimized. Consequently, the C-6 methyl pseudo axial conformation **16A** was favoured as it minimized steric interactions between the chiral auxilary and the C-6 methyl group. The stereoelectronically controlled approach of the incoming hydride from the axial direction would lead to formation of the major reaction product **13a**. The same considerations involving iminium **15B** can explain the formation of **8** in the course of the reduction of **7** with $NaBH_4$.



Scheme 6

Hydrogenolysis (H_2, $Pd(OH)_2/C$) of **13a** and **13b** afforded (+) **9** and **14** in 75 and 80% yield respectively. Compound **9** was identical with the *trans*-2,6-dimethylpiperidine obtained from lactam **6** (IR, MS, NMR) and exhibited an opposite $[\alpha]_D$ value. For the *cis*-2,6-derivative **14**, all the spectra data correlated well with those previously reported[8].

In conclusion we have developed a new strategy for the preparation of both enantiomers of *trans*-2,6-dimethylpiperidine. Some informations concerning the configuration of the intermediates have been obtained, it can explain the results observed during the alkylation and reduction steps. The application of this methodology to the synthesis of various *trans*-substituted piperidines will be reported in due course.

EXPERIMENTAL SECTION

Melting points were determined on a Büchi 530 apparatus and were uncorrected. Boiling points were uncorrected . For a column chromatography, silica gel (Merck silica gel 60F234, 70-230 mesh) was used. ^{1}H-NMR spectra were recorded on a Bruker ARX 250 spectrometer in $CDCl_3$ with TMS as internal standard. The data were presented in the format : chemical shift (multiplicity, number of protons, coupling constant). ^{13}C-NMR were recorded on a Bruker ARX 250 spectrometer in $CDCl_3$. Optical rotations were measured on a Perkin-Elmer model 241 polarimeter. Concentrations in g/100 mL of solvent were included following the measured optical rotations. Microanalyses were made by Université P. et M. Curie (Centre Régional de Microanalyse). Mass spectra was made by J. C. Tabet (Université P. et M. Curie) or by F. Libot (Faculté de Pharmacie).

(-)-(3*R*,8a*S*)-8a-methyl-3-phenyl-hexahydro-oxazolo-[3,2-a]-pyridin-5-one 5

5-Oxohexanoic acid (10.3 g, 80 mmol) and *R*-(-)-phenylglycinol **4** (10.9 g, 80 mmol) in toluene (100 mL) were refluxed for a night. The solvent was removed *in vacuo* and the diastereomers were isolated (d.e. 60%). After separation by chromatography on silica gel using ethyl acetate/cyclohexane (90 : 10), the *cis* isomer was obtained in 74% yield and crystallized from Et_2O; mp 62°C ; $[\alpha]^{20}_D$ -164.9 (c 1.43, MeOH) ; ^{1}H NMR ($CDCl_3$) δ : 1.4 (s, 3H), 1.5-2.0 (m, 2H), 2.1-2.2 (m, 2H), 2.2-2.6 (m, 2H), 3.9 (dd, 1H, J = 7.8 and 8.8 Hz), 4.5 (dd, 1H, J = 1.0 and 8.8 Hz), 5.3 (dd, 1H and 7.8 Hz), 7.2 (m, 5H) ; ^{13}C NMR ($CDCl_3$) δ : 16.7, 23.1, 30.2, 34.7 58.0, 69.0, 93.4, 125.0, 126.6, 128.0, 139.6, 168.9. Anal. Calcd for $C_{14}H_{17}NO_2$: 72.70 (C) ; 7.41 (H) ; 6.06 (N) : Found 72.68 (C) ; 7.62 (H) ; 5.89 (N).

(-)-(6*R*)-1-((1*R*)-2-hydroxy-1-phenyl-ethyl)-6-methyl-piperidin-2-one 6

At -78°C, titanium (IV) chloride (14 mL, 6 eq) was added to lactam **5** (5 g, 21 mmol) in CH_2Cl_2 (125 mL). After 15 min of complexation, triethylsilane (20 mL, 6 eq) was added to the solution. The reaction mixture was stirred for 90 min at -78°C and 16 h at rt. The solution was hydrolyzed at -20°C by saturated aqueous NH_4F (50 mL) for 3 h. Then, the solution was extracted with CH_2Cl_2. The organic layers were washed with saturated aqueous $NaHCO_3$ (20 mL), saturated aqueous $(NH_4)_2SO_4$ (20 mL) and dried over $MgSO_4$. The solvent was removed *in vacuo* and the diastereomers (d.e. 80%) were obtained in 72% yield.

Benzoyl chloride (2.1 mL, 1.2 eq) and pyridine (2,1 mL) in CH_2Cl_2 (5 mL) were added to crude diastereomeric alcohols (3.6 g, 10 mmol) at 0°C. After stirring for 15 min, the organic layer was washed with hydrochloric acid 2N (5 mL), with saturated aqueous $(NH_4)_2SO_4$ (5 mL) and dried over $MgSO_4$. Diastereomeric benzoates were isolated (d.e. 80%). The major one was isolated by crystallization from Et_2O in 84% yield (mp 101°C).

The latter was saponified with 1% NaOH in MeOH for 1 h. The solvent was removed and the residue was dissolved in H_2O (5 mL). The aqueous layer was extracted with CH_2Cl_2. The combined organic layers were then dried over $MgSO_4$ and the solvent was removed *in vacuo*. The alcohol was crystallized from Et_2O in 95% yield (d.e. > 98%); mp 82°C ; $[\alpha]^{20}_D$ -12.2 (c 1.3, MeOH) ; ^1H NMR ($CDCl_3$) δ : 1.1 (d, 3H, J = 6.5 Hz), 1.5-2.0 (m, 4H), 2.3-2.6 (m, 2H), 3.4 (m, 1H), 4.0 (m, 1H), 4.3 (m, 1H), 4.5 (m, 1H), 4.6 (m, 1H), 7.2 (m, 5H) ; ^{13}C NMR ($CDCl_3$) δ : 16.3, 19.8, 29.6, 32.2, 53.4, 64.3, 65.7, 127.5, 128.6, 137.5, 171.8. Anal. Calcd for $C_{14}H_{19}NO_2$: 72.07 (C) ; 8.21 (H) ; 6.00 (N) ; Found 71.98 (C) ; 8.19 (H) ; 5.93 (N).

(-)-(3*R*,5*R*,8a*S*)-(5,8a)-dimethyl-3-phenyl-hexahydro-oxazolo[3,2-a]-pyridine 7

Sodium hydride (171 mg, 4.3 mmol) (60% by weight in mineral oil) was added to alcohol **6** (1 g, 4.3 mmol) in THF (10 mL). After stirring at rt for 1 h, MeMgCl (3M/THF) (10 mL, 7 eq) was added to the mixture and the solution was refluxed for 12 h. After cooling, the reaction mixture was quenched with saturated aqueous NH_4Cl (20 mL) and with hydrochloric acid 2.4 N (10 mL). The solution was extracted with CH_2Cl_2. The combined organic layers were dried over $MgSO_4$, the solvent removed *in vacuo* and the residue chromatographed on silica gel using ethyl acetate/cyclohexane (90 : 10). Compound **7** was crystallized from pentane in 55% yield (d.e. > 98%); mp 47°C ; $[\alpha]^{20}_D$ -101.5 (c 1.04, MeOH) ; ^1H NMR ($CDCl_3$) δ : 0.6 (d, 3H, J = 6.9 Hz), 1.1-1.8 (m, 6H), 1.4 (s,3H), 3.1 (m, 1H), 3.5 (dd, 1H, J = 9.5 and 12.4 Hz), 4.2 (dd, 2H, J = 3.8 and 12.4 Hz) 7.1-7.4 (m, 5H). ^{13}C NMR ($CDCl_3$) δ : 22.1, 22.3, 24.1, 26.3, 29.7, 51.4, 59.4, 72.7, 95.5, 126.7, 126.9, 128.2, 147.0. Anal. Calcd for $C_{15}H_{21}NO$: 77.88 (C) ; 9.15 (H) ; 6.05 (N) ; Found 77.53 (C) ; 9.05 (H) ; 5.78 (N).

(-)-(2'*R*)-((2*R*,6*R*)-2,6-dimethyl-piperidin-1-yl)-2'-phenyl-ethanol 8

A: Oxazolopiperidine **7** (400 mg, 1.7 mmol) in Et_2O (10 mL) was slowly added at 5°C to $LiAlH_4$ (100 mg, 2.6 mmol) in suspension in Et_2O (10 mL). The mixture was stirred at this temperature for 1 h. The reaction mixture was then quenched with H_2O (5 mL) and with NaOH 3N (5 mL). After filtration through celite, the solution was extracted with Et_2O. The organic layer was dried over $MgSO_4$ and the solvent removed *in vacuo*. Compound **8** was isolated in 82% yield as a colorless oil (d.e. > 98%). $[\alpha]^{20}_D$ -79.5 (c 1.27, MeOH) ; ^1H NMR ($CDCl_3$) δ : 0.7 (d, 6H, J = 6.4 Hz), 1.1-1.3 (m, 2H), 1.4 -1.7 (m, 4H), 3.2 (m, 2H), 3.5 (dd, 1H, J = 5.0 and 9.9 Hz), 3.9 (t, 1H, J = 9.9 Hz), 4.3 (dd, 1H, J = 5.0 and 9.9 Hz), 7.1-7.3 (m, 5H) ; ^{13}C NMR ($CDCl_3$) δ : 17.5, 19.2, 35.9, 46.1, 58.3, 58.4, 127.4, 127.9, 128.0, 128.5, 140.3. Anal. Calcd for $C_{15}H_{23}NO$: 77.20 (C) ; 9.94 (H) ; 6.00 (N) ; Found 77.39 (C) ; 10.14 (H) ; 5.73 (N).

B: $NaBH_4$ (114 mg, 3 mmol) was added to a cooled (5°C) solution of oxazolidine **7** (100 mg, 0.4 mmol) in MeOH (30 mL). The resulting mixture was stirred at this temperature for 3 h then quenched with H_2O (10 mL) and the solvent removed *in vacuo*. The aqueous layer was then dried over $MgSO_4$ and the solvent removed *in vacuo*. Compound **8** was isolated in 80% yield (de > 98%).

(-)-(2*R*,6*R*)-2,6-dimethylpiperidine or lupetidine 9

Alcohol **8** (850 mg, 3.6 mmol) in ethanol (5 mL) was added to palladium on charcoal (10%) (850 mg, 1 eq) in suspension in ethanol (20 mL). Concentrated hydrochloric acid (5 mL) was added and the mixture was hydrogenolyzed at rt under atmospheric pressure for 12 h. After filtration on celite, the solvent was removed *in vacuo*. The residue was dissolved in H_2O and the aqueous layer was washed with Et_2O. Then, the acid layer was neutralized with solid K_2CO_3 and the reaction mixture extracted with Et_2O. The combined organic layers were dried over $MgSO_4$ and the solvent distilled under atmospheric pressure. Compound **9** was purified by distillation and obtained in 60% yield; bp 74°C (85 mm Hg). $[\alpha]^{20}_D$ -12 (c 0.5, EtOH) (lit[11] -14° (EtOH)) ; ^{1}H NMR ($CDCl_3$) δ : 1.0 (d, 6H, J = 6.5 Hz), 1.2 (m, 2H), 1.5 (m, 4H), 3.1 (m, 2H) ; ^{13}C NMR ($CDCl_3$) δ : 19.4, 21.0, 32.8, 46.0. Anal. Calcd for $C_7H_{15}N$: 74.27 (C) ; 13.36 (H) ; 12.37 (N) ; Found 74.04 (C) ; 13.31 (H) ; 12.23 (N) ; MS m/e 114.98.

(3*R*,5*S*)-(5,8a)-dimethyl-3-phenyl-hexahydro-oxazolo[3,2-a]-pyridine 12a,b

Sodium hydride (238 mg, 6.18 mmol) (60% by weight in mineral oil) was added at 0°C under a nitrogen atmosphere to a solution of lactame **11** (1.2 g, 5.15 mmol) in THF (100 mL). After stirring at rt for 1 h, MeMgI (17 mL, 10 eq, 3M/Et_2O) was carefully added, giving a white precipitate. This mixture was vigorously stirred for 2 h. After cooling, the resulting suspension was quenched with saturated aqueous NH_4Cl (40 mL) then extracted twice with EtOAc. The combined organic layers were dried over $MgSO_4$ and the solvent removed *in vacuo*. The oily residue was purified by flash-chromatography on silica gel using EtOAc to furnish oxazolidine **12** (536 mg, 2.32 mmol, 45%) as a 80:20 mixture of unseparable diastereomers, and recovered lactam **11** (443 mg, 1.9 mmol, 37%). ^{1}H NMR ($CDCl_3$) δ : 0.55 and 0.95 (2d, J = 6 Hz, 6H, Me), 0.85 (m, 2H, H-4), 1.5-1.9 (2m, 4H, H-3, H-5), 2.80 (m, 1H, H-2), 3.64 (t, J = 6.9 Hz, 1H, H-8), 4.18 (dd, J = 7.7, 6.9 Hz, 1H, H-8), 4.23 (dd, J = 7.7, 6.9 Hz, 1H, H-7), 7.15-7.40 (m, 5H, Ar). ^{13}C NMR ($CDCl_3$) δ : 17.9, 22.7, 28.0, 29.2, 33.1, 53.1, 67.9, 70.4, 95.0, 126.8-128.3, 143.8. MS m/z (relative intensity), 231($M^{+\bullet}$), 216(70), 188(35), 162(45), 146(50).

(-)-(2'*R*)-((2*S*,6*S*)-2,6-dimethyl-piperidin-1-yl)-2'-phenyl-ethanol 13a

To a cooled solution of the oxazolidine mixture **12a,b** (210 mg), 0.91 mmol) in MeOH (15 mL) an excess of $NaBH_4$ (200 mg) was added at 0°C. The resulting mixture was stirred at rt for 2 h then quenched with saturated aqueous NH_4Cl (10 mL) and extracted with CH_2Cl_2. The combined organic layers were dried over $MgSO_4$ and the solvent removed *in vacuo*. The residue was purified by column chromatography (Al_2O_3, CH_2Cl_2:cyclohexane, 50:50) to give **13** (150 mg, 72%) as a 85:15 mixture of diastereomers.

The *trans* diastereomer **13a** was isolated pure after preparative tlc (Al_2O_3) using the same eluant; colorless oil, $[\alpha]_D$: -19 (c = 1.35, $CHCl_3$). ^1H NMR ($CDCl_3$) δ : 1.0-1.4 (3m, 6H, H-3, H-4, H-5), 1.20 (d, J = 7 Hz, 6H, CH_3), 3.32 (m, 2H, H-2, H-6), 3.52 (dd, J = 9.9, 5.6 Hz, 1H, H-8), 3.85 (t, J = 9.9 Hz, 1H, H-8), 4.20 (dd, J = 9.9, 5.6 Hz, 1H, H-7), 7.15-7.40 (m, 5H, Ar). ^{13}C NMR ($CDCl_3$) δ : 20.0, 30.2, 47.8, 59.6, 60.3, 127.2-129.0, 141.3. MS, m/z (relative intensity) : 234(M^{+1}, 100), 202(25). Anal. Calcd for $C_{15}H_{23}NO$: 77.21 (C) ; 9.93 (H) ; 6.00 (N) ; Found 76.95 (C) ; 9.81 (H) ; 6.01 (N).

(-)-(2'*R*)-((2*R*,6*S*)-2,6-dimethyl-piperidin-1-yl)-2'-phenyl-ethanol 13b

A: $LiAlH_4$ (150 mg, 5.70 mmol) was proportionwise added to a cooled (-5°C) solution of oxazolidine **12a,b** (205 mg, 0.88 mmol) in THF (30 mL) under an argon atmosphere. The mixture was stirred at rt for 2 h and then treated successively with H_2O (0.15 mL), 15% NaOH (0.15 mL) and H_2O (0.45 mL). After filtration on a short pad of $MgSO_4$, the residual white solid was washed several times with Et_2O. Removal of the solvent *in vacuo* gave a product which was purified by column chromatography (Al_2O_3, CH_2Cl_2:cyclohexane, 50:50) to yield 135 mg of **13** (0.58 mmol, 68%) as a 20:80 mixture of diastereomers.

B: MeMgI in Et_2O (1.5 mL, 4.5 mmol) was slowly added to a cooled (-5°C) solution of oxazolidine **17** (260 mg, 1.19 mmol) in THF (20 mL) under an argon atmosphere. After stirring at rt for 2 h, the mixture was quenched with saturated aqueous NH_4Cl (10 mL) and extracted with CH_2Cl_2 . The combined organic layers were dried over $MgSO_4$ and the solvent removed *in vacuo*. The oily residue was filtred on a short pad of alumina (CH_2Cl_2) to give a 75:25 mixture of *cis* **13b** and *trans* **13a** diastereomers (220 mg, 78%).The major one **13b** was isolated pure after preparative tlc (Al_2O_3, CH_2Cl_2:cyclohexane, 50:50); colorless oil, $[\alpha]_D$: -24 (c = 1.45, $CHCl_3$). ^1H NMR ($CDCl_3$) δ : 1.08 and 1.18 (2d, J = 7 Hz, 6H, Me-2, Me-6), 1.30-1.45 (m, 4H, H-4, H-5), 1.65 (m, 2H, H-3), 2.88 (m, 1H, H-6), 3.05 (m, 1H, H-2), 3.80 (dd, J = 8.6, 6.3 Hz, 1H, H-8), 3.86 (t, J = 8.6 Hz, 1H, H-8), 4.22 (dd, J = 8.6, 6.3 Hz, 1H, H-7), 7.20-7.35 (m, 5H, Ar). ^{13}C NMR ($CDCl_3$) δ : 19.2, 21.1, 32.9, 33.7, 50.2, 53.0, 61.8, 62.4, 127.3-129.0, 139.8. MS, m/z (relative intensity) : 234 (M^{+1}, 90), 202(30). Anal. Calcd for $C_{15}H_{23}NO$: 77.21 (C) ; 9.93 (H) ; 6.00 (N) ; Found 77.14 (C) ; 9.78 (H) ; 5.82 (N).

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