Stereoselective Intramolecular Cyclization of Allyl and Homoallyl Benzamide via π-Allylpalladium Complex Catalyzed by Pd(0)

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The transformation of acyclic allylic benzamides **4** and homoallylic benzamides **12** to vinyl oxazolines **3** is achieved in the presence of base by the catalysis of Pd(0) in high yield and with high diastereoselectivity. Especially, in the case of homoallylic benzamides **12**, *trans*-oxazolines **3** are formed exclusively or predominantly over *cis*-oxazolines **8**, irrespective of the composition of their stereoisomers. The reaction is believed to proceed via the same π-allylpalladium complex that arises from either primary or secondary allylic acetates. We applied this method to the syntheses of β-amino-α-hydroxy acids **1** and γ-amino-β-hydroxy acids **2**, conveniently protected as oxazoline.

Introduction

The palladium(0)-catalyzed allylation of nucleophiles (the Tsuji−Trost reaction) is a highly accepted synthetic method due to its broad applicability and facile experimental procedure.[1] The catalytic cycle requires the formation of the cationic π-allylpalladium(II) complex, an intermediate which can be attacked by nucleophiles at the allylic system.[2]

The palladium(0)-catalyzed intramolecular cyclization of benzamide via π-allylpalladium complex is useful for the synthesis of highly functionalized compounds, particularly when chirality transfer is involved.[3]

In our previous paper,[4] we described a new procedure for the highly stereoselective formation of 4-phenyl-5-vinyl-substituted oxazoline ring from the acyclic allylic amide having a benzoyl substituent as N-protection group in the presence of tetrakis triphenylphosphine palladium(0) and base (K_2CO_3). The most significant point of this method is that it is based on the *trans*-oxazoline ring formation of **4a** under palladium(0)-catalyzed conditions.

During our investigation, it was reported that vinyloxazolidinones undergo palladium(0)-catalyzed ionization followed by loss of carbon dioxide and subsequent cyclization to form vinyloxazolines.[5] However, little is known about the oxazoline formation reaction in palladium(0)-catalyzed cyclization from acyclic allylic and homoallylic amides having a benzoyl substituent as N-protection group. Despite its importance as an efficient and straightforward method for the preparation of physiologically valuable β-amino acid or γ-amino acid derivatives, the palladium(0)-catalyzed oxazoline formation has not been intensively studied.

In this paper, we describe our complementary investigations of oxazoline ring formation and its conversion to amino hydroxy acids via the oxidation of the vinyl group, protected as the oxazoline (Scheme 1).

Our program is directed toward the application of the newly developed palladium(0)-catalyzed cyclization reaction to the stereoselective synthesis of β-amino-α-hydroxy and γ-amino-β-hydroxy acids, which are biologically active and play very important roles in living organisms. Therefore, the diastereo- and enantiomerically pure oxazoline ring formation reactions are becoming important areas of research.[6]

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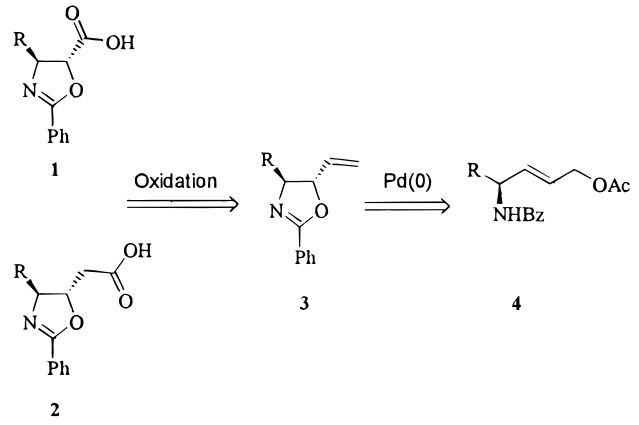
Scheme 1



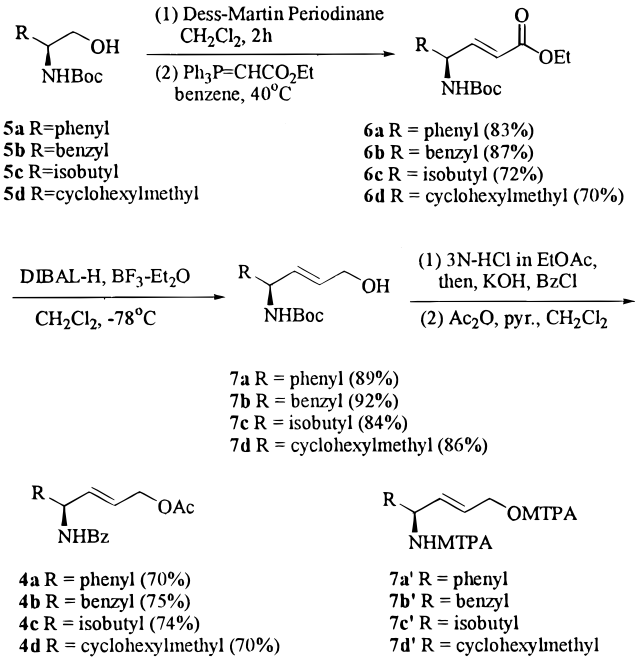
Results and Discussion

The key step in our approach involves a highly enantioselective oxazoline formation catalyzed by palladium(0).

The requisite cyclization precursor **4a** was straightforwardly prepared in high yield (51.7%) from the commercially available *N*-*t*-Boc-L-phenylglycinol (**5a**) by a five-step sequence as shown in Scheme 2. Oxidation of the known alcohol[7] **5a** with Dess−Martin reagent[8] afforded the corresponding aldehyde, followed by a Wittig olefination using (carbethoxymethylene)triphenylphosphorane, led to the *E*-unsaturated ester **6a**. Thus, reduction of the *E*-unsaturated ester, using DIBAL[9] at −78 °C produced the corresponding allyl alcohol[10] **7a** in high yield. Deprotection of the Boc group using aqueous hydrochloric acid followed by benzoylation of the resulting amino group formed the *N*-benzoyl alcohol. Acetylation of the hydroxy group provided the key precursor **4a** of the cyclization.

Conditions for the cyclization of the oxazoline precursor **4a** were intensively explored by examining the effects of bases, ligands, and solvents as summarized in Table 1. The reaction of **4a** with NaH (1 equiv) in DMF in the presence of $Pd(PPh_3)_4$ (5 mol %) at room temperature was monitored by analytical TLC, and the starting material **4a** was completely consumed after 8 h. Purification with silica gel column chromatography using *n*-hexane/ethyl acetate (10:1) as eluent gave a 2:3 mixture of oxazoline **3a** and elimination product **9a** in 75% isolated yield (Table 1, entry 1). Reaction at room temperature for 8 h

Scheme 2



in DMF with NaH (1 equiv) in the presence of Pd_2dba_3−$CHCl_3$ (1 mol %) and PPh_3 (8 equiv) gave about 2:3 mixture of **3a** and **9a** in 77% yield, while the reaction at room temperature for 8 h in DMF with NaH (1 equiv) in the presence of Pd_2dba_3−$CHCl_3$ (1 mol %) and dppe (4 mol %) afforded only the elimination product **9a** in 90% yield (entries 2 and 3). The reaction of **4a** with K_2CO_3 in the presence of $Pd(PPh_3)_4$ in CH_3CN at reflux for 24 h proceeded smoothly to afford a 6:1 mixture of **3a** and **9a** in favor of **3a** as the desired product (entry 4). The use of CH_2Cl_2, DMF, THF as a solvent under the same condition gave **3a** in yields ranging between 40 and 70% (entries 5−7).

A palladium−bidentate phosphine ligand system, such as Pd_2dba_3−$CHCl_3$−dppe or Pd_2dba_3−$CHCl_3$−PPh_3 was also tested, but yields of **3a** were lower than those obtained with $Pd(PPh_3)_4$ (entries 8 and 9). As a result of extensive examination of various reaction conditions, we found that the reaction of **4a** with K_2CO_3 in CH_3CN in the presence of $Pd(PPh_3)_4$ catalyst gave **3a** in high yields. In all cases, *cis*-oxazoline **8a** was not detected.

The reaction of **4b**−**d** having benzyl, isobutyl, and cyclohexylmethyl as substituent group with K_2CO_3 in the presence of $Pd(PPh_3)_4$ in CH_3CN at reflux for 24 h afforded the desired *trans*-oxazolines **3b**−**d** as the major products along with a minor amount of the *cis*-oxazoline products **8b**−**d**. The application of this methodology afforded high diastereoselectivity and chemical yield.[11] The results are summarized in Table 2.

The trans-diastereoselectivity decreased to 86−87% with the sterically less bulky benzyl, isobutyl, and cyclohexylmethyl group of **4**. The trans-diastereoselectivity increased to 100% with the sterically bulkier phenyl group. It is clear from these experiments that an increase of steric bulkiness at the R group produces a high level of trans-diastereoselectivity.

The stereochemistry of the oxazoline obtained above was elucidated by the ^1H NMR data, as shown in Table 3.[12] The *J* values ($J_{4,5}$ = 6−7 Hz) observed in all major isomers clearly indicate that the compounds possess the assigned trans structure.

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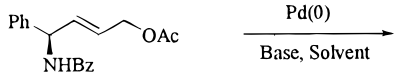
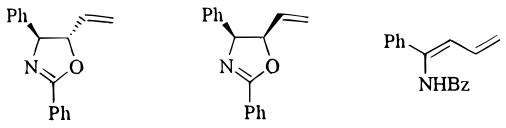
(10) No racemization during this process was confirmed by converting allyl alcohols **7** to the corresponding *N*,*O*-bis-(+)-MTPA amide esters.[a,b] ^1H NMR data indicated their homogeneity: (4*S*)-*N*,*O*-bis-(+)-MTPA-4-amino-4-phenyl-2-butenol (**7a′**): oil; ^1H NMR ($CDCl_3$, 400 MHz) δ 3.37 (q, *J* = 1.1 Hz, 3 H), 3.50 (q, *J* = 1.1 Hz, 3 H), 4.82 (m, 2 H), 5.68 (m, 2 H), 5.96 (m, 1 H), 7.01 (d, *J* = 8.3 Hz, 1 H), 7.24−7.52 (m, 15 H). (4*S*)-*N*,*O*-bis-(+)-MTPA-4-amino-5-phenyl-2-pentenol (**7b′**): oil; ^1H NMR ($CDCl_3$, 400 MHz) δ 2.87 (m, 2 H), 3.18 (q, *J* = 1.0 Hz, 3 H), 3.50 (q, *J* = 1.0 Hz, 3 H), 4.72 (d, *J* = 7 Hz, 2 H), 4.86 (m, 1 H), 5.65 (m, 2 H), 6.58 (d, *J* = 9.0 Hz, 1 H), 7.30 (m, 15 H). (4*S*)-*N*,*O*-bis-(+)-MTPA-4-amino-6-methyl-2-heptenol (**7c′**): oil; ^1H NMR ($CDCl_3$, 400 MHz) δ 0.93 (d, *J* = 7.0 Hz, 6 H), 1.3−1.7 (m, 3 H), 3.42 (q, *J* = 1.0 Hz, 3 H), 3.53 (q, *J* = 1.0 Hz, 3 H), 4.57 (m, 1 H), 4.77 (m, 2 H), 5.67 (m, 2 H), 6.62 (d, *J* = 9 Hz, 1 H), 7.3−7.6 (m, 10 H) (4*S*)-*N*,*O*-bis-MTPA-4-amino-5-cyclohexyl-2-pentenol (**7d′**): oil; ^1H NMR ($CDCl_3$, 400 MHz) δ 0.08−1.85 (m, 13 H), 3.39 (q, *J* = 1.1 Hz, 3 H), 3.50 (q, *J* = 1.1 Hz, 3 H), 4.57 (m, 2 H), 4.73 (m, 2 H), 5.64 (m, 2 H), 6.58 (d, *J* = 8.8 Hz, 1 H), 7.32−7.45 (m, 10 H). (a) Dale, J. A.; Mosher, H. S. *J. Am. Chem. Soc*. **1973**, *95*, 512. (b) Sakaitani, M.; Ohfune, Y. *J. Am. Chem. Soc*. **1990**, *112*, 1150.

Table 1. Palladium-Catalyzed Oxazoline Formation Reaction of 4a



4a

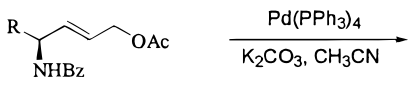


3a **8a** **9a**

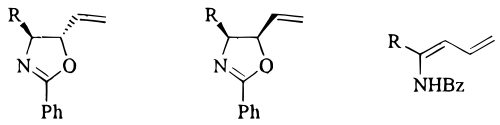
entry	Pd(0)[a]	base[b]	solvent	temp	time (h)	yield (%)[c] (**3a**:**8a**:**9a**)
1	$Pd(PPh_3)_4$	NaH	DMF	rt	8	30:0:45
2	$Pd_2dba_3-CHCl_3-PPh_3$	NaH	DMF	rt	8	29:0:48
3	$Pd_2dba_3-CHCl_3$–dppe	NaH	DMF	rt	8	0:0:90
4	$Pd(PPh_3)_4$	K_2CO_3	CH_3CN	reflux	4	78:0:13
5	$Pd(PPh_3)_4$	K_2CO_3	CH_2Cl_2	reflux	24	70:0:25
6	$Pd(PPh_3)_4$	K_2CO_3	DMF	60 °C	24	40:0:38
7	$Pd(PPh_3)_4$	K_2CO_3	THF	rt	4	49:0:38
8	$Pd_2dba_3-CHCl_3-PPh_3$	K_2CO_3	CH_3CN	reflux	8	63:0:10
9	$Pd_2dba_3-CHCl_3-PPh_3$	K_2CO_3	CH_2Cl_2	reflux	8	19:0:4

[a] Pd(0) were as follows: $Pd(PPh_3)_4$ (5 mol %), $Pd_2dba_3-CHCl_3$ (1 mol %), PPh_3 (8 mol %), dppe (4 mol %). [b] Bases were as follows: NaH (1 equiv), K_2CO_3 (2 equiv). [c] Yields refer to isolated and chromatographically pure products.

Table 2. Palladium(0)-Catalyzed Oxazoline Formation Reaction of Other Primary Allylic Acetates[a] 4b–d



4b-d



3b-d **8b-d** **9b-d**

substrate	R	yield (%)[b]	ratio (**3**:**8**:**9**)[c]
4b	benzyl	78	14:1:0
4c	isobutyl	75	13:1:0
4d	cyclohexylmethyl	72	14:1:0

[a] Reaction conditions: $Pd(PPh_3)_4$ (5 mol %), K_2CO_3 (2 equiv), CH_3CN, reflux. [b] Yields refer to isolated and chromatographically pure products. [c] Ratios were determined by ^1H NMR.

Table 3. ^1H NMR ($CDCl_3$) Coupling Constants of Oxazolines

R	$J_{4,5}$ (Hz) 3	13	21	22
phenyl	8.0	6.5	7.3	6.3
benzyl	7.0	6.1	6.5	6.0
isobutyl	7.0	6.0	7.0	6.0
cyclohexylmethyl	7.0	6.6	7.0	6.0

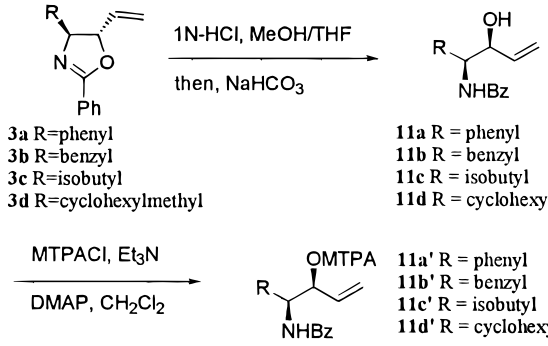
To extend the scope of this method, we replaced the primary allylic acetates with their secondary analogues. Secondary allylic acetates are easily prepared and are interesting in view of their stereoselectivity in the formation of the corresponding oxazolines.

Swern oxidation of alcohols **10a**–**d** gave the corresponding aldehydes, which were reacted with vinylmagnesium bromide in THF at 0 °C to afford the corresponding allyl alcohols **11a**–**d** as the ca. 1.1–2.3:1 mixture of syn/anti isomer (^1H NMR) in 70%–87% yield.[13] Acetylation of the hydroxyl group yielded the secondary allylic acetates **12a**–**d** (Scheme 3).

The standard oxazoline ring formation reaction ($Pd(PPh_3)_4$, K_2CO_3 in CH_3CN) of **12a**–**d** gave the desired *trans*-oxazolines **3a**–**d** as the major compound with high diastereoselectivity and good yield (Table 4). The spectroscopic data of the resulting oxazoline compounds were completely identical to those of oxazoline formed from primary allylic acetates.

Especially, the diastereoselectivity of oxazoline ring

(11) No racemization during this process was confirmed by MTPA esters of alcohols obtained by hydrolysis of oxazolines **3**.[10a] ^1H NMR data indicated their homogeneity: *N*-((1*S*,2*S*)-*O*-MTPA-2-hydroxy-1-phenyl-3-butenyl)benzamide (**11a′**): oil; ^1H NMR ($CDCl_3$, 400 MHz) δ 3.32 (q, J = 1.0 Hz, 3 H), 5.37 (d, J = 9.5 Hz, 1 H), 5.46 (d, J = 16.0 Hz, 1 H), 5.57 (dd, J = 3.7, 9.0 Hz, 1 H), 5.88–5.99 (m, 2 H), 6.79 (d, J = 9.0 Hz, 1 H), 7.26–7.75 (m, 15 H). *N*-((2*S*,3*S*)-*O*-MTPA- 3-hydroxy-1-phenyl-4-pentenyl)benzamide (**11b′**): oil; ^1H NMR ($CDCl_3$, 400 MHz) δ 2.82 (m, 2 H), 3.57 (q, J = 0.9 Hz, 3 H), 4.68 (m, 1 H), 5.31 (d, J = 10.8 Hz, 1 H), 5.34 (d, J = 17.1 Hz, 1 H), 5.60 (m, 1 H), 5.86 (m, J = 6.8, 10.8, 17.1 Hz, 1 H), 6.13 (d, J = 9.3 Hz, 1 H), 7.18–7.58 (m, 15 H). *N*-((3*S*,4*S*)-*O*-MTPA-3-hydroxy-6-methyl-1-heptenyl)benzamide (**11c′**): oil; ^1H NMR ($CDCl_3$, 400 MHz) δ 0.92 (d, J = 7.2 Hz, 6 H), 1.24–1.64 (m, 3 H), 3.54 (q, J = 1.0 Hz, 1 H), 4.54 (m, 1 H), 5.32 (d, J = 10.5 Hz, 1 H), 5.40 (d, J = 17.3 Hz, 1 H), 5.63 (m, 1 H), 5.89 (ddd, J = 7.1, 10.5, 17.3 Hz, 1 H), 5.93 (d, 1 H), 7.39–7.54 (m, 3 H), 7, 63–7.65 (m, 2 H). *N*-((2*S*,3*S*)-*O*-MTPA- 3-hydroxy-1-cyclohexyl-4-pentenyl)benzamide (**11d′**): oil; ^1H NMR ($CDCl_3$, 400 MHz) δ 1.13–1.66 (m, 13 H), 3.52 (q, J = 1.0 Hz, 1 H), 4.55 (m, 1 H), 5.30 (d, J = 10, 5 Hz, 1 H), 5.38 (d, J = 17.3 Hz, 1 H), 5.60 (m, 1 H), 5.86 (ddd, J = 6.8, 10.5, 17.3 Hz, 1 H), 5.90 (d, J = 9.7 Hz, 1 H), 7.37–7.51 (m, 8 H), 7.61–7.63 (m, 2 H).



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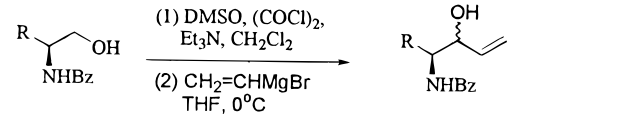
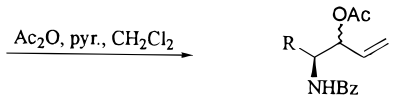
Scheme 3



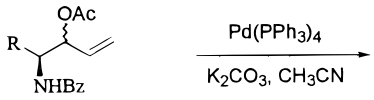
10a R=phenyl
10b R=benzyl
10c R=isobutyl
10d R=cyclohexylmethyl

11a R = phenyl (83%)
11b R = benzyl (87%)
11c R = isobutyl (72%)
11d R = cyclohexylmethyl (70%)

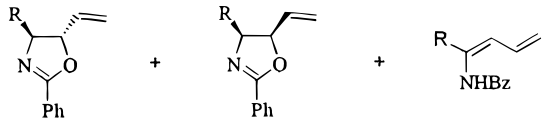


12a R = phenyl (96%)
12b R = benzyl (99%)
12c R = isobutyl (99%)
12d R = cyclohexylmethyl (98%)

Table 4. Palladium(0)-Catalyzed Oxazoline Formation Reaction of Secondary Allylic Acetates 12a−d[a]



12a-d



3a-d **8a-d** **9a-d**

substrate	R	yield (%)[b]	ratio (**3**:**8**:**9**)[c]
12a	phenyl	72	5.5:0:1
12b	benzyl	83	14:1:0
12c	isobutyl	71	13:1:0
12d	cyclohexylmethyl	68	14:1:0

[a] Reaction conditions: $Pd(PPh_3)_4$ (5 mol %), K_2CO_3 (2 equiv), CH_3CN, reflux. [b] Yields refer to isolated and chromatographically pure products. [c] Ratios were determined by ^1H NMR.

formation of primary allylic acetates is very similar to that of the secondary allylic acetates. It is reasonable to assume that the palladium(0)-catalyzed oxazoline ring formation reaction proceeded via the same π-allylpalladium complex that arose from either the primary or secondary allylic acetates.

The high stereoselectivity of the cyclization of **4a−d** or **12a−d** may arise due to the differences of steric interactions between the bulky R group and the hydrogen of the π-allylpalladium complex in the transition state **A** and **B**.[14] Consequently, cyclization proceeds through the more favored transition state **A** as shown in Figure 1.

This change in the diastereoselectivity of oxazoline ring formation is dominantly controlled by the bulkiness of R.

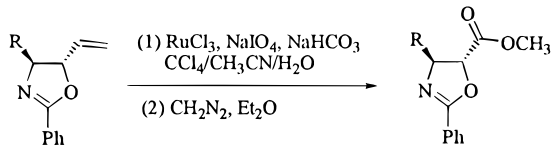
There is an excellent correlation between the diastereoselectivity ratio reported herein and the bulkiness of R in the palladium(0)-catalyzed oxazoline ring formation.

Since oxazoline formation via an intramolecular palladium(0)-catalyzed reaction has proven to be an ex-

A **B**

Figure 1.

Scheme 4



3 **13**

3a R=phenyl
3b R=benzyl
3c R=isobutyl
3d R=cyclohexylmethyl

13a R=phenyl (75%)
13b R=benzyl (75%)
13c R=isobutyl (77%)
13d R=cyclohexylmethyl (75%)

tremely effective method for the synthesis of vicinal amino hydroxy systems with the requisite 1,2-syn stereochemistry, it was applied to β-amino-α-hydroxy and γ-amino-β-hydroxy acids.

We utilized this method for the synthesis of the Taxol (**14**) C-13 side chain,[15] as recently described in a preliminary communication.[4] Oxidative degradation of the vinyl group of oxazoline **2a** with $RuCl_3/NaIO_4$[16] yielded the corresponding (4*S*,5*R*)-2,4-diphenyloxazoline-5-carboxylic acid, which was then converted to its methyl ester **13a** (Scheme 4). From ^1H NMR studies, the observed coupling constant($J_{4,5}$ = 6.5 Hz) between the two protons in the oxazoline ring indicated a trans-relationship. The optical rotation of **13a** {$[\alpha]_D$ = +12.9 (*c* = 1, $CHCl_3$), lit. $[\alpha]_D$ = +13.0 (*c* = 1, $CHCl_3$)}[17] was in good agreement with the

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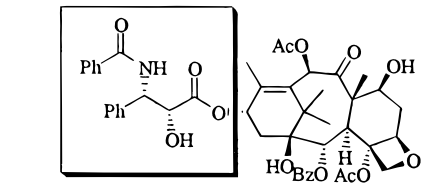
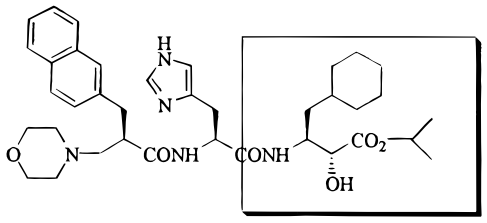
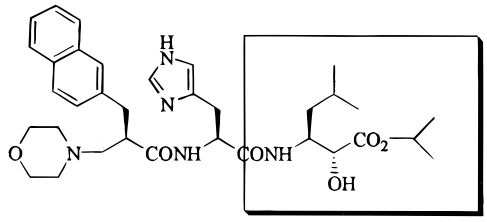


TAXOL (14)

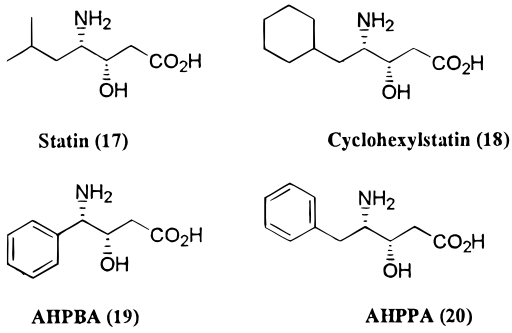


KRI-1314 (15)



KRI-1230 (16)

Figure 2.



Statin (17) Cyclohexylstatin (18)

AHPBA (19) AHPPA (20)

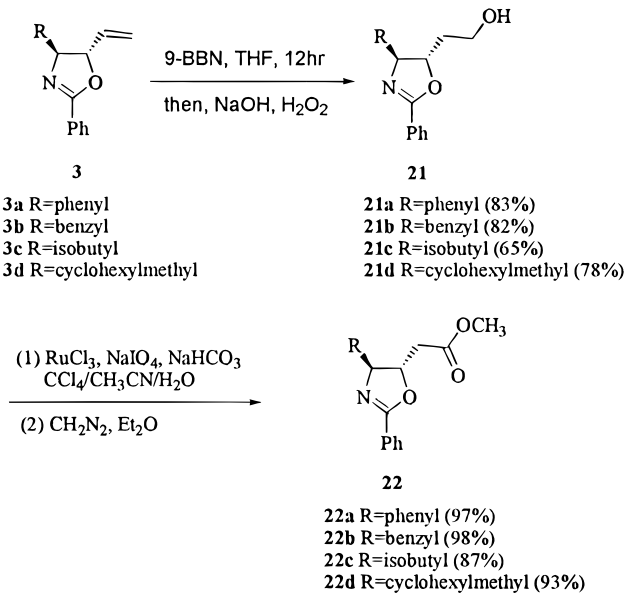
Figure 3.

reported value, which also conclusively proved the stereochemical assignment.

The oxidative degradation of the vinyl group of **3b**−**d** afforded the β-amino-α-hydroxy acids, which were converted to their methyl esters **13b**−**d**, protected as the oxazoline in good yield (Scheme 4). The unnatural amino acids norstatins, which are the key component in the renin inhibitors KRI-1230 (**15**) and KRI-1314 (**16**),[18] are readily available using this methodology (Figure 2).

Statin, (3*S*,4*S*)-4-amino-3-hydroxy-6-methylheptanoic acid, is a key element of pepstatin, a naturally occurring aspartic protease inhibitor. Due to the crucial role of renin in regulating blood pressure, in recent years a great deal of effort has been devoted to developing the practical synthesis of statin (**17**), cyclohexylstatin (**18**), and (3*S*,4*S*)-4-amino-3-hydroxy-4-phenylbutanoic acid (**19**, AHPBA).[19] Also, (3*S*,4*S*)-4-amino-3-hydroxy-5-phenylpentanoic acid

Scheme 5



3

3a R=phenyl
3b R=benzyl
3c R=isobutyl
3d R=cyclohexylmethyl

21

21a R=phenyl (83%)
21b R=benzyl (82%)
21c R=isobutyl (65%)
21d R=cyclohexylmethyl (78%)

22

22a R=phenyl (97%)
22b R=benzyl (98%)
22c R=isobutyl (87%)
22d R=cyclohexylmethyl (93%)

(**20**, AHPPA) has been employed for the design of HIV protease inhibitors (Figure 3).[19]

Oxidation of oxazoline with 9-BBN[20] gave the alcohols **21a**−**d** in 50−89% yield. Direct oxidation of the alcohol to the carboxylic acid with $RuCl_3/NaIO_4$ afforded the γ-amino-β-hydroxy acids, which were converted to their methyl esters **22a**−**d**, conveniently protected as the oxazoline in good yield (Scheme 5).

Conclusion

In summary, a catalytic diastereoselective oxazoline formation reaction of acyclic allyl acetates has been achieved by using a Pd(0) catalyst. The mildness of the reaction, the simplicity of the procedure, and rather high de values offer a convenient and efficient method for the synthesis of the optically pure β-amino-α-hydroxy and

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γ-amino-β-hydroxy acids, protected as the oxazoline. Further applications of this interesting oxazoline formation catalyzed by Pd(0) will be reported in due course.

Experimental Section

General Methods. Melting points were determined with a capillary apparatus and are uncorrected. Optical rotations were measured at 20 ± 0.2 °C in chloroform or methanol. ^{1}H NMR spectra were recorded at 400 or 500 MHz in $CDCl_3$ unless otherwise specified. ^{13}C NMR spectra were recorded at 100 or 125 MHz in $CDCl_3$ unless otherwise specified. Chemical shifts are reported as δ values in ppm relative to $CHCl_3$ (7.26) in $CDCl_3$. High-resolution mass spectra were recorded at 70 eV ionizing voltage; ammonia was used for the chemical ionization (CI). Flash chromatography was executed with Merck Kiesegel 60 (230−400 mesh) using mixtures of ethyl acetate and hexane as eluants. Ethyl acetate and hexane were dried and purified by distillation prior to use. Tetrahydrofuran (THF) and diethyl ether (Et_2O) were distilled over sodium and benzophenone (indicator). Methylene chloride (CH_2Cl_2) was shaken with concentrated sulfuric acid, dried over potassium carbonate, and distilled. Commercially available compounds were used without further purification.

General Procedure for Allyl Alcohols 7. To a solution of Dess−Martin periodinane (6.32 g, 15.0 mmol, 1.5 equiv) in CH_2Cl_2 (50 mL) at 25 °C was added a solution of alcohol **5** (10.0 mmol, 1.0 equiv) in CH_2Cl_2 (50 mL). The reaction mixture was stirred for 2 h at 25 °C, after which time TLC analysis indicated complete reaction. The reaction mixture was diluted with ether (100 mL) and poured into saturated aqueous $NaHCO_3$ (200 mL) containing $Na_2S_2O_3$ (16.6 g, 105.0 mmol, 10.5 equiv). The mixture was stirred to dissolve the solid, and the layers were separated. The ether layer was extracted with saturated $NaHCO_3$ (100 mL) and with water (100 mL), dried ($MgSO_4$), and filtered. The filtrate was concentrated in vacuo to give crude aldehyde. $Ph_3P{=}CHCO_2Et$ (5.0 g, 15 mmol, 1.5 equiv) was added to this aldehyde in benzene (40 mL). The reaction mixture was stirred at 30 °C for 30 min and concentrated in vacuo to give an oily residue, which upon purification by column chromatography on silica gel (hexane/ethyl acetate = 4:1) gave the α,β-unsaturated ester **6**. The resulting α,β-unsaturated ester **6** was reduced immediately, to avoid racemization.

Boron trifluoride etherate (1.23 mL, 10 mmol, 1.0 equiv) was added to a solution of the α,β-unsaturated ester **6** (10.0 mmol) in CH_2Cl_2 (50 mL) at −78 °C and the resulting mixture was stirred at −78 °C for 15 min. To this solution was added 30 mL (30 mmol, 3 equiv) of *i*-Bu_2AlH (1 M solution in hexane). The reaction mixture was stirred at −78 °C for an additional 2 h, quenched by the successive addition of acetic acid (5.46 mL, 95.9 mmol) and H_2O (4 mL), diluted with ether (80 mL), and dried ($MgSO_4$). The resulting suspension was filtered and the filtrate was concentrated in vacuo to give the crude product, which upon purification by column chromatography on silica gel (ethyl acetate/hexane= 1/1) gave the allyl alcohol **7**.

(4*R*)-4-(*N*-*tert*-Butoxycarbonyl)amino-4-phenyl-2-buten-1-ol (7a): 89% yield; colorless needles; mp 110−112 °C (ether/hexane); $[\alpha]^{20}_D$ +13.9° (*c* 1.0, MeOH); IR ($CHCl_3$); 3614, 3447, 1707 cm^{-1}; ^{1}H NMR (500 MHz) δ 1.44 (s, 9 H), 4.19 (dd, *J* = 5.0, 1.0 Hz, 2 H), 4.90 (br s, 1 H), 5.30 (br s, 1 H), 5.81 (dt, *J* = 15.5, 5.0 Hz, 1 H), 5.88 (dd, *J* = 15.5, 5.5 Hz, 1 H), 7.23−7.36 (m, 5 H); ^{13}C NMR (125 MHz) δ 29.1, 56.5, 63.6, 80.5, 127.6, 128.3, 129.4, 131.1, 132.0, 142.0, 155.7.

(4*S*)-4-(*N*-*tert*-Butoxycarbonyl)amino-5-phenyl-2-penten-1-ol (7b): 92% yield; colorless needles; mp 96−97 °C (ether/hexane) (lit.[10b] mp 96−97 °C (ether/hexane)); $[\alpha]^{20}_D$ −4.7° (*c* 1.0, MeOH) (lit.[10b] $[\alpha]^{29}_D$ −5.5° (*c* 1.0, MeOH)); IR ($CHCl_3$) 3615, 3442, 1706 cm^{-1}; ^{1}H NMR (400 MHz) δ 1.39 (s, 9 H), 2.83 (d, *J* = 6.9 Hz, 2 H), 4.09 (br s, 2 H), 4.41 (br s, 1 H), 4.54 (br s, 1 H), 5.69 (m, 2 H), 7.16−7.32 (m, 5 H); ^{13}C NMR (100 MHz) δ 28.3, 41.6, 56.0, 62.7, 79.5, 126.4, 128.3, 129.5, 129.7, 131.4, 137.3, 155.2.

(4*S*)-4-(*N*-*tert*-Butoxycarbonyl)amino-6-methyl-2-hepten-1-ol (7c): 84% yield; colorless prism; mp 82−84 °C (hexane) (lit.[10b] mp 82−83 °C (hexane)); $[\alpha]^{20}_D$ −19.0 ° (*c* 1.0, MeOH) (lit.[10b] $[\alpha]^{30}_D$ −22.0° (*c* 1.0, MeOH)); IR ($CHCl_3$) 3613, 3444, 1705 cm^{-1}; ^{1}H NMR (400 MHz) δ 0.89 (dd, 6 H), 1.30 (m,2 H), 1.41 (s, 9 H), 1.61 (m, 1 H), 4.11 (t, 3 H), 4.38 (br s, 1 H), 5.55−5.60 (m, 1 H), 5.71−5.77 (m, 1 H); ^{13}C NMR (100 MHz) δ 22.4, 22.7, 24.7, 28.4, 44.7, 50.1, 63.1, 79.7, 129.0, 133.0, 155.3.

(4*S*)-4-(*N*-*tert*-Butoxycarbonyl)amino-5-cyclohexyl-2-penten-1-ol (7d): 86% yield; colorless needles; mp 96−97 °C (hexane); $[\alpha]^{20}_D$ −18.9° (*c* 1.0, MeOH); IR ($CHCl_3$) 3615, 3443, 1706 cm^{-1}; ^{1}H NMR (400 MHz) δ 0.87 (m, 2 H), 1.14−1.31 (m, 8 H), 1.41 (s, 9 H), 1.63 (m, 2 H), 1.71 (d, 1 H), 4.11 (br s, 2 H), 4.14 (br s, 1 H), 4.18 (br s, 1 H), 5.59−5.61 (m, 1 H), 5.70−5.76 (m, 1 H); ^{13}C NMR (100 MHz) δ 26.1, 26.2, 26.4, 28.4, 33.0, 33.4, 34.1, 43.3, 49.2, 63.1, 77.4, 128.8, 133.1, 152.0.

General Procedure for Allyl Benzamides 4. Allyl alcohol **7** (10.0 mmol) was dissolved in 3 M HCl-EtOAc (10 mL). After 30 min, 30 mL of 1 N NaOH aqueous solution was added, and the mixture was stirred for 10 min. Benzoyl chloride (1.16 mL, 10.0 mmol, 1.0 equiv) was then added at 0 °C. After being stirred for 2 h, the organic layer was separated, dried with Na_2SO_4, filtered, and evaporated in vacuo. Acetic anhydride (0.81 mL, 10.0 mmol, 1.0 equiv) and pyridine (0.94 mL, 10.0 mmol, 1.0 equiv) was added to the resulting solution of compound in CH_2Cl_2 (20 mL), and stirring was allowed to continue for 12 h. The reaction mixture was washed with 1 N HCl (20 mL × 2), saturated aqueous $NaHCO_3$ solution (20 mL × 2), and brine (20 mL × 2); dried with Na_2SO_4; and evaporated in vacuo. The resulting substance was purified by silica gel column chromatography (ethyl acetate/hexane = 1:4) or by recrystallization (ethyl acetate/hexane).

***N*-((1*R*)-4-Acetoxy-1-phenyl-2-butenyl)benzamide (4a):** 71% yield; colorless needles; mp 108−110 °C (ethyl acetate/hexane); $[\alpha]^{20}_D$ +41.8° (*c* 1.0, $CHCl_3$); IR ($CHCl_3$) 3445, 1734, 1662 cm^{-1}; ^{1}H NMR (500 MHz) δ 2.08 (s, 3 H), 4.63 (dt, *J* = 4.5, 1.5 Hz, 2 H), 5.82 (dt, *J* = 15.5, 6.0 Hz, 1 H), 5.89 (dd, *J* = 8.0, 5.5 Hz, 1 H), 6.06 (dd, *J* = 15.5, 5.5 Hz, 1 H), 6.37 (d, *J* = 8.0 Hz, 1 H), 7.31−7.54 (m, 8 H), 7.79−7.81 (m, 2 H); ^{13}C NMR (100 MHz) δ 21.6, 55.2, 64.8, 126.8, 127.7, 127.9, 128.6, 129.3, 129.6, 132.4, 134.1, 134.9, 141.0, 167.1, 171.4; HRMS (EI, 70 eV) calcd for $C_{19}H_{19}NO_3$ 309.1365, found 309.1363.

***N*-((2*S*)-5-Acetoxy-1-phenyl-3-butenyl)benzamide (4b):** 75% yield; colorless needles; mp 94−96 °C (ethyl acetate/hexane); $[\alpha]^{20}_D$ +19.6° (*c* 1.0, $CHCl_3$); IR ($CHCl_3$) 3442, 1734, 1660 cm^{-1}; ^{1}H NMR (500 MHz) δ 2.05 (s, 3 H), 3.01 (dd, *J* = 6.5, 1.5 Hz, 2 H) 4.54 (d, *J* = 6.0 Hz, 2 H), 5.02 (m, 1 H), 5.71 (dd, *J* = 15.5, 1.5 Hz, 1 H), 5.84 (dd, *J* = 15.5, 5.5 Hz, 1 H), 6.11 (d, *J* = 8.0 Hz, 1 H), 7.22−7.49 (m, 8 H), 7.68−7.69 (m, 2 H); ^{13}C NMR (100 MHz) δ 20.9, 41.0, 51.3, 64.1, 117.9, 125.1, 126.8, 128.5, 128.6, 129.5, 131.5, 133.8, 134.4, 136.8, 166.7, 170.6; HRMS (EI, 70 eV) calcd for $C_{20}H_{21}NO_3$ 323.1521, found 323.1521.

***N*-((4*S*)-1-Acetoxy-6-methyl-2-heptenyl)benzamide (4c):** 74% yield; colorless needles; mp 88−89 °C (hexane); $[\alpha]^{20}_D$ −1.3° (*c* 1.0, $CHCl_3$); IR ($CHCl_3$) 3443, 1733, 1659 cm^{-1}; ^{1}H NMR (500 MHz) δ 0.97 (dd, 6 H), 1.50 (m, 2 H), 1.71 (m, 1 H), 2.07 (s, 3 H), 4.56 (d, *J* = 3.5 Hz, 2 H), 4.78 (m, 1 H), 5.78 (m, 2 H), 5.96 (d, *J* = 7.5 Hz, 1 H), 7.43−7.53 (m, 3 H), 7.77−7.79 (m, 2 H); ^{13}C NMR (100 MHz) δ 20.9, 22.3, 22.8, 24.9, 44.2, 48.9, 64.3, 124.4, 126.8, 128.5, 131.5, 134.5, 135.2, 166.6, 170.6; HRMS (EI, 70 eV) calcd for $C_{17}H_{23}NO_3$ 289.1688, found 289.1677.

***N*-((2*S*)-5-Acetoxy-1-cyclohexyl-3-butenyl)benzamide (4d):** 70% yield; colorless needles; mp 145−146 °C (hexane); $[\alpha]^{20}_D$ −5.4° (*c* 1.0, $CHCl_3$); IR ($CHCl_3$) 3443, 1733, 1658 cm^{-1}; ^{1}H NMR (500 MHz) δ 0.87−1.02 (m, 2 H), 1.10−1.26 (m, 4 H), 1.33−1.41 (m, 1 H), 1.51 (m, 3 H), 1.72 (m, 2 H), 1.83 (d, 1 H), 2.06 (s, 3 H), 4.57 (m, 2 H), 4.80 (m, 1 H), 5.75 (m, 2 H), 5.98 (m, 1 H), 7.42 (m, 1 H), 7.51 (m, 1 H), 7.77 (m, 1 H); ^{13}C NMR (100 MHz) δ 21.7, 26.8, 26.9, 27.1, 33.6, 34.2, 35.0, 43.5, 48.9, 65.0, 124.9, 127.5, 129.3, 132.2, 135.2, 136.1, 167.3, 171.4; HRMS (EI, 70 eV) calcd for $C_{20}H_{27}NO_3$ 329.1991, found 329.1994.

General Procedure for N-benzoyl-L-amino alcohols 10. The amino acid (33.1 mmol) was carefully added portionwise from the top of the condenser to a stirred mixture of 2.52 g (66.3 mmol) of $LiAlH_4$ in 120 mL of THF at reflux under nitrogen. After the addition, the condenser was rinsed with 7 mL of THF, and the mixture was refluxed for an additional 6 h. The mixture was then allowed to cool to room temperature and was slowly treated with 4.0 mL of 10% aqueous NaOH followed by 5.0 mL of water and was stirred for 5 min. Additional 10% aqueous NaOH (53 mL) and 3.3 mL (4.0 g, 28 mmol) of benzoyl chloride were then introduced at 0 °C, and the resulting mixture was stirred for 30 min at 20 °C, whereupon CH_2Cl_2 and aqueous potassium sodium tartrate (Rochelle salt) were added. The crude product was isolated with CH_2Cl_2 in usual way and recrytallized from CH_2Cl_2−cyclohexane to give **10**.

(−)-*N*-((*S*)-2-Hydroxy-1-phenylethyl)benzamide (10a): 80% yield; white solid; mp 186−187 °C (CH_3OH−CH_2Cl_2) (lit.[13] mp 179−180 °C (CH_2Cl_2−cyclohexane)); $[\alpha]^{20}_D$ −14.6°(*c* 1.5, MeOH); ^{1}H NMR (500 MHz, DMSO-d_6) δ 3.66 (m, 1 H), 3.72 (m, 1 H), 4.94 (t, *J* = 6.0 Hz, 1 H), 5.08 (ddd, *J* = 5.7, 7.9 Hz, 1 H), 7.22−7.53 (m, 8 H), 7.86−7.96 (m, 2 H), 8.72 (d, *J* = 7.9 Hz, 1 H); ^{13}C NMR (125 MHz, DMSO-d_6) δ 57.1, 65.7, 128.0, 128.2, 128.6, 129.3, 129.4, 132.3, 135.8, 142.6, 167.3.

(−)-*N*-((*S*)-1-Hydroxy-3-phenylpropyl)benzamide (10b): 69% yield; white solid; mp 175−176 °C (CH_3OH−CH_2Cl_2); $[\alpha]^{20}_D$ −81.3°(*c* 1.5, MeOH); ^{1}H NMR (500 MHz, DMSO-d_6) δ 2.79 (dd, *J* = 9.3, 13.9 Hz, 1 H), 2.96 (dd, *J* = 5.3, 13.9 Hz, 1 H), 3.42 (ddd, *J* = 5.7, 6.0, 10.8 Hz, 1 H), 3.50 (dd, *J* = 5.4, 5.7, 10.8 Hz, 1 H), 4.16 (m, *J* = 5.3, 5.4, 6.0, 8.2, 9.3 Hz, 1 H), 4.84 (t, *J* = 5.7 Hz, 1 H), 7.13−7.50 (m, 8 H), 7.77−7.79 (m, 2 H), 8.16 (d, *J* = 8.2 Hz, 1 H); ^{13}C NMR (125 MHz, DMSO-d_6) δ 37.7, 54.4, 64.0, 127.0, 128.4, 129.2, 129.3, 130.2, 132.1, 136.0, 140.6, 167.2.

(−)-*N*-((*S*)-1-Hydroxy-4-methylpentyl)benzamide (10c): 80% yield; white solid; mp 186−187 °C (hexane−CH_2Cl_2); $[\alpha]^{20}_D$ −31.3°(*c* 1.0, MeOH); ^{1}H NMR (500 MHz) δ 0.98 (dd, *J* = 2.0 Hz, 6 H), 1.44−1.75 (m, 3 H), 3.67 (dd, *J* = 5.5, 11.0 Hz, 1 H), 3.80 (dd, *J* = 3.5, 11.0 Hz, 1 H), 4.28 (m, *J* = 3.5, 5.5, 7.5 Hz, 1 H), 6.21 (d, *J* = 7.5 Hz, 1 H), 7.43−7.53 (m, 3 H), 7.77−7.79 (m, 2 H); ^{13}C NMR (125 MHz) δ 22.9, 23.8, 25.8, 41.1, 51.2, 66.9, 127.7, 129.3, 132.3, 135.0, 168.9.

(−)-*N*-((*S*)-1-Hydroxy-3-cyclohexylpropyl)benzamide (10d): 87% yield; white solid; mp 114−115 °C (hexane−CH_2Cl_2); $[\alpha]^{20}_D$ −40.2°(*c* 1.0, MeOH); ^{1}H NMR (400 MHz) δ 0.87−1.83 (m, 13 H), 3.62 (dd, *J* = 1.5, 11.2 Hz, 1 H), 3.76 (dd, *J* = 3.4, 11.2 Hz, 1 H), 4.26 (m, 1 H), 6.23 (d, *J* = 7.3 Hz, 1 H), 7.39−7.50 (m, 3 H), 7.73−7.76 (m, 2 H); ^{13}C NMR (125 MHz) δ 26.8, 26.9, 27.2, 33.6, 34.4, 35.2, 39.6, 50.4, 66.7, 127.7, 129.2, 132.3, 135.1, 168.9.

General Procedure for Allyl Alcohols 11. To a stirred solution of 1.05 mL (1.52 g, 12.0 mmol) of oxalyl chloride in 16 mL of CH_2Cl_2 at −78 °C under argon was added 908 μL (1.00 g, 12.8 mmol) of dimethyl sulfoxide (DMSO). After being stirred for 5 min at −78 °C, the reaction mixture was allowed to warm to −60 °C over 20 min, whereupon alcohol **10** (8.0 mmol) suspended in 25 mL of CH_2Cl_2−DMSO (24:1) was added over 15 min. The flask containing the suspension was rinsed with 5 mL of CH_2Cl_2, which was then added to the reaction mixture. The mixture was allowed to warm to −35 °C over 20 min with 8.36 mL (6.20 g, 48.0 mmol) of diisopropylethylamine. The cooling bath was removed for 5 min, and at −78 °C the mixture was added with a double-tipped needle to a room-temperature solution (104 mL, 0.5 M, 52 mmol) of vinylmagnesium bromide in 1:1 THF−CH_2Cl_2. After being stirred for 1 h, the mixture was treated with 8 mL of C_2H_5OH, and 12 mL of saturated aqueous NH_4Cl, CH_2Cl_2, and aqueous HCl were added, and the crude reaction product was isolated with CH_2Cl_2 in the normal way.

(−)-*N*-((1*S*,2*S*)-2-Hydroxy-1-phenyl-3-butenyl)benzamide (*syn*-11a). Purification by silica gel chromatography (ethyl acetate/hexane = 2:1) gave **11a** (ca. 2.3:1 syn:anti by ^{1}H NMR): 83% yield; (***syn*-11a**) colorless needles; mp 143−145 °C (ethyl acetate/hexane) (lit.[13] mp 135−136 °C (CH_2Cl_2−cyclohexane)); $[\alpha]^{20}_D$ −48.9° (*c* 1.0, $CHCl_3$) (lit.[13] $[\alpha]^{23}_D$ −50.0° (*c* 1.0, $CHCl_3$)); IR (neat) 3438, 1657 cm^{-1}; ^{1}H NMR (500 MHz) δ 2.32 (d, *J* = 4.0 Hz, 1 H), 4.57 (ddd, *J* = 3.5, 3.5, 5.0 Hz, 1 H), 5.24−5.26 (m, 2 H), 5.43 (dt, *J* = 1.5, 17.0 Hz, 1 H), 5.96 (ddd, *J* = 5.0, 10.5, 17.0 Hz, 1 H), 6.97 (d, *J* = 7.5 Hz, 1 H), 7.29−7.53 (m, 8 H), 7.80−7.82 (m, 2 H); ^{13}C NMR (100 MHz) δ 57.7, 75.4, 116.7, 126.8, 127.0, 127.7, 128.6, 128.8, 131.6, 134.3, 137.3, 139.5, 167.5; HRMS calcd for $C_{17}H_{17}NO_2$ (M + H) 268.1338, found 268.1337. Anal. Calcd for $C_{17}H_{17}NO_2$: C, 76.38; H, 6.41; N, 5.24. Found: C, 76.32; H, 6.34; N, 5.26.

(−)-*N*-((2*S*,3*S*)-3-Hydroxy-1-phenyl-4-pentenyl)benzamide (*syn*-11b). Purification by silica gel chromatography (ethyl acetate/hexane = 2/1) gave **11b** (ca. 1.2:1 syn:anti by ^{1}H NMR): 87% yield; (***syn*-11b**) colorless needles; mp 153−154 °C (light petroleum/hexane); $[\alpha]^{20}_D$ −73.2° (*c* 1.0, $CHCl_3$); IR (neat) 3380, 1625 cm^{-1}; ^{1}H NMR (500 MHz) δ 3.06 (d, *J* = 7.6 Hz, 2 H), 4.25 (m, 1 H), 4.34 (m, 1 H), 5.16 (dt, *J* = 1.4, 10.5 Hz, 1 H), 5.30 (dt, *J* = 1.4, 17.2 Hz, 1 H), 5.90 (ddd, *J* = 5.2, 10.5, 17.2 Hz, 1 H), 6.53 (d, *J* = 8.6 Hz, 1 H), 7.21−7.49 (m, 8 H), 7.66−7.68 (m, 2 H); ^{13}C NMR (100 MHz) δ 37.7, 55.3, 72.3, 116.1, 126.6, 126.9, 128.5, 128.6, 129.3, 131.5, 134.5, 138.0, 138.3, 167.8; HRMS calcd for $C_{18}H_{19}NO_2$ (M + H) 282.1494, found 282.1495. Anal. Calcd for $C_{18}H_{19}NO_2$: C, 76.84; H, 6.81; N, 4.98. Found: C, 76.53; H, 6.77; N, 4.99.

(−)-*N*-((3*S*,4*S*)-3-hydroxy-6-methyl-1-heptenyl)benzamide (*syn*-11c). Purification by silica gel chromatography (ethyl acetate/hexane = 3:1) gave **11c** (ca. 1.3:1 syn:anti by ^{1}H NMR): 72% yield; (***syn*-11c**) colorless needles; mp 101−102 °C (ethyl acetate/hexane); $[\alpha]^{20}_D$ −58.9° (*c* 1.0, $CHCl_3$); IR (neat) 3346, 1638 cm^{-1}; ^{1}H NMR (500 MHz) δ 0.97 (d, *J* = 6.5 Hz, 1 H), 1.48−1.74 (m, 3 H), 4.24−4.30 (m, 2 H), 5.19 (d, *J* = 10.5 Hz, 1 H), 5.31 (d, *J* = 16.5 Hz, 1 H), 5.94 (ddd, *J* = 6.0, 10.5, 16.5 Hz, 1 H), 6.29 (d, *J* = 8.5 Hz, 1 H), 7.41−7.51 (m, 3 H), 7.75−7.77 (m, 2 H); ^{13}C NMR (125 MHz) δ 22.9, 24.0, 25.7, 41.7, 52.6, 75.6, 116.9, 127.6, 129.3, 132.2, 135.3, 138.9, 168.5; HRMS calcd for $C_{15}H_{21}NO_2$ (M + H) 248.1651, found 248.1650.

(−)-*N*-((2*S*,3*S*)-3-hydroxy-1-cyclohexyl-4-pentenyl)benzamide (*syn*-11d) Purification by silica gel chromatography (ethyl acetate/hexane = 3:1) gave **11d** (ca. 1.1:1 syn:anti by ^{1}H NMR): 70% yield; (***syn*-11b**) colorless needles; mp 136−137 °C (ethyl acetate/hexane); $[\alpha]^{20}_D$ −58.3° (*c* 1.0, $CHCl_3$); IR (neat) 3345, 1638 cm^{-1}; ^{1}H NMR (400 MHz) δ 0.81−1.63 (m, 13 H), 4.15 (m, 1 H), 4.21 (m, 1 H), 5.10 (dt, *J* = 1.2, 10.5 Hz, 1 H), 5.24 (dt, *J* = 1.2, 17.1 Hz, 1 H), 5.86 (ddd, *J* = 5.6, 10,5, 17.1 Hz, 1 H), 6.23 (d, *J* = 9.0 Hz, 1 H), 7.19−7.42 (m, 3 H), 7.67−7.69 (m, 2 H); ^{13}C NMR (100 MHz) δ 26.1, 26.3, 26.5, 32.8, 33.9, 34.5, 39.4, 51.3, 74.9, 116.2, 126.9, 128.5, 131.4, 134.7, 138.3, 167.8; HRMS calcd for $C_{18}H_{25}NO_2$ (M + H) 288.1964, found 288.1963.

General Procedure for Homoallyl Benzamides 12. Acetic anhydride (0.41 mL, 5.0 mmol, 1.0 equiv) and pyridine (0.47 mL, 5.0 mmol, 1.0 equiv) were added to a stirred solution of alcohol **11** (5 mmol) in CH_2Cl_2 (20 mL) and stirring was allowed to continue for 12 h. The reaction mixture was washed with 1 N HCl (20 mL × 2), saturated aqueous $NaHCO_3$ solution (20 mL × 2), and brine (20 mL × 2); dried with Na_2SO_4; and evaporated in vacuo. The resulting substance was purified by either silica gel column chromatography (ethyl acetate/hexane = 1:4) or recrystallization (ethyl acetate/hexane).

(−)-*N*-((1*S*,2*S*)-2-Acetoxy-1-phenyl-3-butenyl)benzamide (*syn*-12a). Purification by silica gel chromatography (ethyl acetate/hexane = 4:1) gave **12a** (ca. 2.3:1 syn:anti by ^{1}H NMR): 96% yield; ***syn*-12a**; colorless needles; mp 133−134 °C (light petroleum/hexane); $[\alpha]^{20}_D$ −35.9° (*c* 1.0, $CHCl_3$); IR (neat) 3018, 1740, 1663 cm^{-1}; ^{1}H NMR (500 MHz) δ 2.06 (s, 3 H), 5.23 (dt, *J* = 1.0, 10.5 Hz, 1 H), 5.28 (dt, *J* = 1.0, 17.0 Hz, 1 H), 5.42 (dd, *J* = 6.5, 8.5 Hz, 1 H), 5.75 (ddd, *J* = 1.0, 6.0, 6.5 Hz, 1 H), 5.81 (ddd, *J* = 6.0, 10.5, 17.0 Hz, 1 H), 6.85 (d, *J* = 8.5 Hz, 1 H), 7.27−7.53 (m, 8 H), 7.77−7.79 (m, 2 H); ^{13}C NMR (125 MHz) δ 21.7, 57.2, 76.8, 119.5, 127.7, 127.8, 128.7, 129.4(2), 132.4, 133.8, 134.9, 139.2, 167.5, 171.3; HRMS calcd for $C_{19}H_{19}NO_3$ 309.1365, found 309.1363.

(−)-*N*-((2*S*,3*S*)-3-Acetoxy-1-phenyl-4-pentenyl)benzamide (*syn*-12b). Purification by silica gel chromatography (ethyl acetate/hexane = 4:1) gave **12b** (ca. 1.2:1 syn:anti by

^{1}H NMR): 99% yield; ***syn*-12b**; colorless needles; mp 147−148 °C (light petroleum/hexane); $[\alpha]^{20}_D$ −72.6° (*c* 1.0, $CHCl_3$); IR (neat) 3020, 1739, 1656 cm^{-1}; ^{1}H NMR (500 MHz) δ 2.93 (dd, J = 3.0, 7.0 Hz, 2 H), 4.67 (m, 1 H), 5.25 (dt, J = 1.1, 10.5 Hz, 1 H), 5.28 (dt, J = 1.1, 17.3 Hz, 1 H), 5.40 (m, 1 H), 5.84 (ddd, J = 5.6, 10.5, 17.3 Hz, 1 H), 6.24 (d, J = 8.5 Hz, 1 H), 7.21−7.52 (m, 8 H), 7.67−7.70 (m, 2 H); ^{13}C NMR (125 MHz) δ 21.7, 38.7, 53.7, 75.2, 119.2, 127.5, 129.3, 123.0, 132.3, 134.3, 135.2, 137.7, 167.8, 170.6; HRMS calcd for $C_{20}H_{21}NO_3$ 323.1521, found 323.1519.

(−)-*N*-((3*S*,4*S*)-3-Acetoxy-6-methyl-1-heptenyl)benzamide (*syn*-12c). Purification by silica gel chromatography (ethyl acetate/hexane = 8:1) gave **12c** (ca. 1.3:1 syn:anti by ^{1}H NMR): 99% yield; ***syn*-12c**; colorless needles; mp 144−145 °C (ethyl acetate/hexane); $[\alpha]^{20}_D$ −58.0° (*c* 1.0, $CHCl_3$); IR (neat) 3323, 1742, 1640 cm^{-1}; ^{1}H NMR (500 MHz) δ 0.96 (d, J = 6.5 Hz, 6 H), 1.39−1.71 (m, 3 H), 4.52 (m, 1 H), 5.25 (d, J = 10.5 Hz, 1 H), 5.29 (d, J = 17.5 Hz, 1 H), 5.40 (q, J = 5.0, 6.0 Hz, 1 H), 5.86 (ddd, J = 6.0, 10.5, 17.5 Hz, 1 H), 6.02 (d, J = 9.5 Hz, 1 H), 7.43−7.52 (m, 3 H), 7.74−7.75 (m, 2 H); ^{13}C NMR (125 MHz) δ 21.7, 22.8, 24.0, 25.6, 41.9, 50.8, 77.0, 119.1, 127.5, 129.3, 132.2, 134.4, 135.3, 167.9, 170.7; HRMS calcd for $C_{17}H_{23}NO_3$ 289.1678, found 289.1678.

(−)-*N*-((2*S*,3*S*)-3-Acetoxy-1-cyclohexyl-4-pentenyl)benzamide (*syn*-12d). Purification by silica gel chromatography (ethyl acetate/hexane = 8/1) gave **12d** (ca. 1.1:1 syn:anti by ^{1}H NMR): 98% yield; ***syn*-12d**; colorless needles; mp 135−136 °C (ethyl acetate/hexane); $[\alpha]^{20}_D$ −54.7° (*c* 1.0, $CHCl_3$); IR (neat) 3423, 1742, 1639 cm^{-1}; ^{1}H NMR (500 MHz) δ 0.83−1.69 (m, 12 H), 1.89 (br d, 1 H), 2.09 (s, 3 H), 4.53 (m, 1 H), 5.24 (dt, J = 1.1, 10.5 Hz, 1 H), 5.28 (dt, J = 1.1, 17.3 Hz, 1 H), 5.38 (ddd, J = 1.1, 4.3, 6.0 Hz, 1 H), 5.85 (ddd, J = 6.0, 10.5, 17.3 Hz, 1 H), 6.00 (d, J = 10.0 Hz, 1 H), 7.43−7.52 (m, 3 H), 7.74−7.75 (m, 2 H); ^{13}C NMR (125 MHz) δ 21.7, 26.8, 26.9, 27.1, 33.4, 34.7, 34.9, 40.4, 50.1, 77.1, 119.0, 127.5, 129.3, 132.2, 134.4, 135.4, 167.8, 170.9; HRMS calcd for $C_{20}H_{27}NO_3$ 329.1991, found 329.1991.

General Procedure for Oxazolines 3. $Pd(PPh_3)_4$ (57.8 mg, 0.05 mmol), was added under N_2 to a stirred solution of allyl benzamide **4** or homoallyl benzamide **12** (1.0 mmol) and K_2CO_3 (0. 414 g, 3.0 mmol, 3 equiv) in 20 mL of CH_3CN. The resulting mixture was refluxed for 24 h, whereupon it was allowed to cool to room temperature and filtered through a pad of silica, and was then evaporated under reduced pressure to give the crude product. Purification of this material by silica gel chromatography gave pure **3**.

(4*S*-*trans*)-4,5-dihydro-2,4-diphenyl-5-vinyloxazoline (3a). Purification by flash column chromatography (ethyl acetate/hexane = 1:10) gave pure **3a** as a colorless oil (73% yield): $[\alpha]^{20}_D$ −11.6° (*c* 1.0, $CHCl_3$); IR (neat) 1649 cm^{-1}; ^{1}H NMR (500 MHz) δ 4.88 (dd, J = 7.0, 8.0 Hz, 1 H), 5.05 (d, J = 8.0 Hz, 1 H), 5.33 (d, J = 10.5 Hz, 1 H), 5.38 (d, J = 17.5 Hz, 1 H), 6.09 (ddd, J = 7.0, 10.5, 17.5 Hz, 1 H), 7.31−7.53 (m, 8 H), 8.08 (m, 2 H); ^{13}C NMR (100 MHz) δ 76.8, 89.2, 118.6, 127.4, 128.3, 128.4, 129.1, 129.2, 129.5, 132.3, 136.6, 142.4, 164.7; HRMS (EI, 70 eV) calcd for $C_{17}H_{15}NO$ 249.1154, found 249.1156.

(4*S*-*trans*)-4,5-Dihydro-4-benzyl-2-phenyl-5-vinyloxazoline (3b). According to the general procedure, allyl benzamide **4b** or homoallyl benzamide **12b** gave a mixture of **3b** and **8b** (205 mg, 78% yield; **3b**:**8b** = 14:1). Purification by flash column chromatography(ethyl acetate/hexane = 20:1) gave pure **3b** as a colorless oil: $[\alpha]^{20}_D$ +36.1° (*c* 1.0, $CHCl_3$); IR (neat) 1650 cm^{-1}; ^{1}H NMR (500 MHz) δ 2,79 (dd, J = 7.5, 13.0 Hz, 1 H), 3.26 (dd, J = 5.5, 13.0 Hz, 1 H), 4.26 (ddd, J = 5.5, 7.0, 7.5 Hz, 1 H), 4.76 (dd, J = 6.5, 7.0 Hz, 1 H), 5.06 (dt, J = 1.2, 10.2 Hz, 2 H), 5.07 (dt, J = 1.2, 17.3 Hz, 1 H) 5.72 (ddd, J = 6.5, 10.2, 17.3 Hz, 1 H), 7.22−7.51 (m, 8 H), 7.97−8.01 (m, 2 H); ^{13}C NMR (100 MHz) δ 42.2, 74.5, 84.6, 116.5, 126.5, 128.3, 128.4, 129.2, 129.5, 131.3, 136.2, 137.5, 163.0; HRMS (EI, 70 eV) calcd for $C_{18}H_{18}NO$ 264.1388, found 264.1390. Minor isomer **8b:** ^{1}H NMR (400 MHz) δ 2.86 (dd, J = 6.8, 14.2 Hz, 1 H), 2.94 (dd, J = 8.0, 14.2 Hz, 1 H), 4.64 (m, J = 6.8, 8.0, 9.2 Hz, 1 H), 5.18 (m, J = 1.2, 6.8, 9.2 Hz, 1 H), 5.32 (dt, J = 1.2, 10.5 Hz, 1 H), 5.40 (dt, J = 1.2, 17.3 Hz, 1 H), 5.94 (ddd, J = 6.8, 10.5, 17.3 Hz, 1 H), 7.22−7.49 (m, 8 H), 7.98−8.00 (m, 2 H).

(4*S*-*trans*)-4,5-Dihydro-4-isobutyl-2-phenyl-5-vinyl-oxazoline (3c). According to the general procedure, allyl benzamide **4c** or homoallyl benzamide **12c g**ave a mixture of **3c** and **8c** (172 mg, 75% yield; **3c**:**8c** = 13:1). Purification by flash column chromatography (ethyl acetate/hexane = 1:20) gave pure **3c** as a colorless oil: $[\alpha]^{20}_D$ −39.2° (*c* 1.0, $CHCl_3$); IR (neat) 1652 cm^{-1}; ^{1}H NMR (500 MHz) δ 0.98 (dd, J = 6.6 Hz, 6 H), 1.41 (m, 1 H), 1.65 (m, 1 H), 1.89 (m, 1 H), 4.01 (dd, J = 7.0, 9.5 Hz, 1 H), 4.63 (dd, J = 7.0 Hz, 1H), 5.25 (dt, J = 1.2, 10.5 Hz, 1 H), 5.39 (d, J = 1.2, 17.1 Hz, 1 H), 5.96 (ddd, J = 7.0, 10.5, 17.1 Hz, 1 H), 7.39−7.49 (m, 3 H), 7.95−7.98 (m, 2 H); ^{13}C NMR (100 MHz) δ 22.6, 22.9, 25.0, 45.2, 70.8, 86.3, 117.1, 128.0, 128.2, 128.3, 131.2, 136.5, 162.4; HRMS (EI, 70 eV) calcd for $C_{15}H_{19}NO$ 229.1467, found 229.1470.

Minor isomer **8c**: ^{1}H NMR (400 MHz) δ 0.97 (d, J = 6.6 Hz, 6 H), 1.31−1.93 (m, 3 H), 3.66 (ddd, J = 5.8, 9.3, 9.5 Hz, 1 H), 5.11 (dd, J = 7.6, 9.3 Hz, 1 H), 5.31 (d, J = 10.5 Hz, 1 H), 5.39 (d, J = 17.5 Hz, 1 H), 5.92 (ddd, J = 7.6, 10.5, 17.5 Hz, 1 H), 7.38−7.47 (m, 3 H), 7.97−7.98 (m, 2 H).

(4*S*-*trans*)-4,5-Dihydro-4-cyclohexylmethyl-2-phenyl-5-vinyloxazoline (3d) According to the general procedure, allyl benzamide **4d** or homoallyl benzamide **12d g**ave a mixture of **3d** and **8d** (194 mg, 72% yield; **3d**:**8d** = 14:1). Purification by flash column chromatography (ethyl acetate/hexane = 20:1) gave pure **3d** as a colorless oil: $[\alpha]^{20}_D$ −40.2° (*c* 1.0, $CHCl_3$); IR (neat) 1651 cm^{-1}; ^{1}H NMR (500 MHz) δ 0.95−0.98 (m, 2 H), 1.21−1.28 (m, 5 H), 1.41−1.44 (m, 1 H), 1.64−1.72 (m, 3 H), 1.80 (m, 2 H), 4.04 (dd, J = 7.0, 7.5 Hz, 1 H), 4.62 (dd, J = 7.0 Hz, 1 H), 5.24 (dt, J = 1.2, 10.5 Hz, 1 H), 5.37 (dt, J = 1.2, 17.1 Hz, 1 H), 5.96 (ddd, J = 7.0, 10.5, 17.1 Hz, 1 H), 7.38−7.48 (m, 3 H), 7.95−7.97 (m, 2 H); ^{13}C NMR (100 MHz) δ 26.2, 26.5, 26.6, 33.3, 33.5, 34.3, 43.7, 70.1, 86.3, 117.0, 128.23, 128.25, 128.26, 131.2, 136.4, 162.4; HRMS (EI, 70 eV) calcd for $C_{18}H_{23}NO$ 269.1780, found 269.1781.

Minor isomer **8d**: ^{1}H NMR (400 MHz) δ 0.87−1.72 (m, 13 H), 4.39 (ddd, J = 5.9, 9.3, 9.5 Hz, 1 H), 5.10 (dd, J = 7.3, 9.3 Hz, 1 H), 5.30 (d, J = 10.5 Hz, 1 H), 5.39 (d, J = 17.1 Hz, 1 H), 5.92 (ddd, J = 7.3, 10.5, 17.1 Hz, 1 H), 7.38−7.47 (m, 3 H), 7.96−7.98 (m, 2 H).

General Procedure for Oxazoline Carboxylic Acid Methyl Esters 13. $NaHCO_3$ (817 mg, 9.76 mmol) and, in small portions, 1.76 g (8.24 mmol) of $NaIO_4$ were added to a stirred solution of 1.5 mmol of oxazoline **3** in 1.5 mL of CH_3CN, 1.5 mL of CCl_4, and 2.25 mL of H_2O at room temperature under argon. The mixture was stirred for 5 min after the addition, 50.8 mg (0.24 mmol) of $RuCl_3$ was then added, and stirring continued for 48 h. The reaction mixture was extracted with ether, and then carefully acidified with aqueous HCl, and the product was isolated with CH_2Cl_2 to give pure **1**. Diazomethane was added to the resulting solution of **1** in ether, after 10 min, the solvent was distilled off under reduced pressure and the oily substance obtained was subjected to silica gel column chromatography (ethyl acetate/hexane = 1:4).

Methyl (4*S*,*trans*)-4,5-dihydro-2,4-diphenyl-5-carboxylate (13a): 75% yield; colorless oil; $[\alpha]^{20}_D$ +12.9° (*c* 1.0, $CHCl_3$); IR (neat) 1760, 1655 cm^{-1}; ^{1}H NMR (500 MHz) δ 3.87 (s, 3 H), 4.93 (d, J = 6.5 Hz, 1 H), 5.46 (d, J = 6.5 Hz, 1 H), 7.31−7.57 (m, 8 H), 8.09−8.12 (m, 2 H); ^{13}C NMR (125 MHz) δ 53.5, 75.4, 83.9, 127.2, 127.5, 128.8, 129.2, 129.4, 129.6, 132.7, 141.8, 164.7, 171.4; HRMS (EI, 70 eV) calcd for $C_{17}H_{15}NO_3$ 281.1052, found 281.1050.

Methyl (4S,*trans*)-4,5-dihydro-2-benzyl-4-phenyl-5-carboxylate (13b): 75% yield; colorless oil; $[\alpha]^{20}_D$ +47.7° (*c* 1.0, $CHCl_3$); IR (neat) 1758, 1656 cm^{-1}; ^{1}H NMR (400 MHz) δ 2.89 (dd, J = 7.1, 13.9 Hz, 1 H), 3.12 (dd, J = 6.1, 13.9 Hz, 1 H), 3.62 (s, 3 H), 4.57 (dd, J = 6.1, 7.1 Hz, 1 H), 4.65 (d, J = 6.1 Hz, 1 H), 7.13−7.43 (m, 8 H), 7.88−7.90 (m, 2 H); ^{13}C NMR (100 MHz) δ 41.5, 52,4, 72.7, 79.5, 126.7, 127.0, 128.3, 128.4, 128.5, 129.6, 131.6, 136.6, 163.2, 170.8; HRMS (EI, 70 eV) calcd for $C_{18}H_{17}NO_3$ 295.1208, found 295.1206.

Methyl (4*S*,*trans*)-4,5-dihydro-2-isobutyl-4-phenyl-5-carboxylate (13c): 77% yield; colorless oil; $[\alpha]^{20}_D$ +10.9° (*c*

1.0, $CHCl_3$); IR (neat) 1762, 1658 cm^{-1}; ^1H NMR (400 MHz) δ 1.00 (dd, 6 H), 1.51 (m, 1 H), 1.69 (m, 1 H), 1.98 (m, 1 H), 3.80 (s, 3 H), 4.35 (dd, J = 6.0, 9.9 Hz, 1 H), 4.66 (d, J = 6.0 Hz, 1 H), 7.39−7.52 (m, 8 H), 7.96−8.00 (m, 2 H); ^{13}C NMR (100 MHz) δ 22.5, 22.8, 25.0, 45.8, 52.5, 70.5, 81.1, 127.2, 128.4, 128.5, 131.6, 162.5, 171.2; HRMS (EI, 70 eV) calcd for $C_{17}H_{15}NO_3$ 261.1365, found 261.1362.

Methyl (4S,*trans*)-4,5-dihydro-2-cyclohexylmethyl-4-phenyl-5-carboxylate (13d): 75% yield; colorless oil; $[\alpha]^{20}_D$ +10.6° (*c* 0.3, $CHCl_3$); IR (neat) 1762, 1658 cm^{-1}; ^1H NMR (400 MHz) δ 0.95−1.05 (m, 2 H), 1.12−1.34 (m, 6 H), 1.47−1.84 (m, 5 H), 3.80 (s, 3 H), 4.40 (dd, J = 6.6, 6.9 Hz, 1 H), 4.64 (d, J = 6.6 Hz, 1 H), 7.39−7.52 (m, 3 H), 7.96−8.00 (m, 2 H); ^{13}C NMR (100 MHz) δ 26.2, 26.5, 26.6, 33.2, 33.5, 34.3, 44.4, 52.5, 69.9, 81.2, 128.4, 128.5, 131.2, 136.4, 165.2, 171.7; HRMS (EI, 70 eV) calcd for $C_{18}H_{23}NO_3$ 301.1678, found 301.1678.

General Procedure for Hydroxyethyloxazolines 21. A 0.5 N 9-BBN hexane solution (4.2 mL, 2.1 mmol) was added to 6 mL of a THF solution of 0.7 mmol of oxazoline **3**. The resulting mixture was stirred at 25 °C for 20 h under a nitrogen atmosphere, and 1.28 mL (21.6 mmol) of ethanol, 0.43 mL (2.6 mmol) of 6 N aqueous solution of sodium hydroxide, and 0.85 mL (7.6 mmol) of 30% aqueous hydrogen peroxide were successively added to the above mixture. The resulting product was stirred for a further 30 min and extracted with ethyl acetate. After the addition of anhydrous magnesium sulfate to the obtained organic layer and drying, the solvent was distilled off under reduced pressure and the oily substance obtained was subjected to silica gel column chromatography (ethyl acetate/hexane = 1:1).

(4*S*-*trans*)-4,5-Dihydro-2,4-diphenyl-5-(2-hydroxyethyl)oxazoline (21a): 83% yield; colorless oil; $[\alpha]^{20}_D$ −67.1° (*c* 1.0, $CHCl_3$); IR (neat) 3325, 1642 cm^{-1}; ^1H NMR (500 MHz) δ 2.05 (m, 2 H), 3.87 (m, 2 H), 4.66 (m, J = 4.9, 7.3 Hz, 1 H), 4.96 (d, J = 7.3 Hz, 1 H), 7.26−7.52 (m, 8 H), 8.02−8.04 (m, 2 H); ^{13}C NMR (125 MHz) δ 38.0, 59.5, 75.8, 85.4, 126.7, 127.6, 127.8, 128.4, 128.5, 128.8, 131.7, 141.9, 163.9; HRMS (EI, 70 eV) calcd for $C_{17}H_{17}NO_2$ 267.1259, found 267.1258.

(4*S*-*trans*)-4,5-Dihydro-4-benzyl-5-(2-hydroxyethyl)-2-phenyloxazoline (21b): 82% yield; colorless oil; $[\alpha]^{20}_D$ −10.7° (*c* 1.0, $CHCl_3$); IR (neat) 3337, 1644 cm^{-1}; ^1H NMR (500 MHz) δ 1.52 (m, 1 H), 1.83 (m, 1 H), 2.71 (dd, J = 9.0, 13.5 Hz, 1 H), 3.26 (dd, J = 5.0, 13.5 Hz, 1 H), 3.63 (m, 2 H), 4.18 (m, J = 5.0, 6.5, 9.0 Hz, 1 H), 4.55 (m, J = 6.5 Hz, 1 H), 7.23−7.50 (m, 8 H), 7.93−7.95 (m, 2 H); ^{13}C NMR (125 MHz) δ 38.7, 42.5, 60.0, 74.1, 82.6, 127.4, 128.5, 128.9, 129.0, 129.1, 130.1, 132.1, 138.3, 163.7; HRMS (EI, 70 eV) calcd for $C_{18}H_{19}NO_2$ 281.1416, found 281.1410.

(4*S*-*trans*)-4,5-Dihydro-5-(2-hydroxyethyl)-4-isobutyl-2-phenyloxazoline (21c): 65% yield; colorless oil; $[\alpha]^{20}_D$ −88.5° (*c* 1.0, $CHCl_3$); IR (neat) 3336, 1646 cm^{-1}; ^1H NMR (500 MHz) δ 0.98 (d, 6 H), 1.38 (m, 1 H), 1.62 (m, 1 H), 1.90 (m, 2 H), 1.97 (m, 1 H), 3,88 (t, J = 6.0 Hz, 2 H), 3.95 (q, J = 7.0 Hz, 1 H), 4.44 (m, 1 H), 7.39−7.49 (m, 3 H), 7.92−7.94 (m, 2 H); ^{13}C NMR (125 MHz) δ 23.4, 23.6, 25.6, 38.8, 46.1, 60.4, 71.1, 83.7, 128.7, 128.9, 129.0, 131.9, 163.0; HRMS (EI, 70 eV) calcd for $C_{15}H_{21}NO_2$ 247.1572, found 247.1574.

(4*S*-*trans*)-4,5-Dihydro-4-cyclohexylmethyl-5-(2-hydroxyethyl)-2-phenyloxazoline (21d): 78% yield; colorless oil; $[\alpha]^{20}_D$ −58.7° (*c* 0.3, $CHCl_3$); IR (neat) 3324, 1646 cm^{-1}; ^1H NMR (500 MHz) δ 0.95−1.00 (m, 2 H), 1.15−1.31 (m, 3 H), 1.37 (m, 1 H), 1.54 (m, 1 H), 1.61 (m, 1 H), 1.65−1.98 (m, 8 H), 3.88 (t, J = 6.0 Hz, 2 H), 3,98 (q, J = 7.5 Hz, 1 H), 4.42 (m, 1 H), 7.38−7.48 (m, 3 H), 7.92−7.94 (m, 2 H); ^{13}C NMR (125 MHz) δ 26.9, 27.3, 34.2, 34.3, 35.0, 38.8, 44.8, 60.4, 70.5, 83.8, 128.7, 128.9, 129.0, 131.9, 163.0; HRMS (EI, 70 eV) calcd for $C_{18}H_{25}NO_2$ 287.1885, found 287.1885.

General Procedure for Carbomethoxymethyloxazolines 22: $NaHCO_3$ (546 mg, 6.5 mmol) and, in small portions, 1.18 g (5.50 mmol) of $NaIO_4$ were added to a stirred mixture of 1 mmol of **21** in 1.5 mL of CH_3CN, 1.5 mL of CCl_4, and 2.25 mL of H_2O at room temperature under argon. The mixture was stirred for 5 min, 33.9 mg (0.16 mmol) of $RuCl_3$ was added, and stirring was allowed to continue for 12 h. The reaction mixture was extracted with ether and then carefully acidified with aqueous HCl, and the product was isolated with CH_2Cl_2 to give pure acid. Diazomethane was added to the resulting solution of the acid in ether. After being stirred for 10 min, the solvent was distilled off under reduced pressure and the resulting oily substance was subjected to column chromatography (ethyl acetate/hexane = 1:3).

Methyl (4*S*-*trans*)-4,5-Dihydro-2,4-diphenyloxazoline-5-acetate (22a): 98% yield; colorless oil; $[\alpha]^{20}_D$ −16.0° (*c* 1.0, $CHCl_3$); IR (neat) 1734, 1644 cm^{-1}; ^1H NMR (500 MHz) δ 2.81 (dd, J = 5.6, 15.8 Hz, 1 H), 2.91 (dd, J = 7.6, 15.8 Hz, 1 H), 3.73 (s, 3 H), 4.91 (m, J = 5.6, 6.3, 7.6 Hz, 1 H), 5.02 (d, J = 6.3 Hz, 1 H), 7.26−7.54 (m, 8 H), 8.03−8.05 (m, 2 H); ^{13}C NMR (125 MHz) δ 39.8, 52.0, 75.3, 83.2, 126.7, 127.3, 127.9, 128.4, 128.6, 128.8, 131.7, 141.4, 163.8, 170.2; HRMS (EI, 70 eV) calcd for $C_{18}H_{17}NO_3$ 295.1208, found 295.1210.

Methyl (4*S*-*trans*)-4,5-dihydro-4-benzyl-2-phenyloxazoline-5-acetate (22b): 98% yield; colorless oil; $[\alpha]^{20}_D$ −10.9° (*c* 1.0, $CHCl_3$); IR (neat) 1741, 1650 cm^{-1}; ^1H NMR (500 MHz) δ 2.32 (dd, J = 5.5, 16.0 Hz, 1 H), 2.62 (dd, J = 8.0, 16.0 Hz, 1 H), 2.79 (dd, J = 8.0, 13.5 Hz, 1 H), 3.22 (dd, J = 5.5, 13.5 Hz, 1 H), 3.63 (s, 3 H), 4.21 (m, J = 5.5, 6.0, 8.0 Hz, 1 H), 4.78 (m, J = 5.5, 6.0, 8.0 Hz, 1 H), 7.22−7.50 (m, 8 H), 7.92−7.94 (m, 2 H); ^{13}C NMR 125 MHz) δ 40.6, 42.2, 52.6, 73.7, 80.4, 127.3, 128.2, 129.0, 129.3, 130.2, 132.2, 138.0, 163.7, 170.9; HRMS (EI, 70 eV) calcd for $C_{19}H_{19}NO_3$ 309.1365, found 309.1363.

Methyl (4*S*-*trans*)-4,5-dihydro-4-isobutyl-2-phenyloxazoline-5-acetate (22c): 87% yield; colorless oil; $[\alpha]^{20}_D$ −44.0° (*c* 0.8, $CHCl_3$); IR (neat) 1742, 1652 cm^{-1}; ^1H NMR (500 MHz) δ 0.98 (d, 6 H), 1.41 (m, 1 H), 1.60 (m, 1 H), 1.89 (m, 1 H), 2.61 (dd, J = 5.5, 16.0 Hz, 1 H), 2.77 (dd, J = 7.5, 16.0 Hz, 1 H), 3.75 (s, 3 H), 3.98 (m, J = 5.5, 6.0, 8.0 Hz, 1 H), 4.67 (m, J = 5.5, 6.0, 7.5 Hz, 1 H), 7.38−7.48 (m, 3 H), 7.92−7.94 (m, 2 H); ^{13}C NMR (125 MHz) δ 23.5, 25.6, 28.0, 40.6, 52.7, 70.9, 81.6, 128.5, 129.0, 132.0, 162.9, 171.3; HRMS (EI, 70 eV) calcd for $C_{16}H_{21}NO_3$ 275.1521, found 275.1525.

Methyl (4*S*-*trans*)-4,5-dihydro-4-cyclohexylmethyl-2-phenyloxazoline-5-acetate (22d): 93% yield; colorless oil; $[\alpha]^{20}_D$ −22.7° (*c* 0.25, $CHCl_3$); IR (neat) 1742, 1651 cm^{-1}; ^1H NMR (500 MHz) δ 0.89−0.99 (m, 2 H), 1.14−1.34 (m, 3 H), 1.40 (m, 1 H), 1.55−1.90 (m, 7 H), 2.60 (dd, J = 5.5, 16.0 Hz, 1 H), 2.76 (dd, J = 8.0, 16.0 Hz, 1 H), 3.70 (s, 3 H), 4.00 (dd, J = 6.0 Hz, 1 H), 4.66 (dd, J = 6.0 Hz, 1 H), 7.38−7.47 (m, 3 H), 7.92−7.93 (m, 2 H); ^{13}C NMR (125 MHz) δ 26.8, 27.2, 33.7, 34.2, 40.6, 44.7, 52.7, 70.2, 81.7, 128.5, 129.0, 132.0, 134.3, 162.9, 171.3; HRMS (EI, 70 eV) calcd for $C_{19}H_{25}NO_3$ 315.1834, found 315.1836.

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Supporting Information Available: NMR spectra for **7d**, **7d′**, **4a**−**d**, **10a**−**d**, **11a**−**d**, **11a′-d′**, **12a**−**d**, **3a**−**d**, **13a**−**d**, **21a**−**d**, and **22a**−**d.** This material is available free of charge via the Internet at http://pubs.acs.org.

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