Stereodivergent Synthesis of Highly Substituted Tetrahydropyrans

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Intramolecular oxa-conjugate addition has been employed in a stereoselective synthesis of enantiopure polyalkyl-substituted tetrahydropyrans, which are frequently found as substructures in many natural products. The requisite cyclization precursors, 7-hydroxy-2-enimides **3** and 7-hydroxy-2-enoates **6** were easily accessible by silyloxy Cope rearrangements of the appropriate chiral *syn*-aldols. It was found that the stereoselectivity of the cyclization could be controlled by judicious choice of the carboxylic acid derivative, resulting in a kinetically controlled reaction for the imides and a thermodynamically controlled process for the esters. Mechanistic considerations that could account for the stereocontrol of the process are outlined.

Introduction

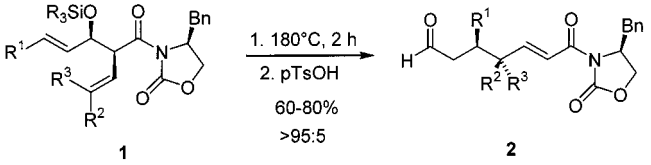
Tetrahydropyrans are commonly encountered substructures in many natural products showing interesting biological properties, the most prominent of these being polyether antibiotics such as monensin, narasin, and tetronomycin.[1] These are able to transport metal ions through membranes by adopting cyclic conformations with the oxygens of the heterocycles coordinating to the metal ion. As a consequence of this ability, they exhibit antibiotic, antiviral, neurotoxic, as well as cardiovascular activity. Other natural products of current interest incorporating tetrahydropyran rings are the bryostatins[2] and spongistatins[3] as well as the highly toxic maitotoxins[4] and brevetoxins,[5] which contain fused tetrahydropyran subunits.

Synthetic methods for the construction of tetrahydropyrans include Ireland−Claisen rearrangements,[6] ring-expansion reactions of tetrahydrofurans,[7] ring-opening reactions of oxa[3.2.1]bicyclic systems,[8] anionic or electrophile-assisted cyclizations of hydroxy tosylates, hydroxy epoxides, and hydroxy olefins,[9] palladium-catalyzed alkyloxy carbonylations of hydroxy olefins,[10] and Prins pinacol cyclization reactions.[11] Intramolecular, base-catalyzed oxa-conjugate addition of hydroxyenoates represents a powerful strategy for the synthesis of tetrahydropyrans.[12] The cyclization is typically reversible and furnishes the heterocycle as mainly one C(2)-stereoisomer with the C(2)-alkyl group in the equatorial position. However, the majority of natural products contain polyalkyl-substituted tetrahydropyrans with various chiral centers in the chain, and these have to be set up correctly before the actual cyclization. Moreover, these stereogenic centers are usually unfunctionalized, which makes it even more difficult to put them in place. Thus, multi-step syntheses are usually required to gain access to the requisite starting compounds.

We have recently established that silyloxy Cope rearrangements of chiral *syn*-aldols proceed very rapidly in high yield, offering excellent levels of stereocontrol.[13] We have taken advantage of the new functional groups generated by the Cope rearrangement to devise new syntheses of piperidines,[14] terpenols,[15] cyclohexanes,[16] and polyol chains.[17] In this article, we detail our observations on the synthesis of polyalkyl-substituted enantiopure tetrahydropyrans by intramolecular oxa-conjugate addition of the hydroxyenimides **3** and hydroxyenoates **6**, which are readily accessible from the Cope products **2**.[18] The stereoselectivity of this process has been systematically studied by varying two parameters: The position and configuration of the alkyl groups in the chain, as well as the nature of the carboxylic acid derivative. As a result of these investigations, we present here the first examples where a clear dependence on the latter variable is evident.

Results and Discussion

A range of enantiopure 7-oxo-2-enimides **2** bearing various substituents at positions C(4) and C(5) were prepared very efficiently and stereoselectively through an aldol Cope sequence, as detailed elsewhere (Scheme 1).[13]



Scheme 1. The silyloxy Cope rearrangement of *syn*-aldols **1**

The Cope products could either be reduced with borane to give rise to the primary hydroxyenimides **3a−f** in high yields, or treated with carbon nucleophiles to give the secondary alcohols **3g−k** (Scheme 2). Oxophilic organometallics were used for this purpose to avoid nucleophilic attack at the very reactive conjugate double bonds of the Cope products that would occur using Grignard reagents and cuprates. Thus, CH_3TiCl_3 addition[19] to **2d** (R^1, R^2 = CH_3) furnished the alcohol **3g** chemoselectively in 60% yield as a 4:1 mixture of stereoisomers. Alternatively, the aldehydes

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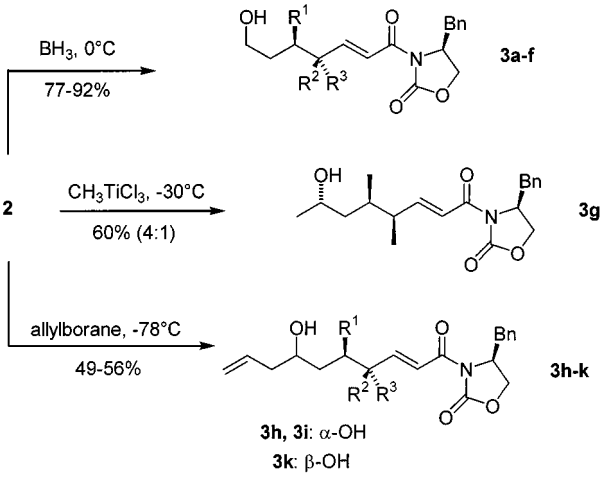
could be converted to the homoallylic alcohols **3h−k** in moderate yields (49−56%) and with good stereocontrol (10−20:1) by means of reagent-controlled allylboration using the chiral diisocaranylboranes developed by Brown.[20] Some of the hydroxyenimides **3** obtained in this way tend to spontaneously cyclize upon exposure to traces of acid or base or on storage in glassware. Therefore, the subsequent reactions were carried out directly on the purified alcohols.

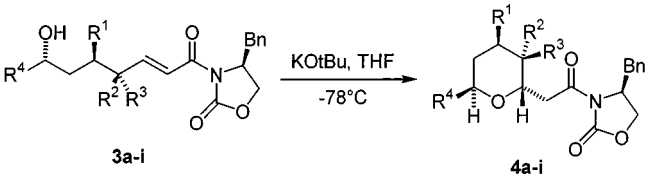


Scheme 2. Synthesis of the 7-hydroxy-2-enemides **3**

The intramolecular oxa-conjugate additions were best performed using either KO*t*Bu or KHMDS as base in THF at −78 °C. Under these conditions, cyclizations furnishing the tetrahydropyrans **4** in good chemical yields occurred within a few minutes (Scheme 3 and Table 1). The use of other bases was also explored, but they were found to give inferior results. The stereoselectivity of the cyclization proved to be substrate-dependent, which gave a first indication that the chiral auxiliary does not exert a significant influence. Thus, the presence of one methyl group at either C(4) or C(5) in the chain resulted in a moderate stereoselectivity of 4−5:1, giving rise to predominantly the 2,4-*trans*- and 2,3-*cis*-disubstituted tetrahydropyrans **4a** and **4b**, respectively. The 2,3-*cis* stereochemistry in **4b** was deduced from the small coupling constant of J(2-H/3-H) = 2.5 Hz and is in good agreement with the observations made by Martin et al. regarding the synthesis of oxy-substituted tetrahydropyrans under comparable reaction conditions.[12a]

Changing the temperature and the reaction time had no effect on the stereoisomeric ratio of the cyclization, showing that it proceeded under kinetic control. We assume that the imide enolate formed by the conjugate addition is exceptionally stable and does not undergo a retro Michael addition. This is also consistent with the low reactivity of imide enolates seen in alkylation reactions, which has been attributed to their high stability.[21]

The 2,3,4-trisubstituted tetrahydropyrans **4d−f** were formed with high stereoselectivity irrespective of the configuration at C(3). Thus, the stereoisomeric hydroxyenimides **3d** and **3e** furnished almost exclusively the 2,4-*trans*-substituted heterocycles **4d** and **4e**, respectively, with the



Scheme 3. Intramolecular oxa-conjugate addition of the 7-hydroxy-2-enimides **3**

Table 1. Tetrahydropyran imides **4a−i**

	R^1	R^2	R^3	R^4	Yield [%]	C(2)-α/C(2)-β[a]
4a	CH_3	H	H	H	79	4:1
4b	H	CH_3	H	H	70	5:1
4c	Ph	H	H	H	83	4:1
4d	CH_3	CH_3	H	H	87	> 20:1
4e	CH_3	H	CH_3	H	73	10:1
4f	Ph	CH_3	H	H	65	10:1
4g	CH_3	CH_3	H	CH_3	62	> 20:1
4h	CH_3	CH_3	H	Allyl	81	> 20:1
4i	CH_3	H	H	Allyl	82	6:1

[a] Determined by NMR spectroscopy.

2,3-stereochemistry being *cis* in **4d** and *trans* in **4e**. Apparently, the 2,4-*trans* selectivity overrides the 2,3-*cis* selectivity in cases where only one of them can be realized. In order to shed light on the influence of the chiral auxiliary, the hydroxyenimide bearing an achiral oxazolidinone was subjected to cyclization, which gave the tetrahydropyran **5** with the same sense and with a comparable level of stereocontrol (Figure 1). This clearly indicated that the stereogenic centers in the chain primarily control the stereoselectivity of the cyclization, with the chiral auxiliary playing only a supporting role. The configurations of the products were assigned on the basis of characteristic $^1H-^1H$ coupling constants. For example, in **4d**, J(2-H/3-H) = 4.0 Hz and J(3-H/4-H) = 7.0 Hz, which indicates an equatorial orientation of the methyl groups at C(3) and C(4) and an axial orientation of the alkyl group at the newly formed chiral center C(2), corresponding to a 2,3-*cis* stereochemistry. In the major isomer of **4e**, however, J(2-H/3-H) = 9.0 Hz, which strongly supports a 2,3-*trans* relationship. This configurational analysis was unambiguously confirmed by performing a crystal structure analysis of a derivative of **4d**.[18]

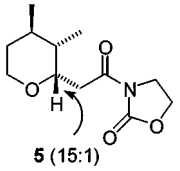
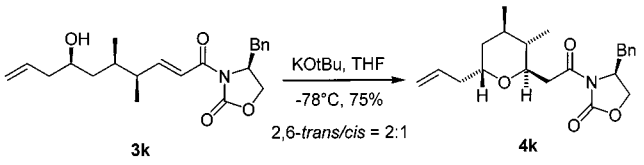


Figure 1

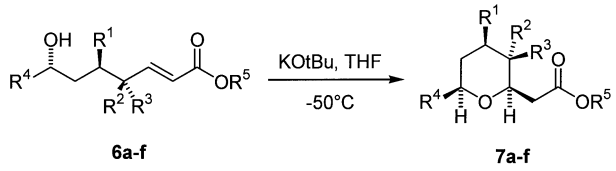
The 2,3,4,6-tetrasubstituted tetrahydropyrans **4g** and **4h** were also obtained with a high degree of stereocontrol at C(2). The C(7) epimeric hydroxyenimide **3k**, however, was cyclized unselectively and gave the tetrahydropyran **4k** as a 2:1 stereoisomeric mixture with respect to the configuration at the newly formed chiral center C(2) (Scheme 4). In con-

trast to all the other tetrahydropyran imides prepared in this study, the major stereoisomer of **4k** has β-configuration at C(2) (see below).



Scheme 4. Stereounselective cyclization of the 7-epimeric hydroxy enimide **3k**

The stereochemical course of the cyclization could be completely reversed by using the hydroxyenoates **6** instead of the enimides (Scheme 5 and Table 2). For this purpose, the imides were converted into the corresponding esters using Ti(O*i*Pr)$_4$/EtOH[22] or MgClOMe.[23] When the identical reaction conditions as above (KO*t*Bu, THF, −78°C, 30 min) were applied to the hydroxyenoate **6a**, the corresponding tetrahydropyran was obtained as a mixture of *cis* and *trans* stereoisomers. However, stereoselective formation of the 2,4-*cis* stereoisomer **7a** in 79% yield proved to be possible under equilibrating conditions (KO*t*Bu, THF, −50°C, 3 h). Other tetrahydropyran esters **7b−f** were prepared as single stereoisomers in this way. **7d** resembles the C(13)−C(22) tetrahydropyran fragment of the polyether antibiotic tetronomycin, which has been prepared in just five steps according to the general protocol.[12h] The C(2)-β configuration of all the tetrahydropyran esters follows from their large coupling constants, *J*(2-H/3-H) = 9.0−11.5 Hz, and the significant upfield shifts of their 2-H signals by 0.5−1 ppm as compared to those of tetrahydropyrans with a C(2)-α configuration.



Scheme 5. Intramolecular oxa-conjugate addition of the 7-hydroxy-2-enoates **6**

Table 2. Tetrahydropyran esters **7a−f**

	R^1	R^2	R^3	R^4	R^5	Yield [%]
7a	CH_3	H	H	H	Et	83
7b	Ph	H	H	H	Et	72
7c	CH_3	CH_3	H	H	Et	79
7d	H	CH_3	H	Allyl	Me	71
7e	CH_3	H	H	Allyl	Et	72
7f	CH_3	CH_3	H	Allyl	Et	81

It is reasonable to assume that a retro Michael addition process is responsible for this thermodynamically controlled equilibration. The ester enolates are clearly less stable than the imide enolates. This different chemical behaviour forms the basis of the stereodivergent synthesis of both C(2)-stereoisomeric tetrahydropyrans reported here. In particular, the important 2,6 stereochemistry frequently found in natural products can be efficiently controlled by judicious choice of the carboxylic acid derivative. If a 2,6-*trans* configuration is required the appropriate hydroxyenimide is subjected to cyclization, whereas if a 2,6-*cis* stereochemistry is required the hydroxyenoate is used.

Whereas the stereoselectivity of the enoate cyclizations can be readily explained, the good to excellent kinetic stereoselection exhibited by the imides merits further comment. The control experiment had revealed that the stereogenic centers in the chain were largely responsible for the selectivity, with the chiral auxiliary having only a supportive effect. We assume that the cyclization proceeds through a chair-like transition structure, which is conformationally fixed by the alkyl groups in the chain. The conjugate double bond can then adopt either a pro-axial or a pro-equatorial orientation, which ultimately lead to the two possible stereoisomers (Figure 2). PM3 calculations using the model compound **8** were performed on the naked anions along both reactions paths, which showed the enamide structure to preferentially adopt an *s-cis* conformation [the *s-trans* conformations would suffer from severe A(1.3) strain and were calculated to be 5−6 kcal/mol higher in energy]. Alternatively, the minor stereoisomer may result from a transition structure with the substituents and the double bond in axial positions. Ab initio calculations by Martin et al.[24] on cyclizations of hydroxyenoates bearing small substituents such as oxygen and halogens in the chain have shown that such transition structures are indeed feasible. In our case, however, a transition structure with two methyl groups in axial positions and an additional 1,3-diaxial interaction of one of them with the double bond is highly unlikely.

It is evident from these calculations that transition structure **A** with a pro-axial double bond is 1.2 kcal/mol lower in energy than transition structure **B** with a pro-equatorial double bond, which corresponds to a 13:1 stereoisomeric ratio at −78°C. By considering this model, the turnaround of stereoselectivity displayed by the epimeric hydroxyenimides **3h** and **3k** can readily be explained. In the case of **3k**, the usually favored transition structure **A** suffers from developing 1,3-diaxial interactions between the C(2) and C(6) alkyl groups of the tetrahydropyran, which results in a preference for transition structure **B** (Figure 3).

Having supported the experimental results by theoretical methods, the question remains as to why the double bond actually prefers the pro-axial position as in transition structure **A**. Martin et al. proposed that the metal ion is bound to the oxygen atoms of both the alkoxide and the enolate being formed in the reaction. A transition structure with a pro-axial double bond can accommodate this double coordination much more easily than one with a pro-equatorial double bond. However, since our calculations ignoring the metal ion clearly show the same preference for the pro-axial orientation of the double bond, another effect may also be operative. Close scrutiny of the angle of nucleophilic attack at the double bond reveals that on going from transition structure **A** to **B** it is decreased from 104° to 99°. This difference is even more pronounced in Martin′s calculations.

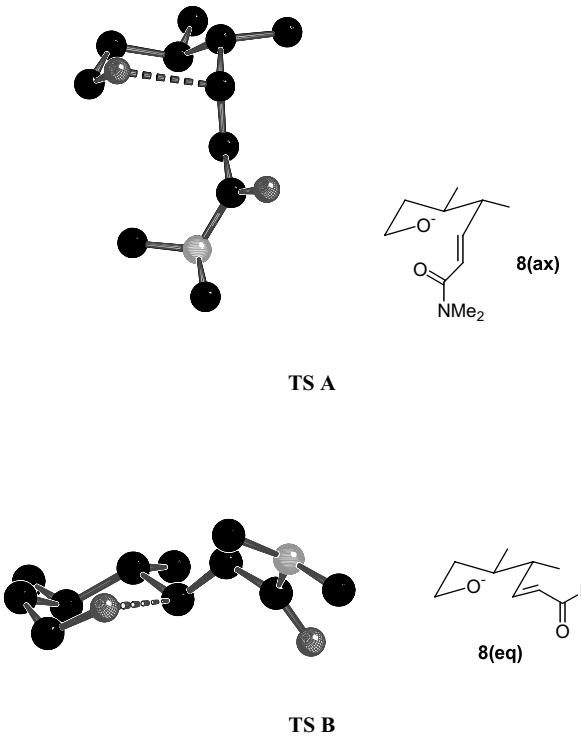


Figure 2. Competing transition structures **TS A** and **TS B** for the intramolecular oxa-conjugate addition of model compound **8** as calculated by PM3

Table 3. Results of the PM3 calculations on the model compound **8**

	TS A	TS B
$\Delta H_f^{\geq}$(PM3) [kcal mol^{-1}]	−91.7	−90.5
Orientation of C_c=C	pro-axial	pro-equatorial
Distance r_{C-O} [Å]	2.32	2.26
Angle $<_{O-C=C}$ [°]	104	99
Torsion $<_{O-C=C-C}$ [°]	−86	81

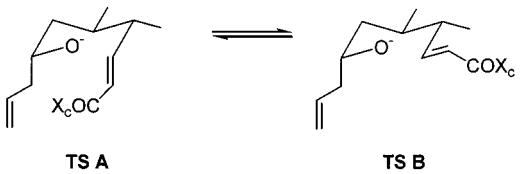


Figure 3. Competing transition structures TS A and TS B in the case of **3k**

A nucleophilic attack at a double bond takes place by initial n(O)→π*(C=C) overlap, which is generally accepted to occur most efficiently for attack angles close to the tetrahedral angle.[25] Accordingly, the observed preference for transition structure **A** may also stem from a more efficient orbital overlap between the lone pair of the oxygen and the π* orbital of the double bond.

Conclusions

A general synthetic strategy allowing access to highly substituted, enantiopure tetrahydropyrans has been developed. The bifunctional products **2** of the silyloxy Cope rearrangement of chiral *syn*-aldols served as the starting compounds, which were transformed in two steps − reduction or alkylation of the aldehyde moiety and intramolecular oxa Michael addition − into a wide variety of tetrahydropyrans with different substitution patterns. The stereoselectivity of the cyclization was found to be highly dependent on the nature of the carboxylic acid derivative, resulting in a kinetic control for the imides and a thermodynamic control for the esters. The kinetic stereoselection ranged from moderate for the less substituted to excellent for the more highly substituted tetrahydropyrans, whereas the thermodynamic stereoselection was excellent in all the examined cases. A stereoelectronic effect arising from the molecular orbital interaction between the lone pair of the oxygen and the antibonding π* orbital of the conjugate double bond has been proposed to account for the observed kinetic stereoselection.

Experimental Section

General: Air- and/or moisture-sensitive reactions were carried out under N_2 using flame-dried glassware. Solvents were distilled from the appropriate drying agents immediately prior to use. The preparation of the Cope products, the chiral 7-oxo-2-enimides **2**, has been reported elsewhere.[13] All reactions were monitored by thin-layer chromatography (TLC) on precoated silica gel SIL G/UV_{254} plates (Machery, Nagel & Co.); spots were visualized with UV light or by treatment with 1% aqueous $KMnO_4$ solution. Products were purified by flash chromatography on Machery, Nagel & Co. silica gel 32−63 (particle size 0.032−0.063 mm). − ^{1}H and ^{13}C NMR spectra were recorded with Varian VXR 200 (200 MHz), Bruker AMX 300 (300 MHz), or Varian VXR 500 (500 MHz) spectrometers in $CDCl_3$ solution at 25°C with TMS as internal standard. − IR spectra of deposited films were recorded with a Bruker IFS 25 FT-IR instrument. − UV spectra were obtained with a Perkin−Elmer Lambda 9 spectrometer. − Optical rotations were measured with a Perkin−Elmer 241 polarimeter. − Mass spectra were measured at 70 eV (EI) or 200 eV (DCI/NH_3) with a Finnigan MAT 95A spectrometer. − Microanalyses were carried out at the microanalytical laboratory of the Institut für Organische Chemie der Universität Göttingen.

Methods of Calculation: The PM3[26] calculations were performed with a PC version of Mopac 6. The 32 bit PC version was compiled by V. Lobanov and is available from ftp://ftp.osc.edu/chemistry/software/MS-WIN95-NT/mopac6. The transition structures were located by examining the reaction path of the retro Michael reaction by incremental elongation of the C−O bond. The preliminary transition structure geometries thus obtained were then fully optimized using the NLLSQ and TS keywords. The FORCE keyword was used to assert that each transition structure had exactly one imaginary force constant.

General Procedure for the Reduction of the 7-Oxo-2-enimides 2: 1.00 mmol of the appropriate aldehyde was dissolved in 5 mL of tetrahydrofuran and treated with 1.10 mL (1.10 mmol) of a 1 M borane solution in tetrahydrofuran at 0°C for 15 min. After the

addition of 2 mL of saturated NH_4Cl solution, the layers were separated and the aqueous phase was extracted twice with diethyl ether. The combined organic extracts were dried with $MgSO_4$ and the solvents were evaporated in vacuo. The residue was purified by chromatography on silica gel.

General Procedure for the Enantioselective Allylation of the 7-Oxo-2-enimides 2: 630 mg (2.00 mmol) of *B*-methoxybis(2-caranyl)borane or *B*-methoxybis(4-caranyl)borane, obtained by hydroboration of 2- and 3-carene, respectively, and subsequent methanolysis, was dissolved in 5 mL of anhydrous diethyl ether and treated with 1 M allylmagnesium bromide solution at 0°C. Stirring was continued for 1 h at room temp. and then the precipitated magnesium salts were allowed to settle. The clear supernatant solution was transferred to another flask by means of a syringe and cooled to −78°C, whereupon a solution of 1.00 mmol of the aldehyde **2** in 2 mL of diethyl ether was added. The resulting mixture was stirred at −78°C for 1 h. Oxidative hydrolysis was then achieved by adding 2 mL of H_2O_2 (30%) and 2 mL of methanol and stirring for 12 h at room temp. The layers were separated and the aqueous phase was extracted three times with diethyl ether. The combined organic extracts were dried with $MgSO_4$ and the solvents were evaporated in vacuo. The crude product was purified by column chromatography on silica gel.

(2′*E*,4*S*,5′*S*)-4-Benzyl-3-[(7′-hydroxy-5′-methyl)-2′-heptenoyl]-2-oxazolidinone (3a): 180 mg (0.57 mmol) of **2a** was reduced according to the general procedure to give 163 mg (90%) of the hydroxyenimide **3a**. − $[\alpha]_D^{20}$ = +52.5 (*c* = 1, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.99 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.35−1.78 (m, 3 H, OH, 6′-CH_2), 1.88 (m_c, 1 H, 5′-CH), 2.27 (m_c, 2 H, 4′-CH_2), 2.80 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−CH), 3.35 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.70 (br. s, 2 H, 7′-CH_2), 4.13−4.27 (m, 2 H, 5-CH_2), 4.72 (m_c, 1 H, 4-CH), 7.10−7.38 (m, 7 H, 2′-CH, 3′-CH, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 19.6 (CH_3), 29.2 (C-5′), 37.7 (benzyl−C), 39.2, 39.9 (C-4′, C-6′), 55.2 (C-4), 60.5 (C-7′), 66.1 (C-5), 121.6 (C-2′), 127.2, 128.8, 129.3, 135.2 (phenyl−C), 150.1 (C-3′), 153.3 (C-2), 164.8 (CO). − IR (film): $\tilde{\nu}$ = 3426 (OH, br), 1778 (C=O, urethane), 1682 (C=O, amide), 1634 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 190.5 nm (4.674). − MS (EI); *m/z*: 317 (21) [M^+], 230 (40), 178 (20) [oxazolidinone + 1], 141 (60) [M^+ + 1 − oxazolidinone], 95 (100). − HRMS for $C_{18}H_{23}NO_4$: calcd. 317.1627; found 317.1627. − $C_{18}H_{23}NO_4$ (317.16): calcd. C 68.12, H 7.30; found C 68.02, H 7.42.

(2′*E*,4*S*,4′*S*)-4-Benzyl-3-[(7′-hydroxy-4′-methyl)-2′-heptenoyl]-2-oxazolidinone (3b): 125 mg (0.40 mmol) of **2b** was reduced according to the general procedure to give 98 mg (77%) of the hydroxyenimide **3b**. − $[\alpha]_D^{20}$ = +78.8 (*c* = 1, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.13 (d, *J* = 7.0 Hz, 3 H, CH_3), 1.35−1.68 (m, 5 H, OH, 5′-CH_2, 6′-CH_2), 2.46 (sept, *J* = 7.0 Hz, 1 H, 4′-CH), 2.79 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−CH), 3.35 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.65 (t, br., *J* = 6.0 Hz, 2 H, 7′-CH_2), 4.13−4.27 (m, 2 H, 5-CH_2), 4.72 (m_c, 1 H, 4-CH), 7.07 (dd, *J* = 15.0 Hz, *J* = 7.0 Hz, 1 H, 3′-CH), 7.18−7.40 (m, 6 H, 2′-CH, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 19.6 (CH_3), 29.2 (C-5′), 37.7 (benzyl−C), 39.2 (C-6′), 41.2 (C-4′), 55.2 (C-4), 60.5 (C-7′), 66.1 (C-5), 121.6 (C-2′), 127.2, 128.8, 129.3, 135.2 (phenyl−C), 150.1 (C-3′), 153.3 (C-2), 164.8 (CO). − IR (film): $\tilde{\nu}$ = 3418 (OH, br), 1779 (C=O, urethane), 1682 (C=O, amide), 1633 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 190 nm (4.628). − MS (EI); *m/z*: 317 (21) [M^+], 230 (40) [$M^+ - C_5H_{11}O$], 178 (20) [oxazolidinone + 1], 141 (78) [M^+ + 1 − oxazolidinone], 95 (100). − HRMS for $C_{18}H_{23}NO_4$: calcd. 317.1627; found 317.1627. − $C_{18}H_{23}NO_4$ (317.16): calcd. C 68.12, H 7.30; found C 68.12, H 7.43.

(2′*E*,4*S*,5′*S*)-4-Benzyl-3-[(7′-hydroxy-5′-phenyl)-2′-heptenoyl]-2-oxazolidinone (3c): 190 mg (0.50 mmol) of **2c** was reduced according to the general procedure to give 147 mg (90%) of the hydroxyenimide **3c**. − $[\alpha]_D^{20}$ = +25.6 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.60 (s, 1 H, OH), 1.75−2.10 (m, 2 H, 5′-CH_2), 2.66 (t, *J* = 7.0 Hz, 2 H, 4′-CH_2), 2.79 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−CH), 2.90−3.07 (m, 1 H, 5′-CH), 3.29 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.40−3.62 (m, 2 H, 7′-CH_2), 4.12−4.25 (m, 2 H, 5-CH_2), 4.69 (m_c, 1 H, 4-CH), 7.06 (dt, *J* = 15.5 Hz, *J* = 7.0 Hz, 1 H, 3′-CH), 7.15−7.30 (m, 11 H, 2′-CH, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 37.8 (benzyl−C), 38.7, 39.9 (C-4′, C-6′), 41.5 (C-5′), 55.3 (C-4), 60.6 (C-7′), 66.1 (C-5), 121.7 (C-2′), 126.6, 127.2, 127.5, 128.7, 128.9, 129.4, 135.3, 143.5 (phenyl−C), 149.3 (C-3′), 153.4 (C-2), 164.7 (CO). − IR (film): $\tilde{\nu}$ = 3446 (OH, br), 1782 (C=O, urethane), 1684 (C=O, amide), 1634 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 190.5 nm (4.668). − EI-MS (70 eV); *m/z*: 379 (46) [M^+], 245 (100) [crotonoyl oxazolidinone]. − HRMS for $C_{23}H_{25}NO_4$: calcd. 379.1783; found 379.1783.

(2′*E*,4*S*,4′*S*,5′*R*)-4-Benzyl-3-[(7′-hydroxy-4′,5′-dimethyl)-2′-heptenoyl]-2-oxazolidinone (3d): 257 mg (0.78 mmol) of **2d** was reduced according to the general procedure to give 238 mg (92%) of the hydroxyenimide **3d**. − $[\alpha]_D^{20}$ = +72.0 (*c* = 1, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.92 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.09 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.20−1.48 (m, 2 H), 1.60−1.82 (m, 2 H), 2.39 (sext, *J* = 6.5 Hz, 1 H, 4′-CH), 2.79 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−CH), 3.36 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.70 (br. q, *J* = 7.0 Hz, 2 H, 7′-CH_2), 4.12−4.28 (m, 2 H, 5-CH_2), 4.72 (m_c, 1 H, 4-CH), 7.10−7.40 (m, 7 H, 2′-CH, 3′-CH, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 15.3, 16.2 (CH_3), 34.0, 41.8 (C-4′, C-5′), 37.1 (C-6′), 37.9 (benzyl−C), 55.4 (C-4), 60.9 (C-7′), 66.1 (C-5), 119.7 (C-2′), 127.3, 128.9, 129.4, 135.4 (phenyl−C), 153.4 (C-2), 155.8 (C-3′), 165.1 (CO). − IR (film): $\tilde{\nu}$ = 3432 (OH, br), 1780 (C=O, urethane), 1682 (C=O, amide), 1630 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 190.5 nm (4.701). − MS (EI); *m/z*: 331 (92) [M^+], 230 (71), 178 (57) [oxazolidinone + 1], 155 (60) [M^+ + 1 − oxazolidinone], 113 (100) [$M^+ - CH_2COX_c$]. − HRMS for $C_{19}H_{25}NO_4$: calcd. 331.1783; found 331.1783. − $C_{19}H_{25}NO_4$ (331.18): calcd. C 68.86, H 7.60; found C 69.08, H 7.34.

(2′*E*,4*S*,4′*S*,5′*R*,7′*S*)- and (2′*E*,4*S*,4′*S*,5′*R*,7′*R*)-4-Benzyl-3-[(7′-hydroxy-4′,5′-dimethyl-)-2′-octenoyl]-2-oxazolidinone (3g*epi*-3g): 0.38 mL of a methyllithium solution in diethyl ether (1.6 M, 0.60 mmol) was added to a solution of 66 μL (0.60 mmol) of $TiCl_4$ in 2 mL CH_2Cl_2 at −78°C. The resulting mixture was stirred for 10 min at −30°C to give a solution of CH_3TiCl_3. To this, a solution of 165 mg (0.50 mmol) of the aldehyde **2d** in 1 mL CH_2Cl_2 was added at −40°C. Stirring was continued for 2 h at −30°C. Saturated NH_4Cl solution was then added, the layers were separated, and the aqueous phase was extracted twice with diethyl ether. The combined organic extracts were dried with $MgSO_4$ and the solvents were evaporated in vacuo. The crude product was purified by column chromatography on silica gel. Yield: 104 mg (60%) of **3g***epi*-**3g** as a 4:1 mixture of stereoisomers at C-7′. − $[\alpha]_D^{20}$ = +78.3 (*c* = 2, $CHCl_3$). − Spectroscopic data for **3g**: ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.95 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.09 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.20 (d, *J* = 6.0 Hz, 3 H, CH_3), 1.38−1.60 (m, 2 H, 6′-CH_2), 1.74 (s, br., 1 H, OH), 1.78−1.95 (m, 1 H, 5′-CH), 2.37 (sext, *J* = 6.5 Hz, 1 H, 4′-CH), 2.80 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−CH), 3.36 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH),

3.80−3.96 (m, 1 H, 7′-CH), 4.12−4.28 (m, 2 H, 5-CH_2), 4.72 (m_c, 1 H, 4-CH), 7.15−7.37 (m, 7 H, 2′-CH, 3′-CH, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 15.5, 16.1, 24.6 (CH_3), 33.8, 42.2 (C-4′, C-5′), 37.9 (benzyl−C), 43.7 (C-6′), 55.4 (C-4), 65.5 (C-7′), 66.1 (C-5), 119.6 (C-2′), 127.2, 128.9, 129.4, 135.4 (phenyl−C), 153.4 (C-2), 155.9 (C-3′), 165.1 (CO). − IR (film): $\tilde{\nu}$ = 3450 (OH, br), 1776 (C=O, urethane), 1678 (C=O, amide), 1628 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 191 nm (4.684). − MS (EI); *m/z*: 345 (34) [M^+], 275 (77), 178 (100) [oxazolidinone + 1], 127 (77) [$M^+ - CH_2COX_c$]. − HRMS for $C_{20}H_{27}NO_4$: calcd. 345.1940; found 345.1940. − $C_{20}H_{27}NO_4$ (345.19): calcd. C 69.54, H 7.88; found 69.20, H 7.84.

(2′*E*,4*S*,4′*S*,5′*R*,7′*S*)-4-Benzyl-3-[(7′-hydroxy-4′,5′-dimethyl)-2′,9′-decadienoyl]-2-oxazolidinone (3h): 235 mg (0.71 mmol) of **2d** was enantioselectively allylated using allyl(4-car)$_2$B according to the general procedure. Yield: 148 mg (56%) of the hydroxyenimide **3h**. − $[\alpha]_D^{20}$ = +77.0 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.94 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.09 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.22 (ddd, *J* = 13.5 Hz, *J* = 10.5 Hz, *J* = 2.5 Hz, 1 H, 6′-CH), 1.45−1.60 (m, 2 H), 1.82−2.00 (m, 1 H), 2.06−2.44 (m, 3 H), 2.79 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−CH), 3.36 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.72 (m_c, 1 H, 7′-CH), 4.13−4.27 (m, 2 H, 5-CH_2), 4.72 (m_c, 1 H, 4-CH), 5.10−5.25 (m, 2 H, 10′-CH_2), 5.70−5.95 (m, 1 H, 9′-CH), 7.18−7.35 (m, 7 H, 2′-CH, 3′-CH, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 15.4, 15.9 (CH_3), 33.6, 42.2 (C-4′, C-5′), 37.8 (benzyl−C), 41.2, 42.9 (C-6′, C-8′), 55.3 (C-4), 66.0 (C-5), 68.1 (C-7′), 118.0 (C-10′), 119.5 (C-2′), 127.1, 128.8, 129.3, 135.3 (phenyl−C), 134.7 (C-9′), 153.3 (C-2), 155.7 (C-3′), 165.0 (CO). − IR (film): $\tilde{\nu}$ = 3488 (OH, br), 1782 (C=O, urethane), 1682 (C=O, amide), 1632 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 191 nm (4.667). − MS (EI); *m/z*: 371 (20) [M^+], 330 (78) [M^+ − allyl], 259 (37) [M^+ − allyl − crotonaldehyde], 178 (100) [oxazolidinone + 1], 153 (55) [$M^+ - CH_2COX_c$], 135 (85). − HRMS for $C_{22}H_{29}NO_4$: calcd. 371.2096; found 371.2096.

(2′*E*,4*S*,5′*S*,7′*S*)-4-Benzyl-3-[(7′-hydroxy-5′-methyl)-2′,9′-decadienoyl]-2-oxazolidinone (3i): 205 mg (0.65 mmol) of **2a** was enantioselectively allylated using allyl(4-car)$_2$B according to the general procedure. Yield: 114 mg (49%) of the hydroxyenimide **3i**. − $[\alpha]_D^{20}$ = +51.6 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.99 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.26 (ddd, *J* = 13.5 Hz, *J* = 9.5 Hz, *J* = 3.0 Hz, 1 H, 6′-CH), 1.40−1.65 (m, 2 H), 2.00 (m_c, 1 H), 2.05−2.40 (m, 4 H, 4′-CH_2, 8′-CH_2), 2.79 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−CH), 3.35 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.78 (s, br., 1 H, 7′-CH), 4.13−4.28 (m, 2 H, 5-CH_2), 4.72 (m_c, 1 H, 4-CH), 5.10−5.24 (m, 2 H, 10′-CH_2), 5.72−5.95 (m, 1 H, 9′-CH), 7.15−7.37 (m, 7 H, 2′-CH, 3′-CH, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 19.3 (CH_3), 29.0 (C-5′), 37.8 (benzyl−C), 40.7, 42.9, 43.7 (C-4′, C-6′, C-8′), 55.3 (C-4), 66.1 (C-5), 68.2 (C-7′), 118.1 (C-10′), 121.6 (C-2′), 127.2, 128.9, 129.4, 135.3 (phenyl−C), 134.7 (C-9′), 150.2 (C-3′), 153.4 (C-2), 164.9 (CO). − IR (film): $\tilde{\nu}$ = 3486 (OH, br), 1782 (C=O, urethane), 1684 (C=O, amide), 1636 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 191.5 nm (4.579). − MS (70 eV); *m/z*: 357 (7) [M^+], 316 (100) [M^+ − allyl], 259 (20) [M^+ − allyl − crotonaldehyde], 178 (72) [oxazolidinone + 1], 139 (56) [$M^+ - CH_2COX_c$]. − HRMS for $C_{21}H_{27}NO_4$: calcd. 357.1940; found 357.1940. − $C_{21}H_{27}NO_4$ (357.19): calcd. C 70.56, H 7.62; found C 70.69, H 7.58.

(2′*E*,4*S*,4′*S*,5′*R*,7′*R*)-4-Benzyl-3-[(7′-hydroxy-4′,5′-dimethyl)-2′,9′-decadienoyl]-2-oxazolidinone (3k): 115 mg (0.35 mmol) of **2d** was enantioselectively allylated using allyl(2-car)$_2$B according to the general procedure. Yield: 68 mg (52%) of the hydroxyenimide **3k**. − $[\alpha]_D^{20}$ = +65.8 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.93 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.06 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.30−1.60 (m, 3 H), 1.80 (m_c, 1 H), 2.10 (dt, *J* = 13.5 Hz, *J* = 7.5 Hz, 1 H, 8′-CH), 2.28−2.52 (m, 2 H, 4′-CH, 8′-CH), 2.79 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−CH), 3.37 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.72 (m_c, 1 H, 7′-CH), 4.14−4.27 (m, 2 H, 5-CH_2), 4.73 (m_c, 1 H, 4-CH), 5.15 [d, *J* = 17.0 Hz, 1 H, (*E*)-10′-CH], 5.17 [d, *J* = 10.0 Hz, 1 H, (*Z*)-10′-CH], 5.70−5.95 (m, 1 H, 9′-CH), 7.18−7.35 (m, 7 H, 2′-CH, 3′-CH, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 14.2, 16.5 (CH_3), 34.1, 40.8 (C-4′, C-5′), 37.8 (benzyl−C), 41.2, 41.9 (C-6′, C-8′), 55.3 (C-4), 66.1 (C-5), 68.8 (C-7′), 118.0 (C-10′), 119.5 (C-2′), 127.2, 128.8, 129.4, 135.4 (phenyl−C), 134.6 (C-9′), 153.4 (C-2), 156.0 (C-3′), 165.0 (CO). − IR (film): $\tilde{\nu}$ = 3448 (OH, br), 1782 (C=O, urethane), 1682 (C=O, amide), 1630 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 190.5 nm (4.739). − MS (EI); *m/z*: 371 (8) [M^+], 330 (86) [M^+ − allyl], 259 (39) [M^+ − allyl − crotonaldehyde], 178 (100) [oxazolidinone + 1], 153 (60) [$M^+ - CH_2COX_c$], 135 (88). − HRMS for $C_{22}H_{29}NO_4$: calcd. 371.2096; found 371.2096.

Ethyl (2*E*,5*S*)-7-Hydroxy-5-methyl-2-heptenoate (6a): 105 mg (0.57 mmol) of the appropriate aldehyde was reduced as outlined above to yield 85 mg (80%) of **6a**. − $[\alpha]_D^{20}$ = 0 (*c* = 1, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.96 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.29 (t, *J* = 7.0 Hz, 3 H, CH_3), 1.20−1.90 (m, 4 H, OH, 5-CH, 6-CH_2), 2.08 (dtd, *J* = 15.0 Hz, *J* = 7.0, 1.0 Hz, 1 H, 4-CH), 2.24 (dtd, *J* = 15.0 Hz, *J* = 7.0 Hz, *J* = 1.0 Hz, 1 H, 4-CH), 3.70 (dt, *J* = 1.5 Hz, *J* = 6.5 Hz, 2 H, 7-CH_2), 4.17 (q, *J* = 7.0 Hz, 2 H, $CO_2CH_2CH_3$), 5.83 (dt, *J* = 15.0 Hz, *J* = 1.0 Hz, 1 H, 2-CH), 6.94 (dt, *J* = 15.0 Hz, *J* = 7.0 Hz, 1 H, 3-CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 14.2, 19.5 (CH_3), 29.1 (C-5), 39.2, 39.6 (C-4, C-6), 60.1, 60.7 ($CO_2CH_2CH_3$, C-7), 122.6 (C-2), 147.5 (C-3), 166.5 (CO). − IR (film): $\tilde{\nu}$ = 3410 (OH, br), 1720 (C=O), 1652 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 209.5 nm (4.077). − MS (EI); *m/z*: 186 (2) [M^+], 141 (46) [M^+ − OEt], 114 (48) [$M^+ + 1 - CO_2Et$], 95 (70), 86 (100) [CH_2CO_2Et −1]. − HRMS for $C_{10}H_{18}O_3$: calcd. 186.1255; found 186.1255. − $C_{10}H_{18}O_3$ (186.13): calcd. C 64.49, H 9.74; found C 64.74, H 9.81.

Methyl (2*E*,5*S*)-7-Hydroxy-5-phenyl-2-heptenoate (6b): 94 mg (0.38 mmol) of the appropriate aldehyde was reduced as outlined above to yield 83 mg (87%) of **6b**. − $[\alpha]_D^{20}$ = −23.4 (*c* = 2.2, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.48 (s, br., 1 H, OH), 1.70−2.05 (m, 2 H, 6-CH_2), 2.53 (t, *J* = 7.0 Hz, 2 H, 4-CH_2), 2.91 (m_c, 1 H, 5-CH), 3.37−3.65 (m, 2 H, 7-CH_2), 3.69 (s, 3 H, OMe), 5.79 (d, *J* = 15.0 Hz, 1 H, 2-CH), 6.82 (dt, *J* = 15.0 Hz, *J* = 7.0 Hz, 1 H, 3-CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 38.7, 39.6 (C-4, C-6), 41.5 (C-5), 51.4 (OMe), 60.6 (C-7), 122.4 (C-2), 126.7, 127.5, 128.6, 143.5 (phenyl−C), 147.2 (C-3), 166.9 (C-1). − IR (film): $\tilde{\nu}$ = 3420 (OH, br), 1722 (C=O), 1656 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 206.5 nm (4.267). − MS (EI); *m/z*: 248 (1) [M^+], 230 (7) [$M^+ - H_2O$], 149 (38) [M^+ − methyl crotonate], 119 (100). − $C_{15}H_{20}O_3$ (248.30): calcd. C 72.56, H 8.12; found C 72.32, H 8.27.

Methyl (2*E*,4*S*,5*R*)-7-Hydroxy-4,5-dimethyl-2-heptenoate (6c): 123 mg (0.67 mmol) of the appropriate aldehyde was reduced as outlined above to yield 97 mg (78%) of **6c**. − $[\alpha]_D^{20}$ = +45.7 (*c* = 1.7, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.89 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.02 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.25−1.50 (m, 2 H), 1.60−1.80 (m, 2 H), 2.28 (sext, *J* = 6.0 Hz, 1 H, 4-CH), 3.57−3.80 (m, 2 H, 7-CH_2), 3.74 (s, 3 H, OMe), 5.80 (d, *J* = 15.5 Hz, 1 H, 2-CH), 6.93 (dd, *J* = 15.5 Hz, *J* = 6.5 Hz, 1 H, 3-

CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 15.1, 16.1 (CH_3), 33.9, 41.4 (C-4, C-5), 37.0 (C-6), 51.5 (OMe), 61.1 (C-7), 120.2 (C-2), 153.7 (C-3), 167.3 (C-1). − IR (film): $\tilde{\nu}$ = 3419 (OH, br), 1723 (C=O), 1652 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 210 nm (4.120). − MS (EI); *m/z*: 186 (1) [M^+], 168 (2) [$M^+ - H_2O$], 114 (100) [methyl pentenoate], 82 (39), 55 (37). − $C_{10}H_{18}O_3$ (186.13): calcd. C 64.49, H 9.74; found C 64.74, H 9.86.

Methyl (2*E*,4*S*,7*R*)-7-Hydroxy-4-methyl-2,9-decadienoate (6d): 65 mg (0.38 mmol) of the appropriate aldehyde was enantioselectively allylated using allyl(4-car)$_2$B according to the general procedure. Yield: 39 mg (49%) of the hydroxyenoate **6d**. − $[\alpha]_D^{20}$ = +32.5 (*c* = 1.6, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.07 (d, *J* = 7.0 Hz, 3 H, CH_3), 1.35−1.70 (m, 5 H, 5-CH_2, 6-CH_2, OH), 2.16 (sept, *J* = 7.0 Hz, 1 H, 4-CH), 2.19−2.40 (m, 2 H, 8-CH_2), 3.62 (m_c, 1 H, 7-CH), 3.74 (s, 3 H, OMe), 5.06−5.20 (m, 2 H, 10-CH_2), 5.70−5.92 (m, 1 H, 9-CH), 5.79 (dd, *J* = 16.0 Hz, *J* = 1.0 Hz, 1 H, 2-CH), 6.86 (dd, *J* = 16.0 Hz, *J* = 7.0 Hz, 1 H, 3-CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 19.5 (CH_3), 31.9, 34.2, 42.0 (C-5, C-6, C-8), 36.5 (C-4), 51.4 (OMe), 70.4 (C-7), 118.3 (C-10), 119.5 (C-2), 134.6 (C-9), 154.4 (C-3), 167.2 (C-1). − IR (film): $\tilde{\nu}$ = 3435 (OH, br), 1724 (C=O), 1655 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 208.5 nm (4.166). − MS (EI); *m/z*: 171 (32) [M^+ − allyl], 139 (100) [M^+ − allyl − OMe], 111 (61), 93 (81). − $C_{12}H_{20}O_3$ (212.29): calcd. C 67.89, H 9.50; found C 68.19, H 9.64.

Ethyl (2*E*,5*S*,7*S*)-7-Hydroxy-5-methyl-2,9-decadienoate (6e): 125 mg (0.68 mmol) of the appropriate aldehyde was enantioselectively allylated using allyl(4-car)$_2$B according to the general procedure. Yield: 83 mg (54%) of the hydroxyenoate **6e**. − $[\alpha]_D^{20}$ = −15.6 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.98 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.28 (t, *J* = 7.0 Hz, 3 H, CH_3), 1.41 (t, *J* = 6.5 Hz, 2 H, 6-CH_2), 1.57 (d, *J* = 4.0 Hz, 1 H, OH), 1.80−2.40 (m, 5 H, 4-CH_2, 5-CH, 8-CH_2), 3.74 (m_c, 1 H, 7-CH), 4.19 (q, *J* = 7.0 Hz, 2 H, $CO_2CH_2CH_3$), 5.14 [dq, *J* = 17.0 Hz, *J* = 1.5 Hz, 1 H, (*E*)-10-CH], 5.16 [dq, *J* = 10.0 Hz, *J* = 1.0 Hz, 1 H, (*Z*)-10-CH], 5.70−5.95 (m, 1 H, 9-CH), 5.82 (dt, *J* = 15.5 Hz, *J* = 1.5 Hz, 1 H, 2-CH), 6.94 (dt, *J* = 15.5 Hz, *J* = 7.0 Hz, 1 H, 3-CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 14.3, 20.3 (CH_3), 29.3 (C-5), 39.0, 42.3, 43.6 (C-4, C-6, C-8), 60.2 ($CO_2CH_2CH_3$), 68.4 (C-7), 118.5 (C-10), 122.8 (C-2), 134.5 (C-9), 147.7 (C-3), 166.6 (CO). − IR (film): $\tilde{\nu}$ = 3448 (OH, br), 1722 (C=O), 1654 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 210 nm (4.138). − MS (DCI); *m/z*: 244 (100) [$M^+ + NH_4^+$].

Ethyl (2*E*,4*S*,5*R*,7*S*)-7-Hydroxy-4,5-dimethyl-2,9-decadienoate (6f): 205 mg (1.04 mmol) of the appropriate aldehyde was enantioselectively allylated using allyl(4-car)$_2$B according to the general procedure. Yield: 162 mg (65%) of the hydroxyenoate **6f**. − $[\alpha]_D^{20}$ = +30.0 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.90 (d, *J* = 6.5 Hz, 3 H, CH_3), 0.99 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.30 (t, *J* = 7.0 Hz, 3 H, CH_3), 1.25−1.60 (m, 3 H), 1.75 (m_c, 1 H), 2.12 (dt, *J* = 13.5 Hz, *J* = 7.5 Hz, 1 H, 8-CH), 2.25−2.43 (m, 2 H, 4-CH, 8-CH), 3.72 (m_c, 1 H, 7-CH), 4.19 (q, *J* = 7.0 Hz, 2 H, $CO_2CH_2CH_3$), 5.14 [dq, *J* = 17.0 Hz, *J* = 1.5 Hz, 1 H, (*E*)-10-CH], 5.16 [dq, *J* = 10.0 Hz, *J* = 1.0 Hz, 1 H, (*Z*)-10-CH], 5.70−5.93 (m, 1 H, 9-CH), 5.79 (dt, *J* = 15.5 Hz, *J* = 1.0 Hz, 1 H, 2-CH), 6.93 (dt, *J* = 15.5 Hz, *J* = 7.0 Hz, 1 H, 3-CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 14.1, 14.3, 16.5 (CH_3), 34.1, 40.4 (C-4, C-5), 41.2, 41.9 (C-6, C-8), 60.2 ($CO_2CH_2CH_3$), 68.9 (C-7), 118.5 (C-10), 120.5 (C-2), 134.5 (C-9), 153.5 (C-3), 166.8 (CO). − IR (film): $\tilde{\nu}$ = 3448 (OH, br), 1720 (C=O), 1648 cm^{-1} (C=C). − UV (CH_3CN): λ_{max} (lg ε) = 209 nm (4.172). − MS (DCI); *m/z*: 258 (100) [$M^+ + NH_4^+$].

General Procedure for the Intramolecular Oxa Michael Addition of the Hydroxyimides 3 and Hydroxyenoates 6: 0.30 mmol of the appropriate hydroxyenimide **3** or hydroxyenoate **6** was dissolved in 2 mL of tetrahydrofuran and treated with 50 mg (0.45 mmol) of KO*t*Bu at −78°C. Stirring was continued for 30 min at −78°C in the case of the imides and for 2−3 h at −50°C in the case of the esters. Saturated NH_4Cl solution was then added, the layers were separated, and the aqueous phase was extracted twice with diethyl ether. The combined organic extracts were dried with $MgSO_4$ and the solvents were evaporated in vacuo. The crude product was purified by column chromatography on silica gel.

(4*S*,2′*R*,4′*R*)- and (4*S*,2′*S*,4′*R*)-4-Benzyl-3-[(4′-methyltetrahydropyran-2′-yl)acetyl]-1,3-oxazolidin-2-one (4a/*epi*-4a): 95 mg (0.30 mmol) of the hydroxyenimide **3a** was treated with 50 mg (0.45 mmol) of KO*t*Bu for 30 min at −78°C as outlined above to yield 75 mg (79%) of the tetrahydropyrans **4a/*epi*-4a** as a 4:1 stereoisomeric mixture at C-2′ (by ^{1}H NMR). − $[\alpha]_D^{20}$ = +45.0 (*c* = 0.2, $CHCl_3$). − **Major Isomer 4a:** ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.08 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.15−2.07 (m, 5 H, 3′-CH_2, 4′-CH, 5′-CH_2), 2.79 (dd, *J* = 13.0 Hz, *J* = 9.0 Hz, 1 H, benzyl−CH), 2.96 (dd, *J* = 15.5 Hz, *J* = 4.0 Hz, 1 H, C*H*COX_c), 3.32 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.39 (dd, *J* = 15.5 Hz, *J* = 8.0 Hz, 1 H, C*H*COX_c), 3.65−3.82 (m, 2 H, 6′-CH_2), 4.15−4.23 (m, 2 H, 5-CH_2), 4.29 (ddt, *J* = 11.5 Hz, *J* = 8.0 Hz, *J* = 4.0 Hz, 1 H, 2′-CH), 4.70 (m_c, 1 H, 4-CH), 7.20−7.36 (m, 5 H, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 19.1 (CH_3), 24.8 (C-4′), 32.3, 37.4, 40.4 (C-3′, C-5′, CH_2COXc), 37.7 (benzyl−C), 55.2 (C-4), 62.5 (C-6′), 66.0 (C-5), 68.7 (C-2′), 127.3, 128.9, 129.4, 135.2 (phenyl−C), 153.4 (C-2), 171.0 (CO). − IR (film): $\tilde{\nu}$ = 1782 (C=O, urethane), 1702 cm^{-1} (C=O, amide). − EI-MS (70 eV); *m/z*: 317 (52) [M^+], 261 (28), 178 (22) [oxazolidinone + 1], 141 (25) [$M^+ + 1$ − oxazolidinone], 112 (24), 99 (100) [$M^+ - CH_2COX_c$]. − EI-HRMS for $C_{18}H_{23}NO_4$: calcd. 317.1627; found 317.1627. − $C_{18}H_{23}NO_4$ (317.16): calcd. C 68.12, H 7.30; found C 68.06, H 7.38.

(4*S*,2′*S*,3′*S*)- and (4*S*,2′*R*,3′*S*)-4-Benzyl-3-[(3′-methyltetrahydropyran-2′-yl)acetyl]-1,3-oxazolidin-2-one (4b/*epi*-4b): 45 mg (0.14 mmol) of the hydroxyenimide **3b** was treated with 23 mg (0.21 mmol) of KO*t*Bu for 30 min at −78°C as outlined above to yield 30 mg (70%) of the tetrahydropyrans **4b/*epi*-4b** as a 5:1 stereoisomeric mixture at C-2′ (by ^{1}H NMR). − $[\alpha]_D^{20}$ = +45.7 (*c* = 0.7, $CHCl_3$). − **Major Isomer 4b:** ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.03 (d, *J* = 7.0 Hz, 3 H, CH_3), 1.22−1.88 (m, 5 H, 3′-CH, 4′-CH_2, 5′-CH_2), 2.76 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−CH), 2.87 (dd, *J* = 16.0 Hz, *J* = 3.5 Hz, 1 H, C*H*COX_c), 3.29 (dd, *J* = 16.0 Hz, *J* = 9.5 Hz, 1 H, C*H*COX_c), 3.33 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.40−3.60 (m, 1 H, 6′-CH), 3.96 (m_c, 1 H, 6′-CH), 4.04 (ddd, *J* = 9.5 Hz, *J* = 3.5 Hz, *J* = 2.5 Hz, 1 H, 2′-CH), 4.13−4.27 (m, 2 H, 5-CH_2), 4.68 (m_c, 1 H, 4-CH), 7.17−7.35 (m, 5 H, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 12.6 (CH_3), 21.1, 31.0 (C-4′, C-5′), 31.5 (C-3′), 37.8 (benzyl−C), 39.0 (CH_2COX_c), 55.2 (C-4), 66.1 (C-5), 68.2 (C-6′), 76.0 (C-2′), 127.3, 128.9, 129.5, 135.3 (phenyl−C), 153.5 (C-2), 171.4 (CO). − IR (film): $\tilde{\nu}$ = 1782 (C=O, urethane), 1702 cm^{-1} (C=O, amide). − EI-MS (70 eV); *m/z*: 317 (52) [M^+], 261 (28), 178 (22) [oxazolidinone + 1], 141 (25) [$M^+ + 1$ − oxazolidinone], 112 (24), 99 (100) [$M^+ - CH_2COX_c$]. − EI-HRMS for $C_{18}H_{23}NO_4$: calcd. 317.1627; found 317.1627. − $C_{18}H_{23}NO_4$ (317.16): calcd. C 68.12, H 7.30; found C 68.18, 7.34.

(4*S*,2′*R*,4′*R*)- and (4*S*,2′*S*,4′*R*)-4-Benzyl-3-[(4′-phenyltetrahydropyran-2′-yl)acetyl]-1,3-oxazolidin-2-one (4c/*epi*-4c): 83 mg (0.22 mmol) of the hydroxyenimide **3c** was treated with 30 mg

(0.27 mmol) of KO*t*Bu for 30 min at −78°C as outlined above to yield 69 mg (83%) of the tetrahydropyrans **4c**/*epi*-**4c** as a 4:1 stereoisomeric mixture at C-2′ (by ^{1}H- and ^{13}C NMR). − $[\alpha]_D^{20}$ = +18.0 (*c* = 0.2, $CHCl_3$). − **Major Isomer 4c:** ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.71−2.00 (m, 3 H, 3′-CH, 5′-CH_2), 2.15 (ddd, *J* = 13.0 Hz, *J* = 9.5 Hz, *J* = 4.5 Hz, 1 H, 3′-CH), 2.81 (dd, *J* = 13.0 Hz, *J* = 9.0 Hz, 1 H, benzyl−CH), 3.00−3.15 (m, 1 H, 4′-CH), 3.10 (dd, *J* = 15.5 Hz, *J* = 4.5 Hz, 1 H, C*H*COX_c), 3.32 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−CH), 3.65 (dd, *J* = 15.5 Hz, *J* = 8.5 Hz, 1 H, C*H*COX_c), 3.74−4.00 (m, 2 H, 6′-CH_2), 4.15−4.23 (m, 2 H, 5-CH_2), 4.56 (dtd, *J* = 8.5 Hz, *J* = 4.5 Hz, *J* = 2.5 Hz, 1 H, 2′-CH), 4.71 (m_c, 1 H, 4-CH), 7.20−7.36 (m, 10 H, phenyl−CH). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 32.5, 35.9 (C-3′, C-5′), 35.4 (C-4′), 37.7 (benzyl−C), 38.2 (CH_2COX_c), 55.2 (C-4), 62.2 (C-6′), 66.1 (C-5), 69.5 (C-2′), 126.2, 126.7, 127.1, 127.3, 128.5, 128.9, 135.2, 144.7 (phenyl−C), 153.5 (C-2), 170.8 (CO). − IR (film): $\tilde{\nu}$ = 1782 (C=O, urethane), 1702 cm^{-1} (C=O, amide). − EI-MS (70 eV); *m*/*z*: 379 (100) [M^+], 178 (42) [oxazolidinone + 1], 161 (92). − EI-HRMS for $C_{23}H_{25}NO_4$: calcd. 379.1783; found 379.1783.

(4*S*,2′*S*,3′*S*,4′*R*)-4-Benzyl-3-[(3′,4′-dimethyltetrahydropyran-2′-yl)-acetyl]-1,3-oxazolidin-2-one (4d): 105 mg (0.32 mmol) of the hydroxyenimide **3d** was treated with 51 mg (0.46 mmol) of KO*t*Bu for 30 min at −78°C as outlined above to give 91 mg (87%) of the tetrahydropyran **4d**. − Diastereoselectivity at C-2′: > 20:1 (by ^{1}H- and ^{13}C NMR). − $[\alpha]_D^{20}$ = +20.4 (*c* = 1, $CHCl_3$). − ^{1}H NMR (500 MHz, $CDCl_3$): δ = 0.96 (d, *J* = 7.0 Hz, 3 H, CH_3), 1.03 (d, *J* = 7.0 Hz, 3 H, CH_3), 1.22 (dddd, *J* = 13.5, 8.0, 7.0, 4.0 Hz, 1 H, 5′-CH_{ax}), 1.55 (dquint, *J* = 4.0 Hz, *J* = 7.0 Hz, 1 H, 3′-CH_{ax}), 1.63 (dsext, *J* = 4.0 Hz, *J* = 7.0 Hz, 1 H, 4′-CH_{ax}), 1.77 (ddt, *J* = 13.5, 6.5, 4.0 Hz, 1 H, 5′-CH_{eq}), 2.78 (dd, *J* = 13.0 Hz, *J* = 9.5 Hz, 1 H, benzyl−H), 2.92 (dd, *J* = 15.0 Hz, *J* = 4.0 Hz, 1 H, C*H*COX_c), 3.31 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−H), 3.40 (dd, *J* = 15.0 Hz, *J* = 10.5 Hz, 1 H, C*H*COX_c), 3.70 (ddd, *J* = 11.5, 6.5, 4.0 Hz, 1 H, 6′-CH_{eq}), 3.81 (ddd, *J* = 11.5, 8.0, 4.0 Hz, 1 H, 6′-CH_{ax}), 4.15 (dd, *J* = 9.0 Hz, *J* = 3.0 Hz, 1 H, 5-CH), 4.19 (dd, *J* = 9.0 Hz, *J* = 7.5 Hz, 1 H, 5-CH), 4.31 (dt, *J* = 10.5 Hz, *J* = 4.0 Hz, 1 H, 2′-CH_{eq}), 4.69 (ddt, *J* = 9.5, 7.5, 3.0 Hz, 1 H, 4-CH), 7.20−7.34 (m, 5 H, phenyl−H). − ^{13}C NMR (75 MHz, $CDCl_3$): δ = 14.5, 19.1 (2 × CH_3), 31.1 (C-5′), 31.6 (C-3′/C-4′), 35.4 (CH_2COX_c), 37.7 (benzyl−C), 39.1 (C-3′/C-4′), 55.3 (C-4), 62.3 (C-6′), 66.0 (C-5), 72.7 (C-2′), 127.3, 128.9, 129.5, 135.3 (phenyl−C), 153.5 (CO), 171.6 (CO). − IR (film): $\tilde{\nu}$ = 1782 (C=O, urethane), 1702 cm^{-1} (C=O, amide). − EI-MS (70 eV); *m*/*z*: 331 (60) [M^+], 261 (40), 178 (39) [oxazolidinone + 1], 113 (100) [$M^+ - CH_2COX_c$]. − EI-HRMS for $C_{19}H_{25}NO_4$: calcd. 331.1783; found 331.1783. − $C_{19}H_{25}NO_4$ (331.18): calcd. C 68.86, H 7.60; found C 69.02, H 7.49.

(4*S*,2′*S*,3′*R*,4′*R*)-4-Benzyl-3-[(3′,4′-dimethyltetrahydropyran-2′-yl)-acetyl]-1,3-oxazolidin-2-one (4e): 52 mg (0.16 mmol) of the hydroxyenimide **3e**, which was used immediately after the reduction step, was treated with 27 mg (0.24 mg) of KO*t*Bu for 30 min at −78°C as outlined above to yield 38 mg (73%) of the tetrahydropyran **4e** and 4 mg (7%) of the C-2′ epimer after chromatographic separation. − **Major Isomer 4e:** $[\alpha]_D^{20}$ = +20.0 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.88 (d, *J* = 6.5 Hz, 3 H, CH_3), 0.99 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.41 (dq, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, 5′-CH_{eq}), 1.67−2.00 (m, 3 H, 3′-CH, 4′-CH, 5′-CH_{ax}), 2.78 (dd, *J* = 13.0 Hz, *J* = 9.0 Hz, 1 H, benzyl−H), 3.09 (dd, *J* = 15.0 Hz, *J* = 3.0 Hz, 1 H, C*H*COX_c), 3.27 (dd, *J* = 15.0 Hz, *J* = 9.0 Hz, 1 H, C*H*COX_c), 3.33 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−H), 3.63−3.78 (m, 2 H, 6′-CH_2), 3.93 (dt, *J* = 3.0 Hz, *J* = 9.0 Hz, 1 H, 2′-CH_{ax}), 4.15 (dd, *J* = 9.0 Hz, *J* = 3.0 Hz, 1 H, 5-CH), 4.19 (t, *J* = 9.0 Hz, 1 H, 5-CH), 4.70 (m_c, 1 H, 4-CH), 7.19−7.35 (m, 5 H, phenyl−H). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 13.0, 15.0 (2 × CH_3), 30.6, 38.0 (C-3′, C-4′), 32.7, 39.4 (C-5′, CH_2COX_c), 37.7 (benzyl−C), 55.3 (C-4), 62.6 (C-6′), 66.0 (C-5), 74.0 (C-2′), 127.3, 128.9, 129.5, 135.4 (phenyl−C), 153.5 (CO), 171.7 (CO). − IR (film): $\tilde{\nu}$ = 1782 (C=O, urethane), 1706 cm^{-1} (C=O, amide). − EI-MS (70 eV); *m*/*z*: 331 (42) [M^+], 261 (25), 178 (34) [oxazolidinone + 1], 113 (100) [$M^+ - CH_2COX_c$]. − EI-HRMS for $C_{19}H_{25}NO_4$: calcd. 331.1783; found 331.1783. − $C_{19}H_{25}NO_4$ (331.18): calcd. C 68.86, H 7.60; found C 68.70, H 7.46.

(4*S*,2′*S*,3′*S*,4′*R*)- and (4*S*,2′*R*,3′*S*,4′*R*)-4-Benzyl-3-[(3′-methyl-4′-phenyltetrahydropyran-2′-yl)acetyl]-1,3-oxazolidin-2-one (4f/*epi*-4f): 55 mg (0.14 mmol) of the hydroxyenimide **3f**, which was used immediately after the reduction step, was treated with 22 mg (0.20 mmol) of KO*t*Bu for 60 min at −78°C as outlined above to give 36 mg (65%) of the tetrahydropyrans **4f**/*epi*-**4f**. − Diastereoselectivity at C-2′: 10:1 (by ^{1}H- and ^{13}C NMR). − $[\alpha]_D^{20}$ = −24.0 (*c* = 0.9, $CHCl_3$). − Spectroscopic data for the major isomer **4f**: ^{1}H NMR (500 MHz, $CDCl_3$): δ = 0.69 (d, *J* = 7.0 Hz, 3 H, CH_3), 1.70−2.03 (m, 2 H, 3′-CH/5′-CH), 2.29 (m_c, 1 H, 3′-CH/5′-CH), 2.61 (td, *J* = 11.0 Hz, *J* = 4.5 Hz, 1 H, 4′-CH), 2.85 (dd, *J* = 13.5 Hz, *J* = 9.5 Hz, 1 H, benzyl−H), 3.11 (dd, *J* = 15.0 Hz, *J* = 3.5 Hz, 1 H, C*H*COX_c), 3.33 (dd, *J* = 13.5 Hz, *J* = 3.0 Hz, 1 H, benzyl−H), 3.67 (dd, *J* = 15.0 Hz, *J* = 11.0 Hz, 1H, C*H*COX_c), 3.74−3.88 (m, 1 H, 6′-CH_{eq}), 3.97 (td, *J* = 11.0 Hz, *J* = 3.0 Hz, 1 H, 6′-CH_{ax}), 4.15 (dd, *J* = 9.0 Hz, *J* = 3.0 Hz, 1 H, 5-CH), 4.19 (dd, *J* = 9.0 Hz, *J* = 7.5 Hz, 1 H, 5-CH), 4.56 (dt, *J* = 11.0 Hz, *J* = 4.5 Hz, 1 H, 2′-CH_{eq}), 4.74 (ddt, *J* = 9.5, 7.5, 3.0 Hz, 1 H, 4-CH), 7.10−7.34 (m, 5 H, phenyl−H). − ^{13}C NMR (75 MHz, $CDCl_3$): δ = 15.3 (CH_3), 32.4, 34.0 (C-5′, CH_2COX_c), 37.7 (benzyl−C), 38.6 (C-3′), 43.5 (C-4′), 55.4 (C-4), 61.4 (C-6′), 66.1 (C-5), 74.2 (C-2′), 126.5, 127.4, 127.5, 128.6, 129.0, 129.5, 135.2, 144.0 (phenyl−C), 153.6 (C-2), 171.5 (CO). − IR (film): $\tilde{\nu}$ = 1780 (C=O, urethane), 1699 cm^{-1} (C=O, amide). − EI-MS (70 eV); *m*/*z*: 394 (20) [M^+ + 1], 393 (81) [M^+], 188 (38) [$M^+ - 1 - COX_c$], 175 (100) [$M^+ - CH_2COX_c$]. − EI-HRMS for $C_{24}H_{27}NO_4$: calcd. 393.1940; found 393.1940. − $C_{24}H_{27}NO_4$ (393.19): calcd. C 73.31, H 6.92; found C 73.46, H 7.05.

(4*S*,2′*S*,3′*S*,4′*R*,6′*S*)-4-Benzyl-3-[(3′,4′,6′-trimethyltetrahydropyran-2′-yl)acetyl]-1,3-oxazolidin-2-one (4g): 55 mg (0.16 mmol) of the hydroxyenimide **3g**/*epi*-**3g** (as a 4:1 mixture of stereoisomers at C-7′) was treated with 27 mg (0.24 mmol) of KO*t*Bu for 30 min at −78°C according to the general procedure to yield 34 mg (62%) of the tetrahydropyran **4g** after chromatographic separation of the C(6) isomer. − Diastereoselectivity at C-2′: > 20:1 (by ^{1}H and ^{13}C NMR). − $[\alpha]_D^{20}$ = +3.6 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.88 (d, *J* = 6.5 Hz, 3 H, CH_3), 0.92 (d, *J* = 6.5 Hz, 3 H, CH_3), 0.90−1.10 (m, 1 H), 1.12 (d, *J* = 6.0 Hz, 1 H, CH_3), 1.40−1.65 (m, 3 H), 2.78 (dd, *J* = 13.0 Hz, *J* = 9.0 Hz, 1 H, benzyl−H), 3.10 (dd, *J* = 14.0 Hz, *J* = 4.0 Hz, 1 H, C*H*COX_c), 3.32 (dd, *J* = 13.0 Hz, *J* = 3.0 Hz, 1 H, benzyl−H), 3.42 (dd, *J* = 14.0 Hz, *J* = 10.5 Hz, 1H, C*H*COX_c), 3.93 (ddq, *J* = 11.0, 2.0, 6.0 Hz, 1 H, 6′-CH_{ax}), 4.12−4.25 (m, 2 H, 5-CH_2), 4.40 (dt, *J* = 11.0 Hz, *J* = 4.0 Hz, 1 H, 2′-CH_{eq}), 4.70 (m_c, 1 H, 4-CH), 7.20−7.37 (m, 5 H, phenyl−H). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 14.6, 19.7, 22.0 (CH_3), 31.0, 40.0 (C-3′, C-4′), 32.7, 42.5 (C-5′, CH_2COX_c), 37.8 (benzyl−C), 55.4 (C-4), 65.9 (C-6′), 66.0 (C-5), 74.9 (C-2′), 127.3, 128.9, 129.5, 135.3 (phenyl−C), 153.5 (CO), 171.6 (CO). − IR (film): $\tilde{\nu}$ = 1778 (C=O, urethane), 1702 cm^{-1} (C=O, amide). − EI-MS (70 eV); *m*/*z*: 345 (9) [M^+], 275 (40), 178 (44) [oxazolidinone + 1], 127 (45) [$M^+ - CH_2COX_c$], 92 (100) benzyl + 1], 86 (82). − EI-HRMS for $C_{20}H_{27}NO_4$: calcd. 345.1940;

found 345.1940. − $C_{20}H_{27}NO_4$ (345.19): calcd. C 69.54, H 7.88; found C 69.20, H 7.84.

(4*S*,2′*S*,3′*S*,4′*R*,6′*S*)-4-Benzyl-3-[(3′,4′-dimethyl-6′-propenyltetrahydropyran-2′-yl)acetyl]-1,3-oxazolidin-2-one (4h): 65 mg (0.175 mmol) of the hydroxyenimide **3h** was treated with 29 mg (0.26 mmol) of KO*t*Bu as outlined above to yield 53 mg (81%) of the tetrahydropyran **4h**. − Diastereoselectivity at C-2′: > 20:1 (by ^{1}H- and ^{13}C NMR). − $[\alpha]_D^{20}$ = −7.0 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.86 (d, *J* = 6.5 Hz, 3 H, CH_3), 0.92 (d, *J* = 6.5 Hz, 3 H, CH_3), 0.98 (q, *J* = 12.0 Hz, 1 H, 5′-CH_{ax}), 1.45−1.66 (m, 3 H, 3′-CH, 4′-CH, 5′-CH_{eq}), 2.08−2.26 (m, 2 H, allyl−CH_2), 2.78 (dd, *J* = 13.5, 9.0 Hz, 1 H, benzyl−H), 3.07 (dd, *J* = 14.5 Hz, *J* = 4.0 Hz, 1 H, C*H*COX_c), 3.37 (dd, *J* = 13.5 Hz, *J* = 3.5 Hz, 1 H, benzyl−H), 3.43 (dd, *J* = 14.5 Hz, *J* = 10.5 Hz, 1 H, C*H*COX_c), 3.86 (dtd, *J* = 11.0, 6.0, 2.0 Hz, 1 H, 6′-CH_{ax}), 4.12−4.23 (m, 2 H, 5-CH_2), 4.42 (dt, *J* = 11.0 Hz, *J* = 4.0 Hz, 1 H, 2′-CH_{eq}), 4.67 (m_c, 1 H, 4-CH), 5.01 [dq, *J* = 10.0 Hz, *J* = 1.0 Hz, 1 H, (*Z*)-*H*C=CH], 5.06 [dq, *J* = 17.0 Hz, *J* = 1.5 Hz, 1 H, (*E*)-*H*C=CH], 5.82 (ddt, *J* = 17.0, 10.0, 6.5 Hz, 1 H, H_2C=C*H*), 7.20−7.37 (m, 5 H, phenyl−H). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 14.6, 19.7 (CH_3), 30.7, 40.2 (C-3′, C-4′), 32.7, 40.2, 40.9 (C-5′, allyl−CH_2, *C*H_2COX_c), 37.9 (benzyl−C), 55.5 (C-4), 66.1 (C-5), 69.4 (C-6′), 74.9 (C-2′), 116.5 (H_2C=CH), 127.3, 128.9, 129.4, 135.4 (phenyl−C), 135.2 (H_2C=*C*H), 153.5 (CO), 171.5 (CO). − IR (film): $\tilde{\nu}$ = 1778 (C=O, urethane), 1702 cm^{-1} (C=O, amide). − EI-MS (70 eV); *m*/*z*: 371 (25) [M^+], 330 (100) [M^+ − allyl], 178 (88) [oxazolidinone + 1], 153 (83) [M^+ − CH_2COX_c]. − EI-HRMS for $C_{22}H_{29}NO_4$: calcd. 371.2096; found 371.2096.

(4*S*,2′*R*,3′*S*,4′*R*,6′*S*)- and (4*S*,2′*S*,3′*S*,4′*R*,6′*S*)-4-Benzyl-3-[(3′,4′-dimethyl-6′-propenyltetrahydropyran-2′-yl)acetyl]-1,3-oxazolidin-2-one (4i/*epi*-4i): 75 mg (0.21 mmol) of the hydroxyenimide **3i** was treated with 33 mg (0.30 mmol) of KO*t*Bu for 30 min at −78 °C to give 62 mg (82%) of the tetrahydropyrans **4i**/*epi*-**4i** as a 6:1 mixture of stereoisomers at C-2′ (by ^{1}H- and ^{13}C NMR). − $[\alpha]_D^{20}$ = +11.8 (*c* = 0.95, $CHCl_3$). − **Major Isomer 4i:** ^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.92 (d, *J* = 6.5 Hz, 3 H, CH_3), 0.80−0.95 (m, 1 H), 1.44 (dt, *J* = 5.5 Hz, *J* = 12.5 Hz, 1 H, 3′-CH_{ax}), 1.50−1.80 (m, 3 H, 3′-CH, 4′-CH, 5′-CH), 2.20 (m_c, 2 H, allyl−CH_2), 2.78 (dd, *J* = 13.5 Hz, *J* = 9.0 Hz, 1 H, benzyl−H), 3.11 (dd, *J* = 15.5 Hz, *J* = 5.5 Hz, 1 H, C*H*COX_c), 3.34 (dd, *J* = 13.5 Hz, *J* = 3.5 Hz, 1 H, benzyl−H), 3.58 (dd, *J* = 15.5 Hz, *J* = 8.0 Hz, 1 H, C*H*COX_c), 3.74 (dddd, *J* = 11.5, 7.0, 6.5, 2.0 Hz, 1 H, 6′-CH_{ax}), 4.12−4.25 (m, 2 H, 5-CH_2), 4.60−4.75 (m, 2 H, 4-CH, 2′-CH_{eq}), 4.95−5.13 (m, 2 H, H_2C=CH), 5.82 (ddt, *J* = 17.0, 10.0, 6.5 Hz, 1 H, H_2C=C*H*), 7.20−7.37 (m, 5 H, phenyl−H). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 22.4 (CH_3), 24.9 (C-4′), 37.0, 37.2, 39.8, 41.0 (C-3′, C-5′, allyl−CH_2, *C*H_2COX_c), 37.9 (benzyl−C), 55.3 (C-4), 66.1 (C-5), 69.7 (C-6′), 70.0 (C-2′), 116.6 (H_2C=CH), 127.3, 128.9, 129.4, 135.3 (phenyl−C), 135.1 (H_2C=*C*H), 153.5 (CO), 170.9 (CO). − IR (film): $\tilde{\nu}$ = 1782 (C=O, urethane), 1702 cm^{-1} (C=O, amide). − EI-MS (70 eV); *m*/*z*: 357 (10) [M^+], 316 (100) [M^+ − allyl], 178 (63) [oxazolidinone + 1], 139 (44) [M^+ − CH_2COX_c]. − EI-HRMS for $C_{21}H_{27}NO_4$: calcd. 357.1940; found 357.1940. − $C_{21}H_{27}NO_4$ (357.19): calcd. C 70.56, H 7.62; found C 70.80, H 7.68.

Ethyl (2*S*,4*R*)-4-Methyltetrahydropyranyl-2-acetate (7a): 50 mg (0.27 mmol) of the hydroxyenoate **6a** was treated with 45 mg (0.40 mmol) of KO*t*Bu for 2 h at −50 °C according to the general procedure to give 41 mg (83%) of the tetrahydropyran **7a** as a single isomer. − $[\alpha]_D^{20}$ = −11.4 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.94 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.26 (t, *J* = 7.0 Hz, 3 H, $CO_2CH_2CH_3$), 1.50−1.72 (m, 5 H, 3-CH_2, 4-CH, 5-CH_2), 2.38 (dd, *J* = 15.0, 5.5 Hz, 1 H, C*H*CO_2Et), 2.52 (dd, *J* = 15.0 Hz, *J* = 7.5 Hz, 1 H, C*H*CO_2Et), 3.44 (dt, *J* = 2.0 Hz, *J* = 11.5 Hz, 1 H, 6-CH_{ax}), 3.73 (dddd, *J* = 11.5, 7.5, 5.5, 2.0 Hz, 1 H, 2-CH_{ax}), 3.97 (ddd, *J* = 11.5, 4.5, 1.5 Hz, 1 H, 6-CH_{eq}), 4.15 (q, *J* = 7.0 Hz, $CO_2CH_2CH_3$). − ^{13}C NMR (75 MHz, $CDCl_3$): δ = 14.2, 22.3 (CH_3), 30.1 (C-4), 34.3, 40.1, 41.7 (C-3, C-5, *C*H_2CO_2Et), 60.4 ($CO_2CH_2CH_3$), 68.2 (C-6), 74.1 (C-2), 171.4 (CO). − IR (film): $\tilde{\nu}$ = 1740 cm^{-1} (C=O). − EI-MS (70 eV); *m*/*z*: 186 (3) [M^+], 157 (35) [M^+ − Et], 130 (100), 99 (100) [M^+ − CH_2CO_2Et]. − EI-HRMS for $C_{10}H_{18}O_3$: calcd. 186.1255; found 186.1255. − $C_{10}H_{18}O_3$ (186.13): calcd. C 64.49, H 9.74; found C 64.74, H 9.86.

Ethyl (2*S*,4*R*)-4-Phenyltetrahydropyranyl-2-acetate (7b): 40 mg (0.16 mmol) of the hydroxyenoate **6b** was treated with 27 mg (0.24 mmol) of KO*t*Bu for 2 h at −50 °C according to the general procedure to yield 29 mg (72%) of the tetrahydropyran **7b** as a single isomer. − $[\alpha]_D^{20}$ = −15.2 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.27 (t, *J* = 7.0 Hz, 3 H, $CO_2CH_2CH_3$), 1.47 (q, *J* = 11.5 Hz, 1 H, 3-CH_{ax}), 1.70−1.95 (m, 3 H, 3-CH_{eq}, 5-CH_2), 2.43 (dd, *J* = 15.0, 5.5 Hz, 1 H, C*H*CO_2Et), 2.60 (dd, *J* = 15.0, 7.5 Hz, 1 H, C*H*CO_2Et), 2.82 (m_c, 1 H, 4-CH), 3.62 (m_c, 1 H, 6-CH), 3.90 (dddd, *J* = 11.5, 7.5, 5.5, 2.0 Hz, 1 H, 2-CH_{ax}), 4.12 (m_c, 1 H, 6-CH), 4.17 (q, *J* = 7.0 Hz, $CO_2CH_2CH_3$), 7.15−7.32 (m, 5 H, phenyl−H). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 14.2 (CH_3), 33.1, 39.0, 41.6 (C-3, C-5, *C*H_2CO_2Et), 41.5 (C-4), 60.5 ($CO_2CH_2CH_3$), 68.3 (C-6), 74.3 (C-2), 126.4, 126.7, 128.5, 145.3 (phenyl−C), 171.2 (CO). − IR (film): $\tilde{\nu}$ = 1740 cm^{-1} (C=O). − EI-MS (70 eV): *m*/*z* = 248 (95) [M^+] 218 (55) [M^+ − 1 − Et], 161 (100) [M^+ − CH_2CO_2Et], 142 (85). − EI-HRMS for $C_{15}H_{20}O_3$: calcd. 248.1412; found 248.1412. − $C_{15}H_{20}O_3$ (248.14): calcd. C 72.61, H 8.12; found C 72.48, H 8.16.

Ethyl (2*R*,3*S*,4*R*)-3,4-Dimethyltetrahydropyranyl-2-acetate (7c): 55 mg (0.28 mmol) of the hydroxyenoate **6c** was treated with 47 mg (0.42 mmol) of KO*t*Bu for 3 h at −40 °C according to the general procedure to yield 43 mg (79%) of the tetrahydropyran **7c** as a single isomer. − $[\alpha]_D^{20}$ = +1.6 (*c* = 0.5, $CHCl_3$). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.86 (d, *J* = 6.5 Hz, 3 H, CH_3), 0.96 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.00−1.15 (m, 1 H, 3-CH_{ax}), 1.20−1.30 (m, 1 H, 4-CH_{ax}), 1.26 (t, *J* = 7.0 Hz, 3 H, $CO_2CH_2CH_3$), 1.37 (dq, *J* = 4.5 Hz, *J* = 11.5 Hz, 1 H, 5-CH_{ax}), 1.53 (dq, *J* = 11.5 Hz, *J* = 2.0 Hz, 1 H, 5-CH_{eq}), 2.35 (dd, *J* = 15.0 Hz, *J* = 9.5 Hz, 1 H, C*H*CO_2Et), 2.65 (dd, *J* = 15.0 Hz, *J* = 3.0 Hz, 1 H, C*H*CO_2Et), 3.42 (dt, *J* = 3.0 Hz, *J* = 9.5 Hz, 1 H, 2-CH_{ax}), 3.45 (dt, *J* = 2.0 Hz, *J* = 11.5 Hz, 1 H, 6-CH_{ax}), 3.93 (ddd, *J* = 11.5, 4.5, 2.0 Hz, 1 H, 6-CH_{eq}), 4.17 (q, *J* = 7.0 Hz, $CO_2CH_2CH_3$). − ^{13}C NMR (75 MHz, $CDCl_3$): δ = 14.2, 14.3, 19.9 (3 × CH_3), 34.9, 39.7 (*C*H_2CO_2Et, C-5), 36.3, 42.4 (C-3, C-4), 60.4 ($CO_2CH_2CH_3$), 68.0 (C-6), 79.8 (C-2), 172.2 (CO). − IR (film): $\tilde{\nu}$ = 1742 cm^{-1} (C=O). − EI-MS (70 eV); *m*/*z*: 200 (4) [M^+], 171 (10) [M^+ − Et], 143 (41), 130 (55), 113 (100) [M^+ − CH_2CO_2Et]. − EI-HRMS for $C_{11}H_{20}O_3$: calcd. 200.1412; found 200.1412.

Methyl (2*R*,3*S*,6*S*)-3-Methyl-6-propenyltetrahydropyranyl-2-acetate (7d): 24 mg (0.11 mmol) of the hydroxyenoate **6d** was treated with 17 mg (0.16 mmol) of KO*t*Bu for 3 h at −40 °C according to the general procedure to yield 17 mg (71%) of the tetrahydropyran **7d** as a single isomer. − $[\alpha]_D^{20}$ = +15.4 (*c* = 0.65, $CHCl_3$). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.84 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.12−1.88 (m, 5 H, 3-CH, 4-CH_2, 5-CH_2), 2.02−2.46 (m, 3 H, allyl−CH_2, C*H*CO_2Me), 2.64 (dd, *J* = 15.0, 3.0 Hz, 1 H, C*H*CO_2Me), 3.35 (m_c, 1 H, 6-CH_{ax}), 3.44 (dt, *J* = 3.0 Hz, *J* = 9.0 Hz, 1 H, 2-CH_{ax}), 3.69 (s, 3 H, OMe), 4.94−5.15 (m, 2 H, H_2C=CH), 5.78 (ddt, *J* = 17.0, 10.0, 6.5 Hz, 1 H, H_2C=C*H*). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 17.5 (CH_3), 31.6, 32.7, 39.4, 40.5 (*C*H_2CO_2Me, allyl−CH_2, C-4, C-5), 35.4 (C-3), 51.6 (OMe), 77.3

(C-6), 80.5 (C-2), 116.1 (H_2C=CH), 135.2 (H_2C=CH), 172.6 (CO). − IR (film): $\tilde{\nu}$ = 1744 (C=O), 1642 cm^{-1} (C=C). − MS (EI); *m/z*: 212 (5) [M^+], 171 (65) [M^+ − allyl], 139 (100) [M^+ − CH_2CO_2Me]. − $C_{12}H_{20}O_3$ (212.29): calcd. C 67.89, H 9.50; found C 68.11, H 9.61.

Ethyl (2*S*,4*R*,6*S*)-4-Methyl-6-propenyltetrahydropyranyl-2-acetate (7e): 35 mg (0.15 mmol) of the hydroxyenoate **6e** was treated with 25 mg (0.22 mmol) of KO*t*Bu for 3 h at −50°C according to the general procedure to yield 25 mg (72%) of the tetrahydropyran **7e** as a single isomer. − $[\alpha]_D^{20}$ = −6.3 (*c* = 0.24, $CHCl_3$). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.78−0.95 (m, 2 H), 0.93 (d, *J* = 6.0 Hz, 3 H, CH_3), 1.26 (t, *J* = 7.0 Hz, 3 H, $CO_2CH_2CH_3$), 1.57−1.72 (m, 3 H, 3-CH_2, 4-CH or 5-CH_2), 2.13 (m_c, 1 H, allyl−CH), 2.28 (m_c, 1 H, allyl−CH), 2.37 (dd, *J* = 14.5, 5.5 Hz, 1 H, C*H*CO_2Et), 2.55 (dd, *J* = 14.5 Hz, *J* = 7.5 Hz, 1 H, C*H*CO_2Et), 3.36 (dtd, *J* = 11.0, 6.5, 2.0 Hz, 1 H, 6-CH_{ax}), 3.76 (dddd, *J* = 11.0, 7.5, 5.5, 1.5 Hz, 1 H, 2-CH_{ax}), 4.14 (q, *J* = 7.0 Hz, $CO_2CH_2CH_3$), 5.00 [dq, *J* = 10.0 Hz, *J* = 1.0 Hz, 1 H, (*Z*)-*H*C=CH], 5.05 [dq, *J* = 17.0 Hz, *J* = 1.5 Hz, 1 H, (*E*)-*H*C=CH], 5.81 (ddt, *J* = 17.0, 10.0, 6.5 Hz, 1 H, H_2C=C*H*). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 14.3, 22.2 (CH_3), 30.1 (C-4), 39.4, 39.8, 40.6, 41.6 (CH_2CO_2Et, allyl−CH_2, C-3, C-5), 36.3, 42.4 (C-3, C-4), 60.4 ($CO_2CH_2CH_3$), 74.0 (C-6), 77.0 (C-2), 116.3 (H_2C=CH), 135.1 (H_2C=*C*H), 171.6 (CO). − IR (film): $\tilde{\nu}$ = 1740 cm^{-1} (C=O). − EI-MS (70 eV); *m/z*: 226 (8) [M^+], 185 (100) [M^+ − allyl], 139 (100) [M^+ − CH_2CO_2Et]. − EI-HRMS for $C_{13}H_{22}O_3$: calcd. 226.1568; found 226.1568. − $C_{13}H_{22}O_3$ (226.16): calcd. C 69.04, H 9.81; found C 69.19, H 9.90.

Ethyl (2*R*,3*S*,4*R*,6*S*)-3,4-Dimethyl-6-propenyltetrahydropyranyl-2-acetate (7f): 44 mg (0.18 mmol) of the hydroxyenoate **6f** was treated with 27 mg (0.24 mmol) of KO*t*Bu for 3 h at −40°C according to the general procedure to yield 36 mg (81%) of the tetrahydropyran **7f** as a single isomer. − $[\alpha]_D^{20}$ = +11.9 (*c* = 0.14, $CHCl_3$). − ^{1}H NMR (300 MHz, $CDCl_3$): δ = 0.85 (d, *J* = 6.5 Hz, 3 H, CH_3), 0.94 (d, *J* = 6.5 Hz, 3 H, CH_3), 1.26 (t, *J* = 7.0 Hz, 3 H, $CO_2CH_2CH_3$), 0.90−1.08 (m, 2 H), 1.25−1.35 (m, 1 H), 1.60 (ddd, *J* = 13.0, 4.0, 2.0 Hz, 1 H, 5-CH_{eq}), 2.12 (m_c, 1 H, allyl−CH), 2.26 (m_c, 1 H, allyl−CH), 2.35 (dd, *J* = 14.5 Hz, *J* = 9.5 Hz, 1 H, C*H*CO_2Et), 2.64 (dd, *J* = 14.5 Hz, *J* = 3.5 Hz, 1 H, C*H*CO_2Et), 3.38 (m_c, 1 H, 6-CH_{ax}), 3.50 (dt, *J* = 3.5 Hz, *J* = 9.5 Hz, 1 H, 2-CH_{ax}), 4.14 (q, *J* = 7.0 Hz, $CO_2CH_2CH_3$), 4.98 [dq, *J* = 10.0 Hz, *J* = 1.0 Hz, 1 H, (*Z*)-*H*C=CH], 5.03 [dq, *J* = 17.0 Hz, *J* = 1.5 Hz, 1 H, (*E*)-*H*C=CH], 5.79 (ddt, *J* = 17.0 , 10.0, 6.5 Hz, 1 H, H_2C=C*H*). − ^{13}C NMR (50 MHz, $CDCl_3$): δ = 14.1, 14.3, 19.9 (CH_3), 36.4, 39.8, 40.1, 40.5, 42.2 (CH_2CO_2Et, allyl−CH_2, C-3, C-4, C-5), 36.3, 42.4 (C-3, C-4), 60.3 ($CO_2CH_2CH_3$), 76.7 (C-6), 79.8 (C-2), 116.2 (H_2C=CH), 135.2 (H_2C=*C*H), 172.2 (CO). − IR (film): $\tilde{\nu}$ = 1742 cm^{-1} (C=O). − EI-MS (70 eV); *m/z*: 240 (18) [M^+], 199 (100) [M^+ − allyl], 153 (100) [M^+ − CH_2CO_2Et], 125 (38), 107 (40). − EI-HRMS for $C_{14}H_{24}O_3$: calcd. 240.1725; found 240.1725. − $C_{14}H_{24}O_3$ (240.17): calcd. C 70.01, H 10.07; found C 69.79, H 9.83.

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