rum (KBr pallet, cm^{-1}) 3070 w, 3020 w, 2920 w, 2890 w, 2570 s, 2360 w, 1600 w, 1495 m, 1450 w, 1380 w, 1260 w, 1070 w, 1030 s, 1000 w, 980 w, 970 w, 940 w, 900 w, 860 m, 800 w, 755 m, br, 740 m, br, 700 s, 670 w, 650 w, 620 w, 600 w, 530 w, 485 w, 470 w.

10. ^{11}B NMR (160.5 MHz, ppm, CD_3CN) 11.3 (d, $J_{BH}=160$ Hz), 8.4 (d, $J_{BH}=145$ Hz), −7.0 (d, $J_{BH}=145$ Hz), −8.8 (d, $J_{BH}=145$ Hz), −16.8 (d, $J_{BH}=130$ Hz), −21.5 (s), −42.6 (d, $J_{BH}=130$ Hz).

Stereochemical Process in the 1,4-Addition of a Hydroxyl Group to α,β-Unsaturated Carboxylic Esters

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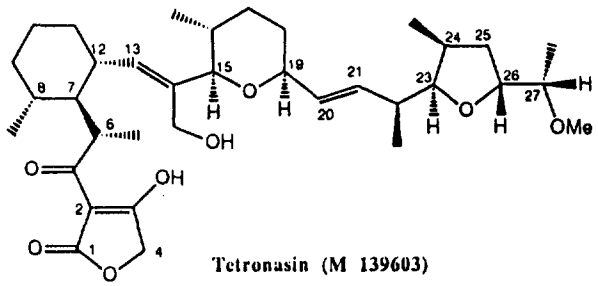
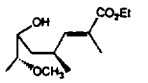
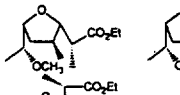
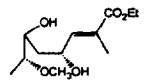
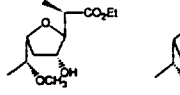
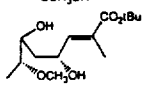
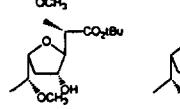
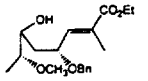
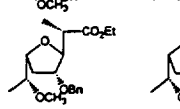
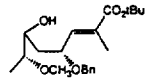
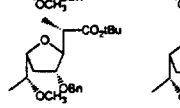
As a part of our synthetic effort toward tetronasin[1] we had a plan of the construction of tetrahydrofuran fragment utilizing the intramolecular 1,4-addition reaction of a hydroxyl group to α,β-unsaturated esters. And it was necessary for us to investigate the stereochemical process about this kind of reaction because the stereochemical outcome of this reaction was crucial in our synthetic scheme. Herein we report stereochemical process in the synthesis of tetrahydrofuran rings *via* 1,4-addition of a hydroxyl group to α,β-unsaturated carboxylic esters.



Tetronasin (M 139603)

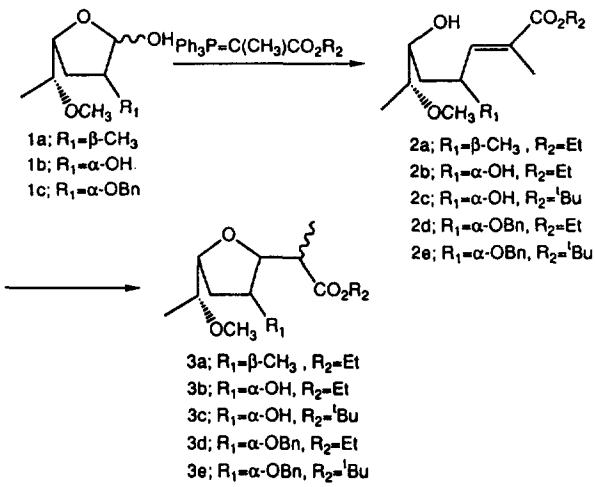
During our synthetic routes to tetronasin, Witting reaction[2] of tetrahydrofuranoid hemiacetal **1a-1c** gave the esters of (*E*)-6-hydroxy-2-enoic acids (**2a-2e**), which were subsequently converted to the corresponding tetrahydrofuran rings **3a-3e** *via* intramolecular 1,4-addition. To see the stereochemical outcome for the formation of the tetrahydrofuran rings, we examined the role of γ-substituents in the stereochemical induction and the results are outlined in Table 1. The stereochemical assignment of the tetrahydrofuranyl esters was determined by ^1H-NMR spectroscopy[3,4]. Furthermore, in order

Table 1. Cyclization of α,β-Unsaturated Esters

Entry	α,β-Unsaturated Esters	Method[a]	Products	Yield[b] (ratio[c])
1		A		94% (2 : 1)
2		A		92% (3 : 1)
3		B		93% (4 : 5)
4		A		84% (2 : 3)
5		B		62% (1 : 3)

[a]Method A: NaOEt (2 eq). Method B: NaO^{t}Bu (2 eq.). [b]Yields refer to isolated products after chromatographic purification. [c]Ratios refer to isomeric products and are based on 300 MHz ^1H-NMR analysis of reaction mixtures.

to determine the stereochemistry of the compound **3a**, the compound **2a** was converted to the reduced alcohol derivative of **3a** *via* a series of reactions including epoxidation-cyclization process[5].



It is noteworthy that all of the compounds **2a-2e** ended as 2,3-*trans* derivatives of tetrahydrofuran rings. The *trans* relationship between C-4 substituent and side chain of the tetrahydrofuranyl ester at C-1 can be accounted by the cyclization *via* more stable conformation as shown Figure 1, where R_M and R_L stand for medium and large substituents at γ-position of the α,β-unsaturated ester, respectively.

Relating to the stereochemical role of the hydroxyl substituents at γ-position of the α,β-unsaturated esters, Felkin's model predicts that the nucleophile would attack the face opposite to the allylic oxygen function because of the anti-bonding effects of secondary orbital[6]. Thus, conformations of **2a-2e** contributing to the cyclization to tetrahydrofuran rings in our system are shown in the Figure 1. Accordingly,

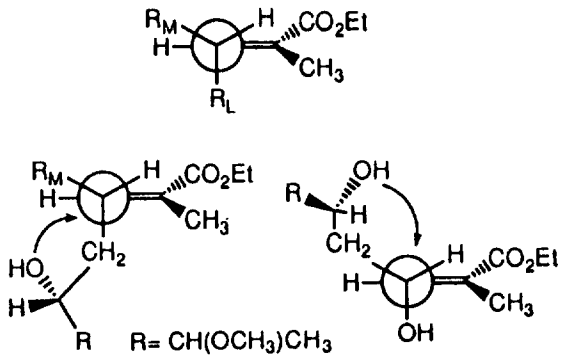


Figure 1.

the stereochemistry at C-4 of α,β-unsaturated esters governs the stereochemical outcome for the formation of tetrahydrofuranyl esters. The rationale was also supported by the fact that even when there was no γ-substitutent for α,β-unsaturated carboxylic ester such as the case for ring closure reaction toward nonactic acid, the predominant product was known to have 2,3-*cis* relationship[7]. Also similar stereochemical result can be found for the intramolecular conjugate addition of carbamate group in the α,β-unsaturated esters[8]. But it is interesting that when we prepared *Z* isomer of **2a** and carried out the cyclization to examine the effect of γ-substituent on stereoselectivity, we had the same stereochemical results as that of *E* isomer of **2a**. On the contrary to the previous report that the stereoselectivity for the conjugate addition of nucleophile to Michael acceptors depends upon *Z/E* configurations of Michael acceptors[9], our results imply that the stereochemical induction for Michael acceptor was insensitive to *Z/E* configurations in our system. Perhaps $A^{1,3}$ strain due to the ester group was almost same as that due to 2-methyl group and thus the steric effect of γ-substituent became dominant in the pocess of stereochemical induction. However, it is still open to the question that the how much the steric effect of α-substituent of *Z/E* isomers can contribute to the stereochemical outcome along with that of competing γ-substituent in the intramolecula Michael reactions leading to tetrahydrofuran rings.

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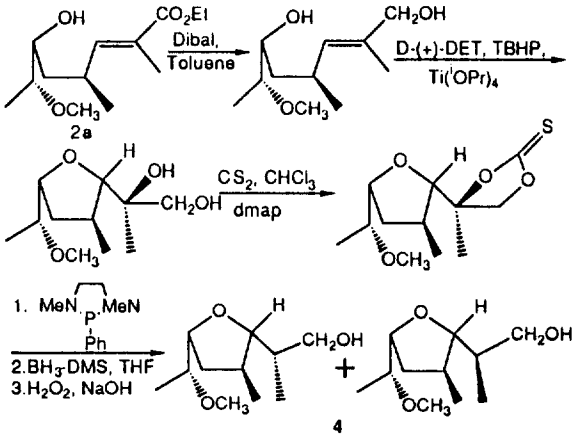

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Synthesis of Specifically Deuterated DNA Hexamer

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The quinoxaline family of antibiotics of which echinomycin is a member are powerful antimicrobial and antitumor agents. The single-crystal X-ray study[1] of a echinomycin complex with d(CGTACG) has shown that, surprisingly, the two central A. T base pairs are of the Hoogsteen type (Figure 1). Two-dimensional NMR studies of echinomycin complexes with d(ACGT) and d(ACGTACGT) duplexes have been reported[2,3]. The van der Waals contacts detected in X-ray crystallographic analysis of are echinomycin-oligonucleotide co-

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