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Diastereospecific Synthesis of 2'- or 3'-*C*-Branched Nucleosides through Intramolecular Free-radical Capture by Silicon-tethered Acetylene

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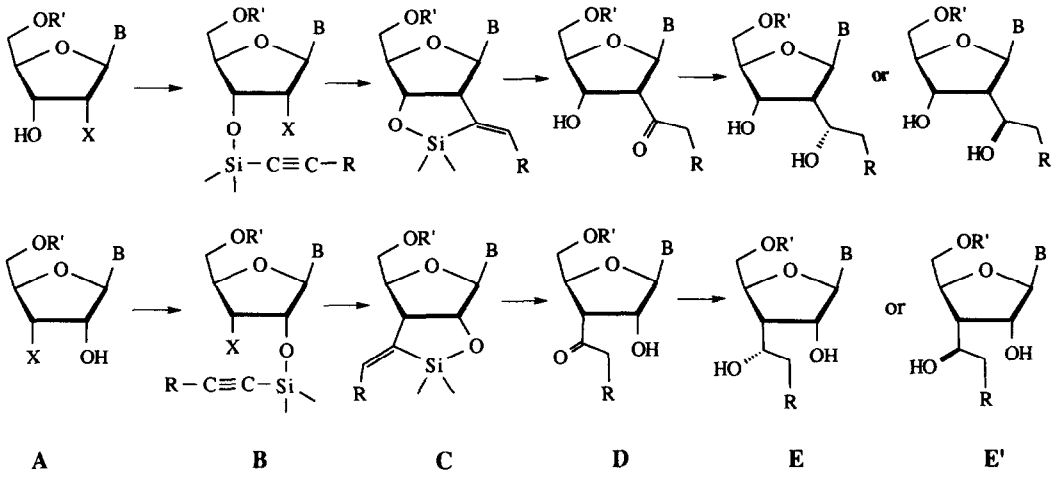
Abstract: *The intramolecular free-radical trapping by a silicon tethered acetylene function in a ribonucleoside* ***2a, 2b, 2c, 8a, 8b*** *or* ***8c*** *gave only the [3.3.0]-cis-fused Z-vinylsiloxane* ***3a, 3b, 3c, 9a, 9b*** *or* ***9c*** *(>90%) in a diastereospecific manner. The temporary silicon connection from the Z-vinylsiloxane was removed by the oxidation to give the 2'- or 3'-C-branched α-keto-β-D-ribonucleoside (~85%), which was diastereospecifically reduced to give 1,3-syn diol (>90%, >97% ee) [2'- or 3'-C-branched-α-substituted R or S-hydroxymethyl-β-D-ribonucleosides* ***5a, 5b, 5c, 11a, 11b*** *or* ***11c****]. These are the first examples of highly diastereospecific synthesis of 2'- or 3'-C-branched ribonucleosides, through a 5-trig-exo radical cyclization, using the silicon-tethered approach.*

The development of new synthetic methodologies for unambiguous synthesis of *C*-branced nucleosides is of considerable importance because they are found in Nature as antibacterial, antitumor or antiviral agents[1,2].Methodologies for the preparation of 2'- or 3'-*C*-branched nucleosides can be grouped into two categories[3]: (i) Glycosylation of an appropriately protected base with preconstructed *C*-branched sugar[4-6]; and (ii) specific modification of the sugar ring of the nucleoside itself. Under the latter category, following methods have been developed: (a) Nucleophilic addition to ketonucleosides[7], (b) Wittig reaction of ketonucleosides[8], (c) Michael addition to unsaturated nucleosides[9], (d) Michael addition of nitro nucleosides to alkenes[10], (e) cycloaddition of nucleosides[11], (f) Nucleophilic ring-opening of epoxy nucleosides[12], (g) Aldol condensation of nucleosides[13], (h) palladium mediated cross-coupling reaction[14], (i) intermolecular free-radical addition[15], and (j) intramolecular free-radical cyclization[16-19]. We have deemed it important for some time now that the stereocontrolled intramolecular free-radical cyclization is a powerful means for the introduction of 2'- or 3'-*C*-branching of β-D-nucleosides, especially through our temporary connection methods[17,19].

Stereocontrolled intramolecular free-radical cyclization has emerged as a powerful tool for carbon-carbon bond formation in organic synthesis owing to our increasing understanding of the mechanistic behaviour of such reaction over the last decade[20,21]. Chirality homologation can be achieved through stereocontrolled intramolecular free-radical cyclization using "chiron approach"[22]. The methodology containing alkyl-transfer based on temporary silicon connection through intramolecular free-radical cyclization has been proved to be useful for the diastereoselective formation of carbon-carbon bond in complex natural product synthesis as shown by Stork[23], Speckamp[24], Myers[25] and us[19]. In our work on the synthesis of 2'- or 3'-*C*-branched nucleosides, we observed that the 2'-*O*-silyl-tethered allyl chain in the *arabino* configuration in the free-radical

precursor gave both the *cis*-fused and *trans*-fused seven-membered siloxane products upon free-radical promoted ring closure[19]. On the other hand, under an identical condition the silicon-tethered allyl chain with the *ribo* or *xylo* configuration in the free-radical precursor gave only *cis*-fused siloxane ring with controlled stereoselectivity. Clearly, the cause of the above non-stereospecific ring-closure was owing to the fact that the radical-trapping reaction could only be mediated through the 7-*endo* cyclization giving the large seven-membered siloxane ring, hence we reasoned that the stereoselectivity of the silicon-tethered ring-closure reaction should be greatly enhanced with the formation of a relatively rigid five-membered ring, which upon cleavage of Si-C bond will give 2'- or 3'-*C*-branched nucleoside diastereospecifically. We here report that an intramolecular free-radical cyclization by a temporary silicon connected acetylene[23] (Scheme 1)[26] in a ribonucleoside (**B**) gave the sole diastereospecific [3.3.0]-*cis*-fused *Z*-vinylsiloxane (**C**) which upon oxidation[27,28] gave a β-hydroxyketone with the α-carbonyl at the *C*-branching (**D**), a formal equivalent of a diastereospecific Aldol condensation product, which also could be converted to a configuration-defined highly substituted 1,3-diol system (**E** or **E'**) using the well-known diastereoselective reduction procedure. The reduction product **E** or **E'** (Scheme 1) is a 2'- or 3'-*C*--α-substituted chiral hydroxymethyl derivatives of nucleosides which are of considerable interest in making antisense analogs as gene-directed drug. The transformation of **A** → **D** is an improved alternative for the Aldol condensation[29] and Refomatsky reaction[30] for the diastereoselective synthesis of β-hydroxyketone in the sense of mildness and convenience.



Scheme 1 : X = radical initiable group

RESULT AND DISCUSSION

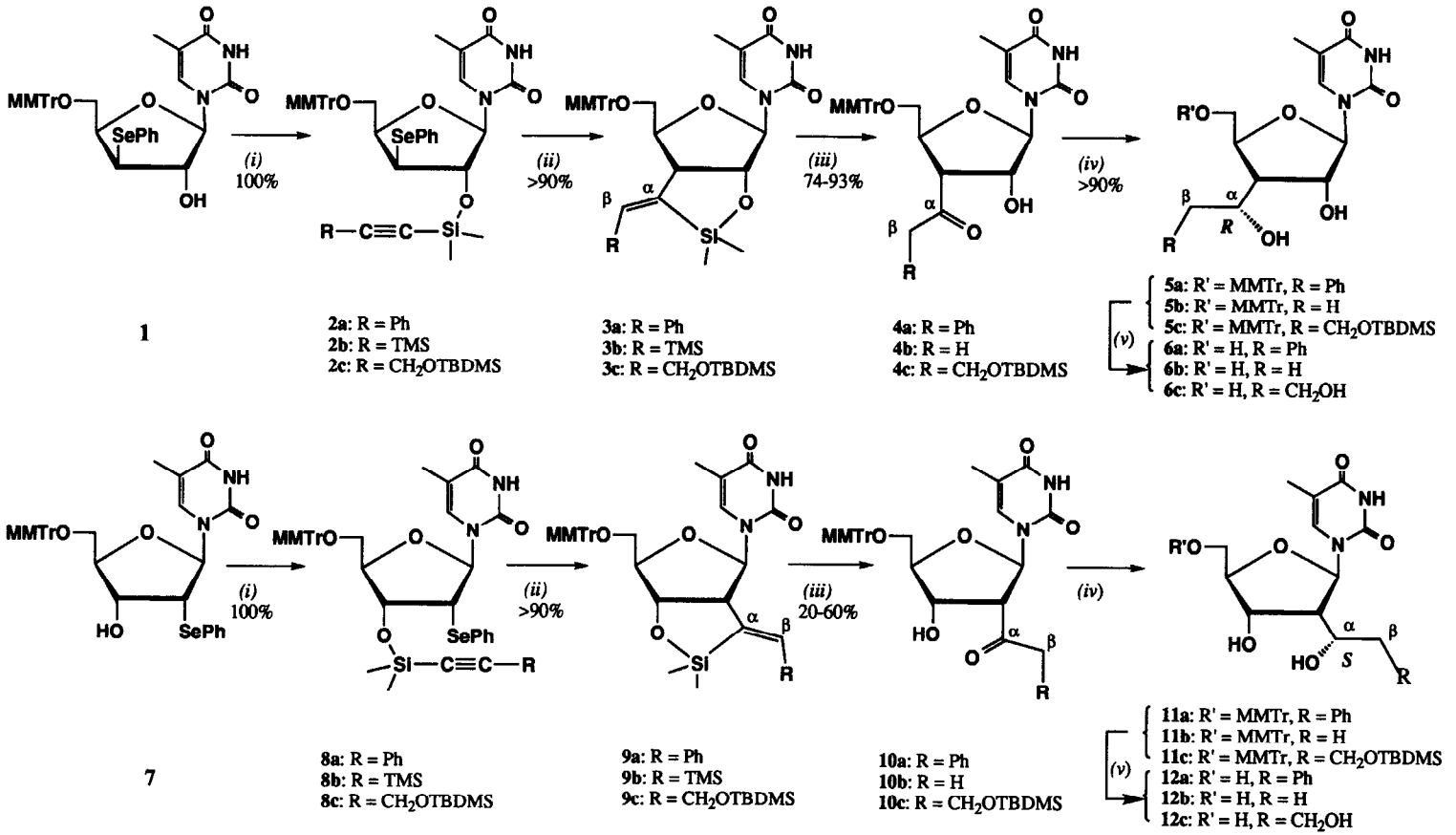
(I) Synthesis of alkynylsilane reagents. The alkynylaminosilanes (the silylating agents) have been prepared according to the Stork procedure[31] from different substituted lithium acetylide with diethylaminodimethylchlorosilane which was prepared from dimethyl dichlorosilane[32]. The substituent of alkyne was such selected as to show the versatility of the methodology shown in Scheme 1. Commercially available lithium phenylacetylide in THF was added dropwise into the neat aminochlorosilane at -78°C, and the

resulting solution was gradually warmed to RT with stirring for 30 min to give phenylethynyl N,N-diethylamino dimethylsilane (reagent: **a**). Similarly, the commercially available lithium trimethylsilyl acetylide gave trimethylsilylethynyl N,N-diethylamino dimethylsilane (reagent: **b**), and the TBDMS protected prapargyl alcohol, after treatment with butyl lithium, gave 3-t-butyldimethylsiloxy-1-propynyl N,N-diethylamino dimethylsilane (reagent: **c**). The reagents **a** - **c** were obtained in 60~90% yield (see experimental).

(II) Silylation of compound 1 & 7 with alkynyl aminosilane reagents. The ligand exchange reaction[31,33] with a slight excess of of aminosilanes (with reagents **a** - **c**) and the nucleoside **1** or **7** in THF at RT or at reflux with bubbling of argon has been used to prepare the free-radical precursors **2a, 2b, 2c, 8a, 8b** or **8c**. The resulting mixture was evaporated to dryness. Repeated precipitation of the residue from diethyl ether by cold hexane gave essentially pure radical precursors in quantitative yields. The foam thus obtained was used as such in the following free-radical reaction without further purification.

(III) Intramolecular free-radical cyclization. To a degassed boiling benzene solution of the alkynylsiloxane **2a, 2b, 2c, 8a, 8b** or **8c** (~0.01 M) was added dropwise a benzene solution of tributyltin hydride (1.5 equiv, ~0.7 M) and a catalytic amount of AIBN by a syringe pump under argon atmosphere over 2 h. The radical, efficiently generated at 2' or 3' carbon regiospecifically[16-19], was efficiently trapped intramolecularly by the 2'- or 3'-alkynylsiloxane to give vinylsiloxane **3a, 3b, 3c, 9a, 9b** or **9c** in ~90% yield. In all the cases tested, the intramolecular free-radical cyclization takes place in a 5-*trig*-*exo* manner to give only one *cis*-fused isomer (NMR) because of the constraints imposed by the [3.3.0]-*cis*-fused ring system[34]. No by-product due to the direct reduction of the endocyclic radical or 6-*endo* cyclization or *trans*-fused product was detectable in the crude reaction mixture (NMR). 1D Difference NOE experiment clearly shows that all vinylsiloxanes[33] **3a, 3b, 3c, 9a, 9b** and **9c** are *Z*-isomer. Consistantly, NOE contact has been found between H_β and H3' in **3a, 3b, 3c** and between H_β and H1' in **9a, 9b** or **9c** (see Experimental). Clearly, the exclusive formation of the *Z*-isomer in the above reactions is due to the stronger steric repulsion of thymine base or 5'-O-MMTr group in the transition state of the 2'- or 3'-vinyl radical, respectively, which forces the alkyl group at the vinyl carbon to turn away. This presumably makes n-Bu_3Sn-H to approach and quench the vinyl radical successfully only from the *endo* face to give the *Z*-vinylsiloxane. It is noteworthy that the above reaction proceeds successfully only with the substituted alkyne, the terminal alkene or terminal alkyne analogues gave complex unidentified mixture of products after free-radical reaction.

(IV) Oxidative cleavage of Si-C bond of vinylsiloxane ring (Tamao Oxidation). The Si-C bond of siloxane ring in nucleosides from the intramolecular free-radical cyclization can be oxidatively cleaved stereoselectively by the Tamao oxidation[27] as we have demonstrated earlier[19]. Here, the oxidative cleavage of Si-C bond of the five-membered vinylsiloxane ring in **3a, 3b, 3c, 9a, 9b** or **9c** is complete within 4 h whereas the similar oxidation of the seven-membered[19] siloxane ring took almost 12 h. To a mixture of vinylsiloxane **3a** (or **3b, 3c, 9a, 9b, 9c**), $KHCO_3$ (1-2 equiv) and KF (2 equiv) was added a 30% aqueous hydrogen peroxide (10 equiv) solution in THF/MeOH (1:1, v/v) at 0°C. The reaction mixture was stirred at RT for 2-4 h to furnish the β-hydroxyketone **4a** (or **4b, 4c, 10a, 10b, 10c**). While the β-hydroxyketone **4a, 4b** or **4c** could be obtained in reasonably good yield after flash chromatography (~90%), the β-hydroxyketones **10a, 10b** or **10c** are obtainable only in a poor yield because of effective formation of the depyrimidination product. Clearly, the



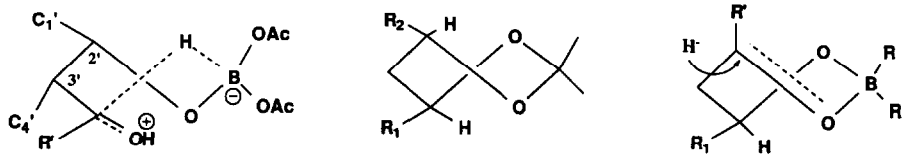
Reaction Conditions: (i) reagent **a**, **b** or **c**, THF, reflux, overnight; (ii)Bu_3SnH, AIBN, PhH, reflux; (iii) 30% H_2O_2 (10 equiv), KF (2 equiv), $KHCO_3$ (1 equiv), MeOH/THF (1:1, v/v), RT, 2 h; (iv) $Me_4NHB(OAc)_3$ or $Et_2BOMe/NaBH_4$, see text; (v) 80% aq. AcOH or cat. BSA in CH_2Cl_2, RT, overnight.

latter reaction is the result of the formation of transient carbanion stabilized by the α-keto group in **10a**, **10b** or **10c** which is structurally similar to the acid- and base-labile 2'-deoxy-3'-keto nucleosides[35].

It is interesting to note that the TMS group of vinylsiloxane in **3b** or **9b** was also cleaved during Tamao oxidation, but in a reductive manner to give methylketone **4b** or **10b**. The Tamao oxidation proceeds successfully in the presence of at least one heteroatom on silicon[27,36] which is evidently featured in our oxidative ring cleavage reaction. On the other hand, the reductive cleavage of the TMS group presumably proceeds through the fluoride ion attack on silicon followed by faster protonation of the carbanion. It is noteworthy that an interesting feature of the Tamao oxidation is the toleration[27] of TBDMS protecting group as shown in the reaction of vinylsiloxane **3c** and **9c** to **4c** or **10c**, respectively.

(V) Diastereoselective reduction of β-hydroxyketone. The diastereoselective reduction of β-hydroxyketones to the corresponding 1,3-*syn* diols or 1,3-*anti* diols has attracted a great deal of research effort due to the frequent occurence of 1,3-dioxygenated fragments in biologically active natural products. Normally, a reduction of β-hydroxyketone by an intramolecular hydride-delivery gives 1,3-*anti* diol[37-39,43] and boron chelation-controlled reduction gives 1,3-*syn* diol[40-43]. The easily accessible β-hydroxyketone derivatives (**4a**, **4b**, **4c**, **10a**, **10b** and **10c**) provided us with the first opportunity to test the diastereoselectivity of the above reduction methods in nucleosides.

Treatment of β-hydroxyketone **4a**, as a model, with $NaBH_4$ in MeOH at RT gave an inseparable mixture of **5a** & **5a'** in 1.3:1 ratio in a quantitative yield. The diols were transformed into 1,3-diol acetonides **13a** & **14a**, which were separated into the isomerically pure form. The availabilty of pure **13a** or **14a** enabled the determination of the configuration of their C_α center by 1D difference NOE experiment and emperical ^{13}C shift correlation method *(vide infra)*, and thus we could unequivocally assign the configuration of C_α in the precursor (*i.e.* **5a** & **5a'**). Diastereoselective reduction of **4a**, **4b** or **4c** under the boron chelation-controlled intermolecular reduction (MeO-BEt_2 and $NaBH_4$)[40,42] furnished the 1,3-*syn* diol **5a**, **5b** or **5c** in excellent diastereoselectivity (>97% ee) in >90 % yield in the expected manner. Intramolecular reductions ($NaBH_4$ in glacial acetic acid)[37] of **4a**, **4b** or **4c**, on the other hand, gave the unexpected 1,3-*syn* diol **5a**, **5b** or **5c** with diastereoselectivity and yield comparable to those from the boron chelation-controlled intermolecular reduction.



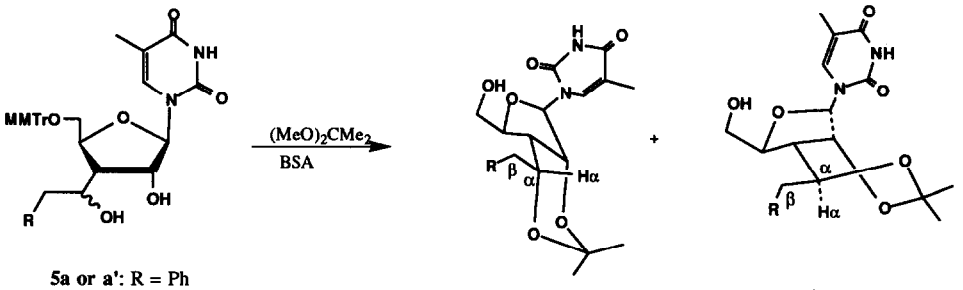
Ttb-intra **1,3-dioxane-tb** **Ttb-inter**

Fig. 1 Ttb-intra (twist-boat for intramolecular reduction) 1,3-dioxane-tb (lowest energy conformer from ab initio MO calculations) Ttb-inter (twist-boat for intermolecular boron-chelation reduction)

The procedure of Evans *et al.* using $Me_4NHB(OAc)_3$][38] gave also the unexpected 1,3-*syn* diol **5a**, **5b** or **5c** instead of the corresponding 1,3-*anti* diol **5a'**, **5b'** & **5c'**[37,38]. The results of the above stereochemical outcome can be easily rationalized by a 2,5-twist-boat transition state (**Ttb**)[44], which enables the delivery of the

hydride in a preferential manner as shown in Fig.1. It is noteworthy that recent *ab initio* MO calculation on a twist-boat conformation for 1,3-dioxane (1,3-dioxane-tb in Fig. 1) was found to be more stable than the corresponding chair form, suggesting the importance of a twist-boat conformation as a transition state of reduction of our β-hydroxyketone system.

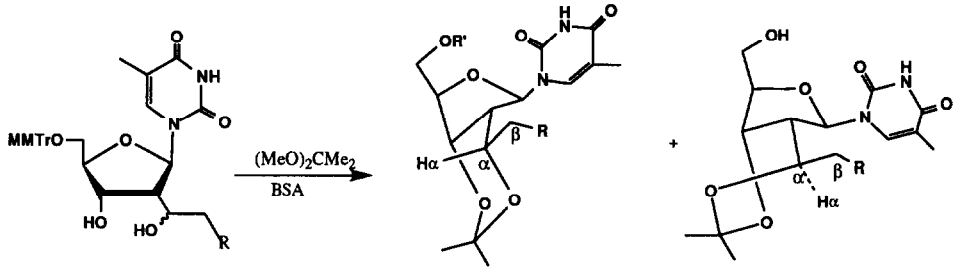
Due to the low isolated yield of β-hydroxyketone **10a, 10b** & **10c**, we carried out their *in situ* reduction to their corresponding 1,3-*syn* diol **11a, 11b** or **11c** by $NaBH_4$. Upon the dissolution of this crude 1,3-diol in dichloromethane, the desired 1,3-*syn* diol **11a, 11b** or **11c** was precipitated out as a gel in analytically pure form. Only in one instance, we could successfully separate out the 1,3-*anti*-diol **11a'** from the 1,3-*syn* diol **11a** by careful silical gel column chromatography in a ratio of 3:1, and transformed into isomerically pure 1,3-*anti* diol acetonide **16a** for the structure determination. The pure 1,3-*syn* diols **11a, 11b** or **11c** were also subsequently converted to their respective 1,3-diol acetonides **15a, 15b** or **15c**.



5a or a': R = Ph
5b: R = H
5c: R = TBDMS-OCH_2

13a: R = Ph
13b: R = H
13c: R = TBDMS-OCH_2

14a: R = Ph



11a & a': R = Ph
11b: R = H
11c: R = $TBDMSOCH_2$

15a: R = Ph, R' = H
15b: R = H, R' = H
15c: R =$TBDMSOCH_2$, R' = H
17 : R = Ph, R' = MeO-CMe_2

16a: R = Ph

(VI) Assignment of the configuration at C_α center of 1,3-diol. The acetonide method has been widely used to assign 1,3-diol stereochemistry[45]. We took the advantage of the acetonide method to determine the configuration at C_α by two independent means: first, the acetonide of 1,3-diol **5a, 5b, 5c, 11a, 11b** or **11c** makes the conformation of nucleoside non-flexible both because of the pseudoequatorial orientation of the *C*-substituent and also due to the constraint imposed by the 1,3-dioxane ring on the sugar puckering[46], which enabled us to establish the configuration based both on the coupling constant analysis and nuclear overhauser effect; the second method was based on the empirical ^{13}C-NMR correlation method[45] for determining the

stereochemistry of 1,3-diol acetonides. In **13a**, the ^3J coupling constants show a North (3'-*endo*-2'-*exo*) conformation of sugar[47], and the chemical shifts of two methyls of isopropylidene group in ^{13}C-NMR (δ29.5 & 19.1) suggests[45] a chair conformer for 1,3-dioxane formed from 1,3-*syn* diol[45]. 1D NOE shows that the methyl proton resonances of isopropylidene at δ1.36 is spatially close to H2' and H_α, which suggests that H2' and H_α are on the same face, *i.e.* **13a** is 1,3-*syn* diol. The configuration at C_α of **13a** has thus been assigned as *R*. Note that the NOE connectivity between H1' and H6 suggests a *syn* conformation of thymine base, which is unusual for an unmodified pyrimidine nucleoside. In **14a**, the ^3J coupling constants still show a North (3'-*endo*-2'-*exo*) conformation of sugar[47], but ^{13}C-NMR absorptions of two methyls of isopropylidene (δ24.2 & 24.1) suggests a 2,5-twist-boat conformer for 1,3-dioxane formed from 1,3-*anti* diol[45]. 1D NOE shows that one of the methyls of isopropylidene at δ1.36 is spatially close to H2' and the second methyl at δ1.26 is close to H_α, which show that H2' and H_α are on the opposite faces, *i.e.* **14a** is 1,3-*anti* diol. The configuration at C_α of **14a** has thus been assigned as *S*. The NOE connectivity between H2' and H6 suggests an *anti* conformation of thymine base. In **15a**, the ^3J coupling constants show a South (2'-*endo*-3'-*exo*) conformation of sugar[47], and ^{13}C-NMR absorptions of isopropylidene-methyls at δ29.7 and 19.2 suggest a chair conformer for 1,3-acetonide formed from 1,3-*syn* diol[45]. 1D NOE shows that the methyl at δ1.46 of isopropylidene is spatially close to H3' and H_α, which puts H3' and H_α on the same face. The above data suggests the presence of a 1,3-*syn* diol system and *S* configuration at C_α in **15a**. Note that the NOE connectivity between H1' and H6 in **15a** also suggests a very unusual *syn* conformation of thymine base. In **16a**, the ^3J coupling constants also show a South (2'-*endo*-3'-*exo*) conformation of sugar[47], but ^{13}C-NMR of two methyls of isopropylidene (δ24.3) suggests a 2,5-twist-boat conformer for 1,3-dioxane formed from 1,3-*anti* diol[45]. 1D NOE shows that H3' and H_α are spatially close to the different methyl of the isopropylidene group, which puts H3' and H_α on the opposite face. Furthermore, the NOE contact of H_α with H1' also certainly put **16a** as 1,3-*anti* diol. The configuration at C_α of **16a** has thus been assigned as *R*, the NOE also shows that H_α, H1' and H6 are close to each other, which suggests a unusual *syn* conformation of thymine base.

The stereochemistry of **13b**, **13c**, **15b** and **15c** has been subsequently assigned basing on the configuration at C_α in **13a**, **14a**, **15a** & **16a**.

EXPERIMENTAL

^1H-NMR spectra were recorded (in δ scale) at 20°C unless otherwise stated with Jeol 90Q spectrometer at 90 or 270 MHz with Jeol JNM-GX 270 spectrometer, using TMS (0.0 ppm) or CH_3CN (2.00 ppm) as reference. ^{13}C-NMR were recorded at 67.8 MHz using both ^1H-coupled and ^1H-decoupled or INEPT modes. Jeol DX 303 instrument was used for recording high resolution mass spectra. Tlc was carried out using Merck pre-coated silica gel F254 plates. Preparative Tlc was carried out using Merck pre-coated silica gel F254 Plc plates. The column chromatographic separations were carried out using Merck G60 silica gel. THF, dioxane, benzene, and toluene were freshly distilled from sodium benzophenone ketyl. Pyridine was distilled over CaH_2. Methanol was treated with magnesium overnight and freshly distilled. All other chemicals were obtained from Aldrich and were used without further purification. All reactions were performed in oven-dried glassware in a dry argon atmosphere. And ^1H- & ^{13}C-NMR assignments of 2'/ 3'-*C*-branched chain protons and carbons are indicated by H_α, H_β and H_γ or C_α, C_β, and C_γ and so on from 2'/3'-*C*- direction.

Phenylethynyl N,N-diethylamino dimethylsilane (reagent: **a**): To a neat diethylamino dimethyl chlorosilane (5.88g, 35.5 mmol) cooled at -78°C was syringed dropwise (~ 10 min) a commercially available 1M THF solution of lithium phenyl acetylide (35.5 ml, 35.5 mmol). The mixture was warmed up to RT, then evaporated in a rotavapor, the residue was diluted with dry hexane (50 ml) and filtered. The organic phase was

evaporated in a rotavapor. Vacuum distillation of the residual oil gave pure **a** (7.62g, 93%). bp. 105-108°C/0.9 mm Hg. ^{1}H-NMR ($CDCl_3$): 7.61 (m, 5H) arom., 2.85 (q, J = 7.08 Hz, 4H) CH_2 of EtN; 1.01 (t, J = 7.08 Hz, 6H) CH_3 of EtN.

Trimethylsilylethynyl N,N-diethylamino dimethylsilane (reagent: **b**): To a neat diethylamino-dimethylchlorosilane (4.14g, 25 mmol) cooled at -78°C was syringed dropwise (~10 min) a commercially available 0.5M THF solution of lithium trimethylsilyl acetylide (50 ml, 25 mmol), The mixture was warmed to RT, then evaporated in a rotavapor, the residue was diluted with dry hexane (50 ml) and filtered. The organic phase was evaporated in a rotavapor. Vacuum distillation of the residual oil gave pure **b** (4.86g, 86%). bp. 47-48°C/0.5 mm Hg. ^{1}H-NMR ($CDCl_3$): 2.85 (q, J = 7.08 Hz, 4H) CH_2 of EtN; 1.01 (t, J = 7.08 Hz, 6H) CH_3 of EtN ; 0.20, 0.16 (2 x s, 15H) 5 x Me.

3-t-butyldimethylsiloxy-1-propynyl N,N-diethylamino dimethylsilane (reagent: **c**): To a TBDMS ether of prapargyl alcohol (7.14 g, 42 mmol) in a 100 ml round-neck flask cooled at -78°C was syringed dropwise a 1.6M hexane solution of butyl lithium (26.2 ml, 42 mmol). After 20 min, a neat diethylamino-dimethylchlorosilane (6.9g, 41.7 mmol) was syringed into the flask. The mixture was warmed to RT, then evaporated in a rotavapor, diluted with dry hexane (50 ml) and filtered. The organic phase was evaporated in a rotavapor. Vacuum distillation of the residual oil gave pure **c** (7.84g, 63%). bp. 144-148°C/20 mm Hg. ^{1}H-NMR ($CDCl_3$): 4.31 (s, 2H) OCH_2; 2.84 (q, J = 7.1 Hz, 4H) 2 x CH_2 of EtN; 1.0 (t, J = 7.1 Hz, 6H) 2 x CH_3 of EtN; 0.9 (s, 9H) 3 x CH_3 of ^{t}Bu; 0.19, 0.12 (2 x s, 12H) 4 x CH_3 of MeSi.

1-[5'-O-(MMTr)-3'-deoxy-2'-*O*,3'-*C*-(1-oxa-2-sila-3-*Z*-(benzylidene)methylidene)-β-D-ribofuranosyl]thymine (3a). *General procedure for the silylation of alcohol and intramolecular free-radical cyclization of the resulted silylether:* (i) silylation of alcohol: The solution of **1** (669 mg, 1.0 mmol) and the reagent **a** (254 mg, 1.1 mmol) in dry THF (20 ml) was heated at reflux overnight, then evaporated to dryness, coevaperated with dry toluene several times. The foam was precipitated from diethyl ether by cold dry hexane several times to give **2a** (801 mg, 97%) in an essentially pure form (Tlc) which was used as such in the following free-radical reaction. (ii) intramolecular free-radical cyclization of silylether: To a refluxing solution of **2a** (801 mg, 0.96 mmol) in benzene (100 ml) was added dropwise by a syringe pump a solution of tributyltin hydride (400 µl, 1.44 mmol) and AIBN (15 mg) in benzene (2 ml) under argon over 2 h. The reaction mixture was then cooled to RT and evaporated to dryness. The residue was washed with cold hexane (4 x 30 ml) to give a foam (602 mg), which was used in the next step. An analytical sample of **3a** has been obtained by flash chromatography. ^{1}H-NMR ($CDCl_3$): 9.00 (s, exchangable, 1H) NH, 7.62 (d, J = 1.0 Hz, 1H) H6, 7.34-6.66 (m, 19 H) arom., 6.60 (s, 1H) Hβ, 5.92 (s, 1H) H1', 4.48 (d, $J_{2',3'}$ = 5.2 Hz, 1H) H2', 3.81 (dt, $J_{4',5'}$ = $J_{4',5''}$ = 2.8 Hz, $J_{3',4'}$ = 9.9 Hz, 1H) H4', 3.61 (dd, 1H) H5', 3.57 (s, 3H) MeO, 3.51 (dd, 1H) H3', 3.10 (dd, $J_{5',5''}$ = 10.7 Hz, 1H) H5", 1.36 (d, 3H) 5-Me, 0.29 (s, 3H) Si-Me, 0.00 (s, 3H) Si-Me. ^{13}C-NMR ($CDCl_3$): 163.8 (s), 158.7 (s), 150.0 (s), 143.9 (s), 143.6 (s), 141.8 (d, J_{CH} = 151.5 Hz) Cβ, 139.0 (s), 138.0 (s), 135.7 (d, J_{CH} = 182.7 Hz) C6, 134.7 (s), 130.4 (d), 128.3 (d), 127.8 (d), 127.0 (d), 113.1 (d), 110.4 (s), 92.2 (d, J_{CH} = 172.3 Hz) C1', 86.6 (s), 85.2 (d, J_{CH} = 156.8 Hz) C2', 84.3 (d, J_{CH} = 144.3 Hz) C4', 60.6 (t, J_{CH} = 143.3 Hz) C5', 55.0 (q, J_{CH} = 144.3 Hz) MeO, 51.9 (d, J_{CH} = 140.1 Hz) C3', 11.9 (q, J_{CH} = 128.7 Hz) 5-Me, 1.0 (q, J_{CH} = 120.4 Hz) Si-Me, -0.9 (q, J_{CH} = 119.4 Hz) Si-Me. 1D NOE ($CDCl_3$): irradiation of H4': Hβ (2.9 %), H1' (9.8%), $H_{5'}$ (9.8%), H5" (6.7%), Si-Me at 0.29 ppm (8.7%); of H6: H1' (7.1%), H2' (6.1%), H3' (12.0%), 5-Me (10.5%); of H3': Hβ (13.1%), H2' (15.4%); of H1': H6 (6.1%), H2' (10.0%), H4' (6.8%); of Hβ: H3' (16.4%). In C-H correlation spectra, there are two cross peaks for C4' or C3', *i.e.* C3' is coupled with H3' & H4'; C4' is coupled with H4' & H3'. HRMS (FAB$^-$): calc. for (M-H)$^-$ 671.2578, found 671.2613.

1-[5'-O-(MMTr)-3'-deoxy-2'-*O*,3'-*C*-(1-oxa-2-sila-3-*Z*-(trimethylsilylmethylidene) methylidene)-β-D-ribofuranosyl]thymine (3b) The general procedure for **3a** was followed using (i) **1** (1.0 g, 1.5 mmol), reagent **b** (1.02 g,4.5 mmol) to give **2b** (1.13 g, 92%); (ii) **2b** (1.02 g, 1.24 mmol), tributyltin hydride (0.52 ml, 1.86 mmol) and AIBN (20 mg) to give **3b** (796 mg, 96%). An analytical sample of **3b** has been obtained by flash chromatography. ^{1}H-NMR ($CDCl_3$): 8.65 (br.s, exchangable, 1H) NH, 7.84 (q, J = 1.1 Hz, 1H) H6, 7.50~6.86 (m, 14H) arom., 6.22 (s, 1H) Hβ, 6.08 (s, 1H) H1', 4.60 (d, $J_{2',3'}$ = 5.1 Hz, 1H) H2', 3.92 (dt, $J_{3',4'}$ = 10.0 Hz, 1H) H4', 3.81 (s, 3H) MeO, 3.74 (dd, $J_{4',5'}$ = 2.7 Hz, $J_{5',5''}$ = 11.1 Hz, 1H) H5', 3.50 (dd, 1H) H3', 3.14 (dd, $J_{4',5''}$ = 2.7 Hz, 1H) H5", 1.44 (d, 3H) 5-Me, 0.37 (s, 3H), Si-Me, 0.33 (s, 3H) Si-Me, 0.00 (s, 9H) 3 x Si-Me. ^{13}C-NMR ($CDCl_3$): 163.6 (s), 158.7 (s), 156.1 (s), 149.9 (s), 146.5 (d, J_{CH} = 129.7 Hz) Cβ, 143.9 (s), 143.6 (s), 135.6 (d, J_{CH} = 180.6 Hz) C6, 134.8 (s), 130.3 (d), 128.4 (d), 127.9 (d), 127.1 (d), 113.1 (d), 110.4 (s), 91.9 (d, J_{CH} = 172.3 Hz) C1', 86.6 (s), 84.9 (d, J_{CH} = 157.8 Hz) C2', 84.2 (d, J_{CH} = 147.4 Hz) C4', 60.4 (t, J_{CH} = 143.8 Hz) C5', 55.1 (q, J_{CH} = 144.3 Hz) MeO, 54.9 (d, J_{CH} = 139.1 Hz) C3', 11.8 (q, J_{CH} = 129.7 Hz) 5-Me, 0.9 (q, J_{CH} = 119.4 Hz) Si-Me, 0.8 (q, J_{CH} = 119.4 Hz) Si-Me, -0.6 (q, J_{CH} = 119.4 Hz) Si-Me. 1D NOE ($CDCl_3$): irradiation of H3': H6 (4.0%), Hβ (10.9%), H2' (12.7%), H4' (2.0%); of H1': H6 (2.2%), H2' (6.4%), H4' (3.9%); of Hβ: H3' (6.4%); of H6:

H1' (4.5%), H2' (3.3%), H3' (5.3%), 5-Me (8.4%). HRMS (FAB⁻): calc. for (M-H)⁻ 667.2660, found 667.2643.

1-[5'-O-(MMTr)-3'-deoxy-2'-*O*,3'-*C*-(1-oxa-2-sila-3-*Z*-(1-(t-butyldimethylsiloxy)-2-ethylidene)methylidene)-β-D-ribofuranosyl]thymine (3c) The general procedure for **3a** was followed using (i) **1** (669 mg, 1.0 mmol), reagent **c** (900 mg, 3.0 mmol) to give **2c** (879 mg, 98%); (ii) to the crude **2c**, tributyltin hydride (0.83 ml, 3.0 mmol) and AIBN (50 mg) to give crude **3c**. An analytical sample of vinylsiloxane **3c** has been obtained by flash chromatography. ^{1}H-NMR ($CDCl_3$): 8.59 (br.s, exchangable, 1H) NH, 7.74 (d, 1H) H6, 7.49~6.83 (m, 14H) arom., 6.03 (s, 1H) H1', 5.74 (t, $J_{\beta,\gamma}$ = 3.7 Hz, 1H) Hβ, 4.53 (d, $J_{2',3'}$ = 5.3 Hz, 1H) H2', 4.12 (dd, $J_{\gamma,\gamma''}$ = 15.2 Hz, 1H) Hγ, 3.97 (dd, 1H) Hγ'', 3.86 (dt, $J_{3',4'}$ = 9.8 Hz, 1H) H4', 3.79 (s, 3H) MeO, 3.72 (dd, $J_{4',5'}$ = 2.9 Hz, $J_{5',5''}$ = 11.1 Hz, 1H) H5', 3.47 (dd, 1H) H3', 3.17 (dd, $J_{4',5''}$ = 2.9 Hz, 1H) H5'', 1.51 (d, J = 1.1 Hz, 3H) 5-Me, 0.89 (s, 9H) ^{t}Bu, 0.33 (s,2H) Si-Me, 0.27 (s, 3H) Si-Me, 0.07 (s, 6H) 2 x Si-Me. ^{13}C-NMR ($CDCl_3$): 163.6 (s), 158.7 (s), 149.9 (s), 143.9 (s), 143.7 (s), 140.1 (d, J_{CH} = 151.5 Hz) Cβ, 135.8 (d, J_{CH} = 182.7 Hz) C6, 135.2 (s), 135.0 (s), 130.3 (d), 128.4 (d), 127.8 (d), 127.1 (d), 113.1 (d), 110.3 (s), 92.1 (d, J_{CH} = 173.3 Hz) C1', 86.6 (s), 85.1 (d, J_{CH} = 155.7 Hz) C2', 84.4 (d, J_{CH} = 147.4 Hz) C4', 64.3 (t, J_{CH} = 144.3 Hz) Cγ, 60.7 (t, J_{CH} = 143.2 Hz) C5', 55.1 (q, J_{CH} = 143.2 Hz) MeO, 49.7 (d, J_{CH} = 136.0 Hz) C3', 26.2 (q, J_{CH} = 125.6 Hz) ^{t}Bu, 11.9 (q, J_{CH} = 128.7 Hz) 5-Me, 0.9 (q, J_{CH} = 119.4 Hz) Si-Me, 0.6 (q, J_{CH} = 119.4 Hz) Si-Me, -5.1 (q, J_{CH} = 119.3 Hz) Si-Me. 1D NOE ($CDCl_3$): irradiation of H3': H6 (5.7%), Hβ (7.7%), H2' (13.1%); of Hβ: arom.(5.3%), Hγ (6.4%), Hγ'' (6.4%), H3' (10.4%). HRMS (FAB⁻): calc. for (M-H)⁻ 739.3235, found 739.3228.

1-[5'-O-(MMTr)-2'-deoxy-3'-*O*,2'-*C*-(1-oxa-2-sila-3-*Z*-(benzylidene)methylidene)-β-D-ribofuranosyl]thymine (9a) The general procedure for **3a** was followed using (i) **7** (669 mg, 1.0 mmol), reagent **a** (254 mg, 1.1 mmol) to give **8a** (782 mg, 95%); (ii) tributyltin hydride (0.4 ml, 1.5 mmol) and AIBN (20 mg) to give **9a** (625 mg, 93 %) after flash chromatography. ^{1}H-NMR ($CDCl_3$): 8.32 (s, exchangable, 1H) NH, 7.66 (s, 1H) H6, 7.50~6.88 (m, 20H) arom., Hβ, 6.20 (d, $J_{1',2'}$ = 8.3 Hz, 1H) H1', 4.76 (dd, $J_{2',3'}$ = 5.8 Hz, $J_{3',4'}$ = 1.4 Hz, 1H) H3', 4.25 (m, 1H) H4', 3.81 (s, 3H) CH_3O, 3.53 (dd, $J_{4',5'}$ = 2.5 Hz, $J_{5',5''}$ = 10.4 Hz, 1H) H5', 3.40 (m, $J_{4',5''}$ = 2.5 Hz, 2H) 2', 5'', 1.44 (s, 3H) 5-Me, 0.56 (s, 3H) Si-CH_3, 0.15 (s, 3H) Si-CH_3. ^{13}C-NMR ($CDCl_3$): 163.4 (s), 158.8 (s), 150.3 (s), 143.9 (s), 143.8 (s), 142.3 (d, J_{CH} = 151.2 Hz) Cβ, 138.6 (s), 138.4 (s), 135.8 (d, J_{CH} = 180.5 Hz) C6, 134.8 (s), 130.5 (d), 128.4 (d), 128.1 (d), 128.0 (d), 127.5 (d), 127.3 (d), 127.1 (d), 113.3 (d), 111.7 (s), 87.9 (d,J_{CH} = 167.7 Hz) C1', 87.2 (s), 85.9 (d, J_{CH} = 150.3 Hz) C4', 81.2 (d, J_{CH} = 155.8 Hz) C3', 64.0 (t, J_{CH} = 143.0 Hz) C5', 58.8 (d, J_{CH} = 135.6 Hz) C2', 55.3 (q, J_{CH} = 143.9 Hz) MeO, 11.7 (q, J_{CH} = 129.2 Hz) 5-Me, 1.44 (q, J_{CH} = 121.0 Hz) Si-Me, -0.85 (q, J_{CH} = 120.1 Hz) Si-Me. 1D NOE ($CDCl_3$): irradiation of Hβ: H1' (3.2%), H2' (5.5%); of H1': H6 (1.1%), Hβ (1.8%), H4' (3.1%), H2' (2.2%), Si-Me at 0.56 ppm (4.0%); of H6: H1' (2.8%), H2' (10.6%), 5-Me (6.4%). HRMS (FAB⁻): calc. for (M-H)⁻ 671.2578, found 671.2612.

1-[5'-O-(MMTr)-2'-deoxy-3'-*O*,2'-*C*-(1-oxa-2-sila-3-*Z*-(trimethylsilylmethylidene) methylidene)-β-D-ribofuranosyl]thymine (9b) The general procedure for **3a** was followed using (i) **7** (669 mg, 1.0 mmol), reagent **b** (454 mg, 2.0 mmol) to give **8b** (790 mg,96%); (ii) **8b** (494 mg,0.6 mmol), tributyltin hydride (0.25 ml, 0.9 mmol) and AIBN (20 mg) to give only one isomer **9b** (345 mg, 86 %) after flash chromatography. ^{1}H-NMR ($CDCl_3$): 8.16 (br.s, exchangable, 1H) NH, 7.61 (q, J = 1.1 Hz, 1H) H6, 7.44~6.83 (m, 14H) arom., 6.48 (d, $J_{2',\beta}$ = 1.2 Hz, 1H) Hβ, 6.08 (d, $J_{1',2'}$ = 8.2 Hz, 1H) H1', 4.72 (dd, $J_{2',3'}$ = 5.7 Hz, $J_{3',4'}$ = 1.5 Hz, 1H) H3', 4.19 (dt, $J_{4',5'}$ = $J_{4',5''}$ = 2.4 Hz, 1H) H4', 3.80 (s, 3H) MeO, 3.50 (dd, $J_{5',5''}$ = 10.3 Hz, 1H) H5', 3.37 (dd, 1H) H5'', 3.21 (m, 1H) H2', 1.42 (d, 3H) 5-Me, 0.48 (s, 3H) Si-Me, 0.36 (s, 3H) Si-Me, 0.10 (s, 9H) 3 x Si-Me. ^{13}C-NMR ($CDCl_3$): 163.6 (s), 158.7 (s), 154.7 (s), 150.2 (s), 146.9 (d J_{CH} = 128.7 Hz) Cβ, 143.7 (s), 135.8 (d, J_{CH} = 177.5 Hz) C6, 134.7 (s), 130.3 (d), 128.3 (d), 127.9 (d), 127.1 (d), 113.1 (d), 110.5 (s), 87.7 (d, J_{CH} = 168.2 Hz) C1', 87.0 (s), 85.7 (d, J_{CH} = 148.4 Hz) C4', 80.4 (d, J_{CH} = 156.7 Hz) C3', 63.8 (t, J_{CH} = 143.3 Hz) C5', 61.6 (d, J_{CH} = 148.4 Hz) C2', 55.1 (q, J_{CH} = 144.2 Hz) MeO, 11.6 (q, J_{CH} = 129.8 Hz) 5-Me, 1.0 (q, J_{CH} = 120.4 Hz) Si-Me, 0.8 (q, J_{CH} = 120.4 Hz) Si-Me, -0.6 (q, J_{CH} = 119.4 Hz) Si-Me. 1D NOE ($CDCl_3$): irradiation of Hβ: H1' (7.5%), H2' (14.0%); of H2': H6 (9.3%), Hβ (10.5%), H3' (8.4%); of H6: H2' (11.3%), 5-Me (5.6%). HRMS (FAB⁻): calc. for (M-H)⁻ 667.2660, found 667.2645.

1-[5'-O-(MMTr)-2'-deoxy-3'-*O*,2'-*C*-(1-oxa-2-sila-3-*Z*-(1-(t-butyldimethylsiloxy)-2-ethylidene)methylidene)-β-D-ribofuranosyl]thymine (9c) The general procedure for **3a** was followed using (i) **7** (1.0 g, 1.5 mmol), reagent **c** (900 mg, 3 mmol) to give **8c** (1.30 g, 97%); (ii) **8c** (1.14 g, 1.27 mmol), tributyltin hydride (0.53 ml, 1.91 mmol) and AIBN (60 mg) to give only one isomer **9c** (843 mg, 90 %) after flash chromatography. ^{1}H-NMR ($CDCl_3$): 8.29 (br.s, exchangable, 1H) NH, 7.55 (d, 1H) H6, 7.34~6.75 (m, 14H) arom., 6.16 (dd, $J_{\beta,\gamma}$ = 3.3 Hz, $J_{\beta,\gamma''}$ = 3.9 Hz, 1H) Hβ. 5.98 (d, $J_{1',2'}$ = 7.9 Hz, 1H) H1', 4.64 (dd, $J_{2',3'}$ = 6.1 Hz, $J_{3',4'}$ = 1.8 Hz, 1H) H3', 4.24 (dd, $J_{\gamma,\gamma''}$ = 14.8 Hz, 1H) Hγ, 4.13 (dd, 1H)

H_{χ}", 4.09 (m, $J_{4',5'} = J_{4',5"} = 2.4$ Hz, 1H) H4', 3.73 (s, 3H) MeO, 3.44 (dd, $J_{5',5"} = 10.5$ Hz, 1H) H5', 3.31 (dd, 1H) H5", 3.24 (m, 1H) H2', 1.31 (s, 3H), 5-Me, 0.85 (s, 9H) ^{t}Bu, 0.36 (s, 3H) Si-Me, 0.28 (s, 3H) Si-Me, 0.05 (s, 6H) 2 x Si-Me. ^{13}C-NMR ($CDCl_3$): 158.7 (s), 150.2 (s), 143.9 (s), 143.8 (s), 140.7 (d, J_{CH} = 155.3 Hz) C_{β}, 134.8 (d, J_{CH} = 180.7 Hz) C6, 130.4 (d), 128.4 (d), 127.9 (d), 127.2 (d), 113.2 (d), 111.5 (s), 88.2 (d, J_{CH} = 168.2 Hz) C1', 87.0 (s), 85.8 (d, J_{CH} = 147.4 Hz) C4', 80.6 (d, J_{CH} = 155.7 Hz) C3', 64.6 (t, J_{CH} = 140.2 Hz) C_{γ}, 63.9 (t, J_{CH} = 142.8 Hz), 56.2 (d, J_{CH} = 141.2 Hz) C2', 55.1 (q, J_{CH} = 143.3 Hz) MeO, 26.3 (q, J_{CH} = 124.6 Hz) tBu, 11.5 (q, J_{CH} = 126.6 Hz) 5-Me, 0.94 (q, J_{CH} = 121.4 Hz) Si-Me, 0.65 (q, J_{CH} = 119.4 Hz) Si-Me, -5.10 (q, J_{CH} = 119.3 Hz) Si-Me. 1D NOE ($CDCl_3$): irradiation of H6: H2' (19.2%), 5-Me (9.2%); of H_{β}: H1' (3.7%), H_{γ} (10.4%), H2' (4.8%). HRMS (FAB$^-$): calc. for (M-H)$^-$ 739.3235, found 739.3273.

1-[5'-O-(MMTr)-3'-deoxy-3'-*C*-(1-oxo-2-phenyl)ethyl-β-D-ribofuranosyl]thymine (4a) *General procedure for the oxidative cleavage of Si-C bond:* To a mixture of **3a** (150 mg, 0.22 mmol), potassium bicarbonate (45 mg, 0.45 mmol) and KF (26 mg, 0.45 mmol), cooled in an ice-water bath, was added a solution of 30% aqueous hydrogen peroxide (0.22 ml, 2.2 mmol) in THF (1.5 ml) and methanol (1.5 ml). The reaction was kept at RT for 4h with stirring. It was then poured into an aqueous saturated ammonium chloride solution (80 ml) and extracted with dichloromethane (3 x 50 ml). The organic phase was dried over sodium sulfate, evaporated to dryness. The foam was purified by flash chromatography to give the pure **4a** (131 mg, 93% from **3a**, 83 % from **1**). ^{1}H-NMR ($CDCl_3$): 7.88 (s, 1H) H6, 7.29~6.76 (m, 19H) arom., 5.77 (s, 1H) H1', 5.56 (br. s, exchangable, 1H) OH, 4.87 (m, 2H) H4', H2', 3.91 (d, $J_{\beta',\beta"} = 15.0$ Hz, 1H) $H_{\beta'}$, 3.84 (d, 1H) $H_{\beta"}$, 3.78 (s, 3H) CH_3O, 3.65 (dd, J = 5.1 Hz, J = 7.6 Hz, 1H) H3', 3.60 (d, $J_{5',5"} = 11.9$ Hz, 1H) H5', 3.37 (d, 1H) H5", 1.25 (s, 3H) 5-Me; ^{13}C-NMR ($CDCl_3$): 202.7 (s), 164.6 (s), 158.6 (s), 150.8 (s), 143.6 (s), 143.5 (s), 135.4 (d, J_{CH} = 182.7 Hz), 134.5, 133.6, 130.2, 129.3, 128.8, 128.1, 127.9, 127.2, 127.1, 113.1 (d, J_{CH} = 158.8 Hz), 110.8 (s), 92.9 (d, J_{CH} = 175.4 Hz), 86.7 (s), 80.9 (d, J_{CH} = 151.5 Hz), 77.7 (d, J_{CH} = 155.7 Hz), 61.6 (t, J_{CH} = 143.8 Hz), 55.1 (q, J_{CH} = 144.3 Hz), 51.4 (d, J_{CH} = 131.8 Hz), 49.7 (t, J_{CH} = 128.7 Hz), 11.6 (q, J_{CH} = 130.7 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 631.2444, found 631.2428.

1-[5'-O-(MMTr)-3'-deoxy-3'-*C*-acetyl-β-D-ribofuranosyl]thymine (4b) General procedure for the oxidative cleavage of Si-C bond for **3a** was followed using the crude **3b** (800 mg), potassium bicarbonate (124 mg, 1.24 mmol) and KF (108 mg, 1.86 mmol) and 30% aqueous hydrogen peroxide (1.24 ml, 12.4 mmol) to give pure **4b** after flash chromatography (596 mg, 87% from **2b**, 80 % from **1**). ^{1}H-NMR ($CDCl_3$): 10.70 (br. s, exchangable, 1H) NH, 7.89 (s, 1H) H6, 7.40~6.82 (m, 14H) arom., 5.74 (s, 1H) H1', 5.48 (s, exchangable, 1H) OH, 4.86 (m, 2H) H4', H2', 3.79 (s, 3H) CH_3O, 3.69 (d, $J_{5',5"} = 10.1$ Hz, 1H) H5', 3.44 (m, 2H) H5", H3', 2.30 (s, 3H) Ac, 1.38 (s, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$): 203.1 (s), 164.5 (s), 158.7 (s), 150.9 (s), 143.8 (s), 143.7 (s), 135.4 (d, J_{CH} = 183.3 Hz), 134.8, 130.2, 128.2, 127.9, 127.1, 113.2 (d, J_{CH} = 162.2 Hz), 110.7 (s), 92.9 (d, J_{CH} = 176.0 Hz), 86.9 (s), 80.9 (d J_{CH} = 152.1 Hz), 77.4 (d, J_{CH} = 156.7 Hz), 62.3 (t, J_{CH} = 143.9 Hz), 55.1 (q, J_{CH} = 143.9 Hz), 53.5 (d, J_{CH} = 131.1 Hz), 29.9 (q, J_{CH} = 127.4 Hz), 11.9 (q, J_{CH} = 129.2 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 555.2131, found 555.2097.

1-[5'-O-(MMTr)-3'-deoxy-3'-*C*-(1-oxo-3-(t-butyldimethylsiloxy))propyl-β-D-ribofuranosyl] thymine (4c): General procedure for the oxidative cleavage of Si-C bond for **3a** was followed using the crude **3c** (720 mg), potassium bicarbonate (100 mg,1.0 mmol) and KF (174 mg, 3.0 mmol) and 30% aqueous hydrogen peroxide (1.0 ml,10 mmol) to give pure **4c** after flash chromatography (520 mg, 74 % from **1**). ^{1}H-NMR ($CDCl_3$): 11.10 (s, exchangable, 1H) NH, 7.84 (s, 1H) H6, 7.39~6.81 (m, 14H) arom., 5.73 (s, 1H) H1', 5.08 (s, exchangable, 1H) OH, 4.86 (m, 2H) H4', H2', 3.92 (t, $J_{\beta,\gamma}$ =6.1 Hz, 2H) H_{γ}, 3.80 (s, 3H) CH_3O, 3.66 (d, $J_{5',5"} = 11.0$ Hz, 1H) H5', 3.46 (m, 2H) H3', H5", 2.85 (m, 2H) H_{β}, $H_{\beta'}$, 1.39 (s, 3H) 5-Me, 0.86 (s, 9H) ^{t}Bu, 0.04 (s, 6H) 2 x Si-CH_3. ^{13}C-NMR ($CDCl_3$): 204.5 (s), 164.2 (s), 159.7 (s), 150.6 (s), 143.8 (s), 143 7 (s), 135.4 (d, J_{CH} = 185.6 Hz), 134.8, 130.2, 128.2, 127.9, 127.1, 113.2 (d, J_{CH} = 159.8 Hz), 110.6 (s), 92.8 (d, J_{CH} = 174.4 Hz), 86.9 (s), 80.5 (d, J_{CH} = 151.6 Hz), 77.4 (d, J_{CH} = 156.7 Hz), 62.5 (t, J_{CH} = 143.8 Hz), 58.7 (t, J_{CH} = 144.3 Hz), 55.1 (q, J_{CH} = 144.3 Hz), 54.2 (d, J_{CH} = 128.7 Hz), 45.5 (t, J_{CH} = 126.6 Hz), 25.8 (q, J_{CH} = 125.6 Hz), 18.2 (s), 11.9 (q, J_{CH} = 129.8 Hz), -5.6 (q, J_{CH} = 118.3 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 699.3102, found 699.3121.

1-[5'-O-(MMTr)-2'-deoxy-2'-*C*-(1-oxo-2-phenyl)ethyl-β-D-ribofuranosyl]thymine (10a) General procedure for the oxidative cleavage of Si-C bond for **3a** was followed using **9a** (246 mg, 0.36 mmol), potassium bicarbonate (72 mg, 0.72 mmol) and KF (42 mg, 0.72 mmol) and 30% aqueous hydrogen peroxide (0.3 ml, 3.6 mmol) for 2 h gave pure **10a** (177 mg, 57%). ^{1}H-NMR ($CDCl_3$): 9.0 (s, exchangable, 1H) NH, 7.41~6.80 (m, 20H) H6, arom., 6.40 (d, $J_{1',2'}$ = 7.4 Hz, 1H) H1', 4.57 (m, $J_{3',4'}$ = 2.3 Hz, 1H) H3', 4.14 (dd, 1H) H4', 3.87 (s, 2H) H_{β}, 3.80 (s, 3H) CH_3O, 3.75 (dd, $J_{2',3'} = 6.3$ Hz, 1H) H2', 3.44 (dd, $J_{4',5'} = 2.8$ Hz, $J_{5',5"} = 10.8$ Hz, 1H) H5', 3.32 (dd, $J_{4',5"} = 2.6$ Hz, 1H) H5", 1.41 (s, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$):

205.0 (s), 163.4 (s), 158.7 (s), 150.0 (s), 143.6 (s), 143.5 (s), 135.3 (d, J_{CH} = 180.6 Hz), 134.5 8s), 132.3, 130.2, 129.5, 129.2, 129.1, 128.8, 128.6, 128.2, 127.9, 127.3, 127.2, 113.2, 111.1, 87.2, 86.4 (d, J_{CH} = 175.4 Hz), 85.9 (d, J_{CH} = 152.6 Hz), 73.6 (d, J_{CH} = 153.7 Hz), 63.2 (t, J_{CH} = 142.7 Hz), 58.2 (d, J_{CH} = 132.9 Hz), 55.1 (q, J_{CH} = 144.2 Hz), 51.2 (t, J_{CH} = 129.3 Hz), 11.7 (q, J_{CH} = 128.7 Hz). HRMS (FAB^-): calc. for $(M-H)^-$ 631.2444, found 631.2438.

1-[5'-O-(MMTr)-3'-deoxy-3'-*C*-(1-*R*-hydroxy-2-phenyl))ethyl-β-D-ribofuranosyl]thymine (5a): (i) Narasaka-Prasad method: To a solution of **4a** (126 mg, 0.2 mmol) in dry THF and methanol (10 ml, 4:1) at -78°C under argon was added dropwise methoxydiethylborane in dry THF (1.0 M, 0.22 ml), and stirred for 15 min, sodium borohydride (12 mg, 0.3 mmol) was then added, and stirred for 5 h, then diluted with dichloromethane, washed with 0.1 N aq. HCl solution, aq. sat. sodium bicarbonate and brine, the organic phase was dried over sodium sulphate, filtered and evaporated to dryness. The residue, after flash chromatography, gave **5a** (119 mg, 94%, >97% ee). (ii) Saksena method: To a glacial acetic acid (2 ml) at 0°C was added sodium borohydride (11 mg, 0.3 mmol) in one portion with stirring. After 10 min, the ketone **4a** (63 mg, 0.1 mmol) in glacial acetic acid (1 ml) was added at 0°C. The resulting mixture was stirred at RT for 5 h, then evaporated to dryness at RT. The residue was partitioned between aq. sat. ammonium chloride (10 ml) containing 0.1N HCl (1 ml) and dichloromethane (2 x 10 ml). The organic phase was dried over sodium sulfate, filtered evaporated to dryness. Flash chromatography of the residue gave **5a** (57 mg, 90%, >97% ee). (iii) Evans method: To a solution of tetramethylammonium triacetoxyborohydride (217 mg, 0.8 mmol) in acetonitrile (1 ml) was added acetic acid (1 ml) and the mixture was stirred at RT for 30 min. The mixture was then cooled to -40°C, and the ketone **4a** (63 mg, 0.1 mmol) in acetonitrile (1 ml) was added. The mixture was stirred at -40°C for 10 h and evaporated to dryness at RT. The residue was partitioned between aq. sat. ammonium chloride (10 ml) containing 0.1N HCl (1 ml) and dichloromethane (2 x 10 ml). The organic phase was dried over sodium sulfate, filtered and evaporated to dryness. Flash chromatography of the residue gave **5a** (59 mg, 92%, >97% ee). ^{1}H-NMR ($CDCl_3$): 7.97 (s, exchangable, 1H) NH, 7.43~6.80 (m, 20H) H6, arom., 5.87 (s, 1H) H1', 5.51 (s, exchangable, 1H) OH, 4.73 (d, $J_{3',4'}$ = 8.6 Hz, 1H) H4', 4.51 (d, $J_{2',3'}$ = 3.2 Hz, 1H) H2', 4.35 (m, 1H) H_α, 3.86 (d, $J_{4',5'}$ = 0 Hz, $J_{5',5''}$ = 10.9 Hz, 1H) H5', 3.76 (s, 3H) CH_3O, 3.37 (d, 1H) H5", 2.92 (s, exchangble, 1H) OH, 2.67 (dd, $J_{\alpha,\beta}$ = 4.1 Hz, $J_{\beta,\beta'}$ = 13.8 Hz, 1H) H_β, 2.48 (dd, $J_{\alpha,\beta'}$ = 8.3 Hz, 2H) $H_{\beta'}$, H3', 1.29 (s, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$): 164.6 (s), 158.7 (s), 150.9 (s), 143.8 (s), 143.6 (s), 138.1 (s), 135.8, 134.7, 130.5, 129.2, 128.4, 127.9, 127.2, 126.3, 113.1 (d), 110.6 (s), 91.7 (d, J_{CH} = 173.2 Hz), 86.8 (s), 80.9 (d, J_{CH} = 145.7 Hz), 78.4 (d, J_{CH} = 151.2 Hz), 69.2 (d, J_{CH} = 147.5 Hz), 63.7 (t, J_{CH} = 143.0 Hz), 55.1 (q, J_{CH} = 143.9 Hz), 44.6 (d, J_{CH} = 130.1 Hz), 41.7 (t, J_{CH} = 126.0 Hz), 11.7 (q, J_{CH} = 128.3 Hz). HRMS (FAB^-): calc. for $(M-H)^-$ 633.2601, found 633.2605.

1-[5'-O-(MMTr)-3'-deoxy-3'-*C*-(1-*R*-hydroxy)ethyl-β-D-ribofuranosyl]thymine (5b): (i) Narasaka-Prasad method: A similar procedure that was used for **5a** was employed. **4b** (132 mg, 0.24 mmol), 1.0 M methoxydiethylborane in THF (0.26 ml, 0.26 mmol), sodium borohydride (18 mg, 0.48 mmol) gave **5b** (127 mg, 97%, >95% ee). (ii) Saksena method: A similar procedure that was used for **5a** was employed. **4b** (39 mg, 0.07 mmol), sodium borohydride (8 mg, 0.21 mmol) gave **5b** (33 mg, 92%, >95% ee). (iii) Evans method: The procedure similar to **5a** using **4b** (39 mg, 0.07 mmol), tetramethylammonium triacetoxy borohydride (190 mg, 0.7 mmol) gave **5b** (31 mg, 85%, >95% ee). ^{1}H-NMR ($CDCl_3$): 10.75 (s, exchangable, 1H) NH, 7.97 (s, 1H) H6, 7.42~6.82 (m, 14H) arom., 5.83 (s, 1H) H1', 5.60 (br. s, exchangable, 1H) OH, 4.68 (m, $J_{3',4'}$ = 8.8 Hz, 1H) H4', 4.48, (d, $J_{2',3'}$ = 5.2 Hz, 1H) H2', 4.30 (m, $J_{3',\alpha}$ =3.2 Hz, 1H) H_α, 3.83 (dd, $J_{4',5'}$ = 1.6 Hz, $J_{5',5''}$ = 11.0 Hz, 1H) H5', 3.78 (s, 3H) CH_3O, 3.34 (dd, $J_{4',5''}$ = 2.1 Hz, 1H) H5", 2.37 (m, 1H) H3', 1.31 (s, 3H) 5-Me, 1.02 (d, $J_{\alpha,\beta}$ = 6.5 Hz, 3H) H_β. ^{13}C-NMR ($CDCl_3$): 164.7 (s), 158.7 (s), 150.9 (s), 143.7 (s), 143 6 (s), 135.8 (d, J_{CH} = 184.8 Hz), 134.7, 130.4, 128.4, 127.8, 127.2, 113 1 (d, J_{CH} = 163.0 Hz), 110.6 (s), 91.6 (d, J_{CH} = 173.3 Hz), 86.8 (s), 80.5 (d, J_{CH} = 149.5 Hz), 78.8 (d, J_{CH} = 152.6 Hz), 64.3 (d, J_{CH} = 144.3 Hz), 63.9 (t, J_{CH} = 142.7 Hz), 55.1 (q, J_{CH} = 144.3 Hz), 46.5 (d, J_{CH} = 130.8 Hz), 21.5 (q, J_{CH} = 126.6 Hz), 11.7 (q, J_{CH} = 129.8 Hz). HRMS (FAB^-): calc. for $(M-H)^-$ 557.2288, found 557.2269.

1-[5'-O-(MMTr)-3'-deoxy-3'-*C*-(1-*R*-hydroxy-3-(t-butyldimethylsiloxy))propyl-β-D-ribofuranosyl]thymine (5c): (i) Narasaka-Prasad method: The procedure similar to **5a** was used, **4c** (147 mg, 0.21mmol), 1.0 M methoxydiethylborane in THF (0.25 ml, 0.25 mmol), sodium borohydride (12 mg, 0.32 mmol) gave **5c** (145 mg, 95%, >95% ee). ii) Saksena method: The procedure similar to **5a** was used, **4c** (140 mg, 0.2 mmol), sodium borohydride (23 mg, 0.6 mmol) gave **5c** (126 mg, 90%, >95% ee). (iii) Evans method: The procedure similar to **5a** was used, **4c** (70 mg, 0.1 mmol), tetramethylammonium triacetoxy borohydride (217 mg, 0.8 mmol) gave **5c** (61 mg, 87%, >95% ee). ^{1}H-NMR ($CDCl_3$): 10.52 (s, exchangable, 1H) NH, 7.97 (s, 1H) H6, 7.50~6.70 (m, 14H) arom., 5.81 (s, 1H) H1', 5.10 (s, exchangable, 1H) OH, 4.66 (m, $J_{3',4'}$ = 8.7 Hz, 1H) H4', 4.46 (d, $J_{2',3'}$ = 5.7 Hz, 1H) H2', 3.74 (m, $J_{3',\alpha}$ = 4.6 Hz, $J_{\alpha,\beta}$ = 8.9 Hz, 1H) H_α, 3.79 (d, 1H) H5', 3.78 (s, 3H) CH_3O, 3.70 (m, 2H) H_γ, 3.39 (dd, $J_{4',5'}$ = 2.7 Hz, $J_{5',5''}$ = 10.9 Hz, 1H) H5", 2.42 (m, 1H) H3', 1.80 (s, exchangable, 1H) OH, 1.50 (m, 2H) H_β, 1.30 (s, 3H) 5-Me, 0.88 (s,

9H) ^{t}Bu, 0.05 (2 x s, 6H) 2 x Si-CH_3. ^{13}C-NMR ($CDCl_3$): 164.6 (s), 158.6 (s), 150.9 (s), 143 8 (s), 135.8 (d, J_{CH} = 182.7 Hz), 134.9 (s), 130.4 (d, J_{CH} = 158.8 Hz), 128.5 (d, J_{CH} = 159.8 Hz), 127.8 (d, J_{CH} = 159.9 Hz), 127.1 (d, J_{CH} = 160.9 Hz), 113.0 (d, J_{CH} = 159.8 H), 110.5 (s), 91.8 (d, J_{CH} = 173.4 Hz), 86.8 (s), 81.5 (d, J_{CH} = 148.4 Hz), 78.5 (d, J_{CH} = 156.7 Hz), 67.6 (d, J_{CH} = 146.4 Hz), 63.7 (t, J_{CH} = 142.8 Hz), 61.6 (t, J_{CH} = 142.2 Hz), 55.1 (q, J_{CH} = 143.8 Hz) ,45.5 (d, J_{CH} = 129.7 Hz), 37.0 (t, J_{CH} = 125.6 Hz), 25.8 (q, J_{CH} = 124.6 Hz), 18.1 (s), 11.6 (q, J_{CH} = 129.7 Hz), -5.57 (q, J_{CH} = 118.3 Hz). HRMS (FAB^-): calc. for $(M-H)^-$ 701.3259, found 701.3231.

1-[5'-O-(MMTr)-2'-deoxy-2'-*C*-(1-*S*-hydroxy-2-phenyl)ethyl-β-D-ribofuranosyl]thymine (11a) & 1-[5'-O-(MMTr)-2'-deoxy-2'-*C*-(1-*R*-hydroxy-2-phenyl)ethyl-β-D-ribofuranosyl] thymine (11a'): To a solution of **10a** (158 mg, 0.25 mmol) in methanol (10 ml) was added sodium borohydride (38 mg, 1 mmol) in one portion at RT with stirring. The mixture, after 2h, was evaporated to dryness, redissolved in dichloromethane (20 ml) and washed with aqueous saturated ammonium chloride containing 0.1% HCl several times. The organic phase was dried over sodium sulfate, evaporated to dryness. The residue, after flash chromatography, gave **11a** (109 mg, 68.6%) and **11a'** (36 mg, 23.6%) in a ratio of 3:1. **11a** : ^{1}H-NMR ($CDCl_3$): 7.56 (s, 1H) H6, 7.40~6.84 (m, 19H) arom., 6.48 (d, $J_{1',2'}$ = 8.6 Hz, 1H) H1', 4.53 (dd, $J_{2',3'}$ = 6.4 Hz, $J_{3',4'}$ = 2.1 Hz, 1H) H3', 4.37 (ddd, 1H) H_α, 4.05 (dt, $J_{4',5'}$ = $J_{4',5''}$ = 2.6 Hz, 1H) H4', 3.79 (s, 3H) MeO, 3.37 (d, 2H) H5', H5", 3.05 (dd, $J_{\alpha,\beta'}$ = 4.6 Hz, $J_{\beta',\beta''}$ = 13.7 Hz, 1H) $H_{\beta'}$, 2.85 (dd, $J_{\alpha,\beta''}$ = 7.3 Hz, 1H) $H_{\beta''}$, 2.47 (ddd, $J_{2',\alpha}$ = 7.7 Hz, 1H) H2', 1.28 (s, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$): 164.1 (s), 158.1 (s), 150.3 (s), 143.2 (s), 143.0 (s), 137.5 (s), 136.1 (d), 134.0, 129.4, 128.4, 127.4, 127.2, 126.8, 126.0, 125.1, 112.1, 109.7 (s), 86.2 (s), 85.9 (d), 85.4 (d), 71.9 (d), 68.7 (d), 63.1 (t), 53.6 (q), 50.9 (t), 40.8 (d), 9.8 (q). HRMS (FAB^-): calc. for $(M-H)^-$ 633.2601, found 633.2595. **11a'**: ^{1}H-NMR ($CDCl_3$): 10.5 (br.s, 1H), NH, 7.56 (s, 1H) H6, 7.40~6.80 (m, 19H) arom., 6.53 (d, $J_{1',2'}$ = 9.4 Hz, 1H) H1', 4.78 (d, $J_{2',3'}$ = 5.1 Hz, 1H) H3', 4.70 (br.s, exchangable, 1H) OH, 4.21 (m, 1H) H_α, 4.16 (t, $J_{4',5'}$ = $J_{4',5''}$ = 2.7 Hz, 1H) H4', 3.94 (br.s, exchangable, 1H) OH, 3.79 (s, 3H) CH_3O, 3.35 (m, 2H) H5', H5", 3.08 (dd, $J_{\alpha,\beta}$ = 7.7 Hz, $J_{\beta,\beta'}$ = 13.5 Hz, 1H) H_β, 2.96 (dd, 1H) $H_{\beta'}$, 2.39 (ddd, $J_{2',\alpha}$ = 4.7 Hz, 1H) H2', 1.30 (s, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$): 163.6 (s), 158.7 (s), 151.2 (s), 143.7 (s), 143.5 (s), 137.1, 135.2 (d, J_{CH} = 180.5 Hz), 134.7, 130.2, 129.1, 128.7, 128.2, 127.9, 127.2, 126.9, 113.2 (d), 112.0(S), 87.3 (d, J_{CH} = 149.4 Hz), 86.9 (s), 85.5 (d, J_{CH} = 167.7 Hz), 74.5 (d, J_{CH} = 156.7 Hz), 69.7 (d, J_{CH} = 146.6 Hz), 64.1 (t, J_{CH} = 143.0 Hz), 55.1 (q, J_{CH} = 143.8 Hz), 52.2 (d, J_{CH} = 128.3 Hz), 41.8 (t, J_{CH} = 127.4 Hz), 11.5 (q, J_{CH} = 129.2 Hz). HRMS (FAB^-): calc. for $(M-H)^-$ 633.2601, found 633.2595.

1-[5'-O-(MMTr)-2'-deoxy-2'-*C*-(1-*S*-hydroxy)ethyl-β-D-ribofuranosyl]thymine (11b) The general procedure for **4a** was followed using **9b** (167 mg, 0.25 mmol), potassium bicarbonate (50 mg, 0.5 mmol) and KF (29 mg, 0.5 mmol) and 30% aqueous hydrogen peroxide (0.5 ml, 5 mmol) to give crude **10b**. The crude **10b** in methanol (10 ml) was treated with sodium borohydride (38 mg, 1 mmol) at RT. A standard work up, described for **11a**, gave a residue which was redissolved in dichloromethane and precitated out as analytical pure gel **11b** (29 mg, 22 % from **9b**). ^{1}H-NMR ($CDCl_3$ + CD_3OD): 7.56 (s, 1H) H6, 7.44~6.84 (m, 14H) arom., 6.46 (d, $J_{1',2'}$ = 8.8 Hz, 1H) H1', 4.45 (dd, $J_{3',4'}$ = 1.8 Hz, $J_{2',3'}$= 6.3 Hz, 1H) H3', 4.27 (m, 1H) H_α, 4.06 (m, 1H) H4', 3.81 (s, 3H) CH_3O, 3.43 (dd, $J_{4',5'}$ = 2.8 Hz, $J_{5',5''}$ = 10.6 Hz, 1H) H5', 3.36 (dd, $J_{4',5''}$ = 3.7 Hz, 1H) H5", 2.38 (ddd, $J_{2',\alpha}$ = 6.3 Hz, 1H) H2', 1.42 (s, 3H) 5-Me, 1.29 (d, $J_{\alpha,\beta}$ = 6.4 Hz, 3H) H_β. ^{13}C-NMR ($CDCl_3$ + CD_3OD): 164.4 (s), 158.5 (s), 151.0 (s), 143.6 (s), 143.4 (s), 137.2 (s), 136.1 (d, J_{CH} = 178.7 Hz), 134.6 (s), 130.1, 128.1, 127.6, 126.9, 112.9 (d, J_{CH} = 159.5 Hz), 111.1(s), 86.9 (s), 85.7 (d, J_{CH} = 153.1 Hz), 73.4 (d, J_{CH} = 150.3 Hz), 64.5 (d, J_{CH} = 146.6 Hz), 63.7 (t, J_{CH} = 142.0 Hz), 54.8 (q, J_{CH} = 143.8 Hz), 53.8 (d, J_{CH} = 128.3 Hz), 21.2 (q, J_{CH} = 126.5 Hz), 11.2 (q, J_{CH} = 129.2 Hz). HRMS (FAB^-): calc. for $(M-H)^-$ 557.2288, found 557.2291.

1-[5'-O-(MMTr)-2'-deoxy-2'-*C*-(1-*S*-hydroxy-3-(t-butyldimethylsiloxy))propyl-β-D-ribofuranosyl]thymine (11c) The general procedure for **4a** was followed using **9c** (740 mg, 1.0 mmol), potassium bicarbonate (100 mg, 1.0 mmol) and KF (174 mg, 3.0 mmol) and 30% aqueous hydrogen peroxide (1.0 ml, 10 mmol) to give crude **10c**. The crude **10c** in methanol (10 ml) was treated with sodium borohydride (190 mg, 5 mmol) at RT. A standard work up, described for **11a**, gave a residue which was redissolved in dichloromethane and precitated out as analytical pure gel **11c** (203 mg, 29 % from **9c**). ^{1}H-NMR ($CDCl_3$ + CD_3OD): 7.59 (s, 1H) H6, 7.45~6.85 (m, 14H) arom., 6.48 (d, $J_{1',2'}$ = 8.6 Hz, 1H) H1', 4.49 (dd, $J_{2',3'}$ =6.2 Hz, $J_{3',4'}$ = 2.1 Hz, 1H) H3', 4.30 (ddd, $J_{2',\alpha}$ = 6.6 Hz, 1H) H_α, 4.08 (dd, 1H) H4', 3.87 (dd) H_γ, 3.81 (s, 3H) CH_3O, 3.45 (dd, $J_{4',5'}$ = 2.9 Hz, $J_{5',5''}$ = 10.6 Hz, 1H) H5', 3.38 (dd, $J_{4',5''}$ = 2.9 Hz, 1H) H5", 2.48 (ddd, 1H) H2', 1.80 (m, $J_{\alpha,\beta}$ = 2.6 Hz, $J_{\alpha,\beta'}$ = 8.1 Hz, 2H) H_β, $H_{\beta'}$, 1.40 (s, 3H) 5-Me, 0.91 (s, 9H) ^{t}Bu, 0.1 (s, 6H) 2 x Si-CH_3. ^{13}C-NMR ($CDCl_3$ + CD_3OD): 164.4 (s), 158.4 (s), 150.8 (s), 143.6 (s), 143.4 (s), 136.2 (d, J_{CH} = 179.6 Hz), 134.6, 130.0, 128.0, 127.6, 126.8, 112.8 (d, J_{CH} = 159.8 Hz), 111.0 (s), 86.8 (s), 85.7 (d, J_{CH} = 171.3 Hz), 85.4 (d, J_{CH} = 149.5 Hz), 73.1 (d, J_{CH} = 151.6 Hz), 66.6 (d, J_{CH} = 147.4

Hz), 63.6 (t, J_{CH} = 142.7 Hz), 60.8 (t, J_{CH} = 142.2 Hz), 54.7 (q, J_{CH} = 143.2 Hz), 52.6 (d, J_{CH} = 127.7 Hz), 37.2 (t, J_{CH} = 125.6 Hz), 25.4 (q, J_{CH} = 125.6 Hz), 17.8 (s), 11.2 (q, J_{CH} = 128.7 Hz), -6.0 (q, J_{CH} = 118.4 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 701.3259, found 701.3251.

Compounds 13a & 14a: (i) To a solution of pure **5a** (32 mg, 0.05 mmol) (from Narasaka-Prasad method) in 2,2-dimethoxypropane (1 ml) was added benzenesulfonic acid (1 mg) at RT with stirring. After 2h, the reaction mixture was quenched by adding 3 drops of water with stirring for 5 min and diluted with dichloromethane (10 ml), washed with aqueous saturated sodium bicarbonate, 0.1% HCl and brine, and dried over sodium sulfate. Flash chromatography gave **13a** (19 mg, 95%). (ii) To a solution of a mixture of **5a** and **5a'** (64 mg, 0.1 mmol) in 2,2-dimethoxypropane (1 ml) was added benzenesulfonic acid (2 mg) at RT with stirring. A standard work up, described above to give **13a** (21 mg, 52.5%) and **14a** (16 mg, 40%) in a ratio of 1.3:1. **13a**: ^{1}H-NMR ($CDCl_3$): 9.03 (s, exchangable, 1H) NH, 7.86 (s, 1H) H6, 7.33~7.21 (m, 5H) arom., 5.70 (s, $J_{1',2'}$ = 0 Hz, 1H) H1', 4.71 (m, $J_{3',4'}$ = 10.4 Hz, 1H) H4', 4.55 (d, $J_{2',3'}$ = 3.7 Hz, 1H) H2', 4.44 (ddd, $J_{3',\alpha}$ = 3.2 Hz, $J_{\alpha,\beta'}$ = 9.9 Hz, $J_{\alpha,\beta''}$ = 3.7 Hz, 1H) H$_\alpha$, 4.28 (d, $J_{5',5''}$ = 12.5 Hz, 1H) H5', 3.94 (dd, $J_{4',5''}$ = 1.8 Hz, 1H) H5", 2.84 (dd, $J_{\beta',\beta''}$ = 14.2 Hz, 1H) H$_{\beta'}$, 2.75 (dd, 1H) H$_{\beta''}$, 2.45 (ddd, 1H) H3', 2.35 (br.s, exchangable, 1H) 5'-OH, 1.87 (s, 3H) 5-Me, 1.42 (s, 3H) Me, 1.36 (s, 3H) Me. ^{13}C-NMR ($CDCl_3$): 163.9 (s), 150.1 (s), 138.1 (d, J_{CH} = 181.4 Hz), 137.0 (s), 128.6, 128.3, 126.4, 109.7 (s), 99.0 (s), 90.9 (d, J_{CH} = 175.0 Hz), 80.2 (d, J_{CH} = 149.4 Hz), 78.0 (d, J_{CH} = 154.9 Hz), 67.4 (d, J_{CH} = 146.6 Hz), 62.6 (t, J_{CH} = 142.1 Hz), 39.6 (t, J_{CH} = 128.3 Hz), 36.9 (d, J_{CH} = 132.9 Hz), 29.4 (q, J_{CH} = 126.5 Hz), 19.1 (q, J_{CH} = 126.5 Hz), 12.3 (q, J_{CH} = 129.2 Hz). 1D NOE ($CDCl_3$): irradiation of H$_\alpha$: arom.(6.0%), H$_{\beta'}$ & H$_{\beta''}$ (5.0%), H3' (8.3%), Me at 1.36 ppm (7.2%); of Me at 1.36 ppm: H2' (2.6%), H$_\alpha$ (2.4%); of H2': H1' (5.5%), H3' (5.1%), Me at 1.36 ppm (5.9%); of H1': H6 (4.5%), H2' (3.2%), H4' (1.5%). HRMS (FAB$^-$): calc. for (M-H)$^-$ 401.1712, found 401.1680. **14a** ^{1}H-NMR ($CDCl_3$): 7.31~7.23 (m, 6H) H6, arom., 5.59 (s, 1H) H1', 4.50 (d, $J_{2',3'}$ = 6.7 Hz, 1H) H2', 4.12 (m, $J_{3',4'}$ = 8.7 Hz, 1H) H4', 3.85 (m, $J_{4',5'}$ = 2.8 Hz, 2H) H$_\alpha$, H5', 3.30 (dd, $J_{4',5''}$ = 3.2 Hz, $J_{5',5''}$ = 12.4 Hz, 1H) H5", 2.93 (dd, $J_{\alpha,\beta'}$ = 8.1 Hz, $J_{\beta',\beta''}$ = 14.3 Hz, 1H) H$_{\beta'}$, 2.78 (m, $J_{\alpha,\beta''}$ = 8.7 Hz, $J_{3',\alpha}$ = 4.1 Hz, 2H) H3', H$_{\beta''}$, 1.91 (s, 3H) 5-Me, 1.36 (s, 3H) Me, 1.26 (s, 3H) Me. ^{13}C-NMR ($CDCl_3$): 163.6 (s), 150.1 (s), 138.1 (d, J_{CH} = 184.2 Hz), 137.5 (s), 129.2, 128.5, 128.2, 126.6, 126.2, 110.8 (s), 100.6 (s), 93.9 (d, J_{CH} = 166.8 Hz), 84.6 (d, J_{CH} = 144.8 Hz), 76.9 (d, J_{CH} = 156.7 Hz), 71.1 (d, J_{CH} = 145.7 Hz), 62.4 (t, J_{CH} = 143.0 Hz), 45.6 (d, J_{CH} = 136.6 Hz), 41.0 (t, J_{CH} = 126.5 Hz), 24.2 (q, J_{CH} = 126.5 Hz), 24.1 (q, J_{CH} = 126.5 Hz), 12.3 (q, J_{CH} = 129.2 Hz). 1D NOE ($CDCl_3$): irradiation of H2': H6 (3.5%), H1' (3.6%), H3' (8.9%), Me at 1.36 ppm (4.4%); of H5' & H$_\alpha$: arom.(2.1%), H4' (8.7%), H5" (7.0%), Me at 1.26 ppm (2.7%), H$_\beta$ (3.0%); of Me at 1.36 ppm: H2' (4.1%). HRMS (FAB$^-$): calc. for (M-H)$^-$ 401.1712, found 401.1713.

Compound 13b: To a solution of pure **5b** (20 mg, 0.036 mmol) (from Narasaka-Prasad method) in 2,2-dimethoxypropane (1 ml) was added benzenesulfonic acid (1 mg) at RT with stirring. A standard work up, described for **13a**, gave **13b** (11 mg, 94%). ^{1}H-NMR ($CDCl_3$): 8.57 (br.s, exchangable, 1H) NH, 7.80 (s, 1H) H6, 5.68 (s, 1H) H1', 4.60 (m, 1H) H4', 4.54 (d, $J_{2',3'}$ = 3.9 Hz, 1H) H2', 4.35 (dq, $J_{3',\alpha}$ = 3.2 Hz, 1H) H$_\alpha$, 4.24 (d, $J_{5',5''}$ = 12.2 Hz, 1H) H5', 3.86 (dd, $J_{4',5''}$ = 2.4 Hz, 1H) H5", 2.36 (ddd, $J_{3',4'}$ = 10.4 Hz, 1H) H3', 2.23 (br.s, exchangable, 1H) 5'-OH, 1.89 (s, 3H) 5-Me, 1.47 (s, 3H) Me, 1.44 (s, 3H) Me, 1.24 (d, $J_{\alpha,\beta}$ = 6.1 Hz, 3H) H$_\beta$. ^{13}C-NMR ($CDCl_3$): 163.6 (s), 150.0 (s), 137.1 (d, J_{CH} = 181.5 Hz), 109.8 (s), 98.7 (s), 91.4 (d, J_{CH} = 173.2 Hz), 80.3 (d, J_{CH} = 149.4 Hz), 77.7 (d, J_{CH} = 154.9 Hz), 63.0 (t, J_{CH} = 142.5 Hz), 62.2 (d, J_{CH} = 143.0 Hz), 37.4 (d, J_{CH} = 133.8 Hz), 29.6 (q, J_{CH} = 126.4 Hz), 19.4 (q, J_{CH} = 126.5 Hz), 19.1 (q, J_{CH} = 125.6 Hz), 12.3 (q, J_{CH} = 129.2 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 325.1400, found 325.1412.

Compound 13c: To a solution of pure **5c** (30 mg, 0.043 mmol) (from Narasaka-Prasad method) in 2,2-dimethoxypropane (1 ml) was added benzenesulfonic acid (1 mg) at RT with stirring.A standard work up, described for **13a**, gave **13c** (14 mg, 78%). ^{1}H-NMR ($CDCl_3$): 8.90 (br.s, exchangable, 1H) NH, 7.92 (d, J = 1.1 Hz, 1H) H6, 5.71 (s, 1H) H1', 4.61 (br. d, 1H) H4', 4.52 (d, $J_{2',3'}$ = 2.4 Hz, 1H) H2', 4.37 (m, 1H) H$_\alpha$, 4.23 (d, 1H) H5', 3.87 (dd, $J_{4',5''}$ = 2.5 Hz, $J_{5',5''}$ = 12.7 Hz, 1H) H5", 3.74 (m, 2H) H$_{\gamma'}$, H$_{\gamma''}$, 2.76 (br.s, exchangable, 1H) 5'-OH, 2.31 (dt, $J_{3',4'}$ = 10.4 Hz, $J_{3',\alpha}$ = 2.4 Hz, 1H) H3', 1.89 (d, 3H) 5-Me, 1.77~1.65 (m, $J_{\alpha,\beta'}$ = 4.6 Hz, $J_{\alpha,\beta''}$ = 8.2 Hz, $J_{\beta',\beta''}$ = 13.8 Hz, 2H) H$_{\beta'}$, H$_{\beta''}$, 1.46 (s, 3H) CH_3, 1.42 (s, 3H) CH_3, 0.89 (s, 9H) ^{t}Bu, 0.06 (2 x s, 6H) Si-Me. ^{13}C-NMR ($CDCl_3$): 163.9 (s), 150.0 (s), 136.8 (d, J_{CH} = 181.4 Hz), 109.6 (s), 98.9 (s), 90.5 (d, J_{CH} = 172.3 Hz), 80.5 (d, J_{CH} = 148.5 Hz), 77.9 (d, J_{CH} = 154.9 Hz), 63.3 (d, J_{CH} = 144.8 Hz), 62.6 (t, J_{CH} = 142.0 Hz), 59.2 (t, J_{CH} = 142.5 Hz), 37.0 (d, J_{CH} = 131.1 Hz), 36.3 (t, J_{CH} = 121.4 Hz), 29.5 (q, J_{CH} = 126.5 Hz), 25.8 (q, J_{CH} = 124.6 Hz), 19.2 (q, J_{CH} = 125.6 Hz), 12.3 (q, J_{CH} = 129.2 Hz), -5.5 (q, J_{CH} = 118.2 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 469.2370, found 469.2397.

Compound 15a: To a solution of pure **11a** (32 mg, 0.05 mmol) in 2,2-dimethoxypropane (1 ml) was added benzenesulfonic acid (1 mg) at RT with stirring. A standard work up, described for **13a**, gave **15a** (19 mg, 95%). ^{1}H-NMR ($CDCl_3$): 7.26~7.02 (m, 6H) H6, arom., 6.15 (br. s, 1H) H1', 4.65 (d, $J_{2',3'}$ = 4.0 Hz, 1H)

H3', 4.57 (dt, $J_{2',\alpha}$ = 2.9 Hz, $J_{\alpha,\beta'}$ = $J_{\alpha,\beta''}$ = 6.9 Hz, 1H) H_α, 4.04 (dd, $J_{3',4'}$ = 0 Hz, 1H) H4', 3.86 (m, $J_{4',5'}$ = 3.9 Hz, $J_{5',5''}$ = 12.2 Hz, 1H) H5', 3.76 (m, $J_{4',5''}$ = 3.8 Hz, 1H) H5", 2.88 (m, $J_{\beta',\beta''}$ = 14.8 Hz, 2H) $H_{\beta'}$, H2', 2.48 (dd, 1H) $H_{\beta''}$, 1.85 (s, 3H) 5-Me, 1.47 (s, 3H) Me, 1.46 (s, 3H) Me. ^{13}C-NMR ($CDCl_3$): 163.2 (s), 150.3 (s), 138.5 (d, J_{CH} = unobs.) C6(weak), 136.7 (s), 128.3, 128.1, 126.4, 111.6 (s), 98.8 (s), 88.1 (d, J_{CH} = unobs.) C1'(weak), 85.3 (d, J_{CH} = 149.5 Hz), 74.1 (d, J_{CH} = 154.7 Hz), 66.4 (d, J_{CH} = 142.3 Hz), 63.6 (t, J_{CH} = 142.7 Hz), 41.2 (d, J_{CH} = unobs.) C2', 38.6 (t, J_{CH} = 127.2 Hz), 29.6 (q, J_{CH} = 126.7 Hz), 19.1 (q, J_{CH} = 126.7 Hz), 12.2 (q, J_{CH} = 128.7 Hz). ^{1}H-NMR ($CDCl_3$ at 50°C): 7.26~7.02 (m, 6H) H6, arom., 6.17 (d, $J_{1',2'}$ = 9.5 Hz, 1H) H1', 4.63 (d, $J_{2',3'}$ = 4.0 Hz, 1H) H3', 4.56 (dt, $J_{2',\alpha}$ = 3.1 Hz, $J_{\alpha,\beta'}$ = $J_{\alpha,\beta''}$ = 7.3 Hz, 1H) H_α, 4.03 (dd, $J_{3',4'}$ = 0 Hz, 1H) H4', 3.85 (dd, $J_{4',5'}$ = 2.5 Hz, $J_{5',5''}$ = 12.0 Hz, 1H) H5', 3.77 (dd, $J_{4',5''}$ = 2.6 Hz, 1H) H5", 2.88 (m, 2H) $H_{\beta'}$, H2', 2.48 (dd, $J_{\alpha,\beta''}$ = 6.7 Hz, $J_{\beta',\beta''}$ = 14.8 Hz, 1H) $H_{\beta''}$, 1.84 (s, 3H) 5-Me, 1.46 (s, 3H) Me, 1.45 (s, 3H) Me. ^{13}C-NMR ($CDCl_3$ at 50°C): 163.0 (s), 150.3 (s), 138.3 (d, J_{CH} = 179.6 Hz) C6, 136.9 (s), 128.3, 128.2, 126.4, 111.6 (s), 98.9 (s), 88.1 (d, J_{CH} = 165.0 Hz) C1', 85.4 (d, J_{CH} = 151.2 Hz), 74.2 (d, J_{CH} = 154.0 Hz), 66.6 (d, J_{CH} = 142.1 Hz), 63.7 (t, J_{CH} = 142.5 Hz), 41.5 (d, J_{CH} = 132.0 Hz) C2', 38.7 (t, J_{CH} = 128.8 Hz), 29.7 (q, J_{CH} = 126.5 Hz), 19.2 (q, J_{CH} = 126.5 Hz), 12.2 (q, J_{CH} = 129.2 Hz). 1D NOE ($CDCl_3$ at 50°C): irradiation of H1': H6 (8.1%); of H3': H4' (3.0%), H5' (1.8%), H2' (3.0%), Me at 1.46 ppm (9.1%); of Me at 1.46 ppm: H3' (1.9%), H_α (2.7%); of H_α: Arom. (8.5%), H2' & $H_{\beta'}$ (9.0%), $H_{\beta''}$ (6.4%), Me at 1.46 ppm (5.9%). HRMS (FAB$^-$): calc. for (M-H)$^-$ 401.1712, found 401.1693.

Compound 16a: To a solution of pure **11a'** (16 mg, 0.025 mmol) in 2,2-dimethoxypropane (1 ml) was added benzenesulfonic acid (1 mg) at RT with stirring.A standard work up, described for **13a**, gave **16a** (9 mg, 90%). ^{1}H-NMR ($CDCl_3$): 7.26~6.93 (m, 6H) H6, arom., 5.87 (d, $J_{1',2'}$ = 8.2 Hz, 1H) H1', 4.44 (dd, $J_{2',3'}$ = 7.3 Hz, $J_{3',4'}$ = 1.8 Hz, 1H) H3', 4.10 (dd, 1H) H4', 4.04 (ddd, $J_{2',\alpha}$ = 8.1 Hz, 1H) H_α, 3.91 (dd, $J_{4',5'}$ = 2.4 Hz, $J_{5',5''}$ = 12.0 Hz, 1H) H5', 3.77 (dd, $J_{4',5''}$ = 2.8 Hz, 1H) H5", 2.90 (dd, $J_{\alpha,\beta'}$ = 6.2 Hz, $J_{\beta',\beta''}$ = 13.9 Hz, 1H) $H_{\beta'}$, 2.72 (m, $J_{\alpha,\beta''}$ = 6.8 Hz, 2H) H2', $H_{\beta''}$, 1.82 (s, 3H) 5-Me, 1.40 (s, 3H) Me, 1.36 (s, 3H). ^{13}C-NMR ($CDCl_3$): 163.1 (s), 150.0 (s), 136.8 (d, J_{CH} = 179.5 Hz), 136.3 (s), 129.3, 128.3, 126.4, 111.2 (s), 100.4 (s), 90.7 (d, J_{CH} = 165.1 Hz), 84.0 (d, J_{CH} = 149.5 Hz), 72.6 (d, J_{CH} = 154.7 Hz), 70.1 (d, J_{CH} = 145.4 Hz), 63.1 (t, J_{CH} = 142.7 Hz), 50.9 (d, J_{CH} = 133.9 Hz), 41.4 (t, J_{CH} = 128.2 Hz), 24.3 (q, J_{CH} = 126.7 Hz), 12.4 (q, J_{CH} = 128.7 Hz). 1D NOE ($CDCl_3$): irradiation of H3': H4' (3.4%), $H_{\beta'}$, $H_{\beta''}$ & H2' (9.8%), Me at 1.40 ppm (7.0%); of Me at 1.36 ppm: H_α (3.7%); of Me at 1.40 ppm: H3' (3.0%); of H1': H6 (12.5%), H4' (3.9%), H_α (12.9%); of H_α: H1' (14.2%), H6 (8.6%), Me at 1.36 ppm (8.4%), $H_{\beta'}$ (5.3%), $H_{\beta''}$ & H2' (6.5%). HRMS (FAB$^-$): calc. for (M-H)$^-$ 401.1712, found 401.1723.

Compound 15b: To a solution of pure **11b** (9 mg, 0.016 mmol) (from Narasaka-Prasad method) in 2,2-dimethoxypropane (1 ml) was added benzenesulfonic acid (1 mg) at RT with stirring.A standard work up, described for **13a**, gave **15b** (4.7 mg, 94%). ^{1}H-NMR ($CDCl_3$): 8.50 (s, exchangable, 1H) NH, 7.34 (br.d, J = 7.0 Hz, 1H) H1', 4.63 (d, $J_{2',3'}$ = 4.1 Hz, 1H) H3', 4.33 (dq, $J_{\alpha,\beta}$ = 6.7 Hz, $J_{2',\alpha}$ = 3.2 Hz, 1H) H_α, 4.04 (t, 1H) H4', 3.90 (dt, $J_{4',5'}$ = $J_{5',OH}$ = 2.1 Hz, $J_{5',5''}$ = 12.2 Hz, 1H) H5', 3.76 (ddd, $J_{4',5''}$ = 2.1 Hz, $J_{5'',OH}$ = 8.1 Hz, 1H) H5", 3.42 (br. s, exchangable, 1H) 5'-OH, 2.91 (br. s, 1H) H2', 1.93 (d, J = 1.1 Hz, 3H) 5-Me, 1.50 (s, 3H) Me, 1.44 (s, 3H) Me, 1.06 (d, 3H) H_β. ^{13}C-NMR ($CDCl_3$): 163.2 (s), 150.3 (s), 139.4 (d, J_{CH} = 178.7 Hz) C6 (broad & weak), 111.6 (s), 98.7 (s), 89.8 (d, J_{CH} = 178.5 Hz) C1' (very weak), 85.5 (d, J_{CH} = 151.21 Hz), 73.7 (d, J_{CH} = 153.0 Hz), 63.7 (t, J_{CH} = 142.5 Hz), 61.9 (d, J_{CH} = 145.7 Hz), 42.4 (d, J_{CH} = 132.0 Hz), 29.7 (q, J_{CH} = 126.5 Hz), 19.1 (q, J_{CH} = 126.5 Hz), 18.8 (q, J_{CH} = 127.4 Hz), 12.3 (q, J_{CH} = 128.3 Hz). ^{1}H-NMR ($CDCl_3$ at 50°C): 8.15 (s, exchangable, 1H) NH, 7.30 (q, 1H) H6, 5.98 (d, $J_{1',2'}$ = 9.6 Hz, 1H) H1', 4.60 (d, $J_{2',3'}$ = 4.1 Hz, 1H) H3', 4.32 (dq, $J_{\alpha,\beta}$ = 6.7 Hz, $J_{2',\alpha}$ = 3.2 Hz, 1H) H_α, 4.03 (t, 1H) H4', 3.88 (dt, $J_{4',5'}$ = $J_{5',OH}$ = 2.4 Hz, $J_{5',5''}$ = 12.1 Hz, 1H) H5', 3.76 (ddd, $J_{4',5''}$ = 2.5 Hz, $J_{5'',OH}$ = 7.1 Hz, 1H) H5", 3.13 (br.s, exchangable, 1H) 5'-OH, 2.86 (pseudo dt, 1H) H2', 1.93 (d, J = 1.2 Hz, 3H) 5-Me, 1.49 (s, 3H) Me, 1.44 (s, 3H) Me, 1.06 (d, 3H) H_β. ^{13}C-NMR ($CDCl_3$ at 50°C): 162.9 (s), 150.3 (s), 139.1 (d, J_{CH} = 177.8 Hz), 111.6 (s), 98.7 (s), 89.5 (d, J_{CH} = 174.1 Hz) C1', 85.6 (d, J_{CH} = 152.13 Hz), 73.8 (d, J_{CH} = 154.0 Hz), 63.8 (t, J_{CH} = 142.5 Hz), 62.1 (d, J_{CH} = 144.8 Hz), 42.7 (d, J_{CH} = 133.8 Hz), 29.8 (q, J_{CH} = 126.5 Hz), 19.2 (q, J_{CH} = 126.5 Hz), 18.8 (q, J_{CH} = 126.5 Hz), 12.2 (q, J_{CH} = 129.22 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 325.1400, found 325.1410.

Compound 15c: To a solution of pure **11c** (65 mg, 0.09 mmol) (from Narasaka-Prasad method) in 2,2-dimethoxypropane (1 ml) was added benzenesulfonic acid (1 mg) at RT with stirring. A standard work up, described for **13a**, gave **15c** (40 mg, 95%). ^{1}H-NMR ($CDCl_3$): 8.85 (s, exchangable, 1H) NH, 7.38 (br. s, 1H) H6, 6.05 (br.s, 1H) H1', 4.64 (d, $J_{2',3'}$ = 4.0 Hz, 1H) H3', 4.42 (dt, $J_{\alpha,\beta'}$ = 3.1 Hz, $J_{\alpha,\beta''}$ = 9.3 Hz, $J_{2',\alpha}$ = 3.1 Hz, 1H) H_α, 4.04 (t, $J_{4',5'}$ = $J_{4',5''}$ = 2.1 Hz, 1H) H4', 3.90 (dd, $J_{5',5''}$ = 11.7 Hz, 1H) H5', 3.78 (dd, 1H) 5", 3.6 (m, 2H) H_γ, $H_{\gamma''}$, 3.34 (br.s, exchangable, 1H) 5'-OH, 2.82 (br.s, 1H) H2', 1.92 (s,3H) 5-Me, 1.76~1.40 (m, 2H) $H_{\beta'}$, $H_{\beta''}$, 1.48 (s, 3H) Me, 1.43 (s, 3H) Me, 0.87 (s, 9H) ^{t}Bu, 0.02 (s, 6H) 2 x Si-Me. ^{13}C-NMR ($CDCl_3$): 163.3 (s), 150.4 (s), 138.9 (d, J_{CH} = unobs.) C6 (weak), 111.6 (s), 98.7 (s), 88.8 (d, J_{CH} = unobs.) C1' (weak), 85.4 (d, J_{CH} = 150.5 Hz), 74.0 (d, J_{CH} = 153.6 Hz), 63.7 (t, J_{CH} = 142.8

Hz), 61.9 (d, J_{CH} = 144.3 Hz), 58.0 (t, J_{CH} = 142.7 Hz), 42.3 (d, J_{CH} = 130.8 Hz) C2' (weak), 35.8 (t, J_{CH} = 125.6 Hz), 29.7 (q, J_{CH} = 127.6 Hz), 25.8 (q, J_{CH} = 125.6 Hz) ^{t}Bu, 19.2 (q, J_{CH} = 127.7 Hz), 18.2 (s), 12.3 (q, J_{CH} = 130.8 Hz), -5.5 (q, J_{CH} = 119.4 Hz). ^{1}H-NMR ($CDCl_3$ at 50°C): 8.43 (s, exchangable, 1H) NH, 7.34 (sharp s, 1H) H6, 6.06 (d, $J_{1',2'}$ = 9.4 Hz, 1H) H1', 4.62 (d, $J_{2',3'}$ = 4.0 Hz, 1H) H3', 4.40 (dt, $J_{\alpha,\beta'}$ = $J_{2',\alpha}$ = 3.2 Hz, $J_{\alpha,\beta''}$ = 9.7 Hz, 1H) H_α, 4.03 (t, $J_{4',5'}$ = $J_{4',5''}$ = 2.4 Hz, 1H) H4', 3.88 (dd, $J_{5',5''}$ = 11.7 Hz, 1H) H5', 3.77 (dd, 1H) H5", 3.60 (m, 2H) H_γ, $H_{\gamma'}$, 3.08 (br.s, exchangable, 1H) 5'-OH, 2.78 (ddd, 1H) H2', 1.92 (s, 3H) 5-Me, 1.60~1.24 (m, 2H) $H\beta'$, $H\beta''$, 1.48 (s, 3H) Me, 1.42 (s, 3H) Me, 0.87 (s, 9H) tBu, 0.02 (s, 6H) 2 x Si-Me. ^{13}C-NMR ($CDCl_3$ at 50°C): 163.1 (s), 150.4 (s), 138.8 (d, J_{CH} = 186.9 Hz) C6, 111.6 (s), 98.8 (s), 88.7 (d, J_{CH} = 165.0 Hz) C1' (weak), 85.5 (d, J_{CH} = 150.5 Hz), 74.1 (d, J_{CH} = 153.7 Hz), 63.7 (t, J_{CH} = 142.7 Hz), 62.1 (d, J_{CH} = 143.3 Hz), 58.2 (t, J_{CH} = 142.2 Hz), 42.5 (d, J_{CH} = 131.8 Hz) C2', 35.9 (t, J_{CH} = 125.1 Hz), 29.8 (q, J_{CH} = 126.6 Hz), 25.8 (q, J_{CH} = 125.6 Hz), 19.2 (q, J_{CH} = 126.6 Hz), 18.2 (s), 12.2 (q, J_{CH} = 129.8 Hz), -5.5 (q, J_{CH} = 119.4 Hz). HRMS (FAB$^-$): calc. for $(M-H)^-$ 469.2370, found 469.2344.

1-[3'-deoxy-3'-*C*-(1-*R*-hydroxy-2-phenyl))ethyl-β-D-ribofuranosyl]thymine (6a): Treatment of **13a** (18 mg, 0.044 mmol) with 80% AcOH at 60°C gave **6a** (15 mg, 94%). ^{1}H-NMR ($CDCl_3$ + CD_3OD): 8.07 (s, 1H) H6, 7.31~7.20 (m, 5H) arom., 5.73 (d, $J_{1',2'}$ = 1.2 Hz, 1H) H1', 4.47 (dt, $J_{4',5'}$ = $J_{4',5''}$ = 2.7 Hz, $J_{3',4'}$ = 9.6 Hz, 1H) H4', 4.32 (dd, $J_{2',3'}$ = 5.2 Hz, 1H) H2', 4.19 (ddd, 1H) H_α, 4.04 (dd, $J_{5',5''}$ = 12.3 Hz, 1H) H5', 3.94 (dd, 1H) H5", 3.06 (dd, $J_{\alpha,\beta}$ = 3.1 Hz, $J_{\beta,\beta'}$ = 13.7 Hz, 1H) $H\beta$, 2.65 (dd, $J_{\alpha,\beta'}$ = 9.5 Hz, 1H) $H\beta'$, 2.23 (ddd, $J_{3',\alpha}$ = 7.8 Hz, 1H) H3', 1.90 (d, J = 1.0 Hz, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$ + CD_3OD): 164.6 (s), 150.6 (s), 138.1 (s), 136.2 (d, J_{CH} = 182.7 Hz), 128.8, 127.7, 125.7, 109.3 (s), 91.5 (d, J_{CH} = 173.4 Hz), 84.0 (d, J_{CH} = 149.5 Hz), 76.8 (d, J_{CH} = 153.6 Hz), 69.6 (d, J_{CH} = 148.4 Hz), 62.0 (t, J_{CH} = 142.7 Hz), 45.4 (d, J_{CH} = 128.7 Hz), 41.7 (t, J_{CH} = 126.1 Hz), 11.4 (q, J_{CH} = 129.2 Hz). HRMS (FAB$^-$): calc. for $(M-H)^-$ 361.1400, found 361.1388.

1-[3'-deoxy-3'-*C*-(1-*S*-hydroxy-2-phenyl))ethyl-β-D-ribofuranosyl]thymine (6a'): Treatment of **14a** (8 mg, 0.02 mmol) with 80% AcOH at 60°C gave **6a'** (7 mg, 97%). ^{1}H-NMR ($CDCl_3$ + CD_3OD): 8.04 (s, 1H) H6, 7.40~7.20 (m, 5H) arom., 5.72 (s, 1H) H1', 4.60 (dt, $J_{4',5'}$ = $J_{4',5''}$ = 2.0 Hz, $J_{3',4'}$ = 10 8 Hz, 1H) H4', 4.53 (d, $J_{2',3'}$ = 5.0 Hz, 1H) H2', 4.10 (m, 2H) H5', H_α, 3.77 (dd, $J_{5',5''}$ = 12.8 Hz, 1H) H5", 3.01 (dd, $J_{\alpha,\beta}$ = 8.9 Hz, 1H) $H\beta$, 2.91 (dd, $J_{\alpha,\beta'}$ = 4.8 Hz, $J_{\beta,\beta'}$ = 13.8 Hz, 1H) $H\beta'$, 2.27 (ddd, $J_{3',\alpha}$ = 4.0 Hz, 1H) H3', 1.87 (s, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$ + CD_3OD): 164.5 (s), 150.7 (s), 138.3 (s), 136.3 (d), 128.8, 128.0, 126.0, 109.6 (s), 91.8 (d, J_{CH} = 174.1 Hz), 81.8 (d, J_{CH} = 149.4 Hz), 77.8 (d, J_{CH} = 188.8 Hz), 70.0 (d, J_{CH} = 149.4 Hz), 59.6 (t, J_{CH} = 140.7 Hz), 42.9 (d, J_{CH} = 122.8 Hz), 42.4 (t, J_{CH} = 126.5 Hz), 11.7 (q, J_{CH} = 129.2 Hz). HRMS (FAB$^-$): calc. for $(M-H)^-$ 361.1400, found 361.1387.

1-[3'-deoxy-3'-*C*-(1-*R*-hydroxy)ethyl-β-D-ribofuranosyl]thymine (6b): Treatment of **5b** (35 mg, 0.063 mmol) with 80% AcOH gave **6b** (16.5 mg, 92%). ^{1}H-NMR ($CDCl_3$ + CD_3OD): 8.01 (s, 1H) H6, 5.65 (s, 1H) H1', 4.43 (dt, $J_{3',4'}$ = 10.1 Hz, $J_{4',5'}$ = $J_{4',5''}$ = 2.8 Hz, 1H) H4', 4.20 (d, 1H) H2', 4.10 (m, 1H) H_α, 4.02 (dd, $J_{5',5''}$ = 12.4 Hz, 1H) H5', 3.96 (dd, 1H) H5", 2.03 (ddd, $J_{2',3'}$ = 5.4 Hz, $J_{3',\alpha}$ = 7.6 Hz, 1H) H3', 1.91 (s, 3H) 5-Me, 1.31 (d, $J_{\alpha,\beta}$ = 6.2 Hz, 3H) $H\beta$. ^{13}C-NMR ($CDCl_3$ + CD_3OD): 164.6 (s), 150.7 (s), 136.1 (d, J_{CH} = 182.4 Hz), 109.6 (s), 91.8 (d, J_{CH} = 173.2 Hz), 84.2 (d, J_{CH} = 147.6), 77.4 (d, J_{CH} = 154.0 Hz), 64.9 (d, J_{CH} = 146.6 Hz), 62.2 (t, J_{CH} = 142.5 Hz), 47.5 (d, J_{CH} = 130.1 Hz), 21.6 (q, J_{CH} = 126.5 Hz), 11.7 (q, J_{CH} = 129.2 Hz). HRMS (FAB$^-$): calc. for $(M-H)^-$ 285.1086, found 285.1094.

1-[3'-deoxy-3'-*C*-(1-*R*-3-bis-hydroxy)propyl-β-D-ribofuranosyl]thymine (6c): Treatment of **5c** (25 mg, 0.036 mmol) with catalytic amount of benzenesulfonic acid (3 mg) gave **6c**(10 mg, 91%). ^{1}H-NMR ($CDCl_3$ + CD_3OD): 8.00 (q, J = 1.1 Hz, 1H) H6, 5.76 (d, $J_{1',2'}$ = 1.5 Hz, 1H) H1', 4.77 (m, 2H) H_γ, 4.47~4.34 (m, 3H) H4', H_α, H2', 4.00 (dd, $J_{4',5'}$ = 2.6 Hz, $J_{5',5''}$ = 12.4 Hz, 1H) H5', 3.70 (dd, $J_{4',5''}$ = 3.0 Hz, 1H) H5", 2.13 (ddd, $J_{2',3'}$ = 5.5 Hz, $J_{3',4'}$ = 10.1 Hz, $J_{3',\alpha}$ = 13.4 Hz, 1H) H3', 1.94~1.85 (m, 2H) $H\beta$, 1.89 (d, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$ + CD_3OD): 164.6 (s), 150.5 (s), 136.2 (d, J_{CH} = 183.3 Hz), 109.1 (s), 92.0 (d, J_{CH} = 172.3 Hz), 80.7 (d, J_{CH} = 147.5 Hz), 75.4 (d, J_{CH} = 158.5 Hz), 61.2 (t, J_{CH} = 141.6 Hz), 32.1 (t, J_{CH} = 131.5 Hz), 11.1 (q, J_{CH} = 129.2 Hz). HRMS (FAB$^-$): calc. for $(M-C_3H_7O_2)^-$ 241.0825, found 241.0842.

1-[2'-deoxy-2'-*C*-(1-*S*-hydroxy-2-phenyl)ethyl-β-D-ribofuranosyl]thymine (12a): Treatment of **15a** (28 mg, 0.07 mmol) with 80% AcOH gave **12a** (23 mg, 91%). ^{1}H-NMR ($CDCl_3$ + CD_3OD): 7.49 (s, 1H) H6, 7.30~7.17 (m, 5H) arom., 6.34 (d, $J_{1',2'}$ = 8.1 Hz, 1H) H1', 4.43 (dd, $J_{2',3'}$ = 6.9 Hz, $J_{3',4'}$ = 2.9 Hz, 1H) H3', 4.34 (ddd, $J_{2',\alpha}$ = 6.5 Hz, 1H) H_α, 3.97 (ddd, $J_{4',5'}$ = $J_{4',5''}$ = 3.1 Hz, 1H) H4', 3.81 (dd, $J_{5',5''}$ = 12.0 Hz, 1H) H5', 3.73 (dd, 1H) H5", 2.90 (dd, $J_{\alpha,\beta}$ = 4.9 Hz, $J_{\beta,\beta'}$ = 13.5 Hz, 1H) $H\beta$, 2.72 (dd, $J_{\alpha,\beta'}$ = 8.9 Hz, 1H) $H\beta'$, 2.47 (ddd, 1H) H2', 1.88 (s, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$ + CD_3OD): 164.4 (s), 150.8 (s), 137.9 (s), 137.5 (d, J_{CH} = 177.8 Hz), 128.9, 128.1, 126.1, 110.9 (s), 87.1 (d, J_{CH} = 165.0 Hz), 86.8 (d,

J_{CH} = 148.5 Hz), 86.7 (s), 72.3 (d, J_{CH} = 150.3 Hz), 69.7 (d, J_{CH} = 150.3 Hz), 61.7 (t, J_{CH} = 142.5 Hz), 50.7 (d, J_{CH} = 129.2 Hz), 41.2 (t, J_{CH} = 127.4 Hz), 11.9 (q, J_{CH} = 128.3 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 361.1400, found 361.1405.

1-[2'-deoxy-2'-*C*-(1-*R*-hydroxy-2-phenyl)ethyl-β-D-ribofuranosyl]thymine (12a'): Treatment of **16a** (28 mg, 0.07 mmol) with 80% AcOH gave **12a'** (24 mg, 94%). ^{1}H-NMR ($CDCl_3$ + CD_3OD): 7.60 (d, 1H), 7.31~7.20 (m, 5H) arom., 6.35 (d, $J_{1',2'}$ = 9.4 Hz, 1H) H1', 4.62 (dd, $J_{2',3'}$ = 5.6 Hz, $J_{3',4'}$ = 1.4 Hz, 1H) H3', 3.90 (m, 2H) H4', H_α, 3.79 (dd, $J_{4',5'}$ = 2.9 Hz, $J_{5',5''}$ = 12.0 Hz, 1H) H5', 3.74 (dd, $J_{4',5''}$ = 2.9 Hz, 1H) H5", 2.86 (d, $J_{\alpha,\beta}$ = 6.7 Hz, 2H) Hβ, Hβ', 2.46 (ddd, $J_{2',\alpha}$ = 9.3 Hz, 1H) H2', 1.86 (d, J = 1.1 Hz, 3H) 5-Me. ^{13}C-NMR ($CDCl_3$ + CD_3OD): 164.2 (s), 150.9 (s), 137.7 (s), 136.3 (d, J_{CH} = 186.0 Hz), 128.7, 127.7, 125.8, 110.8 (s), 87.0 (d, J_{CH} = 148.5 Hz), 85.7 (d, J_{CH} = 166.8 Hz), 73.2 (d, J_{CH} = 154.9 Hz), 69.2 (d, J_{CH} = 147.6 Hz), 61.8 (t, J_{CH} = 141.6 Hz), 51.0 (d, J_{CH} = 127.4 Hz), 41.4 (t, J_{CH} = 126.5 Hz), 11.4 (q, J_{CH} = 129.2 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 361.1400, found 361.1420.

1-[2'-deoxy-2'-*C*-(1-*S*-hydroxyethyl)-β-D-ribofuranosyl]thymine (12b): Treatment of **11b** (24 mg, 0.034 mmol) with 80% AcOH gave **12b** (6 mg, 56%), which has very bad solubility in different solvent such as chloroform, methanol, water etc. ^{1}H-NMR ($CDCl_3$ + CD_3OD): 7.55 (q, 1H) H6, 6.25 (d, $J_{1',2'}$ = 8.4 Hz, 1H) H1', 4.38 (dd, $J_{2',3'}$ = 6.6 Hz, $J_{3',4'}$ = 2.5 Hz, 1H) H3', 4.23 (m, 1H) H_α, 3.96 (dd, $J_{4',5'}$ = $J_{4',5''}$ = 3.3 Hz, 1H) H4', 3.81 (dd, $J_{5',5''}$ = 11.9 Hz, 1H) H5', 3.74 (dd, 1H) H5", 2.38 (ddd, $J_{2',\alpha}$ = 5.1 Hz, 1H) H2', 1.90 (d, J = 1.1 Hz, 3H) 5-Me, 1.22 (d, $J_{\alpha,\beta}$ = 6.4 Hz, 3H) Hβ. ^{13}C-NMR ($CDCl_3$ + CD_3OD): 151.0 (s), 137.5 (d, J_{CH} = 179.6 Hz), 111.0 (s), 87.5 (d, J_{CH} = 166.1 Hz), 86.8 (d, J_{CH} = 149.5 Hz), 72.8 (d, J_{CH} = 143.2 Hz), 64.6 (d, J_{CH} = 150.52 Hz), 61.9 (t, J_{CH} = 142.2 Hz), 52.7 (d, J_{CH} = 132.9 Hz), 21.1 (q, J_{CH} = 125.6 Hz), 11.8 (q, J_{CH} = 129.7 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 285.1086, found 285.1111.

1-[2'-deoxy-2'-*C*-(1-*S*-3-bis-hydroxypropyl)-β-D-ribofuranosyl]thymine (12c): Treatment of **11c** (8 mg, 0.014 mmol) with 80% AcOH gave **12c** (4 mg, 97%), which has extremely bad solubility in different solvents. ^{1}H-NMR (D_2O + CD_3OD): 7.72 (s, 1H) H6, 6.42 (d, $J_{1',2'}$ = 8.9 Hz, 1H) H1', 4.50 (m, $J_{3',4'}$ = 5.8 Hz, 1H) H4', 4.17 (m, 2H) H3', H_α, 3.85~3.79 (m, 4H) H5', H5", H_γ, $H_{\gamma''}$, 2.58 (m, 1H) H2', 1.98 (s, 3H) 5-Me, 1.73 (m, 1H) Hβ', 1.33 (m, 1H) Hβ". HRMS (FAB$^-$): calc. for (M-H)$^-$ 315.1159, found 315.1184.

Compound **17**: Treatment of **15a** (20 mg, 0.05 mmol) in 2,2-dimethoxypropane (1 ml) with benzenesulfonic acid (1 mg) gave **17** (15 mg, 63%). ^{1}H-NMR ($CDCl_3$): 8.34 (s, exchangable, 1H) NH, 7.24~7.03 (m, 6H) H6, arom., 6.64 (d, $J_{1',2'}$ = 9.4 Hz, 1H) H1', 4.61 (ddd, $J_{2',\alpha}$ = 2.4 Hz, 1H) H_α, 4.50 (d, $J_{2',3'}$ = 3.57 Hz, 1H) H3', 4.10 (s, 1H) H4', 3.59 (s, 2H) H5', H5", 3.00 (dd, $H_{\alpha,\beta'}$ = 7.7 Hz, $J_{\beta',\beta''}$ = 15.2 Hz, 1H) Hβ', 2.55 (dd, $J_{\alpha,\beta''}$ = 7.6 Hz, 1H) Hβ", 2.40 (ddd, 1H) H2', 1.71 (s, 3H) 5-Me, 1.49 (s, 6H) 2 x Me, 1.37 (s, 6H) 2 x Me. ^{13}C-NMR ($CDCl_3$): 149.9 (s), 136.8 (s), 135.4 (d, J_{CH} = 179.6 Hz), 128.2, 128.0, 126.2, 111.0 (s), 100.3 (s), 98.8 (s), 83.2 (d, J_{CH} = 150.3 Hz), 82.7 (d, J_{CH} = 174.0 Hz), 74.5 (d, J_{CH} = 152.1 Hz), 65.9 (d, J_{CH} = 142.1 Hz), 62.1 (t, J_{CH} = 143.0 Hz), 48.8 (q, J_{CH} = 142.1 Hz), 42.7 (d, J_{CH} = 130.1 Hz), 37.6 (t, J_{CH} = 128.3 Hz), 29.6 (q, J_{CH} = 127.4 Hz), 24.3 (q, J_{CH} = 127.4 Hz), 19.1 (q, J_{CH} = 125.6 Hz), 12.1 (q, J_{CH} = 129.2 Hz). HRMS (FAB$^-$): calc. for (M-H)$^-$ 473.2288, found 473.2311.

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