SYNTHESIS OF 2',3'-DIDEHYDRO-2',3'-DIDEOXYNUCLEOSIDES UTILIZING COUPLING REACTIONS BETWEEN NUCLEIC BASES AND PHENYLTHIO-SUBSTITUTED 2,3-DIDEOXYRIBOSE

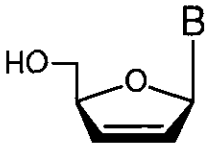
Hiroshi Kawakami,* Takashi Ebata, Koshi Koseki, Katsuya Matsumoto, Hajime Matsushita, Yoshitake Naoi,† and Kazuo Itoh†

Life Science Research Laboratory, Japan Tobacco Inc., 6-2 Umegaoka, Midori-ku, Yokohama, Kanagawa 227, Japan

†Tokyo Research Laboratory, Yuki Gosei Kogyo Co., Ltd., 3-37-1 Sakashita, Itabashi-ku, Tokyo 174, Japan

Abstract --- Stereoselectivities in coupling reactions between silylated pyrimidine bases and 3- or 2-α-phenylthio-2,3-dideoxyribose were examined. In the former case, no stereoselectivies were observed when the coupling reactions were performed either with 1-chlorosugar in an S_N2 mode or in the presence of Lewis acids as catalyst in an S_N1 mode. Coupling reaction with 2-α-phenylthio-2,3-dideoxyribose in the presence of Lewis acids, especially $SnCl_4$, proceeded with good stereoselectivity to give anomeric mixtures of $\alpha : \beta = 1 : 9$. All these nucleosides were converted to 2',3'-didehydro-2',3'-dideoxynucleosides by oxidation to sulfoxides followed by thermal elimination of sulfenic acid.

2',3'-Didehydro-2',3'-dideoxynucleosides (d_4Ns, **1**) are useful intermediates for the preparation of 2',3'-dideoxynucleosides (ddNs),[1] which are anti-HIV agents.[2] Some d_4Ns have also been shown active against HIV.[3] As the importance of d_4Ns has been recognized from this viewpoint, some practical methods for the preparation of these nucleosides have been developed. In many of these methods, the starting materials are



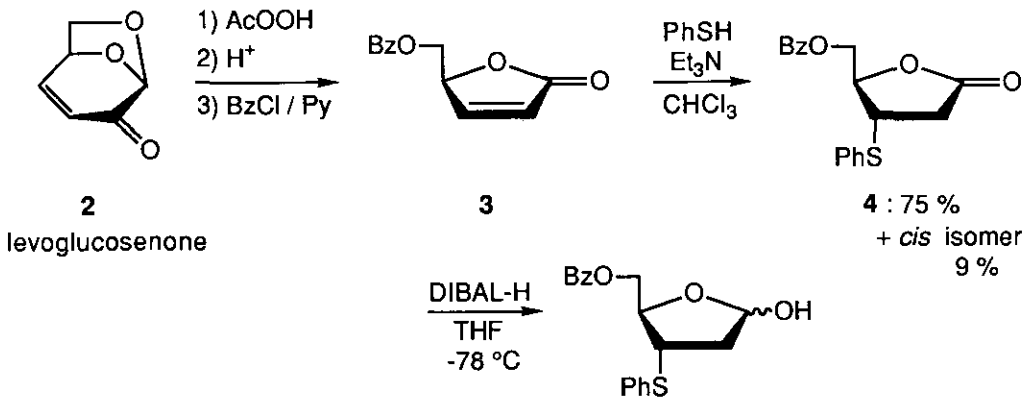
1 : 2',3'-didehydro-2',3'-dideoxynucleoside (d_4Ns)

ribonucleosides[1a,4] or 2'-deoxynucleosides.[1b,5] There are no reports on the synthesis of **1** utilizing coupling reactions between 2,3-didehydro-2,3-dideoxyribose and nucleic bases, probably because of the instability of the sugar moiety.[6]

In connection with our studies on the stereoselective preparation of deoxynucleosides utilizing coupling reactions,[7] attention was directed to the organothio group in the sugar part as a stereocontrolling element. Thermal elimination of sulfoxides is a well-known procedure[8] for constructing a carbon-carbon double bond and thus it was considered possible to utilize the 3'- or 2'-phenylthio (PhS) group on a nucleoside to construct double bond by oxidation followed by thermal elimination. In this paper, stereoselectivities in the coupling reactions with 3- or 2-phenylthio-2,3-didoxyribose derivatives and the synthesis of d_4Ns **1** from their coupling products are described.

Coupling Reactions with 3-Phenylthio-2,3-dideoxyribose

We reported that acyl-protected 1-chloro-2,3-dideoxyriboses exist as mixtures of α- and β-anomers in a ratio of 6 : 4,[7d] but are mainly in the α-form in the case of acylated 1-chloro-2-deoxyriboses.[9] The 3-α-substituent (acyloxy group) may thus increase the ratio of 1-α-chlorosugar. Coupling reactions between 1-chlorosugar and silylated nucleobases with no catalysts proceed in an S_N2 mode,[7,10] and the introduction of organothio group as 3-α-substituent to 2,3-dideoxyribose may make the stereoselective coupling reactions possible. The PhS group was thus introduced into 2,3-dideoxyribose as such substituent.



2 levoglucosenone

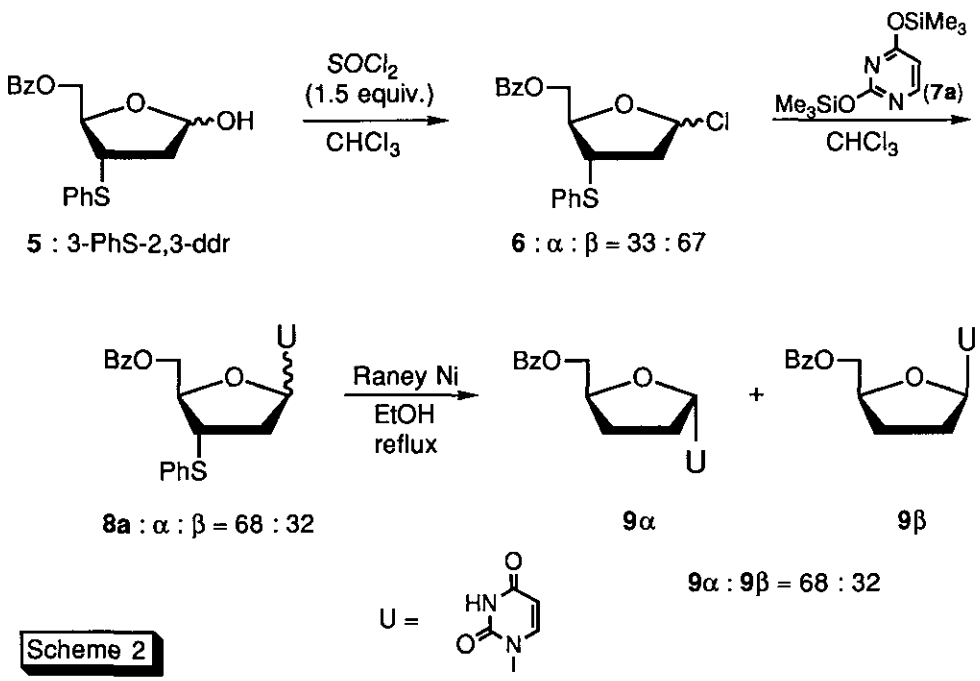
3

4 : 75 %
+ *cis* isomer
9 %

5 : 3-PhS-2,3-ddr
71 %

Scheme 1

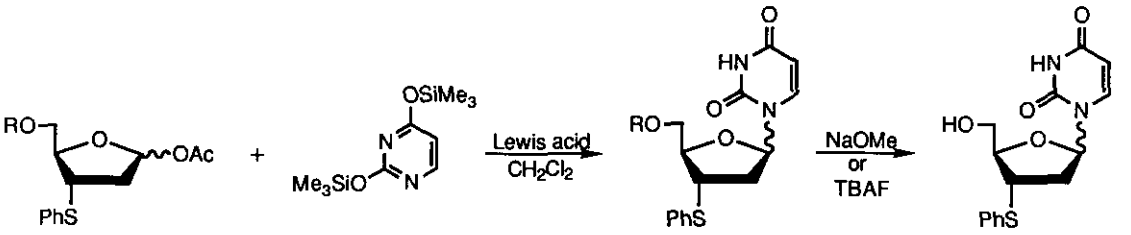
3-α-Phenylthio-2,3-dideoxyribose (3-PhS-2,3-ddr, **5**)[11] was prepared as shown in Scheme 1 from γ-butenolide (**3**), easily prepared from levoglucosenone (**1**).[12] Chlorination of this sugar (**5**) with HCl-$MgSO_4$[13] gave an anomeric mixture of 1-chlorosugar (**6**) in a ratio of 33 : 67, as determined by ^{1}H-nmr (Scheme 2). The anomeric ratio of **6** appeared to be not as high as that expected from the results of 1-chloro-2-deoxyribose. Coupling reaction between **6** and silylated uracil (**7a**) in chloroform without any catalysts (S_N2-mode coupling reaction)[7c,d,10a] resulted in the formation of an anomeric mixture of nucleosides (**8a**) in a ratio of 68 : 32 (^{1}H-nmr). In both stages of 1-chlorosugar (**6**) and nucleoside (**8a**), their stereochemistries could not be determined, and **8a** was further converted to benzoylated 2',3'-dideoxyuridine (9β) and its α-anomer (9α) by reductive desulfurization with Raney Ni (W-2). A comparison with authentic samples previously synthesized by us[7d] indicated the anomeric mixture of **9** consisting of both anomers in a ratio of α : β = 68 : 32. This result indicates that 1-chlorosugar (**6**) prepared as shown in Scheme 2 existed at a ratio of α : β = 33 : 67, as the coupling reaction was performed under the conditions to proceed completely in S_N2 mode.[10] The nature of 3-α-substituents or their steric hindrance thus strongly affects the stability of each anomer of 1-chlorosugar.



Scheme 2

Chu found that coupling reactions between 3-α-phenylthio-2,3-dideoxyribose and silylated nucleic bases in the presence of trimethylsilyl trifluoromethanesulfonate (TMSOTf) as a catalyst proceeded in a non-stereoselective manner to give a mixture of equal amounts of both anomers.[11] The stereoselectivity in the coupling reaction of S_N1 mode is known to vary when the catalyst is changed.[14] We thus examined the effects of Lewis acids on the coupling reactions between sugar (**10**) or (**11**) and silylated uracil (**7a**). Yields and stereoselectivities were determined by hplc after deprotection of nucleosides (**8a**) and (**12**). The results are summarized in Table 1. Remarkable stereoselectivity could not be achieved. The α-selectivity increased when Lewis acids that coordinate to sulfur atoms were used (Entries 4-8) or the protecting group changed from benzoyl group (Entry 3) to *tert*-

Table 1. Coupling reactions between sugar (**10**) or (**11**) and uracil (**7a**) in the presence of Lewis acids[a)]



10 : R=Bz-
11 : R=^{t}BuPh$_2$Si-

7a

8a : R=Bz-
12 : R=^{t}BuPh$_2$Si-

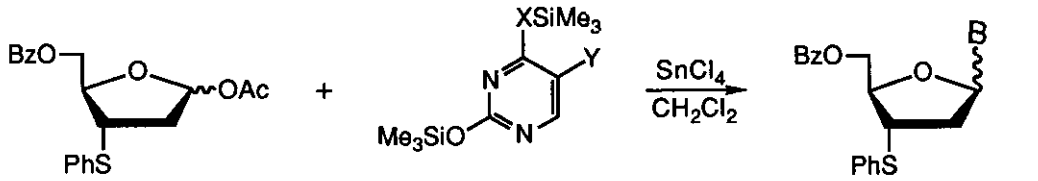
Entry	Sugar (R-)	Lewis Acid[b)]	Yield/%[c)] (α + β)	Stereoselectivity[c)] (α : β)
1	**10** (Bz-)	TMSOTf	87	60:40
2		TMSBr	56	54:46
3		$SnCl_4$	73	31:69
4		TMSOTf+$HgBr_2$	61	69:31
5		TMSOTf+$Sn(OTf)_2$	78	63:37
6		TMSBr+$HgBr_2$	81	68:32
7		TMSBr+$Sn(OTf)_2$	84	65:35
8[d)]		^{n}BuSnCl_3	83	77:23
9	**11** (^{t}BuPh$_2$Si-)	$SnCl_4$	70	53:47

a) Coupling reactions were carried out under following conditions; 0.25 mmol scale, sugar : uracil = 1 : 5, with 0.13 mmol of Lewis acids, in 3 ml of CH_2Cl_2, room temperature, overnight.

b) TMSOTf : trimethylsilyl trifluoromethanesulfonate, TMSBr : bromotrimethylsilane, $Sn(OTf)_2$: stannous trifluoromethanesulfonate

c) Determined by hplc after deprotection of crude nucleosides with NaOMe for **10** or ^{n}Bu$_4$N$^+$F$^-$ for **11**.

d) 0.60 mmol of Lewis acid was used.



10

7a : X=O, Y=H

7b : X=O, Y=Me

7c : X=NAc, Y=H

8a : B=U ; 73 %
α : β = 31 : 69

8b : B=T ; 34 %
α : β = 52 : 48

8c : B=C^{Ac} ; 89 %
α : β = 43 : 57

Scheme 3

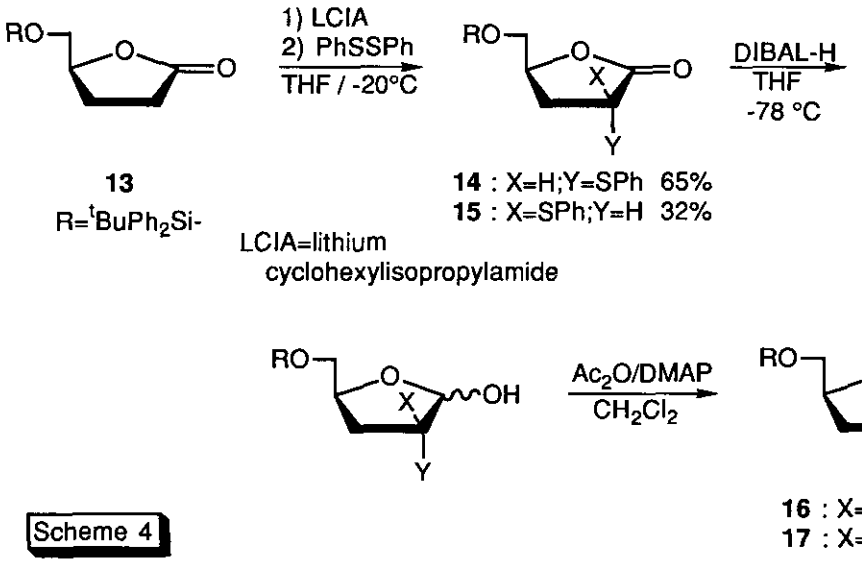
butyldiphenylsilyl group (Entry 9). Repulsion between the 3- and 4-substituents on furanose ring of sugar (**10**) or (**11**) became greater in both cases and conformational change in the furanose ring would thus appear to occur to form the α-nucleoside preferentially.

When $SnCl_4$[15] was used as a catalyst, an exceptional β-selectivity was observed (Entry 3). This encouraged us to examine coupling reactions with other silylated bases [thymine (**7b**) and N^4-acetylcytosine (**7c**)] under similar reaction conditions. The results shown in Scheme 3 indicate these reaction conditions not to be general for good β-selectivity. Good stereoselectivity could not be achieved in the coupling reactions with 3-PhS-2,3-ddr and silylated pyrimidine bases either in S_N2 mode or S_N1 mode reactions.

Coupling Reactions with 2-Phenylthio-2,3-dideoxyribose

The α-PhS group at the 3-position on 2,3-dideoxyribose did not have any significant effect on increase in β-selectivity in the coupling reactions, and thus the stereochemistry in coupling reactions with 2,3-dideoxyribose which has the PhS group at the 2-position was studied.[6a,b] Three similar cases have been reported,[16] and increase in bulkiness of the organothio groups at C-2 of sugars raised the stereoselectivity in coupling reactions to give mainly 1',2'-*trans* nucleosides. Nicolaou has reported the selective formation of 1,2-*trans* glycosyl bond in glycosylation reactions with 2-phenylthiopyranose.[17] This is attributed to the participation of an episulfonium ion intermediate, assumed to be formed by attack of a lone pair of the sulfur atom on the cationic center at the anomeric carbon, and to interfere the formation of glycosyl bonds on the same side. Both steric and electronic effects should lead to better stereoselectivity in coupling reactions between 2-phenylthio-2,3-dideoxyribose and nucleobases.

2-Phenylthio-2,3-dideoxyribose derivatives (2-PhS-2,3-ddr, **16** and **17**) were prepared as follows (Scheme 4). γ-Lactone (**13**) prepared conveniently from levoglucosenone (**2**),[12] was phenylsulfenylated by the procedure reported by Trost[18] to give two isomers (**14**) and (**15**). After separation of these isomers by column chromatography, each isomer was reduced by DIBAL-H. In this work-up, small quantities of epimerization at the C-2 were detected, but purification was easily performed after acetylation.



13
R=^{t}BuPh$_2$Si-

14 : X=H;Y=SPh 65%
15 : X=SPh;Y=H 32%

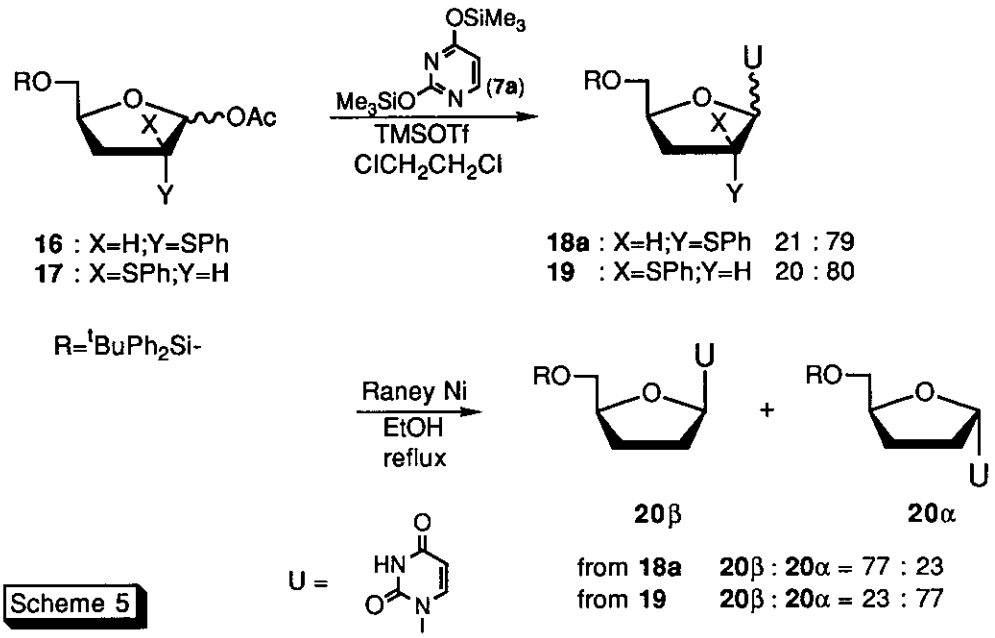
LCIA=lithium cyclohexylisopropylamide

16 : X=H;Y=SPh
17 : X=SPh;Y=H

Scheme 4

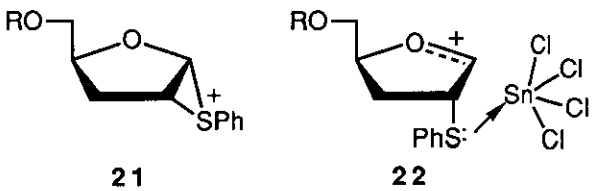
Coupling reactions between silylated uracil (**7a**) and 2-PhS-2,3-ddr (**16**) or (**17**) were performed in the presence of TMSOTf,[19] hoping to obtain cationic centers at anomeric carbons (Scheme 5). Configurations of the anomeric centers of the nucleosides (**18a**) and (**19**) were determined by comparison with an authentic sample of silylated 2',3'-dideoxyuridine (**20β**)[20] after removal of the PhS group by Raney Ni (W-2). In both cases, anomeric mixtures of **18a** or **19** were obtained in a ratio of 2 : 8, and the major isomers had 1',2'-*trans* relationship. Stereoselectivity in the coupling reactions is thus strictly controlled by the PhS group on C-2 of sugars (**16**) and (**17**). Thus, we used sugar (**16**) to achieve higher β-selectivity.

The reaction conditions of coupling reactions between **16** and **7a** were examined, and the results are summarized in Table 2. Change of the solvent from 1,2-dichloroethane to acetonitrile raised β-selectivity (Entry 2). This appears to support the intermediacy of episulfonium ion (**21**), since a more polar solvent (MeCN) stabilized the



Scheme 5

ionic species to increase the contribution of **21**. The nature of Lewis acids varied selectivity. With $SnCl_4$ instead of TMSOTf as catalyst, β-selectivity became much higher (Entries 4 and 5). This may be explained as follows. Nicolaou also reported that in the presence of



$SnCl_2$, 1,2-*trans* selectivity was lost because complexion of $SnCl_2$ to sulfur atoms in sugar prevented the formation of episulfonium intermediates.[17] $SnCl_4$ can be also expected to coordinate to sulfur atoms, and thus another intermediate (**22**) was thought involved in the reaction. Comlpexed $SnCl_4$ may cause severe steric hindrance on the α-face of the sugar to increase β-selectivity.

The above reaction conditions were used for coupling reactions with other silylated pyrimidine bases, *i.e.*, silylated thymine (**7b**) and silylated N^4-acetylcytosine (**7c**). The results are summarized in Scheme 6 and indicate that coupling reactions between **16** and silylated pyrimidine bases in the presence of $SnCl_4$ as a catalyst generally proceed with good stereoselectivity to give anomeric mixtures of nucleosides in a ratio of α : β = 1 : 9 .

Table 2. Coupling reactions between sugar (**16**) and silylated uracil (**7a**) in the presence of Lewis acids[a)]

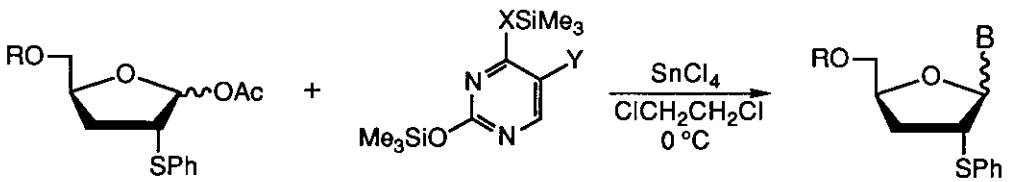
Entry	Lewis acid (equiv.)	Solvent	Yield/%[b)] ($\alpha + \beta$)	Stereoselectivity[c)] ($\alpha : \beta$)
1	TMSOTf (0.2)	$ClCH_2CH_2Cl$	90	21 : 79
2	TMSOTf (0.2)	MeCN	96	11 : 89
3	$TiCl_4$ (6.0)	$ClCH_2CH_2Cl$	65	15 : 85
4	$SnCl_4$ (6.0)	$ClCH_2CH_2Cl$	96	3 : 97
5[d)]	$SnCl_4$ (1.8)	$ClCH_2CH_2Cl$	91	7 : 93

a) Coupling reactions were carried out under following conditions; 0.10 mmol scale, sugar : uracil = 1 : 5, in 2 ml solvent, room temperature.

b) Isolated yields (preparative tlc).

c) Determined by ^{1}H-nmr.

d) Reaction conditions; 3.0 mmol scale, sugar : uracil = 1 : 1.5, in 20.5 ml solvent, 0 °C.



10

R=^{t}BuPh$_2$Si-

7a : X=O, Y=H

7b : X=O, Y=Me

7c : X=NAc, Y=H

18a : B=U ; 91 %
$\alpha : \beta$ = 7 : 93

18b : B=T ; 87 %
$\alpha : \beta$ = 8 : 92

18c : B=C^{Ac} ; 93 %
$\alpha : \beta$ = 11 : 89

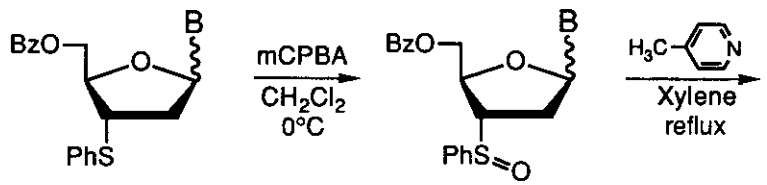
Scheme 6

Conversion of PhS-substituted Nucleosides to d_4Ns

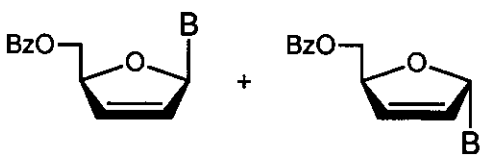
Nucleosides functionalized with PhS group on sugar moiety were obtained and thus a method for converting them to d_4Ns was developed. Initially, we chose the thymidine derivative (**8b**) ($\alpha : \beta$ = 52 : 48, one anomer could not be separated from the other by hplc) as a starting material. Oxidation of sulfide (**8b**) to sulfoxide (**23b**) was performed with *m*-chloroperbenzoic acid (mCPBA) under the conditions reported by Wu.[21] Although **23b** has not been fully characterized yet, ^{1}H-nmr showed two diastereomeric pairs of each anomers of sulfoxide (**23b**),

due to a newly formed chiral center at the sulfur atom, to be present in similar quantities. When a solution of **23b** in xylene was refluxed for thermal elimination reaction, thymine was formed immediately. Sulfenic acid formed by the thermal elimination of sulfoxide may thus have destroyed nucleosides (**23b**) or (**24b**). The latter one is known to be particularly unstable to acids. To neutralize acidity in the reaction solution, the thermal reaction was carried out in the presence of a base. Some reaction conditions, for example, bases ($NaHCO_3$, 4-picoline, DBU, KO^tBu) and solvent (xylene, dioxane), were examined. While monitoring by tlc, it was noted that (1)reactions went to completion faster in xylene than in dioxane at reflux and (2)basicities of the bases did not affect reaction rates very much. The best results were obtained when reactions were performed in xylene-4-picoline solution at reflux for 4 h. 4-Picoline acted both as a base and co-solvent to increase the solubility of the nucleoside (**23b**) in xylene. Only protected d_4T (**24b**β) and its α-anomer (**24b**α) were obtained.

Nucleosides (**8a**) (α : β = 31 : 69) and (**8c**) (α : β = 43 : 56), neither of which could be separated to each anomers, were converted under the same reaction conditions as those for thymidine derivative (**8b**). The results are summarized in Scheme 7. Starting with uridine derivatives (**8a**), similar results were obtained. Cytidine derivatives (**8c**), however, gave product (**24c**) in low yield with formation of N^4-acetylcytosine. Lability of the glycosyl bonds of cytidine derivatives appeared to be the cause for this.



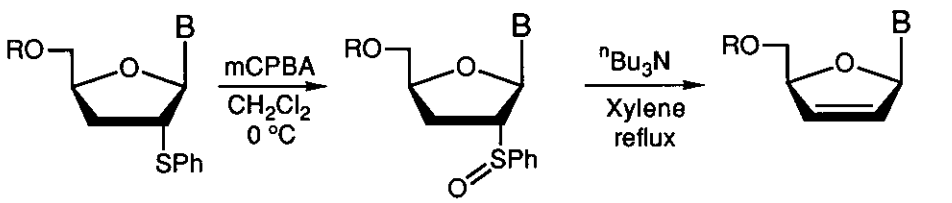
8a : B=U; α : β = 31 : 69 **23a** : B=U
8b : B=T; α : β = 52 : 48 **23b** : B=T
8c : B=C^{Ac}; α : β = 43 : 57 **23c** : B=C^{Ac}



24a : B=U;	55%	35%
24b : B=T;	36%	37%
24c : B=C^{Ac};	10%	11%

Scheme 7

Following the same procedure, 2'-phenylthionucleoside (**18aβ-18cβ**) were also thought to be possible to convert to d_4Ns. Oxidation of **18aβ-18cβ**, purified by recrystallization (**18bβ**, **18cβ**) or hplc (**18aβ**), with mCPBA proceeded smoothly to give sulfoxides (**25a-c**). All these sulfoxides were soluble in xylene alone and thus thermal elimination was carried out in the presence of 2.3 equivalents of Bu_3N instead of a large quantity of 4-picoline. In all cases, the starting material was consumed within 1 h to give d_4Ns (**26a-c**) in the yields shown in Scheme 8. Protected d_4U (**26a**) and d_4T (**26b**) were obtained in good yields, but the yield of N^4-acetyl-d_4C (**26c**) was not as high as that of **26a** or **26b**. During thermal elimination of cytidine derivative (**25c**), the formation of N^4-acetylcytosine was detected, as in the case of 3'-phenylthio derivative (**23c**). The better yield of **26c** than that of **24c**, however, appears to be due to the shorter reaction time. All nucleosides (**26a-c**) were deprotected with tetrabutylammonium fluoride (TBAF) under the standard conditions and were confirmed by comparison with those reported.[1,4,5]



18aβ : B=U
18bβ : B=T
18cβ : B=C^{Ac}
R=^{t}BuPh$_2$Si-

25a : B=U
25b : B=T
25c : B=C^{Ac}

26a : B=U ; 100%
26b : B=T ; 85%
26c : B=C^{Ac} ; 56%

Scheme 8

Conclusion

The effects of the PhS group on 2,3-dideoxyribose on stereoselectivity in coupling reactions with silylated pyrimidine bases were clarified. Good stereoselectivity could not be achieved in coupling reactions with 3-α-PhS-2,3-ddr either in the S_N2 mode or S_N1 mode reaction. In contrast, coupling reactions between 2-α-PhS-2,3-ddr and silylated pyrimidine bases proceeded with high β-selectivity by using Lewis acid catalysts, especially $SnCl_4$. Nucleosides with PhS group on the sugar moiety could be converted to d_4Ns by oxidation to sulfoxides

with mCPBA followed by thermal elimination. These procedures should be applicable to preparation of new d_4Ns derivatives.

EXPERIMENTAL

General procedure for the coupling reactions between 3-phenylthio-2,3-dideoxyribose (3-PhS-2,3-ddr, **10**) and silylated pyrimidine bases (**7**)

Under argon atmosphere, silylated pyrimidine base (**7**, 8.90 mmol)[7d] and 1-*O*-acetyl-5-*O*-benzoyl-2,3-dideoxy-3-phenylthio-D-*erythro*-pentofuranose (**10**, 1.60 g, 4.30 mmol) were dissolved in dry dichloromethane (40 ml). To this solution, 10 ml of 1.0 M solution of $SnCl_4$ in dichloromethane[22] was added dropwise at 0 °C, and the mixture was stirred under argon atmosphere at room temperature overnight. The reaction mixture was poured into a saturated aqueous solution of sodium bicarbonate and extracted with dichloromethane three times. The organic layer was dried over anhydrous magnesium sulfate, and the solvent was distilled away under reduced pressure. The residue obtained was purified by silica gel column chromatography (dichloromethane : acetone= 95 : 5-80 : 20) to give an anomeric mixture of nucleosides.

1-(5-*O*-Benzoyl-2,3-dideoxy-3-phenylthio-D-*erythro*-pentofuranosyl)uracil (**8a**): 1.60 g (4.30 mmol) of **10** and 1.00 g (8.90 mmol) of uracil gave 1.33 g of **8a**, 73% yield (α : β= 31 : 69) ; ^{1}H-nmr ($CDCl_3$) :δ 9.77 (1H, br, NH), 8.08-7.96 (2.25H, m, aromatic H,α-H-6), 7.65-7.25 (8.75H, m, aromatic H, β-H-6), 6.20 (0.25H, dd, *J*=6.4, 5.3 Hz, α-H-1'), 6.08 (0.75H, dd, *J*=5.9, 4.5 Hz, β-H-1'), 5.79 (0.25H, d, *J*=8.1 Hz, α-H-5), 5.51 (0.75H, d, *J*=7.4 Hz, β-H-5), 4.66 (0.75H, dd, *J*=12.5, 2.6 Hz, β-H-5'), 4.58-4.47 (0.5H, m, α-H-4', α-H-5'), 4.44 (0.75H, dd, *J*=12.5, 3.7 Hz, β-H-5'), 4.33 (0.25H, dd, *J*=11.9, 4.6 Hz, α-H-5'), 4.28-4.22 (0.75H, m, β-H-4'), 3.86-3.70 (1H, m, H-3'), 3.08-2.97 (0.25H, m, α-H-2'), 2.59-2.45 (1.5H, m, β-H-2'), 2.14 (0.25H, ddd, *J*=14.4, 6.6, 5.2 Hz, α-H-2').

1-(5-*O*-Benzoyl-2,3-dideoxy-3-phenylthio-D-*erythro*-pentofuranosyl)thymine (**8b**): 1.60 g (4.30 mmol) of **10** and 1.12 g (8.88 mmol) of thymine gave 0.65 g of **8b**, 34% yield (α : β= 52 : 48) ;^{1}H-nmr ($CDCl_3$) :δ 8.92 (1H, br, NH), 8.05-7.96 (2H, m, aromatic H), 7.65-7.56 (1H, m, aromatic H), 7.50-7.25 (8H, m, aromatic H, H-6), 6.23 (0.5H, t, *J*=6.1 Hz, α-H-1'), 6.13 (0.5H, t, *J*=5.7 Hz, β-H-1'), 4.69 (0.5H, dd, *J*=12.5, 2.5 Hz, β-H-5'), 4.58-4.23 (2.5H, m, H-4', H-5'), 3.85-3.75 (1H, m, H-3'), 3.03-2.92 (0.5H, m, α-H-2'), 2.54-2.48 (1H, m, β-H-2'), 2.13 (0.5H, ddd, *J*=14.0, 7.5, 6.1 Hz, a-H-2'), 1.96 (1.5H, s, α-Me), 1.63 (1.5H, s, β-Me).

N^4-Acetyl-(5-*O*-benzoyl-2,3-dideoxy-3-phenylthio-D-*erythro*-pentofuranosyl)cytosine (**8c**): 1.63 g (4.37 mmol) of **10** and 1.31 g (8.56 mmol) of N^4-acetylcytosine gave 1.81 g of **8c**, 89% yield (α : β= 43 : 57) ; ^{1}H-nmr ($CDCl_3$) :δ 9.42 (1H, br, NH), 8.20 (0.6H, d, *J*=7.5 Hz, β-H-6), 8.05-7.95 (2.4H, m, aromatic H, α-H-6), 7.68-7.58 (1H, m, aromataic H), 7.55-7.25 (8H, m, aromatic H, H-5), 6.17 (0.4H, dd, *J*=6.4, 3.9 Hz, α-H-1'), 6.07 (0.6H, dd, *J*=6.5, 2.8 Hz, β-H-1'), 4.72-4.25 (3H, m, H-4', H-5'), 3.85 (0.4H, dt, *J*=7.8, 5.0 Hz, α-H-3'), 3.65-3.55 (0.6H, m, β-H-3'), 3.23-3.12 (0.4H, m, α-H-2'), 2.73-2.54 (1.2H, m, β-H-2'), 2.30-2.12 (3.4H, m, α-H-2', Ac).

General procedure for the coupling reactions between 2-phenylthio-2,3-dideoxyribose (2-PhS-2,3-ddr, **16**) and silylated pyrimidine bases (**7**)

Under argon atmosphere, silylated pyrimidine base (**7**, 8.90 mmol)[7d] and 1-*O*-acetyl-5-*O*-(*tert*-butyldiphenylsilyl)-2,3-dideoxy-2-phenylthio-D-*erythro*-pentofuranose(**16**, 1.51 g, 2.98 mmol) were dissolved in dry 1,2-dichloroethane (15 ml). To this solution, 5.5 ml of 1.0 M solution of $SnCl_4$ in 1,2-dichloroethane was added dropwise at 0 °C, and the mixture was stirred under argon atmosphere at 0 °C for 4 h. The reaction mixture was poured into a saturated aqueous solution of sodium bicarbonate and extracted with dichloromethane three times. The organic layer was dried over anhydrous magnesium sulfate, and the solvent was distilled away under reduced pressure. The residue obtained was purified by silica gel column chromatography (chloroform : methanol= 98 : 2-96 : 4) to give an anomeric mixture of nucleosides. Anomers were separated by recrystallization in the cases of thymidine derivative (**18b**) and cytidine derivative (**18c**), or by hplc (ODS; 30 mmϕ X 250 mm; acetonitrile : water= 80 : 20; 10 ml/min.).

1-[5-*O*-(*tert*-Butyldiphenylsilyl)-2,3-dideoxy-2-phenylthio-β-D-*erythro*-pentofuranosyl]uracil (**18aβ**): 1.51 g (2.98 mmol) of **16** and 0.51 g (4.57 mmol) of uracil gave 1.38 g of **18aβ**, 83% yield ; $[\alpha]_D^{28}$ +41.0 ° (*c* 1.12, $CHCl_3$); ^{1}H-nmr ($CDCl_3$) :δ 9.32 (1H, br, NH), 7.72 (1H, d, *J*=8.1 Hz, H-6), 7.67-7.61 (4H, m, aromatic H), 7.50-7.36 (8H, m, aromatic H), 7.28-7.24 (3H, m, aromatic H), 6.08 (1H, d, *J*=5.5 Hz, H-1'), 5.31 (1H, dd, *J*=8.1, 2.0 Hz, H-5), 4.38-4.30 (1H, m, H-4'), 4.08 (1H, dd, *J*=11.7, 2.1 Hz, H-5'), 3.90-3.73 (1H, m, H-2'), 3.69 (1H, dd, *J*=11.7, 2.2 Hz, H-5'), 2.52 (1H, ddd, *J*=13.2, 7.2, 6.0 Hz, H-3'), 2.10 (1H, dt, *J*=13.1, 7.4 Hz, H-3'), 1.10 (9H, s, *tert*-Bu); ^{13}C-nmr($CDCl_3$) :δ 163.10 (C-4), 150.15 (C-2), 139.50 (C-6), 135.39 (aromatic C), 135.14 (aromatic C), 133.38 (aromatic C), 132.74 (aromatic C), 132.13 (aromatic C), 132.00 (aromatic C), 129.93 (aromatic C), 128.99 (aromatic C), 127.83 (aromatic C), 102.25 (C-5), 89.62 (C-1'), 78.98 (C-4'), 65.20 (C-5'), 51.21 (C-2'), 32.18 (C-3'), 27.00 (quaternary C of *tert*-Bu), 19.34 (Me of *tert*-Bu);

ir (KBr) :ν_{max} 1688 (s), 1462 (m), 1429 (m), 1383 (m), 1280 (m), 1114 (m), 1083 (m), 822 (m), 743 (m), 702 (m), 503 (m), 487 (m) cm^{-1} ; uv($CHCl_3$) :λ_{max} 261 nm (log ε 4.10); *Anal.* Calcd for $C_{31}H_{34}N_2O_4SSi$: C, 66.64; H, 6.13; N, 5.01; S, 5.74. Found: C, 66.60; H, 6.08; N, 5.01; S, 5.88.

1-[5-*O*-(*tert*-Butyldiphenylsilyl)-2,3-dideoxy-2-phenylthio-β-D-*erythro*-pentofuranosyl]thymine (**18b**β): 1.51 g (2.98 mmol) of **16** and 0.57 g (4.51 mmol) of thymine gave 1.25 g of **18b**β, 73% yield ; mp 152-154 °C (*n*-hexane-CH_2Cl_2); $[\alpha]_D^{27}$ +38.5 ° (*c* 1.01, $CHCl_3$); ^{1}H-nmr ($CDCl_3$) :δ 9.53 (1H, br, NH), 7.70-7.62 (4H, m, aromatic H), 7.52-7.33 (8H, m, aromatic H), 7.27-7.15 (4H, m, H-6, aromatic H), 6.12 (1H, d, *J*=7.6 Hz, H-1'), 4.28-4.21 (1H, m, H-4'), 4.02 (1H, dd, *J*=11.5, 1.8 Hz, H-5'), 3.89-3.72 (1H, m, H-2'), 3.68 (1H, dd, *J*=11.5, 2.1 Hz, H-5'), 2.54 (1H, ddd, *J*=12.5, 8.0, 4.2 Hz, H-3'), 2.14 (1H, dt, *J*=12.9, 9.2 Hz, H-3'), 1.50 (3H, s, Me), 1.13 (9H, s, *tert*-Bu); ^{13}C-nmr($CDCl_3$) :δ 163.41 (C-4), 150.39 (C-2), 135.36 (aromatic C), 135.11 (aromatic C), 134.72 (C-6), 133.59 (aromatic C), 132.98 (aromatic C), 132.31 (aromatic C), 131.94 (aromatic C), 129.87 (aromatic C), 128.89 (aromatic C), 128.07 (aromatic C), 127.83 (aromatic C), 111.15 (C-5), 89.07 (C-1'), 77.58 (C-4'), 65.81 (C-5'), 49.77 (C-2'), 32.55 (C-3'), 27.06 (quaternary C of *tert*-Bu), 19.47 (Me of *tert*-Bu), 11.81(Me); ir (KBr) :ν_{max} 1702 (s), 1682 (s), 1466 (m), 1116 (m), 1067 (m), 712 (m), 698 (m), 505 (m) cm^{-1}; uv($CHCl_3$) :λ_{max} 262 nm (log ε 4.06); *Anal.* Calcd for $C_{32}H_{36}N_2O_4SSi$: C, 67.10; H, 6.33; N, 4.89; S, 5.60. Found: C, 67.00; H, 6.32; N, 4.87; S, 5.80.

N^4-Acetyl-1-[5-*O*-(*tert*-butyldiphenylsilyl)-2,3-dideoxy-2-phenylthio-β-D-*erythro*-pentofuranosyl]cytosine (**18c**β): 1.51 g (2.98 mmol) of **16** and 0.69 g (4.52 mmol) of N^4-acetylcytosine gave 1.45 g of **18c**β, 81% yield; mp 165-166 °C; $[\alpha]_D^{27}$ +50.4 ° (*c* 1.01, $CHCl_3$); ^{1}H-nmr ($CDCl_3$) :δ 10.52 (1H, br, NH), 8.34 (1H, d, *J*=7.5 Hz, H-6), 7.68-7.61 (4H, m, aromatic H), 7.50-7.35 (8H, m, aromatic H), 7.30-7.24 (3H, m, aromatic H), 7.20 (1H, d, *J*=7.5 Hz, H-5), 6.08 (1H, d, *J*=2.6 Hz, H-1'), 4.55-4.45 (1H, m, H-4'), 4.18 (1H, dd, *J*=11.9, 2.2 Hz, H-5'), 3.88 (1H, dt, *J*=6.3, 3.0 Hz, H-2'), 3.72 (1H, dd, *J*=12.0, 2.6 Hz, H-5'), 2.40 (1H, ddd, *J*=13.3, 9.2, 6.6 Hz, H-3'), 2.27 (3H, s, Ac), 1.94 (1H, dd, *J*=13.3, 5.7, 3.2 Hz, H-3'), 1.11 (9H, s, *tert*-Bu); ^{13}C-nmr($CDCl_3$) :δ 171.09 (C=O of Ac), 162.92 (C-4), 154.90 (C-2), 144.11 (C-6), 135.48 (aromatic C), 135.33 (aromatic C), 133.01 (aromatic C), 132.86 (aromatic C), 132.61 (aromatic C), 132.34 (aromatic C), 129.99 (aromatic C), 128.99 (aromatic C), 127.86 (aromatic C), 96.64 (C-5), 9.15 (C-1'), 81.21 (C-4'), 64.19 (C-5'), 53.22 (C-2'), 31.48 (C-3'), 27.03 (quaternary C of *tert*-Bu), 24.92 (Me of Ac), 19.34 (Me of *tert*-Bu); ir (KBr) :ν_{max} 1719 (m), 1671 (s), 1626 (m), 1560 (m), 1495 (s), 1392 (m), 1317 (m), 1238 (m), 1114 (m), 1093 (m), 789 (m), 743 (m), 704 (m) cm^{-1} ; uv($CHCl_3$) :λ_{max} 306 nm (log ε 3.84), 252 nm (log e 4.18); *Anal.* Calcd for $C_{33}H_{37}N_3O_4SSi$: C, 66.08; H, 6.22; N, 7.01; S, 5.34. Found: C, 65.86; H, 6.24; N, 6.95; S, 5.42.

General procedure for the oxidation and thermal elimination of sulfenic acid of 3'-phenylthionucleosides (**8**)

3'-Phenylthionucleoside (**8**, 3.13 mmol) was dissolved in dry 1,2-dichloromethane (30 ml). To this solution, a solution of *m*-chloroperbenzoic acid (0.690 g, 3.40 mmol) in dry dichloromethane (30 ml) was added dropwise at 0 °C, and the mixture was stirred at 0 °C for 2 h. The reaction mixture was poured into a saturated aqueous solution of sodium bicarbonate and extracted with dichloromethane three times. The organic layer was dried over anhydrous magnesium sulfate, and the solvent was removed under reduced pressure. The residual amorphous was dissolved in 4-picoline (3 ml) and diluted with xylene (10 ml). This mixture was heated under reflux under argon atmosphere for 4 h. The solvent was evaporated under reduced pressure (2 mmHg). The residual oil was dissolved in dichloromethane and the solution was washed successively with 1% aqueous sulfuric acid and a saturated aqueous solution of sodium bicarbonate. The organic layer was dried over anhydrous magnesium sulfate, and the solvent was distilled off under reduced pressure. The residue obtained was purified by silica gel column chromatography (dichloromethane : acetone= 85 : 20-70 : 30) to give an anomeric mixture of nucleosides (**24**). These anomers were separated by hplc (ODS; 30 mmϕ X 250 mm; acetonitrile : water= 35 : 65-40 : 60; 7.5 ml/min.).

1-(5-*O*-Benzoyl-2,3-dideoxy-D-*glycero*-pento-2-enofuranosyl)uracil (**24a**): 1.33 g (3.13 mmol) of **8a** gave 0.54 g of **24a**β (55% yield) and 0.34 g of **24a**α (35% yield).

1-(5-*O*-Benzoyl-2,3-dideoxy-β-D-*glycero*-pento-2-enofuranosyl)uracil (**24a**β): mp 133-136 °C (ethyl acetate, lit.,[4b] 136-137 °C); $[\alpha]_D^{24}$ -155.8 ° (*c* 0.51, $CHCl_3$); ^{1}H-nmr (acetone-d_6) :δ 10.48 (1H, br, NH), 8.01 (2H, d, *J*=7.1 Hz, aromatic H), 7.67 (1H, t, *J*=7.4 Hz, aromatic H), 7.54 (2H, t, *J*=7.5 Hz, aromatic H), 7.49 (1H, d, *J*=8.1 Hz, H-6), 7.02-6.96 (1H, m, H-1'), 6.56 (1H, m, H-3'), 6.06 (1H, m, H-2'), 5.29 (1H, d, *J*=8.1 Hz, H-5), 5.21 (1H, br, H-4'), 4.61 (2H, m, H-5'); ^{13}C-nmr(acetone-d_6) :δ 166.37 (C=O of Bz), 163.80 (C-4), 151.48 (C-2), 140.94 (C-6), 134.49 (C-3'), 134.05 (aromatic C), 130.53 (aromatic C), 130.04 (aromatic C), 129.36 (aromatic C),127.56 (C-2'), 102.66 (C-5), 90.47 (C-1'), 85.26 (C-4'), 65.78 (C-5'); ir (KBr) :ν_{max} 1730 (s), 1700 (s), 1462 (m), 1398 (m), 1263 (s), 1081 (m), 712 (m) cm^{-1} ; uv($CHCl_3$) :λ_{max} 261 nm (log ε 3.96); *Anal.* Calcd for $C_{16}H_{14}N_2O_5$: C, 61.14; H, 4.49; N, 8.91. Found C, 60.99; H, 4.36; N, 8.87.

1-(5-*O*-Benzoyl-2,3-dideoxy-α-D-glycero-pento-2-enofuranosyl)uracil (**24a**α): $[\alpha]_D^{27}$ -157.3 ° (*c* 0.51, $CHCl_3$); ^{1}H-nmr (acetone-d_6) :δ 10.39 (1H, br, NH), 8.03 (2H, d, *J*=7.0 Hz, aromatic H), 7.64 (1H, t, *J*=7.4 Hz, aromatic H), 7.51 (2H, t, *J*=7.5 Hz, aromatic H), 7.40 (1H, d, *J*=8.1 Hz, H-6), 7.10 (1H, dt, *J*=5.2, 1.5 Hz, H-1'), 6.57 (1H, dt, *J*=6.0, 1.6 Hz, H-3'), 6.10 (1H, ddd, *J*=6.0, 2.2, 1.5 Hz, H-2'), 5.68 (1H, d, *J*=8.1 Hz, H-5), 5.53-5.47 (1H, m, H-4'), 4.52 (1H, dd, *J*=11.8, 3.5 Hz, H-5'), 4.47 (1H, dd, *J*=11.8, 4.6 Hz, H-

5'); ^{13}C-nmr(acetone-d_6) :δ 166.40 (C=O of Bz), 163.90 (C-4), 151.44 (C-2), 140.85 (C-6), 134.53 (C-3'), 133.95 (aromatic C), 130.68 (aromatic C), 130.10 (aromatic C), 129.31 (aromatic C),127.63 (C-2'), 103.04 (C-5), 91.16 (C-1'), 85.91 (C-4'), 66.08 (C-5'); ir (KBr) :ν_{max} 1710 (s), 1688 (s), 1276 (m), 1247 (m), 1071 (m), 714 (m) cm^{-1} ; uv(CHCl$_3$) :λ_{max} 261 nm (log ε 3.99); hrms(FAB) :Calcd for $C_{16}H_{15}N_2O_5$: 315.0904. Found: 315.0974 (M^++H).

1-(5-*O*-Benzoyl-2,3-dideoxy-D-*glycero*-pento-2-enofuranosyl)thymine (**24b**): 649 mg (1.48 mmol) of **8b** gave 175 mg of **24b**β (36% yield) and 182 mg of **24b**α (37% yield).

1-(5-*O*-Benzoyl-2,3-dideoxy-β-D-*glycero*-pento-2-enofuranosyl)thymine (**24b**β): mp 161-163 °C (ethyl acetate), $[\alpha]_D^{27}$ -116.3 ° (*c* 0.51, CHCl$_3$); ^{1}H-nmr (CDCl$_3$) :δ 8.40 (1H, br, NH), 8.01 (2H, d, *J*=7.0 Hz, aromatic H), 7.60 (1H, t, *J*=7.4 Hz, aromatic H), 7.46 (2H, t, *J*=7.6 Hz, aromatic H), 7.11-7.08 (1H, m, H-6), 7.03-6.97 (1H, m, H-1'), 6.42 (1H, dt, *J*=5.9, 1.7 Hz, H-3'), 5.97-5.92 (1H, m, H-2'), 5.20-5.13 (1H, m, H-4'), 4.63 (1H, dd, *J*=12.4, 3.7 Hz, H-5'), 4.57 (1H, dd, *J*=12.5, 3.0 Hz, H-5'), 1.52 (3H, s, Me); ^{13}C-nmr(CDCl$_3$) :δ 166.02 (C=O of Bz), 163.14 (C-4), 150.21 (C-2), 135.11 (C-6), 133.56 (aromatic C), 133.40 (C-3'), 129.63 (aromatic C), 129.37 (aromatic C), 128.68 (aromatic C),127.28 (C-2'), 111.28 (C-5), 89.82 (C-1'), 84.49 (C-4'), 64.83 (C-5'), 12.00 (Me); ir (KBr) :ν_{max} 1721 (s), 1707 (s), 1688 (s), 1454 (m), 1294 (m), 1081 (m), 712 (m) cm^{-1}; uv(CHCl$_3$) :λ_{max} 267 nm (log ε 3.96); *Anal.* Calcd for $C_{17}H_{16}N_2O_5$: C, 62.19; H, 4.91; N, 8.53. Found: C, 62.28; H, 5.04; N, 8.51.

1-(5-*O*-Benzoyl-2,3-dideoxy-α-D-*glycero*-pento-2-enofuranosyl)thymine(**24b**α): mp 164.5-165.5 °C (ethyl acetate); $[\alpha]_D^{27}$ -221.4 ° (*c* 0.49, CHCl$_3$); ^{1}H-nmr (CDCl$_3$) :δ 9.23 (1H, br, NH), 8.04 (2H, d, *J*=7.0 Hz, aromatic H), 7.58 (1H, t, *J*=7.4 Hz, aromatic H), 7.45 (2H, t, *J*=7.5 Hz, aromatic H), 7.14 (1H, dt, *J*=5.3, 1.6 Hz, H-1'), 6.89 (1H, q, *J*=1.1 Hz, H-6), 6.40 (1H, dt, *J*=6.0, 1.6 Hz, H-3'), 5.96 (1H, ddd, *J*=6.0, 2.3, 1.4 Hz, H-2'), 5.45-5.35 (1H, m, H-4'), 4.55-4.43 (2H, m, H-5'), 1.91 (3H, d, *J*=1.3 Hz, Me); ^{13}C-nmr(CDCl$_3$) :δ 166.23 (C=O of Bz), 163.71 (C-4), 150.60 (C-2), 134.89 (C-6), 133.30 (aromatic C), 133.21 (C-3'), 129.65 (aromatic C), 129.46 (aromatic C), 128.46 (aromatic C),127.46 (C-2'), 111.54 (C-5), 90.38 (C-1'), 85.10 (C-4'), 65.30 (C-5'), 12.53 (Me) ; ir (KBr) :ν_{max} 1721 (s), 1694 (s), 1272 (m), 1251 (m), 1081 (m), 716 (m) cm^{-1}; uv (CHCl$_3$) :λ_{max} 267 nm (log ε 4.00); *Anal.* Calcd for $C_{17}H_{16}N_2O_5$: C, 62.19; H, 4.91; N, 8.53. Found: C, 62.32; H, 5.02; N, 8.55.

N^4-Acetyl-1-(5-*O*-benzoyl-2,3-dideoxy-D-*glycero*-pento-2-enofuranosyl)cytosine (**24c**): 1.81 g (3.90 mmol) of **8c** gave 145 mg of **24c**β (10% yield) and 151 mg of **24c**α (11% yield).

N^4-Acetyl-1-(5-*O*-benzoyl-2,3-dideoxy-β-D-*glycero*-pento-2-enofuranosyl)cytosine (**24cβ**): mp > 192 °C (decomp.) (dichloromethane-ethyl acetate); $[\alpha]_D^{25}$ +14.2 ° (*c* 1.05, $CHCl_3$); ^{1}H-nmr ($CDCl_3$) :δ 10.32 (1H, br, NH), 7.97 (2H, d, *J*=7.9 Hz, aromatic H), 7.90 (1H, d, *J*=7.5 Hz, H-6), 7.62 (1H, t, *J*=7.4 Hz, aromatic H), 7.48 (2H, t, *J*=7.7 Hz, aromatic H), 7.23 (1H, d, *J*=7.5 Hz, H-5), 7.04-6.97 (1H, m, H-1'), 6.32 (1H, dt, *J*=6.0, 1.6 Hz, H-3'), 6.11-6.05 (1H, m, H-2'), 5.26 (1H, br, H-4'), 4.78 (1H, dd, *J*=12.5, 3.5 Hz, H-5'), 4.51 (1H, dd, *J*=12.6, 2.7 Hz, H-5'), 2.29 (3H, s, Ac); ^{13}C-nmr ($CDCl_3$) :δ 171.04 (C=O of Ac), 166.10 (C=O of Bz), 163.04 (C-4), 155.34 (C-2), 144.31 (C-6), 133.67 (aromatic C), 132.16 (C-3'), 129.55 (aromatic C), 129.19 (aromatic C), 128.61 (aromatic C), 128.00 (C-2'), 97.02 (C-5), 91.67 (C-1'), 85.53 (C-4'), 64.62 (C-5'), 24.88 (Ac); ir (KBr) :ν_{max} 1721 (s), 1663 (m), 1489 (m), 1400 (m), 1317 (m), 1292 (m), 1236 (s), 1083 (m), 719 (m) cm^{-1}; uv ($CHCl_3$) :λ_{max} 306 nm (log ε 3.80), 250 nm (log ε 4.02); *Anal.* Calcd for $C_{18}H_{17}N_3O_5$: C, 60.84; H, 4.82; N, 11.83. Found: C, 61.19; H, 4.81; N, 11.93.

N^4-Acetyl-1-(5-*O*-benzoyl-2,3-dideoxy-α-D-*glycero*-pento-2-enofuranosyl)cytosine (**24cα**): mp > 190 °C (decomp.) (dichloromethane-ethyl acetate); $[\alpha]_D^{27}$ -368.3 ° (*c* 0.50, $CHCl_3$); ^{1}H-nmr ($CDCl_3$) :δ 10.35 (1H, br, NH), 8.03 (2H, d, *J*=7.0 Hz, aromatic H), 7.65 (1H, d, *J*=7.5 Hz, H-6), 7.58 (1H, t, *J*=7.4 Hz, aromatic H), 7.48-7.40 (3H, m, aromatic H, H-5), 7.09 (1H, dt, *J*=5.2, 1.4 Hz, H-1'), 6.34 (1H, dt, *J*=6.1, 1.5 Hz, H-3'), 6.15 (1H, ddd, J=6.0, 2.2, 1.4 Hz, H-2'), 5.50-5.43 (1H, m, H-4'), 4.55-4.46 (2H, m, H-5'), 2.29 (3H, s, Ac); ^{13}C-nmr($CDCl_3$) :δ 170.98 (C=O of Ac), 166.22 (C=O of Bz), 162.97 (C-4), 155.18 (C-2), 143.68 (C-6), 133.34 (aromatic C), 131.96 (C-3'), 129.66 (aromatic C), 129.46 (aromatic C), 128.49 (aromatic C), 128.37 (C-2'), 97.16 (C-5), 92.67 (C-1'), 85.78 (C-4'), 65.13 (C-5'), 24.93 (Ac) ; ir (KBr) :ν_{max} 1720 (s), 1711 (s), 1663 (s), 1487 (m), 1396 (m), 1315 (m), 1294 (m), 1234 (s), 1073 (m), 719 (m) cm^{-1}; uv ($CHCl_3$) :λ_{max} 306 nm (log ε 3.81), 250 nm (log ε 4.07); *Anal.* Calcd for $C_{18}H_{17}N_3O_5$: C, 60.84; H, 4.82; N, 11.83. Found: C, 61.02; H, 4.55; N, 11.93.

General procedure for the oxidation and thermal elimination of sulfenic acid of 2'-phenylthionucleosides (**18β**).

2'-Phenylthionucleoside (**18β**, 2.81 mmol) was dissolved in dry 1,2-dichloromethane (25 ml). To this solution, a solution of *m*-chloroperbenzoic acid (0.640 g, 2.95 mmol) in dry dichloromethane (25 ml) was added dropwise at 0 °C, and the mixture was stirred at 0 °C for 6 h. The reaction mixture was poured into a saturated aqueous solution of sodium bicarbonate and extracted with dichloromethane three times. The organic layer was dried over anhydrous magnesium sulfate, and the solvent was distilled off under reduced pressure. The residual amorphous was dissolved in xylene (50 ml). To this solution, tributylamine (1.5 ml, 6.3 mmol) was added, and the mixture

was heated under reflux under argon atmosphere for 1 h. The solvent was removed under reduced pressure (2 mmHg). The residue obtained was purified by silica gel column chromatography (chloroform : methanol= 97 : 3-94 : 6) to give the nucleosides (**26**).

1-[5-*O*-(*tert*-Butyldiphenylsilyl)-2,3-dideoxy-β-D-*glycero*-pento-2-enofuranosyl]uracil (**26a**): 1.57 g (2.81 mmol) of **18a**β gave 1.25 g of **26a**, 100% yield; $[\alpha]_D^{24}$ -7.6 ° (*c* 0.50, $CHCl_3$); ^{1}H-nmr ($CDCl_3$) :δ 9.12 (1H, br, NH), 7.78-7.60 (5H, m, H-6, aromatic H), 7.55-7.37 (6H, m, aromatic H), 7.03 (1H, t, *J*=1.8 Hz, H-1'), 6.30 (1H, dt, *J*=6.0, 1.6 Hz, H-3'), 5.86 (1H, m, H-2'), 5.20 (1H, d, *J*=8.3 Hz, H-5), 4.90 (1H, br, H-4'), 3.99 (1H, dd, *J*=11.5, 3.1 Hz, H-5'), 3.87 (1H, dd, *J*=11.7, 3.0 Hz, H-5'), 1.07 (9H, s, *tert*-Bu); ^{13}C-nmr($CDCl_3$) :δ 163.65 (C-4), 150.84 (C-2), 140.57 (C-6), 135.39 (aromatic C), 135.19 (aromatic C), 134.25 (C-3'), 132.88 (aromatic C), 132.23 (aromatic C), 129.97 (aromatic C), 129.85 (aromatic C), 127.79 (aromatic C), 127.70 (aromatic C), 126.45 (C-2'), 102.45 (C-5), 89.48 (C-1'), 86.93 (C-4'), 64.86 (C-5'), 26.84 (quaternary C of *tert*-Bu), 19.20 (Me of *tert*-Bu); ir (KBr) :ν_{max} 1705 (s), 1690 (s), 1460 (m), 1253 (m), 1112 (m), 1083 (m), 1042 (m), 835 (m), 702 (m) cm^{-1} ; uv ($CHCl_3$) :λ_{max} 262 nm (log ε 3.88); *Anal.* Calcd for $C_{25}H_{28}N_2O_4Si$: C, 66.94; H, 6.29; N, 6.24. Found: C, 66.86; H, 6.41; N, 6.23.

1-[5-*O*-(*tert*-Butyldiphenylsilyl)-2,3-dideoxy-β-D-*glycero*-pento-2-enofuranosyl]thymine (**26b**): 1.53 g (2.68 mmol) of **18b**β gave 1.05 g of **26b**, 85% yield; $[\alpha]_D^{25}$ +4.2 ° (*c* 1.05, $CHCl_3$); ^{1}H-nmr ($CDCl_3$) :δ 9.13 (1H, br, NH), 7.68-7.60 (4H, m, aromatic H), 7.45-7.33 (6H, m, aromatic H), 7.16 (1H, d, *J*=1.1 Hz, H-6), 7.05-7.00 (1H, m, H-1'), 6.35 (1H, dt, *J*=5.9, 1.6 Hz, H-3'), 5.87 (1H, m, H-2'), 4.97-4.90 (1H, m, H-4'), 3.92 (1H, dd, *J*=11.1, 3.7 Hz, H-5'), 3.88 (1H, dd, *J*=11.2, 3.9 Hz, H-5'), 1.48 (3H, s, Me), 1.08 (9H, s, *tert*-Bu); ^{13}C-nmr($CDCl_3$) :δ 163.70 (C-4), 150.75 (C-2), 135.58 (C-6), 135.43 (aromatic C), 135.34 (aromatic C), 134.66 (C-3'), 133.28 (aromatic C), 132.77 (aromatic C), 130.01 (aromatic C), 129.91 (aromatic C), 127.83 (aromatic C), 127.79 (aromatic C), 126.31 (C-2'), 111.12 (C-5), 89.78 (C-1'), 86.89 (C-4'), 65.51 (C-5'), 26.96 (quaternary C of *tert*-Bu), 19.39 (Me of *tert*-Bu), 11.90 (Me); ir (KBr) :ν_{max} 1688 (s), 1466 (m), 1251 (m), 1116 (m), 706 (m) cm^{-1} ; uv ($CHCl_3$) :λ_{max} 266 nm (log ε 3.94); hrms(FAB) : Calcd for $C_{26}H_{31}N_2O_4Si$: 463.0921. Found 463.2070 (M^++H).

N^4-Acetyl-1-[5-*O*-(*tert*-butyldiphenylsilyl)-2,3-dideoxy-β-D-*glycero*-pento-2-enofuranosyl]cytosine (**26c**): 1.75 g (2.93 mmol) of **18c**β gave 0.80 g of **26c**, 56% yield; mp 162.5-164.5 °C (ethyl acetate); $[\alpha]_D^{24}$ +90.6 ° (*c* 1.04, $CHCl_3$); ^{1}H-nmr ($CDCl_3$) :δ 10.08 (1H, br, NH), 8.11 (1H, d, *J*=7.5 Hz, H-6), 7.68-7.60 (4H, m, aromatic H), 7.48-7.33 (6H, m, aromatic H), 7.13 (1H, d, *J*=7.5 Hz, H-5), 7.02 (1H, br, H-1'), 6.18 (1H, m, H-3'), 6.01 (1H, m, H-2'), 5.00-4.92 (1H, m, H-4'), 3.99 (1H, dd, *J*=11.7, 3.0 Hz, H-5'), 3.83 (1H, dd,

J=12.0, 3.3 Hz, H-5'), 2.28 (3H, s, Ac), 1.07 (9H, s, *tert*-Bu); ^{13}C-nmr($CDCl_3$) :δ 170.76 (C=O of Ac), 162.85 (C-4), 155.42 (C-2), 145.02 (C-6), 135.58 (aromatic C), 135.42 (aromatic C), 133.16 (aromatic C), 132.85 (C-3'), 132.54 (aromatic C), 130.07 (aromatic C), 130.01 (aromatic C), 127.89 (aromatic C), 127.86 (aromatic C), 127.37 (C-2'), 96.94 (C-5), 91.74 (C-1'), 87.72 (C-4'), 65.06 (C-5'), 26.92 (quaternary C of *tert*-Bu), 24.89 (Me of Ac), 19.27 (Me of *tert*-Bu) ; ir_{max} (KBr) :ν 1719 (m), 1669 (s), 1613 (m), 1555 (m), 1491 (s), 1394 (m), 1307 (m), 1238 (m), 1114 (m), 702 (m) cm^{-1}; uv($CHCl_3$) :λ_{max} 307 nm (log ε 3.85), 249 nm (log ε 4.01); *Anal.* Calcd for $C_{27}H_{31}N_3O_4Si$: C, 66.23; H, 6.38; N, 8.58. Found: C, 66.42; H, 6.51; N, 8.65.

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Received, 24th September, 1991