Stereocontrolled Syntheses of Deoxyribonucleosides via Photoinduced Electron-Transfer Deoxygenation of Benzoyl-Protected Ribo- and Arabinonucleosides

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The stereocontrolled, de novo syntheses of β-2′-deoxy-, α-2′-deoxy-, β-3′-deoxy-, and β-2′,3′-dideoxyribonucleosides are described. Strategically protected ribose, arabinose, and xylose glycosylation precursors were synthesized bearing C2-esters capable of directing Vorbrüggen glycosylation. The key step is the regioselective deoxygenation of the desired hydroxyl group as either the benzoyl- or 3-(trifluoromethyl)benzoyl derivative. This deoxygenation is accomplished via a photoinduced electron-transfer (PET) mechanism using carbazole derivatives as the photosensitizer. The syntheses of the desired deoxynucleoside generally proceed in three steps from a common, readily available precursor.

Introduction

Nucleosides and nucleoside analogues have long been an important class of medicinal agents, possessing anticancer and antiviral activity.[1,2] 5-Fluoro-2′-deoxyuridine is an inhibitor of thymidylate synthase and has been used clinically for the treatment of leukemia and colorectal cancer.[2] Recent interest in antiviral nucleosides has centered on the development of reverse transcriptase inhibitors as potential AIDS therapies.[1a] The nucleoside analogues 3′-azido-3′-deoxythymidine (AZT), 2′,3′-dideoxycytidine (ddC), 2′,3′-dideoxyinosine (ddI), and 2′,3′-dideoxy-3′-thiacytidine (3TC) are currently approved for the treatment of AIDS and are believed to work by termination of the replicating DNA chain since these compounds do not possess a 3′-hydroxyl group. In addition to these compounds, a number of nucleoside analogues have been synthesized and undergone preliminary clinical testing; this subject has been extensively reviewed in recent years.[1] Modified nucleosides play a central role in the development of genetic therapies such as triplex (antigene) and antisense strategies.[3] In these approaches, 2′-deoxyoligonucleotides can prevent the expression of specific genes, thus inhibiting the biosynthesis of disease related proteins. Thus, general and convenient methods for the synthesis of nucleosides are of obvious importance and widespread interest.[1]

The most widely used strategy for the chemical synthesis of nucleosides involves Vorbrüggen glycosylation of ribose tetraesters (**1**) with a silylated nucleoside base under strong Lewis acid conditions (Scheme 1).[4] In this approach, the presence of a C2-directing group on the ribose glycosylation precursor is necessary to control the anomeric stereochemistry; glycosylation of 2-deoxyribose derivatives generally leads to a mixture of anomers which can be difficult to separate.[5] If 2′-deoxyribonucleosides are desired, the 3′ and 5′-hydroxyls are selectively protected with a bifunctional silylating agent (**3**)[6] followed by radical deoxygenation of the 2′-hydroxyl as developed by Robins (Scheme 1).[7]

We are interested in developing more efficient methods for the deoxygenation of ribonucleosides to deoxynucleosides. For example, our strategy for the synthesis of β-2′-deoxynucleosides involved the preparation of a ribose glycosylation precursor in which the C2-hydroxyl was derivatized with a group capable of directing the glycosylation and serving as a deoxygenation precursor (Scheme 2). Since our initial report,[8] we have extended this strategy to the stereocontrolled syntheses of α-2′-deoxyribonucleosides,[9] β-3′-deoxyribonucleosides, and β-2′,3′-dideoxyribonucleosides. The key step in this work was the use of a photoinduced electron-transfer (PET) deoxy-

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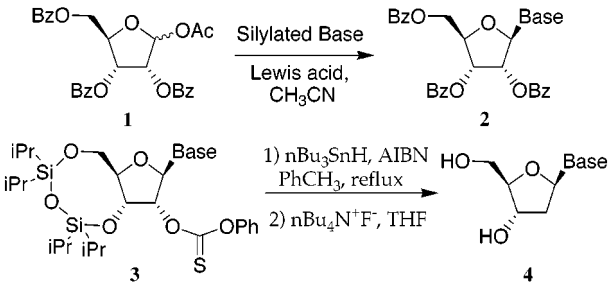
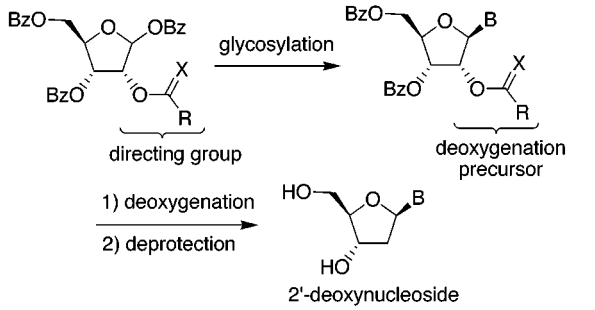
Scheme 1



Scheme 2

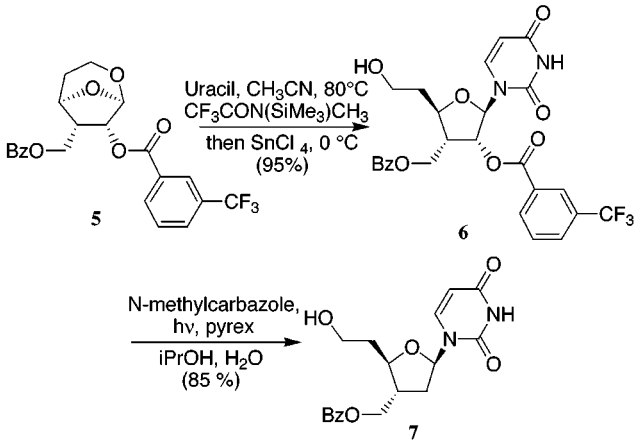


genation of 3-(trifluoromethyl)benzoates and benzoates using carbazoles as the photosensitizer.[10] This method has been used rather sparingly for the deoxygenation of alcohols.[11] Greenberg and co-workers have made excellent use of this PET deoxygenation to study the fate of nucleoside radicals as mechanistic models for oxidative damage to DNA.[12]

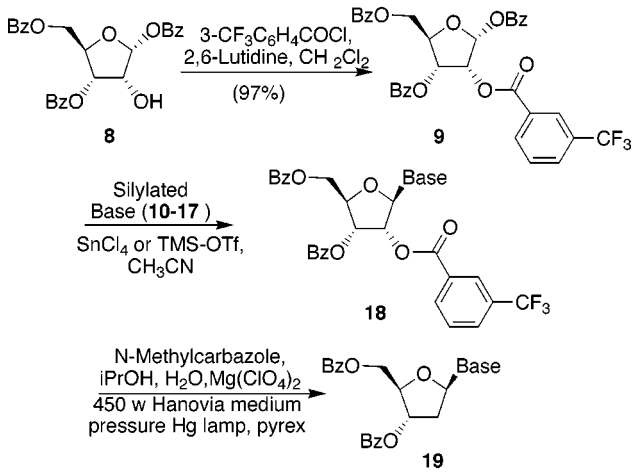
***β*-2′-Deoxyribonucleosides.** Prior to our work, Benner and co-workers reported an identical strategy for the synthesis of potential antisense nucleosides with modified backbones (Scheme 3).[13] In this work, a glycosylation precursor **5** was prepared in about 10 steps from diacetone glucose in which a 3-(trifluoromethyl)benzoyl group was used to direct the Vorbrüggen glycosylation. PET deoxygenation under the conditions originally reported by Saito[10a] using stoichiometric 9-methylcarbazole (MCZ) as the photosensitizer gave the 2′-deoxynucleoside analogues (**7**). It was also reported that PET deoxygenation of the corresponding cytidine derivative proceeded in lower yield and the *N*-benzoyladenosine derivative failed to give the desired 2′-deoxynucleoside analogue.[13a]

We generalized this approach for the synthesis of natural *β*-2′-deoxyribonucleosides according to Scheme 4.[8] The glycosylation precursor was easily prepared by esterification of commercially available α-D-1,3,5-triben-

Scheme 3



Scheme 4



zoylribofuranose (**8**) with *m*-(trifluoromethyl)benzoyl chloride to give **9**. Vorbrüggen glycosylation of **9** with silylated nucleoside bases (**10**-**17**) gave the protected *β*-ribonucleosides (**18**) in high yield; in no case did we detect any of the α-anomer. PET deoxygenation of **18** provided the corresponding protected *β*-2′-deoxyribonucleoside (**19**). Our results are shown in Table 1. Our original report was limited to the synthesis of *β*-2′-deoxypyrimidines (entries a−e) and the PET deoxygenation was accomplished as previously described by Saito,[10a] Benner,[13a] and others,[11,12] using stoichiometric 9-methylcarbazole (**20**, MCZ). We have since extended this strategy to the synthesis of *β*-2′-deoxypurines and have developed a more efficient photosensitizer, 3,6-dimethyl-9-ethylcarbazole (**21**, DMECZ, Figure 1).[10b] We proposed that the methyl groups of DMECZ block or slow potential degradation pathways of the carbazole radical cation, an intermediate in the PET deoxygenation, allowing for the photosensitizer to turnover. Deoxygenations are typically accomplished with 10−15 mol % of DMECZ. In addition, we found this photosensitizer to be significantly more reactive, deoxygenating both 3-(trifluoromethyl)benzoates and benzoates faster than stoichiometric MCZ.[10b] For the ribothymidine example **18b** (Scheme 5), deoxygenation with DMECZ gave protected thymidine (**19b**) in 52% yield along with 12% of the dideoxynucleoside **22**.[8b] The PET deoxygenations of examples f−h in Table 1, as well as all subsequent work, were accomplished using DMECZ and the 2′,3′-dideoxynucleosides were often minor products.

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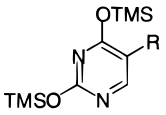
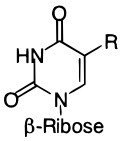
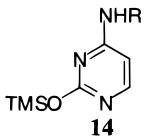
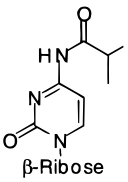
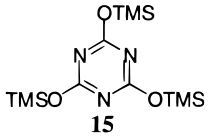
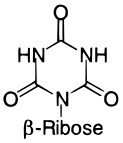
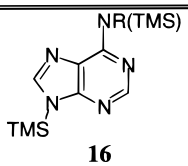
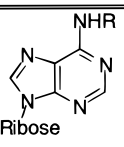
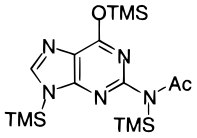
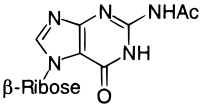
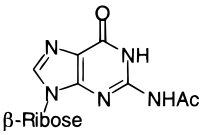
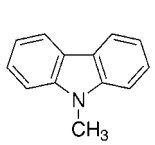
(13) (a) Huang, Z.; Schneider, K. C.; Benner, S. A. *J. Org. Chem.* **1991**, *56*, 3869. (b) This strategy was also proposed by Chapeau and Marnett: Chapeau, M.-C.; Marnett, L. J. *J. Org. Chem.* **1993**, *58*, 7258

Table 1. Yields for the Gycosylation of 9 and Deoxygenation of 18

Entry	Base	Yield of **18**	Protected Nucleoside	Yield of **19**
				
a	**10**, R=H	95		70
b	**11**, R= CH_3	98		73
c	**12**, R= F	91		53
d	**13**, R= CF_3	97		44
e	 **14**	91		62
f	 **15**	85		75
g	 **16**	80 R=Bz		<5 R=Bz
h		86 R=H (from **18g**)		58 R= H
i	 **17** (-20 °C)	85	 exclusively N7	75
j	**17** (reflux, 12 h)	72	 7:1 N9:N7	70


MCZ (**20**)

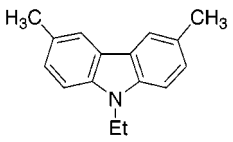
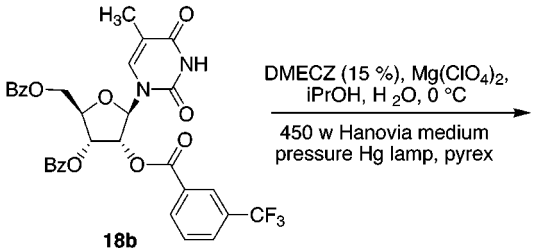

DMECZ (**21**)

Figure 1.

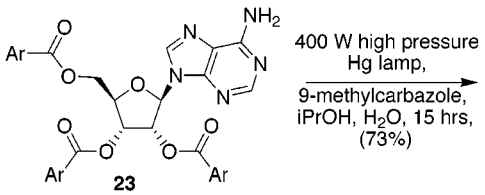
Scheme 5



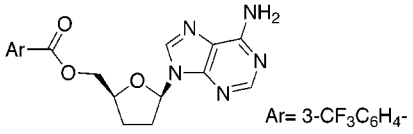
18b **19b** **22**

A second disadvantage to using MCZ as the photosensitizer is that the rate of PET deoxygenation is optimal at a substrate concentration of 1.4 mM. For ribonucleoside examples **18**, this translated to about 1 mg of substrate per mL of solution; increasing the substrate concentration resulted in sharp decreases in the rate of deoxygenation. We found using 15 mol % of DMECZ, the concentration of **18b** could be increased to nearly 10 mM with only a modest increase in reaction times.[8b]

Scheme 6



23



24

In all of our work, the PET deoxygenation reaction was carried out using a Hanovia medium-pressure Hg lamp through Pyrex, which has a UV cutoff of approximately 280 nm. The carbazole photosensitizers have UV absorbances at 290 (ϵ = 18 000), 330 (ϵ = 4400) and 340 (ϵ = 5400) for **20** and 300 (ϵ=18 000), 340 (ϵ = 4000) and 360 (ϵ = 4400) for **21**. When the deoxygenation was attempted through a uranium glass filter (340 nm cutoff), very little reaction was observed. This indicates that the absorbance at 290 and 300 for **20** and **21**, respectively, are probably responsible for the PET chemistry.

Glycosylation of **9** with per-silylated N^6-benzoyladenine gave the corresponding protected ribonucleoside (**18g**, R = Bz) in 80% yield as a single regio- and stereoisomer. PET deoxygenation, however only gave a trace of the desired product, consistent with the results previously reported by Benner.[13a] Saito demonstrated that adenosine derivative **23** could be successfully deoxygenated with stoichiometric MCZ (Scheme 6).[10a] The principle difference between **23** and our substrate (**18g**) is that N^6 is

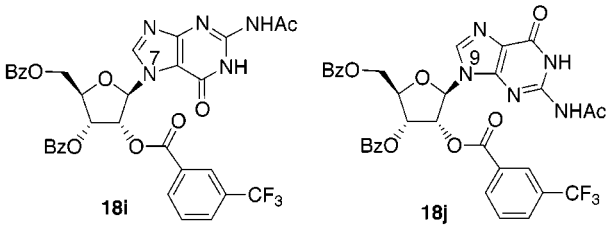
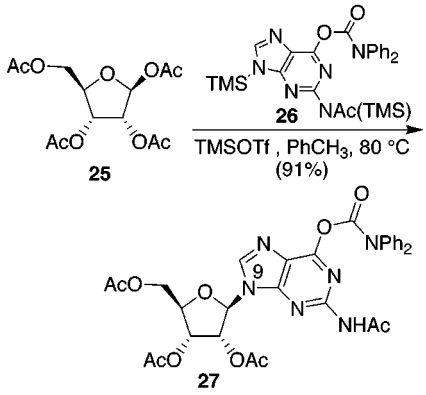


Figure 2.

Scheme 7



unprotected in the Saito example. Glycosylation with persilylated adenine without an N^6-protecting group gave the desired glycosylation product (**18h**, R = H), however, as a mixture of N9 and N7 regioisomers. It had been previously reported that selective N-deacylation of nucleoside bases could be achieved with zinc bromide.[14] We therefore elected to selectively deprotect the N^6-benzoyl group of **18g** (R = Bz) which was accomplished in 86% yield to give **18h** (R = H); PET deoxygenation now proceeded smoothly to give the corresponding 2′-deoxyadenosine derivatives (**19h**, R = H) in 58% yield.

The regiochemistry for the glycosylation of guanine is a long-standing problem in the synthesis of nucleosides giving a mixture of N9 (**18j**) and N7 (**18i**) products (Figure 2). Under kinetic conditions (Lewis acid, dichloroethane, −20 °C), Vorbrüggen glycosylation gave exclusively the unnatural N7-isomer (**18i**). When the reaction was heated at reflux for 8 h, the N9-isomer (**18j**) was isolated in 65% yield, along with 7% of the N7-isomer; importantly, these products were separable by flash chromatography on silica. These results are in accord with previous observations.[4a,15] The PET deoxygenation of both regioisomers proceeded smoothly.

Recently, solutions to the regiochemical problem of guanine glycosylation have been reported, most notably by Robins and co-workers (Scheme 7), who showed that glycosylation with the O^6-diphenylcarbamoyl derivative of N^2-acetylguanine (**26**, after in situ silylation) gave exclusively the N9-regioisomer (**27**).[16] While we were able to repeat the regioselective glycosylation of **25**, less optimistic results were obtained for the glycosylation of

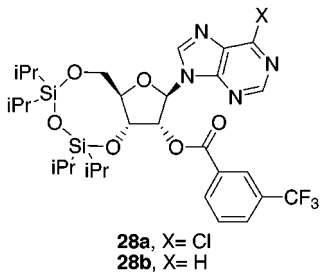


Figure 3.

9, giving instead a complex mixture of products that were difficult to purify by flash chromatography. Jenny and Benner reported that glycosylation with O^6-2-(4-nitrophenyl)ethyl-protected guanine gave exclusively the N9 glycosylated nucleoside; however, we did not feel that the 4-nitrophenyl group would be compatible with the PET deoxygenation reaction.[17]

Nucleosides with chloropurine bases such as 6-chloro-, 2,6-dichloro-, and 2-amino-6-chloropurine are important intermediates for the preparation of biologically active nucleosides. It has been shown that glycosylation of ribose tetraester with 6-chloropurine is regioselective, giving the N7-product exclusively.[18a] Previously, we attempted the PET deoxygenation of α-6-bromouridine derivative of **34** (Scheme 8) and observed a variety of decomposition products which we attributed to reduction of the 6-bromo group. We therefore had reservation as to whether the chloro group of chloropurines would survive the PET deoxygenation reaction. To test this, we prepared protected nucleoside **28a** (X = Cl) from commercially available 6-chloropurine ribonucleoside (Figure 3). Using DMECZ as the photosensitizer, attempted photodeoxygenation of **28a** resulted in clean dechlorination to give **28b**.[18b] The structure of **28b** was confirmed by independent synthesis from commercially available purine ribonucleoside

α-2′-Deoxyribonucleosides. α-Nucleosides have often been regarded as unwanted side products of nonstereoselective glycosylation reactions and there has been relatively little interest in their biological activity. Inspired by predictions made by Sequin based on Dreiding stereomodels,[19] Imbach prepared oligo-α-2′-deoxynucleotides in order to study their hybridization properties. In accord with Sequin's predictions, oligo-α-2′-deoxynucleotides hybridized with a complimentary oligo-β-2′-deoxynucleotides to form a B-like *parallel* duplex. The parallel nature of the hybridization was confirmed by 2D-NMR and molecular modeling[20] and the stability of the duplexes were studied by melting temperature (T_m)

(14) Kierzek, R.; Ito, H.; Bhatt, R.; Itakura, K. *Tetrahedron Lett.* **1981**, *22*, 3761.

(15) (a) Dudycz, L. W.; Wright, G. E. *Nucleosides Nucleotides* **1984**, *3*, 33. (b) Wright, G. E.; Dudycz, L. W. *J. Med. Chem.* **1984**, *27*, 175. (c) Garner, P.; Ramakanth, S. *J. Org. Chem.* **1988**, *53*, 1294.

(16) (a) Robins, M. J.; Zou, R.; Guo, Z.; Wnuk, S. F. *J. Org. Chem.* **1996**, *61*, 9207. (b) Zou, R.; Robins, M. J. *Can. J. Chem.* **1987**, *65*, 1436. (c) Robins, M. J.; Zou, R.; Hansske, F.; Madej, D.; Tyrrell, D. L. J. *Nucleosides Nucleotides* **1989**, *8*, 725.

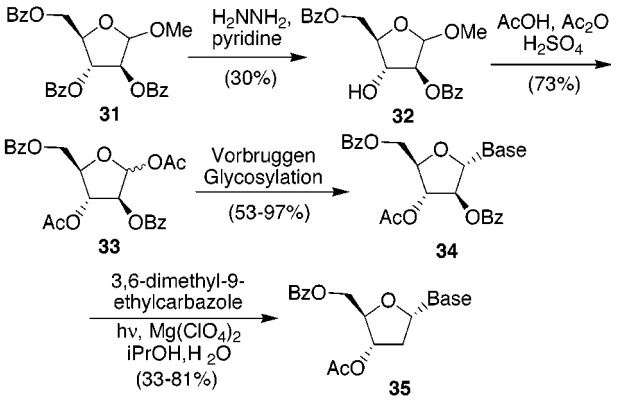
(17) (a) Jenny, T. F.; Benner, S. A.; *Tetrahedron Lett.* **1992**, *33*, 6619. (b) For an enzymatic solution to the regiochemical problem of guanine glycosylation see: Müller, M.; Hutchinson, L. K.; Guengerich, F. P. *Chem. Res. Toxicol.* **1996**, *9*, 1140 and references therein.

(18) (a) Saneyoshi, M.; Satoh, E. *Chem. Pharm. Bull.* **1979**, *27*, 2518. (b) We are grateful to a reviewer of this manuscript for suggesting this experiments.

(19) Sequin, U. *Experientia* **1973**, *29*, 1059.

(20) (a) Morvan, F.; Rayner, B.; Imbach, J. L. *Anticancer Drug Des.* **1991**, *6*, 521. (b) Morvan, F.; Rayner, B.; Imbach, J.-L.; Chang, D.-K.; Lown, J. W. *Nucleosides Nucleotides* **1987**, *6*, 471. (c) Debart, F.; Rayner, B.; Degols, G.; Imbach, J.-L. *Nucleic Acids Res.* **1992**, *20*, 1193. (d) Gmeiner, W. H.; Rao, K. E.; Rayner, B.; Vasseur, J.-J.; Morvan, F.; Imbach, J.-L.; Lown, J. W. *Biochemistry* **1990**, *29*, 10329. (e) Also see ref 1c and references therein.

Scheme 8



measurements.[21] The stability of the parallel α−β hybrid was dependent upon the sequence but was generally in the range of the corresponding antiparallel β−β duplex. Of note, the unnatural oligo-α-2′-deoxynucleotides were resistant to enzymatic degradation making them of interest as potential antisense agents.[1c,20,21]

α-Nucleosides are prepared by nonstereoselective glycosylation from a 2-deoxyribose precursor or anomerization of natural 2′-deoxynucleosides with Lewis acids;[22] both methods require separation of the anomers. We set out to extend our strategy for the stereocontrolled synthesis of β-2′-deoxyribonucleosides to the α-anomers. It is documented that Vorbrüggen glycosylation of arabinose tetraesters selectively gives the α-anomeric stereochemistry.[23] Our initial plan was to invert the C-2 stereochemistry of **8** to give the desired arabinose derivative, however Mitsunobu reaction of **8** with 3-(trifluoromethyl)benzoic acid failed to give the desired inverted product under a variety of conditions.[9,24] Instead, we obtained compound **29** (Figure 4) which we believe arises from an S_N1 type mechanism with suprafacial migration of the anomeric benzoate.[9] Glycosylation of **29** with bistrimethylsilylthymidine gave **30**, the structure of which was confirmed by independent synthesis providing further support for the structure of **29**. Concurrent with our work, Perez-Perez reported that under different conditions, Mitsonobu reaction of **8** gave retention of the C2-configuration, providing **9** in up to 70% yield.[24]

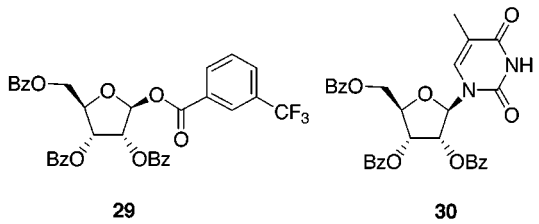
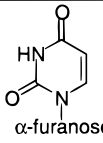
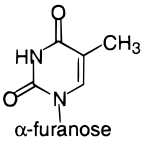
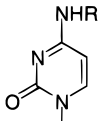
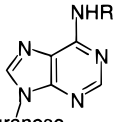
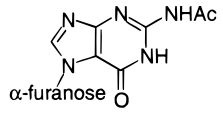
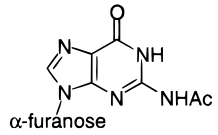


Figure 4.

The synthesis of a suitable glycosylation precursor (**33**) is shown in Scheme 8. It is reported that the C2-benzoate of methyl arabinoside 2,3,5-tribenzoate (**31**) could be selectively hydrolyzed,[25] however in our hands this was only a minor product with the major product being the C3-deprotected compound **32**. The ability of 3,6-dimethyl-9-ethylcarbazole to efficiently deoxygenate benzoates is now a key observation in that the C2-benzoyl group could be used instead of the more expensive 3-(trifluoromethyl)-benzoate as the directing group and deoxygenation precursor. Acetylation of **32** and Vorbrüggen glycosylation of **33** gave arabinonucleoside **34** exclusively as the α-anomer. PET deoxygenation of the 2′-benzoate provided the protected α-2′-deoxynucleoside **35**. The sequence required seven steps from arabinose, but only three steps from common intermediate **33**. The results of our effort toward α-2′-deoxynucleosides are summarized in Table 2.[9]

Table 2. Synthesis of α-2′-Deoxynucleosides. Yields for the Glycosylation of 33 and Deoxygenation of 34

Entry	Silylated Base	Yield of **34**	Protected Nucleoside	Yield of **35**
a	**10**	94	 α-furanose	69
b	**11**	97	 α-furanose	73
c	**14** (R=Ac)	95	 α-furanose	dec.
d	**14** (R=H)	93		33
e.	**16** (R= Bz)	87 R= Bz	 α-furanose	<5 (R=Bz)
f.	R=H	88 (from **34e**)		76 (R= H)
g.	**17** (-20 °C)	92	 α-furanose exclusively N7	78
h.	**17** (reflux, 12 h)	53	 α-furanose 6:1 N9:N7	81

In most cases, the glycosylation proceeded smoothly to give the desired protected α-arabinonucleoside **34**. The

(21) (a) Morvan, F.; Rayner, B.; Imbach, J.-L.; Thenet, S.; Bertrand, J.-R.; Paoletti, J.; Malvy, C.; Paoletti, C. *Nucleic Acids Res.* **1987**, *15*, 3421. (b) Cazenave, C.; Chevrier, M.; Thuong, N. T.; Helene, C. *Nucleic Acids Res.* **1987**, *15*, 10507.

(22) (a) Yamaguchi, T.; Saneyoshi, M. *Chem. Pharm. Bull.* **1984**, *32*, 1441. (b) Ward, D. I.; Jeffs, S. M.; Coe, P. L.; Walker, R. T. *Tetrahedron Lett.* **1993**, *34*, 6779. (c) Morvan, F.; Rayner, B.; Imbach, J.-L. In *Protocols for Oligonucleotides and Analogs; Synthesis and Properties*; Agrawal, S., Ed.; Humana Press: Totowa, NJ, 1993; pp 261−283.

(23) Adams, A. D.; Petrie, C. R.; Meyer, R. B. *Nucleic Acids Res.* **1991**, *19*, 3647.

(24) (a) Rubira, M.-J.; Perez-Perez, M.-J.; Balzarini, J.; Camarasa, M.-J. *Synlett* **1998**, 177. (b) Hughes, D. L. *Org. React.* **1992**, *42*, 335.

(25) (a) Ishido, Y.; Sakairi, N.; Sekiya, M.; Nakazaki, N. *Carbohydr. Res.* **1981**, *97*, 51. (b) Kawabata, Y.; Kaneko, S.; Kusakabe, I.; Gama, Y. *Carbohydr. Res.* **1995**, *267*, 39.

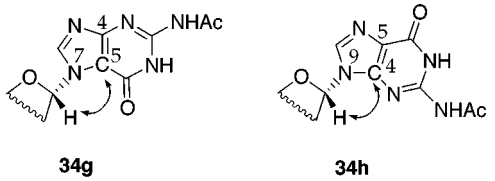


Figure 5.

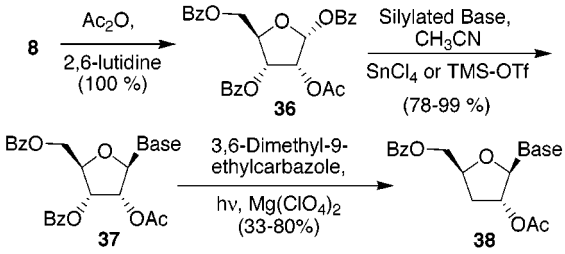
deoxygenation of the 2′-*O*-benzoyl group using 3,6-dimethyl-9-ethylcarbazole as the photosensitizer worked with varying success. We found that the attempted deoxygenation of protected α-arabinocytosine and adenine (**34c** and **34e**) gave decomposition. Based on the Saito result discussed earlier,[10a] we suspected that the protecting group on the exocyclic amino group might be responsible for the photodecomposition. In analogy to the β-nucleoside series, selective deprotection of the N^6-benzoyl group of **34e** with $ZnBr_2$ gave **34f**, which undergoes PET deoxygenation to afford α-2′-deoxyadenosine in 76% yield. However, deoxygenation with N^6-unprotected cytosine (**34d**) proceeded in only 33% yield with 35% recovery of starting material (entry d, Table 2). Prolonged irradiation gave lower yields of the desired product.

Glycosylation of N^2-acetylguanine at −20 °C gave exclusively the N7-glycosylated α-guanosine derivative (entry g) in analogy with the β-series discussed earlier. When the glycosylation was carried out in acetonitrile at reflux, the α-N9-guanosine derivative was isolated in 53% yield along with 8% of the α-N7 isomer. Both the N7- and N9-regioisomers were deoxygenated in excellent yield.

In the β-series, the structure of the N9 regioisomer was confirmed by chemical correlation to natural guanosine. The N7 and N9 regioisomers of simple methylated purines have been distinguished by selective INEPT spectra where the *N*-methyl protons were irradiated and either the C4 or C5 carbon resonance was enhanced.[26] For the α-nucleosides and other unnatural nucleoside analogues, we relied on long-range $^1H-^{13}C$ heteronuclear correlation spectroscopy (HMBC) to unambiguously assign the structures.[27] We were able to correlate three-bond coupling from the anomeric proton (H1′) to key carbon resonances of the base (Figure 5). In general, upon 2′-deoxygenation, the key $^1H-^{13}C$ three-bond coupling constant were on the order of 1−2 Hz and were regarded as unreliable; these coupling constants were significantly larger (∼10 Hz) at the ribo- or arabinonucleoside stage. For the N7-isomer, we observed three bond coupling from H1′ (δ = 6.64 ppm) to C5 (δ = 111.4 ppm) of the base, but not to C4 (δ = 157.5 ppm). For N9-guanosine, three bond coupling was observed from H1′ (δ = 6.24 ppm) to C4 (δ = 155 ppm). The carbon resonances of guanosine have been previously assigned.[28] Our assignments are also in accord with the empirical observation that the C8 proton of the N-7-isomer is downfield from that of the N9-isomer.[29]

***β*-3′-Deoxyribonucleosides.** β-3′-Deoxynucleosides have been known for over 40 years. Much of the interest in this class of compounds has centered on cordycepin (3′-deoxyadenosine), which was the first reported nucleoside antibiotic.[30] More recently, 3′-deoxynucleosides were shown to possess antiviral, antifungal and antitumor activities as well.[31] Oligomers of 3′-deoxynucleosides possessing the unnatural 2′,5′-phosphodiester linkage have also attracted some interest.[32,33]

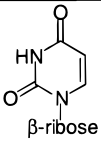
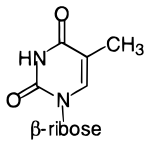
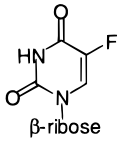
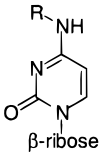
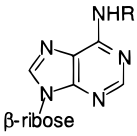
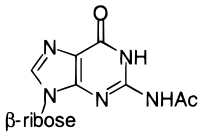
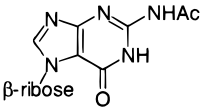
Scheme 9



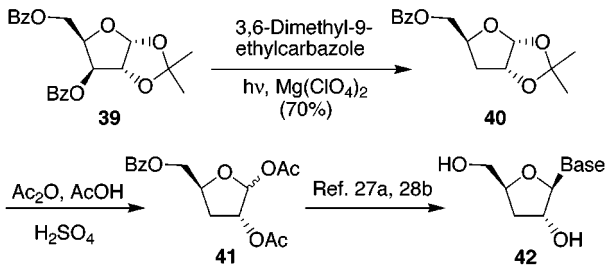
We have extended our strategy to include β-3′-deoxynucleosides (Scheme 9), which also rely on the ability of DMECZ to deoxygenate simple benzoyl groups. Acylation of α-1,3,5-tribenzoylribose (**8**) gave glycosylation precursor **36**. Glycosylation of **36** is directed by the C2-acetyl group to give exclusively the β-ribonucleoside **37**. Deoxygenation using 3,6-dimethyl-9-ethylcarbazole provided the protected β-3′-deoxyribonucleoside (**38**) in variable yield (Table 3). We found that deoxygenation of the 3′-position of **37** is much slower than the 2′-position of **18** or **34**, used in the synthesis of β- and α-2′-deoxyribonucleosides, and required significantly longer reaction times. Unfortunately, the longer reaction times allow for unwanted side reactions or decomposition to take place. For instance, PET deoxygenation of **37b** (base = T) gave only 33% of the desired product with the major product arising from reduction of the 5,6-double bond of the base. When the deoxygenation was carried out in 2-propanol-*d*1 (^{i}Pr-OD), we observed no deuterium incorporation in the 5,6-dihydroribothymidine products. When per-deuterated 2-propanol-d_8 was used, the rate of this undesired reaction was significantly slowed so that 3′-deoxygenation was the only observed product (61% yield). NMR analysis of the 3′-deoxy-5-methyluridine (**38b**) indicated that deuterium was incorporated exclusively into the 3′-α-position. 5-Fluorouridine derivative **37c**, gave decomposition upon attempted PET deoxygenation, presumably through the 5,6-dihydro derivative. Attempted PET

(26) Osterman, P. M.; McKittrick, B. A.; Chan, T.-M. *Tetrahedron Lett.* **1992**, *33*, 4867.
(27) Wang, Z.; Rizzo, C. J. *Org. Lett.* **2000**, *2*, 227.
(28) Kalinowski, H.-O.; Berger, S.; Braun, S. *Carbon-13 NMR Spectroscopy*; J. Wiley & Sons: New York, 1988; p 440.
(29) Kjellberg, J.; Johansson, N.; G. *Tetrahedron* **1986**, *42*, 6541.
(30) Murray, D. H.; Prokop, J. *J. Pharm. Sci.* **1965**, *54*, 1468.
(31) (a) Kumar, A.; Khan, S. I.; Manglani, A.; Khan, A. K.; Katti, S. B. *Nucleosides Nucleotides* **1994**, *13*, 1049. (b) Ge, G.-X.; Bischofberger, N. *Tetrahedron Lett.* **1995**, *36*, 6991. (c) Jagger, D. V.; Kredich, N. M.; Guarino, A. J. *Cancer Res.* **1961**, *21*, 216. (d) Nakatsugawa, S.; Dewey, W. C. *Int. J. Radiat. Oncol., Biol., Phys.* **1984**, *10*, 1425. (e) Widell, A.; Hansson, B. G.; Oberg, B.; Nordenfelt, E. *Antiviral Res.* **1986**, *6*, 103. (f) Volpini, R.; Camaioni, E.; Costanzi, S.; Vittori, S.; Cristalli, G. *Helv. Chim. Acta* **1998**, *81*, 2326. (g) Volpini, R.; Costanzi, S.; Vittori, S.; Cristalli, G.; Lupidi, G. *Helv. Chim. Acta* **1999**, *82*, 2112. (h) Ghosal, S.; KrishnaPrasad, B. N.; Khanna, M.; Dwivedi, A. K.; Singh, S.; Kumar, A.; Katti, S. B. *Int. J. Pharm.* **2000**, *194*, 15. (i) Gosselin, G.; Boudou, V.; Griffon, J.-F.; Pavia, G.; Pierra, C.; Imbach, J.-L.; Faraj, A.; Sommadossi, J.-P. *Nucleosides Nucleotides* **1998**, *17*, 1731.
(32) (a) Dougherty, J. P.; Rizzo, C. J.; Breslow, R. *J. Am. Chem. Soc.* **1992**, *114*, 6254. (b) Rizzo, C. J.; Dougherty, J. P.; Breslow, R. *Tetrahedron Lett.* **1992**, *33*, 4129. (c) Jin, R.; Chapman, W. H.; Srinivasan, A. R.; Olson, W. K.; Breslow, R.; Breslauer, K. J. *Proc. Natl. Acad. Sci. U.S.A.* **1993**, *90*, 10568. (d) Sheppard, T. L.; Rosenblatt, A. T.; Breslow, R. *J. Org. Chem.* **1994**, *59*, 7243. (e) Sheppard, T. L.; Breslow, R. C. *J. Am. Chem. Soc.* **1996**, *118*, 9810. (f) Breslow, R.; Sheppard, T. L. *Pure Appl. Chem.* **1996**, *68*, 2037.
(33) (a) Hashimoto, H.; Switzer, C. *J. Am. Chem. Soc.* **1992**, *114*, 6255. (b) Kung, K.-E.; Switzer, C. *J. Am. Chem. Soc.* **1994**, *116*, 6059. (c) Robinson, H.; Jung, K.-E.; Switzer, C.; Wang, A. H.-J. *J. Am. Chem. Soc.* **1995**, *117*, 837.

Table 3. Synthesis of β-3′-Deoxynucleosides. Yields for the Glycosylation of 36 and Deoxygenation of 37

Entry	Silylated Base	Yield of **37**	Protected Nucleoside	Yield of **38**
a	**10**	99		60
b.	**11**	94		33
c.	**12**	89		dec.
d.	**14** (R=Ac)	86		No reaction
e.	**14** (R=H)	66		No reaction
f.	**16** (R= Bz)	91		
g.	(R= H)	75 (from **37f**)		78
h.	**17** TMSOTf, reflux	78	 6:1 N9 : N7	71
i.	**17** $SnCl_4$, -20 °C	96		80

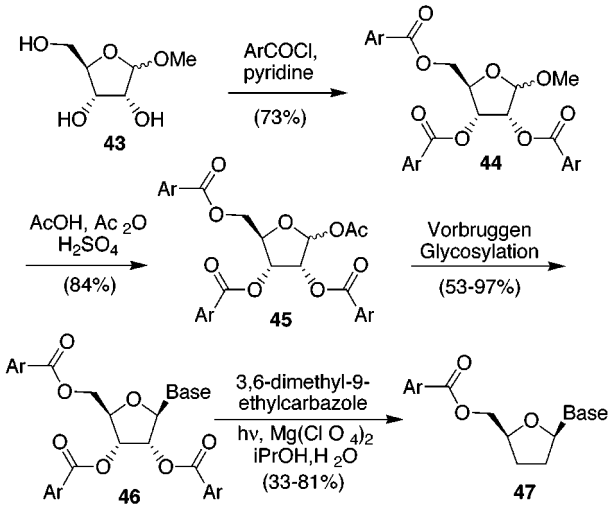
Scheme 10



deoxygenation of the N4-protected or unprotected cytidine (entries d and e) gave no reaction. The corresponding uridine and N7 and N9 guanosine derivatives of **37** undergo PET deoxygenation in 66−80% yield.

Stereocontrolled syntheses of 3′-deoxynucleosides have been previously reported from the glycosylation of **41** (Scheme 10). In this work, **41** was prepared from commercially available 1,2-*O*-isopropylidene-D-xylose by selective benzoylation of the C5-hydroxyl followed by Barton deoxygenation of the C3-position to give **40**.[31a,f,32b]

Scheme 11



We have previously shown that **40**, the immediate precursor to **41**, can be conveniently prepared by benzoylation of 1,2-*O*-isopropylidene-D-xylose to give **39**, followed by PET deoxygenation.[10b] Given some of the difficulties we experienced in the deoxygenation of **37** such as long reactions times and unwanted side reactions, the synthesis of β-3′-deoxynucleosides from **41** (Scheme 10) may be superior in some cases.

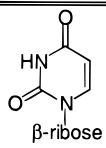
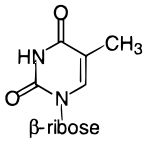
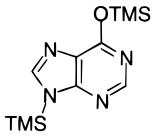
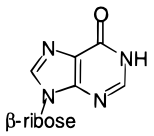
2′,3′-Dideoxyribonucleosides. In addition to being an important class of antiviral agents,[34] 2′,3′-dideoxynucleosides are an established class of anticancer nucleosides, particularly for virally transmitted leukemias.[35] They are also key reagents used in the Sanger method of DNA sequencing. Of particular interest is the incorporation of fluorescent tags on dideoxynucleosides so that detection is spectrophotometric rather than requiring a radioactive ^{32}P label. As such, there is still some interest in efficient methods for the de novo synthesis of this class of compounds. Approaches involving tin hydride reduction of 2′,3′-bis-xanthates produce the 2′,3′-olefin since the radical that results from reduction of one xanthate disproportionates to give the double bond.[1a] Since α-benzoyl radicals do not undergo disproportionation, each benzoate is reduced independently to give the saturated product directly.

With the example shown in Scheme 6, Saito demonstrated that the PET deoxygenation is a viable route to β-2′,3′-dideoxyribonucleosides.[10a] We have generalized this approach for the synthesis of β-2′,3′-dideoxyribonucleosides (Scheme 11). Glycosylation precursor **45** was synthesized in three steps from ribose (Ar = 3-(trifluoromethyl)benzoyl-). For entries **a** and **b** (Table 4), glycosylation gave the β-ribonucleosides **46a** and **b** as a single regioisomer. In the case of per-silylated hypoxanthine (entry c), we obtained an inseparable 1:1 mixture of N7- and N9-regioisomers. To explore the deoxygenation of **46c**, the desired N9 regioisomer was prepared by esterification of inosine with 3-(trifluoromethyl)benzoyl chlo-

(34) Herdewijn, P.; Balzarini, J.; De Clercq, E. In *Advances in Antiviral Drug Design*; De Clercq, E., Ed.; JAI Press: Greenwich, 1993; Vol. 1, pp 233−318.

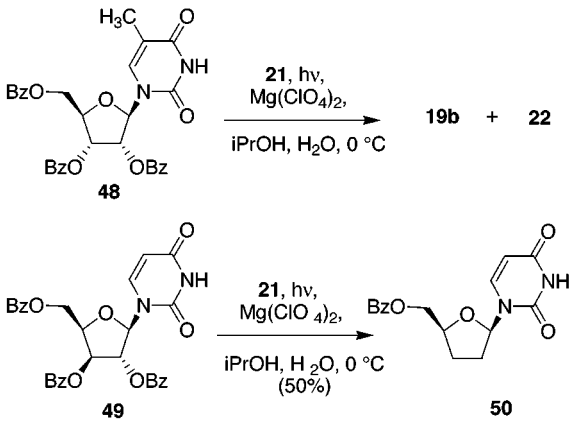
(35) (a) Lin, T.-S.; Liu, M.-C. In *Nucleosides and Nucleotides as Antitumor and Antiviral Agents*; Chu, C. K., Baker, D. C., Eds.; Plenum Press: New York, 1993; 177−202. (b) Lin, T.-S.; Chen, M. S.; McLaren, C.; Gao, Y.-S.; Ghazzouli, I.; Prusoff, W. H. *J. Med. Chem.* **1987**, *30*, 440.

Table 4. Synthesis of β-2′,3′-Deoxynucleosides. Yields for the Gycosylation of 45 and Deoxygenation of 46 (Ar = 3-$CF_3C_6H_4$−)

Entry	Base	Protected Nucleoside	Yield of **46**	Yield of **47**
a	**10**		91	68
b	**11**		95	85
c			89	65

1:1 N9:N7

Scheme 12

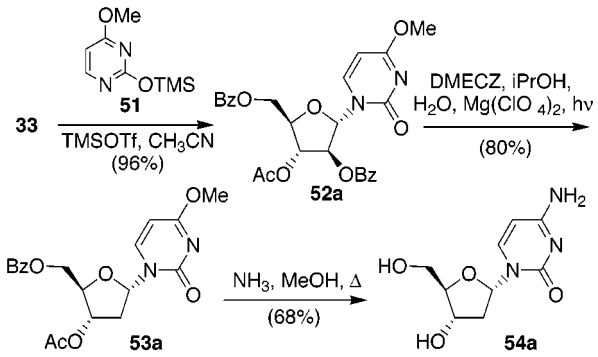


ride in pyridine. The PET deoxygenation to the corresponding β-2′,3′-dideoxyribonucleosides (**47**) proceeded in good yield.

Since we have shown that 3,6-dimethyl-9-ethylcarbazole is capable of deoxygenating benzoates, we examined the dideoxygenation of benzoyl-protected ribonucleoside **48** (Scheme 12). An advantage to this sequence is that the glycosylation precursor, 1-acetyl-2,3,5-tribenzoylribose (**1**), is commercially available and the de novo synthesis of 2′,3′-dideoxynucleoside would require only three steps from this starting material. The Vorbrüggen glycosylation of **1** is well established.[1,4] When the deoxygenation of 2′,3′,5′-tri-*O*-benzoyluridine (**48**) was attempted with DMECZ (**21**) as the photosensitizer, we found that the reaction could be stopped at the 2′-deoxy stage (Scheme 12). Upon prolonged irradiation, the 2′,3′-dideoxynucleoside was obtained, although the reaction time was significantly longer than for **46a**.

Since the 3′-α-position seems to be inherently more difficult to deoxygenate, we also examined the deoxygenation of the corresponding xylonucleoside which possesses the 3′-β-stereochemistry (Scheme 12). β-Xylonucleoside **49** was prepared via Vorbrüggen glycosylation of commercially available 1,2,3,5-tetra-*O*-benzoylxylofuranose

Scheme 13



in 94% yield.[36] PET deoxygenation of **49** was somewhat improved over **46b** or **48**, giving the desired 2′,3′-dideoxynucleoside **50**, in 50% unoptimized yield along with an inseparable mixture of 2′-deoxy- and 3′-deoxynucleoside.

Synthesis of Deoxycytidines. Although we reported that N^4-protected cytidine **18e** (R = −$CH(CH_3)_2$) in the β-series undergoes PET deoxygenation (Table 1), we have subsequently found the deoxygenation of this and other cytidine derivatives to be capricious and in some cases not work at all, which is consistent with previous studies by Benner.[13a] It is well established that uridine can be converted into cytidines by conversion of the C4-carbonyl to a thionocarbonyl (Lawesson's reagents) or the 4-triazolo group (triazole, $POCl_3$) followed by aminolysis.[37] A general solution for the synthesis of cytidines via the PET deoxygenation route was developed and is shown in Scheme 13 for α-2′-deoxycytidine. Vorbrüggen glycosylation was accomplished with silylated 4-methoxypyrimidone (**51**) and the intermediate α-arabinonucleoside **52a** was deoxygenation in good yield. Treatment of the deoxynucleoside **53a** with methanolic ammonia in a sealed tube at 100 °C, deprotects the 3′- and 5′-esters as well as displaces the C4-methoxy group to give α-2′-deoxycytidine (**54a**) in 68% yield.[38] We successfully extended this sequence to the β-2′-deoxy and β-3′-deoxy series as well (Table 5).

We attempted to further extend this strategy to the synthesis of the anticancer nucleoside 5-aza-2′-deoxycytidine (**58**, Scheme 14).[39] Glycosylation of **9** with silylated 4-methoxy-5-azapyrimidone[40] (**55**) gave ribonucleoside **56** in 85% yield. Unfortunately, PET deoxygenation of **56** proceeded poorly, giving a number of unidentified products, from which **57** was isolated in less than 10% yield. The PET deoxygenation substrate (**56**) was stable to the irradiation conditions without DMECZ, however, when the photosenstizer was added, it was quickly consumed. A ribonucleoside similar to intermediate **57** with 2′,3′,5′-acetyl groups has been previously converted to 5-aza-2′-deoxycytidine (**58**) by displacement of a 4-methoxy group with ammonia.[38b]

Summary. In summary, we have developed a unified synthetic strategy for the synthesis of β-2′-deoxyribo-

(36) Gosselin, G.; Bergogne, M. C.; de Rudder, J.; De Clercq, E.; Imbach, J. L. *J. Med. Chem.* **1986**, *29*, 203.

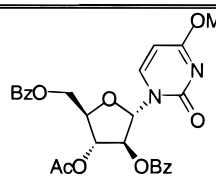
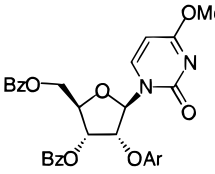
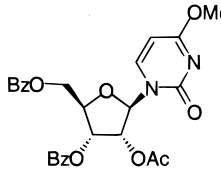
(37) (a) Kaneko, K.; Katayama, H.; Wakabayashi, T.; Kumonaka, T. *Synthesis* **1988**, 152. (b) Sung, W. L. *J. Org. Chem.* **1982**, *47*, 3623.

(38) (a) Acedo, M.; Fabrega, C.; Avino, A.; Goodman, M.; Fagan, P.; Wemmer, D.; Eritja, R. *Nucleic Acid. Res.* **1994**, *22*, 2982. (b) Pikala, A.; Sorm, F. *Collect. Czech. Chem. Commun.* **1964**, *29*, 2060.

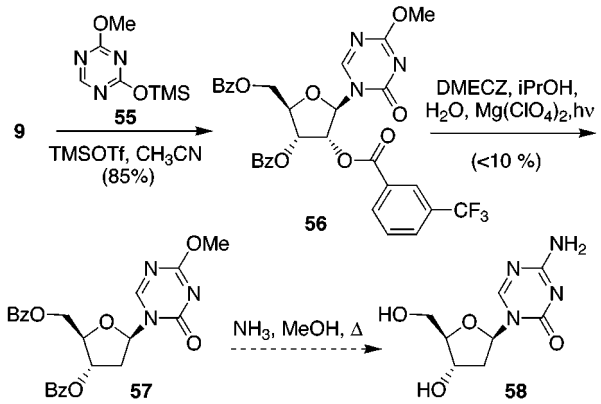
(39) (a) Momparler, R. L. *Pharmac. Ther.* **1985**, *30*, 287. (b) Driscoll, J. S.; Johns, D. A.; Plowman, J. *Invest. New Drugs* **1985**, *3*, 331.

(40) Piskala, A.; Gut, J. *Collect. Czech. Chem. Commun.* **1963**, *28*, 1681.

Table 5. Synthesis of Deoxycytidines (Ar = 3-$CF_3C_6H_4CO$−)

Entry	Protected Pyrimidones Nucleoside	Yield of **52**	Yield of **53**	Yield of **54**
a		96 from **33**	80	68
b	 Ar= 3-$CF_3C_6H_4$-	92 from **9**	63	50
c		83 from **36**	55	80

Scheme 14



nucleosides, α-2′-deoxyribonucleosides, β-3′-deoxyribonucleosides, and β-2′,3′-dideoxy-nucleosides. The overall strategy is shown in Scheme 15 and involved the preparation of strategically protected furanose tetra-ester glycosylation precursors. The stereochemistry of the Vorbrüggen glycosylation is directed by a C2-ester of the glycosylation precursor. The key step in the sequences is the selective deoxygenation of a benzoyl or 3-(trifluoromethyl)benzoyl group of the ribo-, arabino- or xylo-nucleoside via a photoinduced electron-transfer (PET) mechanism using carbazoles as the photosensitizer to give the desired deoxynucleoside. In each case, the glycosylation precursor is readily available and the deoxynucleosides are obtained in three steps from a common intermediate. While the developmental work described here was typically performed on less than 0.1 mmol scale, we have recently showed that the sequence can carried out to provide one gram of the protected deoxygenated nucleoside using a 500 mL photochemical immersion well.[8b] Thus, our work should make modified deoxynucleosides available in gram quantities by an operationally simple procedure. Of note, we have made significant practical improvements of the PET deoxygenation of benzoyl groups that made this unified synthetic strategy possible and this method of deoxygenation much more useful. By studying the radical cation chemistry of carbazoles, an intermediate in the PET deoxygenation reaction, we were able to design new, more reactive carbazole photosensitizers (DMECZ) that showed turnover and is typically used in 10 mol %.[10b] These improvements will make the PET deoxygenation of benzoyl derivatives more useful to synthetic chemists as an alternative to the Barton and related deoxygenation reactions.

Experimental Section

All commercially obtained chemicals were used as received. Acetonitrile and 2,6-lutidine were purchased from Aldrich in Sure Seal bottles and used as received. Methylene chloride was freshly distilled from calcium hydride. All reactions were performed under an argon atmosphere. Melting points are uncorrected. Proton and carbon-13 NMR data were recorded at 300 and 75 MHz, respectively in $CDCl_3$ unless otherwise noted. Coupling constants are reported as absolute values in Hz. Elemental analyses were performed by Atlantic Microlabs (Norcross, GA). High resolution FAB mass spectra were obtained from the University of Illinois or the University of Notre Dame Mass Spectrometry Centers using either "magic bullet" (MB) or nitrobenzyl alcohol (NBA) as the matrix. 9-Methylcarbazole (MCZ) was purchased from Aldrich and recrystallized from ethanol; 3,6-dimethyl-9-ethylcarbazole was prepared as previously described.[41] Silylated pyrimidine bases were prepared and distilled as previously reported;[42] purine bases were silylated in situ.[15]

α-D-1,3,5-Tri-*O*-benzoyl-2-*O*-[3-(trifluoromethyl)benzoyl]-ribofuranose (9). A stirred solution of 1,3,5-tri-*O*-benzoyl-α-D-ribofuranose (**8**, 436 mg, 1.0 mmol) and 2,6-lutidine (0.14 mL, 1.2 mmol) in dry CH_2Cl_2 (10 mL) was cooled to 0 °C, and then 3-(trifluoromethyl)benzoyl chloride (0.23 mL, 1.5 mmol) was added dropwise. The solution was stirred for 2.5 h at room temperature and then quenched with saturated aqueous bicarbonate, and the aqueous layer was extracted with ethyl acetate. The combined organic layers were dried over anhydrous magnesium sulfate, filtered, and concentrated. The residue was purified by flash chromatography eluting with 25% ethyl acetate in hexanes. The resulting solid was recrystallized from ethyl acetate/hexane to give 615 mg (97%) of **9** as white prisms: mp 109−111 °C (lit.[43] mp 102 °C); $[\alpha]^{23}_D$ +89.5° (*c* 0.1, $CHCl_3$); ^{1}H NMR ($CDCl_3$) δ 8.11−8.0 (m, 8H), 7.72 (d, J = 4.3, 1H), 7.61−7.31 (m, 10H), 6.91 (d, J = 4.3, 1H), 5.88 (dd, J = 2.1, 6.5, 1H), 5.79 (dd, J = 4.4, 6.5, 1H), 4.93 (m, 1H), 4.71 (ABX, J_{AB} = 12.1, J_{AX} = 3.5, J_{BX} = 3.1, $\Delta\nu_{AB}$ = 32.6, 2H); ^{13}C NMR δ 166.0, 165.6, 165.1, 163.5, 133.7, 133.6, 133.4, 133.0, 130.0, 129.8, 129.7, 129.5, 129.3, 129.2, 128.9, 128.6, 128.5, 128.4, 126.4, 126.3, 94.9, 82.8, 71.5, 70.7, 64.0.

Anal. Calcd for $C_{34}H_{25}F_3O_9$: C, 64.36; H, 3. 97. Found: C, 64.36; H, 3.99.

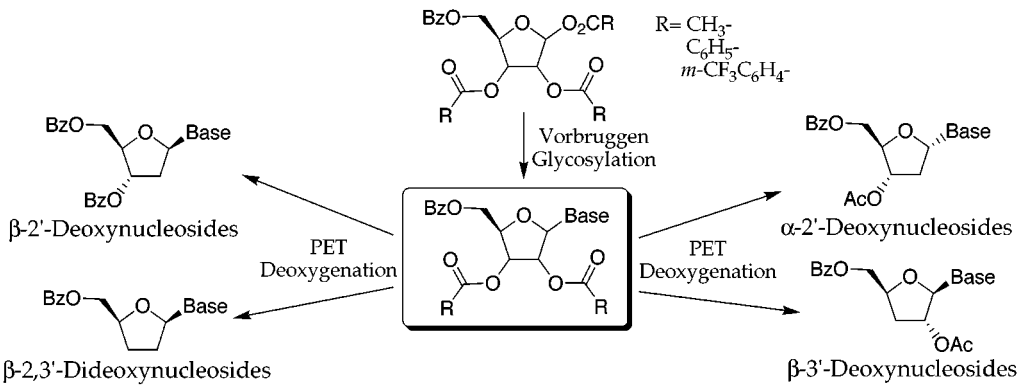
General Procedure for the Glycosylation Reaction. 3′,5′-Di-*O*-benzoyl-2′-*O*-[3-(trifluoromethyl)benzoyl]uridine (18a). A stirred solution of **9** (1.0 g, 1.6 mmol) and 2,4-bis-trimethylsilyluracil (**10**) [42] (0.577 g, 2.4 mmol) in dry CH_3CN (16 mL) was cooled to 0 °C, and then $SnCl_4$ (2.08 g, 8.0 mmol) was added dropwise with vigorous stirring. The reaction was warmed to room temperature and stirred for 4 h, after which time the reaction was quenched with saturated aqueous bicarbonate. The mixture was filtered through a pad of Celite and extracted with ethyl acetate. The organic extracts were washed with brine, dried over anhydrous sodium sulfate,

(41) (a) Park, M.; Buck, J. R.; Rizzo, C. J. *Tetrahedron* **1998**, *54*, 12707. (b) Buck, J. R.; Park, M.; Wang, Z.; Prudhomme, D. R.; Rizzo, C. J. *Org. Synth.* **1999**, *77*, 153.

(42) (a) Nishimura, T.; Iwai, I. *Chem. Pharm. Bull.* **1964**, *12*, 352. (b) Nishimura, T.; Shimizu, B.; Iwai, I. *Chem. Pharm. Bull.* **1964**, *12*, 1471.

(43) Koch, A.; Lamberth, C.; Wetterich, F.; Giese, B. *J. Org. Chem.* **1993**, *58*, 1083.

Scheme 15



and concentrated. The residue was purified by flash chromatography on silica eluted with 25% ethyl acetate in hexanes to afford **18a** (932 mg, 95% yield) as a viscous oil which crystallized on standing: mp 134−135 °C; $[\alpha]^{23}_D$ −55.5° (*c* 0.1, $CHCl_3$); IR (thin film) 1726, 1697, 1453, 1264, 1216 cm^{-1}; ^1H NMR ($CDCl_3$) δ 9.27 (br s, 1H), 8.16−8.08 (m, 4H), 7.99 (d, *J* = 7.6, 2H),7.79 (d, *J* = 7.8, 1H), 7.63−7.39 (m, 8H), 6.30 (d, *J* = 5.3, 1H), 5.90 (pseudo t, J_{app}= 5.8, 1H), 5.81 (t, *J* = 5.7, 1H), 5.63 (d, *J* = 8.0, 1H), 4.77 (ABX, J_{AB} = 12.0, J_{AX} = 2.6, J_{BX} = 3.7, $\Delta\nu_{AB}$ = 49.9, 2H), 4.75 (m, 1H); ^{13}C NMR δ 166.0, 165.3, 164.1, 162.8, 150.1, 139.5, 133.9, 133.7, 1334., 133.1, 133.0, 130.3, 129.8, 129.7, 129.3, 129.2, 129.1, 128.7, 128.6, 128.3, 103.4, 88.2, 80.4, 74.1, 71.1, 63.7; HRMS (FAB, MB) *m*/*z* calcd for $C_{31}H_{24}F_3N_2O_9$ (M + H) 615.1435, found 615.1435.

3′,5′-Di-*O*-benzoyl-2′-*O*-[3-(trifluoromethyl)benzoyl]-5-methyluridine (18b). Obtained in 98% yield as a white powder: mp 92−95 °C; $[\alpha]^{23}_D$ −78.0° (*c* 0.1, $CHCl_3$); IR (KBr) 1725, 1619, 1452, 1267 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.78 (br s, 1H), 8.17−7.99 (m,4H), 7.93 (d, *J* = 7.3, 2H), 7.63−7.33 (m, 8H), 6.33 (d, *J* = 6.1, 1H), 5.84 (dd, *J* = 3.8, 6.0, 1H), 5.75 (t, *J* = 6.1, 1H), 4.70 (ABX, J_{AB} = 12.3, J_{AX} = 2.6, J_{BX} = 3.5, $\Delta\nu_{AB}$ = 69.5, 2H), 4.65 (m, 1H), 1.54 (s, 3H); ^{13}C NMR δ 166.2, 165.7, 164.4, 163.7, 150.6, 135.1, 134.0, 133.4, 130.6, 130.0, 129.9, 129.6, 129.4, 129.1, 128.9, 128.7, 127.0, 112.5, 87.3, 80.8, 74.0, 71.6, 64.2, 12.4; HRMS (FAB) *m*/*z* calcd for $C_{32}H_{26}F_3N_2O_9$ (M + H) 639.1599, found 639.1598.

Anal. Calcd for $C_{32}H_{26}F_3N_2O_9$: C, 60.19; H, 3.95; N, 4.39. Found: C, 60.13; H, 4.03; N, 4.26.

3′,5′-Di-*O*-benzoyl-2′-*O*-[3-(trifluoromethyl)benzoyl]-5-fluorouridine (18c). Obtained in 91% yield as a white powder: mp 187−188 °C; $[\alpha]^{23}_D$ −21.8° (*c* 0.1, CH_3CN); IR (KBr) 1726, 1675, 1452, 1267 cm^{-1}; ^1H NMR (CD_3CN) δ 9.38 (br s, 1H), 8.16 (d, *J* = 6.4, 2H), 8.05 (d, *J* = 8.0, 2H), 7.91 (d, *J* = 8.0, 3H), 7.70−7.37 (m, 8H), 6.19 (d, *J* = 4.5, 1H), 5.91−5.82 (m, 2H), 4.79−4.61 (m, 3H); ^{13}C NMR δ 166.9, 166.0, 164.8, 157.9, 157.6, 149.8, 143.4, 140.3, 134.7, 134.5, 134.2, 131.7, 131.2, 130.9, 130.7, 130.4, 129.9, 129.7, 129.6, 127.1, 126.0, 125.6, 89.7, 80.9, 75.2, 71.5, 64.5; HRMS (FAB, MB) *m*/*z* for $C_{31}H_{23}F_4N_2O_9$ (M + H) 643.1316, found 643.1316.

Anal. Calcd for $C_{31}H_{23}F_4N_2O_9$: C, 57.95; H 3.45, N, 4.36. Found: C, 57.85; H, 3.54; N, 4.25.

3′,5′-Di-*O*-benzoyl-2′-*O*-[3-(trifluoromethyl)benzoyl]-5-trifluoromethyluridine (18d). Obtained in 97% yield as a white powder: mp 115−117 °C; $[\alpha]^{23}_D$ −76.0° (*c* 0.1, $CHCl_3$); IR (KBr) 1727, 1461, 1336, 1267 cm^{-1}; ^1H NMR ($CDCl_3$) δ 9.75 (br s, 1H), 8.15−8.02 (m, 8H), 7.78 (d, *J* = 7.8, 1H), 7.62−7.40 (m, 6H), 6.29 (d, *J* = 5.5, 1H), 5.93−5.90 (m, 1H), 5.84 (t, *J* = 5.7, 1H), 4.82−4.71 (m, 3H); ^{13}C NMR δ 170.9, 165.8, 165.1, 164.0, 158.2, 148.9, 140.6, 133.8, 133.5, 132.9, 129.5, 129.3, 128.4, 128.2, 88.6, 80.9, 74.2, 71.0, 63.4.

Anal. Calcd for $C_{32}H_{23}F_6N_2O_9$: C, 55.50; H, 3.20; N, 4.05. Found: C, 55.27, H, 3.20, N, 3.97.

3′,5′-Di-*O*-benzoyl-2′-*O*-[3-(trifluoromethyl)benzoyl]-4-isobutyroylcytosine (18e, R = −COCH(CH$_3$)$_2$). Obtained in 91% yield as a white powder: mp 146−148 °C; $[\alpha]^{23}_D$ −36.4° (*c* 0.1, $CHCl_3$); IR (KBr) 1728, 1692, 1627, 1494, 1266 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.58 (br s, 1H), 8.18−8.07 (m, 4H), 7.97−7.90 (m, 3H), 7.80 (d, *J* = 7.8, 1H), 7.64−7.37 (m, 8H), 7.47 (d, *J* = 7.5, 1H), 6.41 (d, *J* = 4.2, 1H), 5.93−5.85 (m, 2H), 4.88−4.70 (m, 3H), 2.65−2.55 (m, 1H), 1.22 (d, *J* = 6.9, 6H); ^{13}C NMR δ 177.4, 166.0, 165.1, 163.8, 163.2, 154.9, 144.3, 133.7, 133.5, 133.0, 129.6, 129.5, 129.1, 128.6, 128.3. 97.4, 89.9, 80.4, 75.0, 70.9, 63.5, 36.4, 18.9; HRMS (FAB, MB) *m*/*z* for $C_{35}H_{31}F_3N_3O_9$ (M + H) 694.2012, found 694.2012.

Anal. Calcd for $C_{35}H_{31}F_3N_3O_9$: C, 60.61; H, 4.36; N, 6.09. Found: C, 60.56; H, 4.39; N, 6.12.

3′,5′-Di-*O*-benzoyl-2′-*O*-[3-(trifluoromethyl)benzoyl]-β-D-ribofuranosylcyanuric Acid (18f). Obtained in 85% yield as a white solid: mp 252.2−252.7 °C; $[\alpha]^{23}_D$ −23.2° (*c* 0.5, DMSO); IR (KBr) 1703, 1463, 1244 cm^{-1}; ^1H NMR (methanol-d_4) δ 11.78 (s, 1H), 8.24 (d, *J* = 7.9, 1H), 8.14 (s, 1H), 8.04 (d, *J* = 7.9, 1H), 8.0−7.95 (m, 2H), 7.80−7.72 (m, 3H), 7.66−7.56 (m, 2H), 7.47 (t, *J* = 7.7, 2H), 7.34 (t, *J* = 7.7, 2H), 6.44 (d, *J* = 2.3, 1H), 6.15−6.03 (m, 2H), 4.75−4.48 (m, 3H); ^{13}C NMR (methanol-d_4) δ 165.8, 164.8, 163.9, 149.4, 148.6, 134.1, 133.8, 130.7, 130.2, 130.1, 129.8, 129.7, 129.6, 129.4, 129.0, 128.8, 128.7, 126.0, 126.0, 124.9 (1, J_{C-F}= 272), 85.8, 78.1, 74.5, 70.1, 63.6; HRMS (FAB, NBA) *m*/*z* calcd for $C_{30}H_{23}F_3N_3O_{10}$ (M + H) 642.1336, found 642.1342.

N^6-Benzoyl-3′,5′-di-*O*-benzoyl-2′-*O*-[3-(trifluoromethyl)-benzoyl]adenosine (18g, R = Bz). Obtained in 80% yield as a pale yellow solid: mp 80−82 °C; $[\alpha]^{23}_D$ −74.6° (*c* 0.55, $CHCl_3$); IR (thin film) 1726, 1585, 1270 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.96 (s, 1H), 8.65 (s, 1H), 8.15−8.10 (m, 2H), 8.08 (d, *J* = 7.24, 4H), 8.01−7.97 (m, 4H), 7.78 (d, *J* = 7.9, 1H), 7.61−7.35 (m, 9H), 6.49−6.43 (m, 2H), 6.22 (t, *J* = 4.7, 1H), 4.91 (dd, *J* = 3.3, 12.1, 1H), 4.86−4.82 (m, 1H), 4.68 (dd, *J* = 4.0, 12.1, 1H), 1.61 (s, 3H); ^{13}C NMR ($CDCl_3$) δ 166.1, 165.3, 164.4, 163.9, 153.0, 141.5, 133.9, 133.5, 133.1, 132.8, 130.3, 129.7, 129.3, 128.9, 128.7, 127.8, 126.7, 86.9, 81.0, 74.3, 71.5, 63.5; HRMS (FAB, NBA) *m*/*z* calcd for $C_{39}H_{29}F_3N_5O_8$ (M + H) 752.1968, found 752.1981.

3′,5′-Di-*O*-benzoyl-2′-*O*-[3-(trifluoromethyl)benzoyl]adenosine (18h, R = H). Obtained in 86% yield from **18g**, as a white powder: mp 80−81 °C; $[\alpha]^{23}_D$ −43.7° (*c* 2.7, $CHCl_3$); IR (thin film) 1729, 1633, 1218 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.25 (s, 1H), 8.18 (s, 1H), 8.12−8.07 (m, 3H), 8.00 (d, *J* = 7.4, 2H), 7.96 (s, 1H), 7.80 (d, *J* = 7.9, 1H), 7.62−7.26 (m, 7H), 6.43 (m, 2H), 6.28−6.25 (m, 1H), 5.86 (s, 1H), 4.91 (dd, *J* = 3.3, 11.9, 1H), 4.84 (m, 1H), 4.71 (dd, *J* = 11.9, 4.0, 1H); ^{13}C NMR ($CDCl_3$) δ 164.7, 163.8, 162.5, 154.2, 152.0, 148.4, 137.6, 132.4, 132.0, 131.6, 130.1, 128.8, 128.3, 128.0, 127.9, 127.8, 127.7, 127.2, 127.1, 125.3, 125.2, 85.4, 79.3, 76.0, 72.9, 70.1, 62.2, 58.9, 28.3; HRMS (FAB, NBA) *m*/*z* calcd for $C_{32}H_{25}F_3N_5O_7$ (M + H) 648.1706, found 648.1720.

N^2-Acetyl-N^7-(3′,5′-di-*O*-benzoyl-2′-*O*-[(3-trifluoromethyl)benzoyl]-β-D-ribofuranosyl)guanine (18i). Obtained in 85% yield as a white solid: mp 117−125 °C; $[\alpha]^{23}_D$ +15.04° (*c* 0.25, $CHCl_3$); IR (thin film) 1715, 1363, 1266, 1223 cm^{-1}; ^1H NMR ($CDCl_3$) δ 11.18 (s, 1H), 8.17−8.01 (m, 5H), 7.96 (d, *J* = 7.4, 2H), 7.75 (d, *J* = 7.8, 1H), 7.60−7.36 (m, 8H), 6.61 (d, *J* = 5.0, 1H), 6.17 (t, *J* = 5.6, 1H), 6.02 (t, *J* = 5.6, 1H), 4.92−4.73 (m, 3H), 2.35 (s, 3H); ^{13}C NMR ($CDCl_3$) 173.2, 166.1, 165.2, 163.8, 157.6, 152.7, 148.4, 141.9, 133.8, 133.5, 133.1, 132 (q,

J_{C-F} = 33), 130.2, 129.7, 129.4, 129.3, 128.6, 128.4, 127.0, 126.7, 126.6, 125.2 (q, J_{C-F} = 272), 111.6, 89.0, 80.6, 75.6, 71.0, 63.6, 25.1, 24.5; HRMS (FAB, NBA) *m/z* calcd for $C_{34}H_{27}F_3N_5O_9$ (M + H) 706.1761, found 706.1746.

***N*²-Acetyl-3′,5′-di-*O*-benzoyl-2′-*O*-[3-(trifluoromethyl)-benzoyl]guanosine (18j)**. Obtained in 72% yield as a white powder: mp 130−132 °C; $[\alpha]^{23}_D$ −44.6° (*c* 1.42, $CHCl_3$); IR (thin film) 1702, 1527, 1216 cm^{-1}; ^1H NMR ($CDCl_3$) δ 11.89 (s, 1H), 9.36 (s, 1H), 8.15 (s, 1H), 8.11 (d, *J* = 7.7, 1H), 7.94−7.90 (m, 4H), 7.84 (d, *J* = 7.4, 1H), 7.76 (s, 1H), 7.61−7.54 (m, 3H), 7.41−7.35 (m, 4H), 6.42 (t, *J* = 5.4, 1H), 6.35 (t, *J* = 4.6, 1H), 6.20 (d, *J* = 3.6, 1H), 5.09 (dd, *J* = 11.5, 5.1, 1H), 4.90−4.86 (m, 1H), 4.81 (dd, *J* = 11.5, 5.0, 1H), 2.32 (s, 1H); ^{13}C NMR ($CDCl_3$) 173.4, 171.7, 166.9, 166.2, 165.5, 163.9, 155.3, 147.4, 147.2, 138.6, 133.9, 133.8, 133.1, 131.1, (q, J_{C-F} = 30) 130.4, 129.7, 129.6, 129.4, 129.3, 128.9, 128.6, 128.4, 126.5, 122.7, (q, J_{C-F} = 270), 88.2, 80.0, 74.6, 71.4, 62.8, 29.7, 24.3; HRMS (FAB, NBA) *m/z* calcd for $C_{34}H_{27}F_3N_5O_9$ (M + H) 706.1761, found 706.1762.

General Procedure for the PET Deoxygenation Reaction with *N*-Methylcarbazole.[8a] **3′,5′-Di-*O*-benzoyl-2′-deoxyuridine (19a).** A solution of **18a** (20 mg, 0.03 mmol), 9-methylcarbazole (**20**, 6 mg, 0.03 mmol), and magnesium perchlorate hexahydrate (10 mg, 0.03 mmol) in 9:1 2-propanol−water (21 mL) was degassed with argon. The reaction mixture was irradiated in a water-jacketed Pyrex reaction vessel (UV cutoff is ∼280 nm) with a Hanovia 450 W medium-pressure mercury lamp for 10−15 h under an argon atmosphere at 25 °C. The temperature was maintained by a circulating temperature bath. After the reaction was complete, the reaction mixture was diluted with saturated aqueous bicarbonate and extracted with ethyl acetate. The combined organic layers were washed with brine, dried over anhydrous sodium sulfate and concentrated. The residue was purified by preparative TLC to afford **18a** (9.8 mg, 70% yield). Recrystallized from ethyl acetate/hexanes: mp 221−223 °C (lit.[44] mp 225−6 °C); ^1H NMR($CDCl_3$) δ 8.30 (br s, 1H), 8.04−8.00 (m, 4H), 7.63−7.58 (m, 2H), 7.52−7.44 (m, 5H), 6.39 (dd, *J* = 5.6, 8.3, 1H), 5.63−5.56 (m, 2H), 4.73−4.66 (m, 2H), 4.56−4.54 (m, 1H), 2.78−2.72 (m, 1H), 2.36−2.27 (m, 1H); ^{13}C NMR δ 166.0, 162.3, 150.0, 138.8, 133.8, 129.8, 129.5, 128.8, 128.2, 102.9, 85.4, 82.9, 74.8, 64.2, 38.3.

General Procedure for the PET Deoxygenation Reaction with 3,6-Dimethyl-9-Ethylcarbazole. 3′,5′-Di-*O*-benzoylthymidine (19b).[8b,10b] A solution of **18b** (1.0, 1.57 mmol), 3,6-dimethyl-9-ethylcarbazole (**21**, 35 mg, 0.28 mmol), and magnesium perchlorate (130 mg, 0.39 mmol) in 2-propanol (270 mL) and water (30 mL) was placed in a 500 mL photochemical immersion well and degassed with an argon for 20 min (sonication may be necessary to fully dissolve **21**). The solution was placed in a water jacketed, Pyrex reaction vessel (UV cutoff is ∼280 nm) and degassed for an additional 10 min with argon. The reaction was photolyzed with a Hanovia 450W medium-pressure mercury lamp under an argon atmosphere; the reaction temperature was maintained below 23 °C with an ice bath. After 1.5 h the reaction was judged complete by TLC analysis and neutralized with saturated sodium bicarbonate. The reaction mixture was transferred to a round-bottomed flask and concentrated with a rotary evaporated. The residue was taken up in ethyl acetate and washed with brine. Purification by flash chromatography on silica, eluting with 25% ethyl acetate in hexanes gave **19b** (367 mg, 52% yield) as a white powder [mp 193−195 °C (lit.[44] mp 194−5 °C); ^1H NMR ($CDCl_3$) δ 8.50 (br s, 1H), 8.09−8.03 (m, 4H), 7.65−7.60 (m, 2H), 7.51−7.46 (m, 5H), 6.47 (dd, *J* = 5.6, 8.7, 1H), 5.66 (d, *J* = 4.5, 1H), 4.75 (ABX, J_{AB} = 12.3, J_{AX} =3.0, J_{BX} = 2.9, $\Delta\nu_{AB}$ = 36.7, 2H), 4.54 (d, *J* = 2.0 H, 1H), 2.73−2.67 (m, 1H), 2.37−2.35 (m, 1H), 1.62 (s, 3H); ^{13}C NMR δ 166.0, 163.2, 150.1, 134.4, 133.7, 129.8, 129.5, 129.3, 129.0, 128.8, 128.6, 111.7, 84.9, 82.7, 75.0, 64.3, 38.0, 12.7] and **5′-*O*-benzoyl-3′-deoxythymidine** (**22**, 62 mg, 12% yield) as a white powder: mp 71−74 °C (lit.[45] mp 57−9 °C); ^1H NMR ($CDCl_3$) δ 8.98 (br s, 1H), 8.03 (d, *J* = 7.1, 2H), 7.60 (t, *J* = 7.4, 1H), 7.45 (t, *J* = 7.5, 2H), 7.35 (s, 1H), 6.1 (dd, *J* = 6.4, 4.2, 1H), 4.65 (dd, *J* = 12.2, 2.8, 1H), 4.53 (dd, *J* = 12.2, 4.6, 1H), 4.40−4.50 (m, 1H), 2.44−2.51 (m, 1H), 1.76−2.21 (m, 3H), 1.70 (d, *J* = 0.9, 3H); ^{13}C NMR δ 166.0, 163.8, 150.3, 135.1, 133.5, 133.4, 129.6, 128.7, 110.7, 86.1, 78.4, 65.3, 32.3, 26.0, 12.4.

3′,5′-Di-*O*-benzoyl-5-fluoro-2′-deoxyuridine (19c). Obtained in 53% yield. Recrystallized from chloroform: mp 246 °C dec (lit.[46] mp >250 °C dec); ^1H NMR ($CDCl_3$) δ 8.07−8.02 (m, 4H), 7.65−7.60 (m, 3H), 7.51−7.46 (m, 4H), 6.40−6.38 (m, 1H), 5.62 (d, *J* = 6.6, 1H), 4.78−4.74 (m, 2H), 4.57 (d, *J* = 2.6, 1H), 2.79−2.72 (m, 1H), 2.32−2.25 (m, 1H); ^{13}C NMR (DMSO-d_6) δ 165.5, 165.2, 157.0 (J_{C-F} = 104), 149.0, 140.2 (J_{C-F} = 920), 133.7, 133.6, 129.4, 129.2, 128.8, 128.4, 124.8 (J_{C-F} = 137) 85.0, 81.2, 74.5, 64.3, 35.9.

3′,5′-Di-*O*-benzoyl-5-trifluoromethyl-2′-deoxyuridine (19d). Obtained in 44% yield (71% yield based on recovered starting material). Recrystallized from ethyl acetate/hexanes: mp 152−155 °C; $[\alpha]^{23}_D$ −28.3° (*c* 0.1, $CHCl_3$); IR (KBr) 1723, 1465, 1269 cm^{-1}; H NMR ($CDCl_3$) δ 8.68 (br s, 1H), 8.12−7.97 (m, 5H), 7.66−7.58 (m, 2H), 7.51−7.43 (m, 4H), 6.33 (dd, *J* = 5.5, 8.5, 1H), 5.64 (d, *J* = 6.4, 1^H), 4.77−4.75 (m, 2H), 4.64 (d, *J* = 2.25, 1H), 2.90 (dd, *J* = 5.5, 14.2, 1H), 2.36−2.26 (m, 1H); 13C NMR δ 171.2, 166.0, 165.9, 158.6, 149.1, 140.1, 140.0, 133.8, 133.7, 130.2, 129.8, 128.9, 128.8, 86.6, 83.8, 74.9, 64.1, 39.0; HRMS (FAB, MB) *m/z* calcd for $C_{24}H_{20}F_3N_2O_7$ (M + H) 505.1222, found 505.1223.

3′,5′-Di-*O*-benzoyl-4-isobutyroyl-2′-deoxycytidine (19e, R = −COCH(CH₃)₂). Obtained in 62% yield. Recrystallized from ethyl acetate/hexanes: mp 182−183 °C; $[\alpha]^{23}_D$ −24.0° (*c* 0.1, $CHCl_3$); IR (KBr) 1722, 1668, 1626, 1493, 1316, 1271 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.62 (br s, 1H), 8.17−7.97 (m, 5H), 7.64−7.32 (m, 7H), 6.38 (dd, *J* = 5.7, 7.8, 1H), 5.62 (d, *J* = 6.36, 1H), 4.76−4.65 (m, 3H), 3.12−3.05 (m, 1H), 2.62−2.57 (m, 1H), 2.32−2.22 (m, 1H), 1.23 (d, *J* = 6.8, 6H); ^{13}C NMR δ 176.9, 166.0, 165.9, 162.5, 154.9, 143.3, 133.6, 133.5, 129.7, 129.4, 128.6, 128.5, 96.6, 87.4, 83.4, 75.0, 64.1, 39.3, 36.6, 19.0, 18.9; HRMS (FAB, MB) *m/z* calcd for $C_{27}H_{28}N_3O_7$ (M + H) 506.1927, found 506.1925.

3,5-Di-*O*-benzoyl-2-deoxy-*β*-D-*erythro*-pentofuranosylcyanuric Acid (19f). Obtained in 75% yield as a white solid: mp = 171.2−172.0 °C; $[\alpha]^{23}_D$ −14.0° (*c* 1.17, MeOH); IR (KBr) 1721, 1450, 1275 cm^{-1}; ^1H NMR (methanol-d_4) δ 8.02−7.98 (m, 4H), 7.60−7.35 (m, 6H), 6.65 (m, 1H), 5.87−5.80 (m, 1H), 4.68−4.61 (m, 2H), 3.23−3.14 (m, 1H), 2.55−2.45 (m, 1H); ^{13}C NMR (methanol-d_4) δ 168.2, 167.8, 151.2, 134.9, 134.7, 131.5, 131.3, 131.1, 131.0, 130.0, 129.8, 84.3, 83.5, 77.0, 66.3, 36.6.

3′,5′-Di-*O*-benzoyl-2′-deoxyadenosine (19h, R = H). Obtained in 55% yield as a pale yellow foam: mp 105−107 °C (lit.[47] 140−141 °C); $[\alpha]^{23}_D$ −23.5° (*c* 0.65, $CHCl_3$); IR (KBr) 1710, 1690, 1600, 1290 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.32 (s, 1H), 8.08 (d, *J* = 7.4, 2H), 8.03−7.98 (m, 3H), 7.65−7.40 (m, 6H), 6.54 (dd *J* = 5.8, 8.2, 1H), 5.85−5.82 (m, 3H), 4.81−4.63 (m, 3H), 3.21−3.12 (m, 1H), 2.87−2.80 (m, 1H); ^{13}C NMR ($CDCl_3$) δ 166.1, 165.9, 155.4, 153.1, 138.7, 133.7, 133.4, 129.8, 129.6, 129.4, 129.1, 128.6, 84.8, 82.8, 75.3, 64.2, 37.7, 29.7; HRMS (FAB, NBA) *m/z* calcd for $C_{24}H_{21}N_5O_5$ (M^+) 459.1543, found 459.1525.

***N*²-Acetyl-*N*7-(3,5-di-*O*-benzoyl-2-deoxy-*β*-D-*erythro*-pentofuranosyl)guanine (19i).** Obtained in 75% yield as a pale yellow syrup which solidified upon standing: mp 79−81 °C; $[\alpha]^{23}_D$ −6.5° (*c* 2.6, $CHCl_3$); IR (thin film) 1720, 1460, 1216, 1253 cm^{-1}; ^1H NMR ($CDCl_3$) δ 12.31 (s, 1H), 10.61 (s, 1H), 8.14 (s, 1H), 8.07 (d, *J* = 7.2, 2H), 7.98 (d, *J* = 7.1, 2H), 7.65−7.37 (m, 6H), 6.73 (t, *J* = 7.5, 1H), 5.72−5.69 (m 1H), 4.81−4.63 (m, 1H), 3.04−2.96 (m, 1H), 2.83−2.73 (m, 1H), 2.37 (s, 3H); ^{13}C NMR ($CDCl_3$) δ 172.8, 166.1, 165.9, 157.5, 152.8, 147.9,

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140.7, 133.7, 133.4, 129.8, 129.6, 129.1, 128.6, 87.3, 83.3, 74.8, 64.2, 49.8, 40.3, 24.6; HRMS (FAB, NBA) calcd for $C_{26}H_{24}N_5O_7$ (M + H) 518.1676, found 518.1699.

***N*²-acetyl-3′,5′-di-*O*-benzoyl-2′-deoxyguanosine (19j).** Obtained in 70% yield as a white powder: mp 96−98 °C; $[\alpha]^{23}_D$ −45.2° (*c* 1.55, $CHCl_3$); IR (KBr) 1683, 1613, 1270 cm^{-1}; ^1H NMR ($CDCl_3$) δ 9.65 (s, 1H), 8.05−7.98 (m, 4H), 7.76 (s, 1H), 7.64−7.55 (m, 2H), 7.50−7.26 (m, 4H), 6.30 (t, *J* = 7.0, 1H), 5.83−5.81 (m, 1H), 5.21−5.14 (m, 1H), 4.75−4.67 (m, 2H), 3.21−3.12 (m, 1H), 2.72−2.65 (m, 1H), 2.36 (s, 1H); ^{13}C NMR ($CDCl_3$) δ 175.1, 172.0, 167.4, 165.8, 155.3, 147.3, 138.3, 133.7, 129.7, 129.2, 128.7, 122.8, 86.2, 82.5, 75.3, 63.9, 36.9, 24.3; HRMS (FAB, NBA) calcd for $C_{26}H_{24}N_5O_7$ (M + H) 518.1676, found 518.1685.

***N*9-[3′,5′-*O*-(1,1,3,3-tetrakis(isopropyl)-1,3-disiloxanediyl)-2′-*O*-(3-trifluoromethyl)benzoyl-*β*-D-ribosyl]-6-chloropurine (28a).** To a stirred solution of 6-chloropurine ribonucleoside (57 mg, 0.2 mmol) and pyridine (1 mL) was added 1,3-dichloro-1,1,3,3-tetraisopropyldisiloxane (69 mg, 0.22 mmol). The reaction was stirred at room temperature for 12 h, then quenched with saturated sodium bicarbonate. The aqueous was extracted with ethyl acetates, and the organic extracts were dried over magnesium sulfate, filtered, and evaporated to give red syrup. The residue was taken up in methylene chloride (5 mL), cooled to 0 °C then 2,6-lutidine (33 μL, 0.28 mmol) and 3-(trifluoromethyl)benzoyl chloride (29 μL, 0.21 mmol) were added successively. The reaction mixture was allowed to warm to room temperature and stirred for 12 h after which time it was quenched with saturated sodium bicarbonate, and the aqueous was extracted with ethyl acetate. The organic extracts were dried over magnesium sulfate, filtered and evaporated. Purification by flash chromatography on silica gave **28a** (99 mg, 75% yield) as clear syrup: $[\alpha]^{23}_D$ −27.3° (*c* 2.0, $CHCl_3$);^1H NMR ($CDCl_3$) δ 8.74 (s, 1H), 8.37 (s, 1H), 8.35 (s, 1H), 8.28 (d, *J* = 7.8, 1H), 7.88 (d, *J* = 7.8, 1H), 7.64 (t, *J* = 7.8, 1H),), 6.26 (s, 1H), 6.02 (d, *J* = 5.6, 1H), 5.20−5.16 (m, 1H), 4.26−4.20 (m, 1H), 4.10 dd, *J* = 13.3, 3.1, 1H), 1.13−0.90 (m, 28 H); ^{13}C NMR ($CDCl_3$) δ 164.4, 152.6, 144.2, 133.4, 130.6, 130.4, 129.7, 129.5, 127.1, 88.3, 82.9, 69.9, 60.7, 17.8, 17.7, 17.6, 17.5, 17.3, 17.2, 17.1, 13.8, 13.3, 13.2, 13.0; HRMS (FAB, NBA) calcd for $C_{30}H_{41}ClF_3N_4O_6Si_2$ (M + H) 701.2205, found 701.2206.

***N*9-[3′,5′-*O*-(1,1,3,3-tetrakis(isopropyl)-1,3-disiloxanediyl)-2′-*O*-(3-trifluoromethyl)benzoyl-*β*-D-ribosyl]-purine (28b).** Obtained as a pale yellow syrup: $[\alpha]^{23}_D$ −14.6° (*c* 0.33, $CHCl_3$); ^1H NMR ($CDCl_3$) δ 9.12 (s, 1H), 8.90 (s, 1H), 8.28−8.15 (m,3H), 7.81 (d, *J* = 7.8, 1H), 7.57 (t, *J* = 7.8, 1H), 6.20 (s, 1H), 6.01 (d, *J* = 5.0, 1H), 5.22−5.17 (m, 1H), 4.19−4.12 (m, 2H), 4.04 (dd, *J* = 13.2, 3.0, 1H), 1.06−0.70 (m, 28 H); ^{13}C NMR ($CDCl_3$) δ 164.5, 153.2, 149.5, 144.4, 133.4, 130.7, 130.4, 129.7, 127.1, 87.9, 82.8, 69.6, 60.9, 17.8, 17.7, 17.6, 17.3, 17.3, 17.1, 13.7, 13.4, 13.2, 13.0; HRMS (FAB, NBA) calcd for $C_{30}H_{42}F_3N_4O_6Si_2$ (M + H) 667.2595, found 667.2578.

1-[3-(Trifluoromethyl)benzoyl]-2,3,5-tribenzoyl-*β*-D-ribofuranose (29). Obtained as a syrup: $[\alpha]^{23}_D$ +8.7°(*c* 0.76, $CHCl_3$); ^1H NMR ($CDCl_3$) δ 8.29 (s, 1H), 8.14 (d, *J* = 7.9, 1H), 8.03 (d, *J* = 7.9, 2H), 7.93 (m, 4H), 7.83 (d, *J* = 7.8, 1H), 7.62−7.41(m, 6H), 7.38 (t, *J* = 7.8, 2H), 7.23 (t, *J* = 7.8, 2H), 6.68 (s, 1H), 6.00 (m, 2H), 4.89 (m, 1H), 4.82 (dd, *J* = 12.1, 3.9, 1H), 4.57 (dd, *J* = 12.1, 4,4, 1H); ^{13}C NMR δ 165.9, 165.4, 165.0, 163.6, 133.7, 133.6, 133.1, 132.9, 131.3(q, J_{C-F} = 33), 130.0, 129.8, 129.7, 129.5, 129.3, 129.2, 129.0, 128.7, 128.6, 128.5, 128.4, 128.2, 126.9, 123.4(q, J_{C-F} = 273), 99.6, 80.3, 75.0, 71.3, 63.5; HRMS (FAB, NBA) *m/z* calcd for $C_{34}H_{25}F_3O_9Na$ (M+ Na) 657.1348, found 657.1342.

Methyl 2,5-Di-*O*-benzoyl-D-arabinofuranoside (32). To a solution of methyl 2,3,5-tribenzoylarabinofuranoside[25] (**31**, 80 g, 0.168 mol) in dry pyridine (800 mL) was added hydrazine monohydrate (16.8 g, 0.336 mol) at 0 °C. The reaction mixture was stirred at room temperature for 12 h and then quenched by the additional of acetone and the mixture stirred for an additional 2 h. The solvents were evaporated under reduced pressure while keeping the temperature below 40 °C. The residue was dissolved hot ethyl acetate/hexanes (1:4, 500 mL); after cooling to room temperature the precipitates were removed by suction filtration. The filtrate was evaporated and the residue purified by a flash chromatography on silica eluted with 10% ethyl acetate in hexanes. The resulting syrup was recrystallized from ethyl acetate/hexanes (1:10) to give **30** (19 g, 30%) as colorless needles: mp 92−94 °C (lit.[25b] mp 92−93 °C); $[\alpha]^{23}_D$ +46.3° (*c* 0.86, $CHCl_3$); IR (thin film) 1721, 1601, 1452, 1273 cm^{-1}; ^1H NMR($CDCl_3$) δ 8.04−8.00 (m, 4H), 7.63−7.57 (m, 1H), 7.55−7.49 (m, 1H), 7.47−7.42 (m, 2H), 7.37−7.32 (m, 2H), 5.20 (s, 1H), 5.12 (d, *J* = 2.2, 1H), 4.64 (dd, *J* = 11.9, 3.8,1H), 4.52 (dd, *J* = 11.9, 5.4, 1H), 4.46−4.41 (m, 1H), 4.26−4.21 (m, 1H), 3.48 (s, 3H), 3.28 (d, *J* = 5.6, 1H); ^{13}C NMR δ 166.6, 166.3, 133.7, 133.1, 129.8, 129.7, 129.0, 128.6, 128.3, 106.5, 85.5, 81.9, 77.3, 63.8, 55.1. Anal. Calcd for $C_{20}H_{20}O_7$: C, 64.51; H, 5.41. Found: C, 64.26; H, 5.53.

1,3-Di-*O*-acetyl-2,5-di-*O*-benzoyl-D-arabinofuranose (33). To a solution of **32** (1.0 g, 2.7 mmol) and 2,6-lutidine (0.63 mL, 5.4 mmol) in dry methylene chloride (25 mL) at 0 °C was added acetyl chloride (0.24 mL, 3.4 mmol) dropwise over 5 min. The reaction mixture was stirred for 6 h at 25 °C and then diluted with CH_2Cl_2 and washed with brine, 10% HCl, saturated bicarbonate, and brine. The organic layer was dried over Na_2SO_4, filtered, and evaporated to give 1.15 g of colorless oil, which was dissolved in a solution of acetic anhydride (2.7 mL) and acetic acid (13.5 mL). The solution was cooled to 0 °C then sulfuric acid (0.78 mL) was added dropwise. The reaction mixture was stirred at 5−10 °C for 12 h and then poured into ice−water and extracted with chloroform. The combined organic layers were washed with saturated bicarbonate until then pH was 8 (pH paper) and then washed with brine, dried over Na_2SO_4 and evaporated to give **33** (1.17 g, 99% yield) as a mixture of two anomers which could be used in the next step without further purification. The two anomers can be separated by flash chromatography on silica, eluted with 5% ethyl acetate in hexanes. 1,3-Di-*O*-acetyl-2,5-*O*-dibenzoyl-α-D-arabinofuranose was obtained as a colorless oil: $[\alpha]^{23}_D$ +14.4 ° (*c* 4.25, $CHCl_3$); IR (thin film) 1726, 1452, 1370, 1275 cm^{-1}; ^1H NMR($CDCl_3$) δ 8.01−7.96 (m, 4H), 7.59−7.46 (m, 2H), 7.38 (t, *J* = 7.7, 2H), 7.27 (t, *J* = 7.7, 2H), 6.39 (s, 1H), 5.47 (s, 1H), 5.37 (d, *J* = 3.8, 1H), 4.72−4.54 (m, 3H), 2.14 (s, 3H), 2.13 (s, 3H); ^{13}C NMR δ170.0, 169.2, 166.1, 165.2, 133.7, 133.1, 129.9, 129.7, 129.6, 128.7, 128.6, 128.3, 99.4, 82.8, 81.5, 77.1, 63.4, 21.0, 20.7. 1,3-Di-*O*-acetyl-2,5-*O*-dibenzoyl-*β*-D-arabinofuranose was obtained as a colorless oil; $[\alpha]^{23}_D$ −36° (*c* 1.25, $CHCl_3$); IR (thin film) 1751, 1725, 1602, 1452, 1371, 1315, 1271 cm^{-1}; ^1H NMR($CDCl_3$) δ 8.11−8.02 (m, 4H), 7.61−7.54 (m, 2H), 7.49−7.41 (m, 4H), 6.57 (d, *J* = 4.7, 1H), 5.74 (dd, *J* = 6.8, 5.7, 1H), 5.60 (dd, *J* = 6.8, 4.7, 1H), 4.69 (dd, *J* = 11.9, 4.2H, 1H), 4.56 (dd, *J* = 11.9, 6.1, 1H), 4.45−4.41 (m, 1H), 2.11 (s, 3H), 1.92 (s, 3H); ^{13}C NMR δ170.2, 169.2, 166.0, 165.4, 133.7, 133.2, 129.9, 129.8, 129.7, 128.7, 128.6, 128.4, 93.7, 79.7, 76.0, 74.8, 64.6, 20.9, 20.7.

***N*1-(3-*O*-Acetyl-2,5-di-*O*-benzoyl-α-D-arabinofuranosyl)uracil (34a).** Obtained in 94% yield as a white powder: mp 96−98 °C; $[\alpha]^{23}_D$ +24.6° (*c* 0.57, $CHCl_3$); IR (KBr) 1724, 1693, 1453, 1266, 1110 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.60 (br s, 1H), 8.07 (d, *J* = 7.2, 2H), 8.01 (d, *J* = 7.2, 2H), 7.63−7.53 (m, 2H), 7.47−7.37 (m, 5H), 6.15 (d, *J* = 3.3,1H), 5.80 (dd, *J* = 8.1, 2.1, 1H), 5.77 (t, *J* = 3.3,1H), 5.52 (t, *J* = 3.3, 1H), 4.83−4.78 (m, 1H), 4.69−4.56 (m, 2H), 2.13 (s, 3H); ^{13}C NMR δ 169.7, 166.1, 165.3, 162.9, 150.0, 140.2, 134.0, 133.4, 130.0, 129.8, 129.3, 128.7, 128.5, 128.3, 102.8, 91.4, 83.4, 80.5, 76.8, 63.7, 20.7.

Anal. Calcd for $C_{25}H_{22}N_2O_9$: C, 60.73; H, 4.48; N, 5.67. Found: C, 60.49; H, 4.53; N, 5.53.

***N*1-(3-*O*-Acetyl-2,5-di-*O*-benzoyl-α-D-arabinofuranosyl)-5-methyluracil (34b).** Obtained in 97% yield. Recrystallized from CH_2Cl_2/pentane to give white prisms: mp 110−112 °C; $[\alpha]^{23}_D$ +48.6° (*c* 0.35, $CHCl_3$); IR (KBr) 1724, 1693, 1452, 1268 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.52 (br s, 1H), 8.08 (d, *J* = 7.2, 2H), 7.99 (d, *J* = 7.2, 2H), 7.63−7.53 (m, 2H), 7.47−7.38 (m, 4H), 7.20 (d, *J* = 1.5, 1H), 6.18 (d, *J* = 3.6, 1H), 5.77 (t, *J* = 3.6, 1H), 5.54 (t, *J* = 3.6, 1H), 4.82−4.77 (m, 1H), 4.68−4.56 (m, 2H), 2.14 (s, 3H), 1.96 (d, *J* = 1.5, 3H); ^{13}C NMR δ 169.7, 166.1, 165.4, 163.3, 150.0, 135.9, 133.9, 133.4, 130.0, 129.8, 129.4, 128.7, 128.5, 128.3, 111.4, 90.8, 82.8, 80.3, 63.8, 20.7, 12.6.

Anal. Calcd for $C_{26}H_{24}N_2O_9$: C, 61.41; H, 4.76; N, 5.51. Found: C, 61.14; H, 4.84; N, 5.37.

***N*⁴-Acetyl-*N*1-(3-*O*-acetyl-2,5-di-*O*-benzoyl-α-D-arabinofuranosyl)cytosine (34c).** Obtained in 95% yield as a white powder: mp 170−171 °C; $[\alpha]^{23}_D$ −18.7° (*c* 0.76, $CHCl_3$); ^1H NMR($CDCl_3$) δ 9.12 (br s, 1H), 8.08−8.02 (m, 4H), 7.80 (d, *J* = 7.2, 1H). 7.63−7.53 (m, 2H), 7.50−7.37 (m, 5H), 6.20 (d, *J* = 2.0, 1H), 5.82 (t, *J* = 2.0, 1H), 5.44 (t, *J* = 2.5, 1H), 4.93−4.88 (m, 1H), 4.67 (dd, *J* = 11.8, 6.3, 1H), 4.58 (dd, *J* = 11.8, 5.0, 1H), 2.25 (s, 3H), 2.07 (s, 3H); ^{13}C NMR δ 171.0, 169.5, 166.1, 164.9, 163.3, 155.0, 144.4, 133.9, 133.4, 130.0, 129.8, 129.4, 128.7, 128.5, 96.6, 93.0, 84.9, 80.4, 80.3, 63.6, 25.0, 20.7; HRMS (FAB, NBA) *m*/*z* calcd for $C_{27}H_{26}N_3O_9$ (M + H) 536.1669, found 536.1691.

***N*1-(3-*O*-Acetyl-2,5-di-*O*-benzoyl-α-D-arabinofuranosyl)-cytosine (34d).** Obtained in 93% yield as a white powder: mp 114−117 °C; $[\alpha]^{23}_D$ +17.8° (*c* 0.93, $CHCl_3$); IR (thin film) 1726, 1644, 1489, 1271 cm^{-1}; ^1H NMR($CDCl_3$) δ 8.20 (br s, 1H), 8.07−8.00 (m, 4H), 7.59−7.51 (m, 2H), 7.45−7.36 (m, 5H), 6.43 (br s, 1H), 6.11 (d, *J* = 2.1,1H), 5.90 (d, *J* = 7.5, 1H), 5.82 (t, *J* = 2.1,1H), 5.40 (t, *J* = 2.6, 1H), 4.85−4.80 (m, 1H), 4.66−4.54 (m, 2H), 2.06 (s, 3H); ^{13}C NMR δ 169.7, 166.1, 166.0, 165.1, 155.5, 140.9, 133.8, 133.3, 130.0, 129.8, 129.4, 128.6, 128.5, 95.1, 92.5, 84.1, 80.5, 76.8, 63.8, 20.7;

Anal. Calcd for $C_{25}H_{23}N_3O_8$: C, 60.85; H, 4.70; N, 8.52. Found: C, 60.56 H, 4.81; N, 8.31.

***N*⁶-Benzoyl-N9-(3-*O*-acetyl-2,5-di-*O*-benzoyl-α-D-arabinofuranosyl)adenine (34e, R = Bz).** Obtained in 87% yield as a white powder: mp 83−85 °C; $[\alpha]^{23}_D$ +55° (*c*, 2.25, $CHCl_3$); IR (thin film) 1725, 1609, 1583, 1510, 1488, 1452, 1273 cm^{-1}; ^1H NMR($CDCl_3$) δ 9.30 (br s, 1H), 8.77 (s, 1H), 8.26 (s, 1H), 8.07−7.98 (m, 6H), 7.61−7.29 (m, 9H), 6.51 (d, *J* = 2.7, 1H), 6.29 (t, *J* = 2.8, 1H), 5.67 (dd, *J* = 2.8, 4.7, 1H), 4.98−4.93 (m, 1H), 4.74−4.63 (m, 2H), 2.10 (s, 3H); ^{13}C NMR δ 169.8, 166.1, 165.3, 164.9, 152.8, 151.8, 149.8, 141.5, 134.0, 133.5, 133.4, 132.8, 130.0, 129.8, 129.4, 128.8, 128.7, 128.5, 128.2, 128.0, 123.4, 88.7, 82.9, 80.4, 76.6, 63.4, 20.7.

Anal. Calcd for $C_{33}H_{27}N_5O_8$: C, 63.76,; H, 4.38; N, 11.27. Found: C, 63.79 H, 4.55; N, 11.08.

General Procedure for the Selective N⁶-Debenzoylation of Protected Adenosine. *N*9-(3-*O*-Acetyl-2,5-di-*O*-benzoyl-α-D-arabinofuranosyl)adenine (34f, R = H). *N*⁶-Benzoyl-(α-D-3′-*O*-acetyl-2′,5′-di-*O*-benzoylarabinosyl)-adenine (**34e**, 30 mg, 0.048 mmol) was dissolved in 3 mL of 1 M solution of dry $ZnBr_2$ in methanol/chloroform (4:1). The mixture was stirred at room temperature for 12 h and then diluted with chloroform and washed with brine. The organic layer was dried over Na_2SO_4, filtered, and evaporated. The residue was purified by a flash chromatography on silica, eluted with chloroform/methanol (80:1) to give **32f** (22 mg, 88% yield) as a white powder: mp 116−119 °C; $[\alpha]^{23}_D$ +58.1° (*c* 1.06, $CHCl_3$); IR (thin film) 1725, 1643, 1600, 1273 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.39 (s, 1H), 8.04 (s, 1H), 8.09−8.01 (m, 4H), 7.63−7.53 (m, 2H), 7.47−7.37 (m, 4H), 6.43 (d, *J* = 3.0, 1H), 6.31 (t, *J* = 3.0, 1H), 5.90 (br s, 2H), 5.65 (dd, *J* = 3.0, 4.8, 1H), 4.97−4.92 (m, 1H), 4.74−4.62 (m, 2H), 2.12 (s, 3H); ^{13}C NMR δ 169.8, 166.1, 165.3, 155.4, 153.2, 149.8, 139.0, 134.0, 133.3, 130.0, 129.8, 129.4, 128.7, 128.5, 128.3, 120.0, 88.4, 82.5, 80.3, 76.7, 63.4, 20.7.

Anal. Calcd for $C_{26}H_{23}N_5O_7$: C, 60.35; H, 4.48; N, 13.53. Found: C, 60.12; H, 4.58; N, 13.36.

***N*²-Acetyl-N7-(3-*O*-acetyl-2,5-di-*O*-benzoyl-α-D-arabinofuranosyl)guanine (34 g).** Obtained in 92% yield as a white powder: mp 134−136 °C; $[\alpha]^{23}_D$ +18.2° (*c* 1.06, $CHCl_3$); IR (thin film) 1727, 1681, 1613, 1548, 1451, 1371, 1264 cm^{-1}; ^1H NMR ($CDCl_3$) δ 12.4 (br s, 1H), 11.0 (br s, 1H), 8.07 (s, 1H), 8.09−8.00 (m, 4H), 7.62−7.53 (m, 2H), 7.47−7.37 (m, 4H), 6.64 (d, *J* = 3.3, 1H), 6.13 (t, *J* = 3.3, 1H), 5.61 (t, *J* = 3.3, 1H), 5.00−4.95 (m, 1H), 4.67−4.66 (m, 2H), 2.37 (s, 3H), 2.09 (s, 3H); ^{13}C NMR δ 173.3, 169.8, 166.1, 165.0, 157.5, 153.1, 148.4, 141.7, 133.9, 133.4, 130.0, 129.8, 129.4, 128.7, 128.5, 128.3, 111.4, 90.5, 82.9, 81.2, 76.4, 63.7, 24.6, 20.7.

Anal. Calcd for $C_{28}H_{25}N_5O_9$: C, 58.43; H, 4.38; N, 12.17. Found: C, 58.19; H, 4.44; N, 11.92.

***N*²-Acetyl-*N*9-(3-*O*-acetyl-2,5-di-*O*-benzoyl-α-D-arabinofuranosyl)guanine (34h).** Obtained in 53% yield as a white powder: mp 127−129 °C; $[\alpha]^{23}_D$ +37.4° (*c* 0.54, $CHCl_3$); IR (KBr) 1723, 1681, 1612, 1560, 1269 cm^{-1}; ^1H NMR ($CDCl_3$) δ 12.1 (br s, 1H), 9.5 (br s, 1H), 8.04−7.96 (m, 4H), 7.98 (s, 1H), 7.62−7.51 (m, 2H), 7.44−7.34 (m, 4H), 6.24 (d, *J* = 2.1, 1H), 6.08 (t, *J* = 2.2, 1H), 5.54 (dd, *J* = 2.5, 3.8,1H), 4.88−4.83 (m, 1H), 4.66−4.65 (m, 2H), 2.26 (s, 3H), 2.08 (s, 3H); ^{13}C NMR δ 172.1, 169.7, 166.2, 165.2, 155.4, 147.9, 147.7, 137.0, 134.1, 133.4, 129.9, 129.8, 129.3, 128.7, 128.5, 128.2, 121.3, 88.5, 83.2, 80.3, 77.0, 63.4, 24.4, 20.7; HRMS (FAB, MB) *m*/*z* calcd for $C_{28}H_{26}N_5O_9$ (M + H) 576.1731, found 576.1733.

***N*1-(3-*O*-Acetyl-5-*O*-benzoyl-2-deoxy-α-D-*erythro*-pentofuranosyl)uridine (35a).** Obtained in 69% yield as a white powder: mp 168−170 °C; $[\alpha]^{23}_D$ −38.4° (*c* 0.5, $CHCl_3$); IR (thin film) 1719, 1701, 1688, 1460, 1377, 1269 cm^{-1}; ^1H NMR ($CDCl_3$) δ 9.41 (br s, 1H), 8.00 (d, *J* = 7.3, 2H), 7.57 (t, *J* = 7.3, 1H), 7.48−7.43 (m, 3H), 6.24 (dd, *J* = 6.9, 1.6, 1H), 5.74 (d, *J* = 8.1, 1H), 5.33 (d, *J* = 6.3, 1H), 4.70 (t, *J* = 4.3,1H), 4.49−4.40 (m, 2H), 2.83 (dt, *J* = 15.4, 6.7, 1H), 2.30 (br d, *J* = 15.4, 1H), 2.03 (s, 3H); ^{13}C NMR δ 170.0, 166.1, 163.6, 150.3, 139.4, 133.6, 129.7, 129.2, 128.7, 101.6, 87.6, 85.1, 74.3, 64.0, 38.7, 20.9; HRMS (FAB, MB) *m*/*z* calcd for $C_{18}H_{19}N_2O_7$ (M + H) 375.1192, found 375.1194.

***N*1-(3-*O*-Acetyl-5-*O*-benzoyl-2-deoxy-α-D-*erythro*-pentofuranosyl)thymine (35b).** Obtained in 73% yield as a white powder: mp 60−62 °C; $[\alpha]^{23}_D$ −18 °(*c* 0.75, $CHCl_3$); IR (thin film) 1721, 1702, 1476, 1451, 1379, 1272 cm^{-1}; ^1H NMR δ 8.74 (br s, 1H), 8.01 (d, *J* = 7.3, 2H), 7.65−7.57 (m, 1H), 7.47 (t, *J* = 7.7, 2H), 7.33 (d, *J* = 0.9, 1H), 6.32 (dd, *J* = 7.2, 2.3, 1H), 5.35 (d, *J* = 6.4, 1H), 4.73 (t, *J* = 4.1, 1H), 4.52−4.40 (m, 2H), 2.87 (dt, *J* = 15.4, 7.0, 1H), 2.30 (br d, *J* = 15.4, 1H), 2.05 (s, 3H), 1.96 (d, *J* = 0.9, 3H). ^{13}C NMR δ 169.9, 166.1, 164.0, 150.3, 135.3, 133.5, 129.7, 129.3, 128.7, 110.3, 86.9, 84.6, 74.4, 64.1, 38.5, 20.9, 12.7; HRMS (FAB, MB) *m*/*z* calcd for $C_{19}H_{21}N_2O_7$ (M + H) 389.1349, found 389.1349.

***N*1-(3-*O*-Acetyl-5-*O*-benzoyl-2-deoxy-α-D-*erythro*-pentofuranosyl)cytidine (35d).** Obtained in 33% yield as a white powder: mp 86−88 °C; $[\alpha]^{23}_D$ −41° (*c*, 0.42, $CHCl_3$); IR (thin film) 1721, 1643, 1525, 1486, 1452, 1272, 1247 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.02 (d, *J* = 7.2, 2H), 7.62−7.56 (m, 2H), 7.47 (t, *J* = 7.6, 2H), 6.24 (dd, *J* = 6.7, 1.2, 1H), 5.74 (d, *J* = 7.5, 1H), 5.33 (d, *J* = 6.1, 1H), 4.72 (t, *J* = 4.2,1H), 4.52−4.42 (m, 2H), 2.85 (dt, *J* = 15.4, 6.6, 1H), 2.46 (br d, *J* = 15.4, 1H), 1.97 (s, 3H); ^{13}C NMR δ 170.0, 166.1, 165.6, 155.6, 140.8, 133.5, 129.7, 129.3, 128.7, 93.0, 88.7, 85.1, 74.6, 64.2, 38.9, 20.9; HRMS (FAB, MB) *m*/*z* calcd for $C_{18}H_{20}N_3O_6$ (M + H) 374.1352, found 374.1352.

***N*9-(3-*O*-Acetyl-5-*O*-benzoyl-2-deoxy-α-D-*erythro*-pentofuranosyl)adenine (35f, R = H).** Obtained in 76% yield as a white powder: mp 177−179 °C; $[\alpha]^{23}_D$ 22.5° (*c* 0.55, $CHCl_3$); IR (thin film) 1723, 1644, 1600, 1473, 1274 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.35 (s, 1H), 8.11 (s, 1H), 8.03 (d, *J* = 7.0, 2H), 7.59 (t, *J* = 7.6, 1H), 7.46 (t, *J* = 7.6, 2H), 6.57 (dd, *J* = 7.1, 1.9, 1H), 6.11 (br s, 2H), 5.45 (dt, *J* = 6.8, 1.7, 1H), 4.77 (m, 1H), 4.60−4.50 (m, 2H), 2.99 (dt, *J* = 15.2, 6.9, 1H), 2.82 (dt, *J* = 15.2, 1.7, 1H), 1.99 (s, 3H); ^{13}C NMR δ 170.2, 166.1, 155.3, 152.7, 149.4, 138.5, 133.5, 129.6, 129.4, 128.6, 119.9, 85.4, 84.3, 74.6, 64.1, 38.3, 20.9; HRMS (FAB, MB) *m*/*z* calcd for $C_{19}H_{20}N_5O_5$ (M + H) 398.1464, found 398.1463.

***N*²-Acetyl-*N*7-(3-*O*-acetyl-5-*O*-benzoyl-2-deoxy-α-D-*erythro*-pentofuranosyl)guanine (35g).** Obtained in 78% yield. Recrystallized from chloroform to give colorless needles: mp 108−110 °C; $[\alpha]^{23}_D$ −19° (*c* 0.7, CH_2Cl_2); IR (thin film) 1681, 1613, 1547, 1529, 1451, 1369, 1270 cm^{-1}; ^1H NMR (acetone-d_6) δ 12.2 (br s, 1H), 10.6 (br s, 1H), 8.33 (s, 1H), 8.07 (d, *J* = 7.6, 2H), 7.60 (t, *J* = 7.4, 1H), 7.47 (t, *J* = 7.6, 2H), 6.76 (dd, *J* = 6.7, 1.8, 1H), 5.47 (m, 1H), 4.96 (m, 1H), 4.60−4.40 (m, 2H), 3.08 (dt, *J* = 15.2, 6.7 1H), 2.65 (br d, *J* = 15.2, 1H), 2.29 (s, 3H), 1.92 (s, 3H); ^{13}C NMR δ 174.1, 170.7, 166.5, 159.1, 153.7, 148.1, 142.3, 134.2, 130.7, 130.3, 129.5, 111.8, 88.8, 85.3, 75.3, 65.1, 45.4, 40.3, 24.1, 20.8; HRMS (FAB, MB) *m*/*z* calcd for $C_{21}H_{22}N_5O_7$ (M + H) 456.1519, found 456.1519.

***N*²-acetyl-*N*9-(3-*O*-Acetyl-5-*O*-benzoyl-2-deoxy-α-D-*erythro*-pentofuranosyl)guanine (35h).** Obtained in 81% yield.

Recrystallized from chloroform to give colorless needles: mp 131−133 °C; $[\alpha]^{23}_D$ +11° (*c* 0.75, $CHCl_3$); IR (thin film) 1714, 1680, 1611, 1555, 1475, 1400, 1270 cm^{-1}; ^1H NMR ($CDCl_3$) δ 12.1 (br s, 1H), 9.3 (br s, 1H), 8.11 (s, 1H), 8.02 (d, J = 7.3, 2H), 7.60 (t, J = 7.4, 1H), 7.47 (t, J = 7.6, 2H), 6.27 (d, J = 6.8, 1H), 5.42 (d, J = 6.7, 1H), 4.68 (m, 1H), 4.57−4.46 (m, 2H), 2.90 (m, 1H), 2.60 (br d, J = 15.4, 1H), 2.32 (s, 1H), 2.06 (s, 3H); ^{13}C NMR ($CDCl_3$) δ 172.0, 170.3, 166.2, 155.3, 147.8, 147.6, 136.9, 133.6, 129.7, 129.3, 128.7, 120.6, 84.8, 84.2, 74.2, 64.0, 38.0, 24.5, 20.9; HRMS (FAB, MB) *m*/*z* calcd for $C_{21}H_{22}N_5O_7$ (M + H) 456.1519, found 456.1519.

α-D-2-*O*-Acetyl-1,3,5-tri-*O*-benzoylribofuranose (36). To a stirred solution of **8** (3.0 g, 6.5 mmol) and 2,6-lutidine (3 mL, 25.7 mmol) in dry methylene chloride (50 mL) at −20 °C was added acetyl chloride (0.7 mL, 9.8 mmol) dropwise over 10 min. The reaction was stirred at room temperature for 10 h then diluted with methylene chloride (100 mL) and washed with brine (3 × 50 mL). The organic layer was dried over Na_2SO_4, filtered and evaporated. Purification by flash chromatography on silica eluting with 25% ethyl acetate in hexanes gave **36** (3.0 g, 92% yield) as a colorless oil: $[\alpha]^{23}_D$ +67.2° (*c* 0.96, $CHCl_3$); IR (thin film) 1726, 1602, 1452, 1268 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.14−8.08 (m, 6H), 7.66−7.57 (m, 3H), 7.50−7.37 (m, 6H), 6.80 (d, J = 4.4, 1H), 5.80 (dd, J = 6.4, 1.8, 1H), 5.56 (dd, J = 6.4, 4.4, 1H), 4.85 (m, 1H), 4.73 (dd, J = 12.2, 3.0, 1H), 4.61 (dd, J = 12.2, 3.5, 1H), 2.02 (s, 3H); ^{13}C NMR δ 169.6, 166.1, 165.7, 165.2, 133.7, 133.5, 133.4, 130.0, 129.9, 129.7, 129.6, 129.4, 129.3, 128.6, 128.5, 128.4, 94.7, 82.8, 70.9, 70.7, 64.0, 20.3; HRMS (FAB, NBA) *m*/*z* calcd for $C_{21}H_{19}O_7$ (M − $C_6H_5CO_2$) 383.1131, found 383.1125.

2′-*O*-Acetyl-3′,5′-*O*-benzoyluridine (37a). Obtained in 99% yield as a white powder: mp 100−103 °C; $[\alpha]^{23}_D$ −35° (*c* 1.0, $CHCl_3$); IR (KBr) 1722, 1695, 1633, 1602, 1453, 1379, 1268 cm^{-1}; ^1H NMR ($CDCl_3$) δ 9.00 (br s, 1H), 8.08−8.04 (m, 4H), 7.66−7.57 (m, 2H), 7.51−7.45 (m, 4H), 7.35 (d, J = 8.2, 1H), 6.21 (d, J = 5.9, 1H), 5.75 (dd, J = 5.9, 4.1, 1H), 5.60−5.52 (m, 2H), 4.81−4.75 (m, 1H), 4.66−4.58 (m, 2H), 2.05 (s, 3H); ^{13}C NMR δ 169.7, 166.0, 165.3, 162.6, 150.1, 139.2, 133.9, 133.7, 129.8, 129.6, 129.1, 128.8, 128.7, 128.6, 103.5, 87.3, 80.4, 73.0, 71.0, 63.7, 20.4;

Anal. Calcd for $C_{25}H_{22}N_2O_9$: C, 60.73; H, 4.48; N, 5.67. Found: C, 60.48; H, 4.60; N, 5.54.

2′-*O*-Acetyl-3′,5′-*O*-benzoyl-5-methyluridine (37b). Obtained in 94% yield as a white powder: mp 163−165 °C; $[\alpha]^{23}_D$ −70.7° (*c* 1.01, $CHCl_3$); IR (KBr,) 1724, 1694, 1452, 1375, 1267 cm^{-1}; ^1H NMR ($CDCl_3$) δ 9.05 (br s, 1H), 8.12−8.05 (m, 4H), 7.64−7.59 (m, 2H), 7.51−7.46 (m, 4H), 7.10 (d, J = 1.0, 1H), 6.31 (d, J = 6.7, 1H), 5.78 (dd, J = 5.9, 3.1, 1H), 5.56 (t, J = 6.3, 1H), 4.83 (dd, J = 11.7, 2.1, 1H), 4.63−4.56 (m, 2H), 2.05 (s, 3H), 1.54 (d, J = 1.0, 3H); ^{13}C NMR δ 169.8, 165.9, 165.4, 163.2, 150.4, 134.5, 133.9, 133.8, 129.9, 129.6, 129.1, 128.9, 128.7, 112.3, 86.2, 80.4, 72.6, 71.3, 63.9, 20.4, 12.1. Anal. Calcd for $C_{26}H_{24}N_2O_9$: C, 61.41; H, 4.76; N, 5.51. Found: C, 61.30; H, 4.86; N, 5.44.

2′-*O*-Acetyl-3′,5′-*O*-dibenzoyl-5-fluorouridine (37c). Obtained in 89% yield. Recrystallization from ethyl acetate/hexanes gave colorless needles: mp 183−84 °C; $[\alpha]^{23}_D$ −24° (*c* 0.495, CH_2Cl_2); IR (KBr) 1719, 1672, 1638, 1601, 1452, 1378, 1266 cm^{-1}; ^1H NMR (DMSO-d_6) δ 12.0 (br s, 1H), 8.15 (d, J = 6.8, 1H), 8.00−7.95 (m, 4H), 7.72−7.62 (m, 2H), 7.58−7.45 (m, 4H), 5.99 (d, J = 4.6, 1H), 5.77 (dd, J = 5.9, 5.0, 1H), 5.66 (dd, J = 5.9, 5.0, 2H), 4.67−4.59 (m, 3H), 1.98 (s, 3H); ^{13}C NMR δ 169.3, 165.5, 164.6, 157.0 (d, J_{C-F} = 26), 149.0, 140.2 (d, J_{C-F} = 230), 133.9, 133.6, 129.4, 129.3, 129.2, 128.9, 128.8, 128.6, 125.8 (d, J_{C-F} = 35), 88.3, 78.9, 72.2, 70.0, 63.7, 20.2; HRMS (FAB, MB) *m*/*z* calcd for $C_{25}H_{22}N_2O_9F$ (M + H) 513.1309, found 513.1307.

***N*4-Acetyl-2′-*O*-acetyl-3′,5′-*O*-dibenzoylcytidine (37d, R = Ac).** Obtained in 86% yield. Recrystallized from ethyl acetate/hexanes to give colorless needles: mp 217−218 °C; $[\alpha]^{23}_D$ −15° (*c* 1.0, $CHCl_3$); IR (thin film) 1725, 1671, 1628, 1561, 1492, 1451, 1373, 1316, 1267 cm^{-1}; ^1H NMR ($CDCl_3$) δ 10.00 (br s, 1H), 8.06−7.99 (m, 4H), 7.90 (d, J = 7.6, 1H), 7.63−7.57 (m, 2H), 7.49−7.42 (m, 4H), 7.34 (d, J = 7.6, 1H), 6.25 (d, J = 4.5, 1H), 5.74 (t, J = 5.4, 1H), 5.64 (dd, J = 5.4, 4.5, 1H), 4.80−4.63 (m, 3H), 2.27 (s, 3H), 2.04 (s, 3H); ^{13}C NMR ($CDCl_3$) δ 171.0, 169.4, 166.0, 165.2, 163.2, 154.8, 144.0, 133.8, 133.7, 129.8, 129.6, 129.1, 128.7, 128.6, 97.5, 89.2, 80.4, 74.0, 70.7, 63.4, 49.6, 24.9, 20.4.

Anal. Calcd for $C_{27}H_{25}N_3O_9$: C, 60.56; H, 4.71; N, 7.85. Found: C, 60.59; H, 4.70; N, 7.74.

2′-*O*-Acetyl-3′,5′-*O*-dibenzoylcytidine (37e, R = H). Obtained in 66% yield. Recrystallized from chloroform/hexanes to give a white powder: mp 225−227 °C; $[\alpha]^{23}_D$ −11° (*c* 1.8, CH_2Cl_2); IR (thin film) 1723, 1649, 1603, 1492, 1451, 1373, 1268 cm^{-1}; ^1H NMR (DMSO-d_6) δ 7.97 (d, J = 7.4, 4H), 7.71−7.61 (m, 3H), 7.57−7.44 (m, 4H), 7.37 (br s, 2H), 5.92 (d, J = 4.1, 1H), 5.81 (t, J = 6.0, 1H), 5.70 (d, J = 7.4, 1H), 5.64 (dd, J = 6.0, 4.1, 1H), 4.67−4.52 (m, 3H), 1.97 (s, 3H); ^{13}C NMR (DMSO-d_6) δ 169.4, 165.9, 165.5, 164.6, 154.7, 142.9, 133.8, 133.5, 129.4, 129.3, 129.2, 128.9, 128.7, 94.7, 90.5, 78.5, 72.9, 70.6, 63.9, 20.3; HRMS (FAB, MB) *m*/*z* calcd for $C_{25}H_{24}N_3O_8$ (M + H) 494.1563, found 494.1561.

2′-*O*-Acetyl-3′,5′-di-*O*-benzoyl-*N*6-benzoyladenosine (37f, R = Bz). Obtained in 91% as a white powder: mp 85−87 °C; $[\alpha]^{23}_D$ −62.9° (*c* 1.95, $CHCl_3$); IR (thin film) 1725, 1611, 1584, 1511, 1453, 1268 cm^{-1}; ^1H NMR ($CDCl_3$) δ 9.20 (br s, 1H), 8.63 (s, 1H), 8.15 (s, 1H), 8.12−8.01 (m, 6H), 7.65−7.43 (m, 9H), 6.37 (d, J = 6.1, 1H), 6.27 (dd, J = 6.1, 5.5, 1H), 6.10 (dd, J = 5.5, 3.8, 1H), 4.89 (dd, J = 12.2, 3.1, 1H), 4.80−4.73 (m, 1H), 4.65 (dd, J = 12.2, 4.0, 1H), 2.04 (s, 3H); ^{13}C NMR δ 169.4, 166.1, 165.3, 152.9, 151.8, 149.8, 141.7, 133.8, 133.4, 132.8, 129.8, 129.7, 129.3, 128.8, 128.7, 128.6, 127.9, 123.7, 86.4, 81.0, 73.0, 71.5. 63.6, 20.3.

Anal. Calcd for $C_{33}H_{27}N_5O_8$: C, 63.76; H, 4.38; N, 11.27. Found: C, 63.46 H, 4.50; N, 11.12.

2′-*O*-Acetyl-3′,5′-di-*O*-benzoyladenosine (37g, R = H). Obtained in 75% yield from **37f**, as a white powder: mp 86−89 °C; $[\alpha]^{23}_D$ −64° (*c* 1.0, $CHCl_3$); IR (thin film) 1723, 1642, 1599, 1451, 1266 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.23 (s, 1H), 8.08 (d, J = 8.0, 4H), 7.91 (s, 1H), 7.65−7.53 (m, 2H), 7.51−7.40 (m, 4H), 6.29 (d, J = 5.6, 1H), 6.22 (t, J = 5.6, 1H), 6.17 (br s, 2H), 6.11 (t, J = 4.8,1H), 4.84 (dd, J = 12.0, 3.1, 1H), 4.75−4.71 (m, 1H), 4.65 (dd, J = 12.0, 4.1, 1H), 2.02 (s, 3H); ^{13}C NMR δ 169.5, 166.1, 165.3, 155.6, 153.2, 149.8, 139.1, 133.8, 133.4, 129.8, 129.7, 129.4, 128.8, 128.6, 128.5, 120.1, 86.3, 80.7, 73.2, 71.5, 63.7, 20.4.

Anal. Calcd for $C_{26}H_{23}N_5O_7$: C, 60.35; H, 4.48; N, 13.53. Found: C, 60.16; H, 4.57; N, 13.28.

***N*2-Acetyl-2′-*O*-acetyl-3′,5′-di-*O*-benzoylguanosine (37h).** Obtained in 78% yield as a white powder: mp 135−138 °C; $[\alpha]^{23}_D$ −77° (*c* 0.935, $CHCl_3$); IR (KBr) 1725, 1682, 1612, 1561, 1538, 1405, 1374, 1268 cm^{-1}; ^1H NMR ($CDCl_3$) δ 12.10 (br s, 1H), 10.40 (br s, 1H), 7.98 (d, J = 7.7, 2H), 7.90 (s, 1H), 7.84 (d, J = 7.6, 2H), 7.59 (t, J = 7.4, 1H), 7.49−7.40 (m, 3H), 7.28 (t, J = 7.6, 2H), 6.20 (t, J = 5.2, 1H), 6.12 (d, J = 5.2, 1H), 6.07 (t, J = 4.1, 1H), 4.74−4.65 (m, 2H), 4.59−4.53 (m, 1H), 2.31 (s, 3H), 1.99 (s, 3H); ^{13}C NMR δ 172.8, 169.7, 166.4, 165.3, 155.5, 148.0, 147.8, 139.1, 133.8, 133.5, 129.7, 129.5, 128.9, 128.7, 128.6, 128.4, 122.3, 87.6, 80.2, 72.7, 71.6, 63.4, 24.3, 20.5.

Anal. Calcd for $C_{28}H_{25}N_5O_9$: C, 58.43; H, 4.38; N, 12.17. Found: C, 58.19; H, 4.33; N, 11.91.

***N*2-Acetyl-*N*7-(*β*-D-2′-*O*-acetyl-3′,5′-di-*O*-benzoyl-*β*-D-ribofuranosyl)guanine (37i).** Obtained in 96% yield as a white powder: mp 148−150 °C; $[\alpha]^{23}_D$ −6.2° (*c* 1.1, $CHCl_3$); IR (KBr) 3148, 3071, 2960, 1725, 1687, 1614, 1549, 1452, 1377, 1267 cm^{-1}; ^1H NMR ($CDCl_3$) δ 12.4 (br s, 1H), 11.1 (br s, 1H), 8.09−8.04 (m, 4H), 7.65−7.54 (m, 2H), 7.50−7.40 (m, 3H), 6.47 (d, J = 5.0, 1H), 5.98 (t, J = 5.1, 1H), 5.91 (t, J = 5.0, 1H), 4.86−4.67 (m, 3H), 2.39 (s, 3H), 2.05 (s, 3H); ^{13}C NMR δ 173.4, 169.4, 166.1, 165.2, 157.5, 152.7, 148.4, 141.7, 133.8, 133.5, 129.8. 129.7. 129.3. 128.7, 128.6, 111.6, 88.8, 80.4, 74.6, 70.7, 63.6, 24.7, 20.4.

Anal. Calcd for $C_{28}H_{25}N_5O_9$: C, 58.43; H, 4.38; N, 12.17. Found: C, 58.16; H, 4.45; N, 11.99.

2′-*O*-Acetyl-5′-*O*-benzoyl-3′-deoxyuridine (38a). Obtained in 60% yield as a white powder: mp 64−66 °C; $[\alpha]^{23}_D$ +5.0° (*c* 1.0, $CHCl_3$); IR (thin film) 1714, 1692, 1601, 1453, 1377, 1274 cm^{-1}; ^1H NMR($CDCl_3$) δ 8.55 (br s, 1H), 8.03−8.00 (m, 2H), 7.61−7.57 (m, 1H), 7.46 (t, J = 8.1, 3H), 5.80 (d, J =

1.6, 1H), 5.53 (dd, J = 8.1, 2.2, 1H), 5.34 (m, 1H), 4.69 (dd, J = 12.2, 2.7, 1H), 4.66−4.62 (m, 1H), 4.51 (dd, J = 12.2, 4.2, 1H), 2.35−2.27 (m, 1H), 2.17 (ddd, J = 14.0, 5.6, 1.7, 1H), 2.11 (s, 3H); ^{13}C NMR δ 170.0, 166.2, 162.9, 149.8, 139.9, 133.7, 129.6, 129.4, 128.7, 102.5, 91.6, 78.3, 77.7, 64.3, 32.5, 20.9; HRMS (FAB, MB) m/z calcd for $C_{18}H_{19}N_2O_7$ (M + H) 375.1192, found 375.1191.

2′-*O*-Acetyl-5′-*O*-benzoyl-3′-deoxy-5-methyluridine (38b). Obtained in 33% yield as a white powder: mp 60−62 °C; $[\alpha]^{23}_D$ −18°(c 0.45, $CHCl_3$); IR (thin film) 1712, 1693, 1601, 1452, 1373, 1273 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.32 (br s, 1H), 8.05 (d, J = 7.2, 2H), (m, 2H), 7.63−7.57 (m,1H), 7.46 (t, J = 7.6, 2H), 7.14 (d, J = 1.0, 1H), 5.83 (d, J = 2.4, 1H), 5.37 (dt, J = 6.7, 2.4, 1H), 4.71 (dd, J = 12.2, 2.6, 1H), 4.63 (m, 1H), 4.47 (dd, J = 12.2, 4.4, 1H), 2.46−2.36 (m, 1H), 2.20 (ddd, J = 14.0, 5.9, 2.4, 1H), 2.13 (s, 3H), 1.70 (d, J = 1.0, 3H); ^{13}C NMR δ 170.1, 166.2, 163.3, 149.8, 135.6, 133.6, 129.6, 129.4, 128.7, 111.2, 91.2, 77.6, 77.4, 64.6, 32.8, 20.9, 12.3; HRMS (FAB, MB) m/z calcd for $C_{19}H_{21}N_2O_7$ (M + H) 389.1349, found 389.1349.

2′-*O*-Acetyl-5′-*O*-benzoyl-3′-deoxyadenosine (38 g). Obtained in 78% yield as a white powder: mp 73−76 °C; $[\alpha]^{23}_D$ −9.6° (c 0.5, $CHCl_3$); IR (thin film) 1744, 1721, 1643, 1600, 1476, 1373, 1274 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.27 (s, 1H), 7.97 (d, J = 7.8, 2H), 7.94 (s, 1H), 7.56 (t, J = 7.4, 1H), 7.41 (dd, J = 7.8, 7.4, 2H), 6.06 (d, J = 1.0, 1H), 5.99 (br s, 1H), 5.83 (d, J = 5.8, 1H), 4.78−4.71 (m, 1H), 4.68 (dd, J = 12.1, 3.0, 1H), 4.53 (dd, J = 12.1, 5.3, 1H), 2.85 (m, 1H), 2.30 (ddd, J = 14.0, 5.6, 0.8, 1H), 2.15 (s, 3H); ^{13}C NMR δ 170.1, 166.3, 155.0, 152.1, 149.2, 139.7, 133.3, 129.6, 129.5, 128.4, 120.2, 90.2, 78.8, 77.9, 64.9, 33.1, 20.9; HRMS (FAB, MB) m/z calcd for $C_{19}H_{20}N_5O_5$ (M + H) 398.1464, found 398.1465.

N^2-Acetyl-2′-*O*-acetyl-5′-*O*-benzoyl-3′-deoxyguanosine (38h). Obtained in 71% yield as a white powder: mp 108−110 °C; $[\alpha]^{23}_D$ −52.3° (c 0.83, $CHCl_3$); IR (thin film) 1719, 1680, 1612, 1560,1482, 1374, 1253 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 12.0 (br s, 1H), 9.81 (br s, 1H), 7.97 (d, J = 7.3, 2H), 7.78 (s, 1H), 7.59 (t, J = 7.4, 1H), 7.44 (t, J = 7.5, 2H), 5.91 (d, J = 1.0, 1H), 5.55 (m, 1H), 5.05 (dd, J = 11.3, 5.7, 1H), 4.80−4.74 (m, 1H), 4.52 (dd, J = 11.3, 5.5, 1H), 2.84 (ddd, J = 14.0, 9.5, 6.2, 1H), 2.34 (s, 1H), 2.18 (ddd, J = 14.0, 6.1, 1.4, 1H), 2.11 (s, 3H); ^{13}C NMR δ 172.4, 170.2, 166.9, 155.5, 147.6, 147.4, 138.4, 133.7, 129.6, 129.2, 128.6, 121.9, 91.0, 78.9, 78.2, 64.7, 33.2, 24.3, 20.9; HRMS (FAB, MB) m/z calcd for $C_{21}H_{22}N_5O_7$ (M + H) 456.1519, found 456.1517.

***N*^{2}-Acetyl-*N*7-(2-*O*-acetyl-5-*O*-benzoyl-3-deoxy-β-D-*erythro*-pentofuranosyl)guanine (38i).** Obtained in 80% yield as a white powder: mp 114−116 °C; $[\alpha]^{23}_D$ +82.4° (c 1.0, $CHCl_3$); IR (thin film) 1746, 1720, 1685, 1614, 1548, 1451, 1372 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 12.3 (br s, 1H), 10.9 (br s, 1H), 8.06 (d, J = 7.5, 2H), 8.04 (s, 1H), 7.59 (t, J = 7.5, 1H), 7.46 (t, J = 7.5, 2H), 6.32 (s, 1H), 5.79 (d, J = 5.4, 1H), 4.80−4.76 (m, 1H), 4.71 (dd, J = 12.3, 2.8, 2H), 4.62 (dd, J = 12.3, 5.4, 2H), 2.50 (m, 1H), 2.36 (s, 3H), 2.25−2.18 (m, 1H), 2.18 (s, 3H); ^{13}C NMR δ 173.3, 170.0, 166.3, 157.4, 152.8, 148.0, 140.8, 133.5, 129.7, 129.4, 128.6, 111.1, 91.8, 79.1, 79.0, 64.9, 32.3, 24.5, 21.0; HRMS (FAB, MB) m/z calcd for $C_{21}H_{22}N_5O_7$ (M + H) 456.1519, found 456.1517.

Methyl 2,3,5-Tri-*O*-[3-(trifluoromethyl)benzoyl]-D-ribofuranoside (44). To a stirred solution of the **43** (2.6 g, 15.8 mmol) and 2, 6-lutidine (5.36 g, 50 mmol) in dry methylene chloride (54 mL) at 0 °C, was added 3-(trifluoromethyl)benzoyl chloride (9.91 g, 47.5 mmol) dropwise over 15 min. The reaction was allowed to warm to room temperature and stirred for 14 h at room temperature after which time saturated bicarbonate solution was added. The layers were separated and the aqueous phase extracted with ethyl acetate. The organic extracts were dried over sodium sulfate, filtered and concentrated under reduced pressure. Purification by flash chromatography on silica, eluted with 5% ethyl acetate/hexanes, gave **44** as a 3:1 (β:α) mixture of anomers and as a waxy white solid (7.8 g, 73% yield): mp 63−65 °C; $[\alpha]^{23}_D$ 25.6 (c 1.75, $CHCl_3$); ^{1}H NMR ($CDCl_3$) δ 8.36−8.30 (m, 1H), 8.26−8.22 (m, 3H), 8.11−8.08 (m, 2H), 7.87−7.76 (m, 3H), 7.60−7.50 (m, 3H), 5.95 and 5.76 (diastereomers, dd, J = 6.4, 5.0 J = 6.9, 2.9, 1H), 5.72 and 5.38 (diastereomers. d, dd, J = 5.0, J = 6.9, 4.4, 1H), 5.44 and 5.24 (diastereomers, d, s, J = 4 0.4, 1H), 4.82−4.60 (m, 3H), 3.53 and 3.48 (diasteromers, s, s, 3H).

1-*O*-Acetyl-2,3,5-tri-*O*-[3-(trifluoromethyl)benzoyl]-D-ribofuranose (45). To a stirred solution of **44** (1.30 g, 2.0 mmol) in acetic acid (10.1 mL) cooled to 4 °C, was added acetic anhydride (7.3 mL) and concentrated sulfuric acid (0.6 mL). The reaction was stirred at 4 °C for 5 h, then at room-temperature overnight. The reaction was then cooled to 4 °C and quenched with an ice cold, saturated bicarbonate. The layers were separated and the aqueous phase extracted with chloroform water and brine, then dried over sodium sulfate, filtered and evaporated under reduced pressure. Flash chromatography on silica eluted with 5% ethyl acetate/hexanes, gave **45** as a 3:2 (β:α) mixture of anomers as a syrup (1.30 g, 92% yield): $[\alpha]^{23}_{D\ 17.7}$ (c 2.53, $CHCl_3$); ^{1}H NMR ($CDCl_3$) δ 8.21−8.16 (m, 4H), 8.00−7.94 (m, 2H), 7.76−7.66 (m, 3H), 7.52−7.39 (m, 3H), 6.63 and 6.41 (diastereomers, d, s, J = 4.5, 1H), 5.90−5.80 (m, 1H), 5.75−5.70 and 5.65−5.55 (diastereomers, m, m, 1H), 4.70−4.50 (m, 3H), 2.07 and 1.98 (diastereomers, s, s, 3H).

2′,3′,5′-Tri-*O*-[3-(trifluoromethyl)benzoyl]uridine (46a). Obtained in 91% yield as a white powder. Recrystallized from ethanol to give white needles: mp 179−180 °C; $[\alpha]^{23}_D$ −28.40 (c 1.0, $CHCl_3$); IR (thin film) 1727, 1700, 1336, 1250, 1130 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 9.24 (br s, 1H), 8.24 (s, 1H), 8.19 (s, 1H) 8.17 (s, 1H), 8.10−8.00 (m, 4H), 7.80−7.70 (m, 3H), 7.53−7.42 (m, 3H), 7.28 (d, J = 8.1, 1H), 5.96 (d, J = 4.0, 1H), 5.92−5.89 (m, 1H), 5.85−5.81 (m, 1H), 5.69 (dd, J = 8.1, 2.0, 1H), 4.78−4.67 (m, 3H); ^{13}C NMR ($CDCl_3$) δ 167.5, 166.8, 166.6, 165.7, 152.6, 143.5, 135.6, 135.5, 134.1 (q, J_{C-F} = 33), 133.9 (q, J_{C-F} = 33), 133.1, 133.0, 132.8, 132.7, 132.1, 132.0, 131.9, 131.8, 131.7, 126.1 (q, J_{C-F} = 272), 125.9 (q, J_{C-F} = 273), 125.7 (q, J_{C-F} = 272), 106.0, 93.6, 82.5, 77.0, 73.9, 66.7; HRMS (FAB, NBA) m/z calcd for $C_{33}H_{22}F_9N_2O_9$ (M + H) 761.1182, found 761.1157.

2′,3′,5′-Tri-*O*-[3-(trifluoromethyl)benzoyl]-5-methyluridine (46b). Obtained in 95% yield as a white powder: mp, 99−100 °C; $[\alpha]^{23}_D$ −39.70° (c 1.25, $CHCl_3$); IR (thin film) 1727, 1336, 1255, 1174 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.44 (s, 1H), 8.37 (s, 1H), 8.30 (d, J = 7.9, 1H), 8.18−8.12 (m, 4H), 7.88−7.81 (m, 3H), 7.66−7.55 (m, 3H), 7.12 (d, J = 1.0, 1H), 6.10 (d, J = 4.7, 1H), 5.98 (t, J = 5.8, 1H), 5.90−5.86 (m, 1H), 4.87−4.84 (m, 1H), 4.76−4.73 (m, 2H), 1.8 (d, J = 1.0, 3H); ^{13}C NMR ($CDCl_3$) δ 167.5, 166.7, 166.6, 166.1, 152.7, 138.7, 135.6, 135.5, 134.0 (q, J_{C-F} = 33), 133.1, 132.1, 132.0, 131.9, 131.8, 129.3, 129.1, 129.0, 125.9 (q, J_{C-F} = 270), 114.7, 92.6, 82.4, 76.7, 74.0, 66.7; HRMS (FAB, NBA) m/z calcd for $C_{34}H_{23}F_9N_2O_9$ (M + H) 775.1338, found 775.1357.

2′,3′,5′-Tri-*O*-[3-(trifluoromethyl)benzoyl]inosine (46c). Inosine was dried overnight at 100 °C under vacuum over P_2O_5. To a solution of inosine (0.320 g, 1.2 mmol) and DMAP (20 mg) in pyridine (20 mL) was added 3-(trifluoromethyl)-benzoyl chloride (1.00 g, 4.8 mmols), dropwise over 10 min. The reaction was stirred for 27 h, and then the pyridine removed in vacuo. The residue was then taken up in ethyl acetate and quenched with saturated bicarbonate. The organic layer was then washed with brine and water and then dried over magnesium sulfate, filtered and evaporated. Purification by flash chromatography, eluting with 1% methanol in chloroform gave **46c** (0.600 g, 86% yield) as a white solid: mp 110−112 °C; $[\alpha]^{23}_D$ −45.0 (c 0.80, $CHCl_3$); IR (thin film) 1731, 1705, 1336, 1250, 1127 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.38−8.24 (m, 3H), 8.19−8.15 (m, 3H), 8.05 (d, J = 4.0, 2H), 7.84−7.82 (m, 3H), 7.65−7.54 (m, 3H), 6.44−6.37 (m, 2H), 6.25 (t, J = 5.4, 1H), 4.95−4.87 (m, 2H), 4.86−4.77 (m, 1H); ^{13}C NMR ($CDCl_3$) δ 169.3, 165.2, 164.3, 164.2, 159.2, 149.0, 146.2, 140.2, 133.6, 133.4, 133.3, 132.0, 131.5, 131.4, 130.8, 130.6, 129.8, 129.5, 129.7, 129.4, 127.1, 127.0, 126.9, 126.8, 121.7, 88.1, 80.7, 74.8, 72.1, 64.4; HRMS (FAB, NBA) m/z calcd for $C_{34}H_{21}F_3N_4O_8$ (M + H) 785.1294, found 785.1298.

5′-*O*-[3-(Trifluoromethyl)benzoyl]-2′,3′-dideoxyuridine. (47a). Obtained in 68% yield as a clear syrup: $[\alpha]^{23}_D$ +24.9° (c 0.65, $CHCl_3$); IR (thin film) 1690, 1254, 1128 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.23−8.15 (m, 3H), 7.80 (d, J = 6.8, 1H), 7.55 (t, J = 8.0, 1H), 7.50 (d, J = 8.1, 1H), 6.01−5.98 (m, 1H),

5.55 (dd, J = 8.1, 1.8, 1H), 4.54 (s, 2H), 4.43−4.38 (m, 1H), 2.55−2.41 (m, 1H), 2.15−2.01 (m, 2H), 1.87−1.80 (m, 1H); ^{13}C NMR ($CDCl_3$) δ 165.4, 163.5, 150.6, 139.7, 133.2, 131.6 (J_{C-F} = 33), 130.6 (J_{C-F} = 28), 129.7, 127.0, 121 (J_{C-F} = 275), 102.5, 87.1, 79.2, 66.1, 32.9, 26.3; HRMS (FAB, NBA) *m/z* calcd for $C_{17}H_{16}F_3N_2O_5$ (M + H) 385.1011, found 385.1010.

5′-*O*-[3-(Trifluoromethyl)benzoyl]-3′-deoxythymidine (47b). Obtained in 85% yield as a clear syrup: $[\alpha]^{23}_D$ +11.0° (*c* 0.41, $CHCl_3$); IR (thin film) 1692, 1470, 1335, 1254, 1130 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.69 (s, 1H), 8.25 (s, 1H), 8.17 (d, J = 7.8, 1H), 7.80−7.70 (m, 1H), 7.57−7.50 (m, 1H), 7.22 (d, J = 1.1, 1H), 6.02 (dd, J = 6.6, 4.5, 1H), 4.59−4.20 (m, 3H), 2.47−2.38 (m, 1H), 2.24−1.82 (m, 3H), 1.71 (d, J = 1.1, 3H); ^{13}C NMR ($CDCl_3$) δ 165.4, 164.0, 150.6, 135.4, 133.2, 130.6 (J_{C-F}= 38), 129.7, 127.0, 111.2, 86.7, 78.5, 66.5, 32.4, 26.6, 12.8; HRMS (FAB, NBA) *m/z* calcd for $C_{18}H_{18}F_3N_2O_5$ (M + H) 399.1168, found 399.1174.

5′-*O*-[3-(Trifluoromethyl)benzoyl]-2′,3′-dideoxyinosine (47c). Obtained in 65% yield as a white powder: mp 197 °C dec; $[\alpha]^{23}_D$ +18.35 (*c* 0.85, DMSO); IR (KBr) 1728, 1676, 1340, 1255, 1130 cm^{-1}; ^{1}H NMR (methanol-*d*4) 8.12 (br s, 1H), 8.09 (s, 1H), 8.02 (d, J = 7.9, 1H), 7.88 (s, 1H), 7.79 (d, J = 7.9, 1H), 7.56 (t, J = 7.9, 1H), 6.20 (dd, J = 6.7, 3.4, 1H), 4.55−4.44 (m, 3H), 2.59−2.55 (m, 2H), 2.22−2.17 (m, 2H); ^{13}C NMR ($CDCl_3$) 164.7, 157.5, 148.1, 146.4, 138.4, 133.5, 130.7, 130.6, 130.3, 130.2, 130.1, 129.7, 125.8, 125.6, 124.8, 122.2, 105.2, 84.3, 78.8, 66.8, 31.5, 26.7; HRMS (FAB) *m/z* calcd for $C_{18}H_{16}F_3N_4O_4$ (M + H) 409.1124, found 409.1108.

1-(2′,3′,5′-Tri-*O*-benzoyl-*β*-D-xylofuranosyl)uracil (49). A solution of α-D-1,2,3,4-tetra-*O*-benzoylxylofuranose (0.5 g, 0.882 mmol) and 2,4-bis-trimethylsilyluracil (0.45 g, 1.75 mmol) in dry dichloroethane (10 mL) was cooled to −20 °C. To the vigorously stirred solution was added dropwise $SnCl_4$ (0.52 mL, 4.4 mmol). The reaction was allowed to warm to room temperature and stirred overnight, after which time it was quenched with saturated aqueous bicarbonate. The layers were separated and the aqueous phase extracted with ethyl acetate. The combined organic extracts were washed with brine, dried over anhydrous sodium sulfate, filtered and evaporated Purification by flash chromatography on silica, eluting with 1% methanol in chloroform, gave **49** (430 mg, 87%) as a white solid: mp 106−108 °C; $[\alpha]^{23}_D$ +67° (*c* 2.0, $CHCl_3$); ^{1}H NMR ($CDCl_3$) δ 9.37 (br, s, 1H), 8.06 (d, J = 7.8, 2H), 7.95 (d, J = 8.2, 4H), 7.74 (d, J = 8.2, 1H), 7.62−7.51 (m, 3H), 7.48−7.35 (m, 6H), 6.26 (d, J = 2.0, 1H), 5.85 (1H, dd, J = 3.9, 1.5, 1H), 5.71 (dd, J = 8.2, 1.2, 1H), 5.67 (t, J = 2.0, 1H), 4.90−4.85 (m, 1H), 4.80−4.69 (m, 2H); ^{13}C NMR δ 166.0, 164.7, 164.6, 162.9, 150.0, 139.2, 134.1, 133.9, 133.4, 130.0, 129.7, 129.6, 129.1, 128.7, 128.5, 128.4, 128.3, 128.2, 102.7, 88.8, 80.2, 79.5, 75.1, 61.4; HRMS (FAB, NBA) *m/z* calcd for $C_{30}H_{25}N_2O_9$ (M + H) 557.1560, found 557.1541.

1-(2′,5′-*O*-Dibenzoyl-3′-*O*-acetyl-α-D-arabinofuranosyl)-4-methoxy-2-pyrimidone (52a). Obtained in 96% yield from **33**, as a white powder: mp 70−72 °C; $[\alpha]^{23}_D$ −19° (*c* 2.0, $CHCl_3$); IR (thin film) 1725, 1664, 1631, 1601, 1585, 1542, 1481, 1316, 1266 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.08 (d, J = 7.2, 2H), 8.03 (d, J = 7.2, 2H), 7.61−7.50, (m, 2H), 7.46−7.35 (m, 4H), 6.18 (d, J = 2.4, 1H), 5.94 (d, J = 7.4, 1H), 5.82 (t, J = 2.4, 1H), 5.46 (t, J = 2.9, 1H), 4.90−4.85 (m, 1H), 4.67−4.54 (m, 2H), 3.96 (s, 3H), 2.07 (s, 3H); ^{13}C NMR δ 172.2, 169.6, 166.1, 165.2, 155.6, 142.9, 133.8, 133.3, 130.0, 129.8, 129.4, 128.6, 128.5, 95.7, 93.0, 84.2, 80.7, 76.9, 63.8, 54.6, 20.7.

Anal. Calcd for $C_{26}H_{24}N_2O_9$: C, 61.41; H, 4.76; N, 5.51. Found: C, 61.32; H, 4.88; N, 5.52.

1-(3,5-*O*-Dibenzoyl-2-*O*-[3-(trifluoromethyl)benzoyl])-*β*-D-ribofuranosyl]-4-methoxy-2-pyrimidone (52b). Obtained in 92% yield from **9**, as a white powder: mp 181−182 °C; $[\alpha]^{23}_D$ −3.9°(*c* 1.14, $CHCl_3$); IR (thin film) 1727, 1675, 1638, 1544, 1483, 1315, 1269 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.19 (s, 1H), 8.14 (d, J = 7.9, 1H), 8.10−8.07 (m, 2H), 7.98−7.95 (m, 2H), 7.79 (d, J = 7.9, 1H), 7.69 (d, J = 7.5, 1H), 7.63−7.36 (m, 7H), 6.45 (d, J = 4.9, 1H), 5.90 (t, J = 5.4, 1H), 5.82 (m, 2H), 4.85 (dd, J = 12.0, 2.8, 1H), 4.79−4.75 (m, 1H), 4.69 (dd, J = 12.0, 3.9, 1H), 3.94 (s, 3H); ^{13}C NMR δ 171.9, 166.0, 165.3, 164.1, 155.5, 142.1, 133.8, 133.6, 133.2, 131.2 (q, J_{C-F} = 33), 130.1, 129.8, 129.6, 129.5, 129.2, 128.7, 128.6, 128.4, 126.7, 123.4 (q, J_{C-F} = 272), 96.7, 89.2, 80.6, 75.0, 71.2, 63.8, 54.6.

Anal. Calcd for $C_{32}H_{25}F_3N_2O_9$: C, 60.19; H, 3.95; N, 4.39. Found: C, 60.27; H, 3.89; N, 4.41.

1-(2-*O*-Acetyl-3,5-*O*-dibenzoyl-*β*-D-ribofuranosyl)-4-methoxy-2-pyrimidone (52c). Obtained in 83% yield from **36**, as a white powder: mp 170−171 °C; $[\alpha]^{23}_D$ +10.8° (*c* 1.15, $CHCl_3$); IR (thin film) 1725, 1676, 1637, 1601, 1543, 1482, 1452, 1316 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.07−8.03 (m, 4H), 7.64 (d, J = 7.5, 1H), 7.64−7.57 (m, 2H), 7.50−7.43 (m, 4H), 6.35 (d, J = 5.4, 1H), 5.76 (d, J = 7.5, 1H), 5.73 (t, J = 4.7, 1H), 5.57 (t, J = 5.4, 1H), 4.79 (dd, J = 11.5, 1.9, 1H), 4.69−4.60 (m, 2H), 3.94 (s, 3H), 2.06 (s, 3H); ^{13}C NMR δ 171.8, 169.6, 166.0, 165.3, 155.6, 141.8, 133.8, 133.6, 129.8, 129.6, 129.2, 128.7, 128.6, 96.7, 88.4, 80.4, 73.8, 71.0, 63.7, 54.6, 20.5.

Anal. Calcd for $C_{26}H_{24}N_2O_9$: C, 61.41; H, 4.76; N, 5.51. Found: C, 61.31; H, 4.88; N, 5.58.

1-(3-*O*-Acetyl-5-*O*-benzoyl-2-deoxy-α-D-*erythro*-pentofuranosyl)-4-methoxy-2-pyrimidone (53a). Obtained in 80% yield as a white powder: mp 135−137 °C; $[\alpha]^{23}_D$ −74.7° (*c* 0.9, $CHCl_3$); IR (thin film) 1734, 1661, 1621, 1603, 1584, 1538, 1476, 1380, 1316, 1273 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.01 (d, J = 7.4, 2H), 7.71 (d, J = 7.4, 1H), 7.59 (t, J = 7.4, 1H), 7.46 (t, J = 7.4, 2H), 6.25 (d, J = 6.0, 1H), 5.92 (d, J = 7.4, 1H), 5.34 (d, J = 6.0, 1H), 4.74 (m, 1H), 4.52−4.42 (m, 2H), 3.96 (s, 3H), 2.87 (dt, J = 15.5, 6.5, 1H), 2.48 (br d, J = 15.5, 1H), 1.94 (s, 3H); ^{13}C NMR δ 172.1, 169.9, 166.0, 155.8, 141.8, 133.5, 129.6, 129.3, 128.6, 94.6, 89.0, 85.4, 74.5, 64.1, 54.5, 38.8, 20.8; HRMS (FAB, MB) *m/z* calcd for $C_{19}H_{21}N_2O_7$ (M + H) 389.1349, found 389.1349.

1-(3,5-*O*-Dibenzoyl-2-deoxy-*β*-D-*erythro*-pentofuranosyl)-4-methoxy-2-pyrimidone (53b). Obtained in 63% yield as a white powder: mp 72−75 °C; $[\alpha]^{23}_D$ +5.0° (*c* 2.0, $CHCl_3$); IR (thin film) 1721, 1668, 1633, 1544, 1314, 1269 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.06 (d, J = 7.0, 2H), 7.97 (d, J = 7.0, 2H), 7.83 (d, J = 7.5, 1H), 7.64−7.57 (m, 2H), 7.51−7.42 (m, 4H), 6.42 (dd, J = 8.0, 5.6, 1H), 5.79 (d, J = 7.5, 1H), 5.61 (dt, J = 6.5, 2.0, 1H), 4.76 (dd, J = 12.2, 3.4, 1H), 4.69 (dd, J = 12.2, 3.6, 1H), 4.63−4.60 (m, 1H), 3.94 (s, 3H), 3.03 (ddd, J = 14.5, 5.6, 2.0, 1H), 2.26 (ddd, J = 14.5, 8.0, 6.5, 1H); ^{13}C NMR δ 171.8, 166.1, 155.7, 141.4, 133.7, 133.6, 129.9, 129.5, 129.2, 129.0, 128.7, 128.6, 95.9, 87.2, 83.3, 75.1, 64.4, 54.5, 39.2; HRMS (FAB, NBA) *m/z* calcd for $C_{24}H_{23}N_2O_7$ (M + H) 451.1505, found 451.1497.

1-(2-*O*-Acetyl-5-*O*-benzoyl-3-deoxy-*β*-D-*erythro*-pentofuranosyl)-4-methoxy-2-pyrimidone (53c). Obtained in 55% yield as a white powder: mp 62−64 °C; $[\alpha]^{23}_D$ +53° (*c* 0.45, $CHCl_3$); IR (thin film) 1744, 1722, 1669, 1632, 1602, 1543, 1481, 1371, 1313, 1275 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 8.03 (d, J = 7.4, 2H), 7.82 (d, J = 7.4, 1H), 7.61 (t, J = 7.4, 2H), 7.47 (t, J = 7.4, 2H), 5.95 (d, J = 0.7, 1H), 5.72 (d, J = 7.4, 1H), 5.40−5.35 (m, 1H), 4.74−4.65 (m, 2H), 4.56 (dd, J = 12.8, 5.0, 1H), 3.94 (s, 3H), 2.20−2.15 (m, 2H), 2.14 (s, 3H); ^{13}C NMR δ 171.9, 169.8, 166.1, 155.4, 142.2, 133.5, 129.6, 129.4, 128.6, 95.6, 92.1, 78.6, 78.0, 64.5, 54.5, 32.3, 21.0.; HRMS (FAB, MB) *m/z* calcd for $C_{19}H_{21}N_2O_7$ (M + H) 389.1349, found 389.1349.

α-2′-Deoxycytidine (54a). A solution of **53a** (40 mg, 0.103 mmol) in 2.0 M methanolic ammonia (5 mL) was heated at 100 °C for 15 h in a sealed tube. The reaction mixture was then cooled to room temperature and evaporated to dryness. Purification by flash chromatography on silica, eluted with 33% methanol in chloroform, gave α-2′-deoxycytidine (**54a**, 16 mg, 68% yield) as a white powder: mp 201−203 °C (lit.[22a] mp 203−4 °C); $[\alpha]^{23}_D$ −47° (*c* 0.65, H_2O); IR (KBr) 1658, 1642, 1605, 1530, 1492, 1289 cm^{-1}; ^{1}H NMR (D_2O) δ 7.80 (d, J = 7.5, 1H), 6.07 (dd, J = 7.0, 2.4, 1H), 5.96 (d, J = 7.5, 1H), 4.38−4.34 (m, 2H), 3.66 (dd, J = 12.4, 3.7, 1H), 3.57 (dd, J = 12.4, 5.3, 1H), 2.65 (dt, J = 14.7, 6.5, 1H), 2.09 (br d, J = 14.7, 1H); ^{13}C NMR δ 166.6, 157.8, 142.2, 95.6, 89.2, 88.3, 71.1, 61.9, 40.3.

2′-Deoxycytidine (54b). Obtained in 50% as white powder: mp 206−209 °C (lit.[48] mp 200−201 °C); $[\alpha]^{23}_D$ +54°(c, 0.5, H_2O) (lit. $[\alpha]^{25}$D +54° (*c* 2.0, H_2O); IR (KBr) 1661, 1618, 1486 cm^{-1}; ^{1}H NMR (D_2O) δ 7.78 (d, J = 7.5, 1H), 6.23 (t, J = 6.6, 1H), 6.00 (d, J = 7.5, 1H), 4.41−4.36 (m, 1H), 4.03−3.99 (m,

1H), 3.80 (dd, J = 12.5, 3.6, 1H), 3.71 (dd, J = 12.5, 5.2, 1H), 2.39 (m, 1H), 2.25 (m, 1H). ^{1}H NMR data are identical with those of authentic sample.

3′-Deoxycytidine (54c). Obtained in 80% yield as a white powder: mp 217−219 °C (lit.[31a] mp 220 °C); $[\alpha]^{23}_D$ +50° (*c* 0.8, H_2O); IR (KBr) 1649, 1605, 1529, 1492, 1403, 1288 cm^{-1}; ^{1}H NMR (D_2O) δ 7.83 (d, J = 7.5, 1H), 5.93 (d, J = 7.5, 1H), 5.75 (s, 1H), 4.51−4.43 (m, 1H), 4.40−4.37 (m, 1H), 3.90 (dd, J = 12.7, 2.8, 1H), 3.71 (dd, J = 12.7, 5.0, 1H), 1.95−1.90 (m, 2H); ^{13}C NMR δ 166.5, 157.8, 141.5, 95.8, 93.3, 81.9, 76.0, 62.4, 32.8.

1-(3,5-*O*-Dibenzoyl-2-[3-(trifluoromethyl)benzoyl]-β-D-ribofuranosyl)-4-methoxy-1,3,5-triazin-2-one (56). Obtained as a white solid: mp 188−190 °C; $[\alpha]^{23}_D$ −11.0 ° (*c* 0.95, $CHCl_3$); ^{1} H NMR ($CDCl_3$) δ 8.40 (s, 1H), 8.15 (s, 1H), 8.11 (d, J = 8.0, 1H), 8.06 (d, J = 7.9, 2H), 8.00 (d, J = 7.9, 2H), 7.79 (d, J = 7.8, 1H), 7.61−7.38 (m, 7H), 6.16 (d, J = 4.0, 1H), 5.99−5.90 (m, 2H), 4.86−4.70 (m, 3H), 4.02 (s, 1H); ^{13}C NMR δ 170.2, 166.0, 165.2, 164.2, 157.6, 153.6, 133.9, 133.6, 133.2, 131.3 (q, J_{C-F}= 33), 130.4, 129.8, 129.7, 129.3, 129.1, 128.7, 128.6, 128.3, 126.7, 123.3 (q, J_{C-F}= 274), 90.4, 81.1, 75.2, 71.3, 63.7, 56.3; HRMS (FAB, NBA) *m*/*z* calcd for $C_{31}H_{25}F_3N_3O_9$ (M + H) 640.1543 found 640.1547.

1-(3,5-*O*-Dibenzoyl-2-deoxy-β-D-*erythro*-pentofuranosyl)-4-methoxy-1,3,5-triazin-2-one (57). Obtained as a white solid: mp 196−198 °C; $[\alpha]^{23}_D$ 6.8° (*c* 0.32, $CHCl_3$); ^{1}H NMR ($CDCl_3$) δ 8.54 (s, 1H), 8.04 (d, J = 8.1, 2H), 7.93 (d, J = 8.1, 2H), 7.62−7.54 (m, 2H), 7.49−7.40 (m, 4H), 6.26 (dd, J = 7.8, 5.7, 1H), 5.61 (dt, J = 6.5, 1.8, 1H), 4.73−4.66 (m, 3H), 3.97 (s, 3H), 3.10 (ddd, J = 14.5, 5.7, 1.8, 1H), 2.32 (ddd, J = 14.5, 7.8, 6.5, 1H); ^{13}C NMR δ 170.4, 166.0, 165.9, 156.4, 154.1, 133.8, 133.7, 129.8, 129.5, 129.0, 128.9, 128.7, 128.6, 87.7, 84.1, 75.0, 64.2, 56.1, 39.7; HRMS (FAB, NBA) *m*/*z* calcd for $C_{23}H_{22}N_3O_7$ (M + H) 452.1458, found 452.1487.

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Supporting Information Available: UV spectra of **20** and **21**. This material is available free of charge via the Internet at http://pubs.acs.org.

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