21. Nucleosides

Part LI[1])

The 2-(4-Nitrophenyl)ethoxycarbonyl (npeoc) and 2-(2,4-Dinitrophenyl)ethoxycarbonyl (dnpeoc) Groups for Protection of Hydroxy Functions in Ribonucleosides and 2′-Deoxyribonucleosides

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The common 2′-deoxypyrimidine and -purine nucleosides, thymidine (**4**), O^4-[2-(4-nitrophenyl)ethyl]-thymidine (**17**), 2′-deoxy-N^4-[2-(4-nitrophenyl)ethoxycarbonyl]cytidine (**26**), 2′-deoxy-N^6-[2-(4-nitrophenyl)-ethoxycarbonyl]adenosine (**39**), and 2′-deoxy-N^2-[2-(4-nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)ethyl]-guanosine (**52**) were further protected by the 2-(4-nitrophenyl)ethoxycarbonyl (npeoc) and the 2-(2,4-dinitrophenyl)ethoxycarbonyl (dnpeoc) group at the OH functions of the sugar moiety to form new partially and fully blocked intermediates for nucleoside and nucleotide syntheses. The corresponding 5′-*O*-monomethoxytrityl derivatives **5**, **18**, **30**, **40**, and **56** were also used as starting material to synthesize some other intermediates which were not obtained by direct acylations. In the ribonucleoside series, the 5′-*O*-monomethoxytrityl derivatives **14**, **36**, **49**, and **63** reacted with 2-(4-nitrophenyl)ethyl chloroformate (**1**) to the corresponding 2′,3′-bis-carbonates **15**, **37**, **50**, and **64** which were either detritylated to **16**, **38**, **51**, and **65**, respectively, or converted by 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) treatment to the 2′,3′-cyclic carbonates **66**–**69**. The newly synthesized compounds were characterized by elemental analyses and UV and ^{1}H-NMR spectra.

1. Introduction. – The selective protection of different OH functions is one of the crucial problems in the synthesis involving nucleosides and other polyfunctional compounds. The development of the 2-(4-nitrophenyl)ethyl (npe) and 2-(4-nitrophenyl)-ethoxycarbonyl (npeoc) groups for base [2], phosphate [2–4], and phosphite [5] [6] protection has improved the blocking-group strategy substantially by offering the so far most universal blocking groups in nucleoside, nucleotide, and oligonucleotide chemistry [7] [8]. This new type of protecting groups is stable under mild hydrolytic conditions (*e.g.* NH_3, Et_3N in MeOH, dioxan, and H_2O) but can be cleaved quantitatively by 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) or 1,5-diazabicyclo[4.3.0]non-5-ene (DBN) in aprotic solvents *via* β-elimination.

The good features of the 2-(4-nitrophenyl)ethoxycarbonyl (npeoc) protecting group for various functions prompted us to extend this group for protection of OH positions in deoxyribo- and ribonucleosides [9]. The corresponding protections by the 2-(2,4-dinitrophenyl)ethoxycarbonyl (dnpeoc) group in the 2′-deoxyribonucleoside series was based upon a new, purely base-dependent methodology to synthesize oligodeoxynucleotides. Since the dnpeoc group is extremely base-labile, it can function as a transient protecting

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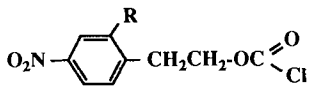
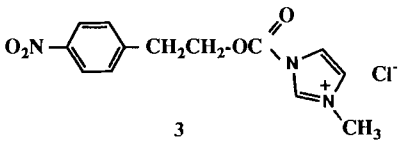


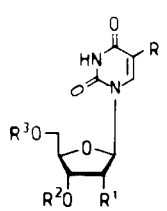
1 R = H
2 R = NO_2



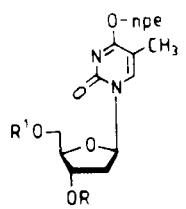
3

group which can be cleaved selectively by tertiary amines not harming the npe and npeoc groups blocking other functionalities. The higher reactivity of the primary 5′-OH groups allows a highly selective monoacylation at this position by the corresponding chloroformate **1** or **2** or its 3-methyl-1*H*-imidazolium chloride salt **3**, whereas analogous reactions at the secondary OH groups work only prior to 5′-OH protection.

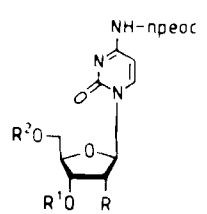
2. Syntheses. – The systematic investigations of OH protection at the sugar moieties of the common 2′-deoxyribo- and ribonucleosides were started with thymidine (**4**) as the most simple candidate of this series. Treatment of thymidine (**4**) with 2-(4-nitrophenyl)ethyl chloroformate (**1**) in dry pyridine/CH_2Cl_2 at −10 to −20° led, within 3 h, to the disappearance of **4** and the formation of two products. After isolation by chromatographical means, they were identified spectroscopically as 5′-*O*-[2-(4-nitrophenyl)-ethoxycarbonyl]- (**7**; 70%) and 3′,5′-bis-*O*-[2-(4-nitrophenyl)ethoxycarbonyl]thymidine (**9**; 29%). The 3′-*O*-[2-(4-nitrophenyl)ethoxycarbonyl]thymidine (**8**) was detected only in traces under these conditions, but was prepared from 5′-*O*-(monomethoxytrityl)-3′-*O*-[2-(4-nitrophenyl)ethoxycarbonyl]thymidine (**6**; obtained from **5**) by detritylation and from 5′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-3′-*O*-[2-(4-nitrophenyl)ethoxycarbonyl]-thymidine (**13**) by a selective β-elimination of the base-labile 5′-substituent with Et_3N/dioxan/MeOH 1:1:1. The structural assignment of the 3′- and 5′-regioisomers can easily be achieved from the ^{1}H-NMR spectra showing either a *d* for the 3′-OH or a *t*/*m* for the 5′-OH group.



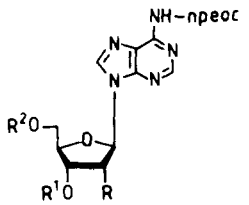
	R	R^1	R^2	R^3
4	Me	H	H	H
5	Me	H	H	MeOTr
6	Me	H	npeoc	MeOTr
7	Me	H	H	npeoc
8	Me	H	npeoc	H
9	Me	H	npeoc	npeoc
10	Me	H	H	dnpeoc
11	Me	H	dnpeoc	H
12	Me	H	dnpeoc	dnpeoc
13	Me	H	npeoc	dnpeoc
14	H	OH	H	MeOTr
15	H	Onpeoc	npeoc	MeOTr
16	H	Onpeoc	npeoc	H



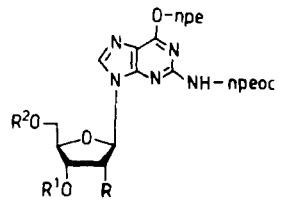
	R	R^1
17	H	H
18	H	MeOTr
19	H	npeoc
20	npeoc	H
21	npeoc	npeoc
22	npeoc	MeOTr
23	H	dnpeoc
24	dnpeoc	H
25	dnpeoc	dnpeoc



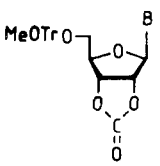
	R	R^1	R^2
26	H	H	H
27	H	H	npeoc
28	H	npeoc	H
29	H	npeoc	npeoc
30	H	H	MeOTr
31	H	npeoc	MeOTr
32	H	H	dnpeoc
33	H	dnpeoc	H
34	H	dnpeoc	dnpeoc
35	OH	H	H
36	OH	H	MeOTr
37	Onpeoc	npeoc	MeOTr
38	Onpeoc	npeoc	H



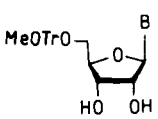
	R	R¹	R²
39	H	H	H
40	H	H	MeOTr
41	H	H	npeoc
42	H	npeoc	npeoc
43	H	npeoc	MeOTr
44	H	npeoc	H
45	H	H	dnpeoc
46	H	dnpeoc	H
47	H	dnpeoc	dnpeoc
48	OH	H	H
49	OH	H	MeOTr
50	Onpeoc	npeoc	MeOTr
51	Onpeoc	npeoc	H



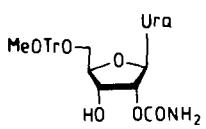
	R	R¹	R²
52	H	H	H
53	H	H	npeoc
54	H	npeoc	H
55	H	npeoc	npeoc
56	H	H	MeOTr
57	H	npeoc	MeOTr
58	H	H	dnpeoc
59	H	dnpeoc	H
60	H	dnpeoc	dnpeoc
61	H	dnpeoc	MeOTr
62	OH	H	H
63	OH	H	MeOTr
64	Onpeoc	npeoc	MeOTr
65	Onpeoc	npeoc	H



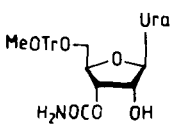
	Base
66	Ura
67	Cyt
68	Ade
69	Guo



	Base
14	Ura
70	Cyt
71	Ade
72	Guo



73



74

Acylation of **4** with 2-(2,4-dinitrophenyl)ethyl chloroformate (**2**) proceeded in an analogous manner, and the three products 5′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]- (**10**), 3′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]- (**11**), and 3′,5′-bis-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]thymidine (**12**) could be separated and isolated in 75, 6, and 1% yield, respectively. The synthesis of 5′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-3′-*O*-[2-(4-nitrophenyl)ethoxycarbonyl]thymidine (**13**) was achieved by two ways, either from **8** with **2** or from **10** with **1**, giving 76 and 75% yield, respectively.

In the uridine series, 5′-*O*-(monomethoxytrityl)uridine (**14**) was treated with 3-methyl-1-[2-(4-nitrophenyl)ethoxycarbonyl]-1*H*-imidazol-3-ium chloride [2] (**3**) in CH_2Cl_2 in presence of 4-(dimethylamino)pyridine at room temperature and led, surprisingly, in almost quantitative yield to 2′,3′-bis-*O*-[2-(4-nitrophenyl)ethoxycarbonyl]-5′-*O*-(monomethoxytrityl)uridine (**15**) and only traces of the 2′,3′-cyclic carbonate **66** (see below). Detritylation of **15** by AcOH/H_2O 4:1 gave **16** in high yield, which can be used as a 3′-terminal building block in oligonucleotide synthesis.

Protection of the sugar OH groups in O^4-[2-(4-nitrophenyl)ethyl]thymidine [2] (**17**) by **1** or **2** gave again three reaction products (**19–21** and **23–24**, resp.), of which the 5′-*O*-monosubstituted derivatives **19** and **23** were the main products. The 3′-mono- (**20** and **24**) and the 3′,5′-bis-carbonates (**21** and **25**) were always formed as minor components which could, however, be separated and isolated in pure form from the reaction mixture. The 3′-*O*-[2-(4-nitrophenyl)ethoxycarbonyl]-O^4-[2-(4-nitrophenyl)-ethyl]thymidine (**20**) was also prepared in higher quantities (88% yield) from 5′-*O*-(monomethoxytrityl)-O^4-[2-(4-nitrophenyl)ethyl]thymidine [2] (**18**) and **3** (→**22**, 89% yield), followed by acid treatment. This reactions sequence was additionally taken as a structural proof of **20**.

The acylations of 2′-deoxy-N^4-[2-(4-nitrophenyl)ethoxycarbonyl]cytidine [2] (**26**), 2′-deoxy-N^6-[2-(4-nitrophenyl)ethoxycarbonyl]adenosine [2] (**39**), and 2′-deoxy-N^2-[2-(4-nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)ethyl]guanosine (**52**) with **1** or **2** proceeded at low temperature with the formation of the same product pattern yielding the 5′-mono-carbonate **27** or **32**, **41** or **45**, and **53** or **58**, respectively, as main component, whereas the 3′-mono-carbonate **28** or **33**, **46**, and **54** or **59**, respectively, and the 3′,5′-bis-carbonate **29** or **34**, **42** or **47**, and **55** or **60**, respectively, were obtained in minor amounts. Compounds **44** and **59** were only detected chromatographically and could not be separated and isolated in pure form (see however, below). Treatment of **52** with excess of **1** or **2**, led to the 3′,5′-bis-carbonate **55** or **60**, respectively.

Similarly, the corresponding 5-*O*′-monomethoxytrityl derivatives **30**, **40** [2], and **56** [1] were transformed with **3** to the 3′-mono-carbonate **31**, **43**, and **57**, respectively. Detritylation of **43** yielded **44** (see above), and reaction of **56** with **2** (→**61**, 58% yield), followed by detrilyation gave **59** (see above) in 73% yield.

In the ribonucleoside series, only the 2′,3′-bis-carbonates were prepared. Thus, acylation of 5′-*O*-(monomethoxytrityl)-N^4-[2-(4-nitrophenyl)ethoxycarbonyl]cytidine [2] (**36**; from **35**), 5′-*O*-(monomethoxytrityl)-N^6-[2-(4-nitrophenyl)ethoxycarbonyl]adenosine [2] (**49**; from **48**), and 5′-*O*-(monomethoxytrityl)-N^2-[2-(4-nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)ethyl]guanosine [2] (**63**; from **62**) with reagent **3** and 4-(dimethylamino)pyridine at room temperature gave 2′,3′-bis-carbonates **37**, **50**, and **64**, respectively, and small amounts of the corresponding 2′,3′-cyclic carbonates **67–69** which, however, were not isolated. Detritylation to the final products **38**, **51**, and **65**, respectively, worked well either with 80% aq. AcOH or with 2% TsOH in CH_2Cl_2/MeOH.

The fully protected ribonucleosides **15**, **37**, **50**, and **64** were also used for deblocking experiments in which the 2-(4-nitrophenyl)ethoxycarbonyl and 2-(4-nitrophenyl)ethyl groups were cleaved off in the usual manner by 0.5M 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) solution in dry pyridine (β-elimination). Base protection was removed directly, but under these conditions, the 2′,3′-bis-carbonate functions were converted into the 2′,3′-cyclic carbonates **66–69**, of which **66** was isolated in almost quantitative yield and characterized by comparison with an authentic sample [10]. Subsequent hydrolysis of **66–69** with Et_3N/H_2O/MeOH 1:1:1 [11] at room temperature for 90 min afforded the 5′-*O*-(monomethoxytrityl) derivatives **14** [12] and **70–72** of uridine [12], cytidine, adenosine, and guanosine, respectively, in very good yields. The hydrolysis of the 2′,3′-cyclic carbonates can also be achieved by NaOH at pH 8.5 [13], and reaction of **66** with concentrated ammonia led to an isomeric mixture (80% yield) of the corresponding 2′- and 3′-*O*-carbamoyl-5′-*O*-(monomethoxytrityl)uridines **73** and **74**, which were not sepa-

rated due to very similar physical properties. This was not an unexpected result, since mixtures of uridine carbamates resulted also from the reaction of uridine with diiminosuccinonitrile or cyanogen bromide in aqueous solution [14].

3. Physical Data. – All newly synthesized compounds were characterized in the usual manner by elemental analysis and UV and ^{1}H-NMR spectra. Comparisons of the UV spectra indicate that the shape of the 5′-monomethoxytritylated ribonucleosides (**14**, **36**, **49**, and **63**) and 2′-deoxyribonucleosides (**5**, **18**, **30**, **40**, and **56**) is not altered much by the introduction of the 2-(4-nitrophenyl)ethoxycarbonyl and 2-(2,4-dinitrophenyl)ethoxycarbonyl groups into the 2′- and 3′-position, respectively. Only the extinction coefficient of the long-wavelength band increases by *ca.* 10000 and is additive regarding the number of the protecting groups. Surprising is, to some extent, that in the thymidine and O^4-[2-(4-nitrophenyl)ethyl]thymidine series, the introduction of one or two dnpeoc groups is associated with a successive hypsochromic shift of the long-wavelength absorption band.

The ^{1}H-NMR spectra (mostly in $CDCl_3$) are of complex nature but can usually be analyzed exactly according to the structural features. There are characteristic deviations in the chemical shifts of H–C(1′), influenced even by long-distance effects. In the pyrimidine nucleoside series, the introduction of a monomethoxytrityl group causes the strongest down-field shift of the anomeric proton, followed by a 5′-*O*-npeoc or -dnpeoc group, whereas the same functions at the 3′-*O*-position show a minor influence. The presence of an unsubstituted 5′-OH group is associated with an up-field shift of H–C(1′) into the normal range of this function. As expected, blocking of the sugar OH groups by acyl functions is reflected in a down-field shift of the adjacent ring protons by *ca.* 1–1.5 ppm. The 2-(4-nitrophenyl)ethoxycarbonyl and 2-(2,4-dinitrophenyl)ethoxycarbonyl group can nicely be detected by their aromatic-proton signals (2*d* and a low-field *s*, resp.).

Experimental Part

General. TLC: Precoated silica gel TLC sheets *F1500 LS 254* from *Schleicher & Schüll* or *60 F_{254}* from *Merck*. Prep. TLC: silica gel *60 PF_{254}* (*Merck*). Prep. column chromatography (CC): silica gel (*Merck 60*, 0.063–0.2 mesh); FC = flash chromatography. M.p.: *Büchi* apparatus, model Dr. *Tottoli*; no corrections. UV/VIS: *Uvikon 820, Kontron*, and *Perkin Elmer, Lambda 5*; λ_{max} in nm (logε). ^{1}H-NMR: *Bruker WM-250*; δ in ppm rel. to TMS or $CDCl_3$ ((D_6)DMSO) as internal standard.

1. *2-(2,4-Dinitrophenyl)ethyl Chloroformate* (**2**). A suspension of 2-(2,4-dinitrophenyl)ethanol [3] (42.5 g, 0.2 mol) in anh. toluene (200 ml) was warmed up to 35° for few min and then treated with phosgene at r.t. for 4 h. Then, excess phosgene and toluene were condensed into a cooled (−60°) flask. From the residual sirup, light-yellowish crystals were obtained on cooling which were dried under high vacuum: pure **2** (52.4 g, 95%). The product was used in this form for further reactions. Recrystallization from abs. toluene yielded yellowish crystals. M.p. 41–45°. UV (MeOH): 240 (4.17). ^{1}H-NMR ($CDCl_3$): 8.85 (*d*, 1H of dnpeoc); 8.43 (*dd*, 1H of dnpeoc); 7.64 (*d*, 1H of dnpeoc); 4.66 (*t*, CH_2CH_2O); 3.44 (*t*, CH_2CH_2O). Anal. calc. for $C_9H_7N_2O_6Cl$ (274.6): C 39.36, H 2.57, N 10.20; found: C 39.48, H 2.41, N 10.03.

2. *5′-O-(Monomethoxytrityl)-3′-O-[2-(4-nitrophenyl)ethoxycarbonyl]thymidine* (**6**). To a soln. of **5** [19] (1.03 g, 2 mmol) in abs. CH_2Cl_2 (20 ml), 4-(dimethylamino)pyridine (72 mg, 0.6 mmol), and 3-methyl-1-[2-(4-nitrophenyl)ethoxycarbonyl]-1*H*-imidazol-3-ium chloride [2] (**3**; 1.25 g, 4 mmol) were added. After stirring for 24 h at r.t., $CHCl_3$ (150 ml) was added and the mixture washed twice with phosphate buffer (pH 7; 100 ml). The org. phase was dried (Na_2SO_4) and evaporated. Purification was achieved by CC (silica gel, 20 × 3 cm, $CHCl_3$, then $CHCl_3$/MeOH 100:1): 1.26 g (89%) of colourless foam. UV (MeOH): 267 (4.29), 232 (sh, 4.27). ^{1}H-NMR ($CDCl_3$): 9.31 (*s*, NH); 8.16 (*d*, 2H *o* to NO_2); 7.58 (*s*, H–C(6)); 7.42–7.18 (*m*, 14H, MeO*Tr*, 2H *m* to NO_2); 6.83 (*d*, 2H *o* to MeO); 6.43 (*dd*, H–C(1′)); 5.31 (*d*, H–C(3′)); 4.38 (*m*, OCH_2CH_2); 4.17 (*m*, H–C(4′)); 3.78 (*s*, MeO); 3.45 (*m*, H–C(5′)); 3.08 (*t*, OCH_2CH_2); 2.60–2.30 (*m*, H–C(2′)); 1.38 (*s*, Me–C(5)). Anal. calc. for $C_{39}H_{37}N_3O_{10}\cdot$ ½ H_2O (716.7): C 65.36, H 5.34, N 5.86; found: C 65.28, H 5.15, N 5.81.

3. *5′-O-[2-(4-Nitrophenyl)ethoxycarbonyl]thymidine* (**7**) *and 3′,5′-Bis-O-[2-(4-nitrophenyl)ethoxycarbonyl]thymidine* (**9**). A soln. of thymidine (**4**; 1.0 g, 4.13 mmol) in dry pyridine (15 ml) was cooled to −25° (i-PrOH/dry ice-bath), and then 2-(4-nitrophenyl)ethyl chloroformate [2] (**1**; 1.42 g, 6.19 mmol) in dry CH_2Cl_2 (15 ml) was added dropwise. After stirring for 3 h at −15 ± 5°, the mixture was diluted with $CHCl_3$ (150 ml), washed with H_2O (3 × 150 ml), dried ($MgSO_4$), evaporated, and co-evaporated with toluene (3 × 20 ml). The residue was taken up in $CHCl_3$ and purified by CC (silica gel, 19 × 3.5 cm). Elution with $CHCl_3$ (250 ml), $CHCl_3$/acetone 100:1 (750 ml), $CHCl_3$/acetone 20:1 (250 ml), $CHCl_3$/acetone 5:1 (1.2 l), and finally with $CHCl_3$/acetone 2:1 (450 ml) gave first 756 mg (29%) of **9** and finally 1.25 g (70%) of **7** as amorphous solids.

7: UV (MeOH): 267 (4.26), 212 (sh, 4.21). ^{1}H-NMR ($CDCl_3$): 9.12 (*s*, NH); 8.14 (*d*, H *o* to NO_2); 7.37 (*d*, H *m* to NO_2); 7.32 (*d*, H–C(6)); 6.30 (*t*, H–C(1′)); 4.40 (*m*, CH_2CH_2O, H–C(3′), 2 H–C(5′)); 4.12 (*q*, H–C(4′)); 3.07 (*t*, CH_2CH_2O); 2.95 (*s*, OH–C(3′)); 2.39 (*m*, H–C(2′)); 2.15 (*m*, H–C(2′)); 1.85 (*d*, Me–C(5)). Anal. calc. for $C_{19}H_{21}N_3O_9$ (435.4): C 52.42, H 4.86, N 9.65; found: C 52.05, H 4.98, N 9.60.

9: UV (MeOH): 267 (4.46), 212 (sh, 4.38). ^{1}H-NMR ($CDCl_3$): 9.67 (*s*, NH); 8.11 (2*d*, 4H *o* to NO_2); 7.36 (2*d*, 4H *m* to NO_2); 7.26 (*d*, H–C(6)); 6.30 (*t*, H–C(1′)); 5.08 (*d*, H–C(3′)); 4.48–4.30 (*m*, $2CH_2CH_2O$, 2H–C(5′)); 4.22 (*d*, H–C(4′)); 3.07 (*t*, $2CH_2CH_2O$); 2.44 (*m*, H–C(2′)); 2.18 (*m*, H–C(2′)); 1.82 (Me–C(5)). Anal. calc. for $C_{28}H_{28}N_4O_{13}$ (628.5): C 53.51, H 4.49, N 8.91; found: C 53.52, H 4.52, N 8.92.

4. *3′-O-[2-(4-Nitrophenyl)ethoxycarbonyl]thymidine* (**8**). 4.1. A soln. (40 ml) of 1% TsOH in CH_2Cl_2/MeOH 4:1 was stirred with **6** (708 mg, 1 mmol). After 30 min, the mixture was diluted with $CHCl_3$ (60 ml) and washed with phosphate buffer (pH 7; 3 × 100 ml). The $CHCl_3$ phase was dried (Na_2SO_4) and evaporated. The product was purified by CC (silica gel, 17 × 2.5 cm, $CHCl_3$, then $CHCl_3$/MeOH 100:1→100:3). Drying at 40°/high vacuum gave 396 mg (91%) of **8**. Solid foam. UV (MeOH): 267 (4.28). ^{1}H-NMR ($CDCl_3$): 9.45 (*s*, NH); 8.16 (*d*, 2H *o* to NO_2); 7.48 (*s*, H–C(6)); 7.39 (*d*, 2H *m* to NO_2); 6.18 (*t*, H–C(1′)); 5.23 (*m*, H–C(3′)); 4.39 (*t*, CH_2CH_2O); 4.10 (*m*, H–C(4′)); 3.87 (*m*, 2H–C(5′)); 3.08 (*t*, CH_2CH_2O; OH–C(5′)); 2.50–2.30 (*m*, 2H–C(2′)); 1.87 (*s*, Me–C(5)). Anal. calc. for $C_{19}H_{21}N_3O_9$ (435.4): C 52.41, H 4.86, N 9.65; found: C 52.45, H 4.96, N 9.39.

4.2. For 2 h, **13** (100 mg, 0.148 mmol) was treated with dioxane/MeOH/Et_3N 1:1:1 (6 ml; TLC: no **13** left). The mixture was diluted with $CHCl_3$ (30 ml), washed with H_2O (3 × 30 ml), dried (Na_2SO_4), and evaporated. Purification by CC (silica gel, 13.5 × 1.5 cm; CH_2Cl_2, $CHCl_3$, and $CHCl_3$/MeOH 100:1) gave, after drying at 40°/high vacuum, an amorphous solid: 63 mg (98%) of **8**.

4.3. A soln. of **13** (210 mg, 0.31 mmol) in 5 mM DBU in MeCN (30 ml) was stirred for 30 min, then neutralized by addition of 0.1M AcOH (15 ml), and evaporated. The residue was purified by CC (silica gel, 32 × 1.5 cm, CH_2Cl_2): 116 mg (86%) of **8**. Colourless foam.

5. *5′-O-[2-(2,4-Dinitrophenyl)ethoxycarbonyl]thymidine* (**10**), *3′-O-[2-(2,4-Dinitrophenyl)ethoxycarbonyl]-thymidine* (**11**), *and 3′,5′-Bis-O-[2-(2,4-dinitrophenyl)ethoxycarbonyl]thymidine* (**12**). Thymidine (**4**; 1.0 g, 4.1 mmol) was co-evaporated with dry pyridine (2 × 20 ml) and then taken up in dry pyridine (10 ml), and, after cooling to −25°, a soln. of **2** (1.36 g, 4.95 mmol) in anh. CH_2Cl_2 (10 ml) was added within 30 min. The mixture was stirred at −10 to −20° for further 2 h, diluted with $CHCl_3$ (3 × 100 ml), washed with H_2O (2 × 100 ml), dried (Na_2SO_4), evaporated, and co-evaporated with toluene (2 × 30 ml). The residue was taken up in $CHCl_3$ and purified by CC (silica gel, 27 × 3.5 cm). Elution with $CHCl_3$ gave, after evaporation and drying under high vacuum, 115 mg (6%) of **11** and 30 mg (1%) of **12** and then, with $CHCl_3$/MeOH 100:1 and 100:4, 1.49 g (75%) of **10** as colourless amorphous foams.

10: UV (MeOH): 259 (4.29). ^{1}H-NMR ($CDCl_3$): 8.83 (*s*, NH); 8.79 (*d*, 1H of dnpeoc); 8.40 (*dd*, 1H of dnpeoc); 7.62 (*d*, dnpeoc); 7.28 (*s*, H–C(6)); 6.28 (*t*, H–C(1′)); 4.47 (*m*, H–C(3′), CH_2CH_2O); 4.34 (*d*, 2H–C(5′)); 4.11 (*q*, H–C(4′)); 3.42 (*t*, CH_2CH_2O); 2.74 (*d*, OH–C(3′)); 2.39 (*m*, H–C(2′)); 2.21 (*m*, H–C(2′)); 1.86 (*s*, Me–C(5)). Anal. calc. for $C_{19}H_{20}N_4O_{11}$ (480.4): C 47.51, H 4.20, N 11.66; found: C 47.44, H 4.23, N 11.25.

11: UV (MeOH): 259 (4.30). ^{1}H-NMR ($CDCl_3$): 8.85 (*d*, 1H of dnpeoc); 8.44 (*dd*, 1H of dnpeoc); 8.17 (*s*, NH); 7.65 (*d*, dnpeoc); 7.40 (*d*, H–C(6)); 6.15 (*t*, H–C(1′)); 5.23 (*d*, H–C(3′)); 4.49 (*t*, CH_2CH_2O); 4.13 (*d*, H–C(4′)); 3.89 (*m*, 2H–C(5′)); 3.41 (*t*, CH_2CH_2O); 2.42 (*m*, OH–C(5′), 2H–C(2′)); 1.90 (*s*, Me–C(5)). Anal. calc. for $C_{19}H_{20}N_4O_{11}$ (480.4): C 47.51, H 4.20, N 11.66; found: C 47.04, H 4.58, N 11.28.

12: UV (MeOH): 250 (4.51). ^{1}H-NMR ($CDCl_3$): 8.80, 8.74 (2*d*, 2H of dnpeoc); 8.47 (*s*, NH); 8.40, 8.36 (2*dd*, 2H of dnpeoc); 7.61, 7.57 (2*d*, 2H of dnpeoc); 7.21 (*s*, H–C(6)); 6.27 (*t*, H–C(1′)); 5.07 (*t*, H–C(3′)); 4.42 (*m*, $2CH_2CH_2O$); 4.30 (*m*, 2H–C(5′)); 4.18 (*m*, H–C(4′)); 3.38 (*m*, $2CH_2CH_2O$); 2.45 (*m*, H–C(2′)); 2.27 (*m*, H–C(2′)); 1.83 (*s*, Me–C(5)). Anal. calc. for $C_{28}H_{26}N_6O_{17}$ (718.5): C 46.80, H 3.65, N 11.70; found: C 47.00, H 3.59, N 11.44.

6. *5′-O-[2-(2,4-Dinitrophenyl)ethoxycarbonyl]-3′-O-[2-(4-nitrophenyl)ethoxycarbonyl]thymidine* (**13**). 6.1. To a soln. of **8** (435 mg, 1 mmol) in dry pyridine (5 ml) was added dropwise a soln. of **2** (412 mg, 1.5 mmol) in dry

CH_2Cl_2 (5 ml). The mixture was stirred 6 h at r.t., diluted with H_2O (100 ml), and extracted 3 times with $CHCl_3$ (4 × 50 ml). The org. layers were dried (Na_2SO_4), evaporated, and co-evaporated with toluene (2 × 20 ml). The product was obtained as a colourless foam after CC (silica gel, $CHCl_3$): 511 mg (76%). UV (MeOH): 263 (4.47), 224 (4.43). ^{1}H-NMR ($CDCl_3$): 8.78 (*d*, 1H of dnpeoc); 8.40 (*dd*, 1H of dnpeoc, NH); 8.18 (*d*, H *o* to NO_2); 7.61 (*d*, 1H of dnpeoc); 7.40 (*d*, H *m* to NO_2); 7.26 (*d*, H–C(6)); 6.31 (*q*, H–C(1′)); 5.11 (*m*, H–C(3′)); 4.42 (*m*, 6H, 2H–C(5′), 2CH_2CH_2O); 4.21 (*d*, H–C(4′)); 3.42 (*m*, CH_2CH_2O of dnpeoc); 3.09 (*t*, CH_2CH_2O of dnpeoc); 2.47 (*m*, H–C(2″)); 2.26 (*m*, H–C(2′)); 1.88 (*d*, Me–C(5)). Anal. calc. for $C_{28}H_{27}N_5O_{15}$ (637.5): C 49.93, H 4.04, N 10.40; found: C 50.24, H 3.98, N 10.20.

6.2. In abs. pyridine (5 ml), **10** (480 mg, 1 mmol) was dried by 3 co-evaporations. The residue was dissolved in abs. pyridine (5 ml), a soln. of **1** (690 mg, 3 mmol) in dry CH_2Cl_2 (5 ml) was added, and after stirring at r.t. for 23 h, the mixture was diluted with $CHCl_3$ (4 × 50 ml), washed with H_2O (2 × 100 ml), dried (Na_2SO_4), evaporated, and coevaporated with toluene. The residue was purified by CC ($CHCl_3$): 503 mg (75%) of **13** and 90 mg (10%) of *5′-O-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-*N^3*, 3′-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]thymidine.*

7. *5′-O-(Monomethoxytrityl)uridine* (**14**). A soln. of **66** (212 mg, 0.39 mmol) in MeOH/H_2O/Et_3N 1:1:1 [11] (6 ml) was stirred at r.t. for 3 h. $CHCl_3$ (80 ml) was added and the mixture washed with H_2O (3 × 80 ml), dried, and evaporated: 200 mg (99%) of amorphous **14**; identical (spectrophotometrical comparison [12]) with authentic material.

8. *2′,3′-Bis-O-[2-(4-nitrophenyl)ethoxycarbonyl]-5′-O-(monomethoxytrityl)uridine* (**15**). A mixture of **14** (200 mg, 0.39 mmol), 4-(dimethylamino)pyridine (55 mg, 0.45 mmol), and **3** (300 mg, 0.96 mmol) in CH_2Cl_2 (10 ml) was stirred at r.t. for 3 h. CH_2Cl_2 (20 ml) was added and the mixture washed 2 times with H_2O (15 ml), dried, and evaporated. Purification by prep. TLC ($CHCl_3$/MeOH 20:1) gave 330 mg (94%) of amorphous solid. UV (MeOH): 265 (4.45), 235 (4.35). ^{1}H-NMR ($CDCl_3$): 8.78 (*s*, NH); 8.13 (*dd*, 4H *o* to NO_2); 7.65 (*d*, H–C(6)); 7.21–7.37 (*m*, 16H, MeO*Tr*, 4H *m* to NO_2); 6.83 (*d*, 2H *o* to MeO); 6.20 (*d*, H–C(1′)); 5.49 (*t*, H–C(2′)); 5.44 (*t*, H–C(3′)); 5.30 (*dd*, H–C(5)); 4.37 (*m*, 2CH_2CH_2O); 4.26 (*d*, H–C(4′)); 3.78 (*s*, MeO); 3.46 (*m*, 2H–C(5′)); 3.04 (*q*, 2CH_2CH_2O). Anal. calc. for $C_{47}H_{42}N_4O_{15}$ (902.9): C 62.52, H 4.69, N 6.21; found: C 62.30, H 4.33, N 6.16.

9. *2′,3′-Bis-O-[2-(4-nitrophenyl)ethoxycarbonyl]uridine* (**16**). A soln. of **15** (903 mg, 1 mmol) in MeOH (2 ml) and 80% aq. AcOH (10 ml) was stirred at r.t. for 24 h. The mixture was evaporated and co-evaporated 8 times with MeOH (6 ml). The residue was crystallized from MeCN: 530 mg (84%) of colourless crystals. M.p. 104–106° (sintering), 171–176° (fully dec.). UV (MeOH): 265 (4.44), 212 (sh, 4.34). ^{1}H-NMR ((D_6)DMSO): 11.45 (*s*, NH); 8.11 (*t*, 4H *o* to NO_2); 7.86 (*d*, H–C(6)); 7.50 (*dd*, 4H *m* to NO_2); 5.96 (*d*, H–C(1′)); 5.29 (*d*, H–C(2′)); 5.21 (*q*, H–C(3′)); 5.73 (*d*, H–C(5)); 5.45 (*s*, OH–C(5′)); 4.33 (*m*, 2CH_2CH_2O); 4.15 (*d*, H–C(4′)); 3.58 (*m*, 2H–C(5′)); 3.02 (*q*, 2CH_2CH_2O). Anal. calc. for $C_{27}H_{26}N_4O_{14}$ (630.5): C 51.43, H 4.16, N 8.89; found: C 51.13, H 4.08, N 8.68.

10. *5′-O-(Monomethoxytrityl)-*O^4*-[2-(4-nitrophenyl)ethyl]thymidine* (**18**). To a soln. of **17** [16] [17] (1.17 g, 3 mmol; co-evaporated 3 times with abs. pyridine (10 ml)) in 15 ml of abs. pyridine was added monomethoxytrityl chloride (MeOTrCl) (1.11 g, 3.6 mmol) and kept at r.t. for 28 h. MeOH (10 ml) was added and the mixture evaporated and co-evaporated with toluene (2 × 20 ml). CC ($CHCl_3$, then $CHCl_3$/MeOH 10:1) yielded 1.88 g (94%) of **18** as a colourless amorphous solid, identical (TLC, spectra) with authentic material [2], synthesized *via* *3′-O*-debenzoylation.

11. *5′-O-[2-(4-Nitrophenyl)ethoxycarbonyl]-*O^4*-[2-(4-nitrophenyl)ethyl]thymidine* (**19**), *3′-O-[2-(4-Nitrophenyl)ethoxycarbonyl]-*O^4*-[2-(4-nitrophenyl)ethyl]thymidine* (**20**), *and 3′,5′-Bis-O-[2-(4-nitrophenyl)ethoxycarbonyl]-*O^4*-[2-(4-nitrophenyl)ethyl]thymidine* (**21**). In anh. pyridine (5 ml), **17** (392 mg, 1 mmol) was dried by 3 co-evaporations. The residue was dissolved in anh. pyridine (4 ml) and cooled to −25°. Then, a soln. of **1** (345 mg, 1.5 mmol) in anh. CH_2Cl_2 (4 ml) was added. The mixture was stirred at −15 ± 5° for 3 h, then diluted with $CHCl_3$ (50 ml), and washed with H_2O (50 ml). The H_2O phase was washed 2 times with $CHCl_3$ (80 ml). The org. layers were washed with H_2O (2 × 80 ml), dried (Na_2SO_4), and evaporated. After co-evaporation with toluene (3 × 25 ml), the residue was taken up in $CHCl_3$ and purified by CC (silica gel, 20 × 2 cm). Elution with $CHCl_3$ gave first 117 mg (15%) of **21** and 46 mg (8%) of **20** as amorphous solids. Elution with $CHCl_3$/acetone 4:1 gave 428 mg (73%) of **19** as a colourless amorphous foam. Overall yields: 96%.

19: UV (MeOH): 273 (4.37). ^{1}H-NMR ($CDCl_3$): 8.14 (2*d*, 4H *o* to NO_2); 7.59 (*s*, H–C(6)); 7.38 (2*d*, 4H *m* to NO_2); 6.27 (*t*, H–C(1′)); 4.60 (*t*, CH_2CH_2O (O^4)); 4.40 (*m*, H–C(3′), 2 H–C(5′), CH_2CH_2O of npeoc); 4.17 (*q*, H–C(4′)); 3.30 (*s*, OH–C(3′)); 3.15 (*t*, CH_2CH_2O (O^4)); 3.07 (*t*, CH_2CH_2O of npeoc); 2.57 (*m*, H–C(2′)); 2.07 (*m*, H–C(2″)); 1.78 (*s*, Me–C(5)). Anal. calc. for $C_{27}H_{28}N_4O_{11}$ (584.5): C 55.48, H 4.83, N 9.58; found: C 55.38, H 5.03, N 9.48.

21: UV (MeOH): 272 (4.05), 214 (sh, 4.10). ^{1}H-NMR ($CDCl_3$): 8.12 (3*d*, 6H, H *o* to NO_2); 7.48 (*s*, H–C(6)); 7.36 (3*d*, 6H *m* to NO_2); 6.29 (*t*, H–C(1′)); 5.05 (*m*, H–C(3′)); 4.60 (*t*, CH_2CH_2O (O^4)); 4.38 (*m*, $2CH_2CH_2O$ of npeoc, 2H–C(5′)); 4.25 (*m*, H–C(4′)); 3.14 (*t*, CH_2CH_2O (O^4)); 3.06 (2*t*, $2CH_2CH_2O$ of npeoc); 2.62 (*m*, H–C(2′)); 2.06 (*m*, H–C(2′)); 1.75 (*s*, Me–C(5)). Anal. calc. for $C_{36}H_{35}N_5O_{15}$ (777.7): C 55.60, H 4.54, N 9.00; found: C 55.60, H 4.83, N 8.90.

12. *3′-O-[2-(4-Nitrophenyl)ethoxycarbonyl]-O^4-[2-(4-nitrophenyl)ethyl]thymidine* (**20**). A soln. of **22** (294 mg, 0.34 mmol) in 2% TsOH in CH_2Cl_2/MeOH 4:1 (7.2 ml) was stirred at r.t. for 30 min. Then, the mixture was diluted with $CHCl_3$ (50 ml) and washed with H_2O (3 × 50 ml). The $CHCl_3$ phase was dried and evaporated and the product purified by CC (silica gel, $CHCl_3$) and finally crystallized from AcOEt: 176 mg (88%) of colourless crystals. M.p. 144–146°. UV (MeOH): 273 (4.39), 218 (sh, 4.39). ^{1}H-NMR ($CDCl_3$): 8.15 (2*d*, 4H *o* to NO_2); 7.61 (*s*, H–C(6)); 7.39 (2*d*, 4H *m* to NO_2); 6.09 (*t*, H–C(1′)); 5.23 (*m*, H–C(3′)); 4.62 (*t*, CH_2CH_2O (O^4)); 4.37 (*m*, CH_2CH_2O of npeoc); 4.14 (*s*, H–C(4′)); 3.87 (*m*, 2H–C(5′)); 3.15 (*t*, CH_2CH_2O (O^4)); 3.11 (*s*, OH–C(5′)); 3.07 (*t*, CH_2CH_2O of npeoc); 2.50 (*m*, 2H–C(2′)); 1.85 (*s*, Me–C(5)). Anal. calc. for $C_{27}H_{28}N_4O_{11}$ (584.5): C 55.48, H 4.83, N 9.58; found: C 55.24, H 4.82, N 9.50.

13. *5′-O-(Monomethoxytrityl)-3′-O-[2-(4-nitrophenyl)ethoxycarbonyl]-O^4-[2-(4-nitrophenyl)ethyl]thymidine* (**22**). To a soln. of **18** (332 mg, 0.5 mmol) and 4-(dimethylamino)pyridine (64 mg, 0.5 mmol) in dry CH_2Cl_2 (10 ml) was added **3** (312 mg, 1.0 mmol). The mixture was stirred overnight, evaporated, diluted with $CHCl_3$ (50 ml), washed twice with H_2O (2 × 50 ml), dried (Na_2SO_4), and evaporated. The product was purified by CC (18 × 2 cm, CH_2Cl_2, then CH_2Cl_2/$CHCl_3$ 1:1): 382 mg (89%) of colourless foam. UV (MeOH): 274 (4.38), 234 (sh, 4.27). ^{1}H-NMR ($CDCl_3$): 8.17 (2*d*, 4H *o* to NO_2); 7.83 (*s*, H–C(6)); 7.42–7.23 (*m*, 16H, 4H *m* to NO_2, MeO*Tr*); 6.82 (*d*, 2H *o* to MeO); 6.42 (*q*, H–C(1′)); 5.24 (*m*, H–C(3′)); 4.65 (*t*, CH_2CH_2O (O^4)); 4.38 (*m*, CH_2CH_2O of npeoc); 4.22 (*t*, H–C(4′)); 3.79 (*s*, MeO); 3.43 (*m*, 2H–C(5′)); 3.17 (*t*, CH_2CH_2O (O^4)); 3.09 (*t*, CH_2CH_2O of npeoc); 2.73, 2.30 (2*m*, 2H–C(2′)); 1.44 (*s*, Me–C(5)). Anal. calc. for $C_{47}H_{44}N_4O_{12}$ (856.9): C 65.88, H 5.18, N 6.54; found: C 65.64, H 5.66, N 5.89.

14. *5′-O-[2-(2,4-Dinitrophenyl)ethoxycarbonyl]-O^4-[2-(4-nitrophenyl)ethyl]thymidine* (**23**), *3′-O-[2-(2,4-Dinitrophenyl)ethoxycarbonyl]-O^4-[2-(4-nitrophenyl)ethyl]thymidine* (**24**), *and 3′,5′-Bis-O-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-O^4-[2-(4-nitrophenyl)ethyl]thymidine* (**25**). A soln. of **17** [16] [17] (587 mg, 1.5 mmol) in anh. pyridine (6 ml), which was first co-evaporated 3 times with abs. pyridine (5 ml), was cooled to −25°. Then, a soln. of **2** (690 mg, 2.5 mmol) in abs. CH_2Cl_2 (6 ml) was added within 10 min. The mixture was stirred at −10 to −20° for 3.5 h. After warming up to r.t., the soln. was evaporated and co-evaporated with toluene (4 × 20 ml). Purification by CC (silica gel, 23 × 3.5 cm, $CHCl_3$ (300 ml), $CHCl_3$/acetone 20:1 (400 ml), then $CHCl_3$/acetone 1:1 (700 ml)) gave mainly **23** (664 mg, 70%) as colourless amorphous solid. The fraction containing **24** and **25** was further purified by prep. TLC (toluene/AcOEt/MeOH 5:4:1): 54 mg (6%) of **24** and 93 mg (7%) of **25** as amorphous solids. Overall yield: 83%.

23: UV (MeOH): 265 (4.35). ^{1}H-NMR ($CDCl_3$): 8.77 (*d*, 1H of dnpeoc); 8.39 (*dd*, 1H of dnpeoc); 8.15 (*d*, 2H *o* to NO_2); 7.61 (*d*, 1H of dnpeoc); 7.56 (*s*, H–C(6)); 7.41 (*d*, 2H *m* to NO_2); 6.27 (*t*, H–C(1′)); 4.61 (*t*, CH_2CH_2O (O^4)); 4.55–4.35 (*m*, CH_2CH_2O of dnpeoc, 2H–C(5′)); 4.15 (*q*, H–C(4′)); 3.40 (*m*, $2CH_2CH_2O$); 3.10 (*s*, OH–C(3′)); 2.58 (*m*, H–C(2′)); 2.09 (*m*, H–C(2′)); 1.82 (*s*, Me–C(5)). Anal. calc. for $C_{27}H_{27}N_5O_{13}$ (629.5): C 51.51, H 4.32, N 11.12; found: C 51.51, H 4.15, N 10.95.

24: UV (MeOH): 266 (4.32). ^{1}H-NMR ($CDCl_3$): 8.77 (*d*, 1H of dnpeoc); 8.40 (*dd*, 1H of dnpeoc); 8.06 (*d*, 2H *o* to NO_2); 7.70 (*s*, H–C(6)); 7.65 (*d*, 1H of dnpeoc); 7.37 (*d*, 2H *m* to NO_2); 6.11 (*t*, H–C(1′)); 5.20 (*t*, H–C(3′)); 4.58 (*t*, CH_2CH_2O (O^4)); 4.44 (*t*, CH_2CH_2O of dnpeoc); 4.13 (*m*, H–C(4′)); 3.85 (*m*, 2H–C(5′)); 3.40–3.35 (*t*, CH_2CH_2O of dnpeoc; *s*, OH–C(5′)); 3.13 (*t*, CH_2CH_2O (O^4)); 2.44 (*m*, 2H–C(2′)); 1.83 (*s*, Me–C(5)). Anal. calc. for $C_{27}H_{27}N_5O_{13}$ (629.5): C 51.51, H 4.32, N 11.12; found: C 51.17, H 4.64, N 10.88.

25: UV (MeOH): 257 (4.53), 249 (4.53). ^{1}H-NMR ($CDCl_3$): 8.83, 8.76 (2*d*, 2H of dnpeoc); 8.47–8.36 (2*dd*, 2H of dnpeoc); 8.14 (*d*, 2H *o* to NO_2); 7.67, 7.58 (2*d*, 2H of dnpeoc); 7.48 (*d*, H–C(6)); 7.40 (*d*, 2H *m* to NO_2); 6.30 (*q*, H–C(1′)); 5.07 (*d*, H–C(3′)); 4.63 (*t*, CH_2CH_2O (O^4)); 4.55–4.22 (*m*, $2CH_2CH_2O$, H–C(4′)), 2H–C(5′)); 3.40 (2*t*, $2CH_2CH_2O$); 3.17 (*t*, CH_2CH_2O (O^4)); 2.64 (*m*, H–C(2′)); 2.11 (*m*, H–C(2′)); 1.82 (*d*, Me–C(5)). Anal. calc. for $C_{36}H_{33}N_7O_{19}$ (867.7): C 49.83, H 3.83, N 11.30; found: C 49.70, H 4.24, N 11.11.

15. *2′-Deoxy-N^4,5′-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**27**), *2′-Deoxy-N^4,3′-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**28**), *and 2′-Deoxy-N^4,3′-O,5′-O-tris-[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**29**). After co-evaporation of **26** [2] (1.0 g, 2.38 mmol) with dry pyridine (3 × 10 ml), it was taken up in dry pyridine (10 ml) and cooled to −25°. Then a soln. of **1** (820 mg, 3.57 mmol) in anh. CH_2Cl_2 (10 ml) was added within few min. The mixture was stirred at −15 ± 5° for 3 h, diluted with $CHCl_3$ (3 × 100 ml), washed with H_2O (3 × 100 ml),

dried (Na_2SO_4), evaporated, and co-evaporated with toluene (3 × 20 ml). The residue was taken up in $CHCl_3$ and purified by CC (silica gel, 23 × 3.5 cm). Elution with $CHCl_3$/acetone 20:1 (840 ml), 10:1 (880 ml), 5:1 (360 ml), and finally 1:1 (1.6 l) gave, after evaporation and drying under high vacuum, 208 mg (11%) of **29**, 110 mg (8%) of **28**, and 954 mg (65%) of **27**. Overall yield: 84%.

27: UV (MeOH): 273 (4.36), 246 (4.32), 211 (4.51). ^{1}H-NMR ($CDCl_3$): 8.15 (2*d*, 4H *o* to NO_2); 7.99 (*s*, H–C(6)); 7.98 (*s*, NH); 7.39 (2*d*, 4H *m* to NO_2); 7.11 (*d*, H–C(5)); 6.25 (*t*, H–C(1′)); 4.41 (*m*, H–C(3′), 2H–C(5′), $2CH_2CH_2O$); 4.22 (*m*, H–C(4′)); 3.81 (*s*, OH–C(3′)); 3.09 (2*t*, $2CH_2CH_2O$); 2.70 (*m*, H–C(2′)); 2.08 (*m*, H–C(2′)). Anal. calc. for $C_{27}H_{27}N_5O_{12}$ (613.5): C 52.86, H 4.44, N 11.41; found: C 53.03, H 4.57, N 10.94.

29: UV (MeOH): 271 (4.33), 244 (sh, 4.12), 210 (sh, 4.32). ^{1}H-NMR ($CDCl_3$): 8.17 (3*d*, 6H *o* to NO_2); 7.89 (*d*, H–C(6)); 7.46 (3*d*, 6H *m* to NO_2; *s*, NH); 7.07 (*d*, H–C(5)); 6.24 (*t*, H–C(1′)); 5.08 (*m*, H–C(3′)); 4.38 (*m*, $3CH_2CH_2O$, 2H–C(5′), H–C(4′)); 3.09 (*m*, $3CH_2CH_2O$); 2.78 (*m*, H–C(2′)); 2.08 (*m*, H–C(2′)). Anal. calc. for $C_{36}H_{34}N_6O_{16}$ (806.7): C 53.60, H 4.25, N 10.42; found: C 53.36, H 4.54, N 10.10.

16. *2′-Deoxy-*N^4*,3′-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**28**). A soln. of **31** (886 mg, 1 mmol) in 1% TsOH in CH_2Cl_2/MeOH 4:1 (40 ml) was stirred at r.t. for 15 min. Then, the mixture was diluted with $CHCl_3$ (60 ml), and washed with phosphate buffer (pH 7; 3 × 100 ml). The org. layer was dried (Na_4SO_4) and evaporated. The residue was purified by CC (silica gel, 25 × 2.5 cm, CH_2Cl_2, $CHCl_3$, then $CHCl_3$/MeOH 100:1, 100:2): Crystallization (AcOEt) gave 570 mg (93%) of **28**. M.p. 143–145°. UV (MeOH): 273 (4.39), 247 (4.36). ^{1}H-NMR ($CDCl_3$): 8.40 (*s*, NH); 8.20 (*d*, H–C(6)); 8.12 (*d*, 2H *o* to NO_2); 8.10 (*d*, 2H *o* to NO_2); 7.38 (*d*, 2H *m* to NO_2); 7.34 (*d*, 2H *m* to NO_2); 7.15 (*d*, H–C(5)); 6.16 (*t*, H–C(1′)); 5.27 (*d*, H–C(3′)); 4.37 (2*t*, $2CH_2CH_2O$); 4.20 (*s*, H–C(4′)); 3.88 (*m*, 2H–C(5′)); 3.75 (*s*, OH–C(5′)); 3.05 (2*t*, $2CH_2CH_2O$); 2.64 (*m*, H–C(2′)); 2.37 (*m*, H–C(2′)). Anal. calc. for $C_{27}H_{27}N_5O_{12}$ (613.5): C 52.86, H 4.44, N 11.41; found: C 52.86, H 4.50, N 11.32.

17. *2′-Deoxy-5′-*O*-(monomethoxytrityl)-*N^4*,3′-*O*-bis[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**31**). To a soln. of **30** [2] (693 mg, 1 mmol) and 4-(dimethylamino)pyridine (150 mg, 1.2 mmol) in anh. CH_2Cl_2 (10 ml), **3** (780 mg, 2.5 mmol) was added. After stirring for 6 h at r.t., CH_2Cl_2 (100 ml) was added, the mixture washed with phosphate buffer (pH 7; 2 × 100 ml), dried, and evaporated. Purification was achieved by CC (silica gel, 24 × 2.5 cm, CH_2Cl_2, then $CHCl_3$): 810 mg (91%) of colourless amorphous solid. UV (MeOH): 273 (4.40), 236 (4.47). ^{1}H-NMR ($CDCl_3$): 8.17 (*d*, 4H *o* to NO_2); 8.04 (*d*, H–C(6)); 7.53 (*s*, NH); 7.45–7.15 (*m*, 16H, 4H *m* to NO_2, MeO*Tr*); 6.92 (*d*, H–C(5)); 6.82 (*d*, 2H *o* to MeO); 6.23 (*t*, H–C(1′)); 5.22 (*m*, H–C(3′)); 4.39 (*m*, $2CH_2CH_2O$); 4.27 (*m*, H–C(4′)); 3.78 (*s*, MeO); 3.44 (*m*, 2H–C(5′)); 3.09 (*m*, $2CH_2CH_2O$); 2.85 (*m*, H–C(2′)); 2.27 (*m*, H–C(2′)). Anal. calc. for $C_{47}H_{43}N_5O_{13}$ (885.9): C 63.72, H 4.89, N 7.91; found: C 63.63, H 5.09, N 7.78.

18. *2′-Deoxy-5′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-*N^4*-[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**32**), *2′-Deoxy-3′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-*N^4*-[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**33**), *and 2′-Deoxy-3′,5′-bis-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-*N^4*-[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**34**). In abs. pyridine (10 ml), **26** (631 mg, 1.5 mmol) was dried by 3 co-evaporations. The residue was dissolved in abs. pyridine (6 ml) and cooled to −25°. Then, a soln. of **2** (690 mg, 2.5 mmol) in abs. CH_2Cl_2 (6 ml) was added slowly within 10 min. After stirring at −10 to −20° for 3.5 h, the mixture was evaporated and co-evaporated with toluene (3 × 15 ml) and $CHCl_3$ (3 × 15 ml). The residue was dissolved in $CHCl_3$/acetone 3:2 (6 ml) and purified by CC (silica gel 16 × 3.5 cm, $CHCl_3$/acetone 1:1), giving mainly **32** (700 mg, 71%) as colourless amorphous solid. The fractions containing **33** and **34** were further purified by prep. TLC ($CHCl_3$/MeOH 19:1): 29 mg (3%) of **33** and 40 mg (3%) of **34** as amorphous solids. Overall yields: 77%.

32: UV (MeOH): 290 (sh, 4.22), 242 (4.49), 211 (sh, 4.58). ^{1}H-NMR ($CDCl_3$): 8.76 (*d*, 1H of dnpeoc); 8.40 (*dd*, 1H of dnpeoc); 8.14 (*d*, 2H *o* to NO_2); 8.03 (*s*, NH); 7.98 (*d*, H–C(6)); 7.61 (*d*, 1H of dnpeoc); 7.41 (*d*, 2H *m* to NO_2); 7.07 (*d*, H–C(5)); 6.25 (*t*, H–C(1′)); 4.43 (*m*, CH_2CH_2O (N^4), CH_2CH_2O of dnpeoc, H–C(3′), 2H–C(5′)); 4.20 (*q*, H–C(4′)); 4.06 (*s*, OH–C(3′)); 3.40 (*t*, CH_2CH_2O of dnpeoc); 3.10 (*t*, CH_2CH_2O (N^4)); 2.69 (*m*, H–C(2′)); 2.11 (*m*, H–C(2′)). Anal. calc. for $C_{27}H_{26}N_6O_{14}$ (658.5): C 49.25, H 3.98, N 12.76; found: C 49.13, H 3.96, N 12.51.

33: UV (MeOH): 290 (sh, 4.22), 243 (4.51), 211 (4.58). ^{1}H-NMR ($CDCl_3$): 8.81 (*d*, 1H of dnpeoc); 8.42 (*dd*, 1H of dnpeoc); 8.14 (*m*, NH, 2H *o* to NO_2, H–C(6)); 7.65 (*d*, 1H of dnpeoc); 7.37 (*d*, 2H *m* to NO_2); 7.15 (*m*, H–C(5)); 6.14 (*t*, H–C(1′)); 5.27 (*d*, H–C(3′)); 4.47 (*t*, CH_2CH_2O of dnpeoc); 4.40 (*t*, CH_2CH_2O (N^4)); 4.20 (*m*, H–C(4′)); 3.89 (*m*, 2H–C(5′)); 3.39 (*t*, CH_2CH_2O of dnpeoc, OH–C(5′)); 3.07 (*t*, CH_2CH_2O (N^4)); 2.62 (*m*, H–C(2′)); 2.36 (*m*, H–C(2′)). Anal. calc. for $C_{27}H_{26}N_6O_{14}$ (658.5): C 49.25, H 3.98, N 12.76; found: C 49.16, H 3.99, N 12.54.

34: UV (MeOH): 290 (sh, 4.27), 243 (4.65), 210 (sh, 4.66). ^{1}H-NMR ($CDCl_3$): 8.84, 8.77 (2*d*, 2H of dnpeoc); 8.43 (*dd*, 2H of dnpeoc); 8.16 (*d*, 2H *o* to NO_2); 7.88 (*d*, H–C(6)); 7.64 (*d*, NH, 1H of dnpeoc); 7.54 (*d*, 1H of dnpeoc); 7.40 (*d*, 2H *m* to NO_2); 7.04 (*d*, H–C(5)); 6.25 (*t*, H–C(1′)); 5.09 (*m*, H–C(3′)); 4.45 (*m*, $2CH_2CH_2O$ of

dnpeoc, CH_2CH_2O (N^4), H–C(4'), 2H–C(5')); 3.41 (2*t*, $2CH_2CH_2O$ of dnpeoc); 3.11 (*t*, CH_2CH_2O (N^4)); 2.75 (*m*, H–C(2')); 2.14 (*m*, H–C(2')). Anal. calc. for $C_{36}H_{32}N_8O_{20}$ (896.7): C 48.22, H 3.60, N 12.50; found: C 48.43, H 3.47, N 12.19.

19. *N^4-[2-(4-Nitrophenyl)ethoxycarbonyl]cytidine* [2] (**35**). The mixture of 1.21 g (5 mmol) of dry cytidine, 15 ml (11.6 g, 72 mmol) of hexamethyldisilazane, and a catalytic amount of $(NH_4)_2SO_4$ was heated under reflux in anh. dioxane (15 ml) for 3.5 h. The soln. was then cooled to r.t., evaporated, and co-evaporated with anh. toluene (50 ml). The residue was taken up in anh. CH_2Cl_2 (50 ml), stirred together with **3** (2.03 g, 6.5 mmol) at r.t. for 1 h, and evaporated. Then, the residue was kept at r.t. in MeOH (50 ml) and Et_3N (10 ml) over night. The precipitated **35** was filtered by suction, washed with MeOH and Et_2O, and dried at 40°/high vacuum: 2 g (92%) of colourless powder. M.p. 85–89°. UV (MeOH): 280 (4.14), 242 (4.23). ^{1}H-NMR ((D$_6$)DMSO): 10.76 (*s*, NH); 8.39 (*d*, H–C(6)); 8.17 (*d*, 2H *o* to NO_2); 7.60 (*d*, 2H *m* to NO_2); 6.96 (*d*, H–C(5)); 5.76 (*d*, H–C(1')); 5.49 (*d*, OH); 5.16 (*t*, OH); 5.05 (*d*, OH); 4.35 (*t*, CH_2CH_2O); 4.02–3.82 (*m*, H–C(2'), H–C(3'), H–C(4')); 3.80–3.52 (*m*, 2H–C(5')); 3.08 (*t*, CH_2CH_2O). Anal. calc. for $C_{18}H_{20}N_4O_9 \cdot H_2O$ (454.4): C 47.58, H 4.88, N 12.33; found: C 47.36, H 4.51, N 12.29.

20. *5'-O-(Monomethoxytrityl)-N^4-[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**36**). To a soln. of **35** (2.06 g, 4.72 mmol; coevaporated 4 times with pyridine) in anh. pyridine (24 ml) was added MeOTrCl (1.75 g, 5.66 mmol) and kept at r.t. for 48 h. $CHCl_3$ was added and the mixture washed with H_2O, dried, evaporated, and co-evaporated with toluene. CC (silica gel, 30 × 3.5 cm, $CHCl_3$) yielded 2.9 g (87%) of **36**. Colourless amorphous solid. UV (MeOH): 281 (4.20), 276 (4.20), 235 (4.44). ^{1}H-NMR ($CDCl_3$): 8.17–8.14 (*d*, H–C(6), 2H *o* to NO_2); 7.96 (*s*, NH); 7.38 (*d*, 2H *m* to NO_2); 7.34–7.19 (*m*, 12H, MeO*Tr*); 7.01 (*d*, H–C(5)); 6.81 (*d*, 2H *o* to MeO); 5.82 (*d*, H–C(1')); 5.72 (br. *s*, OH–C(3')); 4.44–4.36 (*m*, H–C(2'), H–C(3'), H–C(4'), CH_2CH_2O); 3.77 (*s*, MeO); 3.54 (*s*, OH–C(2')); 3.46–3.32 (*m*, 2H–C(5')); 3.09 (*t*, CH_2CH_2O). Anal. calc. for $C_{38}H_{36}N_4O_{10}$ (708.7): C 64.40, H 5.12, N 7.91; found: C 63.94, H 4.66, N 7.77.

21. *5'-O-(Monomethoxytrityl)-N^4,2'-O-3'-O-tris[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**37**). A mixture of **36** (1.42 g, 2 mmol), **3** (1.87 g, 6 mmol) and 4-(dimethylamino)pyridine (244 mg, 2 mmol) in anh. CH_2Cl_2 (30 ml) was stirred at r.t. for 2 h. $CHCl_3$ (200 ml) was added and the mixture washed twice with H_2O (100 ml), dried, and evaporated. The resulting foam was purified by CC (silica gel, $CHCl_3$, then $CHCl_3$/MeOH 100:1): 1.95 g (89%) of amorphous colourless foam. UV (MeOH): 270 (4.54), 238 (4.53). ^{1}H-NMR ($CDCl_3$): 8.18–8.10 (*m*, H–C(6), 6H *o* to NO_2); 7.71 (*s*, NH); 7.39–7.23 (*m*, 12H, MeO*Tr*, 6H *m* to NO_2); 6.89 (*d*, H–C(5)); 6.82 (*d*, 2H *o* to MeO); 6.18 (*d*, H–C(1')); 5.39 (*m*, H–C(2'), H–C(3')); 4.44–4.30 (*m*, H–C(4'), $3CH_2CH_2O$); 3.78 (*s*, MeO); 3.63–3.40 (*m*, 2H–C(5')); 3.06 (*m*, $3CH_2CH_2O$). Anal. calc. for $C_{56}H_{50}N_6O_{18}$ (1095.0): C 61.42, H 4.60, N 7.68; found: C 61.13, H 4.67, N 7.41.

22. *N^4,2'-O,3'-O-Tris[2-(4-nitrophenyl)ethoxycarbonyl]cytidine* (**38**). 22.1. A soln. of **37** (164 mg, 0.15 mmol) in CH_2Cl_2/MeOH 4:1 (3 ml) containing 2% TsOH · H_2O was kept at r.t. for 30 min. The mixture was diluted with $CHCl_3$ (40 ml), washed with H_2O (2 × 80 ml), dried, and evaporated. The residue was passed through a silica-gel column with $CHCl_3$/0.1% MeOH: 117 mg (95%) of colourless foam. UV (MeOH): 270 (4.52), 252 (sh, 4.45). ^{1}H-NMR ($CDCl_3$): 8.24–8.09 (*m*, 6H *o* to NO_2); 7.95 (*d*, H–C(6)); 7.39–7.32 (*m*, 7H, 6H, *m* to NO_2, NH); 7.17 (*d*, H–C(5)); 5.83 (*d*, H–C(1')); 5.71 (*t*, H–C(2')); 5.38 (*t*, H–C(3')); 4.33 (*m*, H–C(4'), $3CH_2CH_2O$); 4.01–3.76 (*m*, 2H–C(5')); 3.31 (*s*, OH–C(5')); 3.05 (*m*, $3CH_2CH_2O$). Anal. calc. for $C_{36}H_{34}N_6O_{17}$ (822.7): C 52.56, H 4.17, N 10.21; found: C 52.27, H 4.05, N 10.01.

22.2. A soln. of **37** (220 mg, 0.2 mmol) in $CHCl_3$/MeOH 1:3 (0.8 ml) and 80% AcOH (3 ml) was stirred at r.t. for 26 h. The mixture was evaporated and coevaporated with $CHCl_3$/MeOH 1:3 (7 × 8 ml). Purification of **38** by prep. TLC (toluene/AcOEt/MeOH 5:4:1) gave 150 mg (91%) of amorphous solid.

23. *2'-Deoxy-N^6,5'-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**41**), *and 2'-Deoxy-N^6,3'-O,5'-O-tris[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**42**). A soln. of **39** [2] (1.0 g, 1.5 mmol) in abs. pyridine (10 ml), which was first co-evaporated 3 times with anh. pyridine (10 ml), was cooled to −25°. To this soln., **1** (775 mg, 3.38 mmol) in anh. CH_2Cl_2 (10 ml) was added. The mixture was stirred at −15 ± 5° for 3 h, diluted with $CHCl_3$ (200 ml), washed with H_2O (3 × 200 ml), dried (Na_2SO_4), evaporated, and finally co-evaporated with toluene (3 × 20 ml) and $CHCl_3$ (2 × 20 ml). Purification by CC (silica gel, 19 × 3.5 cm, $CHCl_3$, then $CHCl_3$/acetone 50:1, 10:1, and 2:1) gave amorphous solids: 413 mg (22%) of **42** and 992 mg (69%) of **41**. Overall yield: 91%.

41: UV (MeOH): 267 (4.56). ^{1}H-NMR ($CDCl_3$): 8.66 (*s*, H–C(8)); 8.38 (*s*, NH); 8.13 (2*d*, 4H *o* to NO_2); 8.09 (*s*, H–C(2)); 7.42 (*d*, 2H *m* to NO_2); 7.36 (*d*, 2H *m* to NO_2); 6.48 (*t*, H–C(1')); 4.68 (*m*, H–C(3')); 4.53 (*t*, CH_2CH_2O); 4.37 (*m*, CH_2CH_2O, 2H–C(5')); 4.23 (*m*, H–C(4')); 3.14 (*t*, CH_2CH_2O); 3.05 (*t*, CH_2CH_2O); 2.78 (*m*, H–C(2')); 2.54 (*m*, H–C(2')); 2.91 (*s*, OH–C(3')). Anal. calc. for $C_{28}H_{27}N_7O_{11}$ (637.6): C 52.75, H 4.27, N 15.38; found: C 52.44, H 4.40, N 15.29.

42: UV (MeOH): 267 (4.62), 209 (4.64). ^{1}H-NMR ($CDCl_3$): 8.69 (*s*, H–C(8)); 8.34 (*s*, NH); 8.17 (3*d*, 6H *o* to NO_2); 8.02 (*s*, H–C(2)); 7.40 (3*d*, 6H *m* to NO_2); 6.49 (*q*, H–C(1′)); 5.29 (*d*, H–C(3′)); 4.53 (*t*, CH_2CH_2O); 4.40 (*m*, $2CH_2CH_2O$, H–C(4′), 2H–C(5′)); 3.11 (3*t*, $3CH_2CH_2O$); 2.86 (*m*, H–C(2′)); 2.64 (*m*, H–C(2′)). Anal. calc. for $C_{37}H_{34}N_8O_{15}$ (830.7): C 53.50, H 4.12, N 13.49; found: C 53.25, H 4.29, N 13.70.

24. *2′-Deoxy-5′-O-(monomethoxytrityl)-N^6,3′-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**43**). To a soln. of **40** [2] (717 mg, 1 mmol) in abs. CH_2Cl_2 (10 ml), 4-(dimethylamino)pyridine (36 mg, 0.3 mmol) and **3** (624 mg, 2 mmol) were added. The mixture was stirred at r.t. for 18 h, diluted with CH_2Cl_2, washed twice with H_2O (100 ml), dried (Na_2SO_4), and evaporated. The product was purified by CC (24 × 2.5 cm, CH_2Cl_2, then CH_2Cl_2/$CHCl_3$ 1:1): 792 mg (87%) of colourless amorphous solid after drying (40°/high vacuum). UV (MeOH): 268 (4.58), 236 (4.36). ^{1}H-NMR ($CDCl_3$): 8.61 (*s*, H–C(8)); 8.44 (*s*, NH); 8.16 (*d*, 2H *o* to NO_2); 8.12 (*d*, 2H *o* to NO_2); 8.08 (*s*, H–C(2)); 7.45–7.12 (*m*, 16H, 4H *m* to NO_2, MeO*Tr*); 6.78 (*d*, 2H *o* to MeO); 6.44 (*dd*, H–C(1′)); 5.40 (*d*, H–C(3′)); 4.52 (*t*, CH_2CH_2O); 4.41 (*t*, CH_2CH_2O); 4.32 (*m*, H–C(4′)); 3.76 (*s*, MeO); 3.42 (*m*, 2H–C(5′)); 3.12 (*t*, CH_2CH_2O); 3.10 (*t*, CH_2CH_2O); 3.02 (*m*, H–C((2′)); 2.68 (*m*, H–C(2′)). Anal. calc. for $C_{48}H_{43}N_7O_{12}$ (909.9): C 63.36, H 4.76, N 10.78; found: C 63.14, H 5.01, N 10.76.

25. *2′-Deoxy-N^6,3′-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**44**). Compound **43** (546 mg, 0.6 mmol) was stirred together with 2% TsOH in CH_2Cl_2/MeOH 4:1 (25 ml) at r.t. After 15 min, the mixture was diluted with $CHCl_3$ (35 ml) and washed with phosphate buffer (pH 7, 3 × 60 ml). The org. phase was dried (Na_2SO_4) and evaporated and the residue purified by CC (silica gel, $CHCl_3$/1% MeOH and 2% MeOH) and finally crystallized from AcOEt: 344 mg (90%) of colourless crystals. M.p. 143°. UV (MeOH): 267 (4.56). ^{1}H-NMR ($CDCl_3$): 8.92 (*s*, NH); 8.67 (*s*, H–C(8)); 8.16 (*d*, 2H *o* to NO_2); 8.10 (*d*, 2H *o* to NO_2); 8.00 (*s*, H–C(2)); 7.39 (2*d*, 4H *m* to NO_2); 6.27 (*dd*, H–C(1′)); 5.89 (*dd*, OH–C(5′)); 5.43 (*d*, H–C(3)); 4.52 (*t*, CH_2CH_2O); 4.42 (*t*, CH_2CH_2O); 4.29 (*s*, H–C(4′)); 3.88 (*m*, 2H–C(5′)); 3.20–3.00 (*m*, $2CH_2CH_2O$, H–C(2′)); 2.48 (*dd*, H–C(2′). Anal. calc. for $C_{28}H_{27}N_7O_{11}$ (637.6): C 52.75, H 4.27, N 15.38; found: C 52.74, H 3.87, N 15.32.

26. *2′-Deoxy-5′-O-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-N^6-[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**45**), *2′-Deoxy-3′-O-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-N^6-[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**46**), *and 2′-Deoxy-3′,5′-bis-O-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-N^6-[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**47**). A soln. of **39** (667 mg, 1.5 mmol) in abs. pyridine (6 ml), which was first co-evaporated 3 times with abs. pyridine (10 ml), was cooled to −25°. After dropwise addition of **2** (690 mg, 2.5 mmol) in abs. CH_2Cl_2 (6 ml), the mixture was stirred at −10 to −20° for 4 h. The volume was concentrated to ¼, co-evaporated with toluene (3 × 20 ml) and $CHCl_3$ (2 × 10 ml), and purified by CC (silica gel, 14 × 3.5 cm, $CHCl_3$/acetone 1:1 (700 ml)). The main product was dried at 40°/high vacuum: 814 mg (80%) of **45** as a solid foam. The by-products **46** and **47** were further purified by prep. TLC ($CHCl_3$/MeOH 9:1): 30 mg (3%) of **46** and 100 mg (7%) of **47**. Overall yield: 90%.

45: UV (MeOH): 265 (4.53). ^{1}H-NMR ($CDCl_3$): 8.78 (*d*, 1 H of dnpeoc); 8.67 (*s*, H–C(8)); 8.42 (*dd*, 1 H of dnpeoc); 8.34 (*s*, NH); 8.14 (*d*, 2 H *o* to NO_2); 8.06 (*s*, H–C(2)); 7.62 (*d*, 1 H of dnpeoc); 7.43 (*d*, 2 H *m* to NO_2); 6.50 (*t*, H–C(1′)); 4.70 (*m*, H–C(3′)); 4.54 (*t*, CH_2CH_2O of dnpeoc); 4.45 (*t*, CH_2CH_2O (N^6)); 4.36 (*m*, 2 H–C(5′)); 4.22 (*q*, H–C(4′)); 3.40 (*m*, CH_2CH_2O of dnpeoc); 3.16 (*t*, CH_2CH_2O (N^6)); 2.82 (*m*, H–C(2′)); 2.72 (*s*, OH–C(3′)); 2.56 (*m*, H–C(2′)). Anal. calc. for $C_{28}H_{26}N_8O_{13}$ (682.6): C 49.47, H 3.84, N 16.42; found: C 48.93, H 3.83, N 16.02.

46: UV (MeOH): 265 (4.54). ^{1}H-NMR ($CDCl_3$): 8.83 (*d*, 1 H of dnpeoc): 8.71 (*s*, H–C(8)); 8.43 (*dd*, 1 H of dnpeoc); 8.20 (*s*, NH); 8.17 (*d*, 2 H *o* to NO_2); 7.99 (*s*, H–C(2)); 7.65 (*d*, 1 H of dnpeoc); 7.42 (*d*, 2 H *m* to NO_2); 6.29 (*q*, H–C(1′)); 5.92 (*m*, OH–C(5′)); 5.44 (*d*, H–C(3′)); 4.53 (*m*, CH_2CH_2O of dnpeoc); CH_2CH_2O (N^6)); 4.32 (*m*, H–C(4′)); 3.90 (*m*, 2 H–C(5′)); 3.44 (*m*, CH_2CH_2O of dnpeoc); 3.23–3.12 (*m*, CH_2CH_2O (N^6), H–C(2′)); 2.51 (*m*, H–C(2′)). Anal. calc. for $C_{28}H_{26}N_8O_{13}\cdot H_2O$ (700.6): C 48.00, H 4.03, N 15.99; found: C 48.17, H 3.94, N 15.78.

47: UV (MeOH): 265 (4.66). ^{1}H-NMR ($CDCl_3$): 8.84 (*d*, 1 H of dnpeoc); 8.80 (*d*, 1 H of dnpeoc); 8.72 (*s*, H–C(8)): 8.44 (2*dd*, 2 H of dnpeoc); 8.17 (*d*, 2 H *o* to NO_2); 8.03 (*s*, H–C(2)); 8.01 (*s*, NH); 7.64 (2*d*, 2 H of dnpeoc); 7.46 (*d*, 2 H *m* to NO_2); 6.52 (*q*, H–C(1′)); 5.30 (*d*, H–C(3′)); 4.51 (3*t*, $2CH_2CH_2O$ of dnpeoc), CH_2CH_2O (N^6)); 4.36 (*m*, H–C(4′)); 2 H–C(5′)); 3.43 (2*t*, 2 CH_2CH_2O of dnpeoc); 3.17 (*t*, CH_2CH_2O (N^6)); 2.91 (*m*, H–C(2′)); 2.67 (*m*, H–C(2′)). Anal. calc. for $C_{37}H_{32}N_{10}O_{19}$ (920.7): C 48.27, H 3.50, N 15.21; found: C 48.36, H 3.58, N 14.63.

27. *N^6-[2-(4-Nitrophenyl)ethoxycarbonyl]adenosine* [2] (**48**). A mixture of dry adenosine (13.5 g, 50 mmol), hexamethyldisilazane (125 ml, 97 g, 0.6 mol), and a catalytic amount of $(NH_4)_2SO_4$ was heated under reflux in anh. dioxane (125 ml) for 3 h. Then, the soln. was evaporated and co-evaporated with anh. toluene (2 × 250 ml). The residue was dissolved in anh. CH_2Cl_2 (500 ml), and **3** (20.3 g, 65 mmol) was added. After stirring for 18 h at r.t., the precipitate was filtered off and the filtrate evaporated. The residue was taken up in MeOH (500 ml) and stirred

together with Et_3N (125 ml) overnight at r.t. (hydrolysis of Me_3Si groups), and **48** was crystallized out, filtered by suction, washed with MeOH, and dried at 60°/high vacuum: 20.43 g (89%) of colourless powder. M.p. 152–160°. UV (MeOH): 268 (4.45). ^{1}H-NMR ((D_6)DMSO): 10.60 (*s*, NH); 8.86 (*s*, H–C(8)); 8.62 (*s*, H–C(2)); 8.17 (*d*, 2 H *o* to NO_2); 7.61 (*d*, 2 H *m* to NO_2); 5.99 (*d*, H–C(1′)); 5.53 (*d*, OH); 5.24 (*d*, OH); 5.14 (*t*, OH); 4.62 (*m*, H–C(2′)); 4.40 (*t*, CH_2CH_2O); 4.18 (*m*, H–C(3′)); 3.98 (*m*, H–C(4′)); 3.75–3.50 (*m*, 2 H–C(5′)); 3.11 (*t*, CH_2CH_2O). Anal. calc. for $C_{19}H_{20}N_6O_8$ (460.4): C 49.57, H 4.38, N 18.25; found: C 49.42, H 4.26, N 18.30.

28. *5′-O-(Monomethoxytrityl)-N^6-[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**49**). Compound **48** (1.38 g, 3 mmol) was co-evaporated twice with dry pyridine (15 ml) and then taken up in dry pyridine (15 ml). At r.t., MeOTrCl (1.11 g, 3.6 mmol) was added. The soln. was stirred for 18 h, diluted with $CHCl_3$ (3 × 40 ml), washed with phosphate buffer (pH 7; 2 × 50 ml), dried (Na_2SO_4), evaporated, and co-evaporated with toluene (3 × 20 ml) to remove pyridine. The crude product was purified by short CC (silica gel (30 g), $(CH_2)_2Cl_2$, $CHCl_3$, $CHCl_3$/MeOH 100:1). The main product was dried (40°/high vacuum): 1.98 g (90%) of **49**. Solid foam. UV (MeOH): 268 (4.45), 235 (4.30). ^{1}H-NMR ($CDCl_3$): 8.74 (*s*, NH); 8.59 (*s*, H–C(8)); 8.20 (*s*, H–C(2)); 8.08 (*d*, 2 H *o* to NO_2); 7.33 (*d*, 2 H *m* to NO_2); 7.29–7.05 (*m*, 12 H, MeO*Tr*); 6.72 (*d*, 2 H *o* to MeO); 6.03 (*d*, H–C(1′)); 5.69 (br. *s*, OH); 4.86 (*m*, H–C(2′)); 4.46 (*m*, H–C(3′)), CH_2CH_2O); 4.39 (*m*, H–C(4′)); 3.72 (*s*, MeO, OH); 3.50–3.22 (*m*, 2 H–C(2′)); 3.08 (*t*, CH_2CH_2O). Anal. calc. for $C_{39}H_{36}N_6O_9$ (732.8): C 63.93, H 4.95, N 11.47; found: C 63.41, H 4.90, N 11.39.

29. *5′-O-(Monomethoxytrityl)-N^6,2′-O,3′-O-tris[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**50**). A mixture of **49** (358 mg, 0.49 mmol), 4-(dimethylamino)pyridine (31 mg, 0.25 mmol), and **3** (390 mg, 1.25 mmol) in CH_2Cl_2 (10 ml) was stirred at r.t. for 2 h. Then, $CHCl_3$ (40 ml) was added and the soln. washed with H_2O (2 × 40 ml), dried, and evaporated. Purification of **50** by prep. TLC ($CHCl_3$/MeOH 95:5) gave 456 mg (83%) of colourless amorphous solid. UV (MeOH): 268 (4.64), 238 (4.38). ^{1}H-NMR ($CDCl_3$): 8.63 (*s*, H–C(8)); 8.31–8.05 (*m*, 6 H *o* to NO_2); 8.10 (*s*, NH); 8.04 (*s*, H–C(2)); 7.41–7.16 (*m*, 18 H, 6 H *m* to NO_2, MeO*Tr*); 6.78 (*d*, 2 H *o* to MeO); 6.27 (*d*, H–C(1′)); 6.13 (*t*, H–C(2′)); 5.59 (*q*, H–C(3′)); 4.51 (*t*, CH_2CH_2O (N^6)); 4.38–4.30 (*m*, 2 CH_2CH_2O, H–C(4′)); 3.75 (*s*, MeO); 3.56–3.37 (*m*, 2 H–C(5′)); 3.12 (*t*, CH_2CH_2O (N^6)); 3.02 (*q*, 2 CH_2CH_2O). Anal. calc. for $C_{57}H_{50}N_8O_{17}$ (1119.1): C 61.18, H 4.50, N 10.01; found: C 60.89, H 4.36, N 9.74.

30. *N^6,2′-O,3′-O-Tris[2-(4-nitrophenyl)ethoxycarbonyl]adenosine* (**51**). 30.1. A soln. of 168 mg (0.15 mmol) of **50** in 3 ml of CH_2Cl_2/MeOH 4:1 containing 2% of TsOH·H_2O was kept at r.t. for 30 min. The reaction was stopped by addition of H_2O (80 ml) and the mixture extracted with $CHCl_3$ (4 × 40 ml). The org. layer was washed with H_2O (2 × 40 ml), dried, and evaporated. Purification by CC (silica gel, $CHCl_3$) gave 117 mg (92%) of an amorphous solid. UV (MeOH): 267 (4.67), 212 (sh, 4.64). ^{1}H-NMR ($CDCl_3$): 8.72 (*s*, H–C(8)); 8.24 (*s*, NH); 8.21–8.06 (*m*, 6 H *o* to NO_2); 7.90 (*s*, H–C(2)); 7.44–7.26 (*m*, 6 H *m* to NO_2); 6.02–5.93 (*m*, H–C(1′), H–C(2′), OH–C(5′)); 5.51 (*d*, H–C(3′)); 4.54 (*t*, CH_2CH_2O (N^6)); 4.39–4.22 (*m*, 2 CH_2CH_2O, H–C(4′)); 3.99–3.75 (*m*, 2 H–C(5′)); 3.18–2.96 (3*t*, 3 CH_2CH_2O). Anal. calc. for $C_{37}H_{34}N_8O_{16}$ (846.7): C 52.49, H 4.05, N 13.23; found: C 52.11, H 3.87, N 12.92.

30.2. Compound **50** (224 mg, 0.2 mmol) in $CHCl_3$/MeOH 5:4 (0.9 ml) was treated with 80% aq. AcOH (2 ml) at r.t. overnight. MeOH (6 ml) was added and evaporated. Final co-evaporation with $CHCl_3$/MeOH 1:1 (8 × 10 ml) gave crude **51**. Purified cation by prep. TLC (toluene/AcOEt/MeOH 5:4:1) yielded 106 mg (63%) of colourless amorphous foam.

31. *2′-Deoxy-N^2-[2-(4-nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)ethyl]guanosine* (**52**). The mixture of 3′,5′-bis-*O*-acetyl-2′-deoxyguanosine [19] (694 mg, 2 mmol), PPh_3 (840 mg, 3.2 mmol), and 2-(4-nitrophenyl)ethanol [3] (501 mg, 3 mmol) in anh. dioxane (40 ml) was stirred for few min at r.t. Then, diethyl azodicarboxylate (0.5 ml, 3.2 mmol) was added, and the mixture became clear after stirring for 1 h. The soln. was evaporated and co-evaporated with anh. pyridine (40 ml). Then, the residue was dissolved in anh. pyridine (10 ml) and cooled to 0°, and a soln. of **1** (1.38 g, 6 mmol) in anh. $CHCl_3$ (10 ml) was added within 5 min at 0°. The mixture was stirred for 1 h at 0° and for another 3 h at r.t. and diluted with $CHCl_3$ (4 × 50 ml). The org. phase was washed with H_2O (100 ml) and sat. NaCl soln. (200 ml), dried (Na_2SO_4), evaporated, and co-evaporated with toluene (2 × 50 ml) to remove pyridine. The residue was purified by CC (silica gel, 25 × 2.5 cm, CH_2Cl_2, then $CHCl_3$). The fractions containing *3′,5′-bis-O-acetyl-2′-deoxy-N^2-[2-(4-nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)-ethyl]guanosine* were evaporated, then dissolved in MeOH/dioxane/conc. NH_3 soln. 1:1:1 (75 ml), kept for 15 h at 4°, and then evaporated. The residue was treated with hot MeOH (80 ml), and on cooling, crystals of **52** were obtained, which were dried at 60°: 810 mg (66%). M.p. 179–182° (MeOH/H_2O). UV (MeOH): 269 (4.54), 216 (4.63). ^{1}H-NMR ((D_6)DMSO): 10.33 (*s*, NH); 8.40 (*s*, H–C(8)); 8.17 (*d*, 4 H *o* to NO_2); 7.64 (*d*, 2 H *m* to NO_2); 7.61 (*d*, 2 H *m* to NO_2); 6.30 (*t*, H–C(1′)); 5.32 (*d*, OH–C(3′)); 4.89 (*t*, OH–C(5′)); 4.41 (*m*, CH_2CH_2O (O^6), H–C(3′)); 4.37 (*t*, CH_2CH_2O (N^2)); 3.83 (*m*, H–C(4′)); 3.67–3.42 (*m*, 2 H–C(5′)); 3.30 (*t*, CH_2CH_2O (O^6)); 3.11 (*t*, CH_2CH_2O

(N^2)); 2.71 (*m*, H–C(2′)); 2.25 (*m*, H–C(2′)). Anal. calc. for $C_{27}H_{27}N_7O_{10} \cdot 1/2\ H_2O$ (618.5): C 52.43, H 4.56, N 15.85; found: C 52.32, H 4.67, N 15.63.

32. *2′-Deoxy-*N^2*,5′-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**53**) *and 2′-Deoxy-*N^2*,3′-O,5′-O-tris[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**55**). Compound **52** (1.0 g, 1.64 mol) was co-evaporated 3 times with anh. pyridine (10 ml), then dissolved in anh. pyridine (10 ml), and cooled to $-25°$. A soln. of **1** (565 mg, 2.46 mmol) in anh. CH_2Cl_2 was added. After stirring at $-15 \pm 5°$ for 3 h, the mixture was diluted with $CHCl_3$ (200 ml), washed with H_2O (3 × 200 ml), dried (Na_2SO_4), evaporated, and co-evaporated with toluene (3 × 30 ml) and $CHCl_3$ (2 × 20 ml). The residue was taken up in $CHCl_3$ and purified by CC (silica gel, 23 × 3.5 cm, $CHCl_3$ (150 ml), then $CHCl_3$/acetone 1:1): small amount of crude **55** and then 1.03 g (78%) of pure **53** as colourless foams. Further purification of **55** by prep. TLC ($CHCl_3$/acetone 9:1) gave, after drying, 223 mg (14%) of **55**. Overall yield: 92%.

53: UV (MeOH): 269 (4.61), 215 (4.65). ^{1}H-NMR ($CDCl_3$): 8.12 (3*d*, 6 H *o* to NO_2); 8.03 (*s*, H–C(8)); 7.43 (*s*, NH); 7.40 (3*d*, 6 H *m* to NO_2); 6.52 (*t*, H–C(1′)); 4.75 (*t*, H–C(3′), CH_2CH_2O); 4.40 (*m*, 2 CH_2CH_2O, 2 H–C(5′)); 4.29 (*m*, H–C(4′)); 3.27 (*t*, CH_2CH_2O); 3.15 (*s*, OH–C(3′)); 3.10 (*t*, CH_2CH_2O); 3.04 (*t*, CH_2CH_2O); 2.72 (*m*, H–C(2′)); 2.51 (*m*, H–C(2′)). Anal. calc. for $C_{36}H_{34}N_8O_{14}$ (802.7): C 53.87, H 4.27, N 13.96; found: C 53.73, H 4.35, N 13.64.

55: UV (MeOH): 269 (4.73), 214 (4.75). ^{1}H-NMR ($CDCl_3$): 8.16 (4*d*, 8 H *o* to NO_2); 7.93 (*s*, H–C(8)); 7.41 (4*d*, NH, 8 H *m* to NO_2); 6.35 (*t*, H–C(1′)); 5.35 (*d*, H–C(3′)); 4.77 (*t*, CH_2CH_2O); 4.42 (*m*, H–C(4′), 2 H–C(5′), 3 CH_2CH_2O); 3.28 (*t*, CH_2CH_2O); 3.03 (*m*, 3 CH_2CH_2O); 2.94 (*m*, H–C(2′)); 2.57 (*m*, H–C(2′)). Anal. calc. for $C_{45}H_{41}N_9O_{18}$ (995.9): C 54.27, H 4.15, N 12.66; found: C 54.11, H 4.36, N 12.23.

33. *2′-Deoxy-*N^2*,3′-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**54**). A soln. of **57** (1.08 g, 1 mmol) in 1% TsOH in CH_2Cl_2/MeOH 4:1 (40 ml) was stirred at r.t. for 15 min. Then, the mixture was diluted with $CHCl_3$ (100 ml) and washed with phosphate buffer (pH 7; 3 × 100 ml). The org. phase was dried (Na_2SO_4) and evaporated. The product was purified by CC (silica gel, 25 × 2.5 cm, CH_2Cl_2, then $CHCl_3$): 722 mg (90%) of amorphous **54**, after drying at 40°/high vacuum. UV (MeOH): 269 (4.65), 216 (4.70). ^{1}H-NMR ($CDCl_3$): 8.22–8.08 (3*d*, 6 H *o* to NO_2); 7.85 (*s*, H–C(8)); 7.48 (*d*, 2 H *m* to NO_2); 7.40 (2*d*, 4 H *m* to NO_2); 7.31 (*s*, NH); 6.20 (*dd*, H–C(1′)); 5.44 (*d*, H–C(3′)); 4.90 (*dd*, OH–C(5′)); 4.79 (*t*, CH_2CH_2O); 4.47 (*t*, CH_2CH_2O); 4.42 (*t*, CH_2CH_2O); 4.24 (*m*, H–C(4′)); 4.00–3.75 (*m*, 2 H–C(5′)); 3.28 (*t*, CH_2CH_2O); 3.18 (*m*, H–C(2′)); 3.10 (*t*, 2 CH_2CH_2O); 2.43 (*dd*, H–C(2′)). Anal. calc. for $C_{36}H_{34}N_8O_{14}$ (802.7): C 53.87, H 4.27, N 13.96; found: C 53.66, H 4.27, N 13.88.

34. *2′-Deoxy-5′-O-(monomethoxytrityl)-*N^2*-[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]-guanosine* (**56**). Compound **52** (4.27 g, 7 mmol) was coevaporated with anh. pyridine (50 ml), dissolved in anh. pyridine (35 ml), and then stirred together with MeOTrCl (2.81 g, 9.1 mmol) for 16 h at r.t. The mixture was diluted with $CHCl_3$ (100 ml), washed with H_2O (100 ml), dried (Na_2SO_4), evaporated, and co-evaporated with toluene. Purification by CC (silica gel, 25 × 3.5 cm, CH_2Cl_2, $CHCl_3$, then $CHCl_3$/MeOH 100:1) gave, after drying at 40°/high vacuum, 5.55 g (90%) of **56**. Amorphous solid. UV (MeOH): 269 (4.55), 236 (4.37). ^{1}H-NMR ($CDCl_3$): 8.12–8.01 (2*d*, 4 H *o* to NO_2); 7.96 (*s*, H–C(8)); 7.51 (*s*, NH); 7.48–7.10 (*m*, 16 H, 4 H *m* to NO_2, MeO*Tr*); 6.73 (*d*, 2 H *o* to MeO); 6.56 (*t*, H–C(1′)); 4.73 (*t*, 3 H, CH_2CH_2O (O^6), H–C(3′)); 4.34 (*t*, CH_2CH_2O (N^2)); 4.20 (*m*, H–C(4′)); 3.72 (*s*, MeO); 3.57 (*d*, OH–C(3′)); 3.35 (*m*, 2 H–C(5′)); 3.25 (*t*, CH_2CH_2O (O^6)); 3.02 (*t*, CH_2CH_2O (N^2)); 2.70 (*m*, H–C(2′)); 2.56 (*m*, H–C(2′)). Anal. calc. for $C_{47}H_{43}N_7O_{11}$ (881.9): C 64.01, H 4.91, N11.12; found: C 63.89, H 5.05, N 10.92.

35. *2′-Deoxy-5′-O-(monomethoxytrityl)-*N^2*,3′-O-bis[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**57**). At r.t., **3** (624 mg, 2 mmol) and 4-(dimethylamino)pyridine (36 mg, 0.3 mmol) were added to a soln. of **56** (882 mg, 1 mmol) in anh. CH_2Cl_2 (10 ml). After stirring for 18 h, the mixture was diluted with $CHCl_3$, washed twice with H_2O, dried (Na_2SO_4), and evaporated. Purification was achieved by CC (silica gel, CH_2Cl_2, then $CHCl_3$): colourless amorphous **57** (970 mg, 90%). UV (MeOH): 269 (4.65), 237 (4.42). ^{1}H-NMR ($CDCl_3$): 8.20–8.05 (3*d*, 6 H *o* to NO_2); 7.92 (*s*, H–C(8)); 7.48 (*d*, 2 H *m* to NO_2); 7.43–7.10 (*m*, 17 H, 4 H *m* to NO_2, MeO*Tr*, NH); 6.76 (*d*, 2 H *o* to MeO); 6.35 (*dd*, H–C(1′)); 5.39 (*d*, H–C(3′)); 4.78 (*t*, CH_2CH_2O); 4.43 (*t*, CH_2CH_2O); 4.39 (*t*, CH_2CH_2O); 4.25 (*m*, H–C(4′)); 3.75 (*s*, MeO); 3.39 (*m*, 2 H–C(5′)); 3.29 (*t*, CH_2CH_2O); 3.09 (*t*, 2 CH_2CH_2O); 2.96 (*m*, H–C(2′)); 2.62 (*m*, H–C(2′)). Anal. calc. for $C_{56}H_{50}N_8O_{15}$ (1075.1): C 62.57, H 4.69, N 10.42; found: C 62.58, H 4.89, N 10.33.

36. *2′-Deoxy-5′-O-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-*N^2*-[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**58**). Compound **52** (610 mg, 1 mmol) was co-evaporated twice with abs. pyridine (10 ml), then dissolved in abs. pyridine (6 ml), and cooled to $-25°$. A soln. of **2** (412 mg, 1.5 mmol) in abs. CH_2Cl_2

(6 ml) which was cooled to 0° was added dropwise. After 5 h at −10 to −20°, the mixture was diluted with $CHCl_3$ (3 × 100 ml), washed with H_2O (3 × 100 ml), dried (Na_2SO_4), evaporated, and co-evaporated with toluene (2 × 30 ml) to remove pyridine. The residue was taken up in $CHCl_3$ (5 ml) and purified by CC (silica gel, 20 × 2 cm). Elution with $CHCl_3$ gave < 2% of **59**/**60**. Then, **58** (688 mg, 81%) was eluted with $CHCl_3$/1% MeOH. Amorphous solid. UV (MeOH): 267 (4.59), 215 (4.66). ^{1}H-NMR ($CDCl_3$): 8.77 (*d*, 1 H of dnpeoc); 8.39 (*dd*, 1 H of dnpeoc); 7.63 (*d*, 1 H of dnpeoc); 8.14 (2*d*, 4 H *o* to NO_2); 8.00 (*s*, H–C(8)); 7.45 (2*d*, 4 H *m* to NO_2); 7.42 (*s*, NH); 6.58 (*t*, H–C(1′)); 4.79 (*m*, H–C(3′)); 4.77 (*t*, CH_2CH_2O (O^6)); 4.49–4.37 (*m*, CH_2CH_2O of dnpeoc, CH_2CH_2O (N^2), 2 H–C(5′)); 3.49–3.10 (3*t*, CH_2CH_2O of dnpeoc, 2 CH_2CH_2O (O^6, N^2), OH–C(3′)); 4.27 (*q*, H–C(4′)); 2.74 (*m*, H–C(2′)); 2.54 (*m*, H–C(2′)). Anal. calc. for $C_{36}H_{33}N_9O_{16}$ (847.7): C 51.01, H 3.92, N 14.87; found: C 50.74, H 3.50, N 14.48.

37. *2′-Deoxy-3′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-*N^2*-[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**59**). A soln. (1 ml) of 2% TsOH in CH_2Cl_2/MeOH 4:1 was stirred together with **61** (94 mg, 0.08 mmol). After 30 min, the mixture was diluted with $CHCl_3$ (30 ml) and washed with H_2O (2 × 30 ml). The $CHCl_3$ phase was dried and evaporated and the product purified by prep. TLC (2 × $CHCl_3$/acetone 9:1). Drying under high vacuum gave 52 mg (73%) of amorphous solid. UV (MeOH): 267 (4.37), 256 (sh, 4.33), 215 (4.46). ^{1}H-NMR ($CDCl_3$): 8.83 (*d*, 1 H of dnpeoc); 8.43 (*dd*, 1 H of dnpeoc); 8.15 (2*d*, 4 H *o* to NO_2); 7.85 (*s*, H–C(8)); 7.65 (*d*, 1 H of dnpeoc); 7.50 (*s*, NH); 7.48 (*d*, H *o* to NO_2); 7.41 (*d*, H *o* to NO_2); 6.21 (*q*, H–C(1′)); 5.44 (*d*, H–C(3′)); 4.82–4.77 (*t*, CH_2CH_2O (O^6); OH–C(5′)); 4.49 (*m*, CH_2CH_2O of dnpeoc); 4.46 (*t*, CH_2CH_2O (N^2)); 4.25 (*s*, H–C(4′)); 3.88 (*m*, 2 H–C(5′)); 3.44 (*m*, CH_2CH_2O of dnpeoc); 3.29 (*t*, CH_2CH_2O (O^6)); 3.11 (*t*, CH_2CH_2O (N^2)); 3.16 (*m*, H–C(2′)); 2.45 (*m*, H–C(2′)). Anal. calc. for $C_{36}H_{33}N_9O_{16}$ (847.7): C 51.01, H 3.92, N 14.87; found: C 50.70, H 3.66, N 14.57.

38. *2′-Deoxy-5′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-*N^2*-[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**58**), *2′-Deoxy-3′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-*N^2*-[2-(4-nitrophenyl)-ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**59**), and *2′-Deoxy-3′,5′-bis-*O*-[2-(2,4-dinitrophenyl)-ethoxycarbonyl]-*N^2*-[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**60**). Compound **52** (500 mg, 0.82 mmol) was co-evaporated twice with abs. pyridine (5 ml), then taken up in dry pyridine (5 ml). At r.t., a soln. of **2** (507 mg, 1.85 mmol) in abs. CH_2Cl_2 (5 ml) was added. After 4 h, the mixture was diluted with $CHCl_3$ (100 ml) and washed twice with H_2O (2 × 80 ml). The $CHCl_3$ phase was dried (Na_2SO_4), evaporated, and co-evaporated with toluene (3 × 25 ml) to remove pyridine. The residual mixture was separated by FC (silica gel, 13 × 2.5 cm, CH_2Cl_2/Et_2O 1:1 (200 ml), 2:1 (400 ml, elution of **60**), CH_2Cl_2 (100 ml), CH_2Cl_2/2% MeOH (500 ml, elution of **59** and then of **58**)): 187 mg (21%) of **60**, 35 mg (5%) of **59**, and 360 mg (52%) of **58** as amorphous solids. Overall yield: 78%.

60: UV (MeOH): 285 (sh, 4.38), 262 (4.71), 258 (sh, 4.71), 214 (4.79). ^{1}H-NMR ($CDCl_3$): 8.82, 8.76 (2*d*, 2 H of dnpeoc); 8.43, 8.38 (2*dd*, 2 H of dnpeoc); 8.14 (*d*, 2 H *o* to NO_2); 8.11 (*d*, 2 H *o* to NO_2); 7.93 (*s*, H–C(8)); 7.66, 7.62 (2*d*, 2 H of dnpeoc); 7.48 (*d*, 2 H *m* to NO_2); 7.42 (*s*, NH); 7.41 (*d*, 2 H *m* to NO_2); 6.36 (*q*, H–C(1′)); 5.34 (*m*, H–C(3′)); 4.78 (*t*, CH_2CH_2O (O^6)); 4.52–4.37 (*m*, 3 CH_2CH_2O, 2 H–C(5′), H–C(4′)); 3.42 (*t*, CH_2CH_2O of dnpeoc); 3.37 (*t*, CH_2CH_2O of dnpeoc); 3.28 (*t*, CH_2CH_2O (O^6)); 3.11 (*t*, CH_2CH_2O (N^2)); 3.02 (*m*, H–C(2′)); 2.59 (*m*, H–C(2′)). Anal. calc. for $C_{45}H_{39}N_{11}O_{22}$ (1085.9): C 49.78, H 3.62, N 14.19; found: C 50.10, H 3.91, N 14.01.

39. *2′-Deoxy-3′-*O*-[2-(2,4-dinitrophenyl)ethoxycarbonyl]-5′-*O*-(monomethoxytrityl)-*N^2*-[2-(4-nitrophenyl)ethoxycarbonyl]-*O^6*-[2-(4-nitrophenyl)ethyl]guanosine* (**61**). A soln. of **56** (290 mg, 0.33 mmol) in dry pyridine (3 ml) was cooled to 0°, and then **2** (362 mg, 1.32 mmol) in dry CH_2Cl_2 (3 ml) was added. After stirring at 0° for 1 h and at r.t. for 18 h, the mixture was diluted with $CHCl_3$ (3 × 60 ml), washed with H_2O (3 × 60 ml), dried ($MgSO_4$), evaporated, and co-evaporated with toluene (2 × 15 ml). Purification by CC (silica gel, 15 × 2 cm, $CHCl_3$), evaporation, and drying gave an amorphous solid: 213 mg (58%) of **61**. UV (MeOH): 267 (4.63), 236 (4.56). ^{1}H-NMR ($CDCl_3$): 8.83 (*d*, 1 H of dnpeoc); 8.42 (*dd*, 1 H of dnpeoc); 8.15 (2*d*, 4 H *o* to NO_2); 7.93 (*s*, H–C(8)); 7.64 (*d*, 1 H of dnpeoc); 7.50–7.34 (*m*, 7 H, NH, 4 H *m* to NO_2); 7.66–7.17 (*m*, 12 H, MeO*Tr*); 6.75 (*d*, 2 H *o* to MeO); 6.36 (*q*, H–C(1′)); 5.39 (*d*, H–C(3′)); 4.78 (*t*, CH_2CH_2O (O^6)); 4.48 (*m*, CH_2CH_2O of dnpeoc); 4.43 (*t*, CH_2CH_2O (N^2)); 4.24 (*d*, H–C(4′)); 3.75 (*s*, MeO); 3.43–3.34 (*m*, 2 H–C(5′)), CH_2CH_2O of dnpeoc); 3.29 (*t*, CH_2CH_2O (O^6)); 3.09 (*t*, CH_2CH_2O (N^2)); 2.93 (*m*, H–C(2′)); 2.62 (*m*, H–C(2′)). Anal. calc. for $C_{56}H_{49}N_9O_{17}\cdot H_2O$ (1138.1): C 59.10, H 4.52, N 11.08; found: C 59.46, H 4.44, N 10.88.

40. *N^2-[2-(4-Nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)ethyl]guanosine* (**62**). 40.1. *2′,3′,5′-Tri-*O*-acetylguanosine* [15]. A suspension of dry guanosine (14.2 g, 50 mmol) in anh. pyridine (15 ml) and anh. DMF (40 ml) containing anh. Ac_2O (30 ml) was stirred for 4 h at 75°. The soln. was cooled to r.t. and evaporated under high

vacuum. The residual solid was treated with hot i-PrOH (100 ml), cooled, filtered by suction, and dried for 20 h (50°/high vacuum): 16 g (78%) of colourless crystals. M.p. 230–234° ([15]: m.p. 230–233°; 87% yield).

40.2. *N^2-[2-(4-Nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)ethyl]guanosine* (**62**). A suspension of 2′,3′,5′-tris-*O*-acetylguanosine (10.1 g, 24.6 mmol), PPh_3 (9.8 g, 37.5 mmol), and 2-(4-nitrophenyl)ethanol [3] (5.85 g, 35 mmol) in anh. dioxane (150 ml) was stirred for 45 min at 80°. Then, diethyl azodicarboxylate (5.88 ml, 37.5 mmol) was added, the mixture started to boil and became clear immediately. The soln. was kept for 1 h at 60°, cooled to r.t., and evaporated. The residue was treated with CH_2Cl_2 (30 ml) and cooled. Then, the diethyl hydrazinedicarboxylate was filtered off and the soln. evaporated. The residual oil was purified by CC (silica gel, 30 × 3.5 cm, Et_2O (500 ml), Et_2O/CH_2Cl_2 9:1 (150 ml), Et_2O/CH_2Cl_2 4:1 (150 ml), Et_2O/CH_2Cl_2 1:1 (150 ml), CH_2Cl_2 (250 ml), CH_2Cl_2/MeOH 49:1 (200 ml), and finally with CH_2Cl_2/MeOH 19:1). All product fractions of *O^6-[2-(4-nitrophenyl)ethyl]-2′,3′,5′-tris-*O*-acetylguanosine* were evaporated and twice co-evaporated with pyridine (50 ml). The residue was dissolved in pyridine (100 ml) and cooled in an ice-bath. A soln. of **1** (8.04 g, 35 mmol) in CH_2Cl_2 (100 ml) was added within 10 min at 0°. The mixture was stirred for 1 h at 0° and for 18 h at r.t., evaporated, co-evaporated 3 times with toluene (50 ml), and submitted to CC (silica gel, 40 × 3.5 cm, CH_2Cl_2, then $CHCl_3$). After evaporation, the fractions containing *2′,3′,5′-tri-*O*-acetyl-N^2-[2-(4-nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)ethyl]guanosine* were dissolved in MeOH/dioxane/conc. NH_3 soln. 1:1:1 (150 ml), kept for 20 h at 4°, and then evaporated. Final co-evaporation with toluene/MeOH 1:1 (3 × 50 ml) gave crude **62**, which crystallized from MeOH/Et_2O 1:1 (100 ml). On cooling, more crystals were obtained which were dried at 50°/high vacuum (3 d): 7.4 g (48%). The filtrate containing crude **62** was evaporated and the residue purified by CC (silica gel, CH_2Cl_2, then $CHCl_3$) and crystallization from MeOH/Et_2O 1:1 (15 ml): 0.5 g. Overall yield (3 steps): 51% (7.9 g) of **62**. M.p. 172–174° (dec.; MeOH/H_2O). UV (MeOH): 269 (4.53), 216 (4.62). ^{1}H-NMR ((D_6)DMSO): 10.37 (*s*, NH); 8.42 (*s*, H–C(8)); 8.17 (*d*, 4 H *o* to NO_2); 7.64 (*d*, 2 H *m* to NO_2); 7.61 (*d*, 2 H *m* to NO_2); 5.89 (*d*, H–C(1′)); 5.49 (*d*, OH–C(2′)); 5.20 (*d*, OH–C(3′)); 4.98 (*t*, OH–C(5′)); 4.77 (*t*, CH_2CH_2O (*O^6*)); 4.60 (*m*, H–C(2′)); 4.38 (*t*, CH_2CH_2O (*N^2*)); 4.18 (*m*, H–C(3′)); 3.92 (*m*, H–C(4′)); 3.72–3.47 (*m*, 2 H–C(5′)); 3.30 (*t*, CH_2CH_2O (*N^2*)); 3.10 (*t*, CH_2CH_2O (*O^6*)). Anal. calc. for $C_{27}H_{27}N_7O_{11}\cdot H_2O$ (643.5): C 50.38, H 4.54, N 15.23; found: C 50.40, H 4.38, N 15.25.

41. *5′-O-(Monomethoxytrityl)-N^2-[2-(4-nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)ethyl]guanosine* (**63**). 41.1. To a soln. of **62** (1.88 g, 3 mmol; coevaporated 3 times with pyridine) in anh. pyridine (15 ml) was added MeOTrCl (1.11 g, 3.6 mmol) and kept at r.t. for 15 h. MeOH (2 ml) was added and the mixture evaporated to a smaller volume and applied to CC (silica gel, 33 × 3.5 cm, $CHCl_3$ (600 ml), then $CHCl_3$/MeOH 20:1 (600 ml)). The crude product was co-evaporated 3 times with toluene (15 ml), the residue dissolved in hot $CHCl_3$ (70 ml), Et_2O (70 ml) added at r.t., and at once, the product crystallized out. On cooling, more crystals were obtained, which were dried at 40°/high vacuum: 2.1 g (78%). M.p. 138–142° (sintering), 152° (fully dec.). UV (MeOH): 270 (4.55), 236 (4.38). ^{1}H-NMR ((D_6)DMSO): 10.33 (*s*, NH); 8.32 (*s*, H–C(8)); 8.16 (*d*, 4 H *o* to NO_2); 7.62 (*t*, 4 H *m* to NO_2); 7.31–7.14 (*m*, 12 H, MeO*Tr*); 6.76 (*d*, 2 H *o* to MeO); 5.92 (*d*, H–C(1′)); 5.59 (*d*, OH–C(3′)); 5.13 (*d*, OH–C(2′)); 4.78–4.66 (*m*, CH_2CH_2O (*O^6*), H–C(2′)); 4.37–4.31 (*m*, CH_2CH_2O (*N^2*), H–C(3′)); 4.02 (*t*, H–C(4′)); 3.69 (*s*, MeO); 3.29 (*m*, CH_2CH_2O (*O^6*)); 3.24–3.14 (*m*, 2 H–C(5′)); 3.08 (*t*, CH_2CH_2O (*N^2*)). Anal. calc. for $C_{47}H_{43}N_7O_{12}$ (897.9): C 62.87, H 4.83, N 10.92; found: C 62.89, H 4.77, N 10.78.

41.2. A soln. of **62** (1.25 g, 2 mmol) and MeOTrCl (926 mg, 3 mmol) in abs. pyridine (10 ml) was stirred at r.t. for 24 h. The mixture was diluted with AcOEt (100 ml) and washed with H_2O (100 ml). The org. soln. was dried, evaporated, and co-evaporated with toluene (2 × 50 ml). The residual crude product was treated with AcOEt (100 ml). The precipitation was filtered off and dried at 60°/high vacuum: 1.41 g (79%) of **63**.

42. *5′-O-(Monomethoxytrityl)-N^2,2′-O,3′-O-tris[2-(4-nitrophenyl)ethoxycarbonyl]-O^6-[2-(4-nitrophenyl)-ethyl]guanosine* (**64**). At r.t., **3** (624 mg, 2 mmol) and 4-(dimethylamino)pyridine (198 mg, 1.6 mmol) were added to a soln. of **63** (449 mg, 0.5 mmol) in anh. CH_2Cl_2 (50 ml). After stirring for 6 h, H_2O (80 ml) and $CHCl_3$ (80 ml) were added to the mixture. The org. layer was washed with H_2O (80 ml), dried (Na_2SO_4), and evaporated. Purification was achieved by CC (silica gel, CH_2Cl_2, then $CHCl_3$). The main fraction was evaporated: colourless amorphous **64** (444 mg, 69%). UV (MeOH): 270 (4.71), 237 (sh, 4.45). ^{1}H-NMR ($CDCl_3$): 8.15–8.06 (*m*, 8 H *o* to NO_2); 7.86 (*s*, H–C(8)); 7.51–7.15 (*m*, 21 H, 8 H *m* to NO_2, NH, MeO*Tr*); 6.75 (*d*, 2 H *o* to MeO); 6.18–6.10 (*m*, H–C(1′), H–C(2′)); 5.67 (*t*, H–C(3′)); 4.83–4.31 (*m*, H–C(4′), 4 CH_2CH_2O); 3.74 (*s*, MeO); 3.51–3.35 (*m*, 2 H–C(5′)); 3.32–2.98 (*m*, 4 CH_2CH_2O). Anal. calc. for $C_{65}H_{57}N_9O_{20}$ (1284.2): C 60.79, H 4.47, N 9.82; found: C 60.54, H 4.69, N 9.67.

43. *O^6-[2-(4-Nitrophenyl)ethyl]-N^2,2′-O,3′-O-tris[2-(4-nitrophenyl)ethoxycarbonyl]guanosine* (**65**). 43.1. A soln. of **64** (128 mg, 0.1 mmol) in $CHCl_3$/MeOH 1:3 (0.8 ml) was treated with 80% aq. AcOH (3 ml) at r.t. for 20 h.

The mixture was evaporated and co-evaporated with $CHCl_3$/MeOH 1:1 (6 × 6 ml). The residue was submitted to CC (silica gel, $CHCl_3$, then $CHCl_3$/MeOH 100:1): 92 mg (91%) or colourless foam. UV (MeOH): 269 (4.70), 214 (4.72). ^{1}H-NMR ($CDCl_3$): 8.18–8.06 (*m*, 6 H *o* to NO_2); 7.79 (*s*, H–C(8)); 7.50–7.27 (*m*, NH, 6 H *m* to NO_2); 5.96–5.87 (*m*, H–C(1'), H–C(2')); 5.56 (*d*, H–C(3')); 4.98 (*s*, OH–C(5')); 4.37–4.21 (*m*, H–C(4'), 3 CH_2CH_2O); 3.92 (*q*, 2 H–C(5')); 4.14–2.97 (*m*, 3 CH_2CH_2O). Anal. calc. for $C_{45}H_{41}N_9O_{19}$ (1011.9): C 53.42, H 4.08, N 12.46; found: C 52.11, H 3.87, N 12.92.

43.2. A soln. of **64** (128 mg, 0.1 mmol) in CH_2Cl_2/MeOH 4:1 (2 ml) containing 2% TsOH · H_2O was kept at r.t. for 30 min. The mixture was diluted with $CHCl_3$ (160 ml), washed 2 times with H_2O (80 ml), dried, evaporated to a small volume, and applied to CC (silica gel, $CHCl_3$/MeOH 100:1): 78 mg (78%) of **65** as a solid foam.

44. *5'-O-(Monomethoxytrityl)uridine 2':3'-Carbonate(cyclic)* (**66**). 44.1. See [10]: A soln. of **14** (3.1 g, 6 mmol) and 1,1'-carbonylbis(imidazole) (973 mg, 6 mmol) in anh. DMF (6 ml) and anh. toluene (30 ml) was stirred at r.t. for 6 h and then evaporated. Extraction with AcOEt (3 × 160 ml) and H_2O (3 × 180 ml) was followed. The org. layers were collected, dried (Na_2SO_4), evaporated, and dried at 30°/high vacuum: 3.22 g (99%) of **66** as colourless foam, identical (spectrophotometrical comparison) with authentic material [10].

44.2. A soln. of **15** (362 mg, 0.4 mmol) in 0.5M DBU/pyridine (8 ml) was stirred at r.t. for 30 min. The mixture was neutralized with 1M AcOH/pyridine (4 ml), diluted with H_2O (100 ml), and washed with $CHCl_3$ (2 × 100 ml). The org. phase was dried, evaporated, and co-evaporated 4 times with toluene (15 ml). Purification was achieved by prep. TLC ($CHCl_3$/MeOH 100:1): 212 mg (98%) of amorphous **66**, identical with authentic material (see *44.1*).

45. *5'-O-(Monomethoxytrityl)cytidine* (**70**). A soln. of **37** (219 mg, 40.2 mmol) in 0.5M DBU (4 ml) in pyridine was stirred at r.t. for 17 h and then neutralized by addition of 1M AcOH/pyridine (2 ml). The mixture was diluted with $CHCl_3$ (2 × 80 ml), washed with H_2O (2 × 80 ml), dried, evaporated, and co-evaporated with toluene (2 × 20 ml). The crude *5'-O-(monomethoxytrityl)cytidine 2',3'-carbonate(cyclic)* (**67**) was treated with MeOH/H_2O/Et_3N 1:1:1 (6 ml) at r.t. for 90 min. Then, $CHCl_3$ (2 × 80 ml) was added and the org. phase washed with H_2O (2 × 80 ml), dried, and evaporated. Purification of **70** by prep. TLC ($CHCl_3$/MeOH 9:1) gave 88 mg (85%) of a colourless powder.

46. *5'-O-(Monomethoxytrityl)adenosine* (**71**). The 2-(4-nitrophenyl)ethoxycarbonyl groups of **50** (224 mg, 0.2 mmol) were deblocked as described for **70** to give 91 mg (84%) of **71** as an amorphous solid.

47. *5'-O-(Monomethoxytrityl)guanosine* (**72**). To achieve deblocking of the 2-(4-nitrophenyl)ethoxycarbonyl groups, **64** (257 mg, 0.2 mmol) was treated with 0.5M DBU/pyridine soln. (8 ml), neutralized with 1M AcOH/pyridine, and then stirred with MeOH/H_2O/Et_2N 1:1:1 (12 ml) as described for **70**. The product crystallized from $(CH_2)_2Cl_2$/H_2O: 97 mg (87%) of colourless crystals.

48. *2'-O-Carbamoyl-5'-O-(monomethoxytrityl)uridine* (**73**) *and 3'-O-Carbamoyl-5'-O-(monomethoxytrityl)-uridine* (**74**). A soln. of **66** (200 mg, 0.37 mmol) in 25% NH_3 soln. (2 ml) was stirred for 15 min. at r.t., then evaporated, and co-evaporated with CH_2Cl_2 (5 × 30 ml). The residue was purified by CC ($CHCl_3$/acetone 1:1). Lyophilization (dioxane) gave 170 mg (82%) of **73**/**74**. Colourless powder. **73**/**74**: UV (MeOH): 260 (4.04), 232 (4.25). ^{1}H-NMR ((D_6)DMSO): 7.69, 7.70 (2*d*, H–C(6)); 7.50 (br. *s*, NH); 7.43–7.19 (*m*, 12 H, MeO*Tr*); 6.91 (*d*, 2 H *o* to MeO); 6.77, 6.69 (2 br. *s*, NH_2); 5.91 (*d*, H–C(1')); 5.80 (*m*, H–C(1'), OH–C(2')); 5.55 (*d*, OH–C(3')); 5.39, 5.37 (2*d*, H–C(5)); 5.12, 5.07 (2*t*, H–C(3')); 4.36 (*m*, H–C(2')); 4.10, 3.98 (2*m*, H–C(4')); 3.73 (*s*, MeO); 3.32–3.13 (*m*, 2 H–C(5')). Anal. calc. for $C_{30}H_{29}N_3O_8 \cdot 1$ dioxane (647.7): C 63.05, H 5.76, N 6.49; found: C 63.04, H 5.34, N 6.76.

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