

## Oligonucleosides with a Nucleobase-Including Backbone

Part 4

### A Convergent Synthesis of Ethynediyl-Linked Adenosine Tetramers

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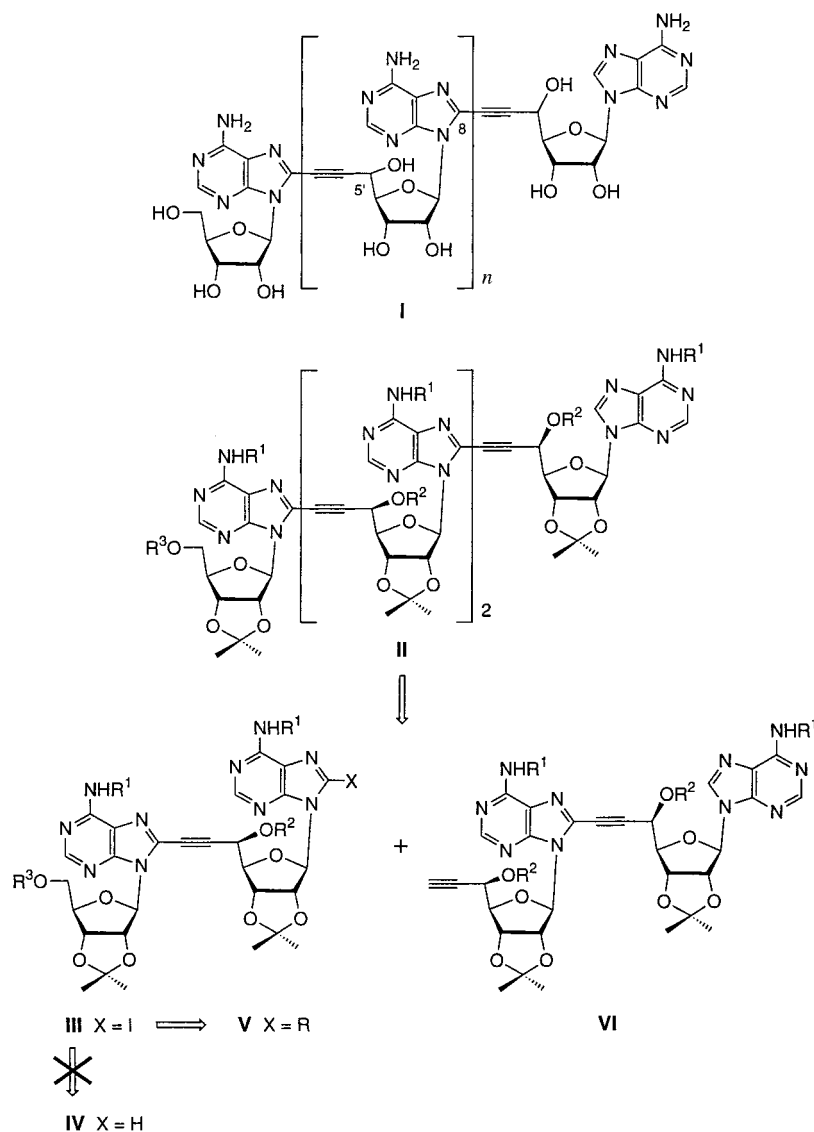
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Deprotection of the tetramer **24**, obtained by coupling the iodinated dimer **18** with the alkyne **23** gave the 8',5'-ethynediyl-linked adenosine-derived tetramer **27** (*Scheme 3*). As direct iodination of C(5')-ethynylated adenosine derivatives failed, we prepared **18** via the 8-amino derivative **17** that was available by coupling the imine **15** with the iodide **7**; **15**, in its turn, was obtained from the 8-chloro derivative **12** via the 4-methoxybenzylamine **14** (*Scheme 2*). This method for the introduction of the 8-iodo substituent was worked out with the *N*-benzoyladenosine **1** that was transformed into the azide **2** by lithiation and treatment with tosyl azide (*Scheme 1*). Reduction of **2** led to the amine **3** that was transformed into **7**. 1,3-Dipolar cycloaddition of **3** and (trimethylsilyl)acetylene gave **6**. The 8-substituted derivatives **4a–d** were prepared similarly to **2**, but could not be transformed into **7**. The known chloride **8** was transformed into the iodide **11** via the amines **9** and **10**. The amines **3**, **10**, and **16** form more or less completely persistent intramolecular C(8)N–H...O(5') H-bonds, while the dimeric amine **17** forms a *ca.* 50% persistent H-bond. There is no UV evidence for a base-base interaction in the protected and deprotected dimers and tetramers.

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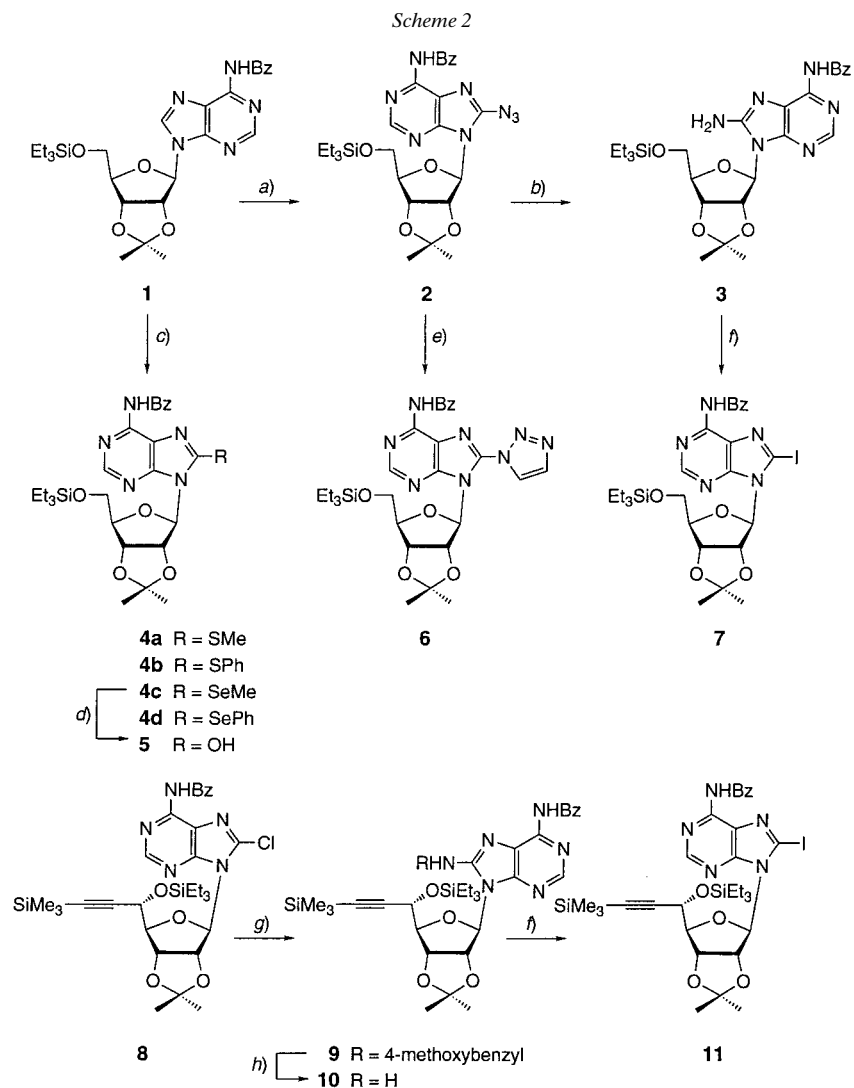
**1. Introduction.** – In the context of the synthesis of 8,5'-ethynediyl-linked analogues of adenosine-oligonucleosides, we have so far prepared dimers (**I**,  $n = 0$ ; *Scheme 1*) by cross-coupling C(5')-ethynylated and C(8)-halogenated monomers [1][2]. A convergent route appeared attractive for the preparation of higher oligomers that are required to test for base-pairing and formation of double-stranded associates. We planned to synthesise the tetramer **I** ( $n = 2$ , *Scheme 1*) by cross-coupling dimers **III** and **VI** to **II**, followed by deprotection. Unfortunately, the method used to directly iodinate monomers at C(8), which is based on a regioselective lithiation at C(8) [1], failed for dimers of type **IV**. Treatment of **IV** ( $R^1 = \text{Bz}$ ,  $R^2 = R^3 = \text{Et}_3\text{Si}$ ) with LDA at  $-78^\circ$  in THF led rapidly to a multitude of products, confirming the previously noted base-sensitivity of these ethynylated products [1]. The monomeric iodo derivatives had also been prepared by addition of (trimethylsilyl)ethynylmagnesium bromide to an iodo-aldehyde [1], but, in view of the base sensitivity of the ethynylated adenosines and the unsatisfactory diastereoselectivity of the addition, we required a different method to obtain dimeric iodides **III**, and considered to introduce a C(8)-substituent that is inert to the coupling conditions of the monomers (leading to **V**) and to subsequently displace it by an I substituent.

We describe the synthesis of two 8-I-substituted monomers (*Scheme 2*) and of the 8-iodinated dimer **18** (*Scheme 3*) by introducing a C(8)-imino group that is inert to the coupling conditions, and replacing it subsequently by a I substituent. We also describe the transformation of **18** into the protected 8,5'-ethynediyl-linked adenosine tetramer **24**, and its deprotection to **27** (*Scheme 4*).

Scheme 1. 8,5'-Acetyleno-Linked Adenosine Oligomers **I** and Retrosynthetic Pathway for the Tetramer **II**

**Results and Discussion.** – Several at C(8) N-, S-, and Se-substituted adenosines were considered as precursors of C(8)-iodo compounds. To evaluate these derivatives, we used the protected adenosine **1**, proceeding similarly as for the preparation of 8-Cl-adenosines [1], *i.e.*, by regioselective lithiation with LDA in THF, followed by treatment with the appropriate electrophile. Lithiation of **1** with LDA at  $-78^\circ$  followed by treatment with  $\text{TsN}_3$  at  $0^\circ$  gave the 8- $\text{N}_3$  derivative **2** in 84% yield (Scheme 2), considerably improving the current method that is based on substitution of 8-Br derivatives with  $\text{NaN}_3$  at  $75-90^\circ$  [3][4]. The monomers **4a-d** were similarly

prepared in yields of 46–94% by deprotonation of **1** with LDA and treatment with the appropriate S- or Se-electrophile. Oxidation of the methylseleno compound **4c** led to the 8-OH derivative **5**. Considering the potential of azides for the synthesis of heterocycles, we checked the reactivity of the azide **2** as a 1,3-dipolar reagent. While **2** reacted with (trimethylsilyl)acetylene to afford the triazole **6** in modest yields, it proved inert towards phenylacetylene, indicating the need for additional activation (appropriate substitution at N(6)?).



a) LDA, TsN<sub>3</sub>, THF; 84%. b) 10% Pd/C, H<sub>2</sub>, EtOH; 91%. c) LDA, electrophile ((MeS)<sub>2</sub>, (PhS)<sub>2</sub>, (MeSe)<sub>2</sub>, or PhSeCl), THF; **4a** (89%), **4b** (78%), **4c** (94%), **4d** (46%). d) *m*-Chloroperbenzoic acid, CH<sub>2</sub>Cl<sub>2</sub>; 96%. e) Me<sub>3</sub>Si–C≡CH, DMF; 45%. f) C<sub>3</sub>H<sub>11</sub>ONO, KI, I<sub>2</sub>, CH<sub>2</sub>I<sub>2</sub>; **7** (71%), **11** (82%). g) 4-Methoxybenzylamine, EtOH; 93%. h) DDQ, CH<sub>2</sub>Cl<sub>2</sub>/H<sub>2</sub>O 18:1; 66% from **8**.

Attempts to introduce an 8-I substituent by treating compounds **2**, **4a–d**, and **6** with several sources of I anion failed. However, adoption of the known transformation of 6- and 2-aminopurines into the corresponding halides [5] proved successful. The amine **3** is available in a yield of 91% by hydrogenation of the azide **2**. Its treatment with amyl nitrite in the presence of KI and I<sub>2</sub> [6] in CH<sub>2</sub>I<sub>2</sub> yielded 71% of the 8-I derivative **7** [1]. To test the scope of this iodination, we transformed the C(5′)-ethynylated 8-chloroadenosine derivative **8** [1] into the amine **10**. Treatment of **8** with 4-methoxybenzylamine [7–9] in EtOH afforded **9** that was debenzylated by DDQ in aqueous CH<sub>2</sub>Cl<sub>2</sub> [10] to provide the amine **10** in an overall yield of 66%. Following the conditions described above, this amine was smoothly converted to the 8-iodo derivative **11** in 82% yield [1].

These results encouraged us to synthesize the key iodo dimer **18** *via* the amine **17** (*Scheme 3*). Desilylation of **12** (TBAF in THF) [1], followed by *O*-triethylsilylation, yielded 67% of the protected chloride **13**. Its treatment with 4-methoxybenzylamine gave the secondary amine **14** (95%). Oxidation of **14** with DDQ in aqueous CH<sub>2</sub>Cl<sub>2</sub> led to a mixture of the imine **15** (18%) and the amine **16** (62%), while analogous oxidation of the *C*-trimethylsilylated **9** led only to the amine **10**<sup>1)</sup>. The analogous oxidation of **14** under anhydrous conditions gave selectively the imine **15** (87%). Following the observation that the imine **15** is not stable to Et<sub>3</sub>N, we prepared the amine **16** by exposing **15** for several hours to neat Et<sub>3</sub>N. In view of this result and considering that anhydrous Et<sub>3</sub>N had proven the best solvent for cross-coupling [2], we exposed **7** and **15** to the established cross-coupling conditions, and obtained the desired amino dimer **17** in 70%. The desired iodo dimer **18** was obtained in 55% yield from the amine **17**.

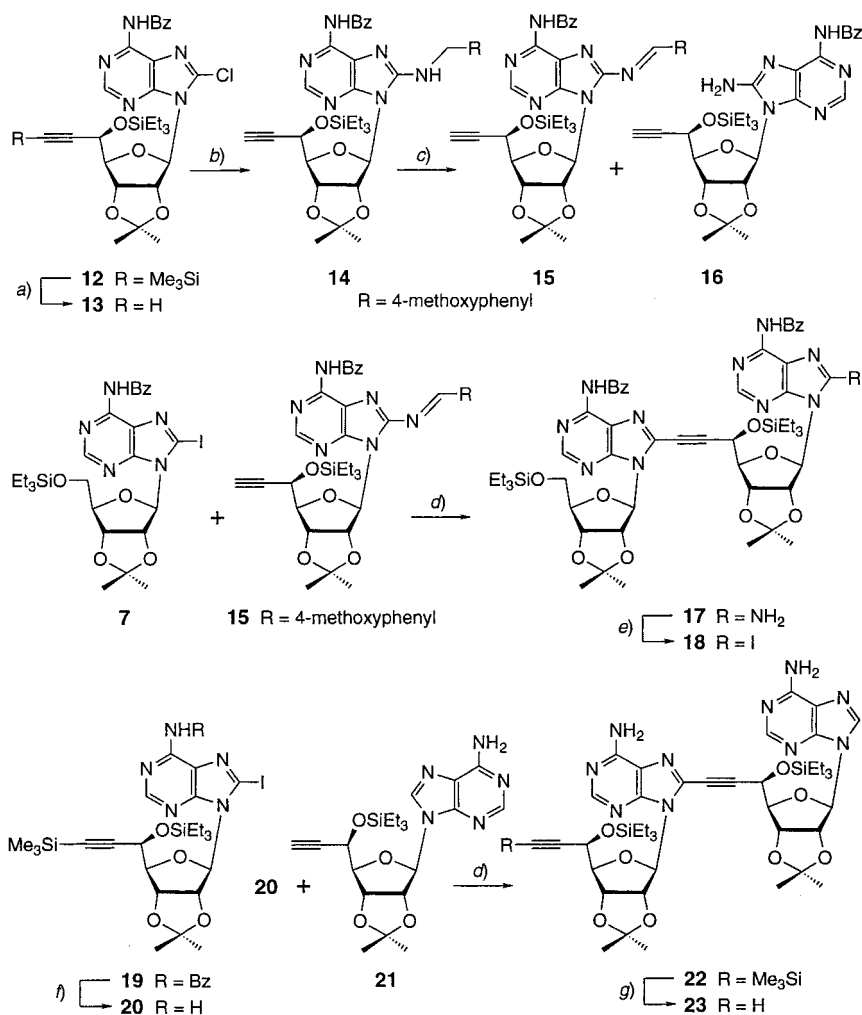
As described in the preceding paper [2], cross coupling of *N*-benzoylated acetylenoadenosines requires a temperature of 80°, while the analogous amines react at room temperature. We, therefore, prepared the dimeric amine **23** as the coupling partner for the iodide **18**. For this, we debenzoylated the known iodo derivative **19** [1] with 4-methoxybenzylamine in EtOH at 80°<sup>2)</sup> to **20** that was isolated in a yield of 81%. Coupling of **20** and **21** [1] proceeded smoothly at room temperature to give 85% of the dimer **22**, confirming the increased reactivity of the acetylenoadenosines with a free H<sub>2</sub>N–C(6) group. Cleavage of the C–SiMe<sub>3</sub> group of **22** was not straightforward. Treating **22** with AgNO<sub>3</sub> in aqueous THF/MeOH for 4.5 h, followed by addition of aqueous KCN [11][12] removed the Me<sub>3</sub>Si group, but also led to partial cleavage of the Et<sub>3</sub>SiO groups. Silylation of the crude with Et<sub>3</sub>SiCl and imidazole in DMF was slow, but led to **23** in a yield of 72% from **22**, while silylation with triethylsilyl triflate gave a complex mixture, containing *N*-silylated products.

Since the iodo derivative **18** is insoluble in Et<sub>3</sub>N, the dimers **18** and **23** were coupled in Et<sub>3</sub>N/toluene 1:1 to yield 79% of the tetramer **24** (*Scheme 4*). This coupling proceeded smoothly at room temperature, but appreciably more slowly than the analogous coupling of the monomers, illustrating the reduced reactivity of the dimers **18** and **23**.

1) It is not clear whether this difference is due to the Me<sub>3</sub>Si group or to the configuration at C(5′).

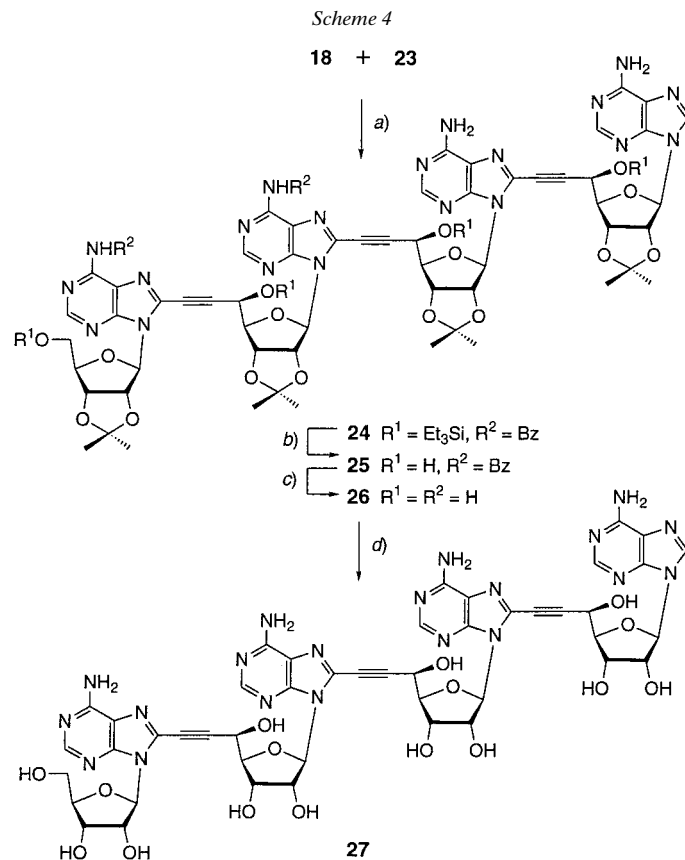
2) The conditions for this deprotection were discovered during an abortive attempt to introduce an NH<sub>2</sub> substituent at C(8).

Scheme 3



a)  $\text{Bu}_4\text{NF}$  (TBAF), THF;  $\text{Et}_3\text{SiCl}$ , imidazole, DMF; 67%. b) 4-Methoxybenzylamine, EtOH; 95%. c) 2,3-Dichloro-5,6-dicyano-1,4-benzoquinone (DDQ),  $\text{CH}_2\text{Cl}_2$ ;  $\mathbf{15}$  (87%) or DDQ,  $\text{CH}_2\text{Cl}_2/\text{H}_2\text{O}$  18:1;  $\mathbf{15}$  (18%),  $\mathbf{16}$  (62%). d)  $\text{CuI}$ ,  $[\text{Pd}_2(\text{dba})_3]$ ,  $\text{P}(\text{fur})_3$ ,  $\text{Et}_3\text{N}$ ;  $\mathbf{17}$  (70%),  $\mathbf{22}$  (85%). e)  $\text{C}_5\text{H}_{11}\text{ONO}$ ,  $\text{KI}$ ,  $\text{I}_2$ ,  $\text{CH}_2\text{I}_2$ ; 55%. f) 4-Methoxybenzylamine, toluene; 81%. g)  $\text{AgNO}_3$ , THF/MeOH/ $\text{H}_2\text{O}$ ; 5% aq. KCN;  $\text{Et}_3\text{SiCl}$ , imidazole, DMF; 72%.

The tetramer  $\mathbf{24}$  was desilylated with aqueous AcOH to yield 89% of the tetrol  $\mathbf{25}$ . Debenzoylation of  $\mathbf{25}$  with aqueous  $\text{NH}_4\text{OH}$  in toluene/MeOH 1:1 afforded a complex mixture from which we isolated *ca.* 25% of the desired, slightly impure tetramine  $\mathbf{26}$ , indicating that  $\mathbf{25}$  and/or  $\mathbf{26}$  are not stable to aqueous base. As HCOOH has proven effective for the deisopropylideneation of the related monomers [1] and dimers [2], we used it for the final deprotection of  $\mathbf{26}$ . Treatment of  $\mathbf{26}$  with 80% HCOOH at room



a) CuI, [Pd<sub>2</sub>(dba)<sub>3</sub>], P(fur)<sub>3</sub>, Et<sub>3</sub>N; 79%. b) THF/AcOH/H<sub>2</sub>O 1:2:1; 89%. c) NH<sub>4</sub>OH, toluene/MeOH/H<sub>2</sub>O; 25%. d) HCO<sub>2</sub>H/H<sub>2</sub>O 4:1; 72%.

temperature for 22 h yielded the deprotected acetyleno-adenosine tetramer **27** in an overall yield of 16% from **24**.

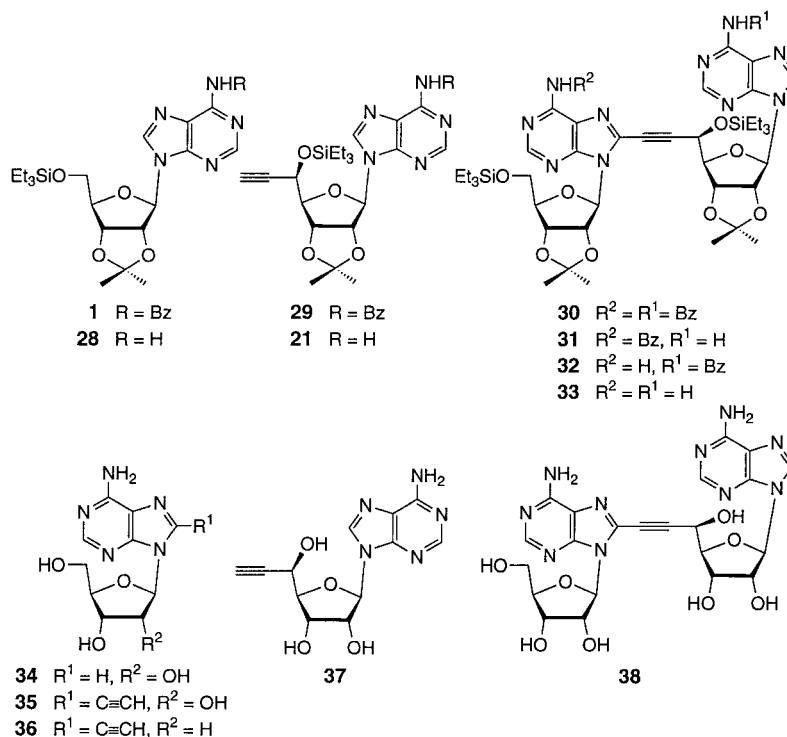
A comparison of the <sup>1</sup>H-NMR data (Tables 2 and 3 in the *Exper. Part*) shows that the 8-substituted monomers **2**, **4–6**, **13**, **15**, and **20** possess a flattened ring ( $J(1',2') + J(3',4') = 4.8–6.3$  Hz [13]). The (*N*) ⇌ (*S*) equilibrium is slightly shifted to the (*N*)-conformer ( $J(1',2') = 1.8–2.5$  Hz,  $J(3',4') = 3.0–3.8$  Hz), in agreement with the behaviour of the 8-halo analogues **7**, **11**, **12**, and **19** [1]. H–C(2') of the sulfides **4a–b**, the selenides **4c–d**, the triazole **6**, and the halides **13** and **20** appears at a similar position as H–C(2') of the halides **7**, **11**, **12**, and **19** (5.76–5.91 ppm), evidencing a complete *syn*-orientation of the nucleobase. The relatively weak upfield shift of H–C(2') of the imine **15** (5.67 ppm), the azide **2** (5.66 ppm), and the alcohol **5** (5.56 ppm) indicates a dominant participation of the *syn*-conformer in the *syn* ⇌ *anti* equilibrium. However, H–C(2') of the primary amines **3**, **10**, and **16** is strongly shifted upfield and resonates at 5.06–5.27 ppm at a position similar to the H–C(2') of the 8-unsubstituted adenosines **1** and **21**. These upfield shifts reveal an *anti*-conformation (see [1][2] and refs. cit. there) and

suggest a C(8)N–H $\cdots$ O(5') H-bond, as it is known for related 8-aminopurines [14–16]. The intramolecular H-bond of **3**, **10**, and **16** is ascertained by a small  $J(4',5')$  value of 1.8–3.5 Hz, evidencing a *trans*-arrangement of the H–C(4') and the O–C(5') bonds and, hence, a small distance between O(5') and H<sub>2</sub>N–C(8). Indeed, MM3\* modeling of **3** (Macromodel V. 6.0, gas phase [17]) results in a bifurcated H-bond from HN–C(8) to O(5') (H $\cdots$ O distance 1.75 Å) and O(4') (H $\cdots$ O distance 2.24 Å), and in *synclinal* H–C(4') and H–C(5') bonds (calculated  $J(4',5')$  values of 0.8 and 3.5 Hz, resp.). Due to this H-bond, the amines **3**, **10**, and **16** show an enhanced ring puckering ( $J(1',2') + J(3',4') = 7.3\text{--}8.3$  Hz) and a *ca.* 1:1 (*N*)  $\rightleftharpoons$  (*S*) equilibrium. The larger  $J(3',4')$  value and the stronger downfield shift of H–C(2') of the *D-allo*-configured **16** as compared to the corresponding values of the *D-ribo*-configured **3** and *L-talo*-configured **10** ( $\Delta J \approx 1$  Hz,  $\Delta\delta \approx 0.2$  ppm) indicate a *ca.* 80% preference of **16** for the intramolecular H-bond and the *syn*-conformation. Monoalkylation at H<sub>2</sub>N–C(8) of **10** and **16** leads to a destabilisation of the intramolecular H-bond. Again, the *D-allo*-configured **14** shows a weaker preference for the intramolecular H-bond than the *L-talo*-configured **9**: 45 vs. 60%, as calculated from  $J(4',5') = 5.5$  and 4.5 Hz, respectively. In agreement with this assignment, H–C(2') of **14** resonates 0.2 ppm downfield to H–C(2') of **9**.

H–C(2'/II)<sup>3</sup>) of the dimers **17**, **18**, **22**, and **23** resonates at 5.61–5.70 ppm (*Table 4, Exper. Part*) indicating a complete preference for the *syn*-conformation. H–C(2'/I) of these dimers shows only a weak upfield shift ( $\Delta\delta = 0.04\text{--}0.07$  ppm relative to  $\delta(\text{H–C}(2'/\text{II}))$ ). Neglecting the influence of the ethynyl group on  $\delta(\text{H–C}(2'/\text{II}))$ , this weak upfield shift suggests a more or less complete preference for the *syn*-conformation of unit I of the iodo derivative **18**, the 8-unsubstituted **22** and **23**, and, surprisingly, also of the amine **17**. However,  $J(4',5'/\text{I})$  of the amine **17** (5.5 Hz) is distinctly smaller than  $J(4',5'/\text{I})$  of **18** (8.0 Hz) and reveals a *ca.* 45% persistent intramolecular H-bond and thus a *ca.* 11:9 *syn*  $\rightleftharpoons$  *anti* equilibrium. Similarly, the smaller  $J(4',5'/\text{I})$  values of **22** (7.5 Hz) and **23** (7.0 Hz) reflect a weaker steric interaction of the nucleobase with the propargylic side chain in the *anti*-conformation (compare with  $J(4',5') = 4.8$  Hz of **21** [2]; *Table 3*) and indicate a 7:3 and a 6:4 *syn*  $\rightleftharpoons$  *anti* equilibrium, respectively. Thus, there is a significant influence of the 8-ethynyl group on  $\delta(\text{H–C}(2'))$ . The  $J(4',5'/\text{II–IV})$  values of the protected tetramer **24** are large and evidence a *syn*-conformation for units II–IV, whereas  $J(4',5'/\text{I}) = 7.5$  Hz indicates a 7:3 *syn*  $\rightleftharpoons$  *anti* equilibrium, as already observed for the dimer **22**.

2',3'-*O*-Isopropylidenedated 5'-hydroxyadenosines form a completely persistent intramolecular O(5')–H $\cdots$ N(3) H-bond in CDCl<sub>3</sub> [1]. In (D<sub>6</sub>)DMSO solution, the persistence of such a H-bond is *ca.* 20% [19]. Thus, the tetrols **25** and **26** may form weakly persistent intramolecular H-bonds.  $J(5',\text{OH})$  values of 5–6 Hz suggest more or less completely solvated OH groups (see [20] and refs. cit. there). However, the  $J(4',5'/\text{I–IV})$  values of **25** and **26** are smaller than the corresponding values of the protected **24** (*Table 4, Exper. Part*). They suggest 10–30% persistent intramolecular H-bonds, which are also evidenced by a downfield shift of the OH signals; the primary HO–C(5'/IV) of **25** and **26** resonate at 4.92 and 5.24 ppm, respectively, and the secondary HO–C(5'/I–III) at 6.59–6.78 ppm.

<sup>3</sup>) Starting from the downstream end, the units of the oligonucleosides are specified by roman numerals (*cf.* [18]).



To assess interactions between the base units, we compared the UV spectra of the tetramers **24** (CHCl<sub>3</sub>) and **27** (DMSO) with those of the related dimers and monomers (Table 1). We first checked for a possible influence of the ethynyl substituent at C(5') by comparing the UV spectra of the protected adenosines **28** and **21**, the corresponding benzoates **1** and **29**, and the unprotected adenosines **34** and **37**. As expected, there is no evidence for such an interaction; the difference of 6 nm for λ<sub>max</sub> of **34** and **37** is due to the solvent. The UV spectra of 8-ethynyladenosine (**35** [22]) and 2'-deoxy-8-ethynyladenosine (**36** [23]) show in H<sub>2</sub>O a band with λ<sub>max</sub> = 292 nm. Besides this band, the UV spectrum of **36** shows a shoulder at 303 nm. This shoulder is found in the UV spectra of a series of 8-(alk-1-ynyl)adenosines [23] [24]; it is characteristic for 8-ethynyladenosines. On the basis of a solvent correction of 6 nm for the 8-unsubstituted and for the 8-ethynyl-substituted adenine moiety of **38** in DMSO, one expects bands at 266 and 298 nm and a shoulder at 309 nm, close to the observed bands at 271 and 301 nm, and a shoulder at 312 nm. The maximum at 271 nm does not correctly reflect the λ<sub>max</sub> of the 8-unsubstituted adenine moiety as it is also influenced by strong absorptions of the 8-ethynyladenine moiety. The λ values of 301 and 312 nm probably indicate a larger solvent shift (9 instead of 6 nm) for the 8-ethynyladenine moiety. Thus, there is no evidence for a base/base interaction in **38**. The UV spectrum of the tetramer **27** resembles that of the dimer **38**, again in keeping with the absence of a base/base interaction. The protected monoamines **28** and **21** show exactly the same λ<sub>max</sub> as adenosine (**34**), suggesting that the bands of the protected diamine **33** should show a hypsochromic shift of ca. 6 nm (*i.e.*, a solvent shift for the change from H<sub>2</sub>O to DMSO)



to the bands of the deprotected diamine **38**. This is indeed the case ( $\Delta\lambda = 4-6$  nm); there is no evidence for a base/base interaction in **33**.

Table 1. UV Absorptions of the Monomers **1**, **21**, **28**, **29**, and **34–37**, the Dimers **30–33**, and **38**, and the Tetramers **24** and **27**

Compound	<b>1</b> [1]	<b>28</b> [2]	<b>29</b> [1]	<b>21</b> [2]	<b>30</b> [2]
Solvent	CHCl <sub>3</sub>	CHCl <sub>3</sub>	CHCl <sub>3</sub>	CHCl <sub>3</sub>	CHCl <sub>3</sub>
$\lambda_{\max}$ [nm] ( $\epsilon$ )	282 (14500) <sup>a</sup> , 276 (15000), 249 (9500)	260 (14000)	279 (19000), 247 (11000) <sup>a</sup>	260 (13000)	317 (22500), 304 (35000), 292 (39000), 250 (29000)
Compound	<b>31</b> [2]	<b>32</b> [2]	<b>33</b> [2]	<b>24</b>	<b>34</b> [21]
Solvent	CHCl <sub>3</sub>	CHCl <sub>3</sub>	CHCl <sub>3</sub>	CHCl <sub>3</sub>	H <sub>2</sub> O (pH 7)
$\lambda_{\max}$ [nm] ( $\epsilon$ )	317 (23500), 305 (32000), 298 (31000), 253 (29000)	308 (16500) <sup>a</sup> , 284 (32000), 248 (13000)	308 (15500) <sup>a</sup> , 295 (20000), 266 (21000)	316 (61000) <sup>a</sup> , 304 (71000), 296 (71000), 251 (55000)	260 (14400)
Compound	<b>35</b> [22]	<b>36</b> [23]	<b>37</b> [1]	<b>38</b> [2]	<b>27</b>
Solvent	H <sub>2</sub> O	H <sub>2</sub> O	DMSO	DMSO	DMSO
$\lambda_{\max}$ [nm] ( $\epsilon$ )	292 (17000)	303 (13000) <sup>a</sup> , 292 (16800)	266 (13000)	312 (13500) <sup>a</sup> , 301 (17000), 271 (17000)	311 (29500) <sup>a</sup> , 301 (48000), 278 (28000), 270 (25500)

<sup>a</sup>) Shoulder.

The situation is more complicated for the protected tetramer **24**. Three units can be distinguished, *viz.* the 8-unsubstituted adenine (unit I), the 8-ethynylated adenine (unit II), and the 8-ethynylated *N*-benzoyladenine (units III and IV). We considered the monomers **1**, **28**, **29**, and **21**, and the dimers **33**, **31**, and **30** as models to assess the interactions between the nucleobases of units I/II, II/III, and III/IV of **24**. The comparison of the UV spectra of **28** and **1**, and of **21** and **29** shows that *N*-benzoylation leads to a new band (for the benzamido moiety) at *ca.* 250 nm and to a bathochromic shift of *ca.* 20 nm of the band for the adenine moiety. The analysis is impaired by the broad bands of the *N*<sup>6</sup>-benzoyladenines. A comparison of the UV spectra of the dibenzamide **30** and the monobenzamides **1** and **29** shows the expected bathochromic shift for the 8-ethynyladenine moiety (25 nm) and a band at 317 nm instead of the expected shoulder. Again, the strong band of the 8-ethynyladenine moiety prevents an exact assignment of  $\lambda_{\max}$  of the 8-unsubstituted adenine moiety. The UV spectrum of the monobenzamide **31** resembles that of the dibenzamide **30**, and that of the monobenzamide **32** resembles that of the diamine **33** (apart from the band for the benzamido group at 248 nm), evidencing the dominant contribution of the 8-ethynyladenine moiety. The UV spectrum of the tetramer **24** is expected to closely resemble the spectra of **30** and **31**; this is indeed the case, again in agreement with the absence of any base/base interaction.

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## Experimental Part

General. See [1].

*8-Azido-N<sup>6</sup>-benzoyl-2',3'-O-isopropylidene-5'-O-(triethylsilyl)adenosine (2)*. A soln. of <sup>3</sup>Pr<sub>2</sub>NH (63 μl, 0.45 mmol) in dry THF (1.4 ml) was cooled to 0°, treated dropwise with 1.6M BuLi in hexane (0.28 ml, 0.45 mmol), stirred for 25 min, cooled to –78°, treated dropwise with a soln. of **1** [1] (94.2 mg, 0.18 mmol) in dry THF (1.4 ml), stirred for 3 h, treated with TsN<sub>3</sub> (111 mg, 0.56 mmol), stirred for 15 min, warmed to 0°, stirred for 1 h, and treated with sat. aq. NH<sub>4</sub>Cl soln. (2.0 ml) and H<sub>2</sub>O (1.0 ml). The layers were separated, and the aq. layer was extracted with AcOEt (2 × 1.0 ml). The combined org. layers were washed with brine, dried (Na<sub>2</sub>SO<sub>4</sub>), and evaporated. FC (5.0 g of silica gel; CHCl<sub>3</sub>/AcOEt 5:1) gave **2** (85.1 mg, 84%). Light orange plates. *R*<sub>f</sub> (hexane/AcOEt 1:1) 0.57. M.p. 114°. [ $\alpha$ ]<sub>D</sub><sup>25</sup> = –25.9 (*c* = 1.06, CHCl<sub>3</sub>). UV (CHCl<sub>3</sub>): 302 (20000), 251 (18000). IR (CHCl<sub>3</sub>): 3408w, 2997w, 2957w, 2913w, 2877w, 2156s, 1708m, 1615s, 1589m, 1517w, 1498w, 1478m, 1457s, 1431m, 1376s, 1328w, 1268m, 1159w, 1090s, 1004w, 972w, 946w, 916w, 898w, 868w. <sup>1</sup>H-NMR (300 MHz, CDCl<sub>3</sub>): see Table 2; additionally, 0.52 (*q*, *J* = 7.9, (MeCH<sub>2</sub>)<sub>3</sub>Si); 0.89 (*t*, *J* = 7.9, (MeCH<sub>2</sub>)<sub>3</sub>Si); 1.40, 1.61 (2s, Me<sub>2</sub>C); 7.49–7.58 (*m*, 2 arom. H); 7.58–7.65 (*m*, 1 arom. H); 7.96–8.03 (*m*, 2 arom. H); 8.78 (br. s, NH). <sup>13</sup>C-NMR (75 MHz, CDCl<sub>3</sub>): 164.4 (*s*, C=O); 151.8 (*s*, C(6)); 151.5 (*d*, C(2)); 148.3 (*s*, C(4)); 144.1 (*s*, C(8)); 133.8 (*s*); 132.8 (*d*); 129.0 (*2d*); 127.8 (*2d*); 121.5 (*s*, C(5)); 114.3 (*s*, Me<sub>2</sub>C); 89.1 (*d*, C(1')); 87.8 (*d*, C(4')); 82.7 (*d*, C(2')); 81.9 (*d*, C(3')); 62.7 (*t*, C(5')); 27.2, 25.5 (*2q*, Me<sub>2</sub>C); 6.6 (*q*, (MeCH<sub>2</sub>)<sub>3</sub>Si); 4.2 (*t*, (MeCH<sub>2</sub>)<sub>3</sub>Si). FAB-MS: 567 ([*M* + 1]<sup>+</sup>). Anal. calc. for C<sub>26</sub>H<sub>34</sub>N<sub>8</sub>O<sub>5</sub>Si (566.69): C 55.11, H 6.05, N 19.77; found: C 54.92, H 5.86, N 19.68.

Table 2. Selected <sup>1</sup>H-NMR Chemical Shifts [ppm] and Coupling Constants [Hz] for the C(8)-Substituted Adenosines **1–7** in CDCl<sub>3</sub> Solution

	<b>1</b> [1]	<b>2</b>	<b>3</b>	<b>4a</b>	<b>4b</b>	<b>4c</b>	<b>4d</b>	<b>5</b>	<b>6a</b> <sup>a)</sup>	<b>7</b> [1]
H–C(2)	8.83	8.69	8.55	8.67	8.75	8.68	8.76	8.40	8.81	8.73
H–C(1')	6.25	6.04	6.41	6.09	6.33	6.09	6.33	6.28	6.75	6.14
H–C(2')	5.26	5.66	5.06	5.76	5.77	5.79	5.77	5.56	5.91	5.81
H–C(3')	4.95	5.10	4.97	5.13	5.15	5.12	5.13	5.01	5.20	5.18
H–C(4')	4.45	4.27	4.24	4.29	4.31	4.33	4.29	4.27	4.23	4.32
H <sub>a</sub> –C(5')	3.75	3.66	3.87	3.66	3.70	3.66	3.69	3.76	3.68	3.65
H <sub>b</sub> –C(5')	3.87	3.77	4.00	3.76	3.82	3.77	3.80	3.84	3.78	3.76
<i>J</i> (1',2')	2.7	2.3	3.8	2.2	2.5	2.2	2.5	2.2	1.8	2.3
<i>J</i> (2',3')	6.0	6.5	6.7	6.5	6.5	6.5	6.5	6.5	6.5	6.3
<i>J</i> (3',4')	2.5	3.5	4.3	3.5	3.8	3.5	3.5	3.5	3.8	3.5
<i>J</i> (4'a,5')	4.0	6.5	1.8	6.5	6.5	6.5	6.5	6.5	7.0	6.5
<i>J</i> (4'b,5')	3.7	6.5	2.2	6.5	6.5	6.5	6.5	6.5	7.0	6.5
<i>J</i> (5'a,5'b)	11.0	10.8	10.8	10.8	10.8	10.8	10.8	10.5	10.8	10.5

<sup>a)</sup> In CD<sub>3</sub>OD.

*8-Amino-N<sup>6</sup>-benzoyl-2',3'-O-isopropylidene-5'-O-(triethylsilyl)adenosine (3)*. At 25°, a soln. of **2** (535.5 mg, 0.945 mmol) in EtOH (21 ml) was treated with 10% Pd/C (544.0 mg), stirred for 4 h under H<sub>2</sub>, treated with Ar stream, filtered, and evaporated. FC (20 g of silica gel; CHCl<sub>3</sub>/AcOEt 1:2) gave **3** (464.4 mg, 91%). White solid. *R*<sub>f</sub> (CHCl<sub>3</sub>/acetone 3:1) 0.50. M.p. 174°. [ $\alpha$ ]<sub>D</sub><sup>25</sup> = –6.5 (*c* = 1.07, CHCl<sub>3</sub>). UV (CHCl<sub>3</sub>): 303 (16000), 246 (14000). IR (CHCl<sub>3</sub>): 3467w, 3408w, 3324w, 2998w, 2960m, 2914w, 2878w, 1700m, 1639s, 1612m, 1590w, 1554w, 1500m, 1481m, 1438s, 1417w, 1387m, 1334w, 1255m, 1172w, 1156w, 1129w, 1107m, 1084m, 1048w, 1026w, 973w, 935w, 897w, 859w. <sup>1</sup>H-NMR (300 MHz, CDCl<sub>3</sub>): see Table 2; additionally, 0.65 (*q*, *J* = 7.9, (MeCH<sub>2</sub>)<sub>3</sub>Si); 0.99 (*t*, *J* = 7.9, (MeCH<sub>2</sub>)<sub>3</sub>Si); 1.37, 1.64 (2s, Me<sub>2</sub>C); 5.75 (br. s, NH<sub>2</sub>); 7.44–7.53 (*m*, 2 arom. H); 7.54–7.62 (*m*, 1 arom. H); 7.95–8.03 (*m*, 2 arom. H); 8.59 (br. s, NH). <sup>13</sup>C-NMR (75 MHz, CDCl<sub>3</sub>): 165.0 (*s*, C=O); 153.1 (*s*, C(6)); 153.0 (*d*, C(2)); 149.2 (*s*, C(4)); 144.2 (*s*, C(8)); 133.8 (*s*); 132.3 (*d*); 128.6 (*2d*); 127.9 (*2d*); 122.9 (*s*, C(5)); 115.2 (*s*, Me<sub>2</sub>C); 88.2 (*d*, C(1')); 84.6 (*d*, C(4')); 82.9 (*d*, C(2')); 79.3 (*d*, C(3')); 61.8 (*t*, C(5')); 27.4, 25.4 (*2q*, Me<sub>2</sub>C); 6.6 (*q*, (MeCH<sub>2</sub>)<sub>3</sub>Si); 4.0 (*t*, (MeCH<sub>2</sub>)<sub>3</sub>Si). FAB-MS: 541 ([*M* + 1]<sup>+</sup>). Anal. calc. for C<sub>26</sub>H<sub>36</sub>N<sub>6</sub>O<sub>5</sub>Si (540.69): C 57.76, H 6.71, N 15.54; found: C 57.84, H 6.85, N 15.68.

*Iodination of 3*. At 25°, a suspension of **3** (23.1 mg, 42.7 μmol) in CH<sub>2</sub>I<sub>2</sub> (0.35 ml) was treated with C<sub>3</sub>H<sub>11</sub>ONO (0.12 ml, 0.854 mmol), KI (21.3 mg, 0.128 mmol), and I<sub>2</sub> (35.1 mg, 0.138 mmol), warmed to 55°.

stirred for 2 h, diluted with  $\text{CHCl}_3$  (2.0 ml), washed with sat. aq.  $\text{Na}_2\text{S}_2\text{O}_3$  soln. (0.5 ml) and brine (0.5 ml), dried ( $\text{Na}_2\text{SO}_4$ ), and evaporated. FC (1.5 g of silica gel; hexane/AcOEt 5:4) gave **7** [1] (19.7 mg, 71%).

*General Procedure for the Preparation of 4a–d.* Similarly to the preparation of **2**, **1** was treated with LDA and 3 equiv. of the electrophile ( $(\text{MeS})_2$ ,  $(\text{PhS})_2$ ,  $(\text{MeSe})_2$ , or  $\text{PhSeCl}$ ), followed by normal workup.

*N<sup>6</sup>-Benzoyl-2,3'-O-isopropylidene-8-(methylthio)-5'-O-(triethylsilyl)adenosine (4a).* 89% Yield. Light yellow solid.  $R_f$  (hexane/AcOEt 1:1) 0.41.  $^1\text{H-NMR}$  (200 MHz,  $\text{CDCl}_3$ ): see Table 2; additionally, 0.50 ( $q$ ,  $J = 7.9$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 0.88 ( $t$ ,  $J = 7.9$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.40, 1.61 (2s,  $\text{Me}_2\text{C}$ ); 2.77 ( $s$ , MeS); 7.46–7.65 ( $m$ , 3 arom. H); 7.94–8.03 ( $m$ , 2 arom. H); 8.92 (br. s, NH).  $^{13}\text{C-NMR}$  (50 MHz,  $\text{CDCl}_3$ ): 164.1 ( $s$ , C=O); 154.8 ( $s$ , C(6)); 152.9 ( $s$ , C(4)); 150.8 ( $d$ , C(2)); 146.4 ( $s$ , C(8)); 133.7 ( $s$ ); 132.2 ( $d$ ); 128.5 (2d); 127.3 (2d); 122.8 ( $s$ , C(5)); 113.8 ( $s$ ,  $\text{Me}_2\text{C}$ ); 89.8 ( $d$ , C(1')); 87.4 ( $d$ , C(4')); 82.4 ( $d$ , C(2')); 81.6 ( $d$ , C(3')); 62.3 ( $t$ , C(5')); 26.8, 25.0 (2q,  $\text{Me}_2\text{C}$ ); 14.3 ( $q$ , MeS); 6.1 ( $q$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 3.8 ( $t$ ,  $(\text{MeCH}_2)_3\text{Si}$ ).

*N<sup>6</sup>-Benzoyl-2,3'-O-isopropylidene-8-(phenylthio)-5'-O-(triethylsilyl)adenosine (4b).* 78% Yield. Light yellow solid.  $R_f$  (hexane/AcOEt 5:4) 0.44.  $^1\text{H-NMR}$  (200 MHz,  $\text{CDCl}_3$ ): see Table 2; additionally, 0.53 ( $q$ ,  $J = 7.9$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 0.90 ( $t$ ,  $J = 7.9$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.41, 1.62 (2s,  $\text{Me}_2\text{C}$ ); 7.30–7.61 ( $m$ , 8 arom. H); 7.83–7.91 ( $m$ , 2 arom. H); 9.14 (br. s, NH).

*N<sup>6</sup>-Benzoyl-2,3'-O-isopropylidene-8-(methylseleno)-5'-O-(triethylsilyl)adenosine (4c).* 94% Yield. White solid.  $R_f$  (hexane/AcOEt 5:4) 0.38.  $^1\text{H-NMR}$  (200 MHz,  $\text{CDCl}_3$ ): see Table 2; additionally, 0.51 ( $q$ ,  $J = 8.0$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 0.88 ( $t$ ,  $J = 8.0$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.41, 1.62 (2s,  $\text{Me}_2\text{C}$ ); 2.67 ( $s$ , MeSe); 7.45–7.65 ( $m$ , 3 arom. H); 7.96–8.06 ( $m$ , 2 arom. H); 8.97 (br. s, NH).

*N<sup>6</sup>-Benzoyl-2,3'-O-isopropylidene-8-(phenylseleno)-5'-O-(triethylsilyl)adenosine (4d).* 46% Yield. Yellow solid.  $R_f$  (hexane/AcOEt 2:1) 0.42.  $^1\text{H-NMR}$  (300 MHz,  $\text{CDCl}_3$ ): see Table 2; additionally, 0.51 ( $q$ ,  $J = 8.0$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 0.88 ( $t$ ,  $J = 8.0$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.40, 1.61 (2s,  $\text{Me}_2\text{C}$ ); 7.31–7.40 ( $m$ , 3 arom. H); 7.45–7.52 ( $m$ , 2 arom. H); 7.55–7.62 ( $m$ , 1 arom. H); 7.66–7.71 ( $m$ , 2 arom. H); 7.90–7.96 ( $m$ , 2 arom. H); 9.13 (br. s, NH).

*N<sup>6</sup>-Benzoyl-8-hydroxy-2,3'-O-isopropylidene-5'-O-(triethylsilyl)adenosine (5).* At 25°, a soln. of **4c** (90.8 mg, 0.15 mmol) in dry  $\text{CH}_2\text{Cl}_2$  (2.7 ml) was treated with *m*-chloroperbenzoic acid (52.2 mg, 0.3 mmol), stirred for 1 h, washed with sat. aq.  $\text{NaHCO}_3$  soln. (2.0 ml) and brine (1.0 ml), dried ( $\text{Na}_2\text{SO}_4$ ), and evaporated. FC (3.0 g of silica gel; hexane/AcOEt 2:1) gave **5** (76.4 mg, 96%). White solid.  $R_f$  (hexane/AcOEt 2:1) 0.48.  $^1\text{H-NMR}$  (200 MHz,  $\text{CDCl}_3$ ): see Table 2; additionally, 0.60 ( $q$ ,  $J = 8.0$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 0.96 ( $t$ ,  $J = 8.0$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.40, 1.61 (2s,  $\text{Me}_2\text{C}$ ); 7.49–7.60 ( $m$ , 2 arom. H); 7.60–7.72 ( $m$ , 1 arom. H); 7.96–8.03 ( $m$ , 2 arom. H); 8.89 (br. s, NH); 9.57 (br. s, OH).

*N<sup>6</sup>-Benzoyl-2,3'-O-isopropylidene-8-(1H-[1,2,3]triazol-1-yl)-5'-O-(triethylsilyl)adenosine (6).* At 25°, a soln. of **2** (20.1 mg, 35.5  $\mu\text{mol}$ ) in dry DMF (0.6 ml) was treated with (trimethylsilyl)acetylene (40  $\mu\text{l}$ , 0.28 mmol), stirred for 20 h at 80°, poured into ice-water (*ca.* 4 ml), and extracted with  $\text{Et}_2\text{O}/\text{AcOEt}$  1:1 (3  $\times$  1.0 ml). The combined org. layers were washed with  $\text{H}_2\text{O}$ , dried ( $\text{Na}_2\text{SO}_4$ ), and evaporated. FC (1.5 g of silica gel;  $\text{CH}_3\text{Cl}/\text{AcOEt}$  7:2) gave **6** (9.4 mg, 45%). Green solid.  $R_f$  ( $\text{CH}_3\text{Cl}/\text{AcOEt}$  7:2) 0.43.  $^1\text{H-NMR}$  (200 MHz,  $\text{CD}_3\text{OD}$ ): see Table 2; additionally, 0.48 ( $q$ ,  $J = 8.0$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 0.86 ( $t$ ,  $J = 8.0$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.40, 1.59 (2s,  $\text{Me}_2\text{C}$ ); 7.50–7.61 ( $m$ , 2 arom. H); 7.61–7.72 ( $m$ , 1 arom. H); 8.01, 8.83 (2d,  $J = 1.3$ ,  $\text{C}_2\text{H}_2\text{N}_3$ ); 8.02–8.09 ( $m$ , 2 arom. H).

*N<sup>6</sup>-Benzoyl-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)-7-C-(trimethylsilyl)- $\alpha$ -L-talo-hept-6-ynofuranosyl]-8-[(4-methoxyphenyl)methyl]amino]adenine (9).* At 25°, a soln. of **8** [1] (343.2 mg, 0.52 mmol) in dry  $\text{EtOH}$  (10.0 ml) was treated with 4-methoxybenzylamine (0.20 ml, 1.57 mmol), stirred for 25 h, and evaporated. The residue was dissolved in  $\text{CHCl}_3$  (18 ml), washed with sat. aq.  $\text{NaHCO}_3$  soln. (5.0 ml) and brine (5.0 ml), and dried ( $\text{Na}_2\text{SO}_4$ ). Evaporation and FC (20 g of silica gel; hexane/AcOEt 5:7) gave **9** (366.4 mg, 93%), which contained traces of impurities. White solid.  $R_f$  (hexane/AcOEt 1:1) 0.44.  $^1\text{H-NMR}$  (200 MHz,  $\text{CDCl}_3$ ): see Table 3; additionally, 0.17 ( $s$ ,  $\text{Me}_3\text{Si}$ ); 0.52 ( $q$ ,  $J = 8.2$ ), 0.53 ( $q$ ,  $J = 8.0$ ) ( $(\text{MeCH}_2)_3\text{Si}$ ); 0.85 ( $t$ ,  $J = 8.1$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.42, 1.64 (2s,  $\text{Me}_2\text{C}$ ); 3.79 ( $s$ , MeO); 4.56 ( $dd$ ,  $J = 15.0$ , 4.0), 4.77 ( $dd$ ,  $J = 15.0$ , 7.0) ( $\text{ArCH}_2$ ); 6.04 ( $dd$ ,  $J = 7.0$ , 4.0,  $\text{HN}-\text{C}(8)$ ); 6.87 ( $d$ ,  $J = 8.5$ , 2 arom. H); 7.30 ( $d$ ,  $J = 8.5$ , 2 arom. H); 7.43–7.60 ( $m$ , 3 arom. H); 7.93–8.02 ( $m$ , 2 arom. H); 8.81 (br. s,  $\text{HN}-\text{C}(6)$ ).

*8-Amino-N<sup>6</sup>-benzoyl-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)-7-C-(trimethylsilyl)- $\alpha$ -L-talo-hept-6-ynofuranosyl]adenine (10).* At 25°, a soln. of **9** (366.4 mg, *ca.* 0.48 mmol) in  $\text{CH}_2\text{Cl}_2/\text{H}_2\text{O}$  18:1 (12.8 ml) was treated with DDO (150.9 mg, 0.665 mmol), stirred for 5 h, diluted with  $\text{CHCl}_3$  (40 ml), washed with sat. aq.  $\text{NaHCO}_3$  soln. (15 ml) and brine (15 ml), dried ( $\text{Na}_2\text{SO}_4$ ), and evaporated. FC (26 g of silica gel;  $\text{CHCl}_3/\text{acetone}$  3:1) gave **10** (119.6 mg, 66% from **9**). Light pink solid.  $R_f$  ( $\text{CHCl}_3/\text{AcOEt}$  1:3) 0.60. M.p. 113°.  $[\alpha]_D^{25} = +8.6$  ( $c = 1.02$ ,  $\text{CHCl}_3$ ). UV ( $\text{CHCl}_3$ ): 303 (17000), 244 (15000). IR ( $\text{CHCl}_3$ ): 3464w, 3330w, 2997w, 2960m, 2914w, 2878w, 2176w, 1700m, 1638s, 1612m, 1584w, 1553w, 1500m, 1481m, 1438s, 1418w, 1387m, 1328w, 1304w, 1156w, 1125m, 1088s, 1018w, 969w, 942w, 847s.  $^1\text{H-NMR}$  (300 MHz,  $\text{CDCl}_3$ ): see Table 3; additionally, 0.15 ( $s$ ,  $\text{Me}_3\text{Si}$ ); 0.57–

Table 3. Selected  $^1\text{H-NMR}$  Chemical Shifts [ppm] and Coupling Constants [Hz] for the C(8)-Substituted Hept-6-ynofuranosyladenines **9–16** and **19–21** in  $\text{CDCl}_3$  Solution

	<b>9</b>	<b>10</b>	<b>11</b> [1]	<b>12</b> [1]	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>19</b> [1]	<b>20</b>	<b>21</b> [2]
H–C(2)	8.60	8.52	8.76	8.77	8.76	8.59	8.75	8.55	8.73	8.21	8.36
H–C(1')	6.13	6.36	6.15	6.24	6.25	6.06	6.76	6.32	6.13	6.07	6.18
H–C(2')	5.59	5.07	5.77	5.85	5.78	5.81	5.67	5.27	5.90	5.88	5.25
H–C(3')	4.95	4.85	5.29	5.24	5.27	4.96	5.34	5.09	5.26	5.24	5.12
H–C(4')	4.30	4.25	4.22	4.22	4.26	4.23	4.27	4.26	4.22	4.19	4.39
H–C(5')	4.49	4.66	4.41	4.43	4.55	4.41	4.67	4.71	4.41	4.39	4.63
H–C(7')	–	–	–	–	2.35	2.10	2.29	2.61	–	–	2.48
$J(1',2')$	3.7	4.5	2.0	2.0	2.0	3.0	2.0	3.8	2.0	1.8	3.0
$J(2',3')$	6.5	6.5	6.5	6.3	6.5	6.8	6.3	6.5	6.0	6.5	6.5
$J(3',4')$	3.0	3.8	3.0	2.8	3.3	3.0	3.5	3.5	2.8	3.0	2.5
$J(4',5')$	4.5	2.5	8.0	7.5	7.8	5.5	8.0	3.5	8.0	8.8	4.8
$J(5',7')$	–	–	–	–	2.2	2.2	2.2	2.2	–	–	2.2

0.79 (*m*,  $(\text{MeCH}_2)_3\text{Si}$ ); 0.98 (*t*,  $J = 8.1$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.35, 1.64 (2*s*,  $\text{Me}_2\text{C}$ ); 5.80 (br. *s*,  $\text{NH}_2$ ); 7.44 (br. *t*,  $J \approx 7.8$ , 2 arom. H); 7.54 (br. *t*,  $J \approx 7.8$ , 1 arom. H); 7.96 (br. *t*,  $J \approx 7.8$ , 2 arom. H); 8.95 (br. *s*, NH).  $^{13}\text{C-NMR}$  (75 MHz,  $\text{CDCl}_3$ ): 164.9 (*s*, C=O); 153.3 (*d*, C(2)); 153.0 (*s*, C(6)); 149.2 (*s*, C(4)); 144.2 (*s*, C(8)); 133.8 (*s*); 132.3 (*d*); 128.6 (2*d*); 127.9 (2*d*); 122.9 (*s*, C(5)); 115.4 (*s*,  $\text{Me}_2\text{C}$ ); 102.5 (*s*, C(6')); 91.7 (*s*, C(7')); 88.2 (*d*, C(1')); 86.2 (*d*, C(4')); 82.0 (*d*, C(2')); 80.0 (*d*, C(3')); 63.0 (*d*, C(5')); 27.4, 25.5 (2*q*,  $\text{Me}_2\text{C}$ ); 6.7 (*q*,  $(\text{MeCH}_2)_3\text{Si}$ ); 4.5 (*t*,  $(\text{MeCH}_2)_3\text{Si}$ ); –0.4 (*q*,  $\text{Me}_3\text{Si}$ ). FAB-MS: 637 ( $[M+1]^+$ ). Anal. calc. for  $\text{C}_{31}\text{H}_{44}\text{N}_6\text{O}_5\text{Si}_2$  (636.90): C 58.46, H 6.96, N 13.20; found: C 58.50, H 6.99, N 13.13.

**Iodination of 10.** At 25°, a suspension of **10** (12.3 mg, 19.7  $\mu\text{mol}$ ) in  $\text{CH}_2\text{I}_2$  (0.18 ml) was treated with  $\text{C}_5\text{H}_{11}\text{ONO}$  (8.0  $\mu\text{l}$ , 59.2  $\mu\text{mol}$ ), KI (38.7 mg, 0.233 mmol) and  $\text{I}_2$  (61.8 mg, 0.243 mmol), warmed to 55°, stirred for 2 h, diluted with  $\text{CHCl}_3$  (4.0 ml), washed with sat. aq.  $\text{Na}_2\text{S}_2\text{O}_3$  soln. (1.0 ml) and brine (0.7 ml), dried ( $\text{Na}_2\text{SO}_4$ ), and evaporated. FC (0.75 g of silica gel; hexane/AcOEt 5:4) gave **11** [1] (12.2 mg, 82%).

***N*<sup>6</sup>-Benzoyl-8-chloro-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)- $\beta$ -D-allo-hept-6-ynofuranosyl]-adenine (13).** At 25°, a soln. of **12** [1] (149.1 mg, 0.275 mmol) in dry THF (4.5 ml) was treated with 1.0M soln. of TBAF in THF (0.42 ml, 0.42 mmol), stirred for 7 h, and evaporated. FC (7 g of silica gel;  $\text{CHCl}_3/\text{AcOEt}$  3:2) gave the desilylated propargyl alcohol (119.0 mg, 92%). At 25°, a soln. of this alcohol (548.0 mg, 1.17 mmol) and imidazole (246.0 mg, 3.61 mmol) in dry DMF (16 ml) was treated dropwise with  $\text{Et}_3\text{SiCl}$  (0.59 ml, 3.51 mmol), stirred for 15 h, poured into ice-water (*ca.* 60 ml), and extracted with hexane/AcOEt 1:1 (3  $\times$  15 ml). The combined org. layers were washed with  $\text{H}_2\text{O}$ , dried ( $\text{Na}_2\text{SO}_4$ ), and evaporated. FC (25 g of silica gel; hexane/AcOEt 5:4) gave **13** (466.4 mg, 73%). White solid.  $R_f$  (hexane/AcOEt 5:4) 0.50. M.p. 73°.  $[\alpha]_D^{25} = -19.6$  ( $c = 1.02$ ,  $\text{CHCl}_3$ ). UV ( $\text{CHCl}_3$ ): 279 (19000), 240 (18500). IR ( $\text{CHCl}_3$ ): 3408*w* (br.), 3306*w*, 3007*w*, 2958*w*, 2914*w*, 2878*w*, 2100*w*, 1711*m*, 1611*s*, 1589*m*, 1508*w*, 1480*w*, 1450*s*, 1416*w*, 1384*w*, 1376*w*, 1357*w*, 1323*m*, 1248*m*, 1159*w*, 1093*s*, 1005*w*, 973*w*, 892*w*, 872*w*.  $^1\text{H-NMR}$  (300 MHz,  $\text{CDCl}_3$ ): see Table 3; additionally, 0.62 (*q*,  $J = 8.2$ ), 0.63 (*q*,  $J = 8.0$ ) ( $(\text{MeCH}_2)_3\text{Si}$ ); 0.95 (*t*,  $J = 8.1$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.41, 1.62 (2*s*,  $\text{Me}_2\text{C}$ ); 7.48–7.56 (*m*, 2 arom. H); 7.58–7.65 (*m*, 1 arom. H); 7.97–8.03 (*m*, 2 arom. H); 8.98 (br. *s*, NH).  $^{13}\text{C-NMR}$  (75 MHz,  $\text{CDCl}_3$ ): 164.4 (*s*, C=O); 152.5 (*d*, C(2)); 151.7 (*s*, C(6)); 148.5 (*s*, C(4)); 141.9 (*s*, C(8)); 133.4 (*s*); 133.0 (*d*); 128.9 (2*d*); 127.8 (2*d*); 121.7 (*s*, C(5)); 114.4 (*s*,  $\text{Me}_2\text{C}$ ); 90.9 (*d*, C(1')); 89.9 (*d*, C(4')); 82.6 (*d*, C(2')); 82.2 (*s*, C(6')); 82.0 (*d*, C(3')); 74.1 (*s*, C(7')); 62.5 (*d*, C(5')); 27.2, 25.4 (2*q*,  $\text{Me}_2\text{C}$ ); 6.6 (*q*,  $(\text{MeCH}_2)_3\text{Si}$ ); 4.7 (*t*,  $(\text{MeCH}_2)_3\text{Si}$ ). FAB-MS: 584 (100,  $[M+1]^+$ ), 585 (37), 586 (43), 587 (12). Anal. calc. for  $\text{C}_{28}\text{H}_{34}\text{ClN}_5\text{O}_5\text{Si}$  (584.15): C 57.57, H 5.87, N 11.99; found: C 57.48, H 5.86, N 11.90.

***N*<sup>6</sup>-Benzoyl-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)- $\beta$ -D-allo-hept-6-ynofuranosyl]-8-[(4-methoxyphenyl)methyl]amino]adenine (14).** At 25°, a soln. of **13** (597.5 mg, 1.02 mmol) in dry EtOH (18 ml) was treated with 4-methoxybenzylamine (0.40 ml, 3.06 mmol), stirred for 25 h, and evaporated. The residue was dissolved in  $\text{CHCl}_3$  (60 ml), washed with sat. aq.  $\text{NaHCO}_3$  soln. (20 ml) and brine (20 ml), dried ( $\text{Na}_2\text{SO}_4$ ), and evaporated. FC (25 g of silica gel; hexane/AcOEt 1:2) gave **14** (668 mg, 95%). White solid.  $R_f$  (hexane/AcOEt 1:2) 0.42. M.p. 84°.  $[\alpha] = -42.3$  ( $c = 1.04$ ,  $\text{CHCl}_3$ ). UV ( $\text{CHCl}_3$ ): 309 (19000), 245 (18000). IR ( $\text{CHCl}_3$ ): 3400*w* (br.), 3305*w*, 3000*m*, 2959*m*, 2913*w*, 2878*w*, 2838*w*, 2100*w*, 1701*m*, 1620*s*, 1577*s*, 1514*s*, 1478*m*, 1452*s*, 1424*m*, 1384*m*, 1329*m*, 1303*m*, 1252*s*, 1174*m*, 1090*s*, 1036*w*, 1004*w*, 868*w*, 818*w*.  $^1\text{H-NMR}$  (300 MHz,  $\text{CDCl}_3$ ): see Table 3; additionally, 0.57 (*q*,  $J = 8.2$ ), 0.58 (*q*,  $J = 8.0$ ) ( $(\text{MeCH}_2)_3\text{Si}$ ); 0.90 (*t*,  $J = 8.1$ ,  $(\text{MeCH}_2)_3\text{Si}$ ); 1.40, 1.60 (2*s*,  $\text{Me}_2\text{C}$ );

3.79 (s, MeO); 4.61 (*dd*,  $J = 15.0, 5.0$ ), 4.67 (*dd*,  $J = 15.0, 5.0$ ) (ArCH<sub>2</sub>); 5.76–5.81 (br. s, HN–C(8)); 6.88, 7.31 (2*d*,  $J = 8.8, 4$  arom. H); 7.46–7.56 (*m*, 2 arom. H); 7.56–7.62 (*m*, 1 arom. H); 7.98–8.04 (*m*, 2 arom. H); 8.91 (br. s, HN–C(6)). <sup>13</sup>C-NMR (75 MHz, CDCl<sub>3</sub>): 164.7 (s, C=O); 159.2 (s); 153.5 (s, C(6)); 152.3 (s, C(4)); 149.2 (*d*, C(2)); 144.7 (s, C(8)); 134.4 (s); 132.3 (*d*); 129.8 (s); 129.2 (2*d*); 128.7 (2*d*); 127.8 (2*d*); 122.0 (s, C(5)); 114.8 (s, Me<sub>2</sub>C); 114.1 (2*d*); 89.6 (*d*, C(1′)); 88.3 (*d*, C(4′)); 81.4 (*d*, C(2′)); 81.3 (s, C(6′)); 81.0 (*d*, C(3′)); 74.9 (s, C(7′)); 62.6 (*d*, C(5′)); 55.3 (*q*, MeO); 46.6 (*t*, ArCH<sub>2</sub>); 27.1, 25.4 (2*q*, Me<sub>2</sub>C); 6.6 (*q*, (MeCH<sub>2</sub>)<sub>3</sub>Si); 4.6 (*t*, (MeCH<sub>2</sub>)<sub>3</sub>Si). FAB-MS: 685 ([*M* + 1]<sup>+</sup>).

**Oxidation of 14 with DDQ. a)** At 25°, a soln. of **14** (348 mg, 0.51 mmol) in dry CH<sub>2</sub>Cl<sub>2</sub> (10.4 ml) was treated with DDQ (177.5 mg, 0.78 mmol), stirred for 4 h, diluted with CHCl<sub>3</sub> (20 ml), washed with sat. aq. NaHCO<sub>3</sub> soln. (15 ml) and brine (10 ml), dried (Na<sub>2</sub>SO<sub>4</sub>), and evaporated. FC (18 g of silica gel; hexane/AcOEt 1:2) gave **15** (301.4 mg, 87%).

**b)** Similarly, a mixture of **14** (314.9 mg, 0.460 mmol) and DDQ (152.4 mg, 0.671 mmol) in CH<sub>2</sub>Cl<sub>2</sub>/H<sub>2</sub>O 18:1 (12.0 ml) was stirred for 4 h. Analogous workup gave **15** (56.2 mg, 18%) and **16** (160.0 mg, 62%).

**Data of N<sup>6</sup>-Benzoyl-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)-β-D-allo-hept-6-ynofuranosyl]-8-[(4-methoxyphenyl)methylidene]amino]adenine (15):** Yellow solid. *R*<sub>f</sub> (hexane/AcOEt 3:4) 0.52. <sup>1</sup>H-NMR (300 MHz, CDCl<sub>3</sub>): see Table 3; additionally, 0.66 (*q*,  $J = 8.2$ ), 0.67 (*q*,  $J = 8.0$ ) ((MeCH<sub>2</sub>)<sub>3</sub>Si); 0.98 (*t*,  $J = 8.1$ , (MeCH<sub>2</sub>)<sub>3</sub>Si); 1.43, 1.66 (2*s*, Me<sub>2</sub>C); 3.92 (s, MeO); 7.03, 8.03 (2*d*,  $J = 9.0, 4$  arom. H); 7.51–7.59 (*m*, 2 arom. H); 7.59–7.66 (*m*, 1 arom. H); 7.98–8.04 (*m*, 2 arom. H); 8.93 (br. s, NH, exchange with D<sub>2</sub>O); 9.39 (s, CH=N).

**Data of 8-Amino-N<sup>6</sup>-benzoyl-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)-β-D-allo-hept-6-ynofuranosyl]adenine (16):** Light orange solid. *R*<sub>f</sub> (CHCl<sub>3</sub>/AcOEt 1:2) 0.50. <sup>1</sup>H-NMR (200 MHz, CDCl<sub>3</sub>): see Table 3; additionally, 0.73 (*q*,  $J = 8.2$ ), 0.74 (*q*,  $J = 8.0$ ) ((MeCH<sub>2</sub>)<sub>3</sub>Si); 0.99 (*t*,  $J = 8.1$ , (MeCH<sub>2</sub>)<sub>3</sub>Si); 1.42, 1.67 (2*s*, Me<sub>2</sub>C); 5.64 (br. s, NH<sub>2</sub>); 7.44–7.63 (*m*, 3 arom. H); 7.96–8.04 (*m*, 2 arom. H); 8.76 (br. s, NH).

**N<sup>6</sup>-Benzoyl-2′,3′-O-isopropylidene-5′-O-(triethylsilyl)adenosin-8-yl-(8 → 7′)-8-amino-N<sup>6</sup>-benzoyl-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)-β-D-allo-hept-6-ynofuranosyl]adenine (17).** At 25°, a soln. of **5** (287.6 mg, 0.44 mmol) and **15** (301.4 mg, 0.38 mmol) in dry Et<sub>3</sub>N (18 ml) was treated with CuI (8.2 mg, 43 μmol), P(fur)<sub>3</sub> (5.4 mg, 25.8 μmol) and [Pd<sub>2</sub>(dba)<sub>3</sub>] (12.0 mg, 13 μmol), stirred for 3 h, warmed to 80°, stirred for 2 h, and evaporated. The residue was dissolved in CHCl<sub>3</sub> (60 ml) and washed with 2% aq. Na<sub>2</sub>(EDTA) soln. (2 × 15 ml). Drying (Na<sub>2</sub>SO<sub>4</sub>), evaporation, and FC (25 g of silica gel; hexane/acetone 5:4) gave **17** (336.3 mg, 70%). Yellow solid. *R*<sub>f</sub> (hexane/acetone 5:4) 0.46. M.p. 144°. [*α*]<sub>D</sub><sup>25</sup> = +91.2 (*c* = 1.02, CHCl<sub>3</sub>). UV (CHCl<sub>3</sub>): 304 (47000), 248 (32000). IR (CHCl<sub>3</sub>): 3450*w* (br.), 3402*w* (br.), 3338*w* (br.), 3001*m*, 2959*m*, 2913*w*, 2878*w*, 1706*m*, 1637*s*, 1609*s*, 1584*s*, 1501*m*, 1478*s*, 1436*m*, 1385*m*, 1331*m*, 1254*s*, 1170*m*, 1158*m*, 1090*s*, 1003*w*, 972*w*, 866*w*. <sup>1</sup>H-NMR (300 MHz, CDCl<sub>3</sub>): see Table 4; additionally, 0.50 (*q*,  $J = 8.0$ , (MeCH<sub>2</sub>)<sub>3</sub>Si); 0.710 (*q*,  $J = 8.0$ ), 0.715 (*q*,  $J = 7.8$ ) ((MeCH<sub>2</sub>)<sub>3</sub>Si); 0.87, 0.99 (2*t*,  $J = 8.0, 2$  (MeCH<sub>2</sub>)<sub>3</sub>Si); 1.40, 1.42, 1.62, 1.64 (4*s*, 2 Me<sub>2</sub>C); 6.06–6.36 (br. s, NH<sub>2</sub>); 7.47, 7.52 (2*t*,  $J = 8.0, 4$  arom. H); 7.53–7.61 (*m*, 2 arom. H); 7.98 (*d*,  $J = 8.0, 4$  arom. H); 9.27 (br. s, 2 NH). <sup>13</sup>C-NMR (75 MHz, CDCl<sub>3</sub>): 165.0 (*s*, 2 C=O); 153.6, 152.2 (2*s*, C(6/I), C(6/II)); 153.3, 149.2 (2*d*, C(2/I), C(2/II)); 150.6, 149.8 (2*s*, C(4/I), C(4/II)); 144.6 (*s*, C(8/I)); 136.2 (*s*, C(8/II)); 133.8, 133.4 (2*s*); 132.8, 132.3 (2*d*); 128.7 (2*d*); 128.6 (2*d*); 128.0 (2*d*); 127.8 (2*d*); 123.0, 122.1 (2*s*, C(5/I), C(5/II)); 115.0, 114.2 (2*s*, 2 Me<sub>2</sub>C); 95.3 (*s*, C(6′/I)); 90.6, 89.2 (2*d*, C(1′/I), C(1′/II)); 88.5, 88.1 (2*d*, C(4′/I), C(4′/II)); 83.3, 82.1 (2*d*, C(2′/I), C(2′/II)); 82.0, 80.8 (2*d*, C(3′/I), C(3′/II)); 74.5 (*s*, C(7′/I)); 63.1 (*d*, C(5′/I)); 63.0 (*t*, C(5′/II)); 27.1, 27.0, 25.4, 25.3 (4*q*, 2 Me<sub>2</sub>C); 6.6, 6.5 (2*q*, 2 (MeCH<sub>2</sub>)<sub>3</sub>Si); 4.6, 4.2 (2*t*, 2 (MeCH<sub>2</sub>)<sub>3</sub>Si). FAB-MS: 1088 ([*M* + 1]<sup>+</sup>). Anal. calc. for C<sub>54</sub>H<sub>69</sub>N<sub>11</sub>O<sub>10</sub>Si<sub>2</sub> (1088.38): C 59.36, H 6.31, N 14.11; found: C 59.59, H 6.39, N 14.16.

**N<sup>6</sup>-Benzoyl-2′,3′-O-isopropylidene-5′-O-(triethylsilyl)adenosin-8-yl-(8 → 7′)-N<sup>6</sup>-benzoyl-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)-β-D-allo-hept-6-ynofuranosyl]-8-iodoadenine (18).** At 25°, a suspension of **17** (123.7 mg, 0.114 mmol) in CH<sub>2</sub>I<sub>2</sub> (1.9 ml) was treated with C<sub>5</sub>H<sub>11</sub>ONO (0.31 ml, 2.3 mmol), KI (64.2 mg, 0.39 mmol) and I<sub>2</sub> (102.2 mg, 0.4 mmol), warmed to 55°, stirred for 20 min, diluted with CHCl<sub>3</sub> (15 ml), washed with sat. aq. Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> soln. (3 ml) and brine (3 ml), dried (Na<sub>2</sub>SO<sub>4</sub>), and evaporated. FC (18 g of silica gel; hexane/AcOEt 3:5) gave **18** (75.1 mg, 55%). Yellow solid. *R*<sub>f</sub> (hexane/AcOEt 3:5) 0.48. M.p. 119°. [*α*]<sub>D</sub><sup>25</sup> = +17.6 (*c* = 0.57, CHCl<sub>3</sub>). UV (CHCl<sub>3</sub>): 293 (41000), 263 (22000). IR (KBr): 3450*w* (br.), 3410*w* (br.), 3220*w* (br.), 3062*w*, 2954*m*, 2912*w*, 2877*m*, 1706*m*, 1606*s*, 1583*s*, 1509*m*, 1459*m*, 1425*m*, 1382*w*, 1326*m*, 1245*s*, 1214*m*, 1158*m*, 1093*s*, 1004*w*, 974*w*, 870*w*, 798*w*. <sup>1</sup>H-NMR (300 MHz, CDCl<sub>3</sub>): see Table 4; additionally, 0.50 (*q*,  $J = 8.0$ , (MeCH<sub>2</sub>)<sub>3</sub>Si); 0.710 (*q*,  $J = 8.0$ ), 0.715 (*q*,  $J = 7.8$ ) ((MeCH<sub>2</sub>)<sub>3</sub>Si); 0.87, 1.01 (2*t*,  $J = 8.0, 2$  (MeCH<sub>2</sub>)<sub>3</sub>Si); 1.38, 1.43, 1.61, 1.66 (4*s*, 2 Me<sub>2</sub>C); 7.47–7.65 (*m*, 6 arom. H); 7.94–8.02 (*m*, 4 arom. H); 8.95, 9.01 (2 br. s, 2 NH). <sup>13</sup>C-NMR (75 MHz, CDCl<sub>3</sub>): 164.4, 164.3 (2*s*, 2 C=O); 153.4, 152.4 (2*d*, C(2/I), C(2/II)); 151.6, 150.2 (2*s*, C(6/I), C(6/II)); 149.5, 148.4 (2*s*, C(4/I), C(4/II)); 136.6 (*s*, C(8/II)); 133.7, 133.5 (2*s*); 133.0, 132.8 (2*d*); 128.9 (4*d*); 127.8 (4*d*); 125.6 (*s*, C(5/I)); 122.5 (*s*, C(5/II)); 114.5, 114.1 (2*s*, 2 Me<sub>2</sub>C); 104.8 (*s*, C(8/I)); 96.9 (*s*, C(6′/I)); 93.9, 90.7 (2*d*, C(1′/I), C(1′/II)); 89.8, 88.1 (2*d*, C(4′/I), C(4′/II)); 83.2, 83.1 (2*d*, C(2′/I), C(2′/II)); 82.4, 82.2 (2*d*, C(3′/I), C(3′/II));

Table 4. Selected <sup>1</sup>H-NMR Chemical Shifts [ppm] and Coupling Constants [Hz] for the Dimers **17**, **18**, **22**, and **23**, and the Tetramers **24**–**26** in CDCl<sub>3</sub> Solution

	<b>17</b>		<b>18</b>		<b>22</b>		<b>23<sup>a)</sup></b>	
	Unit II	Unit I	Unit II	Unit I	Unit II	Unit I	Unit II	Unit I
H–C(2)	8.79	8.56	8.79	8.73	8.34 <sup>b)</sup>	8.26 <sup>b)</sup>	8.34 <sup>b)</sup>	8.28 <sup>b)</sup>
H–C(8)	–	–	–	–	8.18	–	8.15	–
H–C(1')	6.33	6.26	6.26 <sup>b)</sup>	6.20 <sup>b)</sup>	6.21	6.45	6.23	6.33
H–C(2')	5.70	5.65	5.72	5.63	5.64	5.60	5.61	5.55
H–C(3')	5.15	5.19	5.13	5.40	5.24	5.26	5.245	5.22
H–C(4')	4.31	4.36	4.28	4.44	4.17	4.51	4.21	4.50
H <sub>a</sub> –C(5')	3.66	4.83	3.66	4.89	4.55	4.81	4.64	4.84
H <sub>a</sub> b–C(5' <sup>d)</sup> )	3.79	–	3.78	–	–	–	2.33	–
J(1',2')	1.8	2.0	2.0	2.0	1.8	< 1.0	2.0	2.0
J(2',3')	6.5	6.5	6.5	6.5	6.5	6.5	6.4	6.3
J(3',4')	3.5	3.5	3.5	3.5	3.0	2.5	3.0	2.5
J(4',5'a)	6.5	5.5	6.5	8.0	8.5	7.5	8.2	7.0
J(4',5'b)	7.0	–	6.5	–	–	–	–	–
J(5'a,5'b <sup>e)</sup> )	10.8	–	10.8	–	–	–	2.1	–

	<b>24</b>				<b>25<sup>f)</sup></b>				<b>26<sup>f)</sup></b>			
	Unit IV	Unit III	Unit II	Unit I	Unit IV	Unit III	Unit II	Unit I	Unit IV	Unit III	Unit II	Unit I
H–C(2)	8.76 <sup>b)</sup>	8.79 <sup>b)</sup>	7.99 <sup>c)</sup>	8.01 <sup>c)</sup>	8.65 <sup>b)</sup>	8.69 <sup>b)</sup>	8.09 <sup>c)</sup>	8.10 <sup>c)</sup>	8.16 <sup>b)</sup>	8.15 <sup>b)</sup>	8.15 <sup>b)</sup>	8.14 <sup>b)</sup>
H–C(8)	–	–	–	8.24	–	–	–	8.25	–	–	–	8.32
H–C(1')	6.22 <sup>b)</sup>	6.13 <sup>b)</sup>	6.17 <sup>b)</sup>	6.45	6.18 <sup>b)</sup>	6.15 <sup>b)</sup>	6.11 <sup>b)</sup>	6.04	6.23 <sup>b)</sup>	6.18 <sup>b)</sup>	6.15 <sup>b)</sup>	6.04
H–C(2')	5.64	5.55 <sup>b)</sup>	5.575 <sup>b)</sup>	5.59 <sup>b)</sup>	5.47 <sup>b)</sup>	5.36 <sup>b)</sup>	5.45 <sup>b)</sup>	5.29 <sup>b)</sup>	5.44 <sup>b)</sup>	5.42 <sup>b)</sup>	5.42 <sup>b)</sup>	5.38 <sup>b)</sup>
H–C(3')	5.14	5.37	5.13	5.41	4.92	5.17 <sup>b)</sup>	5.21 <sup>b)</sup>	5.11	4.95	5.21 <sup>b)</sup>	5.23 <sup>b)</sup>	5.18
H–C(4')	4.24	4.41	4.40	4.35	4.01	4.18 <sup>b)</sup>	4.20 <sup>b)</sup>	4.24	4.12	4.23 <sup>b)</sup>	4.26 <sup>b)</sup>	4.30
H <sub>a</sub> –C(5')	3.63	4.89	4.97	4.98	<sup>g)</sup>	4.87 <sup>b)</sup>	4.88 <sup>b)</sup>	4.78	3.46	4.91	4.91	4.85
H <sub>b</sub> –C(5')	3.75	–	–	–	<sup>g)</sup>	–	–	–	3.55	–	–	–
J(1',2')	2.0	1.5 <sup>b)</sup>	2.0 <sup>b)</sup>	1.5	2.5 <sup>b)</sup>	3.0 <sup>b)</sup>	3.0 <sup>b)</sup>	3.0	3.0	3.0	3.0	3.0
J(2',3')	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
J(3',4')	3.5	4.0	2.5	3.5	3.5	3.0	3.0	2.5	3.0	3.0 <sup>b)</sup>	2.5 <sup>b)</sup>	2.5
J(4',5'a)	6.5	8.0	8.8	7.5	5.5	7.5 <sup>b)</sup>	8.0 <sup>b)</sup>	6.5	5.0	6.5 <sup>b)</sup>	6.0 <sup>b)</sup>	6.5
J(4',5'b)	6.5	–	–	–	5.5	–	–	–	5.0	–	–	–
J(5'a,5'b)	10.8	–	–	–	<sup>h)</sup>	–	–	–	12.0	–	–	–

<sup>a)</sup> Assignment based on a DQF-COSY-GRASP spectrum. <sup>b)</sup> <sup>c)</sup> Assignment to the units may be interchanged. <sup>d)</sup> H–C(7') of **23**. <sup>e)</sup> J(5',7') of **23**. <sup>f)</sup> In (D<sub>6</sub>)DMSO. <sup>g)</sup> At 3.35–3.5 ppm, partially hidden by the HDO signal. <sup>h)</sup> Not determined.

II); 73.7 (s, C(7'/I)); 63.3 (d, C(5'/I)); 63.0 (t, C(5'/II)); 27.2, 25.4 (2q, 2 Me<sub>2</sub>C); 6.7, 6.6 (2q, 2 (MeCH<sub>2</sub>)<sub>3</sub>Si); 4.7, 4.2 (2t, 2 (MeCH<sub>2</sub>)<sub>3</sub>Si). FAB-MS: 1199 ([M + 1]<sup>+</sup>). Anal. calc. for C<sub>54</sub>H<sub>67</sub>IN<sub>10</sub>O<sub>10</sub>Si<sub>2</sub> (1199.26): C 54.08, H 5.63, N 11.68; found: C 54.09, H 5.70, N 11.62.

9-[6,7-Dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)-5-C-(trimethylsilyl)-β-D-allo-hept-6-ynofuranosyl]-8-iodoadenine (**20**). At 25°, a soln. of **19** [1] (156.5 mg, 0.21 mmol) in dry toluene (4.7 ml) was treated with 4-methoxybenzylamine (0.14 ml, 1.07 mmol), stirred at 80° for 3 h, and evaporated. FC (10 g of silica gel; CHCl<sub>3</sub>/AcOEt 4:5) gave **20** (114.5 mg, 81%). White solid. R<sub>f</sub> (CHCl<sub>3</sub>/AcOEt 1:1) 0.56. M.p. 79°. [α]<sub>D</sub><sup>25</sup> = –12.3 (c = 1.04, CHCl<sub>3</sub>). UV (CHCl<sub>3</sub>): 266 (15000). IR (CHCl<sub>3</sub>): 3400w (br.), 2959m, 2913w, 2877m, 2173w, 1631s, 1584m, 1520w, 1476m, 1442m, 1417m, 1384m, 1358m, 1321m, 1287m, 1248s, 1158m, 1091s, 1049m, 1004m, 929m, 846s. <sup>1</sup>H-NMR (300 MHz, CDCl<sub>3</sub>): see Table 3; additionally, 0.09 (s, Me<sub>3</sub>Si); 0.61 (q, J = 9.1), 0.62 (q, J = 9.1) ((MeCH<sub>2</sub>)<sub>3</sub>Si); 0.94 (t, J = 8.1, (MeCH<sub>2</sub>)<sub>3</sub>Si); 1.40, 1.61 (2s, Me<sub>2</sub>C); 5.95 (br. s, NH<sub>2</sub>). <sup>13</sup>C-NMR (75 MHz, CDCl<sub>3</sub>): 154.0 (s, C(6)); 152.4 (d, C(2)); 150.4 (s, C(4)); 122.7 (s, C(5)); 113.8 (s, Me<sub>2</sub>C); 104.1 (s, C(8)); 101.0 (s, C(6')); 93.9 (d, C(1')); 90.6 (s, C(7')); 90.0 (d, C(4')); 82.9 (d, C(2')); 82.5 (d, C(3')); 63.0 (d, C(5')); 27.1, 25.4 (2q,

$Me_2C$ ); 6.7 (*q*, ( $MeCH_2$ )<sub>3</sub>Si); 4.8 (*t*, ( $MeCH_2$ )<sub>3</sub>Si); –0.3 (*q*,  $Me_2Si$ ). FAB-MS: 644 ( $[M+1]^+$ ). Anal. calc. for  $C_{24}H_{38}N_3O_4Si_2$  (643.67): C 44.78, H 5.95, N 10.88; found: C 44.95, H 6.11, N 10.79.

9-[6,7-Dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)-7-C-(trimethylsilyl)- $\beta$ -D-allo-hept-6-ynofuranosyl]-adenin-8-yl-(8  $\rightarrow$  7)-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)- $\beta$ -D-allo-hept-6-ynofuranosyl]adenine (**22**). At 25°, a soln. of **20** (268.2 mg, 0.4 mmol) and **21** [2] (178.2 mg, 0.4 mmol) in dry  $Et_3N$  (13.4 ml) was treated with CuI (8.3 mg, 43.6  $\mu$ mol), P(fur)<sub>3</sub> (6.5 mg, 28  $\mu$ mol) and [Pd<sub>2</sub>(dba)<sub>3</sub>] (12.3 mg, 13.4  $\mu$ mol), stirred for 3 h, and evaporated. The residue was dissolved in  $CHCl_3$  (60 ml) and washed with 2% aq. Na<sub>2</sub>(EDTA) soln. (2  $\times$  15 ml). Drying (Na<sub>2</sub>SO<sub>4</sub>), evaporation, and FC (20 g of silica gel;  $CHCl_3$ /acetone 1:2) gave **22** (326.9 mg, 85%). Light yellow solid.  $R_f$  ( $CHCl_3$ /acetone 1:2) 0.56. M.p. 128°.  $[\alpha]_D^{25} = +19.8$  ( $c = 1.00$ ,  $CHCl_3$ ). UV ( $CHCl_3$ ): 296 (21000), 266 (21000). IR ( $CHCl_3$ ): 3412w, 3380w, 3208w, 2992w, 2958m, 2913w, 2878w, 2173w, 1701w, 1633s, 1588m, 1472w, 1414w, 1375m, 1328m, 1296m, 1248w, 1157w, 1095s, 1004m, 856w, 846m. <sup>1</sup>H-NMR (300 MHz,  $CDCl_3$ ): see Table 4; additionally, 0.07 (*s*,  $Me_2Si$ ); 0.60–0.77 (*m*, 2 ( $MeCH_2$ )<sub>3</sub>Si); 0.97, 0.99 (2*t*,  $J = 8.0$ , 2 ( $MeCH_2$ )<sub>3</sub>Si); 1.36, 1.44, 1.57, 1.65 (4*s*, 2  $Me_2C$ ); 6.43 (br. *s*,  $NH_2$ ); 6.9–7.3 (br. *s*,  $NH_2$ ). <sup>13</sup>C-NMR (75 MHz,  $CDCl_3$ ): 155.8 (*s*, C(6/I), C(6/II)); 153.8, 152.9 (2*d*, C(2/I), C(2/II)); 149.0, 148.6 (2*s*, C(4/I), C(4/II)); 140.7 (*d*, C(8/I)); 133.8 (*s*, C(8/II)); 120.1, 119.4 (2*s*, C(5/I), C(5/II)); 114.2, 113.7 (2*s*, 2  $Me_2C$ ); 104.8 (*s*, C(6/II)); 94.9 (*s*, C(6/I)); 91.5, 90.8 (2*d*, C(1'/I), C(1'/II)); 90.3 (*s*, C(7'/II)); 90.2, 89.9 (2*d*, C(4'/I), C(4'/II)); 84.0, 83.3 (2*d*, C(2'/I), C(2'/II)); 82.9, 82.6 (2*d*, C(3'/I), C(3'/II)); 74.5 (*s*, C(7'/I)); 63.5, 63.3 (2*d*, C(5'/I), C(5'/II)); 27.1, 27.0, 25.5, 25.4 (4*q*, 2  $Me_2C$ ); 6.8, 6.7 (2*q*, 2 ( $MeCH_2$ )<sub>3</sub>Si); 4.8, 4.7 (2*t*, 2 ( $MeCH_2$ )<sub>3</sub>Si); –0.3 (*q*,  $Me_2Si$ ). FAB-MS: 961 ( $[M+1]^+$ ).

9-[6,7-Dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)- $\beta$ -D-allo-hept-6-yno-furanosyl]adenin-8-yl-(8  $\rightarrow$  7)-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)- $\beta$ -D-allo-hept-6-ynofuranosyl]adenine (**23**). At 25°, a soln. of **22** (55.8 mg, 58  $\mu$ mol) in THF (0.84 ml) was treated with a soln. of AgNO<sub>3</sub> (25.4 mg, 0.15 mmol) in 75% aq. MeOH (0.84 ml), stirred for 4.5 h, diluted with  $CHCl_3$  (12 ml), washed with 5% aq. KCN soln. (5 ml) and brine (3 ml), dried (Na<sub>2</sub>SO<sub>4</sub>), and evaporated. At 25°, a soln. of the residue and imidazole (25.4 mg, 0.37 mmol) in dry DMF (1.7 ml) was treated dropwise with  $Et_3SiCl$  (49  $\mu$ l, 0.29 mmol), stirred for 48 h, and poured into ice-water (*ca.* 3.5 ml). After extraction with  $Et_2O$ /AcOEt 1:1 (3  $\times$  1.2 ml), the combined org. layers were washed with H<sub>2</sub>O, dried (Na<sub>2</sub>SO<sub>4</sub>), and evaporated. FC (3.0 g of silica gel;  $CHCl_3$ /acetone 2:3) gave **23** (37.0 mg, 72%). Light yellow solid.  $R_f$  ( $CHCl_3$ /acetone 2:3) 0.46. M.p. 126°.  $[\alpha]_D^{25} = +33.8$  ( $c = 1.02$ ,  $CHCl_3$ ). UV ( $CHCl_3$ ): 296 (20000), 266 (21000). IR ( $CHCl_3$ ): 3411w, 3307w, 3207w, 3008s, 2975m, 2914m, 2878m, 1633s, 1588m, 1520w, 1474m, 1421m, 1384m, 1375m, 1329m, 1296m, 1248s, 1157m, 1097s, 1048s, 1006m, 971w, 928m, 873m, 850m, 818m. <sup>1</sup>H-NMR (500 MHz,  $CDCl_3$ , assignment based on a DQFCOSY-GRASP spectrum): see Table 4; additionally, 0.61–0.78 (*m*, 2 ( $MeCH_2$ )<sub>3</sub>Si); 0.98 (*t*,  $J = 7.8$ , 2 ( $MeCH_2$ )<sub>3</sub>Si); 1.38, 1.44, 1.59, 1.65 (4*s*, 2  $Me_2C$ ); 6.23, 6.70 (2 br. *s*, 2  $NH_2$ ). <sup>13</sup>C-NMR (75 MHz,  $CDCl_3$ ): 155.9 (*s*, C(6/I), C(6/II)); 153.8, 152.9 (2*d*, C(2/I), C(2/II)); 148.9, 148.6 (2*s*, C(4/I), C(4/II)); 140.6 (*d*, C(8/I)); 133.7 (*s*, C(8/II)); 120.1, 119.5 (2*s*, C(5/I), C(5/II)); 114.2, 113.8 (2*s*, 2  $Me_2C$ ); 95.1 (*s*, C(6'/I)); 91.5, 90.9 (2*d*, C(1'/I), C(1'/II)); 90.2, 90.0 (2*d*, C(4'/I), C(4'/II)); 84.0, 83.4 (2*d*, C(2'/I), C(2'/II)); 83.0, 82.7 (2*d*, C(3'/I), C(3'/II)); 74.3 (*s*, C(7'/I)); 73.6, 73.5 (2*s*, C(6'/II), C(7'/II)); 63.5, 62.6 (2*d*, C(5'/I), C(5'/II)); 27.1, 27.0, 25.4, 25.3 (4*q*, 2  $Me_2C$ ); 6.7 (*q*, 2 ( $MeCH_2$ )<sub>3</sub>Si); 4.7 (*t*, 2 ( $MeCH_2$ )<sub>3</sub>Si). FAB-MS: 889 ( $[M+1]^+$ ). Anal. calc. for  $C_{42}H_{60}N_{10}O_8Si_2$  (889.17): C 56.56, H 6.79, N 15.66; found: C 56.73, H 6.80, N 15.75.

N<sup>6</sup>-Benzoyl-2',3'-O-isopropylidene-5'-O-(triethylsilyl)adenosin-8-yl-(8  $\rightarrow$  7)-N<sup>6</sup>-benzoyl-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)- $\beta$ -D-allo-hept-6-ynofuranosyl]adenin-8-yl-(8  $\rightarrow$  7)-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)- $\beta$ -D-allo-hept-6-ynofuranosyl]adenin-8-yl-(8  $\rightarrow$  7)-9-[6,7-dideoxy-2,3-O-isopropylidene-5-O-(triethylsilyl)- $\beta$ -D-allo-hept-6-ynofuranosyl]adenine (**24**). At 25°, a soln. of **18** (81.5 mg, 68  $\mu$ mol) and **23** (60.5 mg, 68  $\mu$ mol) in dry  $Et_3N$ /toluene 1:1 (4.2 ml) was treated with CuI (1.7 mg, 8.9  $\mu$ mol), P(fur)<sub>3</sub> (1.2 mg, 5.2  $\mu$ mol) and [Pd<sub>2</sub>(dba)<sub>3</sub>] (2.2 mg, 2.4  $\mu$ mol), stirred for 11 h, and evaporated. The residue was dissolved in  $CHCl_3$  (16 ml) and washed with 2% aq. Na<sub>2</sub>EDTA soln. (2  $\times$  4 ml). Drying (Na<sub>2</sub>SO<sub>4</sub>), evaporation, and FC (7.0 g of silica gel;  $CHCl_3$ /acetone 1:1) gave **24** (105.2 mg, 79%). Light yellow solid.  $R_f$  ( $CHCl_3$ /acetone 1:1) 0.50. M.p. 152°.  $[\alpha]_D^{25} = -6.9$  ( $c = 1.06$ ,  $CHCl_3$ ). UV ( $CHCl_3$ ): 316 (sh. 61000), 304 (71000), 296 (71000), 251 (55000). IR ( $CHCl_3$ ): 3411w (br.), 3370w, 2976s, 2894m, 1709w, 1633m, 1608m, 1585m, 1519s, 1475s, 1423s, 1386m, 1330m, 1080s, 1047s, 929s, 876s, 850s. <sup>1</sup>H-NMR (300 MHz,  $CDCl_3$ ): see Table 4; additionally, 0.48 (*q*,  $J = 8.0$ , ( $MeCH_2$ )<sub>3</sub>Si); 0.55–0.77 (*m*, 3 ( $MeCH_2$ )<sub>3</sub>Si); 0.85, 0.89, 0.95, 0.98 (4*t*,  $J = 8.0$ , 4 ( $MeCH_2$ )<sub>3</sub>Si); 1.37, 1.39 (2 *Me*); 1.40, 1.56, 1.58, 1.61, 1.68 (7*s*, 4  $Me_2C$ ); 6.27 (br. *s*,  $NH_2$ ); 6.65 (br. *s*,  $NH_2$ ); 7.36 (*t*,  $J = 7.8$ , 2 arom. H); 7.41–7.58 (*m*, 4 arom. H); 7.90, 7.94 (2*d*,  $J = 7.8$ , 4 arom. H); 9.24, 9.83 (2 br. *s*, 2  $NH$ ). <sup>13</sup>C-NMR (75 MHz,  $CDCl_3$ ): 164.9, 164.6 (2*s*, 2 C=O); 156.2, 155.7 (2*s*, C(6/I), C(6/II)); 153.7, 153.5, 153.3, 152.9 (4*d*, C(2/I–IV)); 150.2, 150.1 (2*s*, C(6/III), C(6/IV)); 149.7, 148.6 (2*s*, C(4/I–IV)); 140.7 (*d*, C(8/I)); 136.8, 136.6, 133.9 (3*s*, C(8/II–IV)); 133.6 (2*s*); 132.7 (2*d*); 128.8 (2*d*); 128.7 (2*d*); 128.0 (2*d*); 127.9 (2*d*); 122.6, 122.5 (2*s*, C(5/III–IV)); 120.3, 119.6 (2*s*,

C(5/I–II)); 114.3 (2 C), 114.1, 114.0 (3s, 4 Me<sub>2</sub>C); 97.7, 97.2, 95.3 (3s, C(6'/I–III)); 92.1, 90.7, 90.6, 90.1 (4d, C(1'/I–IV)); 89.9, 89.6, 89.3, 88.2 (4d, C(4'/I–IV)); 83.7, 83.5 (2 C), 83.3 (3d, C(2'/I–IV)); 82.9, 82.2 (2 C), 81.9 (3d, C(3'/I–IV)); 74.2, 73.5, 73.2 (3s, C(7'/I–III)); 63.3, 63.2, 63.1 (3d, C(5'/I–III)); 62.9 (t, C(5'/IV)); 27.2 (3 C), 26.9, 25.5, 25.4 (2 C), 25.3 (5q, 4 Me<sub>2</sub>C); 6.8 (q, 3 (MeCH<sub>2</sub>)<sub>3</sub>Si); 6.6 (q, (MeCH<sub>2</sub>)<sub>3</sub>Si); 4.80, 4.75, 4.70, 4.2, (4r, 4 (MeCH<sub>2</sub>)<sub>3</sub>Si). FAB-MS: 1961 ([M + 1]<sup>+</sup>). Anal. calc. for C<sub>96</sub>H<sub>126</sub>N<sub>20</sub>O<sub>18</sub>Si<sub>4</sub> (1960.52): C 58.81, H 6.48, N 14.29; found: C 58.20, H 6.79, N 13.80.

N<sup>6</sup>-Benzoyl-2',3'-O-isopropylideneadenosin-8-yl-(8 → 7)-N<sup>6</sup>-benzoyl-9-(6,7-dideoxy-2,3-O-isopropylidene-β-D-allo-hept-6-ynofuranosyl)adenin-8-yl-(8 → 7)-9-(6,7-dideoxy-2,3-O-isopropylidene-β-D-allo-hept-6-ynofuranosyl)adenine (**25**). At 25°, a soln. of **24** (90 mg, 45.9 μmol) in 50% aq. THF (1.8 ml) was treated with AcOH (1.8 ml), stirred for 21 h, evaporated, and co-evaporated several times with toluene. A soln. of the residue in toluene/MeOH 1 : 1 (1.0 ml) was treated with SiO<sub>2</sub> (242 mg), evaporated, and the residue was charged on a silica-gel column. FC (4.0 g of silica gel; CHCl<sub>3</sub>/MeOH 8 : 1) gave crude **25** (61.3 mg, 89%). Yellow solid. R<sub>f</sub> (CHCl<sub>3</sub>/MeOH 8 : 1) 0.48. <sup>1</sup>H-NMR (300 MHz, (D<sub>6</sub>)DMSO): see Table 4; additionally, 1.17, 1.24 (2 Me), 1.27, 1.37, 1.44, 1.45, 1.46 (7s, 4 Me<sub>2</sub>C); 3.35–3.50 (m, partially hidden by HDO signal, addn. of D<sub>2</sub>O → change, 2 H–C(5'/IV), 2 NH<sub>2</sub>); 4.78 (br. t, J ≈ 6.0, addn. of D<sub>2</sub>O → d, J = 6.5, H–C(5'/I)); 4.85 (br. t, J ≈ 6.5, addn. of D<sub>2</sub>O → 4.87, d, J = 7.5, → 4.88, d, J = 8.0, H–C(5'/II–III)); 4.88–4.96 (signal hidden by a H–C(3) signal, exchange with D<sub>2</sub>O, HO–C(5'/IV)); 6.59 (br. d, J ≈ 6.0, exchange with D<sub>2</sub>O), 6.66 (br. d, J ≈ 5.5, exchange with D<sub>2</sub>O), 6.78 (br. d, J ≈ 5.0, exchange with D<sub>2</sub>O) (HO–C(5'/I–III)); 7.32 (br. s, exchange with D<sub>2</sub>O, 2 NH); 7.44–7.53 (m, 4 arom. H); 7.56–7.63 (m, 2 arom. H); 7.91–7.99 (m, 4 arom. H).

2',3'-O-Isopropylideneadenosin-8-yl-[(8 → 7)-9-(6,7-dideoxy-2,3-O-isopropylidene-β-D-allo-hept-6-ynofuranosyl)adenin-8-yl]<sub>2</sub>-(8 → 7)-9-(6,7-dideoxy-2,3-O-isopropylidene-β-D-allo-hept-6-ynofuranosyl)adenine (**26**). At 25°, a soln. of **25** (72.7 mg, 48.4 μmol) in MeOH (0.73 ml) was treated with toluene (0.73 ml) and 25% aq. NH<sub>4</sub>OH (1.5 ml), stirred for 3.5 h, evaporated, and co-evaporated several times with toluene. A soln. of the residue in toluene/MeOH 1 : 1 (2.0 ml) was treated with SiO<sub>2</sub> (316 mg), evaporated, and the residue was charged on a silica-gel column. FC (6.0 g of silica gel; CHCl<sub>3</sub>/MeOH 5 : 1) gave crude **26** (15.4 mg, 25%). Light yellow solid. R<sub>f</sub> (CHCl<sub>3</sub>/MeOH 5 : 1) 0.53. <sup>1</sup>H-NMR (300 MHz, (D<sub>6</sub>)DMSO): see Table 4; additionally, 1.26, 1.29, 1.31, 1.33, 1.45, 1.49, 1.52, 1.54 (8s, 4 Me<sub>2</sub>C); 3.46 (dt, J ≈ 12.0, 5.5, addn. of D<sub>2</sub>O → dd, J = 12.0, 5.0, H<sub>a</sub>–C(5'/IV)); 3.55 (dt, J = 12.0, 5.5, addn. of D<sub>2</sub>O → dd, J = 12.0, 5.0, H<sub>b</sub>–C(5'/IV)); 4.85 (br. t, J ≈ 6.0, addn. of D<sub>2</sub>O → 4.83, d, J = 6.5, H–C(5'/I)); 4.91 (br. t, J ≈ 6.5, addn. of D<sub>2</sub>O → 4.87, d, J = 6.0, → 4.895, d, J = 6.5, H–C(5'/II–III)); 5.24 (br. t, J ≈ 6.0, exchange with D<sub>2</sub>O, HO–C(5'/IV)); 6.71 (br. d, J ≈ 5.5, exchange with D<sub>2</sub>O), 6.74 (br. d, J ≈ 6.0, exchange with D<sub>2</sub>O), 6.76 (br. d, J ≈ 5.0, exchange with D<sub>2</sub>O) (HO–C(5'/I–III)); 7.37 (br. s, exchange with D<sub>2</sub>O, NH<sub>2</sub>); 7.50–7.80 (br. s, 3 NH<sub>2</sub>).

Adenosin-8-yl-[(8 → 7)-9-(6,7-dideoxy-β-D-allo-hept-6-ynofuranosyl)adenin-8-yl]<sub>2</sub>-(8 → 7)-9-(6,7-dideoxy-β-D-allo-hept-6-ynofuranosyl)adenine (**27**). At 25°, a soln. of crude **26** (30.6 mg) in 80% aq. HCO<sub>2</sub>H (1.0 ml) was stirred for 22 h, evaporated, and co-evaporated several times with toluene. Recrystallisation from DMSO/MeOH gave **27** (13.9 mg, 72%). White plates. M.p. 187° (dec.). R<sub>f</sub> (BuOH/EtOH/H<sub>2</sub>O 1 : 1 : 1) 0.06. [α]<sub>D</sub><sup>25</sup> = –94.2 (c = 0.45, DMSO). UV (DMSO): 311 (sh, 29500), 301 (48000), 278 (28000). IR (KBr): 3600–2500s (br.), 1716w, 1651s, 1602s, 1575m, 1485w, 1423w, 1374m, 1331s, 1303m, 1255m, 1126m, 1075m, 1040m, 970w, 909w. <sup>1</sup>H-NMR (300 MHz, (D<sub>6</sub>)DMSO/D<sub>2</sub>O): 3.6–3.8 (m, partially hidden by HDO signal, 2 H–C(5'/IV)); 3.94–4.01 (m, H–C(4'/IV)); 4.10–4.20 (m, 4 H); 4.30–4.42 (m, 4 H); 4.72 (dd, J = 7.5, 5.0, H–C(2'/I)); 4.89 (d, J = 4.7), 4.97 (d, J = 5.0) (2 H–C(5')); 4.96–5.05 (m, 3 H); 5.91 (d, J = 7.5), 5.95 (d, J = 7.5), 5.97 (d, J = 7.5), 6.00 (d, J = 7.5) (H–C(1'/I–IV)); 8.12, 8.14 (2 H), 8.15 (3s, H–C(2'/I–IV)); 8.33 (s, H–C(8/I)). <sup>13</sup>C-NMR (75 MHz, (D<sub>6</sub>)DMSO): 156.5 (s, C(6'/I–IV)); 153.5, 152.6 (2d, C(2'/I–IV)); 149.2, 148.1 (2s, C(4'/I–IV)); 140.2 (d, C(8/I)); 133.3 (s, C(8'/II–IV)); 119.5 (s, C(5'/I–IV)); 95.1, 95.0, 94.9 (3s, C(6'/I–III)); 89.6 (br.), 88.5 (2d, C(1'/I–IV)); 87.8, 86.8 (2d, C(4'/I–IV)); 73.5, 73.1 (2 br. d, C(2'/I–IV)); 71.6, 70.6 (2d, C(3'/I–IV)); 71.2, 71.0 (2s, C(7'/I–III)); 62.6, 62.5 (2d, C(5'/I–III)); 62.2 (t, C(5'/IV)).

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