Supplementary Material for Organic & Biomolecular Chemistry

Synthesis of Substituted 6-Cyclopropylpurine Bases and Nucleosides by Cross-coupling Reactions or Cyclopropanations

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Experimental

Melting points were determined on a Kofler block and are uncorrected. Mass spectra were measured on a ZAB-EQ (VG Analytical) spectrometer. IR spectra were measured on a Bruker equinox 55 and FTIR spectrometer Nicolet 6700. NMR spectra were recorded on Bruker Avance 600 (^{1}H at 600 MHz, ^{13}C at 151 MHz), Bruker Avance 500 (^{1}H at 500 MHz, ^{13}C at 125.8 MHz) and Bruker Avance 400 (^{1}H at 400 MHz, ^{13}C at 100.6 MHz). ^{1}H and ^{13}C NMR spectra were referenced to the signal of TMS or to the solvent residual signal [DMSO-d_6: 2.50 ppm (^{1}H), 39.70 ppm (^{13}C); CD_3OD: 3.31 ppm (^{1}H); 49.00 ppm (^{13}C)]. H,C-HSQC and H,C-HMBC experiments were performed for complete assignement of all signals. Optical rotations were measured at 25 ◦C on a Autopol IV (Rudolph Research Analytical) polarimeter, $[\alpha]_D$ values are given in 10^{-1} deg cm^2 g^{-1}. Starting compounds were prepared according to literature procedures: **1a**,[1] **1b**,[2] **1c**,[3] **1d**,[4] **3a**,[5] **3b**,[6] **3e**.[7]

General method for the Negishi cross-coupling

THF (3 ml) was added to flame-vacuum dried zinc chloride (272 mg, 2 mmol) under argon atmosphere. The mixture was stirred at -10°C and a cyclopropylmagnesium bromide (4 ml, 0.5 M in THF) was added dropwise. The mixture was stirred for 40 min and then a solution of a 6-chlorpurine **1** (1 mmol) and $Pd(PPh_3)_4$ (70 mg, 0.06 mmol) in THF (3 ml) was added. The resulting mixture was stirred for 2 hours at 40°C. After completion, the reaction mixture was diluted with water (50 ml) and washed with ethyl acetate (3 x 50 ml). The collected organic layers were washed with brine, dried over anhydrous $MgSO_4$, filtered, and concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, ethyl acetate/hexane 0-30%) and crystallized from chloroform/heptane to giving a product.

9-Benzyl-6-cyclopropylpurine (2a)

white solid, yield 88%. ^{1}H NMR (600 MHz, $CDCl_3$): 1.24 and 1.43 (2 × m, 2 × 2H, H-2,3-cycloprop); 2.78 (tt, 1H, J_{vic} = 8.2, 4.7, H-1-cycloprop); 5.43 (s, 2H, CH_2Ph); 7.28-7.38 (m, 5H, Ph); 7.98 (s, 1H, H-8); 8.80 (s, 1H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): 11.54 (CH_2-2,3-cycloprop); 12.97 (CH-1-cycloprop); 47.13 (CH_2Ph); 127.73 (CH-*o*-Ph); 128.49 (CH-*p*-Ph); 129.09 (CH-*m*-Ph); 132.25 (C-5); 135.29 (C-*i*-Ph); 143.15 (CH-8); 150.01 (C-4); 152.75 (CH-2); 164.34 (C-6). FAB-MS, *m/z* (rel. %) 279 (6) $[M+Na]^+$, 251 (100) $[M+H]^+$, 161 (10), 91 (75). HRMS calcd. for $C_{15}H_{15}N_4$ $[M+H]^+$ 251.1296; found: 251.1287. IR ($CHCl_3$): 3112, 3093, 3069, 3035, 1595, 1580, 1500, 1457, 1412, 1331, 1078, 1030, 806, 700, 651, 619, 542, 456.

6-Cyclopropyl-9-(tetrahydropyran-2-yl)purine (2b)

yellow crystals, mp 63-65°C, yield 83%. ^{1}H NMR (500 MHz, $CDCl_3$): 1.23 and 1.42 (2 × m, 2 ×

2H, H-2,3-cycloprop); 1.63-1.86 and 2.17-2.03 (2 × m, 6H, CH_2-THP); 2.78 (tt, 1H, J_{vic} = 8.2, 4.7, H-1-cycloprop); 3.79 (td, 1H, J = 11.6, 2.5, $CH_a\mathbf{H_b}$O-THP); 4.19 (ddt, 1H, J = 11.6, 4.4, 1.8, $C\mathbf{H_a}H_b$O-THP); 5.78 (dd, 1H, J = 10.2, 2.8, CHO-THP); 8.22 (s, 1H, H-8); 8.76 (s, 1H, H-2). ^{13}C NMR (125.7 MHz, $CDCl_3$): 11.48 (CH_2-2,3-cycloprop); 12.97 (CH-1-cycloprop); 22.79, 24.86 and 31.80 (CH_2-THP); 68.81 (CH_2O-THP); 81.84 (CHO-THP); 132.42 (C-5); 141.05 (CH-8); 149.18 (C-4); 152.56 (CH-2); 164.36 (C-6). FAB-MS, *m/z* (rel. %) 245 (22) $[M+H]^+$, 161 (100), 85 (20), 55 (6). HRMS calcd. for $C_{13}H_{17}N_4O$ $[M+H]^+$ 245.1402; found: 245.1393. IR ($CHCl_3$): 3128, 3065, 1598, 1580, 1499, 1460, 1443, 1415, 1378, 1332, 1193, 1086, 1058, 1045, 914, 877, 844, 822, 806, 647, 546.

6-Cyclopropyl-9-(2,3,5-tri-*O*-toluoyl-β-D-ribofuranosyl)purine (2c)

white foam, yield 99%. ^{1}H NMR (500 MHz, $CDCl_3$): 1.22 and 1.41 (2 × m, 2 × 2H, H-2,3-cycloprop); 2.37 and 2.41 (2 × s, 9H, CH_3-Tol); 2.74 (tt, 1H, J_{vic} = 8.2, 4.7, H-1-cycloprop); 4.67 (dd, 1H, J_{gem} = 12.2, $J_{5'b,4'}$ = 4.2, H-5′b); 4.81 (ddd, 1H, $J_{4',3'}$ = 4.6, $J_{4',5'}$ = 4.2, 3.2, H-4′); 4.88 (dd, 1H, J_{gem} = 12.2, $J_{5'a,4'}$ = 3.2, H-5′a); 6.22 (dd, 1H, $J_{3',2'}$ = 5.8, $J_{3',4'}$ = 4.6, H-3′); 6.40 (dd, 1H, $J_{2',3'}$ = 5.8, $J_{2',1'}$ = 5.4, H-2′); 6.47 (d, 1H, $J_{1',2'}$ = 5.4, H-1′); 7.16, 7.21 and 7.25 (3 × m, 3 × 2H, H-*m*-Tol); 7.82, 7.90 and 7.99 (3 × m, 3 × 2H, H-*o*-Tol); 8.15 (s, 1H, H-8); 8.68 (s, 1H, H-2). ^{13}C NMR (125.7 MHz, $CDCl_3$): 11.62 and 11.66 (CH_2-2,3-cycloprop); 13.00 (CH-1-cycloprop); 21.69 and 21.71 (CH_3-Tol); 63.48 (CH_2-5′); 71.41 (CH-3′); 73.64 (CH-2′); 80.90 (CH-4′); 86.69 (CH-1′); 125.67, 126.02 and 126.57 (C-*i*-Tol); 129.19, 129.23 and 129.30 (CH-*m*-Tol); 129.75, 129.85 and 129.86 (CH-*o*-Tol); 132.96 (C-5); 141.91 (CH-8); 144.15, 144.52 and 144.62 (C-*p*-Tol); 149.66 (C-4); 152.82 (CH-2); 164.77 (C-6); 165.15, 165.37 and 166.21 (CO). FAB-MS, *m/z* (rel. %) 647 (50) $[M+H]^+$, 529 (10), 487 (22), 369 (10), 295 (10), 279 (20), 197 (10), 181 (26), 161 (18), 149 (10), 119 (100), 93 (30), 73 (20). HRMS calcd. for $C_{37}H_{35}N_4O_7$ $[M+H]^+$ 647.2505; found: 647.2494. IR ($CHCl_3$): 3117, 3095, 3033, 1727, 1612, 1596, 1580, 1509, 1500, 1412, 1371, 1332, 1311, 1298, 1245, 1193, 1180, 1126, 1114, 1020, 839, 806, 691, 645, 476.

6-Cyclopropyl-9-(2-deoxy-3,5-di-*O*-toluoyl-β-D-*erythro*-pentafuranosyl)purine (2d)

white foam, yield 99%. ^{1}H NMR (500 MHz, $CDCl_3$): 1.23 and 1.41 (2 × m, 2 × 2H, H-2,3-cycloprop); 2.41 and 2.44 (2 × s, 2 × 3H, CH_3-Tol); 2.75 (tt, 1H, J_{vic} = 8.2, 4.7, H-1-cycloprop); 2.84 (ddd, 1H, J_{gem} = 14.2, $J_{2'b,1'}$ = 5.8, $J_{2'b,3'}$ = 2.2, H-2′b); 3.19 (ddd, 1H, J_{gem} = 14.2, $J_{2'a,1'}$ = 8.4, $J_{2'a,3'}$ = 6.4, H-2′a); 4.63-4.70 (m, 2H, H-4′ and H-5′b); 4.76 (m, 1H, J_{gem} = 11.4, $J_{5'a,4'}$ = 3.5, H-5′a); 5.83 (ddd, 1H, $J_{3',2'}$ = 6.4, 2.2, $J_{3',4'}$ = 2.0, H-3′); 6.59 (dd, 1H, $J_{1',2'}$ = 8.4, 5.8, H-1′); 7.22 and 7.28 (2 × m, 2 × 2H, H-*m*-Tol); 7.90 and 7.97 (2 × m, 2 × 2H, H-*o*-Tol); 8.17 (s, 1H, H-8); 8.71 (s, 1H, H-2). ^{13}C NMR (125.7 MHz, $CDCl_3$): 11.57 and 11.58 (CH_2-2,3-cycloprop); 12.96 (CH-1-cycloprop); 21.66 and 21.71 (CH_3-Tol); 37.72 (CH_2-2′); 63.98 (CH_2-5′); 75.12 (CH-3′); 82.99 (CH-4′); 84.74 (CH-1′); 126.36 and 126.62 (C-*i*-Tol); 129.25 and 129.26 (CH-*m*-Tol);

129.61 and 129.78 (CH-*o*-Tol); 132.98 (C-5); 141.46 (CH-8); 144.11 and 144.50 (C-*p*-Tol); 149.45 (C-4); 152.57 (CH-2); 164.61 (C-6); 165.93 and 166.14 (CO). FAB-MS, *m/z* (rel. %) 535 (5) $[M+Na]^+$, 513 (15) $[M+H]^+$, 161 (80), 119 (100), 91 (15), 81 (65). HRMS calcd. for $C_{29}H_{31}N_4O_6$ $[M+H]^+$ 513.2137; found: 513.2160. IR ($CHCl_3$): 3126, 3096, 3063, 1721, 1612, 1596, 1582, 1509, 1498, 1411, 1332, 1311, 1250, 1191, 1179, 1121,1103, 1021, 841, 806, 691, 646, 476.

9-(2-Deoxy-3,5-di-*O-tert*-butyldimethylsil-β-D-*erythro*-pentafuranosyl)-6-vinylpurine (3f)

Tributyl(vinyl)tin (2 ml) was added to an argon purged mixture of 6-chlorpurine nucleoside (2.5 g, 5 mmol), $[PdCl_2(PPh_3)_2]$ (200 mg, 0.26 mmol) in DMF (20 ml) and the mixture was stirre ad 90°C for 6 h. The resulting mixture was diluted with water (350 ml), and then washed with ethyl acetate (3 x 50 ml). The collected organic layers were washed with brine, dried over anhydrous $MgSO_4$, filtered, and concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, ethyl acetate/hexane 0-20%) affording product **3f** as yellowish oil (750 mg, 31%). ^{1}H NMR (600 MHz, $CDCl_3$): 0.03, 0.04 and 0.06 (3 × s, 12H, CH_3Si); 0.85 and 0.87 (2 × s, 2 × 9H, $(CH_3)_3C$); 2.42 (ddd, 1H, J_{gem} = 13.1, $J_{2'b,1'}$ = 6.2, $J_{2'b,3'}$ = 3.8, H-2′b); 2.63 (ddd, 1H, J_{gem} = 13.1, $J_{2'a,1'}$ = 6.9, $J_{2'a,3'}$ = 5.8, H-2′a); 3.73 (dd, 1H, J_{gem}= 11.2, $J_{5'b,4'}$ = 3.1, H-5′b); 3.83 (dd, 1H, J_{gem}= 11.2, $J_{5'a,4'}$ = 4.1, H-5′a); 3.99 (dt, 1H, $J_{4',5'}$ = 4.1, 3.1, $J_{4',3'}$ = 3.1, H-4′); 4.62 (dddd, 2H, $J_{3',2'}$ = 5.8, 3.8, $J_{3',4'}$ = 3.1, $J_{3',1'}$ = 0.5, H-3′); 5.90 (dd, 1H, J_{cis} = 11.0, J_{gem} = 1.6, $CH_a\mathbf{H_b}$=); 6.48 (dd, 1H, $J_{1',2'}$ = 6.9, 6.2, H-1′); 6.97 (dd, 1H, J_{trans} = 17.5, J_{gem} = 1.6, $C\mathbf{H_a}H_b$=); 7.27 (dd, 1H, J_{trans} = 17.5, J_{cis} = 11.0, CH=); 8.34 (s, 1H, H-8); 8.85 (s, 1H, H-2). ^{13}C NMR (125.7 MHz, $CDCl_3$): -5.50, -5.40, -4.81 and -4.68 (CH_3Si); 17.99 and 18.41 $(CH_3)_3\mathbf{C}$); 25.74 and 25.94 ($(\mathbf{C}H_3)_3C$); 41.21 (CH_2-2′); 62.76 (CH_2-5′); 71.94 (CH-3′); 84.39 (CH-1′); 88.00 (CH-4′); 126.15 (CH_2=); 131.62 (C-5); 131.90 (CH=); 142.99 (CH-8); 151.53 (C-4); 152.28 (CH-2); 153.53 (C-6). ESI-MS, m/z (rel. %) 513 (100) $[M+Na]^+$, 491 (95) $[M+H]^+$. HRMS calcd. for $C_{24}H_{42}N_4O_3Si_2Na$ $[M+Na]^+$ 513.26931; found 513.26845. IR (micr. Refl.): 3111, 3057, 3025, 2954, 2929, 2897, 2857, 1762, 1713, 1636, 1584, 1495, 1472, 1464, 1407, 1389, 1362, 1329, 1257, 1214, 1128, 1108, 1071, 1030, 1005, 966, 943, 880, 834, 777, 676.

General method for cyclopropanation of 6-vinylpurines

A mixture of a vinylpurine **3** (0.5 mmol) and copper powder (10 mg, 0.15 mmol) in dry toluene (5 ml) was heated to 95°C under stirring. Then ethyldiazoacetate (0.3 ml, 2.5 mmol) was added at once. The mixture was further stirred at 95°C for 6 h. The solids were removed by filtration, the filtrate was evaporated and purified by column chromatography (silica gel, ethyl acetate/hexane 0-30%).

9-Benzyl-6-[2-(ethoxycarbonyl)cyclopropyl]purine (4a)

Light yellow crystals, yield 75% mp 83-89°C. ^{1}H NMR (400 MHz, $CDCl_3$): 1.27 (t, 3H, J_{vic} = 7.2, C**H**$_3$CH$_2$O); 1.82 (ddd, 1H, J_{vic} = 8.9, 5.8, J_{gem} = 3.7, 3b-cycloprop); 1.90 (ddd, 1H, J_{vic} = 8.6, 5.9, J_{gem} = 3.7, 3a-cycloprop); 2.60 (ddd, 1H, J_{vic} = 8.6, 5.8, 3.9, 2-cycloprop); 3.34 (dddd, 1H, J_{vic} = 8.9, 5.9, 3.9, $J_{CH,2}$ = 0.3, 1-cycloprop); 4.17 (m, 2H, CH$_3$C**H$_2$**O); 5.44 (s, 2H, CH$_2$Ph); 7.29 (m, 2H, H-*o*-Ph); 7.31-7.38 (m, 3H, H-*m,p*-Ph); 8.01 (s, 1H, H-8); 8.81 (s, 1H, H-2). ^{13}C NMR (100.6 MHz, $CDCl_3$): 14.19 (**C**H$_3$CH$_2$O); 17.95 (CH$_2$-3-cycloprop); 22.62 (CH$_2$-1-cycloprop); 25.31 (CH$_2$-2-cycloprop); 47.22 (CH$_2$Ph); 60.85 (CH$_3$**C**H$_2$O); 127.74 (CH-*o*-Ph); 128.57 (CH-*p*-Ph); 129.12 (CH-*m*-Ph); 132.28 (C-5); 135.12 (C-*i*-Ph); 143.77 (CH-8); 150.54 (C-4); 152.60 (CH-2); 160.09 (C-6); 172.37 (CO). FAB-MS, *m/z* (rel. %) 323 (62) $[M+H]^+$, 249 (8), 159 (10), 91 (100), 63 (6). HRMS calcd. for $C_{18}H_{19}N_4O_2$ $[M+H]^+$ 323.1508; found: 323.1520. IR ($CHCl_3$): 3112, 3092, 3069, 3032, 1723, 1596, 1583, 1502, 1477, 1456, 1410, 1403, 1386, 1367, 1327, 1185, 1105, 1090, 1079, 1030, 699, 651, 642, 619, 542, 455.

9-Benzyl-6-[3-diazenyl-3-(ethoxycarbonyl)prop-2-enyl]purine (5a)

yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$): 1.29 (t, 3H, J_{vic} = 7.1, C**H$_3$**CH$_2$O); 3.58 (dd, 1H, J_{gem} = 17.5, J_{vic} = 12.3, CH$_a$**H$_b$**-pur); 3.84 (dd, 1H, J_{gem} = 17.5, J_{vic} = 5.0, C**H$_a$**H$_b$-pur); 4.21 (q, 2H, J_{vic} = 7.1, CH$_3$C**H$_2$**O); 4.54 (dd, 1H, J_{vic} = 12.3, 5.0, CH=); 5.47 (s, 2H, CH$_2$Ph); 6.99 (bs, 1H, NH); 7.26-7.40 (m, 5H, Ph); 8.11 (s, 1H, H-8); 8.97 (s, 1H, H-2). ^{13}C NMR (100.6 MHz, $CDCl_3$): 14.09 (**C**H$_3$CH$_2$O); 35.63 (CH$_2$-pur); 47.25 (CH$_2$Ph); 60.61 (CH=); 61.89 (CH$_3$**C**H$_2$O); 127.69 (CH-*o*-Ph); 128.57 (CH-*p*-Ph); 129.12 (CH-*m*-Ph); 130.05 (C-5); 135.08 (C-*i*-Ph); 145.06 (CH-8); 148.87 and 148.94 (C-6 and C-N=NH); 152.06 (C-4); 152.44 (CH-2); 172.04 (CO). ESI-MS, m/z (rel. %) 373 (95) $[M+Na]^+$, 351 (30) $[M+H]^+$, 316 (37), 288 (100). HRMS calcd. for $C_{18}H_{18}N_6O_2Na$ $[M+Na]^+$ 373.13889; found 373.13812. IR (micr. refl.): 3282, 2980, 2930, 1727, 1599, 1541, 1499, 1455, 1409, 1383, 1366, 1328, 1264, 1212, 1186, 1158, 1097, 1057, 995, 927, 883, 844, 806, 775, 760, 730, 697.

6-[2-(Ethoxycarbonyl)cyclopropyl]-9-(tetrahydropyran-2-yl)purine (4b)

yellow oil, yield 41%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, $CDCl_3$): 1.27 and 1.28 (2 × t, 2 × 3H, J_{vic} = 7.1, C**H$_3$**CH$_2$O); 1.63-1.80 (m, 6H, CH$_2$-THP); 1.81 and 1.82 (2 × ddd, 2 × 1H, J_{vic} = 9.0, 5.8, J_{gem} = 3.7, H-3b-cycloprop); 1.89 and 1.90 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.9, J_{gem} = 3.7, H-3a-cycloprop); 2.02-2.20 (m, 6H, CH$_2$-THP); 2.58 and 2.60 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.8, 3.9, H-2-cycloprop); 3.33 (m, 2H, H-1-cycloprop); 3.79 and 3.80 (2 × td, 2 × 1H, J = 11.8, 2.5, CH$_a$**H$_b$**O-THP); 4.11-4.22 (m, 6H, CH$_3$C**H$_2$**O and C**H$_a$**H$_b$O-THP); 5.785 and 5.788 (2 × dd, 2 × 1H, J = 10.4, 2.3, CHO-THP); 8.261 and 8.264 (2 × s, 2 × 1H, H-8); 8.78 (s, 2H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): 14.12 (**C**H$_3$CH$_2$O); 17.86 and 17.87 (CH$_2$-3-cycloprop); 22.55 and 22.58 (CH-1-cycloprop); 22.67 and 24.75 (CH$_2$-THP); 25.15 and 25.21 (CH-2-cycloprop); 31.71 (CH$_2$-THP); 60.78 and 60.79 (CH$_3$**C**H$_2$O); 68.75 (CH$_2$O-THP); 81.83 and 81.87 (CHO-THP);

132.35 and 132.37 (C-5); 141.68 and 141.70 (CH-8); 149.62 and 149.63 (C-4); 152.33 and 152.34 (CH-2); 160.01 (C-6); 172.30 and 172.31 (CO). FAB-MS, *m/z* (rel. %) = 317 (32) $[M+H]^+$ (cation), 233 (100), 187 (15), 159 (15), 85 (27). HRMS calcd. for $C_{16}H_{21}N_4O_3$ $[M+H]^+$ 317.1613; found: 317.1616. IR ($CHCl_3$): 3127, 3065, 1723, 1598, 1582, 1499, 1477, 1465, 1456, 1443, 1386, 1381, 1367, 1326, 1105, 1087, 1057, 1046, 911, 875, 844, 823, 646, 547.

6-[2-(Ethoxycarbonyl)cyclopropyl]-9-(2,3,5-tri-*O-tert*-butyldimethylsilyl-β-D-ribofuranosyl)purine (4e)

yellow oil, yield 60%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, $CDCl_3$): -0.25, -0.23, -0.041, -0.036, 0.096, 0.100, 0.104, 0.106, 0.139, 0.143, 0.148 and 0.153 (12 × s, 12 × 3H, CH_3Si); 0.79, 0.80, 0.93, 0.94, 0.960 and 0.963 (6 × s, 6 × 9H, $(CH_3)_3C$); 1.275 and 1.277 (2 × t, 2 × 3H, J_{vic} = 7.1, C**H$_3$**CH_2O); 1.811 and 1.813 (2 × ddd, 2 × 1H, J_{vic} = 8.9, 5.8, J_{gem} = 3.37, H-3b-cycloprop); 1.86 and 1.87 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 6.0, J_{gem} = 3.7, H-3a-cycloprop); 2.59 and 2.60 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 5.8, 3.9, H-2-cycloprop); 3.34 and 3.35 (2 × ddd, 2 × 1H, J_{vic} = 8.9, 6.0, 3.9, H-1-cycloprop); 3.79 and 3.80 (2 × dd, 2 × 1H, J_{gem}= 11.4, $J_{5'b,4'}$ = 2.7, H-5′b); 4.02 and 4.03 (2 × dd, 2 × 1H, J_{gem}= 11.4, $J_{5'a,4'}$ = 3.9, H-5′a); 4.14 (ddd, 2H, $J_{4',5'}$ = 3.9, 2.7, $J_{4',3'}$ = 3.7, H-4′); 4.17 and 4.18 (2 × q, 2 × 2H, J_{vic} = 7.1, CH_3C**H$_2$**O); 4.32 (dd, 2H, $J_{3',2'}$ = 4.4, $J_{3',4'}$ = 3.7, H-3′); 4.64 and 4.67 (2 × dd, 2 × 1H, $J_{2',1'}$ = 5.1, $J_{2',3'}$ = 4.4, H-2′); 6.10 and 6.11 (2 × d, 2 × 1H, $J_{1',2'}$ = 5.1, H-1′); 8.40 and 8.41 (2 × s, 2 × 1H, H-8); 8.75 (s, 2H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): -5.37, -5.04, -4.99, -4.75, -4.73, -4.69 and -4.42 (CH_3Si); 14.20 (**C**H_3CH_2O); 17.82, 17.83, 18.07, 18.16, 18.53 and 18.54 ($(CH_3)_3$**C** and CH_2-3-cycloprop); 22.54 and 22.56 (CH-1-cycloprop); 25.21 and 25.26 (CH-2-cycloprop); 25.63, 25.64, 25.82 and 26.08 ((**C**$H_3)_3C$); 60.85 (CH_3**C**H_2O); 62.41 and 62.46 (CH_2-5′); 71.81 and 71.90 (CH-3′); 75.86 and 75.88 (CH-2′); 85.40 and 85.50 (CH-4′); 88.21 and 88.22 (CH-1′); 132.94 (C-5); 142.88 and 142.93 (CH-8); 150.27 (C-4); 152.33 (CH-2); 159.94 and 159.95 (C-6); 172.43 (CO). FAB-MS, *m/z* (rel. %) 729 (10) $[M+Na]^+$, 707 (14) $[M+H]^+$, 231 (10), 177 (25), 154 (32), 137 (25), 109 (10), 89 (7), 73 (100), 59 (11). HRMS calcd. for $C_{34}H_{63}N_4O_6Si_3$ $[M+H]^+$ 707.4055; found: 707.4045. IR ($CHCl_3$): 3118, 3066, 1723, 1596, 1581, 1499, 1472, 1463, 1408, 1390, 1363, 1327, 1258, 1186, 1168, 1110, 1084, 1070, 939, 839, 813, 647.

6-[2-(Ethoxycarbonyl)cyclopropyl]-9-(2-deoxy-3,5-di-*O-tert*-butyldimethylsil-β-D-*erythro*-pentafuranosyl)purine (4f)

yellow oil, yield 44%. Diastereomeric mixture 1:1. ^{1}H NMR (500 MHz, $CDCl_3$): 0.089, 0.091, 0.093, 0.094 and 0.11 (5 × s, 24H, CH_3Si); 0.912, 0.916 and 0.918 (3 × s, 36H, $(CH_3)_3C$); 1.270 and 1.272 (2 × t, 2 × 3H, J_{vic} = 7.1, C**H$_3$**CH_2O); 1.807 and 1.811 (2 × ddd, 2 × 1H, J_{vic} = 9.0, 5.7, J_{gem} = 3.7, H-3b-cycloprop); 1.87 and 1.88 (2 × ddd, 2 × 1H, J_{vic} = 8.4, 6.0, J_{gem} = 3.7, H-3a-cycloprop); 2.45 (ddd, 2H, J_{gem} = 13.1, $J_{2'b,1'}$ = 6.1, $J_{2'b,3'}$ = 3.9, H-2′b); 2.58 and 2.60 (2 × ddd, 2

× 1H, J_{vic} = 8.4, 5.7, 3.9, H-2-cycloprop); 2.65 and 2.66 (2 × ddd, 2 × 1H, J_{gem} = 13.1, $J_{2'a,1'}$ = 6.8, $J_{2'a,3'}$ = 5.7, H-2′a); 3.33 and 3.34 (2 × ddd, 2 × 1H, J_{vic} = 9.0, 6.0, 3.9, H-1-cycloprop); 3.774 and 3.776 (2 × dd, 2 × 1H, J_{gem}= 11.2, $J_{5'b,4'}$ = 3.2, H-5′b); 3.88 (dd, 2H, J_{gem}= 11.2, $J_{5'a,4'}$ = 4.1, H-5′a); 4.030 and 4.032 (2 × dt, 2 × 1H, $J_{4',5'}$ = 4.1, 3.2, $J_{4',3'}$ = 3.2, H-4′); 4.13-4.21 (m, 4H, $CH_3C\mathbf{H_2}O$); 4.62 (ddd, 2H, $J_{3',2'}$ = 5.7, 3.9, $J_{3',4'}$ = 3.2, H-3′); 6.505 and 6.511 (2 × dd, 2 × 1H, $J_{1',2'}$ = 6.8, 6.1, H-1′); 8.35 and 8.36 (2 × s, 2 × 1H, H-8); 8.75 (s, 2H, H-2). ^{13}C NMR (125.7 MHz, $CDCl_3$): -5.48, -5.39, -4.81 and -4.68 (CH_3Si); 14.21 ($\mathbf{C}H_3CH_2O$); 17.95 (CH_2-3-cycloprop); 18.00 and 18.42 $(CH_3)_3\mathbf{C}$); 22.61 and 22.63 (CH-1-cycloprop); 25.20 and 25.24 (CH-2-cycloprop); 25.75 and 25.96 ($(\mathbf{C}H_3)_3C$); 41.24 and 41.26 (CH_2-2′); 60.82 and 60.84 ($CH_3\mathbf{C}H_2O$); 62.75 and 62.77 (CH_2-5′); 71.89 and 71.95 (CH-3′); 84.35 and 84.43 (CH-1′); 87.98 and 88.00 (CH-4′); 132.98 (C-5); 142.46 and 142.49 (CH-8); 149.96 (C-4); 152.29 and 152.30 (CH-2); 159.98 (C-6); 172.41 (CO). FAB-MS, *m/z* (rel. %) = 577 (10) $[M+H]^+$ (cation), 301 (10), 231 (12), 233 (10), 147 (8), 115 (10), 89 (14), 73 (100), 59 (18). HRMS calcd. for $C_{28}H_{49}N_4O_5Si_2$ $[M+H]^+$ 577.3241; found: 577.3242. IR ($CHCl_3$): 3120, 1720, 1597, 1582, 1497, 1471, 1464, 1405, 1389, 1259, 1227, 1185, 1095, 1069, 939, 839, 813, 647.

General method for amidation of esters

A suspension of dry $AlCl_3$ (267 mg, 2 mmol) in dichlormethane (4 ml) was cooled to 0°C follwoed by an addition of an amine (5 mmol). The reaction mixture was stirred for 10 min at 0°C until $AlCl_3$ was dissolved. Then a solution of an ester **4a** (or **4b**, **4e, 4f**) (1 mmol) in dichlormethane (2 ml) was added at once. The resulting mixture was stirred for 1 h at ambient temperature. After completion, the reaction mixture was diluted with water (50 ml), and then washed with ethyl acetate (3 x 50 ml). The collected organic layers were washed with brine, dried over anhydrous $MgSO_4$, filtered, and concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, ethyl acetate/hexane 0-30%) and crystallized from chloroform/heptane to give a product.

9-Benzyl-6-[2-(diethylcarbamoyl)cyclopropyl]purine (6a)

white crystals, mp 94-97°C, yield 89%. ^{1}H NMR (600 MHz, $CDCl_3$): 1.12 and 1.18 (2 × t, 2 × 3H, J_{vic} = 7.1, $C\mathbf{H_3}CH_2N$); 1.74 (ddd, 1H, J_{vic} = 8.5, 5.6, J_{gem} = 3.2, H-3b-cycloprop); 1.90 (ddd, 1H, J_{vic} = 8.9, 5.8, J_{gem} = 3.2, H-3a-cycloprop); 2.80 (ddd, 1H, J_{vic} = 8.5, 5.8, 4.0, H-2-cycloprop); 3.31 (ddd, 1H, J_{vic} = 8.9, 5.6, 4.0, H-1-cycloprop); 3.35-3.50 (m, 4H, $CH_3C\mathbf{H_2}N$); 5.43 (s, 2H, CH_2Ph); 7.29-7.38 (m, 5H, Ph); 8.01 (s, 1H, H-8); 8.82 (s, 1H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): 13.18 and 14.83 ($\mathbf{C}H_3CH_2N$); 18.23 (CH_2-3-cycloprop); 22.12 (CH-1-cycloprop); 23.84 (CH-2-cycloprop); 40.91 and 42.15 ($CH_3\mathbf{C}H_2N$); 47.18 (CH_2Ph); 127.77 (CH-*o*-Ph); 128.52 (CH-*p*-Ph); 129.08 (CH-*m*-Ph); 132.36 (C-5); 135.16 (C-*i*-Ph); 143.62 (CH-8); 150.41 (C-4); 152.55

(CH-2); 161.34 (C-6); 169.92 (CO). FAB-MS, *m/z* (rel. %) = 350 (94) $[M+H]^+$ (cation), 277 (40), 249 (15), 159 (10), 91 (100). 74 (5). HRMS calcd. for $C_{20}H_{24}N_5O$ $[M+H]^+$ 350.1980; found: 350.1978. Anal. Calcd for $C_{20}H_{23}N_5O$: C 68.74, H 6.63, N 20.04. Found: C 68.42, H 6.47, N 19.82. IR ($CHCl_3$): 3112, 3092, 3069, 3035, 1630, 1603, 1595, 1579, 15001456, 1423, 1410, 1382, 1329, 1079, 1030, 808, 701, 642, 619, 454.

9-Benzyl-6-[2-(benzyl(methyl)carbamoyl)cyclopropyl]purine (7a)

white crystals, mp 135-136°C, yield 82%. Mixture of amide rotamers (1:1). ^{1}H NMR (600 MHz, $CDCl_3$): 1.77 and 1.81 (2 × ddd, 2 × 1H, J_{vic} = 8.4, 5.6, J_{gem} = 3.3, H-3b-cycloprop); 1.94 and 1.97 (2 × ddd, 2 × 1H, J_{vic} = 8.8, 5.8, J_{gem} = 3.3, H-3a-cycloprop); 2.82 and 2.90 (2 × ddd, 2 × 1H, J_{vic} = 8.4, 5.8, 4.0, H-2-cycloprop); 3.00 and 3.04 (2 × s, 2 × 3H, CH_3N); 3.28 and 3.38 (2 × ddd, 2 × 1H, J_{vic} = 8.8, 5.6, 4.0, H-1-cycloprop); 4.60 (d, 1H, J_{gem} = 14.7, $CH_a\mathbf{H_b}Ph$); 4.61 (d, 1H, J_{gem} = 16.6, $CH_a\mathbf{H_b}Ph$); 4.66 (d, 1H, J_{gem} = 14.7, $C\mathbf{H_a}H_bPh$); 4.69 (d, 1H, J_{gem} = 16.6, $C\mathbf{H_a}H_bPh$); 5.40 and 5.50 (2 × d, 2H, J_{gem} = 15.2, CH_2Ph-9); 5.43 (s, 2H, CH_2Ph-9); 7.06 (m, 1H, H-*p*-Ph); 7.13 (m, 2H, H-*o*-Ph); 7.18 (m, 1H, H-*m*-Ph); 7.23-7.27 (m, 1H, H-*o,p*-Ph); 7.28-7.38 (m, 12H, H-*m*-Ph and H-*o,m,p*-Ph-9); 7.99 and 8.02 (2 × s, 2 × 1H, H-8); 8.72 and 8.81 (2 × s, 2 × 1H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): 17.90 and 18.35 (CH_2-3-cycloprop); 22.29 and 22.56 (CH-1-cycloprop); 23.80 and 24.14 (CH-2-cycloprop); 34.53 and 34.83 (CH_3N); 47.15 and 47.17 (CH_2Ph-9); 51.17 and 53.53 (CH_2Ph); 126.44 (CH-*o*-Ph); 127.18 and 127.25 (CH-*p*-Ph); 127.75 (CH-*o*-Bn-9); 128.00 (CH-*o*-Ph); 128.51 (CH-*m*-Ph); 128.56 (CH-*p*-Bn-9); 129.06 (CH-*m*-Bn-9); 132.26 and 132.29 (C-5); 135.14 and 135.19 (C-*i*-Bn-9); 136.79 and 137.27 (C-*i*-Ph); 143.52 and 143.67 (CH-8); 150.33 and 150.44 (C-4); 152.42 and 152.53 (CH-2); 160.77 and 161.05 (C-6); 171.07 and 171.24 (CO). FAB-MS, *m/z* (rel. %) 420 (66) $[M+Na]^+$, 398 (100) $[M+H]^+$, 309 (5), 278 (7), 249 (7), 231 (17), 177 (37), 154 (57), 137 (45), 109 (15), 91 (88), 79 (12), 61 (7). HRMS calcd. for $C_{24}H_{24}N_5O$ $[M+H]^+$ 398.1980; found: 398.1996. IR ($CHCl_3$): 3111, 3092, 3069, 1638, 1596, 1581, 1501, 1456, 1424, 1410, 1382, 1331, 1079, 1029, 807, 701, 643.

9-Benzyl-6-[2-(morpholine-4-carbonyl)cyclopropyl]purine (8a)

white crystals, yield 85%, mp 157-159°C. ^{1}H NMR (500 MHz, $CDCl_3$): 1.78 (ddd, 1H, J_{vic} = 8.4, 5.7, J_{gem} = 3.4, H-3b-cycloprop); 1.90 (ddd, 1H, J_{vic} = 8.8, 5.8, J_{gem} = 3.4, H-3a-cycloprop); 2.81 (ddd, 1H, J_{vic} = 8.4, 5.8, 4.0, H-2-cycloprop); 3.32 (ddd, 1H, J_{vic} = 8.8, 5.7, 4.0, H-1-cycloprop); 3.74-3.56 (m, 8H, H-morpholine); 5.43 (s, 2H, CH_2Ph); 7.28-7.38 (m, 5H, H-*o,m,p*-Ph); 8.01 (s, 1H, H-8); 8.80 (s, 1H, H-2). ^{13}C NMR (125.7 MHz, $CDCl_3$): 18.00 (CH_2-3-cycloprop); 22.12 (CH-1-cycloprop); 23.18 (CH-2-cycloprop); 42.49 and 45.94 (CH_2N-morpholine); 47.20 (CH_2Ph); 66.66 and 66.73 (CH_2O-morpholine); 127.78 (CH-*o*-Ph); 128.53 (CH-*p*-Ph); 129.07 (CH-*m*-Ph); 132.31 (C-5); 135.10 (C-*i*-Ph); 143.70 (CH-8); 150.46 (C-4); 152.53 (CH-2); 160.73 (C-6); 169.65 (CO). FAB-MS, *m/z* (rel. %) 386 (70) $[M+Na]^+$, 364 (100) $[M+H]^+$, 309 (10), 249 (7), 231

(27), 177 (57), 154 (97), 137 (70), 109 (27), 91 (70), 79 (15), 61 (12). HRMS calcd. for $C_{20}H_{22}N_5O_2$ $[M+H]^+$ 364.1773; found: 364.1769. IR ($CHCl_3$): 3110, 3090, 3068, 3033, 1635, 1595, 1582, 1497, 1454, 1409, 1378, 1331, 1079, 1029, 809, 700, 643, 619, 456.

6-[2-(Diethylcarbamoyl)cyclopropyl]-9-(tetrahydropyran-2-yl)purine (6b)

yellow solid, yield 66%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, $CDCl_3$): 1.12, 1.13, 1.16 and 1.17 (4 × t, 4 × 3H, J_{vic} = 7.1, CH_3CH_2N); 1.67 (m, 2H, CH_2-THP); 1.74 and 1.75 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.7, J_{gem} = 3.4, H-3b-cycloprop); 1.76-1.85 (m, 6H, CH_2-THP); 1.90 and 1.91 (2 × ddd, 2 × 1H, J_{vic} = 8.9, 5.8, J_{gem} = 3.4, H-3a-cycloprop); 2.00-2.16 (m, 6H, CH_2-THP); 2.76 and 2.79 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.8, 3.9, H-2-cycloprop); 3.28 (ddd, 2H, J_{vic} = 8.9, 5.7, 3.9, H-1-cycloprop); 3.35-3.48 (m, 8H, CH_3CH_2N); 3.796 and 3.800 (2 × td, 2 × 1H, J = 11.8, 2.7, CH_aH_bO-THP); 4.18 (m, 2H, CH_aH_bO-THP); 5.78 and 5.79 (2 × dd, 2 × 1H, J = 10.1, 2.8, CHO-THP); 8.237 and 8.244 (2 × s, 2 × 1H, H-8); 8.79 (s, 2H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): 13.17, 14.79 and 14.81 (CH_3CH_2N); 17.95 and 18.14 (CH_2-3-cycloprop); 22.10 and 22.32 (CH-1-cycloprop); 22.75 (CH_2-THP); 23.85 and 24.00 (CH-2-cycloprop); 24.79, 31.65 and 31.66 (CH_2-THP); 40.92, 40.93, 42.15 and 42.16 (CH_3CH_2N); 68.79 (CH_2O-THP); 81.76 and 81.88 (CHO-THP); 132.44 and 132.51 (C-5); 141.53 and 141.58 (CH-8); 149.60 and 149.62 (C-4); 152.37 and 152.41 (CH-2); 161.34 and 161.37 (C-6); 169.89 and 169.93 (CO). FAB-MS, *m/z* (rel. %) = 344 (15) $[M+H]^+$ (cation), 260 (100), 187 (22), 159 (16). HRMS calcd. for $C_{18}H_{26}N_5O_2$ $[M+H]^+$ 344.2086; found: 344.2076.. IR (KBr): 3128, 3063, 1631, 1597, 1582, 1497, 1467, 1455, 1442, 1423, 1413, 1381, 1187, 1328, 1086, 1058, 1045, 911, 876, 844, 823, 647, 547.

6-[2-(Diethylcarbamoyl)cyclopropyl]-9-(2,3,5-tri-*O-tert*-butyldimethylsilyl-β-D-ribofuranosyl)purine (6e)

white foam, yield 85%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, $CDCl_3$): -0.27, -0.24, -0.046, -0.039, 0.100, 0.103, 0.108, 0.112, 0.138, 0.142, 0.145 and 0.151 (12 × s, 12 × 3H, CH_3Si); 0.78, 0.79, 0.937, 0.939, 0.958 and 0.963 (6 × s, 6 × 9H, $(CH_3)_3C$); 1.130, 1.131, 1.150 and 1.152 (4 × t, 4 × 3H, J_{vic} = 7.2, C**H$_3$**CH_2N); 1.738 and 1.740 (2 × ddd, 2 × 1H, J_{vic} = 8.4, 5.6, J_{gem} = 3.3, H-3b-cycloprop); 1.90 and 1.91 (2 × ddd, 2 × 1H, J_{vic} = 8.1, 5.7, J_{gem} = 3.3, H-3a-cycloprop); 2.77 and 2.79 (2 × ddd, 2 × 1H, J_{vic} = 8.4, 5.7, 4.0, H-2-cycloprop); 3.286 and 3.290 (2 × ddd, 2 × 1H, J_{vic} = 8.1, 5.6, 4.0, H-1-cycloprop); 3.37-3.50 (m, 8H, CH_3C**H$_2$**N); 3.80 (dd, 2H, J_{gem}= 11.4, $J_{5'b,4'}$ = 2.7, H-5′b); 4.02 and 4.03 (2 × dd, 2 × 1H, J_{gem}= 11.4, $J_{5'a,4'}$ = 4.0, H-5′a); 4.13-4.16 (m, 2H, H-4′); 4.32 and 4.34 (2 × dd, 2 × 1H, $J_{3',2'}$ = 4.3, $J_{3',4'}$ = 3.6, H-3′); 4.64 and 4.67 (2 × dd, 2 × 1H, $J_{2',1'}$ = 5.3, $J_{2',3'}$ = 4.3, H-2′); 6.10 and 6.11 (2 × d, 2 × 1H, $J_{1',2'}$ = 5.3, H-1′); 8.38 and 8.41 (2 × s, 2 × 1H, H-8); 8.76 (s, 2H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): -5.40, -5.13, -5.09, -4.75, -4.73, -4.71, -4.69, -4.45 and -4.44 (CH_3Si); 13.22 and 14.80 (**C**H_3CH_2N); 17.80 ($(CH_3)_3$**C**); 18.02 (CH_2-3-cycloprop); 18.05 ($(CH_3)_3$**C**); 18.11 (CH_2-3-cycloprop); 18.50 and 18.51 ($(CH_3)_3$**C**); 22.19 and

22.25 (CH-1-cycloprop); 23.92 and 24.01 (CH-2-cycloprop); 25.61, 25.81, 26.05 and 26.06 (($\mathbf{C}H_3)_3C$); 40.97 and 42.18 ($CH_3\mathbf{C}H_2N$); 62.45 and 62.47 (CH_2-5′); 71.85 and 71.91 (CH-3′); 75.77 and 75.96 (CH-2′); 85.48 and 85.53 (CH-4′); 88.10 and 88.14 (CH-1′); 132.946 and 132.254 (C-5); 142.69 and 142.80 (CH-8); 150.18 (C-4); 152.30 and 152.31 (CH-2); 161.18 and 161.22 (C-6); 169.99 and 170.00 (CO). FAB-MS, *m/z* (rel. %) 756 (35) $[M+Na]^+$, 734 (60) $[M+H]^+$, 718 (12), 676 (12), 416 (12), 147 (10), 89 (6), 73 (100), 59 (12). HRMS calcd. for $C_{36}H_{68}N_5O_5Si_3$ $[M+H]^+$ 734.4528; found: 734.4536. IR ($CHCl_3$): 3118, 3064, 2898, 1629, 1595, 1580, 1497, 1485, 1471, 1463, 1410, 1382, 1363, 1327, 1258, 1083, 1072, 939, 839, 681, 647.

6-[2-(Benzyl(methyl)carbamoyl)cyclopropyl]-9-(2,3,5-tri-*O*-*tert*-butyldimethylsilyl-β-D-ribofuranosyl)purine (7e)

white foam, yield 65%. Diastereomeric mixture of amide rotamers 1:1:1:1. ^{1}H NMR (600 MHz, $CDCl_3$): -0.27, -0.26, -0.24, -0.23, -0.05, -0.041, -0.035, 0.095, 0.100, 0.103, 0.105, 0.108, 0.112, 0.115, 0.139, 0.145, 0.149, 0.154 and 0.16 (19 × s, 72H, CH_3Si); 0.776, 0.782, 0.787, 0.792, 0.934, 0.936, 0.938, 0.958, 0.962, 0.965 and 0.969 (11 × s, 108H, $(CH_3)_3C$); 1.74-1.82 (m, 4H, H-3b-cycloprop); 1.92-1.99 (m, 4H, H-3a-cycloprop); 2.78-2.92 (m, 4H, H-2-cycloprop); 2.99, 3.00, 3.03 and 3.04 (4 × s, 4 × 3H, CH_3N); 3.29, 3.31, 3.366 and 3.372 (4 × ddd, 4 × 1H, J_{vic} = 8.9, 5.7, 3.9, H-1-cycloprop); 3.78-3.82 (m, 4H, H-5′b); 4.00-4.05 (m, 4H, H-5′a); 4.13-4.16 (m, 4H, H-4′); 4.31-4.35 (m, 4H, H-3′); 4.554, 4.558 and 4.60 (3 × d, 4H, J_{gem} = 14.7, $CH_a\mathbf{H_b}Ph$); 4.60 and 4.63 (2 × dd, 2 × 1H, $J_{2',1'}$ = 5.0, $J_{2',3'}$ = 4.3, H-2′); 4.66-4.73 (m, 6H, H-2′ and $C\mathbf{H_a}H_bPh$); 6.07, 6.10, 6.11 and 6.12 (4 × d, 4 × 1H, $J_{1',2'}$ = 5.0, H-1′); 7.11-7.34 (m, 20H, H-*o,m,p*-Ph); 8.37, 8.39, 8.40 and 8.42 (4 × s, 4 × 1H, H-8); 8.671, 8.675, 8.753 and 8.755 (4 × s, 4 × 1H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): -5.40, -5.09, -5.06, -4.76, -4.74, -4.73, -4.71 and -4.44 (CH_3Si); 17.79 and 17.80 (($CH_3)_3\mathbf{C}$); 17.83 and 18.02 (CH_2-3-cycloprop); 18.04 (($CH_3)_3\mathbf{C}$); 18.20 and 18.32 (CH_2-3-cycloprop); 18.50 and 18.51 (($CH_3)_3\mathbf{C}$); 22.25, 22.32, 22.51 and 22.55 (CH-1-cycloprop); 23.84, 23.95, 24.03 and 24.24 (CH-2-cycloprop); 25.60, 25.61, 25.80, 26.05 and 26.06 (($\mathbf{C}H_3)_3C$); 34.38, 34.52, 34.82 and 34.83 (CH_3N); 51.20, 53.51 and 53.55 (CH_2Ph); 62.40, 62.42 and 62.44 (CH_2-5′); 71.81, 71.82 and 71.89 (CH-3′); 75.60, 75.73, 75.99 and 76.06 (CH-2′); 85.42 and 85.47 (CH-4′); 88.03, 88.10 and 88.22 (CH-1′); 126.47 and 126.56 (CH-*o*-Ph); 127.27, 127.28 and 127.33 (CH-*p*-Ph); 128.04 and 128.06 (CH-*o*-Ph); 128.54, 128.628 and 128.633 (CH-*m*-Ph); 132.87, 132.92, 132.94 and 132.96 (C-5); 136.78, 136.79, 137.30 and 137.31 (C-*i*-Ph); 142.55, 142.72, 142.83 and 142.87 (CH-8); 150.13, 150.20 and 150.21 (C-4); 152.17, 152.20, 152.27 and 152.30 (CH-2); 160.63, 160.70, 160.91 and 160.94 (C-6); 171.13, 171.14 and 170.28 (CO). FAB-MS, *m/z* (rel. %) 805 (25) $[M+Na]^+$, 782 (32) $[M+H]^+$, 766 (10), 724 (12), 464 (10), 147 (10), 89 (8), 73 (100), 59 (10). HRMS calcd. for $C_{40}H_{68}N_5O_5Si_3$ $[M+H]^+$ 782.4528; found: 782.4515. IR ($CHCl_3$): 3117, 3089, 3066, 3032, 2898, 1635, 1595, 1582, 1496, 1472, 1463, 1454, 1408,1331, 1084, 1072, 700, 647.

6-[2-(Morpholine-4-carbonyl)cyclopropyl]-9-(2,3,5-tri-*O-tert*-butyldimethylsilyl-β-D-ribofuranosyl)purine (8e)

white foam, yield 76%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, $CDCl_3$): -0.26, -0.24, -0.045, -0.037, 0.099, 0.102, 0.107, 0.110, 0.140, 0.144, 0.147 and 0.154 (12 × s, 12 × 3H, CH_3Si); 0.78, 0.79, 0.936, 0.939, 0.960 and 0.965 (6 × s, 6 × 9H, $(CH_3)_3C$); 1.769 and 1.771 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.7, J_{gem} = 3.5, H-3b-cycloprop); 1.90 and 1.91 (2 × ddd, 2 × 1H, J_{vic} = 8.9, 5.8, J_{gem} = 3.5, H-3a-cycloprop); 2.76 and 2.79 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.8, 4.0, H-2-cycloprop); 3.31 and 3.32 (2 × ddd, 2 × 1H, J_{vic} = 8.9, 5.7, 4.0, H-1-cycloprop); 3.56-3.71 (m, 16H, H-morpholine); 3.79 and 3.80 (dd, 2H, J_{gem}= 11.4, $J_{5'b,4'}$ = 2.4, H-5′b); 4.02 and 4.03 (2 × dd, 2 × 1H, J_{gem}= 11.4, $J_{5'a,4'}$ = 3.8, H-5′a); 4.13-4.16 (m, 2H, H-4′); 4.32 and 4.34 (2 × dd, 2 × 1H, $J_{3',2'}$ = 4.4, $J_{3',4'}$ = 3.5, H-3′); 4.62 and 4.67 (2 × dd, 2 × 1H, $J_{2',1'}$ = 5.2, $J_{2',3'}$ = 4.4, H-2′); 6.10 and 6.12 (2 × d, 2 × 1H, $J_{1',2'}$ = 5.2, H-1′); 8.39 and 8.42 (2 × s, 2 × 1H, H-8); 8.75 (s, 2H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): -5.39, -5.10, -5.07, -4.74, -4.72, -4.69, -4.45 and -4.43 (CH_3Si); 17.82 and 17.93 (CH_2-3-cycloprop); 18.06, 18.51 and 18.53 (($CH_3)_3$**C**); 22.01 and 22.09 (CH-1-cycloprop); 23.34 and 23.44 (CH-2-cycloprop); 25.62, 25.81, 26.06 and 26.07 ((**C**$H_3)_3$C); 42.52 and 45.97 (CH_2N-morpholine); 62.44 and 62.48 (CH_2-5′); 66.70 and 66.80 (CH_2O-morpholine); 71.84 and 71.93 (CH-3′); 75.81 and 76.06 (CH-2′); 85.50 and 85.57 (CH-4′); 88.08 and 88.17 (CH-1′); 132.966 and 132.973 (C-5); 142.81 and 142.95 (CH-8); 150.25 (C-4); 152.32 and 152.34 (CH-2); 160.59 and 160.64 (C-6); 169.70 and 169.72 (CO). FAB-MS, *m/z* (rel. %) 770 (40) $[M+Na]^+$, 748 (45) $[M+H]^+$, 732 (10), 690 (10), 430 (8), 343 (22), 301 (29), 147 (12), 115 (10), 73 (100), 59 (10). HRMS calcd. for $C_{36}H_{66}N_5O_6Si_3$ $[M+H]^+$ 748.4320; found: 748.4308. IR ($CHCl_3$): 3118, 3064, 2899, 1638, 1596, 1581, 1499, 1471, 1463, 1422, 1409, 1390, 1362, 1331, 1257, 1168, 1116, 1083, 1070, 1025, 939, 839, 647.

6-[2-(Diethylcarbamoyl)cyclopropyl]-9-(2-deoxy-3,5-di-*O-tert*-butyldimethylsil-β-D-*erythro*-pentafuranosyl)purine (6f)

white foam, yield 71%, 1:1 mixture of diastereoisomers, ^{1}H NMR (500 MHz, $CDCl_3$): 0.087, 0.091, 0.092, 0.094, 0.108 and 0.110 (6 × s, 24H, CH_3Si); 0.913, 0.915 and 0.919 (3 × s, 36H, $(CH_3)_3C$); 1.125, 1.128, 1.16 and 1.17 (4 × t, 4 × 3H, J_{vic} = 7.1, C**H**$_3$$CH_2N$); 1.72 and 1.73 (2 × ddd, 2 × 1H, J_{vic} = 8.8, 5.6, J_{gem} = 3.3, H-3b-cycloprop); 1.896 and 1.903 (2 × ddd, 2 × 1H, J_{vic} = 8.9, 6.0, J_{gem} = 3.3, H-3a-cycloprop); 2.45 and 2.46 (2 × ddd, 2 × 1H, J_{gem} = 13.1, $J_{2'b,1'}$ = 6.1, $J_{2'b,3'}$ = 3.8, H-2′b); 2.64 and 2.67 (2 × ddd, 2 × 1H, J_{gem} = 13.1, $J_{2'a,1'}$ = 6.8, $J_{2'a,3'}$ = 5.7, H-2′a); 2.78 and 2.79 (2 × ddd, 2 × 1H, J_{vic} = 8.8, 6.0, 4.0, H-2-cycloprop); 3.29 (ddd, 2H, J_{vic} = 8.9, 5.6, 4.0, H-1-cycloprop); 3.35-3.48 (m, 8H, CH_3C**H**$_2$N); 3.78 (dd, 2H, J_{gem}= 11.2, $J_{5'b,4'}$ = 3.2, H-5′b); 3.87 and 3.88 (2 × dd, 2 × 1H, J_{gem}= 11.2, $J_{5'a,4'}$ = 2.7, H-5′a); 4.03 and 4.04 (2 × ddd, 2 × 1H, $J_{4',5'}$ = 3.2, 2.7, $J_{4',3'}$ = 1.3, H-4′); 4.61-4.66 (m, 2H, H-3′); 6.51 and 6.52 (2 × dd, 2 × 1H, $J_{1',2'}$ =

6.8, 6.1, H-1′); 8.35 and 8.36 (2 × s, 2 × 1H, H-8); 8.76 (s, 2H, H-2). ^{13}C NMR (125.7 MHz, $CDCl_3$): -5.51, -5.41, -4.82 and -4.69 (CH_3Si); 13.21, 14.83 and 14.84 (**C**H_3CH_2N); 17.98, 18.01, 18.15 and 18.40 (CH_2-3-cycloprop and $(CH_3)_3$**C**); 22.17 and 22.31 (CH-1-cycloprop); 23.80 and 23.89 (CH-2-cycloprop); 25.73 and 25.93 ((**C**$H_3)_3C$); 40.94 (CH_3**C**H_2N); 41.11 and 41.24 (CH_2-2′); 42.18 (CH_3**C**H_2N); 62.74 (CH_2-5′); 71.90 (CH-3′); 84.26 (CH-1′); 87.94 and 87.97 (CH-4′); 132.99 and 133.03 (C-5); 142.26 and 142.33 (CH-8); 149.88 and 149.89 (C-4); 152.26 and 152.28 (CH-2); 161.23 and 161.26 (C-6); 169.98 and 170.01 (CO). FAB-MS, *m/z* (rel. %) = 626 (20) $[M+Na]^+$ (cation), 604 (14) $[M+H]^+$ (cation), 301 (10), 260 (24), 187 (10), 159 (10), 115 (8), 89 (18), 73 (100), 59 (16). HRMS calcd. for $C_{30}H_{54}N_5O_4Si_2$ $[M+H]^+$ 604.3714; found: 604.3695. IR ($CHCl_3$): 3120, 1631, 1596, 1581, 1498, 1486, 1471, 1763, 1421, 1410, 1391, 1382, 1363, 1258, 1098, 1071, 939, 839, 812, 648, 679.

General method for ester reduction

A mixture of an ester **4a** (or **4b**, **4e, 4f**) (1 mmol) and $NaBH_4$ (1.89 g, 50 mmol) in dry ethanol (50 ml) was heated to 60°C under argon atmosphere for 1 day. After completion, the reaction mixture was diluted with aqueous saturated solution of NH_4Cl (200 ml), and then washed with ethyl acetate (3 x 50 ml). The collected organic layers were washed with brine, dried over anhydrous $MgSO_4$, filtered, and concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, ethyl acetate/hexane 0%-30%) and crystallized from chloroform/heptane.

9-Benzyl-6-[2-(hydroxymethyl)cyclopropyl]purine (10a)

chromatography methanol/chloroform 0%-10%, white crystals, mp 103-104°C, yield 57%. ^{1}H NMR (600 MHz, DMSO-d_6): 1.18 (ddd, 1H, J_{vic} = 8.5, 6.2, J_{gem} = 3.5, H-3b-cycloprop); 1.40 (ddd, 1H, J_{vic} = 8.4, 4.8, J_{gem} = 3.5, H-3a-cycloprop); 1.92 (m, 1H, H-2-cycloprop); 2.59 (ddd, 1H, J_{vic} = 8.5, 4.8, 4.2, H-1-cycloprop); 3.44 and 3.58 (2 × dt, 2H, J_{gem} = 11.3, J_{vic} = 5.6, CH_2O); 4.74 (t, 1H, J_{vic} = 5.6, OH); 5.48 (CH_2Ph); 7.26-7.35 (m, 5H, Ph); 8.63 (s, 1H, H-8); 8.69 (s, 1H, H-2). ^{13}C NMR (151 MHz, DMSO-d_6): 15.56 (CH_2-3-cycloprop); 18.21 (CH-1-cycloprop); 27.44 (CH-2-cycloprop); 46.56 (CH_2Ph); 62.81 (CH_2O); 127.74 (CH-*o*-Ph); 128.08 (CH-*p*-Ph); 128.96 (CH-*m*-Ph); 131.67 (C-5); 136.89 (C-*i*-Ph); 145.41 (CH-8); 149.96 (C-4); 152.24 (CH-2); 162.44 (C-6).FAB-MS, *m/z* (rel. %) = 281 (100) $[M+H]^+$ (cation), 263 (10), 220 (5), 91 (100). HRMS calcd. for $C_{16}H_{17}N_4O$ $[M+H]^+$ 281.1402; found: 281.1406. IR (KBr): 3424, 3228, 1600, 1581, 1510, 1497, 1454, 1410, 1329, 1217, 1080, 1030, 1002, 812, 732, 697, 618, 466.

6-[2-(Hydroxymethyl)cyclopropyl]-9-(tetrahydropyran-2-yl)purine (10b)

chromatography methanol/chloroform 0%-5%, white solid, yield 57%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, $CDCl_3$): 1.211 and 1.214 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.7, J_{gem} = 4.2, H-

3b-cycloprop); 1.65-1.85 (m, 8H, H-3a-cycloprop and CH_2-THP); 2.00-2.16 (m, 8H, H-2-cycloprop and CH_2-THP); 2.719 and 2.722 (2 × ddd, 2 × 1H, J_{vic} = 8.8, 5.0, 4.0, H-1-cycloprop); 3.59 and 3.62 (2 × dd, 2 × 1H, J_{gem} = 11.6, J_{vic} = 7.4, $CH_a\mathbf{H_b}O$); 3.791 and 3.794 (2 × td, 2 × 1H, J = 11.8, 2.6, $CH_a\mathbf{H_b}O$-THP); 3.84 and 3.86 (2 × dd, 2 × 1H, J_{gem} = 11.6, J_{vic} = 6.0, $C\mathbf{H_a}H_bO$); 4.18 (m, 2H, $C\mathbf{H_a}H_bO$-THP); 5.76 and 5.77 (2 × dd, 2 × 1H, J = 10.6, 2.5, CHO-THP); 8.233 and 8.235 (2 × s, 2 × 1H, H-8); 8.75 (s, 2H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): 15.19 and 15.26 (CH_2-3-cycloprop); 18.75 (CH-1-cycloprop); 22.75 and 24.84 (CH_2-THP); 27.71 and 27.81 (CH-2-cycloprop); 31.82 (CH_2-THP); 65.52 and 65.59 (CH_2O); 68.82 (CH_2O-THP); 81.84 and 81.90 (CHO-THP); 132.13 and 132.14 (C-5); 141.21 and 141.26 (CH-8); 149.13 and 149.14 (C-4); 152.51 and 152.52 (CH-2); 162.77 and 162.79 (C-6). FAB-MS, *m/z* (rel. %) = 275 (100) $[M+H]^+$ (cation), 233 (12), 191 (95), 185 (8), 173 (17), 159 (7), 147 (8), 93 (18), 85 (23), 57 (7). HRMS calcd. for $C_{14}H_{19}N_4O_2$ $[M+H]^+$ 275.1508; found: 275.1507. IR ($CHCl_3$): 3614, 3359, 1597, 1580, 1498, 1466, 1456, 1443, 1415, 1397, 1332, 1187, 1086, 1057, 1046, 1032, 911, 872, 823, 647, 547.

6-[2-(Hydroxymethyl)cyclopropyl]-9-(2,3,5-tri-*O*-*tert*-butyldimethylsilyl-β-D-ribofuranosyl)purine (10e)

white foam, yield 68%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, $CDCl_3$): -0.23, -0.21, -0.04, -0.03, 0.100, 0.101, 0.106, 0.109, 0.14 and 0.15 (10 × s, 36H, CH_3Si); 0.79, 0.80, 0.94 and 0.96 (4 × s, 54H, $(CH_3)_3C$); 1.21 and 1.67 (2 × m, 2 × 2H, H-3-cycloprop); 2.13 (m, 2H, H-2-cycloprop); 2.74 (dt, 2H, J_{vic} = 8.8, 4.6, H-1-cycloprop); 3.65 (dd, 1H, J_{gem} = 11.5, J_{vic} = 7.1, $CH_a\mathbf{H_b}O$); 3.79 and 3.80 (2 × dd, 2 × 1H, J_{gem}= 11.3, $J_{5'b,4'}$ = 2.6, H-5′b); 3.81 (dd, 1H, J_{gem} = 11.5, J_{vic} = 6.0, $C\mathbf{H_a}H_bO$); 4.03 and 4.04 (2 × dd, 2 × 1H, J_{gem}= 11.3, $J_{5'a,4'}$ = 3.9, H-5′a); 4.14 (ddd, 2H, $J_{4',5'}$ = 3.9, 2.6, $J_{4',3'}$ = 3.7, H-4′); 4.32 and 4.33 (2 × dd, 2 × 1H, $J_{3',2'}$ = 4.5, $J_{3',4'}$ = 3.7, H-3′); 4.66 and 4.67 (2 × dd, 2 × 1H, $J_{2',1'}$ = 5.0, $J_{2',3'}$ = 4.5, H-2′); 6.09 and 6.10 (2 × d, 2 × 1H, $J_{1',2'}$ = 5.0, H-1′); 8.39 (s, 2H, H-8); 8.73 (s, 2H, H-2). ^{13}C NMR (151 MHz, $CDCl_3$): -5.38, -5.37, -5.04, -5.00, -4.75, -4.71, -4.43 and -4.41 (CH_3Si); 15.37 and 15.43 (CH_2-3-cycloprop); 17.82, 17.83 and 18.06 ($(CH_3)_3\mathbf{C}$); 18.52 (CH-1-cycloprop); 25.63, 25.64, 25.82 and 26.07 ($(\mathbf{C}H_3)_3C$); 27.48 and 27.54 (CH-2-cycloprop); 62.35 and 62.45 (CH_2-5′); 65.58 and 65.60 (CH_2O); 71.74 and 71.86 (CH-3′); 75.74 and 75.93 (CH-2′); 85.30 and 85.43 (CH-4′); 88.20 and 88.32 (CH-1′); 132.68 and 132.73 (C-5); 142.41 and 142.47 (CH-8); 149.76 and 149.78 (C-4); 152.42 and 152.45 (CH-2); 162.55 (C-6). FAB-MS, *m/z* (rel. %) = 665 (10) $[M+H]^+$ (cation), 147 (10), 115 (8), 89 (10), 73 (100), 59 (12). HRMS calcd. for $C_{32}H_{61}N_4O_5Si_3$ $[M+H]^+$ 665.3949; found: 665.3948. IR ($CHCl_3$): 3613, 3354, 3119, 3065, 1596, 1580, 1499, 1473, 1463, 1409, 1390, 1363, 1331, 1258, 1115, 1083, 1073, 1049, 939, 839, 813, 648.

6-[2-(Hydroxymethyl)cyclopropyl]-9-(2-deoxy-3,5-di-*O-tert*-butyldimethylsil-β-D-*erythro*-pentafuranosyl)purine (10f)

white foam, yield 44%. Diastereomeric mixture 1:1. ^{1}H NMR (500 MHz, $CDCl_3$): 0.092, 0.094, 0.095, 0.107 and 0.110 (6 × s, 24H, CH_3Si); 0.911, 0.915, 0.919 and 0.920 (4 × s, 4 × 9H, $(CH_3)_3C$); 1.205 and 1.207 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 6.2, J_{gem} = 4.1, H-3b-cycloprop); 1.67 and 1.68 (2 × ddd, 2 × 1H, J_{vic} = 9.4, 7.9, J_{gem} = 4.1, H-3a-cycloprop); 2.11 (m, 2H, H-2-cycloprop); 2.45 and 2.46 (2 × ddd, 2 × 1H, J_{gem} = 13.0, $J_{2'b,1'}$ = 6.3, $J_{2'b,3'}$ = 3.8, H-2′b); 2.65 and 2.66 (2 × ddd, 2 × 1H, J_{gem} = 13.0, $J_{2'a,1'}$ = 6.6, $J_{2'a,3'}$ = 5.7, H-2′a); 2.73 (m, 2H, H-1-cycloprop); 3.61 and 3.62 (2 × dd, 2 × 1H, J_{gem}= 11.5, J_{vic} = 6.2, $CH_a\mathbf{H_b}OH$); 3.774 and 3.776 (2 × dd, 2 × 1H, J_{gem}= 11.2, $J_{5'b,4'}$ = 3.1, H-5′b); 3.830 and 3.833 (2 × dd, 2 × 1H, J_{gem}= 11.5, J_{vic} = 5.9, $C\mathbf{H_a}H_bOH$); 3.88 and 3.89 (2 × dd, 2 × 1H, J_{gem}= 11.2, $J_{5'a,4'}$ = 2.3, H-5′a); 4.03 and 4.04 (2 × ddd, 2 × 1H, $J_{4',5'}$ = 3.1, 2.7, $J_{4',3'}$ = 1.6, H-4′); 4.60-4.64 (m, 2H, H-3′); 6.49 and 6.51 (2 × dd, 2 × 1H, $J_{1',2'}$ = 6.6, 6.3, H-1′); 8.338 and 8.344 (2 × s, 2 × 1H, H-8); 8.730 and 8.733 (2 × s, 2 × 1H, H-2). ^{13}C NMR (125.7 MHz, $CDCl_3$): -5.49, -5.40, -4.82 and -4.68 (CH_3Si); 15.23 and 15.28 (CH_2-3-cycloprop); 17.98 and 18.41 ($(CH_3)_3\mathbf{C}$); 18.63 (CH-1-cycloprop); 25.74 and 25.94 ($(\mathbf{C}H_3)_3C$); 27.56 and 27.61 (CH-2-cycloprop); 41.20 and 41.23 (CH_2-2′); 62.76 and 62.78 (CH_2-5′); 65.54 and 65.58 (CH_2OH); 71.91 and 71.96 (CH-3′); 84.35 and 84.46 (CH-1′); 87.96 and 87.98 (CH-4′); 132.71 (C-5); 141.96 and 142.02 (CH-8); 149.43 and 149.45 (C-4); 152.38 and 152.39 (CH-2); 162.60 and 162.61 (C-6). FAB-MS, *m/z* (rel. %) = 557 (12) $[M+Na]^+$ (cation), 535 (30) $[M+H]^+$ (cation), 301 (8), 233 (10), 191 (18), 173 (10), 147 (10), 115 (8), 89 (12), 73 (100), 59 (14). HRMS calcd. for $C_{26}H_{47}N_4O_4Si_2$ $[M+H]^+$ 535.3135; found: 535.3147. IR ($CHCl_3$): 3613, 3355, 1723, 1597, 1581, 1498, 1471, 1463, 1409, 1390, 1332, 1258, 1096, 1072, 1052, 939, 838, 813, 679, 648.

6-[2-(Hydroxymethyl)cyclopropyl]-9*H*-purine (10g)

Dichlormethane (5 ml) was added to a dry ester **4g** (190 mg, 0.8 mmol) under argon atmosphere. The mixture was stirred at 0°C and a DIBAH (2 ml, 1M in hexane) was added dropwise. The mixture was stirred for 1 h at ambient temperature. After completion, the reaction mixture was quenched with ethanol (50 ml) and then MnO_2 (200 mg) was added. The mixture was sonicated at ambient temperature for 1 h, filtered and the solvent evaporated. The residue was purified by column chromatography (silica gel, methanol/chloroform 5%-15%) and crystallized from chloroform/heptane to giving **10g** (100 mg, 65%) as white crystals, mp 238-242°C. ^{1}H NMR (500 MHz, DMSO-d_6+DCl): 1.53 (ddd, 1H, J_{vic} = 8.5, 6.8, J_{gem} = 4.2, H-3b-cycloprop); 1.88 (ddd, 1H, J_{vic} = 9.0, 5.2, J_{gem} = 4.2, H-3a-cycloprop); 2.34 (m, 1H, H-2-cycloprop); 2.71 (ddd, 1H, J_{vic} = 8.5, 5.2, 4.2, H-1-cycloprop); 3.46 (dd, 1H, J_{gem} = 11.6, J_{vic} = 6.1, $CH_a\mathbf{H_b}O$); 3.60 (dd, 1H, J_{gem} = 11.6, J_{vic} = 5.0, $C\mathbf{H_a}H_bO$); 9.01 (s, 1H, H-2); 9.11 (s, 1H, H-8). ^{13}C NMR (125.7 MHz, DMSO-d_6+DCl): 18.12 (CH_2-3-cycloprop); 18.52 (CH-1-cycloprop); 30.81 (CH-2-cycloprop); 62.17 (CH_2O); 127.21 (C-5); 147.83 (CH-2); 147.91 (CH-8); 152.82 (C-4); 158.68 (C-6). FAB-MS, *m/z* (rel. %)

= 239 (60), 231 (12), 191 (10) $[M+H]^+$ (cation), 177 (18), 160 (22), 154 (42), 149 (12), 137 (42), 102 (100). HRMS calcd. for $C_9H_{11}N_4O$ $[M+H]^+$ 191.0932; found: 191.0939. IR (KBr): 3435, 2850, 1632, 1604, 1476, 1398, 1324, 1037, 808, 644.

General method for ester hydrolysis

A mixture of an ester **4a** (or **4g**) (1 mmol) and NaOH (240 mg, 6 mmol) in 50% aqueous THF (15 ml) was stirred at ambient temperature for 1 h. After completion, the reaction mixture was neutralized with 10% aqueous H_2SO_4. Solid salts were filtered off and the filtrate was concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, methanol/chloroform 5%-15%) and crystallized from chloroform/heptane.

9-Benzyl-6-[2-(carboxy)cyclopropyl]purine (9a)

white solid, yield 81%. ^{1}H NMR (500 MHz, CD_3OD): 1.74 (ddd, 1H, J_{vic} = 8.9, 5.7, J_{gem} = 3.6, H-3b-cycloprop); 1.86 (ddd, 1H, J_{vic} = 8.5, 5.9, J_{gem} = 3.6, H-3a-cycloprop); 2.48 (ddd, 1H, J_{vic} = 8.5, 5.7, 3.9, H-2-cycloprop); 3.24 (ddd, 1H, J_{vic} = 8.9, 5.9, 3.9, H-1-cycloprop); 5.50 (s, 2H, CH_2Ph); 7.25-7.37 (m, 5H, H-*o,m,p*-Ph); 8.46 (s, 1H, H-8); 8.74 (s, 1H, H-2). ^{13}C NMR (125.7 MHz, CD_3OD): 18.34 (CH_2-3-cycloprop); 22.25 (CH-1-cycloprop); 26.11 (CH-2-cycloprop); 48.17 (CH_2Ph); 128.90 (CH-*o*-Ph); 129.36 (CH-*p*-Ph); 130.00 (CH-*m*-Ph); 133.01 (C-5); 137.27 (C-*i*-Ph); 146.86 (CH-8); 151.75 (C-4); 153.52 (CH-2); 160.94 (C-6); 175.99 (CO). FAB-MS, *m/z* (rel. %) 295 (92) $[M+H]^+$, 224 (6), 91 (100). HRMS calcd. for $C_{16}H_{15}N_4O_2$ $[M+H]^+$ 295.1195; found: 295.1193. IR (KBr): 3111, 3070, 3032, 2571, 2508, 1708, 1700, 1596, 1584, 1508, 1498, 1456, 1409, 1338, 1316, 1212, 1078, 1023, 804, 729, 696, 653, 639, 619, 454.

6-[2-(carboxy)cyclopropyl]-9*H*-purine (9g)

white solid, yield 80%. ^{1}H NMR (600 MHz, DMSO-d_6+DCl): 1.74 (ddd, 1H, J_{vic} = 8.9, 5.9, J_{gem} = 3.8, H-3b-cycloprop); 1.90 (ddd, 1H, J_{vic} = 8.7, 5.9, J_{gem} = 3.8, H-3a-cycloprop); 2.51 (ddd, 1H, J_{vic} = 8.7, 5.9, 3.9, H-2-cycloprop); 3.18 (ddd, 1H, J_{vic} = 8.9, 5.9, 3.9, H-1-cycloprop); 8.93 (s, 1H, H-2); 9.06 (s, 1H, H-8). ^{13}C NMR (151 MHz, DMSO-d_6+DCl): 18.25 (CH_2-3-cycloprop); 22.05 (CH-1-cycloprop); 25.66 (CH-2-cycloprop); 127.33 (C-5); 146.34 (CH-8); 151.05 (CH-2); 152.59 (C-4); 156.19 (C-6); 172.93 (CO). FAB-MS, *m/z* (rel. %) = 231 (30), 227 (14) $[M+Na]^+$ (cation), 205 (30) $[M+H]^+$ (cation), 177 (60), 154 (100), 137 (90), 109 (30), 105 (7), 92 (18), 79 (15), 61 (12). HRMS calcd. for $C_9H_9N_4O_2$ $[M+H]^+$ 205.0725; found: 205.0729. IR (KBr): 3114, 3078, 2570, 2484, 1708, 1600, 1490, 1432, 1404, 1383, 1261, 807, 648, 641.

General method for the cleavage of the THP protective group

A THP-protected compound (1 mmol) was dissolved in ethanol (10 ml) and Dowex 50 (H^+ form, 100 mg) was added. The mixture was heated at 70°C and stirred for 6 h. After completion, the

Dowex was filtered and the filtrate was concentrated under reduced pressure. The residue was purified by column chromatography (silica gel, methanol/chloroform 5%-15%) and crystallized from MeOH/chloroform/heptane to give a product.

6-Cyclopropyl-9*H*-purine (2g)

white crystals, mp 186-191°C, yield 47%. ^{1}H NMR (600 MHz, DMSO-d_6+DCl): 1.52 and 1.70 (2 × m, 2 × 2H, H-2,3-cycloprop); 2.83 (tt, 1H, J_{vic} = 8.2, 4.8, H-1-cycloprop); 9.03 (s, 1H, H-2); 9.14 (s, 1H, H-8). ^{13}C NMR (151 MHz, DMSO-d_6+DCl): 13.62 (CH-1-cycloprop); 14.13 (CH_2-2,3-cycloprop); 126.99 (C-5); 147.50 (CH-8); 148.18 (CH-2); 152.53 (C-4); 159.38 (C-6). FAB-MS, *m/z* (rel. %) = 161 (100) $[M+H]^+$ (cation), 147 (10), 109 (8). HRMS calcd. for $C_8H_9N_4$ $[M+H]^+$ 161.0827; found: 161.0832. Anal. Calcd for $C_8H_8N_4$·: C 59.99, H 5.03, N 34.98. Found: C 59.65, H 4.76, N 34.68. IR (KBr):3097, 3064, 1597, 1489, 1415, 1325, 1193, 807, 646.

6-[2-(Ethoxycarbonyl)cyclopropyl]-9*H*-purine (4g)

white crystals, 85%, mp 190-191°C. ^{1}H NMR (600 MHz, DMSO-d_6+DCl): 1.19 (t, 3H, J_{vic} = 7.2, C**H$_3$**CH_2O); 1.74 (ddd, 1H, J_{vic} = 9.0, 5.8, J_{gem} = 3.9, H-3b-cycloprop); 1.88 (ddd, 1H, J_{vic} = 8.6, 6.0, J_{gem} = 3.9, H-3a-cycloprop); 2.53 (ddd, 1H, J_{vic} = 8.6, 5.8, 3.9, H-2-cycloprop); 3.19 (ddd, 1H, J_{vic} = 9.0, 6.0, 3.9, H-1-cycloprop); 4.12 (q, 2H, J_{vic} = 7.2, CH_3C**H$_2$**O); 8.88 (s, 1H, H-2); 8.95 (s, 1H, H-8). ^{13}C NMR (151 MHz, DMSO-d_6+DCl): 14.34 (**C**H_3CH_2O); 18.02 (CH_2-3-cycloprop); 22.28 (CH-1-cycloprop); 25.06 (CH-2-cycloprop); 61.09 (CH_3**C**H_2O); 127.83 (C-5); 146.01 (CH-8); 151.45 (CH-2); 152.76 (C-4); 155.94 (C-6); 171.66 (CO). FAB-MS, *m/z* (rel. %) = 233 (100) $[M+H]^+$ (cation), 187 (8), 159 (10), 134 (8), 102 (25), 93 (10). HRMS calcd. for $C_{11}H_{13}N_4O_2$ $[M+H]^+$ 233.1038; found: 233.1039. IR (KBr): 3200, 3111, 3072, 2400, 1720, 1600, 1566, 1490, 1475, 1402, 1383, 1338, 1222, 1187, 1180, 1106, 1090, 810, 650.

6-[2-(Diethylcarbamoyl)cyclopropyl]-9*H*-purine (6g)

white hygroscopic solid, yield 66%. ^{1}H NMR (500 MHz, DMSO-d_6+DCl): 1.01 and 1.09 (2 × t, 2 × 3H, J_{vic} = 7.1, C**H$_3$**CH_2N); 1.77 (ddd, 1H, J_{vic} = 8.8, 6.1, J_{gem} = 3.5, H-3b-cycloprop); 1.95 (ddd, 1H, J_{vic} = 8.6, 5.7, J_{gem} = 3.5, H-3a-cycloprop); 3.08-3.16 (m, 2H, H-1,2-cycloprop); 3.30 and 3.44 (2 × q, 2 × 2H, J_{vic} = 7.1, CH_3C**H$_2$**N); 9.04 (s, 1H, H-2); 9.20 (s, 1H, H-8). ^{13}C NMR (125.7 MHz, DMSO-d_6+DCl): 13.46 and 15.17 (**C**H_3CH_2N); 19.13 (CH_2-3-cycloprop); 21.37 (CH-1-cycloprop); 24.84 (CH-2-cycloprop); 40.83 and 42.07 (CH_3**C**H_2N); 127.23 (C-5); 147.51 (CH-8); 149.28 (CH-2); 152.68 (C-4); 156.36 (C-6); 168.51 (CO).FAB-MS, *m/z* (rel. %) = 260 (100) $[M+H]^+$ (cation), 187 (14), 159 (12), 134 (10), 73 (5). HRMS calcd. for $C_{13}H_{18}N_5O$ $[M+H]^+$ 260.1511; found: 260.1514. IR ($CHCl_3$): 3440, 1620, 1598, 1565, 1487, 1436, 1404, 1382, 1375, 1327, 811, 643

General method for the cleavage of the Tol protective group

A Tol-protected compound (1.0 mmol) was dissolved in a solution of MeONa (0.3 mmol) in methanol (40 ml). The mixture was stirred at ambient temperature for 16 h, evaporated and tye residue purified by a silica gel column chromatography (methanol/chloroform 5%-15%) and crystallized from MeOH/chloroform/heptane.

6-Cyclopropyl-9-(β-D-ribofuranosyl)purine (2h)

white crystals, yield 65%, mp 158-160°C. ^{1}H NMR (600 MHz, DMSO-d_6): 1.22 and 1.27 (2 × m, 2 × 2H, H-2,3-cycloprop); 2.69 (tt, 1H, J_{vic} = 8.0, 4.8, H-1-cycloprop); 3.57 (ddd, 1H, J_{gem} = 12.0, $J_{5'b,OH}$ = 6.2, $J_{5'b,4'}$ = 4.0, H-5′b); 3.69 (ddd, 1H, J_{gem} = 12.0, $J_{5'a,OH}$ = 5.1, $J_{5'a,4'}$ = 4.0, H-5′a); 3.97 (td, 1H, $J_{4',5'}$ = 4.0, $J_{4',3'}$ = 3.6, H-4′); 4.18 (td, 1H, $J_{3',2'} = J_{3',OH}$ = 4.9, $J_{3',4'}$ = 3.6, H-3′); 4.62 (ddd, 1H, $J_{2',OH}$ = 6.0, $J_{2',1'}$ = 5.8, $J_{2',3'}$ = 4.9, H-2′); 5.16 (dd, 1H, $J_{OH,5'}$ = 6.2, 5.1, OH-5′); 5.25 (d, 1H, $J_{OH,3'}$ = 4.9, OH-3′); 5.53 (dd, 1H, $J_{OH,2'}$ = 6.0, OH-2′); 6.00 (d, 1H, $J_{1',2'}$ = 5.8, H-1′); 8.71 (s, 1H, H-2); 8.74 (s, 1H, H-8). ^{13}C NMR (151 MHz, DMSO-d_6): 11.34 and 11.37 (CH_2-2,3-cycloprop); 12.98 (CH-1-cycloprop); 61.55 (CH_2-5′); 70.57 (CH-3′); 73.86 (CH-2′); 85.91 (CH-4′); 87.84 (CH-1′); 132.45 (C-5); 144.10 (CH-8); 149.82 (C-4); 152.20 (CH-2); 163.22 (C-6). ESI-MS, m/z (rel. %) 315 (100) $[M+Na]^+$, 293 (60) $[M+H]^+$. HRMS calcd. for $C_{13}H_{17}N_4O_4$ $[M+H]^+$ 293.12498; found 293.12438. Anal. Calcd for $C_{13}H_{16}N_4O_4$: C 53.42, H 5.52, N 19.17. Found: C 53.16, H 5.41, N 18.89. IR (KBr): 3408, 3169, 3117, 3106, 3070, 1501, 1420, 1405, 1341, 1330, 1222, 1210, 811, 804, 649, 640. $[\alpha]_D$ -56.4 (*c* 0.35, MeOH).

6-Cyclopropyl-9-(2-deoxy-β-D-*erythro*-pentafuranosyl)purine (2i)

white crystals, mp 124-126°C, yield 42%. ^{1}H NMR (500 MHz, DMSO-d_6): 1.17-1.29 (m, 4H, H-2,3-cycloprop); 2.32 (ddd, 1H, J_{gem} = 13.3, $J_{2'b,1'}$ = 6.2, $J_{2'b,3'}$ = 3.4, H-2′b); 2.67 (tt, 1H, J_{vic} = 7.9, 4.7, H-1-cycloprop); 2.77 (ddd, 1H, J_{gem} = 13.3, $J_{2'a,1'}$ = 7.3, $J_{2'a,3'}$ = 5.9, H-2′a); 3.52 (ddd, 1H, J_{gem} = 11.7, $J_{5'b,OH}$ = 5.9, $J_{5'b,4'}$ = 4.5, H-5′b); 3.62 (ddd, 1H, J_{gem} = 11.7, $J_{5'a,OH}$ = 5.3, $J_{5'a,4'}$ = 4.8, H-5′b); 3.88 (ddd, 1H, $J_{4',5'}$ = 4.8, 4.5, $J_{4',3'}$ = 3.0, H-4′); 4.44 (m, 1H, $J_{3',2'}$ = 5.9, 3.4, $J_{3',OH}$ = 4.1, $J_{3',4'}$ = 3.0, H-3′); 5.03 (dd, 1H, $J_{OH,5'}$ = 5.9, 5.3, OH-5′); 5.37 (d, 1H, $J_{OH,3'}$ = 4.1, OH-3′); 6.44 (dd, 1H, $J_{1',2'}$ = 7.3, 6.2, H-1′); 8.69 (s, 2H, H-2,8). ^{13}C NMR (125.7 MHz, DMSO-d_6): 11.20 and 11.23 (CH_2-2,3-cycloprop); 12.92 (CH-1-cycloprop); 39.48 (CH_2-2′); 61.80 (CH_2-5′); 70.88 (CH-3′); 83.92 (CH-1′); 88.16 (CH-4′); 132.39 (C-5); 143.90 (CH-8); 149.51 (C-4); 152.07 (CH-2); 163.04 (C-6). FAB-MS, *m/z* (rel. %) = 277 (15) $[M+H]^+$ (cation), 161 (100), 133 (76), HRMS calcd. for $C_{13}H_{17}N_4O_3$ $[M+H]^+$ 277.1300; found: 277.1295. Anal. Calcd for $C_{13}H_{16}N_4O_3$·: C 56.51, H 5.84, N 20.28. Found: C 56.13, H 5.69, N 20.08. IR (KBr): 3420, 3357, 3183, 3113, 3079, 1632, 1595, 1582, 1499, 1421, 1405, 1338, 1324, 1206, 1100, 1067, 1059, 811, 805, 642. $[\alpha]_D$ -13.6 (*c* 0.45, MeOH).

General method for the cleavage of the TBS protective group

A TBS-protected compound (1.0 mmol) was dissolved in a solution of $NEt_3.3HF$ (1 ml, 6 mmol) in THF (3 ml). The mixture was stirred at ambient temperature for 1 day, evaporated and the residue was purified by silica gel column chromatography (methanol/chloroform 5%-15%).

6-[2-(Ethoxycarbonyl)cyclopropyl]-9-(β-D-ribofuranosyl)purine (4h)

white foam, yield 75%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, DMSO-d_6): 1.202 and 1.204 (2 × t, 2 × 3H, J_{vic} = 7.1, C**H**$_3$CH$_2$O); 1.703 and 1.705 (2 × ddd, 2 × 1H, J_{vic} = 9.0, 5.6, J_{gem} = 3.7, H-3b-cycloprop); 1.81 and 1.83 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 6.0, J_{gem} = 3.7, H-3a-cycloprop); 2.43 and 2.45 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 5.6, 4.0, H-2-cycloprop); 3.100 and 3.102 (2 × ddd, 2 × 1H, J_{vic} = 9.0, 6.0, 4.0, H-1-cycloprop); 3.569 and 3.570 (2 × ddd, 2 × 1H, J_{gem} = 12.0, $J_{5'b,OH}$ = 6.1, $J_{5'b,4'}$ = 4.0, H-5′b); 3.688 and 3.691 (2 × ddd, 2 × 1H, J_{gem} = 12.0, $J_{5'a,OH}$ = 5.0, $J_{5'a,4'}$ = 4.0, H-5′a); 3.97 (td, 2H, $J_{4',5'}$ = 4.0, $J_{4',3'}$ = 3.7, H-4′); 4.128 and 4.129 (2 × q, 2 × 2H, J_{vic} = 7.1, CH$_3$C**H**$_2$O); 4.177 and 4.185 (2 × td, 2 × 1H, $J_{3',2'}$ = $J_{3',OH}$ = 5.0, $J_{3',4'}$ = 3.7, H-3′); 4.59 and 4.60 (2 × ddd, 2 × 1H, $J_{2',OH}$ = 5.9, $J_{2',1'}$ = 5.6, $J_{2',3'}$ = 5.0, H-2′); 5.131 and 5.134 (2 × dd, 2 × 1H, $J_{OH,5'}$ = 6.1, 5.0, OH-5′); 5.26 (d, 2H, $J_{OH,3'}$ = 5.0, OH-3′); 5.537 and 5.539 (2 × d, 2 × 1H, $J_{OH,2'}$ = 5.9, OH-2′); 6.015 and 6.016 (2 × d, 2 × 1H, $J_{1',2'}$ = 5.6, H-1′); 8.78 (s, 2H, H-2); 8.809 and 8.811 (2 × s, 2 × 1H, H-8). ^{13}C NMR (151 MHz, DMSO-d_6): 14.30 (**C**H$_3$CH$_2$O); 17.42 (CH$_2$-3-cycloprop); 22.35 (CH-1-cycloprop); 24.48 and 24.56 (CH-2-cycloprop); 60.94 (CH$_3$**C**H$_2$O); 61.42 and 61.44 (CH$_2$-5′); 70.45 and 70.47 (CH-3′); 73.94 (CH-2′); 85.87 and 85.89 (CH-4′); 87.91 and 87.92 (CH-1′); 132.47 (C-5); 144.85 (CH-8); 150.36 (C-4); 152.22 (CH-2); 158.55 and 158.56 (C-6); 171.88 and 171.90 (CO). FAB-MS, *m/z* (rel. %) = 387 (25) $[M+Na]^+$ (cation), 365 (25) $[M+H]^+$ (cation), 331 (7), 309 (15), 231 (30), 207 (10), 177 (70), 154 (100), 137 (85), 109 (27), 92 (17), 79 (14), 61 (14). HRMS calcd. for $C_{16}H_{21}N_4O_6$ $[M+H]^+$ 365.1461; found: 365.1459. IR (KBr):3423, 3255, 3111, 3070, 1725, 1699, 1632, 1599, 1583, 1499, 1406, 1386, 1366, 1328, 1213, 1182, 1093, 1055, 1043, 1025, 805, 645. $[\alpha]_D$ -40.7 (*c* 0.24, MeOH).

6-[2-(Ethoxycarbonyl)cyclopropyl]-9-(2-deoxy-β-D-*erythro*-pentafuranosyl)purine (4i)

white foam, 80%. Diastereomeric mixture 1:1. ^{1}H NMR (500 MHz, DMSO-d_6): 1.196 and 1.198 (2 × t, 2 × 3H, J_{vic} = 7.1, C**H**$_3$CH$_2$O); 1.687 and 1.690 (2 × ddd, 2 × 1H, J_{vic} = 9.1, 5.6, J_{gem} = 3.7, H-3b-cycloprop); 1.80 and 1.81 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 6.2, J_{gem} = 3.7, H-3a-cycloprop); 2.34 (ddd, 2H, J_{gem} = 13.3, $J_{2'b,1'}$ = 6.3, $J_{2'b,3'}$ = 3.5, H-2′b); 2.41 and 2.43 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 5.6, 3.9, H-2-cycloprop); 2.760 and 2.764 (2 × ddd, 2 × 1H, J_{gem} = 13.3, $J_{2'a,1'}$ = 7.2, $J_{2'a,3'}$ = 5.8, H-2′a); 3.084 and 3.086 (2 × ddd, 2 × 1H, J_{vic} = 9.1, 6.2, 3.9, H-1-cycloprop); 3.52 and 3.62 (2 × ddd, 2 × 2H, J_{gem}= 12.0, $J_{5',OH}$ = 5.6, $J_{5',4'}$ = 4.5, H-5′); 3.89 (td, 2H, $J_{4',5'}$ = 4.5, $J_{4',3'}$ = 3.1, H-4′); 4.120 and 4.122 (2 × q, 2 × 2H, J_{vic} = 7.1, CH$_3$C**H**$_2$O); 4.44 (m, 2H, $J_{3',2'}$ = 5.8, 3.5, $J_{3',OH}$ = 4.2,

$J_{3',4'}$ = 3.1, H-3′); 5.010 and 5.013 (2 × t, 2 × 1H, $J_{OH,5'}$ = 5.6, OH-5′); 5.37 (dd, 2H, $J_{OH,3'}$ = 4.2, OH-3′); 6.45 (dd, 2H, $J_{1',2'}$ = 7.2, 6.3, H-1′); 8.76 (s, 4H, H-2,8). ^{13}C NMR (125.7 MHz, DMSO-d_6): 14.26 (**C**H_3CH_2O); 17.35 and 17.41 (CH_2-3-cycloprop); 22.33 (CH-1-cycloprop); 24.43 and 24.49 (CH-2-cycloprop); 39.53 (CH_2-2′); 60.88 (CH_3**C**H_2O); 61.72 (CH_2-5′); 70.80 (CH-3′); 84.00 and 84.02 (CH-1′); 88.20 (CH-4′); 132.44 (C-5); 144.70 (CH-8); 150.05 (C-4); 152.08 (CH-2); 158.41 (C-6); 171.86 and 171.87 (CO). FAB-MS, *m/z* (rel. %) = 349 (25) $[M+H]^+$ (cation), 259 (6), 233 (100), 187 (15), 159 (24), 147 (7), 134 (7), 117 (10), 73 (10). HRMS calcd. for $C_{16}H_{21}N_4O_5$ $[M+H]^+$ 349.1511; found: 349.1521. IR (micr. refl.): 3313, 2979, 2929, 2876, 1727, 1600, 1500, 1456, 1408, 1386, 1366, 1330, 1265, 1213, 1186, 1159, 1095, 1056, 994, 929, 884, 867, 843, 806, 760. $[\alpha]_D$ -9.2 (*c* 0.12, MeOH).

6-[2-(Diethylcarbamoyl)cyclopropyl]-9-(β-D-ribofuranosyl)purine (6h)

white foam, yield 95%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, DMSO-d_6): 1.019, 1.020, 1.060 and 1.062 (4 × t, 4 × 3H, J_{vic} = 7.1, C**H**$_3$$CH_2N$); 1.626 and 1.628 (2 × ddd, 2 × 1H, J_{vic} = 8.8, 5.7, J_{gem} = 3.1, H-3b-cycloprop); 1.68 and 1.69 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 5.9, J_{gem} = 3.1, H-3a-cycloprop); 2.692 and 2.694 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 5.7, 4.0, H-2-cycloprop); 3.01 (ddd, 2H, J_{vic} = 8.8, 5.9, 4.0, H-1-cycloprop); 3.25-3.50 (m, 8H, CH_3C**H**$_2$N); 3.568 and 3.570 (2 × ddd, 2 × 1H, J_{gem} = 12.1, $J_{5'b,OH}$ = 6.1, $J_{5'b,4'}$ = 4.0, H-5′b); 3.684 and 3.685 (2 × ddd, 2 × 1H, J_{gem} = 12.1, $J_{5'a,OH}$ = 5.1, $J_{5'a,4'}$ = 4.0, H-5′a); 3.973 and 3.974 (2 × td, 2 × 1H, $J_{4',5'}$ = 4.0, $J_{4',3'}$ = 3.7, H-4′); 4.18 (ddd, 2H, $J_{3',2'}$ = 5.1, $J_{3',OH}$ = 5.0, $J_{3',4'}$ = 3.7, H-3′); 4.614 and 4.615 (2 × ddd, 2 × 1H, $J_{2',OH}$ = 6.0, $J_{2',1'}$ = 5.7, $J_{2',3'}$ = 5.1, H-2′); 5.15 and 5.16 (2 × dd, 2 × 1H, $J_{OH,5'}$ = 6.1, 5.1, OH-5′); 5.270 and 5.274 (2 × d, 2 × 1H, $J_{OH,3'}$ = 5.0, OH-3′); 5.54 and 5.55 (2 × d, 2 × 1H, $J_{OH,2'}$ = 6.0, OH-2′); 6.010 and 6.011 (2 × d, 2 × 1H, $J_{1',2'}$ = 5.7, H-1′); 8.780 (s, 2H, H-2); 8.784 (s, 2H, H-8). ^{13}C NMR (151 MHz, DMSO-d_6): 13.45, 15.07 and 15.08 (**C**H_3CH_2N); 17.44 (CH_2-3-cycloprop); 21.82 and 21.87 (CH-1-cycloprop); 23.51 and 23.53 (CH-2-cycloprop); 40.69 and 41.98 (CH_3**C**H_2N); 61.53 and 61.56 (CH_2-5′); 70.57 and 70.60 (CH-3′); 73.93 and 73.95 (CH-2′); 85.96 and 85.99 (CH-4′); 87.88 (CH-1′); 132.54 (C-5); 144.65 and 144.68 (CH-8); 150.25 (C-4); 152.28 (CH-2); 160.05 and 160.06 (C-6); 169.31 (CO). FAB-MS, *m/z* (rel. %) = 392 (30) $[M+H]^+$ (cation), 260 (100), 187 (25), 159 (23), 134 (8), 102 (35), 74 (12). HRMS calcd. for $C_{18}H_{26}N_5O_5$ $[M+H]^+$ 392.1933; found: 392.1940. IR (KBr): 3401, 3112, 3070, 1632, 1617, 1598, 1580, 1491, 1406, 1382, 1331, 1218, 807, 646. $[\alpha]_D$ -42.1 (*c* 0.25, MeOH).

6-[2-(Benzyl(methyl)carbamoyl)cyclopropyl]-9-(β-D-ribofuranosyl)purine (7h)

white foam, yield 97%, mp 84-88°C. Diastereomeric mixture of amide rotamers 1:1:1:1. ^{1}H NMR (500 MHz, DMSO-d_6): 1.65-1.71 and 1.74-1.79 (2 × m, 8H, H-3-cycloprop); 2.68, 2.70, 2.82 and 2.83 (4 × ddd, 4 × 1H, J_{vic} = 8.1, 5.9, 3.9, H-2-cycloprop); 2.92 and 2.93 (2 × s, 2 × 3H, CH_3N);

2.94 and 2.96 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.4, 3.9, H-1-cycloprop); 3.02 and 3.03 (2 × s, 2 × 3H, CH_3N); 3.096 and 3.099 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.4, 3.9, H-1-cycloprop); 3.55-3.60 (m, 4H, H-5′b); 3.66-3.73 (m, 4H, H-5′a); 3.96-4.00 (m, 4H, H-4′); 4.17-4.21 (m, 4H, H-3′); 4.522 and 4.525 (2 × d, 2H, J_{gem} = 14.7, $CH_a\mathbf{H_b}Ph$); 4.582 and 4.585 (2 × d, 2H, J_{gem} = 14.7, $C\mathbf{H_a}H_bPh$); 4.60-4.66 (m, 6H, H-2′ and $CH_a\mathbf{H_b}Ph$); 4.74 (d, 2H, J_{gem} = 14.7, $C\mathbf{H_a}H_bPh$); 5.13-5.18 (m, 4H, OH-5′); 5.270, 5.274 and 5.286 (3 × d, 4H, $J_{OH,3'}$ = 5.0, OH-3′); 5.538, 5.541, 5.542 and 5.553 (4 × d, 4 × 1H, $J_{OH,2'}$ = 6.0, OH-2′); 6.01 and 6.02 (2 × d, 4H, $J_{1',2'}$ = 5.7, H-1′); 7.04-7.16, 7.20-7.28 and 7.30-7.35 (3 × m, 20H, H-*o,m,p*-Ph); 8.680 and 8.683 (2 × s, 2 × 1H, H-2); 8.769 and 8.772 (2 × s, 2 × 1H, H-8); 8.78 (s, 2H, H-2); 8.80 (s, 2H, H-8). ^{13}C NMR (125.7 MHz, DMSO-d_6): 16.9, 17.03 and 17.42 (CH_2-3-cycloprop); 21.83, 21.86, 22.29 and 22.32 (CH-1-cycloprop); 23.48, 23.52, 23.91 and 24.01 (CH-2-cycloprop); 34.75, 34.79 and 35.04 (CH_3N); 50.59 and 52.89 (CH_2Ph); 61.47 (CH_2-5′); 70.51 (CH-3′); 73.89 and 73.90 (CH-2′); 85.89 (CH-4′); 87.84 (CH-1′); 126.46 and 126.49 (CH-*o*-Ph); 127.09, 127.11 and 127.27 (CH-*p*-Ph); 127.70 (CH-*o*-Ph); 128.57, 128.60 and 128.69 (CH-*m*-Ph); 132.49 (C-5); 137.75, 137.76 and 137.84 (C-*i*-Ph); 144.41 and 144.56 (CH-8); 150.07, 150.09 and 150.21 (C-4); 151.95 and 152.16 (CH-2); 159.61 and 159.87 (C-6); 170.44 and 170.58 (CO). FAB-MS, *m/z* (rel. %) = 440 (15) $[M+H]^+$ (cation), 308 (10), 217 (15), 201 (40), 185 (50), 93 (100), 91 (66), 73 (24), 57 (25). HRMS calcd. for $C_{22}H_{26}N_5O_5$ $[M+H]^+$ 440.1933; found: 440.1940. IR (KBr): 3401, 3401, 3109, 3067, 3030, 1623, 1598, 1582, 1496, 1410, 1333, 1216, 1120, 1082, 1055, 1030, 808, 748, 699, 645. $[\alpha]_D$ -37.3 (*c* 0.49, MeOH).

6-[2-(Morpholine-4-carbonyl)cyclopropyl]-9-(β-D-ribofuranosyl)purine (8h)

white foam, yield 98%. Diastereomeric mixture 1:1. ^{1}H NMR (600 MHz, DMSO-d_6): 1.63 and 1.64 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 5.6, J_{gem} = 3.1, H-3b-cycloprop); 1.73 and 1.74 (2 × ddd, 2 × 1H, J_{vic} = 8.7, 5.5, J_{gem} = 3.1, H-3a-cycloprop); 2.762 and 2.770 (2 × ddd, 2 × 1H, J_{vic} = 8.7, 5.6, 4.0, H-2-cycloprop); 3.049 and 3.051 (2 × ddd, 2 × 1H, J_{vic} = 8.6, 5.5, 4.0, H-1-cycloprop); 3.44-3.65 (m, 18H, H-5′b and H-morph); 3.69 (ddd, 2H, J_{gem} = 12.0, $J_{5'a,OH}$ = 5.2, $J_{5'a,4'}$ = 4.0, H-5′a); 3.97 (td, 2H, $J_{4',5'}$ = 4.0, $J_{4',3'}$ = 3.6, H-4′); 4.18 (td, 2H, $J_{3',2'}$ = $J_{3',OH}$ = 4.9, $J_{3',4'}$ = 3.6, H-3′); 4.61 and 4.62 (2 × ddd, 2 × 1H, $J_{2',OH}$ = 5.8, $J_{2',1'}$ = 5.7, $J_{2',3'}$ = 4.9, H-2′); 5.143 and 5.145 (2 × dd, 2 × 1H, $J_{OH,5'}$ = 6.0, 5.2, OH-5′); 5.26 and 5.27 (2 × d, 2 × 1H, $J_{OH,3'}$ = 4.9, OH-3′); 5.54 (d, 2H, $J_{OH,2'}$ = 5.8, OH-2′); 6.01 (d, 2H, $J_{1',2'}$ = 5.7, H-1′); 8.77 (s, 2H, H-2); 8.79 (s, 2H, H-8). ^{13}C NMR (151 MHz, DMSO-d_6): 17.18 and 17.21 (CH_2-3-cycloprop); 21.72 and 21.75 (CH-1-cycloprop); 23.05 and 23.09 (CH-2-cycloprop); 42.38 and 45.72 (CH_2N-morph); 61.49 and 61.52 (CH_2-5′); 66.21 and 66.42 (CH_2O-morph); 70.53 and 70.56 (CH-3′); 73.90 and 73.93 (CH-2′); 85.92 and 85.95 (CH-4′); 87.84 and 87.86 (CH-1′); 132.55 and 132.56 (C-5); 144.62 and 144.65 (CH-8); 150.24 (C-4); 152.20 (CH-2); 159.84 (C-6); 169.09 (CO). FAB-MS, *m/z* (rel. %) = 406 (8) $[M+H]^+$ (cation), 390 (7), 274 (20), 201 (7), 185 (18), 110 (8), 102 (100), 93 (32), 75 (8), 57 (7). HRMS calcd. for $C_{18}H_{24}N_5O_6$ $[M+H]^+$ 406.1726; found: 406.1723. IR (KBr):3421, 3255, 1632, 1598,

1582, 1498, 1423, 1332, 1216, 1115, 1093, 1057, 1042, 1026, 929, 860, 806, 645. $[\alpha]_D$ -18.8 (*c* 0.42, MeOH).

6-[2-(Diethylcarbamoyl)cyclopropyl]-9-(2-deoxy-β-D-*erythro*-pentafuranosyl)purine (6i)

white foam, yield 83%. Diastereomeric mixture 1:1. ^{1}H NMR (500 MHz, DMSO-d_6): 1.02 and 1.06 (2 × t, 2 × 6H, J_{vic} = 7.1, C**H$_3$**CH$_2$N); 1.617 and 1.619 (2 × ddd, 2 × 1H, J_{vic} = 8.7, 5.6, J_{gem} = 2.9, H-3b-cycloprop); 1.67 and 1.68 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.7, J_{gem} = 2.9, H-3a-cycloprop); 2.330 and 2.333 (2 × ddd, 2 × 1H, J_{gem} = 13.3, $J_{2'b,1'}$ = 6.4, $J_{2'b,3'}$ = 3.5, H-2′b); 2.68 and 2.69 (2 × ddd, 2 × 1H, J_{vic} = 8.5, 5.6, 3.9, H-2-cycloprop); 2.768 and 2.770 (2 × ddd, 2 × 1H, J_{gem} = 13.3, $J_{2'a,1'}$ = 7.1, $J_{2'a,3'}$ = 5.9, H-2′a); 3.00 (ddd, 2H, J_{vic} = 8.7, 5.7, 3.9, H-1-cycloprop); 3.25-3.50 (m, 8H, CH$_3$C**H$_2$**N); 3.516 and 3.523 (2 × ddd, 2 × 1H, J_{gem}= 12.0, $J_{5'b,OH}$ = 6.7, $J_{5'b,4'}$ = 4.6, H-5′b); 3.61 and 3.62 (2 × ddd, 2 × 1H, J_{gem}= 12.0, $J_{5'a,OH}$ = 5.2, $J_{5'a,4'}$ = 4.6, H-5′a); 3.88 (td, 2H, $J_{4',5'}$ = 4.6, $J_{4',3'}$ = 2.8, H-4′); 4.44 (m, 2H, $J_{3',2'}$ = 5.9, 3.5, $J_{3',OH}$ = 4.1, $J_{3',4'}$ = 2.8, H-3′); 5.02 and 5.03 (2 × dd, 2 × 1H, $J_{OH,5'}$ = 6.1, 5.2, OH-5′); 5.38 (dd, 2H, $J_{OH,3'}$ = 4.1, OH-3′); 6.45 (dd, 2H, $J_{1',2'}$ = 7.1, 6.4, H-1′); 8.75 (s, 2H, H-8); 8.77 (s, 2H, H-2). ^{13}C NMR (125.7 MHz, DMSO-d_6): 13.37 and 15.00 (**C**H$_3$CH$_2$N); 17.31 (CH$_2$-3-cycloprop); 21.74 and 21.79 (CH-1-cycloprop); 23.40 (CH-2-cycloprop); 39.46 (CH$_2$-2′); 40.60 and 41.89 (CH$_3$**C**H$_2$N); 61.76 and 61.77 (CH$_2$-5′); 70.85 and 70.86 (CH-3′); 83.95 (CH-1′); 88.19 (CH-4′); 132.48 (C-5); 144.46 and 144.48 (CH-8); 149.90 (C-4); 152.11 (CH-2); 159.85 and 159.86 (C-6); 169.24 (CO). FAB-MS, *m/z* (rel. %) = 398 (60) $[M+Na]^+$ (cation), 376 (7) $[M+H]^+$ (cation), 308 (10), 282 (45), 260 (100), 217 (15), 187 (30), 177 (10), 159 (40), 137 (10), 117 (7), 109 (10), 100 (7), 79 (7), 72 (14), 61 (6). HRMS calcd. for $C_{18}H_{26}N_5O_4$ $[M+H]^+$ 376.1984; found: 376.1992. Anal. Calcd for $C_{18}H_{25}N_5O_4 \cdot 0.5H_2O$: C 56.24, H 6.82, N 18.22. Found: C 56.16, H 6.79, N 19.97. IR (KBr): 3428, 3111, 3073, 1631, 1621, 1597, 1581, 1490, 1424, 1424, 1405, 1381, 1362, 1329, 1217, 1097, 1058, 807, 646. $[\alpha]_D$ -5.1 (*c* 0.21, MeOH).

6-[2-(Hydroxymethyl)cyclopropyl]-9-(β-D-ribofuranosyl)purine (10h)

white foam, yield 76%. Diastereomeric mixture 2:1 (after repeated column chromatography). ^{1}H NMR (500 MHz, DMSO-d_6): 1.20 and 1.41 (2 × m, 2 × 2H, H-3-cycloprop); 1.93 (m, 2H, H-2-cycloprop); 2.60 (dt, 2H, J_{vic} = 8.2, 4.5, H-1-cycloprop); 3.45 (dt, 2H, J_{gem} = 11.3, J_{vic} = $J_{Hb,OH}$ = 5.7, CH$_a$**H$_b$**O); 3.55 (ddd, 2H, J_{gem} = 11.8, $J_{5'b,OH}$ = 5.7, $J_{5'b,4'}$ = 4.0, H-5′b); 3.59 (dt, 2H, J_{gem} = 11.3, J_{vic} = $J_{Ha,OH}$ = 5.7, C**H$_a$**H$_b$O); 3.69 (dt, 2H, J_{gem} = 11.8, $J_{5'a,OH}$ = 5.7, $J_{5'a,4'}$ = 4.0, H-5′a); 3.97 (td, 2H, $J_{4',5'}$ = 4.0, $J_{4',3'}$ = 3.6, H-4′); 4.18 (ddd, 2H, $J_{3',OH}$ = 4.9, $J_{3',2'}$ = 4.7, $J_{3',4'}$ = 3.6, H-3′); 4.60 and 4.61 (2 × ddd, 2 × 1H, $J_{2',OH}$ = 6.0, $J_{2',1'}$ = 5.7, $J_{2',3'}$ = 4.7, H-2′); 4.75 (t, 2H, J = 5.7, OH); 5.16 (t, 2H, $J_{OH,5'}$ = 5.7, OH-5′); 5.24 (d, 2H, $J_{OH,3'}$ = 4.9, OH-3′); 5.519 and 5.523 (2 × d, 2 × 1H, $J_{OH,2'}$ = 6.0, OH-2′); 5.997 and 5.999 (2 × d, 2 × 1H, $J_{1',2'}$ = 5.7, H-1′); 8.70 (s, 2H, H-2); 8.726 and 8.729 (2 × s, 2 × 1H, H-8). ^{13}C NMR (125.7 MHz, DMSO-d_6): 15.61 and 15.64 (CH$_2$-3-

cycloprop); 18.24 (CH-1-cycloprop); 27.53 and 27.61 (CH-2-cycloprop); 61.52 and 61.54 (CH_2-5′); 62.75 and 62.77 (CH_2O); 70.55 and 70.57 (CH-3′); 73.85 and 73.91 (CH-2′); 85.88 and 85.91 (CH-4′); 87.82 and 87.87 (CH-1′); 132.27 and 132.29 (C-5); 143.98 and 144.02 (CH-8); 149.80 (C-4); 152.13 (CH-2); 162.79 and 162.80 (C-6).FAB-MS, *m/z* (rel. %) = 323 (10) $[M+H]^+$ (cation), 239 (60), 219 (40), 203 (14), 191 (40), 173 (20), 149 (68), 128 (18), 102 (100), 57 (32). HRMS calcd. for $C_{14}H_{19}N_4O_5$ $[M+H]^+$ 323.1357; found: 323.1355. IR (KBr): 3421, 3260, 3113, 1632, 1600, 1581, 1497, 1420, 1399, 1333, 1215, 1128, 1095, 1060, 1027, 809, 643. $[\alpha]_D$ -35.2 (*c* 0.20, MeOH).

6-[2-(Hydroxymethyl)cyclopropyl]-9-(2-deoxy-β-D-*erythro*-pentafuranosyl)purine (10i)

white foam, yield 44%. Diastereomeric mixture 1:1. ^{1}H NMR (500 MHz, DMSO-d_6): 1.17 and 1.40 (2 × m, 2 × 2H, H-3-cycloprop); 1.92 (m, 2H, H-2-cycloprop); 2.32 (ddd, 2H, J_{gem} = 13.3, $J_{2'b,1'}$ = 6.2, $J_{2'b,3'}$ = 3.4, H-2′b); 2.59 (dt, 2H, J_{vic} = 8.6, 4.5, H-1-cycloprop); 2.76 (ddd, 2H, J_{gem} = 13.3, $J_{2'a,1'}$ = 7.2, $J_{2'a,3'}$ = 5.8, H-2′a); 3.45 (dd, 2H, J_{gem} = 11.4, J_{vic} = 6.5, $CH_a\mathbf{H_b}O$); 3.52 (dd, 2H, J_{gem} = 11.8, $J_{5'b,4'}$ = 4.5, H-5′b); 3.58 (dd, 2H, J_{gem} = 11.4, J_{vic} = 5.4, $C\mathbf{H_a}H_bO$); 3.62 (dd, 2H, J_{gem} = 11.8, $J_{5'a,4'}$ = 4.5, H-5′b); 3.88 (td, 2H, $J_{4',5'}$ = 4.5, $J_{4',3'}$ = 3.0, H-4′); 4.44 (ddd, 2H, $J_{3',2'}$ = 5.8, 3.4, $J_{3',4'}$ = 3.0, H-3′); 6.44 (dd, 2H, $J_{1',2'}$ = 7.2, 6.2, H-1′); 8.683 and 8.685 (2 × s, 2 × 1H, H-8); 8.691 (s, 2H, H-2). ^{13}C NMR (125.7 MHz, DMSO-d_6): 15.54 and 15.57 (CH_2-3-cycloprop); 18.21 (CH-1-cycloprop); 27.46 and 27.53 (CH-2-cycloprop); 39.47 (CH_2-2′); 61.80 (CH_2-5′); 62.75 (CH_2O); 70.87 and 70.89 (CH-3′); 83.92 and 83.94 (CH-1′); 88.16 (CH-4′); 132.23 and 132.24 (C-5); 143.85 (CH-8); 149.53 (C-4); 152.01 (CH-2); 162.64 (C-6). ESI-MS, m/z (rel. %) 329 (30) $[M+Na]^+$, 307 (35) $[M+H]^+$, 238 (37), 190 92). HRMS calcd. for $C_{14}H_{18}N_4O_4Na$ $[M+Na]^+$ 329.1226; found 329.1222. IR ($CHCl_3$): 3436, 1632, 1598, 1434, 1399, 1334, 1217, 1098, 1079, 1059, 1037, 641. $[\alpha]_D$ -5.6 (*c* 0.54, MeOH).

X-ray diffraction

X-ray crystallographic analysis of single crystals of **6a** (colourless, 0.01 x 0.01 x 0.59 mm) and **2g** (colourless, 0.07 x 0.37 x 0.44 mm) was performed with Xcalibur X-ray diffractometr with $Cu_{K\alpha}$ (λ=1.54180 Å), data collected at 150K. Both structures were solved by direct methods with SIR92[8] and refined by full-matrix least-squares on F with CRYSTALS[9]]. The hydrogen atoms were all located in a difference map, but those attached to carbon atoms were repositioned geometrically and then refined with riding constraints, while all other atoms were refined anisotropically in both cases.

Crystal data **2g**: $C_8H_8N_4$, monoclinic, space group *C2/m*, *a* = 13.6246(3) Å, *b* = 20.3049(5) Å, *c* = 9.4369(2) Å, β = 99.789(2)°, *V* = 743.25(3) Å^3, *Z* = 4, *M* = 160.18, 11926 reflections measured, 820 independent reflections. Final *R* = 0.0409, *wR* = 0.0577, *GoF* = 0.9440 for 723 reflections with $I > 2\sigma(I)$ and 75 parameters.

Crystal data **6a**: $C_{20}H_{23}N_5O_1$, orthorhombic, space group *Pna2₁*, a = 22.2791(2) Å, b = 7.0143(1) Å, c = 7.8922(2) Å, V = 1796.64(2) Å^3, Z = 4, M = 349.44, 26954 reflections measured, 3604 independent reflections. Final R = 0.0296, wR = 0.0328, GoF = 1.0836 for 2807 reflections with $I > 2\sigma(I)$ and 237 parameters.

CCDC 677191 (**2g**) and CCDC 677192 (**6a**) contain the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

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