Electronic Supplementary Information

Highly Diastereoselective Synthesis of Modified Nucleosides via an Asymmetric Multicomponent Reaction

Arun K. Ghosh,* and Jorden P. Kass

Departments of Chemistry and Medicinal Chemistry, Purdue University,

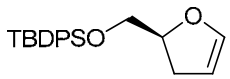
West Lafayette, IN 47907

Table of Contents

Experimentals

All moisture sensitive reactions were carried out under nitrogen or argon atmosphere. Anhydrous solvents were obtained as follows: THF, diethyl ether and benzene, distilled from sodium and benzophenone; dichloromethane, pyridine, triethylamine, and diisopropylethylamine, distilled from CaH_2. All other solvents were HPLC grade. Column chromatography was performed with Whatman 240-400 mesh silica gel under low pressure of 5-10 psi. TLC was carried out with E. Merck silica gel 60-F-254 plates. ^{1}H and ^{13}C NMR spectra were recorded on Varian Mercury 300, Bruker Avance 400 and 500 spectrometers.

I. Preparation of dihydrofuran 5:



5

Lactone **3** (3.41g, 29.4 mmol) is dissolved in DMF (40 mL). To this is added imidazole (4.18g, 59.8 mmol) which is allowed to stir for 1 hour. Then *tert*-butylchlorodiphenylsilane (11.2 mL, 44.1 mmol) is added dropwise. This is then allowed to stir overnight at room temperature. The reaction mixture is then quenched with sat. $NaHCO_3$ (20 mL). The reaction mixture is then extracted with diethyl ether (150 mL) which is then washed with water (3 x 50 mL) and brine (50 mL). The ether layer is then dried over $NaSO_4$ and concentrated *in vacuo*. The crude material was then purified via flash chromatography (10% EtOAc in hexanes) to give product (9.05g, 87% yield).

To solution of lactone **4** (5.96 g, 16.9 mmol) in dichloromethane (55 mL) at –78 °C was added Dibal-H (1.0 M in dichloromethane, 20.0 mL, 20.0 mmol) dropwise over 30 minutes. The reaction mixture was stirred for 1 hours at that temperature and was quenched by addition of methanol (10 mL). The mixture was then allowed to warm up to room temperature , washed with saturated solution of NaKtartrate (25 mL) and brine (25 mL), dried over $NaSO_4$ and concentrated *in vacuo*. The crude lactol was used without further purification (5.97g, quant)

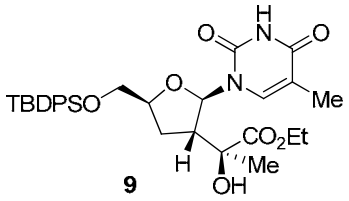
To a solution of crude lactol (5.97g, 16.9 mmol) in dichloromethane (84 mL) at cooled -50 °C was added triethylamine (9.4 mL, 67 mmol), followed by addition of mesyl chloride (1.8 mL, 23.6 mmol). This was allowed to stir at -50 °C for 1.5 hours at which time the reaction mixture was heated to reflux for 1.5 hours. The reaction mixture was then washed with water (50 mL) and brine (50 mL), dried over $NaSO_4$ and concentrated *in vacuo*. The crude material was then purified via flash chromatography (10% EtOAc in hexanes) to give dihydrofuran **5**.

II. General Experimental Procedure for multicomponent Nucleoside synthesis

Dihydrofuran (85 mg , 0.25 mmol) and ethylpyruvate (34 μL, 0.3 mmol, 1.2 eq) was dissolved in DCM (3 mL) under argon. This was then cooled to –78 ˚C followed by addition of $TiCl_4$ (0.3 mL, 1.0M, 0.3 mmol, 1.2 eq). This was allowed to stir for 1 h. The TMS protected nucleoside (prepared according to either method A, B) was then added. The reaction was then stirred at 1 h at –78 ˚C followed by warming to 23 ˚C and stirring for 1 h. The reaction was then cooled back to –78 ˚C and quenched with $NaHCO_3$ (aq, conc). The reaction mixture was then allowed back to 23 ˚C then filtered through celite. The filtrate was then extracted with DCM (3 x 10 mL). The organics were then washed with brine, dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The crude material was then purified via flash chromatography.

Method A: Commercially available, O,O`-Bis(trimethylsilyl)thymine (405 mg, 1.5 mmol, Sigma-Aldrich) was added as a solid to the reaction mixture.

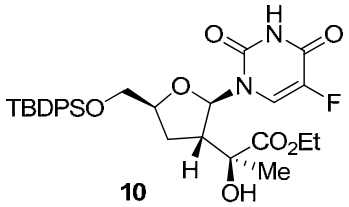
Method B: Silylated nucleoside was prepared as follows. To a suspension of nucleoside (0.75 mmol, 3 eq) in dichloromethane (4 mL) were added triethylamine (209 μL, 1.5 mmol, 6 eq), followed by trimethylsilyl triflate (271 μL, 6 eq). The resulting reaction mixture was stirred until clear, about 30 min. The mixture was typically transferred via cannula to the multicomponent reaction.



9

ethyl 2-((2R,3S,5S)-5-((tert-butyldiphenylsilyloxy)methyl)-2-(5-methyl-2,4-dioxo-3,4-dihydropyrimidin-1(2H)-yl)tetrahydrofuran-3-yl)-2-hydroxypropanoate (9)

Prepared via method A, purified with 60% EtOAc in hexanes. (70%) $[\alpha]_D^{23}$ +37.7 (*c* 1.12, $CHCl_3$). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 9.08 (s, 1H), 7.66 (d, J=6.5 Hz, 4 H), 7.43-7.35 (m, 7H), 6.33 (d, J=6.5 Hz, 1H), 4.38-4.18 (m, 4H), 3.98 (dd, J=9.1, 2.4 Hz, 1H), 3.68 (dd, J=8.6, 2.9 Hz, 1H), 2.76-2.70 (m, 1H), 2.25-2.18 (m, 1H), 2.20-1.86 (m, 1H), 1.58 (s, 3H), 1.42 (s, 3H), 1.32 (t, J=7.1, 3H), 1.11 (s, 9H). **^{13}C NMR** ($CDCl_3$, 100 MHz) δ 175.7, 163.7, 150.2, 135.8, 135.4, 135.2, 133.2, 132.6, 129.9, 129.8, 127.8, 127.7, 111.7, 85.1, 78.7, 77.2, 74.1, 65.1, 62.4, 51.3, 28.3, 27.0, 24.7, 19.4, 14.1, 11.9. **FTIR** (NaCl) ν_{max} = 2955, 2929, 1698, 1684, 1472, 1457, 1258, 1112, 703. **ESI (+) LRMS** *m/z* (relative intensity): $[M+Na]^+$ 603.14 (100%). **ESI (+) HRMS** (*m/z*): [M]+ calcd for $C_{31}H_{40}N_2O_7Si$ 603.2503; found, 603.2506.

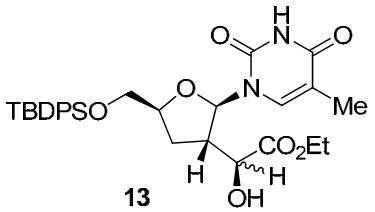


10

ethyl 2-((2R,3S,5S)-5-((tert-butyldiphenylsilyloxy)methyl)-2-(5-fluoro-2,4-dioxo-3,4-dihydropyrimidin-1(2H)-yl)tetrahydrofuran-3-yl)-2-hydroxypropanoate (10)

Prepared via method B, purified with 60% EtOAc in hexanes. (65%) $[\alpha]_D^{23}$ +50.3 (*c* 0.72, $CHCl_3$). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 9.79 (d, J_{H-F}=4.2 Hz, 1H), 7.91 (d, J=5.7 Hz, 1H), 7.67-7.64 (m, 4H), 7.45-7.39 (m, 6H), 6.32 (dd, J=3.9, 1.4 Hz, 1H), 4.40-4.23 (m, 3H), 4.00 (dd, J=9.8, 2.0 Hz, 1H), 3.63 (s, 1H), 3.62 (dd, J=9.1, 2.5 Hz, 1H), 2.74-2.68 (m, 1H) 2.24-2.16 (m, 1H), 1.91-1.85 (m, 1H), 1.48 (s, 3H), 1.32 (t, J=7.1, 3H), 1.11 (s, 9H). **^{13}C NMR** ($CDCl_3$, 100 MHz) δ 175.7, 157.2, 156.9, 148.9, 141.9, 139.5, 135.5, 135.4, 132.6, 132.5, 130.0, 129.9, 127.8, 127.6, 124.5, 124.2, 86.0, 79.9, 74.5, 64.8, 62.5, 60.4, 52.3, 28.0, 26.9, 26.8, 25.0, 19.2, 14.1. **^{19}F NMR** ($CDCl_3$, 376 MHz) δ -164. **FTIR** (NaCl) ν_{max} = 3446,

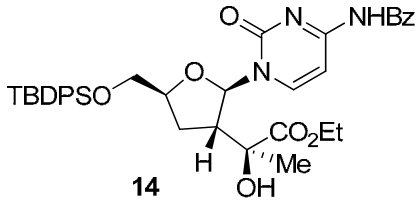
3197, 3027, 2931, 2858, 1720, 1708, 1669, 1471, 1428, 1393, 1363, 1252, 1113, 1068, 758, 702 . **ESI (+) LRMS** *m/z* (relative intensity): 606.99 (100%), 607.99 (35%). **ESI (+) HRMS** (*m/z*): [M+Na]+ calcd for $C_{30}H_{37}N_2O_7FSi$ 607.2252; found, 607.2262.



13

(S)-ethyl 2-((2R,3S,5S)-5-((tert-butyldiphenylsilyloxy)methyl)-2-(5-methyl-2,4-dioxo-3,4-dihydropyrimidin-1(2H)-yl)tetrahydrofuran-3-yl)-2-hydroxyacetate (13)

Prepared via method A with 5% MeOH in $CHCl_3$. (45%) $[\alpha]_D^{23}$ +29.6 (*c* 0.62, $CHCl_3$). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 9.88 (d, *J* = 5.4, 1H), 9.50 (s, 1H), 7.72 – 7.64 (m, 5H), 7.48 – 7.33 (m, 8H), 6.93 (d, *J* = 5.5, 1H), 6.77 (dd, *J* = 8.0, 5.0, 1H), 4.71 – 4.61 (m, 1H), 4.37 – 4.25 (m, 1H), 3.79 – 3.61 (m, 2H), 2.61 – 2.30 (m, 2H), 2.11 – 1.91 (m, 2H), 1.88 (d, *J* = 7.6, 3H), 1.64 (s, 1H), 1.09 – 1.02 (m, 9H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 164.0, 152.8, 135.6, 135.5, 135.3, 134.6, 133.5, 133.4, 133.1, 129.9, 129.8, 129.5, 127.8, 127.7, 127.6, 110.5, 85.7, 84.4, 82.3, 81.6, 80.7, 66.4, 65.1, 32.3, 29.5, 28.3, 26.9, 26.8, 25.4, 19.3, 19.2, 13.9, 12.8, 12.1. **FTIR** (NaCl) ν_{max} = 3241, 2958, 2930, 2858, 1962, 1899, 1714, 1652, 1472, 1428, 1390, 1265, 1230, 1113, 1077, 998, 823, 743, 703. **ESI (+) LRMS** *m/z* (relative intensity): 487.12 (Na^+) (100%), 488.13 (Na^+) (31%).

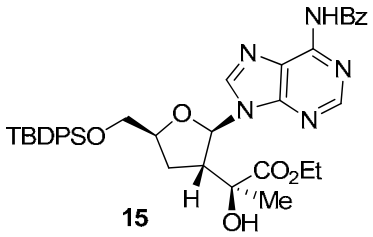


14

ethyl 2-((2R,3S,5S)-2-(4-benzamido-2-oxopyrimidin-1(2H)-yl)-5-((tert-butyldiphenylsilyloxy)methyl)tetrahydrofuran-3-yl)-2-hydroxypropanoate (14)

Prepared via method B, purified with 60% EtOAc in hexanes. (53%) $[\alpha]_D^{23}$ +59.1 (*c* 0.11, $CHCl_3$). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 9.00(brs, 1H), 8.46 (d, J=7.4 Hz, 1H), 7.92 (d, J=7.5 Hz, 2H), 7.68-7.65 (m,

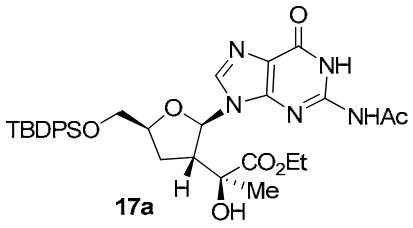
4H), 7.58 (t, J=7.4 Hz, 1H), 7.59-7.38 (m, 9H), 6.43 (d, J=3.6 Hz, 1H), 4.36 (dd, J=6.8, 2.1 Hz, 1H), 4.30-4.20 (m, 1H), 4.25 (t, J=6.8 Hz, 2H), 4.09 (dd, J=9.7, 2.2 Hz, 1H), 3.66 (dd, J=9.3, 2.6 Hz, 1H), 2.74-2.70 (m, 1H), 2.35-2.27 (m, 1H), 1.87-1.81 (m, 1H), 1.58 (s, 3H), 1.30 (t, J=7.2, 3H), 1.13 (s, 9H). **^{13}C NMR** ($CDCl_3$, 100 MHz) δ 175.6, 162.1, 145.1, 135.5, 135.4, 133.0, 132.7, 132.4, 130.0, 128.8, 127.9, 127.7, 127.6, 87.7, 81.4, 75.4, 64.3, 62.1, 54.9, 27.7, 26.9(3), 25.5, 19.8, 14.1. **FTIR** (NaCl) ν_{max} = 3312, 2930, 2858, 1729, 1699, 1668, 1624, 1558, 1486, 1391, 1301, 1256, 1220, 1113, 772, 703. **ESI (+) LRMS** *m/z* (relative intensity): 669.26(40%) 668.27 (100%). **ESI (+) HRMS** (*m/z*): [M]+ calcd for $C_{37}H_{43}N_3O_7Si$ 670.2929; found, 670.2952.



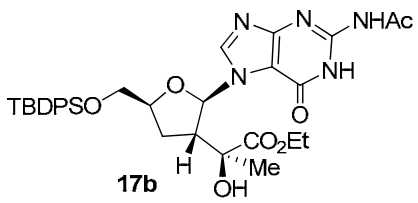
15

ethyl 2-((2R,3S,5S)-2-(6-benzamido-9H-purin-9-yl)-5-((tert-butyldiphenylsilyloxy)methyl)tetrahydrofuran-3-yl)-2-hydroxypropanoate (15)

Prepared via method B, purified with 60% EtOAc in hexanes. (60%) $[\alpha]_D^{23}$ +25.2 (*c* 0.23, $CHCl_3$). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 9.52 (brs, 1H), 8.78 (s, 1H), 8.31 (s, 1H), 8.02 (d, J=7.4 Hz, 2H), 7.67-7.34 (m, 13H), 6.46 (d, J=5.9 Hz, 1H), 4.37-4.32 (m, 1H), 4.29-4.27 (m, 2H), 3.94 (dd, J=4.0, 7.2 Hz, 1H), 3.72 (dd, J=4.1, 7.1Hz, 1H), 3.69 (brs, 1H), 3.36-3.31 (m, 1H), 2.35-2.30 (m, 1H), 2.07-2.98 (m, 1H), 1.30 (s, 3H), 1.29-1.22 (m, Hz, 3H), 1.09 (s, 9H). **^{13}C NMR** ($CDCl_3$, 100 MHz) δ 175.6, 152.5, 141.8, 135.5, 135.4, 133.0, 132.8, 132.6, 129.9, 129.8, 128.7, 128.2, 128.0, 127.8, 127.7, 87.0, 85.6, 80.3, 74.2, 65.3, 62.5, 51.6, 28.7, 26.9, 26.9, 24.9, 19.2, 14.1. FTIR (NaCl) ν_{max} = 3311, 2931, 2858, 1734, 1704, 1636, 1610, 1582, 1455, 1255, 1219, 1113, 772, 704. **ESI (+) LRMS** *m/z* (relative intensity): 693.79 (100%), 694.81 (37%). **ESI (+) HRMS** (*m/z*): [M]+ calcd for $C_{38}H_{43}N_5O_6Si$ 694.3061; found, 694.3065.



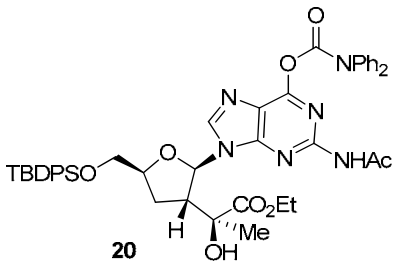
17a



17b

ethyl 2-((2R,3S,5S)-2-(2-acetamido-6-oxo-1H-purin-9(6H)-yl)-5-((tert-butyldiphenylsilyloxy)methyl)tetrahydrofuran-3-yl)-2-hydroxypropanoate, mixture of isomers (17)

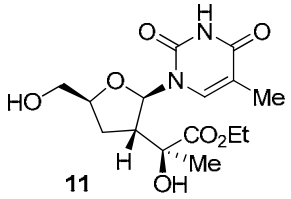
Prepared via method B, except 9 eq of triethyl amine and 9 eq of trimethylsilyltriflate were used, purified with 100% EtOAc. (44%) $[\alpha]_D^{23}$ +40.7 (*c* 0.14, $CHCl_3$). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 12.50 (s, 1H, major), 12.37 (s, 1H, minor), 11.42 (s, 1H, minor), 10.50 (s, 1H, major), 8.27 (s, 1H, minor), 8.02 (s, 1H, minor), 7.65-7.61 (m, 4H) 7.41-7.31 (m, 6H), 6.61 (d, J=5.4, 1H, minor), 6.20 (d, J=6.0, 1H, major), 4.31-4.18 (m, 3H), 3.97 (s, 1H, major) 3.72 (s, 1H, minor), 3.93-3.64 (m, 2H), 3.11-3.02 (m, 1H), 2.35 (s, 3H, minor), 2.22 (s, 3H, major), 1.36 (s, 3H, minor), 1.21 (s, 3H, major), 1.06 (s, 9H). **Major Isomer 17a**, **^{1}H NMR** ($CDCl_3$, 400 MHz) 12.06 (s, 1H), 9.11 (s, 1H), 7.97 (s, 1H), 7.65 – 7.61 (m, 4H), 7.41 – 7.33 (m, 6H), 6.22 (d, *J* = 6.5, 1H), 4.34 – 4.12 (m, 3H), 3.96 (s, 1H), 3.85 (dd, *J* = 11.3, 3.5, 1H), 3.69 – 3.60 (m, 2H), 3.09 (dd, *J* = 16.1, 7.1, 1H), 2.22 (s, 3H), 2.25 – 2.14 (m, 1H), 2.02 (dt, *J* = 12.7, 7.7, 1H), 1.30 (t, *J* = 3.9, 3H), 1.19 (s, 3H), 1.07 (s, 9H). **Minor Isomer 17b, ^{1}H NMR** (400 MHz, $CDCl_3$) δ 11.98 (s, 1H), 8.74 (s, 1H), 7.75 – 7.65 (m, 4H), 7.61 (s, 1H), 7.49 – 7.33 (m, 7H), 6.35 (d, *J* = 5.9, 1H), 4.65 (d, *J* = 7.6, 1H), 4.05 – 3.86 (m, 2H), 3.77 (dd, *J* = 10.9, 4.1, 2H), 3.67 (dd, *J* = 11.0, 3.2, 1H), 3.37 – 3.23 (m, 1H), 2.74 – 2.54 (m, 1H), 2.25 (s, 3H), 2.19 – 2.11 (m, 1H), 1.38 (s, 3H), 1.18 (dd, *J* = 9.0, 5.3, 3H), 1.09 (s, 9H). **^{13}C NMR** ($CDCl_3$, 100 MHz) δ 175.7, 175.3, 173.3, 171.9, 171.1, 156.9, 156.5, 152.8, 148.2, 147.4, 142.1, 137.4, 135.5, 135.8, 133.0, 132.8, 132.7, 129.8, 129.8, 127.7, 120.8, 111.2, 87.6, 84.5, 80.3, 79.9, 77.6, 77.5, 77.2, 74.3, 74.0, 65.5, 62.5, 62.4, 60.3, 53.8, 52.5, 28.6, 28.6, 27.1, 26.9, 24.9, 24.6, 24.4, 24.4, 21.0, 19.2, 14.1, . **FTIR** (NaCl) ν_{max} = 3167, 2931, 2857, 1681, 1615, 1558, 1472, 1428, 1373, 1256, 1113, 754, 702. **ESI (+) LRMS** *m/z* (relative intensity): 647.82 (100%). **ESI (+) HRMS** (*m/z*): [M]+ calcd for $C_{33}H_{41}N_5O_7Si$ 648.2854; found, 648.2845.



20

ethyl 2-((2R,3S,5S)-2-(2-acetamido-6-(diphenylcarbamoyloxy)-9H-purin-9-yl)-5-((tert-butyldiphenylsilyloxy)methyl)tetrahydrofuran-3-yl)-2-hydroxypropanoate (20)

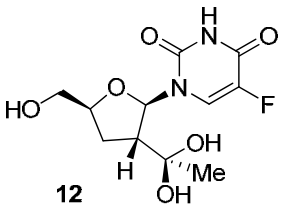
Prepared via method B, purified with 90% EtOAc in hexanes. (38%) $[\alpha]_D^{23}$ +13.7 (*c* 0.45, $CHCl_3$). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 8.43 (s, 1H), 8.11 (s, 1H), 7.64-7.61 (m, 4H), 7.44-7.41 (m, 7H), 7.38-7.33 (m, 9H), 6.21 (d, J=6.6 Hz, 1H), 4.40-4.15 (m, 3H), 3.82 (dd, J=8.1, 3.3 Hz, 1H), 3.64 (dd, J=7.8, 3.4 Hz, 1H), 3.55 (s, 1H), 3.01 (dd, J=8.7, 7.3 Hz, 1H), 2.65 (s, 3H), 2.10-2.03 (m, 1H), 1.87-1.84 (m, 1H), 1.44 (s, 3H), 1.30 (t, J=7.1 Hz, 3H), 1.10 (s, 9H). **^{13}C NMR** ($CDCl_3$, 100 MHz) δ 175.6, 164.8, 152.2, 151.4, 149.8, 146.3, 135.7, 135.5, 135.4, 132.8, 132.6, 129.9, 129.3, 127.8, 127.8, 125.5, 111.1, 86.8, 79.4, 73.4, 67.9, 66.6, 62.7, 52.5, 34.1, 30.2, 28.5, 26.9, 26.7, 25.5, 25.2, 24.8, 19.2, 14.1. **FTIR** (NaCl) ν_{max} = 3304, 2931, 2858, 1748, 1633, 1569, 1492, 1374, 1300, 1234, 1113, 1020, 982, 757, 701. **ESI (+) LRMS** *m/z* (relative intensity): 842.84 (100%), 843.91 (47%). **ESI (+) HRMS** (*m/z*): [M]+ calcd for $C_{46}H_{50}N_6O_8Si$ 843.3538; found, 845.3532.



11

To a solution of **9** (16.4mg, 0.028 mmol) in THF (4.5 mL) in a Nalgene bottle is added HF/pyridine (0.5 mL, 30% HF). This is allowed to stir for 4 hours until complete conversion by TLC (10% MeOH in $CHCl_3$). The reaction is then quenched with $NaHCO_3$ (sat., 6 mL). The reaction mixture is then diluted

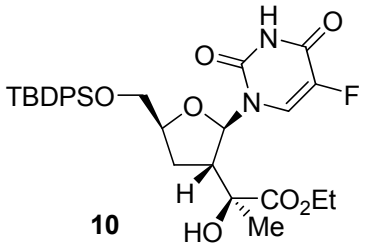
with EtOAc (15 mL) and extracted. The organic layer is washed with brine (5 mL). The organic layer is dried with Na_2SO_4, and concentrated *in vacuo*. The crude is purified via column chromatography (7% MeOH in $CHCl_3$). 8.4mg, 87% yield. $[\alpha]_D^{23}$ +19.6 (*c* 0.84, $CHCl_3$). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 8.78 (s, 1H), 7.32 (d, J=1.0 Hz, 1H), 6.07 (d, J=5.7 Hz, 1H), 4.27 (q, J=7.1, 7.1, 2H), 4.25-4.22 (m, 1H), 3.91 (dd, J=2.4, 12.1, 1H), 3.60 (dd, J=3.4, 12.1, 1H), 2.90-2.85 (m, 1H), 2.18 (ddd, J=8.0, 10.3, 12.8, 1H), 1.94 (s, 3H), 1.87-1.81 (m, 1H), 1.40 (s, 3H), 1.31 (t, J=7.1, 7.1, 3H) **^{13}C NMR** ($CDCl_3$, 100 MHz) δ 175.7, 163.5, 150.1, 137.3, 111.6, 88.2, 79.8, 74.5, 63.6, 62.5, 50.7, 28.3, 24.8, 14.1, 12.5. **FTIR** (NaCl) ν_{max} = 3054, 2983, 2931, 1694, 1470, 1378, 1260, 1219, 1107, 1022, 772. **ESI (+) LRMS** *m/z* (relative intensity): 365.05 (Na^+) (100%), 366.03 (Na^+) (17%).



12

To a solution of **10** (15.6mg, 0.028 mmol) in THF (4.5 mL) in a Nalgene bottle is added HF/pyridine (0.5 mL, 30% HF). This is allowed to stir for 4 hours until complete conversion by TLC (10% MeOH in $CHCl_3$). The reaction is then quenched with $NaHCO_3$ (sat., 6 mL). The reaction mixture is then diluted with EtOAc (15 mL) and extracted. The organic layer is washed with brine (5 mL). The organic layer is dried with Na_2SO_4, and concentrated *in vacuo*. The crude is purified via column chromatography (7% MeOH in $CHCl_3$). 7.6mg, % yield. $[\alpha]_D^{23}$ +34.6 (*c* 0.76, $CHCl_3$). **^{1}H NMR** ($CDCl_3$, 500 MHz) δ 8.71 (s, 1H), 7.94 (d, J=6.3, 1H), 6.19 (dd, J=1.5, 5.2, 1H), 4.31-4.21 (m, 3H), 3.97 (dd, J=2.3, 11.9, 1H), 3.65 (dd, J=3.0, 11.9, 1H), 2.76 (dt, J=5.3, 5.3, 10.3, 1H), 2.18 (ddd, J=7.8, 10.0, 13.0), 1.87 (ddd, J=5.4, 7.5, 13.0, 1H), 1.45 (s, 3H), 1.32 (t, J=7.2, 7.2, 3H) **^{13}C NMR** ($CDCl_3$, 100 MHz) δ 175.6, 148.4, 125.4, 125.1, 87.3, 80.1, 74.5, 63.4, 62.6, 51.8, 29.6, 28.0, 24.9, 14.1. **^{19}F NMR** ($CDCl_3$, 376 MHz) δ -165. **FTIR** (NaCl) ν_{max} = 2986, 2929, 1714, 1470, 1377, 1252, 1220, 1106, 1022, 772.

III. X-ray Crystallographic Data



10

Ethyl 2-((2R,3S,5S)-5-((tert-butyldiphenylsilyloxy)methyl)-2-(5-fluoro-2,4-dioxo-3,4-dihydropyrimidin-1(2H)-yl)tetrahydrofuran-3-yl)-2-hydroxypropanoate (10)

EXPERIMENTAL

DATA COLLECTION

A colorless needle of $C_{30}H_{37}FN_2O_7Si$ having approximate dimensions of 0.18 x 0.10 x 0.08 mm was mounted on a fiber in a random orientation. Preliminary examination and data collection were performed Cu K_α radiation (λ = 1.54184Å) on a Rigaku Rapid II equipped with confocal opticsconfocal optics.

Cell constants for data collection were obtained from least-squares refinement, using the setting angles of 16004 reflections in the range $3 < \theta < 72°$. The monoclinic cell parameters and calculated volume are: a = 9.0216(4), b = 16.7857(6) c = 9.9119(3) Å, β = 100.502(3)°, V = 1475.85(10)Å^3. For Z = 2 and F.W. = 584.72 the calculated density is 1.32 g/cm^3. The refined mosaicity from DENZO/SCALEPACK was (ref 1) was 0.47° indicating good crystal quality. The space group was determined by the program XPREP(ref 2). From the systematic presences of:

0k0 k=2n

and from subsequent least-squares refinement, the space group was determined to be P 1 21 1(# 4).
The data were collected at a temperature of 150(1)K. Data were collected to a maximum 2θ of 144.3°.

DATA REDUCTION

A total of 16004 reflections were collected, of which 5138 were unique. Frames were integrated with DENZO-SMN (ref 1).

Lorentz and polarization corrections were applied to the data. The linear absorption coefficient is 11.5 /mm for Cu K_α radiation. An empirical absorption correction using SCALEPACK (ref 1) was applied. Transmission coefficients ranged from 0.776 to 0.912. Intensities of equivalent reflections were averaged. The agreement factor for the averaging was 3.2% based on intensity.

STRUCTURE SOLUTION AND REFINEMENT

The structure was solved by direct methods using SIR2004 (ref 3). The remaining atoms were located in succeeding difference Fourier syntheses. Hydrogen atoms were included in the refinement but restrained to ride on the atom to which they are bonded. The structure was refined in full-matrix least-squares where the function minimized was $\Sigma w(|Fo|^2-|Fc|^2)^2$ and the weight w is defined as $1/[\sigma^2(Fo^2)+(0.0465P)^2+0.3987P]$ where $P=(Fo^2+2Fc^2)/3$. Scattering factors were taken from the "International Tables for Crystallography" (ref 4). 5138 reflections were used in the refinements. However, only the 5103reflections with $F_o^2>2\sigma(F_o^2)$ were used in, calculating R1. The final cycle of refinement included 383 variable parameters and converged (largest parameter shift was <0.01 times its su) with unweighted and weighted agreement factors of:

$$R1 = \Sigma |Fo - Fc| / \Sigma Fo = 0.030$$

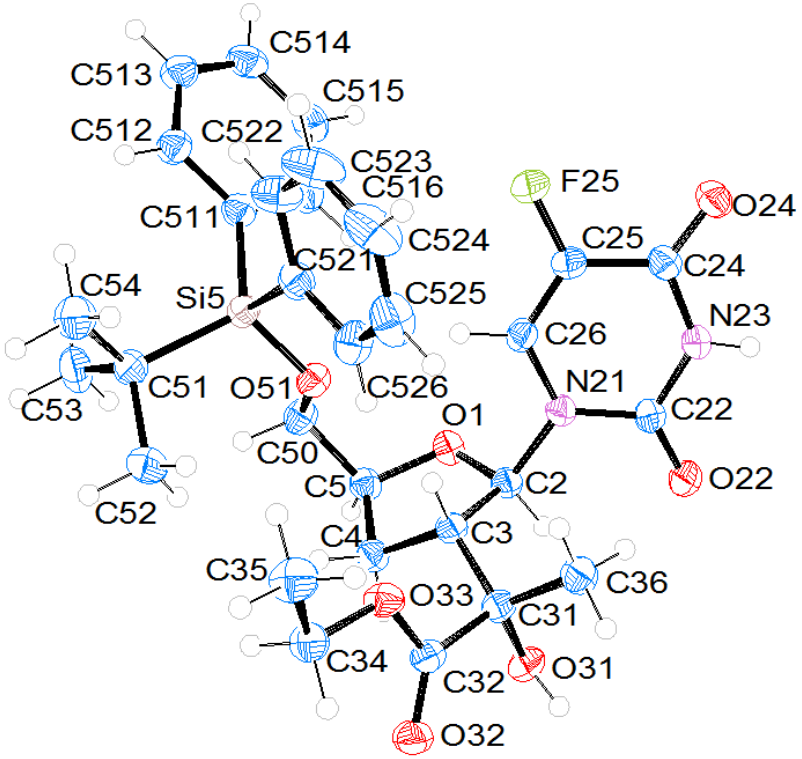
$$R2 = SQRT (\Sigma w (Fo^2 - Fc^2)^2 / \Sigma w (Fo^2)^2) = 0.079$$

The goodness-of-fit parameter was 1.06. The highest peak in the final difference Fourier had a height of 0.21 e/A^3. The minimum negative peak had a height of -0.16 e/A^3. The factor for the determination of the absolute structure (ref 5) refined to 0.00.

Refinement was performed on a LINUX PC using SHELX-97 (ref 2). Crystallographic drawings were done using programs ORTEP (ref 6),and PLUTON (ref 7).

---

(1) Z. Otwinowski and W. Minor, Methods Enzymol., 276, 307 (1997).
(2) G.M. Sheldrick Acta Cryst., A64, 112,(2008).
(3) M. C. Burla, R. Caliandro, M. Camalli, B. Carrozzini,G. L. Cascarano, L. De Caro, C. Giacovazzo, G. Polidori,and R. Spagna. , J. Appl. Cryst., 38, 381 (2005)
(4) "International Tables for Crystallography", Vol. C, Kluwer Academic Publishers, Utrecht, The Netherlands, (1992), Tables 4.2.6.8 and 6.1.1.4
(5) H. D. Flack, Acta Cryst., A39, 876 (1983).
(6) C. K. Johnson, ORTEPII, Report ORNL-5138, Oak Ridge National Laboratory, Tennessee, USA (1976)
(7) A. L. Spek, PLUTON. Molecular Graphics Program. Univ. of Ultrecht, The Netherlands (1991)



CRYSTAL DATA AND DATA COLLECTION PARAMETERS FOR

$C_{30}H_{37}FN_2O_7Si$

formula	$C_{30}H_{37}FN_2O_7Si$
formula weight	584.72
space group	P 1 21 1 (No. 4)
a, Å	9.0216(4)
b, Å	16.7857(6)
c, Å	9.9119(3)
β, deg	100.502(3)
V, Å^3	1475.85(10)
Z	2

d_{calc}, g cm^{-3}	1.316
crystal dimensions, mm	0.18x0.10x0.08
temperature, K	150.
radiation (wavelength, Å)	Cu K_α (1.54184)
monochromator	confocal optics
linear abs coef, mm^{-1}	1.149
absorption correction applied	empirical[a]
transmission factors: min, max	0.78, 0.91
diffractometer	Rigaku_Rapid_II
h, k, l range	-11 to 11 -20 to 20 -12 to 12
2θ range, deg	5.26-144.25
mosaicity, deg	0.47
programs used	SHELXTL
F_{000}	620.0
weighting $1/[\sigma^2(Fo^2)+(0.0465P)^2+0.3987P]$ where $P=(Fo^2+2Fc^2)/3$	
data collected	16004
unique data	5138
R_{int}	0.032
data used in refinement	5138
cutoff used in R-factor calculations	$F_o^2>2.0\sigma(F_o^2)$
data with $I>2.0\sigma(I)$	5103
number of variables	383
largest shift/esd in final cycle	0.00
$R(F_o)$	0.030
$R_w(F_o^2)$	0.079
goodness of fit	1.059
absolute structure determination	Flack parameter[b] (0.00(2))

[a] Otwinowski Z. & Minor, W. Methods Enzymol. **1996**,276307.
[b] Flack, H. D. Acta Cryst., Sect. A **1983**, A39, 876.

Positional Parameters and Their Standard Uncertainties

for $C_{30}H_{37}FN_2O_7Si$

Atom	x	y	z	U(Å ^{2})
Si5	0.89626(5)	0.10155(3)	0.67939(4)	0.02475(10)
F25	0.70266(14)	0.32803(6)	0.42751(12)	0.0410(3)
O1	0.43463(13)	0.07411(7)	0.41427(12)	0.0279(3)
O22	0.30288(15)	0.16701(8)	0.06244(15)	0.0366(4)
O24	0.53391(15)	0.40162(8)	0.19943(14)	0.0345(4)
O31	0.47612(14)	-0.04576(8)	0.08114(14)	0.0305(3)
O32	0.72983(15)	-0.13363(8)	0.10371(14)	0.0367(4)
O33	0.87132(13)	-0.03678(7)	0.21510(13)	0.0305(3)

O51	0.73980(13)	0.07552(7)	0.57254(12)	0.0276(3)
N21	0.48945(16)	0.16495(9)	0.25400(15)	0.0254(4)
N23	0.42347(17)	0.28241(9)	0.13302(16)	0.0277(4)
C2	0.46582(19)	0.07994(10)	0.27898(17)	0.0246(4)
C3	0.60252(19)	0.02663(10)	0.27472(17)	0.0248(4)
C4	0.5820(2)	-0.03818(11)	0.37788(19)	0.0279(5)
C5	0.5088(2)	0.00571(10)	0.48450(18)	0.0273(5)
C22	0.39784(19)	0.20179(11)	0.14397(18)	0.0271(4)
C24	0.5219(2)	0.33005(11)	0.22022(18)	0.0277(5)
C25	0.6054(2)	0.28628(11)	0.33502(18)	0.0292(5)
C26	0.58992(19)	0.20764(11)	0.34728(18)	0.0267(4)
C31	0.61266(19)	-0.00547(10)	0.13115(17)	0.0260(4)
C32	0.7430(2)	-0.06656(10)	0.14749(18)	0.0266(4)
C34	1.0019(2)	-0.09063(12)	0.2384(2)	0.0331(5)
C35	1.1421(2)	-0.04097(14)	0.2583(2)	0.0409(6)
C36	0.6406(2)	0.06039(12)	0.03283(18)	0.0323(5)
C50	0.6182(2)	0.03161(11)	0.61084(18)	0.0296(5)
C51	1.0066(2)	0.01031(11)	0.75458(18)	0.0308(5)
C52	0.9997(3)	-0.05230(12)	0.6399(2)	0.0398(6)
C53	0.9447(3)	-0.02643(14)	0.8744(2)	0.0431(6)
C54	1.1726(2)	0.03246(14)	0.8044(2)	0.0443(6)
C511	0.8420(2)	0.17260(10)	0.80877(18)	0.0277(5)
C512	0.9377(2)	0.19314(11)	0.93017(19)	0.0311(5)
C513	0.8978(2)	0.25184(12)	1.0165(2)	0.0357(5)
C514	0.7610(2)	0.29049(12)	0.9829(2)	0.0370(5)
C515	0.6627(2)	0.27076(12)	0.8634(2)	0.0368(5)
C516	0.7032(2)	0.21262(11)	0.77738(19)	0.0314(5)
C521	1.0101(2)	0.15755(11)	0.5705(2)	0.0298(5)
C522	1.1124(2)	0.21542(13)	0.6301(2)	0.0402(6)
C523	1.2048(3)	0.25474(14)	0.5546(3)	0.0528(7)
C524	1.1961(3)	0.23757(13)	0.4175(3)	0.0502(7)
C525	1.0970(3)	0.17986(15)	0.3560(2)	0.0452(6)
C526	1.0049(2)	0.14022(13)	0.4316(2)	0.0359(5)
H23	0.374(3)	0.3030(15)	0.064(2)	0.034(6)*
H31	0.476(3)	-0.0597(17)	-0.004(3)	0.055(8)*

Starred atoms were refined isotropically

$U_{eq} = (1/3)\Sigma_i\Sigma_j U_{ij}a^*_i a^*_j \mathbf{a}_i.\mathbf{a}_j$

Table of Bond Distances in Angstroms

for $C_{30}H_{37}FN_2O_7Si$

Atom 1	Atom 2	Distance	Atom 1	Atom 2	Distance
Si5	O51	1.6613(13)	C35	H35C	0.980
Si5	C521	1.8724(19)	C36	H36A	0.980
Si5	C511	1.8802(18)	C36	H36B	0.980
Si5	C51	1.9031(19)	C36	H36C	0.980
F25	C25	1.345(2)	C50	H50A	0.990
O1	C2	1.423(2)	C50	H50B	0.990
O1	C5	1.442(2)	C51	C53	1.531(3)
O22	C22	1.215(2)	C51	C54	1.535(3)
O24	C24	1.227(2)	C51	C52	1.541(3)
O31	C31	1.413(2)	C52	H52A	0.980

O31	H31	0.88(3)	C52	H52B	0.980
O32	C32	1.205(2)	C52	H52C	0.980
O33	C32	1.325(2)	C53	H53A	0.980
O33	C34	1.469(2)	C53	H53B	0.980
O51	C50	1.429(2)	C53	H53C	0.980
N21	C26	1.373(2)	C54	H54A	0.980
N21	C22	1.388(2)	C54	H54B	0.980
N21	C2	1.470(2)	C54	H54C	0.980
N23	C24	1.377(2)	C511	C512	1.391(3)
N23	C22	1.381(2)	C511	C516	1.405(3)
N23	H23	0.83(2)	C512	C513	1.395(3)
C2	C3	1.531(2)	C512	H512	0.950
C2	H2	1.000	C513	C514	1.380(3)
C3	C4	1.527(2)	C513	H513	0.950
C3	C31	1.540(2)	C514	C515	1.384(3)
C3	H3	1.000	C514	H514	0.950
C4	C5	1.533(2)	C515	C516	1.388(3)
C4	H4A	0.990	C515	H515	0.950
C4	H4B	0.990	C516	H516	0.950
C5	C50	1.510(2)	C521	C522	1.395(3)
C5	H5	1.000	C521	C526	1.400(3)
C24	C25	1.446(3)	C522	C523	1.385(3)
C25	C26	1.335(3)	C522	H522	0.950
C26	H26	0.950	C523	C524	1.377(4)
C31	C36	1.525(2)	C523	H523	0.950
C31	C32	1.546(2)	C524	C525	1.383(4)
C34	C35	1.498(3)	C524	H524	0.950
C34	H34A	0.990	C525	C526	1.386(3)
C34	H34B	0.990	C525	H525	0.950
C35	H35A	0.980	C526	H526	0.950
C35	H35B	0.980			

Numbers in parentheses are standard uncertanties in the least significant digits.

Table of Bond Angles in Degrees

for $C_{30}H_{37}FN_2O_7Si$

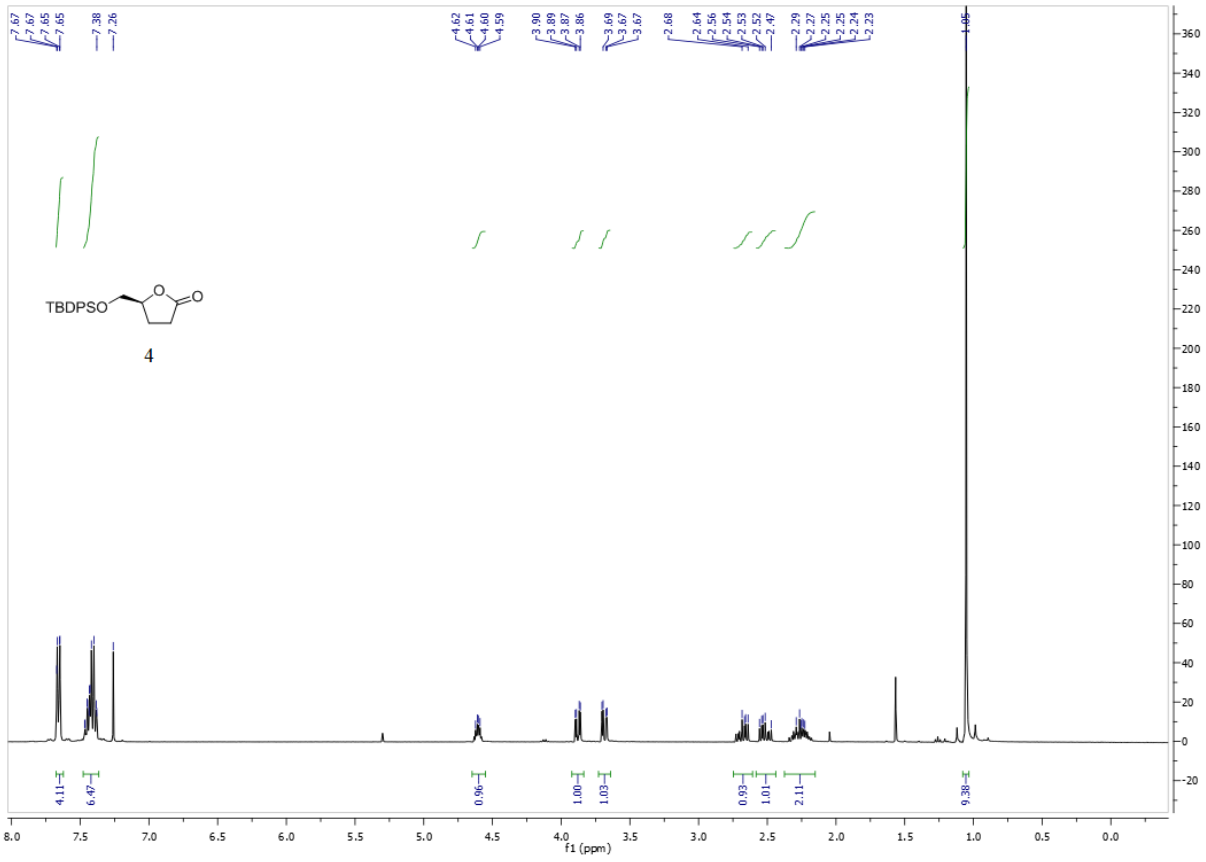
Atom 1	Atom 2	Atom 3	Angle	Atom 1	Atom 2	Atom 3	Angle
O51	Si5	C521	104.84(7)	F25	C25	C24	116.97(16)
O51	Si5	C511	107.76(7)	C25	C26	N21	121.47(16)
C521	Si5	C511	108.23(8)	C25	C26	H26	119.30
O51	Si5	C51	111.17(8)	N21	C26	H26	119.30
C521	Si5	C51	109.09(8)	O31	C31	C36	110.96(15)
C511	Si5	C51	115.21(8)	O31	C31	C3	107.26(13)
C2	O1	C5	110.82(12)	C36	C31	C3	112.42(14)
C31	O31	H31	108.3(18)	O31	C31	C32	108.48(13)
C32	O33	C34	116.67(13)	C36	C31	C32	109.68(14)
C50	O51	Si5	124.77(10)	C3	C31	C32	107.90(14)

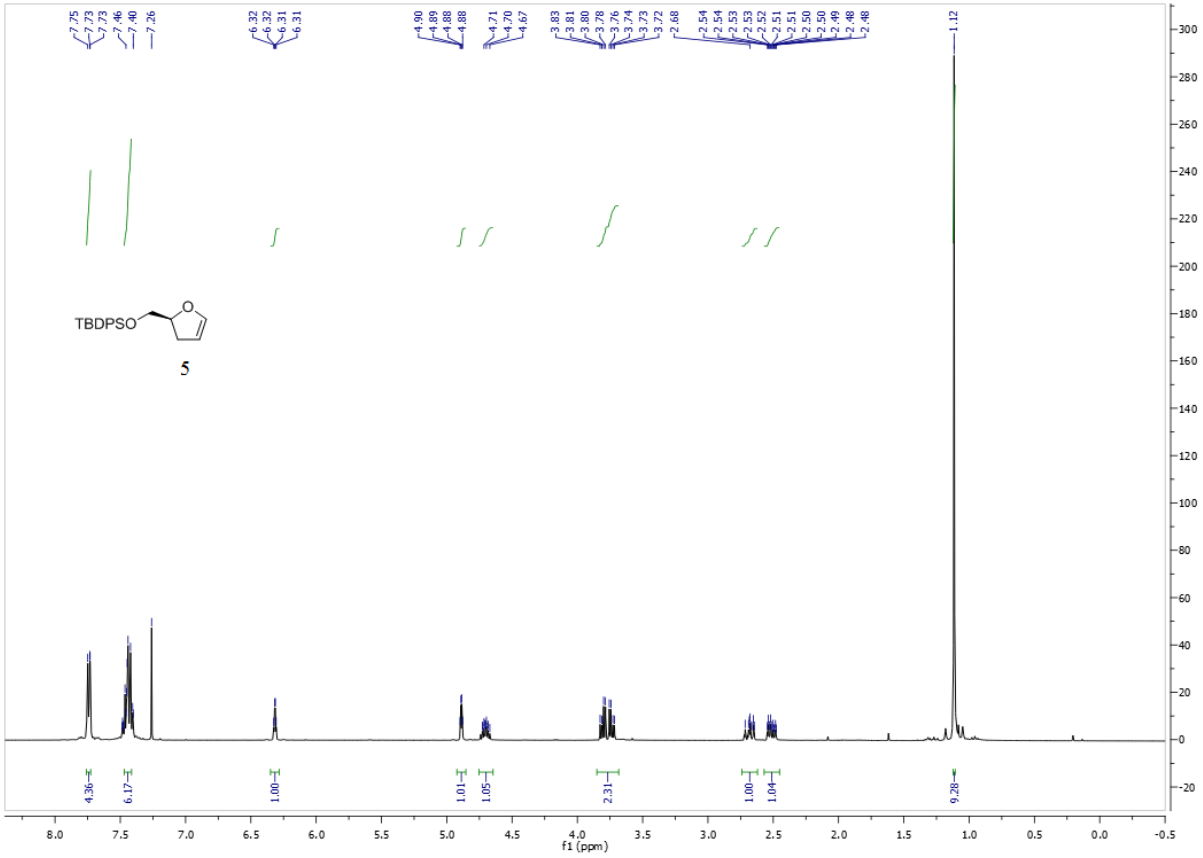
C26	N21	C22	121.48(14)	O32	C32	O33	123.66(17)
C26	N21	C2	119.43(14)	O32	C32	C31	123.98(16)
C22	N21	C2	118.74(14)	O33	C32	C31	112.36(14)
C24	N23	C22	128.18(16)	O33	C34	C35	108.18(15)
C24	N23	H23	118.0(17)	O33	C34	H34A	110.10
C22	N23	H23	113.8(17)	C35	C34	H34A	110.10
O1	C2	N21	106.57(13)	O33	C34	H34B	110.10
O1	C2	C3	106.53(13)	C35	C34	H34B	110.10
N21	C2	C3	114.86(14)	H34A	C34	H34B	108.40
O1	C2	H2	109.60	C34	C35	H35A	109.50
N21	C2	H2	109.60	C34	C35	H35B	109.50
C3	C2	H2	109.60	H35A	C35	H35B	109.50
C4	C3	C2	101.61(13)	C34	C35	H35C	109.50
C4	C3	C31	113.85(14)	H35A	C35	H35C	109.50
C2	C3	C31	114.46(14)	H35B	C35	H35C	109.50
C4	C3	H3	108.90	C31	C36	H36A	109.50
C2	C3	H3	108.90	C31	C36	H36B	109.50
C31	C3	H3	108.90	H36A	C36	H36B	109.50
C3	C4	C5	103.84(14)	C31	C36	H36C	109.50
C3	C4	H4A	111.00	H36A	C36	H36C	109.50
C5	C4	H4A	111.00	H36B	C36	H36C	109.50
C3	C4	H4B	111.00	O51	C50	C5	110.21(13)
C5	C4	H4B	111.00	O51	C50	H50A	109.60
H4A	C4	H4B	109.00	C5	C50	H50A	109.60
O1	C5	C50	110.28(14)	O51	C50	H50B	109.60
O1	C5	C4	105.67(13)	C5	C50	H50B	109.60
C50	C5	C4	114.30(15)	H50A	C50	H50B	108.10
O1	C5	H5	108.80	C53	C51	C54	108.69(17)
C50	C5	H5	108.80	C53	C51	C52	109.02(17)
C4	C5	H5	108.80	C54	C51	C52	107.97(16)
O22	C22	N23	121.78(16)	C53	C51	Si5	112.89(13)
O22	C22	N21	123.74(16)	C54	C51	Si5	109.96(14)
N23	C22	N21	114.47(15)	C52	C51	Si5	108.20(13)
O24	C24	N23	121.99(16)	C51	C52	H52A	109.50
O24	C24	C25	125.49(17)	C51	C52	H52B	109.50
N23	C24	C25	112.52(15)	H52A	C52	H52B	109.50
C26	C25	F25	121.29(17)	C51	C52	H52C	109.50
C26	C25	C24	121.72(16)	H52A	C52	H52C	109.50

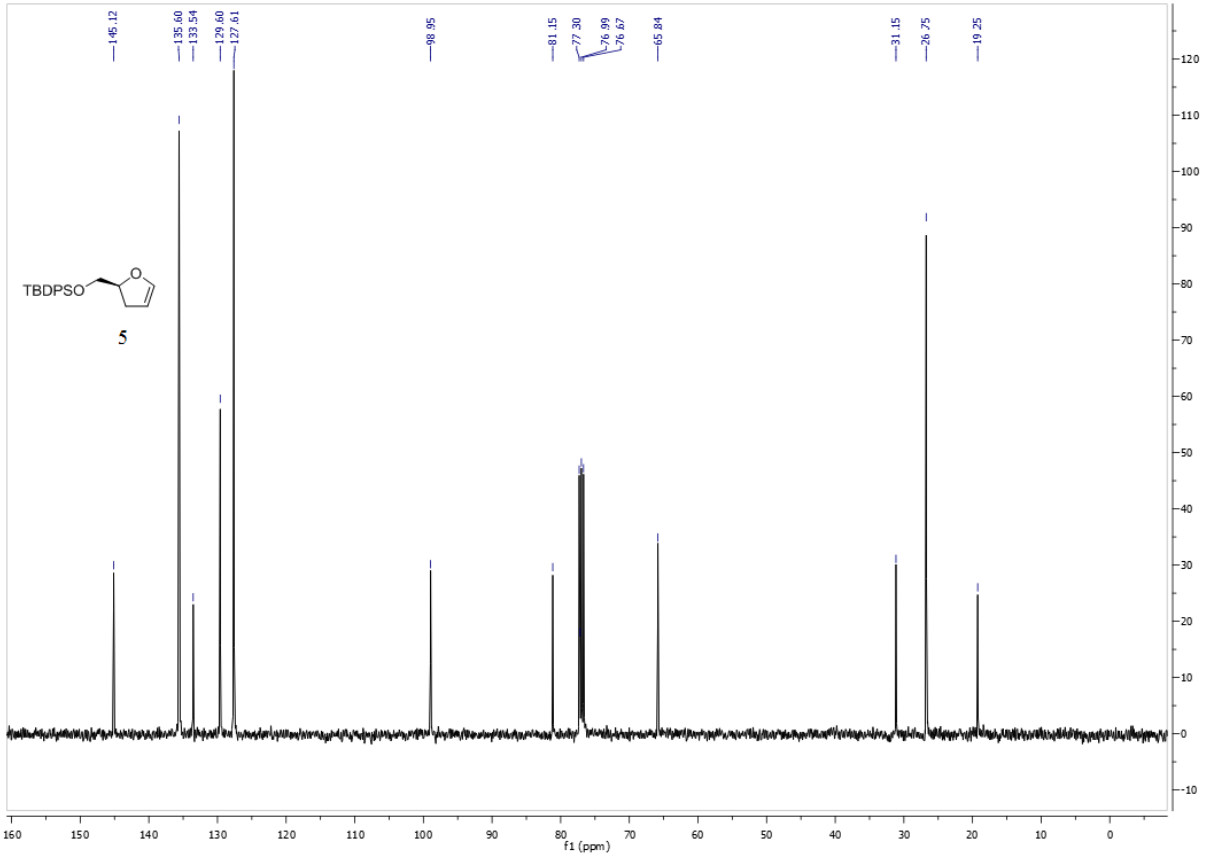
Bond Angles (cont.)

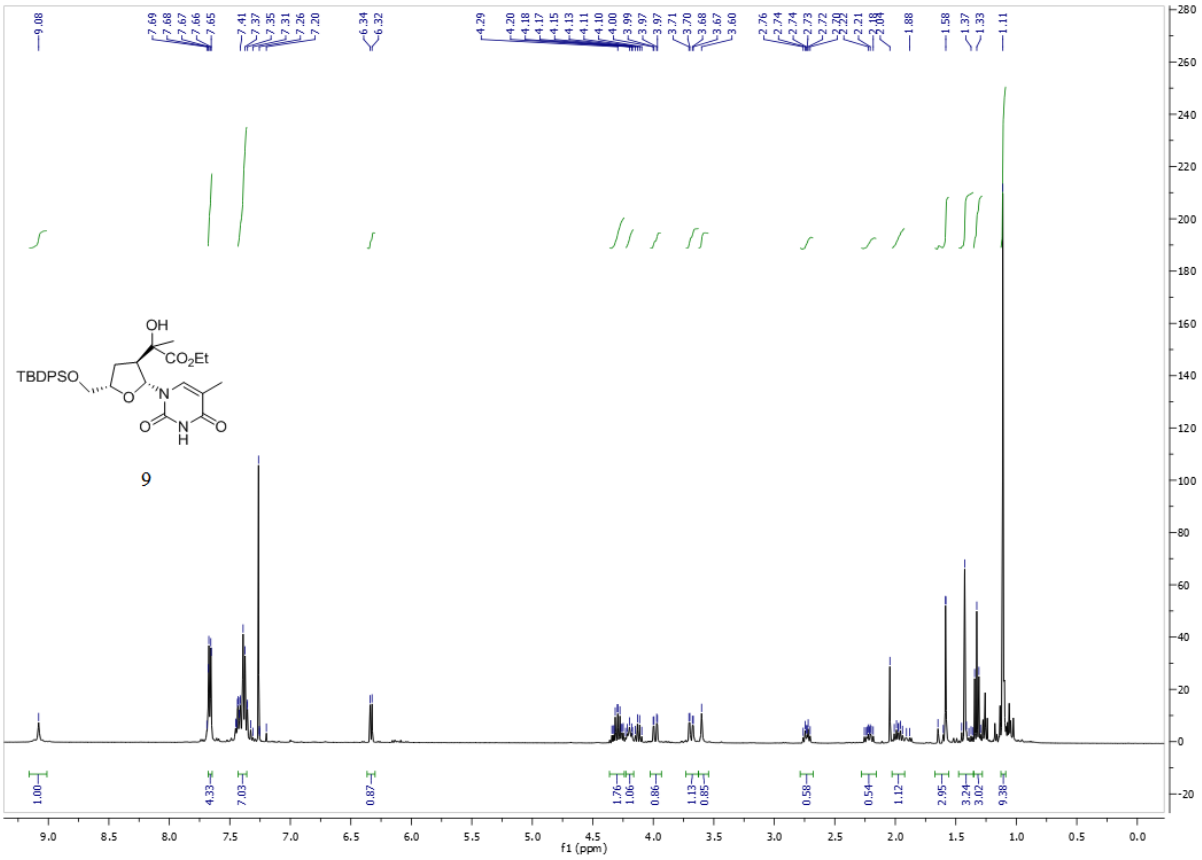
Atom 1	Atom 2	Atom 3	Angle	Atom 1	Atom 2	Atom 3	Angle
H52B	C52	H52C	109.50	C514	C515	C516	119.64(18)
C51	C53	H53A	109.50	C514	C515	H515	120.20
C51	C53	H53B	109.50	C516	C515	H515	120.20
H53A	C53	H53B	109.50	C515	C516	C511	121.60(18)
C51	C53	H53C	109.50	C515	C516	H516	119.20
H53A	C53	H53C	109.50	C511	C516	H516	119.20
H53B	C53	H53C	109.50	C522	C521	C526	117.53(18)
C51	C54	H54A	109.50	C522	C521	Si5	119.72(15)
C51	C54	H54B	109.50	C526	C521	Si5	122.61(14)
H54A	C54	H54B	109.50	C523	C522	C521	121.3(2)
C51	C54	H54C	109.50	C523	C522	H522	119.30
H54A	C54	H54C	109.50	C521	C522	H522	119.30
H54B	C54	H54C	109.50	C524	C523	C522	120.1(2)
C512	C511	C516	117.44(16)	C524	C523	H523	119.90
C512	C511	Si5	123.35(14)	C522	C523	H523	119.90
C516	C511	Si5	118.98(14)	C523	C524	C525	119.9(2)
C511	C512	C513	121.13(18)	C523	C524	H524	120.10
C511	C512	H512	119.40	C525	C524	H524	120.10
C513	C512	H512	119.40	C524	C525	C526	120.1(2)
C514	C513	C512	120.24(18)	C524	C525	H525	120.00
C514	C513	H513	119.90	C526	C525	H525	120.00
C512	C513	H513	119.90	C525	C526	C521	121.1(2)
C513	C514	C515	119.95(18)	C525	C526	H526	119.50
C513	C514	H514	120.00	C521	C526	H526	119.50
C515	C514	H514	120.00				

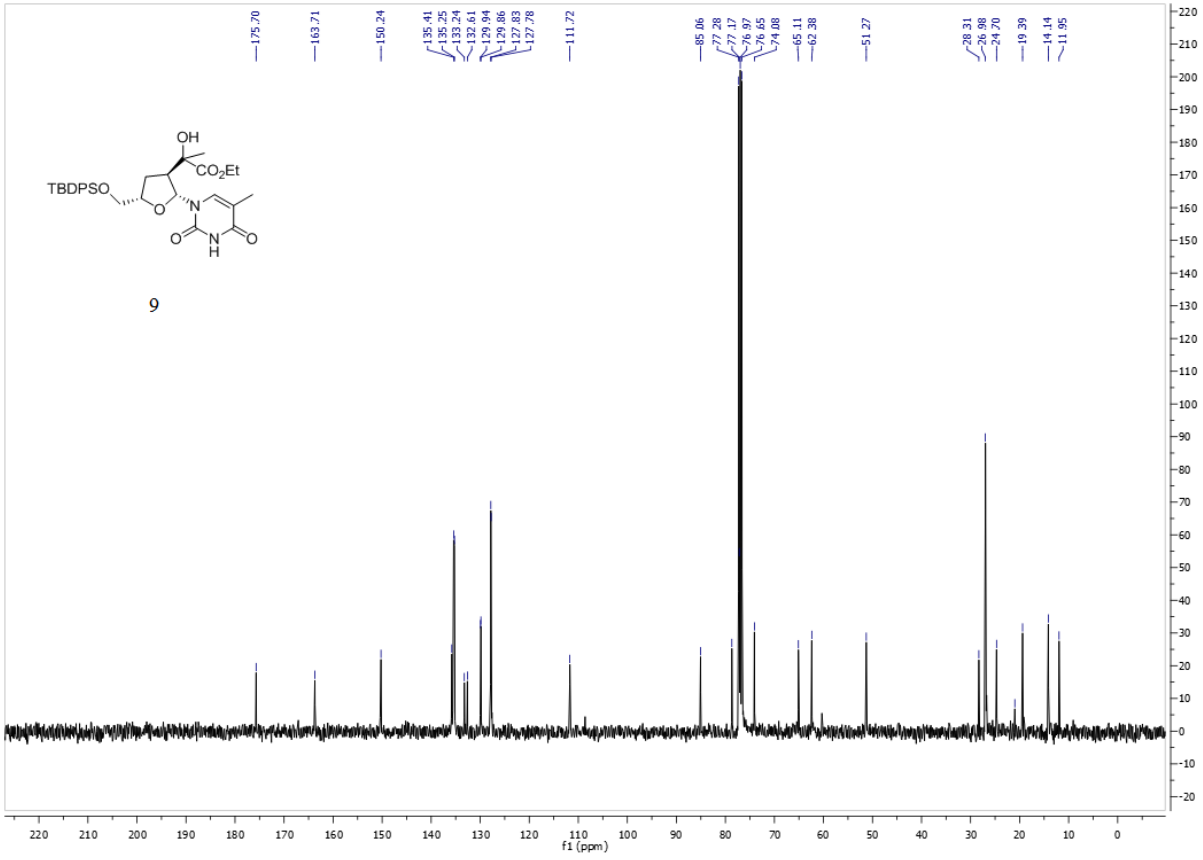
Numbers in parentheses are standard uncertanties in the least significant digits.

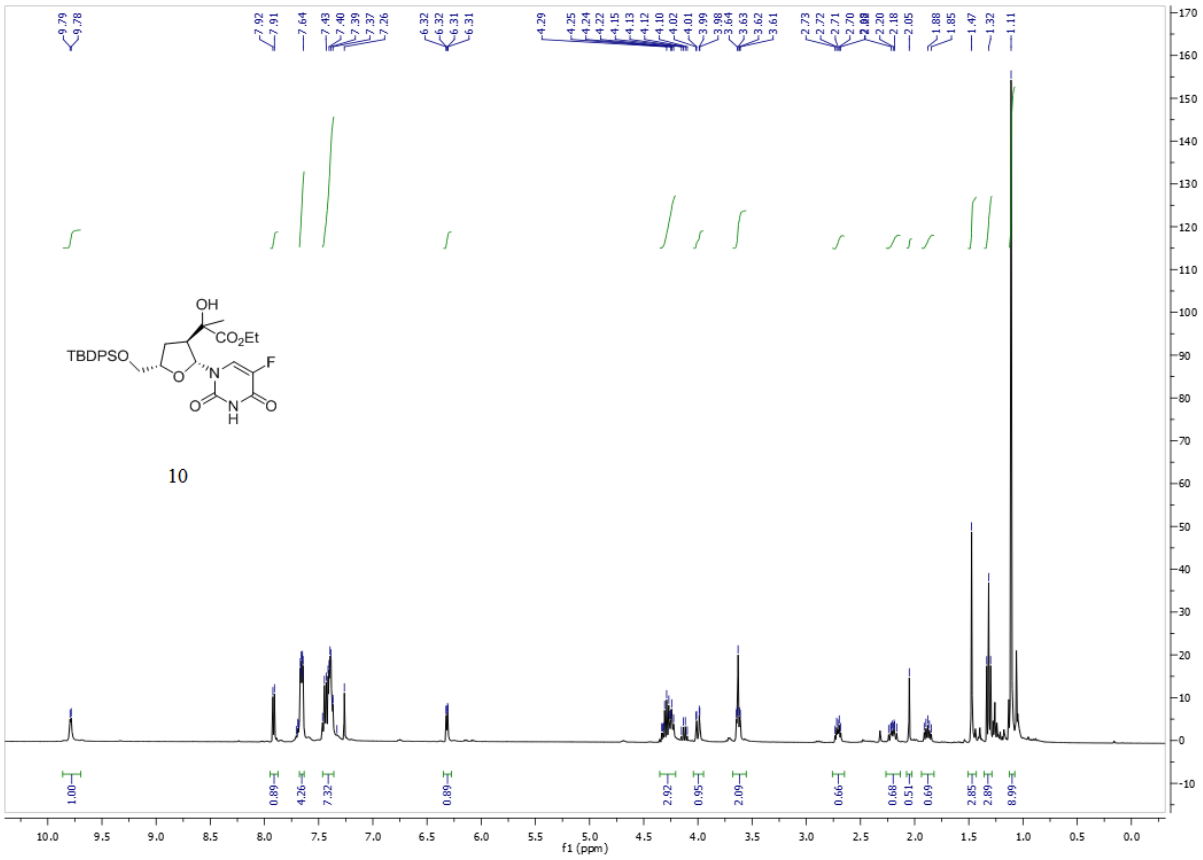

TBDPSO
4
f1 (ppm)


TBDPSO
5
f1 (ppm)

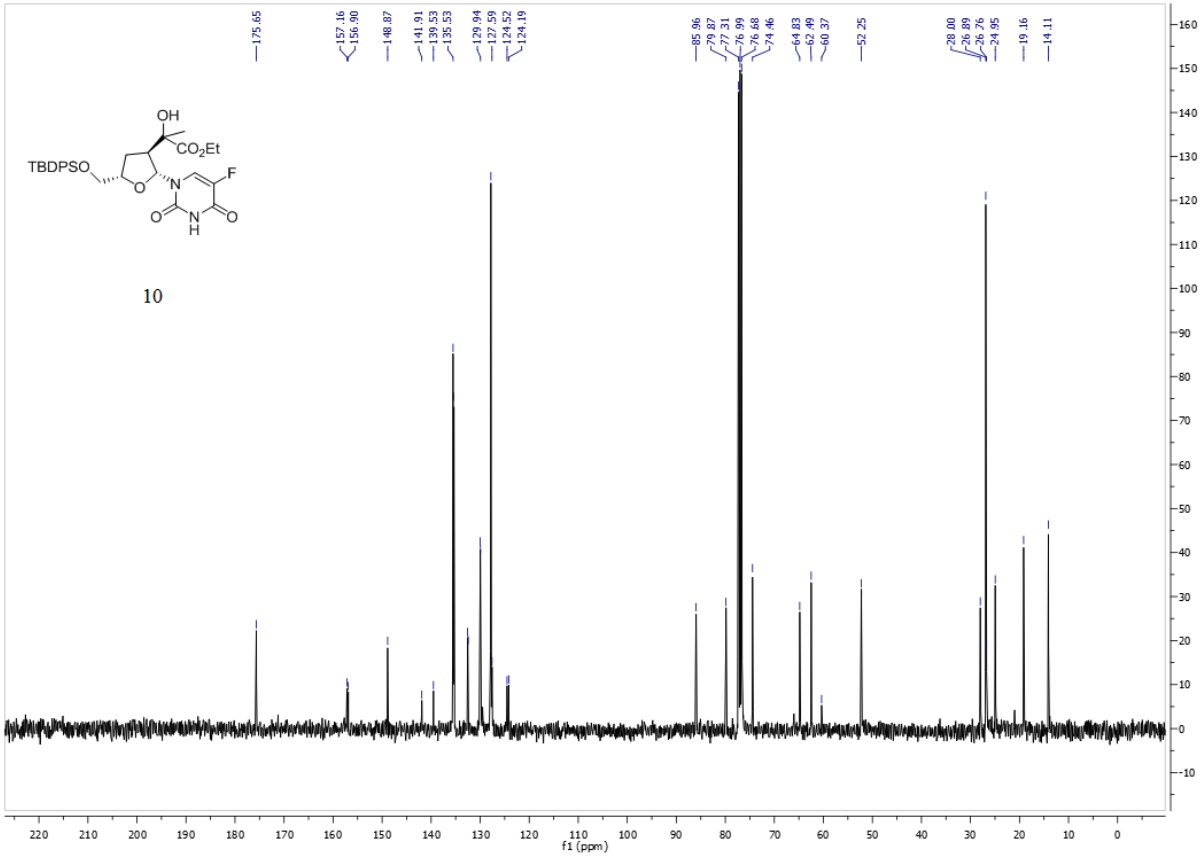

145.12
135.60
133.54
129.60
127.61
98.95
81.15
77.30
76.99
76.67
65.84
31.15
26.75
19.25
TBDPSO
O
5
f1 (ppm)

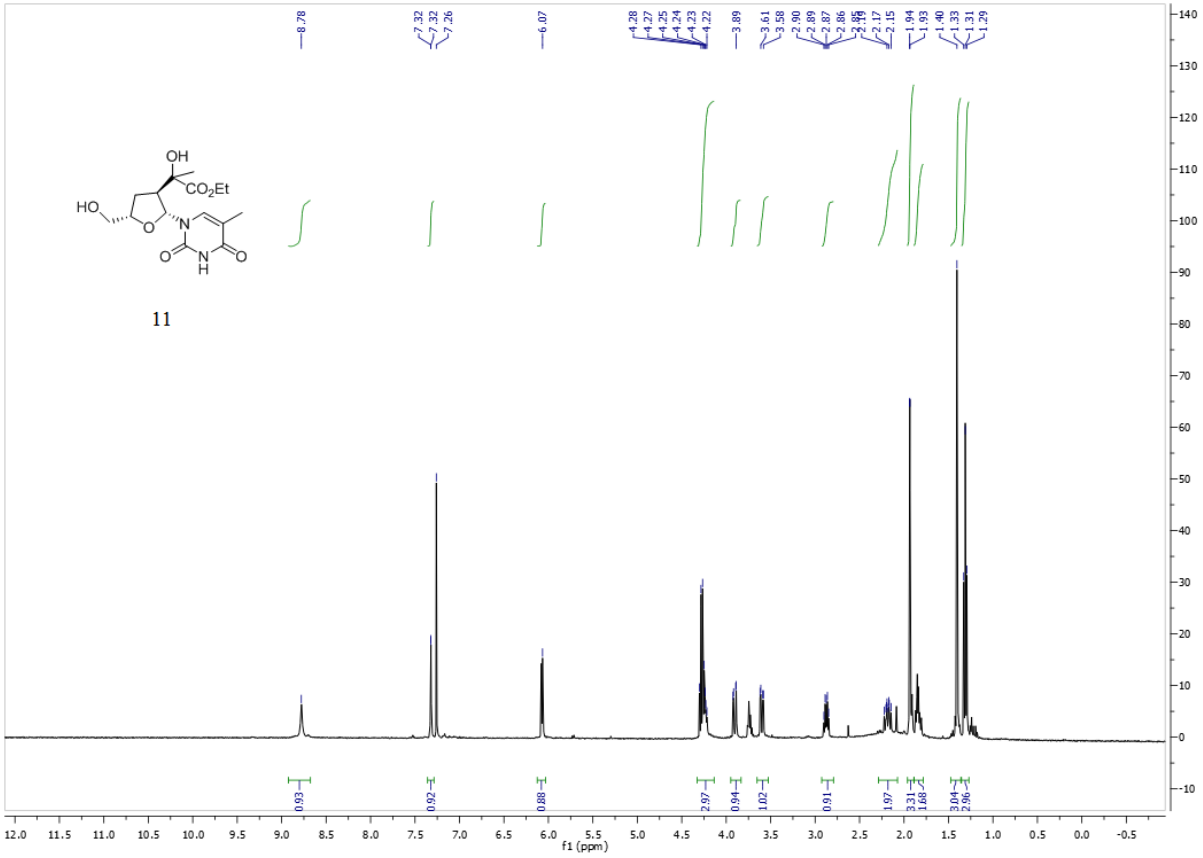

9.08
7.69
7.68
7.67
7.66
7.65
7.41
7.37
7.35
7.31
7.26
7.20
6.34
6.32
4.29
4.20
4.18
4.17
4.15
4.13
4.11
4.10
4.00
3.99
3.97
3.97
3.71
3.70
3.68
3.67
3.60
2.76
2.74
2.74
2.73
2.72
2.70
2.21
2.08
2.04
1.88
1.58
1.37
1.33
1.11
OH
CO2Et
TBDPSO
N
O
N
H
O
9
1.00
4.33
7.03
0.87
1.76
1.06
0.86
1.13
0.85
0.58
0.54
1.12
2.95
3.24
3.02
9.38
f1 (ppm)

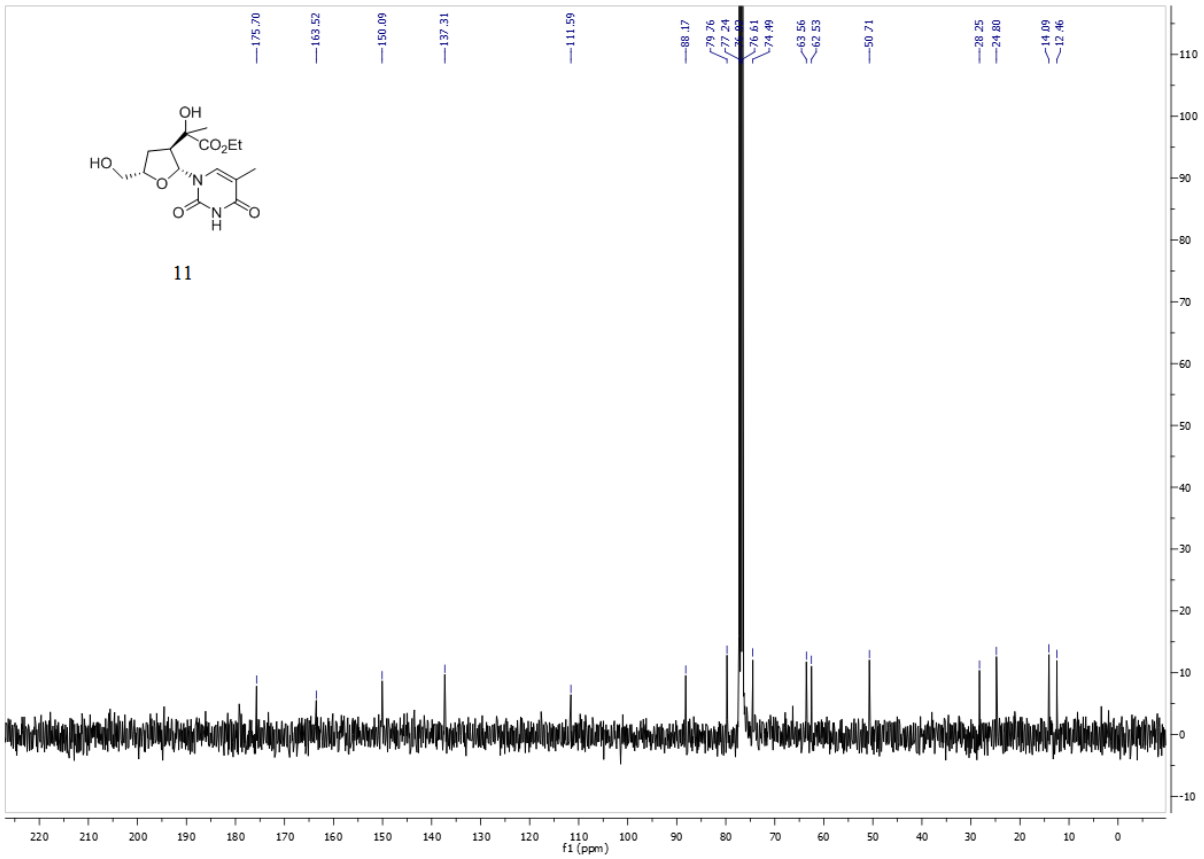

175.70
163.71
150.24
135.41
135.25
133.24
132.61
129.94
129.86
127.83
127.78
111.72
85.06
77.28
77.17
76.97
76.65
74.08
65.11
62.38
51.27
28.31
26.98
24.70
19.39
14.14
11.95
OH
CO2Et
TBDPSO
O
N
O
N
H
O
9
f1 (ppm)

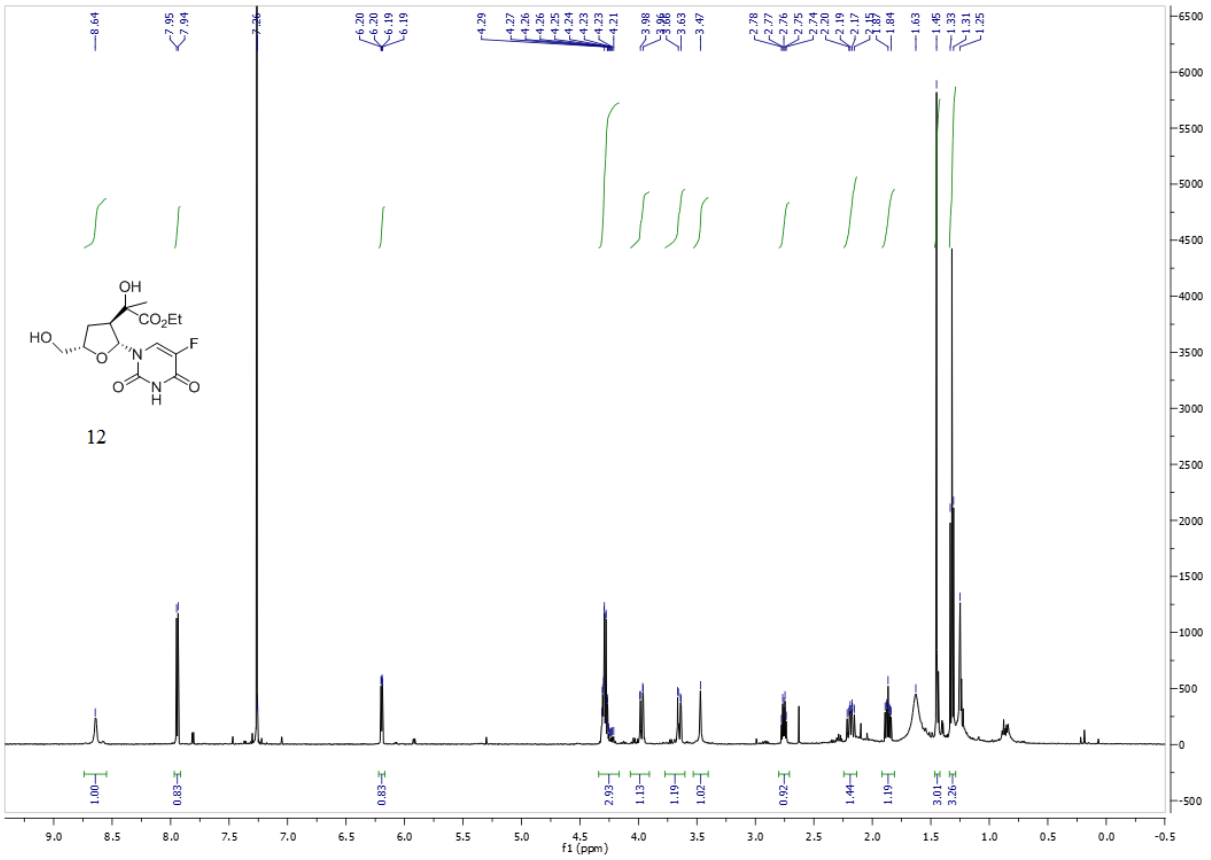


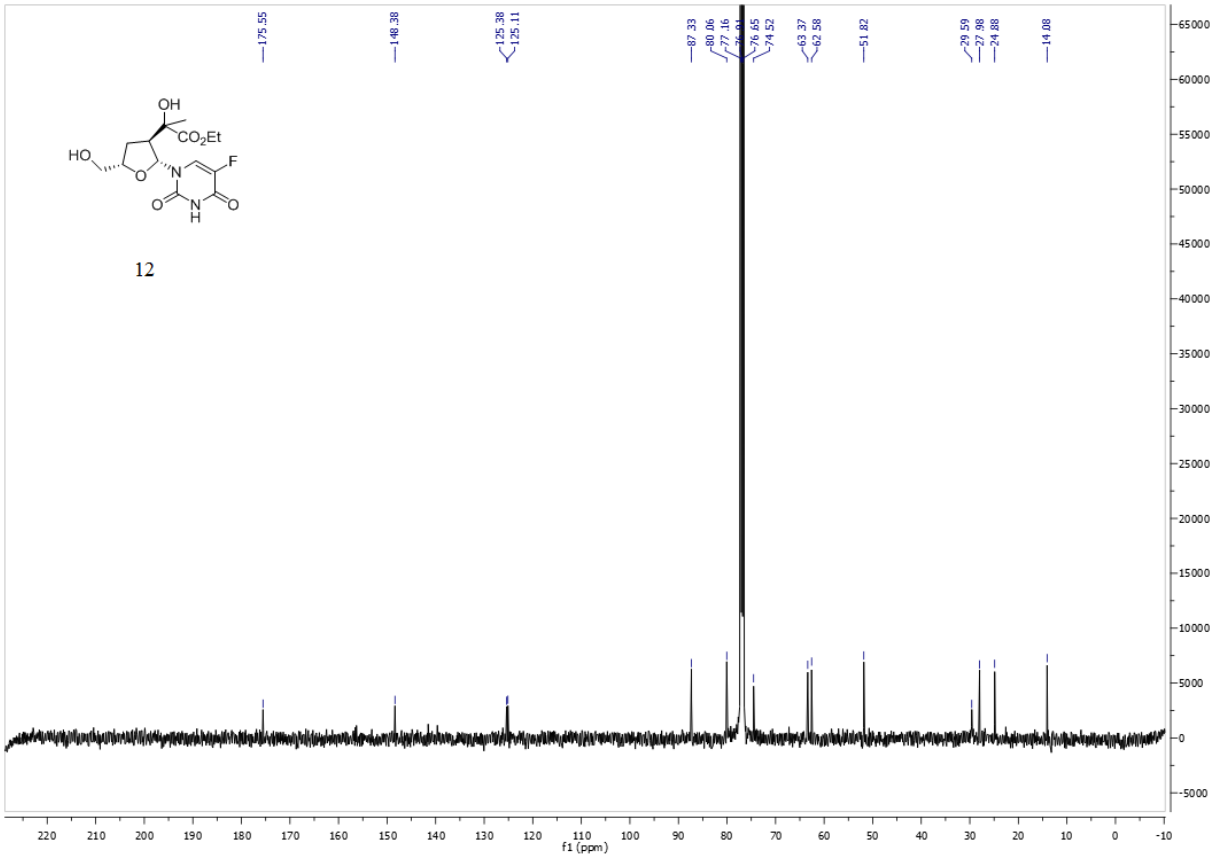
10

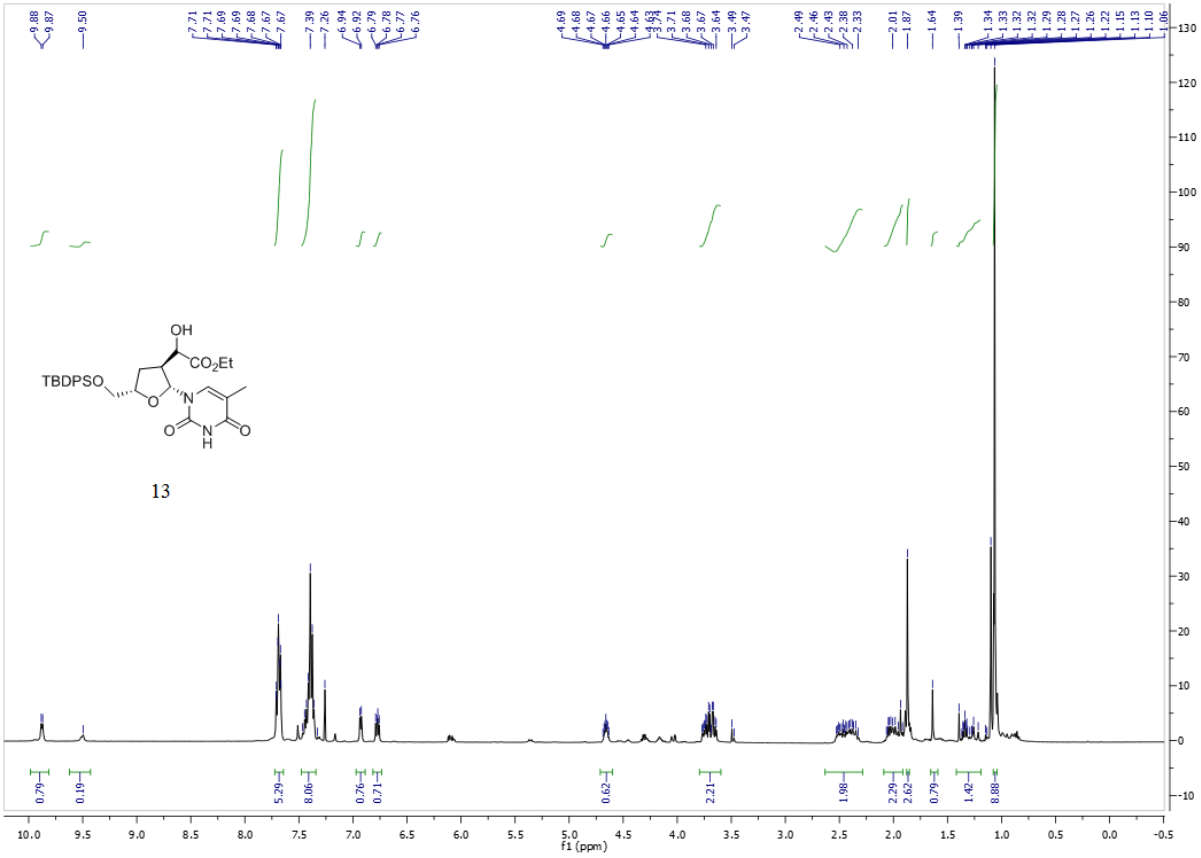

175.65
157.16
156.90
148.87
141.91
139.53
135.53
129.94
127.59
124.52
124.19
85.96
79.87
77.31
76.99
76.68
74.46
64.83
62.49
60.37
52.25
28.00
26.89
26.76
24.95
19.16
14.11
OH
CO2Et
TBDPSO
F
N
O
N
H
O
10
f1 (ppm)

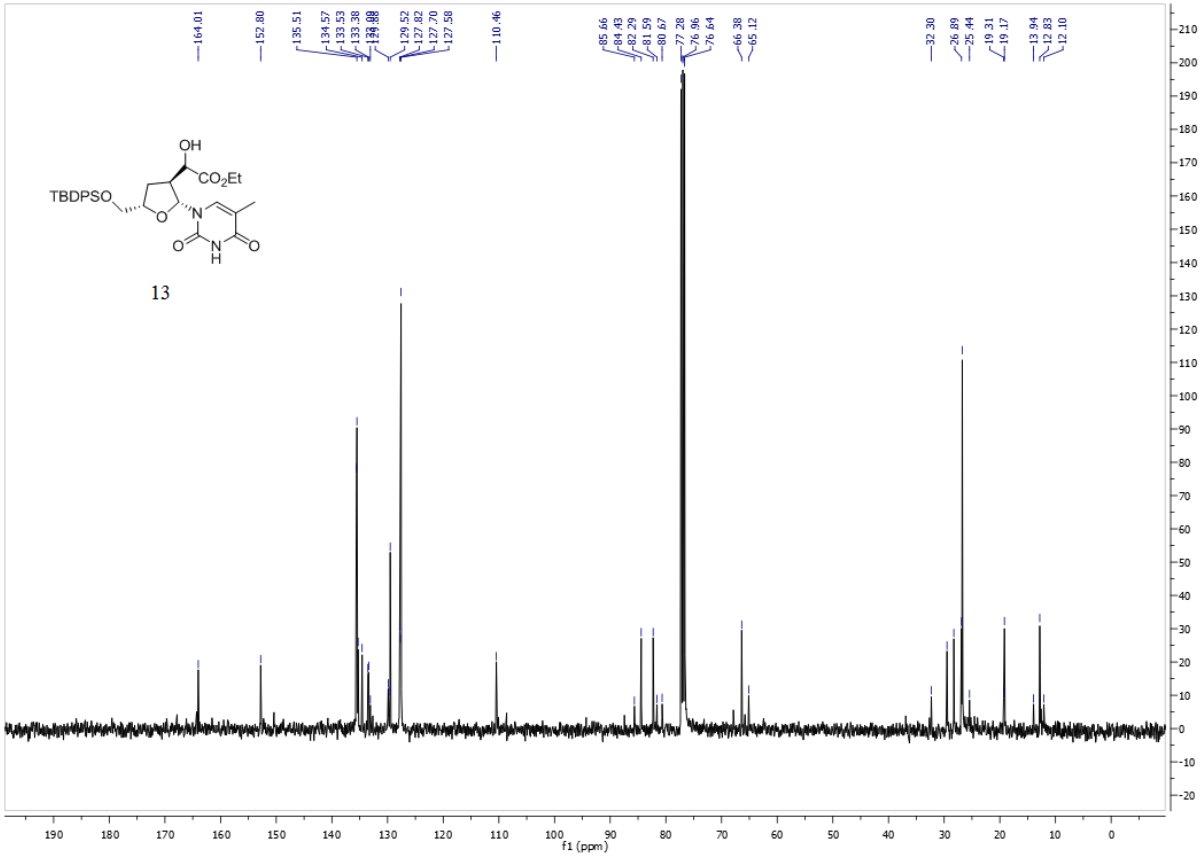

OH
CO2Et
HO
O
N
O
N
H
O
11
8.78
7.32
7.32
7.26
6.07
4.28
4.27
4.25
4.24
4.23
4.22
3.89
3.61
3.58
2.90
2.89
2.87
2.86
2.17
2.15
1.94
1.93
1.40
1.33
1.31
1.29
0.93
0.92
0.88
2.97
0.94
1.02
0.91
1.97
3.31
1.68
3.04
2.96
f1 (ppm)

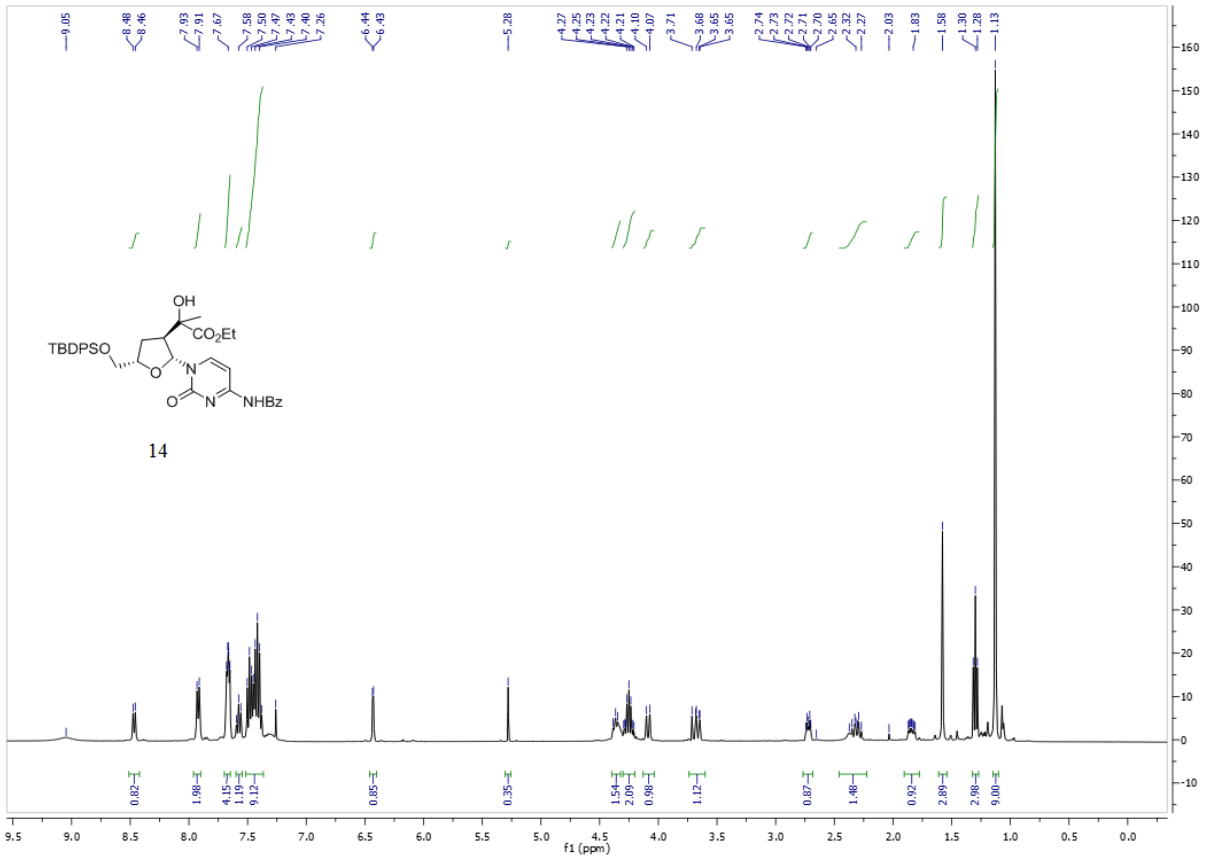

175.70
163.52
150.09
137.31
111.59
88.17
79.76
77.24
76.61
74.49
63.56
62.53
50.71
28.25
24.80
14.09
12.46
OH
CO2Et
HO
O
N
O
N
H
O
11
f1 (ppm)


8.64
7.95
7.94
7.26
6.20
6.20
6.19
6.19
4.29
4.27
4.26
4.26
4.25
4.24
4.23
4.23
4.21
3.98
3.88
3.63
3.47
2.78
2.77
2.76
2.75
2.74
2.70
2.19
2.17
1.85
1.84
1.63
1.45
1.33
1.31
1.25
OH
CO2Et
HO
F
N
O
N
H
O
12
1.00
0.83
0.83
2.93
1.13
1.19
1.02
0.92
1.44
1.19
3.01
3.26
f1 (ppm)

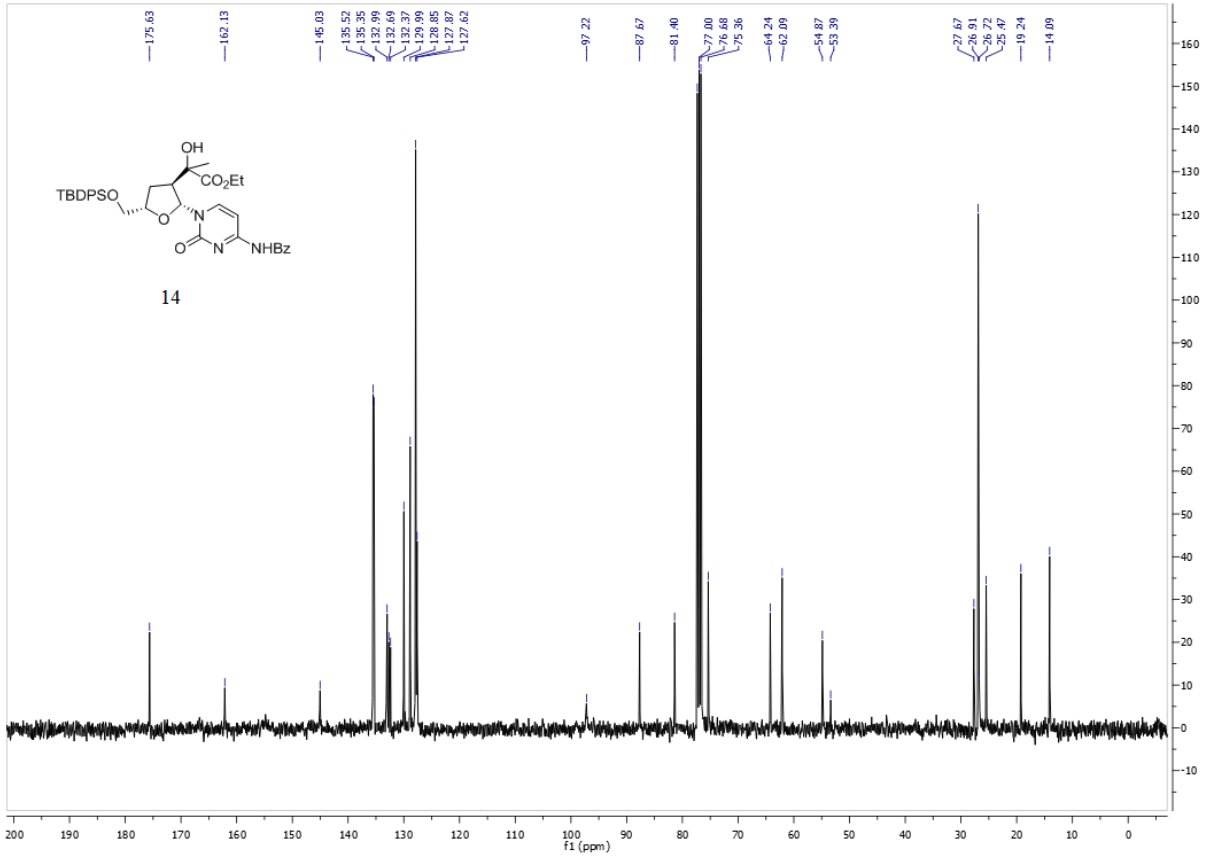

175.55
148.38
125.38
125.11
87.33
80.06
77.16
76.65
74.52
63.37
62.58
51.82
29.59
27.98
24.88
14.08
OH
CO2Et
HO
F
O
N
O
N
H
O
12
f1 (ppm)

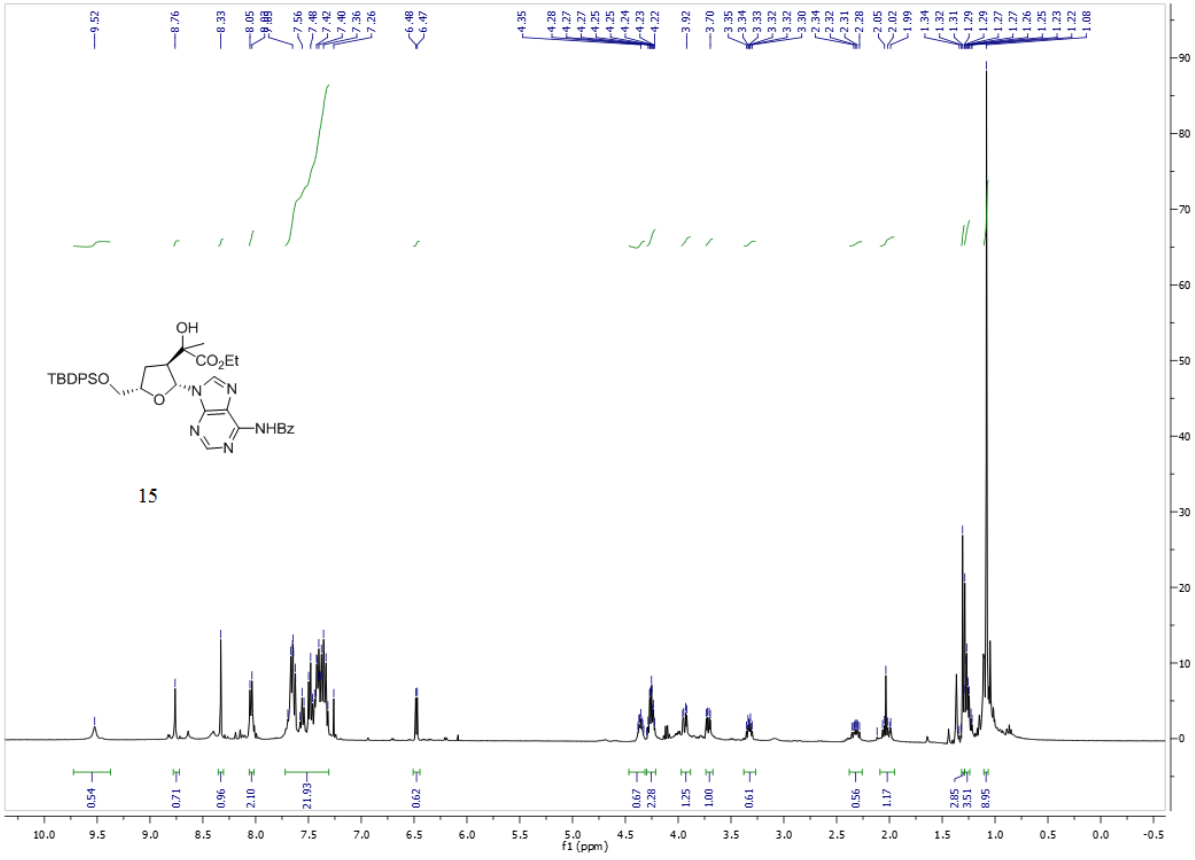

OH
CO2Et
TBDPSO
O
N
O
N
H
O
13
f1 (ppm)

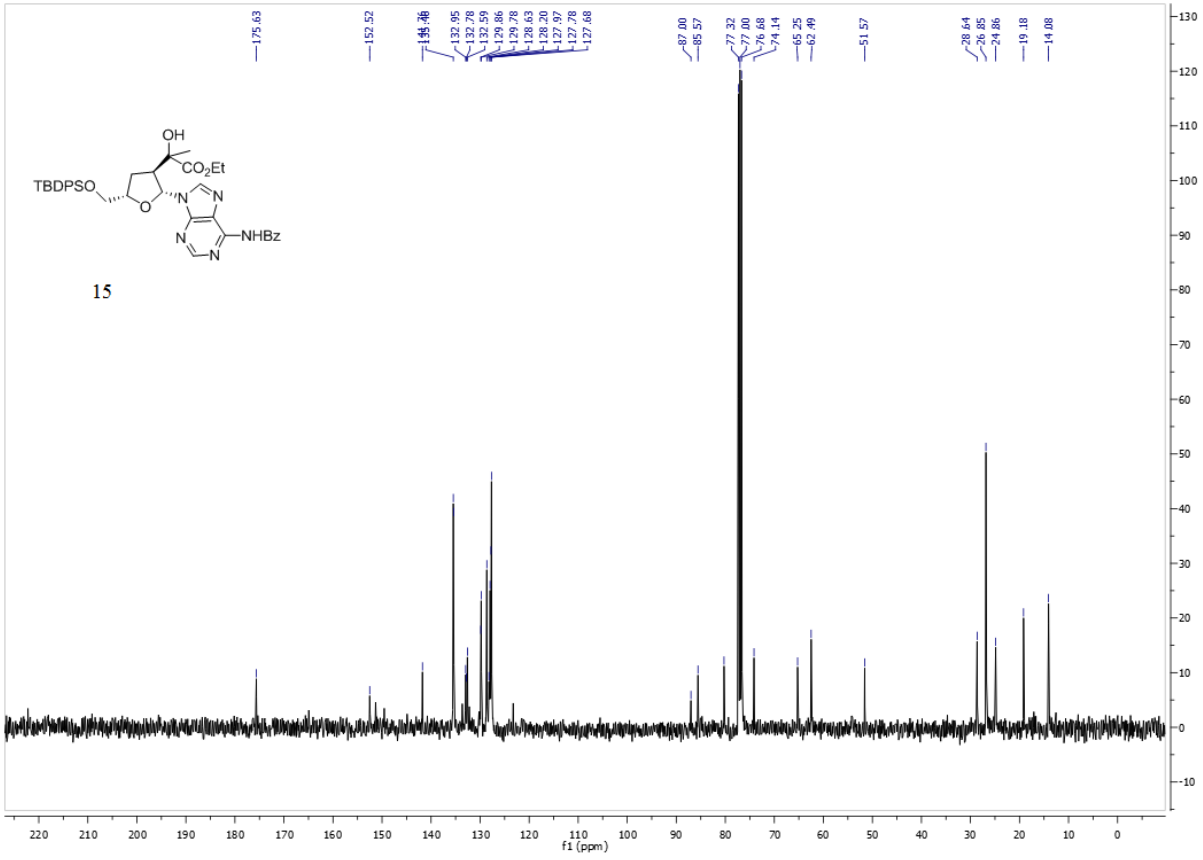

164.01
152.80
135.51
134.57
133.53
133.38
129.52
127.82
127.70
127.58
110.46
85.66
84.43
82.29
81.59
80.67
77.28
76.96
76.64
66.38
65.12
32.30
26.89
25.44
19.31
19.17
13.94
12.83
12.10
OH
CO2Et
TBDPSO
N
O
N
H
O
13
f1 (ppm)

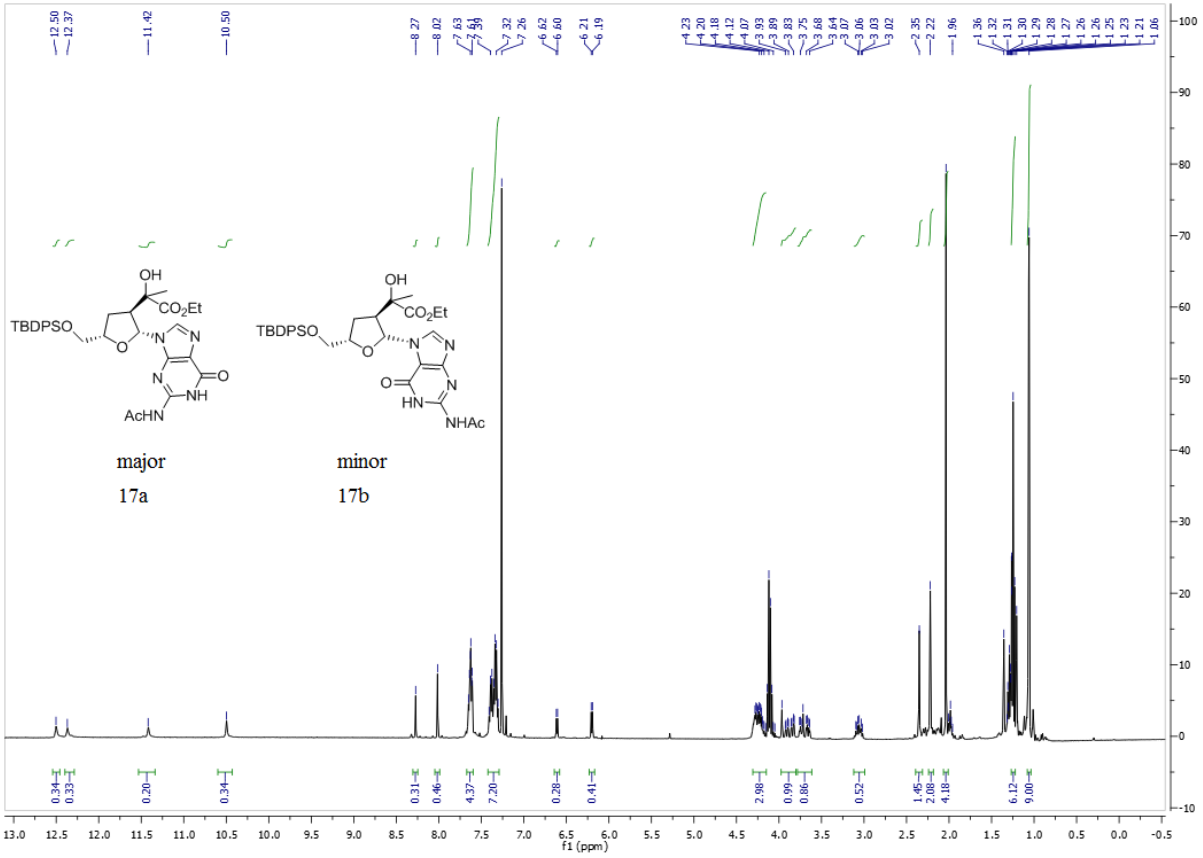


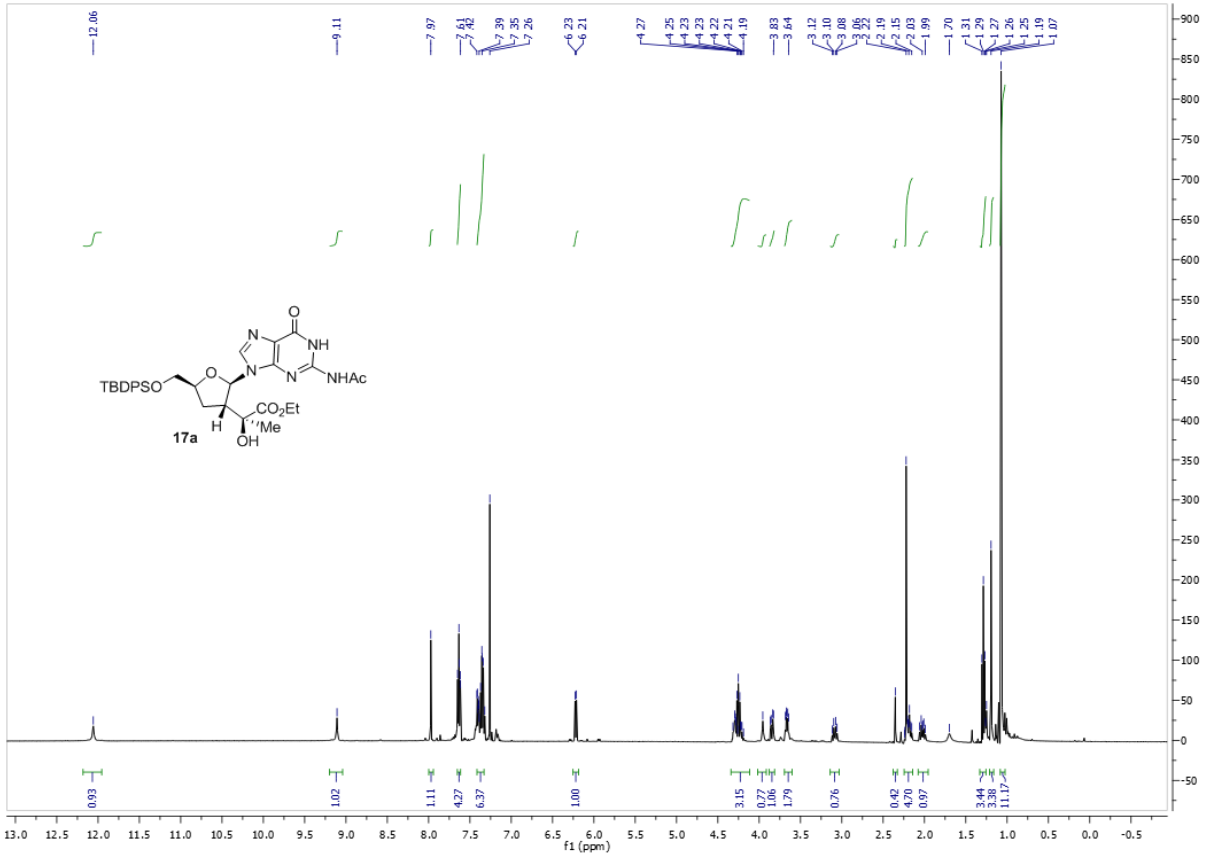
14

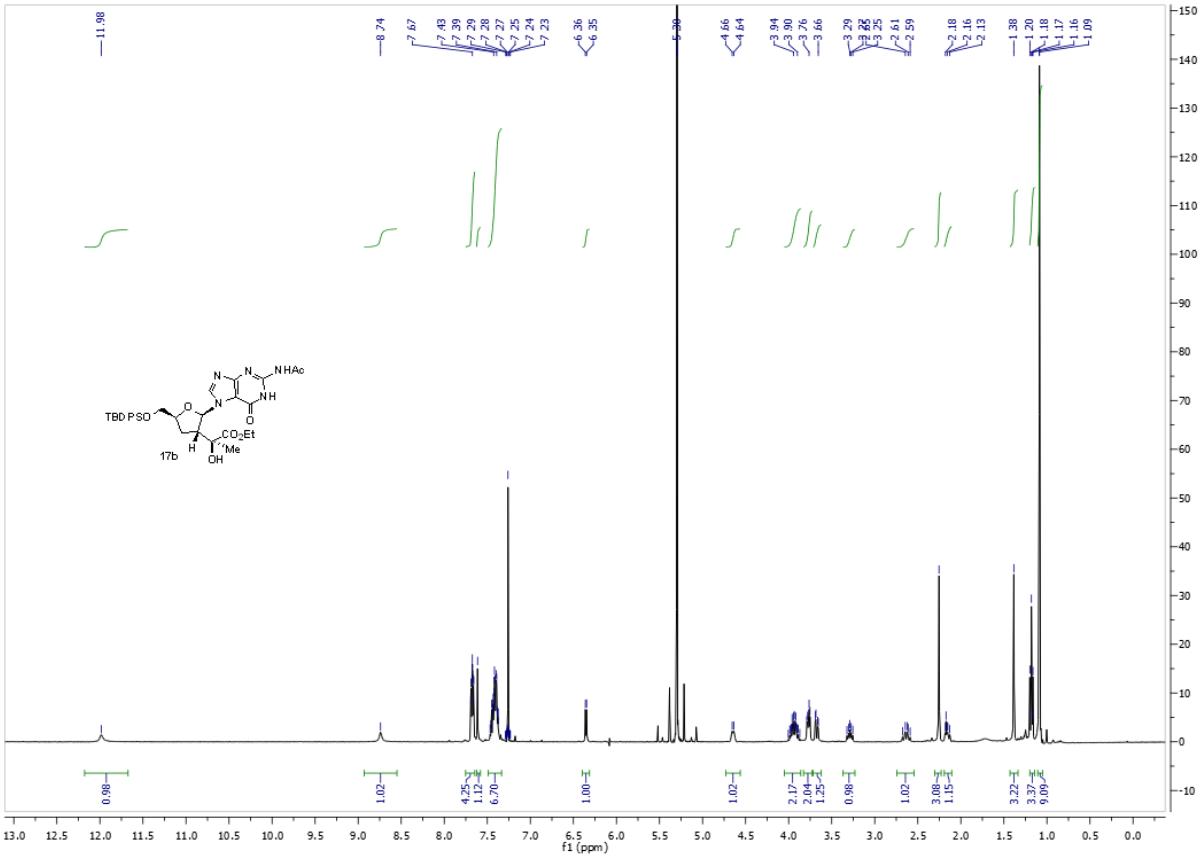

175.63
162.13
145.03
135.52
135.35
132.99
132.69
132.37
129.99
128.85
127.87
127.62
97.22
87.67
81.40
77.00
76.68
75.36
64.24
62.09
54.87
53.39
27.67
26.91
26.72
25.47
19.24
14.09
OH
CO2Et
TBDPSO
O
N
O
N
NHBz
14
f1 (ppm)

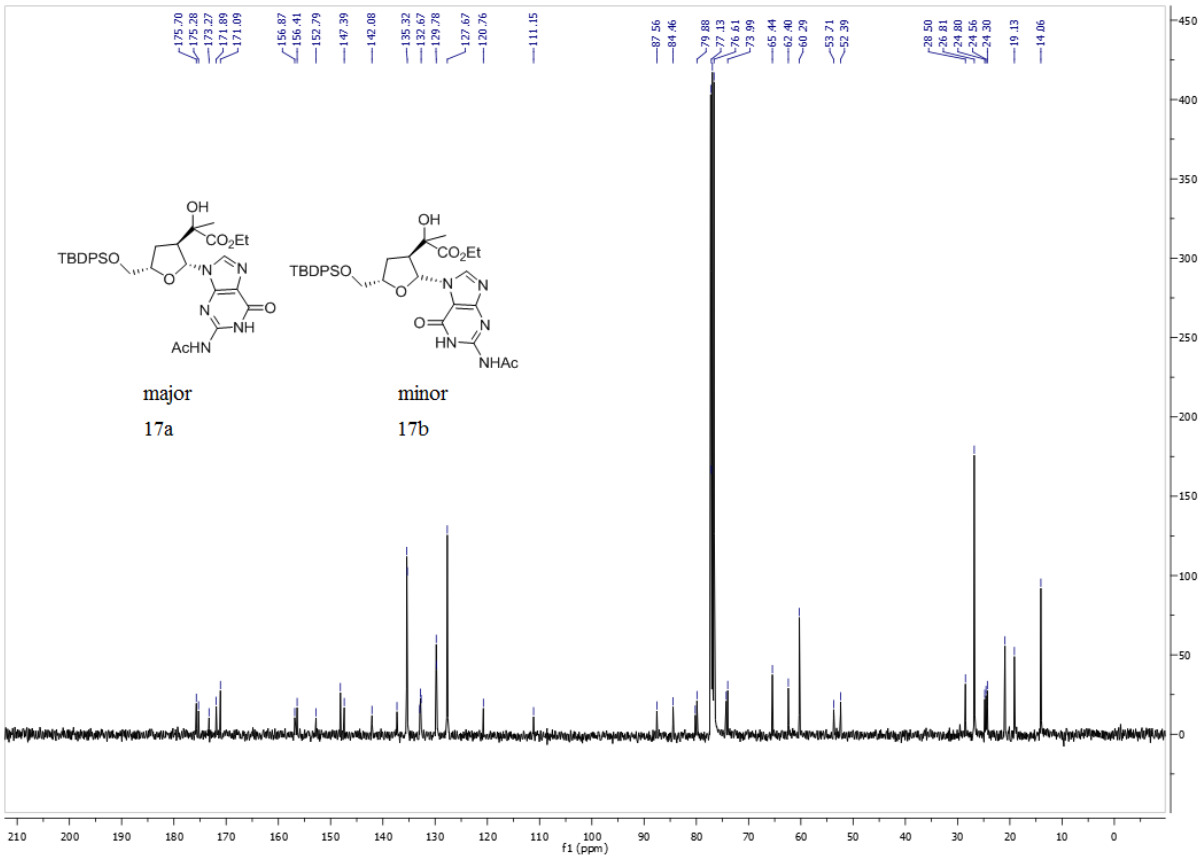

OH
CO2Et
TBDPSO
N
N
N
N
NHBz
15
f1 (ppm)

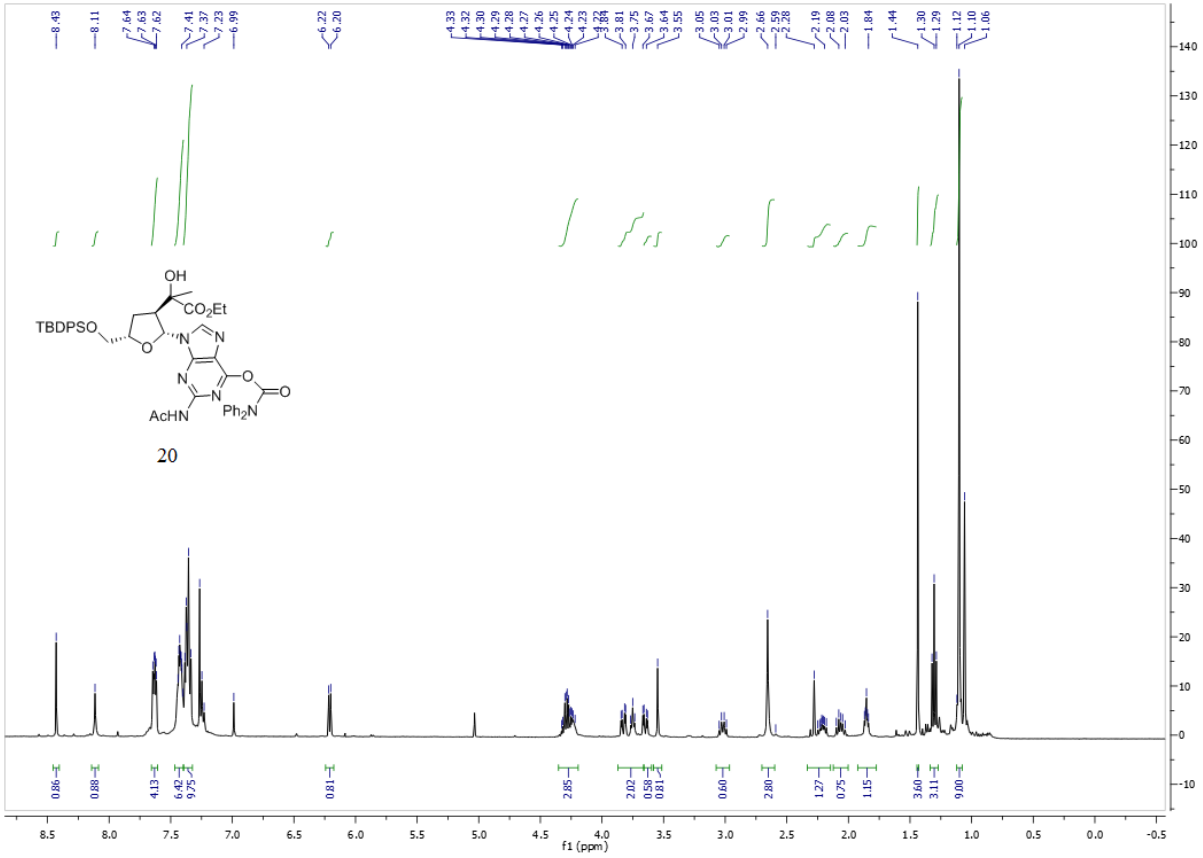

175.63
152.52
132.95
132.78
132.59
129.86
129.78
128.63
128.20
127.97
127.78
127.68
87.00
85.57
77.32
77.00
76.68
74.14
65.25
62.49
51.57
28.64
26.85
24.86
19.18
14.08
OH
CO2Et
TBDPSO
O
N
N
N
N
NHBz
15
f1 (ppm)

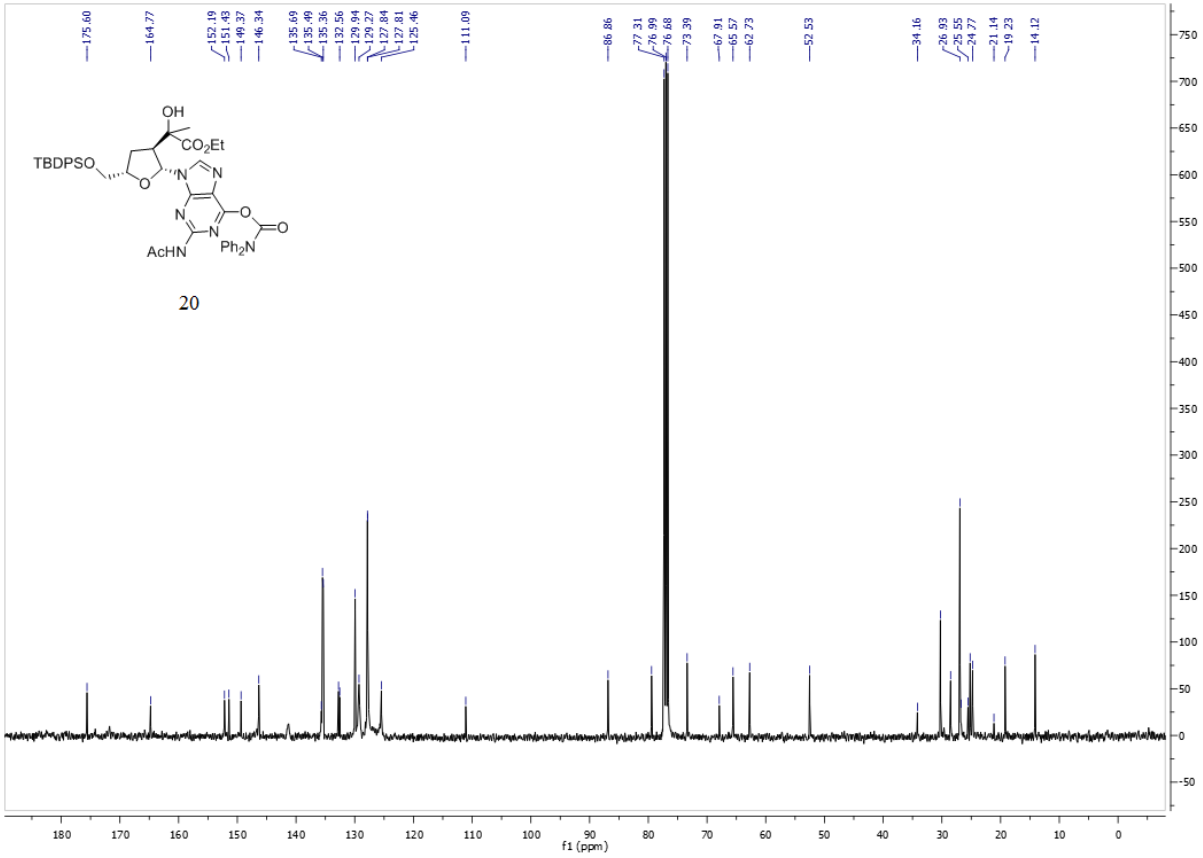

major
17a
minor
17b
f1 (ppm)


12.06
9.11
7.97
7.61
7.42
7.39
7.35
7.26
6.23
6.21
4.27
4.25
4.23
4.23
4.22
4.21
4.19
3.83
3.64
3.12
3.10
3.08
3.05
2.22
2.19
2.15
2.03
1.99
1.70
1.31
1.29
1.27
1.26
1.25
1.19
1.07
TBDPSO
NHAc
CO2Et
Me
OH
H
17a
0.93
1.02
1.11
4.27
6.37
1.00
3.15
0.77
1.06
1.79
0.76
0.42
4.70
0.97
3.44
3.38
11.17
f1 (ppm)


11.98
8.74
7.67
7.43
7.39
7.29
7.28
7.27
7.25
7.24
7.23
6.36
6.35
4.66
4.64
3.94
3.90
3.76
3.66
3.29
3.25
2.61
2.59
2.18
2.16
2.13
1.38
1.20
1.18
1.17
1.16
1.09
NHAc
N
NH
O
TBDPSO
CO2Et
Me
OH
H
17b
0.98
1.02
4.25
1.12
6.70
1.00
1.02
2.17
2.04
1.25
0.98
1.02
3.08
1.15
3.22
3.37
9.09
f1 (ppm)


175.70
175.28
173.37
171.89
171.09
156.87
156.41
152.79
147.39
142.08
135.32
132.67
129.78
127.67
120.76
111.15
87.56
84.46
79.88
77.13
76.61
73.99
65.44
62.40
60.29
53.71
52.39
28.50
26.81
24.80
24.56
24.30
19.13
14.06
OH
CO2Et
TBDPSO
N
N
O
N
NH
AcHN
major
17a
OH
CO2Et
TBDPSO
N
N
O
HN
N
NHAc
minor
17b
f1 (ppm)


OH
CO2Et
TBDPSO
N
N
O
N
N
O
O
AcHN
Ph2N
20
f1 (ppm)


175.60
164.77
152.19
151.43
149.37
146.34
135.69
135.49
135.36
132.56
129.94
129.27
127.84
127.81
125.46
111.09
86.86
77.31
76.99
76.68
73.39
67.91
65.57
62.73
52.53
34.16
26.93
25.55
24.77
21.14
19.23
14.12
OH
CO2Et
TBDPSO
O
N
N
N
N
O
O
N
AcHN
Ph2N
O
f1 (ppm)

20