Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry

Supporting Information

Click Fleximers: A modular approach to purine base-expanded ribonucleoside analogues

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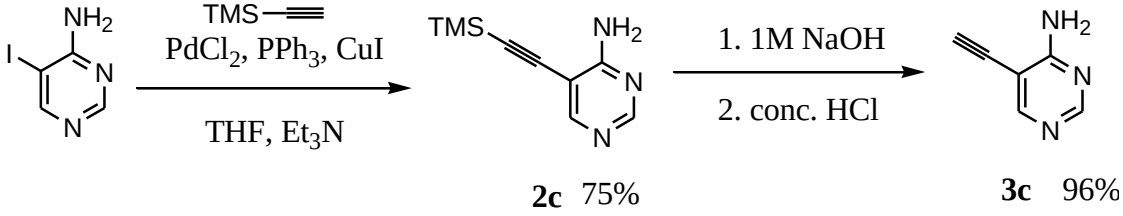
General Remarks

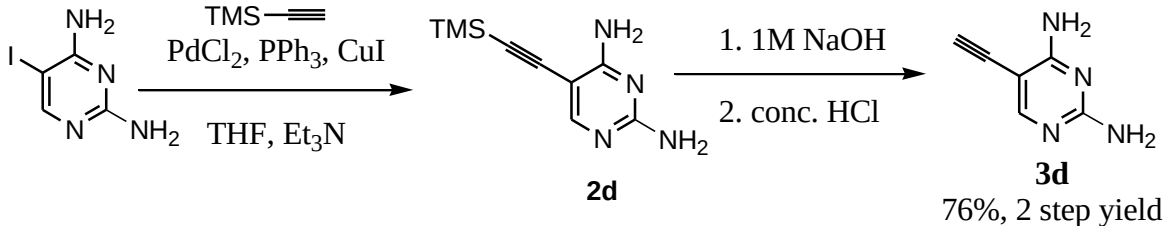
All chemicals were obtained from commercial sources and were of ACS reagent grade or higher and were used without further purification. Solvents for solution-phase chemistry were dried by passing through activated alumina columns. All reactions were performed under inert atmosphere unless otherwise noted. Flash column chromatography (FCC) was performed on Merck Kieselgel 60, 230-400 mesh. Thin layer chromatography (TLC) was performed on Merck Kieselgel 60 TLC plates. Chemical shifts are reported in parts per million (δ), were measured from tetramethylsilane (0 ppm) and are referenced to the solvent $CDCl_3$ (7.26 ppm), DMSO-d_6 (2.49 ppm), D_2O (4.79 ppm) and MeOH-d_4 (3.31 ppm) for ^1H NMR and $CDCl_3$ (77.0 ppm), DMSO-*d6* (39.5 ppm) and MeOH-d_4 (49.0 ppm) for ^{13}C NMR. Multiplicities are described as s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet) and br s (broad singlet). Coupling constants (*J*) are reported in Hertz (Hz). High resolution mass spectra (HRMS) were obtained using electron impact (EI) or electrospray ionization (ESI). UV-Vis experiments were performed using a CARY 300 Bio UV-Visible Spectrophotometer. Fluorescence experiments were performed using a PTI QuantMaster. All spectrophotometric measurements were performed in USP grade ethanol. RP-HPLC/MS were performed using a Sunfire™ C-18 5 µm (4.6 x 150 mm) column, Waters 600 controller, Waters Prep degasser, ESI-MS using Waters Micromass Quattro Micro™ API and Waters MassLynx software (version 4.1). Mobile phases were 0.1 % TFA in H_2O (solvent A) and 0.1 % TFA in MeCN (solvent B) and a flowrate of 1.5 mL/min.
Gradient 1: 0 to 10min, 5 to 10 % B; 10 to 10.5 min, 10 to 95 % B; 10.5 to 15 min, 95 % B
Gradient 2: 0 to 10min, 10 to 15 % B; 10 to 10.5 min, 15 to 95 % B; 10.5 to 15 min, 95 % B
Gradient 3: 0 to 10min, 20 to 80 % B; 10 to 10.5 min, 80 to 95 % B; 10.5 to 15 min, 95 % B



2c 75% **3c** 96%

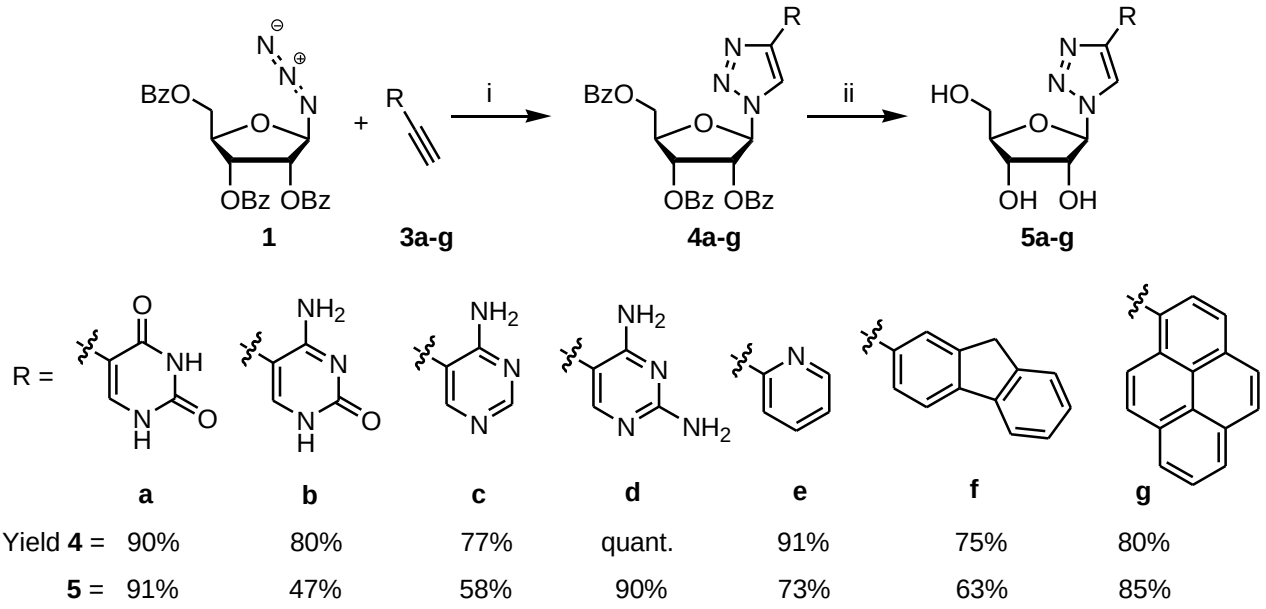
5-TMS-ethynyl-4-aminopyrimidine (2c). 5-Iodo-4-aminopyrimidine (0.417 g, 1.89 mmol) was suspended in THF (9.5 mL) and degassed with N_2. $PdCl_2$ (0.041 g, 0.23 mmol), Ph_3P (0.092 g, 0.35 mmol), and CuI (0.037 g, 0.19 mmol) were added and the solution degassed with N_2. Et_3N (0.60 mL, 4.3 mmol) and TMS-acetylene (1.2 mL, 8.4 mmol) was added and the solution degassed with N_2. The solution was stirred at 40 ºC in the dark for 18 h. THF (200 mL) was added, the solution filtered through Celite, and the solvent removed by rotary evaporation. The residue was subjected to FCC (EtOAc:Hex 1:1→3:2). The relevant fractions were combined and the solvent removed by rotary evaporation to yield **2c** (0.272 g, 75 % yield) as a tan powder: ^{1}H NMR (400 MHz, $CDCl_3$) = 8.43 (s, 1 H), 8.29 (s, 1 H), 6.13 (br. s., 2 H), 0.14 - 0.30 (m, 9 H); ^{13}C NMR (101 MHz, $CDCl_3$) = 162.8, 157.8, 156.8, 104.5, 101.9, 96.5, -0.3; HRMS (EI) calculated for $[C_9H_{13}N_3Si]^+$: 191.0879, Found 191.0886.

5-Ethynyl-4-aminopyrimidine (3c). **2c** (0.272 g, 1.42 mmol) was suspended in 1 M $NaOH_{(aq)}$ (30 mL) and stirred for 2 h. The solution was cooled on ice, and conc. HCl was added dropwise until pH ~3. The solution was diluted with H_2O (30 mL) and filtered. The mother liquor was basified with 1 M $NaOH_{(aq)}$ (10 mL) and extracted with EtOAc (2 x 150 mL). The organic layer was dried with Na_2SO_4, and the solvent was removed with rotary evaporation to yield **3c** (0.162 g, 96 % yield) as a tan powder: ^{1}H NMR (600 MHz, MeOH-d_4) = 8.35 (s, 1 H), 8.23 (s, 1 H), 4.04 (s, 1 H); ^{13}C NMR (151 MHz, MeOH-d_4) = 165.1, 158.5, 158.1, 102.3, 88.3, 76.5; HRMS (EI) calculated for $[C_6H_5N_3]^+$: 119.0483, Found 119.0484.



5-TMS-ethynyl-2,4-diaminopyrimidine (2d). 5-Iodo-2,4-diaminopyrimidine (0.194 g, 0.878 mmol) was suspended in THF (4 mL) and degassed with N_2. $PdCl_2$ (0.018 g, 0.10 mmol), Ph_3P (0.040 g, 0.15 mmol), and CuI (0.038 g, 0.20 mmol) were added and the solution degassed with N_2. Et_3N (0.25 mL, 1.8 mmol) and TMS-acetylene (0.5 mL, 3.5 mmol) was added and the solution degassed with N_2. The solution was stirred at 40 ºC in the dark for 18 h. THF (200 mL) was added, the solution filtered through Celite, and the solvent removed by rotary evaporation. The residue was filtered through a silica plug with EtOAc:Hex (1:1, 200 mL). The silica plug was then flushed with EtOAc (300 mL), which was collected and the solvent removed by rotary evaporation to yield crude **2d** (0.192 g, 113 % theoretical yield): ^{1}H NMR (600 MHz, $CDCl_3$) = 8.04 (s, 1 H), 5.45 (br. s., 2 H), 5.35 (br. s., 2 H), 0.23 (s, 9 H); ^{13}C NMR (151 MHz, $CDCl_3$) = 163.9, 161.6, 159.9, 101.1, 98.2, 92.5, 0.0; HRMS (EI) calculated for $[C_9H_{14}N_4Si]^+$: 206.0988, Found 206.0979.

5-Ethynyl-2,4-diaminopyrimidine (3d). Crude **2d** (0.192 g, 0.878 mmol of 5-iodo-2,4-diaminopyrimidine) was suspended in 1 M $NaOH_{(aq)}$ (20 mL) and stirred for 3 h. The solution was cooled on ice, conc. HCl was added dropwise until the pH ~3, and the solution was filtered. The mother liquor was neutralized with 1 M $NaOH_{(aq)}$ and extracted with EtOAc (150 mL). The organic layer was dried over Na_2SO_4, and the solvent was removed with rotary evaporation to yield **3d** (0.080 g, 76 % yield from 5-iodo-2,4-diaminopyrimidine) as a yellow powder: ^{1}H NMR (600 MHz, MeOH-d_4) = 7.88 (s, 1 H), 3.75 (s, 1 H); ^{13}C NMR (101 MHz, MeOH-d_4) = 166.0, 163.4, 160.4, 92.2, 84.8, 78.0; HRMS (EI) calculated for $[C_6H_6N_4]^+$: 134.0592, Found 134.0599.



	a	b	c	d	e	f	g
Yield **4** =	90%	80%	77%	quant.	91%	75%	80%
5 =	91%	47%	58%	90%	73%	63%	85%

1-(2,3,5-tri-*O*-benzoyl-β-D-ribofuranosyl)-4-(5-(2,4-dihydroxypyrimidinyl))-1,2,3-triazole (4a). **1** (0.043 g, 0.089 mmol) was dissolved in THF (4 mL). **3a** (0.064 g, 0.48 mmol), DIPEA (30 µL, 0.17 mmol), CuI (9.7 mg, 0.051 mmol), and *N*,*N'*-dimethylethylenediamine (50 µL, 0.46 mmol) were added to the solution and the solution was heated to reflux. The reaction was tracked by TLC, and after complete consumption of **1** the solvent was removed. The residue was suspended in EtOAc (100 mL) and washed with H_2O (3 X 50 mL). The organic layer was dried over Na_2SO_4, filtered, and the solvent removed to yield **4a** as a white solid (0.050 g, 90 % yield): ^{1}H NMR (400 MHz, DMSO-d_6): δ = 11.45 (br s, 1 H), 11.26 (br s, 1 H), 8.63 (s, 1 H), 8.04 (s, 1 H), 7.91-7.96 (m, 6 H), 7.62-7.70 (m, 3 H), 7.44-7.52 (m, 6 H), 6.81 (d, *J*=3.1 Hz, 1 H), 6.29 (dd, *J*=5.1, 3.1 Hz, 1 H), 6.13 (dd, *J*=6.3, 5.5 Hz, 1 H), 4.96 (dt, *J*=6.4, 4.1 Hz, 1 H), 4.69 (dd, *J*=12.5, 3.9 Hz, 1 H), 4.57 (dd, *J*=12.1, 4.7 Hz, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 170.1, 165.4, 164.8, 164.5, 162.1, 150.6, 139.6, 138.1, 134.1, 133.9, 133.4, 129.4, 129.4, 129.4, 129.1, 128.8, 128.7, 128.6, 128.5, 128.3, 122.2, 103.3, 89.1, 79.8, 74.4, 71.2, 63.4; HRMS (ESI) calculated for $[C_{32}H_{26}N_5O_9]^+$: 624.5764, Found 624.1376.

1-(2,3,5-tri-*O*-benzoyl-β-D-ribofuranosyl)-4-(5-(4-amino-2-hydroxypyrimidinyl))-1,2,3-triazole (4b). **1** (0.14 g, 0.29 mmol) was dissolved in THF (12 mL). **3b** (0.095 g, 0.70 mmol), DIPEA (0.20 mL, 1.1 mmol), CuI (20 mg, 0.11 mmol), and *N*,*N'*-dimethylethylenediamine (0.20 mL, 1.9 mmol) were added to the solution and the solution was heated to reflux. The reaction was tracked by TLC, and after complete consumption of **1** the solvent was removed. The residue was suspended in EtOAc (100 mL) and washed with H_2O (2 X 100 mL). The organic layer was dried over Na_2SO_4, filtered, and the solvent removed to yield **4b** as a tan solid (0.146 g, 80 % yield): ^{1}H NMR (400 MHz, DMSO-d_6): δ = 11.09 (br. s., 1 H), 8.77 (s, 1 H), 7.38 - 8.02 (m, 19 H), 6.80 (d, *J* = 2.3 Hz, 1 H), 6.33 (dd, *J* = 2.3, 5.1 Hz, 1 H), 6.11 - 6.21 (m, 1 H), 4.93 - 5.07 (m, 1 H), 4.74 (dd, *J* = 2.9, 12.3 Hz, 1 H), 4.60 (dd, *J* = 4.3, 12.1 Hz, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 165.8, 165.1, 164.9, 163.7, 156.2, 143.1, 134.5, 134.3, 133.9, 129.9, 129.8, 129.7, 129.6, 129.5, 129.5, 129.3, 129.2, 129.1, 129.0, 128.9, 128.8, 121.2, 90.1, 80.4, 75.0, 71.3, 63.6; HRMS (ESI) calculated for $[C_{32}H_{27}N_6O_8]^+$: 623.1890, Found 623.1153.

1-(2,3,5-tri-*O*-benzoyl-β-D-ribofuranosyl)-4-(5-(4-aminopyrimidinyl))-1,2,3-triazole (4c). **1** (0.056 g, 0.11 mmol) was dissolved in THF (4 mL). **3c** (0.025 g, 0.21 mmol), DIPEA (37 µL, 0.21 mmol), CuI (6.8 mg, 0.036 mmol), and *N*,*N'*-dimethylethylenediamine (50 µL, 0.46 mmol) were added to the solution and the solution was heated to reflux. The reaction was tracked by TLC, and after complete consumption of **1** the solvent was removed. The residue was suspended in EtOAc (100 mL) and washed with H_2O (3 X 50 mL). The organic layer was dried over Na_2SO_4, filtered, and the solvent removed. The residue was purified by FCC (MeOH-DCM = 1:9, R_f = 0.51) to yield **4c** as a white solid (0.053 g, 77 % yield): ^{1}H NMR (400 MHz, DMSO-d_6) δ = 9.02 (s, 1 H), 8.58 (s, 1 H), 8.40 (s, 1 H), 7.98 (d, *J*=7.4 Hz, 2 H), 7.91 (t, *J*=8.2 Hz, 4 H), 7.58-7.72 (m, 5 H), 7.40-7.54 (m, 6 H), 6.83 (d, *J*=2.7 Hz, 1 H), 6.35 (dd, *J*=5.3, 2.5 Hz, 1 H), 6.17 (dd, *J*=7.0, 5.1 Hz, 1 H), 5.02 (dt, *J*=6.9, 3.8 Hz, 1 H), 4.73 (dd, *J*=12.5, 3.5 Hz, 1 H), 4.60 (dd, *J*=12.5, 4.3 Hz, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.4, 164.7, 164.5, 159.2, 157.4, 153.1, 143.0, 134.1, 133.9, 133.4, 129.5, 129.4, 129.2, 129.1, 128.8, 128.7, 128.5, 128.5, 128.3, 122.0, 89.7, 80.0, 74.6, 70.9, 63.1; HRMS (ESI) calculated for $[C_{32}H_{27}N_6O_7]^+$: 607.1941, Found 607.1077.

1-(2,3,5-tri-*O*-benzoyl-β-D-ribofuranosyl)-4-(5-(2,4-diaminopyrimidinyl))-1,2,3-triazole (4d). **1** (0.125 g, 0.256 mmol) was dissolved in THF (10 mL). **3d** (0.050 g, 0.37 mmol), DIPEA (0.20 mL, 1.1 mmol), CuI (20 mg, 0.11 mmol), and *N*,*N'*-dimethylethylenediamine (0.20 mL, 1.9 mmol) were added to the solution and the solution was heated to reflux. The reaction was tracked by TLC, and after complete consumption of **1** the solvent was removed. The residue was suspended in EtOAc (100 mL) and washed with H_2O (100 mL). The organic layer was dried over Na_2SO_4, filtered, and the solvent removed to yield **4d** as a yellow foam (0.159 g, quant.): ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.03 (br. s., 1 H), 7.90 - 8.00 (m, 6 H), 7.86 (br. s., 2 H), 7.53 (quin, *J* = 7.2 Hz, 3 H), 7.30 - 7.43 (m, 6 H), 6.43 (d, *J* = 3.5 Hz, 1 H), 6.27 (dd, *J* = 3.5, 5.1 Hz, 1 H), 6.12 (t, *J* = 5.5 Hz, 1 H), 5.17 (br. s., 1 H), 4.75 - 4.94 (m, 4 H), 4.56 (dd, *J* = 3.5, 12.1 Hz, 1 H); ^{13}C NMR (101 MHz, CDCl3): δ = 165.9, 165.0, 165.0, 162.2, 160.6, 154.5, 145.0, 133.7, 133.5, 133.3, 129.7, 129.6, 129.5, 128.9, 128.4, 128.4, 128.3, 128.3, 117.0, 90.3, 81.0, 77.2, 75.1, 71.5, 63.2, 29.5; HRMS (ESI) calculated for $[C_{32}H_{28}N_7O_7]^+$: 622.2045, Found 622.2057.

1-(2,3,5-tri-*O*-benzoyl-β-D-ribofuranosyl)-4-(5-(2-pyridinyl))-1,2,3-triazole (4e). **1** (0.123 g, 0.252 mmol) was dissolved in THF (10 mL). **3e** (0.041 g, 0.37 mmol), DIPEA (90 µL, 0.51 mmol), CuI (6.6 mg, 0.035 mmol), and *N*,*N'*-dimethylethylenediamine (50 µL, 0.46 mmol) were added to the solution and the solution was heated to reflux. The reaction was tracked by TLC, and after complete consumption of **1** the solvent was removed. The residue was suspended in EtOAc (100 mL) and washed with H_2O (3 X 50 mL). The organic layer was dried over Na_2SO_4, filtered, and the solvent removed to yield **4e** as a brown foam (0.140 g, 91 % yield): ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.56 (br. s., 1 H), 8.40 (s, 1 H), 8.15 (d, J=7.4 Hz, 1 H), 8.03 (t, J=8.2 Hz, 4 H), 7.96 (d, J=7.4 Hz, 2 H), 7.78 (t, J=7.6 Hz, 1 H), 7.49-7.62 (m, 3 H), 7.35-7.46 (m, 6 H), 7.22-7.26 (m, 1 H), 6.51 (d, J=3.1 Hz, 1 H), 6.33 (dd, J=4.7, 3.5 Hz, 1 H), 6.18 (t, J=5.9 Hz, 1 H), 4.91-4.95 (m, 1 H), 4.82 (dd, J=12.3, 3.3 Hz, 1 H), 4.66 (dd, *J*=12.1, 4.3 Hz, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 166.0, 164.9, 164.8, 149.5, 149.3, 148.7, 136.6, 133.7, 133.5, 133.1, 129.7, 129.6, 129.6, 129.1, 128.5, 128.4, 128.3, 128.3, 121.4, 90.3, 81.0, 75.1, 71.4, 63.5.

1-(2,3,5-tri-*O*-benzoyl-β-D-ribofuranosyl)-4-(5-(2-fluorenyl))-1,2,3-triazole (4f). **1** (0.062 g, 0.12 mmol) was dissolved in THF (5 mL). **3f** (0.035 g, 0.18 mmol), DIPEA (40 µL, 0.23 mmol),

CuI (3.2 mg, 0.017 mmol), and *N,N'*-dimethylethylenediamine (50 µL, 0.46 mmol) were added to the solution and the solution was heated to reflux. The reaction was tracked by TLC, and after complete consumption of **1** the solvent was removed. The residue was suspended in EtOAc (100 mL) and washed with a solution of saturated $NaCl_{(aq)}$ and H_2O (50 mL, 1:1) and H_2O (2 X 50 mL). The organic layer was dried over Na_2SO_4, filtered, and the solvent removed. The residue was purified by FCC (EtOAc-hexanes = 1:3, R_f = 0.20) to yield **4f** as a white solid (0.064 g, 75 % yield): ^{1}H NMR (400 MHz, DMSO-d_6): δ = 8.93 (s, 1 H), 8.06 (s, 1 H), 7.88-8.01 (m, 9 H), 7.61-7.72 (m, 3 H), 7.32-7.54 (m, 9 H), 6.80 (d, *J*=2.7 Hz, 1 H), 6.35 (dd, *J*=5.3, 2.9 Hz, 1 H), 6.18 (dd, *J*=6.6, 5.5 Hz, 1 H), 5.01 (dt, *J*=6.6, 4.1 Hz, 1 H), 4.73 (dd, *J*=12.5, 3.9 Hz, 1 H), 4.62 (dd, *J*=12.1, 4.3 Hz, 1 H), 4.01 (s, 2 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 165.4, 164.7, 164.5, 147.4, 143.7, 143.3, 141.2, 140.7, 134.1, 133.9, 133.5, 129.5, 129.4, 129.3, 129.1, 128.8, 128.7, 128.6, 128.6, 128.5, 128.3, 126.9, 126.8, 125.2, 124.2, 122.0, 121.1, 120.4, 120.1, 109.5, 89.5, 79.9, 74.6, 71.1, 63.4, 36.4; HRMS (ESI) calculated for $[C_{41}H_{32}N_3O_7]^+$: 678.2235, Found 678.2778.

1-(2,3,5-tri-*O*-benzoyl-β-D-ribofuranosyl)-4-(5-(1-pyrenyl))-1,2,3-triazole (4g). **1** (0.135 g, 0.256 mmol) was dissolved in THF (12 mL). **3g** (0.073 g, 0.33 mmol), DIPEA (100 µL, 0.57 mmol), CuI (9.6 mg, 0.050 mmol), and *N,N'*-dimethylethylenediamine (100 µL, 0.92 mmol) were added to the solution and the solution was heated to reflux. The reaction was tracked by TLC, and after complete consumption of **1** the solvent was removed. The product was suspended in EtOAc (100 mL) and washed with a solution of saturated $NaCl_{(aq)}$ and H_2O (50 mL, 1:1) and H_2O (2 X 50 mL). The organic layer was dried over Na_2SO_4, filtered, and the solvent. The residue was purified by FCC (EtOAc-hexanes = 1:5 → MeOH-EtOAc = 1:8) to yield **4g** as a white solid (0.158 g, 80 % yield): ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.63 (d, *J*=9.4 Hz, 1 H), 7.99-8.24 (m, 15 H), 7.60 (q, *J*=7.0 Hz, 2 H), 7.37-7.48 (m, 5 H), 7.28-7.35 (m, 2 H), 6.65 (d, *J*=2.7 Hz, 1 H), 6.40-6.43 (m, 1 H), 6.27 (t, *J*=5.1 Hz, 1 H), 4.92-5.01 (m, 2 H), 4.70 (dd, *J*=12.1, 3.9 Hz, 1 H); ^{13}C NMR (101 MHz, $CDCl_3$): δ = 166.0, 165.1, 165.0, 147.8, 133.7, 133.6, 133.2, 131.2, 131.1, 130.6, 129.8, 129.7, 129.5, 129.1, 128.5, 128.5, 128.4, 128.4, 128.0, 127.7, 127.1, 126.9, 125.9, 125.2, 125.0, 124.7, 124.6, 124.5, 124.4, 124.2, 122.0, 90.4, 81.1, 75.7, 75.3, 71.5, 63.5; HRMS (ESI) calculated for $[C_{44}H_{32}N_3O_7]^+$: 714.2235, Found 714.2722.

1-(1-β-D-ribofuranosyl)-4-(5-(2,4-dihydroxypyrimidinyl))-1,2,3-triazole (5a). 4a (88.4 mg, 0.141 mmol) was suspended in MeOH (25 mL) and cooled to 0 °C. Ammonia gas was bubbled into the solution until saturated. The reaction mixture was sealed and stirred for 72 hours at room temperature. The solvent was removed, the residue triturated with diethyl ether, and filtered to yield **5a** as an off-white powder (40.1 mg, 91 % yield): ^{1}H NMR (400 MHz, D_2O): δ = 8.43 (s, 1 H), 8.06 (s, 1 H), 6.10 (d, *J*=3.9 Hz, 1 H), 4.65 (t, *J*=4.5 Hz, 1 H), 4.41 (t, *J*=5.3 Hz, 1 H), 4.19 (dd, *J*=8.2, 4.7 Hz, 1 H), 3.82 (dd, *J*=12.9, 2.7 Hz, 1 H), 3.70 (dd, *J*=12.5, 5.1 Hz, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 162.2, 150.9, 139.5, 138.2, 120.5, 103.7, 92.1, 85.9, 75.1, 70.6, 61.4; HRMS (ESI) calculated for $[C_{11}H_{14}N_5O_6]^+$: 312.0939, Found 312.1028.

1-(1-β-D-ribofuranosyl)-4-(5-(4-amino-2-hydroxypyrimidinyl))-1,2,3-triazole (5b). 4b (0.107 g, 0.172 mmol) was suspended in MeOH (30 mL) and cooled to 0 °C. Ammonia gas was bubbled into the solution until saturated. The reaction mixture was sealed and stirred for 18 hours at room temperature. The solvent was removed, the residue triturated with diethyl ether (30 mL), and filtered to yield **5b** as an off-white powder (25 mg, 47 % yield): ^{1}H NMR (400 MHz, DMSO-d_6): δ = 11.02 (br. s., 1 H), 8.63 (s, 1 H), 7.94 (br. s., 1 H), 7.77 (br. s., 2 H), 5.95 (d, *J* = 3.9 Hz, 1 H), 5.66 (br. s., 1 H), 5.28 (br. s., 1 H), 4.96 (br. s., 1 H), 4.39 (br. s., 1 H), 4.14 (br. s., 1 H), 3.99 (d, *J* = 3.9 Hz, 1 H), 3.47 - 3.69 (m, 2 H); A sample with the concentration nessessary for a ^{13}C NMR was not able to be obtained; HRMS (ESI) calculated for $[C_{11}H_{15}N_6O_5]^+$: 311.1104, Found 311.0900.

1-(1-β-D-ribofuranosyl)-4-(5-(4-aminopyrimidinyl))-1,2,3-triazole (5c). 4c (0.161 g, 0.265 mmol) was suspended in MeOH (30 mL) and cooled to 0 °C. Ammonia gas was bubbled into the solution until saturated. The reaction mixture was sealed and stirred for 48 hours at room temperature. The solvent was removed, the residue triturated with diethyl ether, and filtered to give **5c** contaminated with benzamide. The mixture was suspended in EtOAc and filtered through silica (EtOAc 300 mL). The silica then was flushed with MeOH:EtOAc (1:4, 300 mL) and the solvent removed from this fraction to yield **5c** as a tan powder (0.045 mg, 58 % yield):

^{1}H NMR (400 MHz, DMSO-d_6): δ = 8.93 (s, 1 H), 8.61 (s, 1 H), 8.39 (s, 1 H), 7.63 (br. s., 2 H), 6.00 (d, *J* = 4.7 Hz, 1 H), 5.69 (d, *J* = 5.9 Hz, 1 H), 5.30 (d, *J* = 5.5 Hz, 1 H), 5.00 (t, *J* = 5.7 Hz, 1 H), 4.44 (q, *J* = 4.8 Hz, 1 H), 4.16 (q, *J* = 5.2 Hz, 1 H), 4.01 (q, *J* = 4.2 Hz, 1 H), 3.66 (dt, *J* = 5.0, 11.9 Hz, 1 H), 3.54 (dt, *J* = 5.2, 11.9 Hz, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 159.5, 157.5, 153.1, 143.0, 120.6, 106.6, 92.8, 86.3, 75.4, 70.5, 61.5; HRMS (ESI) calculated for $[C_{11}H_{15}N_6O_4]^+$: 295.1149, Found 295.1284.

1-(1-β-D-ribofuranosyl)-4-(5-(2,4-diaminopyrimidinyl))-1,2,3-triazole (5d). 4d (0.157 g, 0.252 mmol) was suspended in MeOH (30 mL) and cooled to 0 °C. Ammonia gas was bubbled into the solution until saturated. The reaction mixture was sealed and stirred for 18 hours at room temperature. The solvent was removed, the solid suspended in EtOAc, and filtered through silica (EtOAc 300 mL). The silica then was flushed with MeOH:EtOAc (1:4, 300 mL) and the solvent removed from this fraction to yield **5d** as a yellow powder (0.070 mg, 90 % yield): ^{1}H NMR (400 MHz, MeOH-d_4): δ = 8.45 (s, 1 H), 8.07 (s, 1 H), 6.05 (d, *J* = 3.9 Hz, 1 H), 4.52 (t, *J* = 4.3 Hz, 1 H), 4.33 (t, *J* = 4.9 Hz, 1 H), 4.12 (q, *J* = 3.8 Hz, 1 H), 3.82 (dd, *J* = 2.7, 12.1 Hz, 1 H), 3.69 (dd, *J* = 3.9, 12.5 Hz, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 162.5, 160.3, 155.0, 144.4, 117.7, 97.0, 92.4, 85.9, 75.1, 70.3, 61.3; HRMS (ESI) calculated for $[C_{11}H_{16}N_7O_4]^+$: 310.1258, Found 310.1249; UV/vis $\lambda_{max(EtOH)}$ = 257 nm; $\lambda_{max(water)}$ = 298 nm. Fluorescence (abs. EtOH): emission λ_{max} = 311 nm, excitation λ_{max} = 356 nm, Φ_{EtOH} = 0.48, Φ_{H2O} = 0.05.

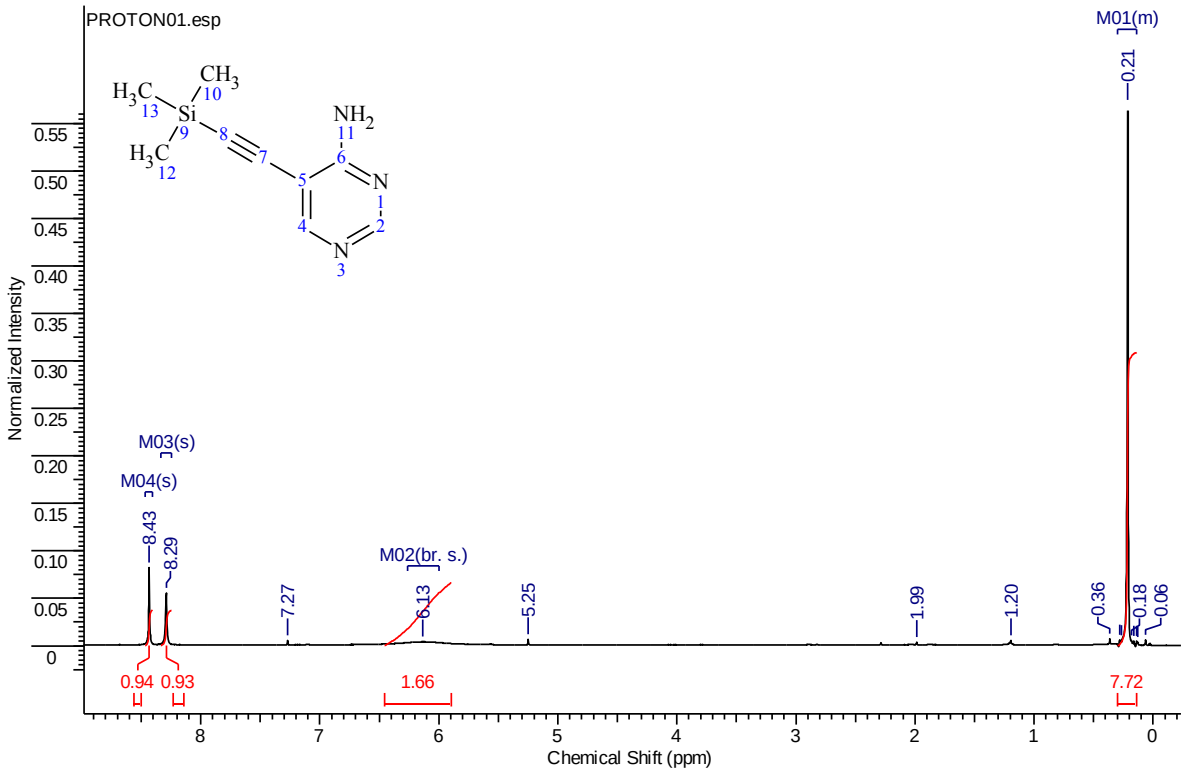
1-(1-β-D-ribofuranosyl)-4-(5-(2-pyridinyl))-1,2,3-triazole (5e). 4e (0.120 g, 0.203 mmol) was suspended in MeOH (35 mL) and cooled to 0 °C. Ammonia gas was bubbled into the solution until saturated. The reaction mixture was sealed and stirred for 48 hours at room temperature. The solvent was removed, the residue triturated with diethyl ether, and filtered to yield **5e** as a light brown powder (41.1 mg, 73 % yield): ^{1}H NMR (400 MHz, DMSO-d_6): δ = 8.87 (s, 1 H), 8.61 (d, *J*=3.9 Hz, 1 H), 8.06 (d, *J*=7.8 Hz, 1 H), 7.90 (td, *J*=7.4, 1.6 Hz, 1 H), 7.36 (dd, *J*=6.8, 5.3 Hz, 1 H), 6.04 (d, *J*=4.7 Hz, 1 H), 5.67 (d, *J*=5.1 Hz, 1 H), 5.29 (d, *J*=4.3 Hz, 1 H), 5.12 (t, *J*=5.3 Hz, 1 H), 4.46 (dd, *J*=9.4, 4.3 Hz, 1 H), 4.19 (dd, *J*=9.0, 5.1 Hz, 1 H), 4.03 (dd, *J*=8.2, 4.3 Hz, 1 H), 3.64 - 3.71 (m, 1 H), 3.53 - 3.60 (m, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 149.8,

149.7, 147.6, 137.3, 123.2, 121.6, 119.6, 92.4, 86.0, 75.4, 70.4, 61.2; HRMS (ESI) calculated for $[C_{12}H_{15}N_4O_4]^+$: 279.1093, Found 279.0934.

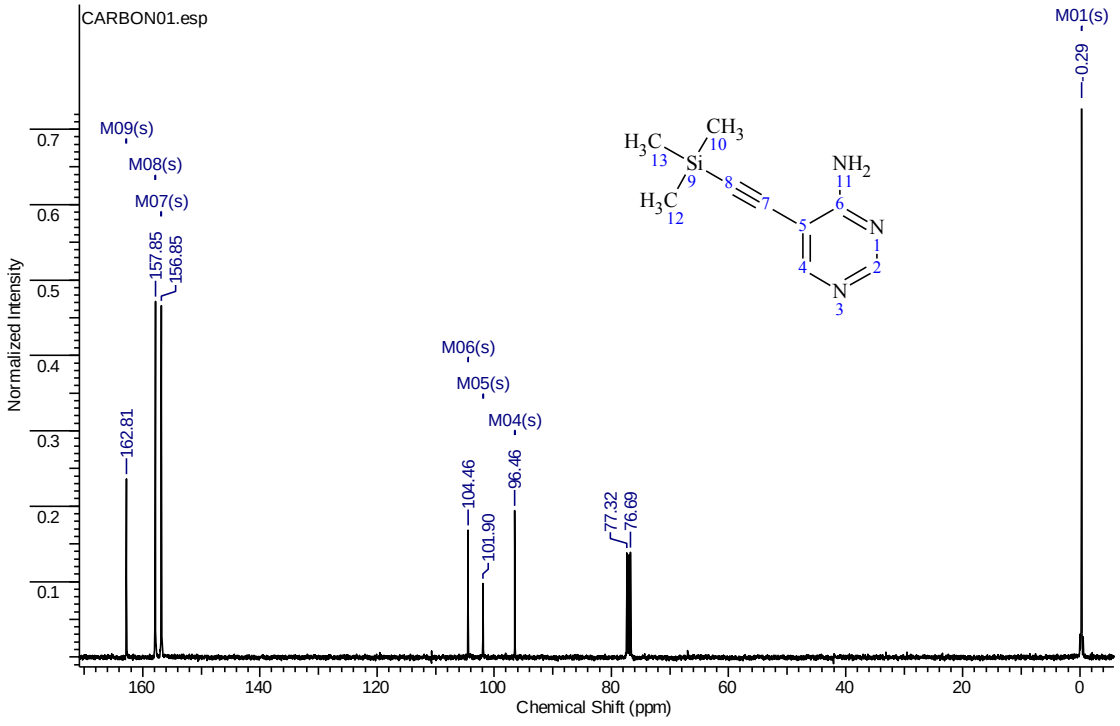
1-(1-β-D-ribofuranosyl)-4-(5-(2-fluorenyl))-1,2,3-triazole (5f). **4f** (0.215 g, 0.318 mmol) was suspended in MeOH (35 mL) and cooled to 0 °C. Ammonia gas was bubbled into the solution until saturated. The reaction mixture was sealed and stirred for 24 hours at room temperature. The solvent was removed, the residue triturated with diethyl ether, and filtered to yield **5f** as a white powder (72.8 mg, 63 % yield): ^{1}H NMR (400 MHz, DMSO-d_6): δ = 8.84 (s, 1 H), 8.10 (s, 1 H), 7.89-8.02 (m, 3 H), 7.61 (d, *J*=7.0 Hz, 1 H), 7.37 (dt, *J*=27.5, 7.1 Hz, 2 H), 6.00 (d, *J*=3.9 Hz, 1 H), 5.67 (d, *J*=5.5 Hz, 1 H), 5.30 (d, *J*=5.1 Hz, 1 H), 5.05 (t, *J*=4.3 Hz, 1 H), 4.46 (dd, *J*=4.7 Hz, 1 H), 4.19 (dd, *J*=4.3 Hz, 1 H), 3.97-4.05 (m, 3 H), 3.69 (dd, *J*=11.3, 5.1 Hz, 1 H), 3.57 (dd, *J*=11.7, 6.3 Hz, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 147.1, 143.8, 143.3, 141.0, 140.8, 129.1, 126.9, 126.9, 125.2, 124.1, 122.0, 120.5, 120.1, 119.7, 92.3, 86.0, 75.2, 70.4, 61.4, 36.5; HRMS (ESI) calculated for $[C_{20}H_{20}N_3O_4]^+$: 366.1454, Found 366.1434.

1-(1-β-D-ribofuranosyl)-4-(5-(1-pyrenyl))-1,2,3-triazole (5g). **4g** (0.156 g, 0.219 mmol) was suspended in MeOH (45 mL) and cooled to 0 °C. Ammonia gas was bubbled into the solution until saturated. The reaction mixture was sealed and stirred for 24 hours at room temperature. The solvent was removed, the residue triturated with diethyl ether, and filtered to yield **5g** contaminated with benzamide. The mixture was suspended in EtOAc and filtered through silica (EtOAc 300 mL). The silica then was flushed with MeOH:EtOAc (1:4, 300 mL) and the solvent removed from this fraction to yield **5g** as a yellow powder (74.6 mg, 85 % yield): ^{1}H NMR (400 MHz, DMSO-d_6): δ = 9.00 (s, 1 H), 8.84 (d, *J* = 9.4 Hz, 1 H), 8.23 - 8.42 (m, 7 H), 8.12 (t, *J* = 7.8 Hz, 1 H), 6.13 (d, *J* = 4.7 Hz, 1 H), 5.75 (d, *J* = 5.9 Hz, 1 H), 5.33 (d, *J* = 5.5 Hz, 1 H), 5.10 (t, *J* = 5.5 Hz, 1 H), 4.58 (q, *J* = 5.1 Hz, 1 H), 4.26 (q, *J* = 4.8 Hz, 1 H), 4.06 (q, *J* = 4.3 Hz, 1 H), 3.72 (ddd, *J* = 3.9, 5.5, 12.1 Hz, 1 H), 3.60 (dt, *J* = 4.9, 12.1 Hz, 1 H); ^{13}C NMR (101 MHz, DMSO-d_6): δ = 146.5, 130.9, 130.7, 130.4, 128.3, 127.8, 127.6, 127.5, 127.3, 127.2, 125.6, 125.2, 125.2, 125.1, 124.8, 124.3, 123.9, 123.1, 92.6, 86.0, 75.4, 70.4, 61.3; HRMS (ESI) calculated for $[C_{23}H_{20}N_3O_4]^+$: 402.1454, Found 402.1493.

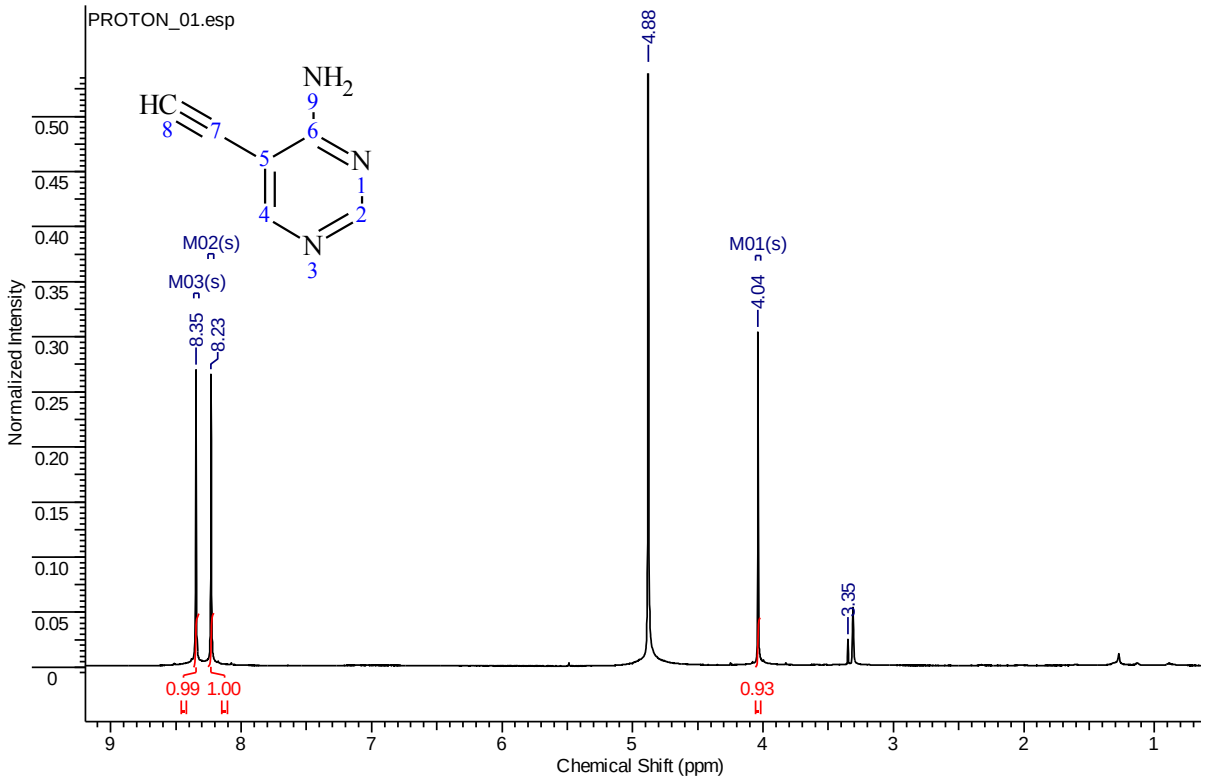
^{1}H NMR (400 MHz, $CDCl_3$) of **2c**



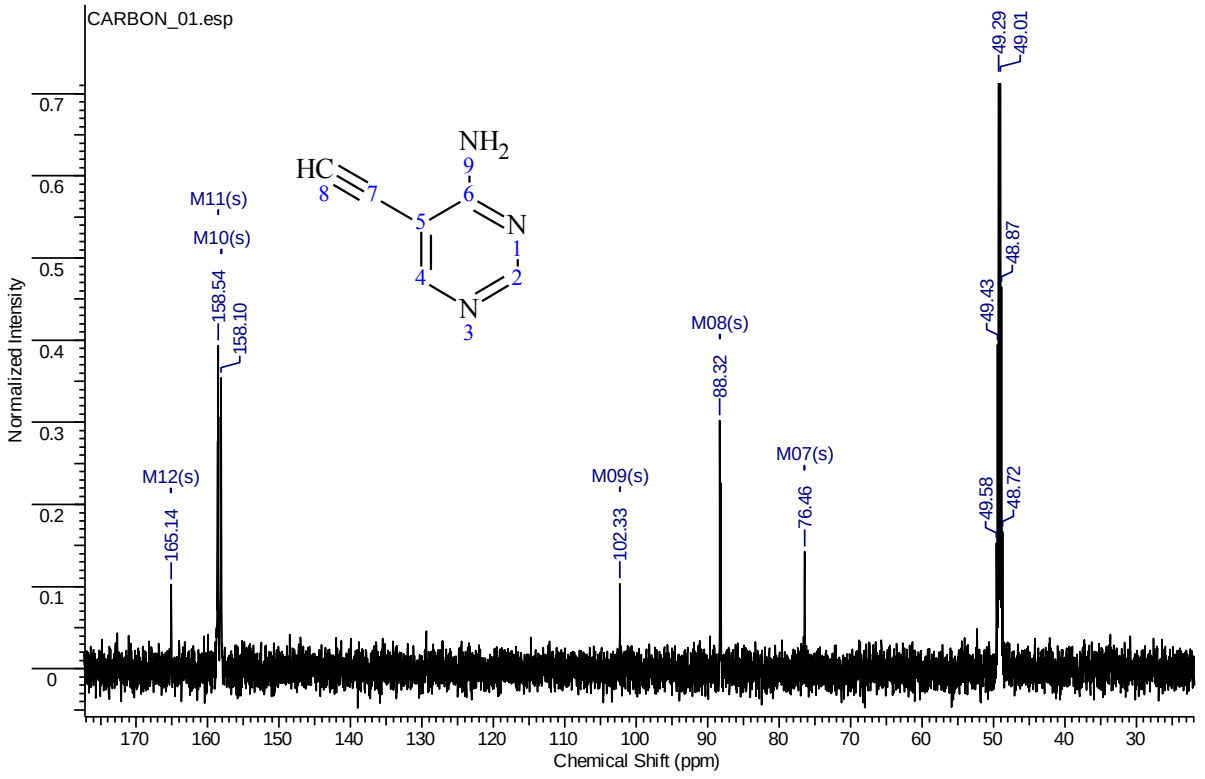
^{13}C NMR (101 MHz, $CDCl_3$) of **2c**



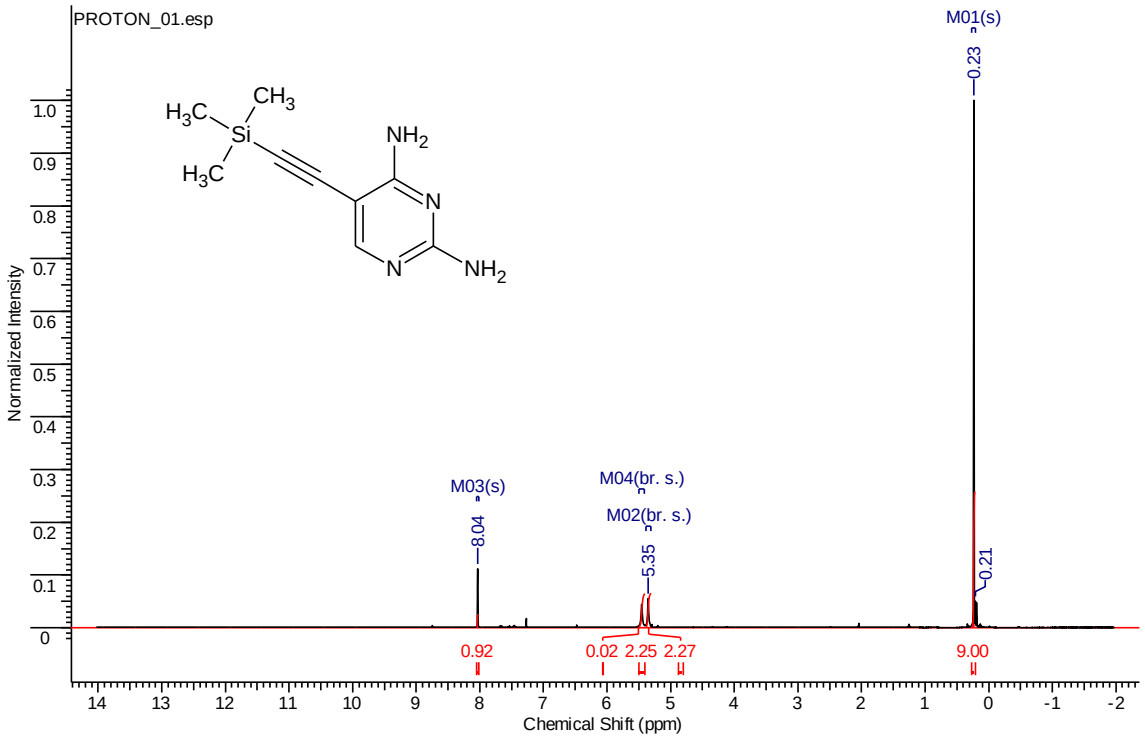
^{1}H NMR (600 MHz, MeOH-d_4) of **3c**



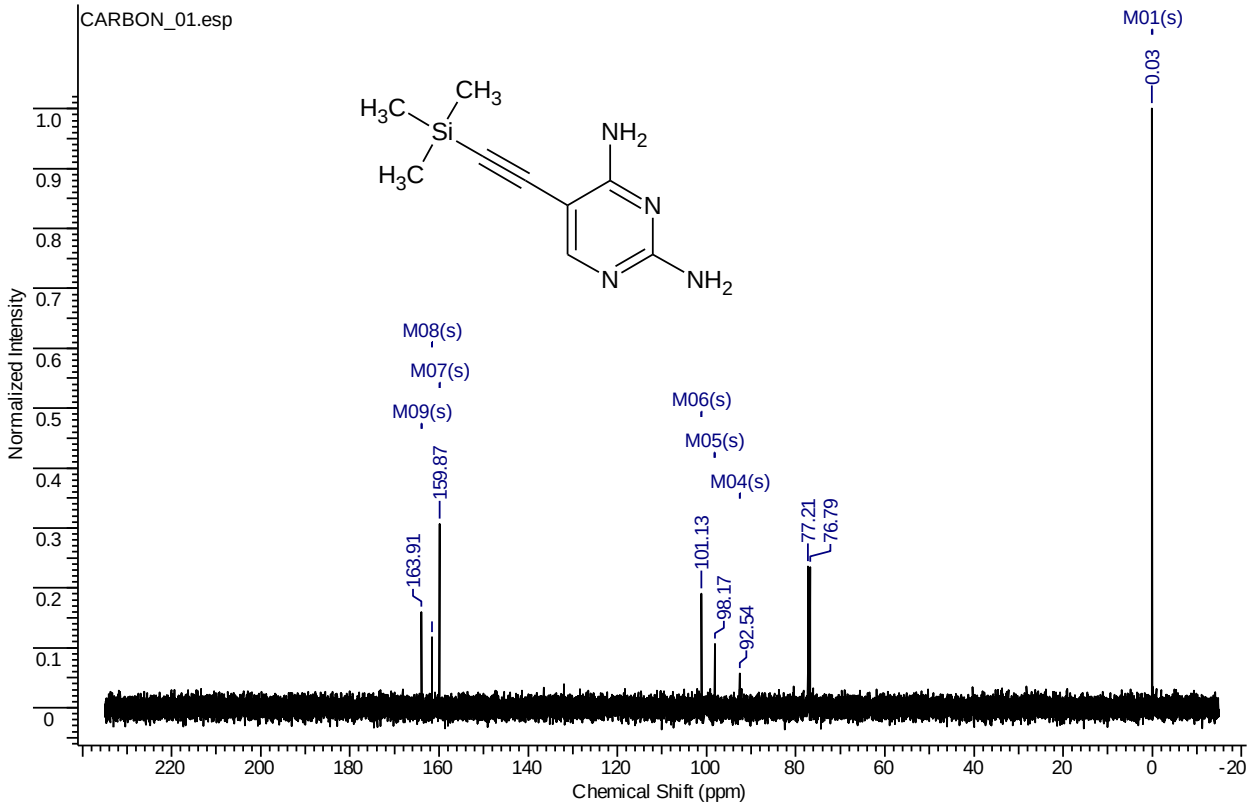
^{13}C NMR (151 MHz, MeOH-d_4) of **3c**



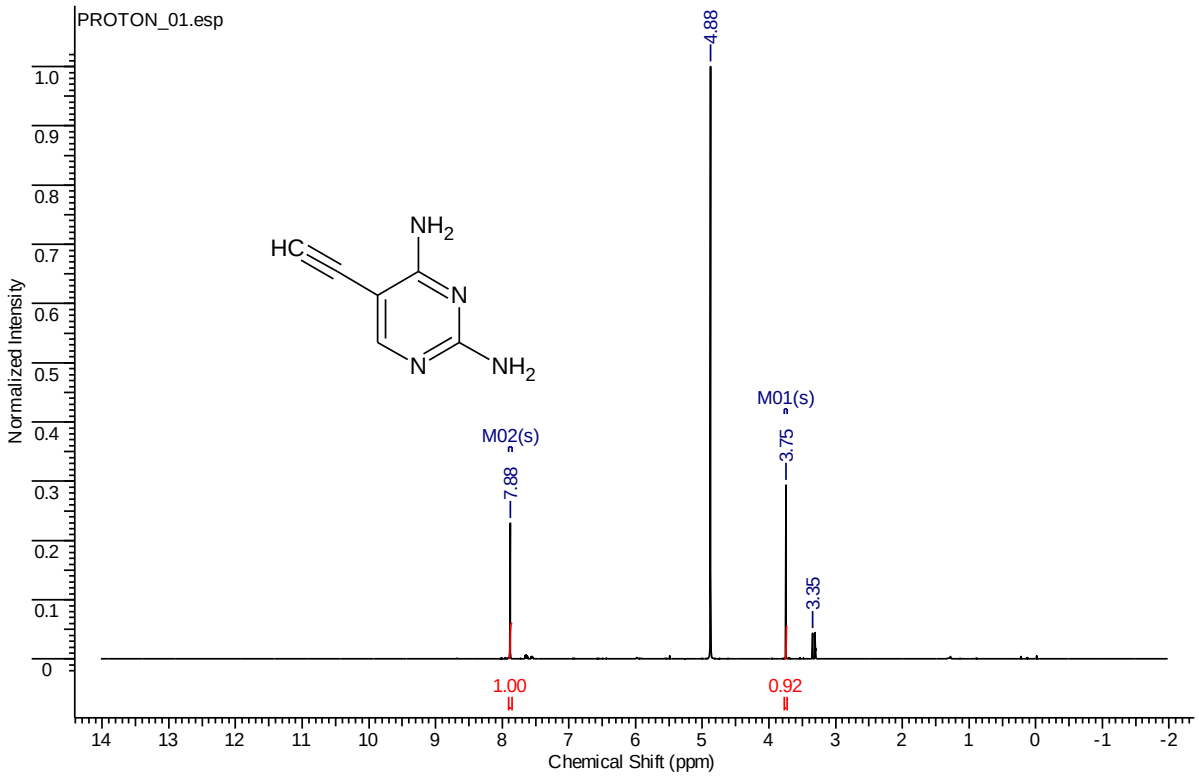
^{1}H NMR (400 MHz, $CDCl_3$) of **2d**



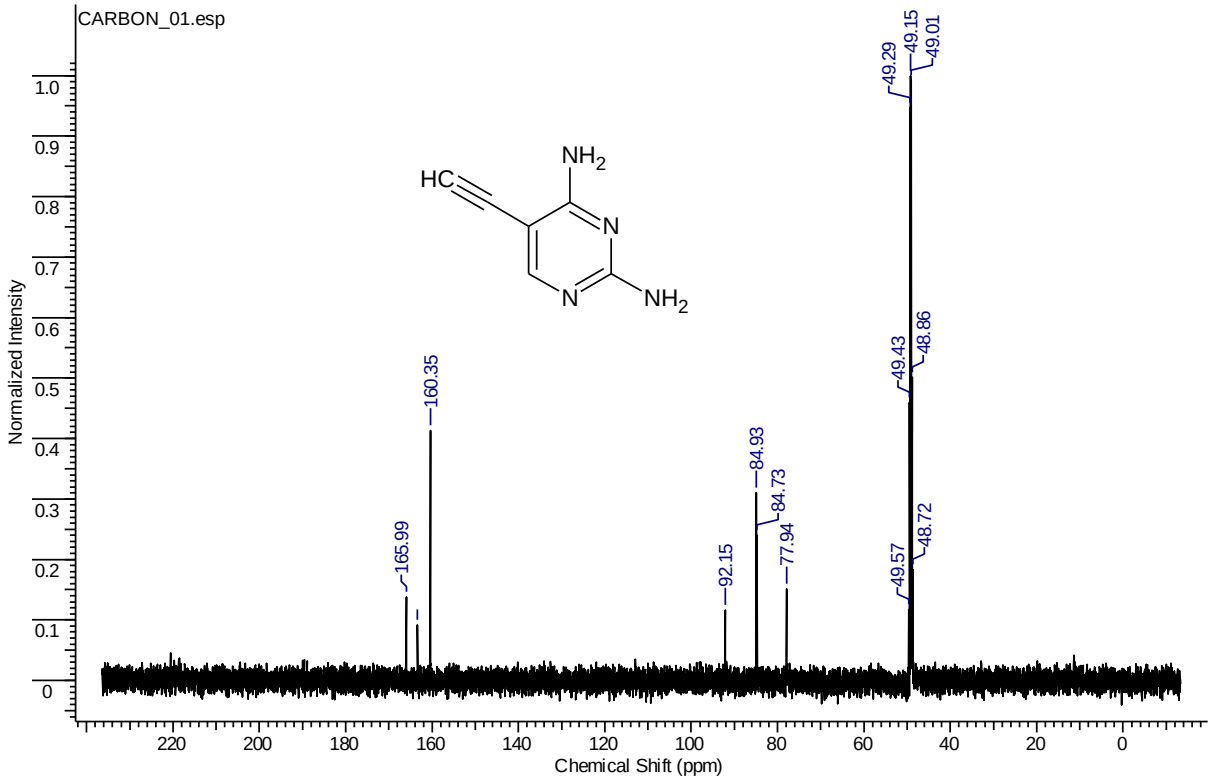
^{13}C NMR (101 MHz, $CDCl_3$) of **2d**



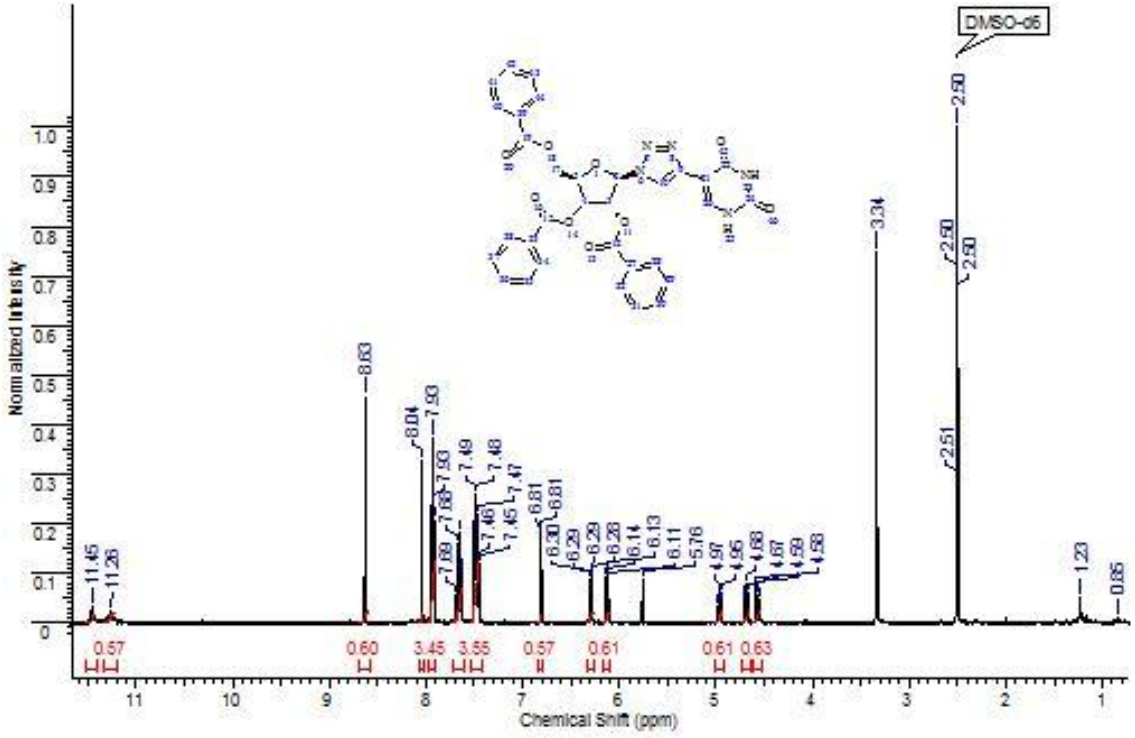
^{1}H NMR (400 MHz, MeOH-*d4*) of **3d**



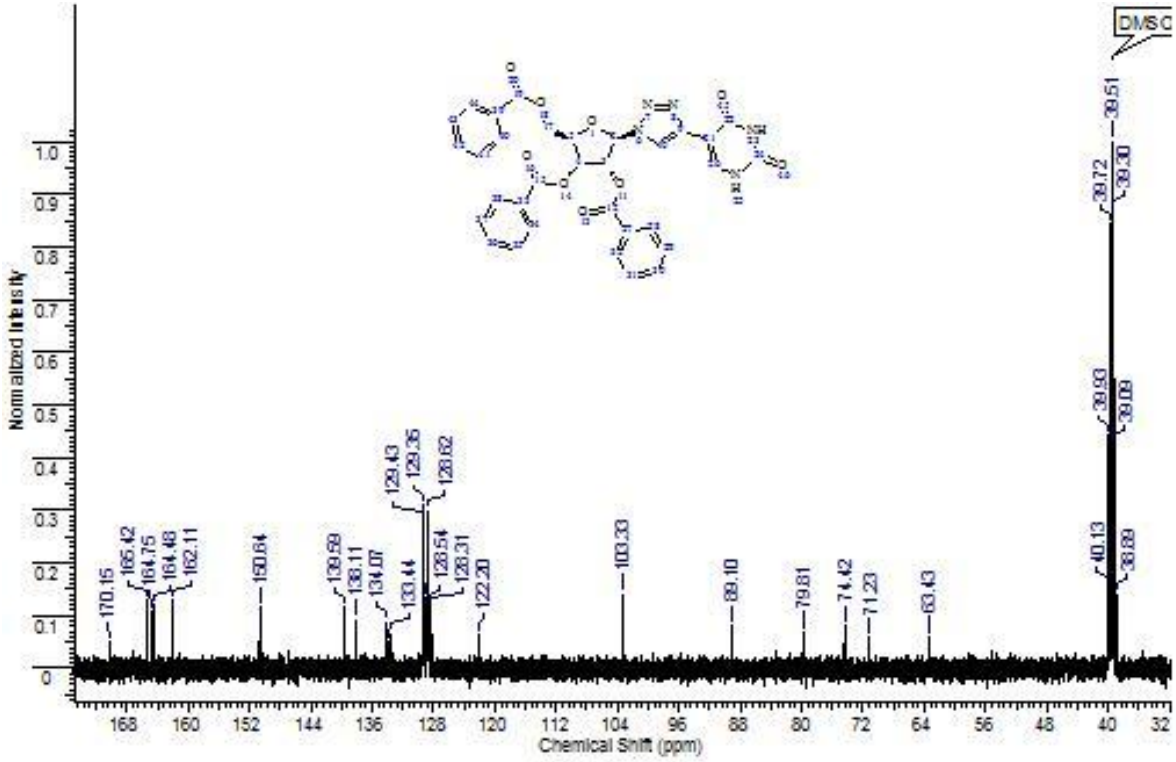
^{13}C NMR (101 MHz, MeOH-*d4*) of **3d**



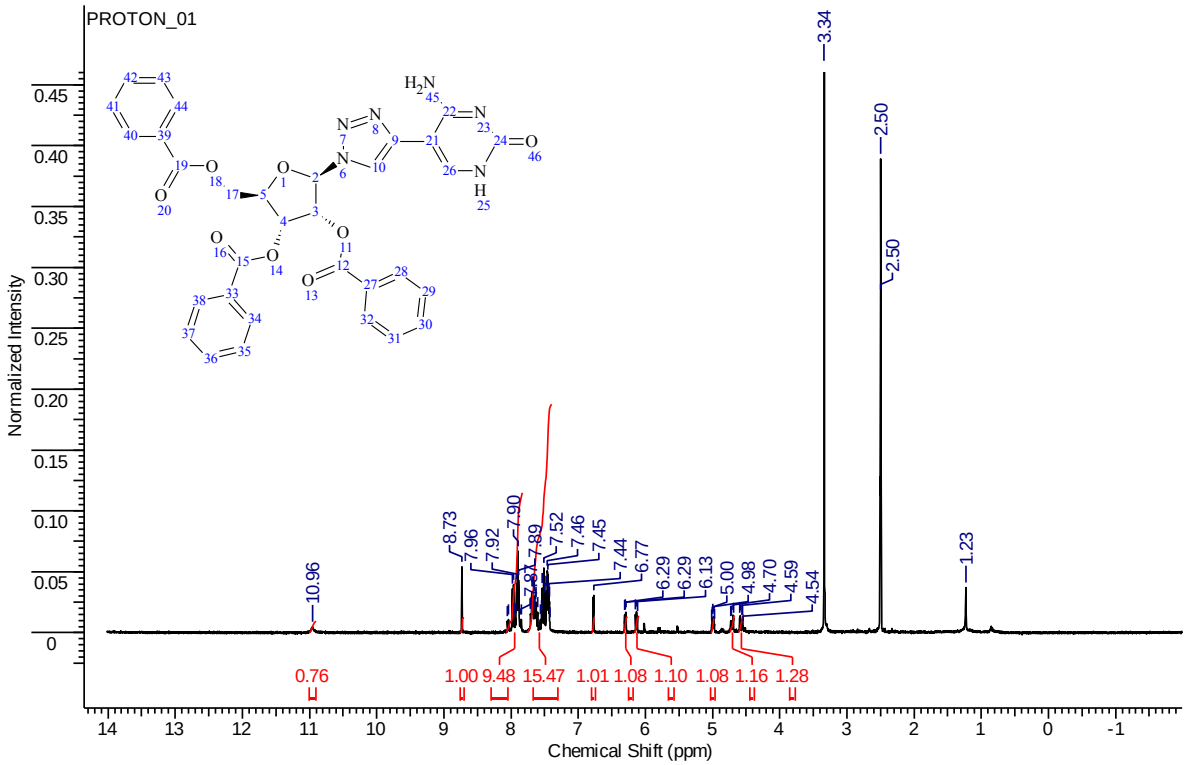
^{1}H NMR (400 MHz, DMSO-d_6) of **4a**



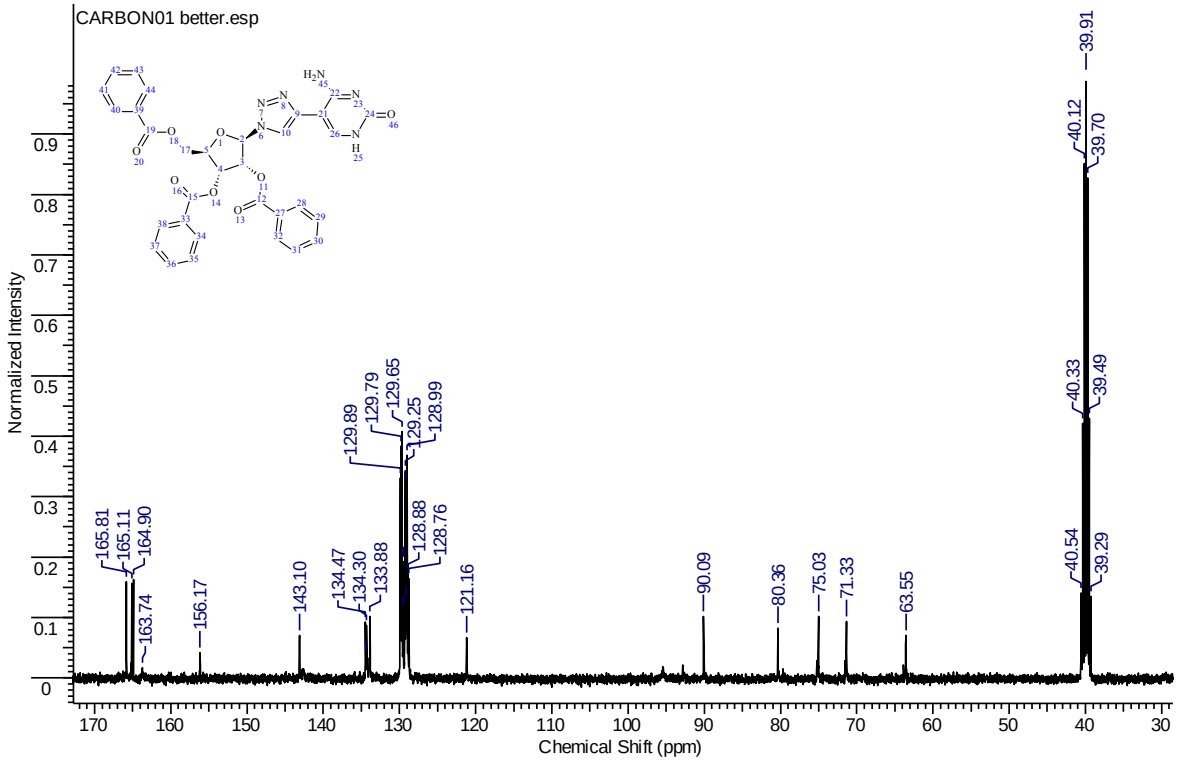
^{13}C NMR (101 MHz, DMSO-d_6) of **4a**



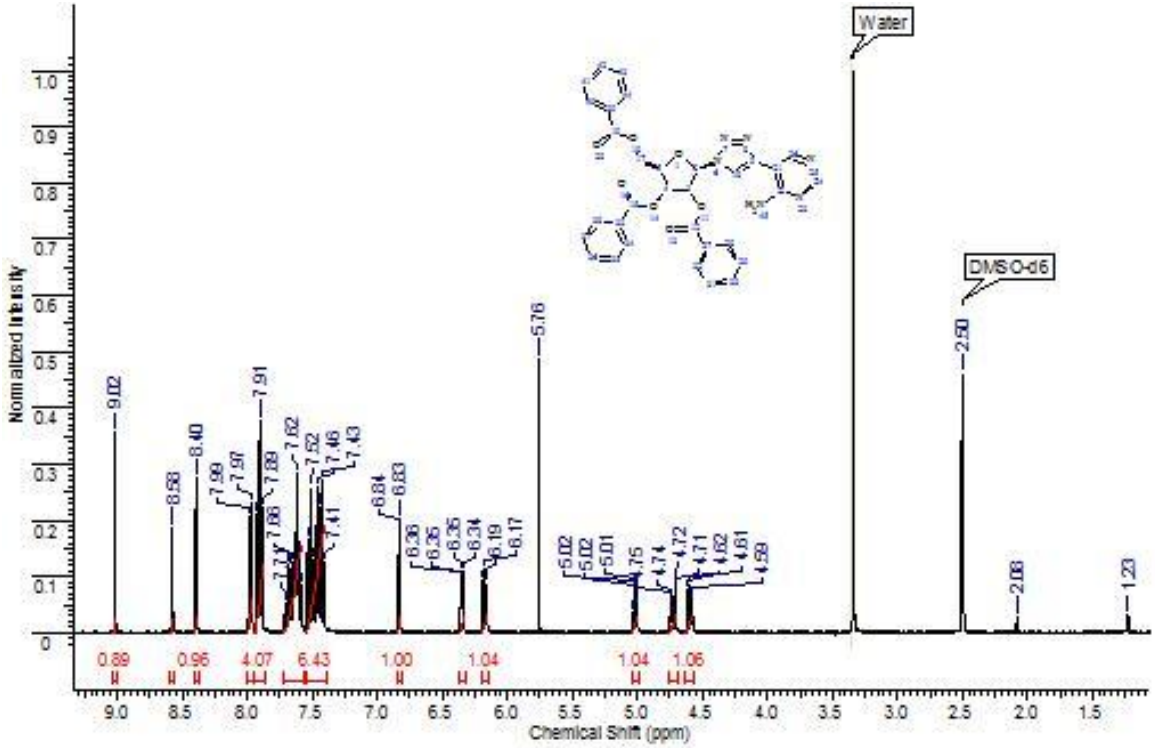
^{1}H NMR (400 MHz, DMSO-d_6) of **4b**



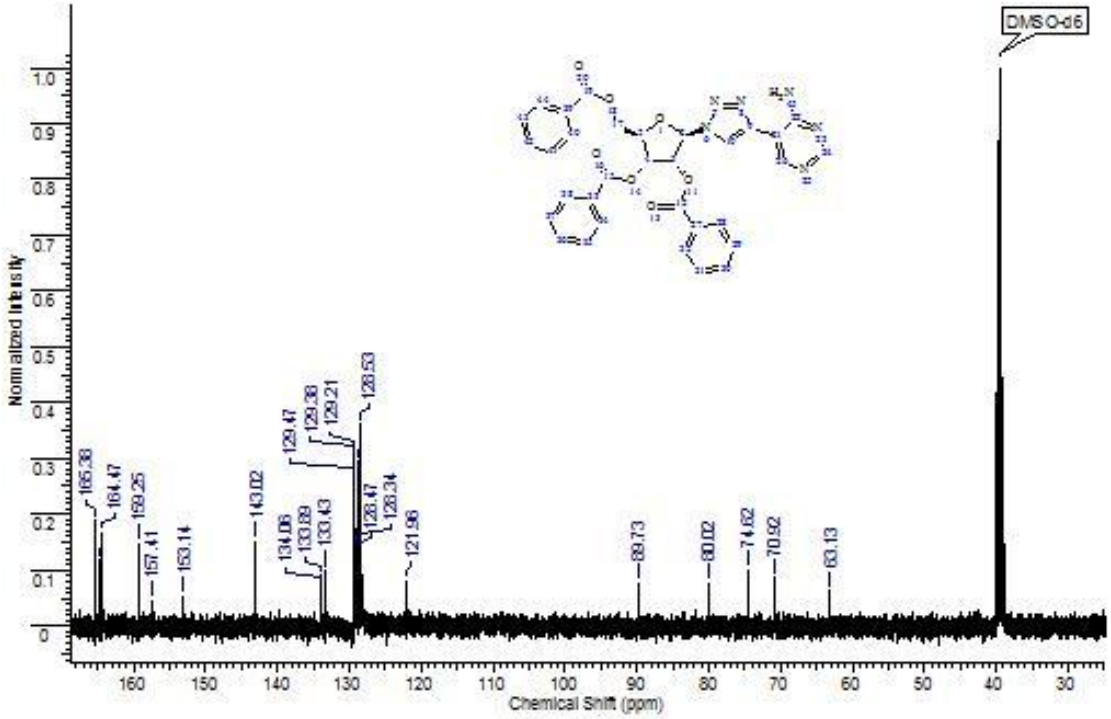
^{13}C NMR (101 MHz, DMSO-d_6) of **4b**



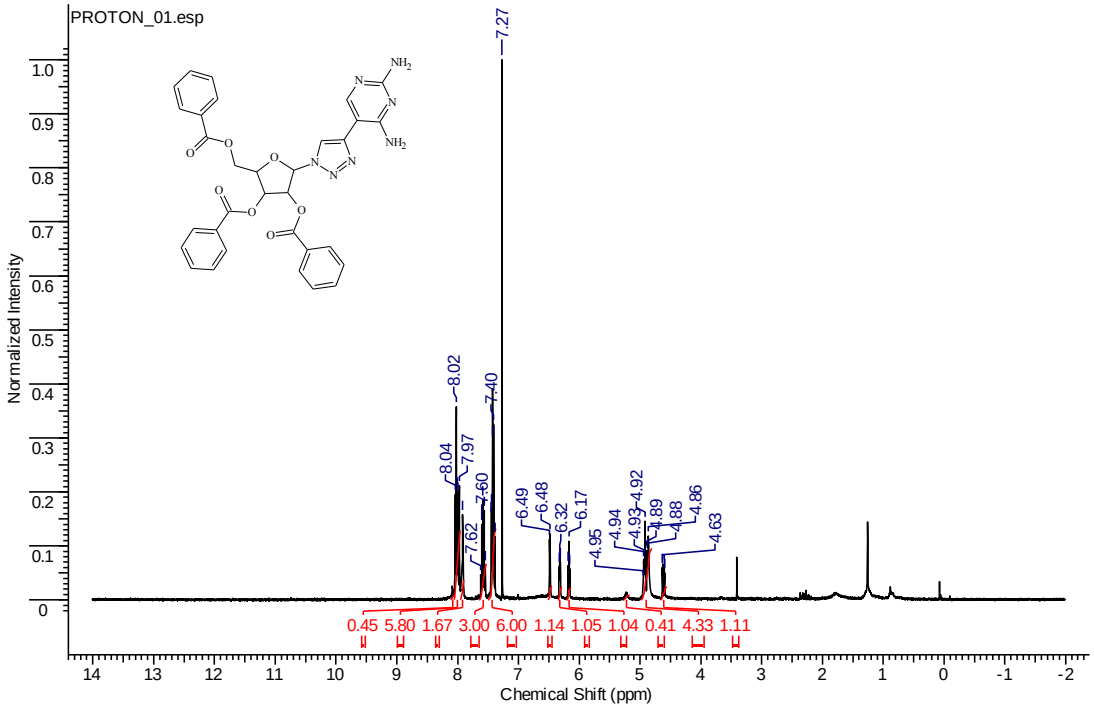
^{1}H NMR (400 MHz, DMSO-d_6) of **4c**



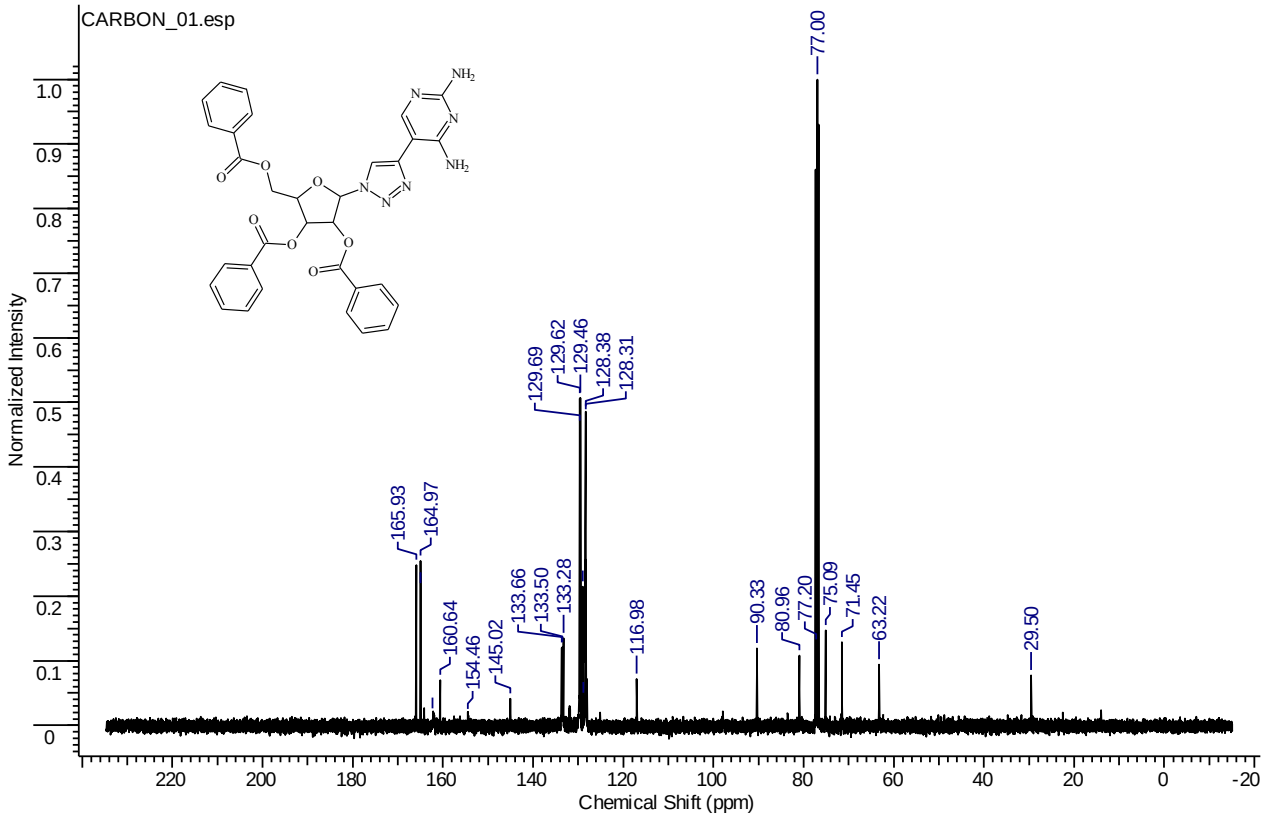
^{13}C NMR (101 MHz, DMSO-d_6) of **4c**



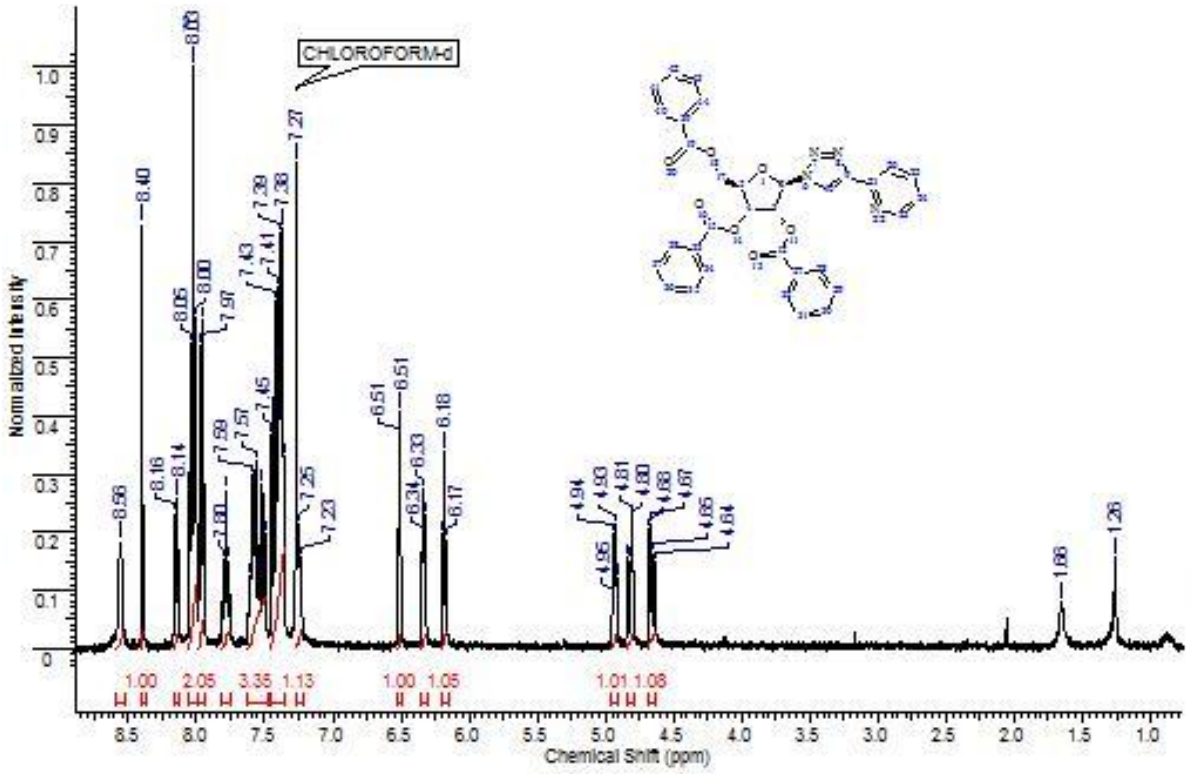
^{1}H NMR (400 MHz, $CDCl_3$) of **4d**



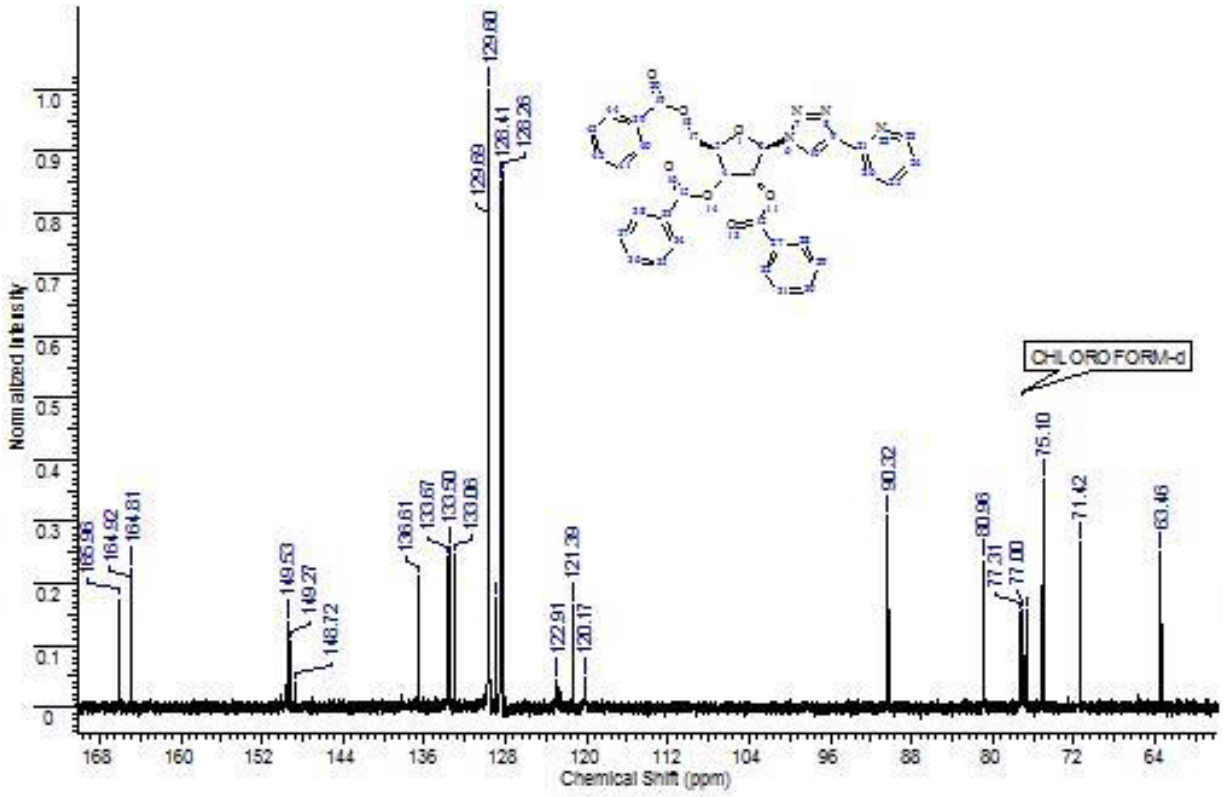
^{13}C NMR (101 MHz, $CDCl_3$) of **4d**



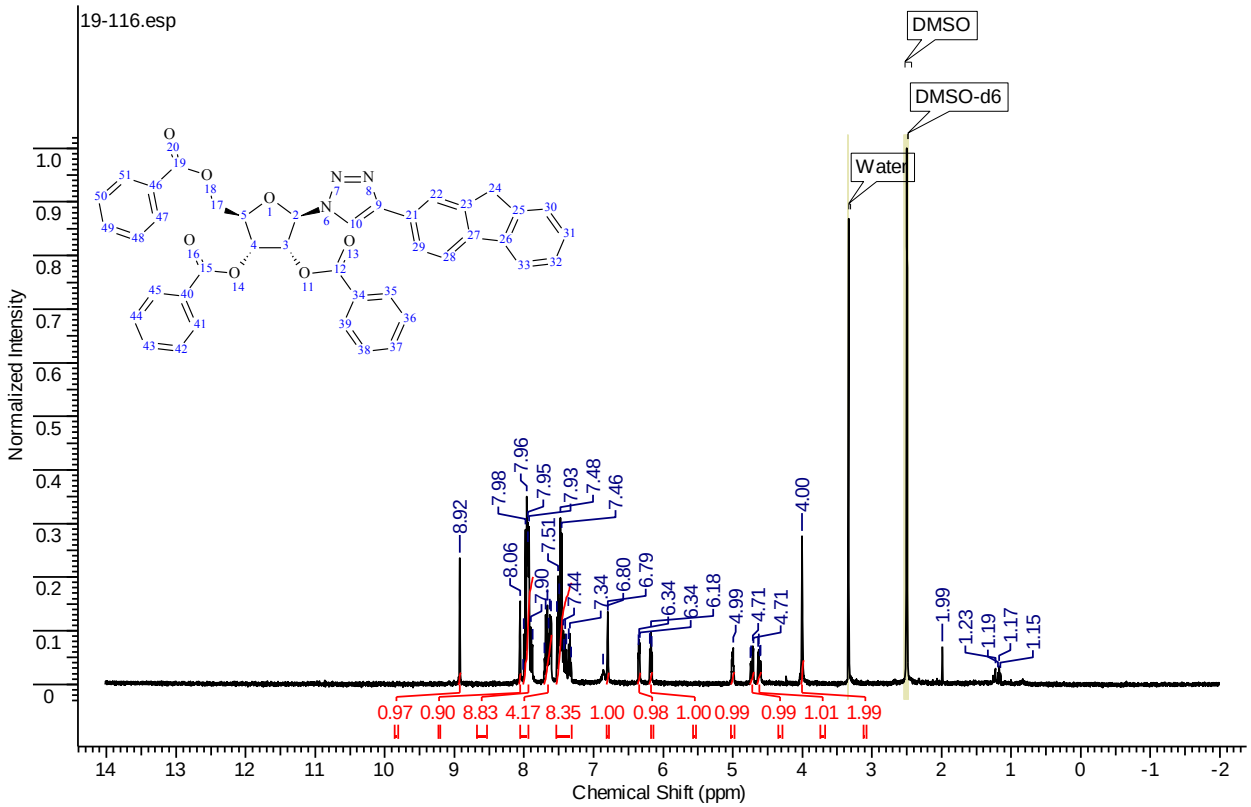
^{1}H NMR (400 MHz, $CDCl_3$) of **4e**



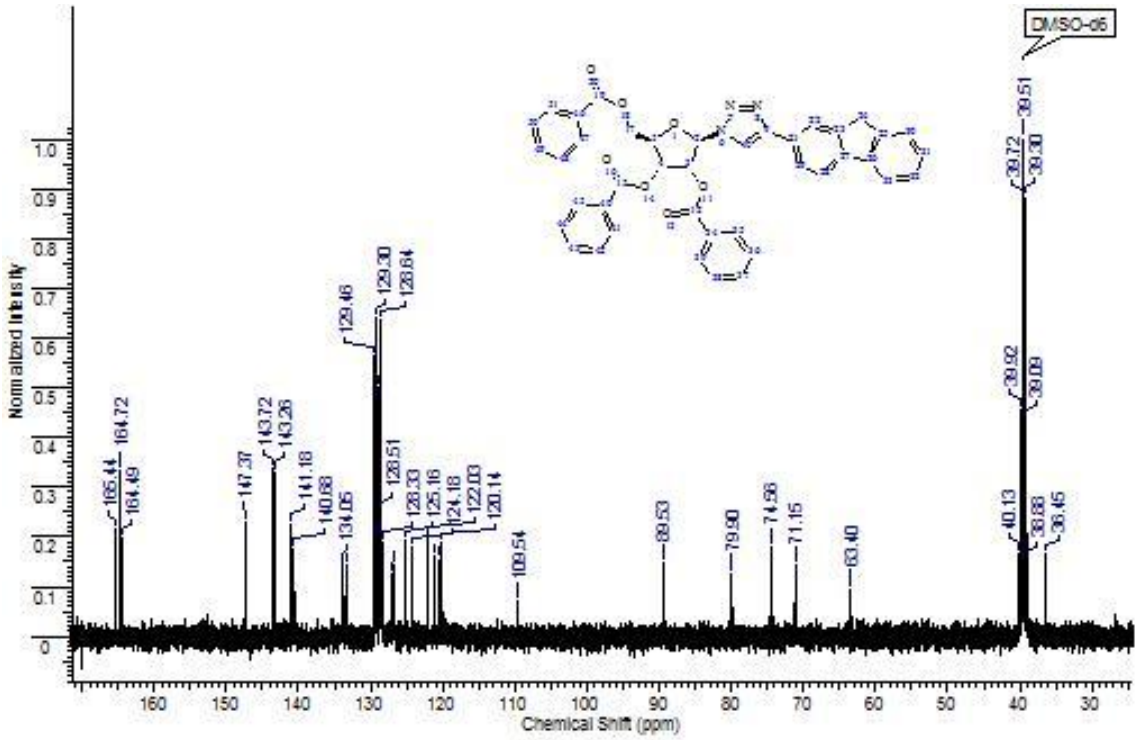
^{13}C NMR (101 MHz, DMSO-d_6) of **4e**



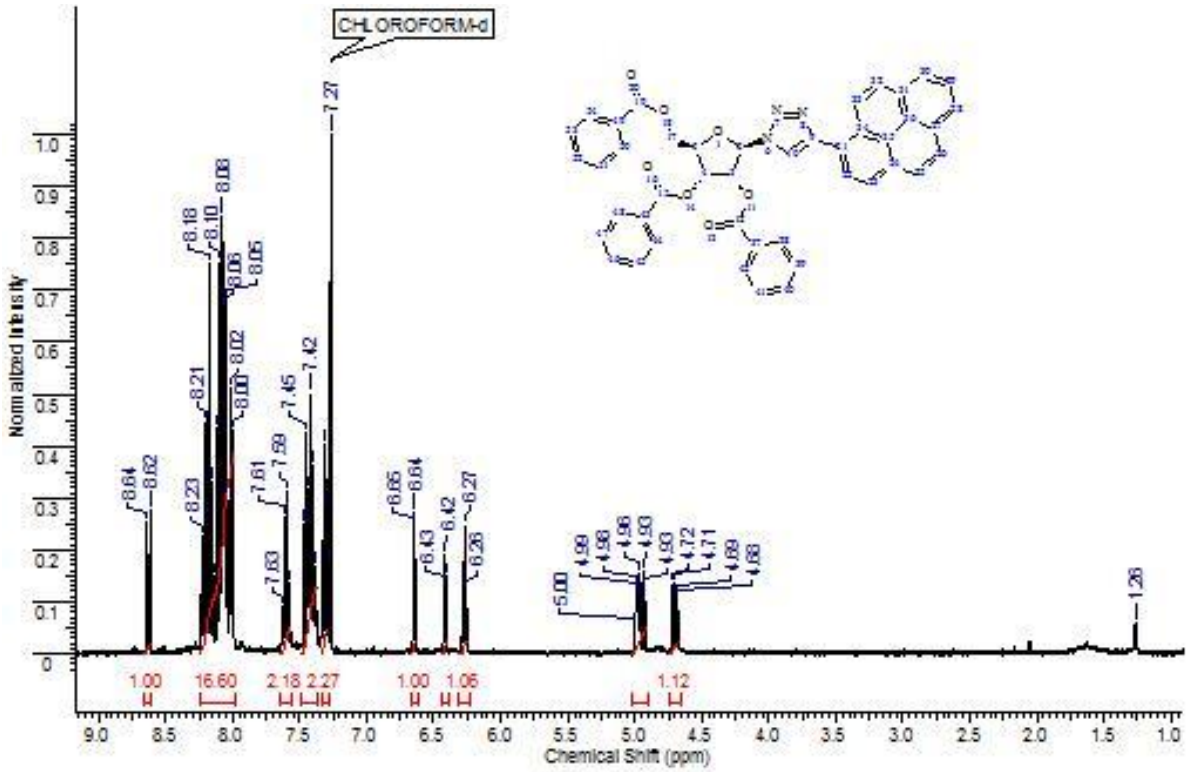
^{1}H NMR (400 MHz, DMSO-d_6) of **4f**



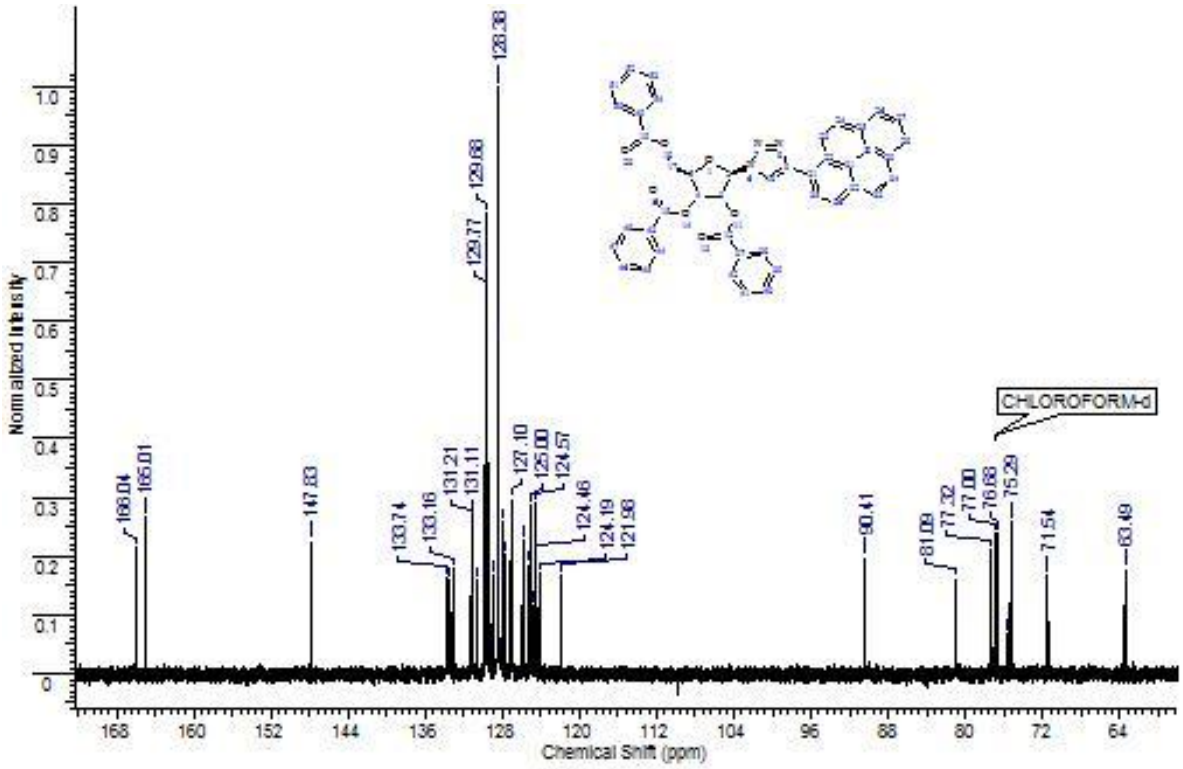
^{13}C NMR (101 MHz, DMSO-d_6) of **4f**



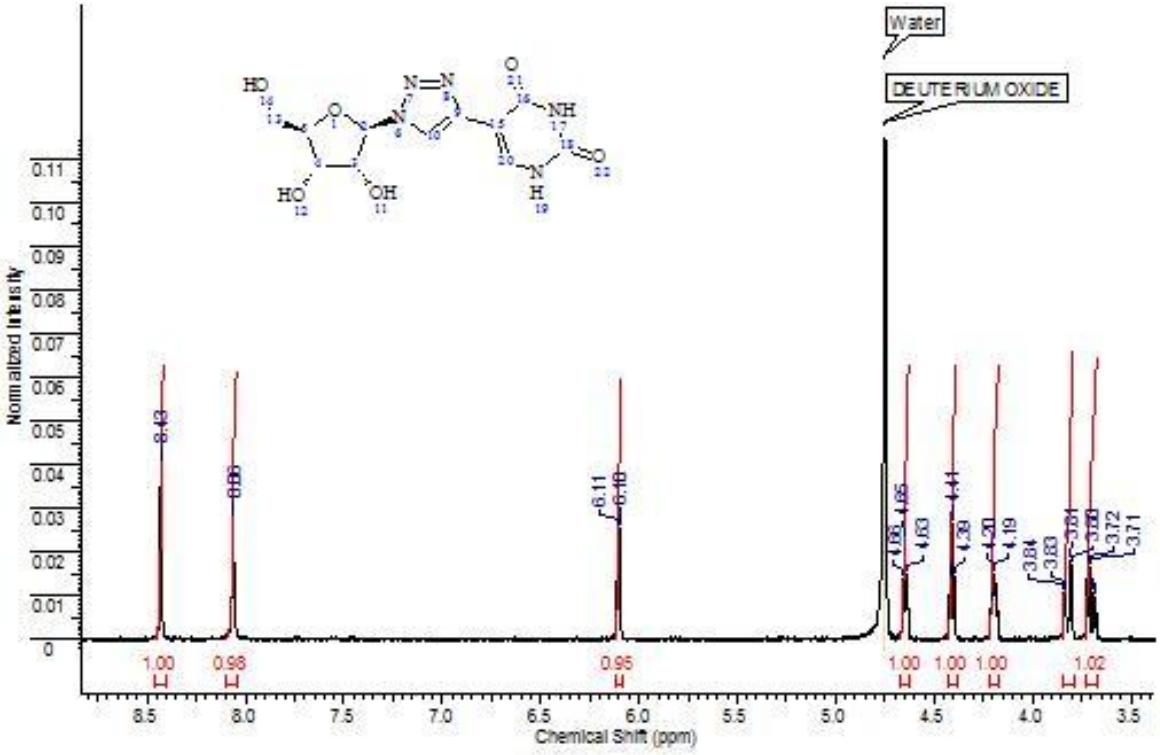
^{1}H NMR (400 MHz, $CDCl_3$) of **4g**



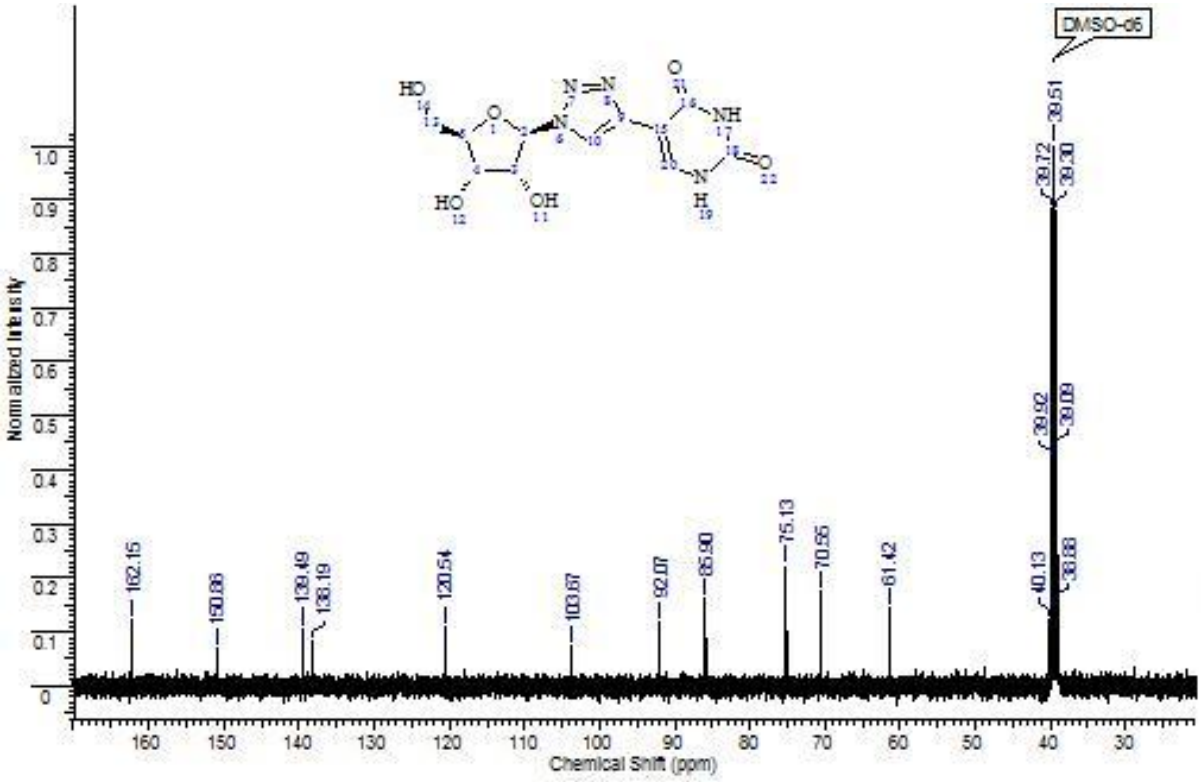
^{13}C NMR (101 MHz, $CDCl_3$) of **4g**



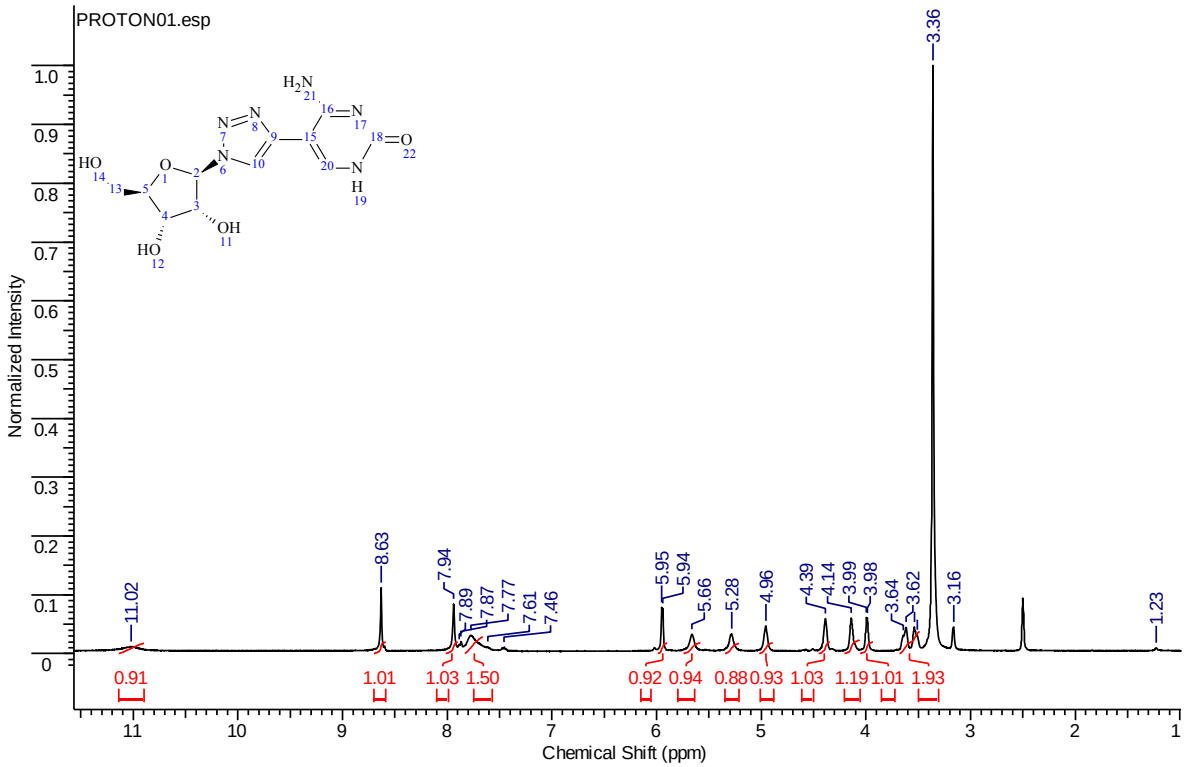
^{1}H NMR (400 MHz, D_2O) of **5a**



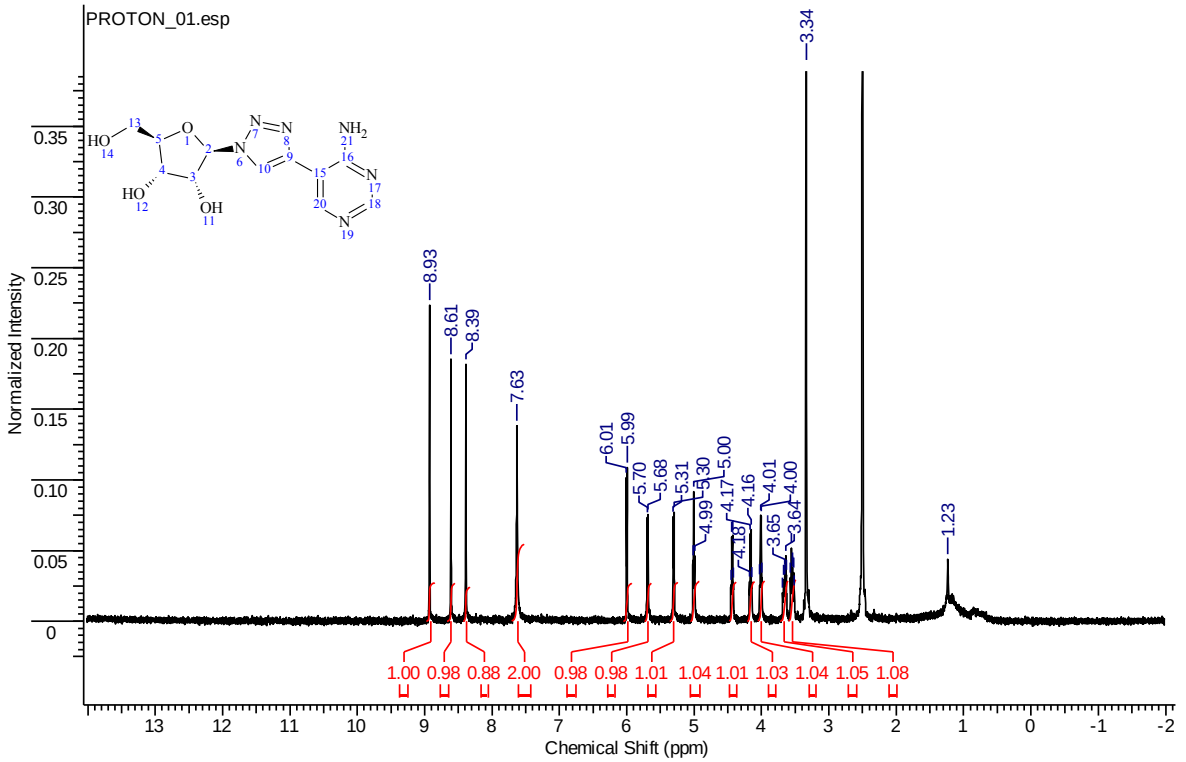
^{13}C NMR (101 MHz, DMSO-d_6) of **5a**



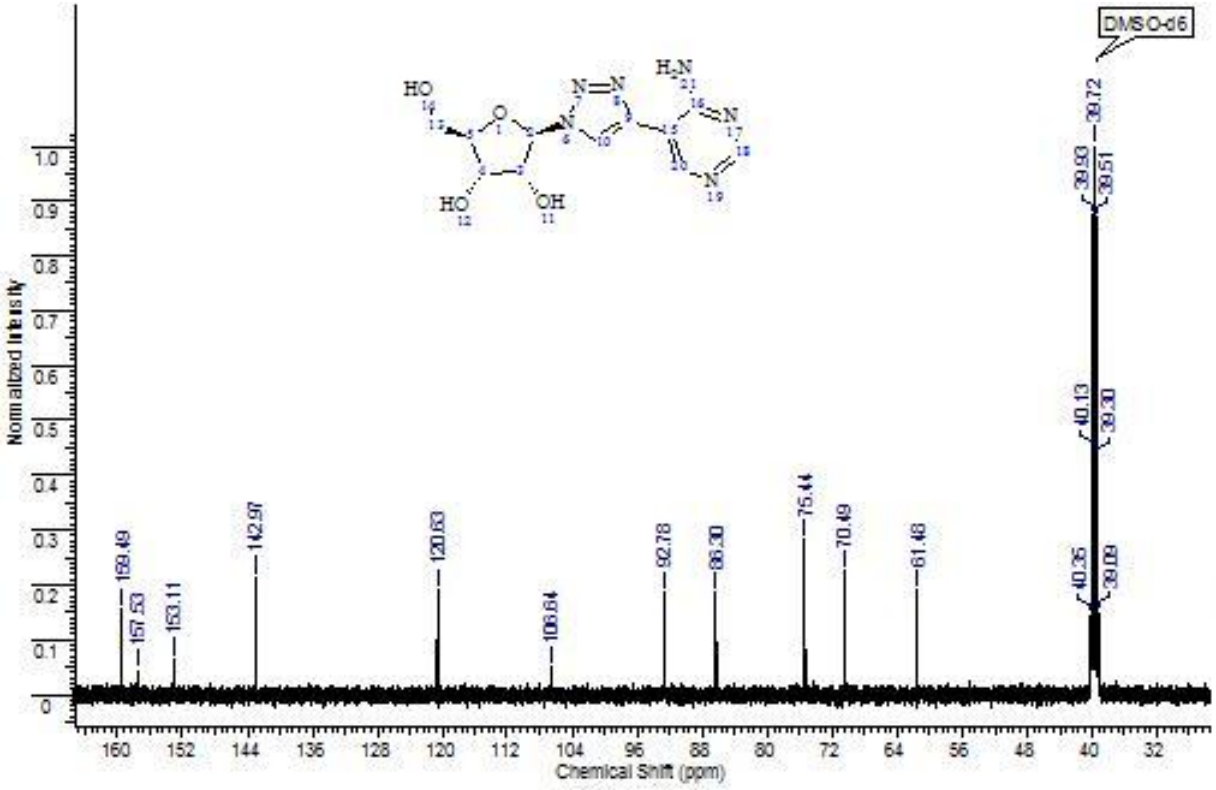
^{1}H NMR (400 MHz, DMSO-d$_6$) of **5b**



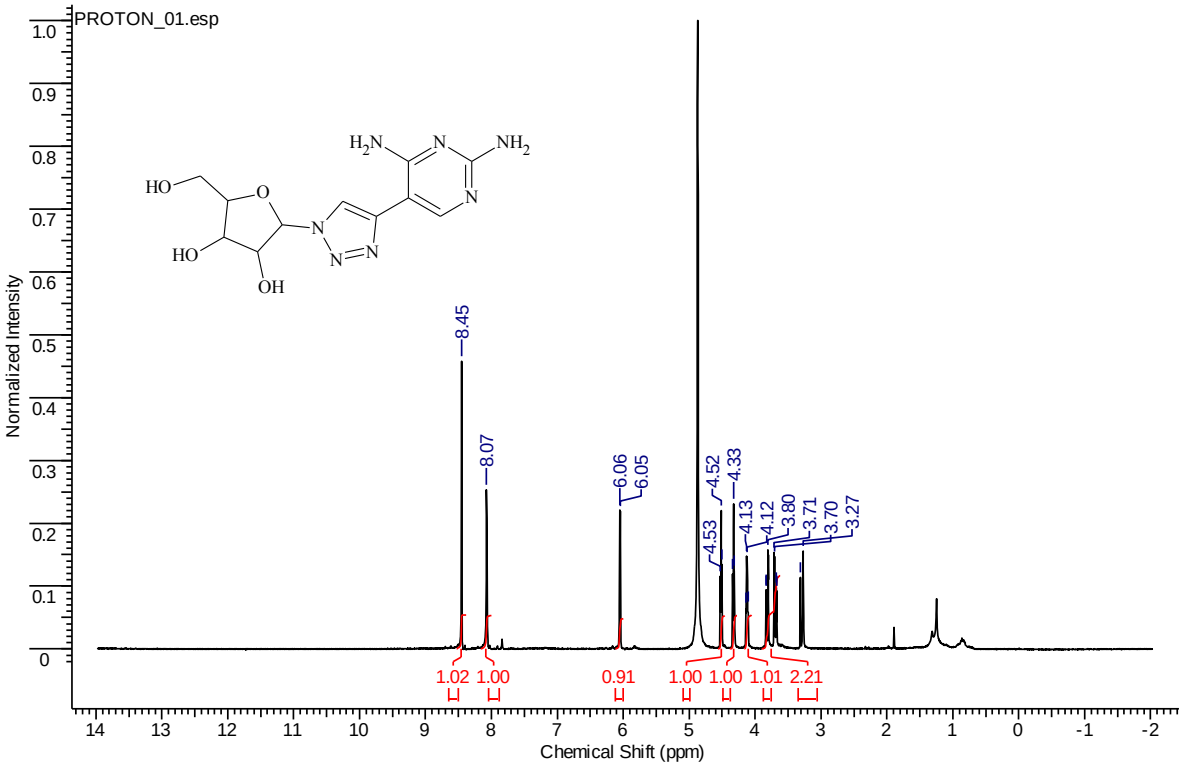
^{1}H NMR (400 MHz, DMSO-d$_6$) of **5c**



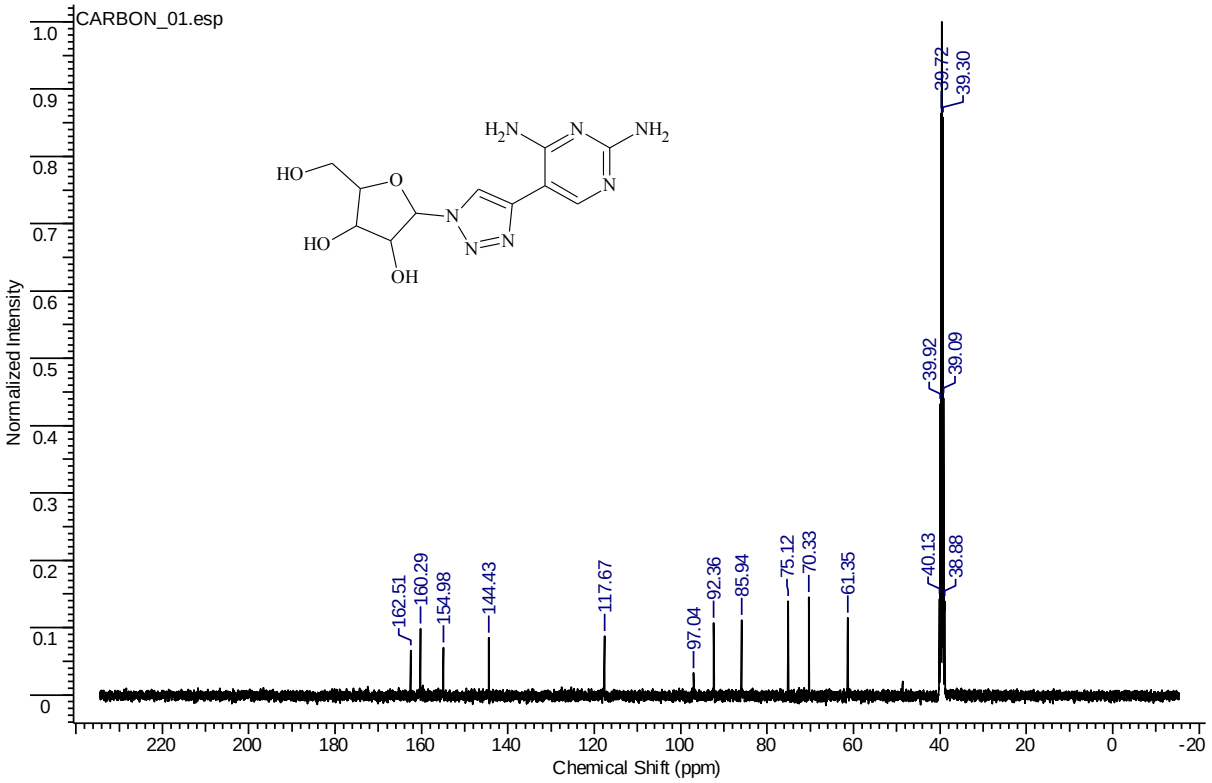
^{13}C NMR (101 MHz, DMSO-d_6) of **5c**



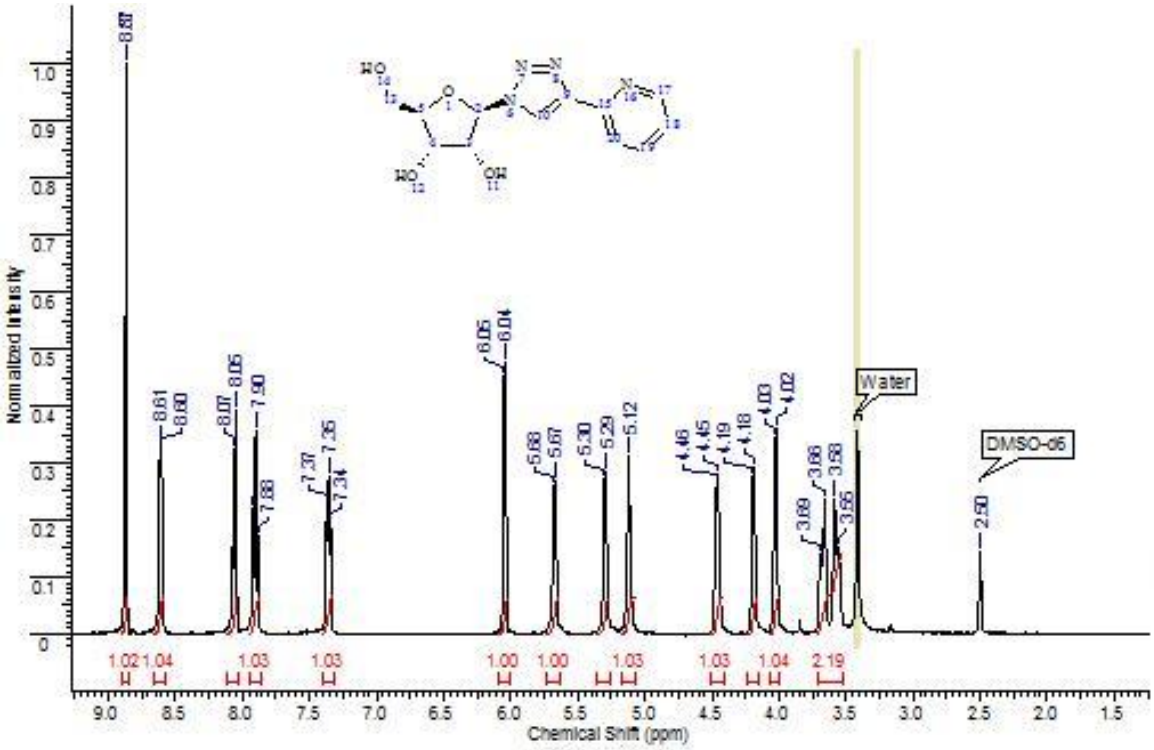
^{1}H NMR (400 MHz, MeOH-d_4) of **5d**



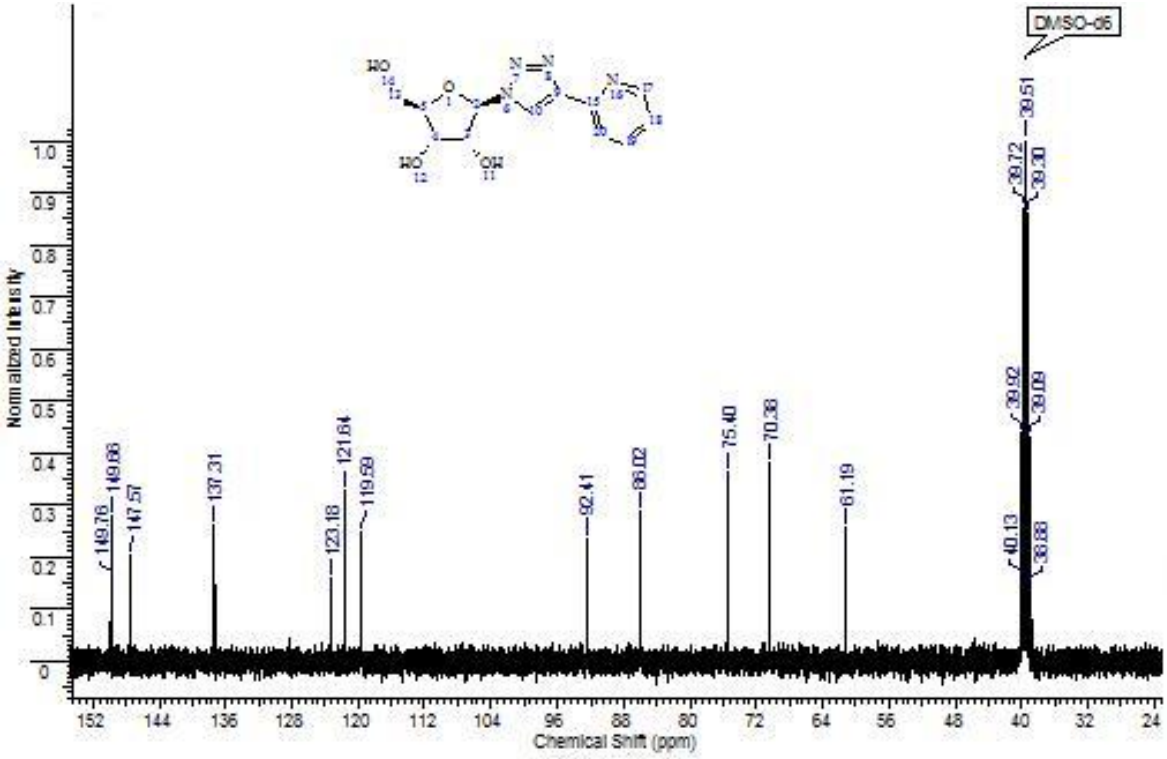
^{13}C NMR (101 MHz, DMSO-d$_6$) of **5d**



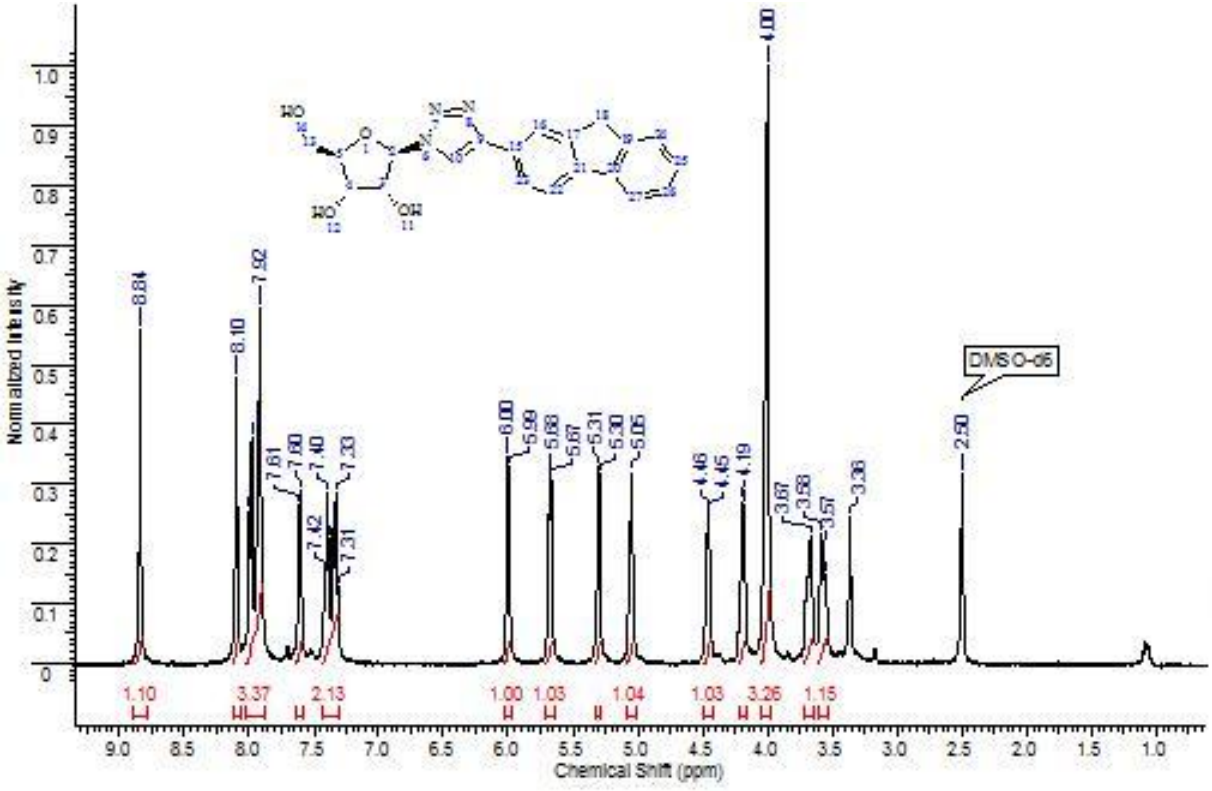
^{1}H NMR (400 MHz, DMSO-d$_6$) of **5e**



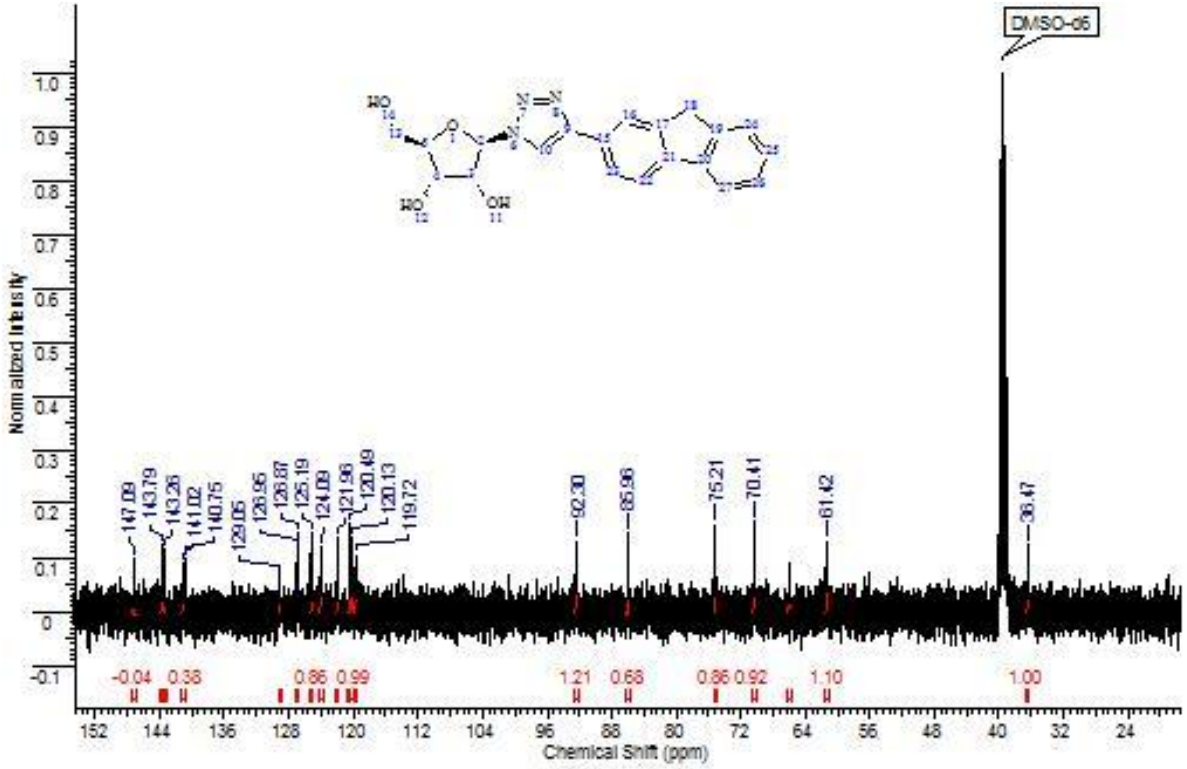
^{13}C NMR (101 MHz, DMSO-d_6) of **5e**



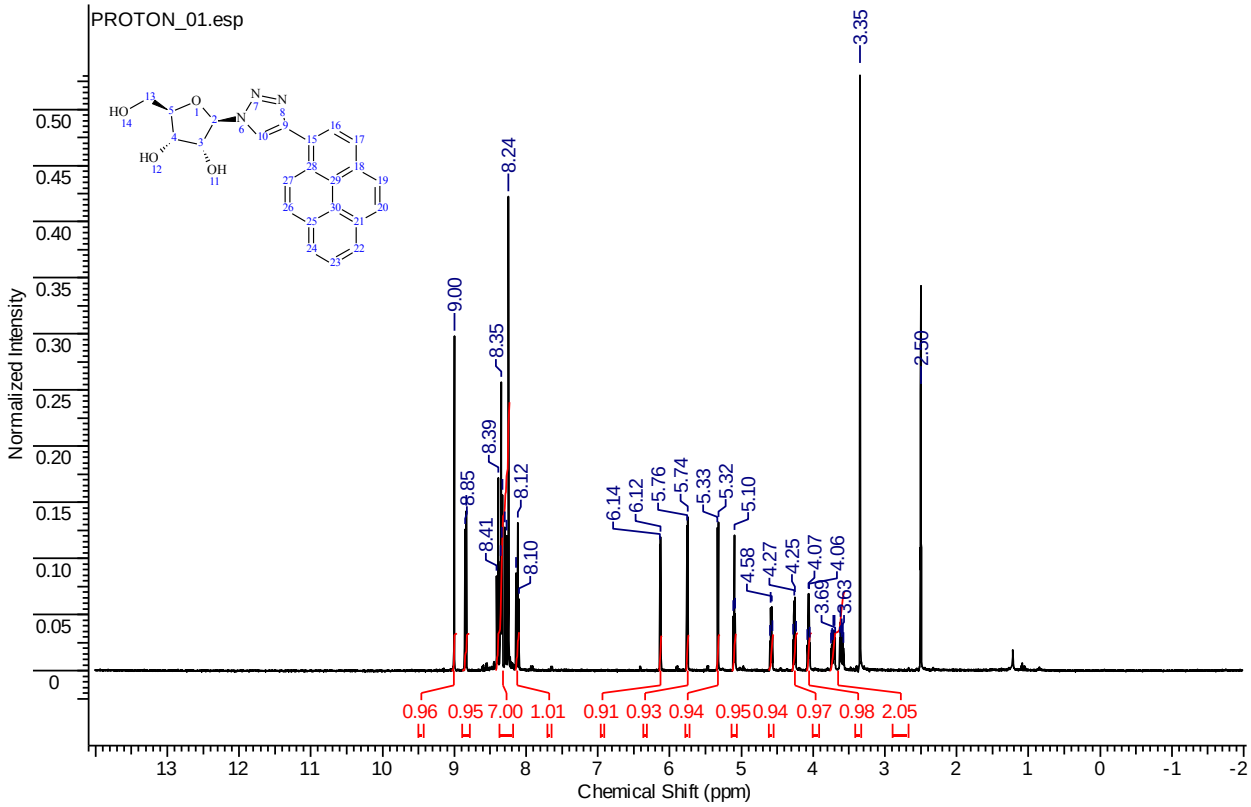
^{1}H NMR (400 MHz, DMSO-d_6) of **5f**



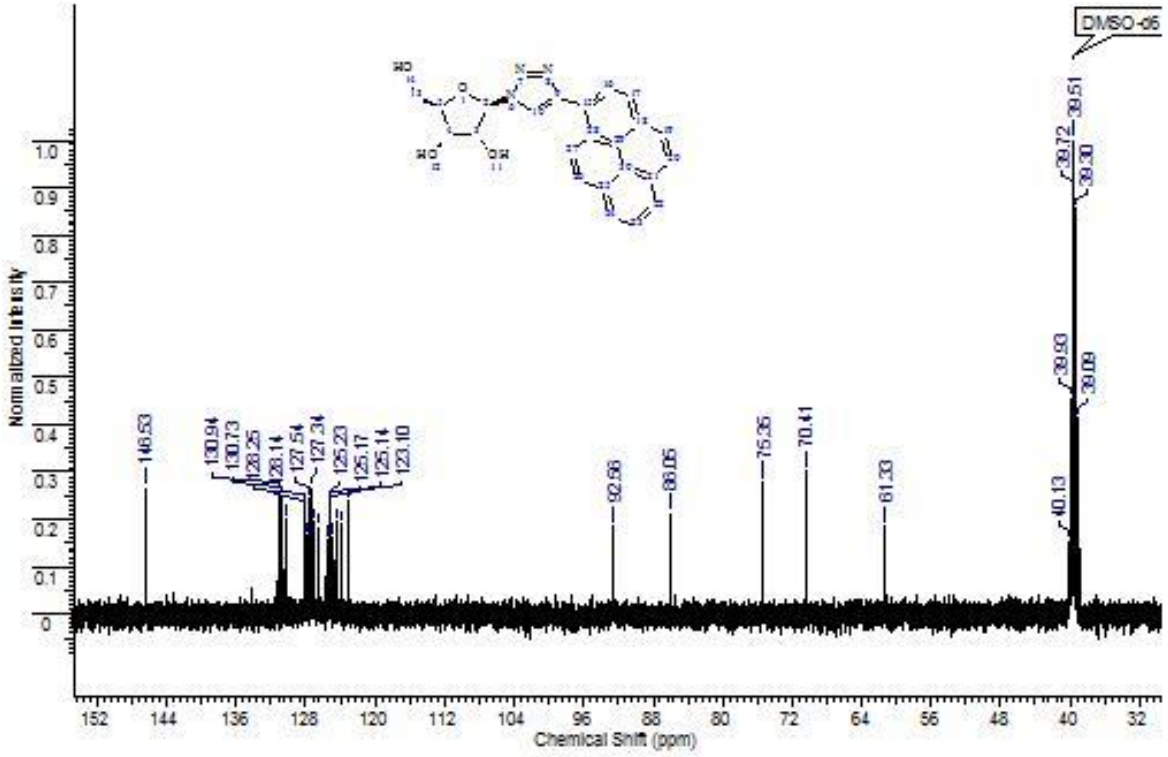
^{13}C NMR (101 MHz, DMSO-d$_6$) of **5f**



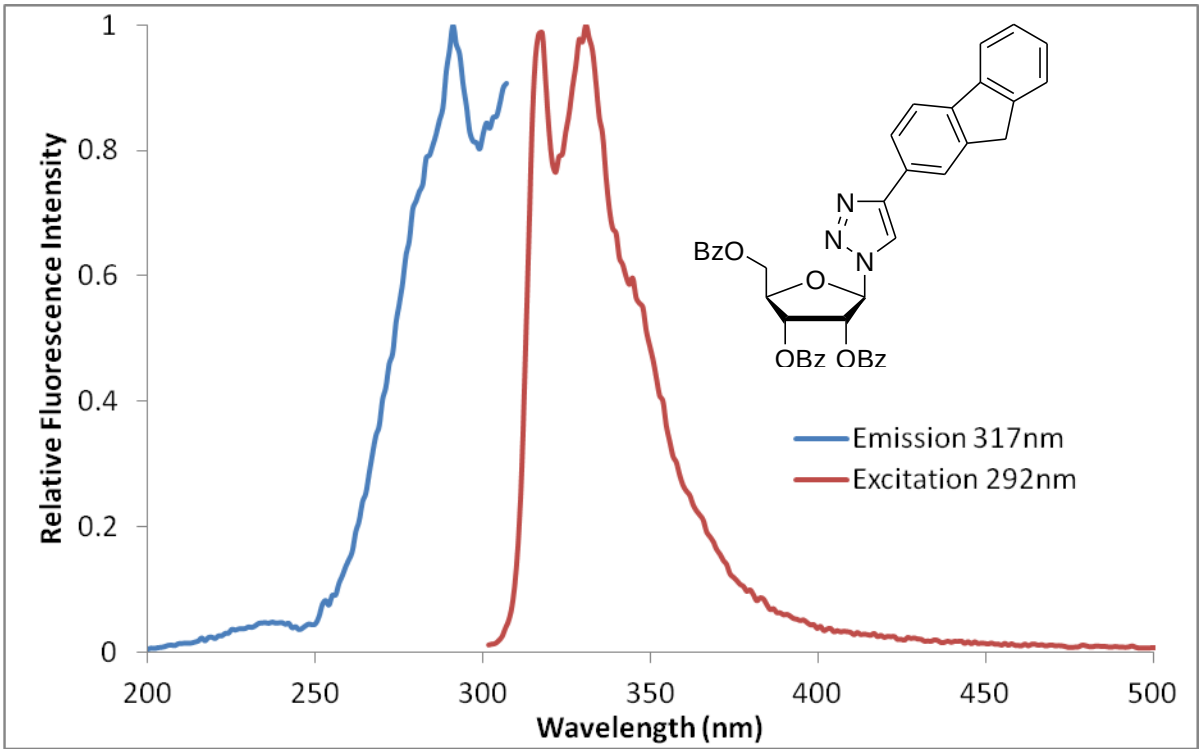
^{1}H NMR (400 MHz, DMSO-d$_6$) of **5g**



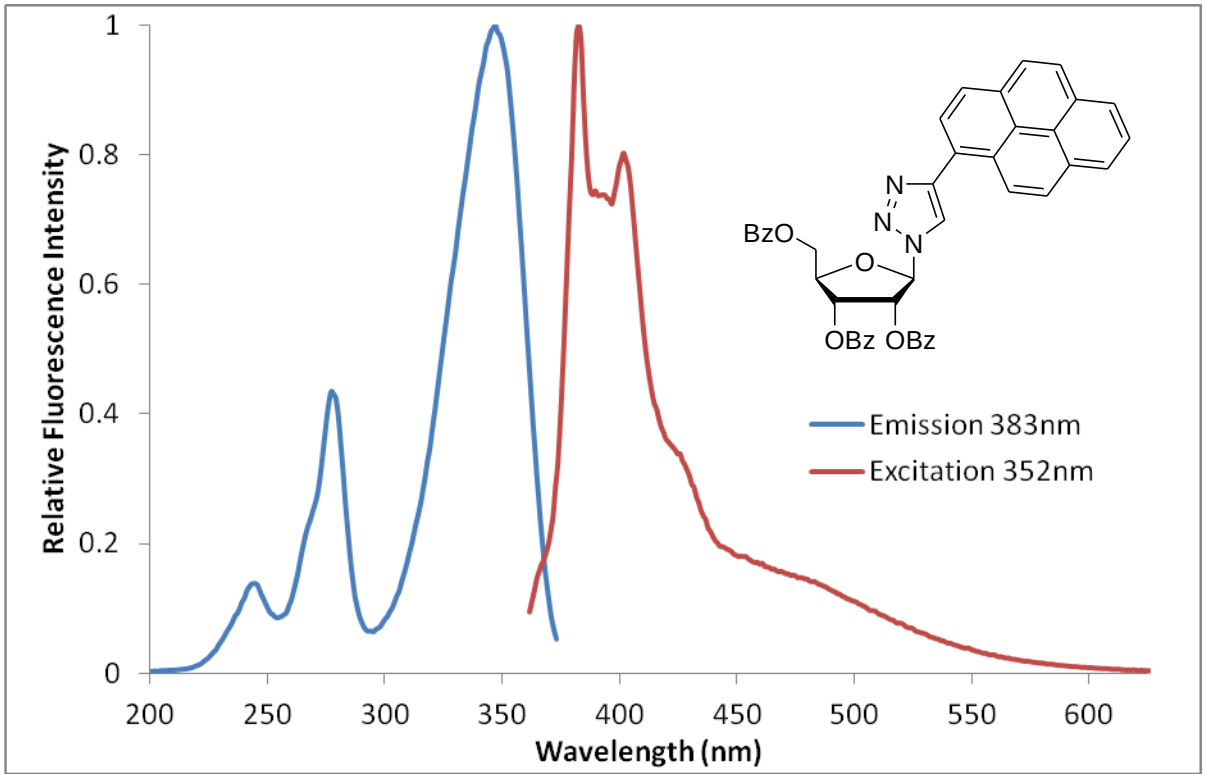
^{13}C NMR (101 MHz, DMSO-d_6) of **5g**



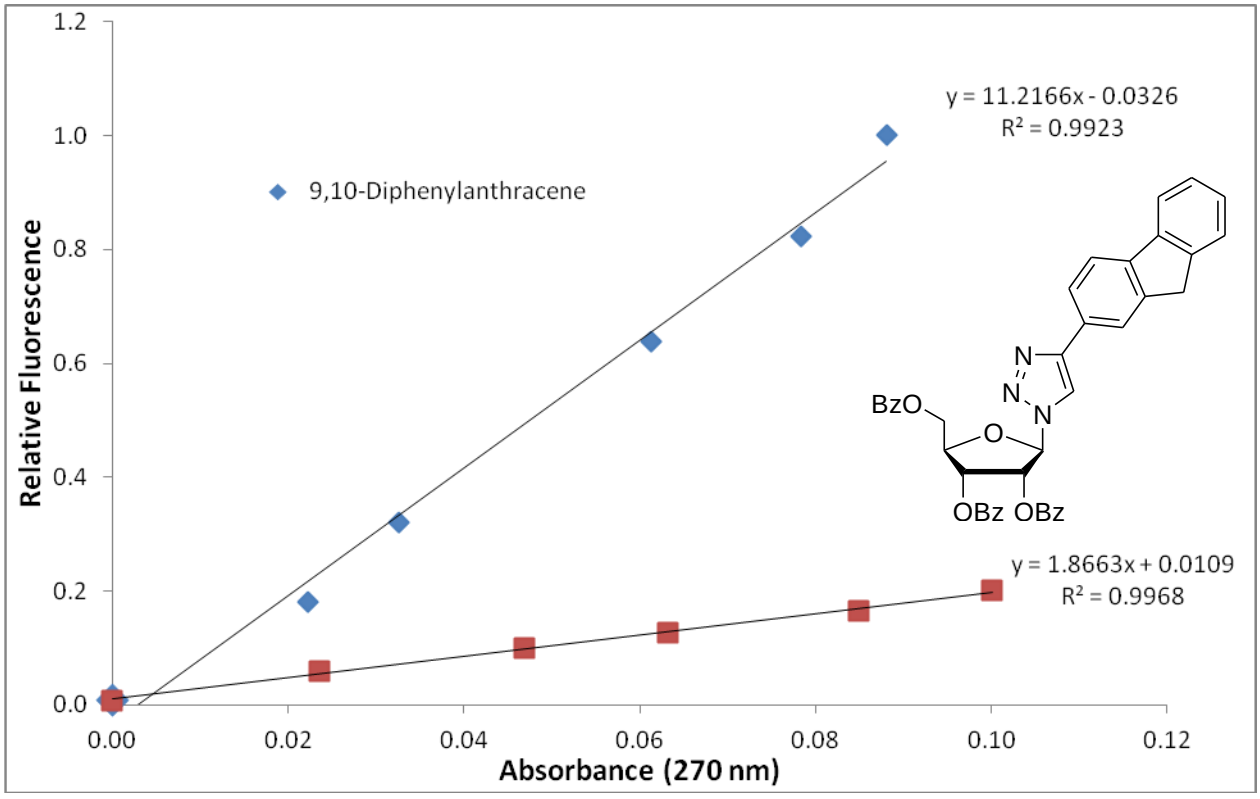
Fluorescence Profile of **4f** (10^{-5} M in EtOH)



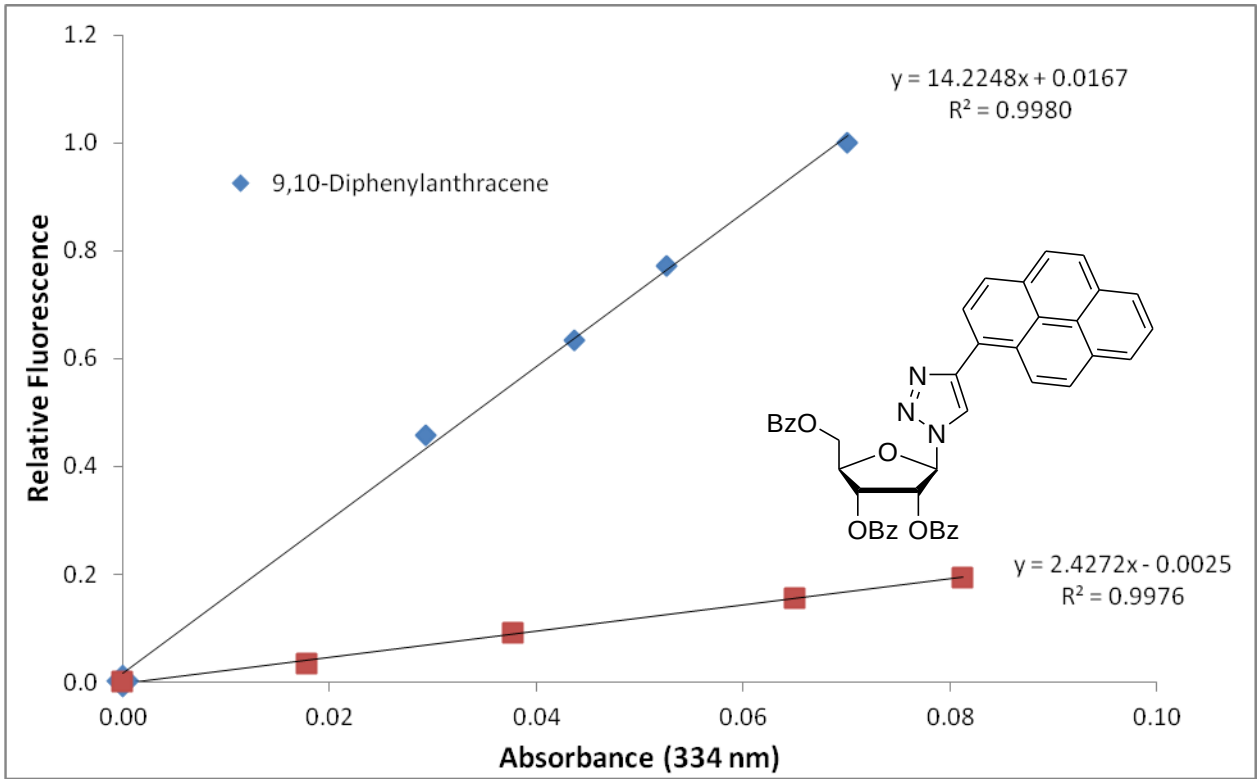
Fluorescence Profile of **4g** (10^{-5} M in EtOH)



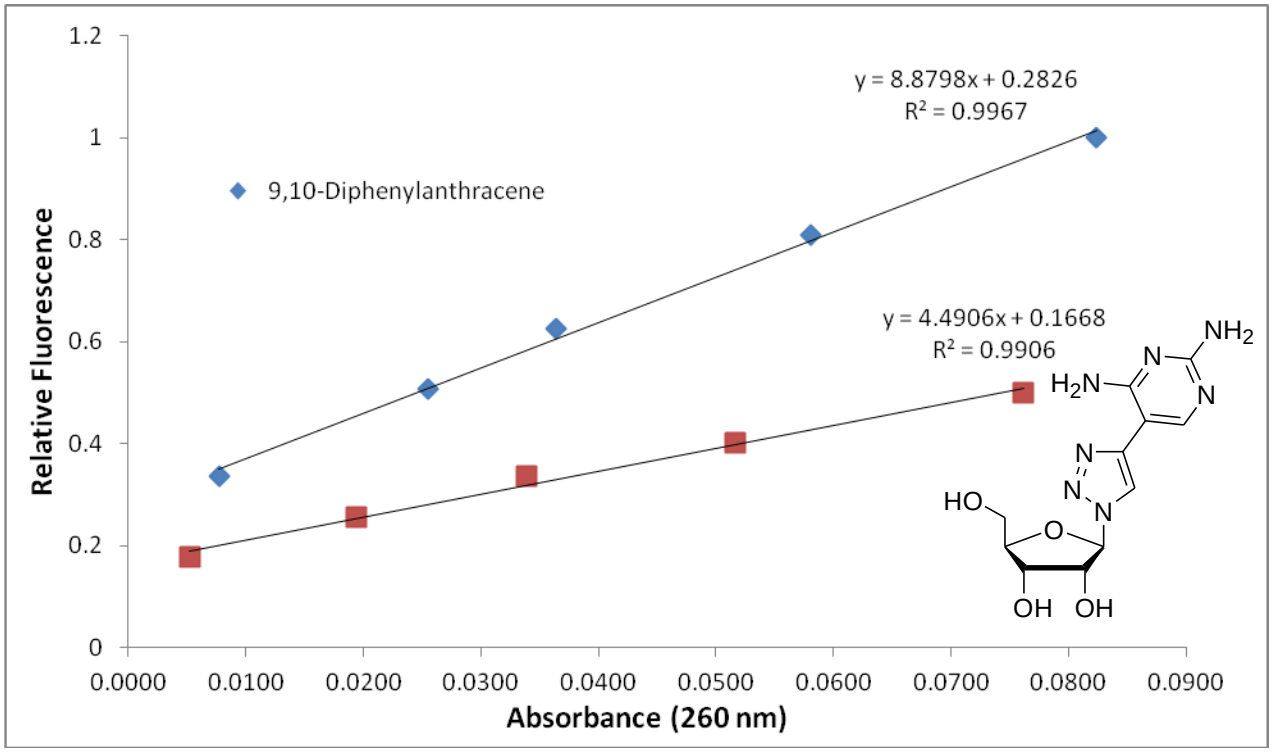
Quantum yield (Φ_F) data for **4f** in EtOH (9,10-diphenylanthracene standard, $\Phi_F = 0.95$[1])



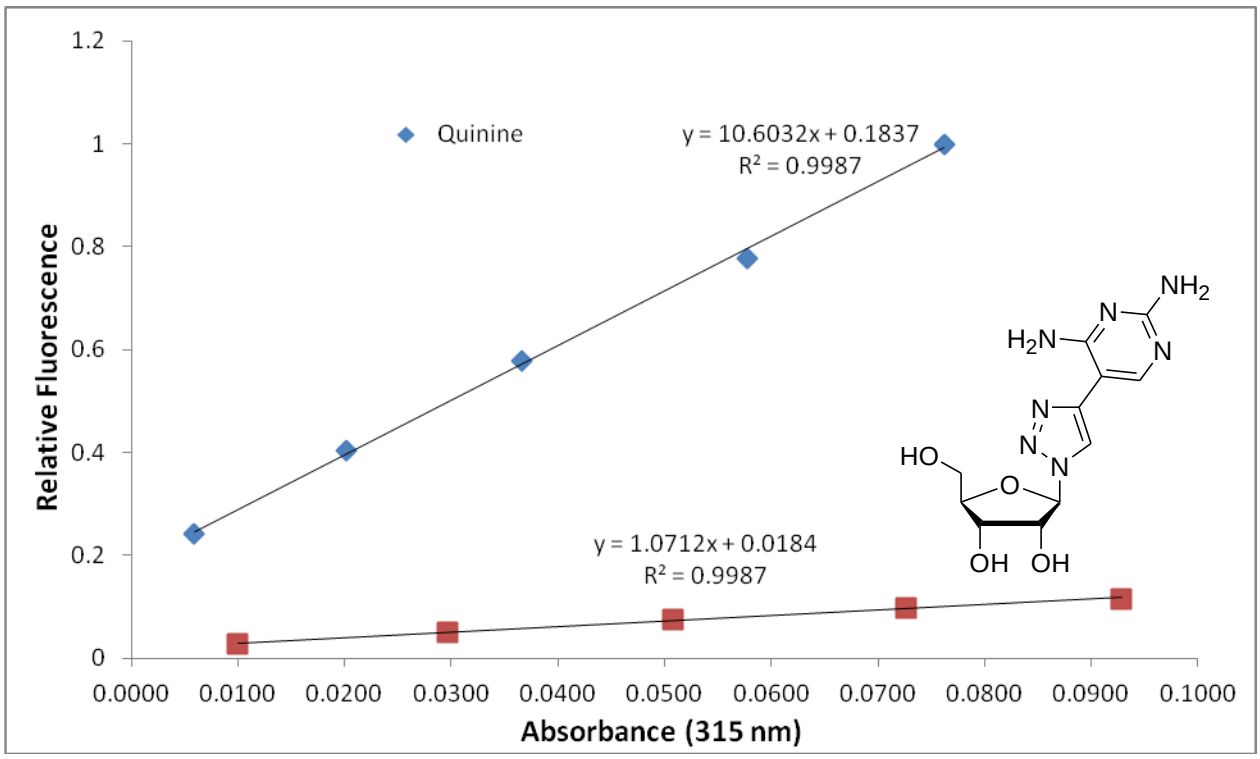
Quantum yield (Φ_F) data for **4g** in EtOH (9,10-diphenylanthracene standard, $\Phi_F = 0.95$[1])



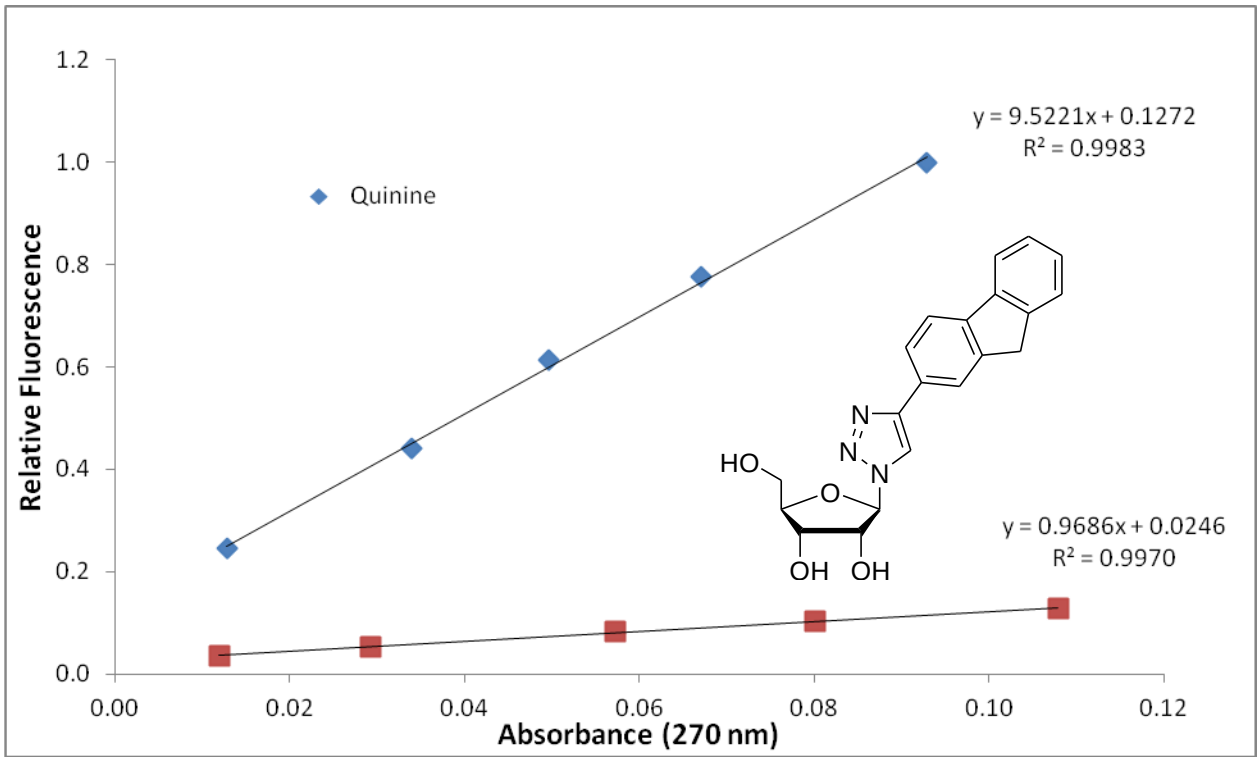
Quantum yield (Φ_F) data for **5d** in EtOH (9,10-diphenylanthracene standard, $\Phi_F = 0.95$[1])



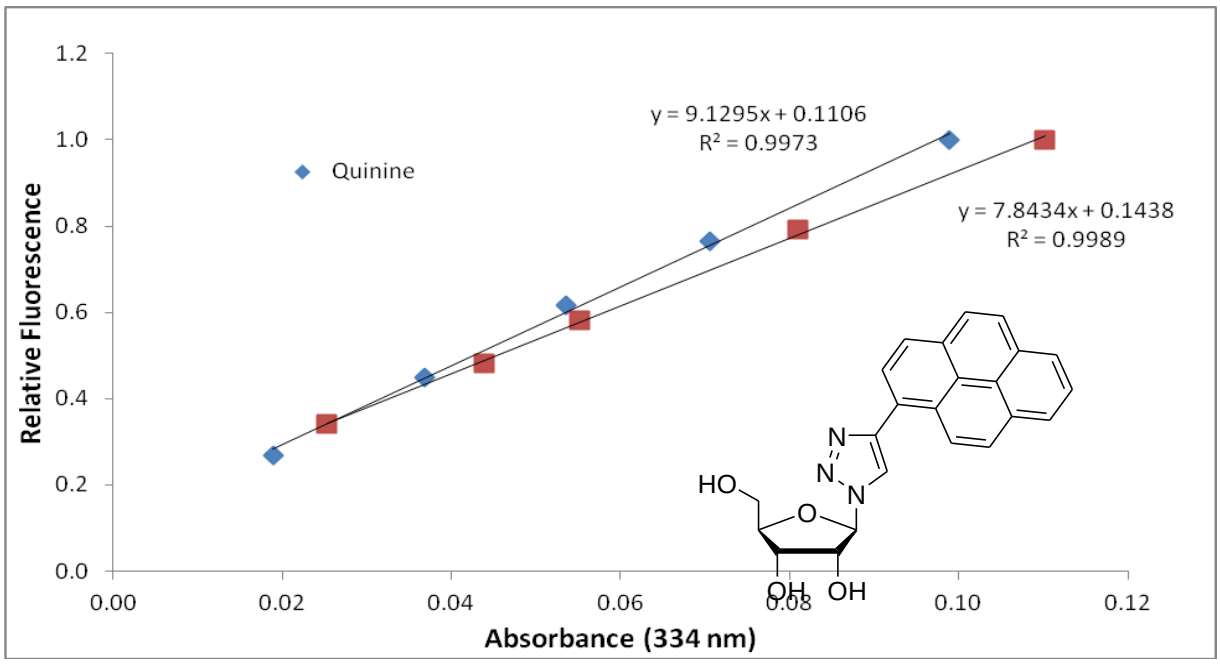
Quantum yield (Φ_F) data for **5d** in H_2O (Quinine sulfate standard, $\Phi_F = 0.54$ in 1 *N* H_2SO_4[2])



Quantum yield (Φ_F) data for **5f** in H_2O (Quinine sulfate standard, $\Phi_F = 0.54$ in 1 *N* H_2SO_4[2])

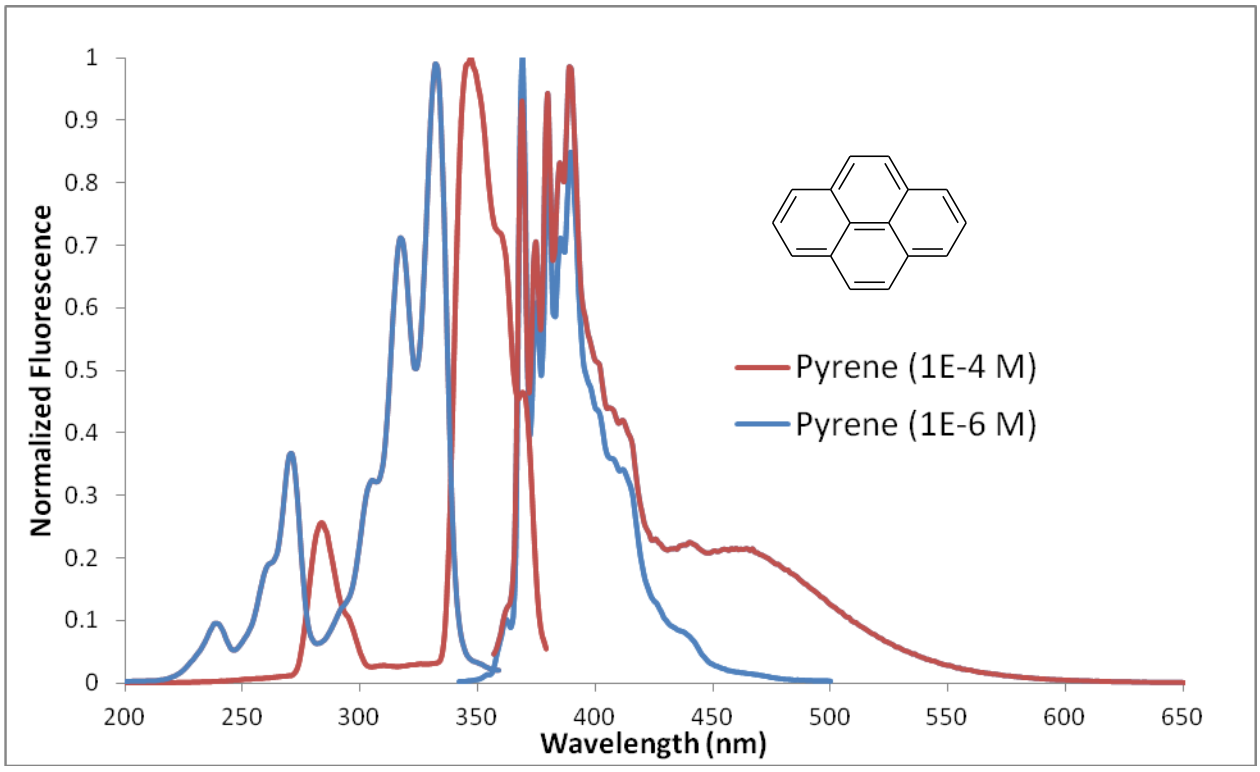


Quantum yield (Φ_F) data for **5g** in H_2O (Quinine sulfate standard, $\Phi_F = 0.54$ in 1 *N* H_2SO_4[2])

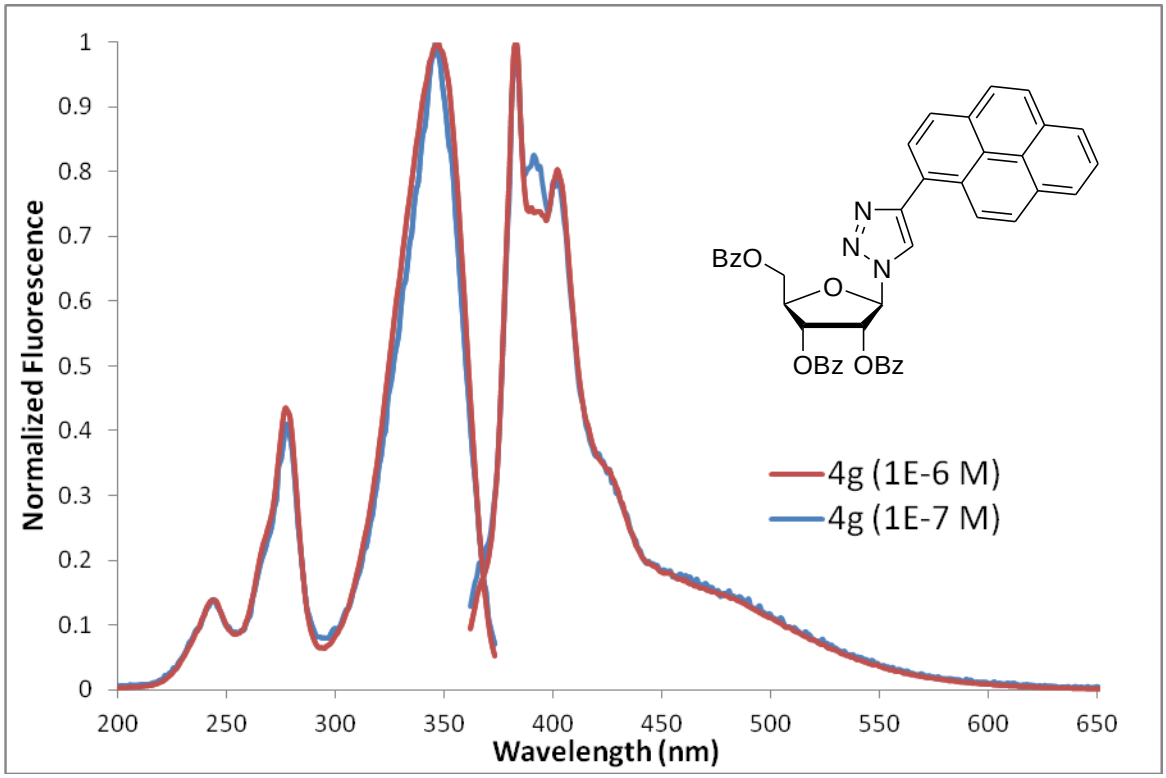


Pyrene excimer formation in EtOH

(Wavelength maxima 10^{-4} M: ex = 347 nm, em = 389 nm / 10^{-6} M: ex = 332 nm, em = 369 nm)



Monomer fluorescence of **5g** in EtOH (Wavelength maxima: ex = 352 nm, em = 383 nm)[3]



References & Notes:

(1) Morris, J. V.; Mahaney, M. A.; Huber, J. R. *The Journal of Physical Chemistry* **1976**, *80*, 969.
(2) Dawson, W. R.; Windsor, M. W. *The Journal of Physical Chemistry* **1968**, *72*, 3251.
(3) The absence of excimer formation was also found for **5g** in H_2O at the concentrations used in the quantum yield studies.

Computational Studies

All calculations were carried out using the B3LYP/6-31+G** level of theory; equilibrium energies of *syn* and *anti* forms were determined by full optimization.

Relaxed scans were carried out using the Opt=ModRedundant keyword. The dihedral defining either the conformation about the glycosidic bond or the biaryl bond was scanned in 24 steps of 15°.

Final structures for the *syn* and *anti* conformers about the glycosidic bond are given after the energy profiles.

Barriers to rotation about the heterobiaryl bond:

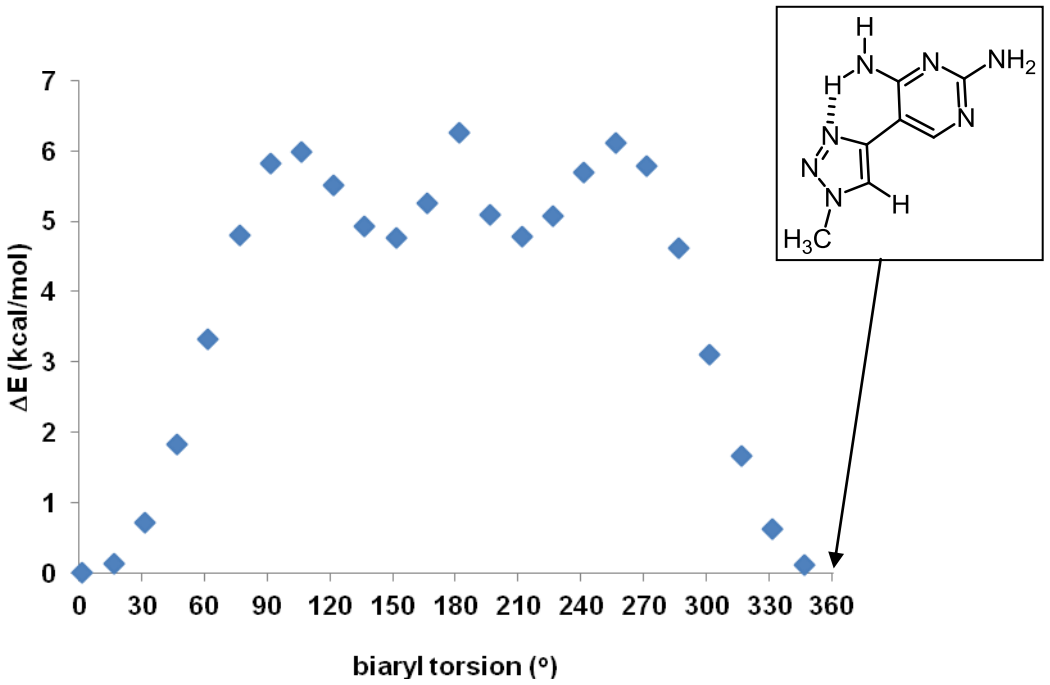


Figure S1. Energy profile for rotation about the biaryl bond for the for N^1-methyl analogue of DAP fleximer **5d** with the lowest energy structure indicated.

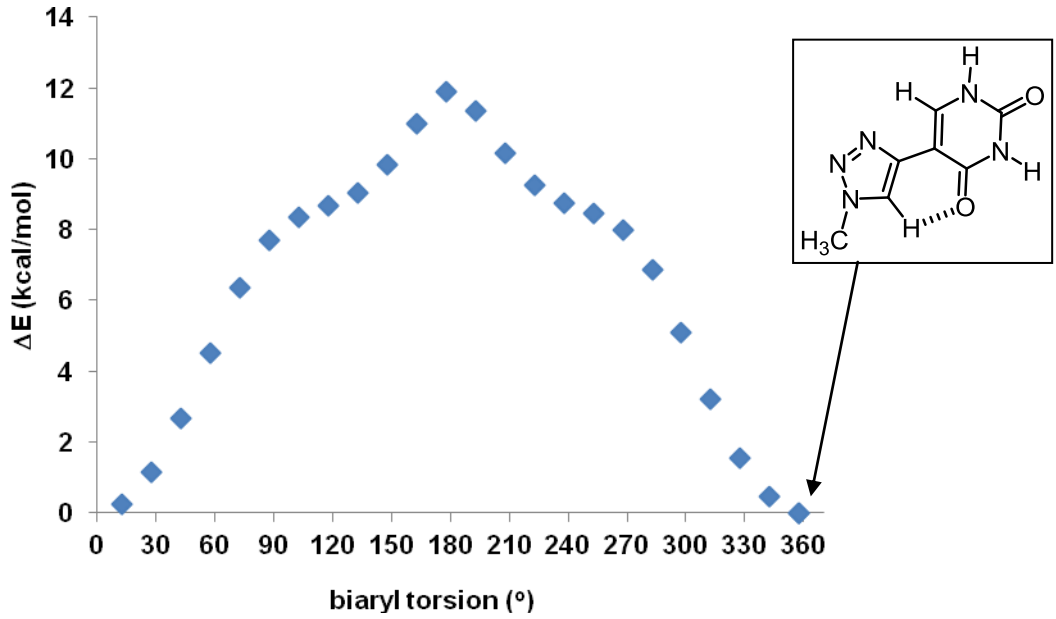


Figure S2. Energy profile for rotation about the biaryl bond for the N^1-methyl analogue of X fleximer **5a** with the lowest energy structure indicated.

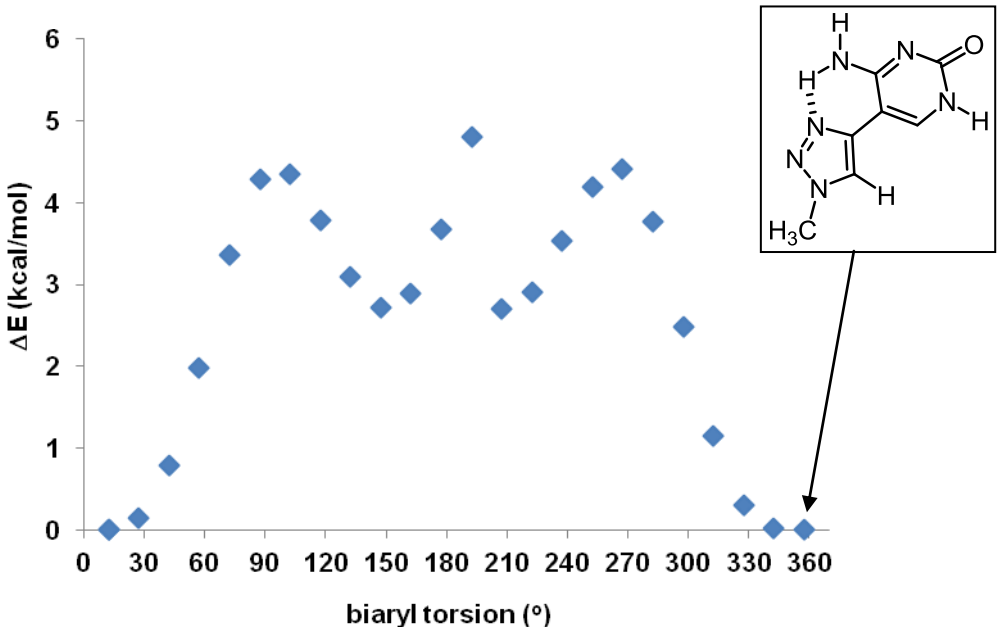


Figure S3. Energy profile for rotation about the biaryl bond for the N^1-methyl analogue of isoG fleximer **5b** with the lowest energy structure indicated.

Barriers to rotation about the glycosidic bond:

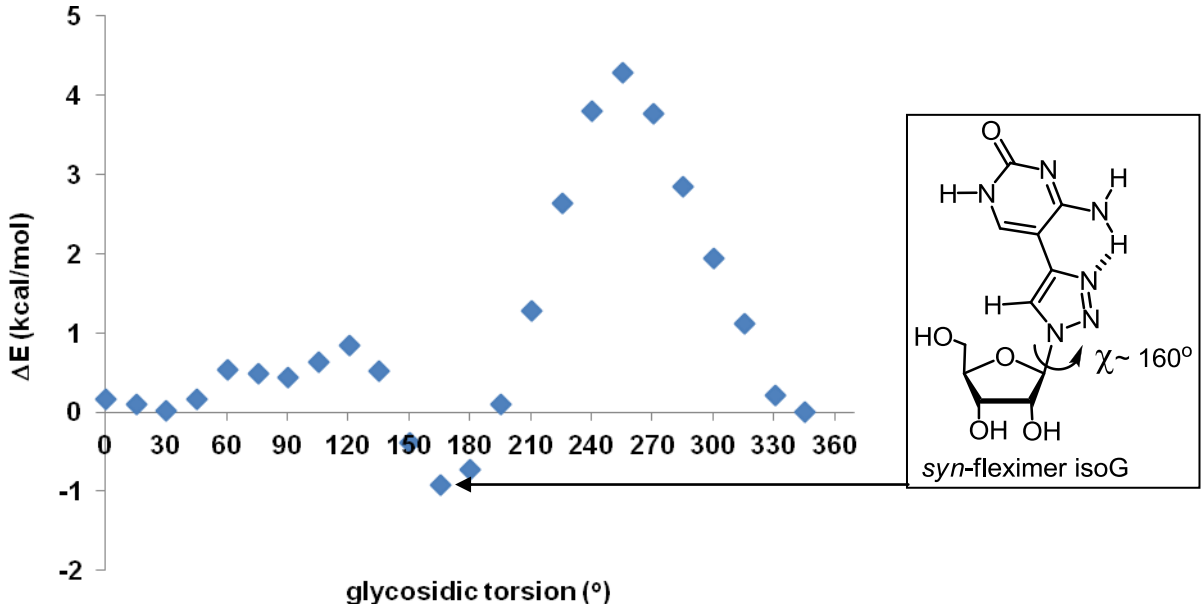


Figure S4. Energy profile for stepwise rotation about the glycosidic bond ($O^{4'}$-$C^{1'}$-N^{1}-C^{5} torsion angle) in 15° increments for the isoG fleximer **5b** indicating the preference for the *syn*-glycoside.

#T b3lyp/6-31+g** POpt Test

A-anti

0 1
O
C 1 R2
H 2 R3 1 A3
H 2 R4 1 A4 3 D4
C 2 R5 1 A5 3 D5
H 5 R6 2 A6 1 D6
O 5 R7 2 A7 1 D7
C 7 R8 5 A8 2 D8
H 8 R9 7 A9 5 D9
N 8 R10 7 A10 5 D10
N 10 R11 8 A11 7 D11
N 11 R12 10 A12 8 D12
C 5 R13 2 A13 1 D13
H 13 R14 5 A14 2 D14
C 8 R15 7 A15 5 D15
H 15 R16 8 A16 7 D16
O 15 R17 8 A17 7 D17
H 17 R18 15 A18 8 D18
C 12 R19 11 A19 10 D19
C 10 R20 8 A20 7 D20
H 1 R21 2 A21 3 D21
C 19 R22 12 A22 11 D22
C 22 R23 19 A23 12 D23
N 23 R24 22 A24 19 D24
H 12 R25 11 A25 10 D25
H 24 R26 23 A26 22 D26
N 23 R27 22 A27 19 D27
C 27 R28 23 A28 22 D28
H 28 R29 27 A29 23 D29
N 28 R30 27 A30 23 D30
C 22 R31 19 A31 12 D31
O 13 R32 5 A32 2 D32
H 32 R33 13 A33 5 D33
H 20 R34 10 A34 8 D34
H 31 R35 22 A35 19 D35
Variables:
R2 = 1.4165
R3 = 1.0954
A3 = 106.5299
R4 = 1.0996

A4 = 111.6002
D4 = 117.47
R5 = 1.5268
A5 = 113.8047
D5 = -119.8444
R6 = 1.0974
A6 = 109.5832
D6 = -192.4264
R7 = 1.4498
A7 = 108.6985
D7 = -74.3005
R8 = 1.4024
A8 = 112.0912
D8 = 134.049
R9 = 1.0937
A9 = 110.6244
D9 = 128.9339
R10 = 1.4763
A10 = 109.3302
D10 = -114.7439
R11 = 1.3433
A11 = 120.844
D11 = 49.3253
R12 = 1.3078
A12 = 107.4595
D12 = -181.5258
R13 = 1.537
A13 = 114.9138
D13 = 43.8076
R14 = 1.0928
A14 = 109.8237
D14 = -25.8329
R15 = 1.5407
A15 = 107.5552
D15 = 8.4579
R16 = 1.0978
A16 = 111.5514
D16 = -144.3965
R17 = 1.4148
A17 = 107.5726
D17 = 93.9192
R18 = 0.9723
A18 = 106.9335
D18 = -141.1578
R19 = 1.3711
A19 = 109.8313

D19 = -0.258
R20 = 1.3542
A20 = 128.2242
D20 = -132.7406
R21 = 0.9737
A21 = 109.6859
D21 = -190.5063
R22 = 1.4641
A22 = 123.2032
D22 = 179.8073
R23 = 1.4301
A23 = 123.5326
D23 = -0.4789
R24 = 1.3509
A24 = 122.9117
D24 = 0.2953
R25 = 2.0254
A25 = 149.4688
D25 = -181.7434
R26 = 1.0084
A26 = 117.6514
D26 = -179.2802
R27 = 1.3504
A27 = 120.5315
D27 = -179.7841
R28 = 1.329
A28 = 117.6011
D28 = -0.0977
R29 = 1.0877
A29 = 116.1634
D29 = -180.0307
R30 = 1.3395
A30 = 127.3428
D30 = -0.0502
R31 = 1.3944
A31 = 121.318
D31 = -180.4272
R32 = 1.4284
A32 = 110.0904
D32 = 96.8097
R33 = 0.9651
A33 = 109.7502
D33 = -139.296
R34 = 1.0783
A34 = 122.0983
D34 = 2.3641

R35 = 1.0889
A35 = 119.8466
D35 = -0.1503

#T b3lyp/6-31+g** POpt Test
A-syn

0 1
O
C 1 R2
H 2 R3 1 A3
H 2 R4 1 A4 3 D4
C 2 R5 1 A5 3 D5
H 5 R6 2 A6 1 D6
O 5 R7 2 A7 1 D7
C 7 R8 5 A8 2 D8
H 8 R9 7 A9 5 D9
N 8 R10 7 A10 5 D10
N 10 R11 8 A11 7 D11
N 11 R12 10 A12 8 D12
C 5 R13 2 A13 1 D13
H 13 R14 5 A14 2 D14
C 8 R15 7 A15 5 D15
H 15 R16 8 A16 7 D16
O 15 R17 8 A17 7 D17
H 17 R18 15 A18 8 D18
C 12 R19 11 A19 10 D19
C 10 R20 8 A20 7 D20
H 1 R21 2 A21 3 D21
C 19 R22 12 A22 11 D22
C 22 R23 19 A23 12 D23
N 23 R24 22 A24 19 D24
H 12 R25 11 A25 10 D25
H 24 R26 23 A26 22 D26
N 23 R27 22 A27 19 D27
C 27 R28 23 A28 22 D28
H 28 R29 27 A29 23 D29
N 28 R30 27 A30 23 D30
C 22 R31 19 A31 12 D31
O 13 R32 5 A32 2 D32
H 32 R33 13 A33 5 D33
H 20 R34 10 A34 8 D34
H 31 R35 22 A35 19 D35
Variables:
R2 = 1.4246
R3 = 1.0945

A3 = 106.9857
R4 = 1.0972
A4 = 110.9461
D4 = 117.7301
R5 = 1.524
A5 = 112.273
D5 = -119.1141
R6 = 1.0989
A6 = 109.3832
D6 = -177.2096
R7 = 1.4398
A7 = 108.5504
D7 = -57.3136
R8 = 1.4215
A8 = 111.2986
D8 = 144.6412
R9 = 1.092
A9 = 111.1269
D9 = 120.8239
R10 = 1.4622
A10 = 109.3565
D10 = -123.3053
R11 = 1.3475
A11 = 119.0437
D11 = -127.7043
R12 = 1.3036
A12 = 107.2278
D12 = -178.1885
R13 = 1.5336
A13 = 115.2269
D13 = 59.8947
R14 = 1.095
A14 = 110.0701
D14 = -33.991
R15 = 1.5428
A15 = 106.9993
D15 = 0.0607
R16 = 1.0977
A16 = 111.3614
D16 = -142.3872
R17 = 1.4148
A17 = 107.6433
D17 = 95.8181
R18 = 0.9715
A18 = 107.2954
D18 = -145.0758

R19 = 1.3746
A19 = 110.0597
D19 = -0.1571
R20 = 1.3588
A20 = 129.9074
D20 = 54.3857
R21 = 0.9669
A21 = 107.5067
D21 = -166.6265
R22 = 1.4644
A22 = 123.0856
D22 = -179.6389
R23 = 1.4305
A23 = 123.4913
D23 = 0.9269
R24 = 1.3507
A24 = 122.8474
D24 = -0.0708
R25 = 2.0161
A25 = 149.2095
D25 = -177.4325
R26 = 1.0084
A26 = 117.6821
D26 = 179.822
R27 = 1.3507
A27 = 120.5335
D27 = 179.9368
R28 = 1.3291
A28 = 117.5889
D28 = 0.0536
R29 = 1.0878
A29 = 116.1451
D29 = -179.9717
R30 = 1.3393
A30 = 127.3656
D30 = 0.0465
R31 = 1.3942
A31 = 121.3686
D31 = -179.0092
R32 = 1.4258
A32 = 109.8918
D32 = 88.4853
R33 = 0.9655
A33 = 109.979
D33 = -146.6271
R34 = 1.0781

A34 = 122.3982
D34 = -3.6736
R35 = 1.089
A35 = 119.8159
D35 = 0.0608

#T b3lyp/6-31+g** POpt Test
DAP-anti

0 1
C
N 1 r2
H 2 r3 1 a3
H 2 r4 1 a4 3 d4
N 1 r5 2 a5 3 d5
C 5 r6 1 a6 2 d6
N 6 r7 5 a7 1 d7
N 6 r8 5 a8 1 d8
H 7 r9 6 a9 5 d9
H 7 r10 6 a10 5 d10
C 1 r11 2 a11 3 d11
C 8 r12 6 a12 5 d12
O 3 r13 2 a13 1 d13
C 13 r14 3 a14 2 d14
H 14 r15 13 a15 3 d15
H 14 r16 13 a16 3 d16
C 14 r17 13 a17 3 d17
H 17 r18 14 a18 13 d18
O 17 r19 14 a19 13 d19
C 19 r20 17 a20 14 d20
H 20 r21 19 a21 17 d21
N 20 r22 19 a22 17 d22
N 22 r23 20 a23 19 d23
N 23 r24 22 a24 20 d24
C 24 r25 23 a25 22 d25
C 22 r26 20 a26 19 d26
C 17 r27 14 a27 13 d27
H 27 r28 17 a28 14 d28
C 20 r29 19 a29 17 d29
H 29 r30 20 a30 19 d30
O 29 r31 20 a31 19 d31
H 31 r32 29 a32 20 d32
O 27 r33 17 a33 14 d33
H 13 r34 3 a34 2 d34
H 26 r35 22 a35 20 d35
H 12 r36 8 a36 6 d36

H 33 r37 27 a37 17 d37
Variables:
r2 = 1.352
r3 = 1.0132
a3 = 120.147
r4 = 1.0081
a4 = 117.8358
d4 = 183.7996
r5 = 1.3436
a5 = 116.5487
d5 = 177.6207
r6 = 1.338
a6 = 117.616
d6 = 179.6731
r7 = 1.3657
a7 = 116.9638
d7 = 182.0286
r8 = 1.3508
a8 = 126.6385
d8 = 0.7555
r9 = 1.0076
a9 = 118.0312
d9 = 346.3557
r10 = 1.0078
a10 = 117.5521
d10 = 192.4425
r11 = 1.4319
a11 = 122.3138
d11 = 357.4814
r12 = 1.3329
a12 = 114.7696
d12 = 359.3453
r13 = 5.3095
a13 = 170.8563
d13 = 330.0337
r14 = 1.4161
a14 = 137.9147
d14 = 17.0447
r15 = 1.0956
a15 = 106.5814
d15 = 164.8789
r16 = 1.0997
a16 = 111.601
d16 = 282.4212
r17 = 1.527
a17 = 113.8511

d17 = 45.1239
r18 = 1.0975
a18 = 109.5611
d18 = 167.7386
r19 = 1.4491
a19 = 108.7917
d19 = 285.9049
r20 = 1.4032
a20 = 112.0841
d20 = 133.6877
r21 = 1.0936
a21 = 110.5428
d21 = 129.4445
r22 = 1.4748
a22 = 109.4498
d22 = 245.9121
r23 = 1.3414
a23 = 120.8603
d23 = 48.7393
r24 = 1.3096
a24 = 107.4625
d24 = 177.7379
r25 = 1.372
a25 = 109.8983
d25 = 359.6575
r26 = 1.3559
a26 = 128.1646
d26 = 225.6314
r27 = 1.537
a27 = 114.8773
d27 = 44.081
r28 = 1.0927
a28 = 109.838
d28 = 334.0841
r29 = 1.5407
a29 = 107.4552
d29 = 9.025
r30 = 1.0977
a30 = 111.4975
d30 = 215.1074
r31 = 1.4153
a31 = 107.6891
d31 = 93.3964
r32 = 0.9722
a32 = 106.8971
d32 = 218.8873

r33 = 1.4289
a33 = 110.0747
d33 = 96.6995
r34 = 0.9745
a34 = 28.3196
d34 = 370.3372
r35 = 1.0783
a35 = 122.0313
d35 = 3.012
r36 = 1.0892
a36 = 115.1096
d36 = 179.8145
r37 = 0.9651
a37 = 109.6894
d37 = 220.1858

#T b3lyp/6-31+g** POpt Test

DAP-syn
0 1
C
N 1 r2
H 2 r3 1 a3
H 2 r4 1 a4 3 d4
N 1 r5 2 a5 3 d5
C 5 r6 1 a6 2 d6
N 6 r7 5 a7 1 d7
N 6 r8 5 a8 1 d8
H 7 r9 6 a9 5 d9
H 7 r10 6 a10 5 d10
C 1 r11 2 a11 3 d11
C 8 r12 6 a12 5 d12
O 12 r13 8 a13 6 d13
C 13 r14 12 a14 8 d14
H 14 r15 13 a15 12 d15
H 14 r16 13 a16 12 d16
C 14 r17 13 a17 12 d17
H 17 r18 14 a18 13 d18
O 17 r19 14 a19 13 d19
C 19 r20 17 a20 14 d20
H 20 r21 19 a21 17 d21
N 20 r22 19 a22 17 d22
N 22 r23 20 a23 19 d23
N 23 r24 22 a24 20 d24
C 24 r25 23 a25 22 d25
C 22 r26 20 a26 19 d26

C 17 r27 14 a27 13 d27
H 27 r28 17 a28 14 d28
C 20 r29 19 a29 17 d29
H 29 r30 20 a30 19 d30
O 29 r31 20 a31 19 d31
H 31 r32 29 a32 20 d32
O 27 r33 17 a33 14 d33
H 13 r34 12 a34 8 d34
H 26 r35 22 a35 20 d35
H 12 r36 8 a36 6 d36
H 33 r37 27 a37 17 d37

Variables:

r2 = 1.3516
r3 = 1.014
a3 = 120.0206
r4 = 1.008
a4 = 117.8962
d4 = 178.5943
r5 = 1.344
a5 = 116.5892
d5 = 180.7216
r6 = 1.3379
a6 = 117.6099
d6 = 179.8665
r7 = 1.3666
a7 = 116.9325
d7 = 182.0129
r8 = 1.3504
a8 = 126.6679
d8 = 0.612
r9 = 1.0076
a9 = 117.9495
d9 = 345.9169
r10 = 1.0078
a10 = 117.474
d10 = 192.5482
r11 = 1.4323
a11 = 122.277
d11 = 360.8879
r12 = 1.3336
a12 = 114.7521
d12 = 359.4929
r13 = 5.2284
a13 = 136.8211
d13 = 203.6681
r14 = 1.424

a14 = 145.3973
d14 = 188.0012
r15 = 1.0944
a15 = 106.9473
d15 = 127.586
r16 = 1.0976
a16 = 110.9344
d16 = 245.1942
r17 = 1.5235
a17 = 112.3564
d17 = 8.1699
r18 = 1.0991
a18 = 109.367
d18 = 182.2461
r19 = 1.4392
a19 = 108.3918
d19 = 302.111
r20 = 1.4236
a20 = 111.2747
d20 = 145.1838
r21 = 1.092
a21 = 111.0116
d21 = 120.225
r22 = 1.4596
a22 = 109.4202
d22 = 236.0748
r23 = 1.346
a23 = 119.0132
d23 = 233.5835
r24 = 1.3047
a24 = 107.2295
d24 = 181.6197
r25 = 1.3759
a25 = 110.1633
d25 = 359.8088
r26 = 1.3609
a26 = 129.9629
d26 = 55.4771
r27 = 1.5335
a27 = 115.3595
d27 = 59.2173
r28 = 1.095
a28 = 110.013
d28 = 325.7541
r29 = 1.5429
a29 = 106.8929

d29 = -0.3598
r30 = 1.0976
a30 = 111.3602
d30 = 217.7195
r31 = 1.4155
a31 = 107.6789
d31 = 95.9316
r32 = 0.9714
a32 = 107.2514
d32 = 214.463
r33 = 1.4263
a33 = 109.967
d33 = 88.2353
r34 = 0.9672
a34 = 60.81
d34 = 109.7397
r35 = 1.0779
a35 = 122.3747
d35 = -3.2912
r36 = 1.0893
a36 = 115.1205
d36 = 180.0851
r37 = 0.9654
a37 = 109.9159
d37 = 213.4824

#T b3lyp/6-31+g** POpt Test
isoG-anti

0 1
O
C 1 R2
H 2 R3 1 A3
H 2 R4 1 A4 3 D4
C 2 R5 1 A5 3 D5
H 5 R6 2 A6 1 D6
O 5 R7 2 A7 1 D7
C 7 R8 5 A8 2 D8
H 8 R9 7 A9 5 D9
N 8 R10 7 A10 5 D10
N 10 R11 8 A11 7 D11
N 11 R12 10 A12 8 D12
C 5 R13 2 A13 1 D13
H 13 R14 5 A14 2 D14
C 8 R15 7 A15 5 D15
H 15 R16 8 A16 7 D16

O 15 R17 8 A17 7 D17
H 17 R18 15 A18 8 D18
O 13 R19 5 A19 2 D19
C 12 R20 11 A20 10 D20
C 10 R21 8 A21 7 D21
H 1 R22 2 A22 3 D22
C 20 R23 12 A23 11 D23
C 23 R24 20 A24 12 D24
N 24 R25 23 A25 20 D25
H 12 R26 11 A26 10 D26
H 25 R27 24 A27 23 D27
N 24 R28 23 A28 20 D28
C 28 R29 24 A29 23 D29
O 29 R30 28 A30 24 D30
N 29 R31 28 A31 24 D31
C 23 R32 20 A32 12 D32
H 21 R33 10 A33 8 D33
H 32 R34 23 A34 20 D34
H 17 R35 15 A35 8 D35
H 31 R36 29 A36 28 D36

Variables:

R2 = 1.4145
R3 = 1.0954
A3 = 106.6138
R4 = 1.1001
A4 = 111.5829
D4 = 117.5953
R5 = 1.5269
A5 = 113.6602
D5 = -119.8047
R6 = 1.1001
A6 = 109.079
D6 = 170.8265
R7 = 1.4499
A7 = 108.4406
D7 = -72.208
R8 = 1.4011
A8 = 112.3876
D8 = 133.8433
R9 = 1.0943
A9 = 110.6883
D9 = 126.7143
R10 = 1.4745
A10 = 109.1681
D10 = -117.1986
R11 = 1.3408

A11 = 120.8107
D11 = 49.8276
R12 = 1.3079
A12 = 107.4207
D12 = -181.3953
R13 = 1.5423
A13 = 115.1195
D13 = 46.4049
R14 = 1.0917
A14 = 109.5246
D14 = -23.5176
R15 = 1.5407
A15 = 107.9938
D15 = 6.1903
R16 = 1.0951
A16 = 111.6206
D16 = -140.4316
R17 = 1.4253
A17 = 106.4665
D17 = 98.6356
R18 = 0.9672
A18 = 108.2614
D18 = 172.0434
R19 = 1.4152
A19 = 114.0581
D19 = 95.134
R20 = 1.3703
A20 = 109.9586
D20 = -0.2362
R21 = 1.3561
A21 = 128.2244
D21 = -132.2237
R22 = 0.9731
A22 = 109.8919
D22 = 169.239
R23 = 1.4651
A23 = 123.0896
D23 = 179.7984
R24 = 1.4642
A24 = 124.4182
D24 = 5.108
R25 = 1.3482
A25 = 119.8687
D25 = -0.9922
R26 = 1.995
A26 = 149.6103

D26 = -172.3956
R27 = 1.0094
A27 = 117.0714
D27 = -179.1217
R28 = 1.3258
A28 = 123.3018
D28 = 178.7871
R29 = 1.3626
A29 = 121.6284
D29 = 0.3494
R30 = 1.2244
A30 = 126.2476
D30 = -179.6358
R31 = 1.4296
A31 = 115.9068
D31 = 0.5918
R32 = 1.3692
A32 = 120.959
D32 = -175.0948
R33 = 1.0785
A33 = 121.8686
D33 = 1.7825
R34 = 1.0853
A34 = 122.5579
D34 = 0.9958
R35 = 2.4884
A35 = 81.952
D35 = -118.9526
R36 = 1.0116
A36 = 115.4024
D36 = 179.1952

#T b3lyp/6-31+g** POpt Test
isoG-syn

0 1
O
C 1 R2
H 2 R3 1 A3
H 2 R4 1 A4 3 D4
C 2 R5 1 A5 3 D5
H 5 R6 2 A6 1 D6
O 5 R7 2 A7 1 D7
C 7 R8 5 A8 2 D8
H 8 R9 7 A9 5 D9
N 8 R10 7 A10 5 D10

N 10 R11 8 A11 7 D11
N 11 R12 10 A12 8 D12
C 5 R13 2 A13 1 D13
H 13 R14 5 A14 2 D14
C 8 R15 7 A15 5 D15
H 15 R16 8 A16 7 D16
O 15 R17 8 A17 7 D17
H 17 R18 15 A18 8 D18
O 13 R19 5 A19 2 D19
C 12 R20 11 A20 10 D20
C 10 R21 8 A21 7 D21
H 1 R22 2 A22 3 D22
C 20 R23 12 A23 11 D23
C 23 R24 20 A24 12 D24
N 24 R25 23 A25 20 D25
H 12 R26 11 A26 10 D26
H 25 R27 24 A27 23 D27
N 24 R28 23 A28 20 D28
C 28 R29 24 A29 23 D29
O 29 R30 28 A30 24 D30
N 29 R31 28 A31 24 D31
C 23 R32 20 A32 12 D32
H 21 R33 10 A33 8 D33
H 32 R34 23 A34 20 D34
H 17 R35 15 A35 8 D35
H 31 R36 29 A36 28 D36

Variables:

R2 = 1.4317
R3 = 1.0985
A3 = 110.8014
R4 = 1.0977
A4 = 110.6611
D4 = 120.9752
R5 = 1.5164
A5 = 109.6712
D5 = -118.6243
R6 = 1.099
A6 = 107.9017
D6 = 175.0817
R7 = 1.4441
A7 = 109.714
D7 = -66.3534
R8 = 1.4089
A8 = 111.2131
D8 = 143.2929
R9 = 1.0938

A9 = 110.9468
D9 = 125.1936
R10 = 1.4687
A10 = 109.156
D10 = -118.5921
R11 = 1.3442
A11 = 118.9911
D11 = -151.6501
R12 = 1.3076
A12 = 106.9597
D12 = -176.9965
R13 = 1.5433
A13 = 115.6655
D13 = 52.455
R14 = 1.0928
A14 = 109.3957
D14 = -36.8873
R15 = 1.5466
A15 = 107.2396
D15 = 3.4187
R16 = 1.0939
A16 = 112.0056
D16 = -145.4679
R17 = 1.4265
A17 = 110.8339
D17 = 89.5947
R18 = 0.9655
A18 = 110.1348
D18 = 87.0626
R19 = 1.4078
A19 = 114.1189
D19 = 83.1637
R20 = 1.3717
A20 = 109.9363
D20 = -0.1565
R21 = 1.3564
A21 = 129.3515
D21 = 31.6835
R22 = 0.9649
A22 = 108.8946
D22 = -56.6352
R23 = 1.466
A23 = 123.0546
D23 = -179.5275
R24 = 1.4629
A24 = 124.3855

D24 = 9.3622
R25 = 1.3488
A25 = 119.6617
D25 = -1.356
R26 = 1.9895
A26 = 149.0929
D26 = -162.7349
R27 = 1.0092
A27 = 117.1314
D27 = -178.7619
R28 = 1.3263
A28 = 123.4223
D28 = 178.3238
R29 = 1.3629
A29 = 121.4846
D29 = 0.3732
R30 = 1.2257
A30 = 126.125
D30 = -179.6132
R31 = 1.4274
A31 = 115.961
D31 = 0.7541
R32 = 1.3683
A32 = 120.9858
D32 = -171.0629
R33 = 1.0796
A33 = 121.4857
D33 = -5.1498
R34 = 1.0851
A34 = 122.4317
D34 = 1.5352
R35 = 2.1346
A35 = 85.5028
D35 = -132.601
R36 = 1.0114
A36 = 115.3838
D36 = 178.9008

#T b3lyp/6-31+g** POpt Test
X-anti

0 1
O
C 1 R2
H 2 R3 1 A3
H 2 R4 1 A4 3 D4

C 2 R5 1 A5 3 D5
H 5 R6 2 A6 1 D6
O 5 R7 2 A7 1 D7
C 7 R8 5 A8 2 D8
H 8 R9 7 A9 5 D9
N 8 R10 7 A10 5 D10
N 10 R11 8 A11 7 D11
N 11 R12 10 A12 8 D12
C 5 R13 2 A13 1 D13
H 13 R14 5 A14 2 D14
C 8 R15 7 A15 5 D15
H 15 R16 8 A16 7 D16
O 15 R17 8 A17 7 D17
H 17 R18 15 A18 8 D18
O 13 R19 5 A19 2 D19
C 12 R20 11 A20 10 D20
C 10 R21 8 A21 7 D21
H 1 R22 2 A22 3 D22
C 20 R23 12 A23 11 D23
C 23 R24 20 A24 12 D24
O 24 R25 23 A25 20 D25
N 24 R26 23 A26 20 D26
C 26 R27 24 A27 23 D27
O 27 R28 26 A28 24 D28
N 27 R29 26 A29 24 D29
C 23 R30 20 A30 12 D30
H 21 R31 10 A31 8 D31
H 30 R32 23 A32 20 D32
H 17 R33 15 A33 8 D33
H 29 R34 27 A34 26 D34
H 26 R35 24 A35 23 D35

Variables:

R2 = 1.4154
R3 = 1.0954
A3 = 106.645
R4 = 1.1004
A4 = 111.4866
D4 = 117.6753
R5 = 1.5253
A5 = 113.9018
D5 = -119.4862
R6 = 1.0983
A6 = 109.353
D6 = 170.8766
R7 = 1.455
A7 = 108.5214

D7 = -71.5325
R8 = 1.4007
A8 = 111.997
D8 = 135.4507
R9 = 1.0949
A9 = 110.4326
D9 = 129.1758
R10 = 1.4747
A10 = 109.6712
D10 = -114.8282
R11 = 1.3493
A11 = 121.0628
D11 = 46.6893
R12 = 1.3039
A12 = 107.7317
D12 = 178.299
R13 = 1.5436
A13 = 115.2131
D13 = 46.4562
R14 = 1.0921
A14 = 109.073
D14 = -29.3236
R15 = 1.5464
A15 = 107.1916
D15 = 8.3947
R16 = 1.0939
A16 = 112.4194
D16 = -146.4256
R17 = 1.4295
A17 = 109.7858
D17 = 89.2535
R18 = 0.9644
A18 = 110.2952
D18 = 100.2908
R19 = 1.4087
A19 = 114.2841
D19 = 90.4798
R20 = 1.3692
A20 = 109.212
D20 = -0.2966
R21 = 1.3574
A21 = 128.118
D21 = -135.6187
R22 = 0.9732
A22 = 109.86
D22 = 166.2574

R23 = 1.4601
A23 = 121.5732
D23 = 179.8357
R24 = 1.4656
A24 = 120.114
D24 = 178.2243
R25 = 1.227
A25 = 125.6697
D25 = 0.1789
R26 = 1.4038
A26 = 114.4
D26 = -179.7797
R27 = 1.3855
A27 = 128.1413
D27 = 0.07
R28 = 1.2195
A28 = 124.1288
D28 = -180.0927
R29 = 1.391
A29 = 112.7412
D29 = -0.0946
R30 = 1.3615
A30 = 121.4073
D30 = -1.5729
R31 = 1.0773
A31 = 124.1416
D31 = 2.7667
R32 = 1.0839
A32 = 121.3314
D32 = -0.2362
R33 = 2.1452
A33 = 85.5214
D33 = -130.1499
R34 = 1.011
A34 = 115.232
D34 = -179.881
R35 = 1.0142
A35 = 116.1427
D35 = -180.0173

#T b3lyp/6-31+g** POpt Test
X-syn

0 1
O
C 1 R2

H 2 R3 1 A3
H 2 R4 1 A4 3 D4
C 2 R5 1 A5 3 D5
H 5 R6 2 A6 1 D6
O 5 R7 2 A7 1 D7
C 7 R8 5 A8 2 D8
H 8 R9 7 A9 5 D9
N 8 R10 7 A10 5 D10
N 10 R11 8 A11 7 D11
N 11 R12 10 A12 8 D12
C 5 R13 2 A13 1 D13
H 13 R14 5 A14 2 D14
C 8 R15 7 A15 5 D15
H 15 R16 8 A16 7 D16
O 15 R17 8 A17 7 D17
H 17 R18 15 A18 8 D18
O 13 R19 5 A19 2 D19
C 12 R20 11 A20 10 D20
C 10 R21 8 A21 7 D21
H 1 R22 2 A22 3 D22
C 20 R23 12 A23 11 D23
C 23 R24 20 A24 12 D24
O 24 R25 23 A25 20 D25
N 24 R26 23 A26 20 D26
C 26 R27 24 A27 23 D27
O 27 R28 26 A28 24 D28
N 27 R29 26 A29 24 D29
C 23 R30 20 A30 12 D30
H 21 R31 10 A31 8 D31
H 30 R32 23 A32 20 D32
H 17 R33 15 A33 8 D33
H 29 R34 27 A34 26 D34
H 26 R35 24 A35 23 D35

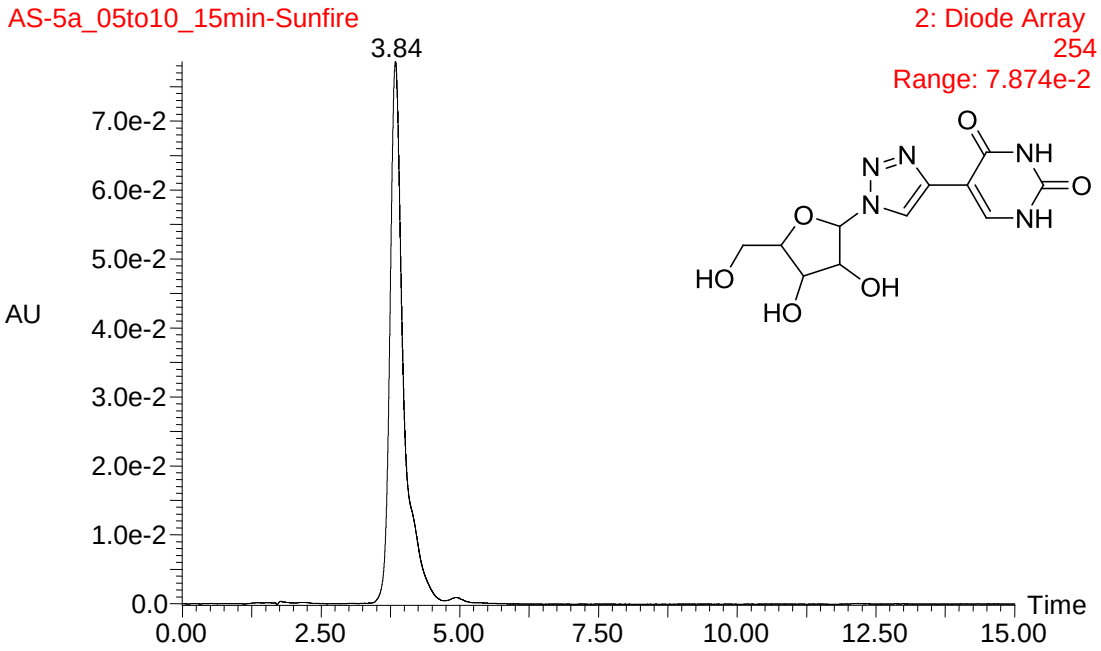
Variables:

R2 = 1.421
R3 = 1.0942
A3 = 106.7931
R4 = 1.0985
A4 = 111.1199
D4 = 117.8171
R5 = 1.5228
A5 = 112.6584
D5 = -118.8095
R6 = 1.1001
A6 = 109.2499
D6 = 182.1365

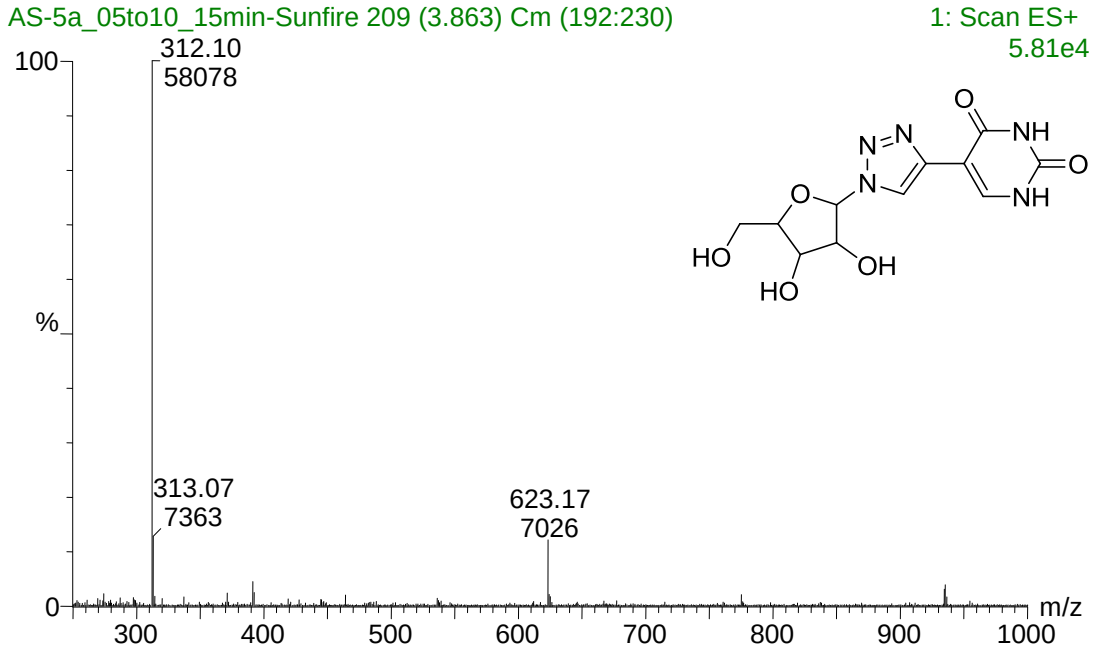
R7 = 1.4446
A7 = 108.3704
D7 = -58.2673
R8 = 1.4182
A8 = 110.565
D8 = 151.1539
R9 = 1.0943
A9 = 111.1261
D9 = 113.5337
R10 = 1.458
A10 = 109.423
D10 = -131.0502
R11 = 1.3543
A11 = 118.8261
D11 = -131.0052
R12 = 1.3008
A12 = 107.4752
D12 = 182.4277
R13 = 1.5393
A13 = 115.5218
D13 = 58.1527
R14 = 1.094
A14 = 108.8319
D14 = -38.5303
R15 = 1.5519
A15 = 107.143
D15 = -7.3397
R16 = 1.0943
A16 = 111.9493
D16 = -137.9958
R17 = 1.4278
A17 = 110.7872
D17 = 97.5913
R18 = 0.9653
A18 = 110.1948
D18 = 86.6289
R19 = 1.4076
A19 = 114.4615
D19 = 81.4517
R20 = 1.3721
A20 = 109.382
D20 = -0.0873
R21 = 1.3595
A21 = 130.1419
D21 = 52.0887
R22 = 0.9668

A22 = 108.0184
D22 = 188.3007
R23 = 1.4602
A23 = 121.3693
D23 = 180.7394
R24 = 1.4662
A24 = 120.1733
D24 = 179.4752
R25 = 1.226
A25 = 125.6845
D25 = -0.0172
R26 = 1.4048
A26 = 114.4044
D26 = -179.9988
R27 = 1.3848
A27 = 128.151
D27 = 0.2375
R28 = 1.22
A28 = 124.1778
D28 = -180.1614
R29 = 1.3908
A29 = 112.7383
D29 = -0.1761
R30 = 1.3613
A30 = 121.3947
D30 = -0.3339
R31 = 1.0769
A31 = 124.2724
D31 = -3.4701
R32 = 1.0838
A32 = 121.3079
D32 = -0.0281
R33 = 2.1197
A33 = 85.9568
D33 = -131.9087
R34 = 1.0109
A34 = 115.2098
D34 = -180.11
R35 = 1.0142
A35 = 116.0743
D35 = -180.0385

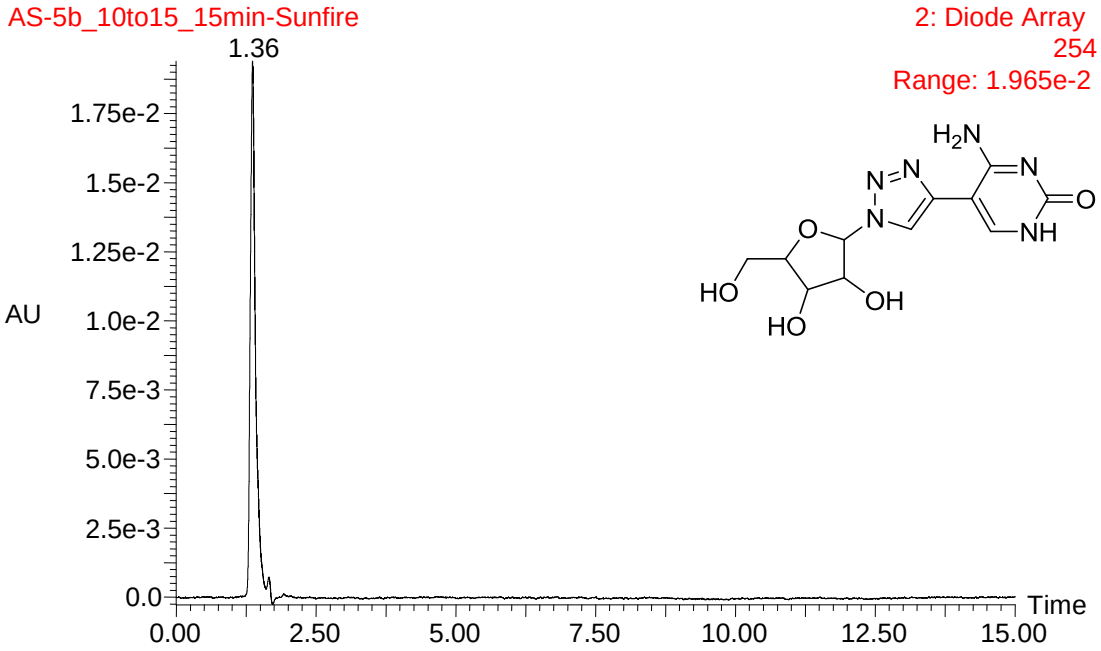
RP-HPLC of **5a** (Gradient 1)



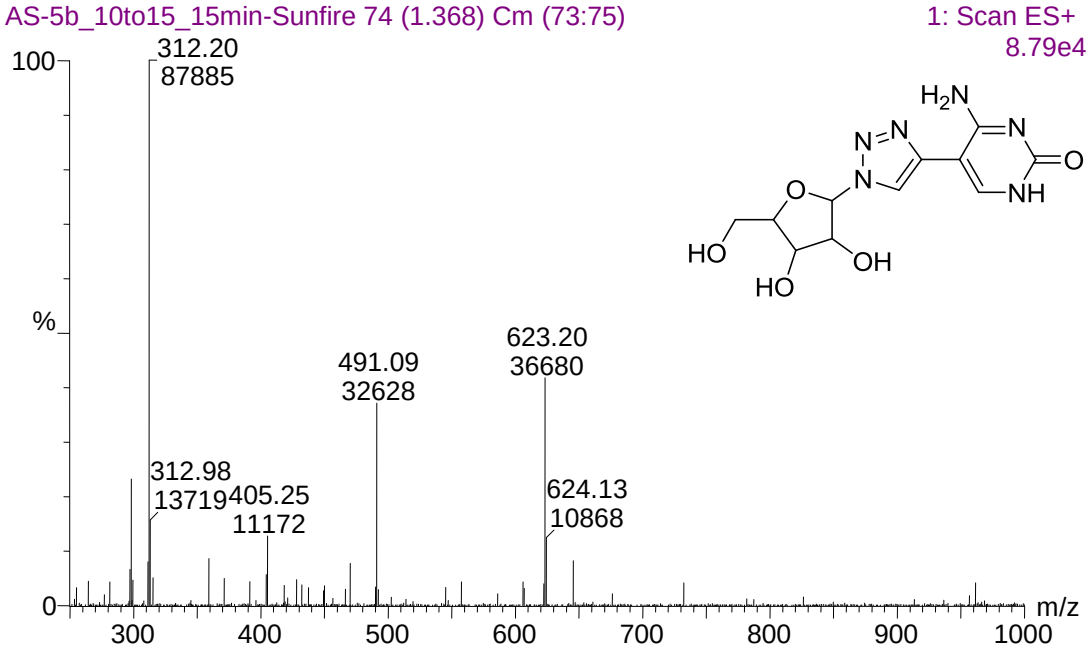
Low Resolution ESI-MS of **5a**



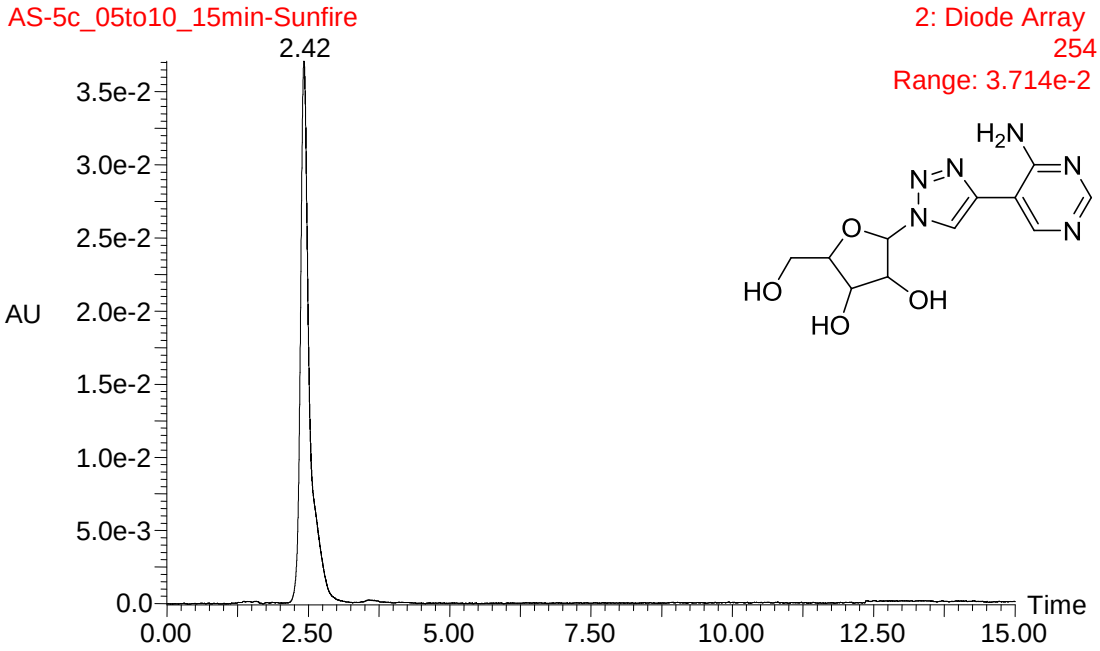
RP-HPLC of **5b** (Gradient 2)



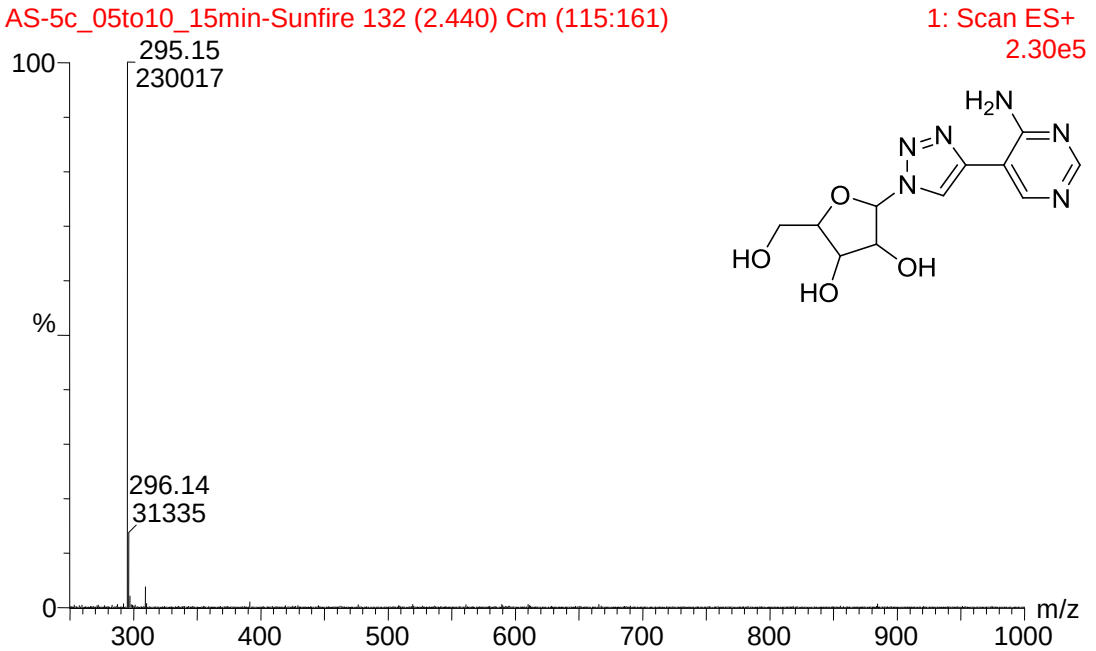
Low Resolution ESI-MS of **5b**



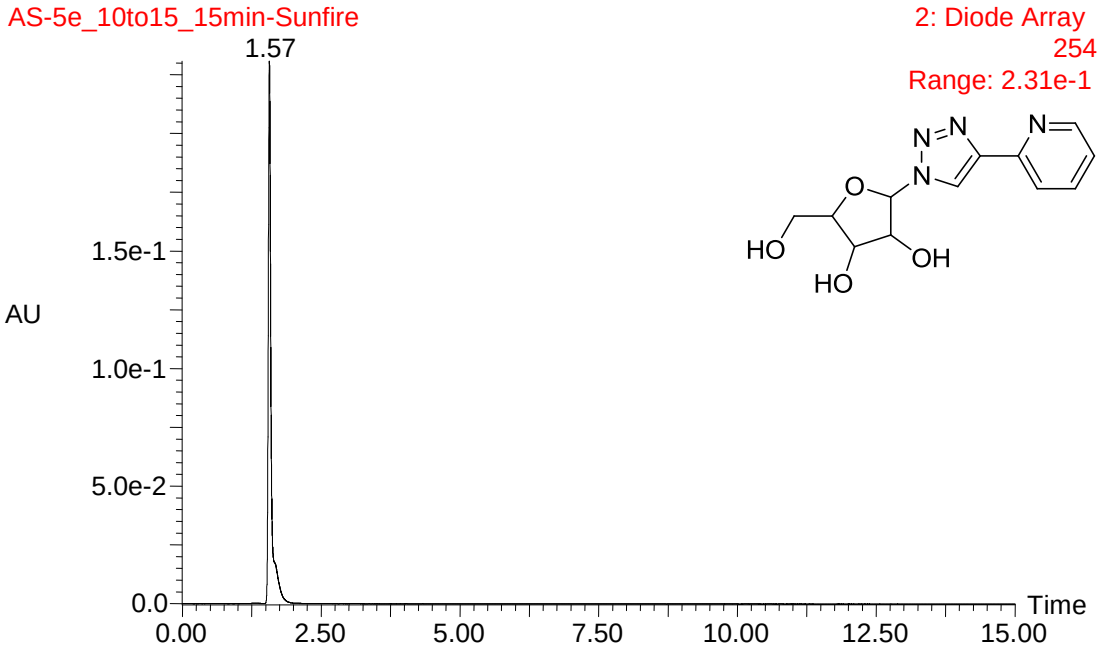
RP-HPLC of **5c** (Gradient 1)



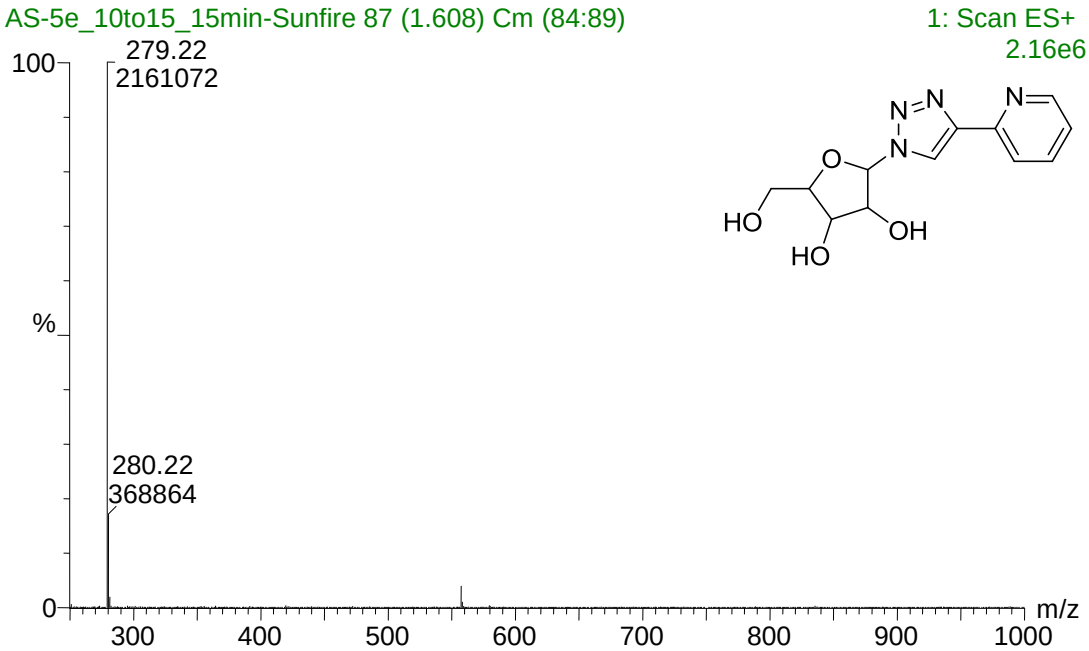
Low Resolution ESI-MS of **5c**



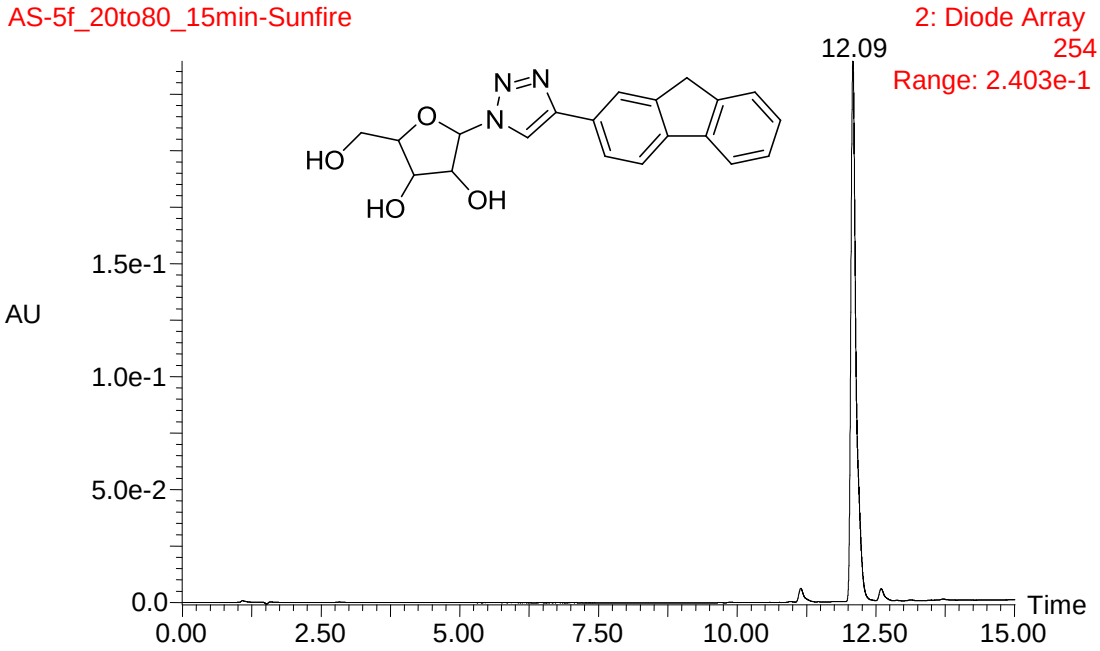
RP-HPLC of **5e** (Gradient 2)



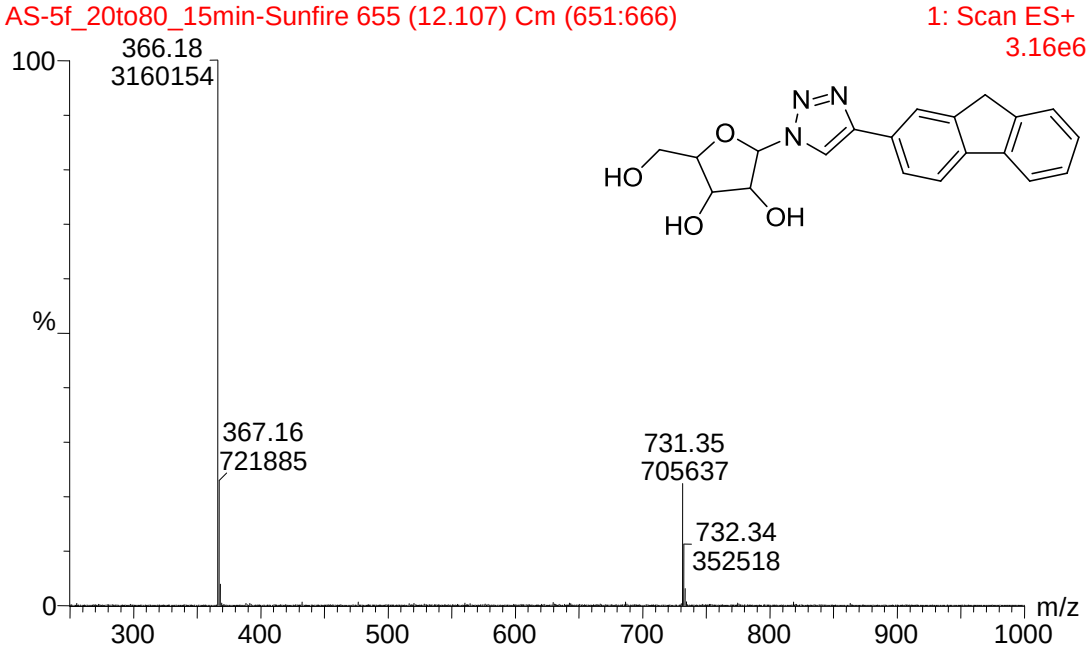
Low Resolution ESI-MS of **5e**



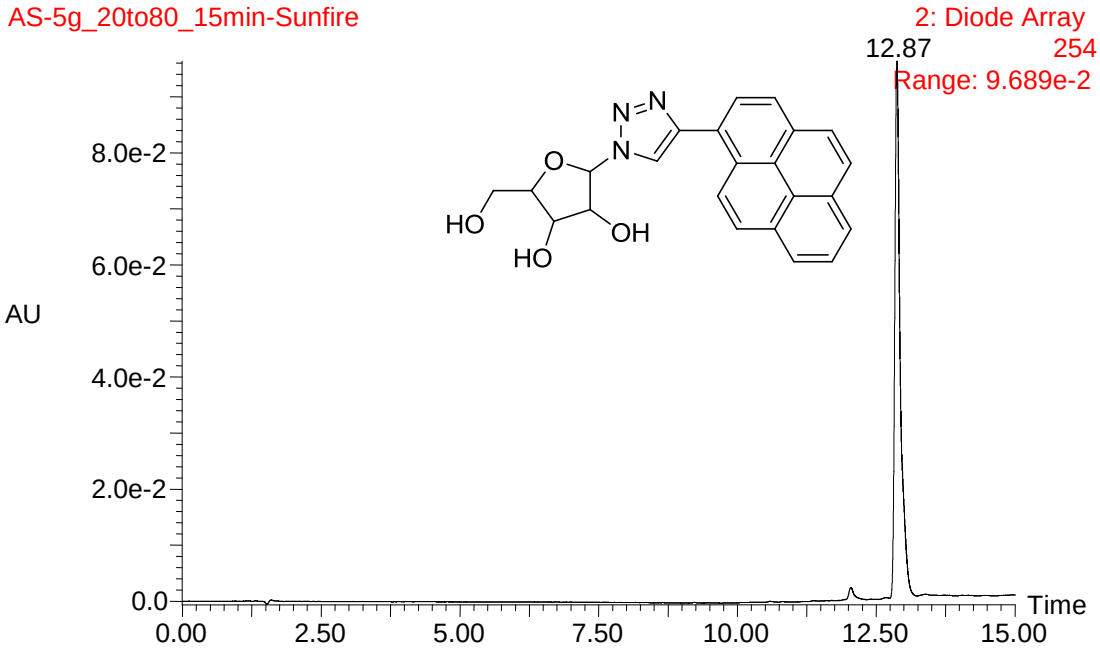
RP-HPLC of **5f** (Gradient 3)



Low Resolution ESI-MS of **5f**



RP-HPLC of **5g** (Gradient 3)



Low Resolution ESI-MS of **5g**