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X-ray crystallographic analysis for 3

N-{N'-[N"(thymin-1-ylacetyl)-2-aminoethyl]-glycil-2-aminoethyl}-N-(4-thiothymin-1-ylacetyl)-glycine

Crystal data : $C_{22}\ H_{30}\ N_8\ O_8, 2H_2\ O$, M_w = 602.62, colorless crystal of 0.06 x 0.30 x 0.30 mm, monoclinic, space group C c, Z = 4, a = 7.634 (2), b = 22.258 (4), c = 17.021 (3) Å, β = 97.52 (3), V= 2867 (1) $Å^3$, d_{calc} = 1.40 g cm^{-3}, F(000) = 1272, λ (Cu Kα) = 1.5418 Å, μ = 1.54 mm^{-1}.

Intensity data were measured on a Enraf-Nonius CAD-4 diffractometer using graphite-monochromated Cu Kα radiation and the (θ-2θ) scan technique up to θ = 66°. Of the 4835 collected reflexions ($-8 \le h \le 8$, $-26 \le k \le 26$, $0 \le l \le 20$), 2534 were unique (R_{int} = 0.057) of which 2479 were considered as observed having $I \ge 3\ \sigma(I)$. Cell parameters were refined from 25 well centered reflexions with $13.1 \le \theta \le 20.6°$. The structure was solved by direct methods using *SHELXS*86 [1] and refined by full-matrix least-squares with *SHELX*76 [2], minimizing the function $\sum w(Fo-|Fc|)^2$. Two water molecules were found on difference Fourier maps. The coordinates of the hydrogen atoms, located in difference Fourier maps, were refined. They were assigned an isotropic thermal factor equivalent to that of the bonded carbon atom, plus 10%. One hydrogen atom of the water molecules W40 was not located on diffrence map it was set in theoretical position according to the probable hydrogen bond W40-H...O5 . Convergence was reached at R = 0.037 and R_w = 0.049 (with $R_w = [\sum w(Fo-|Fc|)^2 / \sum wFo^2]^{1/2}$ and $w = 1/[\sigma^2(Fo) + 0.0002Fo^2]$. The residual electron density in the final difference map was located between -0.35 and 0.22 e $Å^3$. Each molecule of compound **3** crystallizes with two molecules of water (W40 and W41), hydrogen-bonded to 3 .

Intramolecular hydrogen bonds :

N4'B-Hx	....	O7'B	2.733 (3)
W40-H	.....	O2	2.721 (4)
W41-H	.....	O6"	2.776 (4)

Intermolecular hydrogen bonds

N3-H	....	W41	(1/2 + X, - 1/2 - Y , 1/2 + Z)	2.767 (5)
N1'H	....	O4B	(-1/2 +X, Y - 1/2 , Z)	2.803 (4)
N4'B-Hy	....	O6'	(-1/2 +X, -1/2-Y, -1/2+ Z)	2.679 (3)
N1'B -H	....	O6'	(1/2 + X, -1/2 - Y, -1/2 + Z)	2.876(3)
N3B-H	....	W40	(X, -Y, -1/2 + Z)	2.799(4)

W40-H	....	S4	(X, -Y, 1/2 + Z)	3.383 (3)
W41-H	....	O2B	(1/2 + X, -1/2 - Y, 1/2 + Z)	2.891 (5)

(1) Sheldrick, G.M. (1986).SHELXS86. Program for the solution of crystal structures. Univ. of Göttingen, Germany.
(2) Sheldrick, G. M. (1976). SHELX76. Program for crystal structure determination. Univ. of Cambridge, England.

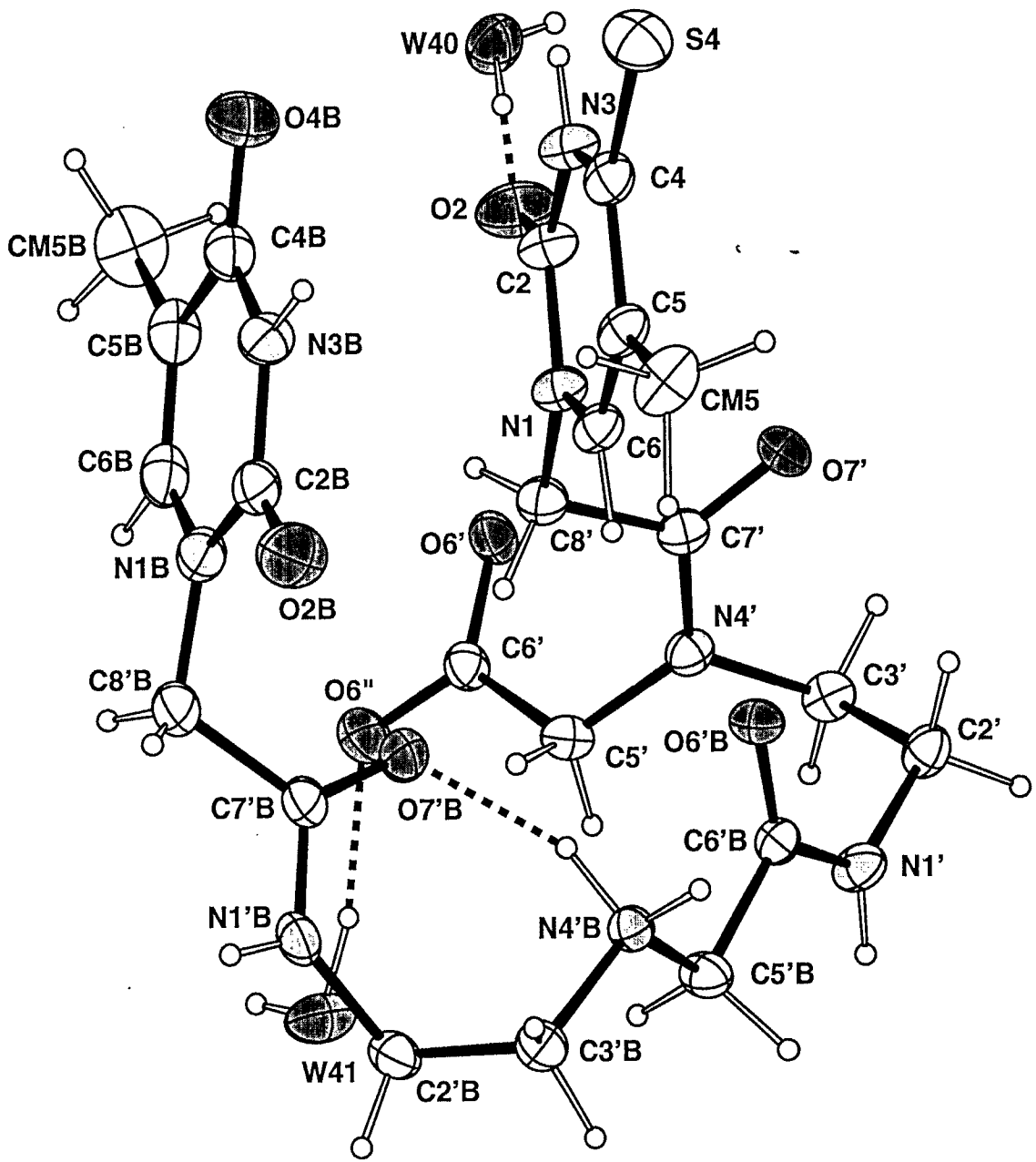

W40
S4
N3
O4B
C4
O2
CM5B
C4B
C2
C5
C5B
N3B
CM5
N1
C6
C6B
O7'
C2B
C8'
C7'
O6'
N1B
O2B
N4'
C6'
C8'B
O6"
C3'
C2'
O6'B
C5'
C7'B
O7'B
C6'B
N1'
N1'B
N4'B
C5'B
C3'B
W41
C2'B

Table 1 : Fractional atomic coordinates (10**4) and equivalent isotropic displacement parameters (*10**3)

	X	Y	Z	U
S4	4337 (0)	539 (0)	4485 (0)	61 (1)
C4	5105 (4)	-142 (1)	4786 (2)	40 (3)
N3	5764 (4)	-240 (1)	5559 (2)	44 (3)
C2	6372 (5)	-773 (1)	5887 (2)	42 (3)
O2	6906 (4)	-830 (1)	6592 (1)	64 (3)
N1	6398 (4)	-1240 (1)	5364 (2)	38 (2)
C6	5762 (4)	-1170 (1)	4576 (2)	38 (3)
C5	5121 (4)	-649 (1)	4269 (2)	40 (3)
CM5	4430 (6)	-603 (2)	3402 (2)	58 (4)
C8'	6982 (4)	-1832 (1)	5663 (2)	39 (3)
C7'	5415 (4)	-2187 (1)	5906 (2)	34 (2)
O7'	4013 (3)	-1936 (1)	5963 (1)	41 (2)
N4'	5668 (3)	-2778 (1)	6024 (1)	35 (2)
C5'	7389 (4)	-3066 (1)	6057 (2)	37 (3)
C6'	8691 (4)	-2915 (1)	6793 (2)	35 (2)
O6'	8208 (3)	-2526 (1)	7266 (1)	42 (2)
O6"	10143 (3)	-3158 (1)	6852 (2)	59 (3)
C3'	4125 (4)	-3149 (1)	6144 (2)	39 (3)
C2'	2836 (4)	-3210 (1)	5385 (2)	39 (3)
N1'	3715 (4)	-3433 (1)	4732 (2)	40 (2)
C6'B	4481 (4)	-3070 (1)	4256 (2)	31 (2)
O6'B	4444 (3)	-2523 (1)	4275 (1)	39 (2)
C5'B	5463 (5)	-3384 (1)	3656 (2)	40 (3)
N4'B	6092 (3)	-2920 (1)	3139 (1)	32 (2)
C3'B	7271 (4)	-3153 (2)	2574 (2)	41 (3)
C2'B	9183 (4)	-3196 (1)	2939 (2)	42 (3)
N1'B	10102 (4)	-2626 (1)	3036 (2)	41 (2)
C7'B	9888 (4)	-2226 (1)	3593 (2)	41 (3)
O7'B	8730 (3)	-2266 (1)	4034 (2)	52 (2)
C8'B	11233 (5)	-1728 (2)	3691 (4)	63 (5)
N1B	10690 (4)	-1200 (1)	4080 (2)	52 (3)
C2B	9700 (4)	-785 (2)	3614 (2)	49 (3)
O2B	9202 (4)	-869 (2)	2913 (2)	74 (3)
N3B	9359 (4)	-268 (1)	3999 (2)	43 (2)
C4B	9865 (4)	-129 (1)	4790 (2)	45 (3)
O4B	9481 (4)	353 (1)	5055 (2)	62 (3)
C5B	10875 (5)	-595 (2)	5245 (2)	49 (3)
CM5B	11488 (8)	-475 (3)	6108 (3)	75 (5)
C6B	11213 (4)	-1097 (2)	4874 (3)	50 (3)
W40	7316 (4)	-635 (1)	8183 (2)	52 (2)
W41	11308 (5)	-4325 (1)	6663 (2)	60 (3)

Table 2: Fractional atomic coordinates (10**3)

	X	Y	Z	U
HN3	580 (5)	6 (2)	588 (2)	48
HC6	574 (5)	-154 (2)	428 (2)	42
HM5x	460 (6)	-105 (2)	307 (3)	64
HM5y	314 (6)	-50 (2)	335 (3)	64
HM5z	525 (6)	-34 (2)	315 (3)	64
H8'x	786 (5)	-177 (2)	608 (2)	43
H8'y	752 (5)	-203 (2)	521 (2)	43
H5'x	731 (5)	-349 (2)	608 (2)	41
H5'y	793 (5)	-299 (2)	564 (2)	41
H3'x	344 (5)	-291 (2)	651 (2)	42
H3'y	461 (5)	-354 (2)	631 (2)	42
H2'x	181 (5)	-347 (2)	544 (2)	43
H2'y	231 (5)	-278 (2)	527 (2)	43
HN1'	384 (5)	-382 (2)	471 (2)	44
H5'B	648 (5)	-359 (2)	389 (2)	44
H5'B	452 (5)	-365 (2)	328 (2)	44
HN4'	679 (5)	-261 (2)	344 (2)	35
HN4'	508 (5)	-272 (2)	289 (2)	35
H3'Bx	718 (5)	-292 (2)	217 (3)	46
H3'By	680 (5)	-357 (2)	244 (2)	46
H2'Bx	927 (5)	-342 (2)	342 (3)	46
H2'By	967 (5)	-343 (2)	253 (2)	46
HN1'B	1091 (6)	-258 (2)	288 (3)	45
H8'Bx	1219 (7)	-183 (2)	400 (3)	70
H8'By	1145 (7)	-171 (3)	325 (3)	70
HN3B	872 (5)	0 (2)	375 (3)	48
HM5Bx	1199 (7)	-7 (3)	618 (3)	82
HM5By	1050 (8)	-53 (2)	647 (3)	82
HM5Bz	1249 (7)	-78 (2)	634 (3)	82
HC6B	1198 (6)	-143 (2)	518 (2)	55
HW41x	1073 (6)	-390 (2)	669 (3)	66
HW41y	1215 (7)	-430 (2)	692 (3)	66
HW40x	658 (7)	-65 (2)	835 (3)	57
HW40y	716	-71	760	57

Table 2: Anisotropic displacement parameters (*10**4)

	U11	U22	U33	U23	U13	U12
S4	720 (6)	398 (4)	680 (6)	137 (4)	125 (4)	95 (4)
C4	415 (16)	339 (14)	439 (16)	56 (12)	88 (12)	-53 (11)
N3	606 (17)	294 (12)	408 (14)	-40 (10)	104 (12)	-44 (11)
C2	578 (19)	329 (14)	343 (16)	-38 (11)	69 (13)	-46 (13)
O2	1037 (23)	493 (14)	361 (13)	-50 (10)	-14 (13)	13 (13)
N1	495 (15)	286 (11)	336 (12)	-5 (9)	79 (10)	-38 (10)
C6	439 (16)	359 (14)	344 (14)	-25 (12)	94 (11)	-100 (12)
C5	448 (16)	360 (14)	372 (15)	22 (12)	76 (12)	-111 (12)
CM5	724 (26)	621 (22)	379 (18)	91 (15)	12 (16)	-198 (19)
C8'	401 (16)	320 (14)	436 (16)	10 (12)	44 (13)	14 (11)
C7'	417 (16)	334 (13)	245 (12)	-16 (10)	3 (10)	-5 (12)
O7'	407 (11)	384 (10)	417 (11)	22 (8)	96 (8)	98 (9)
N4'	373 (13)	299 (11)	356 (12)	12 (9)	2 (10)	-12 (9)
C5'	437 (17)	321 (14)	348 (14)	-26 (11)	35 (12)	52 (12)
C6'	307 (14)	339 (13)	380 (14)	29 (11)	23 (11)	33 (11)
O6'	336 (10)	546 (12)	363 (11)	-85 (9)	21 (8)	54 (9)
O6"	388 (12)	565 (15)	780 (17)	-149 (12)	-49 (12)	133 (10)
C3'	460 (17)	367 (15)	320 (14)	19 (11)	68 (12)	-38 (13)
C2'	401 (16)	425 (16)	345 (15)	-19 (11)	76 (12)	-107 (13)
N1'	489 (15)	328 (12)	364 (13)	-27 (10)	136 (10)	-109 (10)
C6'B	313 (13)	317 (13)	296 (13)	-5 (10)	20 (10)	-18 (10)
O6'B	476 (12)	302 (10)	367 (10)	0 (7)	105 (8)	24 (8)
C5'B	466 (17)	281 (13)	452 (16)	10 (12)	170 (14)	4 (12)
N4'B	341 (12)	308 (11)	297 (11)	-8 (9)	73 (9)	-13 (10)
C3'B	432 (18)	463 (16)	339 (15)	-66 (13)	142 (12)	-31 (13)
C2'B	426 (17)	324 (14)	496 (18)	18 (13)	162 (13)	54 (11)
N1'B	303 (13)	376 (13)	543 (15)	48 (11)	162 (11)	30 (10)
C7'B	293 (15)	349 (14)	566 (18)	5 (13)	52 (13)	47 (11)
O7'B	403 (12)	556 (14)	583 (14)	-188 (11)	151 (11)	-82 (10)
C8'B	350 (19)	360 (16)	1173 (38)	-70 (21)	157 (21)	6 (14)
N1B	346 (14)	332 (13)	847 (22)	4 (14)	-14 (13)	21 (10)
C2B	323 (15)	399 (16)	725 (24)	-29 (15)	-33 (15)	41 (12)
O2B	666 (18)	830 (20)	698 (18)	-233 (16)	-179 (14)	138 (15)
N3B	424 (14)	322 (12)	538 (16)	48 (11)	-71 (12)	77 (11)
C4B	380 (16)	392 (17)	561 (19)	91 (14)	60 (13)	17 (12)
O4B	757 (17)	423 (13)	655 (16)	9 (12)	64 (13)	152 (12)
C5B	404 (17)	488 (18)	568 (20)	183 (15)	22 (15)	5 (14)
CM5B	779 (31)	924 (34)	518 (23)	170 (23)	21 (21)	72 (26)
C6B	335 (16)	371 (16)	785 (24)	193 (15)	6 (15)	19 (12)
W40	509 (15)	557 (14)	476 (14)	-77 (11)	3 (11)	-65 (12)
W41	797 (19)	438 (13)	548 (16)	-136 (11)	-24 (13)	30 (13)

Table 4: Bond distances (Angstroem)

S4	- C4	1.680 (3)	N1'	- C6'B	1.332 (4)
C4	- N3	1.363 (4)	C6'B	- O6'B	1.219 (3)
C4	- C5	1.434 (4)	C6'B	- C5'B	1.513 (4)
N3	- C2	1.367 (4)	C5'B	- N4'B	1.477 (4)
C2	- O2	1.222 (4)	N4'B	- C3'B	1.494 (4)
C2	- N1	1.369 (4)	C3'B	- C2'B	1.513 (5)
N1	- C6	1.374 (4)	C2'B	- N1'B	1.448 (4)
N1	- C8'	1.461 (4)	N1'B	- C7'B	1.325 (4)
C6	- C5	1.338 (4)	C7'B	- O7'B	1.236 (4)
C5	- CM5	1.503 (5)	C7'B	- C8'B	1.505 (5)
C8'	- C7'	1.534 (4)	C8'B	- N1B	1.437 (5)
C7'	- O7'	1.222 (4)	N1B	- C2B	1.377 (5)
C7'	- N4'	1.340 (3)	N1B	- C6B	1.377 (5)
N4'	- C5'	1.457 (4)	C2B	- O2B	1.219 (5)
N4'	- C3'	1.475 (4)	C2B	- N3B	1.366 (4)
C5'	- C6'	1.531 (4)	N3B	- C4B	1.386 (5)
C6'	- O6'	1.269 (4)	C4B	- O4B	1.214 (4)
C6'	- O6"	1.227 (4)	C4B	- C5B	1.455 (5)
C3'	- C2'	1.524 (4)	C5B	- CM5B	1.506 (6)
C2'	- N1'	1.459 (4)	C5B	- C6B	1.326 (5)

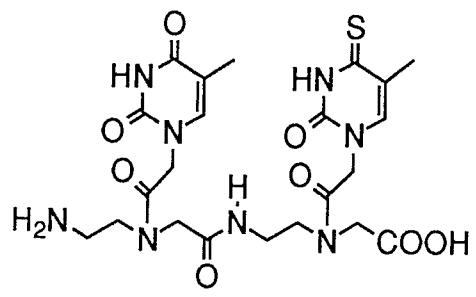
Table 5: Bond angles (degree)

S4	- C4 - N3	120.7 (2)	S4	- C4 - C5	123.6 (2)
N3	- C4 - C5	115.7 (3)	C4	- N3 - C2	126.7 (3)
N3	- C2 - O2	122.9 (3)	N3	- C2 - N1	115.2 (3)
O2	- C2 - N1	121.9 (3)	C2	- N1 - C6	121.0 (3)
C2	- N1 - C8'	119.2 (3)	C6	- N1 - C8'	119.6 (3)
N1	- C6 - C5	123.0 (3)	C4	- C5 - C6	118.3 (3)
C4	- C5 - CM5	121.2 (3)	C6	- C5 - CM5	120.5 (3)
N1	- C8' - C7'	110.2 (2)	C8'	- C7' - O7'	120.5 (3)
C8'	- C7' - N4'	116.3 (2)	O7'	- C7' - N4'	123.1 (3)
C7'	- N4' - C5'	123.3 (2)	C7'	- N4' - C3'	118.0 (2)
C5'	- N4' - C3'	118.7 (2)	N4'	- C5' - C6'	114.8 (2)
C5'	- C6' - O6'	117.3 (3)	C5'	- C6' - O6"	116.9 (3)
O6'	- C6' - O6"	125.7 (3)	N4'	- C3' - C2'	111.8 (2)
C3'	- C2' - N1'	111.5 (2)	C2'	- N1' - C6'B	122.6 (3)
N1'	- C6'B - O6'B	125.2 (3)	N1'	- C6'B - C5'B	115.2 (2)
O6'B	- C6'B - C5'B	119.6 (3)	C6'B	- C5'B - N4'B	108.0 (2)
C5'B	- N4'B - C3'B	114.3 (2)	N4'B	- C3'B - C2'B	112.8 (3)
C3'B	- C2'B - N1'B	114.8 (3)	C2'B	- N1'B - C7'B	124.5 (3)
N1'B	- C7'B - O7'B	123.4 (3)	N1'B	- C7'B - C8'B	115.3 (3)
O7'B	- C7'B - C8'B	121.1 (3)	C7'B	- C8'B - N1B	114.9 (4)
C8'B	- N1B - C2B	117.0 (3)	C8'B	- N1B - C6B	121.5 (3)
C2B	- N1B - C6B	121.4 (3)	N1B	- C2B - O2B	122.5 (3)
N1B	- C2B - N3B	114.5 (3)	O2B	- C2B - N3B	123.0 (3)
C2B	- N3B - C4B	127.4 (3)	N3B	- C4B - O4B	120.5 (3)
N3B	- C4B - C5B	114.7 (3)	O4B	- C4B - C5B	124.8 (3)
C4B	- C5B - CM5B	117.8 (3)	C4B	- C5B - C6B	118.1 (3)
CM5B	- C5B - C6B	124.1 (4)	N1B	- C6B - C5B	123.9 (3)

Table 6: Selected torsional angles (degree)

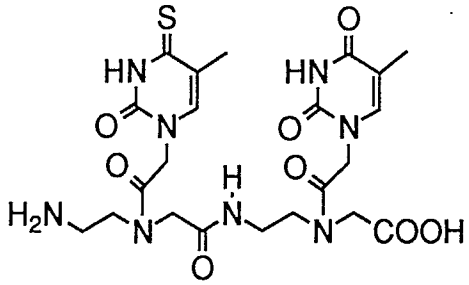
C2	N1	C8'	C7'	87.8	(0.3)
C6	N1	C8'	C7'	-87.3	(0.3)
N1	C8'	C7'	N4'	165.8	(0.3)
C8'	C7'	N4'	C5'	10.1	(0.3)
C8'	C7'	N4'	C3'	-171.3	(0.3)
C7'	N4'	C5'	C6'	70.1	(0.3)
C7'	N4'	C3'	C2'	70.2	(0.3)
N4'	C5'	C6'	O6'	-5.0	(0.3)
N4'	C5'	C6'	O6"	178.5	(0.4)
N4'	C3'	C2'	N1'	54.2	(0.3)
C5'	N4'	C3'	C2'	-111.1	(0.3)
C6'	C5'	N4'	C3'	-108.6	(0.3)
C3'	C2'	N1'	C6'B	-88.4	(0.3)
C2'	N1'	C6'B	C5'B	174.9	(0.4)
N1'	C6'B	C5'B	N4'B	175.2	(0.3)
C6'B	C5'B	N4'B	C3'B	173.2	(0.3)
C6'B	C5'B	N4'B	HN4'	54.2	(1.5)
C6'B	C5'B	N4'B	HN4'	-60.1	(1.6)
C5'B	N4'B	C3'B	C2'B	-84.8	(0.3)
C5'B	N4'B	C3'B	C2'B	-84.8	(0.3)
C5'B	N4'B	HN4'	O7'B	74.8	(2.6)
N4'B	C3'B	C2'B	N1'B	-75.0	(0.3)
C3'B	C2'B	N1'B	C7'B	75.4	(0.3)
C2'B	N1'B	C7'B	C8'B	167.9	(0.4)
N1'B	C7'B	C8'B	N1B	159.6	(0.5)
C7'B	C8'B	N1B	C6B	98.7	(0.4)
C7'B	C8'B	N1B	C2B	-84.5	(0.4)
N1'B	C7'B	O7'B	N4'B	-27.2	(0.2)
N1'B	C7'B	O7'B	HN4'	-34.6	(1.3)

^{1}H NMR spectrum (250 MHz; D_2O) of **1**



1

^{1}H NMR spectrum (300 MHz; D_2O) of **2**



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