Synthesis of 2(5*H*)-Furanone Derivatives with Symmetrical and Unsymmetrical Bis-1,2,3-triazole Structure

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SUPPORTING INFORMATION

Full experimental detail

(Characterization spectra of 32 new compounds 2a-2h, 3a-3h, 5aa-5bh. For each compound, the former is ¹H NMR, and the latter is ¹³C NMR.)

EXPERIMENTAL

General

Melting points were determined on an X-5 digital melting points apparatus and were uncorrected. Infrared spectra were recorded on a Bruker Vector 33 FT-IR instrument by liquid film method in the absorption range of 4000-400 cm^{-1} . ^1H and ^{13}C NMR spectra were obtained in CDCl_3 on a Varian DRX-400 MHz spectrometer and tetramethylsilane (TMS) was used as an internal standard. UV absorption peaks were measured by Shimadzu UV-2550 ultraviolet absorption detector with dichloromethane as a solvent. Optical rotations were determined with an Autopol IV polarimeter in CH_2Cl_2 in a 10 cm cell. Elemental analysis was performed on a Thermo Flash EA 1112 elemental analyzer. The mass spectra (MS) were recorded on Thermo LCQ DECA XP MAX mass spectrometer.

All reagents and solvents were commercially available and used as received. The intermediates *N*-[(5*S*)-5-alkoxy-2(5*H*)-furanonyl] amino acid propargyl esters **1** were prepared according to the literature.^[31]

General procedure for the synthesis of target compounds 2

A flame-dried flask was charged with 1 mmol *N*-[(5*S*)-5-alkoxy-2(5*H*)-furanonyl] amino acid propargyl esters **1**, 0.5 mmol 1,4-diazidobutane,^[42] 0.05 mmol $\text{Cu}(\text{OAc})_2 \cdot \text{H}_2\text{O}$ and 0.1 mmol Cu in CH_3CN (5 mL). The mixture was stirred at room temperature under N_2 atmosphere and monitored by TLC. Once the reaction was completed (about 16 h), the reaction mixture was quenched with a saturated aqueous solution of NH_4Cl (20 mL) and extracted with ethyl acetate (3×30 mL). The organic layer was dried over MgSO_4 , and concentrated *in vacuo*. The residue was purified by column chromatography using the mixture of petroleum ether and ethyl acetate as eluent to yield the desired compounds **2a-2h** in 41-56% isolated yields.

(*S,R,R,S,2S,2'S*)-(1,1'-(butane-1,4-diyl)bis(1*H*-1,2,3-triazole-4,1-diyl))bis(methylene) bis(2-((*S*)-4-bromo-2-((1*R,2S,5R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydrofuran-3-ylamino)-3-methylbutanoate) (2a). Yellowish oil, yield 254 mg (47%); $[\alpha]_{\text{D}}^{20} +112.5$ (*c* 0.027, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 270 nm; ^1H NMR (400 MHz, CDCl_3 -TMS) δ , ppm: 0.85 (d, *J* = 8.0 Hz, 6H), 0.86-1.01 (m, 26H), 1.02-1.16 (m, 4H), 1.31-1.46 (m, 4H), 1.62-1.73 (m, 4H), 1.89-2.01 (m, 4H), 2.11-2.33 (m, 6H), 3.54-3.65 (ddd, *J*₁ = 4.0 Hz, *J*₂ = 4.0 Hz, *J*₃ = 4.0 Hz, 2H), 4.37-4.50 (m, 4H), 4.80 (b, 2H), 5.26-5.39 (m, 6H), 5.76 (s, 2H), 7.75 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3 -TMS) δ , ppm: 15.7, 17.3, 18.0, 20.9, 22.1, 22.7, 25.8, 27.1, 31.5, 31.9, 33.8, 42.2, 47.9, 49.4, 58.5, 59.8, 77.4, 83.2, 99.9, 124.3, 141.8, 157.3, 167.9, 170.5; IR (neat) ν , cm^{-1} : 3379,

3143, 3082, 2951, 2923, 2868, 1745, 1649, 1523, 1460, 1317, 1193, 1133, 952, 628; ESI-MS m/z (%): 1081 ($[M+H]^+$, 44), 1103 ($[M+Na]^+$, 100); Anal. Calcd for $C_{48}H_{72}Br_2N_8O_{10}$: C 53.33, H 6.71, N 10.37, Found: C 53.29, H 6.76, N 10.32.

(*R,S,R,S,2S,2'S*)-(1,1'-(butane-1,4-diyl)bis(1*H*-1,2,3-triazole-4,1-diyl))bis(methylene) bis(2-((*S*)-4-bromo-2-((1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydrofuran-3-ylamino)-3-phenylpropanoate) (2b). Yellowish oil, yield 306 mg (52%); $[\alpha]_D^{20} +51.0$ (c 0.096, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 271 nm; 1H NMR (400 MHz, $CDCl_3$ -TMS) δ , ppm: 0.73 (d, J = 4.0 Hz, 6H), 0.76-0.93 (m, 14H), 0.94-1.10 (m, 4H), 1.27-1.43 (m, 4H), 1.57-1.72 (m, 4H), 1.83-2.19 (m, 8H), 3.04-3.26 (m, 4H), 3.37-3.51 (m, 2H), 4.32-4.50 (m, 4H), 4.84-5.52 (m, 10H), 7.00-7.14 (m, 4H), 7.19-7.35 (m, 6H), 7.63 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$ -TMS) δ , ppm: 15.6, 21.0, 22.1, 22.6, 25.5, 27.1, 31.5, 33.9, 39.8, 42.3, 47.8, 49.4, 55.8, 58.8, 77.3, 83.1, 99.8, 124.5, 127.7, 128.8, 129.4, 134.4, 141.7, 156.8, 167.6, 170.2; IR (neat) ν , cm^{-1} : 3368, 3137, 3066, 3027, 2945, 2923, 2863, 1742, 1646, 1520, 1495, 1451, 1322, 1182, 1117, 955, 744, 697, 648; ESI-MS m/z (%): 1177 ($[M+H]^+$, 30), 1199 ($[M+Na]^+$, 100); Anal. Calcd for $C_{56}H_{72}Br_2N_8O_{10}$: C 57.14, H 6.17, N 9.52, Found: C 57.19, H 6.14, N 9.60.

(*R,R,S,S*)-(1,1'-(butane-1,4-diyl)bis(1*H*-1,2,3-triazole-4,1-diyl))bis(methylene) bis(6-((*S*)-4-bromo-2-((1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydrofuran-3-ylamino)hexanoate) (2c). Yellowish oil, yield 311 mg (56%); $[\alpha]_D^{20} +84.8$ (c 0.031, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 273 nm; 1H NMR (400 MHz, $CDCl_3$ -TMS) δ , ppm: 0.80 (d, J = 8.0 Hz, 6H), 0.83-0.99 (m, 14H), 1.00-1.16 (m, 4H), 1.29-1.46 (m, 8H), 1.55-1.78 (m, 12H), 1.90-2.02 (m, 4H), 2.11-2.28 (m, 4H), 2.36 (t, J = 8.0 Hz, 4H), 3.37-3.55 (m, 4H), 3.56-3.64 (ddd, J_1 = 4.0 Hz, J_2 = 4.0 Hz, J_3 = 4.0 Hz, 2H), 4.33-4.48 (m, 4H), 5.08-5.31 (m, 6H), 5.79 (s, 2H), 7.66 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$ -TMS) δ , ppm: 15.9, 21.1, 22.1, 22.8, 24.2, 25.5, 25.7, 27.1, 30.2, 31.6, 33.7, 33.9, 42.4, 43.6, 48.1, 49.4, 57.4, 77.3, 81.8, 98.5, 123.9, 142.8, 159.8, 168.0, 173.2; IR (neat) ν , cm^{-1} : 3313, 3143, 3093, 2951, 2923, 2868, 1742, 1646, 1523, 1457, 1317, 1155, 1122, 958, 631; ESI-MS m/z (%): 1109 ($[M+H]^+$, 40), 1131 ($[M+Na]^+$, 100); Anal. Calcd for $C_{50}H_{76}Br_2N_8O_{10}$: C 54.15, H 6.91, N 10.10, Found: C 54.12, H 6.99, N 10.14.

(*R,S,R,S*)-(1,1'-(butane-1,4-diyl)bis(1*H*-1,2,3-triazole-4,1-diyl))bis(methylene) bis(4-((*S*)-4-bromo-2-((1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydrofuran-3-ylamino)butanoate) (2d). Yellowish oil, yield 216 mg (41%); $[\alpha]_D^{20} +50.0$ (c 0.020, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 273 nm; 1H NMR (400 MHz, $CDCl_3$ -TMS) δ , ppm: 0.79 (d, J = 8.0 Hz, 3H), 0.81-0.98 (m, 14H), 0.99-1.16 (m, 4H), 1.28-1.43 (m, 4H), 1.58-1.74 (m, 4H), 1.84-2.05 (m, 8H), 2.09-2.28 (m, 4H), 2.47 (t, J = 8.0 Hz, 4H), 3.40-3.72 (m, 6H), 4.30-4.51 (m, 4H), 5.23 (s, 4H), 5.45 (s, 2H), 5.78 (s, 2H), 7.66 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$ -TMS) δ , ppm: 15.8, 21.1, 22.2, 22.7, 25.3, 25.4, 27.1, 31.0, 31.6, 33.9, 42.4, 43.2, 48.1, 49.4, 57.8, 77.3, 81.8, 98.6, 123.9, 142.5, 159.7, 167.9, 172.9; IR (neat) ν , cm^{-1} : 3319, 3137, 3088, 2956, 2929, 2868, 1742, 1646, 1547, 1457, 1322, 1163, 1125, 952, 628; ESI-MS m/z (%): 1053 ($[M+H]^+$, 55), 1075 ($[M+Na]^+$, 100); Anal. Calcd for $C_{46}H_{68}Br_2N_8O_{10}$: C 52.47, H 6.51, N 10.64, Found: C 52.50, H 6.57, N 10.60.

(*S,S,R,S,2S,2'S*)-(1,1'-(butane-1,4-diyl)bis(1*H*-1,2,3-triazole-4,1-diyl))bis(methylene) bis(2-((*S*)-4-bromo-5-oxo-2-((1*S,2R,4S*)-1,7,7-trimethylbi-cyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)-3-methylbutanoate) (2e). Yellowish oil, yield 288 mg (49%); $[\alpha]_{\text{D}}^{20} +77.6$ (*c* 0.077, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 270 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.68-1.10 (m, 30H), 1.12-1.35 (m, 8H), 1.66-1.82 (m, 4H), 1.89-2.03 (m, 4H), 2.19-2.32 (m, 4H), 3.98 (d, *J* = 8.0 Hz, 2H), 4.36-4.48 (m, 4H), 4.75 (b, 2H), 5.23-5.42 (m, 6H), 5.72 (s, 2H), 7.71 (s, 2H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 13.9, 17.3, 18.4, 18.8, 19.6, 26.5, 27.1, 27.9, 32.0, 37.0, 44.8, 47.6, 49.4, 49.5, 58.5, 60.4, 77.3, 88.1, 99.8, 124.2, 141.9, 157.9, 167.6, 170.6; IR (neat) ν , cm⁻¹: 3299, 3138, 3071, 2956, 2929, 2874, 1742, 1651, 1534, 1456, 1329, 1194, 1135, 956, 647; ESI-MS *m/z* (%): 1077 ([*M*+*H*]⁺, 48), 1099 ([*M*+*Na*]⁺, 100); Anal. Calcd for C₄₈H₆₈Br₂N₈O₁₀: C 53.53, H 6.36, N 10.41, Found: C 53.56, H 6.40, N 10.38.

(*S,S,R,S,2S,2'S*)-(1,1'-(butane-1,4-diyl)bis(1*H*-1,2,3-triazole-4,1-diyl))bis(methylene) bis(2-((*S*)-4-bromo-5-oxo-2-((1*S,2R,4S*)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)-3-phenylpropanoate) (2f). Yellowish oil, yield 246 mg (42%); $[\alpha]_{\text{D}}^{20} +77.7$ (*c* 0.026, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 271 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.70-0.97 (m, 18H), 1.14-1.29 (m, 8H), 1.62-1.73 (m, 4H), 1.88-2.01 (m, 4H), 2.10-2.23 (m, 2H), 2.97-3.26 (m, 4H), 3.73-3.90 (m, 2H), 4.33-4.48 (m, 4H), 4.86 (b, 2H), 5.11-5.53 (m, 8H), 7.03-7.16 (m, 4H), 7.24-7.31 (m, 6H), 7.61 (s, 2H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 14.0, 18.8, 19.6, 26.5, 27.1, 27.9, 36.9, 39.4, 44.8, 47.6, 49.4, 49.4, 56.8, 58.8, 77.3, 88.1, 99.4, 124.5, 127.8, 129.0, 129.4, 134.1, 141.8, 156.7, 167.4, 170.3; IR (neat) ν , cm⁻¹: 3380, 3137, 3060, 3027, 2952, 2926, 2874, 1747, 1646, 1520, 1497, 1455, 1323, 1178, 1130, 956, 743, 702, 647; ESI-MS *m/z* (%): 1173 ([*M*+*H*]⁺, 25), 1195 ([*M*+*Na*]⁺, 100); Anal. Calcd for C₅₆H₆₈Br₂N₈O₁₀: C 57.34, H 5.84, N 9.55, Found: C 57.37, H 5.80, N 9.53.

(*S,S,R,S*)-(1,1'-(butane-1,4-diyl)bis(1*H*-1,2,3-triazole-4,1-diyl))bis(methylene) bis(6-((*S*)-4-bromo-5-oxo-2-((1*S,2R,4S*)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yl-oxy)-2,5-dihydrofuran-3-ylamino)hexanoate) (2g). Yellowish oil, yield 238 mg (43%); $[\alpha]_{\text{D}}^{20} +45.0$ (*c* 0.027, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 273 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.86 (s, 12H), 0.89 (s, 6H), 1.19-1.30 (m, 8H), 1.35-1.45 (m, 4H), 1.63-1.87 (m, 12H), 1.91-2.00 (m, 4H), 2.19-2.29 (m, 2H), 2.36 (t, *J* = 8.0 Hz, 4H), 3.37-3.56 (m, 4H), 3.99 (d, *J* = 8.0 Hz, 2H), 4.35-4.46 (m, 4H), 5.20 (s, 4H), 5.30-5.39 (m, 2H), 5.77 (s, 2H), 7.64 (s, 2H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 14.0, 18.8, 19.6, 24.2, 25.8, 26.6, 27.1, 28.0, 30.2, 33.7, 37.1, 44.0, 44.8, 47.6, 49.4, 49.4, 57.4, 77.3, 87.5, 99.1, 123.8, 142.9, 159.9, 167.9, 173.2; IR (neat) ν , cm⁻¹: 3288, 3137, 3088, 2953, 2874, 1744, 1646, 1542, 1454, 1321, 1150, 1132, 956, 625; ESI-MS *m/z* (%): 1105 ([*M*+*H*]⁺, 65), 1127 ([*M*+*Na*]⁺, 100); Anal. Calcd for C₅₀H₇₂Br₂N₈O₁₀: C 54.35, H 6.57, N 10.14, Found: C 54.31, H 6.60, N 10.18.

(*S,S,R,S*)-(1,1'-(butane-1,4-diyl)bis(1*H*-1,2,3-triazole-4,1-diyl))bis(methylene) bis(4-((*S*)-4-bromo-5-oxo-2-((1*S,2R,4S*)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yl-oxy)-2,5-dihydrofuran-3-ylamino)butanoate) (2h). Yellowish oil, yield 241 mg (46%); $[\alpha]_{\text{D}}^{20} +98.6$ (*c* 0.014, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 273 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.86 (s, 12H), 0.88 (s, 6H), 1.20-1.29 (m, 8H), 1.65-1.85 (m, 4H), 1.92-2.03 (m, 8H), 2.20-2.30 (m, 2H), 2.41-2.55 (m, 4H), 3.44- 3.62 (m, 4H), 3.99 (d,

$J = 8.0$ Hz, 2H), 4.32-4.45 (m, 4H), 5.17-5.31 (m, 4H), 5.54-5.64 (m, 2H), 5.75 (s, 2H), 7.65 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3 -TMS) δ , ppm: 14.0, 18.8, 19.6, 25.2, 26.6, 27.1, 28.0, 31.2, 37.1, 43.5, 44.8, 47.6, 49.4, 57.8, 77.3, 87.6, 99.1, 123.9, 142.6, 160.0, 167.7, 173.0; IR (neat) ν , cm^{-1} : 3290, 3136, 2953, 2926, 2874, 1740, 1645, 1561, 1457, 1322, 1165, 1131, 954, 647; ESI-MS m/z (%): 1049 ($[\text{M}+\text{H}]^+$, 58), 1071 ($[\text{M}+\text{Na}]^+$, 100); Anal. Calcd for $\text{C}_{46}\text{H}_{64}\text{Br}_2\text{N}_8\text{O}_{10}$: C 52.68, H 6.15, N 10.68, Found: C 52.70, H 6.12, N 10.71.

General procedure for the synthesis of intermediates 3

A flame-dried flask was charged with 1 mmol *N*-[(5*S*)-5-alkoxy-2(5*H*)-furanonyl] amino acid propargyl ester **1**, 2 mmol 1,4-diazidobutane, 0.05 mmol $\text{Cu}(\text{OAc})_2 \cdot \text{H}_2\text{O}$ and 0.1 mmol Cu in CH_3CN (5 mL). The resulting mixture was stirred at room temperature under N_2 atmosphere until the monitoring by TLC showed almost complete conversion of the substrate (about 12 h). Then, according to the procedure mentioned above, the reaction mixture was treated to yield the desired compounds **3a-3h** in 44-63% isolated yields.

(*S*)-(1-(4-azidobutyl)-1*H*-1,2,3-triazol-4-yl)methyl 2-((*S*)-4-bromo-2-((1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydrofuran-3-ylamino)-3-methylbutanoate (3a). Yellowish oil, yield 385 mg (63%); $[\alpha]_{\text{D}}^{20} +64.3$ (c 0.098, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 270 nm; ^1H NMR (400 MHz, CDCl_3 -TMS) δ , ppm: 0.85 (d, $J = 4.0$ Hz, 3H), 0.87-1.02 (m, 13H), 1.03-1.15 (m, 2H), 1.32-1.46 (m, 2H), 1.57-1.75 (m, 4H), 1.98-2.08 (m, 2H), 2.15-2.35 (m, 3H), 3.36 (t, $J = 8.0$ Hz, 2H), 3.56-3.66 (ddd, $J_1 = 4.0$ Hz, $J_2 = 4.0$ Hz, $J_3 = 4.0$ Hz, 1H), 4.46 (t, $J = 8.0$ Hz, 2H), 4.82 (b, 1H), 5.29-5.46 (m, 3H), 5.79 (s, 1H), 7.80 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3 -TMS) δ , ppm: 15.6, 17.2, 17.8, 20.8, 22.0, 22.6, 25.7, 27.4, 31.4, 32.1, 33.8, 42.2, 47.8, 49.7, 50.5, 58.5, 59.7, 77.5, 83.1, 100.0, 124.1, 141.7, 157.0, 167.7, 170.3; IR (neat) ν , cm^{-1} : 3383, 3145, 3082, 2956, 2928, 2871, 2097, 1744, 1651, 1528, 1456, 1316, 1195, 1134, 956, 632; ESI-MS m/z (%): 612 ($[\text{M}+\text{H}]^+$, 67), 634 ($[\text{M}+\text{Na}]^+$, 100); Anal. Calcd for $\text{C}_{26}\text{H}_{40}\text{BrN}_7\text{O}_5$: 51.15, H 6.60, N 16.06, Found: C 51.20, H 6.62, N 16.02.

(*S*)-(1-(4-azidobutyl)-1*H*-1,2,3-triazol-4-yl)methyl 2-((*S*)-4-bromo-2-((1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydrofuran-3-ylamino)-3-phenylpropanoate (3b). Yellowish oil, yield 356 mg (54%); $[\alpha]_{\text{D}}^{20} +53.5$ (c 0.114, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 271 nm; ^1H NMR (400 MHz, CDCl_3 -TMS) δ , ppm: 0.72 (d, $J = 8.0$ Hz, 3H), 0.75-0.92 (m, 7H), 0.93-1.09 (m, 2H), 1.25-1.40 (m, 2H), 1.54-1.73 (m, 4H), 1.83-2.21 (m, 4H), 3.06-3.27 (m, 2H), 3.35 (t, $J = 8.0$ Hz, 2H), 3.39-3.52 (m, 1H), 4.42 (t, $J = 8.0$ Hz, 2H), 4.81 (b, 1H), 5.19-5.62 (m, 4H), 7.00-7.14 (m, 2H), 7.15-7.33 (m, 3H), 7.65 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3 -TMS) δ , ppm: 15.5, 21.0, 22.1, 22.6, 25.4, 25.8, 27.5, 31.5, 33.8, 39.9, 42.2, 47.8, 49.8, 50.6, 56.4, 58.9, 77.5, 83.2, 99.2, 124.3, 127.6, 128.7, 129.5, 134.3, 141.6, 156.7, 167.5, 170.1; IR (neat) ν , cm^{-1} : 3376, 3137,

3055, 3022, 2955, 2927, 2869, 2097, 1749, 1651, 1522, 1495, 1455, 1324, 1183, 1114, 957, 747, 704, 632; ESI-MS m/z (%): 660 ($[M+H]^+$, 59), 682 ($[M+Na]^+$, 100); Anal. Calcd for $C_{30}H_{40}BrN_7O_5$: C 54.71, H 6.12, N 14.89, Found: C 54.68, H 6.10, N 14.91.

(1-(4-azidobutyl)-1*H*-1,2,3-triazol-4-yl)methyl 6-((*S*)-4-bromo-2-((1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydrofuran-3-ylamino)hexanoate (3c). Yellowish oil, yield 368 mg (59%); $[\alpha]_D^{20} +55.6$ (c 0.083, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 273 nm; 1H NMR (400 MHz, $CDCl_3$ -TMS) δ , ppm: 0.79 (d, J = 4.0 Hz, 3H), 0.82-0.96 (m, 7H), 0.98-1.15 (m, 2H), 1.30-1.44 (m, 4H), 1.57-1.71 (m, 8H), 1.99-2.07 (m, 2H), 2.13-2.26 (m, 2H), 2.36 (t, J = 8.0 Hz, 2H), 3.35 (t, J = 8.0 Hz, 2H), 3.40-3.56 (m, 2H), 3.57-3.65 (ddd, J_1 = 4.0 Hz, J_2 = 4.0 Hz, J_3 = 4.0 Hz, 1H), 4.42 (t, J = 8.0 Hz, 2H), 5.21 (s, 2H), 5.43 (s, 1H), 5.81 (s, 1H), 7.71 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$ -TMS) δ , ppm: 15.8, 21.1, 22.1, 22.7, 24.2, 25.3, 25.7, 25.8, 27.4, 30.1, 31.5, 33.7, 33.9, 42.3, 43.6, 48.0, 49.7, 50.6, 57.4, 77.5, 81.6, 98.3, 123.8, 142.6, 159.9, 168.0, 173.1; IR (neat) ν , cm^{-1} : 3240, 3137, 3099, 2951, 2926, 2868, 2096, 1733, 1650, 1550, 1456, 1315, 1158, 1126, 937, 633; ESI-MS m/z (%): 626 ($[M+H]^+$, 45), 648 ($[M+Na]^+$, 100); Anal. Calcd for $C_{27}H_{42}BrN_7O_5$: C 51.92, H 6.78, N 15.70, Found: C 51.95, H 6.80, N 15.73.

(1-(4-azidobutyl)-1*H*-1,2,3-triazol-4-yl)methyl 4-((*S*)-4-bromo-2-((1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydrofuran-3-ylamino)butanoate (3d). Yellowish oil, yield 262 mg (44%); $[\alpha]_D^{20} +55.0$ (c 0.040, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 272 nm; 1H NMR (400 MHz, $CDCl_3$ -TMS) δ , ppm: 0.79 (d, J = 8.0 Hz, 3H), 0.82-0.97 (m, 7H), 0.98-1.13 (m, 2H), 1.29-1.43 (m, 2H), 1.57-1.70 (m, 4H), 1.93-2.06 (m, 4H), 2.10-2.27 (m, 2H), 2.46 (t, J = 8.0 Hz, 2H), 3.35 (t, J = 8.0 Hz, 2H), 3.46-3.65 (m, 3H), 4.42 (t, J = 8.0 Hz, 2H), 5.23 (s, 2H), 5.44 (s, 1H), 5.78 (s, 1H), 7.67 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$ -TMS) δ , ppm: 15.8, 21.1, 22.1, 22.7, 25.3, 25.4, 25.8, 27.5, 31.0, 31.6, 33.9, 42.4, 43.1, 48.1, 49.8, 50.6, 57.8, 77.4, 81.7, 98.5, 123.7, 142.4, 159.5, 167.9, 172.8; IR (neat) ν , cm^{-1} : 3290, 3132, 2951, 2921, 2868, 2097, 1741, 1646, 1572, 1455, 1309, 1164, 1121, 954, 632; ESI-MS m/z (%): 596 ($[M+H]^+$, 80), 618 ($[M+Na]^+$, 100); Anal. Calcd for $C_{25}H_{38}BrN_7O_5$: C 50.34, H 6.42, N 16.44, Found: C 50.32, H 6.39, N 16.43.

(*S*)-(1-(4-azidobutyl)-1*H*-1,2,3-triazol-4-yl)methyl 2-((*S*)-4-bromo-5-oxo-2-((1*S*,2*R*,4*S*)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)-3-methylbutanoate (3e). Yellowish oil, yield 511 mg (64%); $[\alpha]_D^{20} +70.7$ (c 0.069, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 270 nm; 1H NMR (400 MHz, $CDCl_3$ -TMS) δ , ppm: 0.60-1.09 (m, 15H), 1.10-1.47 (m, 4H), 1.58-1.79 (m, 4H), 1.95-2.10 (m, 2H), 2.16-2.34 (m, 2H), 3.36 (t, J = 8.0 Hz, 2H), 3.99 (d, J = 8.0 Hz, 1H), 4.44 (t, J = 8.0 Hz, 2H), 4.82 (b, 1H), 5.25-5.49 (m, 3H), 5.74 (s, 1H), 7.75 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$ -TMS) δ , ppm: 13.9, 17.3, 18.3, 18.7, 19.5, 25.7, 26.4, 27.4, 27.9, 32.1, 37.0, 44.8, 47.5, 49.4, 49.7, 50.6, 58.5, 60.3, 77.5, 88.0, 99.4, 124.1, 141.8, 157.1, 167.2, 170.5; IR (neat) ν , cm^{-1} : 3385, 3132, 3060, 2955, 2874, 2098, 1747, 1649, 1558, 1451, 1312, 1135, 956, 626; ESI-MS m/z (%): 610 ($[M+H]^+$, 53), 632 ($[M+Na]^+$, 100); Anal. Calcd for $C_{26}H_{38}BrN_7O_5$: C 51.32, H 6.29, N 16.11, Found: C 51.30, H 6.26, N 16.14.

(S)-(1-(4-azidobutyl)-1H-1,2,3-triazol-4-yl)methyl 2-((S)-4-bromo-5-oxo-2-((1S,2R,4S)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)-3-phenylpropanoate (3f). Yellowish oil, yield 348 mg (53%); $[\alpha]_D^{20} +87.5$ (*c* 0.048, CH₂Cl₂); UV-vis (CH₂Cl₂) $\lambda_{\max}$: 271 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.83-1.00 (m, 9H), 1.03-1.37 (m, 4H), 1.57-1.75 (m, 4H), 1.96-2.09 (m, 2H), 2.10-2.23 (m, 1H), 2.96-3.26 (m, 2H), 3.35 (t, *J* = 8.0 Hz, 2H), 3.67-3.91 (m, 1H), 4.42 (t, *J* = 8.0 Hz, 2H), 4.82 (b, 1H), 5.08-5.55 (m, 4H), 6.99-7.16 (m, 2H), 7.17-7.37 (m, 3H), 7.63 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 14.0, 18.7, 19.6, 25.8, 26.5, 27.5, 27.9, 36.9, 39.8, 44.8, 47.5, 49.4, 49.8, 50.6, 57.6, 58.9, 77.4, 88.1, 99.5, 124.2, 127.7, 128.9, 129.4, 134.8, 141.7, 156.3, 167.0, 170.3; IR (neat) ν , cm⁻¹: 3299, 3137, 3055, 3027, 2954, 2923, 2874, 2098, 1752, 1651, 1561, 1520, 1495, 1455, 1323, 1179, 1132, 957, 746, 704, 633; ESI-MS *m/z* (%): 656 ([M+H]⁺, 55), 678 ([M+Na]⁺, 100); Anal. Calcd for C₃₀H₃₈BrN₇O₅: C 54.88, H 5.83, N 14.93, Found: C 54.92, H 5.80, N 14.91.

(1-(4-azidobutyl)-1H-1,2,3-triazol-4-yl)methyl 6-((S)-4-bromo-5-oxo-2-((1S,2R,4S)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)hexanoate (3g). Yellowish oil, yield 379 mg (61%); $[\alpha]_D^{20} +63.3$ (*c* 0.111, CH₂Cl₂); UV-vis (CH₂Cl₂) $\lambda_{\max}$: 274 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.86 (s, 6H), 0.89 (s, 3H), 1.12-1.33 (m, 4H), 1.34-1.46 (m, 2H), 1.59-1.90 (m, 8H), 1.98-2.07 (m, 2H), 2.19-2.29 (m, 1H), 2.36 (t, *J* = 8.0 Hz, 2H), 3.35 (t, *J* = 8.0 Hz, 2H), 3.39-3.66 (m, 2H), 3.99 (d, *J* = 8.0 Hz, 1H), 4.43 (t, *J* = 8.0 Hz, 2H), 5.21 (s, 2H), 5.66 (s, 1H), 5.79 (s, 1H), 7.72 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 13.9, 18.7, 19.6, 24.2, 25.8, 26.5, 27.4, 27.9, 30.2, 33.7, 37.0, 44.0, 44.8, 47.5, 49.4, 49.7, 50.6, 57.4, 77.5, 87.3, 99.1, 123.8, 142.6, 160.5, 168.0, 173.1; IR (neat) ν , cm⁻¹: 3315, 3143, 3088, 2951, 2875, 2097, 1741, 1646, 1561, 1455, 1319, 1156, 1132, 955, 647; ESI-MS *m/z* (%): 624 ([M+H]⁺, 42), 646 ([M+Na]⁺, 100); Anal. Calcd for C₂₇H₄₀BrN₇O₅: C 52.09, H 6.48, N 15.75, Found: C 52.11, H 6.47, N 15.78.

(1-(4-azidobutyl)-1H-1,2,3-triazol-4-yl)methyl 4-((S)-4-bromo-5-oxo-2-((1S,2R,4S)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)butanoate (3h). Yellowish solid, yield 333 mg (56%); m.p. 95.1-95.8 °C; $[\alpha]_D^{20} +78.9$ (*c* 0.065, CH₂Cl₂); UV-vis (CH₂Cl₂) $\lambda_{\max}$: 273 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.82-0.87 (m, 6H), 0.88 (s, 3H), 1.16-1.35 (m, 4H), 1.61-1.87 (m, 4H), 1.95-2.08 (m, 4H), 2.19-2.31 (m, 1H), 2.48 (t, *J* = 8.0 Hz, 2H), 3.35 (t, *J* = 8.0 Hz, 2H), 3.46-3.64 (m, 2H), 4.00 (d, *J* = 12.0 Hz, 1H), 4.42 (t, *J* = 8.0 Hz, 2H), 5.23 (s, 2H), 5.72 (s, 1H), 5.77 (s, 1H), 7.69 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 14.0, 18.8, 19.6, 25.3, 25.8, 26.5, 27.5, 28.0, 31.1, 37.0, 43.4, 44.8, 47.5, 49.4, 49.8, 50.6, 57.8, 77.4, 87.5, 99.2, 123.7, 142.4, 160.5, 167.8, 172.9; IR (neat) ν , cm⁻¹: 3319, 3138, 3093, 2954, 2879, 2098, 1743, 1651, 1531, 1456, 1322, 1167, 1132, 954, 661; ESI-MS *m/z* (%): 594 ([M+H]⁺, 33), 616 ([M+Na]⁺, 100); Anal. Calcd for C₂₅H₃₆BrN₇O₅: C 50.51, H 6.10, N 16.49, Found: C 50.29, H 6.38, N 16.48.

General procedure for the synthesis of target compounds 5

A flame-dried flask was charged with 1 mmol intermediate **3**, 2 mmol alkyne **4**, 0.05 mmol Cu(OAc)₂•H₂O and 0.1 mmol Cu in CH₃CN (5 mL). The resulting mixture was stirred at room temperature under N₂ atmosphere until the monitoring by TLC showed almost complete conversion of the substrate (about 2 h). Then, according to the procedure mentioned above, the reaction mixture was treated to yield the desired compounds **5aa-5bh** in 57-98% isolated yields.

(S)-(1-(4-(4-phenyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 2-((S)-4-bromo-2-((1R,2S,5R)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydro-furan-3-ylamino)-3-methylbutanoate (5aa). Yellowish solid, yield 634 mg (89%); m.p. 143.5-144.1 °C; $[\alpha]_{\text{D}}^{20} +38.2$ (c 0.022, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 257 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.82 (d, *J* = 8.0 Hz, 3H), 0.84-0.97 (m, 13H), 0.98-1.11 (m, 2H), 1.28-1.42 (m, 2H), 1.59-1.70 (m, 2H), 1.89-2.04 (m, 4H), 2.11-2.28 (m, 3H), 3.49-3.59 (ddd, *J*₁ = 4.0 Hz, *J*₂ = 4.0 Hz, *J*₃ = 4.0 Hz, 1H), 4.33-4.49 (m, 4H), 4.79 (b, 1H), 5.24-5.35 (m, 3H), 5.71 (s, 1H), 7.30-7.44 (m, 3H), 7.70 (s, 1H), 7.78-7.85 (m, 2H), 7.87 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 15.7, 17.3, 17.9, 20.9, 22.1, 22.7, 25.8, 27.1, 27.1, 31.4, 32.0, 33.8, 42.2, 47.8, 49.3, 49.4, 58.5, 59.7, 77.4, 83.3, 100.0, 120.0, 124.2, 125.6, 128.2, 128.8, 130.4, 141.8, 147.7, 157.4, 167.9, 170.4; IR (neat) ν , cm⁻¹: 3383, 3136, 3099, 3060, 2956, 2927, 2870, 1744, 1651, 1556, 1521, 1464, 1316, 1192, 1133, 956, 766, 696, 646; ESI-MS *m/z* (%): 714 ([M+H]⁺, 100); Anal. Calcd for C₃₄H₄₆BrN₇O₅: C 57.30, H 6.51, N 13.76, Found: C 57.28, H 6.49, N 13.64.

(S)-(1-(4-(4-phenyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 2-((S)-4-bromo-2-((1R,2S,5R)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydro-furan-3-ylamino)-3-phenylpropanoate (5ab). Yellowish oil, yield 662 mg (87%); $[\alpha]_{\text{D}}^{20} +50.3$ (c 0.095, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 257 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.69 (d, *J* = 4.0 Hz, 3H), 0.74-0.90 (m, 7H), 0.92-1.05 (m, 2H), 1.23-1.35 (m, 2H), 1.56-1.67 (m, 2H), 1.82-2.13 (m, 6H), 3.06-3.23 (m, 2H), 3.34-3.46 (m, 1H), 4.32-4.47 (m, 4H), 4.79 (b, 1H), 5.10-5.49 (m, 4H), 7.01-7.11 (m, 2H), 7.18-7.28 (m, 3H), 7.29-7.43 (m, 3H), 7.64 (s, 1H), 7.75-7.84 (m, 2H), 7.87 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 15.5, 21.0, 22.1, 22.6, 25.4, 27.1, 31.5, 33.8, 39.7, 42.2, 47.8, 49.3, 49.4, 55.6, 58.8, 77.5, 83.0, 99.3, 120.1, 124.4, 125.6, 127.6, 128.2, 128.7, 128.9, 129.5, 130.4, 134.2, 141.6, 147.7, 156.9, 167.6, 170.1; IR (neat) ν , cm⁻¹: 3374, 3136, 3062, 3028, 2953, 2926, 2868, 1747, 1648, 1518, 1497, 1484, 1455, 1325, 1182, 1117, 956, 766, 698, 647; ESI-MS *m/z* (%): 762 ([M+H]⁺, 100), 784 ([M+Na]⁺, 80); Anal. Calcd for C₃₈H₄₆BrN₇O₅: C 60.00, H 6.09, N 12.89, Found: C 60.06, H 6.13, N 12.86.

(1-(4-(4-phenyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 6-((S)-4-bromo-2-((1R,2S,5R)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydro-furan-3-ylamino)hexanoate (5ac). Yellowish solid, yield 414 mg (57%); m.p. 125.6-126.8 °C; $[\alpha]_{\text{D}}^{20} +74.0$ (c 0.049, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 256 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.77 (d, *J* = 4.0 Hz, 3H), 0.80-0.96 (m, 7H), 0.97-1.13 (m, 2H), 1.28-1.41 (m, 4H), 1.56-1.75 (m, 6H), 1.90-2.04 (m, 4H), 2.10-2.24 (m, 2H), 2.33 (t, *J* = 8.0 Hz, 2H), 3.36-3.52 (m, 2H), 3.53-3.61 (ddd, *J*₁ = 4.0 Hz, *J*₂ = 4.0 Hz, *J*₃ = 4.0 Hz, 1H), 4.33-4.51 (m, 4H), 5.12-5.27 (m, 3H), 5.76 (s, 1H), 7.30-7.44 (m, 2H), 7.63 (s,

1H), 7.77-7.92 (m, 3H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ, ppm: 15.9, 21.1, 22.1, 22.7, 24.2, 25.5, 25.7, 27.1, 27.1, 30.2, 31.6, 33.7, 33.9, 42.4, 43.6, 48.0, 49.4, 49.4, 57.4, 77.4, 81.7, 98.6, 119.9, 123.8, 125.6, 128.2, 128.9, 130.4, 142.8, 147.8, 159.5, 168.0, 173.1; IR (neat) ν, cm⁻¹: 3320, 3137, 3096, 3060, 2953, 2928, 2868, 1742, 1647, 1555, 1525, 1484, 1463, 1321, 1159, 1124, 938, 767, 696, 667; ESI-MS *m/z* (%): 728 ([M+H]⁺, 100); Anal. Calcd for C₃₅H₄₈BrN₇O₅: C 57.85, H 6.66, N 13.49, Found: C 57.88, H 6.64, N 13.51.

(1-(4-(4-phenyl-1*H*-1,2,3-triazol-1-yl)butyl)-1*H*-1,2,3-triazol-4-yl)methyl 4-((*S*)-4-bromo-2-((1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydrofuran-3-ylamino)butanoate (5ad). Yellowish solid, yield 650 mg (93%); m.p. 168.8-169.6 °C; [α]_D²⁰ +101.0 (*c* 0.035, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max}: 257 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ, ppm: 0.77 (d, *J* = 4.0 Hz, 3H), 0.82-0.95 (m, 7H), 0.96-1.12 (m, 2H), 1.27-1.38 (m, 2H), 1.59-1.69 (m, 2H), 1.89-2.04 (m, 6H), 2.09-2.22 (m, 2H), 2.43 (t, *J* = 8.0 Hz, 2H), 3.46-3.62 (m, 3H), 4.34-4.48 (m, 4H), 5.20 (s, 2H), 5.39 (s, 1H), 5.74 (s, 1H), 7.30-7.46 (m, 3H), 7.61 (s, 1H), 7.75-7.87 (m, 3H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ, ppm: 15.8, 21.1, 22.1, 22.8, 25.3, 25.5, 27.1, 27.1, 31.0, 31.6, 33.9, 42.4, 43.2, 48.1, 49.4, 49.4, 57.8, 77.3, 81.7, 98.5, 119.8, 123.7, 125.6, 128.2, 128.9, 130.4, 142.6, 147.8, 159.8, 167.8, 172.8; IR (neat) ν, cm⁻¹: 3331, 3137, 3093, 3027, 2954, 2923, 2852, 1742, 1646, 1536, 1484, 1463, 1322, 1165, 1122, 951, 766, 697, 646; ESI-MS *m/z* (%): 700 ([M+H]⁺, 55), 722 [M+Na]⁺, 100; Anal. Calcd for C₃₃H₄₄BrN₇O₅: C 56.73, H 6.35, N 14.03, Found: C 56.57, H 6.63, N 14.25.

(*S*)-(1-(4-(4-phenyl-1*H*-1,2,3-triazol-1-yl)butyl)-1*H*-1,2,3-triazol-4-yl)methyl 2-((*S*)-4-bromo-5-oxo-2-((1*S*,2*R*,4*S*)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)-3-methylbutanoate (5ae). Yellowish oil, yield 696 mg (98%); [α]_D²⁰ +38.0 (*c* 0.108, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max}: 256 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ, ppm: 0.82 (s, 6H), 0.87 (s, 3H), 0.89-0.99 (m, 6H), 1.10-1.31 (m, 4H), 1.61-1.77 (m, 2H), 1.89-2.02 (m, 4H), 2.15-2.27 (m, 2H), 3.96 (d, *J* = 12.0 Hz, 1H), 4.34-4.45 (m, 4H), 4.59 (b, 1H), 5.27-5.33 (m, 2H), 5.46 (d, *J* = 12.0 Hz, 1H), 5.72 (s, 1H), 7.29-7.43 (m, 2H), 7.72 (s, 1H), 7.77-7.84 (m, 2H), 7.89 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ, ppm: 13.8, 17.3, 18.3, 18.7, 19.5, 26.4, 27.0, 27.0, 27.9, 32.0, 36.9, 44.8, 47.5, 49.3, 49.4, 58.5, 60.3, 77.5, 87.9, 99.6, 120.0, 124.2, 125.5, 128.1, 128.8, 130.5, 141.8, 147.6, 158.1, 167.5, 170.4; IR (neat) ν, cm⁻¹: 3383, 3136, 3063, 3027, 2956, 2930, 2876, 1752, 1651, 1523, 1465, 1331, 1193, 1136, 957, 766, 696, 661; ESI-MS *m/z* (%): 710 ([M+H]⁺, 100), 732 ([M+Na]⁺, 57); Anal. Calcd for C₃₄H₄₄BrN₇O₅: C 57.46, H 6.24, N 13.80, Found: C 57.51, H 6.27, N 13.82.

(*S*)-(1-(4-(4-phenyl-1*H*-1,2,3-triazol-1-yl)butyl)-1*H*-1,2,3-triazol-4-yl)methyl 2-((*S*)-4-bromo-5-oxo-2-((1*S*,2*R*,4*S*)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)-3-phenylpropanoate (5af). Yellowish oil, yield 713 mg (94%); [α]_D²⁰ +71.4 (*c* 0.056, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max}: 257 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ, ppm: 0.80 (s, 6H), 0.82 (s, 3H), 1.11-1.32 (m, 4H), 1.59-1.73 (m, 2H), 1.89-2.03 (m, 4H), 2.07-2.16 (m, 1H), 3.02-3.23 (m, 2H), 3.69- 3.86 (m, 1H), 4.32-4.48 (m, 4H), 4.94 (b, 1H), 5.12-5.37 (m, 3H), 5.45 (s, 1H), 7.04-7.14 (m, 2H), 7.17-7.28 (m, 3H), 7.29-7.42 (m, 2H), 7.61 (s, 1H), 7.75-7.87 (m, 3H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ, ppm: 13.9, 18.7, 19.6, 26.5, 27.1, 27.1, 27.9, 36.9, 39.5, 44.8, 47.5, 49.3, 49.4, 49.4, 56.4, 58.8, 77.4, 88.0, 99.5, 120.0, 124.3, 125.6, 127.7, 128.2, 128.8, 128.9, 129.4,

130.4, 134.7, 141.8, 147.8, 158.4, 167.4, 170.2; IR (neat) ν , cm^{-1} : 3375, 3136, 3066, 3029, 2953, 2925, 2868, 1749, 1651, 1519, 1495, 1484, 1455, 1324, 1180, 1130 957, 765, 698, 645; ESI-MS m/z (%): 760 ($[\text{M}+\text{H}]^+$, 100); Anal. Calcd for $\text{C}_{38}\text{H}_{44}\text{BrN}_7\text{O}_5$: C 60.16, H 5.85, N 12.92, Found: C 60.20, H 5.89, N 12.89.

(1-(4-(4-phenyl-1*H*-1,2,3-triazol-1-yl)butyl)-1*H*-1,2,3-triazol-4-yl)methyl 6-((*S*)-4-bromo-5-oxo-2-((1*S*,2*R*,4*S*)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)hexanoate (5ag). Yellowish oil, yield 609 mg (84%); $[\alpha]_{\text{D}}^{20}$ +42.4 (c 0.149, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 256 nm; ^1H NMR (400 MHz, CDCl_3 -TMS) δ , ppm: 0.71-0.98 (m, 9H), 1.09-1.31 (m, 4H), 1.32-1.43 (m, 2H), 1.61-1.89 (m, 6H), 1.91-2.05 (m, 4H), 2.16-2.27 (m, 1H), 2.32 (t, J = 8.0 Hz, 2H), 3.34-3.56 (m, 2H), 3.97 (d, J = 4.0 Hz, 1H), 4.33-4.51 (m, 4H), 5.18 (s, 2H), 5.71-5.97 (m, 2H), 7.30-7.47 (m, 3H), 7.69 (s, 1H), 7.75-7.87 (m, 2H), 7.91 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3 -TMS) δ , ppm: 13.9, 18.7, 19.6, 24.2, 25.7, 26.5, 27.1, 28.0, 30.1, 33.7, 37.0, 44.0, 44.7, 47.5, 49.3, 49.4, 57.4, 77.5, 87.3, 99.1, 120.1, 123.9, 125.6, 128.1, 128.8, 130.4, 142.7, 147.6, 160.5, 168.0, 173.1; IR (neat) ν , cm^{-1} : 3319, 3136, 3095, 3060, 2952, 2874, 1744, 1648, 1555, 1525, 1459, 1320, 1155, 1131, 955, 766, 696, 667; ESI-MS m/z (%): 726 ($[\text{M}+\text{H}]^+$, 100), 748 ($[\text{M}+\text{Na}]^+$, 67); Anal. Calcd for $\text{C}_{35}\text{H}_{46}\text{BrN}_7\text{O}_5$: C 58.01, H 6.40, N 13.53, Found: C 58.04, H 6.45, N 13.51.

(1-(4-(4-phenyl-1*H*-1,2,3-triazol-1-yl)butyl)-1*H*-1,2,3-triazol-4-yl)methyl 4-((*S*)-4-bromo-5-oxo-2-((1*S*,2*R*,4*S*)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)butanoate (5ah). Yellowish solid, yield 691 mg (97%); m.p. 106.5-107.4 $^{\circ}\text{C}$; $[\alpha]_{\text{D}}^{20}$ +103.0 (c 0.045, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 256 nm; ^1H NMR (400 MHz, CDCl_3 -TMS) δ , ppm: 0.82 (s, 6H), 0.84 (s, 3H), 1.12-1.36 (m, 4H), 1.62-1.84 (m, 2H), 1.87-2.04 (m, 6H), 2.15-2.27 (m, 1H), 2.44 (t, J = 8.0 Hz, 2H), 3.43-3.63 (m, 2H), 3.96 (d, J = 8.0 Hz, 1H), 4.33-4.52 (m, 4H), 5.19 (s, 2H), 5.75 (s, 1H), 6.02 (s, 1H), 7.30-7.45 (m, 3H), 7.68 (s, 1H), 7.75-7.84 (m, 2H), 7.90 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3 -TMS) δ , ppm: 13.9, 18.8, 19.6, 25.3, 26.5, 27.1, 27.1, 28.0, 31.0, 37.0, 43.4, 44.7, 47.5, 49.4, 49.4, 57.7, 77.5, 87.4, 99.2, 120.1, 123.9, 125.6, 128.2, 128.8, 130.4, 142.5, 147.6, 160.8, 168.1, 172.8; IR (neat) ν , cm^{-1} : 3312, 3136, 3093, 3049, 2954, 2929, 2874, 1743, 1646, 1556, 1531, 1463, 1322, 1165, 1131, 953, 765, 696, 646; ESI-MS m/z (%): 698 ($[\text{M}+\text{H}]^+$, 39), 720 ($[\text{M}+\text{Na}]^+$, 100); Anal. Calcd for $\text{C}_{33}\text{H}_{42}\text{BrN}_7\text{O}_5$: C 56.90, H 6.08, N 14.07, Found: C 56.75, H 6.35, N 13.84.

(*S*)-(1-(4-(4-propyl-1*H*-1,2,3-triazol-1-yl)butyl)-1*H*-1,2,3-triazol-4-yl)methyl 2-((*S*)-4-bromo-2-((1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydro-furan-3-ylamino)-3-methylbutanoate (5ba). Yellowish solid, yield 550 mg (81%); m.p. 120.6-121.0 $^{\circ}\text{C}$; $[\alpha]_{\text{D}}^{20}$ +75.7 $^{\circ}$ (c 0.073, CH_2Cl_2); UV-vis (CH_2Cl_2) λ_{max} : 270 nm; ^1H NMR (400 MHz, CDCl_3 -TMS) δ , ppm: 0.84 (d, J = 4.0 Hz, 3H), 0.86-1.01 (m, 16H), 1.02-1.15 (m, 2H), 1.26-1.43 (m, 2H), 1.60-1.77 (m, 4H), 1.87-2.02 (m, 4H), 2.11-2.31 (m, 3H), 2.68 (t, J = 8.0 Hz, 2H), 3.53-3.64 (ddd, J_1 = 4.0 Hz, J_2 = 4.0 Hz, J_3 = 4.0 Hz, 1H), 4.31-4.46 (m, 4H), 4.81 (b, 1H), 5.24-5.40 (m, 3H), 5.76 (s, 1H), 7.36 (s, 1H), 7.70 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3 -TMS) δ , ppm: 13.8, 15.7, 17.3, 17.9, 20.9, 22.1, 22.6, 22.7, 25.8, 27.1, 27.1, 27.6, 31.5, 32.0, 33.8, 42.2, 47.9, 49.0, 49.4, 58.5, 59.7, 77.4, 83.2, 99.9, 120.9, 124.1, 141.8, 148.3, 157.3, 167.8, 170.5; IR (neat) ν , cm^{-1} : 3382, 3137, 3082, 2958, 2928, 2872, 1748, 1651, 1551, 1523, 1458, 1317, 1193, 1135, 956, 661; ESI-MS m/z (%): 680 ($[\text{M}+\text{H}]^+$, 100), 702 ($[\text{M}+\text{Na}]^+$, 67); Anal. Calcd for $\text{C}_{31}\text{H}_{48}\text{BrN}_7\text{O}_5$: C 54.86, H 7.13, N 14.45, Found: C 54.57, H 7.36, N 14.30.

(S)-(1-(4-(4-propyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 2-((S)-4-bromo-2-((1R,2S,5R)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydro-furan-3-ylamino)-3-phenylpropanoate (5bb). Yellowish oil, yield 603 mg (83%); $[\alpha]_{\text{D}}^{20} +112.5$ (*c* 0.043, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 271 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.72 (d, *J* = 8.0 Hz, 3H), 0.77-1.09 (m, 12H), 1.25-1.39 (m, 2H), 1.60-1.74 (m, 4H), 1.83-2.18 (m, 6H), 2.68 (t, *J* = 8.0 Hz, 2H), 3.06-3.25 (m, 2H), 3.37-3.51 (m, 1H), 4.30-4.46 (m, 4H), 5.02-5.58 (m, 5H), 7.03-7.12 (m, 2H), 7.20-7.31 (m, 3H), 7.34 (s, 1H), 7.62 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 13.8, 15.5, 21.0, 22.1, 22.6, 22.7, 25.4, 27.1, 27.6, 31.5, 33.8, 39.7, 42.2, 47.8, 49.0, 49.5, 56.1, 58.8, 77.4, 82.8, 99.8, 120.9, 124.3, 127.6, 128.7, 129.5, 134.2, 141.6, 148.3, 157.6, 167.6, 170.1; IR (neat) ν , cm⁻¹: 3379, 3137, 3088, 3029, 2956, 2928, 2870, 1751, 1649, 1552, 1519, 1497, 1456, 1325, 1183, 1120, 957, 746, 704, 628; ESI-MS *m/z* (%): 728 ([M+H]⁺, 100), 750 ([M+Na]⁺, 83); Anal. Calcd for C₃₅H₄₈BrN₇O₅: C 57.85, H 6.66, N 13.49, Found: C 57.82, H 6.70, N 13.47.

(1-(4-(4-propyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 6-((S)-4-bromo-2-((1R,2S,5R)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydro-furan-3-ylamino)hexanoate (5bc). Yellowish solid, yield 610 mg (88%); m.p. 123.8-124.6 °C; $[\alpha]_{\text{D}}^{20} +51.3$ (*c* 0.129, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 272 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.79 (d, *J* = 4.0 Hz, 3H), 0.84-0.99 (m, 10H), 1.00-1.16 (m, 2H), 1.26-1.42 (m, 4H), 1.59-1.73 (m, 8H), 1.88-2.00 (m, 4H), 2.10-2.26 (m, 2H), 2.36 (t, *J* = 8.0 Hz, 2H), 2.68 (t, *J* = 8.0 Hz, 2H), 3.41-3.54 (m, 2H), 3.56-3.63 (ddd, *J*₁ = 4.0 Hz, *J*₂ = 4.0 Hz, *J*₃ = 4.0 Hz, 1H), 4.32-4.44 (m, 4H), 5.15-5.27 (m, 3H), 5.79 (s, 1H), 7.31 (s, 1H), 7.63 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 13.7, 15.8, 21.0, 22.1, 22.6, 22.6, 24.2, 25.2, 25.7, 27.1, 27.5, 30.1, 31.4, 33.6, 33.8, 42.3, 43.5, 48.0, 49.0, 49.3, 57.3, 77.6, 81.3, 98.2, 120.9, 123.8, 142.6, 148.1, 159.6, 168.2, 173.0; IR (neat) ν , cm⁻¹: 3354, 3137, 3082, 2955, 2927, 2869, 1742, 1648, 1551, 1528, 1458, 1320, 1160, 1122, 938, 647; ESI-MS *m/z* (%): 694 ([M+H]⁺, 87), 716 ([M+Na]⁺, 100); Anal. Calcd for C₃₂H₅₀BrN₇O₅: C 55.49, H 7.28, N 14.15, Found: C 55.78, H 7.46, N 14.35.

(1-(4-(4-propyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 4-((S)-4-bromo-2-((1R,2S,5R)-2-isopropyl-5-methylcyclohexyloxy)-5-oxo-2,5-dihydro-furan-3-ylamino)butanoate (5bd). Yellowish solid, yield 572 mg (86%); m.p. 118.2-119.6 °C; $[\alpha]_{\text{D}}^{20} +97.7$ (*c* 0.044, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 272 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.77 (d, *J* = 4.0 Hz, 3H), 0.80-1.00 (m, 10H), 1.01-1.15 (m, 2H), 1.26-1.40 (m, 2H), 1.58-1.78 (m, 4H), 1.82-2.09 (m, 6H), 2.11-2.27 (m, 2H), 2.46 (t, *J* = 8.0 Hz, 2H), 2.67 (t, *J* = 8.0 Hz, 2H), 3.43-3.67 (m, 3H), 4.27-4.50 (m, 4H), 5.22 (s, 2H), 5.74 (s, 1H), 5.81 (s, 1H), 7.35 (s, 1H), 7.67 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 13.8, 15.8, 21.1, 22.1, 22.6, 22.7, 25.3, 27.1, 27.1, 27.6, 30.9, 31.5, 33.9, 42.3, 43.1, 48.0, 49.1, 49.4, 57.7, 77.4, 81.6, 98.4, 120.9, 123.8, 142.5, 148.3, 159.8, 168.0, 172.8; IR (neat) ν , cm⁻¹: 3334, 3137, 3077, 2956, 2926, 2870, 1743, 1651, 1552, 1525, 1458, 1321, 1165, 1122, 952, 647; ESI-MS *m/z* (%): 666 ([M+H]⁺, 100), 688 ([M+Na]⁺, 87); Anal. Calcd for C₃₀H₄₆BrN₇O₅: C 54.21, H 6.98, N 14.75, Found: C 54.18, H 6.73, N 14.49.

(S)-(1-(4-(4-propyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 2-((S)-4-bromo-5-oxo-2-((1S,2R,4S)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)-3-methylbutanoate (5be). Yellowish oil, yield 656 mg (97%); $[\alpha]_{\text{D}}^{20} +84.6$ (*c* 0.063, CH₂Cl₂); UV-vis (CH₂Cl₂) λ_{max} : 270 nm; ¹H NMR (400 MHz,

CDCl₃-TMS) δ , ppm: 0.85 (s, 6H), 0.89 (s, 3H), 0.91-1.05 (m, 9H), 1.09-1.33 (m, 4H), 1.62-1.74 (m, 4H), 1.90-2.01 (m, 4H), 2.18-2.31 (m, 2H), 2.67 (t, J = 8.0 Hz, 2H), 3.99 (d, J = 8.0 Hz, 1H), 4.34-4.47 (m, 4H), 4.82 (b, 1H), 5.28-5.39 (m, 2H), 5.53 (d, J = 8.0 Hz, 1H), 5.77 (s, 1H), 7.39 (s, 1H), 7.75 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 13.7, 13.8, 17.3, 18.3, 18.7, 19.5, 22.6, 26.4, 27.0, 27.1, 27.5, 27.8, 32.0, 36.9, 44.7, 47.5, 49.0, 49.4, 58.4, 60.3, 77.5, 87.9, 99.6, 120.9, 124.2, 141.7, 148.2, 157.6, 167.3, 170.4; IR (neat) ν , cm⁻¹: 3286, 3136, 3079, 2958, 2931, 2874, 1752, 1649, 1552, 1523, 1458, 1331, 1192, 1136, 957, 662; ESI-MS m/z (%): 678 ([M+H]⁺, 100), 700 ([M+Na]⁺, 64); Anal. Calcd for C₃₁H₄₆BrN₇O₅: C 55.03, H 6.85, N 14.49, Found: C 55.01, H 6.88, N 14.45.

(S)-(1-(4-(4-propyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 2-((S)-4-bromo-5-oxo-2-((1S,2R,4S)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)-3-phenylpropanoate (5bf). Yellowish oil, yield 544 mg (75%); $[\alpha]_D^{20}$ +34.3 (c 0.093, CH₂Cl₂); UV-vis (CH₂Cl₂) $\lambda_{\max}$: 271 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.65-0.91 (m, 9H), 0.96 (t, J = 8.0 Hz, 3H), 1.11-1.34 (m, 4H), 1.60-1.74 (m, 4H), 1.87-2.01 (m, 4H), 2.09-2.21 (m, 1H), 2.67 (t, J = 8.0 Hz, 2H), 3.02-3.28 (m, 2H), 3.72-3.91 (m, 1H), 4.30-4.48 (m, 4H), 4.80 (b, 1H), 5.32 (s, 2H), 5.39-5.74 (m, 4H), 7.04-7.16 (m, 2H), 7.18-7.32 (m, 3H), 7.33 (s, 1H), 7.63 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 13.8, 13.9, 18.7, 19.6, 22.7, 26.4, 27.1, 27.6, 27.9, 36.8, 39.5, 44.7, 47.5, 49.0, 49.3, 49.4, 56.3, 58.8, 77.4, 88.0, 99.4, 120.9, 124.3, 127.7, 128.9, 129.4, 134.5, 141.7, 148.3, 159.8, 167.2, 170.2; IR (neat) ν , cm⁻¹: 3361, 3136, 3060, 3027, 2955, 2927, 2873, 1754, 1651, 1551, 1520, 1497, 1456, 1324, 1180, 1131, 958, 748, 703, 647; ESI-MS m/z (%): 726 ([M+H]⁺, 100), 748 ([M+Na]⁺, 85); Anal. Calcd for C₃₅H₄₆BrN₇O₅: C 58.01, H 6.40, N 13.53, Found: C 57.99, H 6.37, N 13.57.

(1-(4-(4-propyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 6-((S)-4-bromo-5-oxo-2-((1S,2R,4S)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)hexanoate (5bg). Yellowish oil, yield 456 mg (66%); $[\alpha]_D^{20}$ +117.6 (c 0.034, CH₂Cl₂); UV-vis (CH₂Cl₂) $\lambda_{\max}$: 274 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.86 (s, 6H), 0.88 (s, 3H), 0.97 (t, J = 8.0 Hz, 3H), 1.22-1.31 (m, 4H), 1.35-1.44 (m, 2H), 1.65-1.87 (m, 6H), 1.90-2.03 (m, 4H), 2.21-2.29 (m, 1H), 2.36 (t, J = 8.0 Hz, 2H), 2.68 (t, J = 8.0 Hz, 2H), 3.38-3.57 (m, 2H), 3.99 (d, J = 12.0 Hz, 1H), 4.29-4.46 (m, 4H), 5.20 (s, 2H), 5.41 (s, 1H), 5.77 (s, 1H), 7.32 (s, 1H), 7.62 (s, 1H); ¹³C NMR (100 MHz, CDCl₃-TMS) δ , ppm: 13.8, 14.0, 18.8, 19.6, 22.7, 24.2, 25.8, 26.6, 27.1, 27.6, 28.0, 30.2, 33.7, 37.1, 43.9, 44.8, 47.6, 49.1, 49.4, 57.5, 77.3, 87.4, 99.1, 120.8, 123.7, 142.8, 148.4, 160.3, 167.8, 173.2; IR (neat) ν , cm⁻¹: 3313, 3136, 3084, 2954, 2931, 2873, 1744, 1650, 1552, 1528, 1458, 1321, 1156, 1132, 955, 634; ESI-MS m/z (%): 692 ([M+H]⁺, 81), 714 ([M+Na]⁺, 100); Anal. Calcd for C₃₂H₄₈BrN₇O₅: C 55.65, H 7.00, N 14.20, Found: C 55.70, H 7.03, N 14.18.

(1-(4-(4-propyl-1H-1,2,3-triazol-1-yl)butyl)-1H-1,2,3-triazol-4-yl)methyl 4-((S)-4-bromo-5-oxo-2-((1S,2R,4S)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yloxy)-2,5-dihydrofuran-3-ylamino)butanoate (5bh). Yellowish solid, yield 652 mg (96%); m.p. 94.7-95.6 °C.; $[\alpha]_D^{20}$ +51.8 (c 0.073, CH₂Cl₂); UV-vis (CH₂Cl₂) $\lambda_{\max}$: 272 nm; ¹H NMR (400 MHz, CDCl₃-TMS) δ , ppm: 0.72-0.93 (m, 9H), 0.96 (t, J = 8.0 Hz, 3H), 1.13-1.37 (m, 4H), 1.64-1.87 (m, 4H), 1.88-2.06 (m, 6H), 2.18-2.28 (m, 1H), 2.48 (t, J = 8.0 Hz, 2H), 2.67 (t, J = 8.0 Hz, 2H), 3.45-3.66 (m, 2H), 3.99 (d, J = 8.0 Hz, 1H), 4.30-4.47 (m, 4H), 5.21 (s, 2H), 5.80 (s, 1H), 6.16 (s, 1H), 7.38 (s, 1H), 7.70 (s, 1H); ¹³C NMR (100

MHz, CDCl₃-TMS) δ , ppm: 13.8, 13.9, 18.7, 19.5, 22.6, 25.3, 26.5, 27.1, 27.1, 27.5, 27.9, 31.0, 37.0, 43.3, 44.7, 47.5, 49.1, 49.3, 49.4, 57.7, 77.5, 87.3, 99.1, 120.9, 123.8, 142.5, 148.2, 160.7, 167.9, 172.8; IR (neat) ν , cm⁻¹: 3318, 3137, 3081, 2955, 2931, 2874, 1745, 1650, 1551, 1457, 1322, 1166, 1131, 953, 661; ESI-MS m/z (%): 686 ([M+Na]⁺, 100); Anal. Calcd for C₃₀H₄₄BrN₇O₅: C 54.38, H 6.69, N 14.80, Found: C 54.40, H 6.72, N 14.79.

Compound 2a

Compound 2a

Compound 2b

Compound 2b

Compound 2c

Compound 2c

Compound 2d

Compound 2d

Compound 2e

Compound 2e

Compound 2f

Compound 2f

Compound 2g

Compound 2g

Compound 2h

Compound 2h

Compound 3a

Compound 3a

Compound 3b

Compound 3b

Compound 3c

Compound 3c

Compound 3d

Compound 3d

Compound 3e

Compound 3e

Compound 3f

Compound 3f

Compound 3g

Compound 3g

Compound 3h

Compound 3h

Compound 5aa

Compound 5aa

Compound 5ab

Compound 5ab

Compound 5ac

Compound 5ac

Compound 5ad

Compound 5ad

Compound 5ae

Compound 5ae

Compound 5af

Compound 5af

Compound 5ag

Compound 5ag

Compound 5ah

Compound 5ah

Compound 5ba

Compound 5ba

Compound 5bb

Compound 5bb

Compound 5bc

Compound 5bc

Compound 5bd

Compound 5bd

Compound 5be

Compound 5be

Compound 5bf

Compound 5bf

Compound 5bg

Compound 5bg

Compound 5bh

Compound 5bh