

Supporting Information

C-linked glycomimetic libraries accessed by the Passerini reaction

Kristina Vlahoviček-Kahlina¹, Josipa Suć Sajko¹, and Ivanka Jerić^{1,}*

¹ Ruđer Bošković Institute, Division of Organic Chemistry and Biochemistry, Bijenička cesta 54, 10000 Zagreb, Croatia

Table of Content

General methods	SI-2
Synthesis of aldehydes and ketones	SI-3
Synthesis and characterisation of Passerini products	SI-5
Post-condensation modification of selected Passerini products	SI-17
Base-mediated deprotection of selected Passerini products	SI-19
NMR and HRMS spectra of Passerini products	SI-21
X-ray structure of 2a	SI-77

General methods

All experiments were monitored by analytical thin layer chromatography (TLC) on Silica Gel 60 F254 plates (Merck; Darmstadt, Germany) after spraying with 10 % H_2SO_4 and heating. Flash column chromatography was performed on silica gel (Merck, 40–63 μm particle size) by standard techniques eluting with solvents as indicated. All NMR experiments were carried out by using Bruker Avance 600 spectrometer (600.13 MHz, ^1H ; 150.91 MHz, ^{13}C). Samples in CDCl_3 solutions were recorded in 5 mm NMR tubes at 298 K. Chemical shifts in parts per million were referenced to TMS as internal standard. Spectra were assigned based on 2D homonuclear (COSY) and heteronuclear (HMQC, HMBC) experiments. ^1H chemical shifts are assigned to the particular starting component, and the following abbreviations are used: cyclohexyl = CyHex; tetrabutyl = tBu; methyl cyanoacetate = Gly; fructopyranose derived aldehyde **1** = Fru; galactose derived aldehyde **2** = Gal; ribose derived aldehyde **3** = Rib; xylose derived aldehyde **4** = Xyl; sorbose derived aldehyde **5** = Sor; allose derived aldehyde **6** = Alo; arabinose derived aldehyde **7** = Ara; glucofuranose derived ketone **8** = GluF; fructopyranose derived ketone **9** = FruP, respectively.

High resolution mass spectrometry (HRMS) was performed on a MALDI-TOF/TOF spectrometer in positive ionization mode. Calibration type was internal with calibrants produced by matrix ionization dissolved in α -cyano-4-hydroxycinnamic acid matrix. Accurately measured spectra were internally calibrated and elemental analysis was performed on Data Explorer v. 4.9 software with mass accuracy better than 5 ppm.

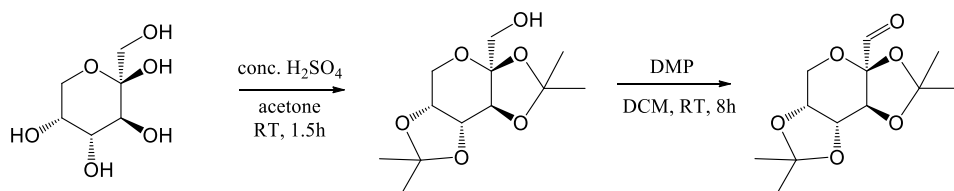
Experimental Procedures and Spectroscopic Characterization of New Compounds

1. Synthesis of aldehydes/ketones to be used in the Passerini reaction:

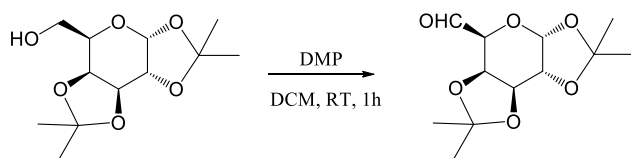
General procedure for the synthesis of aldehydes and ketones:

Isopropylidene-protected alcohols were dissolved in dichloromethane. Dess-Martin periodinane (1.2 eq) was added and the reaction mixture was stirred for 1 h (aldehydes) / 24 h (ketones) at room temperature. The reaction was quenched with solution of $\text{Na}_2\text{S}_2\text{O}_3$ /sat. NaHCO_3 and the product was extracted with dichloromethane. Organic layer was washed with brine and water, dried over Na_2SO_4 and concentrated under reduced pressure. The products were purified by flash column chromatography (petrol ether/ethyl acetate (v/v = 1/1) to afford corresponding carbonyl products **1-9**.

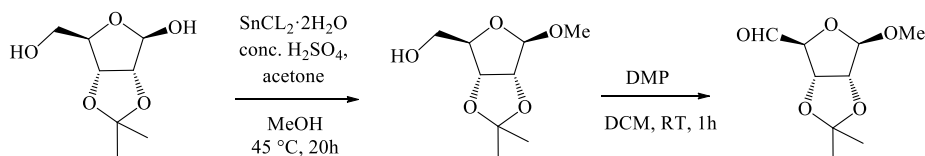
Aldehyde **1** was synthesized according to a literature procedure. (R.F. Brady, *Carbohydrate Research* 1970 **15** 35-40).



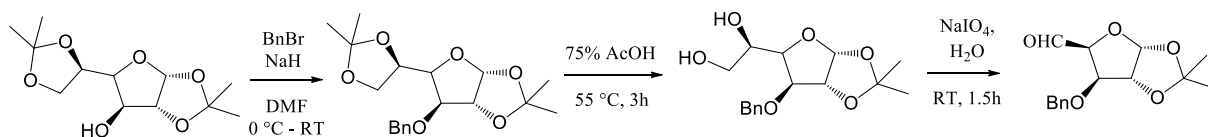
Aldehyde **2** was synthesized according to general procedure:



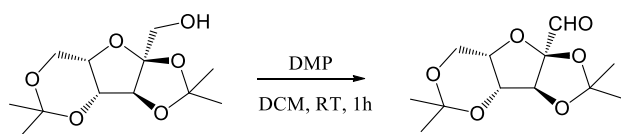
Aldehyde **3** was synthesized according to a literature procedure. (Sairam et al. *Carbohydrate Research* 2003 **338** 303-306):



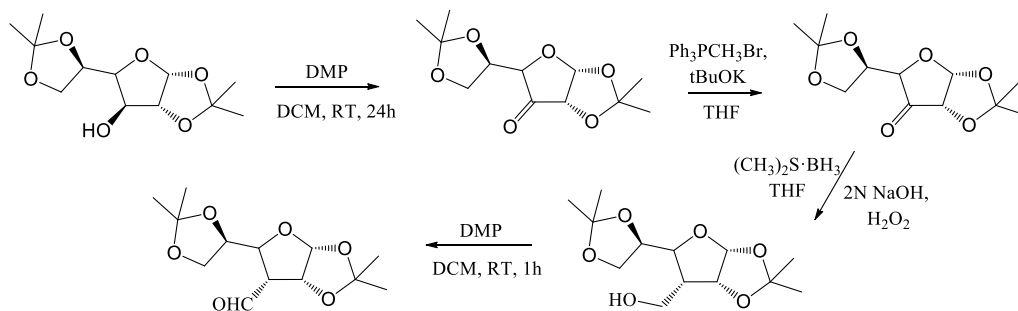
Aldehyde **4** was synthesized according to a literature procedure. (Shun-Yuan Luo et al. *RCS Adv.* 2015 **5** 19027-19033).



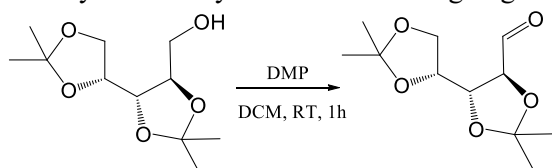
Aldehyde **5** was synthesized according to generale procedure:



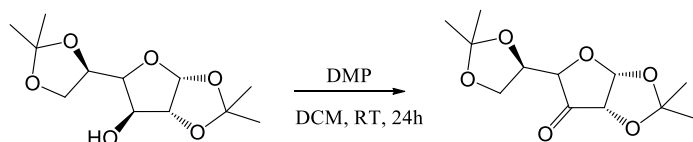
Aldehyde **6** was synthesized according to a literature procedure. (Chun at al. *Nucleosides Nucleotides Nucleic Acid* 2008 **27** 408-420):



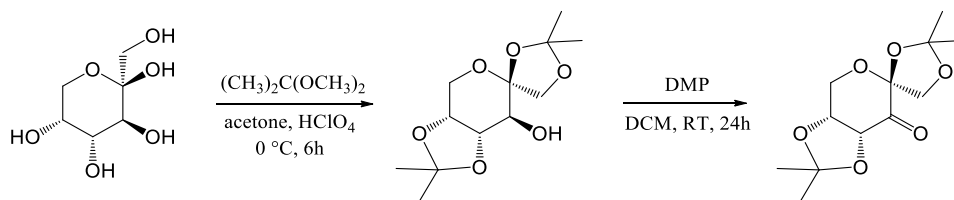
Aldehyde **7** was synthesized according to generale procedure:



Ketone **8** was synthesized according to generale procedure:



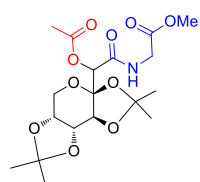
Ketone **9** was synthesized according to a literature procedure. (*Organic Synthesis* 2003 **80** 1-8; *Coll. Voll.* 2009 **11** 177-182)



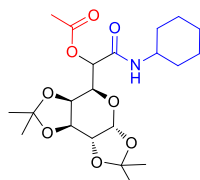
2. Synthesis and characterisation of Passerini products:

General procedure for Passerini reactions:

To a glass vial containing 1 M solution of oxo-compound (0.1 mmol) in DCM under nitrogen were added acid (0.11 mmol) and the isocyanide component (0.11 mmol) dissolved in 100 μ L DCM. With all reactants added, the reaction mixture was stirred at room temperature until the consumption of the aldehyde/ketone component, typically 6-24h. The reactions were concentrated under reduced pressure and reaction mixtures were purified by flash column chromatography.

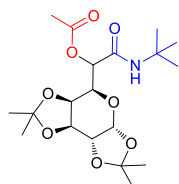


methyl 2-(2-acetoxy-2-((3aR,5aR,8aR,8bS)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-3a-yl)acetamido)acetate (1c) Yield 86 % (36 mg); colorless oil; R_f (DS1,2) = 0.47 (EtOAc/PE 2:1, v/v); *d.r.* 90:10. Chemical shifts are given for both isomers. ^1H NMR (CDCl_3) δ 6.95 (s, 0.9H, NH), 6.91 (s, 0.1H, NH), 5.50 (s, 0.1H, H-1 Fru), 5.18 (s, 0.9H, H-1 Fru), 4.69 (d, J = 2.6 Hz, 0.1H, H-3 Fru), 4.58 (dd, J = 7.9, 2.8 Hz, 0.9H, H-4 Fru), 4.54 (dd, J = 8.0, 2.6 Hz, 0.1H, H-4 Fru), 4.36 (d, J = 2.8 Hz, 0.9H, H-3 Fru), 4.22 (dd, J = 7.9, 1.3 Hz, 0.9H, H-5 Fru), 4.17 (dd, J = 8.0, 1.6 Hz, 0.1H, H-5 Fru), 4.09 (dd, J = 18.5, 5.0 Hz, 1H, CH_2 Gly), 4.02 (dd, J = 18.5, 4.9 Hz, 1H, CH_2 Gly) 3.96 (dd, J = 18.5, 4.6 Hz, 0.1H, H-6 Fru), 3.92 (dd, J = 13.0, 1.9 Hz, 0.9H, H-6 Fru), 3.83 (d, J = 13.0 Hz, 1H, H-6 Fru), 3.73 (s, 0.3H, CH_3 Gly), 3.72 (s, 2.7H, CH_3 Gly), 2.19 (s, 0.3H, CH_3 Ac), 2.17 (s, 2.7H CH_3 Ac), 1.51 (s, 3H, CH_3 isop), 1.48 (s, 3H, CH_3 isop), 1.44 (s, 3H, CH_3 isop), 1.31 (s, 3H, CH_3 isop). ^{13}C NMR (CDCl_3) δ (170.2, 169.2, 165.7) (CO), (109.9, 109.6) (CH_3 isop), (102.1, 101.5) (C-2 Fru), (75.7, 73.8, 71.6, 70.8, 70.8, 70.4, 70.3) (C-1,3,4,5 Fru), (62.0, 61.8) (C-6 Fru), (52.6, 52.4) (CH_3 Gly), (41.6, 41.3) (CH_2 Gly), (26.7, 26.7, 26.2, 26.0, 25.5, 25.2, 24.3, 24.2) (CH_3 isop), (21.1, 20.9) (CH_3 Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{18}\text{H}_{27}\text{NO}_{10}\text{Na}$ $[\text{M}+\text{Na}]^+$ 440.1533; found 440.1528.



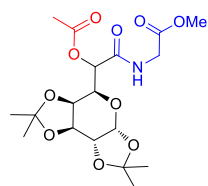
2-(cyclohexylamino)-2-oxo-1-((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethyl acetate (2a) Yield 81 % (35 mg); white solid mp = 111-112 $^{\circ}\text{C}$; R_f (DS1) = 0.52, R_f (DS2) = 0.47 (EtOAc/PE 1:1, v/v); *d.r.* 80:20. Chemical shifts are given for major isomer. ^1H NMR (CDCl_3): δ 6.18 (d, J = 7.9 Hz, 1H, NH), 5.49 (d, J = 4.8 Hz, 1H, H-1 Gal), 4.95 (d, J = 9.7 Hz, 1H, H-6 Gal), 4.60 (dd, J = 7.9, 2.6 Hz, 1H, H-3 Gal), 4.31 (dd, J = 4.8, 2.6 Hz, 1H, H-2 Gal), 4.28 (dd, J = 8.0, 1.8 Hz, 1H, H-4 Gal), 4.17 (dd, J = 9.7, 1.7 Hz, 1H, H-5 Gal), 3.84 – 3.70 (m, 1H, CH-1 CyHex), 2.13 (s, 3H, CH_3 Ac), 1.88 (m, 2H, CyHex), 1.67 (m, 2H, CyHex), 1.56 (m, 1H, CyHex), 1.50 (s, 3H, CH_3 isop), 1.41 (s, 3H, CH_3 isop), 1.36 – 1.32 (m, 2H, CyHex), 1.31 (s, 3H, CH_3 isop), 1.30 (s, 3H, CH_3 isop), 1.16 (d, J = 11.9 Hz, 3H, CyHex). ^{13}C NMR (CDCl_3): δ (169.9, 167.0) (CO), (109.8,

109.7) (C isop), 96.4 (C-1 Gal), (71.0, 70.7, 70.6, 70.6, 67.2) (C-2,3,4,5,6 Gal), 48.6 (CH CyHex), (33.04, 32.99) (CyHex), (26.29, 26.17) (CH₃ isop), 25.78 (CyHex), 25.23 (CH₃ isop), (24.95, 24.91) (CyHex), 24.63 (CH₃ isop), 20.95 (CH₃ Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₂₁H₃₃NO₈ [M+H]⁺ 428.2284; found 428.2291.



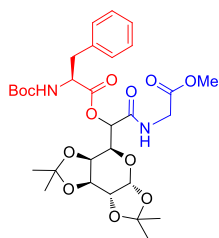
2-(tert-butylamino)-2-oxo-1-((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethyl acetate (2b) Yield 78 % (31 mg); colorless oil; R_f (DS1) = 0.58, R_f (DS2) = 0.60 (EtOAc/PE 1:1, v/v); *d.r.* 80:20. Chemical shifts are given for both isomers. ¹H NMR

(CDCl₃) δ 6.19 (s, 0.8H, NH), 6.09 (s, 0.2H, NH), 5.49 (d, J = 4.8 Hz, 1H, H-1 Gal), 5.14 (d, J = 6.5 Hz, 0.2H, H-6 Gal), 4.87 (d, J = 9.8 Hz, 0.8H, H-6 Gal), 4.61 – 4.55 (m, 1H, H-3 Gal), 4.32 – 4.23 (m, 2H, H-2,4 Gal), 4.18 (d, J = 6.4 Hz, 0.2H, H-5 Gal), 4.11 (dd, J = 9.8, 1.4 Hz, 0.8H, H-5 Gal), 2.13 (s, 3H, CH₃ Ac), 1.49 (s, 3H, CH₃ isop), 1.40 (s, 3H, CH₃ isop), 1.36 – 1.25 (m, 15H, CH₃ isop, CH₃ tBu). ¹³C NMR (CDCl₃) δ (170.5, 169.7, 167.2, 166.3) (CO), (109.8, 109.7, 109.7, 109.3) (C isop), (96.6, 96.4) (C-1 Gal), (73.9, 71.6, 71.1, 71.0, 70.9, 70.6, 70.6, 67.4, 67.4) (C-2,3,4,5,6 Gal), 51.7 (C tBu), (28.9, 28.7) (CH₃ tBu), (26.3, 26.2, 26.2, 26.1, 25.2, 24.6, 24.3) (CH₃ isop), (21.2, 20.9) (CH₃ OAc). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₁₉H₃₁NO₈ [M+H]⁺ 402.2128; found 402.2146.



methyl 2-(2-acetoxy-2-((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)acetamido)acetate (2c) Yield 78 % (32 mg); colorless oil; R_f (DS1, DS2) = 0.45 (EtOAc/PE 1:1, v/v); *d.r.* 70:30. Chemical shifts are given for both isomers. ¹H NMR (CDCl₃) δ 6.88 (s, 0.3H, NH),

6.79 (s, 0.7H, NH), 5.50 (d, J = 4.7 Hz, 1H, H-1 Gal), 5.37 (d, J = 6.8 Hz, 0.3H, H-6 Gal), 5.08 (d, J = 9.5 Hz, 0.7H, H-6 Gal), 4.61 (m, 1H, H-3 Gal), 4.41 (d, J = 8.0 Hz, 0.3H, H-4 Gal), 4.32 – 4.26 (m, 2H, H-4 Gal, H-2 Gal, H-5 Gal), 4.20 (dd, J = 16.5, 8.4 Hz, 1H, H-5 Gal, CH₂ Gly), 4.04 (m, 1.4H, CH₂ Gly), 3.91 (dd, J = 18.3, 4.3 Hz, 0.3H, CH₂ Gly), 3.72 (s, 3H, CH₃ Gly), 2.15 (s, 0.9H, CH₃ Ac), 2.12 (s, 2.1H, CH₃ Ac), 1.53 (s, 0.9H, CH₃ isop), 1.51 (s, 2.1H, CH₃ isop), 1.44 (s, 0.9H, CH₃ isop), 1.42 (s, 2.1H, CH₃ isop), 1.31 (s, 6H, CH₃ isop). ¹³C NMR (CDCl₃) δ (170.5, 170.0, 169.9, 169.8, 168.3, 167.6) (CO), (110.0, 109.8, 109.6, 109.3) (C isop), (96.5, 96.4) (C-1 Gal), (72.9, 71.3, 71.1, 70.91, 70.8, 70.7, 70.7, 70.5, 67.2, 67.0) (C-2,3,4,5,6 Gal), (52.5, 52.5) (CH₃ Gly), (41.6, 41.4) (CH₂ Gly), (26.3, 26.2, 26.1, 26.1, 25.2, 25.2, 24.7, 24.4) (CH₃ isop), (21.1, 20.8) (CH₃ Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₁₈H₂₇NO₁₀ [M+H]⁺ 418.1713; found 418.1711.

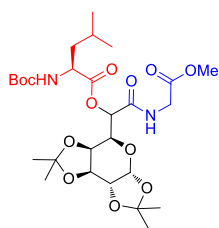


2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethyl 2-((tert-butoxycarbonyl)amino)-3-phenylpropanoate (2d) Yield 80 % (49 mg);

colorless oil; R_f (DS1,2) = 0.47 (EtOAc/PE 1:1, v/v); *d.r.* 70:30. ^1H NMR (CDCl_3)

δ 7.27 – 6.92 (m, 6H, Ph, NH), 5.50 (d, J = 5.0 Hz, 1.3H, H-1,6 Gal), 5.19 (d, J =

8.9 Hz, 0.7H, H-6 Gal), 4.97 (t, J = 8.0 Hz, 1H, NH), 4.67 – 4.45 (m, 2H, H-3 Gal, α -Phe), 4.30 (dd, J = 6.8, 4.4 Hz, 1.3H, H-2,4 Gal), 4.25 – 4.09 (m, 1.7H, H-5, H-4 Gal), 4.07 – 3.87 (m, 2H, CH_2 Gly), 3.72 (d, J = 4.6 Hz, 3H, CH_3 Gly), 3.22 (dd, J = 14.0, 6.2 Hz, 1H, β -Phe), 3.08 (dd, J = 14.8, 6.5 Hz, 1H, β -Phe), 1.54 (d, J = 3.8 Hz, 3H, CH_3 isop), 1.46 (s, 1H, CH_3 isop), 1.37 (bs, 11H, CH_3 Boc, CH_3 isop), 1.30 (dd, J = 8.0, 3.5 Hz, 6H, CH_3 isop). ^{13}C NMR (CDCl_3) δ (171.5, 170.8, 169.8, 169.8, 167.8, 167.3) (CO), (155.5, 155.4) (CO Boc), (136.5, 136.4) (C Ph), (129.8, 129.7, 128.7, 128.6, 127.1, 126.9) (CH Ph), (109.9, 109.8, 109.6, 109.3) (C isop), (96.4, 96.4) (C-1), (80.3, 80.1) (C Boc), (73.3, 71.6, 71.43, 71.03, 70.9, 70.6, 70.3) (C-2,3,4,6), (67.2, 67.0) (C-5 Gal), (54.9, 54.5) (α -Phe), 52.5 (CH_3 Gly), (41.5, 41.3) (CH_2 Gly), (38.3, 37.5) (β -Phe), 28.5 (CH_3 Boc), (26.3, 26.2, 26.2, 26.0, 25.2, 24.5, 24.5) (CH_3 isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{30}\text{H}_{42}\text{N}_2\text{O}_{12}\text{Na}$ $[\text{M}+\text{Na}]^+$ 645.2635; found 645.2615.

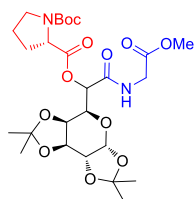


2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethyl 2-((tert-butoxycarbonyl)amino)-4-methylpentanoate (2e) Yield 58 % (34 mg);

colorless oil; R_f (DS1,2) = 0.55, (EtOAc/PE 1:1, v/v); *d.r.* 75:25. ^1H NMR (CDCl_3)

δ 7.33 (s, 0.25H, NH), 6.93 (s, 0.75H, NH), 5.50 (0.25, H-6 Gal), 5.50 (d, J = 4.8

Hz, 0.75H, H-1 Gal), 5.44 (d, J = 4.8 Hz, 0.25H, H-1 Gal), 5.19 (d, J = 8.9 Hz, 0.75H, H-6 Gal), 4.90 (dd, J = 16.4, 7.7 Hz, 1H, NH Leu), 4.63 – 4.60 (m, 0.75H, H-3 Gal), 4.57 (dd, J = 7.9, 2.1 Hz, 0.25H, H-3 Gal), 4.50 (d, J = 7.6 Hz, 0.25H, α -Leu), 4.36 (m, 0.75H, α -Leu), 4.33 – 4.16 (m, 3H, H-2,4,5 Gal), 4.02 (ddd, J = 41.5, 18.2, 5.3 Hz, 2H, CH_2 Gly), 3.70 (d, J = 6.9 Hz, 3H, CH_3 Gly), 1.74 (s, 3H, β -Leu, γ -Leu), 1.51 (d, J = 7.5 Hz, 3H, CH_3 isop), 1.45 – 1.37 (m, 15H, CH_3 Boc, CH_3 isop), 1.31 – 1.27 (m, 3H, CH_3 isop), 0.94 – 0.91 (m, 6H, CH_3 Leu). ^{13}C NMR (151 MHz, CDCl_3) δ (172.8, 172.0, 169.9, 169.8, 167.8, 167.5) (CO), (156.0, 155.7) (CO Boc), (109.9, 109.6, 109.1) (C isop), 96.4 (C-1 Gal), (80.3, 80.0) (C Boc), (72.7, 71.6, 71.0, 71.0, 70.6, 70.4) (C-2,3,4,6 Gal), (67.4, 67.0) (C-5 Gal), (52.9, 52.4, 52.3) (CH_3 Gly, α -Leu), (41.8, 41.4, 41.3, 41.0) (CH_2 Gly, β -Leu), 29.9, (28.5, 28.5) (Boc), (26.3, 26.2, 26.1) (CH_3 isop), (25.3, 25.2) (γ -Leu), (24.9, 24.8, 24.6, 23.1, 23.0) (CH_3 isop), (22.3, 22.0) (δ -Leu). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{27}\text{H}_{44}\text{N}_2\text{O}_{12}\text{Na}$ $[\text{M}+\text{Na}]^+$ 611.2792; found 611.2805.



1-tert-butyl

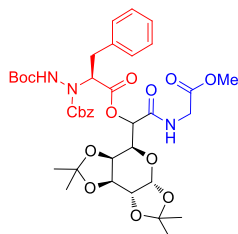
2-(2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-

((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-

bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethyl) pyrrolidine-1,2-dicarboxylate

(2f) Yield 67 % (40 mg); colorless oil; R_f (DS1,2) = 0.35, (EtOAc/PE 1:1, v/v); *d.r.*

55:45. ^1H NMR (CDCl_3) δ 7.38 (dd, J = 19.5, 14.3 Hz, 0.45H, NH), 6.74 (t, J = 4.7 Hz, 0.55H, NH), 5.49 (d, J = 4.8 Hz, 1H, H-1 Gal), 5.28 (d, J = 8.0 Hz, 0.55H, H-6 Gal), 5.05 (d, J = 9.7 Hz, 0.45H, H-6 Gal), 4.60 (ddd, J = 25.8, 7.9, 2.3 Hz, 1H, H-3 Gal), 4.38 – 4.23 (m, 4H, H-2, H-4, H-5 Gal, CH_2 Gly), 4.10 (dd, J = 17.9, 6.0 Hz, 0.55H, CH_2 Gly), 4.02 (t, J = 5.7 Hz, 1H, α -Pro), 3.88 (dd, J = 17.9, 5.3 Hz, 0.45H, CH_2 Gly), 3.71 (s, 1.6H, CH_3 Gly), 3.68 (s, 1.4H, CH_3 Gly), 3.55 – 3.46 (m, 1H, δ -Pro), 3.42 – 3.30 (m, 1H, δ -Pro), 2.33 – 2.26 (m, 0.5H, β -Pro), 2.22 – 2.13 (m, 1.5H, β -Pro), 1.88 (ddd, J = 25.6, 11.5, 8.4 Hz, 2H, γ -Pro), 1.36 (ddd, J = 36.5, 29.4, 26.3 Hz, 21H, CH_3 Boc, CH_3 isop). ^{13}C NMR (CDCl_3) δ (171.8, 171.5, 169.9, 168.3, 167.8) (CO), (155.3, 154.1) (CO Boc), (109.8, 109.7, 109.6, 109.3) (C isop), (96.5, 96.4) (C-1 Gal), (80.2, 80.1) (C Boc), (71.9, 71.2, 70.9, 70.8, 70.7, 70.5, 70.4) (C-2,3,4,6 Gal), (67.1, 66.9) (C-5 Gal), (59.2, 58.9) (α -Pro), (52.4, 52.3) (CH_3 Gly), (47.0, 46.5) (δ -Pro), (41.5, 41.2) (CH_2 Gly), (30.9, 30.2) (β -Pro), (28.7, 28.5) (CH_3 Boc), (26.3, 26.2, 26.2, 25.2, 25.2, 24.7, 24.4) (CH_3 isop), (24.4, 23.4) (γ -Pro). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{26}\text{H}_{40}\text{N}_2\text{O}_{12}$ $[\text{M}+\text{H}]^+$ 595.2479; found 595.2453.



1-benzyl

2-tert-butyl

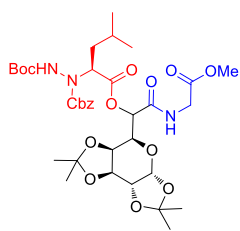
1-(1-(2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-

((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-

bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethoxy)-1-oxo-3-phenylpropan-2-yl)hydrazine-1,2-dicarboxylate (2g) Yield 74 % (57 mg); colorless oil; R_f

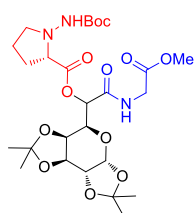
(DS1,2) = 0.44 (EtOAc/PE 1:1, v/v); *d.r.* 70:30. ^1H NMR (CDCl_3) δ 7.27 (d, J =

16.6 Hz, 11H, CH Ph, NH), 5.50 (d, J = 4.8 Hz, 1H, H-1 Gal), 5.25 – 5.16 (m, 4H, H-6 Gal, CH_2 Cbz, NH), 5.07 (m, 1H, α -hPhe), 4.55 (d, J = 10.2 Hz, 1H, H-3 Gal), 4.46 (dd, J = 8.0, 1.3 Hz, 1H, H-4 Gal), 4.30 (dd, J = 4.7, 2.5 Hz, 1H, H-2 Gal), 4.15 – 3.98 (m, 3H, H-5 Gal, CH_2 Gly), 3.72 (s, 1.8H, CH_3 Gly), 3.70 (s, 1.2H, CH_3 Gly), 3.31 (dd, J = 12.8, 6.8 Hz, 1H, β -hPhe), 3.24 – 3.07 (m, 1H, β -hPhe), 1.54 – 1.12 (m, 21H, CH_3 Boc, CH_3 isop). ^{13}C NMR (CDCl_3) δ (169.8, 169.1, 168.5, 167.6) (CO), 155.3 (CO Boc), (137.9, 136.0) (C Ph), (129.6, 128.5, 128.4, 128.2, 127.9, 126.6) (CH Ph), (110.1, 109.8, 109.6, 109.6) (C isop), (96.4, 96.3) (C-1 Gal), (81.2, 81.2) (C Boc), (70.9, 70.8, 70.8, 70.4, 70.2) (H-2,3,4,6 Gal), (68.5, 68.3) (CH_2 Cbz), (67.7, 67.1) (C-5 Gal), (62.7, 62.2) (α -Phe), 52.5 (CH_3 Gly), (41.5, 41.2) (CH_2 Gly), (34.6, 34.3) (β -Phe), (28.3, 28.1) (CH_3 Boc), (26.2, 26.1, 26.0, 25.9, 25.1, 24.4, 24.4, 24.2) (CH_3 isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{38}\text{H}_{49}\text{N}_3\text{O}_{12}\text{Na}$ $[\text{M}+\text{Na}]^+$ 794.3112; found 794.3111.



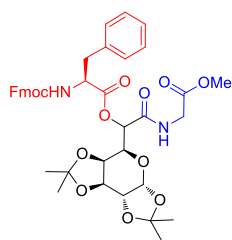
1-benzyl 2-tert-butyl 1-(1-(2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethoxy)-4-methyl-1-oxopentane-2-yl)hydrazine-1,2-dicarboxylate (2h) Yield 53 % (39 mg); colorless oil; R_f

(DS1,2) = 0.54 (EtOAc/PE 1:1, v/v); *d.r.* 70:30. ^1H NMR (CDCl_3) δ 7.31 (m, 5H, Ph Cbz), 6.91 (s, H, NH), 6.72 (s, H, NH), 5.49 (dd, J = 13.6, 4.7 Hz, 1H, H-1 Gal), 5.15 (ddd, J = 33.8, 24.8, 12.0 Hz, 4H, H-6 Gal, CH_2 Cbz, NH), 4.79 (t, J = 10.2 Hz, 1H, α -hLeu), 4.63 – 4.48 (m, 1H, H-3 Gal), 4.39 – 3.86 (m, 5H, H-2,4,5 Gal, CH_2 Gly), 3.72 (d, J = 3.1 Hz, 3H, CH_3 Gly), 1.94 (m, 1H, β -hLeu), 1.63 (m, 1H, β -hLeu), 1.56 – 1.19 (m, 21H, CH_3 Boc, CH_3 isop), 1.06 – 0.80 (m, 6H, δ -hLeu). ^{13}C NMR (CDCl_3) δ (169.8, 169.7, 167.7) (CO), (156.4, 155.1) (CO Boc), 136.1 (C Cbz), (128.8, 128.8, 128.3) (CH Cbz), (109.9, 109.86, 109.8, 109.8) (C isop), (96.4, 96.3) (C-1 Gal), (81.5, 81.4) (CO Boc), (74.4, 71.6, 71.4, 70.9, 70.6, 70.4, 70.2) (C-2,3,4,6), (68.8, 68.7) (CH_2 Cbz), (67.2, 67.1, 66.9) (C-5 Gal), (60.3, 59.3) (α -Leu), 52.5 (CH_3 Gly), (41.6, 39.9) (CH_2 Gly), (37.0, 36.8) (β -Leu), 28.4 (CH_3 Boc), (26.2, 26.2, 26.1, 26.0) (CH_3 isop), (25.2, 25.2) (γ -Leu), (24.5, 24.4, 24.3, 23.9, 23.5) (CH_3 isop), (21.7, 21.7) (δ -Leu). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{35}\text{H}_{51}\text{N}_3\text{O}_{14}$ $[\text{M}+\text{Na}]^+$ 760.3269; found 760.3243.



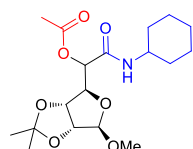
2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethyl 1-((tert-butoxycarbonyl)amino)pyrrolidine-2-carboxylate (2i) Yield 66 % (39 mg); colorless oil; R_f (DS1,2) = 0.38 (EtOAc/PE 2:1, v/v); *d.r.* 70:30. ^1H NMR (CDCl_3) δ 7.03 (s, 0.3H), 6.95 (s, 0.7H), 6.71 (d, J = 13.8 Hz, 1H), 5.52 (d, J = 4.8

Hz, 0.7H), 5.49 (d, J = 4.9 Hz, 0.3H), 5.37 (d, J = 8.0 Hz, 0.3H), 5.19 (d, J = 9.3 Hz, 0.7H), 4.61 (dd, J = 7.9, 2.4 Hz, 1H), 4.47 (dd, J = 8.0, 1.7 Hz, 0.3H), 4.32 (dd, J = 4.9, 2.6 Hz, 0.7H), 4.28 (dd, J = 7.8, 1.8 Hz, 1H), 4.21 (dd, J = 9.3, 1.8 Hz, 0.3H), 4.18 – 4.13 (m, 0.7H), 4.03 (dd, J = 7.4, 5.4 Hz, 2H), 3.92 (dd, J = 18.3, 4.8 Hz, 0.3H), 3.71 (s, 0.9H), 3.71 (s, 2.1H), 3.29 (td, J = 14.2, 7.6 Hz, 1H, δ -Pro), 3.13 – 3.06 (m, 1H, δ -Pro), 2.21 (dq, J = 16.4, 8.2 Hz, 1H, β -Pro), 2.13 – 2.03 (m, 1H, β -Pro), 1.93 – 1.84 (m, 2H, γ -Pro), 1.38 (m, 21H, CH_3 Boc, CH_3 isop). ^{13}C NMR (CDCl_3) δ (173.0, 172.0, 170.0, 169.9, 168.3, 167.1) (CO), (110.1, 110.0, 109.7, 109.3) (C isop), (96.5, 96.4) (C-1 Gal), (80.2, 80.0) (CO Boc), (72.8, 71.1, 70.9, 70.8, 70.7, 70.6, 70.4) (C-2,3,4,6 Gal), (67.5, 67.2) (C-5 Gal), (64.8, 64.0) (α -Pro), (53.4, 53.2) (δ -Pro), (52.5, 52.4) (CH_3 Gly), (41.5, 41.3) (CH_2 Gly), (28.6, 28.5) (CH_3 Boc), (27.9, 27.6) (β -Pro), (26.2, 26.2, 26.1, 25.2, 25.1, 24.6, 24.5) (CH_3 isop), (22.3, 22.2) (γ -Pro). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{26}\text{H}_{41}\text{N}_3\text{O}_{12}\text{Na}$ $[\text{M}+\text{Na}]^+$ 610.2588; found 610.2571.



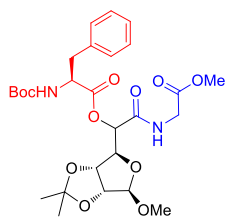
2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-((3aR,5S,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethyl 2-((((9H-fluoren-9-yl)methoxy)carbonyl)amino)-3-phenylpropanoate (2k)

Yield 74% (55 mg); colorless oil; R_f (DS1,2) = 0.39, (EtOAc/PE 1:1, v/v); *d.r.* 70:30. ^1H NMR (CDCl_3) δ 7.73 (d, J = 7.5 Hz, 2H, Fmoc), 7.54 – 7.49 (m, 2H, Fmoc), 7.37 (t, J = 7.4 Hz, 2H, Fmoc), 7.30 – 7.19 (m, 7H, Ph), 6.96 (s, 0.3H, NH), 6.87 (s, 0.7H, NH), 5.52 (d, J = 4.7 Hz, 0.3H, H-1 Gal), 5.50 (d, J = 4.8 Hz, 0.7H, H-1 Gal), 5.44 (d, J = 7.6 Hz, 0.3H, H-6 Gal), 5.31 (d, J = 8.3 Hz, 0.7H, NH), 5.29 – 5.24 (m, 0.3H, NH), 5.17 (d, J = 9.2 Hz, 0.7H, H-6 Gal), 4.78 – 4.69 (m, 1H, α -Phe), 4.58 (ddd, J = 32.1, 7.8, 2.2 Hz, 1H, H-3 Gal), 4.38 (dt, J = 18.2, 9.1 Hz, 1H, CH_2 Fmoc), 4.30 (dd, J = 4.9, 2.6 Hz, 1H, H-2 Gal), 4.27 – 4.00 (m, 6H, CH_2 Gly, CH Fmoc, CH_2 Fmoc, H-5,4 Gal), 3.72 (s, 2.1H, CH_3 Gly), 3.68 (s, 0.9H, CH_3 Gly), 3.26 (dd, J = 14.0, 6.2 Hz, 1H, β -Phe), 3.13 (dd, J = 14.0, 6.4 Hz, 1H, β -Phe), 1.55 – 1.21 (m, 12H, CH_3 isop). ^{13}C NMR (CDCl_3) δ (171.1, 170.5, 169.8, 167.7) (CO Fmoc), (155.9, 155.8) (CO Fmoc), (144.0, 143.9, 141.5) (C Fmoc), (136.4, 136.1) (C Ph), (129.8, 129.8, 128.8, 128.6, 127.9, 127.2, 127.1) (CH Ph), (125.3, 125.3, 125.2) (CH Fmoc-Ph), (120.2, 120.1) (CH Fmoc-Ph), (110.0, 109.9, 109.6, 109.3) (C isop), (96.4, 96.4) (C-1 Gal), (73.5, 71.5, 71.3, 71.0, 70.9, 70.8, 70.5, 70.3) (C-2,3,4,6 Gal), 67.4 (C-5 Gal), 67.2 (CH_2 Fmoc), 67.0 (C-5 Gal), (55.1, 54.9) (α -Phe), (52.5, 52.4) (CH_3 Gly), (47.4, 47.3) (CH Fmoc), (41.5, 41.3) (CH_2 Gly), (38.3, 37.6) (β -Phe), (26.3, 26.2, 26.2, 26.0, 25.2, 24.5, 24.4) (CH_3 isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{40}\text{H}_{44}\text{N}_2\text{O}_{12}$ $[\text{M}+\text{H}]^+$ 745.2972; found 745.2990.



2-(cyclohexylamino)-1-((3aR,4S,6R,6aR)-6-methoxy-2,2-dimethyltetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-2-oxoethyl acetate (3a)

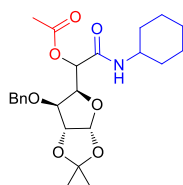
Yield 82% (30 mg); colorless oil; R_f = 0.63 (EtOAc/PE 1:1, v/v); *d.r.* 77:23. Chemical shifts are given for both isomers. ^1H NMR (CDCl_3): δ 5.97 (d, J = 7.5 Hz, 0.77H, NH), 5.90 (d, J = 7.7 Hz, 0.23H, NH), 5.11 (d, J = 7.6 Hz, 0.23H, H-5 Rib), 5.07 (d, J = 6.9 Hz, 0.77H, H-5 Rib), 4.95 (s, 0.23H, H-1 Rib), 4.94 (s, 0.77H, H-1 Rib), 4.87 (dd, J = 6.0, 1.4 Hz, 0.23H, H-2 Rib), 4.71 (dd, J = 6.2, 0.5 Hz, 0.77H, H-2 Rib), 4.60 (d, J = 6.9 Hz, 0.77H, H-4 Rib), 4.55 (d, J = 6.0 Hz, 0.77H, H-3 Rib), 4.53 (d, J = 6.0 Hz, 0.23H, H-3 Rib), 4.50 (dd, J = 7.6, 1.4 Hz, 0.23H, H-4 Rib), 3.79 – 3.72 (m, 1H, CH-1 CyHex), 3.32 (s, 2.3H, OCH_3), 3.28 (s, 0.7H, OCH_3), 2.15 (s, 0.7H, CH_3 Ac), 2.13 (s, 2.3H, CH_3 Ac), 1.89 (m, 2H, CyHex), 1.66 (m, 2H, CyHex), 1.58 (m, 1H, CyHex), 1.45 (s, 3H, CH_3 isop), 1.34 (m, 2H, CyHex), 1.29 (s, 2.3H, CH_3 isop), 1.28 (s, 0.7H, CH_3 isop), 1.16 – 1.14 (m, 3H, CyHex). ^{13}C NMR (CDCl_3) δ (170.0, 166.1) (CO), 112.9 (C isop), (111.1, 110.3) (C-1 Rib), (86.2, 86.0) (C-4 Rib), (85.4, 85.3) (C-3 Rib), (81.7, 81.4) (C-2 Rib), (74.8, 73.6) (C-5 Rib), (56.2, 55.5) (OCH_3), 48.5 (CH CyHex), 48.35 (CH CyHex), (33.1, 33.1) (CyHex), (26.8, 26.7) (CH_3 isop), (25.7, 25.6, 25.3, 24.9, 24.9) (CyHex), (21.4, 21.1) (CH_3 Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{18}\text{H}_{29}\text{NO}_7\text{Na}$ $[\text{M}+\text{Na}]^+$ 394.1842; found 394.1843.



1-((3aR,4S,6R,6aR)-6-methoxy-2,2-dimethyltetrahydrofuro[3,4-d][1,3]dioxol-4-yl)-2-((2-methoxy-2-oxoethyl)amino)-2-oxoethyl 2-((tert-butoxycarbonyl)amino)-3-phenylpropanoate (3d) Yield 78 % (44 mg);

colorless oil; R_f (DS1) = 0.53, (EtOAc/PE 1:1, v/v); *d.r.* 77:23. ^1H NMR (CDCl_3) δ 7.36 – 7.08 (m, 5H, CH Ph), 7.15 (s, 1H, NH), 5.36 (d, J = 4.6 Hz, 1H, NH),

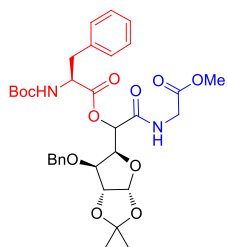
5.19 (d, J = 4.8 Hz, 0.23H, H-5 Rib), 5.04 (d, J = 7.6 Hz, 0.77H, H-5 Rib), 4.96 (s, 0.77H, H-1 Rib), 4.94 (s, 0.23H, H-1 Rib), 4.74 - 4.53 (m, 4H, H-2,3,4 Rib, α -Phe), 4.09 (d, J = 5.8 Hz, 0.23H, CH_2 Gly), 4.03 (d, J = 5.8 Hz, 0.77H, CH_2 Gly), 3.94 (d, J = 5.4 Hz, 0.77H, CH_2 Gly), 3.88 (d, J = 5.4 Hz, 0.23H, CH_2 Gly), 3.71 (d, J = 5.2 Hz, 3H, CH_3 Gly), 3.33 – 3.30 (m, 3.77H, CH_3 Rib, β -Phe), 2.98 (dd, J = 14.3, 8.8 Hz, 1.23H, β -Phe), 1.46 (s, 2.31H, CH_3 isop), 1.42 (s, 0.69H, CH_3 isop), 1.39 (s, 2.31H, Boc), 1.37 (s, 6.9H, Boc), 1.31 (s, 2.1H, CH_3 isop), 1.27 (s, 0.69H, CH_3 isop). ^{13}C NMR (CDCl_3) δ (170.5, 169.6, 167.2) (CO), 156.2 (CO Boc), 136.4 (C Ph), (129.6, 129.3, 129.0, 128.9, 127.6, 127.3) (CH Ph), 112.8 (C isop), (111.9, 109.9) (C-1 Rib), (86.4, 86.2) (C-4 Rib), (85.7, 85.6) (C-3 Rib), (81.2, 81.0) (C-2 Rib), (80.9, 80.7) (C Boc), (75.0, 74.5) (C-5 Rib), (56.3, 55.9) (α -Phe), (55.3, 54.9) (CH_3 Rib), (52.5, 52.3) (CH_3 Gly), (41.2, 41.1) (CH_2 Gly), (37.6, 37.6) (β -Phe), (28.5, 28.4) (CH_3 Boc), (26.9, 26.7) (CH_3 isop), (25.7, 25.3) CH_3 isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{27}\text{H}_{38}\text{N}_2\text{O}_{11}\text{Na}$ $[\text{M}+\text{Na}]^+$ 589.2373; found 589.2399.



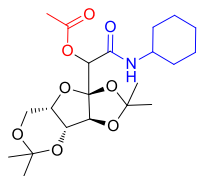
1-((3aR,5S,6S,6aR)-6-(benzyloxy)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-5-yl)-2-(cyclohexylamino)-2-oxoethyl acetate (4a) Yield 79% (36 mg); colorless oil;

R_f (DS1) = 0.40, R_f (DS2) = 0.26 (EtOAc/PE 1:2, v/v); *d.r.* 77:23. Chemical shifts are given for major isomer. ^1H NMR (CDCl_3): δ 7.41 – 7.14 (m, 5H, Ph), 6.01 (d, J = 7.9

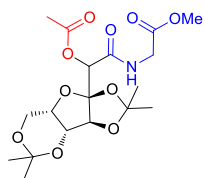
Hz, 1H, NH), 5.92 (d, J = 3.7 Hz, 1H, H-1 Xyl), 5.11 (d, J = 9.2 Hz, 1H, H-5 Xyl), 4.62 (d, J = 11.6 Hz, 1H, CH_{2a} -Ph), 4.60 (d, J = 3.7 Hz, 1H, H-2 Xyl), 4.45 – 4.38 (m, 2H, H-4 Xyl, CH_{2b} -Ph), 3.99 (d, J = 3.1 Hz, 1H, H-3 Xyl), 3.79 – 3.70 (m, 1H, CH-1 CyHex), 1.98 (s, 3H, CH_3 Ac), 1.84 (m, 2H, CyHex), 1.63 (m, 2H), 1.55 – 1.50 (m, 1H, CyHex), 1.45 (s, 3H, CH_3 isop), 1.30 (bs, 5H, CH_3 isop, CyHex), 1.16 – 1.06 (m, 3H, CyHex). ^{13}C NMR (CDCl_3) δ (169.70, 166.78) (CO), 136.97 (C Ph), (128.84, 128.45, 128.35) (CH Ph), 112.61 (C isop), 105.65 (C-1 Xyl), (81.79, 81.30, 78.64, 72.47, 70.22) (C-2,3,4,5-Xyl, CH_2 -Ph), 48.52 (CH CyHex), (32.89, 32.83) (CyHex), (27.01, 26.58) (CH_3 isop), (25.73, 24.79, 24.75) (CyHex), 20.78 (CH_3 Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{24}\text{H}_{33}\text{NO}_7$ $[\text{M}+\text{H}]^+$ 448.2335; found 448.2346.



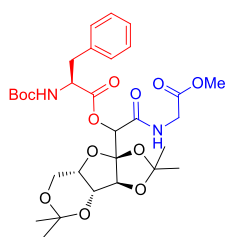
1-((3aR,5S,6S,6aR)-6-(benzyloxy)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-5-yl)-2-((2-methoxy-2-oxoethyl)amino)-2-oxoethyl 2-((tert-butoxycarbonyl)amino)-3-phenylpropanoate (4d) Yield 75 % (48 mg); colorless oil; R_f (DS1) = 0.52, (EtOAc/PE 1:1, v/v); *d.r.* 77:23. ^1H NMR (CDCl_3) δ 7.42 – 7.11 (m, 10H, Bn, Ph), 6.86 (s, 1H, NH), 5.94 (d, J = 3.6 Hz, 1H, H-1 Xyl), 5.65 (d, J = 7.2 Hz, 0.23H, H-5 Xyl), 5.43 (d, J = 9.0 Hz, 0.77H, H-5 Xyl), 4.91 (m, 1H, α -Phe), 4.67 – 4.39 (m, 5.77H, H-2, H-4, H-3 Xyl, NH, CH_2 OBn), 4.24 (d, J = 3.9 Hz, 0.23H, H-3 Xyl), 4.02 (d, J = 5.3 Hz, 0.77H, CH_2 Gly), 3.99 (m, 0.77H, CH_2 Gly), 3.92 (d, J = 5.7 Hz, 0.46H, CH_2 Gly), 3.71 (s, 2.31H, CH_3 Gly), 3.69 (s, 0.69H, CH_3 Gly), 3.28 (dd, J = 14.1, 5.6 Hz, 0.77H, β -Phe), 3.12 (dd, J = 14.2, 5.3 Hz, 0.23H, β -Phe), 3.00 (dd, J = 14.1, 7.7 Hz, 0.77H, β -Phe), 2.88 (dd, J = 14.1, 8.3 Hz, 0.23H, β -Phe), 1.48 (s, 3H, CH_3 isop), 1.35 (s, 3H, CH_3 isop), 1.30 (s, 9H, CH_3 Boc). ^{13}C NMR (CDCl_3) δ (171.0, 169.8, 167.7) (CO), 155.4 (CO Boc), (137.1, 136.5, 136.1) (C Ph), (129.7, 129.5, 128.8, 128.7, 128.6, 128.4, 128.3, 128.2, 127.2, 127.0) (CH Ph), (112.8, 112.4) (C isop), (105.8, 105.2) (C-1 Xyl), (83.0, 83.0) (C-2 Xyl), (81.9, 81.4) (C-3 Xyl), (80.6, 80.0) (C Boc), (79.0, 78.5) (C-4 Xyl), (72.8, 72.6) (CH_2 -OBn), (72.1, 70.0) (C-5 Xyl), (55.0, 54.3) (α -Phe), (52.5, 52.4) (CH_3 Gly), (41.5, 41.1) (CH_2 Gly), (37.9, 37.1) (β -Phe), 28.3 (CH_3 Boc), (28.35, 27.2, 27.0, 26.6, 26.5) (CH_3 isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{33}\text{H}_{42}\text{N}_2\text{O}_{11}\text{Na}$ $[\text{M}+\text{Na}]^+$ 665.2686; found 665.2682.



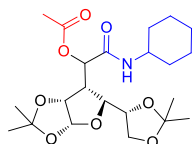
2-(cyclohexylamino)-2-oxo-1-((3aS,3bR,7aS,8aR)-2,2,5,5-tetramethyltetrahydro-3aH-[1,3]dioxolo[4',5':4,5]furo[3,2-d][1,3]dioxin-8a-yl)ethyl acetate (5a) Yield 66 % (28 mg); colorless oil; R_f (DS1) = 0.50, R_f (DS2) = 0.40 (toluen/acetone 5:1, v/v); *d.r.* 90:10. Chemical shifts are given for major isomer. ^1H NMR (CDCl_3): δ 6.30 (d, J = 7.6 Hz, 1H, NH), 5.26 (s, 1H, H-1 Sor), 4.41 (s, 1H, H-5 Sor), 4.31 (d, J = 2.2 Hz, 1H, H-4 Sor), 4.17 (d, J = 1.5 Hz, 1H, H-3 Sor), 4.07 (dd, J = 13.6, 2.2 Hz, 1H, H-6a Sor), 3.98 (d, J = 13.5 Hz, 1H, H-6b Sor), 3.85 – 3.75 (m, 1H, CH-1 CyHex), 2.17 (s, 3H, CH_3 Ac), 1.89 (m, 2H, CyHex), 1.63 (s, 3H, CyHex), 1.54 (m, 1H, CyHex), 1.46 (s, 3H, CH_3 isop), 1.41 (d, 6H, CH_3 isop), 1.38 (bs, 3H, CH_3 isop), 1.34 (m, 1H, CyHex), 1.24 – 1.17 (m, 3H, CyHex). ^{13}C NMR (CDCl_3): δ (169.6, 164.6) (CO), (113.8, 113.2) (C isop), 97.8 (C-2 Sor), 85.66 (C-5 Sor), 73.7 (C-3 Sor), 72.9 (C-4 Sor), 72.7 (C-1 Sor), 60.6 (C-6 Sor), 48.4 (CH CyHex), 32.9 (CyHex), (32.8, 29.2) (CyHex), (27.8, 26.5, 25.9) (CH_3 isop), (24.7, 24.7) (CyHex), 21.0 (CH_3 isop), 18.9 (CH_3 Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{21}\text{H}_{33}\text{NO}_8$ $[\text{M}+\text{H}]^+$ 428.2284; found 428.2272.



methyl 2-(2-acetoxy-2-((3aS,3bR,7aS,8aR)-2,2,5,5-tetramethyltetrahydro-3aH-[1,3]dioxolo[4',5':4,5]furo[3,2-d][1,3]dioxin-8a-yl)acetamido)acetate (5c) Yield 63% (26 mg); colorless oil; R_f (DS1) = 0.30, R_f (DS2) = 0.27 (EtOAc/PE 1:1, v/v); *d.r.* 87:13. ^1H NMR (CDCl_3) δ 7.10 (s, 0.87H, NH), 6.84 (s, 0.13H, NH), 5.68 (s, 0.13H, H-1 Sor), 5.39 (s, 0.87H, H-1 Sor), 4.87 (s, 0.13H, H-5 Sor), 4.41 (s, 0.87H, H-5 Sor), 4.33 (d, J = 1.7 Hz, 0.87H, H-4 Sor), 4.29 (d, J = 2.3 Hz, 0.13H, H-4 Sor), 4.23 – 3.96 (m, 5H, H-3,6 Sor, CH_2 Gly), 3.73 (d, J = 1.8 Hz, 3H, CH_3 Gly), 2.22 (s, 0.39H, CH_3 Ac), 2.18 (s, 2.61H, CH_3 Ac), 1.47-1.30 (m, 12H, CH_3 isop). ^{13}C NMR (CDCl_3) δ (170.2, 169.4, 165.6) (CO), 114.0 (C isop), 112.9 (C isop), 97.8 (C-2 Sor), 85.6 (C-5 Sor), (74.5, 74.0, 73.5, 73.2, 72.8, 72.4) (C-1,3,4 Sor), 60.4 (C-6 Sor), 52.5 (CH_3 Gly), (41.7, 41.3) (CH_2 Gly), (29.1, 28.5, 27.9, 27.7, 26.4) (CH_3 isop), (19.2, 18.8) (CH_3 Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{18}\text{H}_{27}\text{NO}_{10}$ $[\text{M}+\text{H}]^+$ 418,1713; found 418,1697.

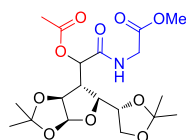


2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-((3aS,3bR,7aS,8aR)-2,2,5,5-tetramethyltetrahydro-3aH-[1,3]dioxolo[4',5':4,5]furo[3,2-d][1,3]dioxin-8a-yl)ethyl 2-((tert-butoxycarbonyl)amino)-3-phenylpropanoate (5d) Yield 65 % (40 mg); colorless oil; R_f (DS1,2) = 0.34 (EtOAc/PE 1:1, v/v); *d.r.* 90:10. ^1H NMR (CDCl_3) δ 7.35 – 7.05 (m, 6H, CH Ph, NH), 5.50 (s, 1H, H-1 Sor), 4.94 (d, J = 8.4 Hz, 1H, NH Phe), 4.65 (dd, J = 12.9, 8.0 Hz, 1H, α -Phe), 4.42 (s, 1H, H-5 Sor), 4.36 (s, 1H, H-4 Sor), 4.25 (s, 1H, H-3 Sor), 4.17 (dd, J = 18.5, 4.9 Hz, 1H, CH_2 Gly), 4.14 – 4.10 (m, 2H, H-6 Sor), 4.07 (dd, J = 18.5, 4.7 Hz, 1H, CH_2 Gly), 3.76 (s, 3H, CH_3 Gly), 3.42 (dd, J = 14.2, 4.7 Hz, 1H, β -Phe), 3.06 (dd, J = 14.2, 8.2 Hz, 1H, β -Phe), (1.51, 1.44, 1.40, 1.36) (21H, CH_3 isop, CH_3 Boc). ^{13}C NMR (CDCl_3) δ (170.8, 170.1, 165.3) (CO), 155.4 (CO Boc), 136.6 (C Ph), (129.8, 128.7, 126.9) (CH Ph), (114.1, 112.8) (C isop), 97.8 (C-2 Sor), 85.5 (C-5 Sor), 80.0 (C Boc), 74.2 (C-3 Sor), 72.7 (C-4 Sor), 60.5 (C-6 Sor), 54.6 (α -Phe), 52.5 (CH_3 Gly), 41.8 (CH_2 Gly), 38.4 (β -Phe), (29.1, 28.4, 27.7, 26.5) (CH_3 isop), 18.9 (CH_3 Boc). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{30}\text{H}_{42}\text{NO}_{12}\text{Na}$ $[\text{M}+\text{Na}]^+$ 645.2635; found 645.2641.



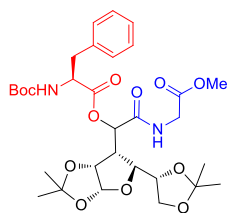
2-(cyclohexylamino)-1-((3aR,5S,6R,6aR)-5-((R)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-6-yl)-2-oxoethyl acetate (6a) Yield 72% (32 mg); colorless oil; R_f (DS1, DS2) = 0.37, (EtOAc/PE 1:1, v/v); *d.r.* 90:10. Chemical shifts are given for both isomers. ^1H NMR (CDCl_3) δ 6.04 (d, J = 7.9 Hz, 1H, NH), 5.75 (d, J = 3.6 Hz, 0.9H, H-3' Alo), 5.73 (d, J = 3.7 Hz, 0.1H, H-3' Alo), 5.37 (d, J = 6.4 Hz, 0.1H, H-1 Alo), 5.21 (d, J = 8.7 Hz, 0.9H, H-1 Alo), 4.69 – 4.62 (m, 1H, H-2 Alo), 4.27 – 4.16 (m, 2H, H-4,5 Alo), 4.03 (dd, J = 8.4, 6.5 Hz, 1H, H-6 Alo), 3.95 (dd, J = 8.4, 6.6 Hz, 0.9H, H-6 Alo), 3.88 (dd, J = 8.1, 5.4 Hz, 0.1H, H-6 Alo), 3.76 (m, 1H, CH-1 CyHex), 2.51 (m, 0.1H, H-3 Alo), 2.40 – 2.28 (m, 0.9H, H-3 Alo), 2.11 (s, 2.7H, CH_3 Ac), 2.09 (s, 0.3H, CH_3 Ac), 1.86 (s, 2H, CyHex), 1.70 –

1.54 (m, 3H, CyHex), 1.50 (s, 3H, CH₃ isop), 1.40 (s, 3H, CH₃ isop), 1.38 – 1.33 (m, 2H, CyHex), 1.32 (s, 3H, CH₃ isop), 1.27 (s, 3H, CH₃ isop), 1.20 – 1.11 (m, 3H, CyHex). ¹³C NMR (CDCl₃) δ (170.2, 167.2) (CO), (112.7, 109.8) (C isop), (105.1, 104.6) (C-1 Alo), (81.6, 81.4, 80.3, 78.5, 76.9, 71.4, 71.3) (C-2,3',4,5), (66.9, 65.8) (C-6 Alo), (48.6) (C-3 Alo), (48.4, 48.3) (CH CyHex), 32.9 (CyHex), (27.0, 26.6, 26.5, 25.7) (CH₃ isop), (25.7, 24.8) (CyHex), 21.1 (CH₃ Ac). HRMS (MALDI-TOF/TOF) *m/z*: calcd. for C₂₂H₃₅NO₈Na [M+Na]⁺ 464.2260; found 464.2254.



methyl 2-(2-acetoxy-2-((3aS,5S,6R,6aS)-5-((R)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-6-yl)acetamido)acetate (6c)

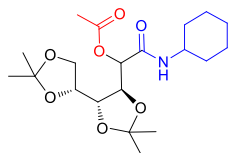
Yield 74 % (32 mg); colorless oil; *R*_f (DS1, DS2) = 0.38, (EtOAc/PE 1:1, v/v); *d.r.* 90:10. Chemical shifts are given for both isomers. ¹H NMR (CDCl₃) δ 6.77 (s, 0.9H, NH), 6.74 (s, 0.1H, NH), 5.76 (d, *J* = 3.6 Hz, 0.9H, H-3' Alo), 5.73 (d, *J* = 3.7 Hz, 0.1H, H-3' Alo), 5.48 (d, *J* = 6.0 Hz, 0.1H, H-1 Alo), 5.38 (d, *J* = 8.2 Hz, 0.9H, H-1 Alo), 4.82 (t, *J* = 4.1 Hz, 0.9H, H-2 Alo), 4.77 (t, *J* = 4.1 Hz, 0.1H, H-2 Alo), 4.26 (dd, *J* = 9.7, 5.0 Hz, 0.9H, H-4 Alo), 4.22 – 4.06 (m, 2.1H, H-4,5 Alo, CH₂ Gly), 4.05 – 4.00 (m, 1H, H-6 Alo), 3.94 (dd, *J* = 8.2, 6.9 Hz, 0.9H, H-6 Alo), 3.87 (dd, *J* = 18.3, 4.4 Hz, 1.1H, H-6 Alo, CH₂ Gly), 3.74 (s, 0.3H, CH₃ Gly), 3.72 (s, 2.7H, CH₃ Gly), 2.52 – 2.45 (m, 0.1H, H-3 Alo), 2.37 – 2.30 (m, 0.9H, H-3 Alo), 2.12 (s, 2.7H, CH₃ Ac), 2.10 (s, 0.3H, CH₃ Gly), 1.77 (s, 0.3H, CH₃ isop), 1.50 (s, 0.3H, CH₃ isop), 1.47 (s, 2.7H, CH₃ isop), 1.39 (s, 2.7H, CH₃ isop), 1.30 (s, 3H, CH₃ isop), 1.28 (s, 3H, CH₃ isop). ¹³C NMR (CDCl₃) δ (170.1, 170.0, 168.8) (CO), (112.7, 109.8) (C isop), (105.1, 104.6) (C-1 Alo), (81.3, 81.2, 79.9, 78.4, 77.3, 76.9, 71.0, 70.7) (C-2,3',4,5), (67.2, 66.0) (C-6 Alo), (52.7, 52.5) (CH₃ Gly), (48.8, 48.7, 48.3) (CH CyHex, C-3 Alo), (41.3, 41.2) (CH₂ Gly), (26.9, 26.8, 26.7, 26.5, 26.4, 25.6, 25.2) (CH₃ isop), (21.0, 20.9) (CH₃ Ac). HRMS (MALDI-TOF/TOF) *m/z*: calcd. for C₁₉H₂₉NO₁₀Na [M+Na]⁺ 454.1689; found 454.1696.



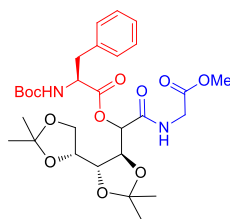
1-((3aS,6aS)-5-(2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-6-yl)-2-((2-methoxy-2-oxoethyl)amino)-2-oxoethyl 2-((tert-butoxycarbonyl)amino)-3-phenylpropanoate (6d)

Yield 77 % (49 mg); colorless oil; *R*_f (DS1,2) = 0.47 (EtOAc/PE 1:1, v/v); *d.r.* 90:10. ¹H NMR (CDCl₃) δ 7.33-7.16 (m, 5H, Ph), 6.92 (s, 1H, NH), 5.75 (d, *J* = 3.7 Hz, 1H, H-3' Alo), 5.49 (d, *J* = 7.6 Hz, 1H, H-1 Alo), 5.01 (d, *J* = 7.4 Hz, 1H, NH Phe), 4.78 (t, *J* = 4.0 Hz, 1H, α-Phe), 4.59 (dd, *J* = 13.3, 6.7 Hz, 1H, H-2 Alo), 4.31 (dd, *J* = 9.7, 4.4 Hz, 1H, H-5 Alo), 4.12 (ddd, *J* = 22.6, 11.3, 5.5 Hz, 2H, H-4 Alo, CH₂ Gly), 3.98 (d, *J* = 6.5 Hz, 2H, H-6 Alo), 3.86 (dd, *J* = 18.0, 4.9 Hz, 1H, CH₂ Gly), 3.72 (s, 3H, CH₃ Gly), 3.22 (dd, *J* = 14.1, 5.7 Hz, 1H, β-Phe), 3.07 (dd, *J* = 14.0, 7.1 Hz, 1H, β-Phe), 2.35 (ddd,

$J = 9.9, 7.8, 4.6$ Hz, 1H, H-3 Alo), 1.57-1.28 (m, 21H, CH₃ Boc, CH₃ isop). ¹³C NMR (CDCl₃) δ (171.1, 169.9, 168.6) (CO), 155.7 (CO Boc), 136.2 (C Ph), (129.6, 128.8, 127.3) (CH Ph), (112.7, 110.0) (C isop), 104.6 (C-1 Alo), 81.3 (C-2 Alo), 80.5 (C Boc), 79.5 (C-4 Alo), 76.6 (C-5 Alo), 71.3 (C-3' Alo), 65.8 (C-6 Alo), 54.8 (α -Phe), 52.5 (CH₃ Gly), 48.2 (C-3 Alo), 41.3 (CH₂ Gly), 37.9 (β -Phe), 28.49 (CH₃ Boc), (26.86, 26.62, 26.39, 25.44) (CH₃ isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₃₁H₄₄N₂O₁₂Na [M+Na]⁺ 659,2792; found 659,2790.

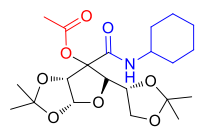


2-(cyclohexylamino)-2-oxo-1-((4R,4'R,5S)-2,2,2',2'-tetramethyl-[4,4'-bi(1,3-dioxolan)]-5-yl)ethyl acetate (7a) Yield 81 % (32 mg); colorless oil; R_f (DS1) = 0.50, R_f (DS2) = 0.48 (EtOAc/PE 1:1, v/v); *d.r.* 55:45. ¹H NMR (CDCl₃) δ 5.95 (d, $J = 7.9$ Hz, 0.55H, NH), 5.77 (d, $J = 8.1$ Hz, 0.45H, NH), 5.37 (d, $J = 2.7$ Hz, 0.55H, H-1 Ara), 5.28 (d, $J = 2.3$ Hz, 0.45H, H-1 Ara), 4.37 (dd, $J = 7.5, 2.3$ Hz, 0.45H, H-2 Ara), 4.32 (t, $J = 7.8$ Hz, 0.55H, H-3 Ara), 4.10 (dd, $J = 8.0, 2.7$ Hz, 0.55H, H-2 Ara), 4.08 – 3.99 (m, 2H, H-4, H-5 Ara), 3.94 (dd, $J = 8.4, 4.9$ Hz, 0.55H, H-5 Ara), 3.89 (m, 0.45H, H-5 Ara), 3.78 – 3.70 (m, 1.45H, H-3 Ara, CH-1 CyHex), 2.15 (s, 1.35H, CH₃ Ac), 2.14 (s, 1.65H, CH₃ Ac), 1.85 (m, 2H, CyHex), 1.64 (m, 2H, CyHex), 1.56 (m, 1H, CyHex), 1.45 (s, 2H, CH₃ isop), 1.36 – 1.26 (m, 12H, CH₃ isop, CyHex), 1.17 – 1.07 (m, 3H, CyHex). ¹³C NMR (CDCl₃) δ (169.3, 169.13, 166.7, 165.9) (CO), (110.5, 110.2, 110.2, 110.1) (C isop), (80.1, 79.4) (C-2 Ara), (77.4, 77.2) (C-3 Ara), (77.1, 76.9) (C-4 Ara), (73.7, 72.7) (C-1 Ara), 67.4 (C-5 Ara), (48.4, 48.3) (CH CyHex), (33.2, 33.1, 33.1, 33.0) (CyHex), (27.4, 27.4, 27.0, 27.0, 26.7) (CH₃ isop), (25.7, 25.7) (CyHex), (25.6, 25.3) (CH₃ isop), (24.9, 24.8) (CyHex), (21.1, 21.0) (CH₃ Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₂₀H₃₃NO₇Na [M+Na]⁺ 422.2155; found 422.2138.



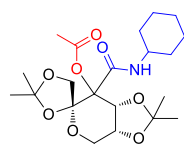
2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-((4R,4'R,5S)-2,2,2',2'-tetramethyl-[4,4'-bi(1,3-dioxolan)]-5-yl)ethyl 2-((tert-butoxycarbonyl)amino)-3-phenylpropanoate (7d) Yield 78 % (46 mg); colorless oil; R_f (DS1) = 0.48 (EtOAc/PE 1:1, v/v); *d.r.* 55:45. ¹H NMR (CDCl₃) δ 7.60 (m, 0.55H, NH), 7.36 – 7.25 (m, 5H, CH Ph), 7.11 (m, 0.45H, NH), 5.50 (d, $J = 2.7$ Hz, 0.55H, H-1 Ara), 5.44 (d, $J = 1.6$ Hz, 0.45H, H-1 Ara), 5.12 (d, $J = 6.0$ Hz, 0.45H, α -Phe), 4.97 (d, $J = 7.1$ Hz, 0.55H, α -Phe), 4.65 – 4.45 (m, 1.45H, H-2 Ara, NH), 4.29 (t, $J = 7.4$ Hz, 0.55H, H-3 Ara), 4.15 – 3.92 (m, 5.45H, H-2, H-3, H-4, H-5, CH₂ Gly), 3.81 (td, $J = 7.9, 3.4$ Hz, 0.55H, H-5 Ara), 3.73 (s, 1.65H, CH₃ Gly), 3.71 (s, 1.35H, CH₃ Gly), 3.21 – 3.05 (m, 2H, β -Phe), 1.47 – 1.27 (m, 21H, CH₃ Boc, CH₃ isop). ¹³C NMR (CDCl₃) δ (171.7, 170.6, 169.8, 169.6, 168.0, 167.0) (CO), 156.0 (CO Boc), (135.9, 135.5) (C Ph), (129.4, 129.3, 129.2, 129.0, 127.6, 127.4) (CH Ph), (110.5, 110.3, 110.0, 109.9) (C isop), (81.0, 80.8) (C Boc), (79.6, 79.2) (C-2 Ara), 77.1 (C-3 Ara), (76.8, 76.6)

(C-4 Ara), (74.2, 72.9) (C-1 Ara), (67.47, 67.2) (C-5 Ara), (55.9, 54.8) (α -Phe), (52.4, 52.3) (CH₃ Gly), (41.3, 41.1) (CH₂ Gly), (37.8, 37.7) (β -Phe), (28.4, 28.4) (CH₃ Boc), (27.4, 27.4, 26.9, 26.9, 26.7, 26.6, 25.5, 25.1) (CH₃ isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₂₉H₄₂N₂O₁₁Na [M+Na]⁺ 617.2686; found 617.2687.



(3aR,5S,6aR)-6-(cyclohexylcarbamoyl)-5-((R)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-6-yl acetate (8a) Yield 67 % (29 mg); colorless oil; R_f (DS1) = 0.70, R_f (DS2) = 0.50 (EtOAc/PE 1:1, v/v); *d.r.* 55:45.

Major isomer: ¹H NMR (CDCl₃): δ 7.40 (d, J = 7.5 Hz, 1H, NH), 5.88 (d, J = 3.6 Hz, 1H, H-1 GlcF), 4.87 (d, J = 3.6 Hz, 1H, H-2, GlcF), 4.45 (t, J = 4.7 Hz, 1H, H-5, GlcF), 4.42 (d, J = 2.8 Hz, 1H, H-4 GlcF), 4.13 (dd, J = 8.4, 6.5 Hz, 1H, H-6a GlcF), 4.06 (dd, J = 8.4, 6.9 Hz, 1H, H-6b, GlcF), 3.80 – 3.73 (m, 1H, CH-1 CyHex), 2.09 (m, 3H, CH₃ Ac), 1.93 – 1.82 (m, 2H, CyHex), 1.67 – 1.60 (m, 2H, CyHex), 1.59 (m, 5H, CH₃ isop, CyHex), 1.41 (s, 3H, CH₃ isop), 1.36 (m, 4H, CH₃ isop, CyHex), 1.33 (s, 3H, CH₃ isop), 1.27 – 1.15 (m, 3H, CyHex). ¹³C NMR (CDCl₃): δ (170.0, 163.9) (CO), (114.0, 108.7) (C isop), 105.4 (C-1 GlcF), 85.6 (C-3 GlcF), 82.8 (C-2 GlcF), 82.3 (C-4 GlcF), 73.5 (C-5 GlcF), 65.0 (C-6 GlcF), 48.4 (CH CyHex), (32.7, 32.7) (CyHex), (27.0, 26.7, 26.5) (CH₃ isop), 25.8 (CyHex), 25.5 (CH₃ isop), (24.6, 24.5) (CyHex), 21.5 (CH₃ Ac). Minor isomer: ¹H NMR (CDCl₃): δ 6.17 (d, J = 8.1 Hz, 1H, NH), 5.85 (d, J = 3.8 Hz, 1H, H-1 GlcF), 5.33 (d, J = 3.8 Hz, 1H, H-2 GlcF), 4.10 – 4.06 (m, 1H, H-6a GlcF), 4.02 (d, J = 9.3 Hz, 1H, H-5 GlcF), 3.97 – 3.91 (m, 2H, H-4, H-6b GlcF), 3.83 – 3.77 (m, 1H, CH-1 CyHex), 2.11 (s, 3H, CH₃ Ac), 1.85 (ddd, J = 27.8, 12.4, 3.5 Hz, 2H, CyHex), 1.69 – 1.54 (m, 4H, CyHex), 1.50 (s, 3H, CH₃ isop), 1.46 (s, 3H, CH₃ isop), 1.41 – 1.33 (m, 1H, CyHex), 1.33 (s, 3H, CH₃ isop), 1.31 (s, 3H, CH₃ isop), 1.22 – 1.08 (m, 3H, CyHex). ¹³C NMR (CDCl₃): δ (169.0, 166.6) (CO), (112.8, 110.1) (C isop), 105.7 (C-1 GlcF), 85.3 (C-3 GlcF), 80.9 (C-2 GlcF), 80.4 (C-4 GlcF), 74.6 (C-5 GlcF), 68.4 (C-6 GlcF), 48.2 (CH CyHex), (33.1, 32.7) (CyHex), (27.1, 27.0, 26.8, 25.8) (CH₃ isop), (25.7, 24.7, 24.7) (CyHex), 21.0 (CH₃ Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₂₁H₃₃NO₈ [M+H]⁺ 428.2284; found 428.2302.



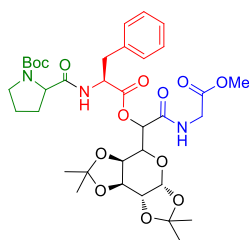
(3aR,4'R,7aR)-7-(cyclohexylcarbamoyl)-2,2,2',2'-tetramethyltetrahydrospiro[[1,3]dioxolo[4,5-c]pyran-6,4'-[1,3]dioxolan]-7-yl acetate (9a) Yield 51 % (22 mg); colorless oil; R_f (DS1) = 0.80, R_f (DS2) = 0.40 (EtOAc/PE 1:1, v/v); *d.r.* 55:45.

Major isomer: ¹H NMR (CDCl₃): δ 5.99 (d, J = 7.7 Hz, 1H, NH), 5.30 (d, J = 7.0 Hz, 1H, H-4 FruP), 4.60 (dt, J = 7.3, 3.7 Hz, 1H, H-5 FruP), 4.57 (d, J = 9.6 Hz, 1H, H-1a FruP), 4.07 (m, 1H, H-1b FruP), 4.05 (m, 1H, H-6a FruP), 3.80 – 3.74 (m, 1H, CH-1 CyHex), 3.68 (dd, J = 12.8, 3.4 Hz, 1H, H-6b FruP), 2.11 (s, 3H, CH₃ Ac), 1.86 (t, J = 17.8 Hz, 2H, CyHex), 1.65–1.57 (m, 4H, CyHex), 1.47 (s, 6H, CH₃ isop), 1.46 (s, 3H, CH₃ isop), 1.38 (s, 1H, CyHex), 1.30 (s, 3H, CH₃ isop),

1.21 – 1.06 (m, 3H, CyHex). ^{13}C NMR (CDCl_3): δ (168.8, 166.6) (CO), (110.6, 109.5) (C isop), 104.5 (C-2 FruP), 80.5 (C-3 FruP), 73.1 (C-4 FruP), 72.8 (C-5 FruP), 72.3 (C-1 FruP), 64.7 (C-6 FruP), 48.3 (CH-1 CyHex), (32.9, 32.7) (CyHex), (26.9, 26.6, 26.1, 25.8, 25.0, 24.7, 24.6) (CH_3 isop), 21.6 (CH_3 Ac). Minor isomer: ^1H NMR (CDCl_3): δ 6.66 (d, J = 7.3 Hz, 1H, NH), 5.08 (d, J = 7.2 Hz, 1H, H-4 FruP), 4.31 (d, J = 9.9 Hz, 1H, H-1a FruP), 4.30 – 4.24 (m, 1H, H-5 FruP), 4.20 (dd, J = 12.6, 3.3 Hz, 1H, H-6a FruP), 3.93 (d, J = 9.9 Hz, 1H, H-1b FruP), 3.79 (dd, J = 12.6, 0.9 Hz, 1H, H-6b FruP), 3.77 – 3.73 (m, 1H, CyHex CH-1), 2.12 (s, 3H, CH_3 Ac), 1.92 (dd, J = 33.6, 9.8 Hz, 2H, CyHex), 1.66 (m, 2H, CyHex), 1.58 (m, 2H, CyHex), 1.51 (s, 3H, CH_3 isop), 1.49 (s, 3H, CH_3 isop), 1.43 (s, 3H, CH_3 isop), 1.36 (s, 3H, CH_3 isop), 1.33 (m, 1H, CyHex), 1.23-1.12 (m, 3H, CyHex). ^{13}C NMR (CDCl_3): δ (169.3, 164.6) (CO), (111.6, 110.8) (C isop), 103.9 (C-2 FruP), 81.0 (C-3 FruP), 73.60 (C-1 FruP), 73.4 (C-4 FruP), 73.0 (C-5 FruP), 64.4 (C-6 FruP), 48.9 (CH-1 CyHex), (32.9, 32.7) (CyHex), (26.4, 26.3, 26.2) (CH_3 isop), 25.8 (CyHex), 25.3 (CH_3 isop), 24.9 (CyHex), 21.7 (CH_3 Ac). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{21}\text{H}_{33}\text{NO}_8\text{Na}$ $[\text{M}+\text{Na}]^+$ 450.2104; found 450.2107.

3. Post-condensation modification of selected Passerini products

Boc deprotection and coupling of amino acid: Passerini product **2d** (10 mg, 0.016 mmol) was dissolved in TFA-DCM (1:1, v/v, 100 μL), reaction was stirred at room temperature for 2 min and the reaction mixture was evaporated with toluene. Boc-Pro-OH (4 mg, 0.018 mmol, 1.2 eq), BOP (10 mg, 0.023 mmol, 1.5 eq), and HOBT (3.5 mg, 0.023 mmol, 1.5 eq) were dissolved in 1 mL DCM:DMF (1:1) followed by the addition of Boc-protected compound (8 mg, 0.015 mmol) and NMM (2eq). Reaction mixture was stirred for 24 h. Product was purified by flash column chromatography (petrol ether/ethyl acetate, v/v = 1/6).

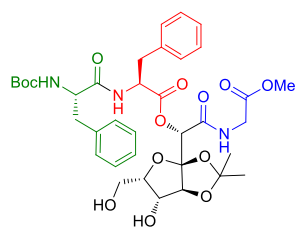


tert-butyl

2-((1-(2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-((3aR,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethoxy)-1-oxo-3-phenylpropan-2-yl)carbamoyl)pyrrolidine-1-carboxylate (**2j**) Yield 78 % (9 mg); colorless oil; R_f (DS1,2) = 0.55 (EtOAc/PE 6/1, v/v); *d.r.* 70:30. ^1H NMR (600 MHz, MeOD) δ 7.36 – 7.18 (m, 5H, Ph), 5.52 (d, J = 4.9 Hz, 0.3H, H-1 Gal), 5.49 (d, J = 4.7 Hz, 0.7H, H-1 Gal), 5.44 (m, 0.3H, H-6 Gal), 5.13 (m, 0.7H, H-6 Gal), 4.84 (s, 1H, α -Phe), 4.66 (dd, J = 8.0, 2.3 Hz, 1H, H-3 Gal), 4.39 (ddd, J = 11.1, 4.7, 2.4 Hz, 1H, H-2 Gal), 4.28 – 4.18 (m, 2H, H-4,5 Gal), 4.15 (bs, 1H, α -Pro), 4.06 – 3.92 (m, 2H, CH_2 Gly), 3.74 (d, J = 2.7 Hz, 3H, CH_3 Gly), 3.44 (m, 1H, δ -Pro), 3.39 – 3.34 (m, 2H, δ -Pro, β -Phe), 3.01 (bs, 1H, β -Phe), 2.17 (m, 1H, β -Pro), 1.91 (m, 1H, β -Pro), 1.78 (m, 2H, γ -Pro), 1.55 (d, J = 11.6 Hz, 3H, CH_3 isop), 1.46 (d, J = 16.2 Hz, 6H, CH_3 isop), 1.37 – 1.24 (m, 12H, CH_3 isop, Boc). ^{13}C NMR (151 MHz, MeOD) δ (170.0, 169.8, 169.3, 169.1, 168.5, 167.7, 167.4) (CO), 136.4

(C Ph), (128.4, 127.6, 125.9) (CH Ph), (108.9, 108.5, 108.3) (C isop), (95.9, 95.7) (C-1 Gal), (72.5, 71.1, 70.3, 70.3, 70.2, 70.0, 69.5, 67.2, 66.5) (C-2,3,4,5,6 Gal), 59.7 (α -Pro), (53.2, 52.9) (α -Phe), (50.7, 50.7) (CH₃ Gly), 45.9 (δ -Pro), (40.1, 39.9) (CH₂ Gly), (36.3, 36.0) (β -Phe), 30.3 (Boc), (26.7, 24.5, 24.4, 23.3) (CH₃ isop), (22.8, 22.5) (γ -Pro). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₃₅H₄₉N₃O₁₃Na [M+Na]⁺ 742.3163; found 742.3190.

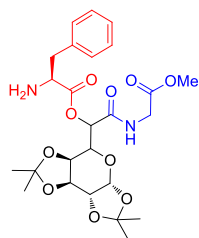
Boc deprotection and coupling of amino acid: Passerini product **5d** (13 mg, 0.02 mmol) was dissolved in TFA-DCM (1:1, v/v, 100 μ L), reaction was stirred at room temperature for 2 min and then the solvent was evaporated. Boc-Phe-OH (6.4 mg, 0.024 mmol, 1.2 eq), BOP (13 mg, 0.03 mmol, 1.5 eq), and HOBT (4.6 mg, 0.03 mmol, 1.5 eq) were dissolved in 1 mL DCM:DMF (1:1) followed by the addition of Boc-deprotected compound and NMM (2 eq). Reaction mixture was stirred for 24 h, solvent evaporated and product extracted with DCM. Product was purified by flash column chromatography (petrol ether/ethyl acetate, v/v = 1/1).



(S)-(S)-1-((3aR,5S,6R,6aS)-6-hydroxy-5-(hydroxymethyl)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-3a-yl)-2-((2-methoxy-2-oxoethyl)amino)-2-oxoethyl 2-((S)-2-((tert-butoxycarbonyl)amino)-3-phenylpropanamido)-3-phenylpropanoate (5j**)** Yield 65 % (9.5 mg); colorless oil; R_f = 0.30 (EtOAc/PE 1/1, v/v). ¹H NMR (CDCl₃): δ 7.68 (s,

1H, NH), 7.38 – 7.16 (m, 8H, CH Ph), 6.91 (dd, J = 6.4, 2.9 Hz, 2H, CH Ph), 6.00 (d, J = 5.4 Hz, 1H, NH Phe), 5.77 (s, 1H, H-1 Sor), 5.16 (d, J = 7.5 Hz, 1H, NH Phe), 4.93 (s, 1H, H-5 Sor), 4.60 (dt, J = 8.8, 5.3 Hz, 1H, α -Phe), 4.35 – 4.12 (m, 4H, α -Phe, CH₂ Gly, H-3,4 Sor), 3.91 – 3.78 (m, 3H, CH₂ Gly, H-6 Sor), 3.75 (s, 3H, CH₃ Gly), 3.14 (dd, J = 14.3, 5.1 Hz, 1H, β -Phe), 3.02 (d, J = 7.1 Hz, 2H, β -Phe), 2.94 – 2.81 (m, 1H, β -Phe), 1.91 (bs, 2H, OH), 1.49 (s, 3H, CH₃ isop), 1.34 – 1.23 (m, 12H, CH₃ isop, Boc). ¹³C NMR (CDCl₃): δ (173.0, 170.0, 169.30, 168.3) (CO), (137.1, 135.2) (C Ph), (129.9, 129.2, 129.1, 129.1, 127.72, 127.5) (CH Ph), 112.7 (C isop), 112.0 (C-2 Sor), (88.0, 82.7, 80.6, 76.7, 75.2) (C-1,3,4,5 Sor), 61.2 (C-6 Sor), (55.9, 54.3) (α -Phe), 52.8 (CH₃ Gly), 41.1 (CH₂ Gly), (38.6, 36.9) (β -Phe), 28.5 (Boc), (27.4, 26.3) (CH₃ isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₃₅H₄₉N₃O₁₃Na [M+Na]⁺ 742.3163; found 742.3190.

Fmoc deprotection: A solution of 20 % piperidine in DMF (0.2 mL) was added to the Passerini product **2k** (20 mg, 0.03 mmol), the mixture was stirred at room temperature for 15 min and then the solvent was evaporated. Product was purified by flash column chromatography (petrol ether/ethyl acetate, v/v = 1/1).

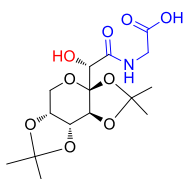


2-((2-methoxy-2-oxoethyl)amino)-2-oxo-1-((3aR,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)ethyl 2-amino-3-phenylpropanoate (21) Yield 77 % (12 mg); colorless oil; R_f (DS1,2) = 0.40 (EtOAc/PE 1:1, v/v); *d.r.* 70:30. ^1H NMR (CDCl_3): δ 7.25 (m, 5H, Ph), 5.45 (d, J = 4.9 Hz, 0.7H, H-1 Gal), 5.41 (d, J = 4.6 Hz, 0.3H, H-1 Gal), 4.91 – 4.84 (m, 0.7H, H-6 Gal), 4.75 (td, J = 8.3, 4.9 Hz, 0.3H, H-6 Gal), 4.62 (ddd, J = 14.4, 8.0, 2.5 Hz, 1H, H-3 Gal), 4.46 (dd, J = 8.0, 1.6 Hz, 0.3H, α -Phe), 4.40 (dd, J = 7.9, 1.7 Hz, 0.7H, α -Phe), 4.31 (dd, J = 4.9, 2.5 Hz, 1H, H-2 Gal), 4.28 – 3.87 (m, 4H, CH_2 Gly, H-5,4 Gal), 3.72 (m, 3H, CH_3 Gly), 3.29 (ddd, J = 37.2, 14.3, 5.2 Hz, 1H, β -Phe), 3.15 – 3.10 (m, 1H, β -Phe), 2.95 (s, 1H, NH), 2.88 (s, 1H, NH), 1.51 – 1.25 (m, 12H, CH_3 isop). ^{13}C NMR (CDCl_3): δ (171.7, 170.4, 170.3, 170.1, 169.8, 169.5) (CO), (136.1, 135.8) (C Ph), (128.8, 128.8, 128.2, 126.5, 126.4) (CH isop), (109.7, 109.1, 109.1, 108.8) (CH_3 isop), (95.9, 95.4) (C-1 Gal), (73.5, 73.5, 70.3, 70.2, 70.2, 70.0, 69.8, 68.8, 67.8, 66.5) (C-2,3,4,5,6 Gal), (53.6, 53.2) (α -Phe), (51.7, 51.5) (CH_3 Gly), (40.7, 40.6) (CH_2 Gly), (36.9, 36.1) (β -Phe), (25.5, 25.4, 25.3, 25.2, 24.6, 24.3, 23.7, 23.3) (CH_3 isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for $\text{C}_{25}\text{H}_{34}\text{N}_2\text{O}_{10}\text{Na}$ $[\text{M}+\text{Na}]^+$ 545.2111; found 545.2109.

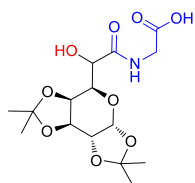
4. Base-mediated deprotection of selected Passerini products - sugar α -hydroxy acids

General procedure for the reactions:

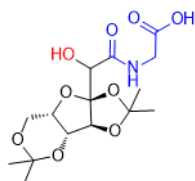
Passerini product (0.035 mmol) was dissolved in MeOH (0.5 mL) and 1N NaOH (2 eq) was added. Reaction was stirred under reflux (10 min) or at room temperature (30 min) and followed by TLC (EtOAc/EtOH/HOAc/ H_2O 70:10:2:2, v/v). Solvent was evaporated and the product was purified by flash column chromatography.



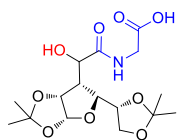
2-((S)-2-hydroxy-2-((3aS,5aR,8aR,8bS)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-3a-yl)acetamido)acetic acid (1m) Yield 91 % (11.5 mg); colorless oil; R_f = 0.74 (EtOAc/EtOH/HOAc/ H_2O 70:10:2:2, v/v). ^1H NMR (CDCl_3) δ 7.36 – 7.29 (m, 1H, NH), 5.52 (bs, 2H, OH), 4.66 (d, J = 2.6 Hz, 1H, H-3 Fru), 4.61 (dd, J = 7.8, 2.6 Hz, 1H, H-4 Fru), 4.22 (d, J = 8.2 Hz, 1H, H-5 Fru), 4.16 – 4.09 (m, 2H, H-1 Fru, CH_2 Gly), 3.99 (dd, J = 18.1, 4.6 Hz, 1H, CH_2 Gly), 3.90 (d, J = 11.7 Hz, 1H, H-6 Fru), 3.80 (d, J = 12.9 Hz, 1H, H-6 Fru), 1.47 (s, 3H, CH_3 isop), 1.46 (s, 3H, CH_3 isop), 1.38 (s, 3H, CH_3 isop), 1.33 (s, 3H, CH_3 isop). ^{13}C NMR (CDCl_3) δ 171.3 (CO), (109.7, 109.4) (C isop), 103.5 (C-2 Fru), (71.6, 70.9, 70.5, 70.4) (C-1,3,4,5 Fru), 61.9 (c-6 Fru), 42.4 (CH_2 Gly), (26.6, 26.2, 25.7, 24.2) (CH_3 isop). HRMS (MALDI-TOF/TOF) m/z : Cclcd. for $\text{C}_{15}\text{H}_{23}\text{NO}_9\text{Na}$ $[\text{M}+\text{Na}]^+$ 384.1271; found 384.1269.



2-(2-hydroxy-2-((3aR,5R,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-3aH-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)acetamido)acetic acid (2m) Yield 79 % (10 mg); colorless oil; R_f (DS1,2) = 0.58 (EtOAc/EtOH/HOAc/H₂O 70:10:2:2, v/v); *d.r.* 70:30. ¹H NMR (CDCl₃) δ 7.44 (s, 1H, NH), 5.54 (dd, J = 16.6, 4.7 Hz, 1H, H-1 Gal), 5.13 (bs, 2H, OH), 4.61 (dt, J = 8.0, 4.0 Hz, 1H, H-3 Gal), 4.48 (d, J = 8.1 Hz, 1H, H-4 Gal), 4.38 – 4.23 (m, 2H, H-2,6 Gal), 4.12 – 3.96 (m, 3H, CH₂ Gly, H-5 Gal), 1.53 – 1.26 (m, 12H, CH₃ isop). ¹³C NMR (CDCl₃) δ (173.5, 171.8) (CO), (110.1, 109.8, 109.60, 109.6) (C isop), (96.6, 96.5) (C-1 Gal), (73.7, 72.9, 71.3, 71.2, 70.9, 70.8, 70.7, 70.4, 67.8, 66.7) (C-2,3,4,5,6), 41.78 (CH₂ Gly), (26.1, 26.1, 26.0, 25.2, 25.1, 24.4, 24.2) (CH₃ isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₁₅H₂₃NO₉Na [M+Na]⁺ 384.1271; found 384.1272.



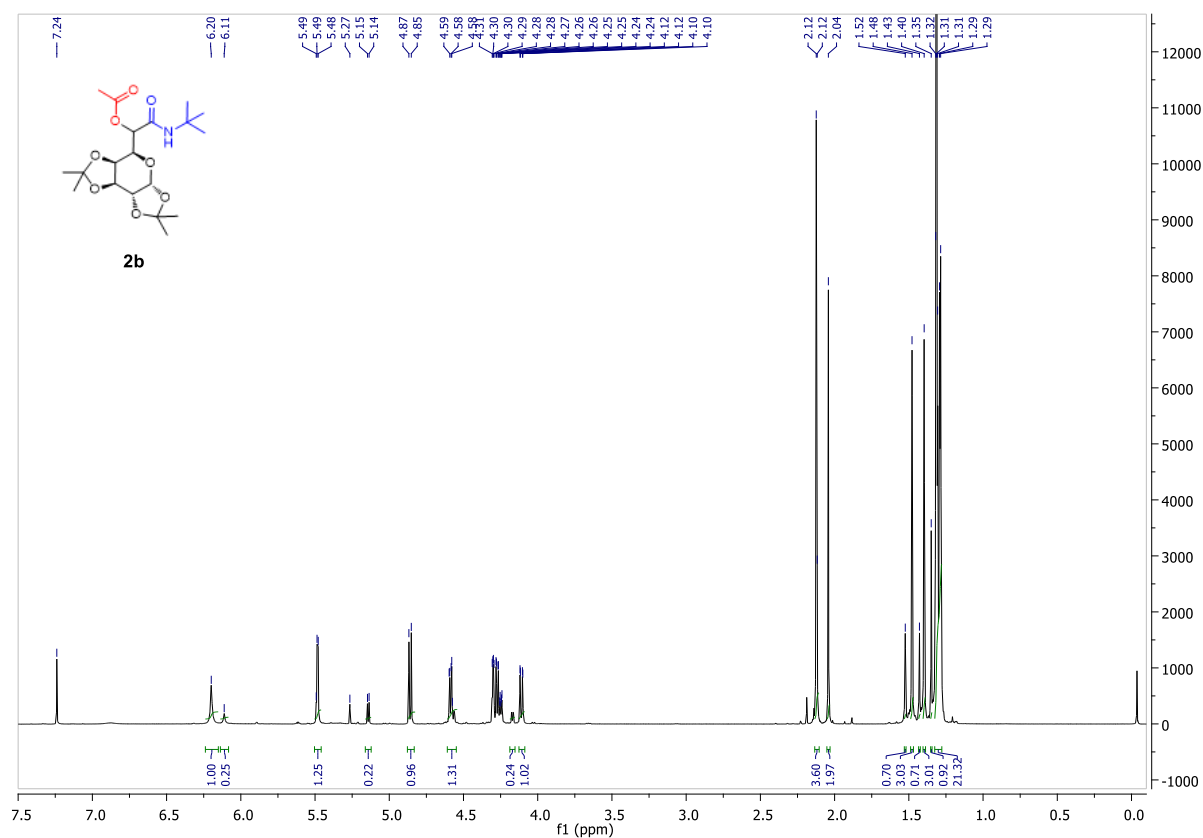
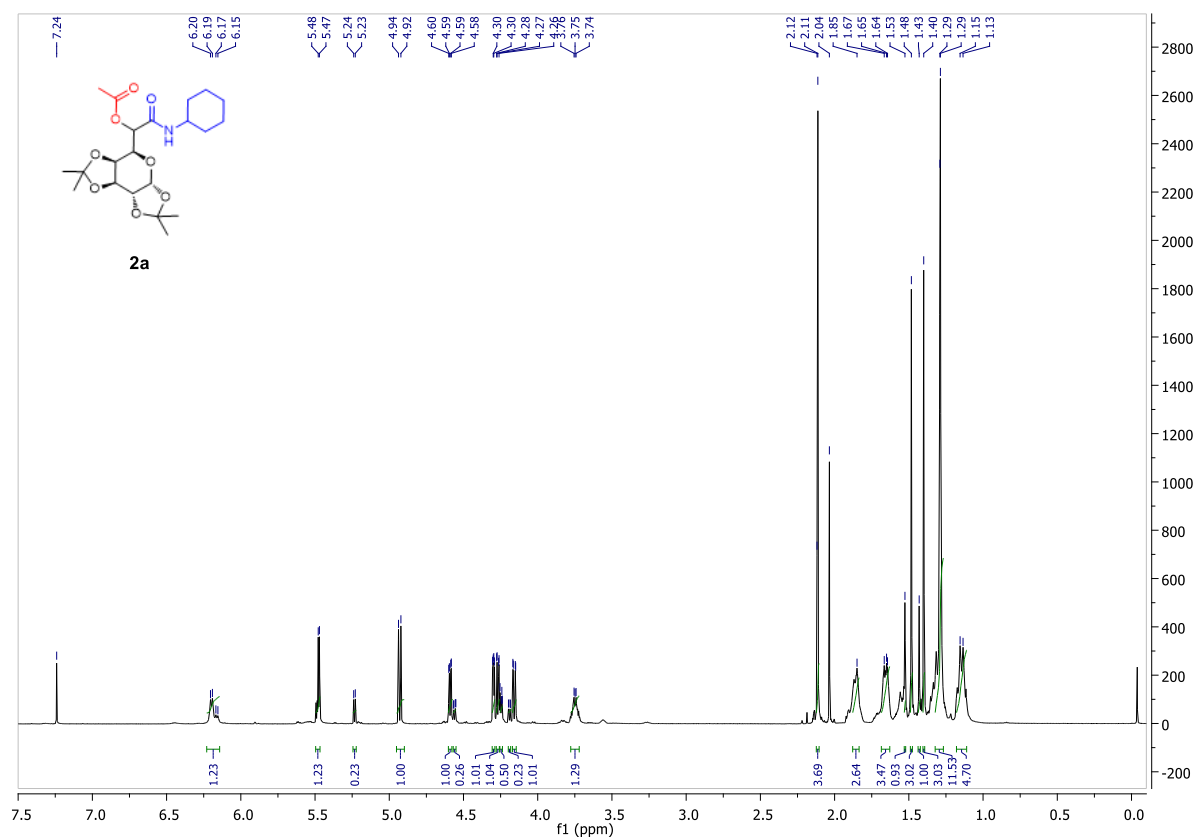
2-((S)-2-hydroxy-2-((3aS,3bR,7aS,8aS)-2,2,5,5-tetramethyltetrahydro-3aH-[1,3]dioxolo[4',5':4,5]furo[3,2-d][1,3]dioxin-8a-yl)acetamido)acetic acid (5m) Yield 76 % (9.6 mg); colorless oil; R_f (DS1,2) = 0.75 (EtOAc/EtOH/HOAc/H₂O 70:10:2:2, v/v); *d.r.* nd. ¹H NMR (CDCl₃) δ 7.35 (d, J = 5.2 Hz, 1H), 4.63 (s, 1H), 4.32 (d, J = 8.0 Hz, 2H), 4.16 (s, 1H), 4.13 – 3.98 (m, 4H), 1.40 (m, 12H). ¹³C NMR (CDCl₃) δ 171.1 (CO), (114.5, 113.7) (C isop), 97.9 (C-2 Sor), 85.3 (C-5), (73.7, 73.0, 70.8) (C-1,3,4), 60.5 (C-6), 42.5 (CH₂ Gly), (29.2, 27.7, 26.6, 18.8) (CH₃ isop). HRMS (MALDI-TOF/TOF) m/z : calcd. for C₁₅H₂₃NO₉Na [M+Na]⁺ 384.1271; found 384.1281.

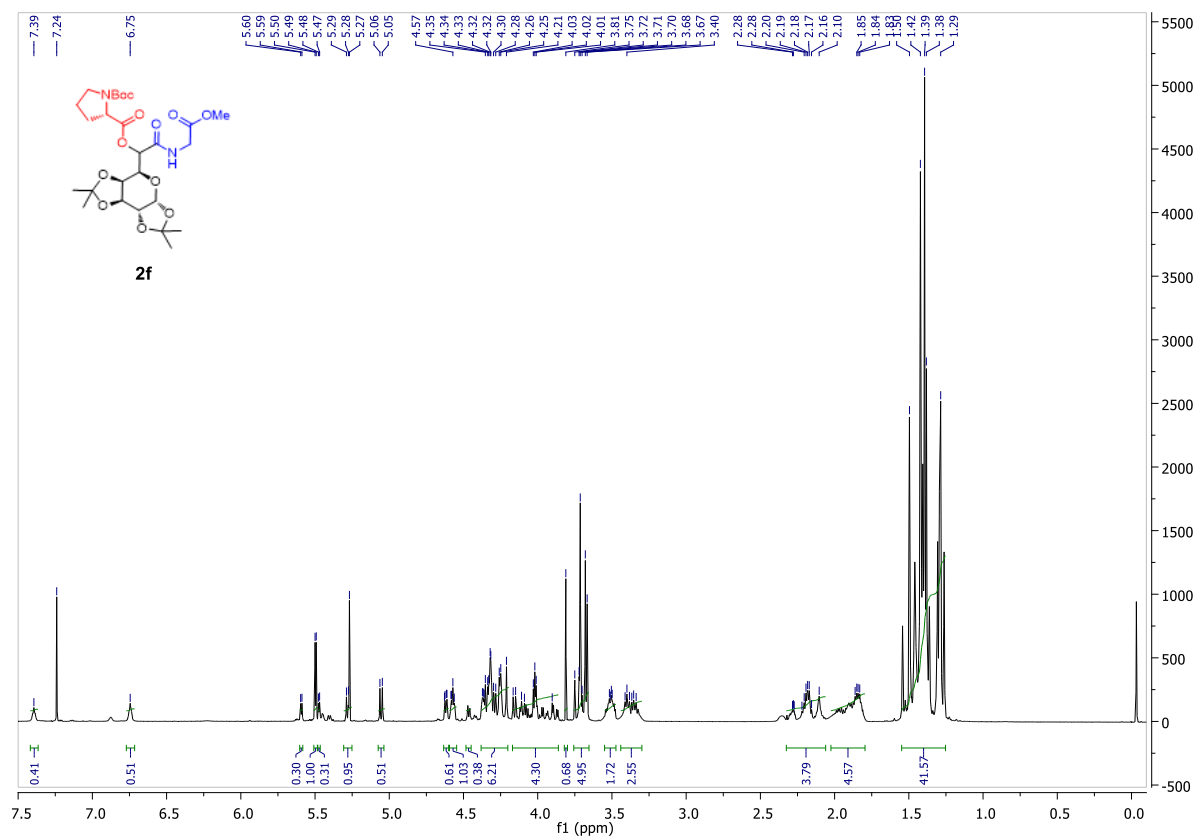
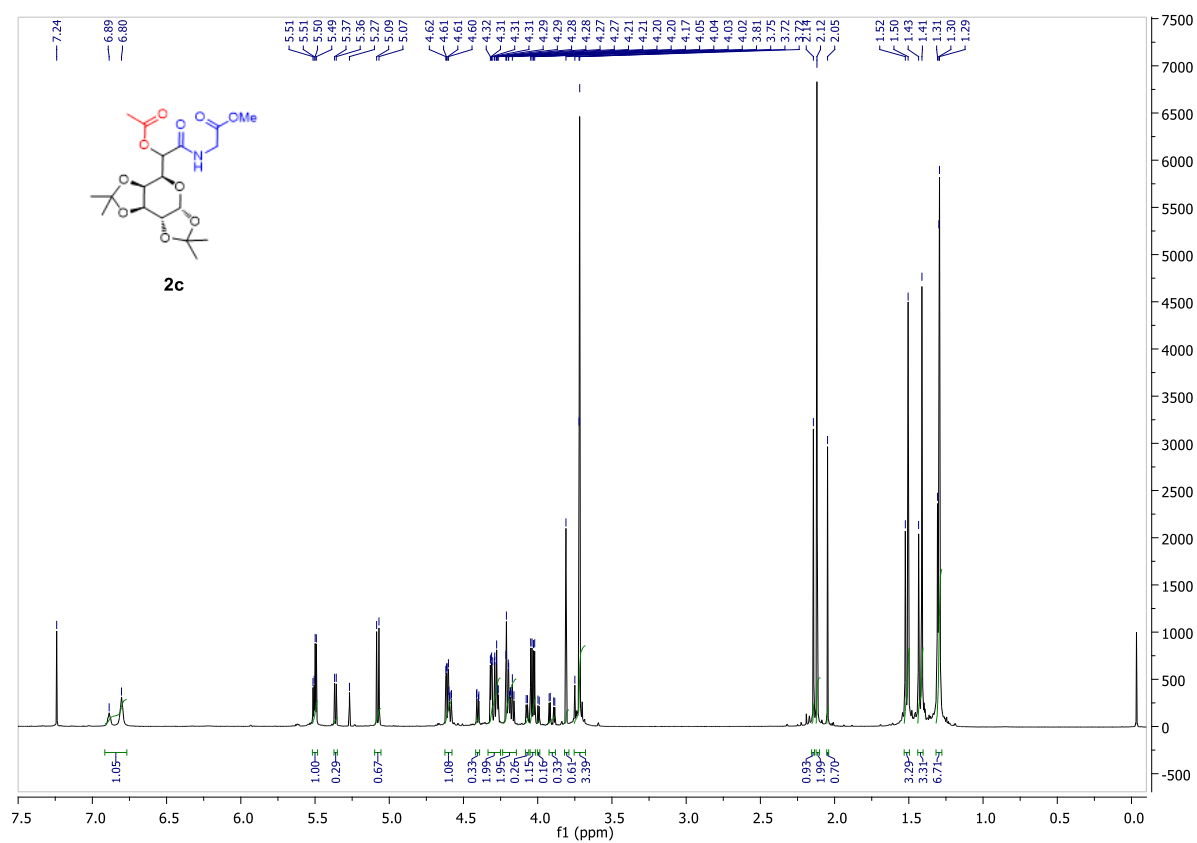


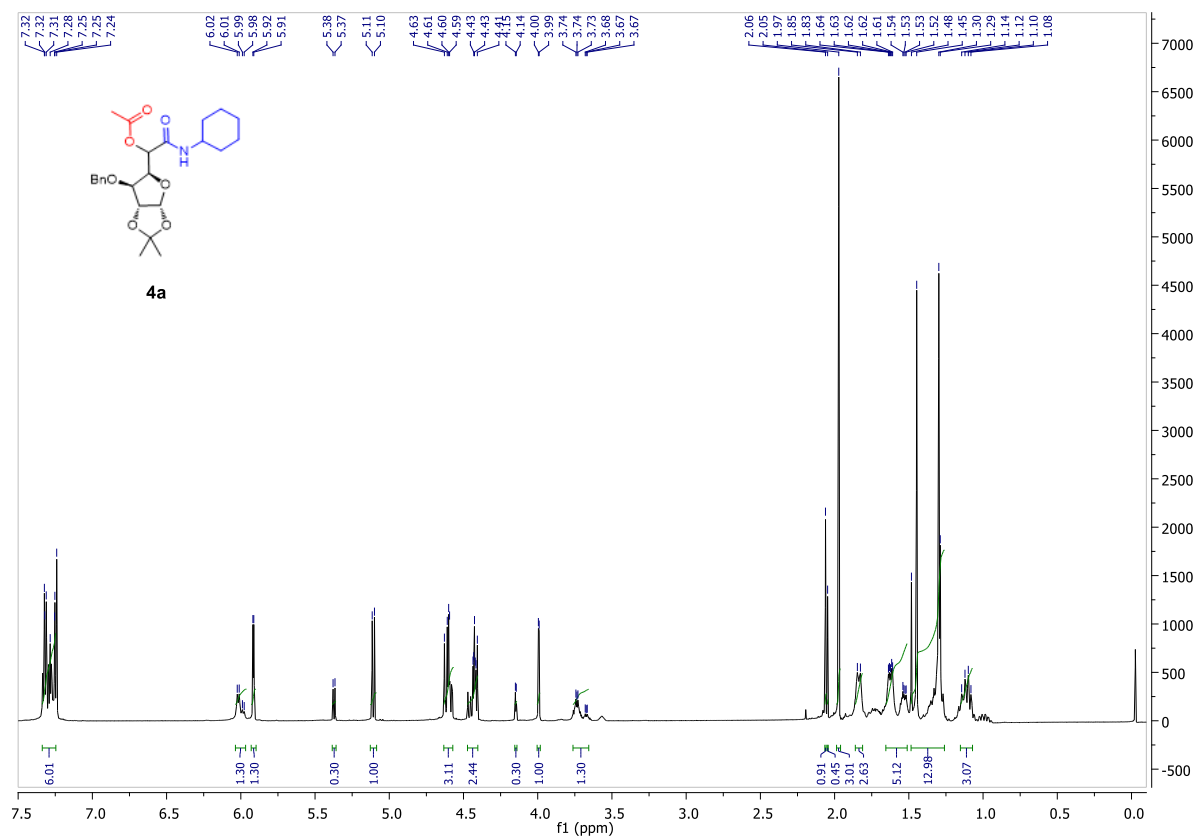
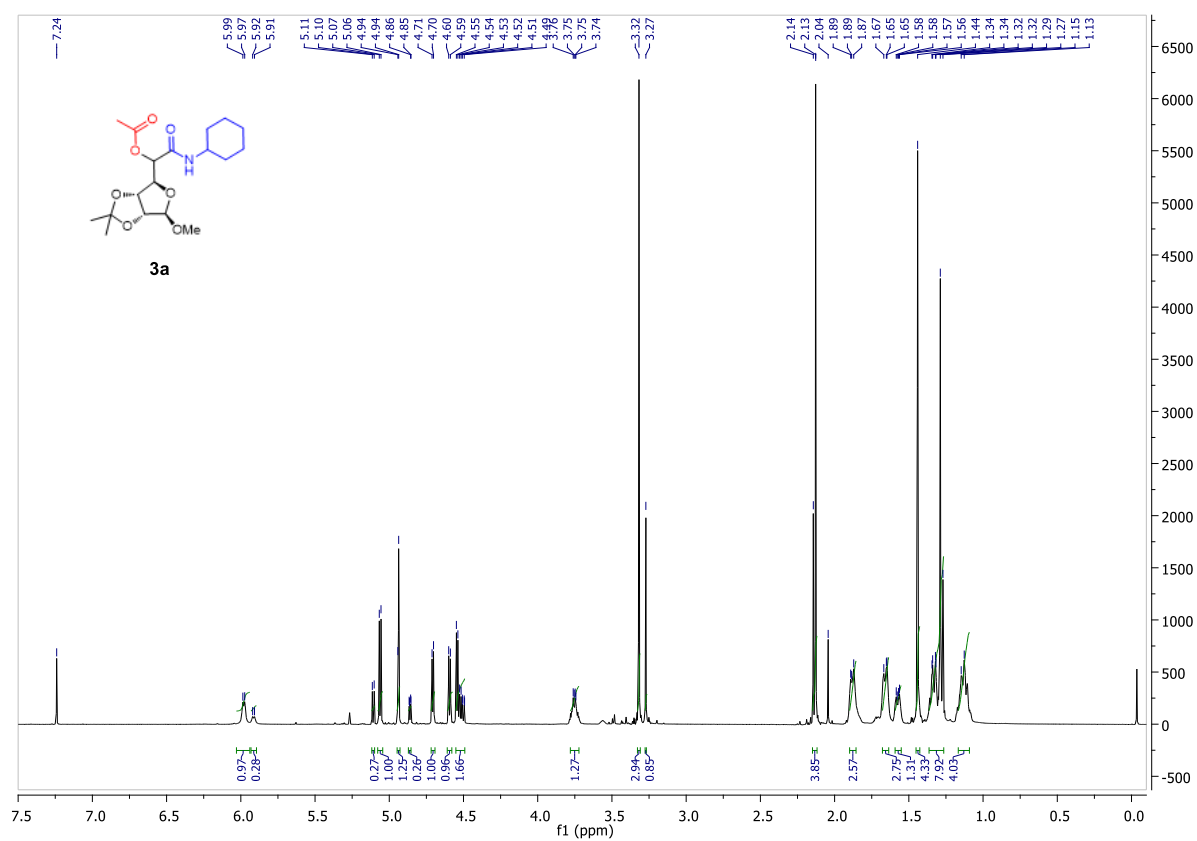
2-(2-((3aS,5S,6R,6aS)-5-((R)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-6-yl)-2-hydroxyacetamido)acetic acid (6m) Yield 70 % (0.11 mmol, 29 mg); colorless oil; R_f (DS1,2) = 0.62

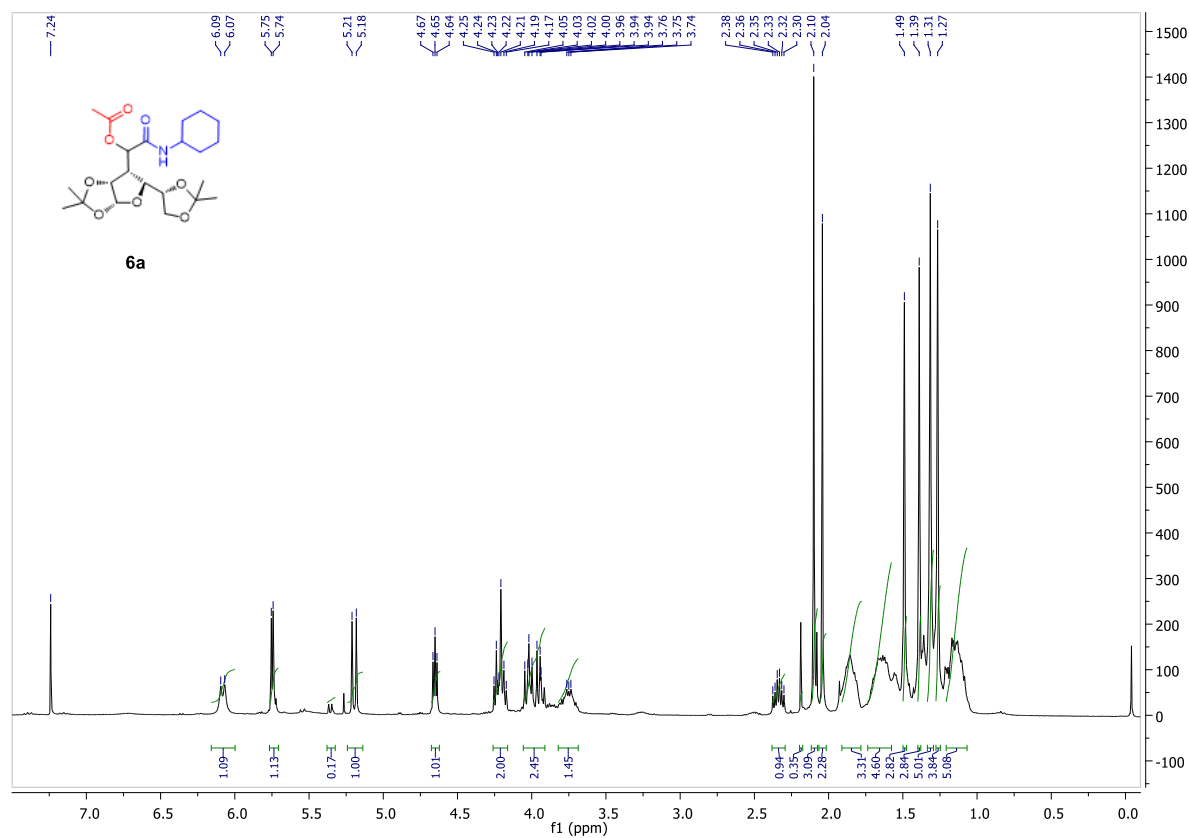
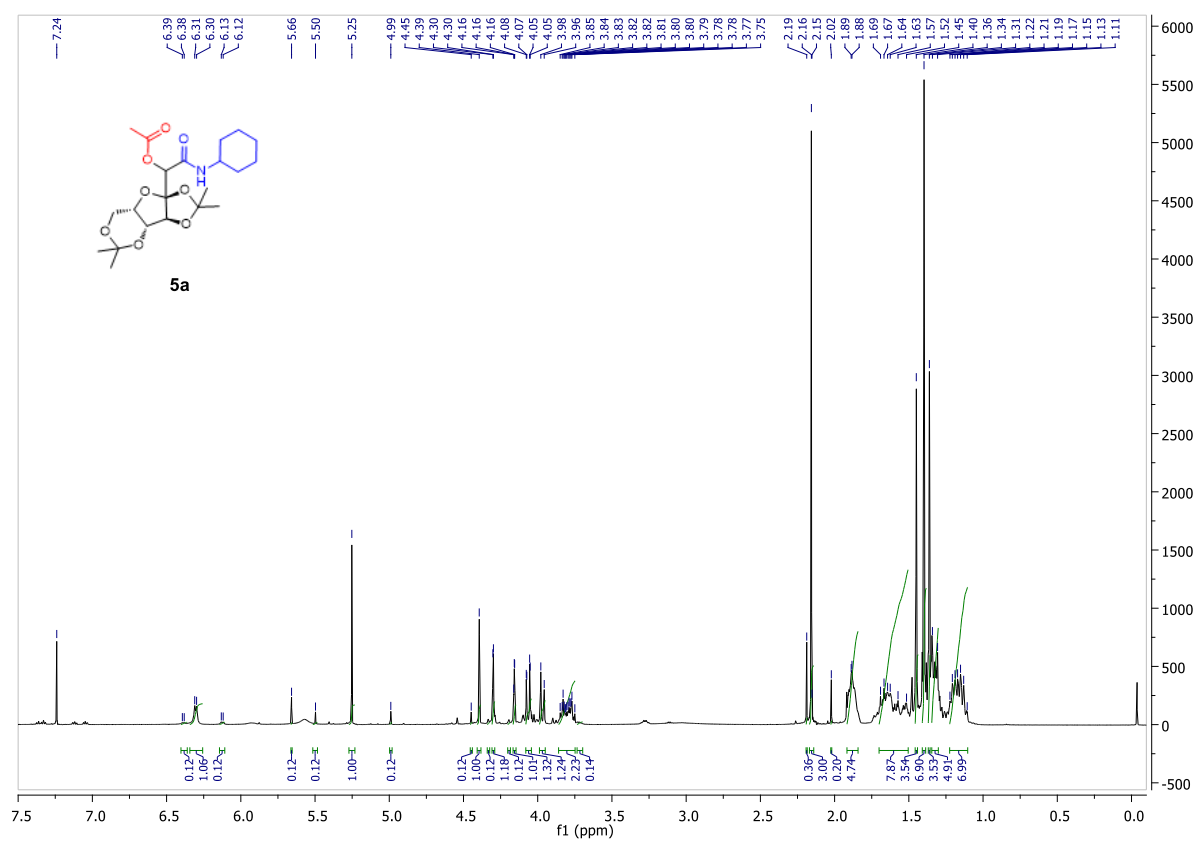
(EtOAc/EtOH/HOAc/H₂O 70:10:2:2, v/v); *d.r.* 90:10. ¹H NMR (CDCl₃): δ 7.44 (t, J = 5.3 Hz, 0.9H, NH), 7.35 – 7.31 (m, 0.1H, NH), 5.76 (d, J = 3.4 Hz, 0.1H, H-3 Alo), 5.74 (d, J = 3.5 Hz, 0.9H, H-3 Alo), 5.58 (s, 2H, OH), 4.86 (t, J = 4.0 Hz, 0.9H, H-2 Alo), 4.83 (t, J = 4.0 Hz, 0.1H, H-2 Alo), 4.63 (d, J = 3.3 Hz, 0.1H, H-4 Alo), 4.51 (d, J = 7.0 Hz, 0.9H, H-4 Alo), 4.28 – 4.22 (m, 0.1H, H-5 Alo), 4.20 (dd, J = 9.5, 6.7 Hz, 0.9H, H-5 Alo), 4.12 – 4.01 (m, 3H, H-1 Alo, H-6, CH₂ Gly), 4.00 – 3.90 (m, 2H, H-6 Alo, CH₂ Gly), 2.66 (dt, J = 10.2, 3.8 Hz, 0.1H, H-3 Alo), 2.28 (ddd, J = 9.7, 7.1, 4.7 Hz, 0.9H, H-3 Alo), 1.54 (s, 0.3H, CH₃ isop), 1.52 (s, 2.7H, CH₃ isop), 1.43 (s, 0.3H, CH₃ isop), 1.41 (s, 2.7H, CH₃ isop), 1.33 (s, 2.7H, CH₃ isop), 1.31 (s, 2.7H, CH₃ isop), 1.28 (s, 0.6H, CH₃ isop). ¹³C NMR (CDCl₃): δ 173.2 (CO), (112.7, 110.4) (C isop), 104.7 (C1 Alo), (82.9, 79.5, 77.0, 69.3) (C-2,4,5,3 Alo), 67.2 (C-6 Alo), 51.1 (CH₃ Gly), 47.6 (C-3 Alo), 41.6 (CH₂ Gly), (27.0, 26.5, 26.4, 25.5) (CH₃ isop). HRMS (MALDI-TOF/TOF) *m/z*: calcd. for C₁₆H₂₅NO₉Na [M+Na]⁺ 398.1427; found 398.1445.

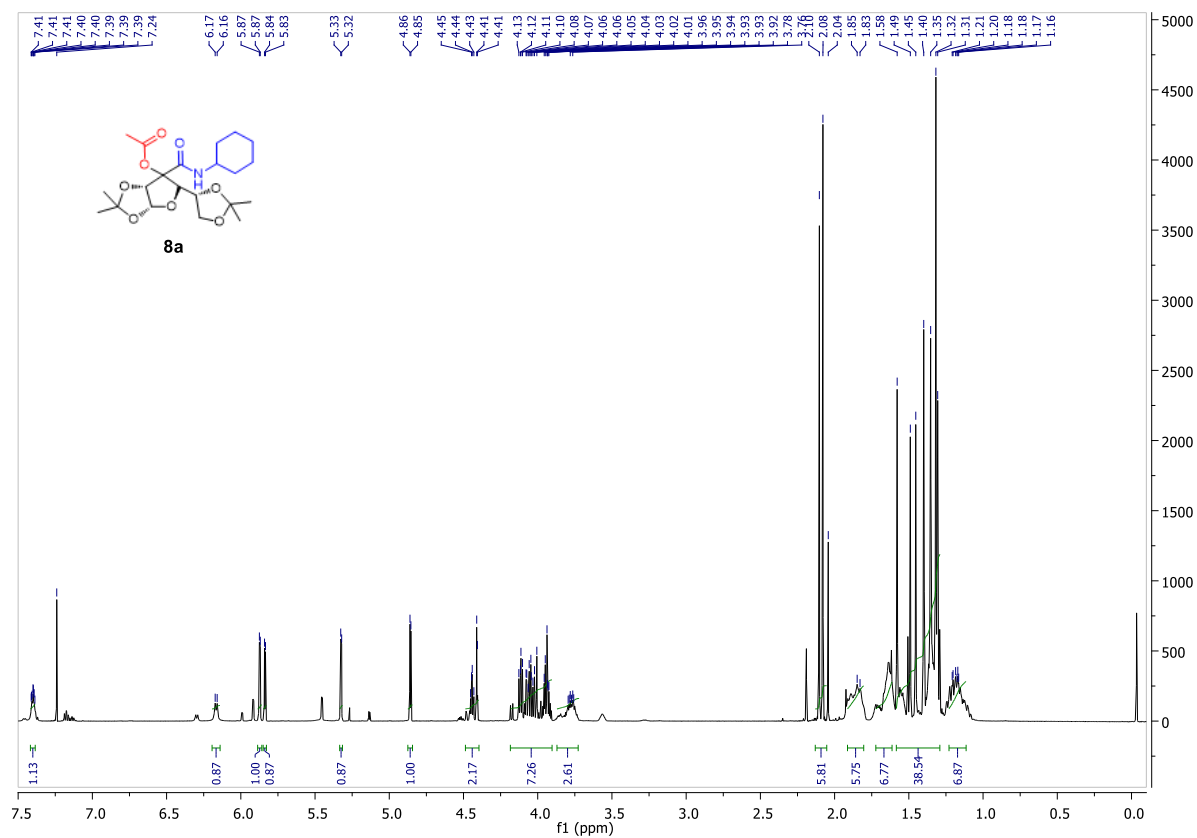
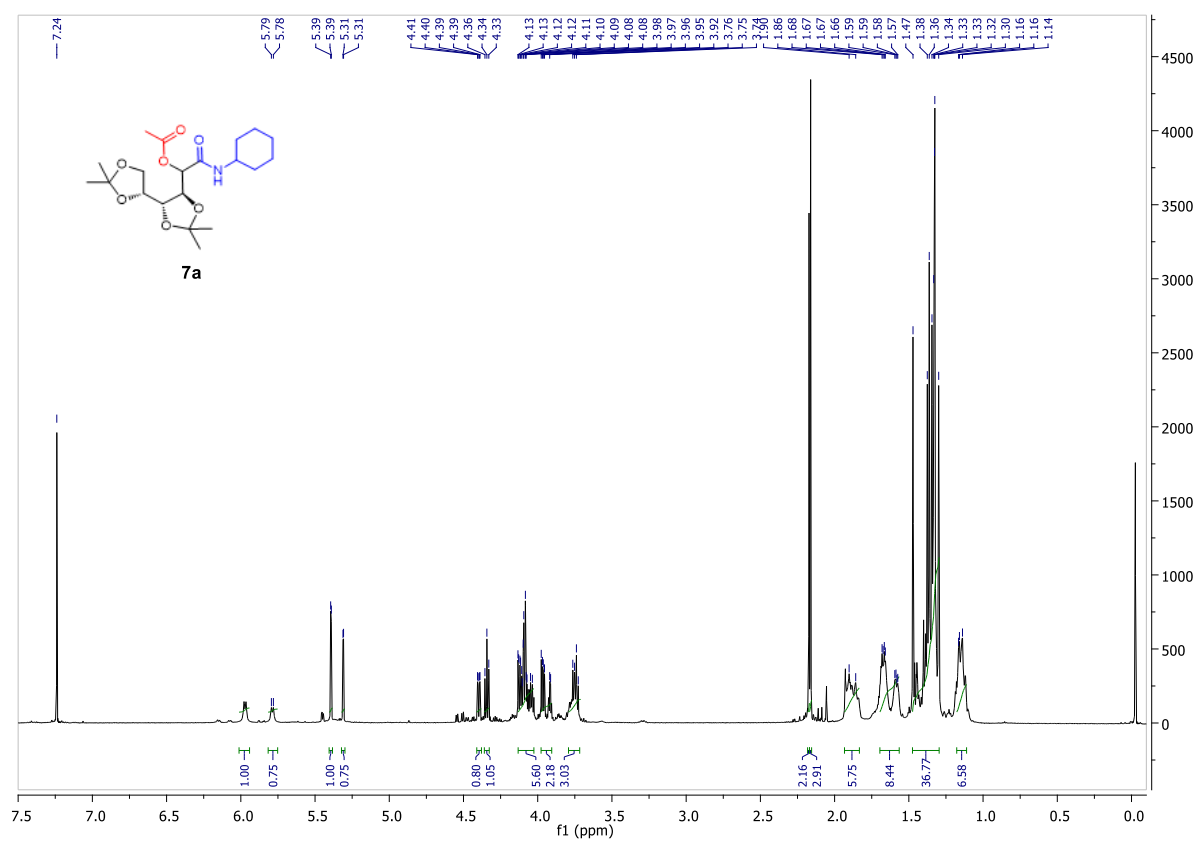
¹H NMR spectra of reaction mixtures (determination of the *d.r.*)

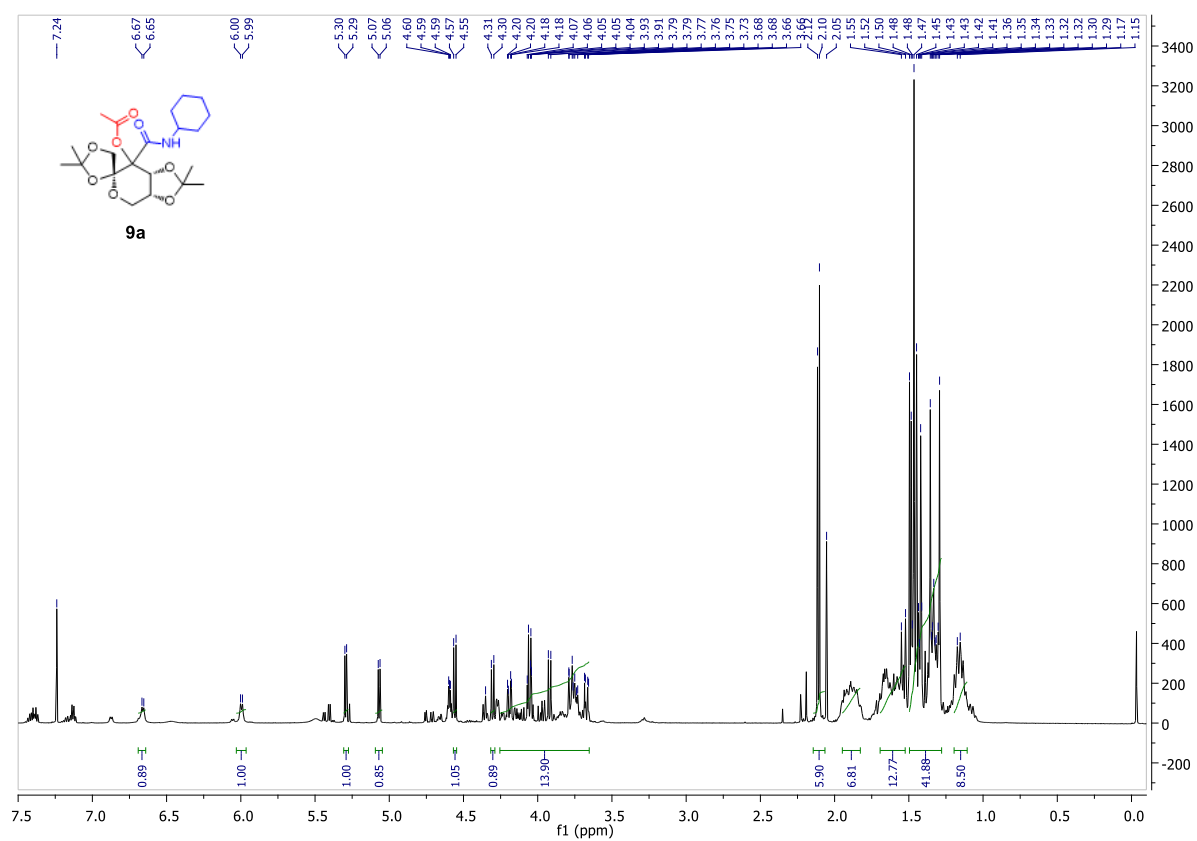




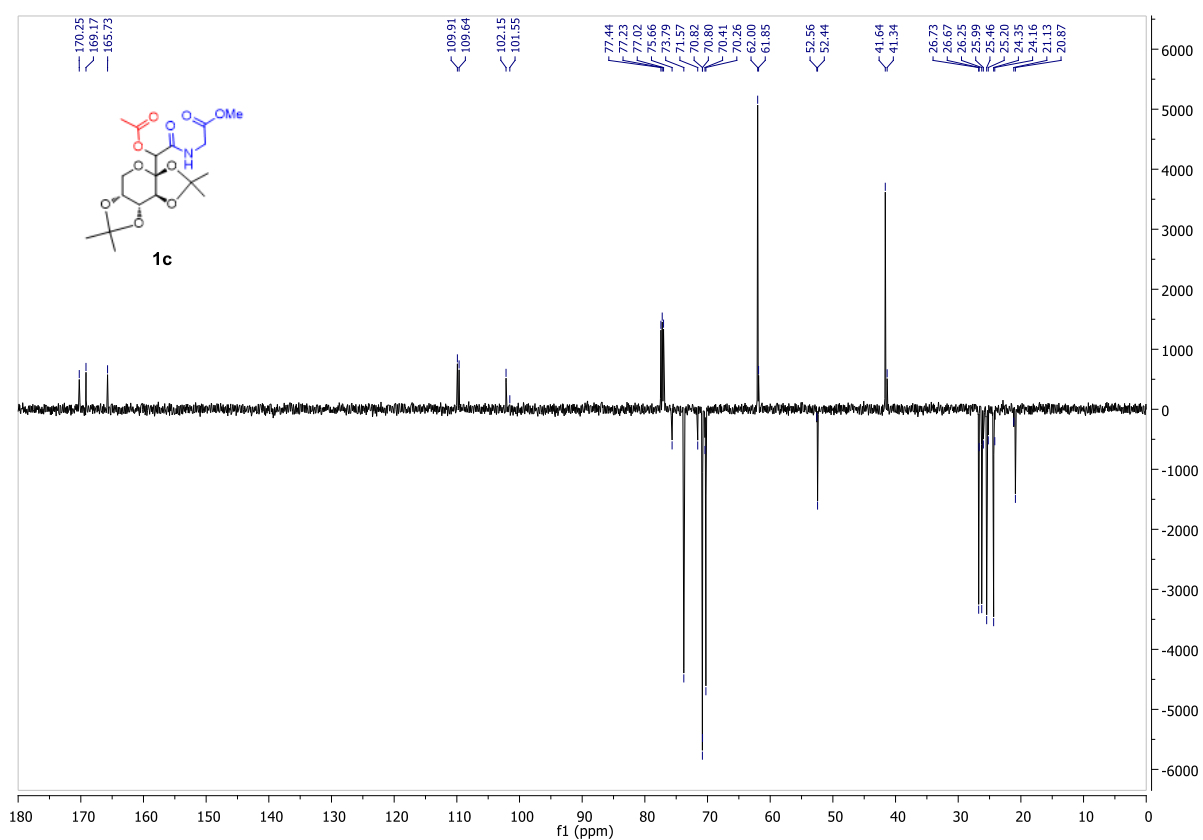
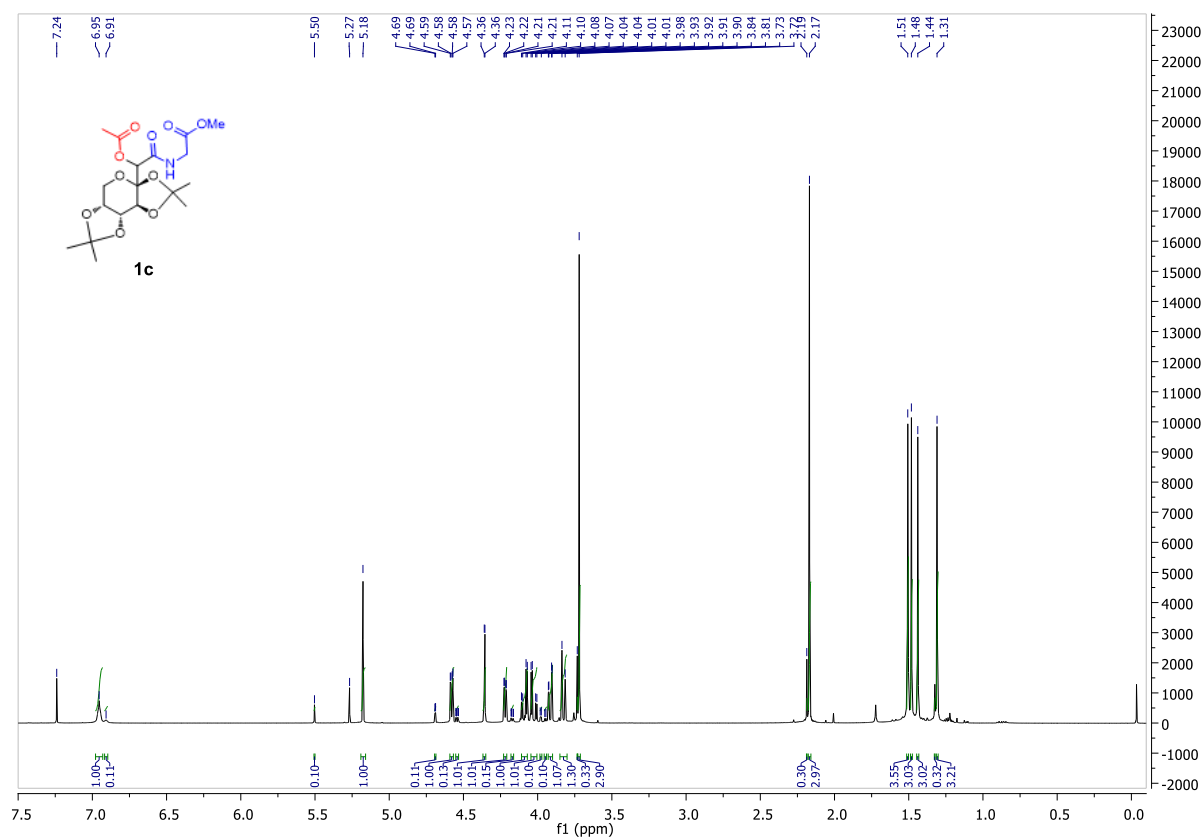




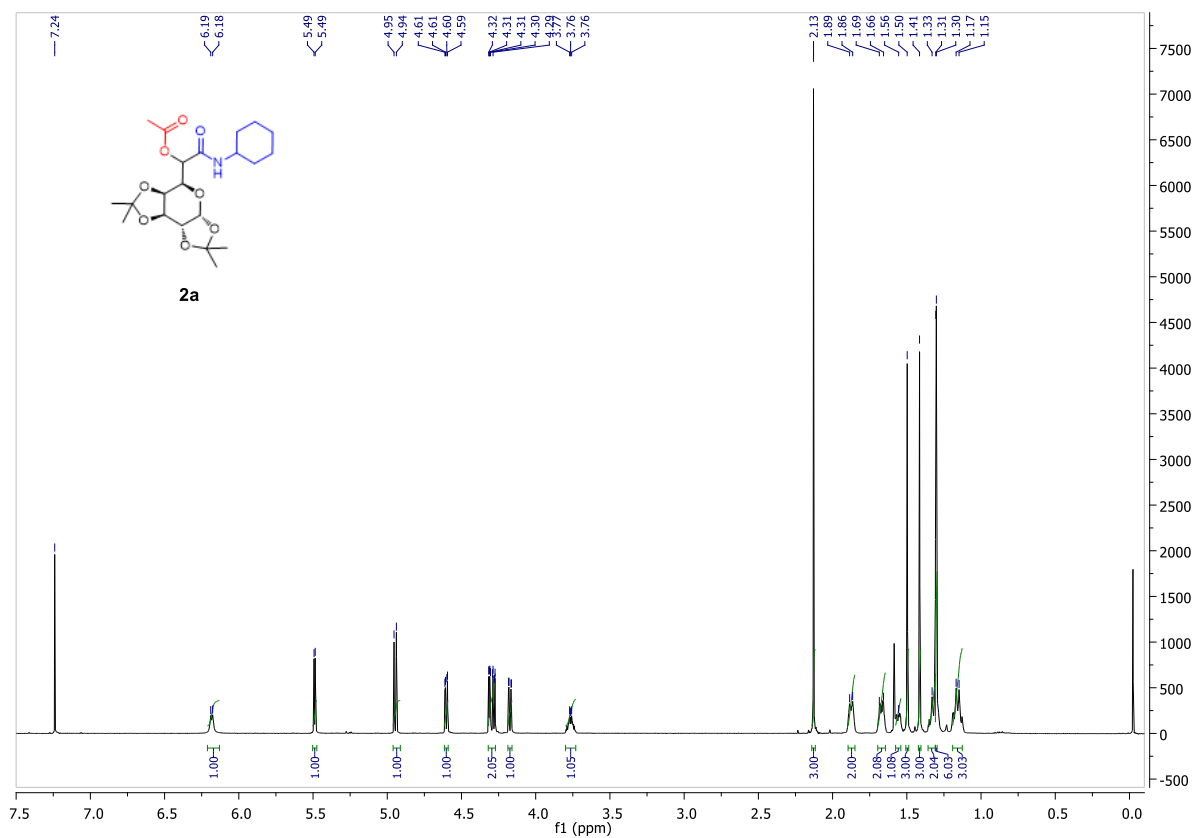
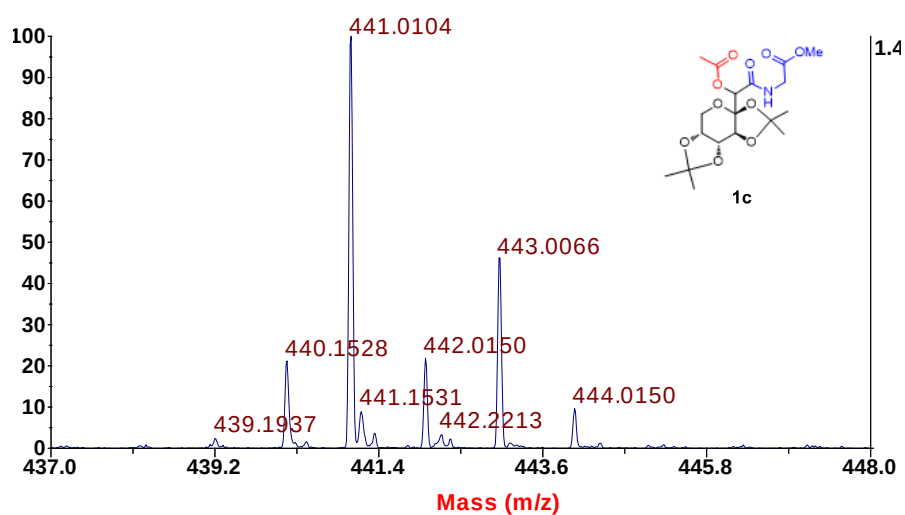


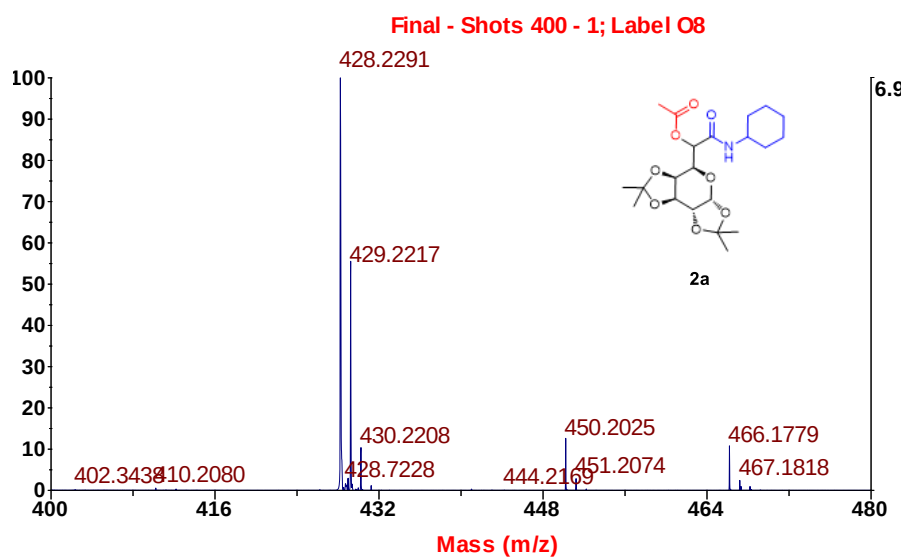
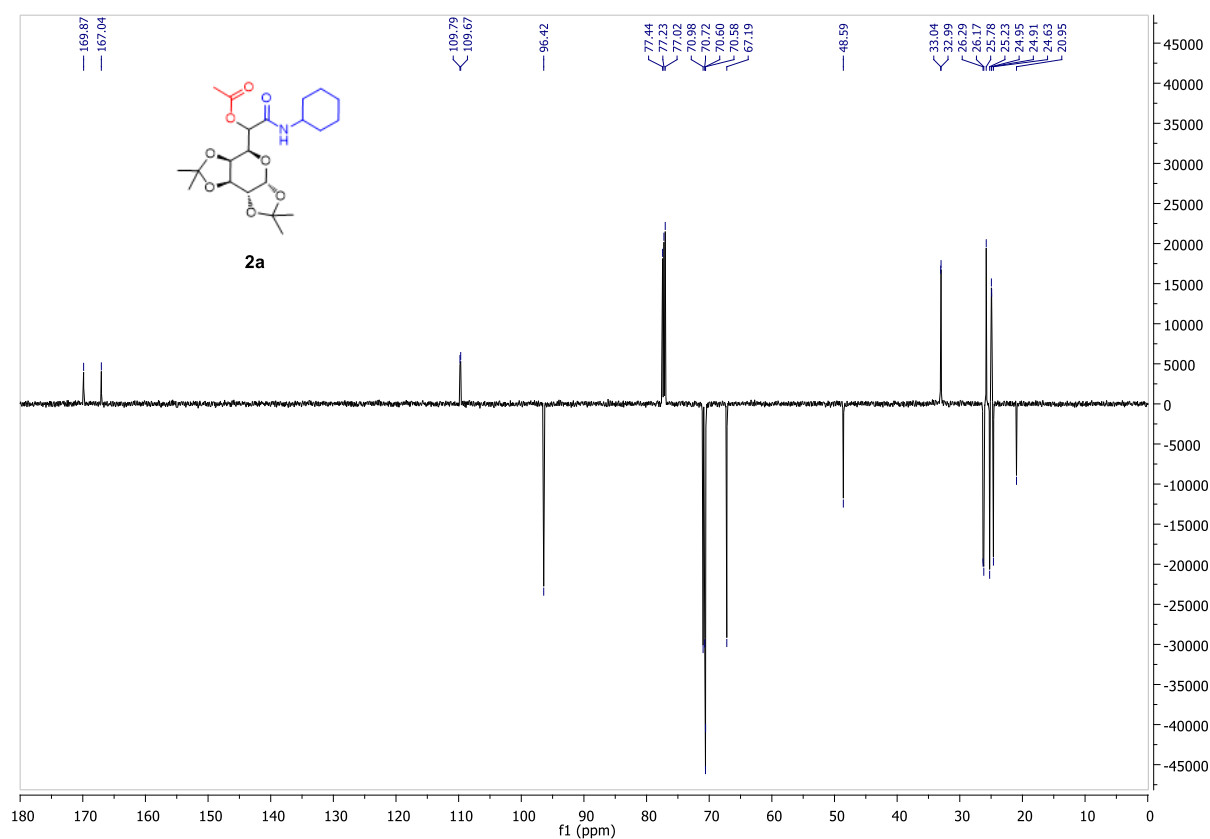


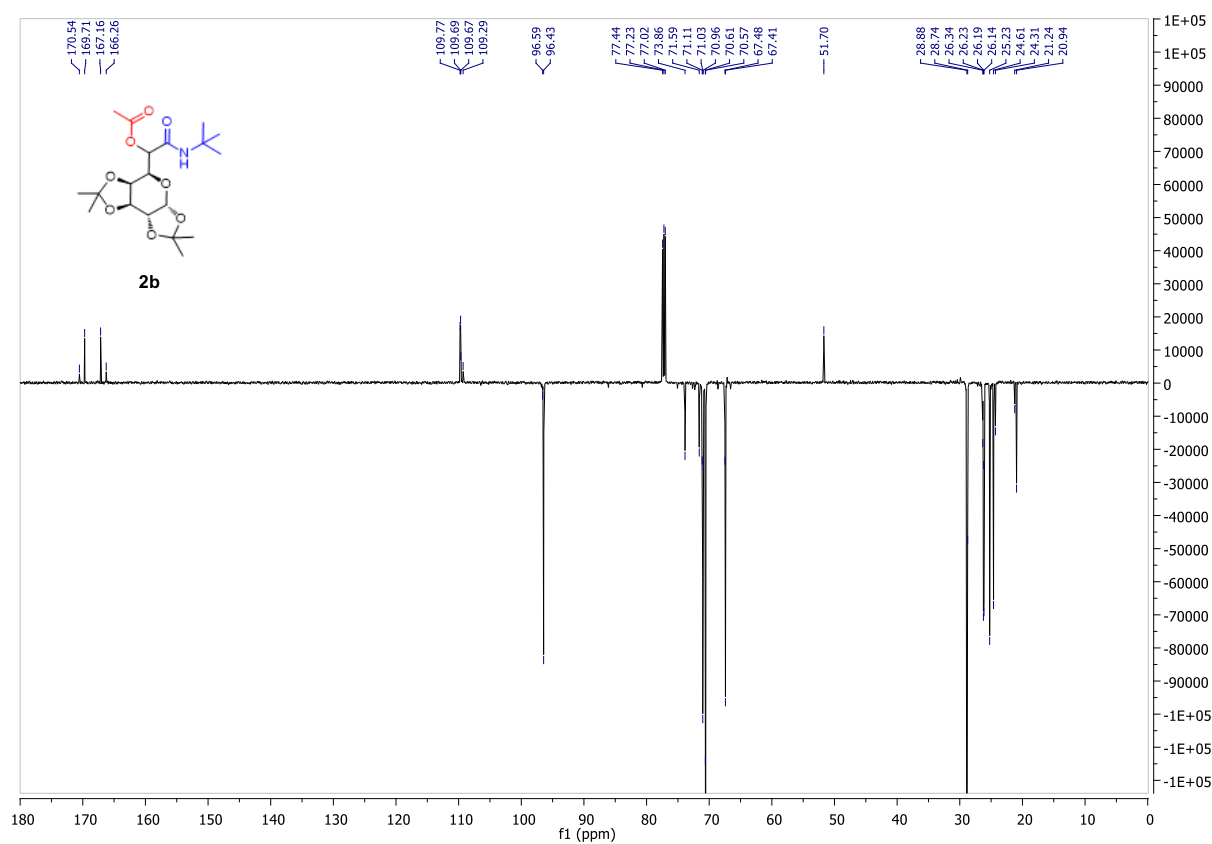
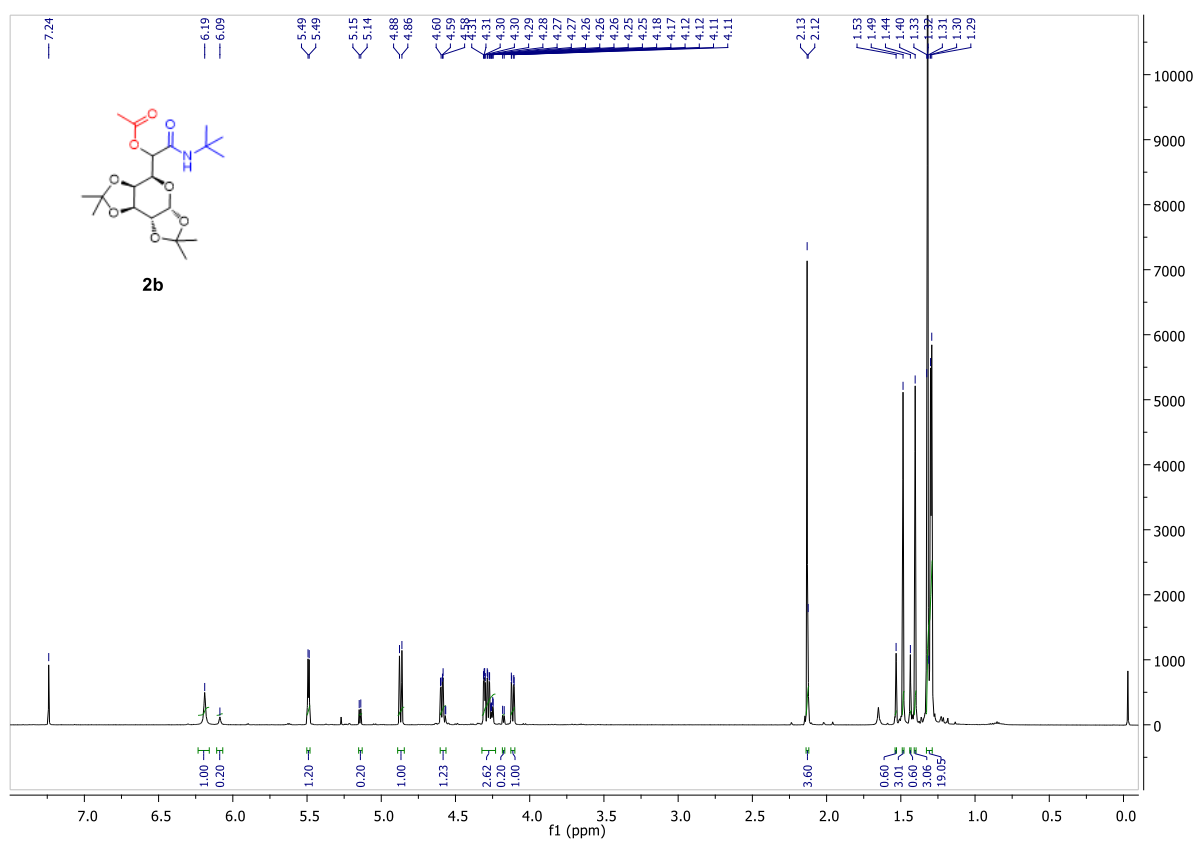
NMR and HRMS spectra of Passerini products obtained after purification:



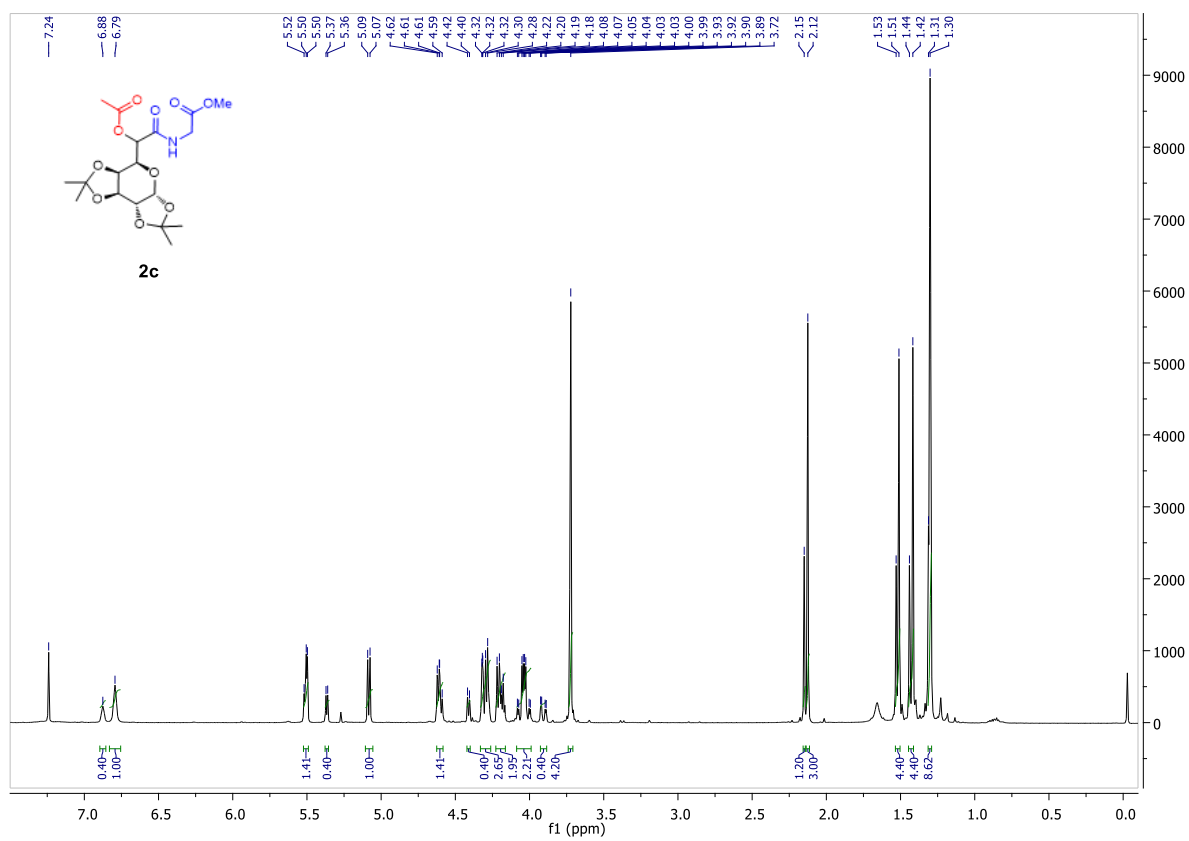
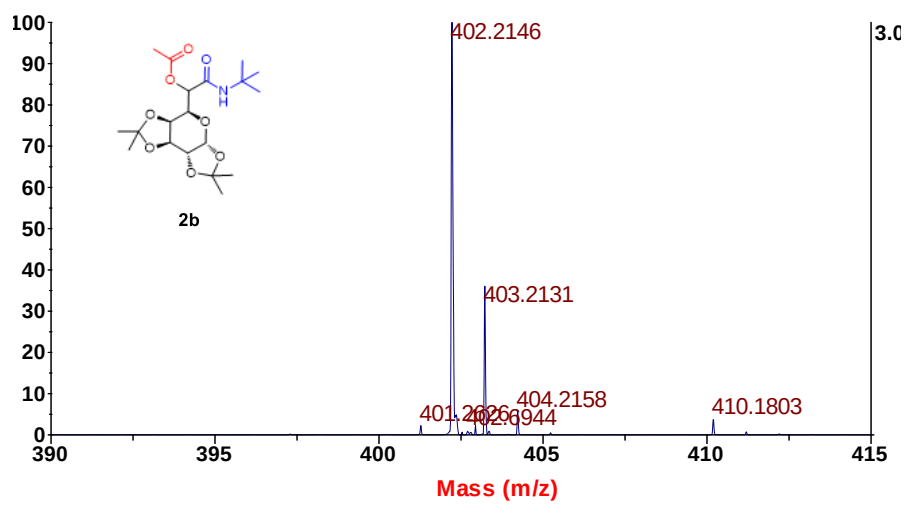
Final - Shots 50 - 1; Label F16

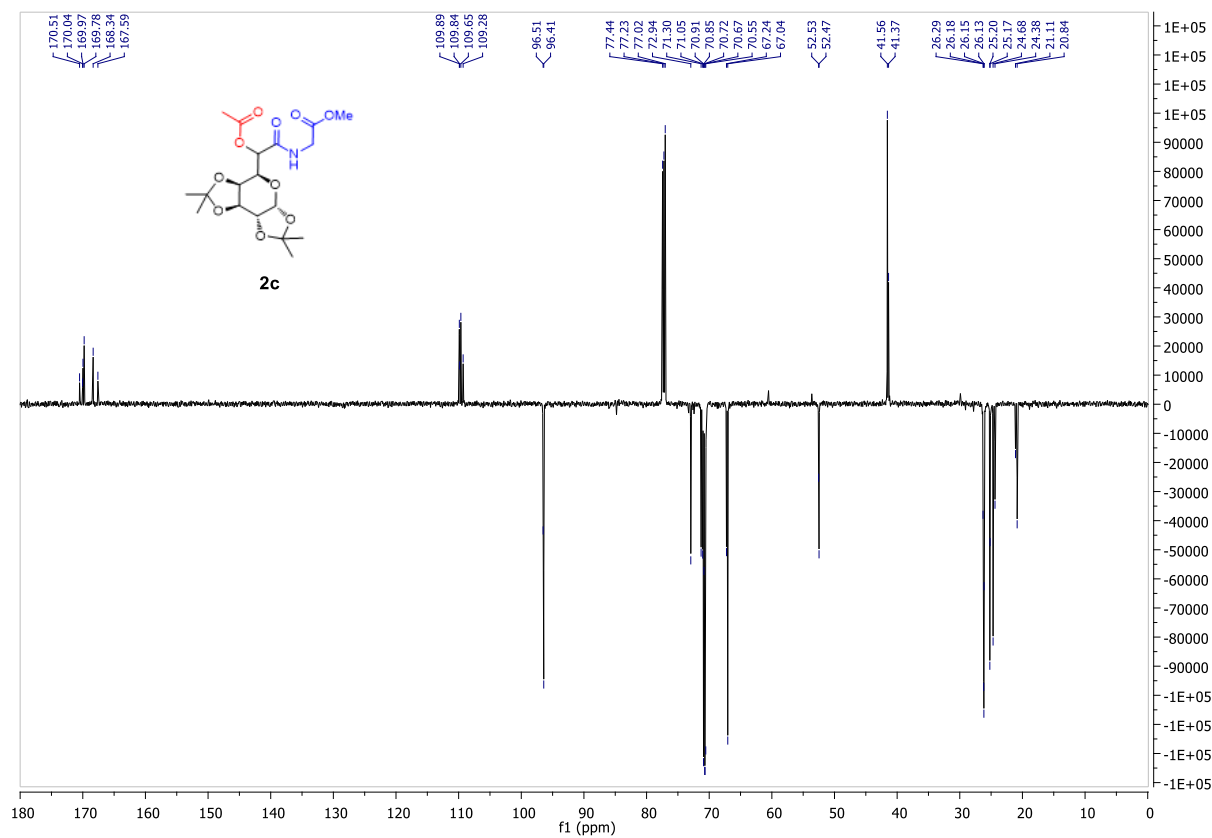




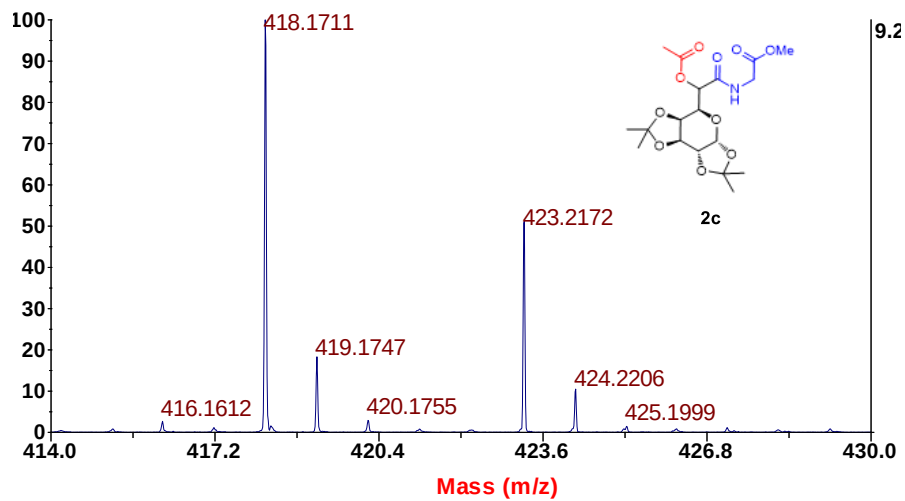


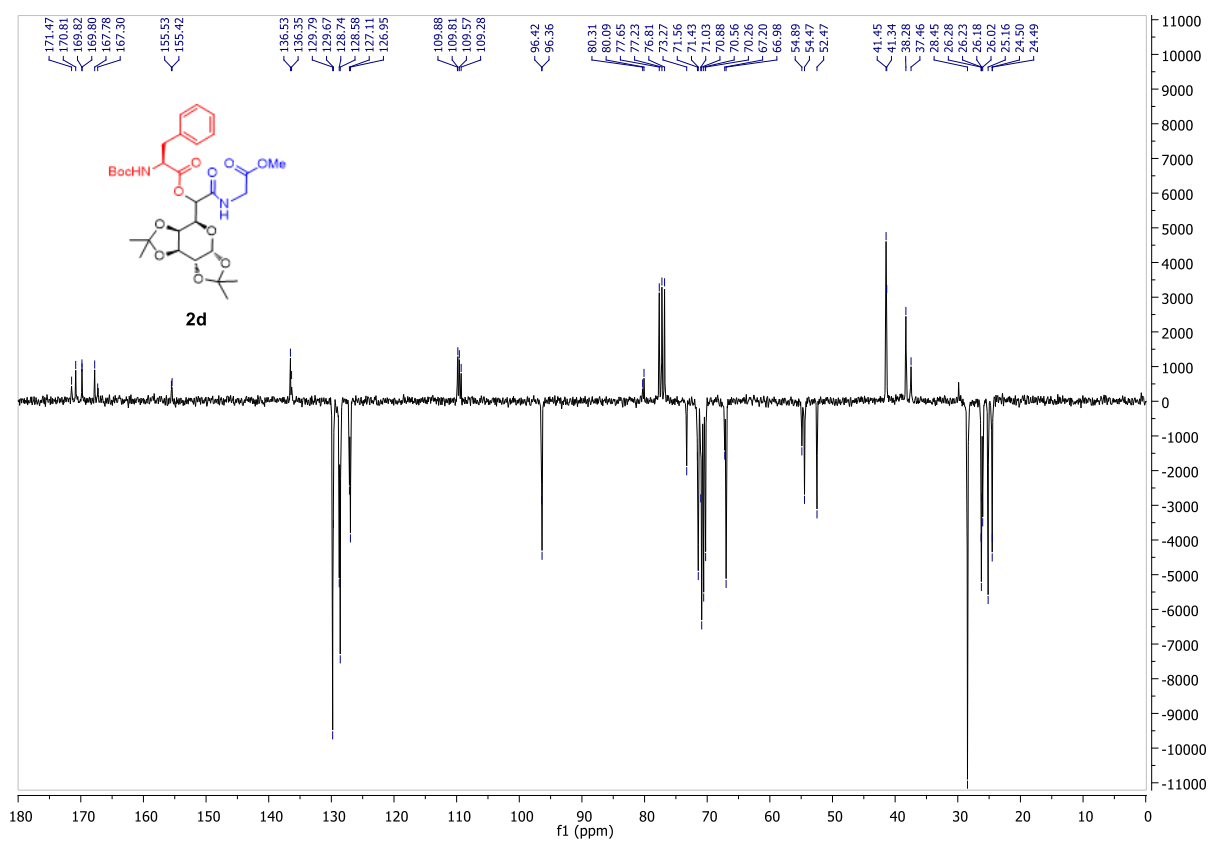
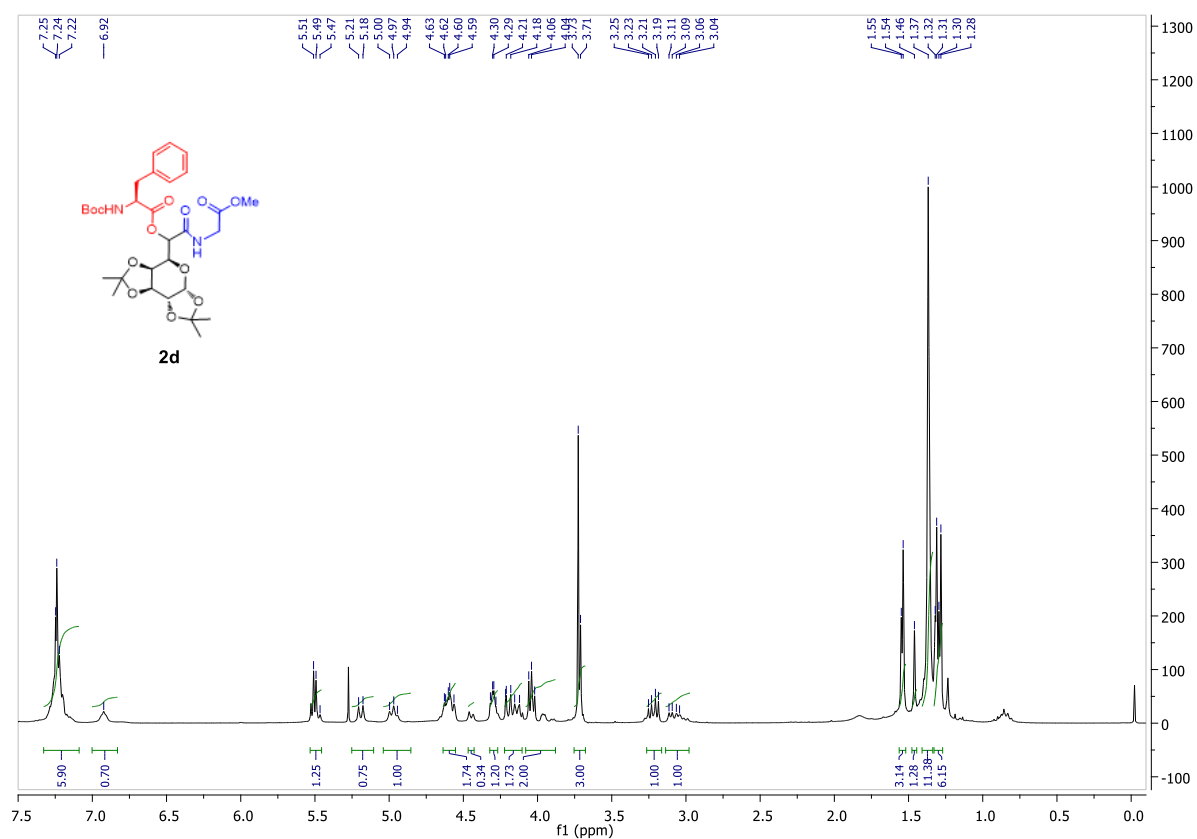
Final - Shots 800 - 1; Label O10



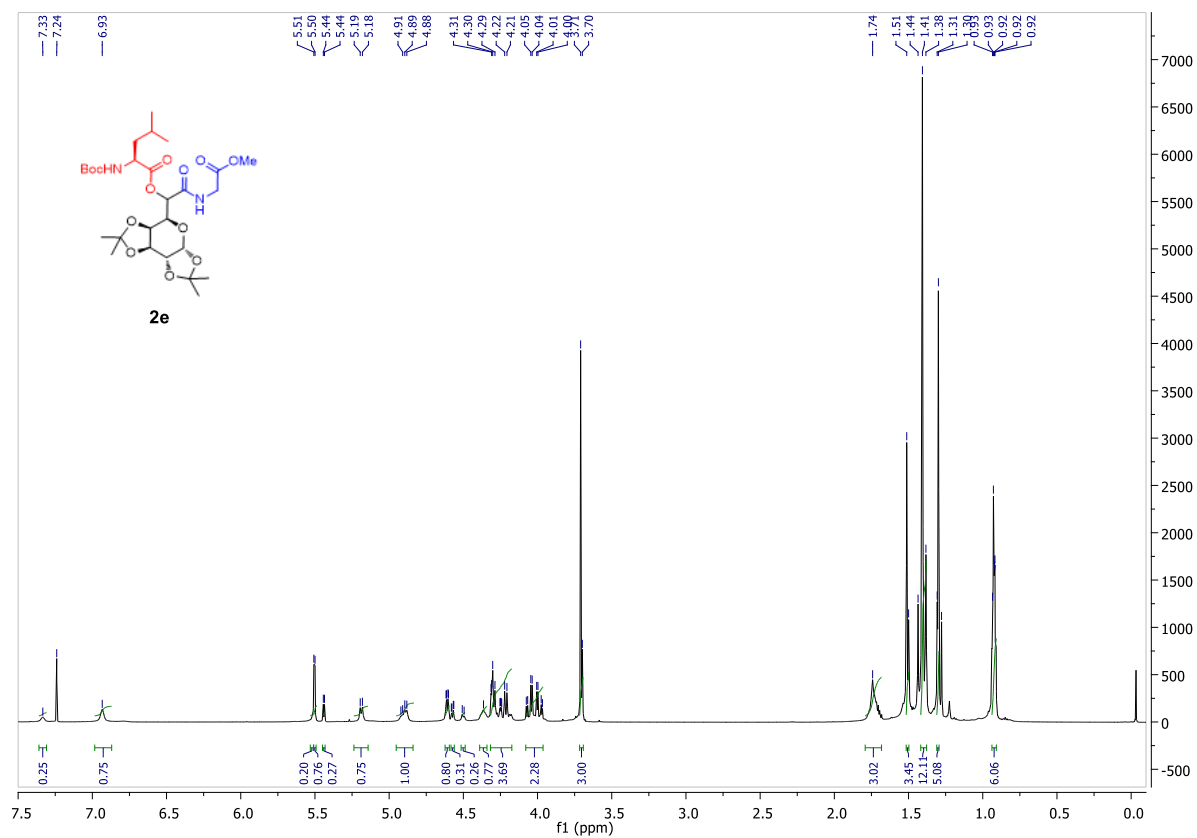
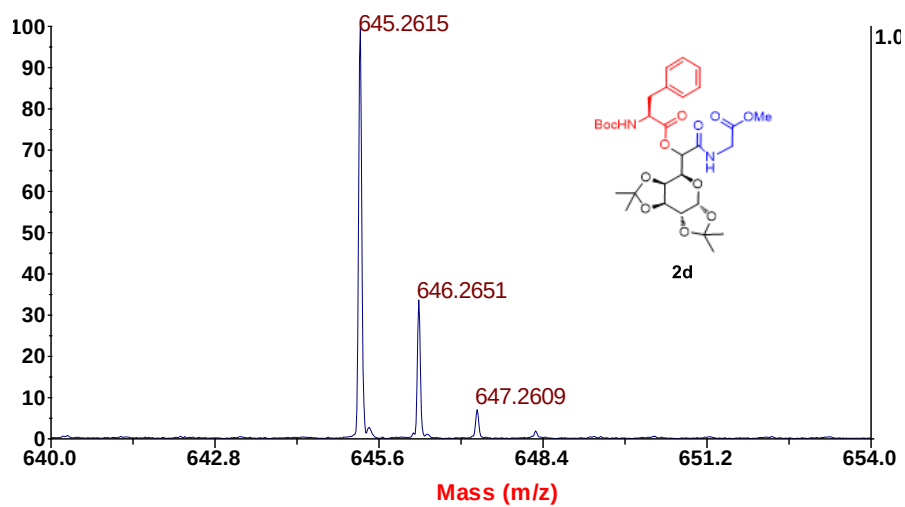


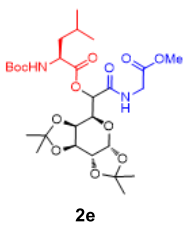
Final - Shots 400 - 1; Label O9





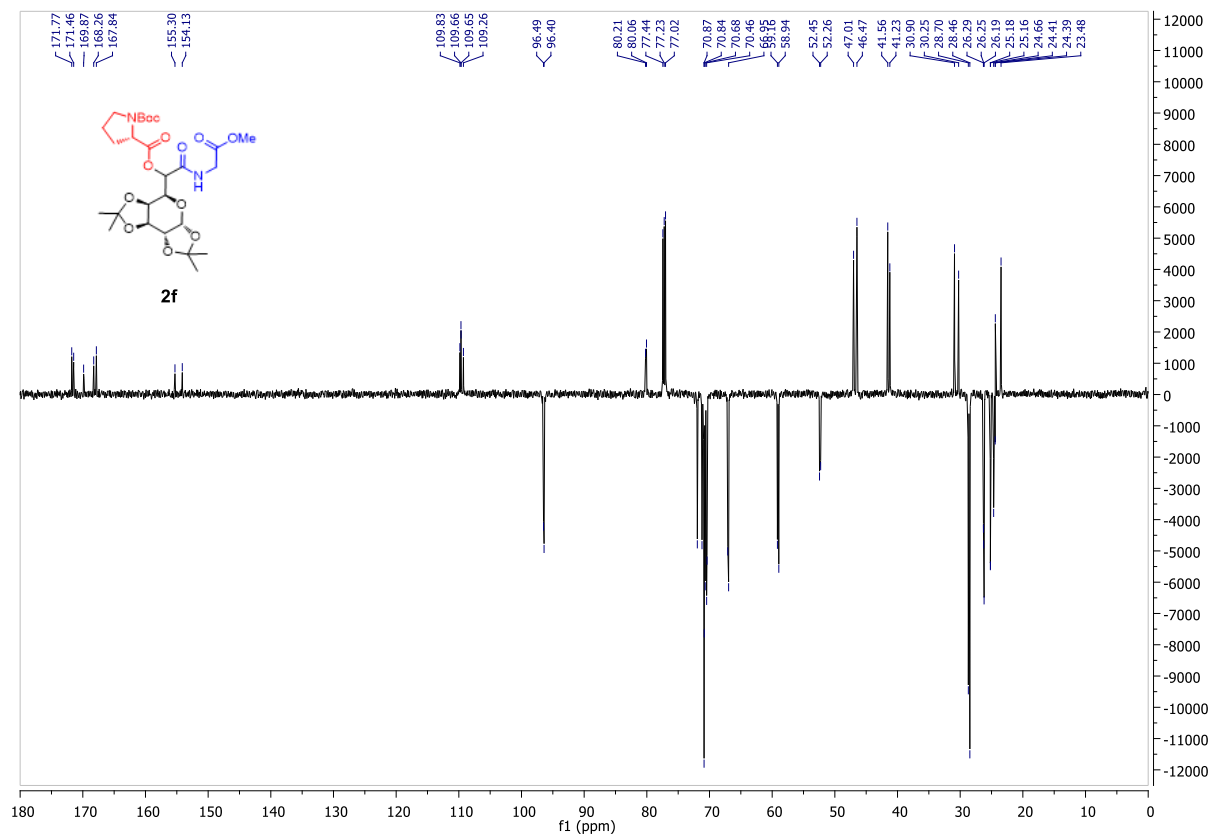
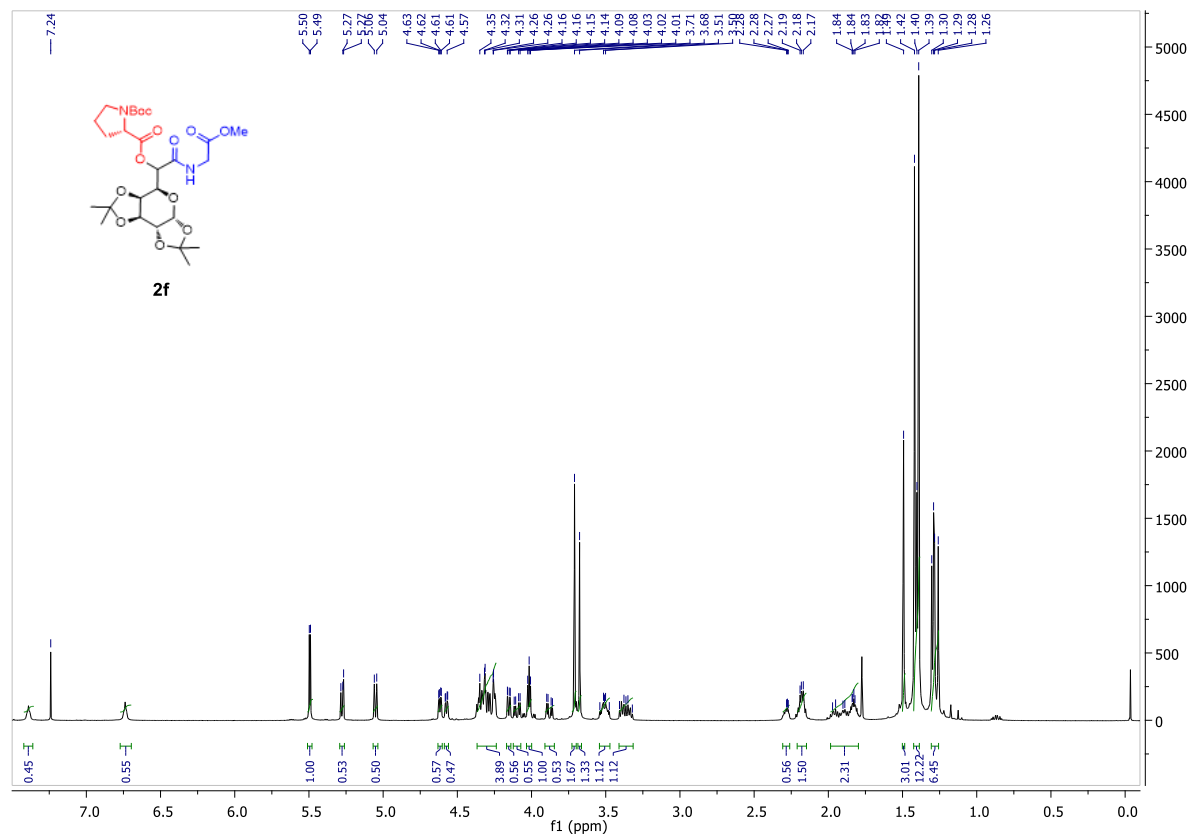
Final - Shots 400 - 1; Label O12



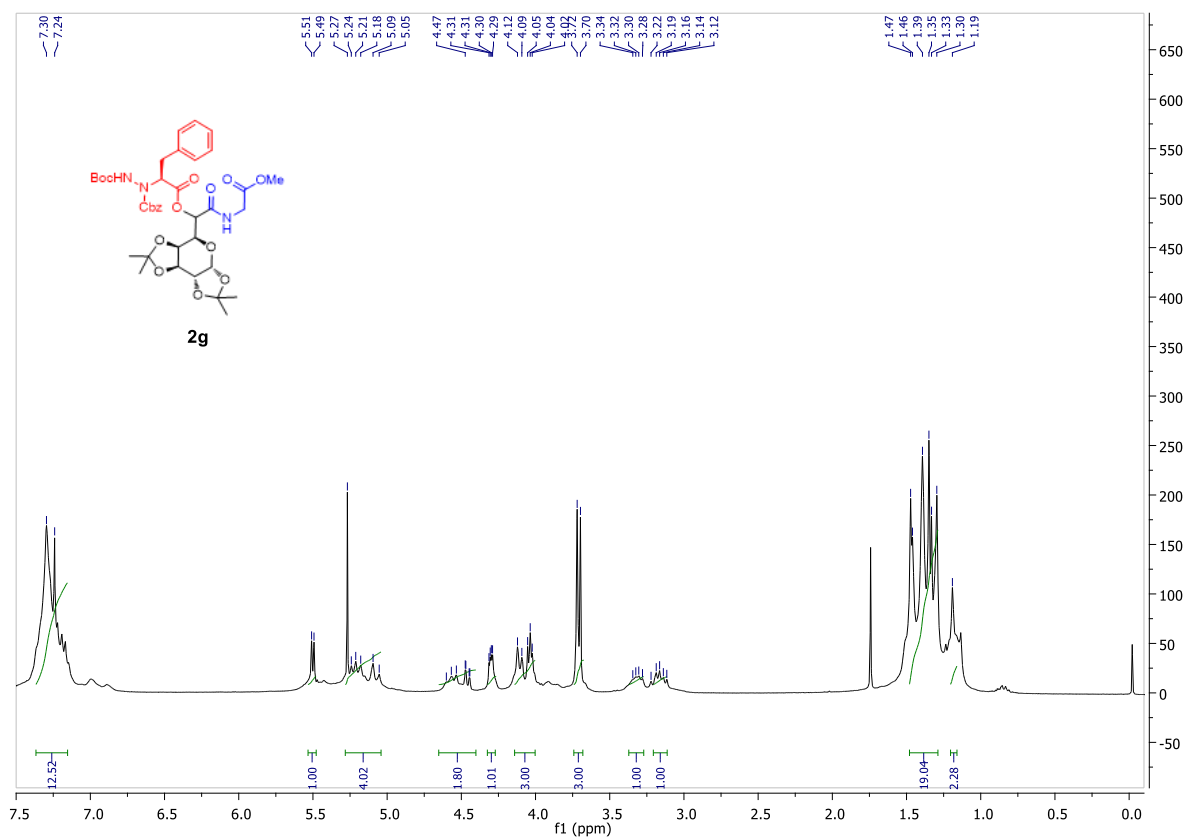
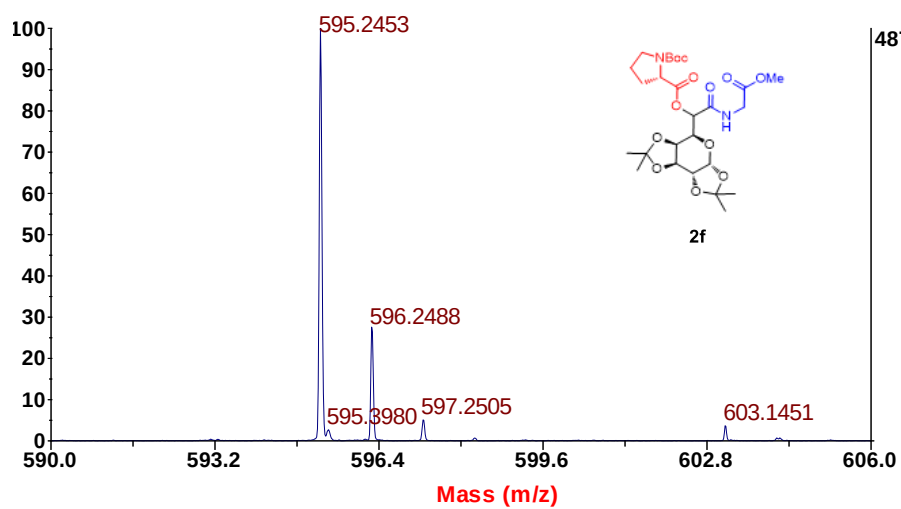


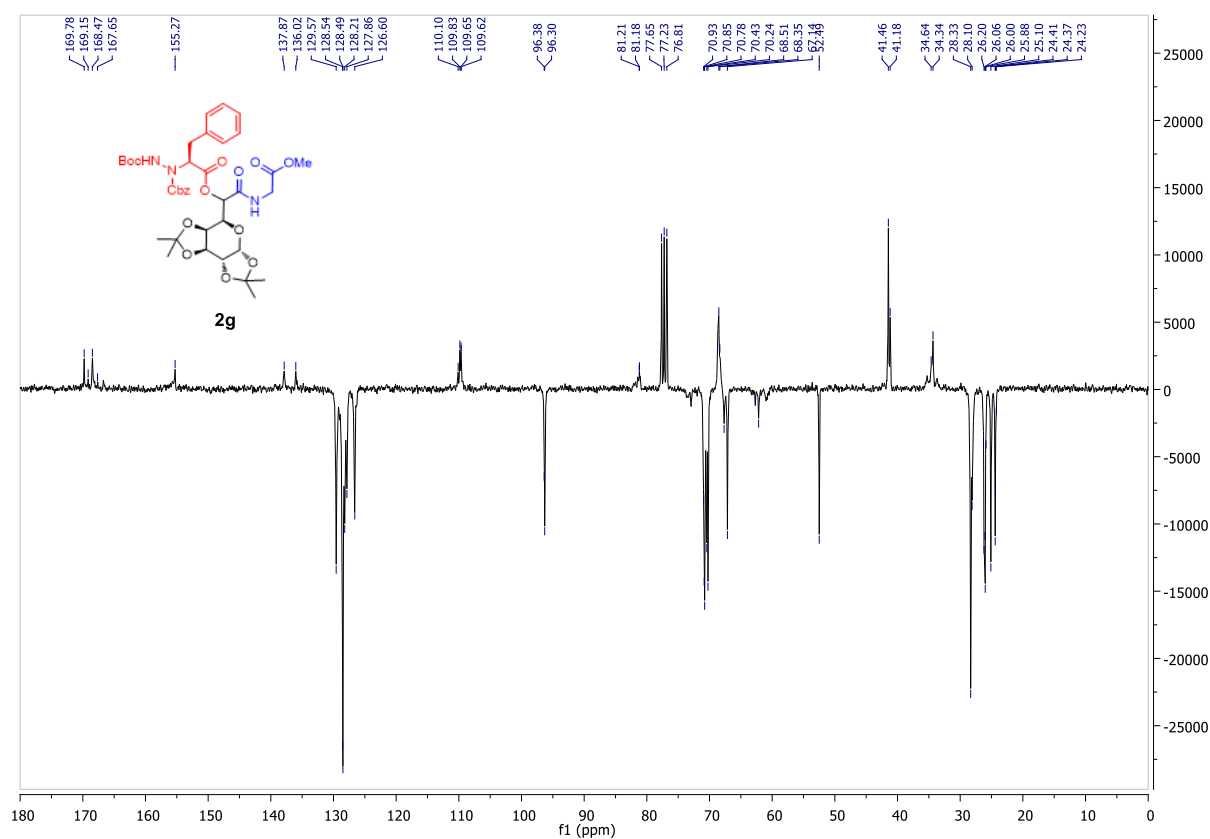
Mass spectrum of compound **2e**. The x-axis represents Mass (m/z) and the y-axis represents relative intensity (0 to 100). The base peak is at m/z 611.2805. Other labeled peaks include m/z 612.2840, 611.4354, 613.2837, and 614.2828. The chemical structure of **2e** is shown as an inset.

CC(C)C(=O)OC1C(OC(=O)C2C(C(C(C2)OC(C)(C)C)OC(C)(C)C)OC(C)(C)C)OC1C(=O)NC(=O)C

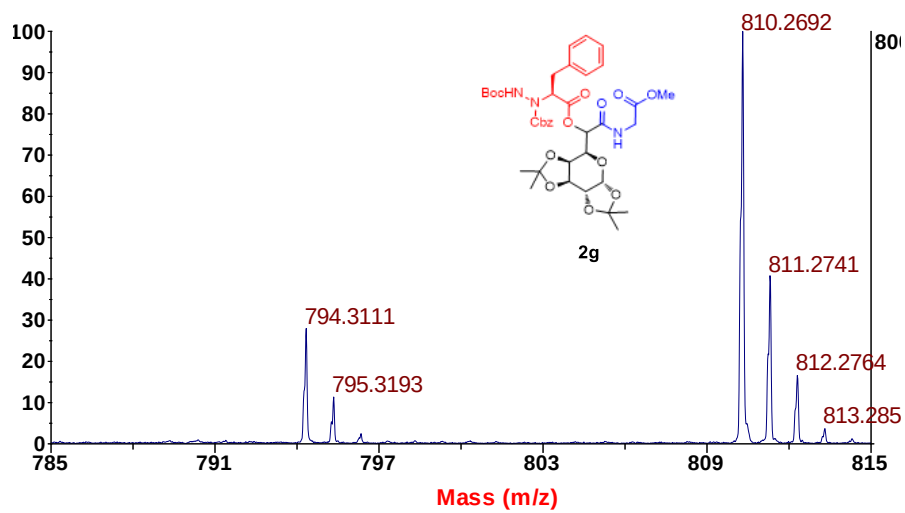


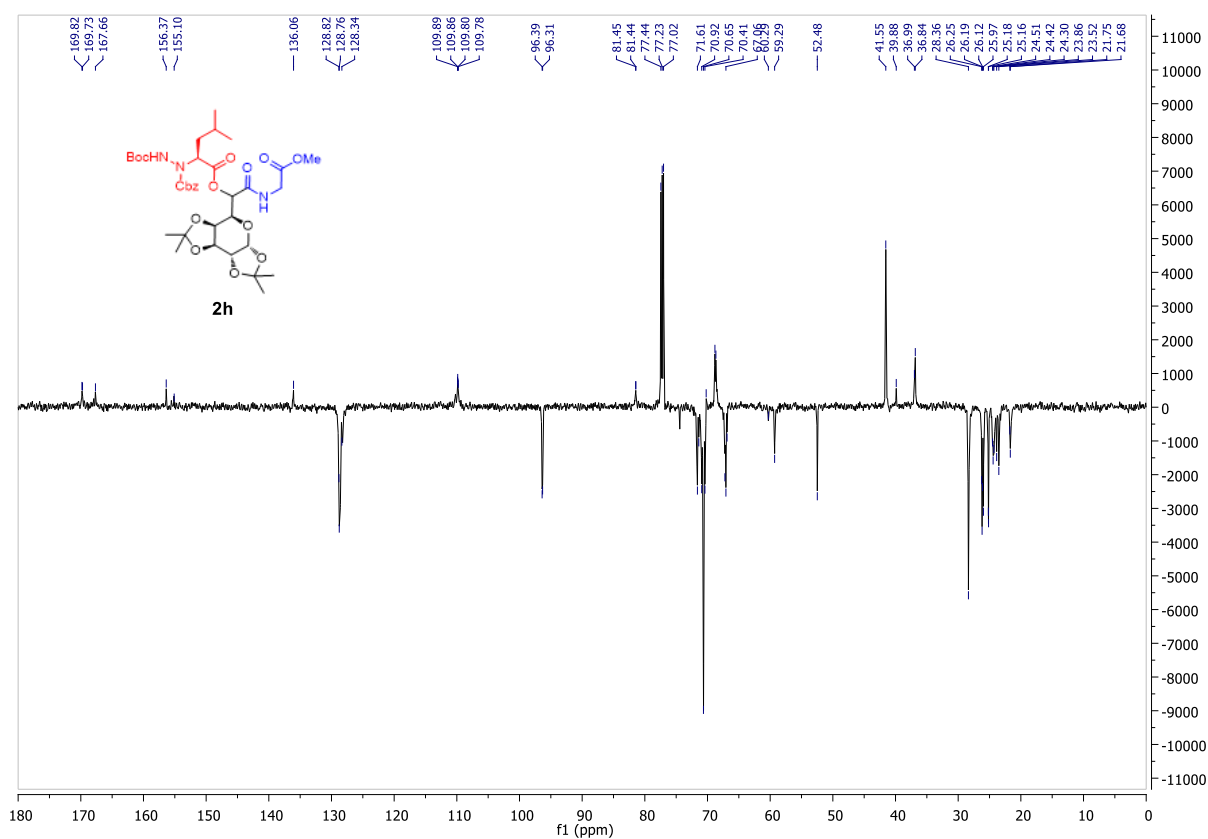
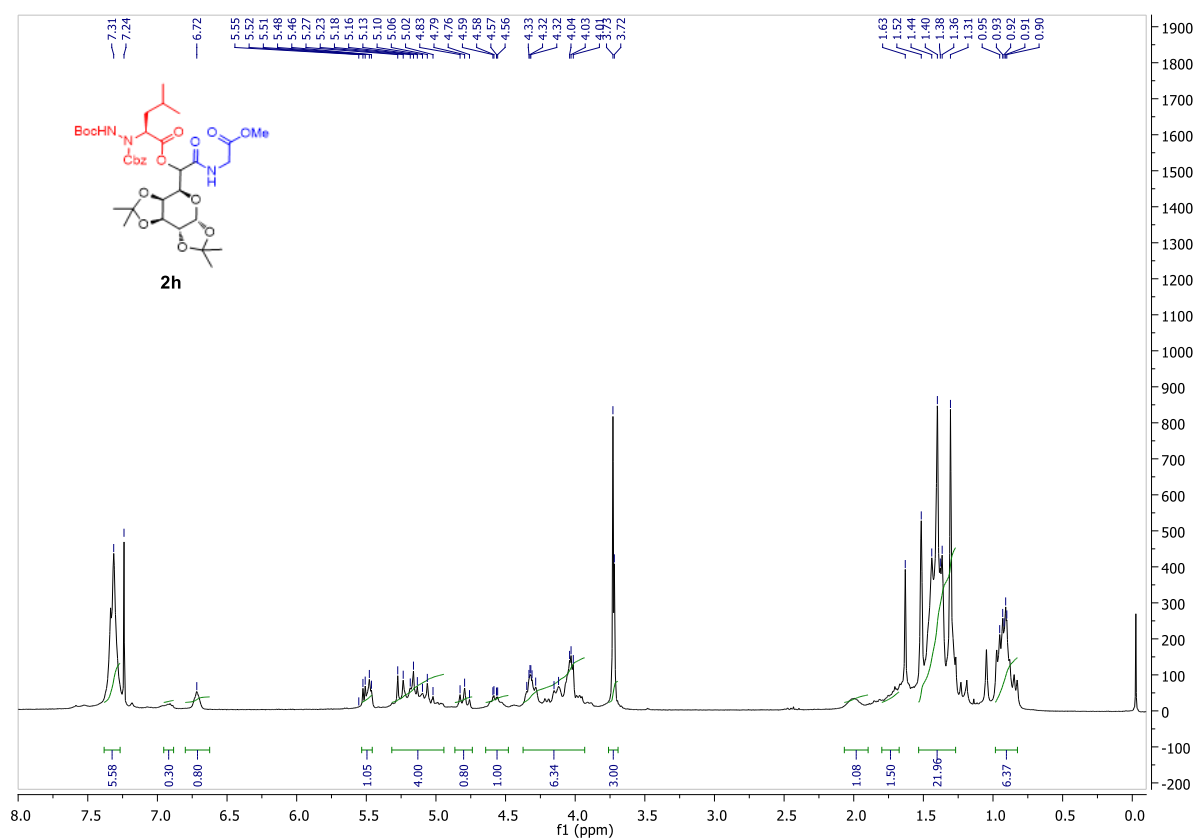
Final - Shots 800 - 1; Label O16



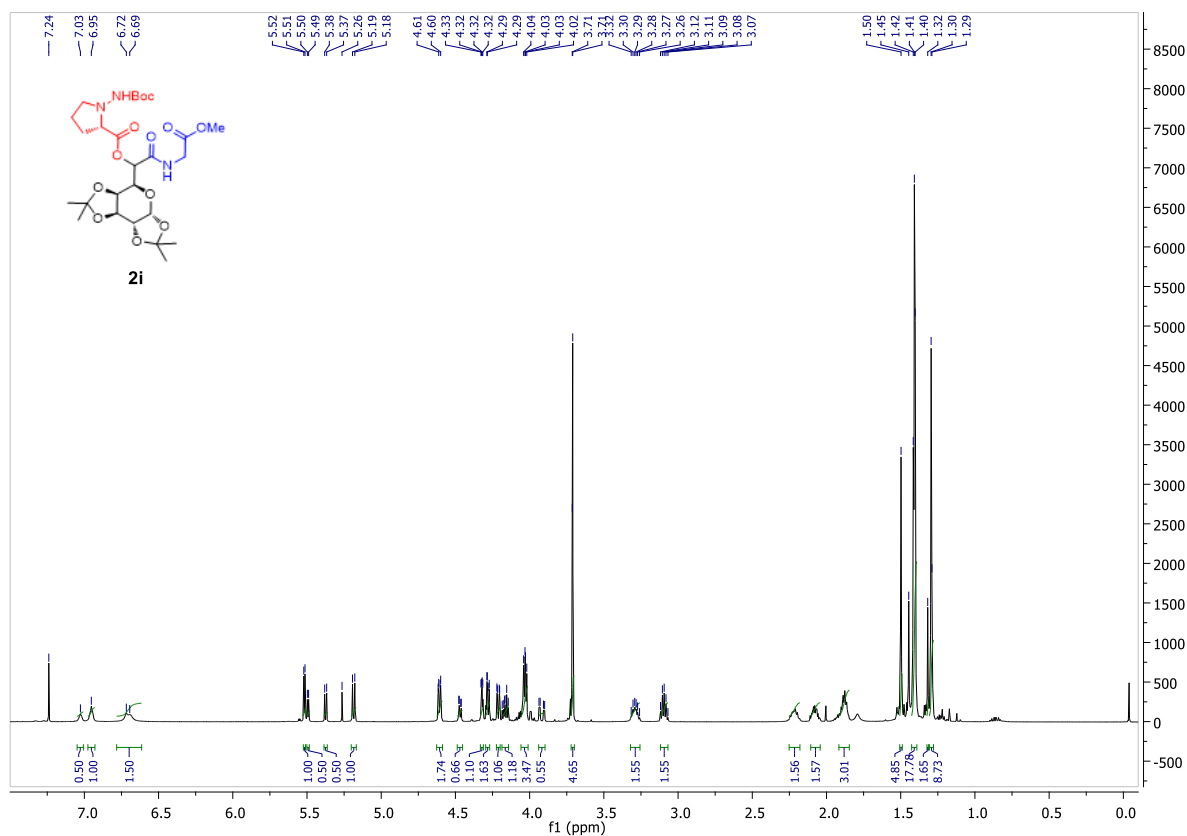
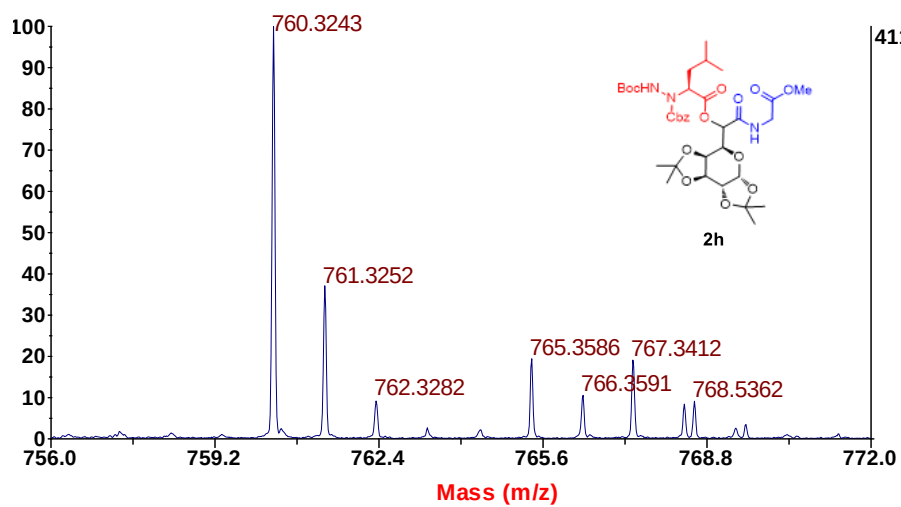


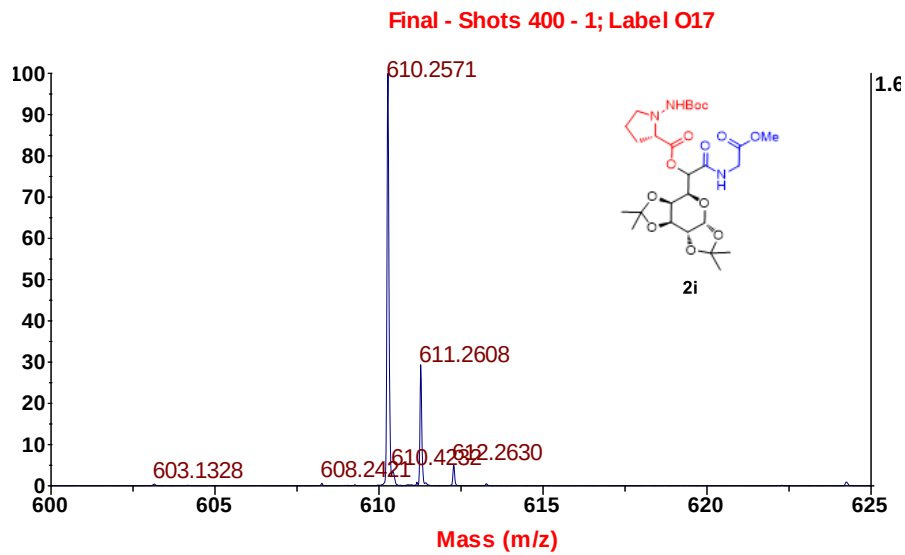
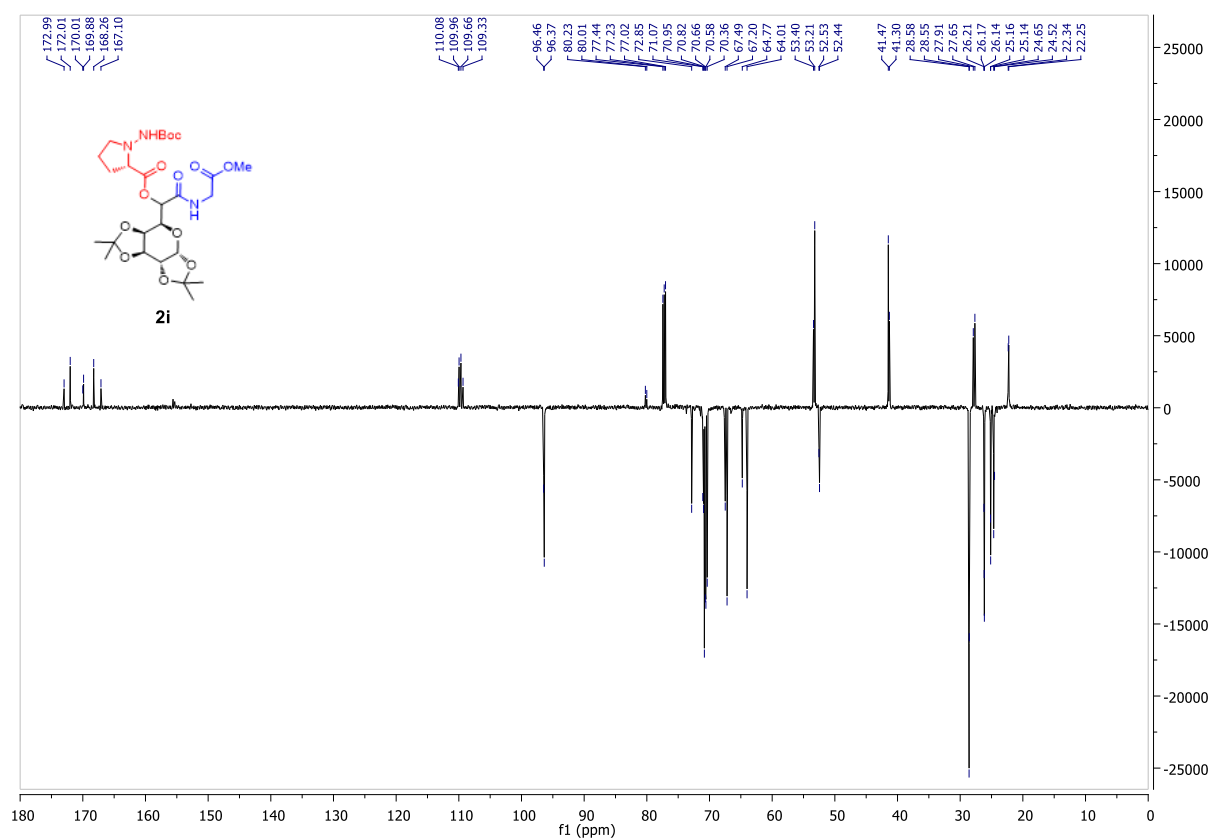
Final - Shots 400 - 1; Label O13

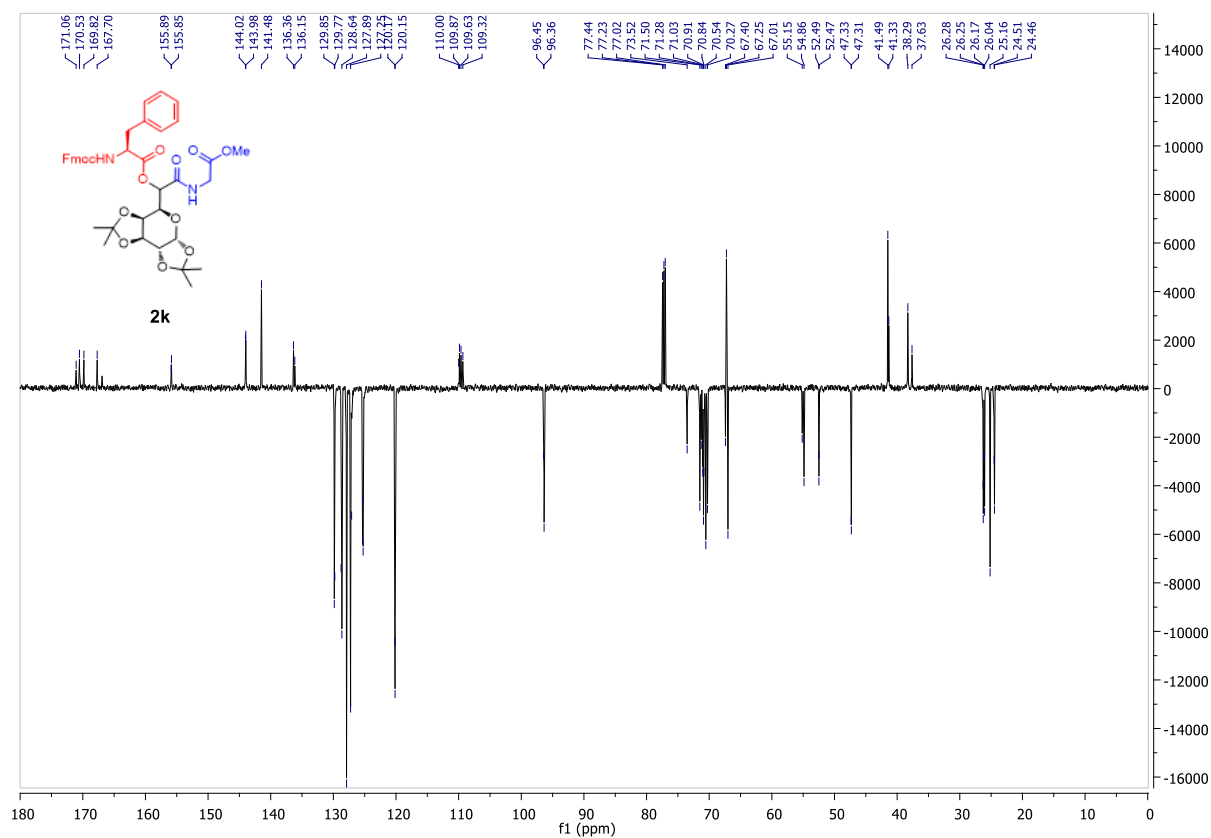
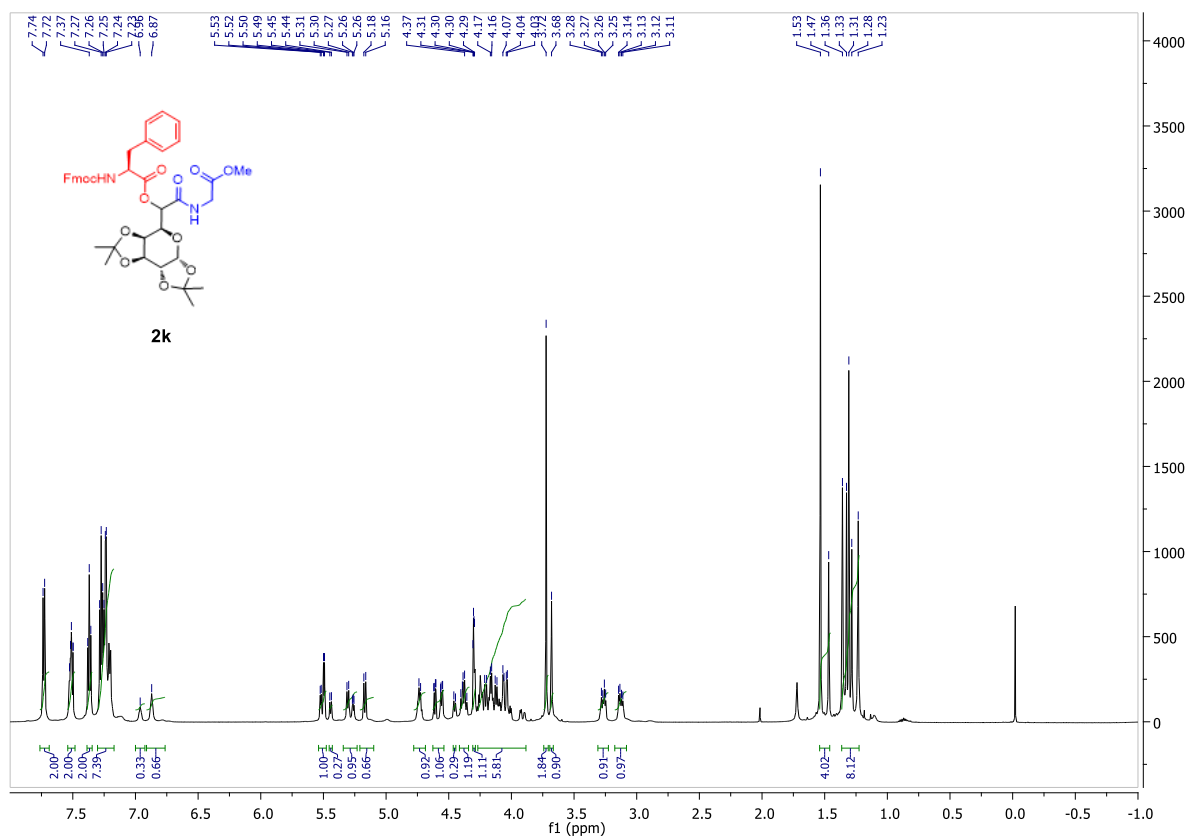




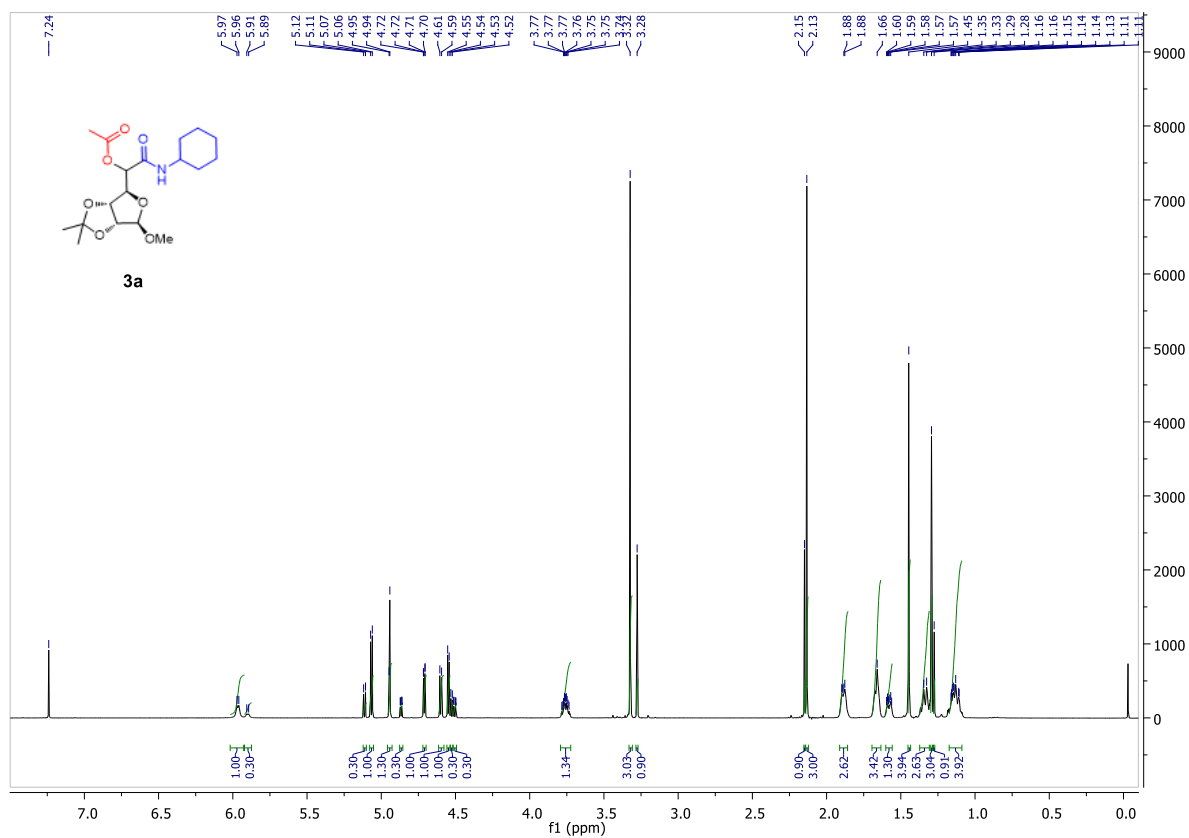
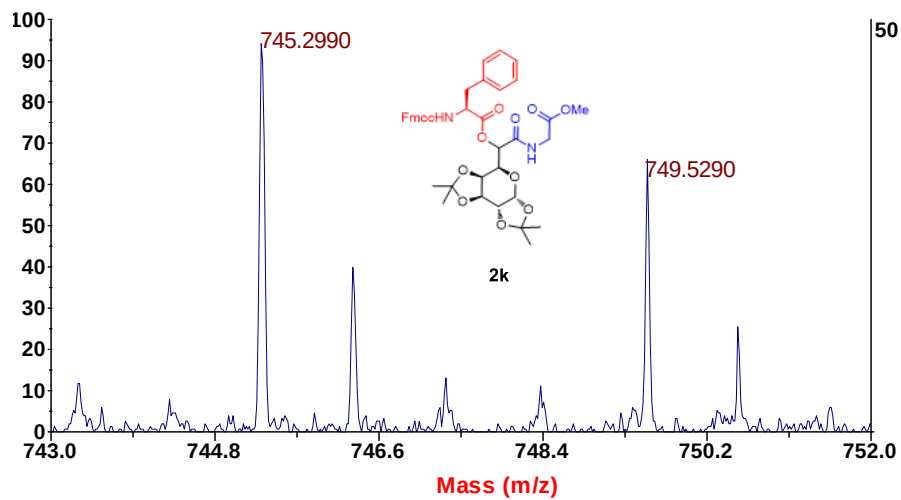
Final - Shots 600 - 1; Label O15

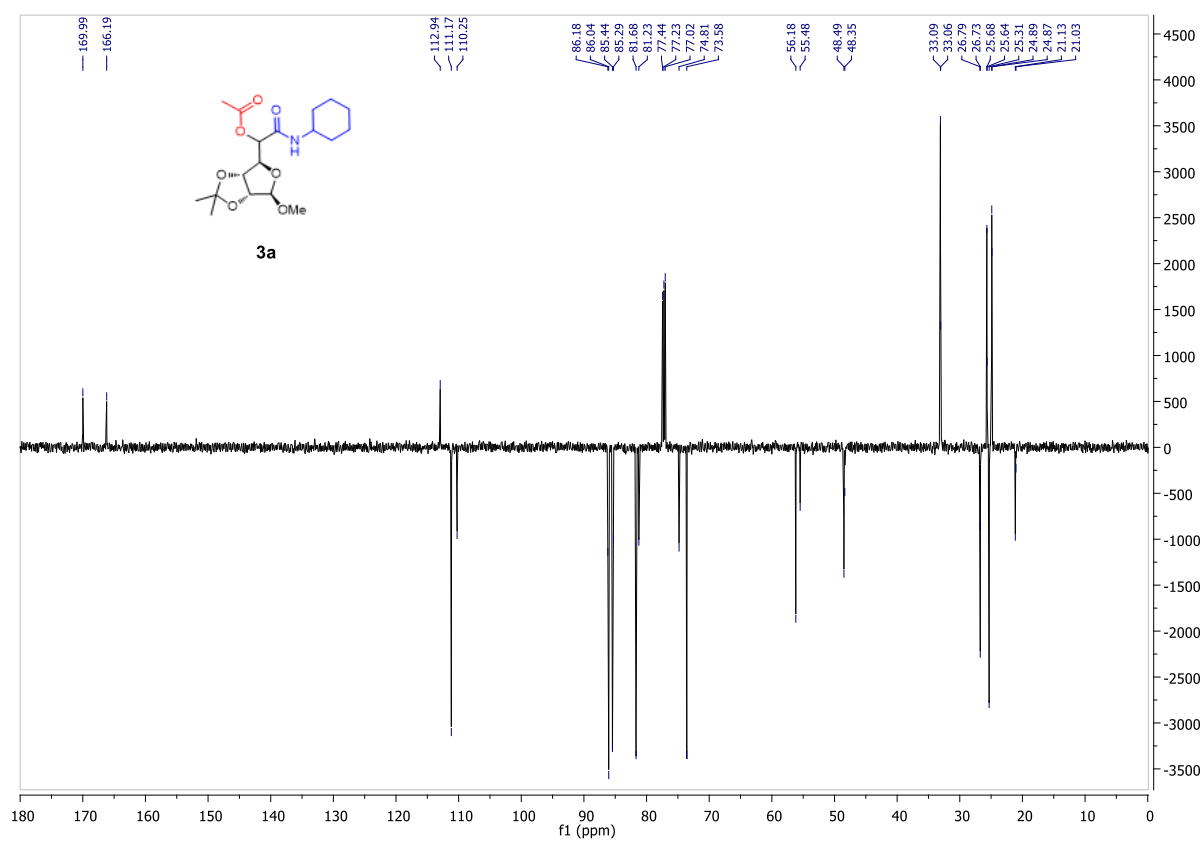




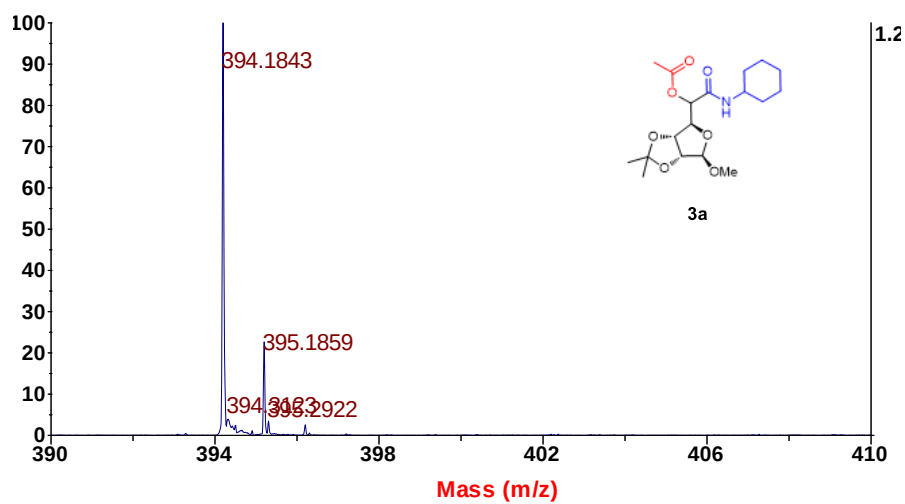


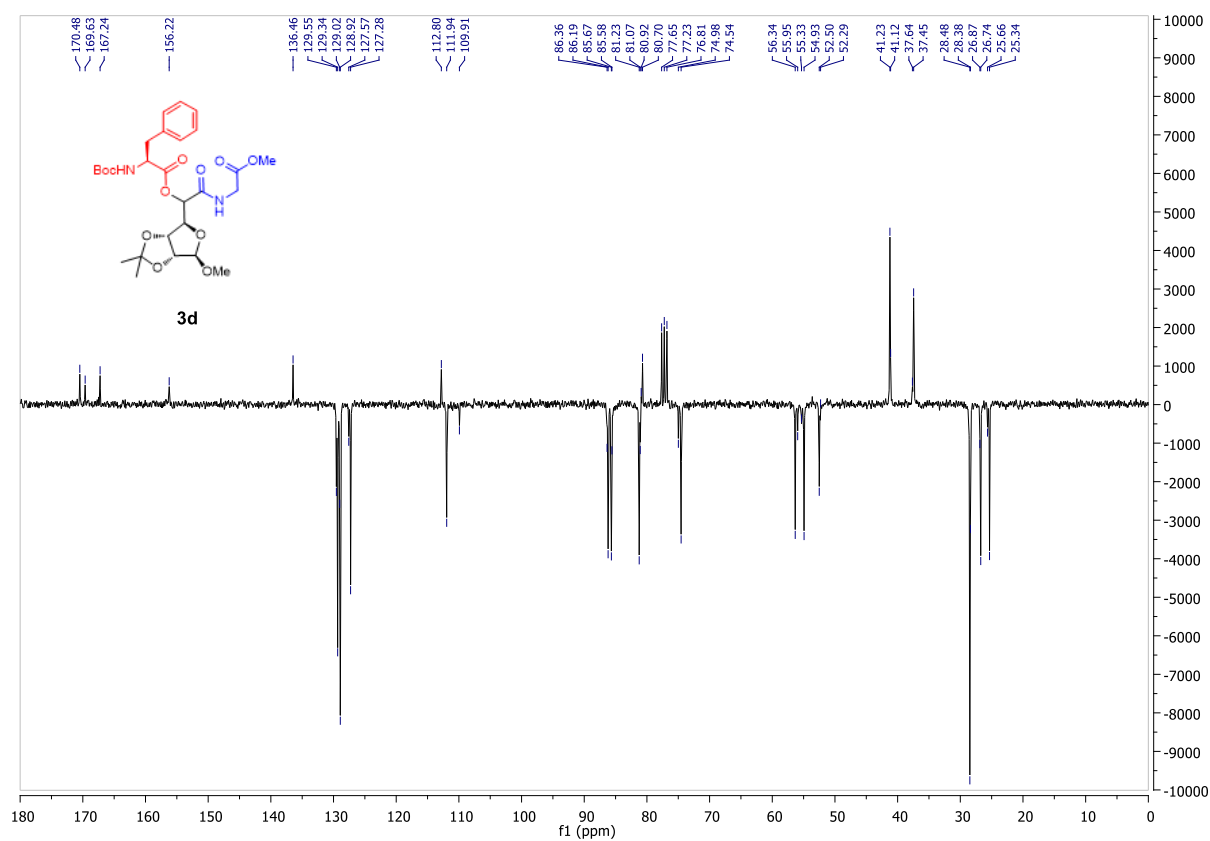
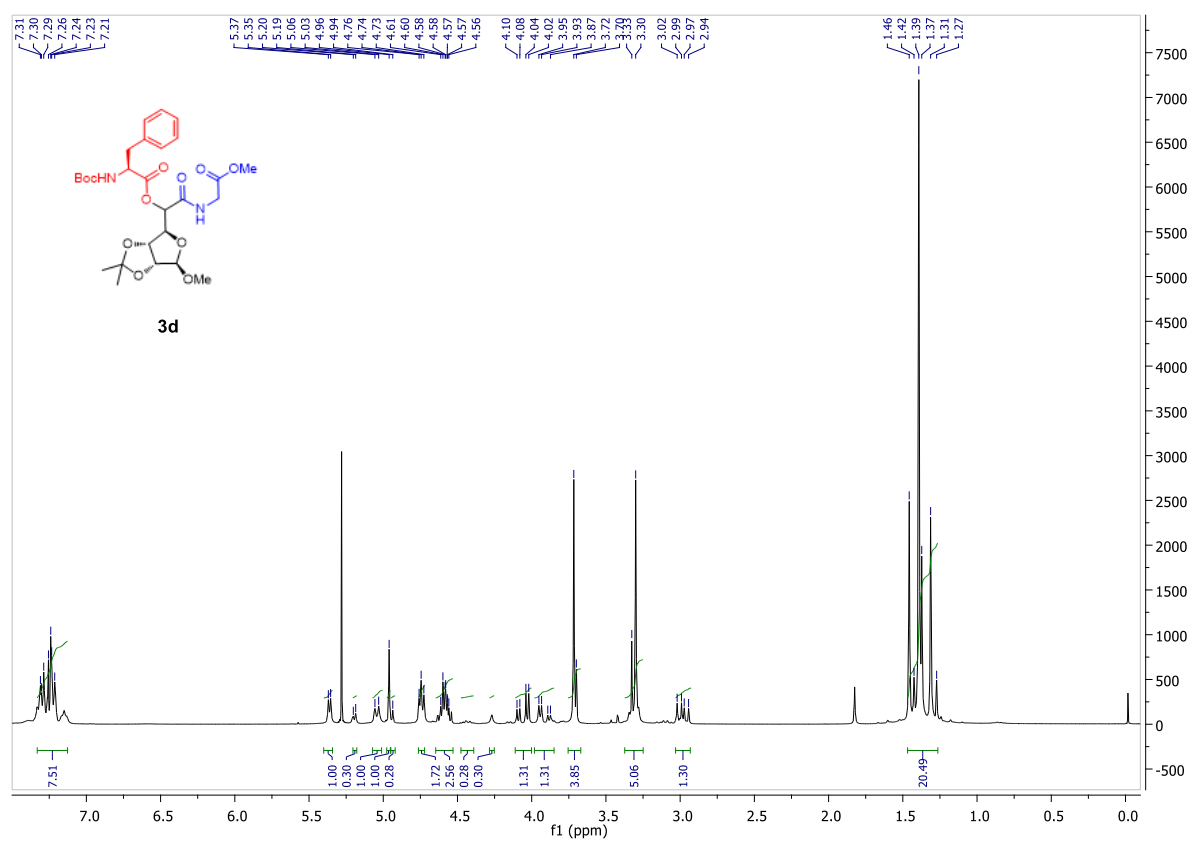
2k



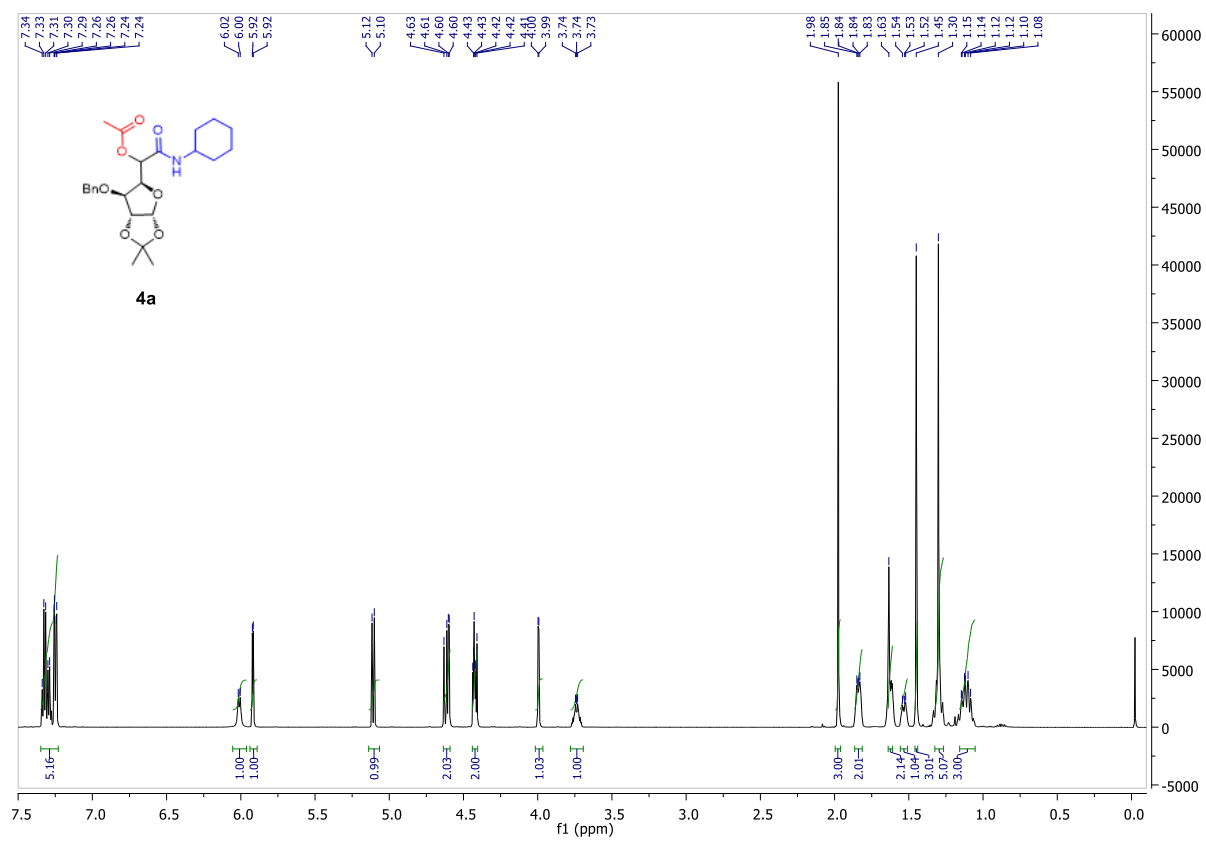
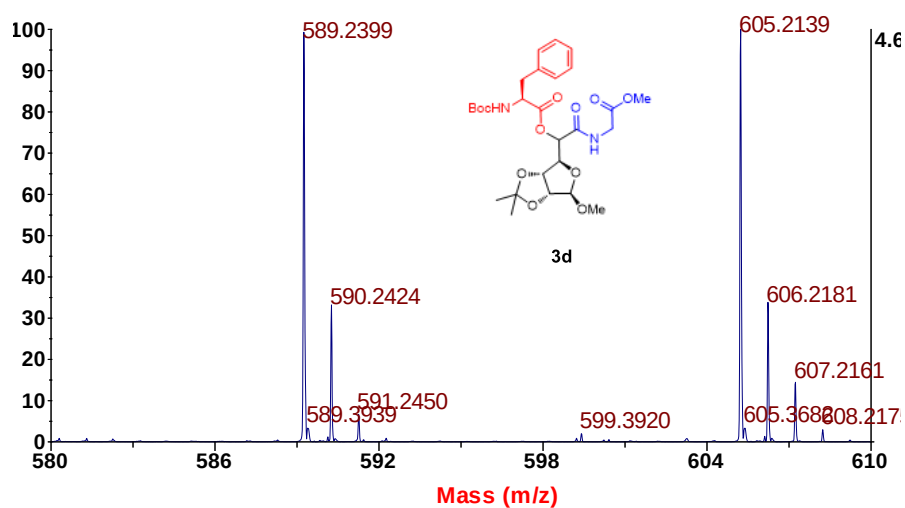


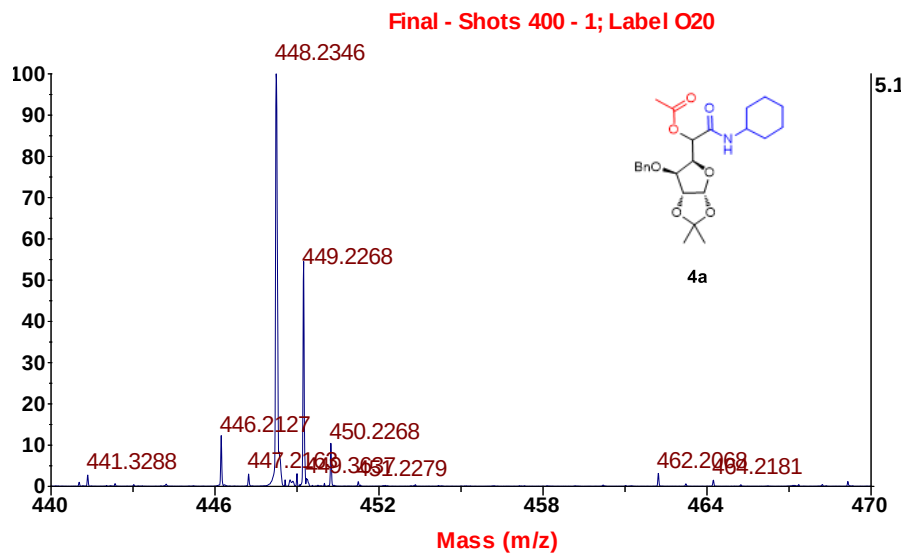
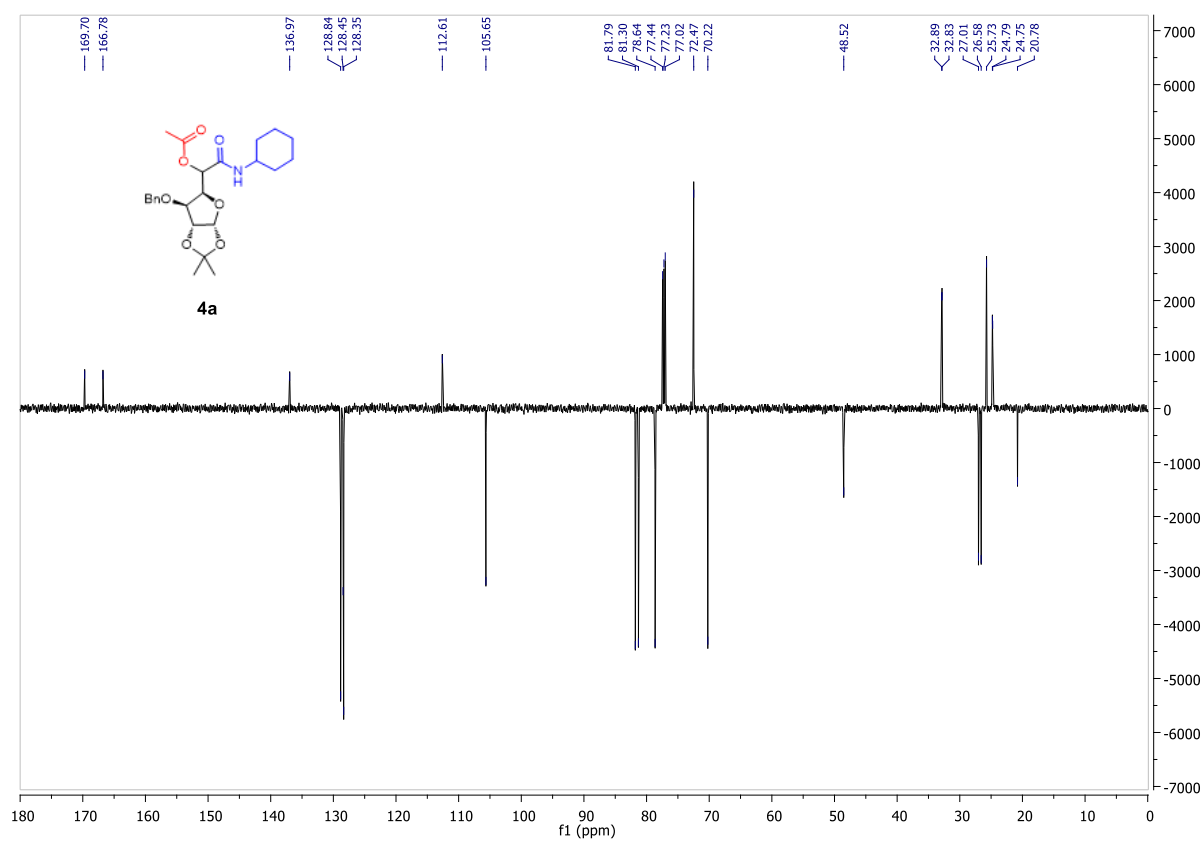
Final - Shots 400 - 1; Label O18

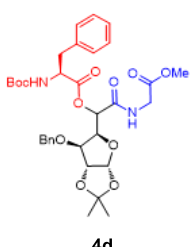
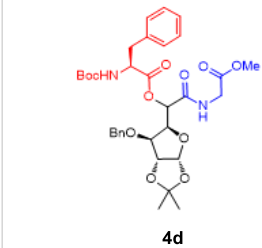




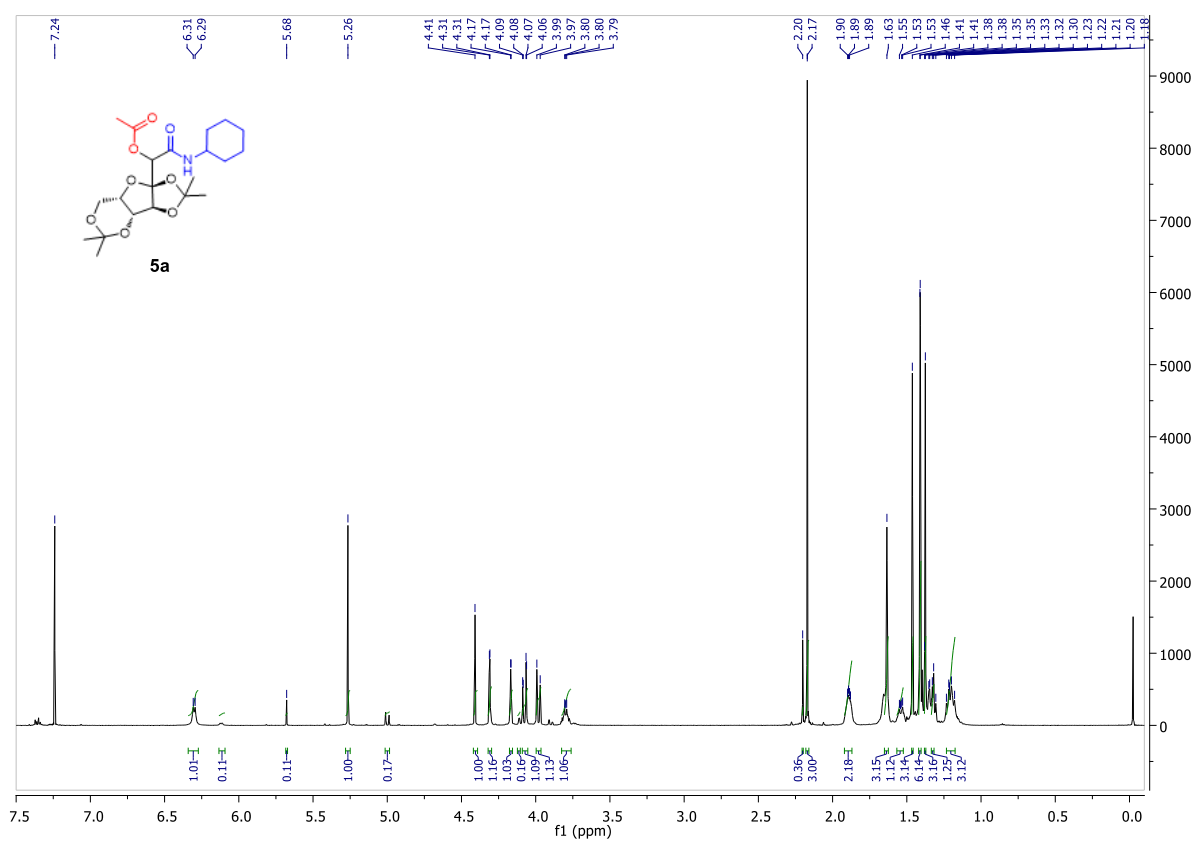
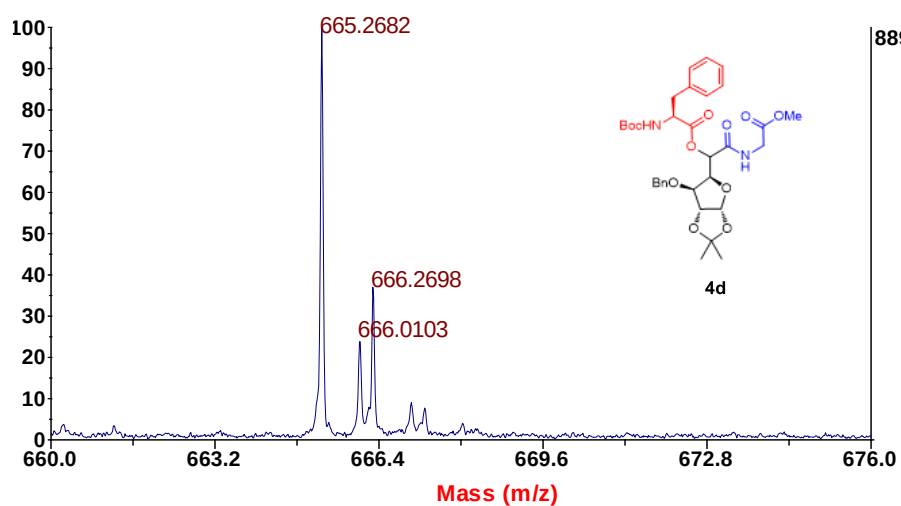
Final - Shots 400 - 1; Label O19

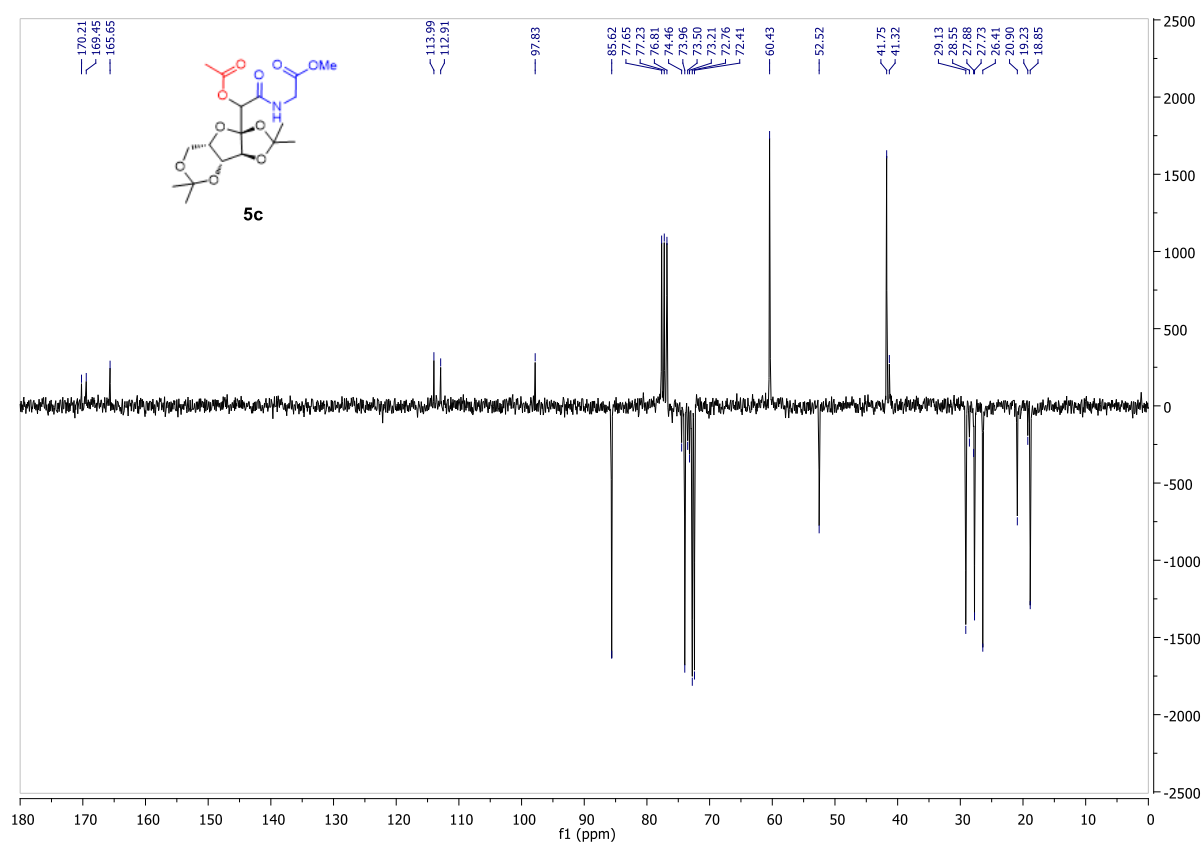
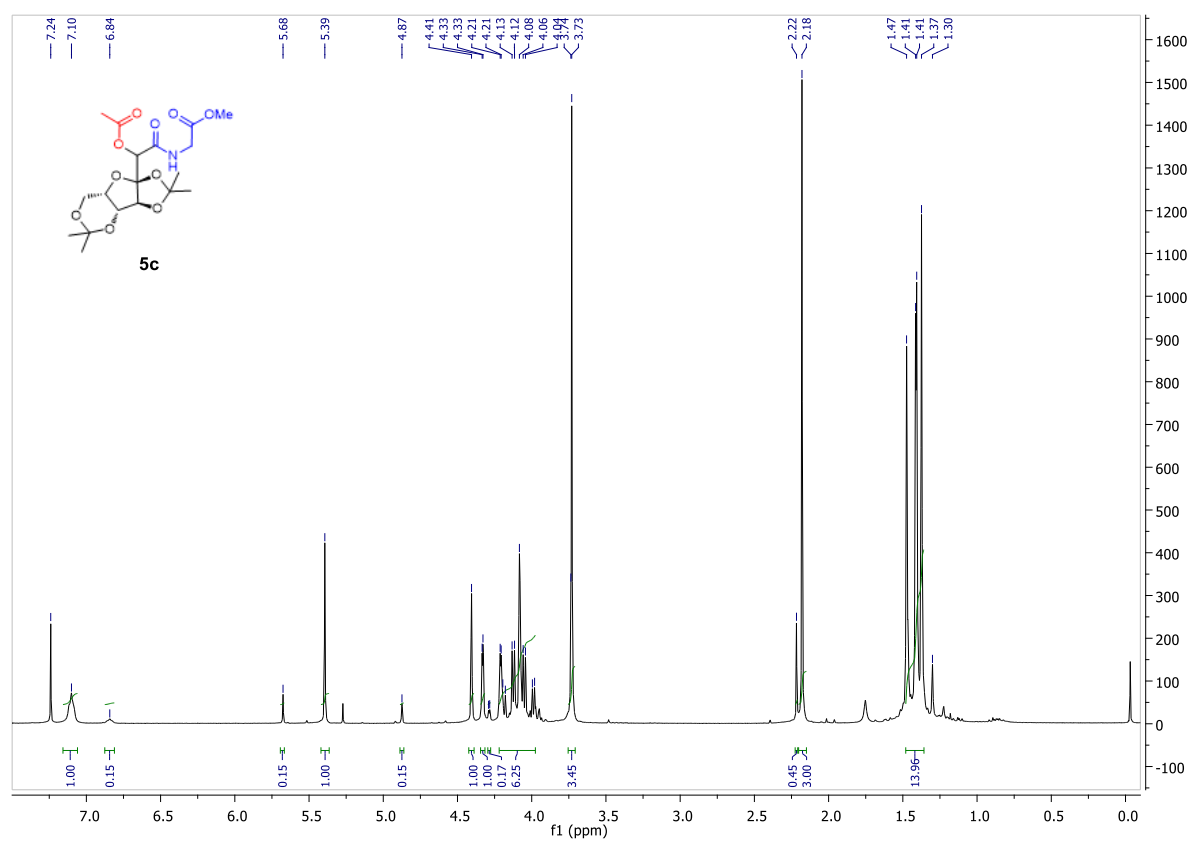




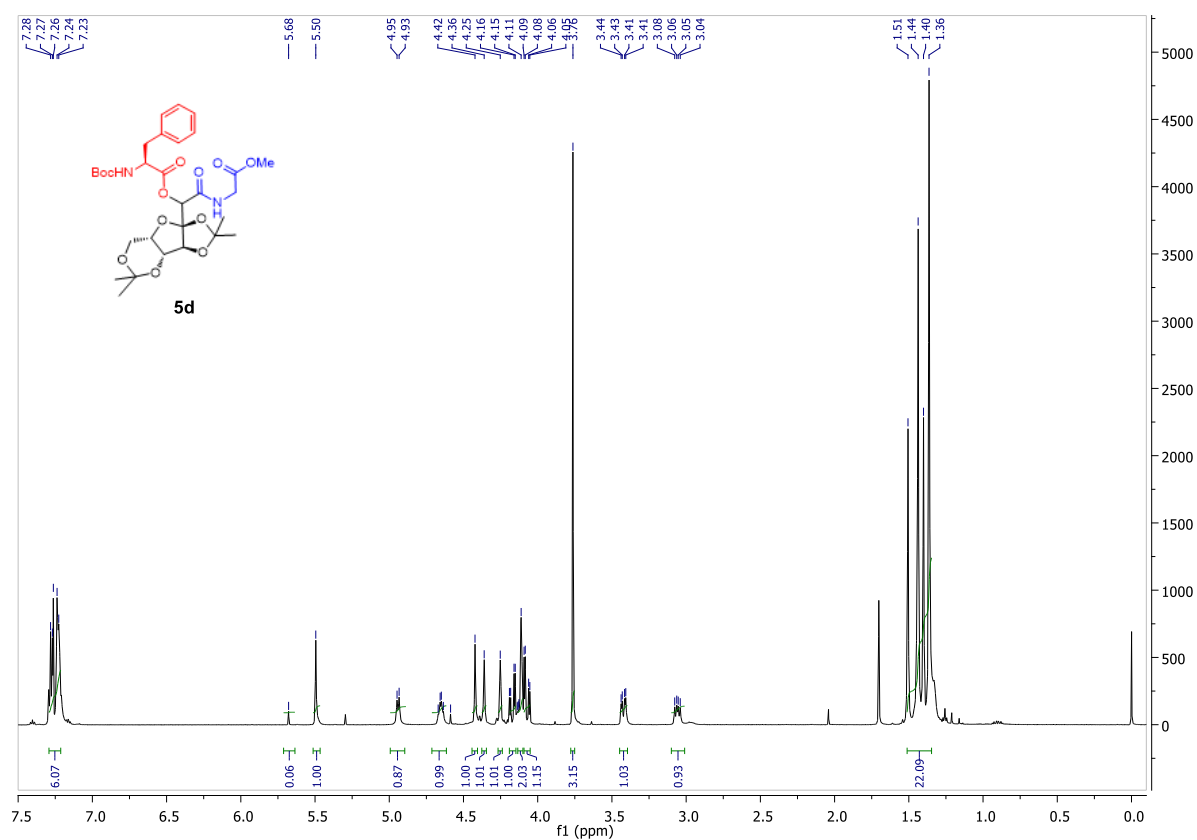
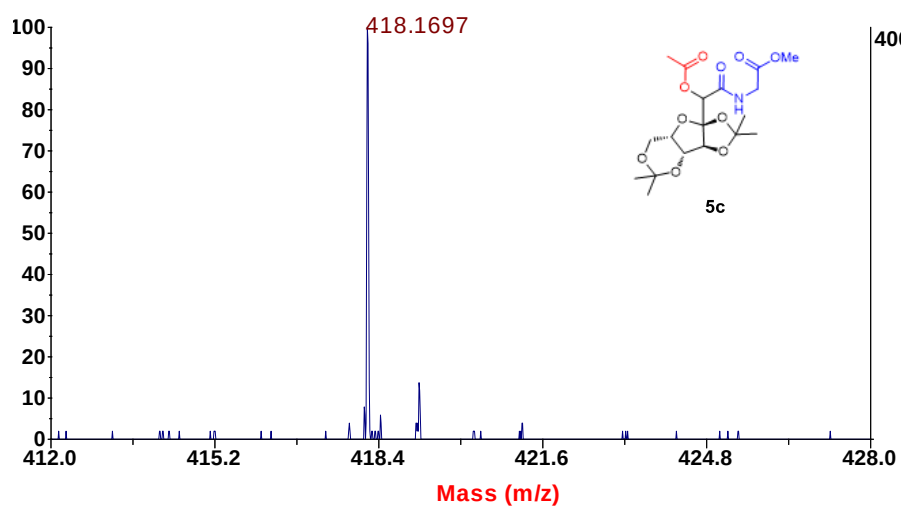


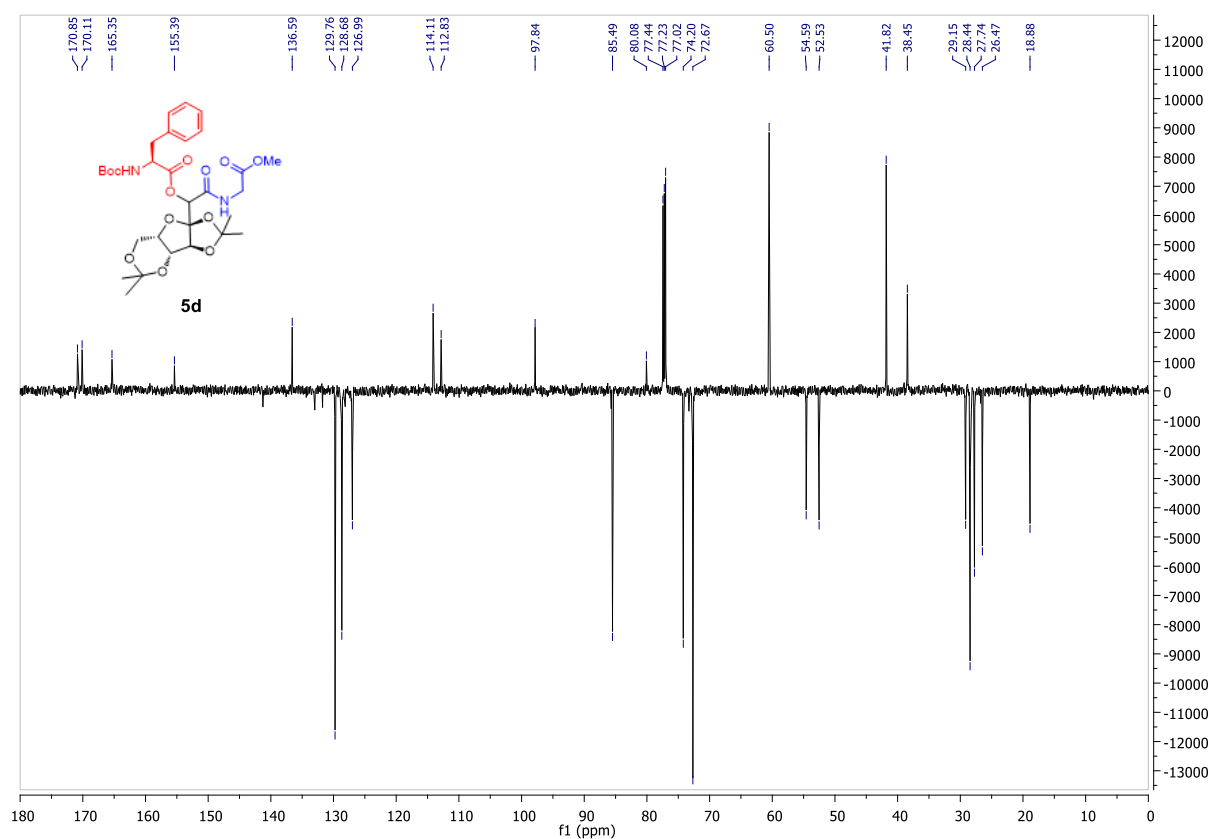
Final - Shots 1000 - 1; Label O21



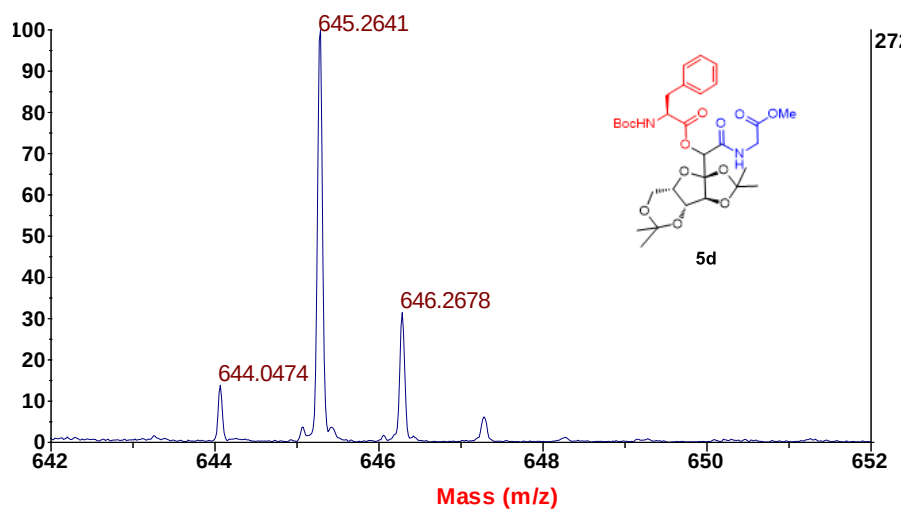


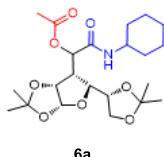
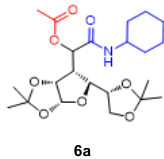
Final - Shots 50 - 1; Label F18



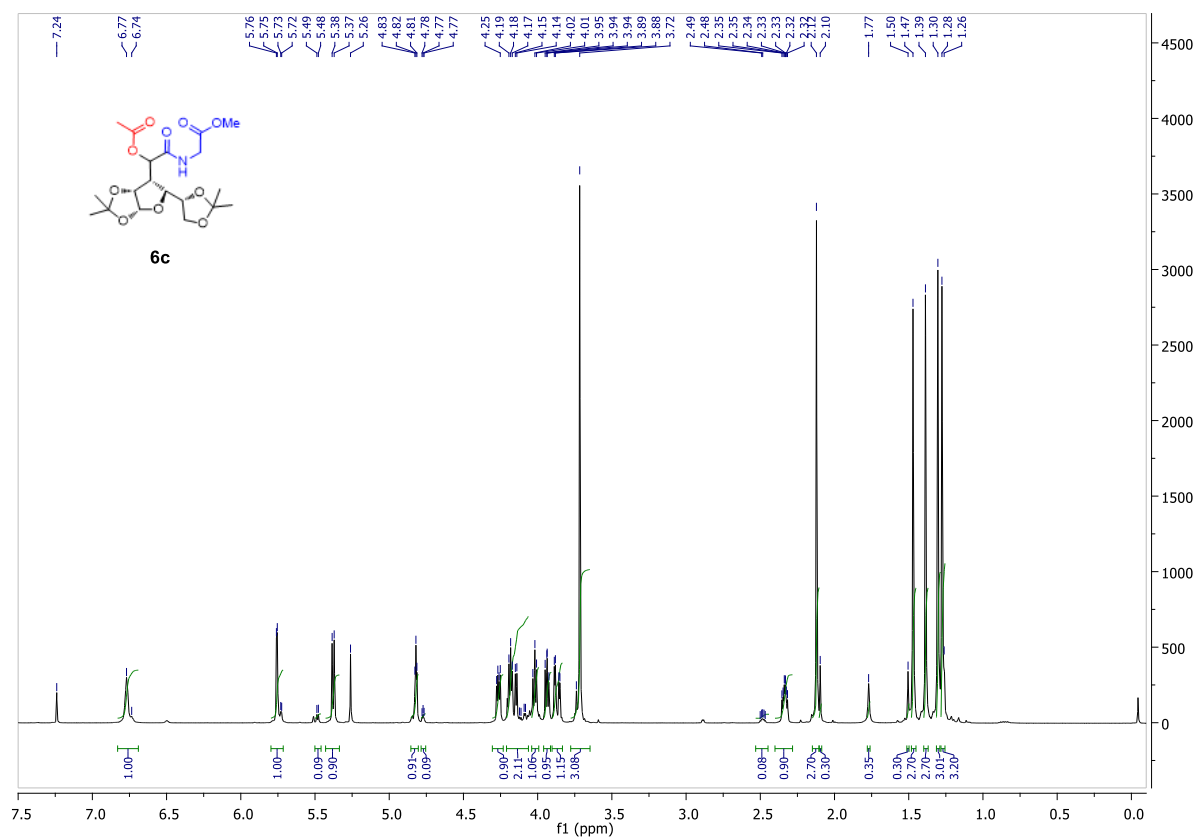
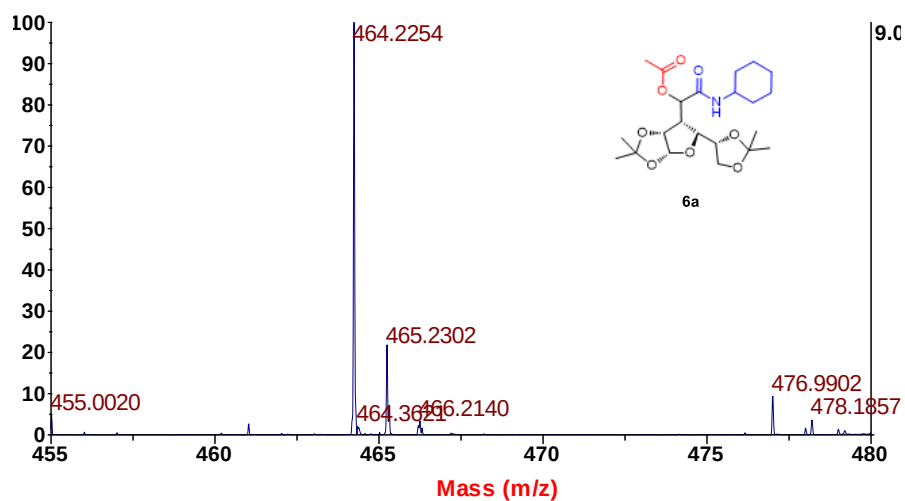


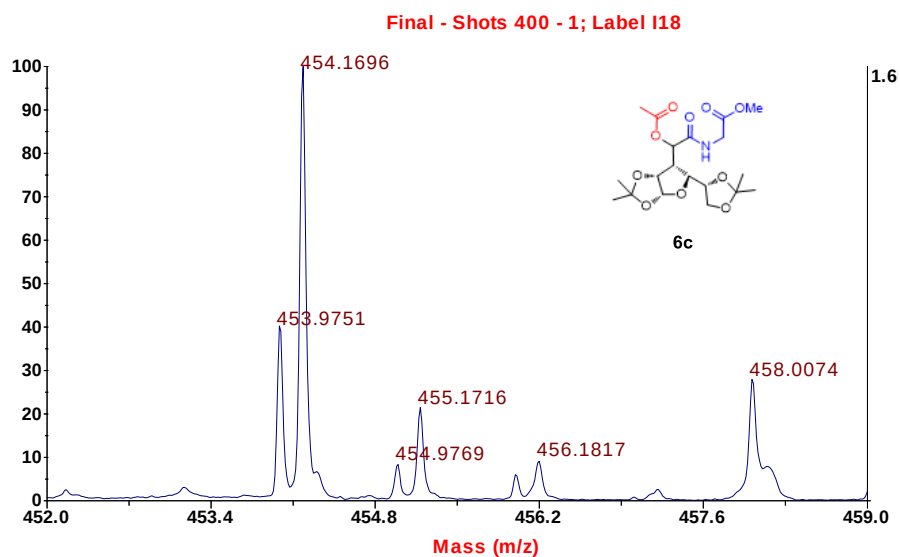
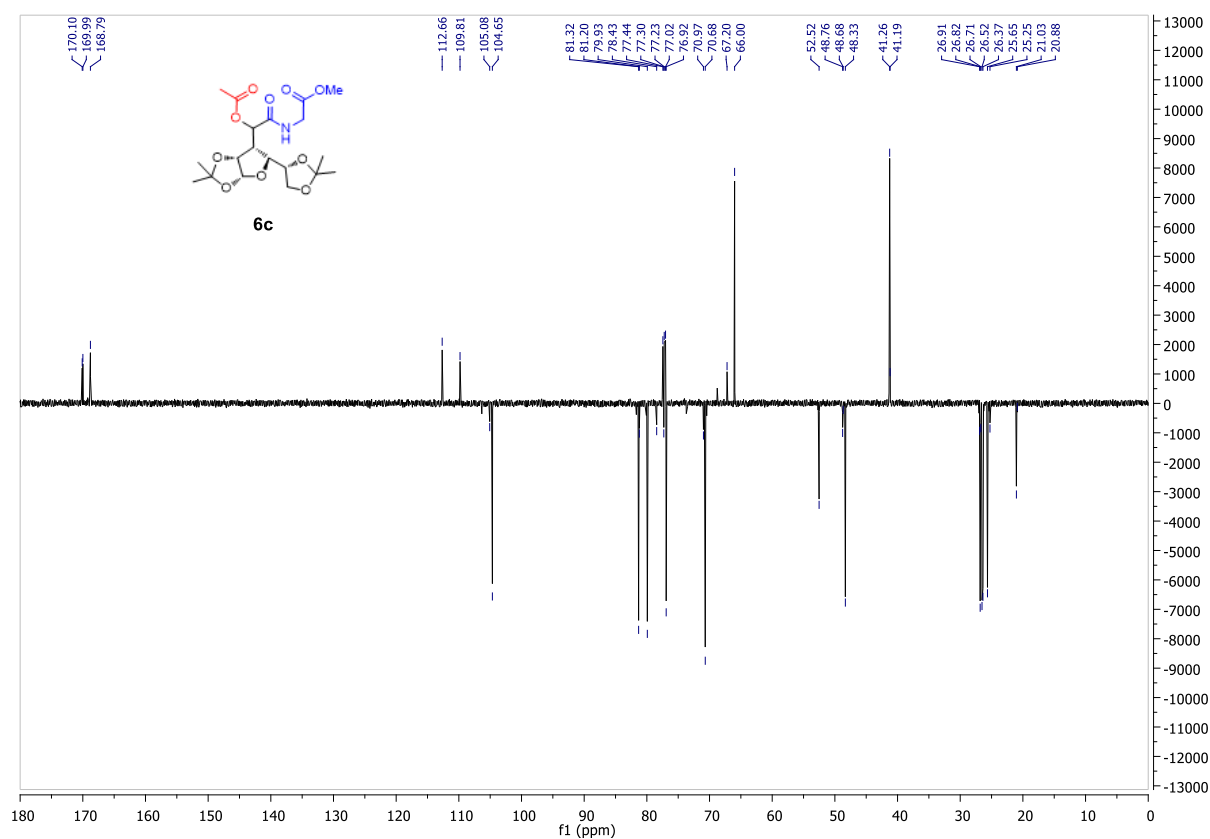
Final - Shots 600 - 1; Label O23

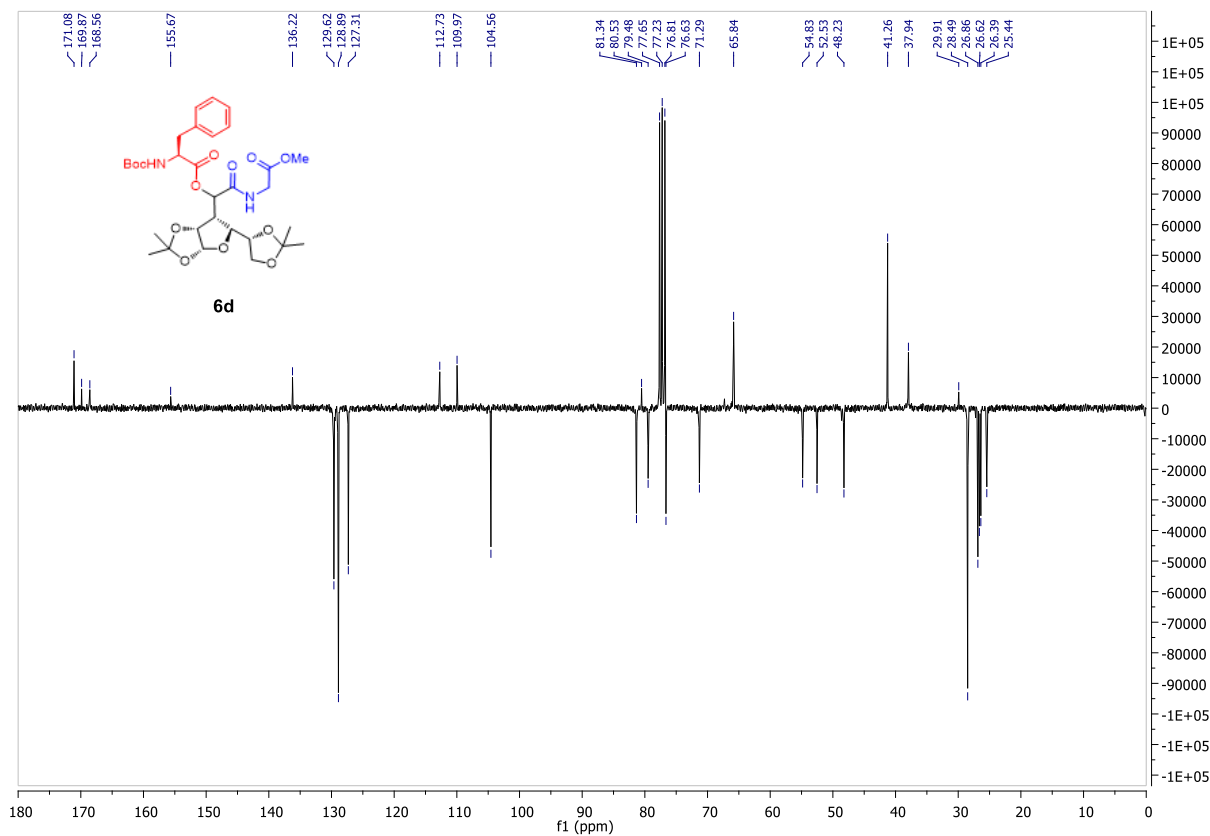
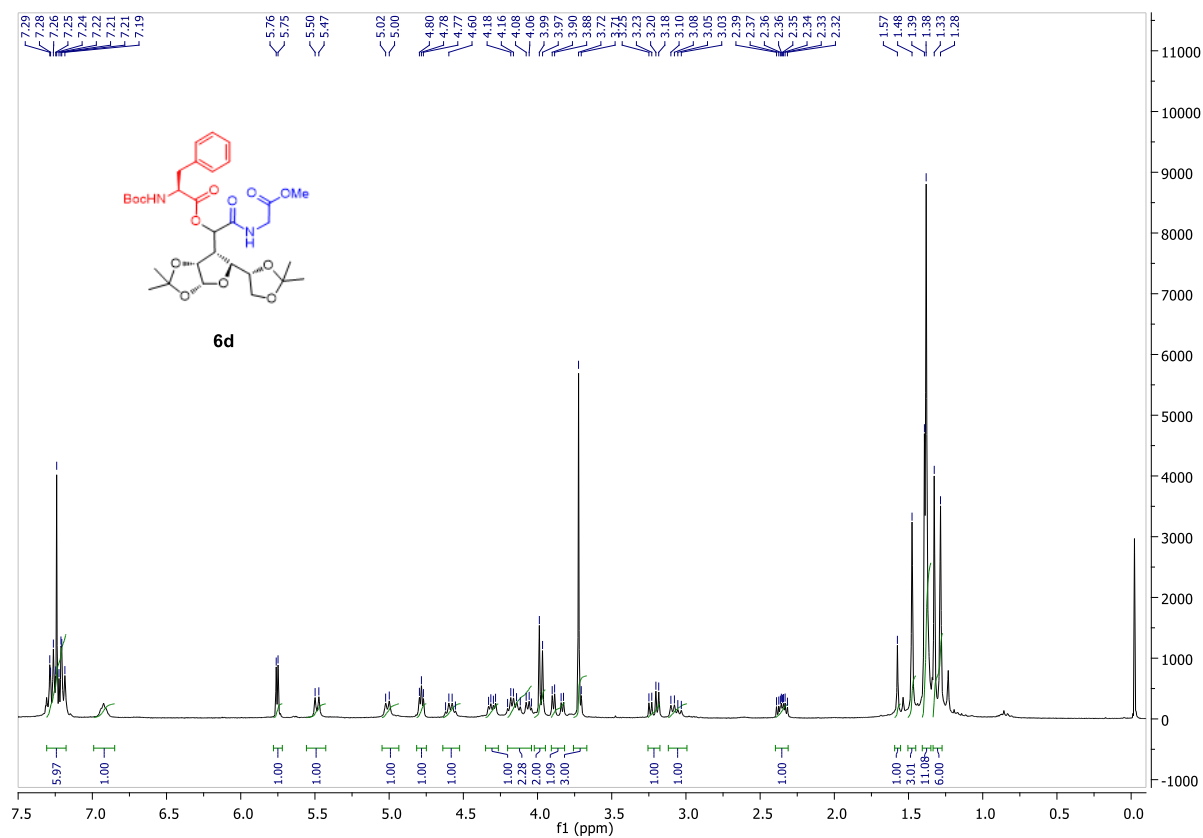




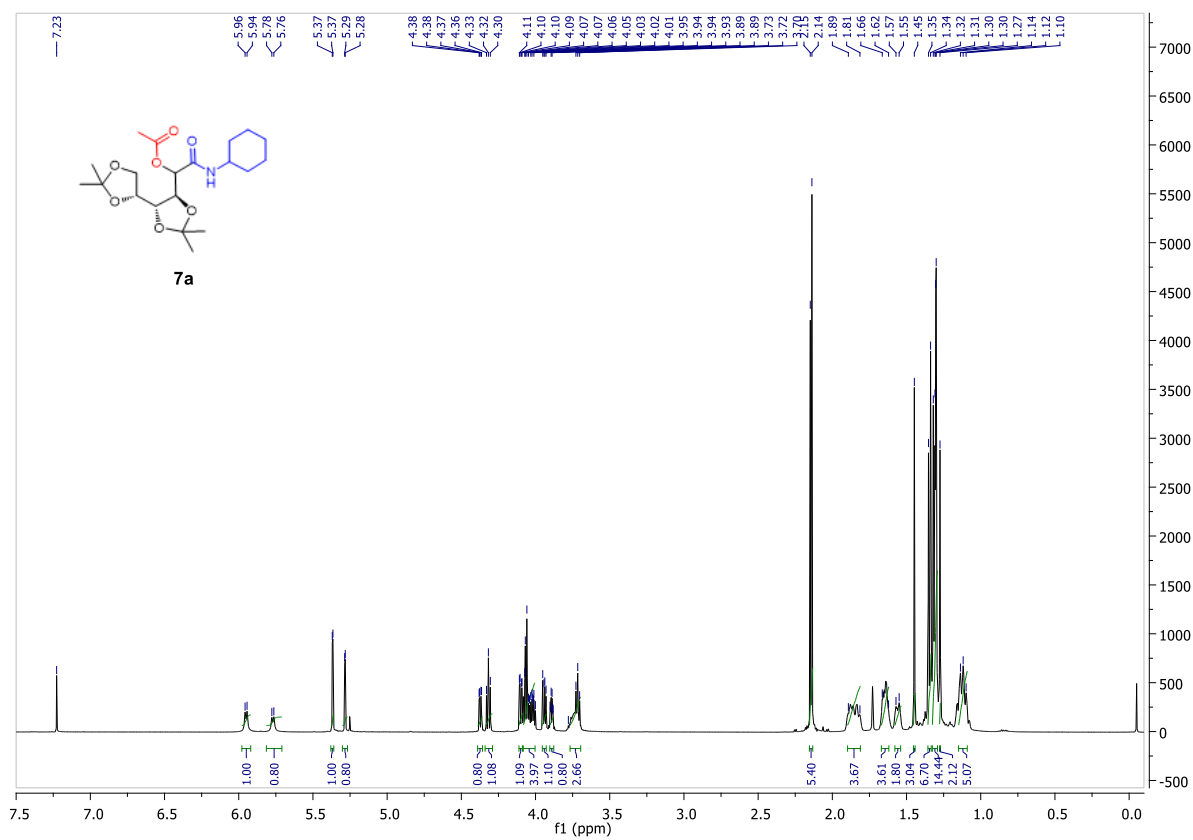
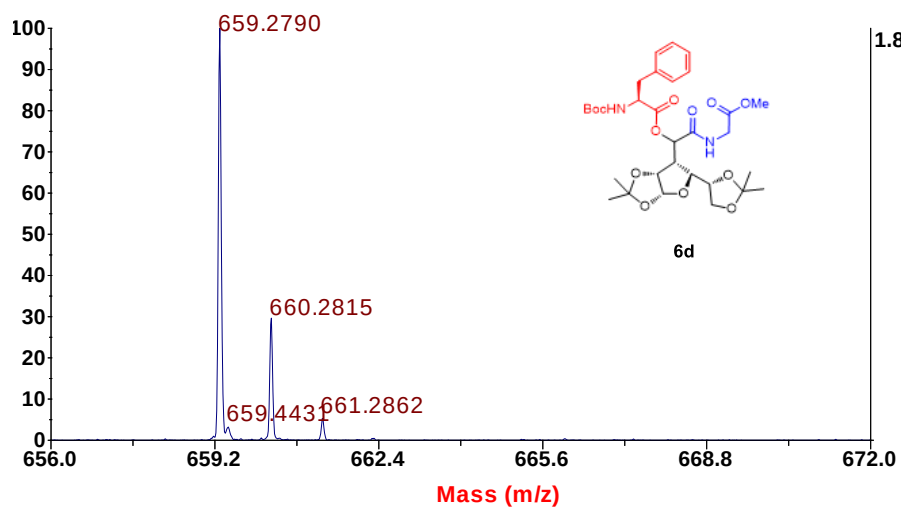
Final - Shots 800 - 1; Label P7

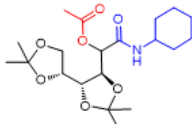
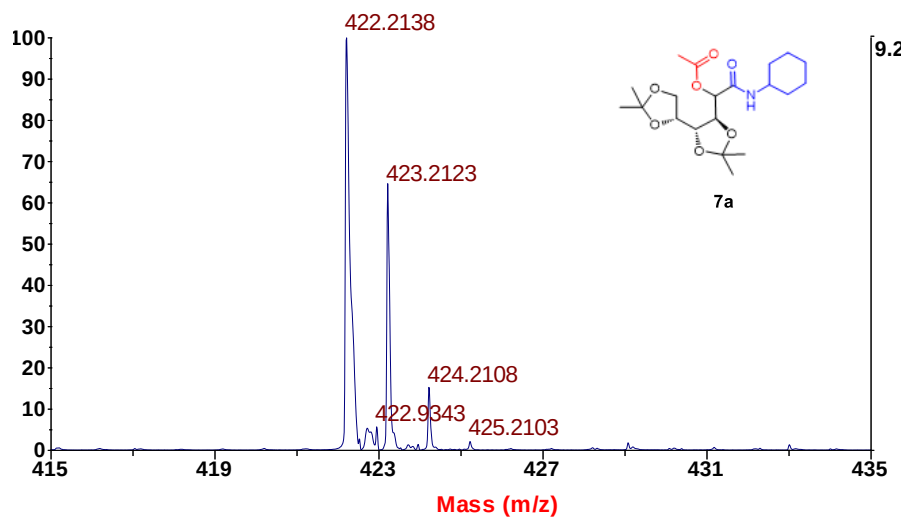
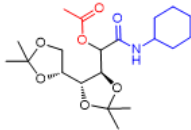


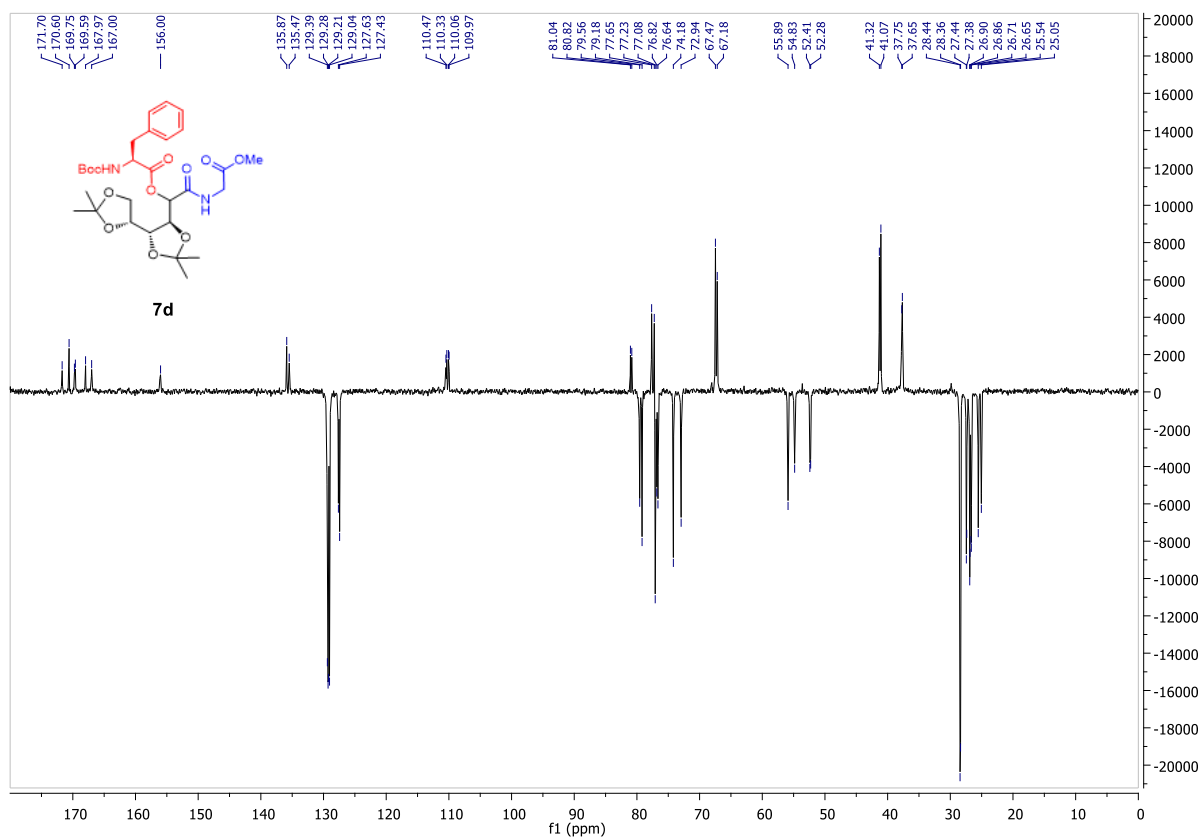
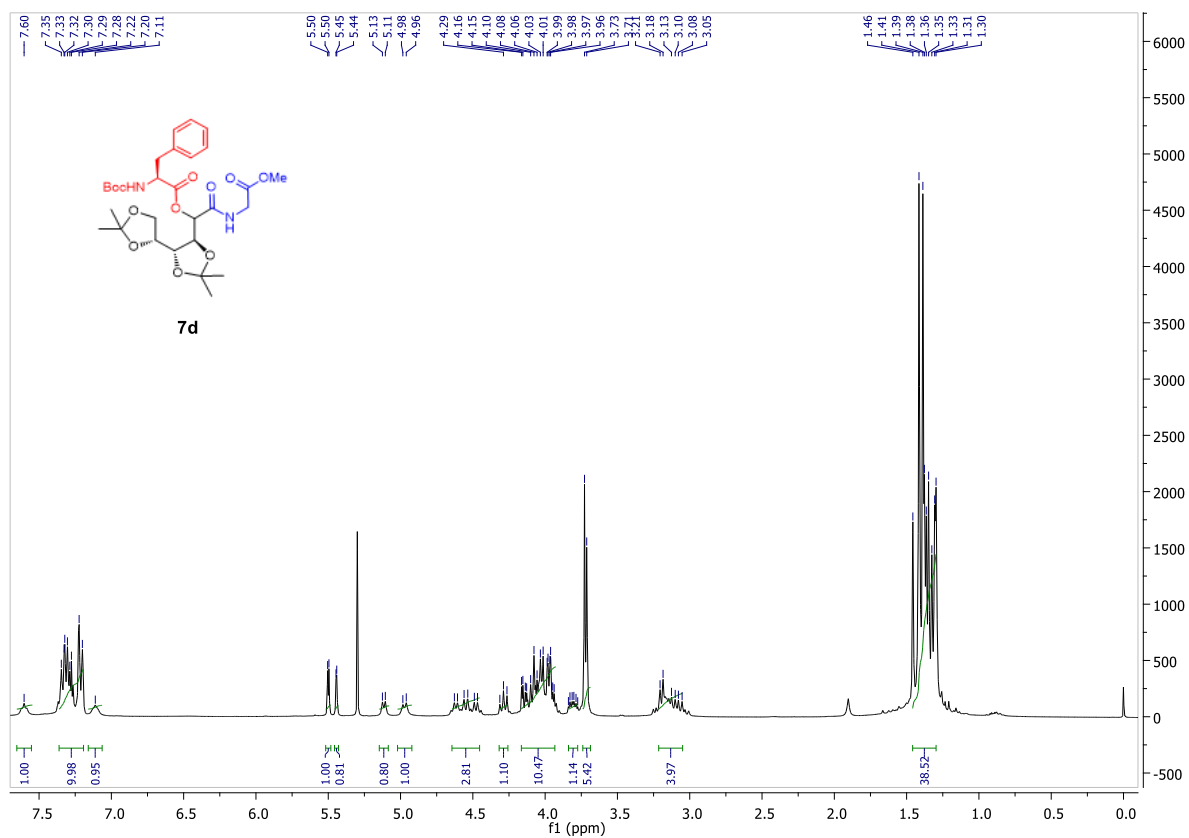


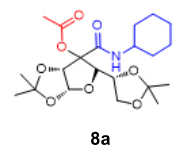
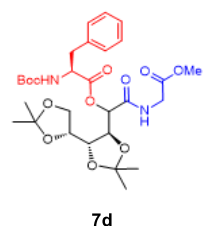


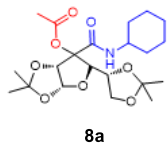
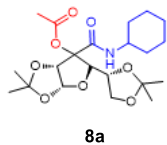
Final - Shots 50 - 1; Label F15

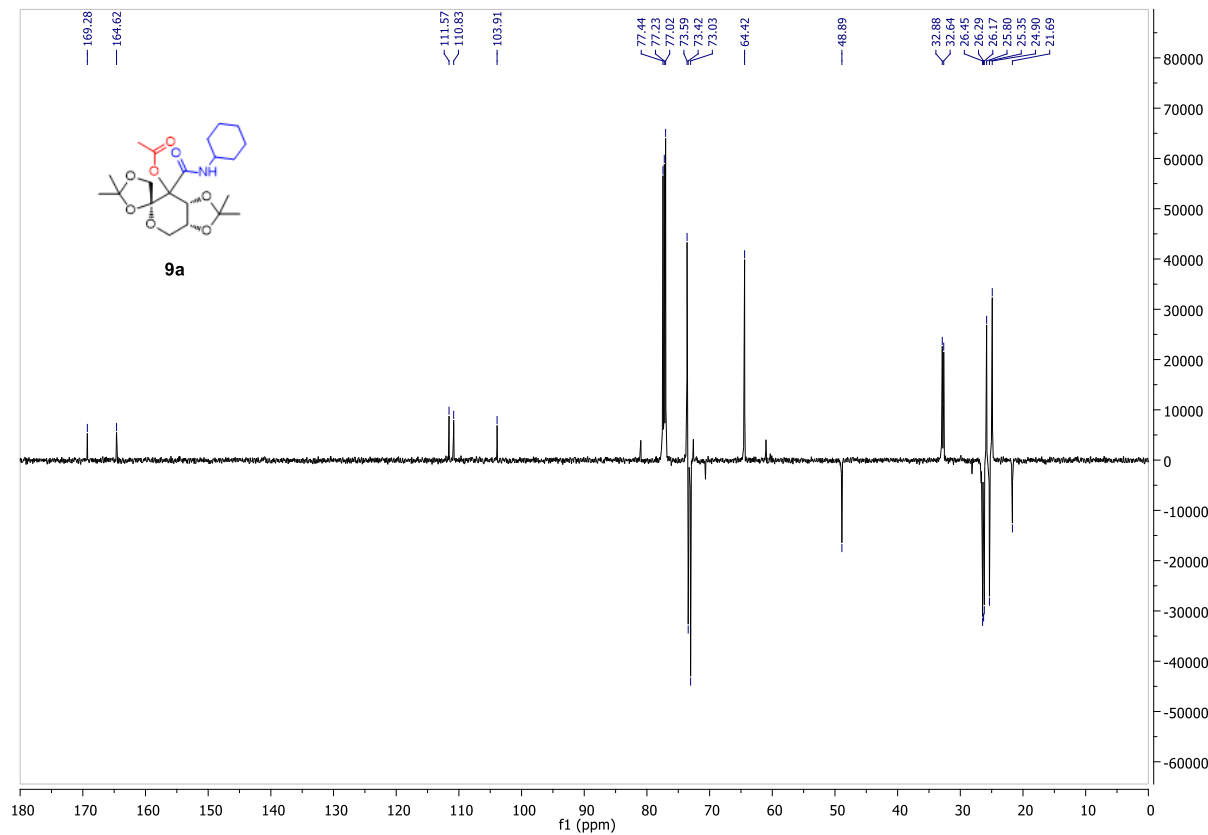
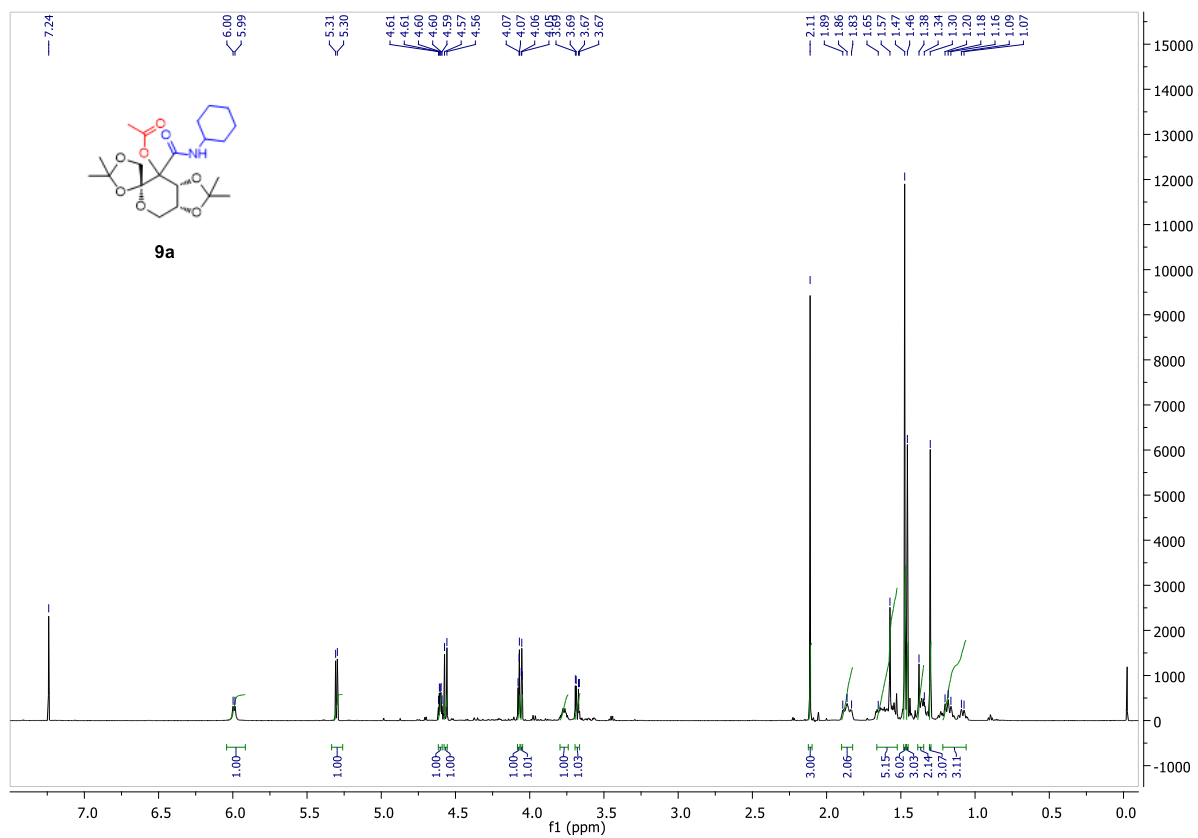




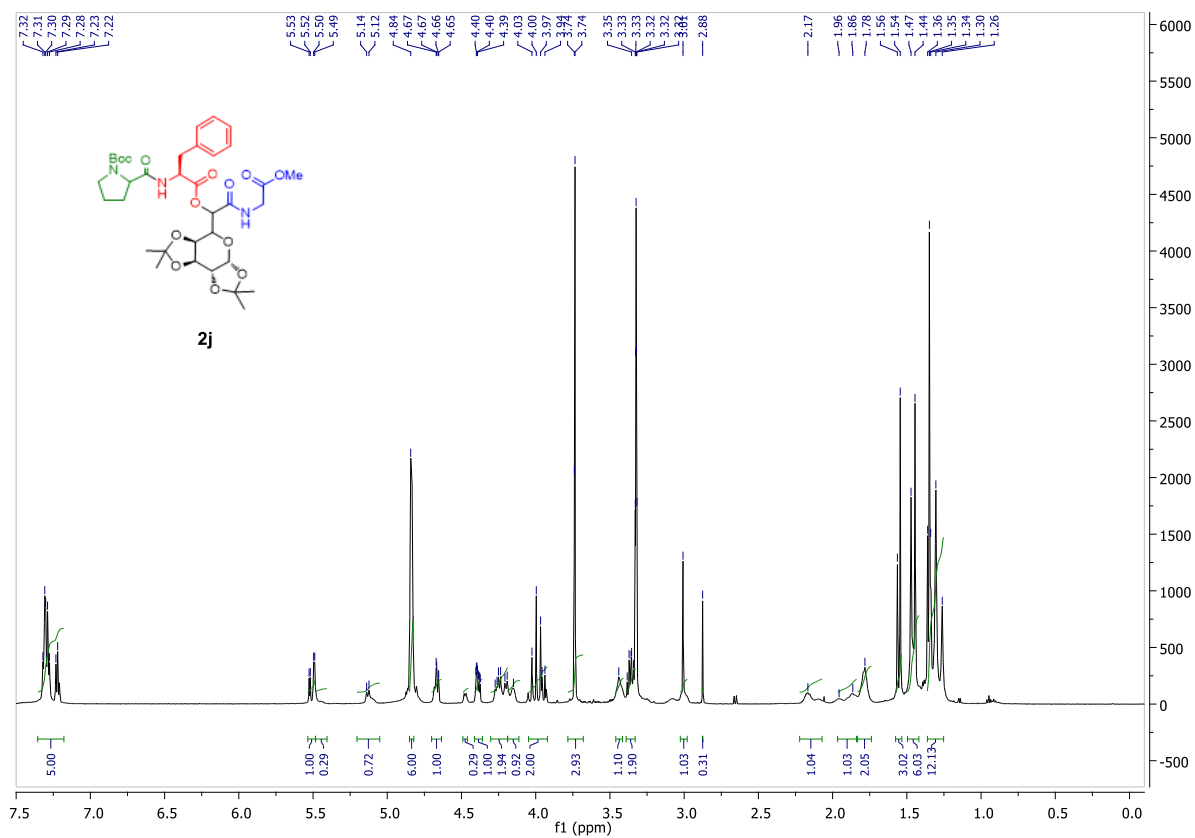
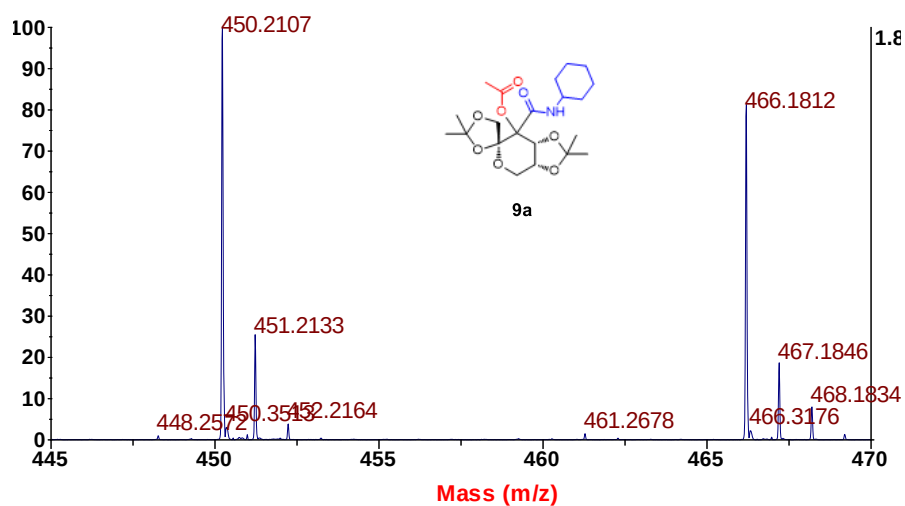


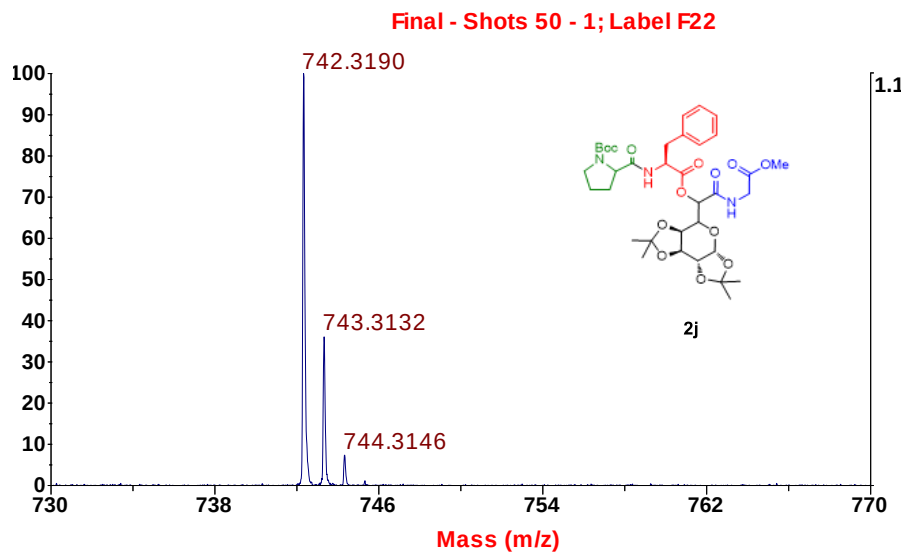
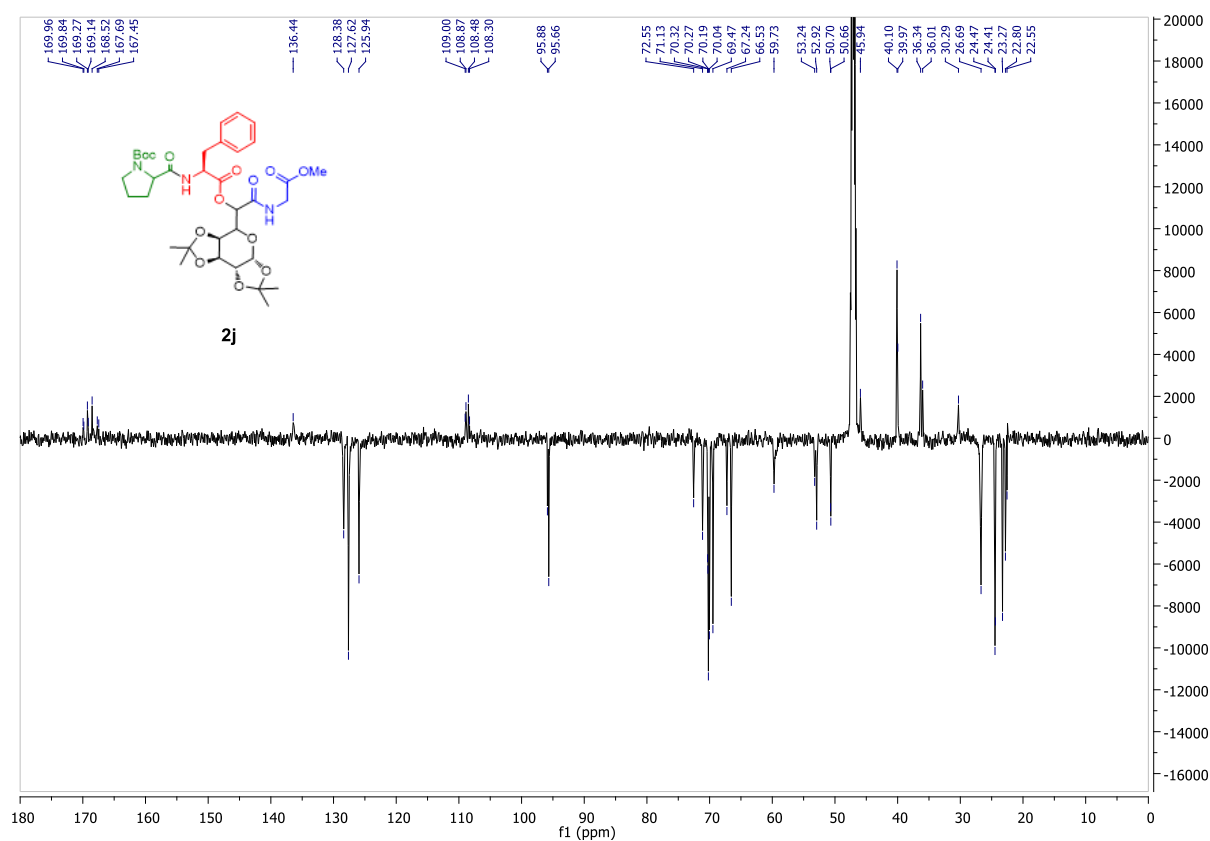


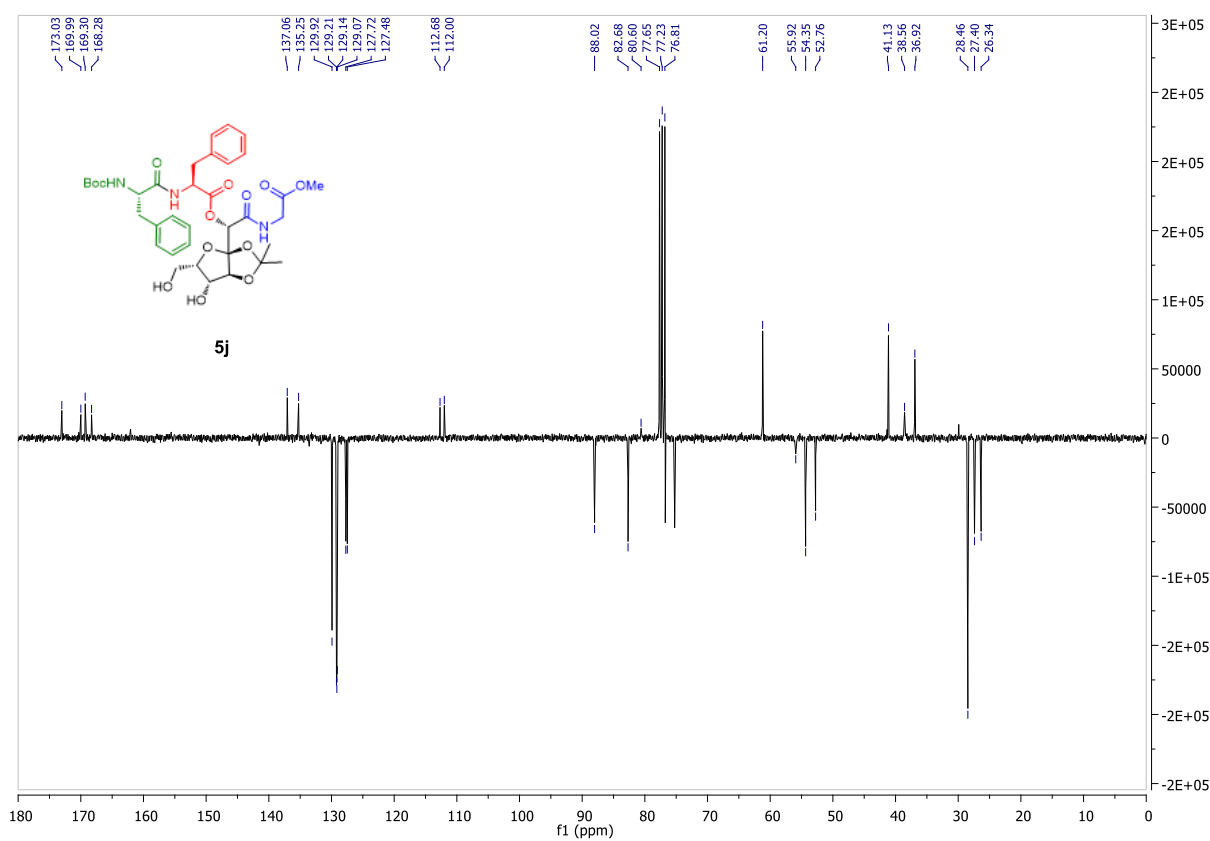
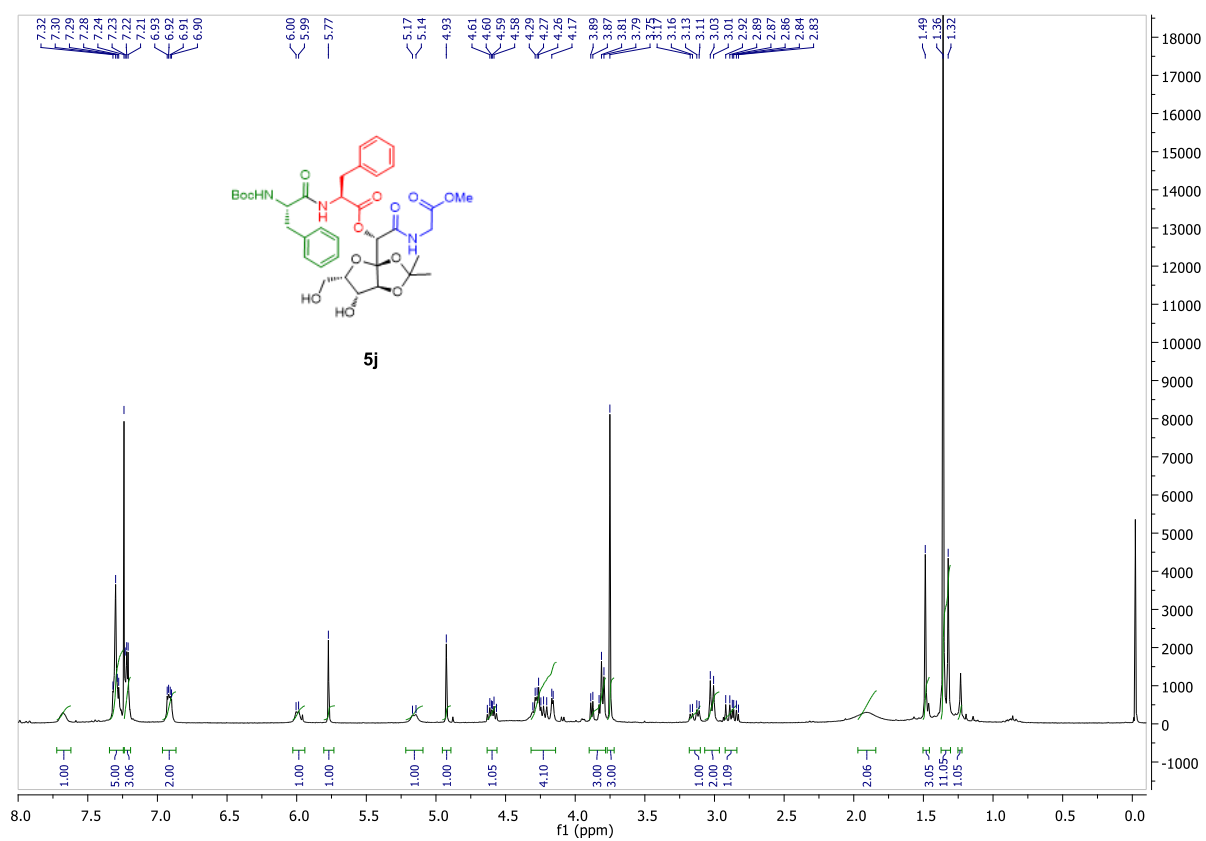




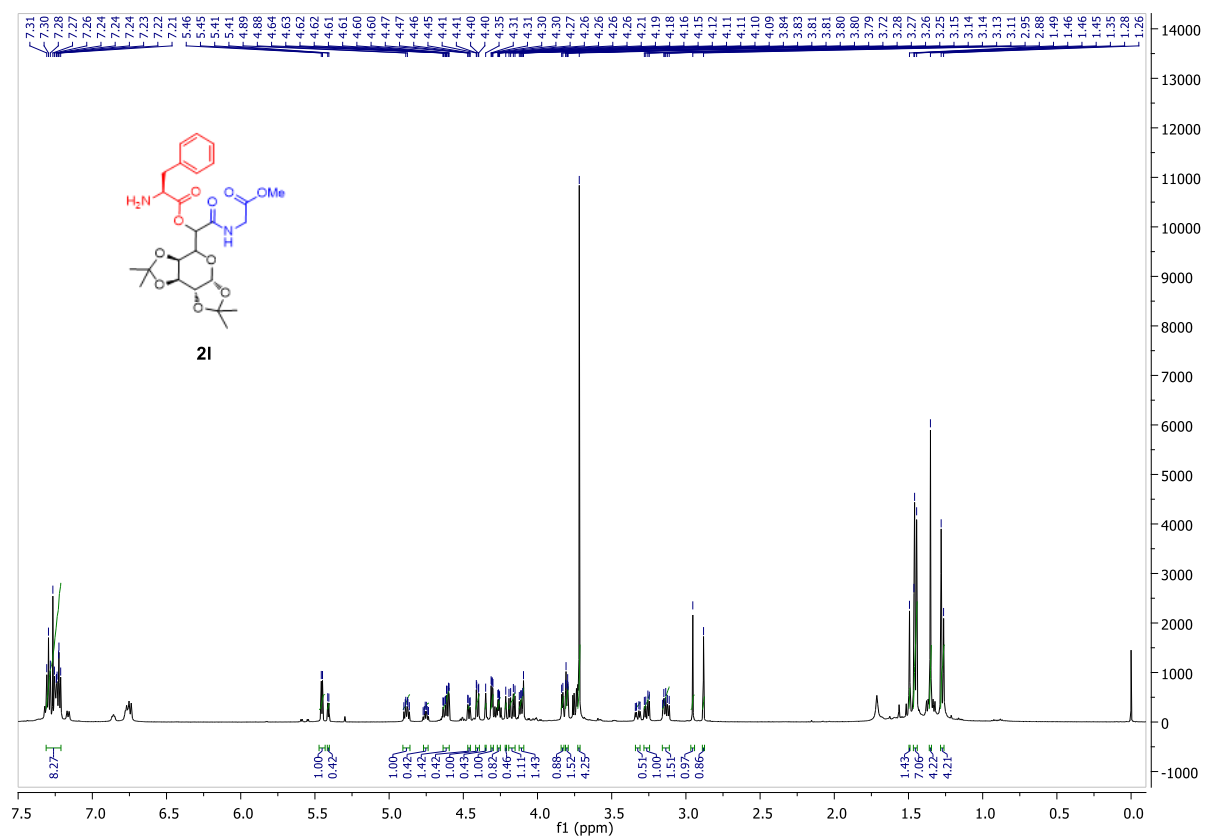
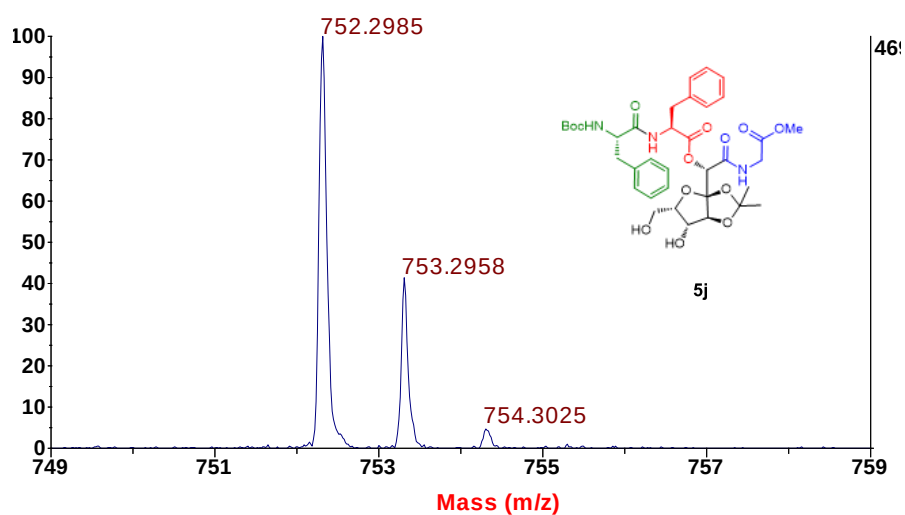
Final - Shots 800 - 1; Label P4

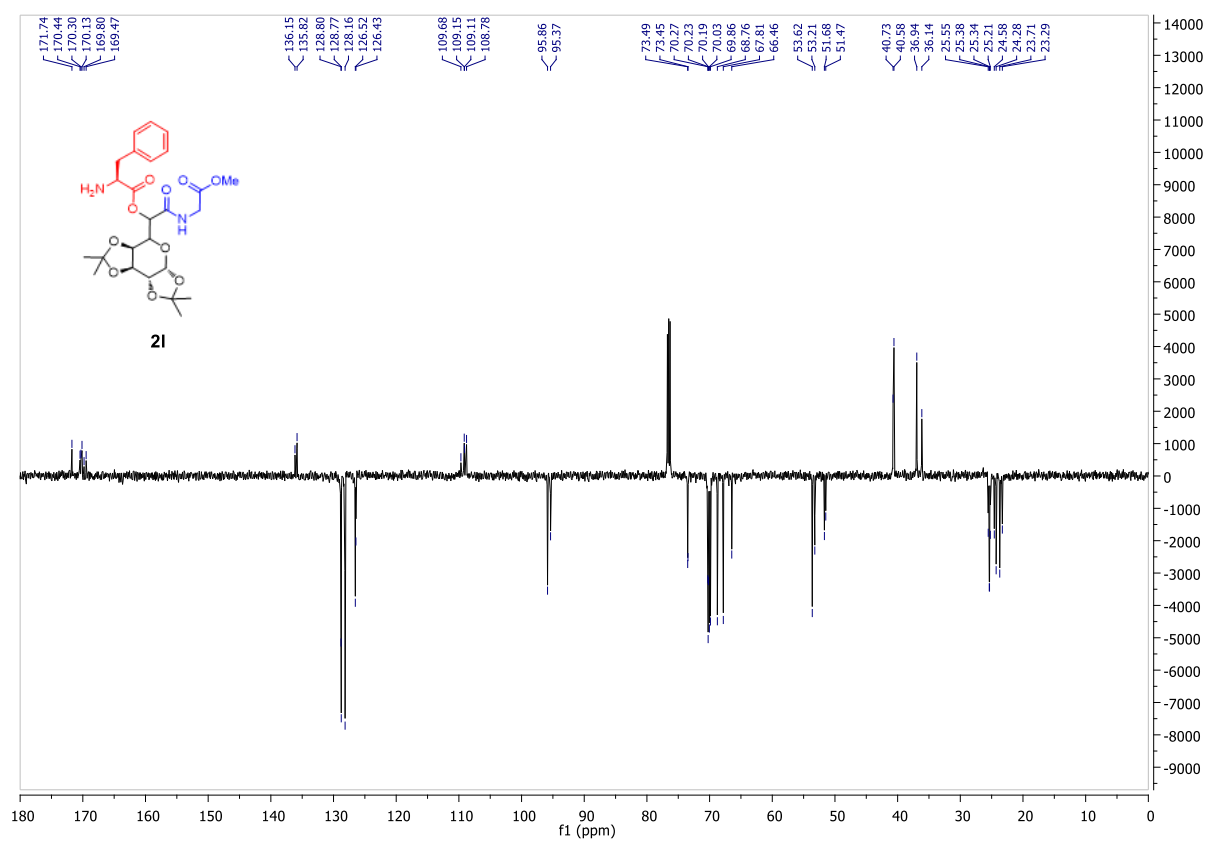




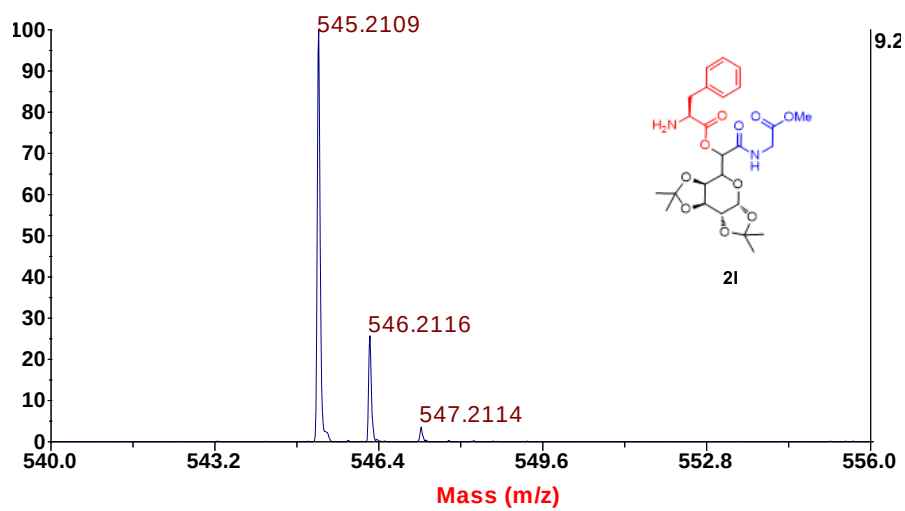


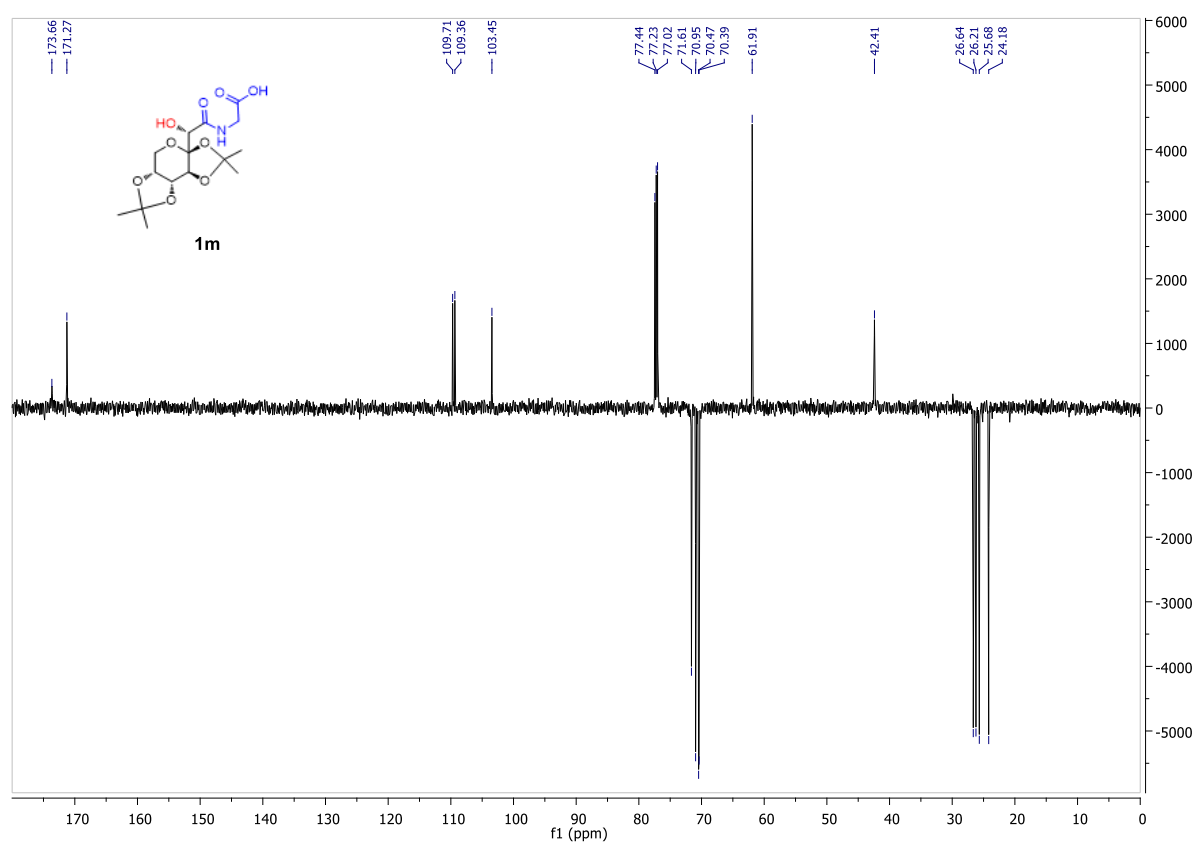
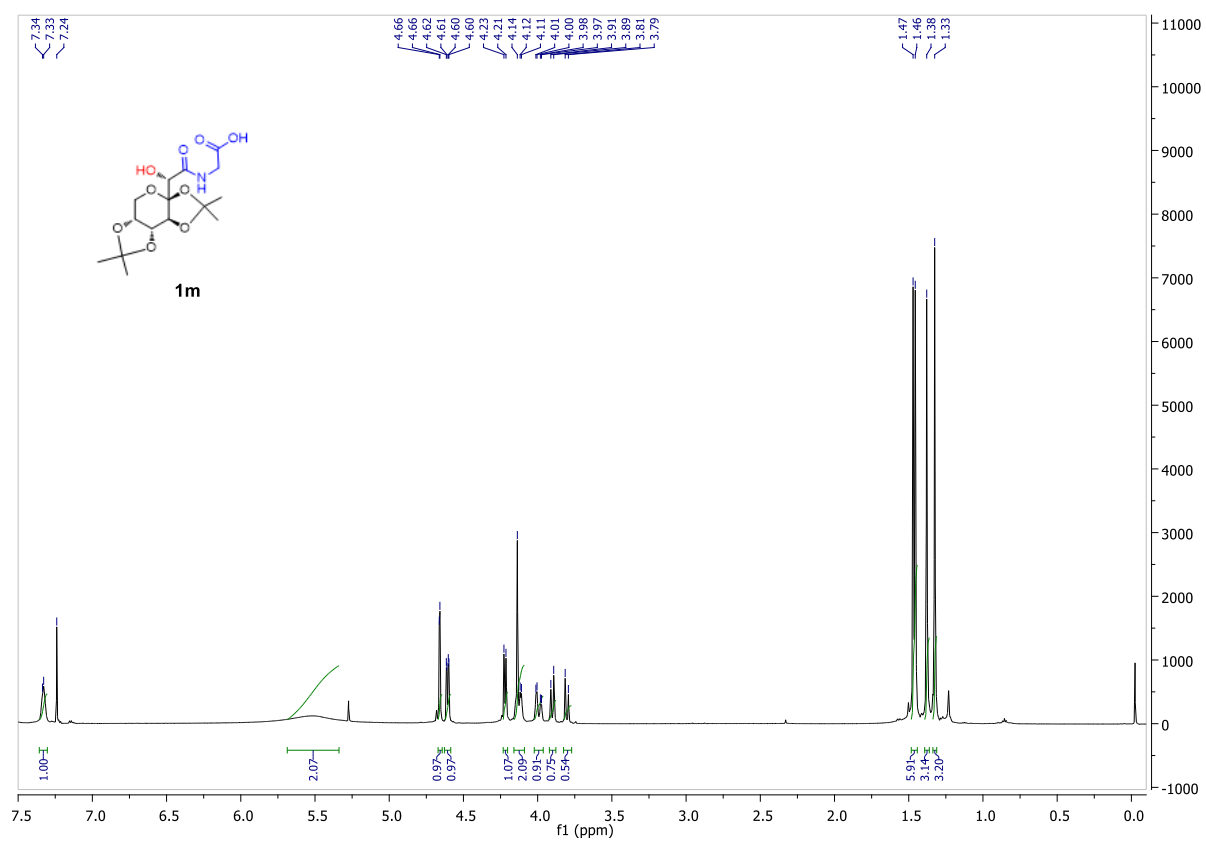
Final - Shots 50 - 1; Label F23



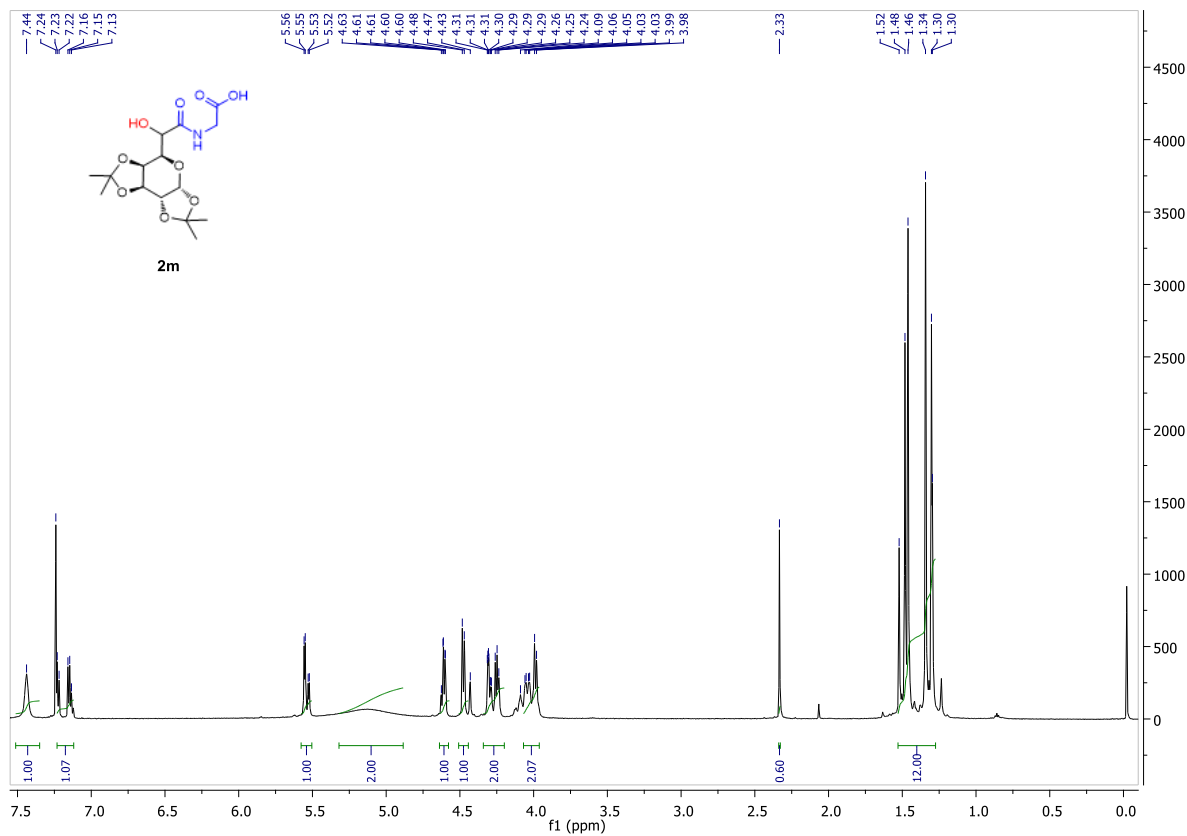
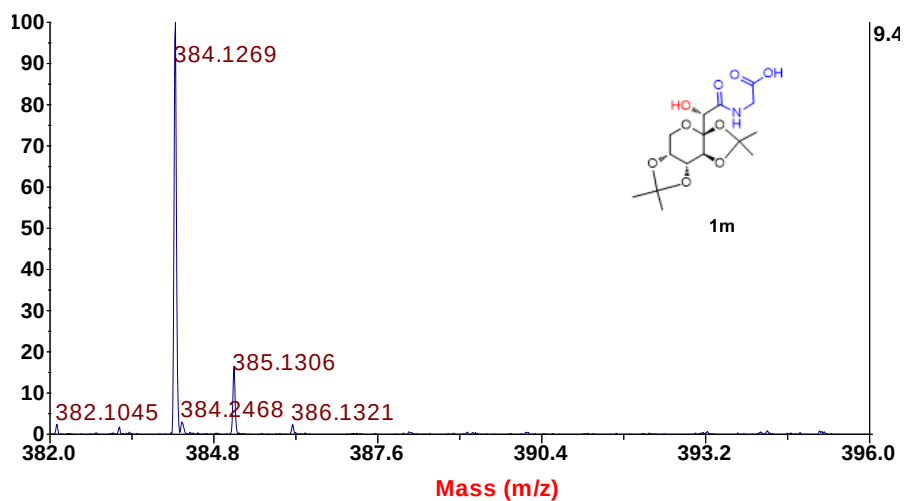


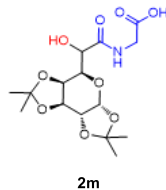
Final - Shots 50 - 1; Label F21





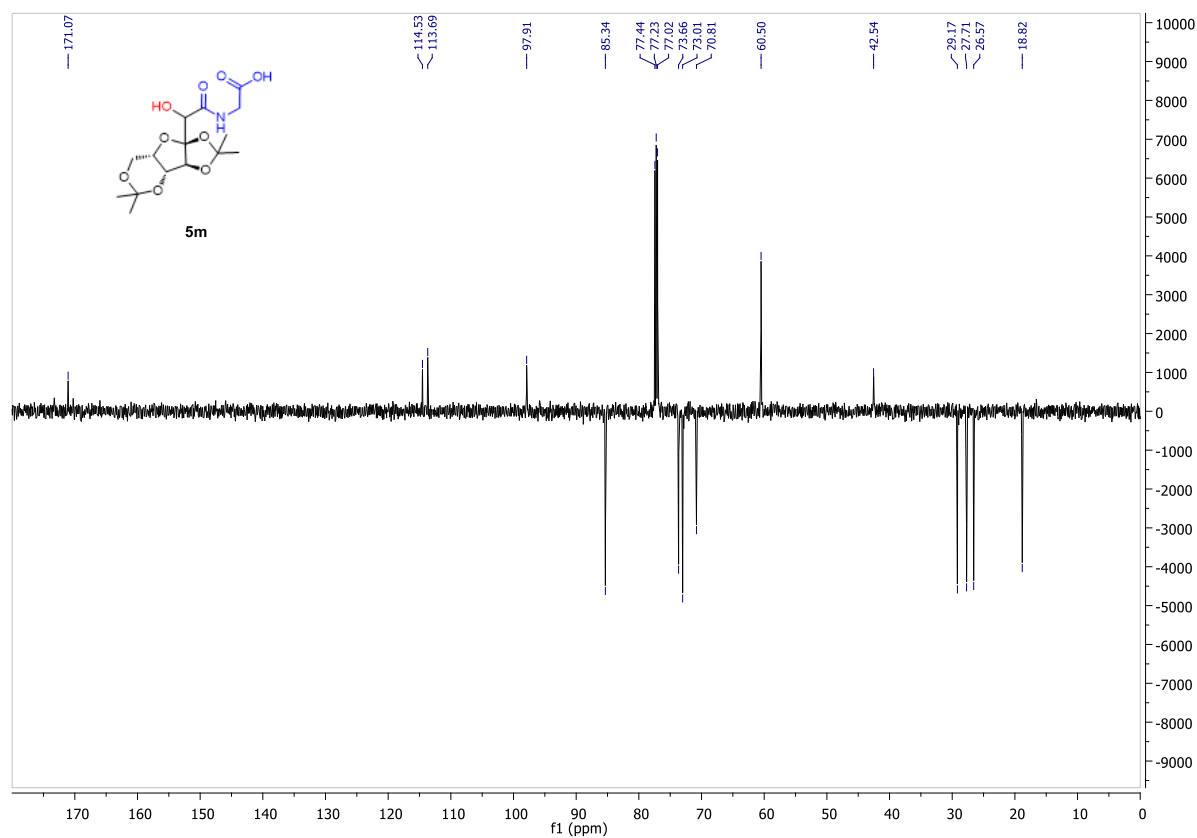
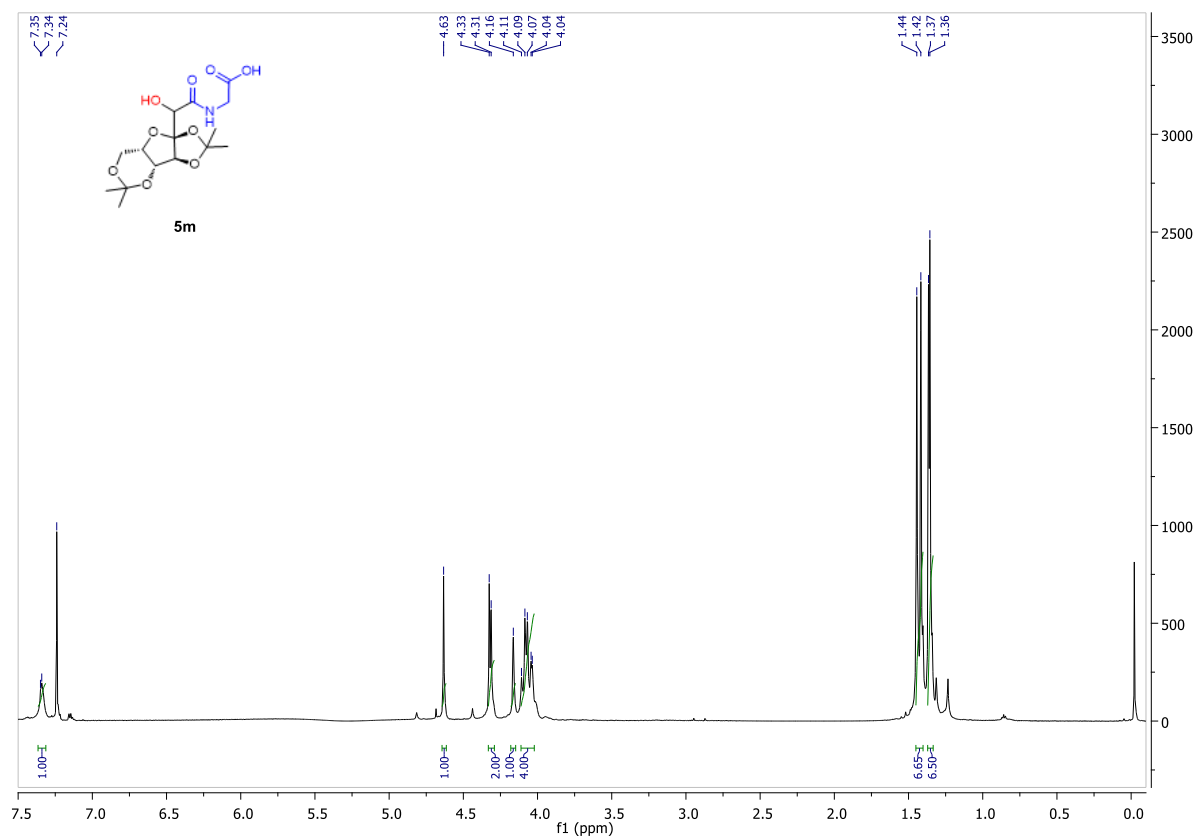
Final - Shots 50 - 1; Label F17



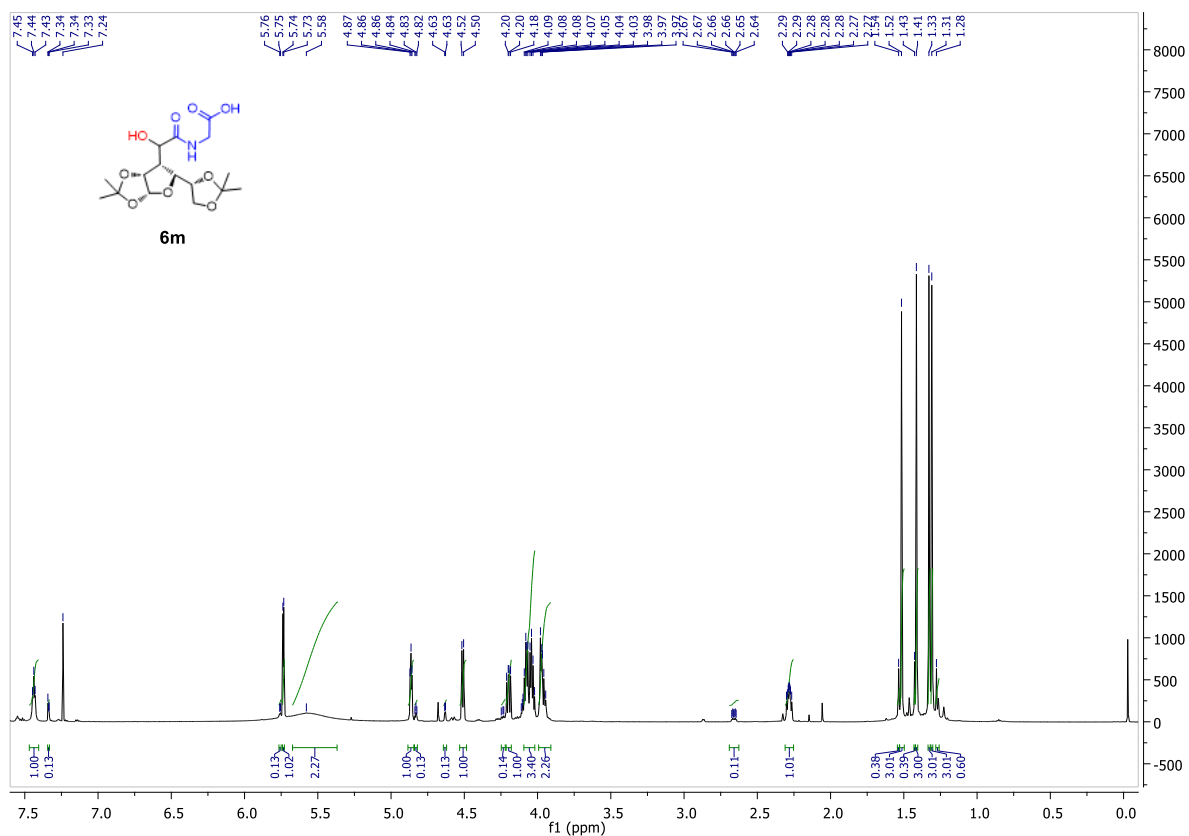
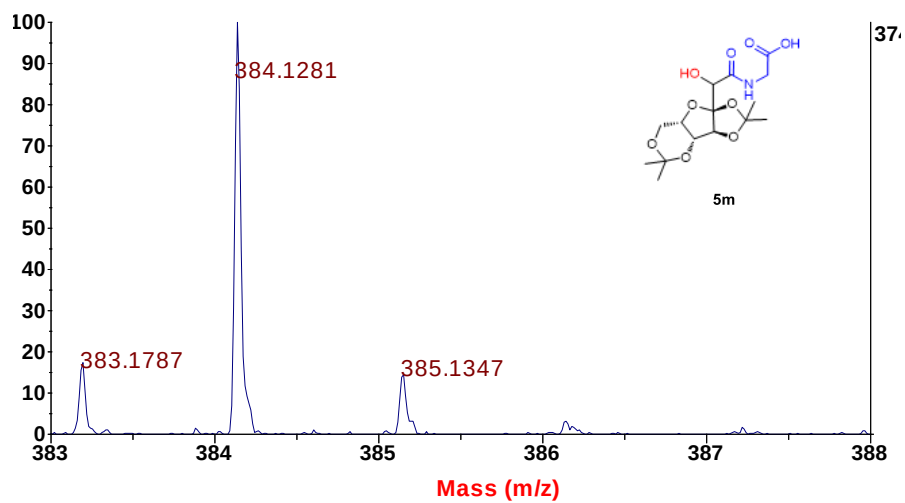


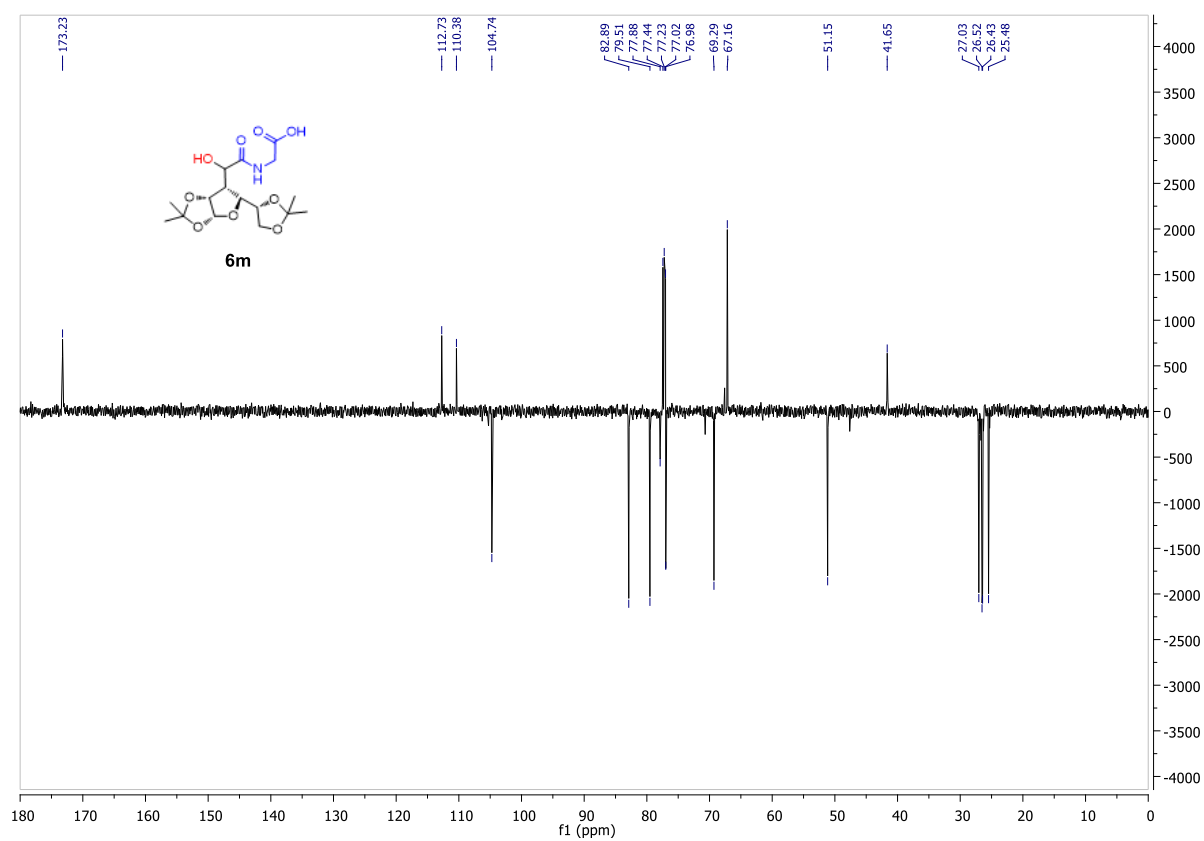
Mass spectrum of compound **2m**. The x-axis represents the mass-to-charge ratio (m/z) from 383.0 to 387.0. The y-axis represents relative intensity from 0 to 100. The base peak is at m/z 384.1272. A smaller peak is labeled at m/z 385.1365. The chemical structure of **2m** is shown in the top right corner.

CC1(C)OC2C(C1)OC(C(C2)OC3C(C(C(C3)OC4C(C(C(C4)OC5C(C(C(C5)OC6C(C(C(C6)OC(=O)NCC(=O)O)O)O)O)O)O)O)O)O)O

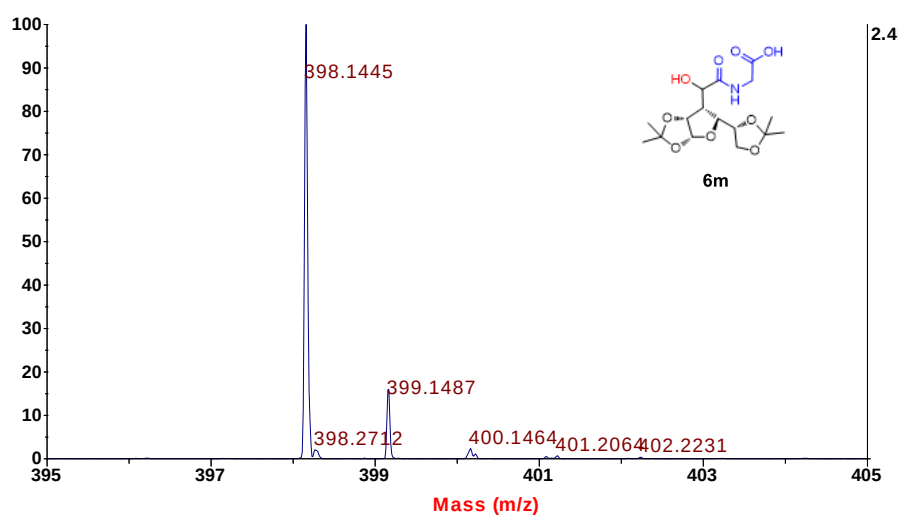


Final - Shots 50 - 1; Label F19





Final - Shots 400 - 1; Label I19



X-ray structure – compound 2a

Crystal data, data collection and refinement parameters are summarized in **Error! Reference source not found.**1. Crystals were prepared by a slow evaporation from from *n*-hexane/*i*-PrOH (9/1, v/v) solution. Data collections were performed at room temperature on an Oxford Diffraction Xcalibur Nova R diffractometer with a microfocusing Cu tube ($\lambda = 1.54179 \text{ \AA}$). Data reduction and cell refinement were carried out using the CRYSTALIS PRO software¹. Structures were solved by direct methods with SIR2014² and refined by a full matrix least-squares refinement based on F^2 , with SHELX.³ Molecular illustrations were prepared with MERCURY⁴ included into the WinGX package.⁵ Calculations of molecular geometries and crystal packing parameters were performed with PLATON.⁶ Hydrogen atoms were either included in their geometrically calculated positions and refined according to the riding model, or located in the Fourier map and refined freely.

CCDC 1865101 contain the supplementary crystallographic data. These data can be obtained free of charge via <http://www.ccdc.cam.ac.uk/conts/retrieving.html>, or from the Cambridge Crystallographic Data Centre, 12 Union Road, Cambridge CB2 1EZ, UK; fax:(+44) 1223-336-033; or e-mail: deposit@ccdc.cam.ac.uk.

Table S1. Crystal data and structure refinement results for compound 2a.

Brutto formula	C ₂₁ H ₃₃ NO ₈
Mol. weight (g mol ⁻¹)	427.48
Crystal colour and habit	colourless plate
Crystal dim. (mm)	0.18 x 0.14 x 0.04
Space group	P1 (triclinic)
<i>a</i> (Å)	5.3974(15)
<i>b</i> (Å)	10.320(2)
<i>c</i> (Å)	10.9130(17)
<i>V</i> (Å ³)	565.6(2)
Z	1
μ (CuK α) (mm ⁻¹)	0.798
Absorption correction	multi-scan
<i>F</i> (000)	230
θ max (°)	70.582
No. refl. measured	4362
No. refl. unique	3283

¹ CrysAlis CCD, Oxford Diffraction Ltd., Version 1.171.32.29 (release 10-02008 CrysAlis171.NET).

² Burla, M. C.; Calandro, R.; Carrozzini, B.; Cascarano, G. L.; Cuocci, C.; Giacovazzo, C.; Mallamo, M.; Mazzone, A.; Polidori, G. Crystal structure determination and refinement via SIR2014. *J. Appl. Cryst.* **2015**, *48*, 306-309.

³ Sheldrick, G. M. SHELX97: Program for the Refinement of Crystal Structures, Universität Göttingen, Germany, 1997.

⁴ Macrae, C. F.; Bruno, I. J.; Chisholm, J. A.; Edgington, P. R.; McCabe, P.; Pidcock, E.; Rodriguez-Monge, L.; Taylor, R.; van de Streek, J.; Wood, P. A. Mercury CSD 2.0 - new features for the visualization and investigation of crystal structures. *J. Appl. Cryst.* **2008**, *41*, 466-470.

⁵ Faruggia, L. J. WinGX suite for small-molecule single-crystal crystallography. *J. Appl. Cryst.* **1999**, *32*, 837-838.

⁶ Spek, A. L. Structure validation in chemical crystallography *Acta Cryst.* **2009**, *D65*, 148-155.

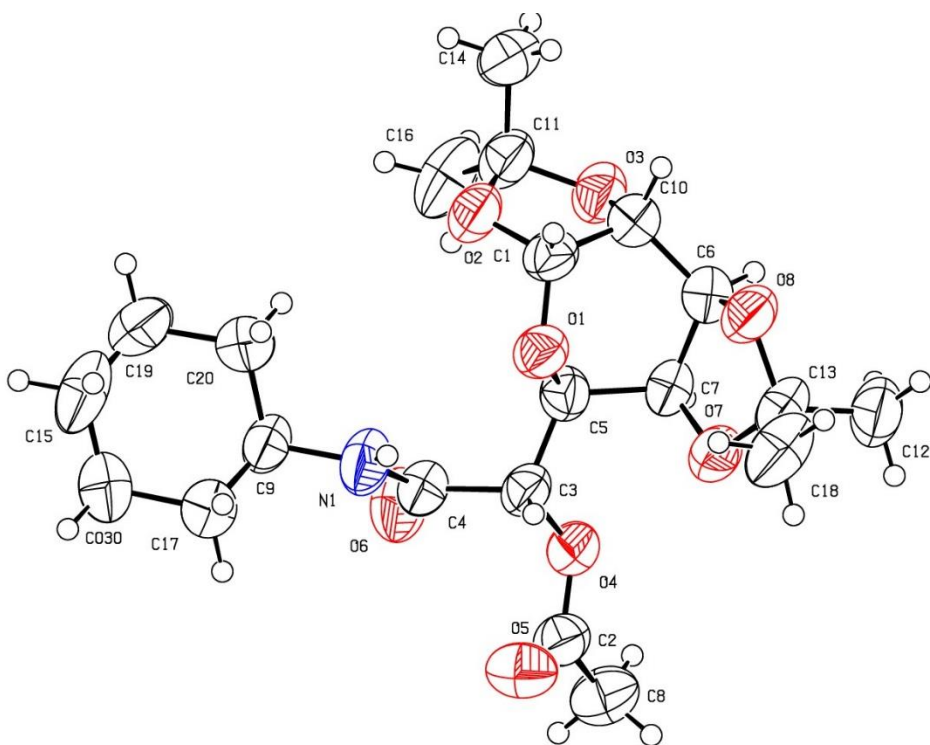


Figure S1. Figure captions: ORTEP drawing of the structure **2a** with the atom numbering. Thermal ellipsoids are scaled to a 50 % probability level.