Electronic Supplementary Material (ESI) for ChemComm.
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Supporting Information

Photoreductive β-aminoalkylation with amino acids affords functionalized γ-aminoketones for nucleoside mimics

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General information

All reactions were carried out in glassware under inert (nitrogen) atmosphere. All used chemicals and reagents were purchased from commercial sources and were used without further purification. Solvents were freshly purified by distillation/drying over molecular sieves following the instructions from the Purification Book. Particularly mentioned anhydrous/dry solvents were purchased from Acros organics. Reactions were monitored by thin-layer chromatography (TLC) performed with Merck alumina plates coated with silica gel 60 F254 and analyzed under UV light (254 nm and 365 nm) or revealed using $KMnO_4$ as staining agent. The photochemical Giese-type reaction was done with a A160WE LED aquarium light purchased from Kessil. The composition of the mobile phase was adjusted to the compound properties. Flash column chromatography was performed on a Biotage® Isolera Prime/One purification system using 40–60 μm pre-packed silica gel columns from Biotage®, HP-spherical 50 μm pre-packed silica gel columns from Interchim (Jumbo Pack), Sfär Silica D 60 μm, Sfär KP amino D 50 μm or Sfär Silica HC D 20 μm pre-packed silica gel columns from Biotage®. NMR spectroscopy and mass spectrometry were used for product identification. NMR spectra were acquired on a BRUKER Avance 400 spectrometer (400 MHz and 100.6 MHz for ^{1}H and ^{13}C respectively), at a temperature of 303 K unless specified using $CDCl_3$ or DMSO-d6 as solvent. Chemical shifts (δ) are reported in ppm, multiplicity abbreviations are as follows: bs = broad singlet, s = singlet, d = doublet, dd = doublet of doublets, ddd = doublet of doublet of doublet, dt = doublet of triplets, t = triplet, td = triplet of doublets, q = quartet, br q = broad quartet, h = heptet, and m = multiplet, coupling constant (J) are expressed in Hz. The ^{1}H assignment resulted from COSY experiments. The ^{13}C assignment resulted from HSQC experiments. Mass spectra were recorded on an Advion expression CMS using an ASAP® (Atmospheric Solids Analysis Probe; aka APCI: Atmospheric Pressure Chemical Ionization) as ion source, on a Thermo Scientific Exactive mass spectrometer using electrospray ionization (ESI) as ion source or HR-MS were obtained on a THERMO SCIENTIFIC Advantage. HPLC analysis was performed to determine the purity of the final nucleosides on an Agilent Technologies 1260 Infinity II system using diode array detector (DAD) UV detection at either 210, 230, 248, 254, 260 & 280 nm. 2 methods were used:

Method A: XBridge® Shield RP18 5 μm 4.6 x 150 mm column and eluent A was H_2O containing 0.05 % trifluoracetic acid (TFA) and eluent B was CH_3CN containing 0.05 % TFA. Linear gradient conditions were as follows: 0–1 min: 100:0 (A/B); 1–9 min: 60:40 (A/B); 9–11 min: 5:95; (A/B); 11–13 min: 5:95 (A/B); 13–14 min: 100:0 (A/B); 14–16 min: 100:0 (A/B) with a flowrate of 0.95 $mL.min^{-1}$.

Method B: Phenomenex Kinetex® 5μm XB-C18 100 Å 250 x 4.6 mm column and eluent A was H_2O containing 0.05 % trifluoracetic acid (TFA) and eluent B was CH_3CN containing 0.05 % TFA. Linear gradient conditions were as follows: 0–1 min: 100:0 (A/B); 1–9 min: 60:40 (A/B); 9–11 min: 5:95; (A/B); 11–13 min: 5:95 (A/B); 13–14 min: 100:0 (A/B); 14–16 min: 100:0 (A/B) with a flowrate of 0.95 $mL.min^{-1}$.

HPLC purification method:

Method C: XBridge® Prep Shield RP18 5 µm 19 x 150 mm column and eluent A was H_2O containing 0.05 % trifluoracetic acid (TFA) and eluent B was CH_3CN containing 0.05 % TFA. Linear gradient conditions were as follows: 0–1 min: 100:0 (A/B); 1–9 min: 100:0→60:40 (A/B); 9–11 min: 60:40→5:95; (A/B); 11–13 min: 5:95 (A/B); 13–14 min: 5:95→100:0 (A/B); 14–20 min: 100:0 (A/B) with a flowrate of 17.10 mL.min^{-1}.

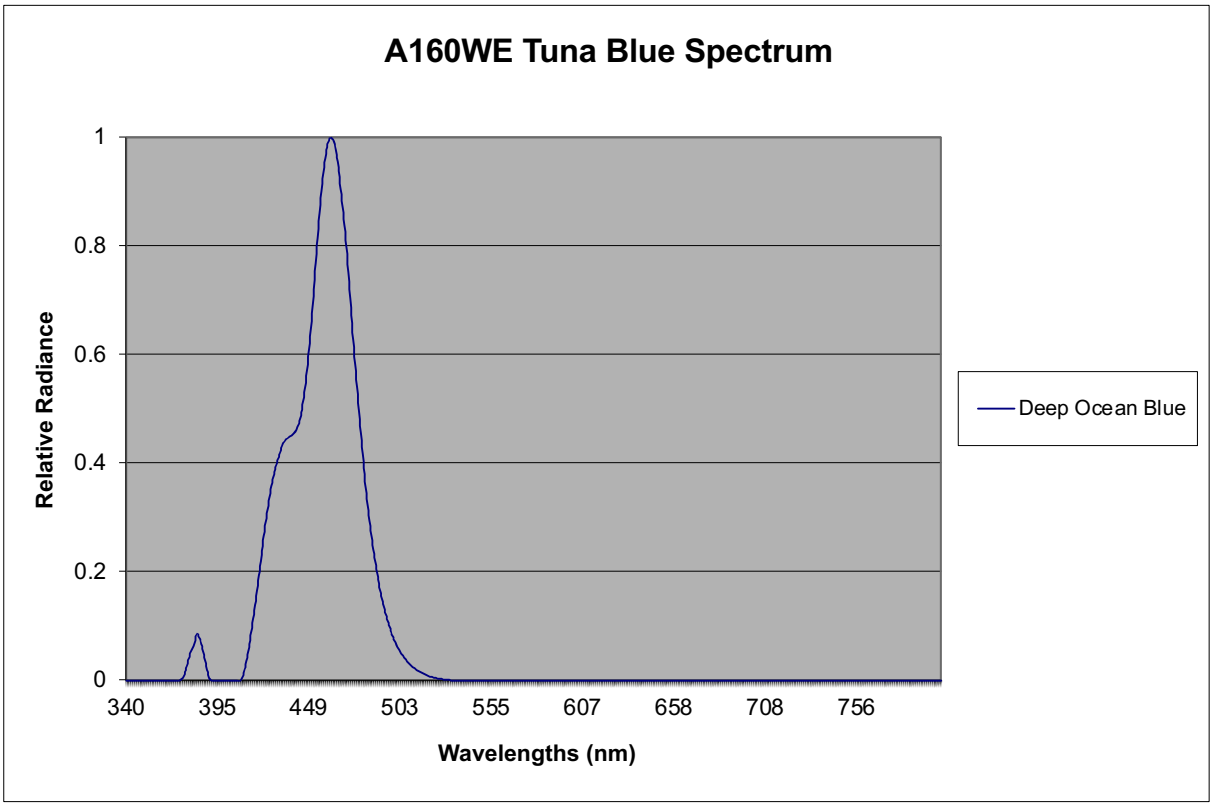


Figure 1 Emission spectrum of the blue LED lamp. Emission maximum at 461 nm

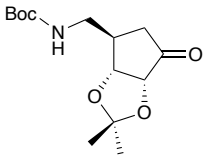
Experimental procedures

Photoreductive β-aminoalkylation

A heat-dried vial was charged with (-)-(3aR,6aR)-3a,6a-Dihydro-2,2-dimethyl-4H-cyclopenta-1,3-dioxol-4-one (0.62 mmol – 4.62 mmol, 1.00 eq.), α-amino acid (1.85 mmol – 13.87 mmol, 3.00 eq.), and anhydrous CsF (1.85 mmol – 13.87 mmol, 3.00 eq) under nitrogen atmosphere. Then, dry DMSO (3.10 mL – 23.10 mL, 0.20 M) was added followed by addition of 3 mol% (Ir[dF(CF_3)ppy]$_2$(dtbpy))PF_6 (0.02 – 0.14 mmol, 0.03 eq.). The resulted solution was degassed for 15 min. Then, the reaction vial was irradiated by blue LED light at 467 nm at ambient temperature for 17 h. The reaction progress was monitored by TLC (petrol ether/EtOAc). Then, the reaction mixture was diluted with water and extracted with EtOAc (3x 50 mL). The combined organic layers were washed with brine (3x 50 mL), dried over sodium sulfate, and concentrated under reduced pressure. The obtained residue was purified by flash chromatography to afford products **3a-3t**.

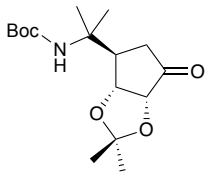
Figure 2 Set up for the decarboxylative redox addition.

***tert*-butyl (((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)methyl)carbamate (3a)**:



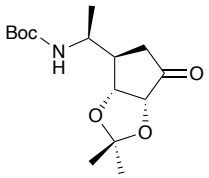
Following the general procedure for photoreductive β-aminoalkylation, compound **3a** was obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.75 g, 4.62 mmol), Boc-Gly-OH (2.45 g, 13.87 mmol), (Ir[dF(CF_3)ppy]$_2$(dtbpy))PF_6 (0.16 g, 0.14 mmol), and CsF (2.13 g, 13.87 mmol) in dry degassed DMSO (0.20 M, 23.10 mL) under blue LED irradiation afforded after column chromatography on silica (petrol ether/EtOAc; 0-50%) the title compound as yellowish solid (1225 mg, 93%). R_f = 0.42 (petrol ether/EtOAc; 50%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 4.67 (d, J = 5.3 Hz, 1H, H2'), 4.70 – 4.60 (m, 1H, -N*H*CH_2-), 4.25 – 4.21 (m, 1H, H2'), 3.33 – 3.10 (m, 2H, -NHC*H*$_2$-), 2.81 – 2.69 (m, 1H, CH_2, H4'), 2.60 – 2.49 (m, 1H, H3'), 2.16 – 2.05 (m, 1H, CH_2, H4'), 1.45 – 1.40 (m, 12H, -$NHCO_2C(CH_3)_3$, C*H*$_3$, acetonide), 1.34 (s, 3H, C*H*$_3$, acetonide). ^{13}C-NMR (101 MHz, $CDCl_3$) δ 213.0 (1C, *C*O), 156.0 (1C, -O*C*ONH-), 111.9 (1C, -$O_2C(CH_3)_2$), 80.2 (C1), 80.0 (1C, -O*C*$(CH_3)_3$), 78.2 (C2), 43.0 (C3), 38.3 (1C, -HN*C*H_2-), 37.8 (C4), 28.2 (3C, -$NHCO_2C(CH3)_3$), 26.7 (1C, *C*H_3, acetonide), 24.7 (1C, *C*H_3, acetonide). HRMS calc.: 285.16; found: 308.1470 $[M+Na]^+$.

***tert*-butyl (2-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)propan-2-yl)carbamate (3b)**:

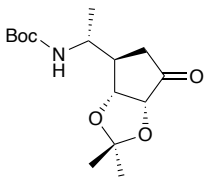


Following the general procedure for photoreductive β-aminoalkylation, compound **3b** was obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.31 g, 1.91 mmol), Boc-AiB-OH (1.18 g, 5.73 mmol), (Ir[dF(CF_3)ppy]$_2$(dtbpy))PF_6 (0.06 g, 0.06 mmol), and CsF (0.88 g, 5.73 mmol) in dry degassed DMSO (0.20 M, 9.60 mL) under blue LED irradiation afforded after column chromatography on silica (petrol ether/EtOAc; 0-30%) the title compound as yellowish resin (480 mg, 80%). R_f = 0.71 (petrol ether/EtOAc; 30%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 4.83 (d, *J* = 5.5 Hz, 1H, H1'), 4.46 (s, 1H, -N*H*C(CH_3)$_2$-), 4.29 – 4.26 (m, 1H, H2'), 2.80 (ddd, *J* = 9.9, 5.0, 1.4 Hz, 1H, H3'), 2.72 – 2.63 (m, 1H, H4'), 2.38 – 2.30 (m, 1H, H4'), 1.43 (s, 3H, C*H*$_3$, acetonide), 1.41 (s, 9H, -NHCO$_2$C(C*H*$_3$)$_3$), 1.35 (s, 3H, C*H*$_3$, acetonide), 1.32 (s, 3H, -NHC(C*H*$_3$)$_2$-), 1.29 (s, 3H, -NHC(C*H*$_3$)$_2$-). ^{13}C-NMR (101 MHz, $CDCl_3$) δ 213.4 (1C, *C*O), 154.5 (1C, -NH*C*O$_2$-), 112.0 (1C, -O$_2$*C*(CH_3)$_2$), 81.1 (1C, -NHCO$_2$*C*(CH_3)$_3$), 79.1 (1C, C1), 79.0 (1C, C2), 53.5 (1C, -NH*C*(CH_3)$_2$-), 47.5 (1C, C3), 37.1 (1C, C4), 28.5 (3C, NHCO$_2$C(*C*H_3)$_3$), 27.0 (1C, *C*H_3, acetonide), 26.4 (1C, -NHC(*C*H_3)$_2$-), 25.4 (1C, -NHC(*C*H_3)$_2$-), 25.0 (1C, *C*H_3, acetonide). HRMS calc.: 313.19; found: 336.1780 [M+Na]$^+$.

***tert*-butyl ((*S*)-1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)ethyl)carbamate (3c, structure assumed) & *tert*-butyl ((*R*)-1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)ethyl)carbamate (3d, structure assumed)**:

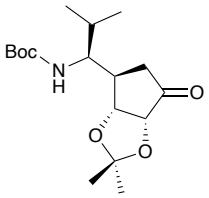


Following the general procedure for photoreductive β-aminoalkylation, compound **3c** and **3d** were obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.10 g, 0.62 mmol), Boc-Ala-OH (0.35 g, 1.85 mmol), (Ir[dF(CF_3)ppy]$_2$(dtbpy))PF_6 (0.02 g, 0.02 mmol), and CsF (0.28 g, 1.85 mmol) in dry degassed DMSO (0.20 M, 3.10 mL) under blue LED irradiation afforded after column chromatography on silica (petrol ether/EtOAc; 0-40%) the title compounds (164 mg, 94%, d.r. 1:1.2). **3c** as colorless solid (73 mg) and **3d** as orange resin (91 mg). R_f = 0.53 (petrol ether/EtOAc; 30%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 4.82 (d, *J* = 4.9 Hz, 1H, H1'), 4.19 (d, *J* = 8.6 Hz, 1H, -N*H*CH-), 4.17 – 4.08 (m, 1H, H2'), 4.05 – 3.95 (m, 1H, -NHC*H*-), 2.68 (dd, *J* = 18.6, 9.2 Hz, 1H, CH_2, H4'), 2.42 (dt, *J* = 9.2, 2.9 Hz, 1H, H3'), 2.21 – 2.10 (m, 1H, CH_2, H4'), 1.42 (s, 12H, -NHCO$_2$C(C*H*$_3$)$_3$, C*H*$_3$, acetonide), 1.33 (s, 3H, C*H*$_3$, acetonide), 1.17 (d, *J* = 6.9 Hz, 3H, -CHC*H*$_3$). ^{13}C-NMR (101 MHz, $CDCl_3$) δ 213.3 (1C, *C*O), 155.5 (1C, O*C*ONH-), 111.6 (1C, -O$_2$*C*(CH_3)$_2$), 81.3 (1C, C1), 80.3 (1C, -O*C*(CH_3)$_3$), 78.3 (1C, C2), 48.1 (1C, -HN*C*HCH$_3$-), 44.4 (1C, C3), 35.5 (1C, C4), 28.4 (3C, -NHCO$_2$C(*C*H3)$_3$), 26.9 (1C, *C*H_3, acetonide), 24.8 (1C, *C*H_3, acetonide), 20.2 (1C, *C*H$_3$CH-, Me). HRMS calc.: 299.17; found: 322.1630 [M+Na]$^+$.

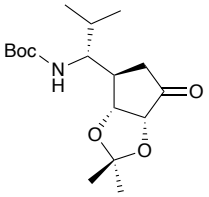


R_f = 0.35 (petrol ether/EtOAc; 30%). ^{1}H-NMR (400 MHz, Chloroform-d) δ 4.65 (d, J = 5.8 Hz, 1H, H1'), 4.43 – 4.35 (m, 1H, -N*H*CH-), 4.33 (d, J = 5.9 Hz, 1H, H2'), 3.76 – 3.61 (m, 1H, -NHC*H*-), 2.71 (dd, J = 18.4, 9.0 Hz, 1H, H4'), 2.36 – 2.28 (m, 1H, H3'), 2.28 – 2.19 (m, 1H, CH_2, H4'), 1.45 – 1.41 (m, 12H, 12H, -NHCO$_2$C(C*H*$_3$)$_3$, C*H*$_3$, acetonide), 1.33 (s, 3H, C*H*$_3$, acetonide), 1.19 (d, J = 6.8 Hz, 3H, -CHC*H*$_3$). ^{13}C-NMR (101 MHz, $CDCl_3$) δ 212.5 (1C, *C*O), 155.7 (1C, O*C*ONH-), 112.2 (1C, -O$_2$*C*(CH$_3$)$_2$), 78.9 (1C, C1), 78.7 (1C, C2), 48.5 (1C, -HN*C*HCH$_3$-), 44.8 (1C, C3), 38.8 (1C, C4), 28.5 (3C, -NHCO$_2$C(*C*H3)$_3$), 27.0 (1C, *C*H$_3$, acetonide), 24.9 (1C, *C*H$_3$, acetonide), 19.8 (1C, *C*H$_3$CH-, Me). HRMS calc.: 299.17; found: 322.1630 $[M+Na]^+$.

***tert*-butyl ((*S*)-1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)-2-methylpropyl)carbamate (3e, structure assumed) & *tert*-butyl ((*R*)-1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)-2-methylpropyl)carbamate (3f, structure assumed)**:



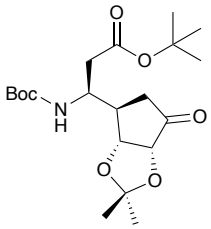
Following the general procedure for photoreductive β-aminoalkylation, compound **3e** and **3f** were obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.25 g, 1.54 mmol), Boc-Val-OH (1.01 g, 4.62 mmol), (Ir[dF(CF$_3$)ppy]$_2$(dtbpy))PF$_6$ (0.05 g, 0.05 mmol), and CsF (0.71 g, 4.62 mmol) in dry degassed DMSO (0.20 M, 7.70 mL) under blue LED irradiation afforded after column chromatography on silica (petrol ether/EtOAc; 0-40%) the title compounds as yellowish resins (376 mg, 75%, d.r. 1.3:1). **3e** (211 mg) and **3f** (165 mg). R_f = 0.67 (petrol ether/EtOAc; 30%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 4.80 (d, *J* = 5.5 Hz, 1H, H1'), 4.15 – 4.05 (m, 1H, H2'), 3.58 (td, *J* = 9.3, 2.7 Hz, 1H, -NHC*H*-), 2.71 – 2.61 (m, 2H, H3, H4'), 2.13 – 2.04 (m, 1H, H4'), 1.65 – 1.55 (m, 1H, -C*H*(CH$_3$)$_2$), 1.43 – 1.40 (m, 12H, -NHCO$_2$C(C*H*$_3$)$_3$, C*H*$_3$, acetonide), 1.33 (s, 3H, C*H*$_3$, acetonide), 0.96 (dd, *J* = 9.2, 6.7 Hz, 6H, -CH(C*H*$_3$)$_2$). ^{13}C-NMR (101 MHz, $CDCl_3$) δ 213.4 (1C, *C*O), 156.2, (1C, O*C*ONH-), 111.5 (1C, -O$_2$*C*(CH$_3$)$_2$), 82.2 (1C, C1), 80.2 (1C, -O*C*(CH$_3$)$_3$), 78.3 (1C, C2), 58.5 (1C, -HN*C*HCH(CH$_3$)$_2$-), 40.5 (1C, C3), 35.3 (1C, C4), 31.5 (1C, -*C*H(CH$_3$)$_2$), 28.4 (3C, -NHCO$_2$C(*C*H$_3$)$_3$), 26.9 (1C, *C*H$_3$, acetonide), 24.8 (1C, *C*H$_3$, acetonide), 20.1 (1C, CH$_3$, -CH(*C*H$_3$)$_2$), 19.1 (1C, CH$_3$, -CH(*C*H$_3$)$_2$). HRMS calc.: 327.20; found: 350.1943 $[M+Na]^+$.



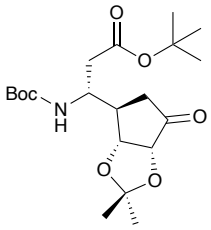
R_f = 0.68 (petrol ether/EtOAc; 30%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.61 (d, *J* = 7.9 Hz, 1H, H1'), 4.35 (d, *J* = 6.1 Hz, 1H, H2'), 3.43 – 3.35 (m, 1H, -NHC*H*-), 2.68 (dd, *J* = 18.2, 9.0 Hz, 1H, H4'), 2.51 – 2.39 (m, 1H, H3'), 2.29

– 2.20 (m, 1H, H4'), 1.81 (h, *J* = 6.7 Hz, 1H, -C*H*(CH$_3$)$_2$), 1.46 – 1.41 (m, 12H, -NHCO$_2$C(C*H*$_3$)$_3$, C*H*$_3$, acetonide), 1.32 (s, 3H, C*H*$_3$, acetonide), 1.00 (d, *J* = 6.7 Hz, 3H, -CH(C*H*$_3$)$_2$), 0.88 (d, *J* = 6.8 Hz, 3H, -CH(C*H*$_3$)$_2$). ^{13}C NMR (101 MHz, CDCl$_3$) δ 212.3 (1C, *C*O), 156.6 (1C, O*C*ONH-), 112.2 (1C, -O$_2$*C*(CH$_3$)$_2$), 80.0 (1C, -O*C*(CH$_3$)$_3$), 78.9, (1C, C1), 78.8 (1C, C2), 58.0 (1C, -HN*C*HCH(CH$_3$)$_2$-), 41.3 (1C, C3), 39.3 (1C, C4), 30.0 (1C, -*C*H(CH$_3$)$_2$), 28.4 (3C, -NHCO$_2$C(*C*H$_3$)$_3$), 26.9 (1C, *C*H$_3$, acetonide), 24.9 (*C*H$_3$, acetonide), 20.3 (1C, CH$_3$, -CH(*C*H$_3$)$_2$), 17.0 (1C, CH$_3$, -CH(*C*H$_3$)$_2$). HRMS calc.: 327.20; found: 350.1943 [M+Na]$^+$.

***tert*-butyl (*S*)-3-((*tert*-butoxycarbonyl)amino)-3-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)propanoate (3g, structure assumed) & *tert*-butyl (*R*)-3-((*tert*-butoxycarbonyl)amino)-3-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)propanoate (3h, structure assumed)**:



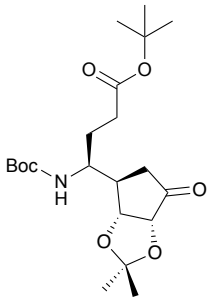
Following the general procedure for photoreductive β-aminoalkylation, compound **3g** and **3h** were obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.26 g, 1.59 mmol), Boc-Asp(*t*Bu)-OH (1.45 g, 4.77 mmol), (Ir[dF(CF$_3$)ppy]$_2$(dtbpy))PF$_6$ (0.06 g, 0.05 mmol), and CsF (0.73 g, 4.77 mmol) in dry degassed DMSO (0.20 M, 8.00 mL) under blue LED irradiation afforded after column chromatography on silica (petrol ether/EtOAc; 0-35%) the title compounds as yellowish solids (610 mg, 96%, d.r. 1.1:1). **3g** (321 mg) and **3h** (289 mg). R$_f$ = 0.51 (petrol ether/EtOAc; 30%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 4.81 – 4.74 (m, 1H, H1'), 4.27 – 4.18 (m, 1H, -NHC*H*CH$_2$-), 4.17 (d, *J* = 5.7 Hz, 1H, H2'), 2.67 (dd, *J* = 18.5, 9.1 Hz, 1H, H4'), 2.54 – 2.34 (m, 3H, H3', -C*H*$_2$CO$_2$-), 2.24 – 2.17 (m, 1H, H4'), 1.46 – 1.42 (m, 12H, -NHCO$_2$C(C*H*$_3$)$_3$, C*H*$_3$, acetonide), 1.41 (s, 9H, -CO$_2$C(C*H*$_3$)$_3$), 1.33 (s, 3H, C*H*$_3$, acetonide). ^{13}C-NMR (101 MHz, CDCl$_3$) δ 212.2 (1C, *C*O), 169.8 (1C, -CH$_2$*C*O$_2$-), 155.3 (1C, -NH*C*O$_2$-), 111.9 (1C, -O$_2$*C*(CH$_3$)$_2$), 99.9 (1C, -CH$_2$CO$_2$*C*(CH$_3$)$_3$), 81.6 (1C, -NHCO$_2$*C*(CH$_3$)$_3$), 81.1 (1C, C1), 78.2 (1C, C2), 49.7 (1C, NH*C*HCH$_2$-), 43.3, (1C, C3) 39.8 (1C, -NHCH*C*H$_2$-), 36.3 (1C, C4), 28.2 (3C, -NHCO$_2$C(*C*H3)$_3$), 27.9 (3C, -CO$_2$C(*C*H$_3$)$_3$), 26.7 (1C, *C*H$_3$, acetonide), 24.7 (1C, *C*H$_3$, acetonide). HRMS calc.: 399.23; found: 422.2149 [M+Na]$^+$.



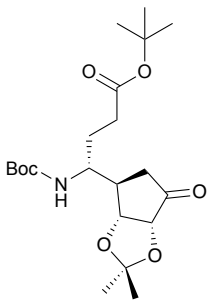
R$_f$ = 0.45 (petrol ether/EtOAc; 30%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 5.17 (d, *J* = 9.3 Hz, 1H, -N*H*CHCH$_2$-), 4.66 (dd, *J* = 5.9, 1.5 Hz, 1H, H1'), 4.36 (d, *J* = 5.7 Hz, 1H, H2'), 3.92 – 3.85 (m, 1H, -NHC*H*CH$_2$-), 2.77 – 2.66 (m, 1H, H4'), 2.60 – 2.38 (m, 2H, -C*H*$_2$CO$_2$-), 2.27 – 2.19 (m, 1H, H4'), 1.45 (s, 9H, -NHCO$_2$C(C*H*$_3$)$_3$), 1.43 (s, 12H, -CO$_2$C(C*H*$_3$)$_3$, C*H*$_3$, acetonide), 1.32 (s, 3H, C*H*$_3$, acetonide). ^{13}C-NMR (101 MHz, CDCl$_3$) δ 211.8 (1C, *C*O), 170.2 (1C, -CH$_2$*C*O$_2$-), 155.6 (1C, -NH*C*O$_2$-), 112.2 (1C, -O$_2$*C*(CH$_3$)$_2$), 99.9 (1C, -CH$_2$CO$_2$*C*(CH$_3$)$_3$), 81.7 (1C, -NHCO$_2$*C*(CH$_3$)$_3$), 78.6 (1C, C1), 78.4 (1C, C2), 49.6 (1C, NH*C*HCH$_2$-), 42.9 (1C, C3), 38.9 (1C, C4), 38.8 (1C, -

NHCH<u>C</u>H$_2$-), 28.2 (3C, -NHCO$_2$C(<u>C</u>H3)$_3$), 27.9 (3C, -CO$_2$C(<u>C</u>H$_3$)$_3$), 26.7 (1C, <u>C</u>H$_3$, acetonide), 24.7 (1C, <u>C</u>H$_3$, acetonide). HRMS calc.: 399.23; found: 422.2149 $[M+Na]^+$.

***tert*-butyl (*S*)-4-((*tert*-butoxycarbonyl)amino)-4-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)butanoate (3i, structure assumed) & *tert*-butyl (*R*)-4-((*tert*-butoxycarbonyl)amino)-4-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)butanoate (3j, structure assumed)**:



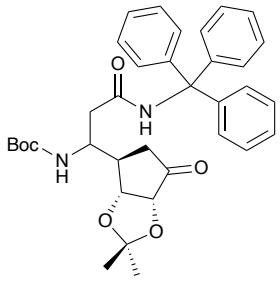
Following the general procedure for photoreductive β-aminoalkylation, compounds **3i** and **3j** were obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.11 g, 0.65 mmol), Boc-Glu(^{t}Bu)-OH (0.62 g, 1.94 mmol), (Ir[dF(CF$_3$)ppy]$_2$(dtbpy))PF$_6$ (0.02 g, 0.02 mmol), and CsF (0.30 g, 1.94 mmol) in dry degassed DMSO (0.20 M, 3.20 mL) under blue LED irradiation afforded after column chromatography on silica (petrol ether/EtOAc; 0-35%) the title compounds as yellowish resins (245 mg, 92%, d.r. 1.2:1). **3i** (131 mg) and **3j** (110 mg). R_f = 0.58 (petrol ether/EtOAc; 30%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.81 (d, J = 5.6 Hz, 1H, H1'), 4.37 (d, J = 9.0 Hz, 1H, -N<u>*H*</u>CHCH$_2$-), 4.13 – 4.08 (m, 1H, H2'), 3.91 – 3.81 (m, 1H, -NHC<u>*H*</u>CH$_2$-), 2.67 (dd, J = 18.9, 8.9 Hz, 1H, H4'), 2.49 – 2.42 (m, 1H, H3'), 2.35 – 2.25 (m, 2H, -NHCHC<u>*H*$_2$</u>-), 2.21 – 2.12 (m, 1H, H4'), 1.81 – 1.63 (m, 2H, -NHCHCH$_2$C<u>*H*$_2$</u>-), 1.44 (s, 9H, -CO$_2$C(C<u>*H*$_3$</u>)$_3$), 1.42 – 1.39 (m, 12H, -NHCO$_2$C(C<u>*H*$_3$</u>)$_3$, C<u>*H*$_3$</u>, acetonide), 1.32 (s, 3H, C<u>*H*$_3$</u>, acetonide). ^{13}C NMR (101 MHz, $CDCl_3$) δ 213.0 (1C, <u>C</u>O), 172.5 (1C, -<u>C</u>O$_2$C(CH$_3$)$_3$), 155.6 (1C, -NH<u>C</u>O$_2$-), 111.4 (1C, -O$_2$<u>C</u>(CH$_3$)$_3$), 81.2 (1C, C1), 80.9 (1C, -CO$_2$<u>C</u>(CH$_3$)$_3$), 80.1 (1C, -NHCO$_2$<u>C</u>(CH$_3$)$_3$), 78.1 (1C, C2), 52.4 (1C, -NH<u>C</u>HCH$_2$-), 43.2 (1C, C3), 35.3 (1C, C4), 32.0 (1C, -NHC*H*<u>C</u>H$_2$CH$_2$-), 28.4 (1C, -NHC*H*CH$_2$<u>C</u>H$_2$-), 28.2 (3C, -CO$_2$C(<u>C</u>H$_3$)$_3$), 28.0 (3C, -NHCO$_2$C(<u>C</u>H$_3$)$_3$), 26.7 (1C, <u>C</u>H$_3$, acetonide), 24.6 (1C, <u>C</u>H$_3$, acetonide). HRMS calc.: 413.23; found: 414.2339 $[M+H]^+$.



R_f = 0.33 (petrol ether/EtOAc; 30%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.65 (dd, J = 5.8, 1.5 Hz, 1H, H1'), 4.55 – 4.45 (m, 1H, -NHC<u>*H*</u>CH$_2$-), 4.33 (d, J = 5.8 Hz, 1H, H2'), 3.65 – 3.53 (m, 1H, -NHC<u>*H*</u>CH$_2$-), 2.72 (dd, J = 18.5, 8.1 Hz, 1H, H4'), 2.40 – 2.24 (m, 4H, H3', H4', -NHCHC<u>*H*$_2$</u>-), 1.89 – 1.67 (m, 2H, -NHCHCH$_2$C<u>*H*$_2$</u>-), 1.44 (s, 9H, -CO$_2$C(C<u>*H*$_3$</u>)$_3$), 1.43 – 1.40 (m, 12H, -NHCO$_2$C(C<u>*H*$_3$</u>)$_3$, C<u>*H*$_3$</u>, acetonide), 1.32 (s, 3H, C<u>*H*$_3$</u>, acetonide). ^{13}C NMR (101 MHz, $CDCl_3$) δ 212.3 (1C, <u>C</u>O), 172.9 (1C, -<u>C</u>O$_2$C(CH$_3$)$_3$), 156.1 (1C, -NH<u>C</u>O$_2$-), 112.2 (1C, -

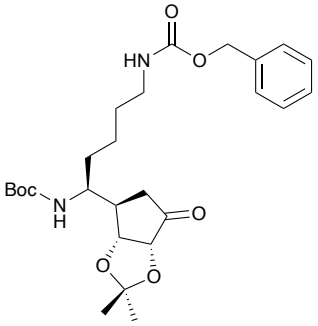
$O_2\underline{C}(CH_3)_3$), 81.1 (1C, -$CO_2\underline{C}(CH_3)_3$), 80.1 (1C, -$NHCO_2\underline{C}(CH_3)_3$), 78.8 (1C, C1), 78.7 (1C, C2), 52.9 (1C, -$NH\underline{C}HCH_2$-), 44.0 (1C, C3), 39.1 (1C, C4), 32.1 (1C, -$NHCH\underline{C}H_2CH_2$-), 28.5 (1C, -$NHCHCH_2\underline{C}H_2$-), 28.4 (3C, -$CO_2C(\underline{C}H_3)_3$), 28.2 (3C, -$NHCO_2C(\underline{C}H_3)_3$), 26.9 (1C, $\underline{C}H_3$, acetonide), 24.9 (1C, $\underline{C}H_3$, acetonide). HRMS calc.: 413.23; found: 414.2339 $[M+H]^+$.

***tert*-butyl (1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)-3-oxo-3-(tritylamino)propyl)carbamate (3k)**:

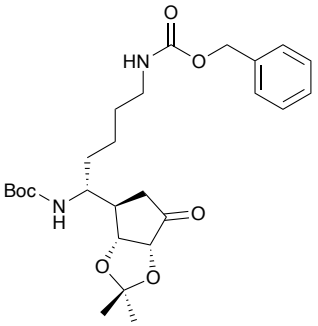


Following the general procedure for photoreductive β-aminoalkylation, compound **3k** was obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.10 g, 0.62 mmol), Boc-Asn(Trt)-OH (0.89 g, 1.85 mmol), $(Ir[dF(CF_3)ppy]_2(dtbpy))PF_6$ (0.02 g, 0.02 mmol), and CsF (0.28 g, 1.85 mmol) in dry degassed DMSO (0.20 M, 3.10 mL) under blue LED irradiation afforded after column chromatography on silica (cyclohexane/EtOAc; 0-60%) the title compound as yellowish solid (300 mg, 83%, d.r. 1.4:1). R_f = 0.72 (petrol ether/EtOAc; 80%). Diastereomeric mixture: ^{1}H-NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.15 (m, 30H, trityl), 5.65 (dd, J = 18.1, 8.7 Hz, 2H, -CON$\underline{H}$C-), 4.66 (d, J = 4.7 Hz, 1H, H1), 4.60 (dd, J = 6.7, 2.6 Hz, 1H, H1), 4.34 – 4.25 (m, 2H, H2), 4.00 – 3.91 (m, 1H, -NHC$\underline{H}$-), 3.77 – 3.66 (m, 1H, -NHC$\underline{H}$-), 2.73 – 2.41 (m, 8H, H3', H4', -NHCHC$\underline{H_2}$-), 2.41 – 2.29 (m, 1H, H4'), 2.12 (ddd, J = 18.1, 5.4, 1.8 Hz, 1H, H4'), 1.40 (s, 3H, C$\underline{H_3}$, acetonide), 1.39 (s, 9H, -$NHCO_2C(C\underline{H_3})_3$), 1.37 (s, 9H, -$NHCO_2C(C\underline{H_3})_3$), 1.32 – 1.30 (m, 6H, C$\underline{H_3}$, acetonide), 1.30 (s, 3H, C$\underline{H_3}$, acetonide). ^{13}C NMR (101 MHz, $CDCl_3$) δ 211.9 (1C, $\underline{C}$O), 211.4 (1C, $\underline{C}$O), 169.7 (2C, -$CH_2\underline{C}$ONH-), 155.8 (1C, -$NH\underline{C}O_2$-), 155.7 (1C, -$NH\underline{C}O_2$-), 144.5 (2C, -$CH_2CONHC(\underline{C})_3$-), 144.4 (1C, -$CH_2CONHC(\underline{C})_3$-), 128.8 (*m*-$\underline{C}_{Ar}$), 128.7 (*m*-$\underline{C}_{Ar}$), 128.2 (*m*-$\underline{C}_{Ar}$), 128.2 (*m*-$\underline{C}_{Ar}$), 127.4 (3C, *p*-$\underline{C}_{Ar}$), 113.1 (1C, -$O_2\underline{C}(CH_3)_3$), 112.6 (1C, -$O_2\underline{C}(CH_3)_3$), 80.8 (1C, C1), 80.0 (2C, $NHCO_2\underline{C}(CH_3)_3$), 79.3 (1C, C1), 78.9 (1C, C2), 78.6 (1C, C2), 71.0 (2C, -$CH_2CONH\underline{C}(C)_3$-), 51.1 (1C, -NHC$\underline{H}CH_2$-), 50.8 (1C, -NHC$\underline{H}CH_2$-), 44.5 (1C, C3), 43.0 (1C, C3), 40.0 (2C, -$NHCH\underline{C}H_2$-), 39.6 (1C, C4), 38.9 (1C, C4), 28.4 (6C, -$CO_2C(\underline{C}H_3)_3$), 27.0 (1C, $\underline{C}H_3$, acetonide), 26.8 (1C, $\underline{C}H_3$, acetonide), 25.0 (1C, $\underline{C}H_3$, acetonide), 24.9 (1C, $\underline{C}H_3$, acetonide). HRMS calc.: 584.29; found: 607.2775 $[M+Na]^+$.

benzyl *tert*-butyl ((*S*)-1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)pentane-1,5-diyl)dicarbamate (3l, structure assumed) & benzyl *tert*-butyl ((*R*)-1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)pentane-1,5-diyl)dicarbamate (3m, structure assumed):



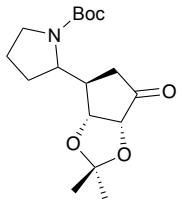
Following the general procedure for photoreductive β-aminoalkylation, compounds **3l** and **3m** were obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.25 g, 1.54 mmol), Boc-Lys(Z)-OH (1.78 g, 4.62 mmol), (Ir[dF(CF$_3$)ppy]$_2$(dtbpy))PF$_6$ (0.05 g, 0.05 mmol), and CsF (0.71 g, 4.62 mmol) in dry degassed DMSO (0.20 M, 7.70 mL) under blue LED irradiation afforded after column chromatography on silica (petrol ether/EtOAc; 0-50%) the title compounds as colorless oils (644 mg, 85%, d.r. 1.2:1). **3l** (337 mg) and **3m** (277 mg). R_f = 0.45 (petrol ether/EtOAc; 60%). ^{1}H-NMR (400 MHz, Chloroform-d) δ 7.39 – 7.31 (5H, Ar$_{(CBz)}$), 5.09 (d, J = 4.4 Hz, 2H, -OC$\underline{H_2}$Ph), 4.80 (d, J = 5.6 Hz, 2H, -CH$_2$N$\underline{H}$CO$_2$-, H1'), 4.27 (d, J = 8.9 Hz, 1H, -CO$_2$N$\underline{H}$CH-), 4.16 – 4.08 (m, 1H, H2'), 3.89 – 3.80 (m, 1H, -NHC$\underline{H}$CH$_2$-), 3.26 – 3.10 (m, 2H, -NHC$\underline{H_2}$CH$_2$-), 2.65 (dd, J = 18.6, 9.3 Hz, 1H, H4'), 2.48 – 2.41 (m, 1H, H3'), 2.16 – 2.07 (m, 1H, H4'), 1.57 – 1.36 (m, 18H, -CH(C$\underline{H_2}$)$_{\underline{3}}$CH$_2$NH-, -NHCO$_2$C(C$\underline{H_3}$)$_3$, C$\underline{H_3}$, acetonide), 1.33 (s, 3H, C$\underline{H_3}$, acetonide). ^{13}C-NMR (101 MHz, CDCl$_3$) δ 213.4 (1C, $\underline{C}$O), 156.7 (1C, -NH$\underline{C}$O$_2$CH$_2$Ph), 156.0 (1C, -O$\underline{C}$ONH-), 136.6 (1C, -OCH$_2\underline{C}$(CH)$_2$-), 128.7 (2C, *m*-Ar), 128.6 (1C, *p*-Ar), 128.3 (2C, *o*-Ar), 111.6 (1C, -O$_2\underline{C}$(CH$_3$)$_2$), 81.6 (1C, C1), 80.3 (1C, O$\underline{C}$(CH$_3$)$_3$), 78.3 (1C, C2), 66.9 (1C, -CO$_2\underline{C}$H$_2$Ph), 52.4 (1C, -HN$\underline{C}$H(CH$_2$)$_4$-), 43.1 (1C, C3), 40.5 (1C, -NHC$\underline{H_2}$CH$_2$-), 35.4 (1C, C4), 33.6 (1C, -NHCH$\underline{C}$H$_2$CH$_2$-), 29.7 (1C, -NHCH$_2\underline{C}$H$_2$-), 28.4 (3C, -O($\underline{C}$H$_3$)$_3$), 26.9 (1C, $\underline{C}$H$_3$, acetonide), 24.8 (1C, $\underline{C}$H$_3$, acetonide), 23.1 (1C, -NHCH$_2$CH$_2\underline{C}$H$_2$-). HRMS calc.: 490.27; found: 513.2576 [M+Na]$^+$.



R_f = 0.33 (petrol ether/EtOAc; 60%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 7.39 – 7.28 (5H, Ar$_{(CBz)}$), 5.09 (d, *J* = 5.5 Hz, 2H, -OC$\underline{H_2}$Ph), 4.85 – 4.76 (m, 1H, -CH$_2$N$\underline{H}$CO$_2$-), 4.63 (d, *J* = 6.0 Hz, 1H, H1'), 4.43 (d, *J* = 6.0 Hz, 1H, -CO$_2$N$\underline{H}$CH-), 4.33 (d, *J* = 5.6 Hz, 1H, H2'), 3.63 – 3.51 (m, 1H, -NHC$\underline{H}$CH$_2$-), 3.26 – 3.10 (m, 2H, -NHC$\underline{H_2}$CH$_2$-), 2.70 (dd, *J* = 18.5, 8.8 Hz, 1H, H4'), 2.40 – 2.30 (m, 1H, H3'), 2.31 – 2.21 (m, 1H, H4'), 1.56 – 1.36 (m, 18H, CH(C$\underline{H_2}$)$_{\underline{3}}$CH$_2$NH-, -NHCO$_2$C(C$\underline{H_3}$)$_3$, C$\underline{H_3}$, acetonide), 1.32 (s, 3H, C$\underline{H_3}$, acetonide). ^{13}C-NMR (101 MHz, CDCl$_3$)

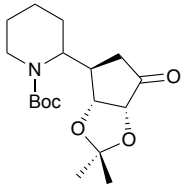
δ 212.3 (1C, <u>C</u>O), 156.5 (1C, -NH<u>C</u>O$_2$CH$_2$Ph), 156.1 (1C, -O<u>C</u>ONH-), 136.4 (1C, -OCH$_2$<u>C</u>(CH)$_2$-), 128.5 (3C, *m,p*-Ar), 128.1 (2C, *o*-Ar), 112.0 (1C, -O$_2$<u>C</u>(CH$_3$)$_2$), 80.0 (1C, O<u>C</u>(CH$_3$)$_3$), 78.6 (1C, C1), 78.5 (1C, C2), 66.7 (1C, -CO$_2$<u>C</u>H$_2$Ph), 52.5 (1C, -HN<u>C</u>H(CH$_2$)$_4$-), 43.5 (1C, C3), 40.3 (1C, -NHC<u>*H*$_2$</u>CH$_2$-), 38.9 (1C, C4), 32.8 (1C, -NHCH<u>C</u>H$_2$CH$_2$-), 29.6 (1C, -NHCH$_2$<u>C</u>H$_2$-), 28.3 (3C, -O(<u>C</u>H$_3$)$_3$), 26.7 (1C, <u>C</u>H$_3$, acetonide), 24.7 (1C, <u>C</u>H$_3$, acetonide), 22.7 (1C, -NHCH$_2$CH$_2$<u>C</u>H$_2$-). HRMS calc.: 490.27; found: 513.2576 [M+Na]$^+$.

***tert*-butyl 2-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)pyrrolidine-1-carboxylate (3n)**:



Following the general procedure for photoreductive β-aminoalkylation, compound **3n** was obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.25 g, 1.54 mmol), Boc-Pro-OH (1.01 g, 4.62 mmol), (Ir[dF(CF$_3$)ppy]$_2$(dtbpy))PF$_6$ (0.05 g, 0.05 mmol), and CsF (0.71 g, 4.62 mmol) in dry degassed DMSO (0.20 M, 7.70 mL) under blue LED irradiation afforded after column chromatography on silica (cyclohexane/EtOAc; 0-30%) the title compound as colorless resin (425 mg, 85%, d.r. 1.3:1). R$_f$ = 0.51 (cyclohexane/EtOAc; 30%). ^{1}H NMR (400 MHz, CDCl$_3$) δ 4.95 – 4.80 (m, 1H, H1'), 4.70 (d, *J* = 5.2 Hz, 1H, H1'), 4.47 – 4.38 (m, 1H, H2'), 4.34 – 4.23 (m, 1H, H2'), 4.08 – 3.97 (m, 1H, -CH$_2$CH$_2$C<u>*H*</u>CH-), 3.74 – 3.66 (m, 1H, -CH$_2$CH$_2$C<u>*H*</u>CH-), 3.57 – 3.39 (m, 2H, -NC<u>*H*$_2$</u>CH$_2$CH$_2$-), 3.38 – 3.28 (m, 1H, -NC<u>*H*$_2$</u>CH$_2$CH$_2$-), 3.24 – 3.09 (m, 1H, -NC<u>*H*$_2$</u>CH$_2$CH$_2$-), 2.75 – 2.67 (m, 1H, H4'), 2.67 – 2.59 (m, 1H, H4'), 2.54 – 2.43 (m, 2H, H3'), 2.30 – 2.18 (m, 1H, H4'), 2.15 – 2.05 (m, 1H, H4'), 1.97 – 1.78 (m, 5H, -NCH$_2$C<u>*H*$_2$</u>C<u>*H*$_2$</u>-), 1.72 – 1.56 (m, 2H, -NCH$_2$C<u>*H*$_2$</u>C<u>*H*$_2$</u>-), 1.46 (s, 9H, -NCO$_2$C(C<u>*H*$_3$</u>)$_3$), 1.45 – 1.41 (m, 12H, -NHCO$_2$C(C<u>*H*$_3$</u>)$_3$, C<u>*H*$_3$</u>, acetonide), 1.41 (s, 3H, C<u>*H*$_3$</u>, acetonide), 1.35 – 1.33 (m, 3H, C<u>*H*$_3$</u>, acetonide), 1.32 (s, 3H, C<u>*H*$_3$</u>, acetonide). ^{13}C NMR (101 MHz, CDCl$_3$) δ 213.0 (1C, <u>C</u>O), 156.0 (1C, -N<u>C</u>O$_2$-), 111.8 (1C, -O$_2$<u>C</u>(CH$_3$)$_3$), 82.1 (1C, C1), 79.6 (1C, C1), 78.8 (2C, C2), 59.0 (2C, -CH$_2$CH$_2$<u>C</u>HCH-), 48.0 (1C, -N<u>C</u>H$_2$CH$_2$CH$_2$-), 47.2 (1C, -N<u>C</u>H$_2$CH$_2$CH$_2$-), 44.4 (1C, C3), 41.8 (1C, C3), 38.6 (1C, C4), 36.6 (1C, C4), 31.3 (1C, -NCH$_2$CH$_2$<u>C</u>H$_2$-), 29.8 (3C, 3C, -NHCO$_2$C(<u>C</u>H$_3$)$_3$), 29.5 (1C, -NCH$_2$CH$_2$<u>C</u>H$_2$-), 28.5 (3C, 3C, -NHCO$_2$C(<u>C</u>H$_3$)$_3$), 27.0 (1C, <u>C</u>H$_3$, acetonide), 25.0 (1C, <u>C</u>H$_3$, acetonide), 24.3 (1C, -NCH$_2$CH$_2$<u>C</u>H$_2$-), 23.6 (1C, -NCH$_2$CH$_2$<u>C</u>H$_2$-). HRMS calc.: 325.19; found: 348.1941 [M+Na]$^+$.

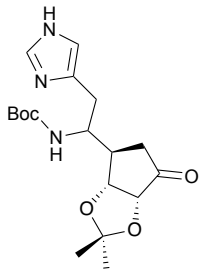
***tert*-butyl 2-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)piperidine-1-carboxylate (3o)**:



Following the general procedure for photoreductive β-aminoalkylation, compound **3o** was obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.25 g, 1.54 mmol), Boc-Pip-OH (1.07 g, 4.62 mmol), (Ir[dF(CF$_3$)ppy]$_2$(dtbpy))PF$_6$ (0.05 g, 0.05 mmol), and CsF (0.71 g, 4.62 mmol) in dry degassed DMSO (0.20 M, 7.70 mL) under blue LED irradiation afforded after column chromatography on silica (cyclohexane/EtOAc; 0-30%) the title compound as colorless resin (435 mg, 94%, d.r. 2.3:1). R$_f$ = 0.54 (petrol

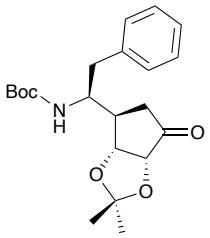
ether/EtOAc; 30%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.53 – 4.47 (m, 2H, H1'), 4.43 – 4.30 (m, 2H, H2'), 4.10 – 3.91 (m, 2H, -$CH_2CH_2C\underline{H}CH$-), 2.98 – 2.67 (m, 2H, H3'), 2.64 – 2.46 (m, 2H, H4', -NCHC$\underline{H_2}$-), 2.27 – 2.07 (m, 2H, H4'), 1.95 – 1.83 (m, 2H, -NC$\underline{H_2}C\underline{H_2}$-), 1.75 – 1.54 (m, 12H, -NC$\underline{H_2}C\underline{H_2}C\underline{H_2}CH_2$-), 1.46 (s, -$NHCO_2C(C\underline{H_3})_3$), 1.45 (s, 3H, C$\underline{H_3}$, acetonide), 1.43 (s, 3H, C$\underline{H_3}$, acetonide), 1.41 (s, -$NHCO_2C(C\underline{H_3})_3$), 1.35 (s, 3H, C$\underline{H_3}$, acetonide), 1.30 (s, 3H, C$\underline{H_3}$, acetonide). ^{13}C NMR (101 MHz, $CDCl_3$) δ 212.9 (1C, $\underline{C}$O), 212.3 (1C, $\underline{C}$O), 154.8 (1C, -N$\underline{C}O_2$-), 112.7 (1C, -$O_2\underline{C}(CH_3)_3$), 112.1 (1C, -$O_2\underline{C}(CH_3)_3$), 80.5 (1C, C1), 80.1 (1C, C2), 79.0 (1C, C1), 78.6 (1C, C2), 51.9 (2C, -N$\underline{C}$H-), 39.0 (2C, C4), 37.7 (2C, C3), 28.4 (3C, -$CO_2C(\underline{C}H_3)_3$), 28.2 (-$CO_2C(\underline{C}H_3)_3$), 27.0 (1C, $\underline{C}H_3$, acetonide), 26.8 (1C, $\underline{C}H_3$, acetonide), 26.3 (1C, -N$\underline{C}H_2CH_2$-), 26.1 (1C, -N$\underline{C}H_2CH_2$-), 25.1 (1C, $\underline{C}H_3$, acetonide), 24.9 (1C, $\underline{C}H_3$, acetonide), 24.7 (2C, -$NCH_2\underline{C}H_2$-), 18.9 (2C, -$NCH_2CH_2\underline{C}H_2\underline{C}H_2$-), 18.6 (2C, -$NCH_2CH_2\underline{C}H_2\underline{C}H_2$-). HRMS calc.: 339.20; found: 378.1890 $[M+Na]^+$.

***tert*-butyl (1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)-2-(1*H*-imidazol-4-yl)ethyl)carbamate (3p)**:

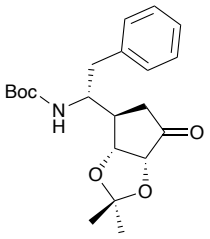


Following the general procedure for photoreductive β-aminoalkylation, compound **3p** was obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.10 g, 0.62 mmol), Boc-His-OH (0.50 g, 1.85 mmol), (Ir[dF(CF_3)ppy]$_2$(dtbpy))PF_6 (0.02 g, 0.02 mmol), and CsF (0.28 g, 1.85 mmol) in dry degassed DMSO (0.20 M, 3.10 mL) under blue LED irradiation afforded after column chromatography on silica (CH_2Cl_2, MeOH; 0-10%) the title compound as yellowish solid (165 mg, 73%, d.r. 1.3:1). R_f = 0.16 (CH_2Cl_2, MeOH; 10%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (s, 1H, H2 imidazole), 7.73 (s, 1H, H2 imidazole), 6.88 (s, 1H, H5 imidazole), 6.86 (s, 1H, H5 imidazole), 4.80 (d, J = 5.6 Hz, 1H, H1'), 4.70 (d, J = 5.2 Hz, 1H, H1'), 4.38 (d, J = 5.3 Hz, 1H, H2'), 4.25 (d, J = 4.1 Hz, 1H, H2'), 4.05 – 3.86 (m, 2H, -NHC$\underline{H}$-), 3.05 – 2.88 (m, 2H, -NHCHC$\underline{H_2}$-), 2.76 – 2.63 (m, 2H, -NHCHC$\underline{H_2}$-), 2.61 – 2.46 (m, 3H, H3', H4'), 2.10 – 1.96 (m, 3H, H4'), 1.50 (s, 3H, C$\underline{H_3}$, acetonide), 1.47 (s, 3H, C$\underline{H_3}$, acetonide), 1.42 (s, 9H, $NHCO_2C(C\underline{H_3})_3$), 1.41 (s, 9H, $NHCO_2C(C\underline{H_3})_3$), 1.36 (s, 6H, C$\underline{H_3}$, acetonide). ^{13}C NMR (101 MHz, $CDCl_3$) δ 214.7 (2C, CO), 155.4 (1C, -N$\underline{C}O_2$-), 155.3 (1C, -N$\underline{C}O_2$-), 135.4 (2C, -$CH_2\underline{C}$-), 134.8 (2C, C2 imidazole), 112.2 (1C, C5 imidazole), 111.9 (1C, C5 imidazole), 81.4 (2C, C1'), 79.9 (1C, C2'), 79.8 (1C, C2'), 51.6 (2C, -NH$\underline{C}HCH_2$-), 42.5 (2C, C3'), 38.5 (2C, C4'), 28.3 (2C, -NHCH$\underline{C}H_2$-), 28.3 (3C, -$CO_2C(\underline{C}H_3)_3$), 28.3 (3C, -$CO_2C(\underline{C}H_3)_3$), 26.5 (1C, $\underline{C}H_3$, acetonide), 26.3 (1C, $\underline{C}H_3$, acetonide), 24.5 (1C, $\underline{C}H_3$, acetonide), 24.4 (1C, $\underline{C}H_3$, acetonide). APCI calc.: 365.2; found: 366.0 $[M+H]^+$.

tert-butyl ((S)-1-((3aR,4R,6aR)-2,2-dimethyl-6-oxotetrahydro-4H-cyclopenta[d][1,3]dioxol-4-yl)-2-phenylethyl)carbamate (3q, structure assumed) & tert-butyl ((R)-1-((3aR,4R,6aR)-2,2-dimethyl-6-oxotetrahydro-4H-cyclopenta[d][1,3]dioxol-4-yl)-2-phenylethyl)carbamate **(3r structure assumed)**:

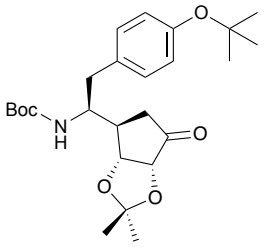


Following the general procedure for photoreductive β-aminoalkylation, compound **3q** and **3r** was obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.25 g, 1.54 mmol), Boc-Phe-OH (1.24 g, 4.62 mmol), (Ir[dF(CF_3)ppy]$_2$(dtbpy))PF_6 (0.05 g, 0.05 mmol), and CsF (0.71 g, 4.62 mmol) in dry degassed DMSO (0.20 M, 7.70 mL) under blue LED irradiation afforded after column chromatography on silica (petrol ether/EtOAc; 0-30%) the title compounds (547 mg, 95%, d.r. 1.1:1). **3q** as white solid (289 mg) and **3r** as yellow solid (257 mg). R_f = 0.29 (petrol ether/EtOAc; 30%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 7.35 – 7.26 (m, 2H, *m*-Ar), 7.28 – 7.19 (m, 1H, *p*-Ar), 7.19 – 7.13 (m, 2H, *o*-Ar), 4.81 (d, *J* = 5.0 Hz, 1H, H1'), 4.26 – 4.18 (m, 1H, -NHC*H*CH_2-), 4.18 – 4.08 (m, 2H, NH, H2'), 2.76 (t, *J* = 7.6 Hz, 2H, -PhC*H*$_2$CH-), 2.68 (dd, *J* = 18.5, 9.0 Hz, 1H, H4'), 2.50 – 2.44 (m, 1H, H3'), 2.24 – 2.10 (m, 1H, H4'), 1.40 (s, 3H, C*H*$_3$, acetonide), 1.35 (s, 9H, -$NHCO_2C(CH_3)_3$), 1.32 (s, 3H, C*H*$_3$, acetonide). ^{13}C-NMR (101 MHz, $CDCl_3$) δ 213.1 (1C, *C*O), 155.5 (1C, O*C*ONH-), 129.0 (2C, *o*-Ar), 128.7 (2C, *m*-Ar), 126.9 (1C, *p*-Ar), 111.3 (1C, -$O_2C(CH_3)_2$), 81.7 (1C, C1), 80.2 (1C, -O*C*$(CH_3)_3$), 78.1 (1C, C2), 53.3 (1C, -HN*C*HCH_2Ph-), 41.2 (1C, C3), 40.2 (1C, -CH*C*H_2Ph-), 35.0 (1C, C4), 28.1 (3C, -O(*C*$H_3)_3$), 26.7 (1C, *C*H_3, acetonide), 24.6 (1C, *C*H_3, acetonide).). HRMS calc.: 375.20; found: 398.1948 $[M+Na]^+$.

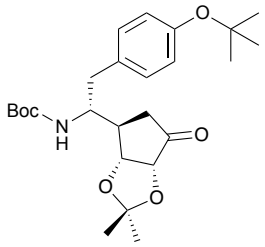


R_f = 0.24 (petrol ether/EtOAc; 30%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 7.29 – 7.18 (m, 2H, *m*-Ar), 7.23 – 7.13 (m, 1H, *p*-Ar), 7.14 – 7.06 (m, 1H, *o*-Ar), 4.62 (d, *J* = 5.9 Hz, 1H, H1'), 4.32 – 4.23 (m, 1H, H2'), 3.88 – 3.76 (m, 1H, -NHC*H*CH_2-), 2.89 (dd, *J* = 14.2, 5.5 Hz, 1H, -PhC*H*$_2$CH-), 2.74 – 2.63 (m, 2H, PhC*H*$_2$CH-, H4'), 2.37 – 2.20 (m, 2H, H3', H4'), 1.35 (s, 3H, C*H*$_3$, acetonide), 1.28 (s, 9H, -$NHCO_2C(CH_3)_3$), 1.27 (s, 3H, C*H*$_3$, acetonide). ^{13}C-NMR (101 MHz, $CDCl_3$) δ 212.1, (1C, *C*O), 155.7 (1C, -O*C*ONH-), 136.6 (1C, -$OCH_2C(CH)_2$-), 129.2 (2C, *o*-Ar), 128.6 (2C, *m*-Ar), 126.8 (2C, *p*-Ar), 112.1 (1C, -$O_2C(CH_3)_2$), 80.0 (1C, -O*C*$(CH_3)_3$), 78.6 (1C, C1), 78.5 (1C, C2), 53.4 (1C, -HN*C*HCH_2Ph-), 42.2 (1C, C3), 39.3 (2C, -CH*C*H_2Ph-, C4), 28.2 (3C, -O(*C*$H_3)_3$), 26.7 (1C, *C*H_3, acetonide), 24.7 (1C, *C*H_3, acetonide). HRMS calc.: 375.20; found: 398.1948 $[M+Na]^+$.

***tert*-butyl ((*S*)-2-(4-(*tert*-butoxy)phenyl)-1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)ethyl)carbamate (3s, structure assumed) & *tert*-butyl ((*R*)-2-(4-(*tert*-butoxy)phenyl)-1-((3a*R*,4*R*,6a*R*)-2,2-dimethyl-6-oxotetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)ethyl)carbamate (3t, structure assumed)**:



Following the general procedure for photoreductive β-aminoalkylation, compound **3s** and **3t** were obtained starting from (3a*R*,6a*R*)-2,2-dimethyl-3a,6a-dihydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-one (0.10 g, 0.62 mmol), Boc-Tyr(*t*Bu)-OH (0.63 g, 1.85 mmol), (Ir[dF(CF_3)ppy]$_2$(dtbpy))PF_6 (0.02 g, 0.02 mmol), and CsF (0.28 g, 1.85 mmol) in dry degassed DMSO (0.20 M, 3.10 mL) under blue LED irradiation afforded after column chromatography on silica (petrol ether/EtOAc; 0-30%) the title compound as yellowish resin (240 mg, 87%, d.r. 1.2:1). **3s** (129 mg) and **3t** (111 mg). R_f = 0.70 (petrol ether/EtOAc; 30%). ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.08 – 7.02 (m, 2H, *o*-Ar), 6.95 – 6.90 (m, 2H, *m*-Ar), 4.82 (d, J = 5.3 Hz, 1H, H1'), 4.23 – 4.09 (m, 3H, -N*H*CHCH$_2$-, H2', -NHC*H*CH$_2$-), 2.73 – 2.68 (m, 2H, -NHCHC*H*$_2$-), 2.67 – 2.63 (m, 1H, H4'), 2.52 – 2.46 (m, 1H, H3'), 2.22 – 2.13 (m, 1H, H4'), 1.40 (s, 3H, C*H*$_3$, acetonide), 1.35 (s, 9H, -OC(C*H*$_3$)$_3$), 1.33 – 1.32 (m, 12H, -NHCO$_2$C(C*H*$_3$)$_3$, C*H*$_3$, acetonide). ^{13}C-NMR (101 MHz, $CDCl_3$) δ 213.3 (1C, *C*O), 155.7 (1C, -NH*C*O$_2$-), 154.4 (1C, -O*C*(CH$_3$)$_3$), 131.7 (1C, -CH$_2$*C*-), 129.6 (2C, *o*-Ar), 124.5 (2C, *m*-Ar), 111.6 (1C, -O$_2$*C*(CH$_3$)$_2$), 81.9 (1C, -O*C*(CH$_3$)$_3$), 80.3 (1C, -NHCO$_2$*C*(CH$_3$)$_3$), 78.6 (1C, C1), 78.3 (1C, C2), 53.5 (1C, -NH*C*HCH$_2$-), 41.7 (1C, C3), 39.8 (1C, -NHCH*C*H$_2$-), 35.2 (1C, C4), 29.0 (3C, NHCO$_2$C(*C*H$_3$)$_3$), 28.4 (3C, -OC(*C*H$_3$)$_3$), 26.9 (1C, *C*H$_3$, acetonide), 24.8 (1C, *C*H$_3$, acetonide).). HRMS calc.: 447.26; found: 448.2546 $[M+H]^+$.

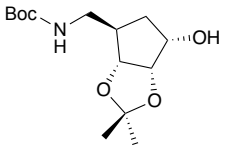


R_f = 0.58 (petrol ether/EtOAc; 30%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.09 – 7.03 (m, 2H, *o*-Ar), 6.96 – 6.90 (m, 2H, *m*-Ar), 4.69 (d, J = 5.7 Hz, 1H, H1'), 4.37 – 4.30 (m, 2H, -N*H*CHCH$_2$-, H2'), 3.93 – 3.79 (m, 1H, -NHC*H*CH$_2$-), 2.92 (dd, J = 14.3, 5.4 Hz, 1H, -NHCHC*H*$_2$-), 2.81 – 2.66 (m, 2H, -NHCHC*H*$_2$-, H3'), 2.46 – 2.27 (m, 2H, H4'), 1.42 (s, 3H, C*H*$_3$, acetonide), 1.36 (s, 9H, -OC(C*H*$_3$)$_3$), 1.34 (s, 3H, C*H*$_3$, acetonide), 1.33 (s, 9H, -NHCO$_2$C(C*H*$_3$)$_3$). ^{13}C NMR (101 MHz, $CDCl_3$) δ 212.3 (1C, *C*O), 155.9 (1C, -NH*C*O$_2$-), 154.4 (1C, -O*C*(CH$_3$)$_3$), 131.6 (1C, -CH$_2$*C*-), 129.8 (2C, *o*-Ar), 124.5 (2C, *m*-Ar), 124.4 (1C, -*C*OC(CH$_3$)$_3$), 112.3 (1C, -O$_2$*C*(CH$_3$)$_3$), 80.1 (1C, -O*C*(CH$_3$)$_3$), 78.8 (1C, C1), 78.7 (1C, C2), 78.6 (1C, -NHCO$_2$*C*(CH$_3$)$_3$), 53.6 (1C, -NH*C*HCH$_2$-), 42.5 (1C, C3), 39.4 (1C, C4), 38.8 (1C, -NHCH*C*H$_2$-), 29.0 (3C, NHCO$_2$C(*C*H$_3$)$_3$), 28.4 (3C, -OC(*C*H$_3$)$_3$)), 27.0 (1C, *C*H$_3$, acetonide), 24.9 (1C, *C*H$_3$, acetonide). HRMS calc.: 447.26; found: 448.2546 $[M+H]^+$.

Ketone reduction

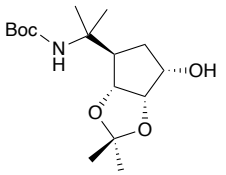
To an ice-bath cooled solution of compounds **3a**, **3b**, and **3n** (1.24 – 1.80 mmol, 1.00 eq.) in dry MeOH (6.20 – 9.00 mL, 0.20 M), $NaBH_4$ (1.86 – 2.70 mmol, 1.50 eq.) was added portion wise over 5 min. After complete addition, the reaction was stirred for 1 h at 0 °C. TLC (cyclohexane/EtOAc, 40%) was used to monitor the reaction progress. Cold water was added once the starting material was fully consumed. The aqueous phase was extracted with DCM (4x 25 mL). The combined organic layers were dried over sodium sulfate and concentrated under reduced pressure. The crude product was purified over silica gel chromatography to obtain the reduced products.

***tert*-butyl (((3a*R*,4*R*,6*S*,6a*S*)-6-hydroxy-2,2-dimethyltetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)methyl)carbamate (4a)**:



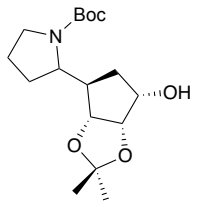
Gradient (cyclohexane/EtOAc; 0-50%) afforded the target molecule as colorless solid (464 mg, 90%). R_f = 0.32 (petrol ether/EtOAc; 50%). ^{1}H-NMR (400 MHz, Chloroform-*d*) δ 4.63 – 4.55 (m, 1H, -N*H*CH_2-), 4.51 (t, *J* = 5.7 Hz, 1H, H2'), 4.40 (dd, *J* = 6.2, 1.7 Hz, 1H, H3'), 4.11 – 4.05 (m, 1H, H1'), 3.10 – 2.97 (m, 2H, -NHC*H*$_2$-), 2.42 (d, *J* = 7.3 Hz, 1H, -CHO*H*), 2.23 – 2.13 (m, 1H, H4'), 1.89 (dt, *J* = 13.3, 7.4 Hz, 1H, H5'), 1.69 (dt, *J* = 13.2, 5.2 Hz, 1H, H5'), 1.50 (s, 3H, C*H*$_3$, acetonide), 1.44 (s, 9H, -NHCO$_2$C(C*H*$_3$)$_3$), 1.34 (s, 3H, C*H*$_3$, acetonide). ^{13}C-NMR (101 MHz, $CDCl_3$) δ 156.2 (1C, -NH*C*O$_2$-), 112.2 (1C, -O$_2$*C*(CH$_3$)$_2$), 82.9 (1C, C2), 79.7 (1C, -NHCO$_2$*C*(CH$_3$)$_3$), 79.5 (1C, C3), 71.1 (1C, C1), 43.0 (1C, -NHC*H*$_2$-), 42.4 (1C, C4), 35.4 (1C, C5), 28.5 (3C, -CO$_2$C(*C*H$_3$)$_3$), 26.3 (1C, *C*H$_3$, acetonide), 24.5 (1C, *C*H$_3$, acetonide). HRMS calc.: 287.17; found: 310.1846 $[M+Na]^+$.

***tert*-butyl (2-((3a*R*,4*R*,6*S*,6a*S*)-6-hydroxy-2,2-dimethyltetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)propan-2-yl)carbamate (4b)**:



Gradient (cyclohexane/EtOAc; 0-40%) afforded the desired compound as colorless oil (500 mg, 84%). R_f = 0.25 (petrol ether/EtOAc; 40%). ^{1}H NMR (400 MHz, Chloroform-*d*) δ 4.61 – 4.57 (m, 1H, -N*H*CH-), 4.56 (s, 1H, H3'), 4.47 (dd, *J* = 7.3, 5.0 Hz, 1H, H2'), 4.08 (br q, *J* = 4.2 Hz, 1H, H1'), 2.60 (s, 1H, H4'), 2.52 – 2.43 (m, 1H, -CHO*H*), 2.02 (ddd, *J* = 13.7, 7.2, 2.9 Hz, 1H, H5'), 1.71 – 1.56 (m, 1H, H5'), 1.53 (s, 3H, C*H*$_3$, acetonide), 1.43 (s, 9H, -NHCO$_2$C(C*H*$_3$)$_3$), 1.36 (s, 3H, C*H*$_3$, acetonide), 1.34 (s, 3H, -NHC(C*H*$_3$)$_2$-), 1.29 (s, 3H, -NHC(C*H*$_3$)$_2$-). ^{13}C NMR (101 MHz, $CDCl_3$) δ 114.0 (1C, -O$_2$*C*(CH$_3$)$_2$), 81.3 (1C, C3), 80.8 (1C, C2), 69.9 (1C, C1), 53.3 (1C, -NH*C*(CH$_3$)$_2$-), 53.1 (1C, C4), 34.8 (1C, C5), 28.6 (3C, -CO$_2$C(*C*H$_3$)$_3$), 26.6 (1C, *C*H$_3$, acetonide), 26.0 (1C, -NHC(*C*H$_3$)$_2$-), 25.0 (1C, *C*H$_3$, acetonide), 24.8 (1C, -NHC(*C*H$_3$)$_2$-). HRMS calc.: 315.20; found: 338.1937 $[M+Na]^+$.

***tert*-butyl 2-((3a*R*,4*R*,6*S*,6a*S*)-6-hydroxy-2,2-dimethyltetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)pyrrolidine-1-carboxylate (4c)**:

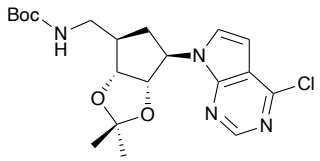


Gradient (cyclohexane/EtOAc; 0-40%) afforded the desired compound as colorless resin (diastereomeric mixture, 320 mg, 79%). Rf = 0.15 (petrol ether/EtOAc; 30%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.66 – 4.30 (m, 4H, H2', H3'), 4.21 – 4.03 (m, 2H, H1'), 3.86 – 3.59 (m, 2H, -NC*H*-), 3.58 – 3.28 (m, 3H, -NC*H*$_2$CH$_2$CH$_2$-), 3.25 (ddd, *J* = 11.7, 8.0, 3.7 Hz, 1H, -NC*H*$_2$CH$_2$CH$_2$-), 2.41 (s, 2H, -O*H*), 2.20 – 2.09 (m, 1H, H4'), 2.03 – 1.60 (m, 13H, H4', H5', -NCH$_2$C*H*$_2$C*H*$_2$-), 1.49 (s, 3H, C*H*$_3$, acetonide), 1.49 – 1.42 (m, 21H, -NCO$_2$C(C*H*$_3$)$_3$, C*H*$_3$, acetonide), 1.34 (s, 3H, C*H*$_3$, acetonide), 1.32 (s, 3H, C*H*$_3$, acetonide). ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.0 (1C, -NH*C*O$_2$-), 155.6 (1C, -NH*C*O$_2$-), 112.4 (1C, -O$_2$*C*(CH$_3$)$_2$), 111.0 (1C, -O$_2$*C*(CH$_3$)$_2$), 84.1 (1C, C2), 83.1 (1C, -NHCO$_2$*C*(CH$_3$)$_3$), 82.3 (1C, C3), 82.0 (1C, -NHCO$_2$*C*(CH$_3$)$_3$), 80.2 (1C, C2), 79.3 (1C, C3), 70.9 (2C, C1), 58.7 (1C, -N*C*H-), 58.3 (1C, -N*C*H-), 48.0 (1C, C4), 46.9 (1C, C4), 46.5 (1C, -N*C*H$_2$CH$_2$CH$_2$-), 46.3 (1C, -N*C*H$_2$CH$_2$CH$_2$-) 35.4 (2C, C5), 30.2 (1C, -NCH$_2$*C*H$_2$CH$_2$-), 29.9 (1C, -NCH$_2$*C*H$_2$CH$_2$-), 28.6 (3C, -NCO$_2$C(*C*H$_3$)$_3$), 28.5 (3C, -NCO$_2$C(*C*H$_3$)$_3$), 26.4 (1C, *C*H$_3$, acetonide), 26.2 (1C, *C*H$_3$, acetonide), 24.6 (1C, *C*H$_3$, acetonide), 23.6 (1C, -NCH$_2$CH$_2$*C*H$_2$-), 23.4 (1C, -NCH$_2$CH$_2$*C*H$_2$-). HRMS calc.: 327.20; found: 350.1852 $[M+Na]^+$.

Mitsunobu-type glycosylation

A heat-dried three-necked round bottom flash equipped with an air condenser, thermometer, and stirring bar was charged with 6-chlorodeazapurine (0.62 – 1.29 mmol, 1.00 eq.), PPh_3 (1.24 – 2.58 mmol, 2.00 eq.), and compound **4a-4c** (0.93 – 1.93 mmol, 1.50 eq.). Then, dry toluene (0.25 M, 3.10 –5.20 mL) was added, and the resulted solution was cooled down to 0 °C. A solution of DBAD (1.24 – 2.58 mmol, 2.00 eq.) in dry toluene (1.10 M, 1.10 –2.30 mL) was added dropwise. After complete addition, the reaction mixture was stirred for 10 min at 0 °C before the reaction was stirred at 60 °C for 17 h. The reaction progress was monitored by TLC. Then, the reaction solution was concentrated to complete dryness and the obtained residue was purified by flash chromatography.

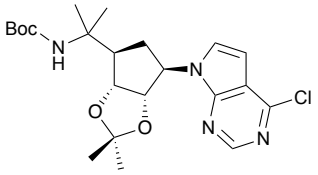
***tert*-butyl (((3a*R*,4*R*,6*R*,6a*S*)-6-(4-chloro-7*H*-pyrrolo[2,3-*d*]pyrimidin-7-yl)-2,2-dimethyltetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)methyl)carbamate (5a)**:



The crude product was first purified by flash chromatography using gradient (cyclohexane/EtOAc; 0-40%). The obtained residue contained an azo-dicarboxylate byproduct which was separated by flash chromatography using gradient (CH_2Cl_2/MeOH; 0-2%). This purification afforded the pure product as white foam (245 mg, 45%). R_f = 0.30 (petrol ether/EtOAc; 40%). ^{1}H NMR (400 MHz, DMSO) δ 8.65 (s, 1H, H2), 7.97 (d, *J* = 3.7 Hz, 1H, H6), 7.01 (t, *J* = 5.9 Hz, 1H, -N*H*CH$_2$-), 6.73 (d, *J* = 3.7 Hz, 1H, H5), 5.06 (dt, *J* = 12.7, 6.5 Hz, 1H, H1'), 4.93 (dd, *J* = 7.4, 6.2 Hz, 1H, H2'), 4.51 (dd, *J* = 7.4, 4.8 Hz, 1H, H3'), 3.20 – 3.00 (m, 2H, -NHC*H*$_2$-), 2.32 – 2.19 (m, 2H, H4', H5'), 2.12 – 2.01 (m, 1H, H5'), 1.47 (s, 3H, C*H*$_3$, acetonide), 1.37 (s, 9H, -NHCO$_2$C(C*H*$_3$)$_3$), 1.20 (s, 3H,

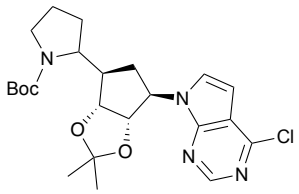
C*H*$_3$, acetonide). ^{13}C NMR (101 MHz, DMSO) δ 155.9 (1C, -NH*C*O$_2$-), 150.9 (1C, -N*C*N-), 150.6 (1C, -*C*Cl), 150.3 (1C, C2), 129.4 (1C, C6), 117.0 (1C, -CH*C*CCl-), 112.7 (1C, -O$_2$*C*(CH$_3$)$_2$), 99.2 (1C, C5), 83.5 (1C, C2'), 81.4 (1C, C3'), 77.7 (1C, -NHCO$_2$*C*(CH$_3$)$_3$), 60.4 (1C, C1'), 43.6 (1C, C4'), 42.2 (1C, -NH*C*H$_2$-), 35.1 (1C, C5'), 28.2 (3C, -CO$_2$C(*C*H$_3$)$_3$), 27.4 (1C, *C*H$_3$, acetonide), 25.1 (1C, *C*H$_3$, acetonide). APCI calc.: 422.17; found: 422.9/424.9 [M+H]$^+$.

***tert*-butyl (2-((3a*R*,4*R*,6*R*,6a*S*)-6-(4-chloro-7*H*-pyrrolo[2,3-*d*]pyrimidin-7-yl)-2,2-dimethyltetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)propan-2-yl)carbamate (5b)**:



The crude product was purified over silica gel chromatography using the elution system (petrol ether/THF; 0-30%) which afforded the title compound as white foam (150 mg, 0.33 mmol). The eluted product contained still some azo-dicarboxylate by-product which was separated in the next step. R_f = 0.57 (petrol ether/THF; 30%). ^{1}H NMR (400 MHz, DMSO) *δ* 8.63 (s, 1H, H2), 7.99 (d, *J* = 3.7 Hz, 1H, H6), 6.72 (d, *J* = 3.7 Hz, 1H, H5), 5.02 (dt, *J* = 12.0, 6.8 Hz, 1H, H1'), 4.95 – 4.87 (m, 1H, H2'), 4.63 (dd, *J* = 7.6, 5.7 Hz, 1H, H3'), 2.74 – 2.64 (m, 1H, H4'), 2.26 – 2.07 (m, 2H, H5'), 1.46 (s, 3H, C*H*$_3$, acetonide), 1.39 – 1.35 (m, 9H, -NHCO$_2$C(C*H*$_3$)$_3$), 1.27 (s, 3H, -NHC(C*H*$_3$)$_2$-), 1.26 (s, 3H, -NHC(C*H*$_3$)$_2$-), 1.21 (s, 3H, C*H*$_3$, acetonide). ^{13}C NMR (101 MHz, DMSO) *δ* 155.6 (1C, -NH*C*O$_2$-), 150.8 (1C, -N*C*N-), 150.6 (1C, -*C*Cl), 150.2 (1C, C2), 129.6 (1C, C6), 117.1 (1C, -CH*C*CCl-), 112.7 (1C, -O$_2$*C*(CH$_3$)$_2$), 99.1 (1C, C5), 83.2 (1C, C2'), 79.2 (1C, C3'), 78.9 (1C, -NHCO$_2$*C*(CH$_3$)$_3$), 60.6 (1C, C1'), 52.4 (1C, -NH*C*(CH$_3$)$_2$-), 50.7 (1C, C4'), 32.8 (1C, C5'), 28.3 (3C, -CO$_2$C(*C*H$_3$)$_3$), 27.5 (1C, *C*H$_3$, acetonide), 25.2 (1C, *C*H$_3$, acetonide), 25.0 (1C, -NHC(*C*H$_3$)$_2$-), 24.7 (1C, -NHC(*C*H$_3$)$_2$-). APCI calc.: 450.20; found: 451.20/453.20 [M+H]$^+$.

***tert*-butyl 2-((3a*R*,4*R*,6*R*,6a*S*)-6-(4-chloro-7*H*-pyrrolo[2,3-*d*]pyrimidin-7-yl)-2,2-dimethyltetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)pyrrolidine-1-carboxylate (5c)**:



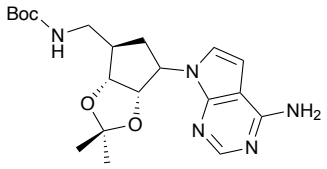
Gradient (petrol ether/THF; 0-30%) afforded the desired compound as white foam (diastereomeric mix, 182 mg, 64%, d.r. 1.5:1). R_f = 0.24 (petrol ether/THF; 30%). ^{1}H NMR (400 MHz, DMSO-*d*6) δ 8.65 (s, 2H, H2), 8.03 (d, *J* = 3.7 Hz, 1H, H6), 7.96 (bs, 1H, H6), 6.74 (d, *J* = 3.6 Hz, 2H, H5), 5.10 – 4.90 (m, 3H, H1', H2'), 4.89 – 4.66 (m, 1H, H3'), 4.60 – 4.52 (m, 1H, H3'), 4.47 – 4.16 (m, 1H, H2'), 4.06 – 3.96 (m, 1H, -NC*H*-), 3.96 – 3.89 (m, 1H, -NC*H*-), 3.41 – 3.12 (m, 4H, -NC*H*$_2$CH$_2$CH$_2$-), 2.47 – 2.05 (m, 6H, H4', H5'), 2.03 – 1.66 (m, 8H, -NCH$_2$C*H*$_2$C*H*$_2$-), 1.47 (s, 3H, C*H*$_3$, acetonide), 1.48 – 1.36 (m, 15H, -NCO$_2$C(C*H*$_3$)$_3$, C*H*$_3$, acetonide), 1.34 (s, 9H, -NCO$_2$C(C*H*$_3$)$_3$), 1.23 (s, 3H, C*H*$_3$, acetonide). ^{13}C NMR (101 MHz, DMSO) *δ* 154.2 (1C, -N*C*O$_2$-), 153.8 (1C, -N*C*O$_2$-), 150.8 (1C, -N*C*N-), 150.8 (1C, -N*C*N-), 150.6 (1C, -*C*Cl), 150.5 (1C, -*C*Cl), 150.2 (2C, C2), 129.7 (1C, C6), 129.5 (1C, C6), 117.1 (2C, (-CH*C*CCl-), 113.0 (2C, -O$_2$*C*(CH$_3$)$_2$), 99.1 (1C, C5), 99.1 (1C, C5), 83.3 (1C,

C2'), 81.0 (1C, C3'), 80.8 (1C, C3'), 80.5 (1C, C2'), 78.5 (1C, -$NCO_2\underline{C}(CH_3)_3$), 78.2 (1C, -$NHCO_2\underline{C}(CH_3)_3$), 60.3 (1C, C1'), 60.1 (1C, C1'), 58.9 (1C, -N$\underline{C}$H-), 58.0 (1C, -N$\underline{C}$H-), 47.8 (1C, C4'), 47.3 (1C, C4'), 46.1 (2C, -N$\underline{C}H_2CH_2CH_2$-), 35.6 (1C, C5'), 34.1 (1C, C5'), 28.1 (3C, -$NCO_2C(\underline{C}H_3)_3$), 28.1 (-$NCO_2C(\underline{C}H_3)_3$), 27.8 (1C, $\underline{C}H_3$, acetonide), 27.4 (1C, $\underline{C}H_3$, acetonide), 27.4 (1C, $\underline{C}H_3$, acetonide), 25.1 (1C, $\underline{C}H_3$, acetonide), 23.2 (2C, -$NCH_2\underline{C}H_2CH_2$-), 22.4 (2C, -$NCH_2\underline{C}H_2CH_2$-). APCI calc.: 462.20; found: 463.00/465.00 $[M+H]^+$.

Aromatic substitution with ammonia

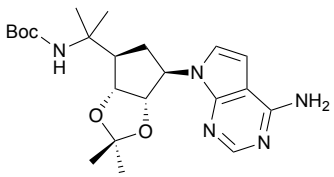
In a sealed pressure flask compounds **5a**, **5b**, and **5c** (0.33 – 0.49 mmol, 1.00 eq) was suspendend in mixture of 1,4 dioxane and aqueous ammonia (1:2, 0.10 M, 3.30 –4.90 mL). The reaction mixture was heated to 100 °C and stirred for 17 h. The reaction mixture was allowed to coole down to rt and concentrated to complete dryness. The crude product was purified over silica gel chromatography to obtain the target compounds.

***tert*-butyl (((3a*R*,4*R*,6a*S*)-6-(4-amino-7*H*-pyrrolo[2,3-*d*]pyrimidin-7-yl)-2,2-dimethyltetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)methyl)carbamate (6a)**:



Gradient (CH_2Cl_2/MeOH; 0-10%) afforded the target molecule as colorless foam (145 mg, 73%). R_f = 0.53 (CH_2Cl_2/MeOH; 10%). ^{1}H NMR (400 MHz, DMSO) δ 8.04 (s, 1H, H2), 7.30 (d, J = 3.5 Hz, 1H, H6), 6.99 – 6.92 (m, 3H, -CN$\underline{H}_2$, -N$\underline{H}CH_2$-), 6.56 (d, J = 3.5 Hz, 1H, H5), 4.92 – 4.84 (m, 2H, H1', H2'), 4.47 (dd, J = 6.5, 4.7 Hz, 1H, H3'), 3.19 – 2.98 (m, 2H, -NHC$\underline{H}_2$-), 2.27 – 2.11 (m, 2H, H4', H5'), 2.06 – 1.88 (m, 1H, H4'), 1.45 (s, 3H, C$\underline{H}_3$, acetonide), 1.37 (s, 9H, -$NHCO_2C(C\underline{H}_3)_3$), 1.20 (s, 3H, C$\underline{H}_3$, acetonide). ^{13}C NMR (101 MHz, DMSO) δ 157.5 (1C, -$\underline{C}NH_2$), 155.8 (1C, -NH$\underline{C}O_2$-), 151.5 (1C, -N$\underline{C}$HN-), 149.6 (1C, -N$\underline{C}$N-), 122.1 (1C, C6), 112.4 (1C, -$\underline{C}CNH_2$-), 102.7 (1C, -$O_2\underline{C}(CH_3)_2$), 99.0 (1C, C5), 83.5 (1C, C2'), 81.4 (1C, C3'), 77.6 (1C, $NHCO_2\underline{C}(CH_3)_3$), 59.7 (1C, C1'), 43.7 (1C, -NH$\underline{C}H_2$-), 42.3 (1C, C4'), 35.5 (1C, C5'), 28.2 (3C, -$NHCO_2C(\underline{C}H_3)_3$), 27.4 (1C, $\underline{C}H_3$, acetonide), 25.1 (1C, $\underline{C}H_3$, acetonide). APCI calc.: 403.22; found: 403.90 $[M+H]^+$.

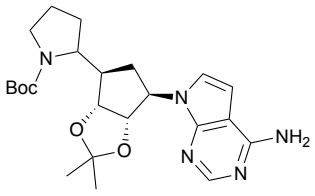
***tert*-butyl (2-((3a*R*,4*R*,6*R*,6a*S*)-6-(4-amino-7*H*-pyrrolo[2,3-*d*]pyrimidin-7-yl)-2,2-dimethyltetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)propan-2-yl)carbamate (6b)**:



Gradient (CH_2Cl_2/MeOH; 0-5%) afforded the target compound as colorless foam (100 mg, 77%). R_f = 0.64 (CH_2Cl_2/MeOH; 10%). ^{1}H NMR (400 MHz, DMSO) δ 8.04 (s, 1H, H2), 7.32 (d, J = 3.5 Hz, 1H, H6), 6.97 (s, 2H, -CN$\underline{H}_2$), 6.55 (d, J = 3.5 Hz, 1H, H5), 6.52 (bs, 1H, -N$\underline{H}C(CH_3)_2$-), 4.90 – 4.81 (m, 2H, H1', H2'), 4.62 (t, J = 6.3 Hz, 1H, H3'), 2.67 – 2.56 (m, 1H, H4'), 2.17 – 2.00 (m, 2H, H5'), 1.44 (s, 3H, C$\underline{H}_3$, acetonide), 1.37 (s, 9H, -$NHCO_2C(C\underline{H}_3)_3$), 1.28 – 1.23 (m, 6H, -$NC(C\underline{H}_3)_2$-), 1.21 (s, 3H, C$\underline{H}_3$, acetonide). ^{13}C NMR (101 MHz, DMSO) δ 157.5 (1C, -$\underline{C}NH_2$), 154.4 (1C, -NH$\underline{C}O_2$-), 151.5 (1C, -N$\underline{C}$HN-), 149.6 (1C, -N$\underline{C}$N-), 122.3 (1C, -CH$\underline{C}$HN-), 112.3 (1C, -$O_2\underline{C}(CH_3)_2$), 102.8 (1C, -$\underline{C}CNH_2$-), 98.9 (1C, -$\underline{C}$HCHN-), 83.4 (1C, C2'), 79.3 (1C, C3'), 59.8 (1C, C1'), 52.5 (1C, -N$\underline{C}(CH_3)_2$-), 51.1 (1C, C4'), 33.2 (1C, C5'), 28.3 (1C, $\underline{C}H_3$, acetonide), 27.5 (3C, -$CO_2C(\underline{C}H_3)_3$), 25.2

(1C, <u>C</u>H$_3$, acetonide), 25.0 (1C, -NHC(<u>C</u>H$_3$)$_2$-), 24.8 (1C, -NHC(<u>C</u>H$_3$)$_2$-). APCI calc.: 431.25; found: 431.90 $[M+H]^+$.

***tert*-butyl 2-((3a*R*,4*R*,6*R*,6a*S*)-6-(4-amino-7*H*-pyrrolo[2,3-*d*]pyrimidin-7-yl)-2,2-dimethyltetrahydro-4*H*-cyclopenta[*d*][1,3]dioxol-4-yl)pyrrolidine-1-carboxylate (6c)**:

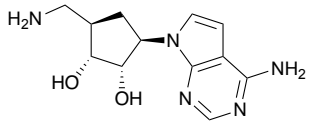


Gradient (CH_2Cl_2/MeOH; 0-10%) afforded the desired product as white foam (101 mg, 67%, diastereomeric mixture; d.r. 1.5:1). R_f = 0.68 (CH_2Cl_2/MeOH; 10%). ^{1}H NMR (400 MHz, DMSO) δ 8.04 (s, 2H, H2), 7.34 (d, J = 3.5 Hz, 1H, H6), 7.31 – 7.25 (m, 1H, H6), 6.98 (bs, 2H, 2H, -CN<u>*H*$_2$</u>), 6.57 – 6.54 (m, 2H, H5), 4.96 – 4.75 (m, 4H, H1', H2'), 4.55 – 4.47 (m, 2H, H3'), 4.01 – 3.93 (m, 1H, -CH$_2$CH$_2$C<u>*H*</u>CH-), 3.93 – 3.85 (m, 1H, -CH$_2$CH$_2$C<u>*H*</u>CH-), 3.50 – 3.37 (m, 1H, -NC<u>*H*$_2$</u>CH$_2$CH$_2$-), 3.26 – 3.11 (m, 1H, -NC<u>*H*$_2$</u>CH$_2$CH$_2$-), 2.40 – 2.26 (m, 2H, H4', H5'), 2.25 – 2.14 (m, 2H, H4', H5'), 2.12 – 2.00 (m, 2H, H5'), 1.95 – 1.71 (m, 8H, -NCH$_2$C<u>*H*$_2$</u>C<u>*H*$_2$</u>-), 1.44 (s, 6H, C<u>*H*$_3$</u>, acetonide), 1.42 (s, 9H, -NHCO$_2$C(C<u>*H*$_3$</u>)$_3$), 1.33 (s, 9H, -NHCO$_2$C(C<u>*H*$_3$</u>)$_3$), 1.21 (s, 6H, C<u>*H*$_3$</u>, acetonide). ^{13}C NMR (101 MHz, DMSO) δ 157.5 (1C, -<u>C</u>NH$_2$), 154.0 (1C, -N<u>C</u>O$_2$-), 151.5 (1C, -N<u>C</u>HN-), 149.6 (1C, -N<u>C</u>N-), 149.6 (1C, -N<u>C</u>N-), 122.3 (1C, -CH<u>C</u>HN-), 112.7 (1C, -O$_2$<u>C</u>(CH$_3$)$_2$), 102.7 (1C, -<u>C</u>CNH$_2$-), 99.0 (1C, -<u>C</u>HCHN-), 83.4 (2C, C2'), 81.0 (2C, C3'), 78.5 (2C, NHCO$_2$<u>C</u>(CH$_3$)$_3$), 59.7 (2C, C1'), 59.0 (1C, -N<u>C</u>H-), 58.0 (1C, -N<u>C</u>H-), 47.8 (1C, C4'), 47.6 (1C, C4'), 46.1 (2C, N<u>C</u>H$_2$CH$_2$CH$_2$-), 36.3 (1C, C5'), 36.0 (1C, C5'), 29.0 (2C, -NCH$_2$<u>C</u>H$_2$CH$_2$-), 28.1 (3C, -NCO$_2$C(<u>C</u>H$_3$)$_3$), 28.1 (3C, -NCO$_2$C(<u>C</u>H$_3$)$_3$), 27.5 (1C, <u>C</u>H$_3$, acetonide), 27.4 (1C, <u>C</u>H$_3$, acetonide), 23.2 (2C, -NCH$_2$CH$_2$<u>C</u>H$_2$-). APCI calc.: 443.25; found: 444.30 $[M+H]^+$.

Deprotection

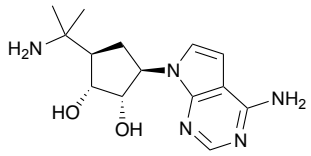
The protected nucleosides **6a**, **6b**, and **6c** (0.18 – 0.32 mmol, 1.00 eq) were suspended in a mixture of TFA and water (4:1, 0.05 M, 3.60 –6.40 mL). The solution was stirred for 3 h at ambient temperature. The reaction mixture was concentrated under reduced pressure and the obtained residue was purified by preparative HPLC (water/MeCN; 0.05% TFA) to obtain the desired nucleosides **7a**, **7b**, **7c**, and **7d** as TFA salts.

(1*R*,2*S*,3*R*,5*R*)-3-(4-amino-7*H*-pyrrolo[2,3-*d*]pyrimidin-7-yl)-5-(aminomethyl)cyclopentane-1,2-diol (7a):



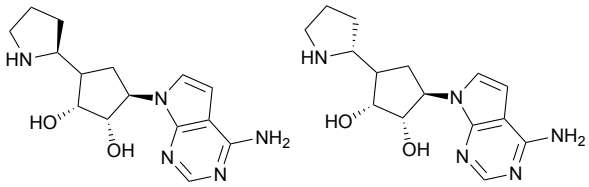
Purification by preparative HPLC using method C (water/MeCN; 0.05% TFA) afforded the desired compound as white foam (97.3 mg, 81%, TFA salt). R_t = 2.912 min. ^{1}H NMR (400 MHz, DMSO) δ 8.38 (s, 1H, H2), 7.88 (bs, 3H, -NH$_3^+$), 7.66 (d, J = 3.5 Hz, 1H, H6), 6.96 (d, J = 3.5 Hz, 1H, H5), 4.95 (dt, J = 10.6, 7.9 Hz, 1H, H1'), 4.18 (dd, J = 7.9, 5.8 Hz, 1H, H2'), 3.87 (t, J = 5.3 Hz, 1H, H3'), 3.13 – 2.84 (m, 2H, -NH$_3^+$C<u>*H*$_2$</u>-), 2.35 – 2.25 (m, 1H, H5'), 2.24 – 2.14 (m, 1H, H4'), 1.57 (dt, J = 12.7, 9.9 Hz, 1H, H5'). ^{13}C NMR (101 MHz, DMSO) δ 158.3 (1C, -<u>C</u>NH$_2$), 151.1 (1C, -N<u>C</u>HN-), 147.1 (1C, -N<u>C</u>N-), 125.5 (1C, -CH<u>C</u>HN-), 101.9 (1C, -<u>C</u>HCHN-), 101.5 (1C, -CNH$_2$<u>C</u>-), 74.9 (1C, C2'), 72.2 (1C, C3'), 59.4 (1C, C1'), 41.9 (1C, -NH$_3^+$<u>C</u>H$_2$-), 41.3 (1C, C4'), 31.0 (1C, C5'). APCI calc.: 264.14; found: 264.4 $[M+H]^+$. Using method A: UV-purity at 210 nm 97.7%.

(1*R*,2*S*,3*R*,5*R*)-3-(4-amino-7*H*-pyrrolo[2,3-*d*]pyrimidin-7-yl)-5-(2-aminopropan-2-yl)cyclopentane-1,2-diol (7b):



Purification over preparative HPLC with method C (water/MeCN; 0.05% TFA) afforded the target molecule as white foam (71.6 mg, 97%, TFA salt). R_t = 6.946 min. ^{1}H NMR (400 MHz, DMSO) δ 9.33 – 8.78 (m, 3H, -NH_3^+), 8.40 (s, 1H, H2), 7.93 (s, 2H, -CN$\underline{H_2}$), 7.71 (d, J = 3.7 Hz, 1H, H6), 6.97 (d, J = 3.6 Hz, 1H, H5), 4.89 (ddd, J = 11.4, 8.9, 6.9 Hz, 1H, H1'), 4.10 (dd, J = 9.1, 6.4 Hz, 1H, H2'), 3.99 (dd, J = 6.5, 4.3 Hz, 1H, H3'), 2.21 – 2.13 (m, 1H, H5'), 2.11 – 2.01 (m, 1H, H5'), 1.79 – 1.68 (m, 1H, H4'), 1.31 (s, 3H, -NC(C$\underline{H_3}$)$_2$-), 1.26 (s, 3H, -NC(C$\underline{H_3}$)$_2$-). ^{13}C NMR (101 MHz, DMSO) δ 151.1 (1C, -$\underline{C}NH_2$), 147.2 (1C, -N$\underline{C}$HN-), 142.2 (1C, -N$\underline{C}$N-), 125.6 (1C, -CH$\underline{C}$HN-), 101.9 (1C, -$\underline{C}$HCHN-), 101.6 (1C, -CNH$_2\underline{C}$-), 74.8 (1C, C2'), 68.9 (1C, C3'), 59.2 (1C, C1'), 54.8 (1C, -$NH_3^+\underline{C}(CH_3)_2$-), 51.6 (1C, C4'), 27.9 (1C, C5'), 23.5 (1C, -NH_3^+C($\underline{C}H_3$)$_2$-), 23.2 (1C, -NH_3^+C($\underline{C}H_3$)$_2$-). Using method B: UV-purity at 210 nm: 98.9%. APCI calc.: 291.17; found: 291.90 $[M+H]^+$.

***(1R,2S,3R,5R)-3-(4-amino-7H-pyrrolo[2,3-d]pyrimidin-7-yl)-5-((R)-pyrrolidin-2-yl)cyclopentane-1,2-diol* (7c) & (1*R*,2*S*,3*R*,5*R*)-3-(4-amino-7*H*-pyrrolo[2,3-*d*]pyrimidin-7-yl)-5-((*S*)-pyrrolidin-2-yl)cyclopentane-1,2-diol (7d)**:



Following the general procedure for deprotection, compounds x & y were obtained starting from compound y (0.09 g, 0.19 mmol) in a mixture of water and TFA (0.05 M, 3.80 mL, 1:1) after preparative HPLC using method C (water/MeCN; 0.05% TFA) as white foams (1 TFA salt, 64.66 mg, 82%).

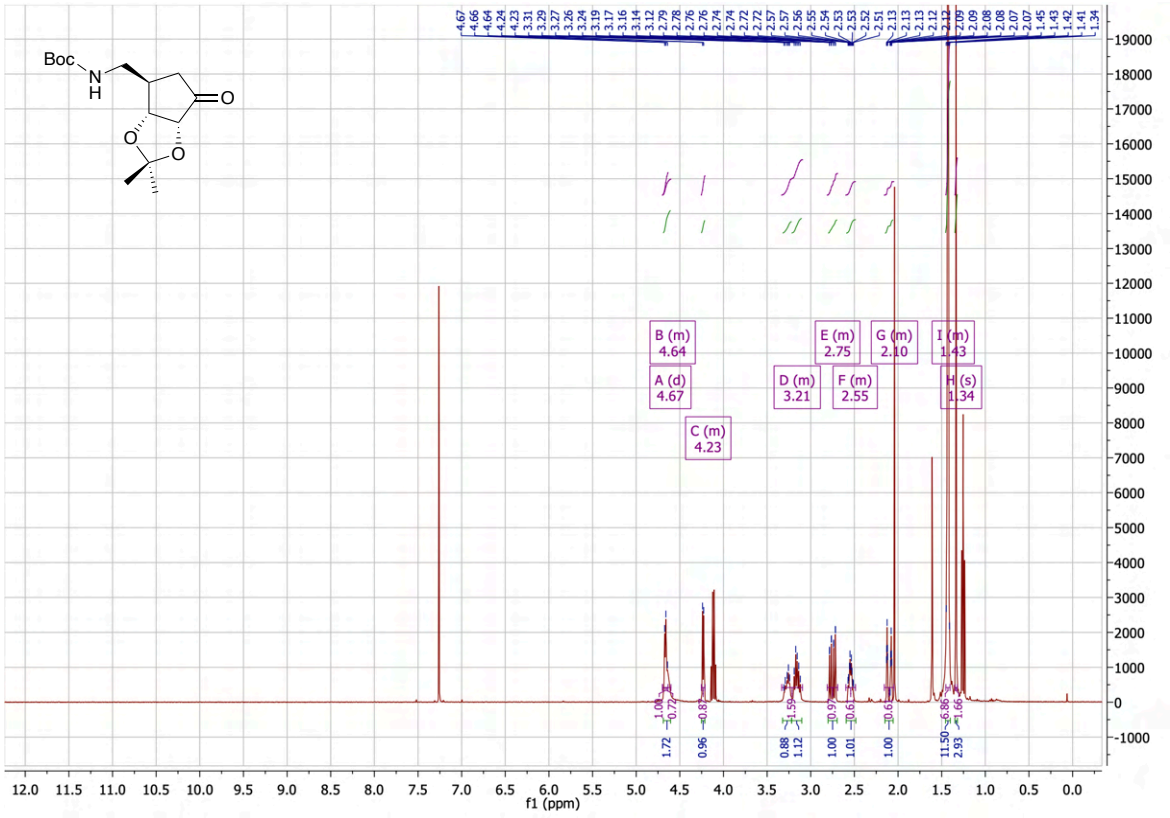
7c: 37.78 mg. R_t = 6.030 min. ^{1}H NMR (400 MHz, DMSO) δ 9.33 – 9.19 (m, 1H, NH_2^+), 8.58 – 8.47 (m, 1H, NH_2^+), 8.36 (s, 1H, H2), 7.62 (d, J = 3.5 Hz, 1H, H6), 6.94 (d, J = 3.5 Hz, 1H, H5), 4.91 (dt, J = 10.8, 7.9 Hz, 1H, H1'), 4.20 (dd, J = 8.2, 6.1 Hz, 1H, H2'), 3.88 – 3.83 (m, 1H, H3'), 3.57 – 3.44 (m, 1H, -$NH_2^+CH_2CH_2C\underline{H}$-), 3.26 – 3.09 (m, 2H, -$NH_2^+C\underline{H_2}CH_2CH_2CH$-), 2.35 – 2.20 (m, 2H, H5', -$NH_2^+CH_2C\underline{H_2}CH_2$-), 2.20 – 2.10 (m, 1H, H4'), 2.04 – 1.81 (m, 2H, -$NH_2^+CH_2C\underline{H_2}C\underline{H_2}$-), 1.80 – 1.63 (m, 2H, H5', -$NH_2^+CH_2CH_2C\underline{H_2}$-). ^{13}C NMR (101 MHz, DMSO) δ 158.8 (1C, $CF_3\underline{C}OO^-$), 158.5 (1C, -CNH_2), 151.6 (1C, -N$\underline{C}$HN-), 142.9 (1C, C2), 125.2 (1C, -CH$\underline{C}$HN-), 118.5 (1C, $\underline{C}F_3COO^-$), 101.7 (1C, -$\underline{C}$HCHN-), 101.7 (1C, -CNH$_2\underline{C}$-), 74.8 (1C, C2'), 72.1 (1C, C3'), 63.1 (1C, -$NH_2^+\underline{C}$H-), 59.5 (1C, C1'), 45.6 (1C, C4'), 44.5 (1C, -$NH_2^+\underline{C}H_2CH_2CH_2$-), 31.1 (1C, C5'), 28.8 (1C, -$NH_2^+CH_2\underline{C}H_2CH_2$-), 23.2 (1C, -$NH_2^+CH_2CH_2\underline{C}H_2$-). APCI calc.: 304.17; found: 304.4 $[M+H]^+$. Using method B: UV-purity at 210 nm 99.3%.

7d: 26.88 mg. R_t = 6.941 min. ^{1}H NMR (400 MHz, DMSO) δ 9.28 – 9.18 (m, 1H, -NH_2^+), 8.49 – 8.40 (m, 1H, -NH_2^+), 8.38 (s, 1H, H2), 7.67 (d, J = 3.6 Hz, 1H, H6), 6.96 (d, J = 3.6 Hz, 1H, H5), 4.94 (dt, J = 10.9, 7.5 Hz, 1H, H1'), 4.18 (dd, J = 7.5, 6.0 Hz, 1H, H2'), 3.98 (t, J = 5.5 Hz, 1H, H3'), 3.56 – 3.43 (m, 1H, -$NH_2^+CH_2CH_2C\underline{H}$-), 3.28 – 3.12 (m, 2H, -$NH_2^+C\underline{H_2}CH_2CH_2CH$-), 2.30 – 2.14 (m, 2H, H4', H5'), 2.12 – 2.01 (m, 1H, -

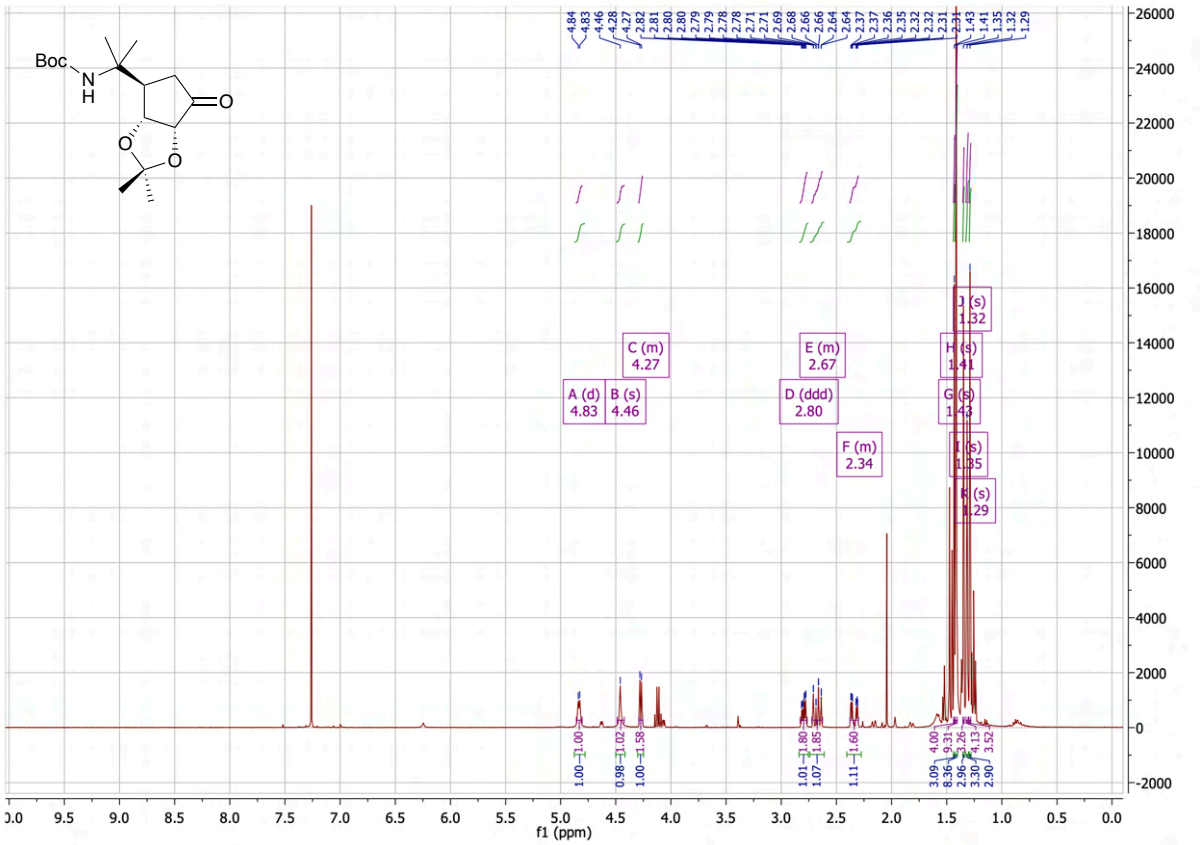
$NH_2^+CH_2C\underline{H_2}CH_2$-), 1.99 – 1.78 (m, 1H, -$NH_2^+CH_2C\underline{H_2}CH_2CH$-), 1.70 – 1.50 (m, 2H, H5', -$NH_2^+CH_2C\underline{H_2}CH$-). ^{13}C NMR (101 MHz, DMSO) δ 158.6 (1C, $CF_3\underline{C}OO^-$), 158.3 (1C, -CNH_2), 151.1 (1C, -N$\underline{C}$HN-), 142.3 (1C, -N$\underline{C}$N-), 125.7 (1C, -CH$\underline{C}$HN-), 118.1 (1C, $\underline{C}F_3COO^-$), 101.9 (1C, -$\underline{C}$HCHN-), 101.6 (1C, -$CNH_2\underline{C}$-), 75.0 (1C, C2'), 72.8 (1C, C3'), 62.5 (1C, -$NH_2^+\underline{C}$H-), 59.7 (1C, C1'), 45.0 (1C, C4'), 45.0 (1C, -$NH_2^+\underline{C}H_2CH_2CH_2$-), 30.2 (1C, C5'), 28.5 (1C, -$NH_2^+CH_2\underline{C}H_2CH_2$-), 22.7 (1C, -$NH_2^+CH_2CH_2\underline{C}H_2$-). UV-purity at 210 nm: 100%. APCI calc.: 304.17; found: 304.40 $[M+H]^+$. Using method B: UV-purity at 210 nm 100%.

^{1}H-NMR-spectra

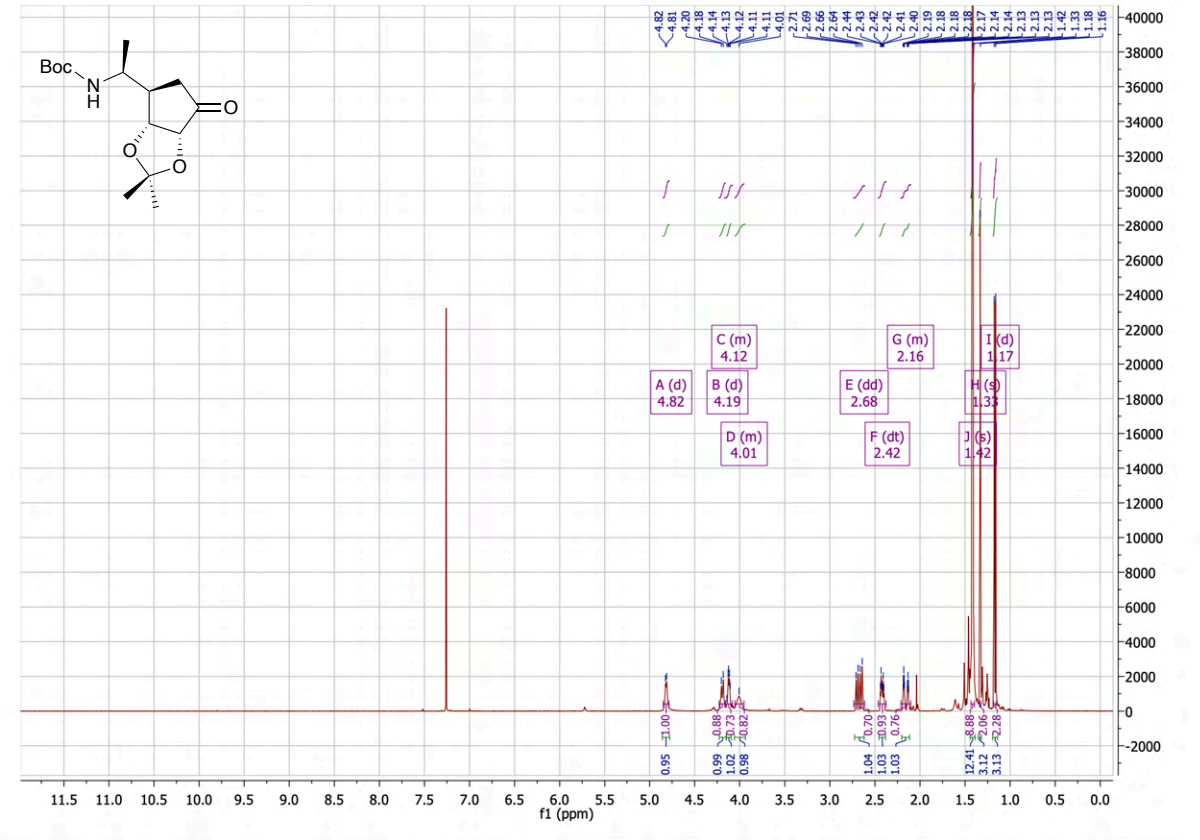
Compound 3a



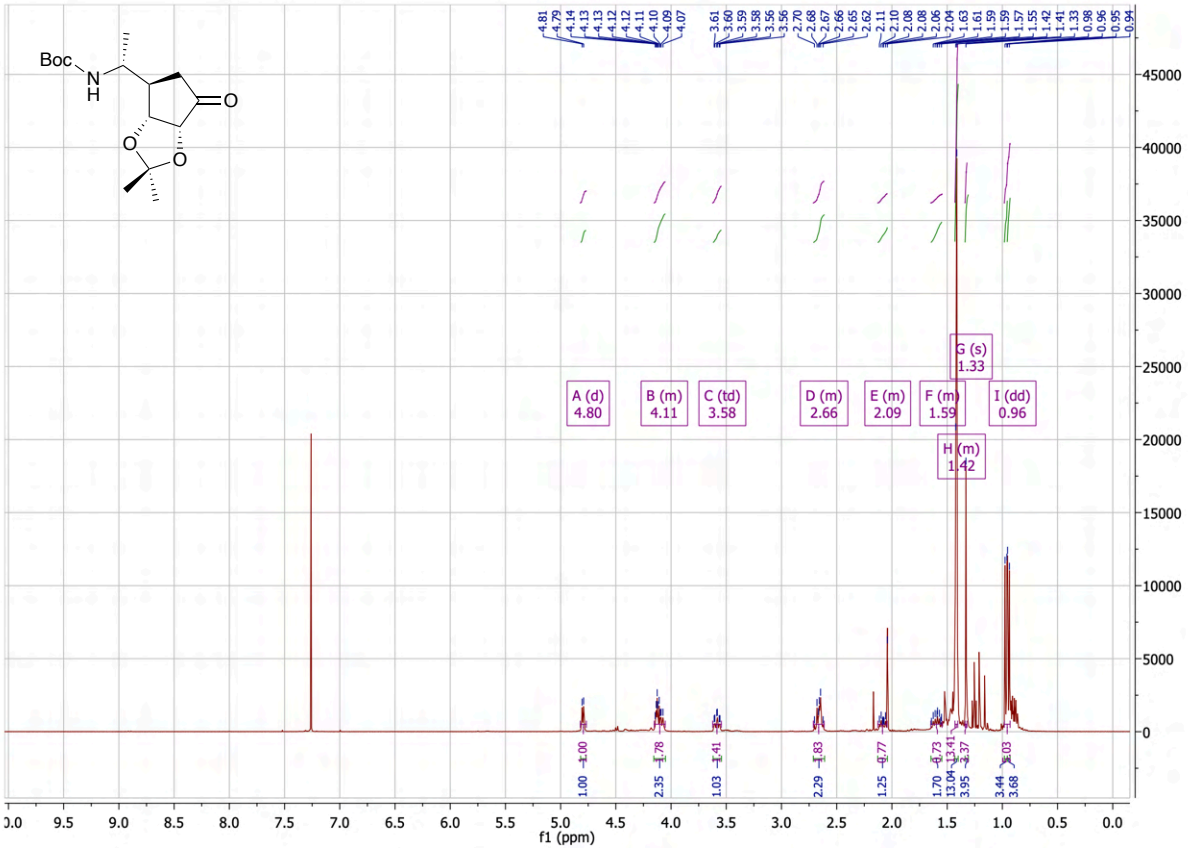
Compound 3b



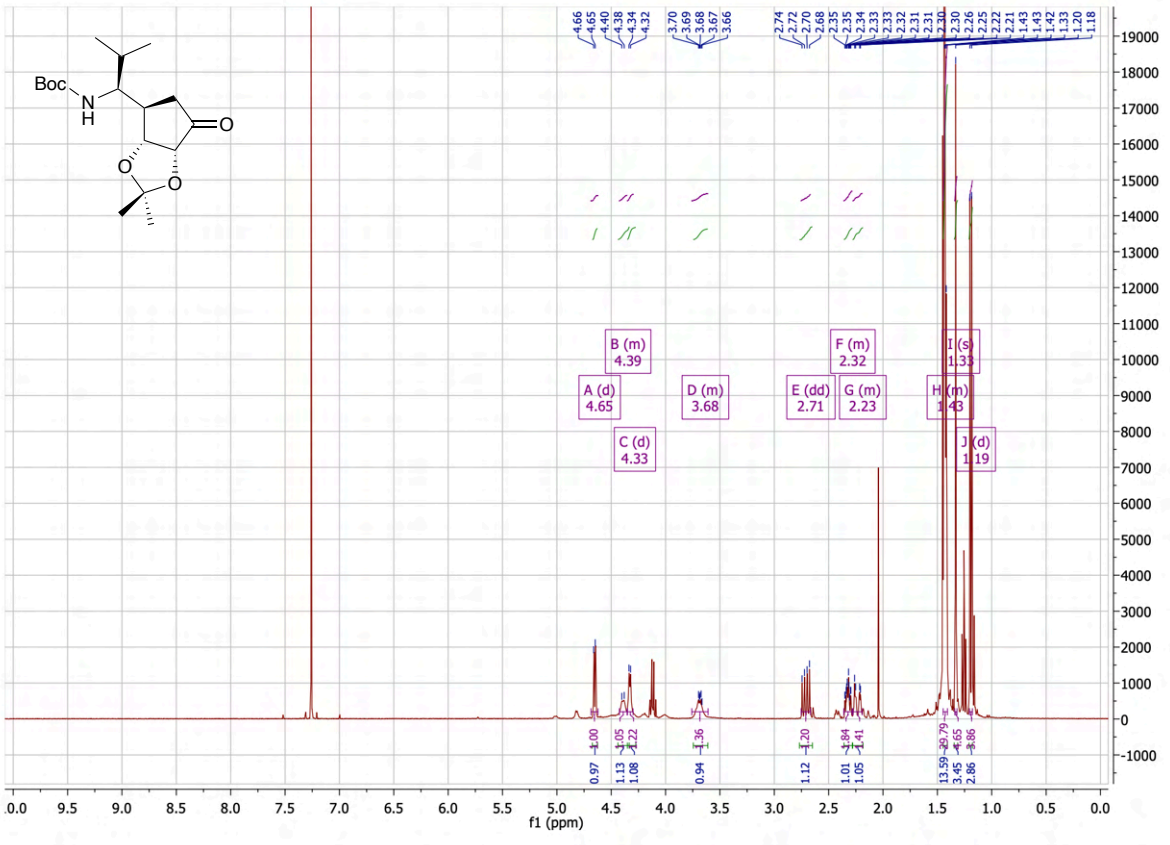
Compound 3c



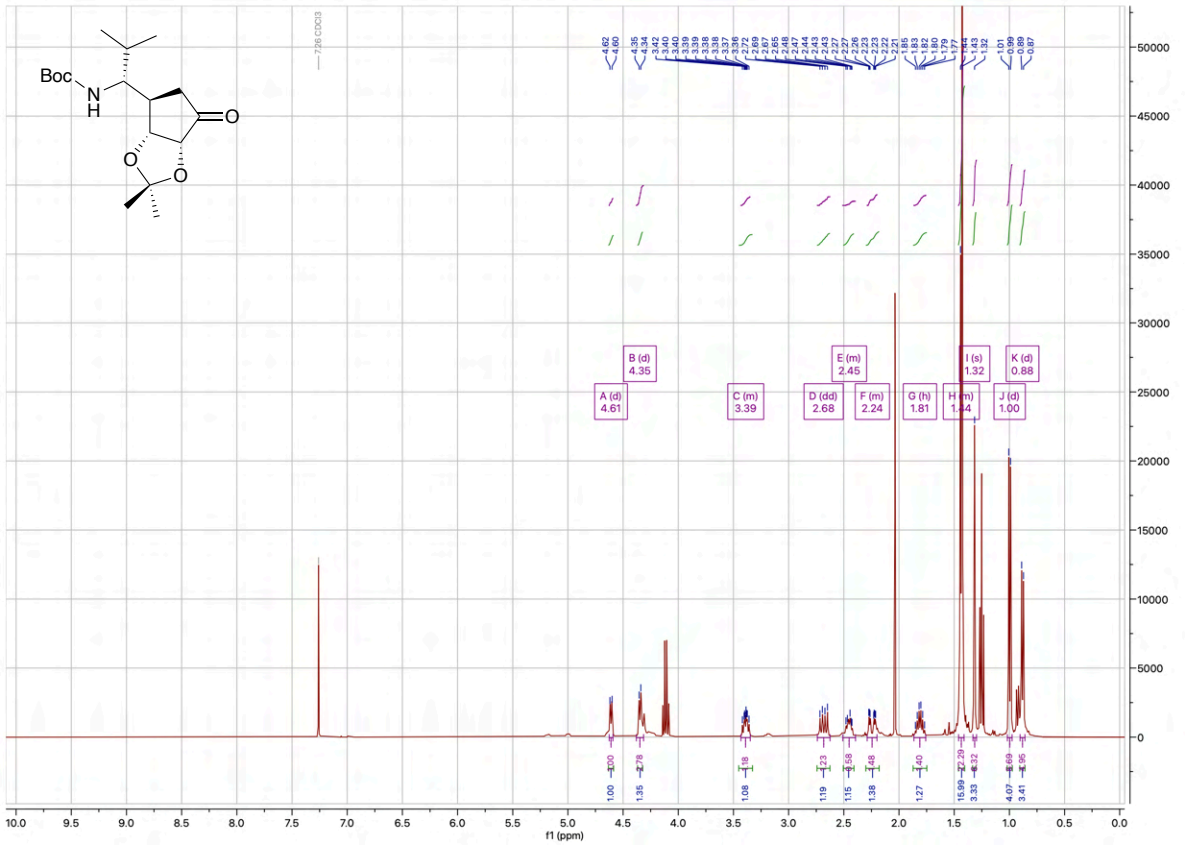
Compound 3d



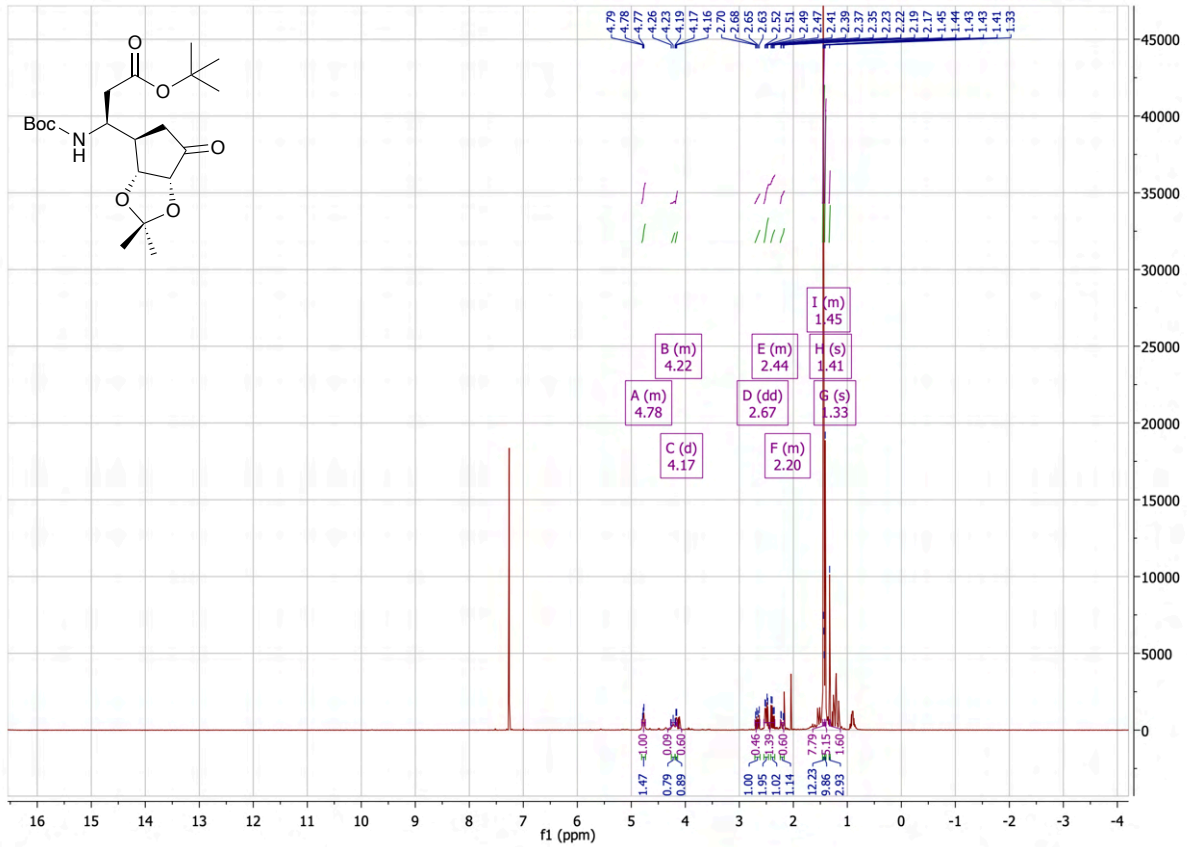
Compound 3e



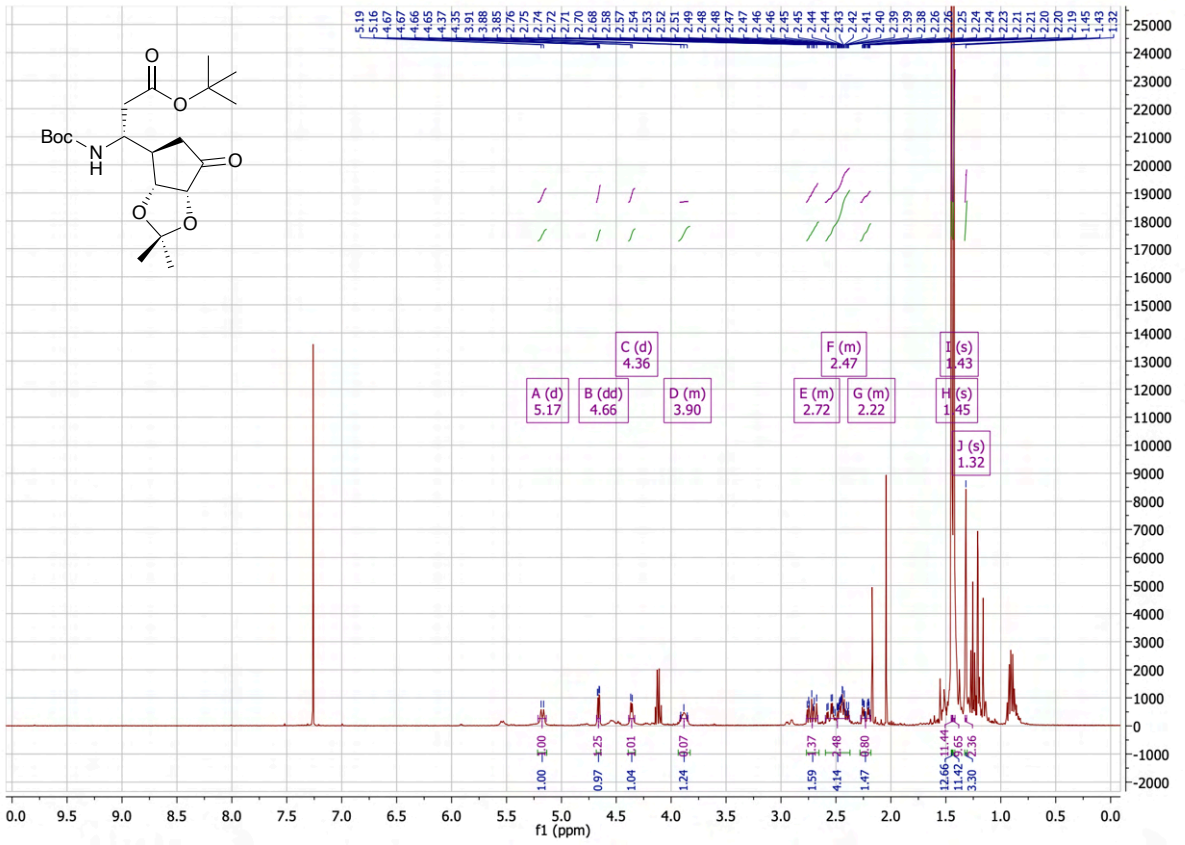
Compound 3f



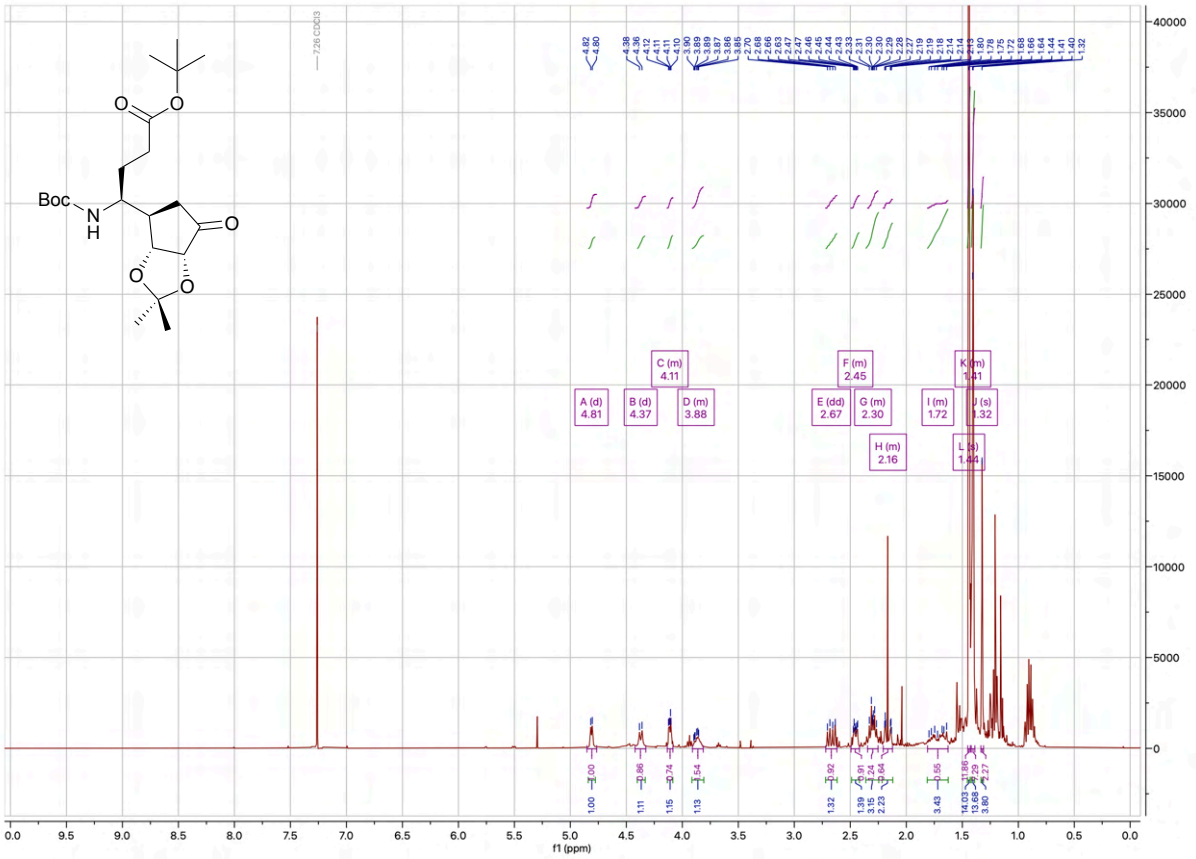
Compound 3g



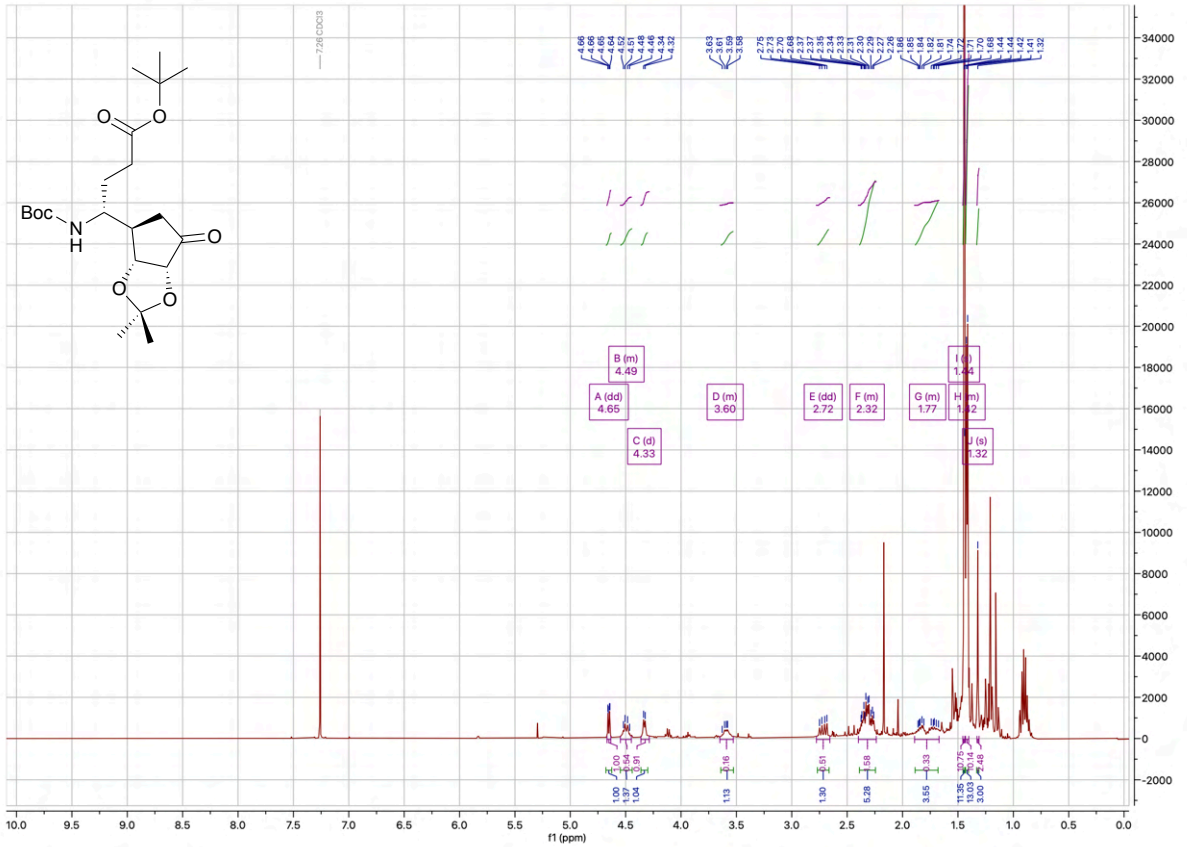
Compound 3h



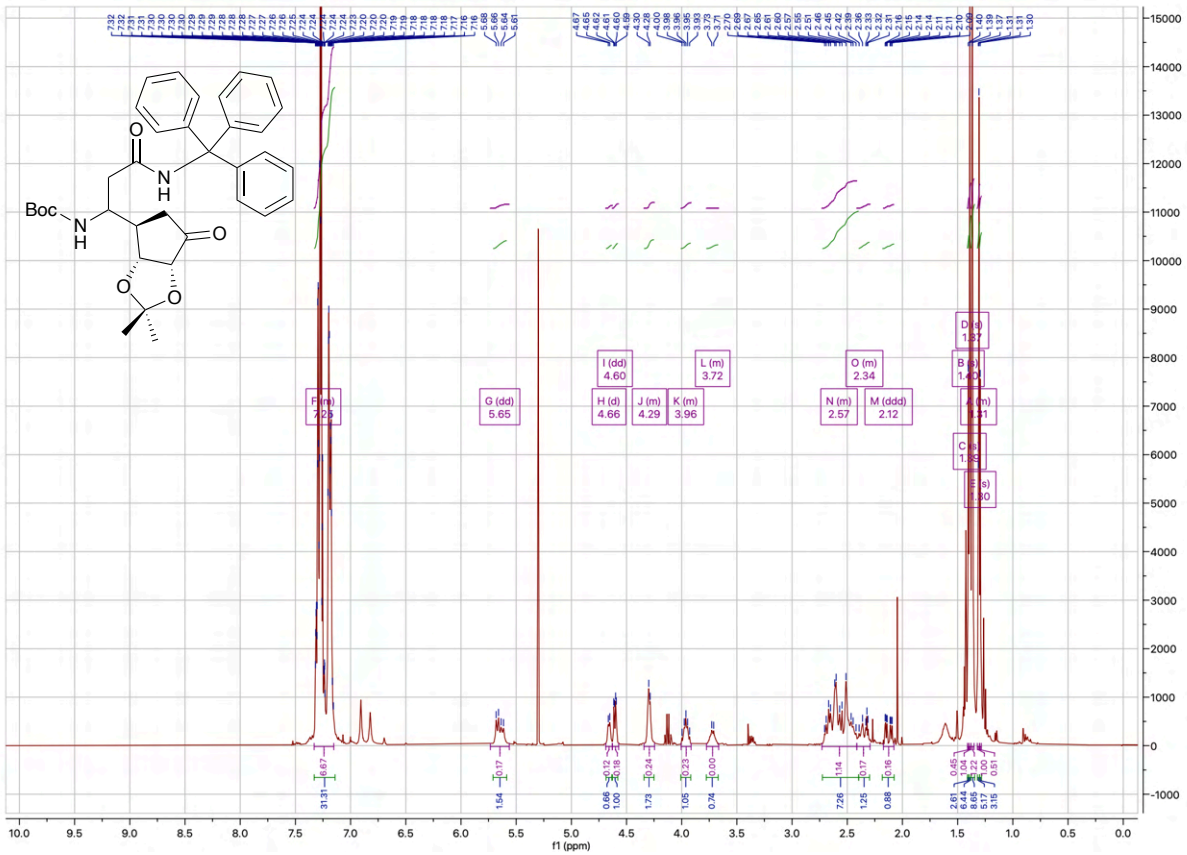
Compound 3i



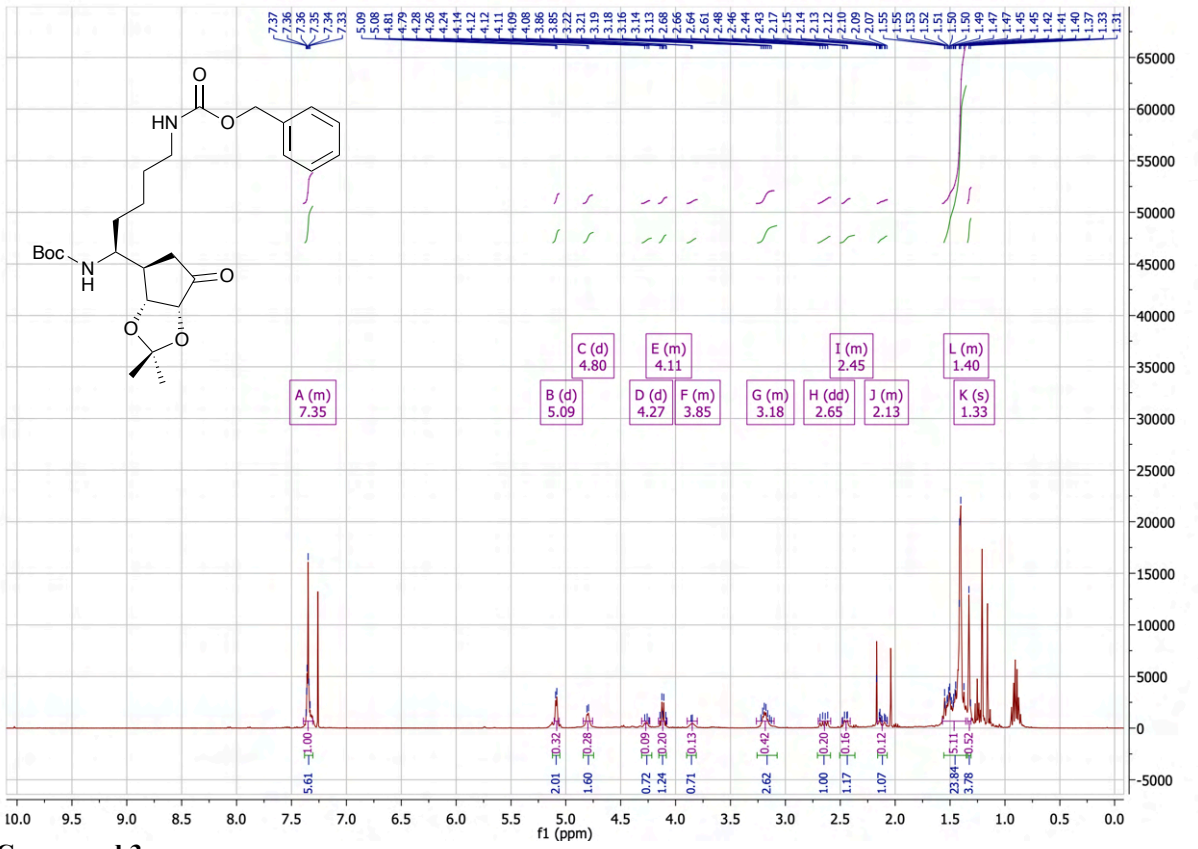
Compound 3j



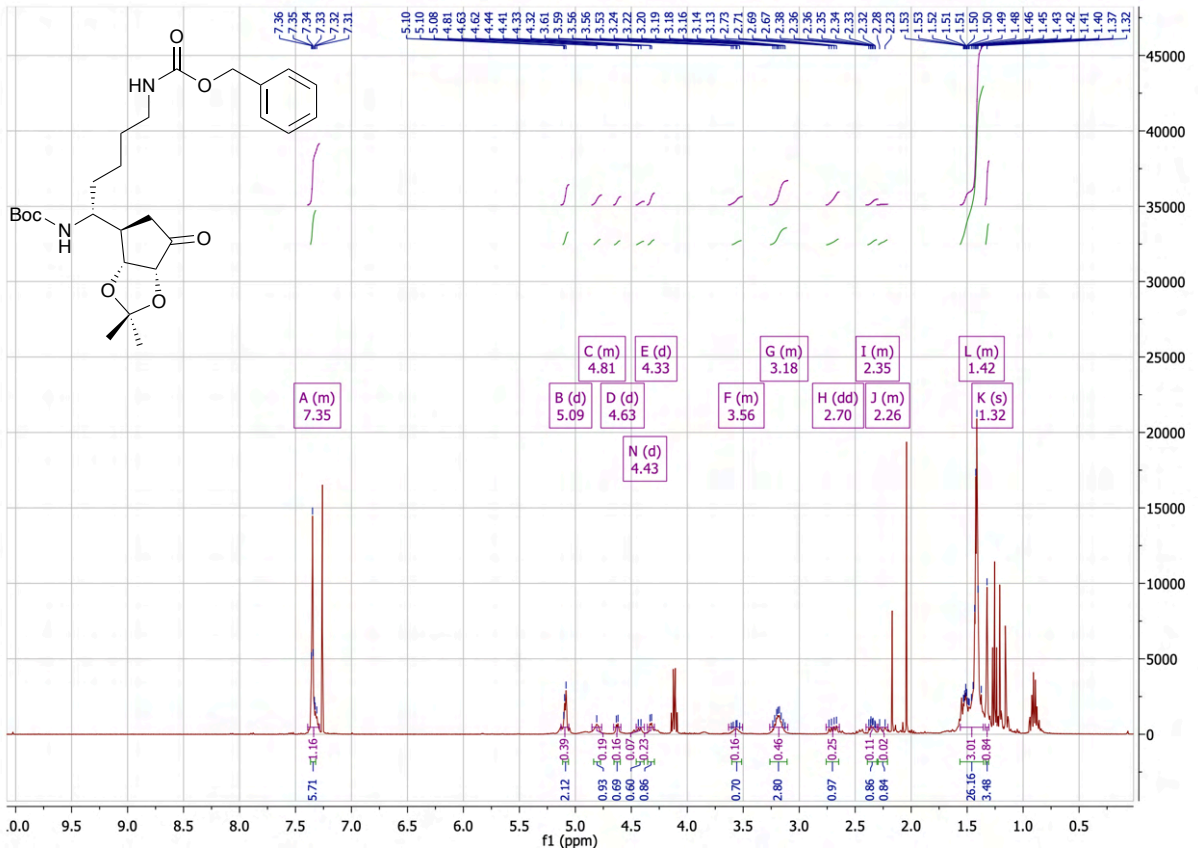
Compound 3k



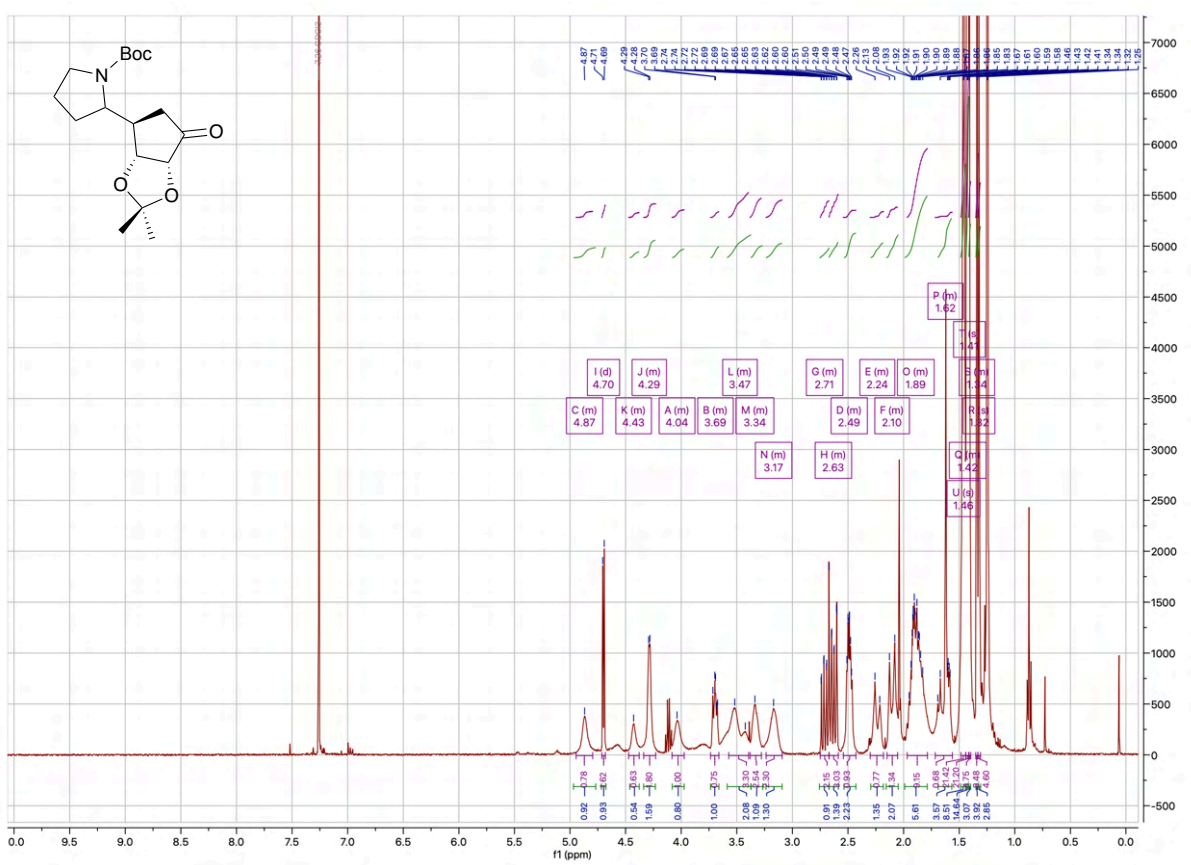
Compound 3l



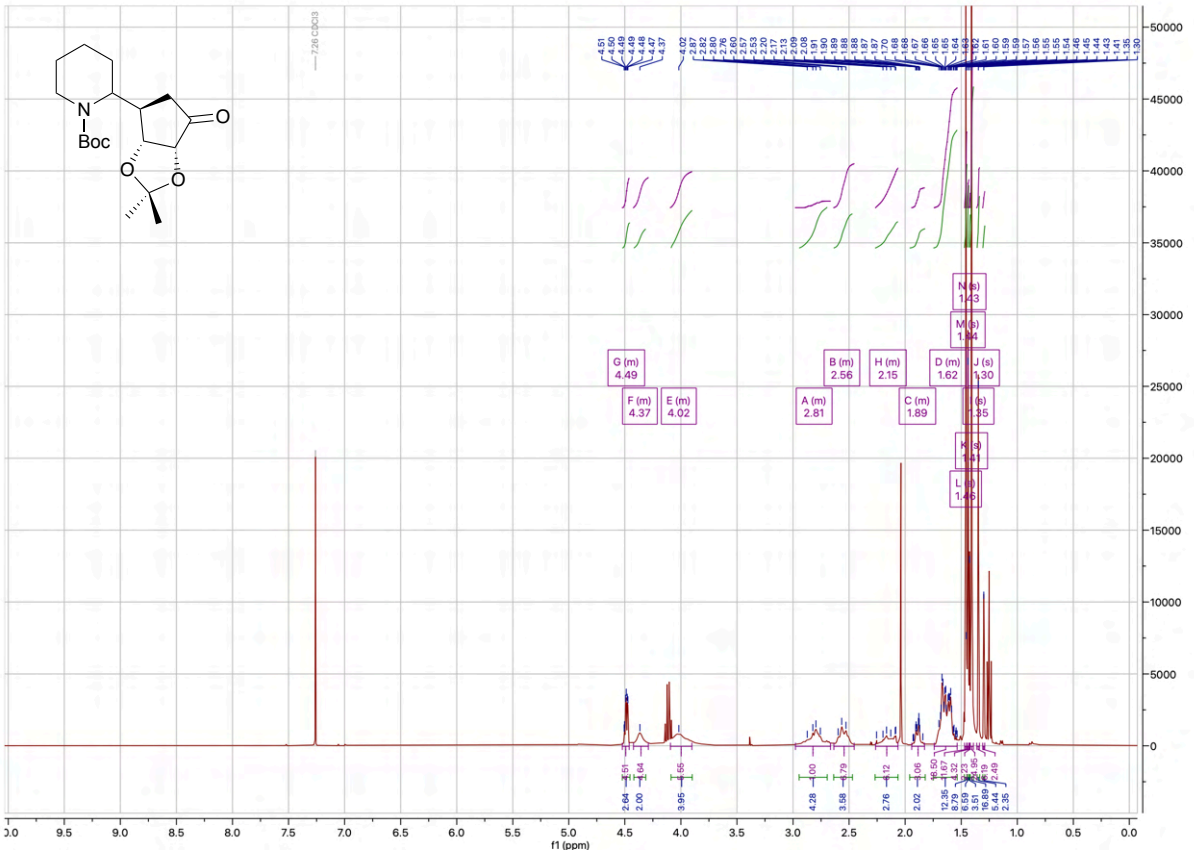
Compound 3m



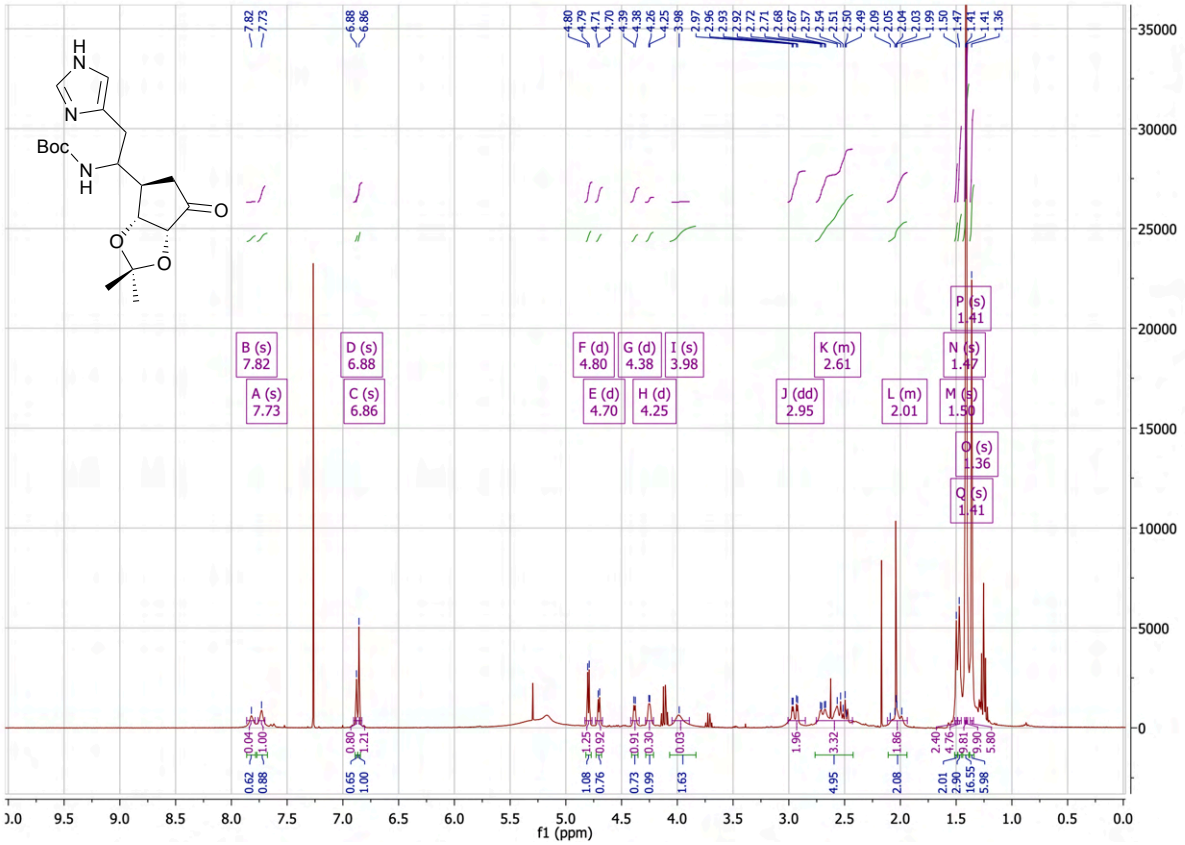
Compound 3n



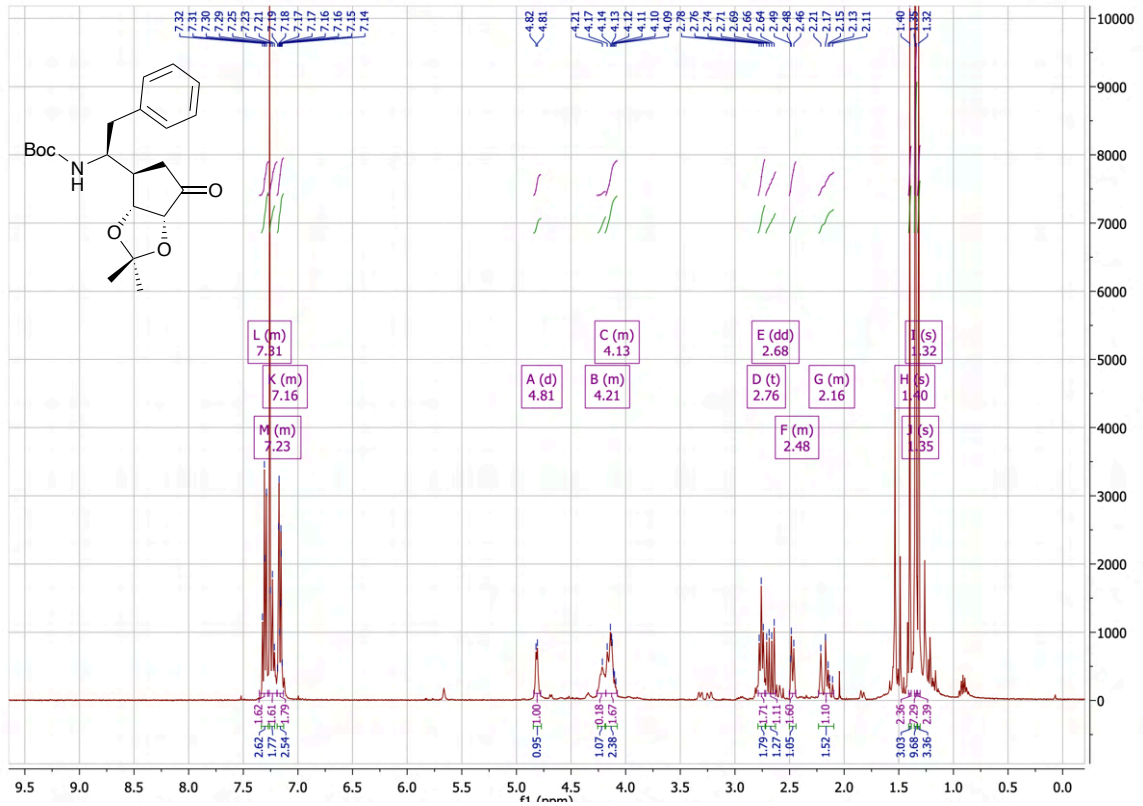
Compound 3o



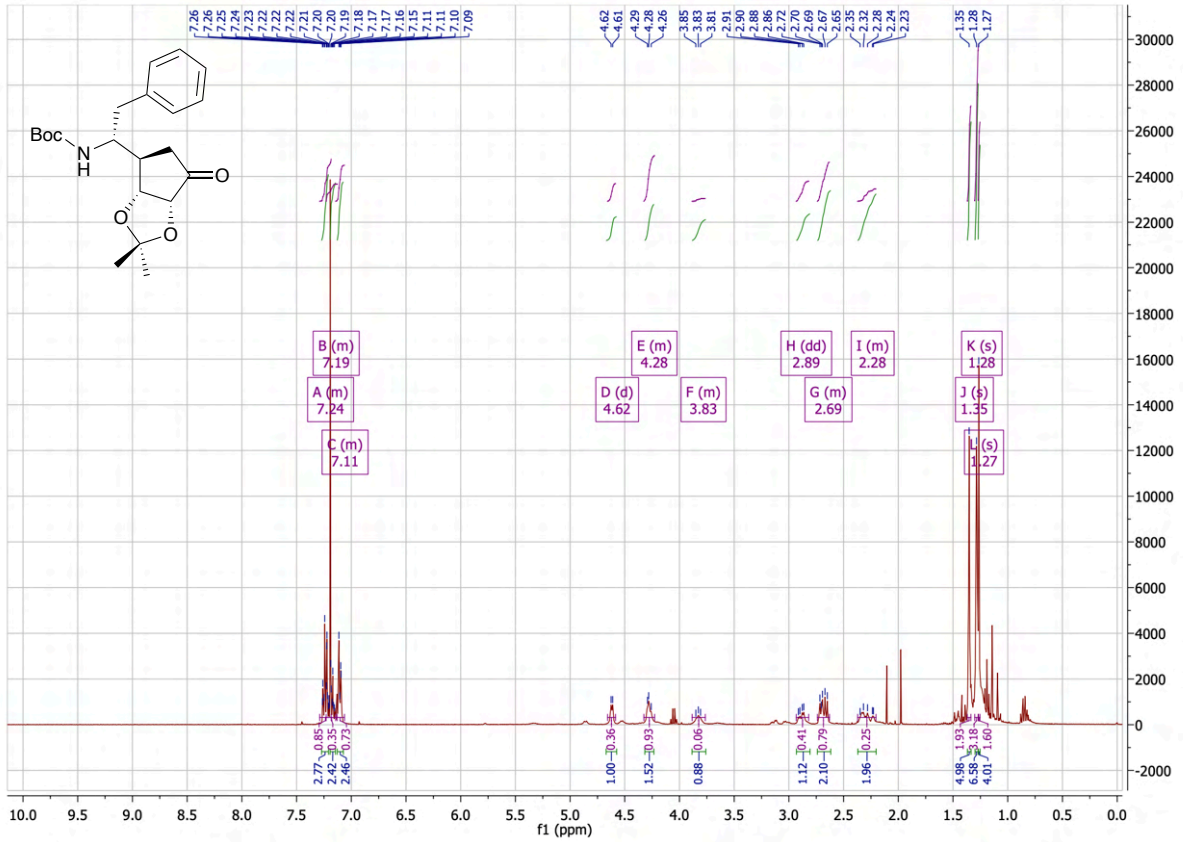
Compound 3p



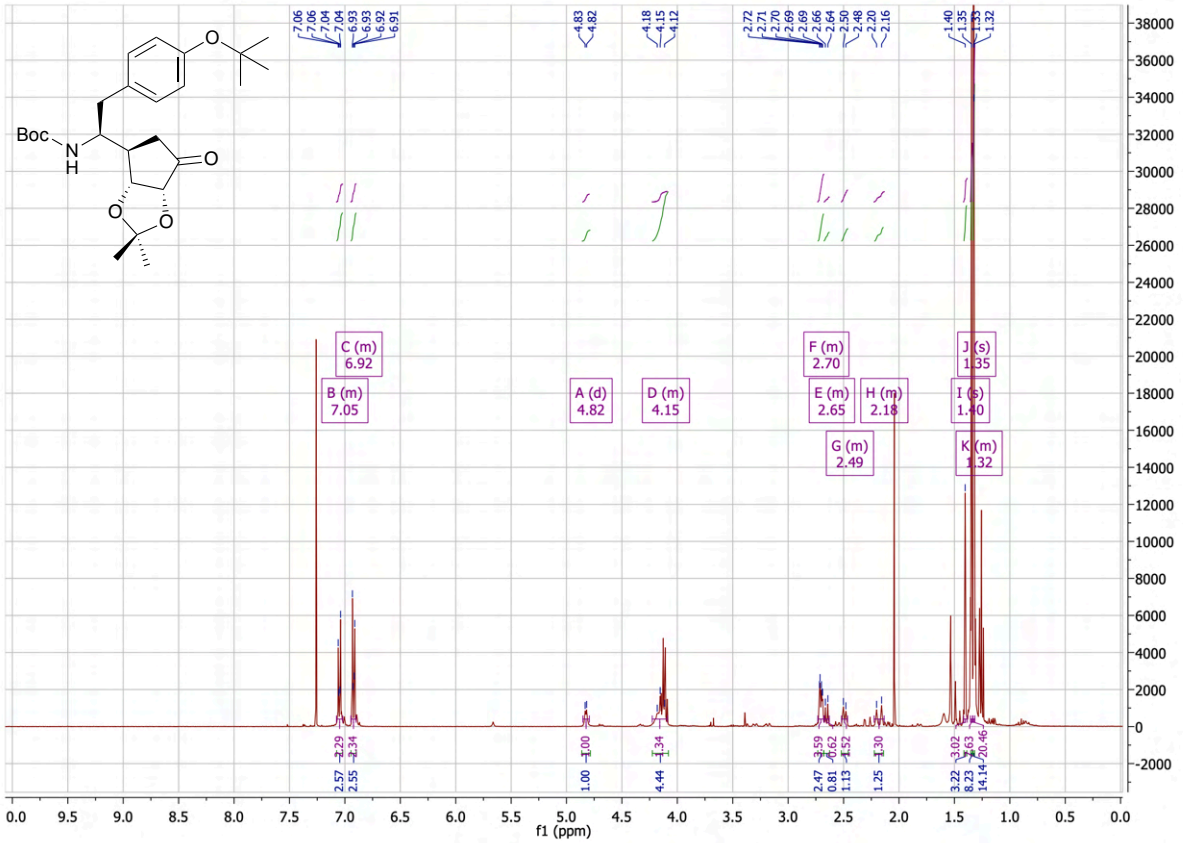
Compound 3q



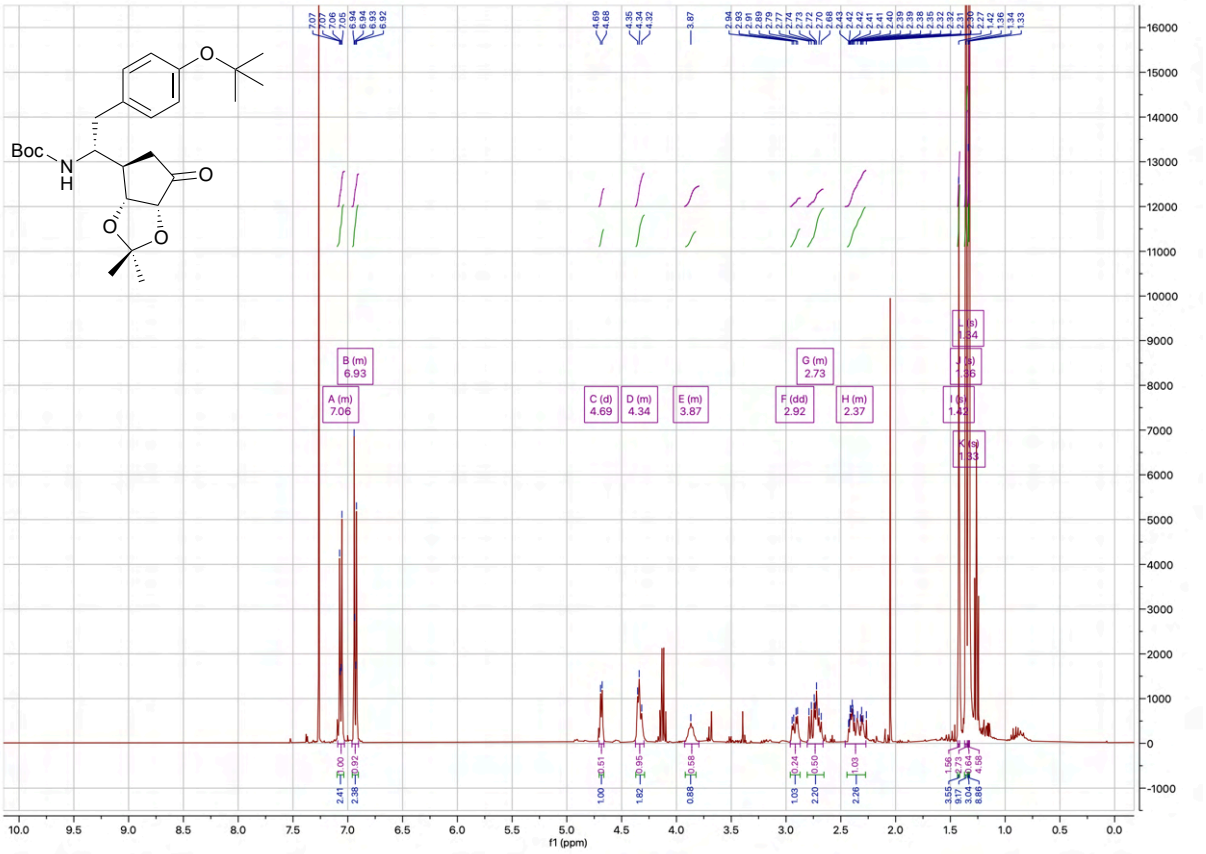
Compound 3r



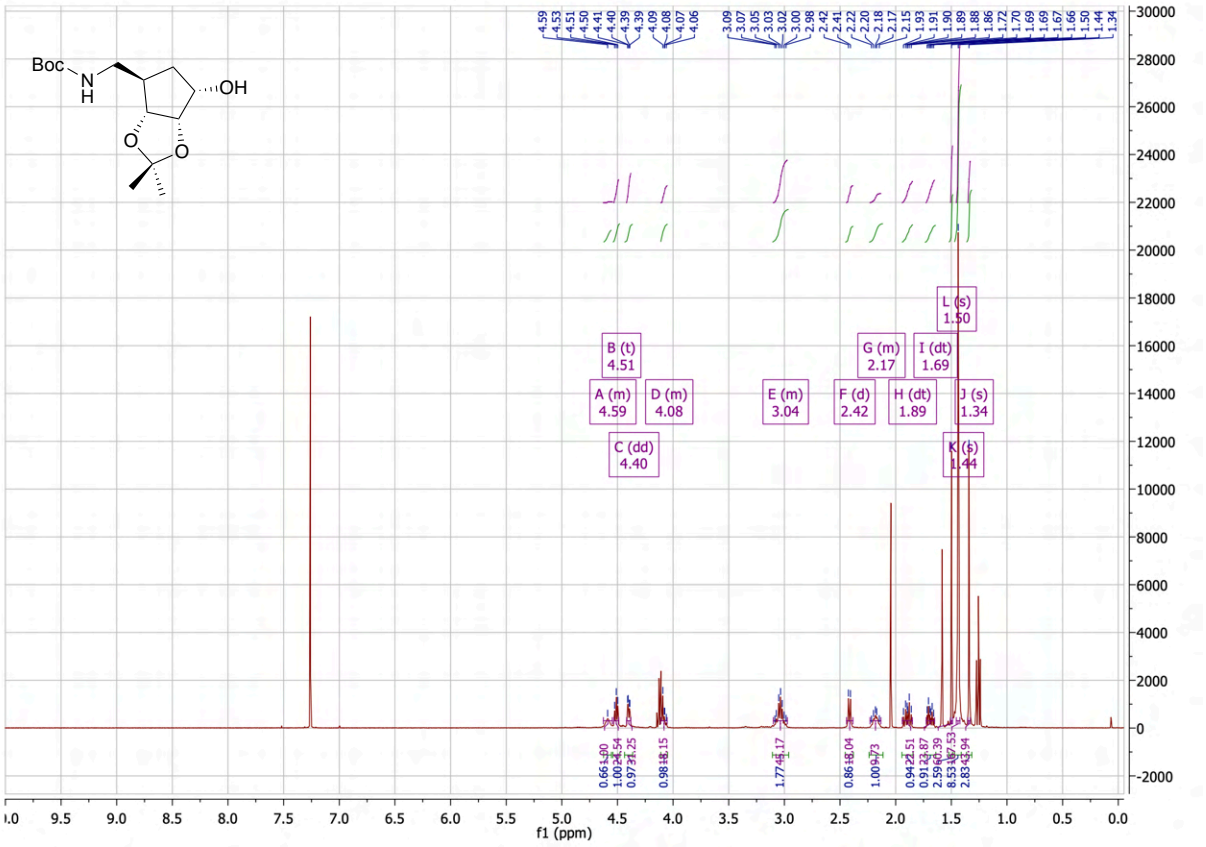
Compound 3s



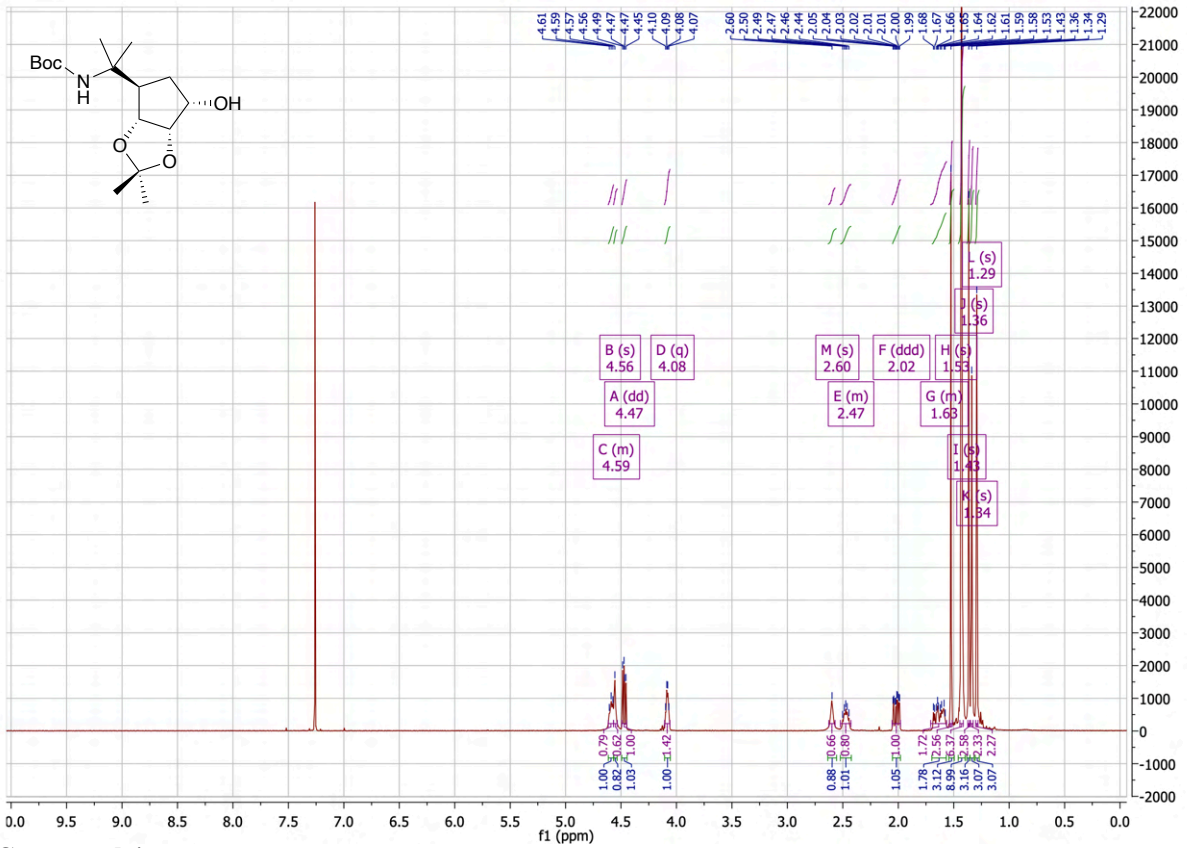
Compound 3t



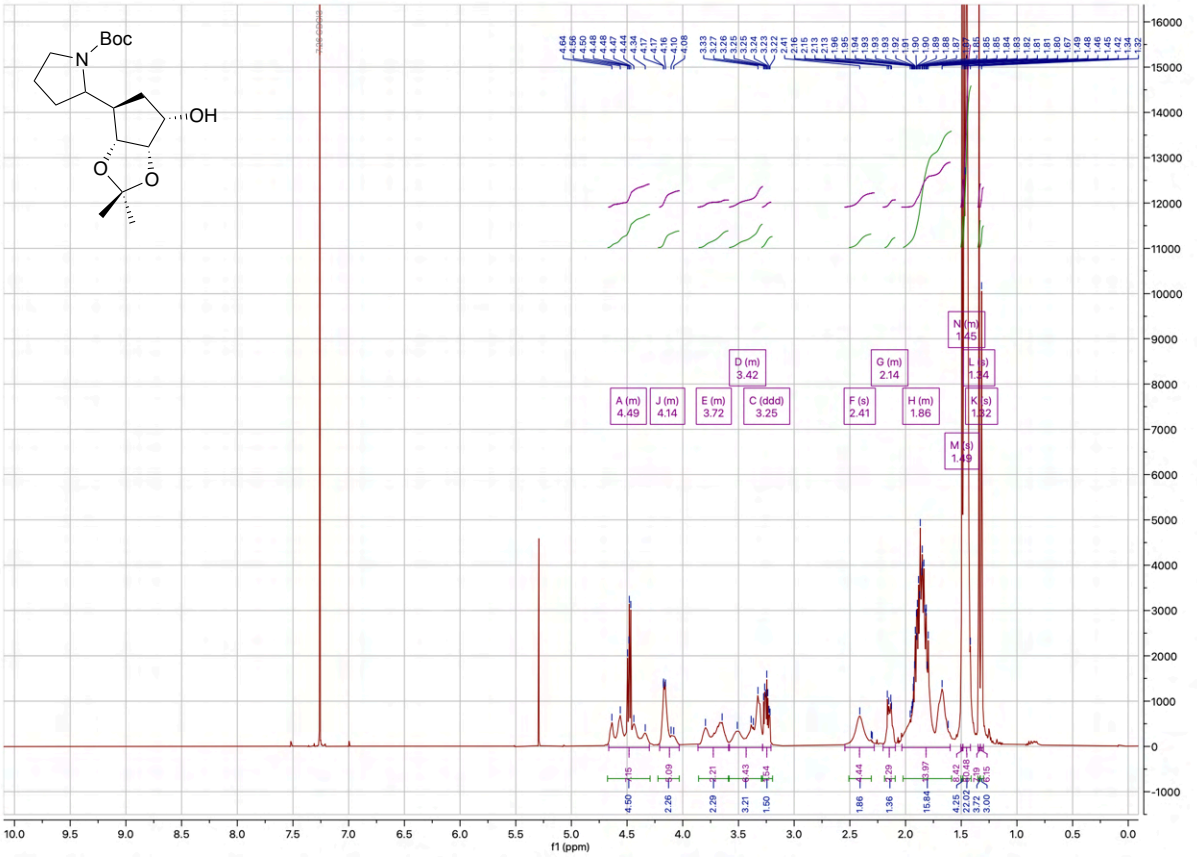
Compound 4a



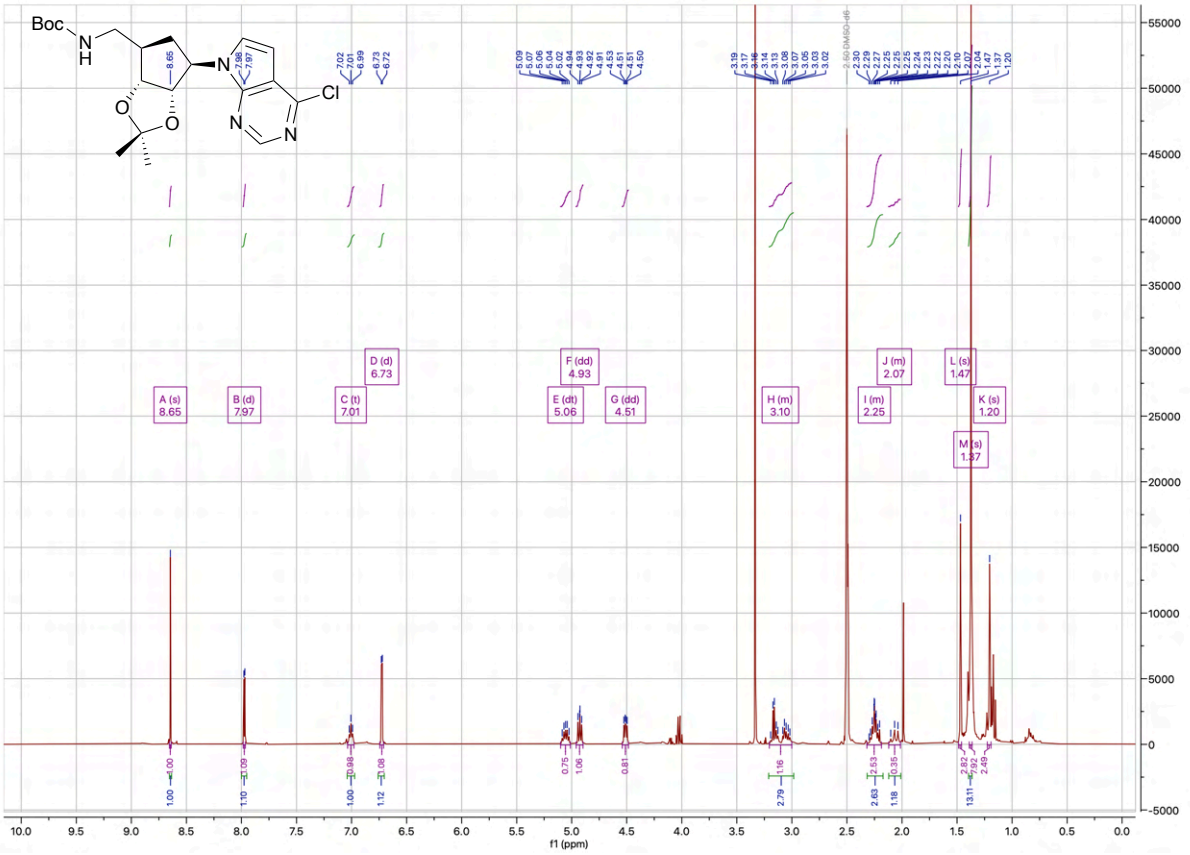
Compound 4b



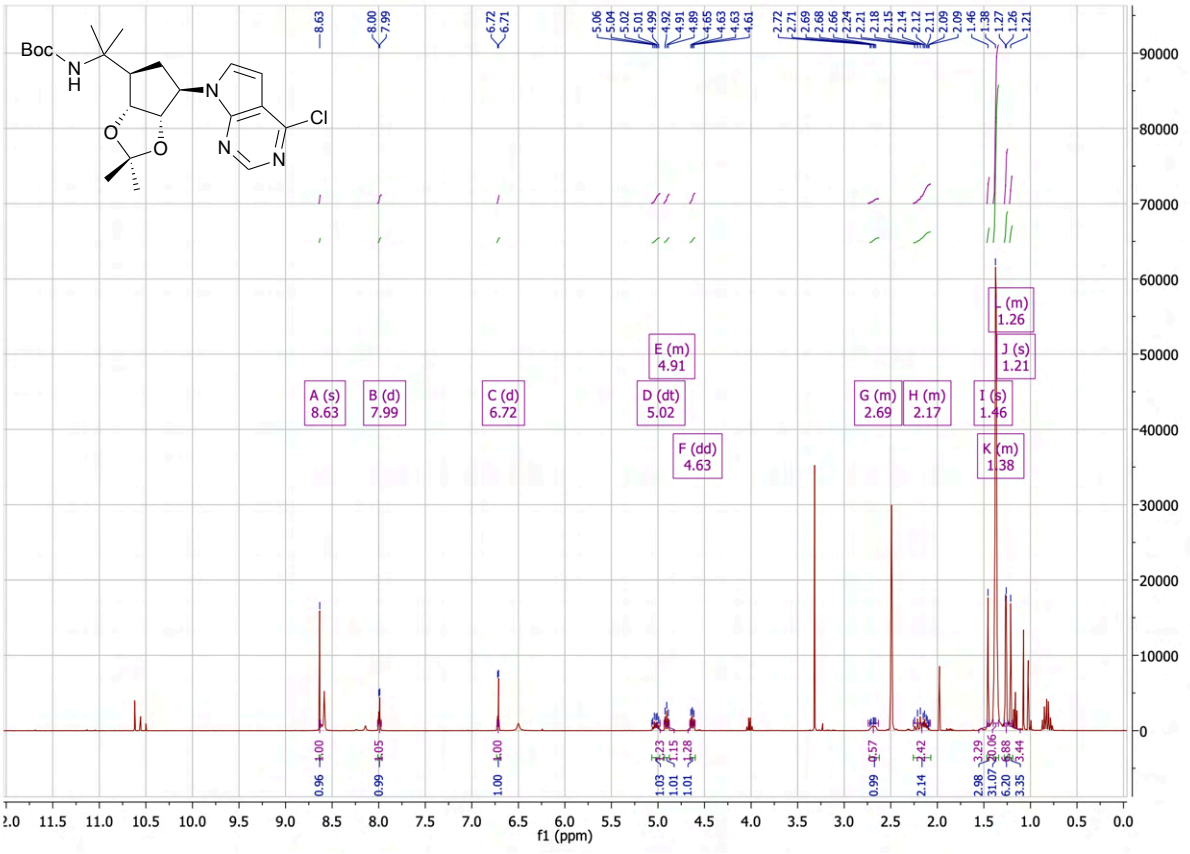
Compound 4c



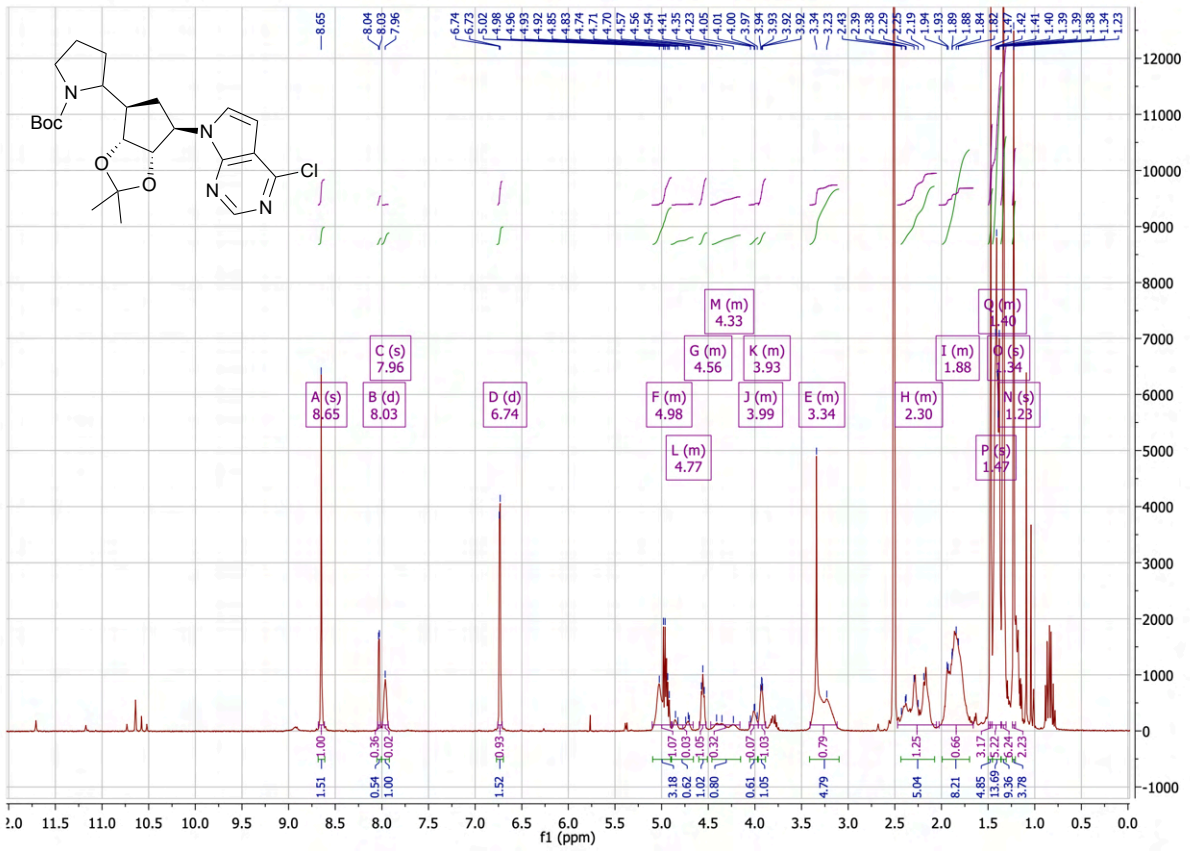
Compound 5a



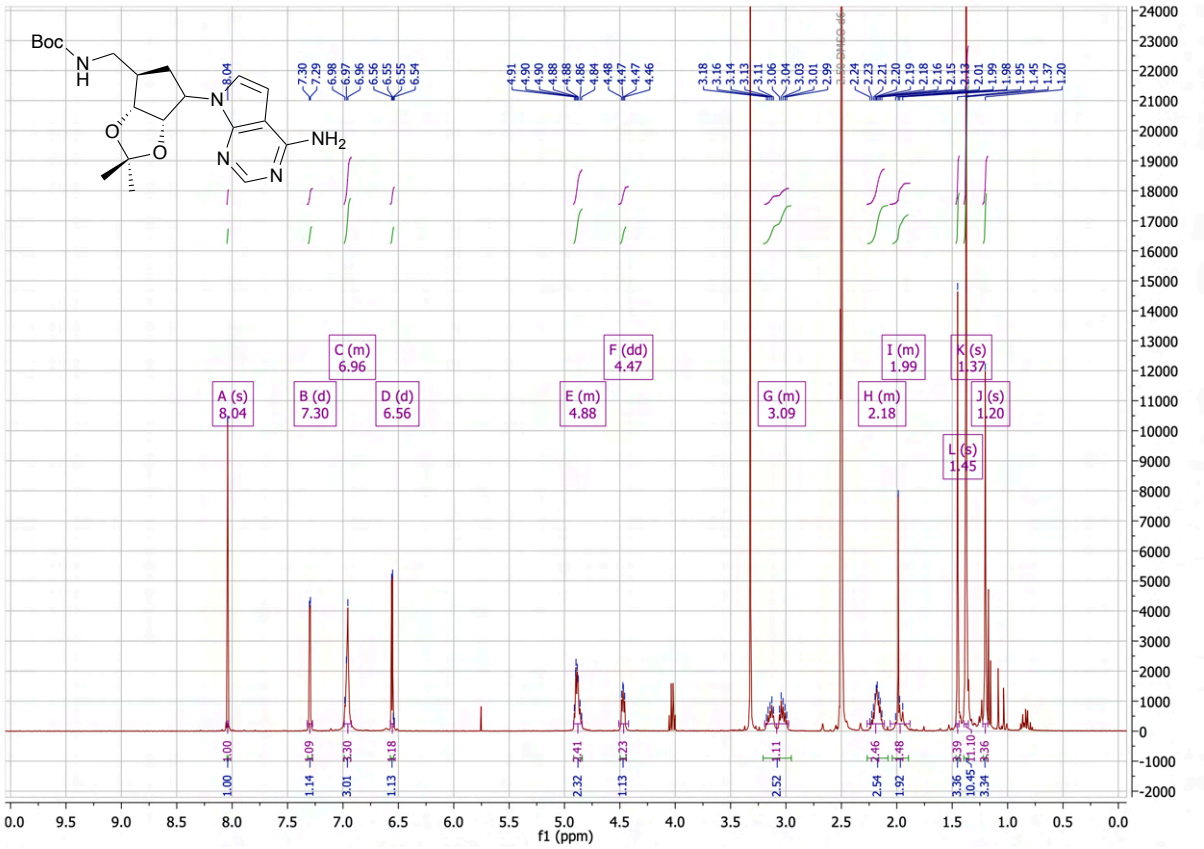
Compound 5b



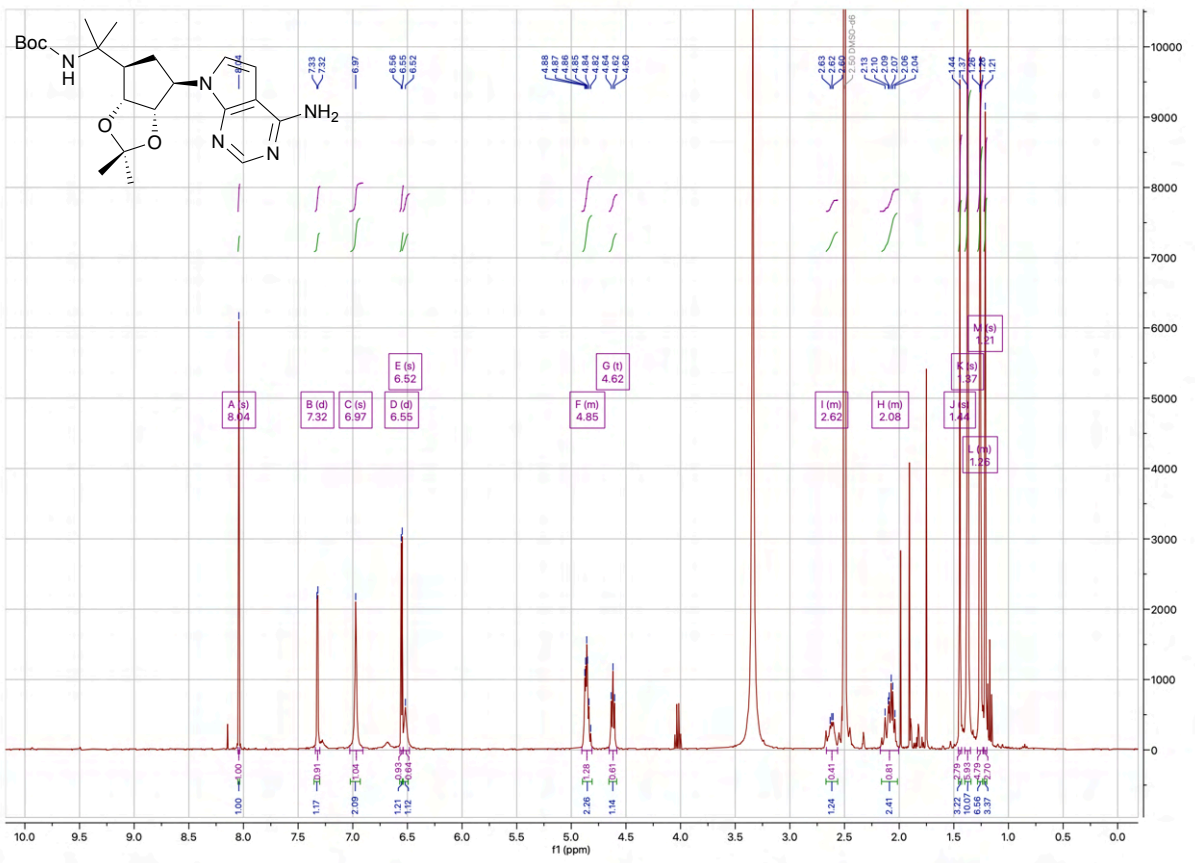
Compound 5c



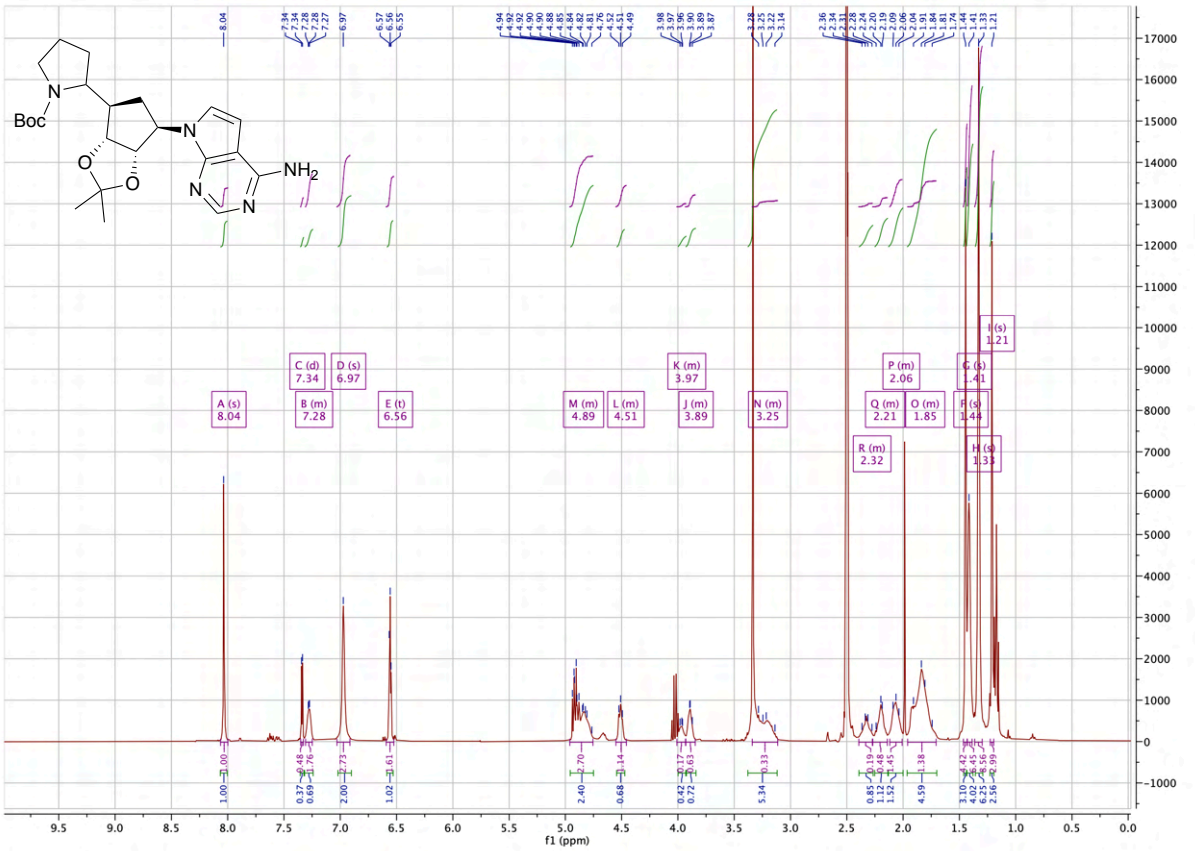
Compound 6a



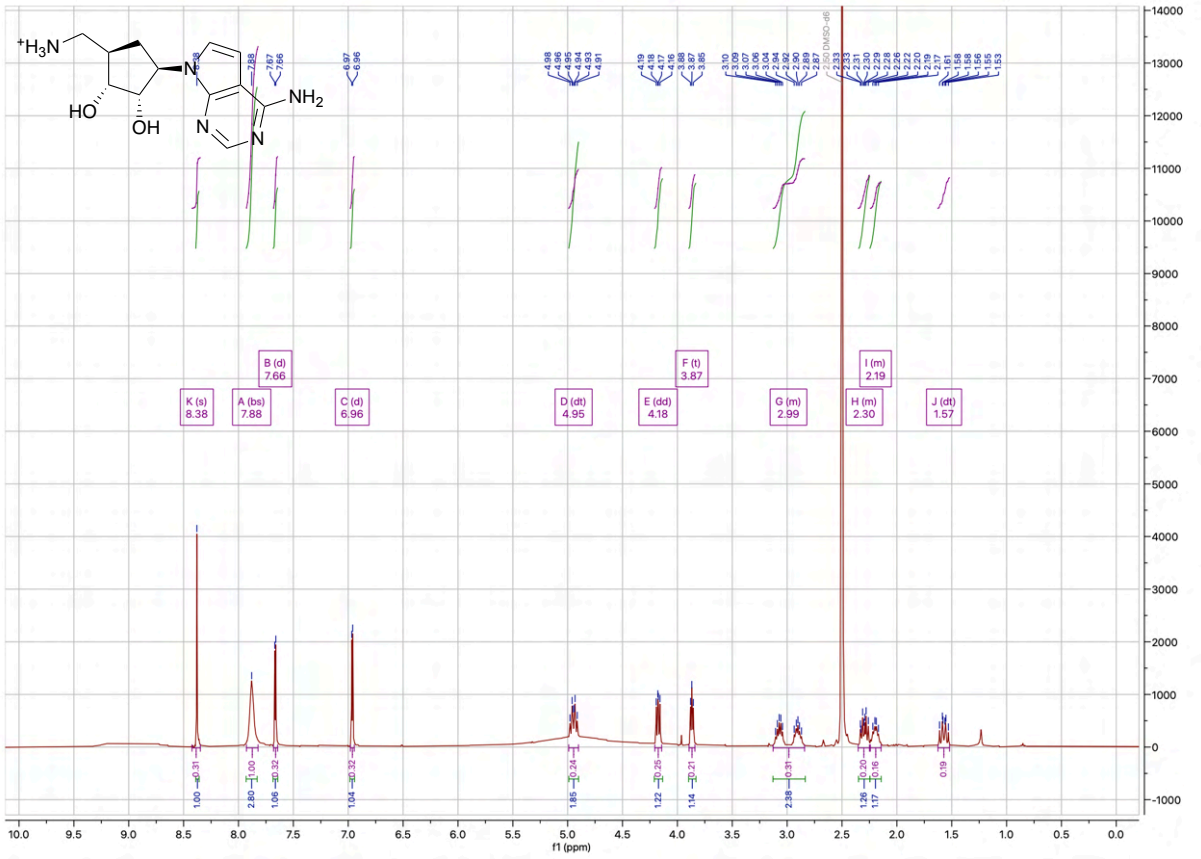
Compound 6b



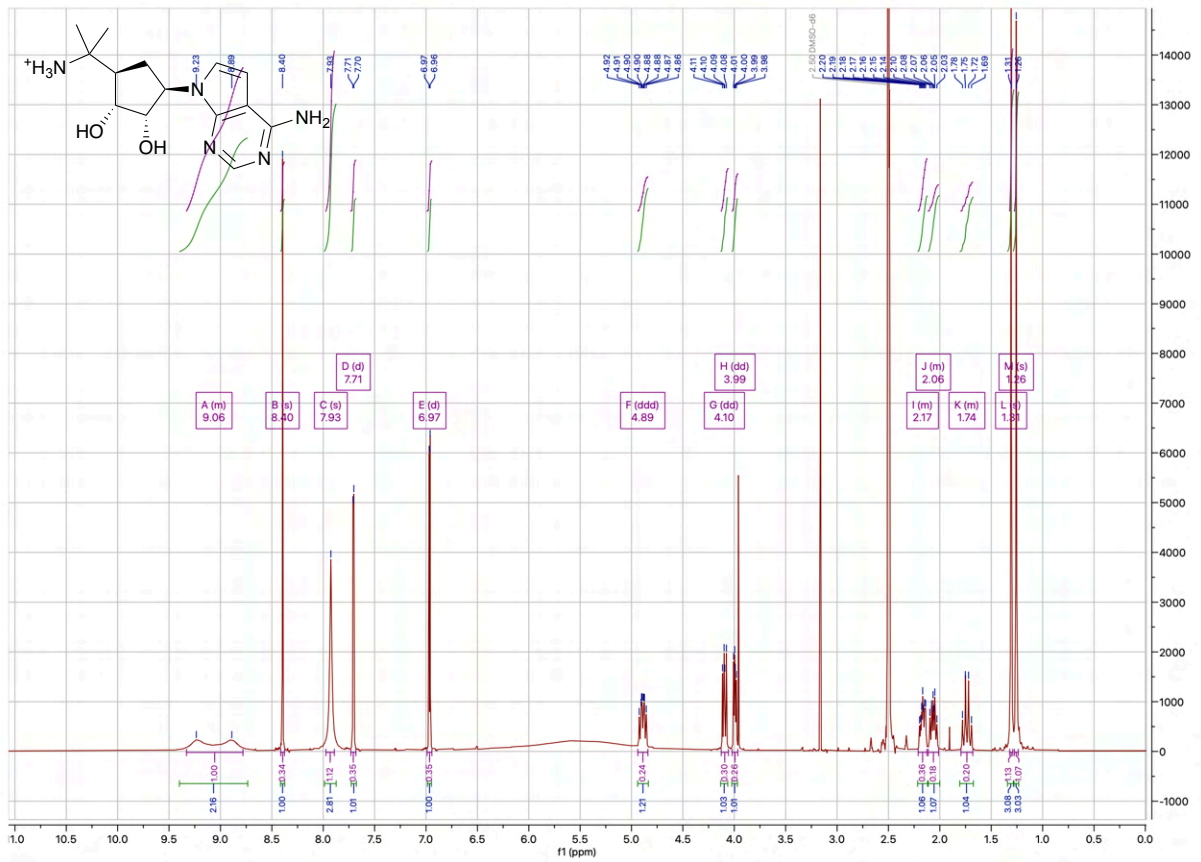
Compound 6c



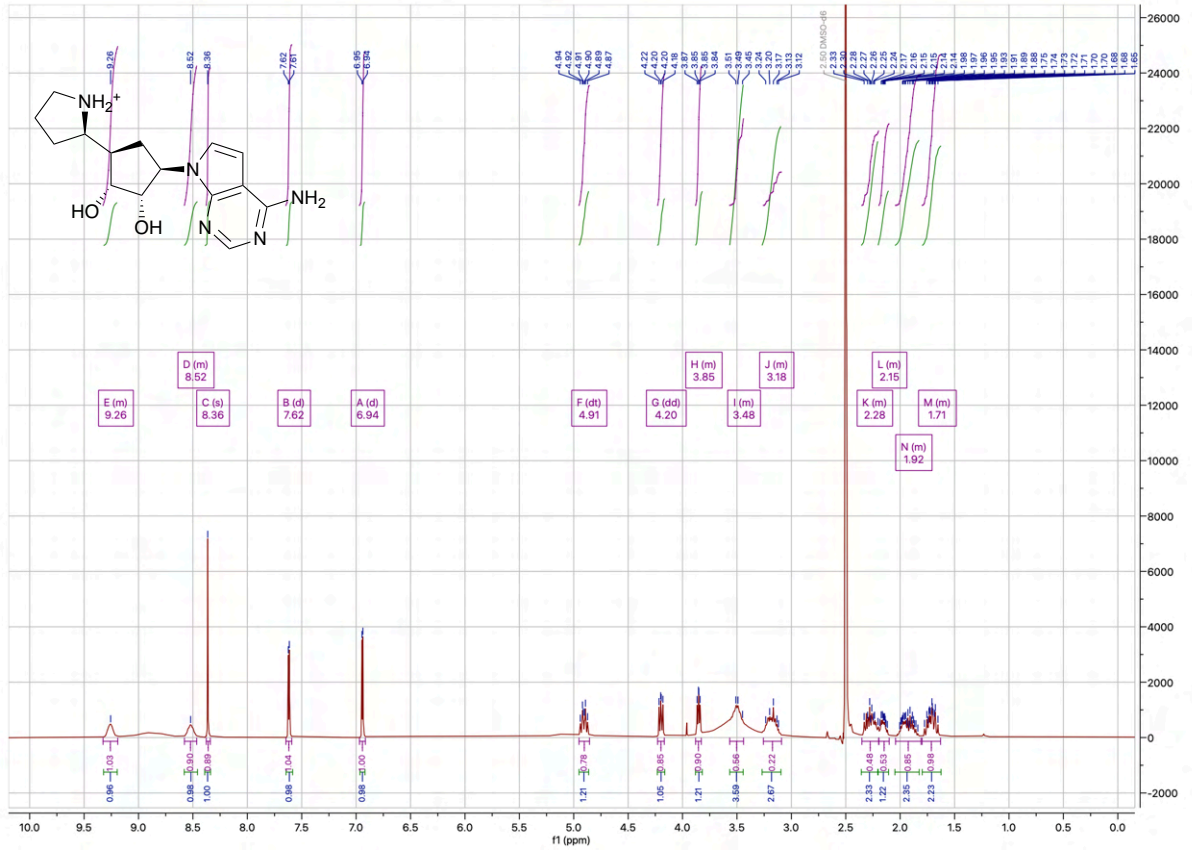
Compound 7a



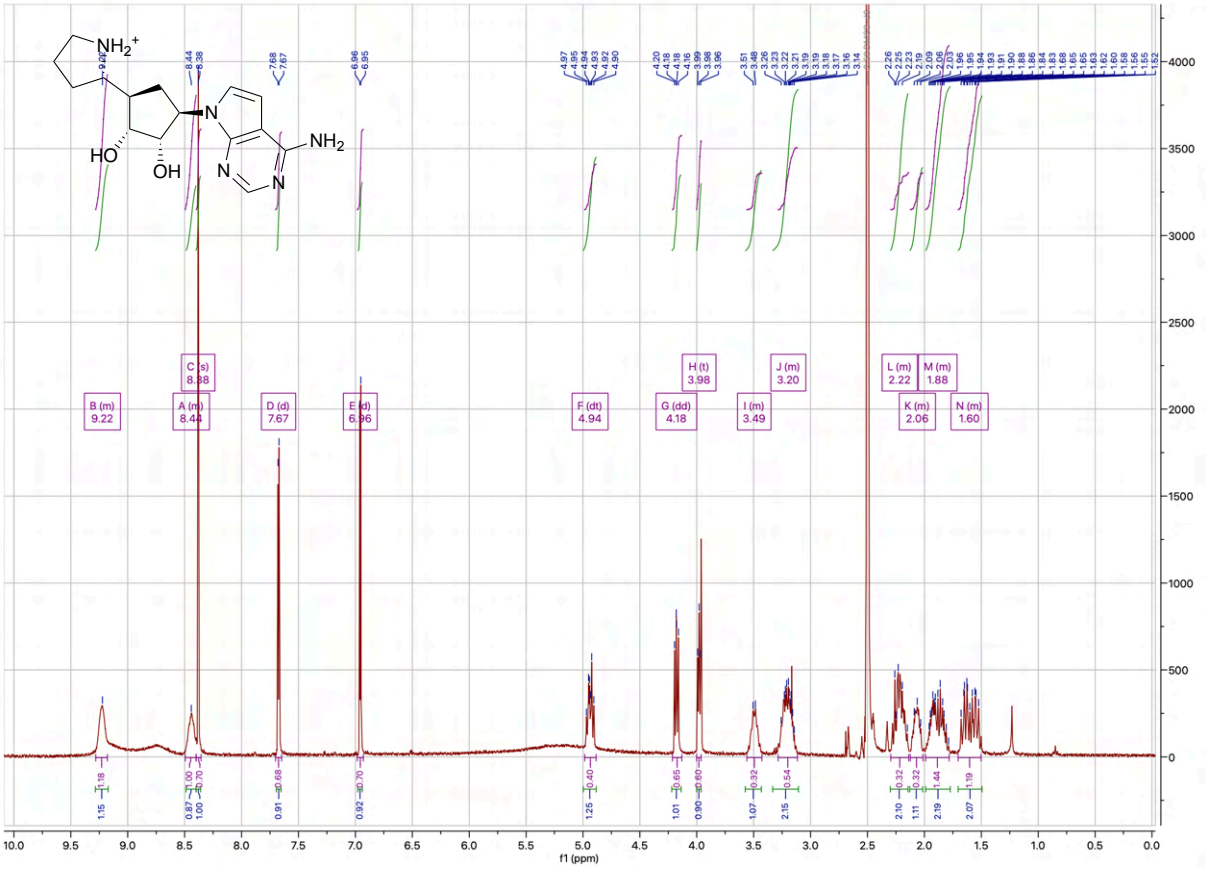
Compound 7b



Compound 7c

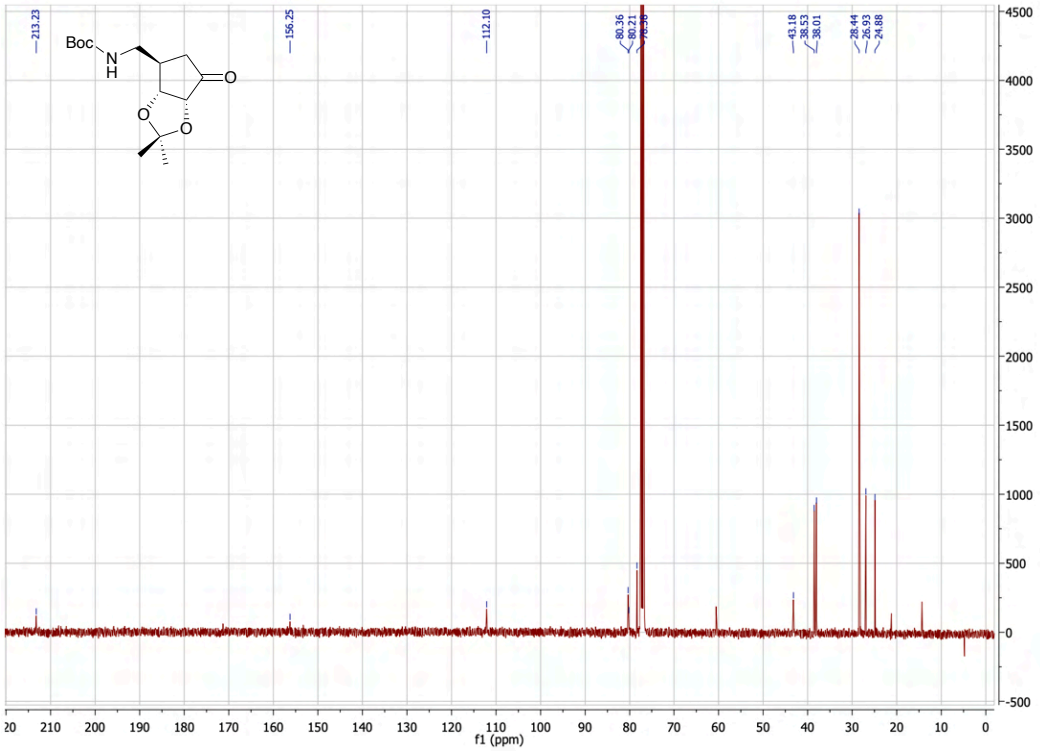


Compound 7d

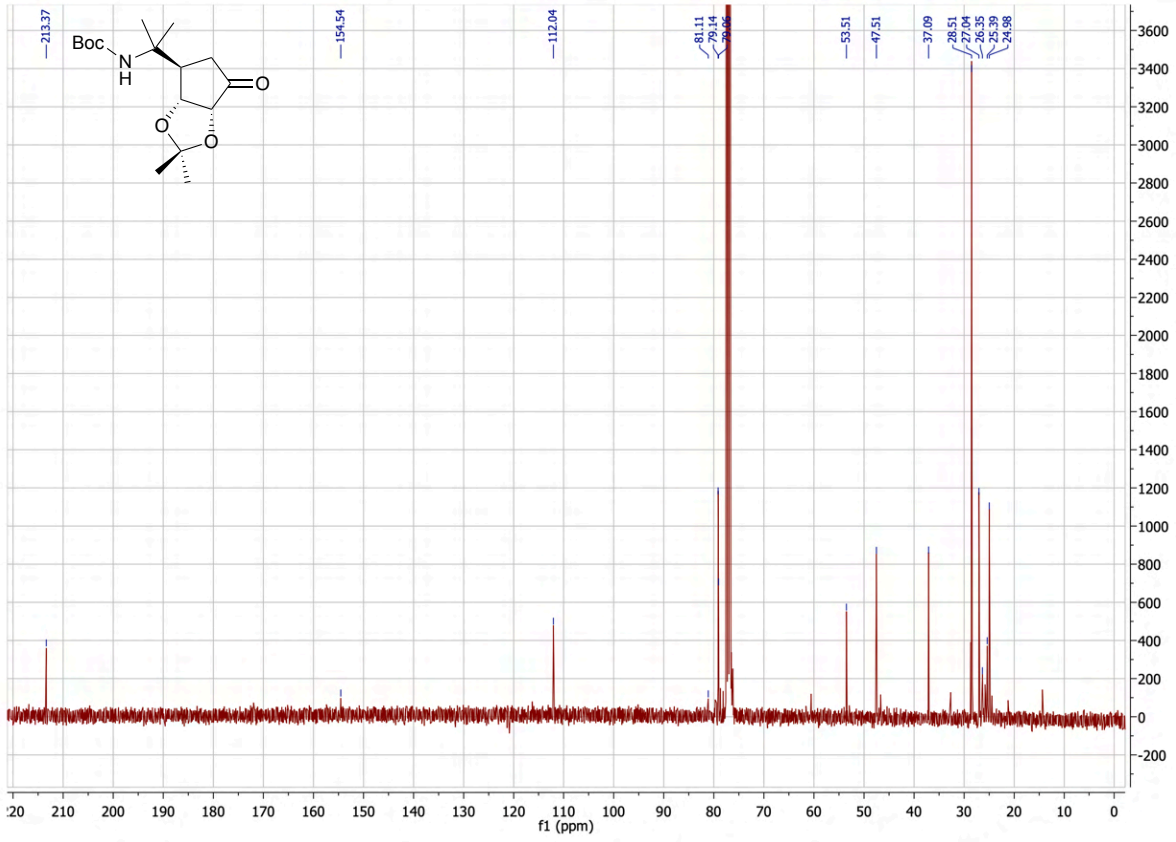


^{13}C-Spectra

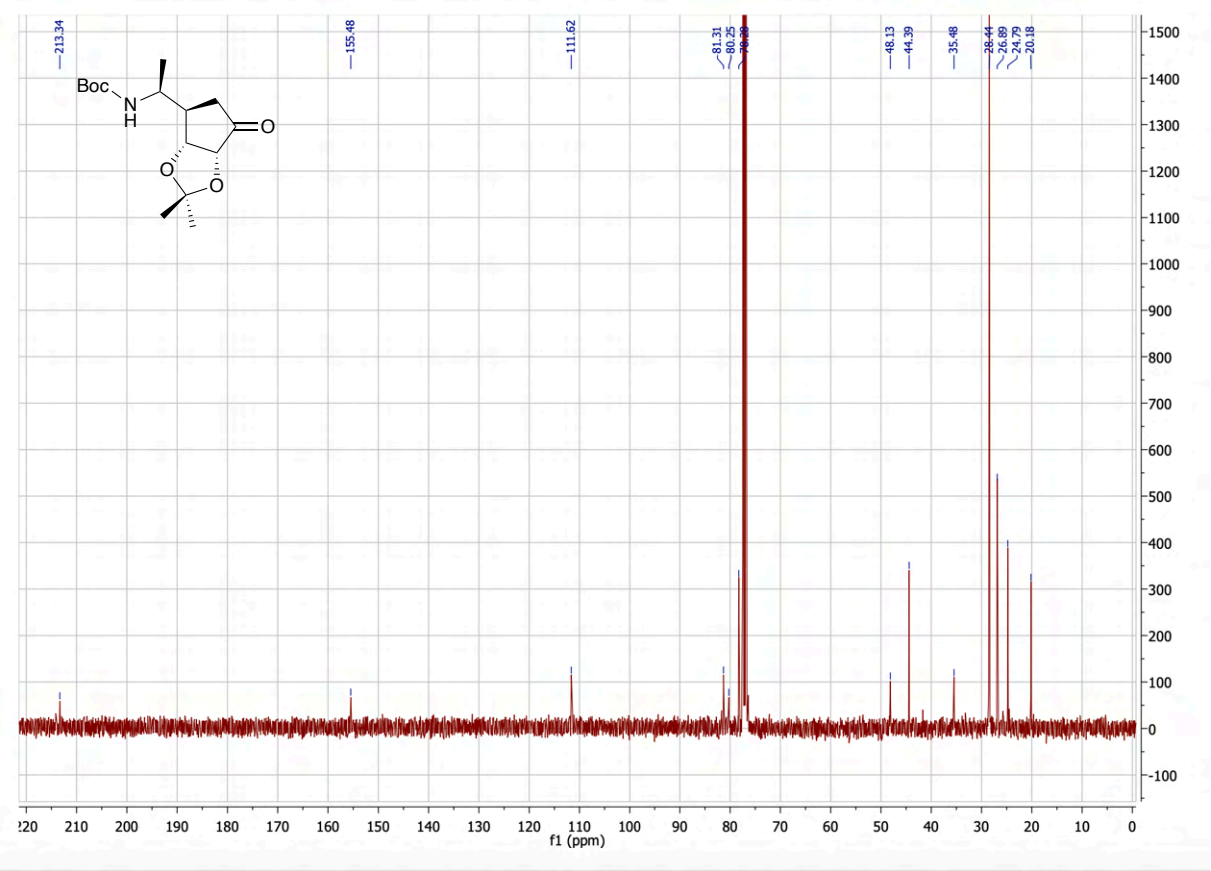
Compound 3a



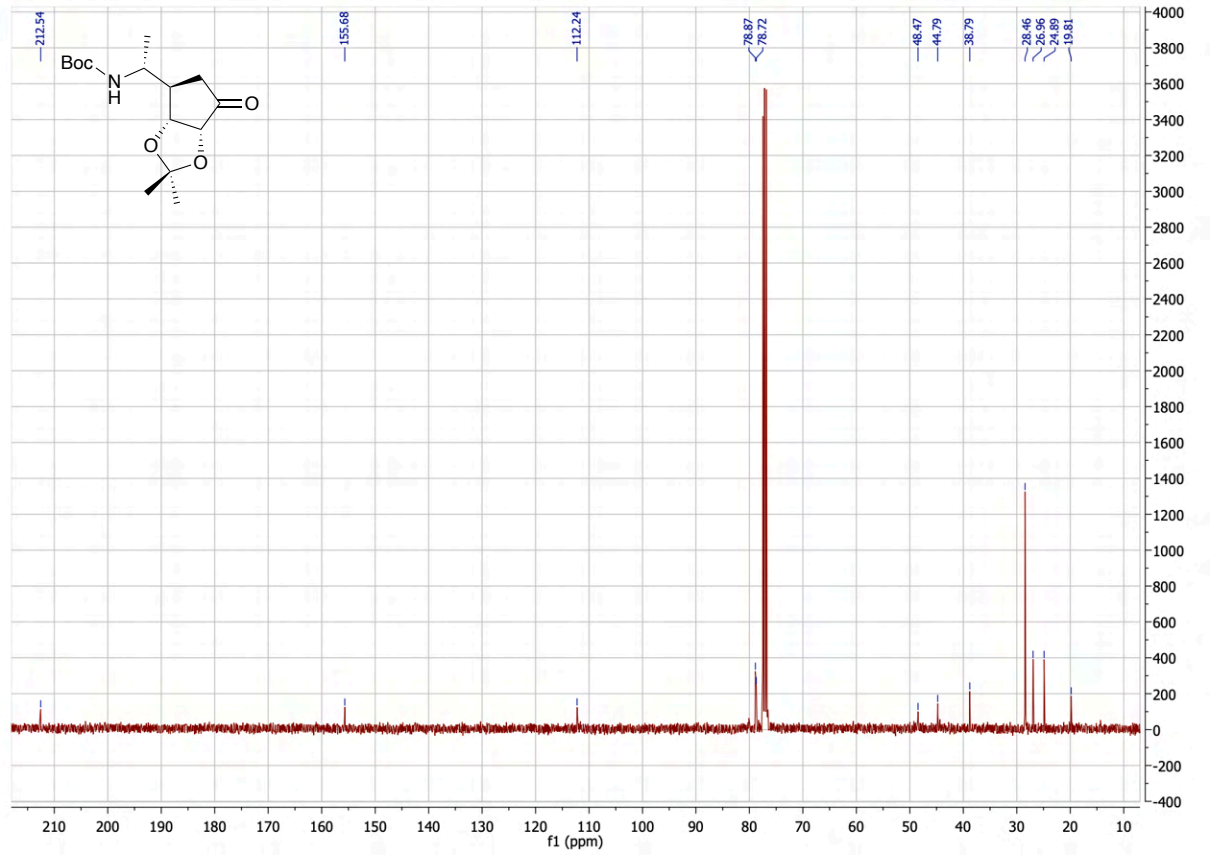
Compound 3b



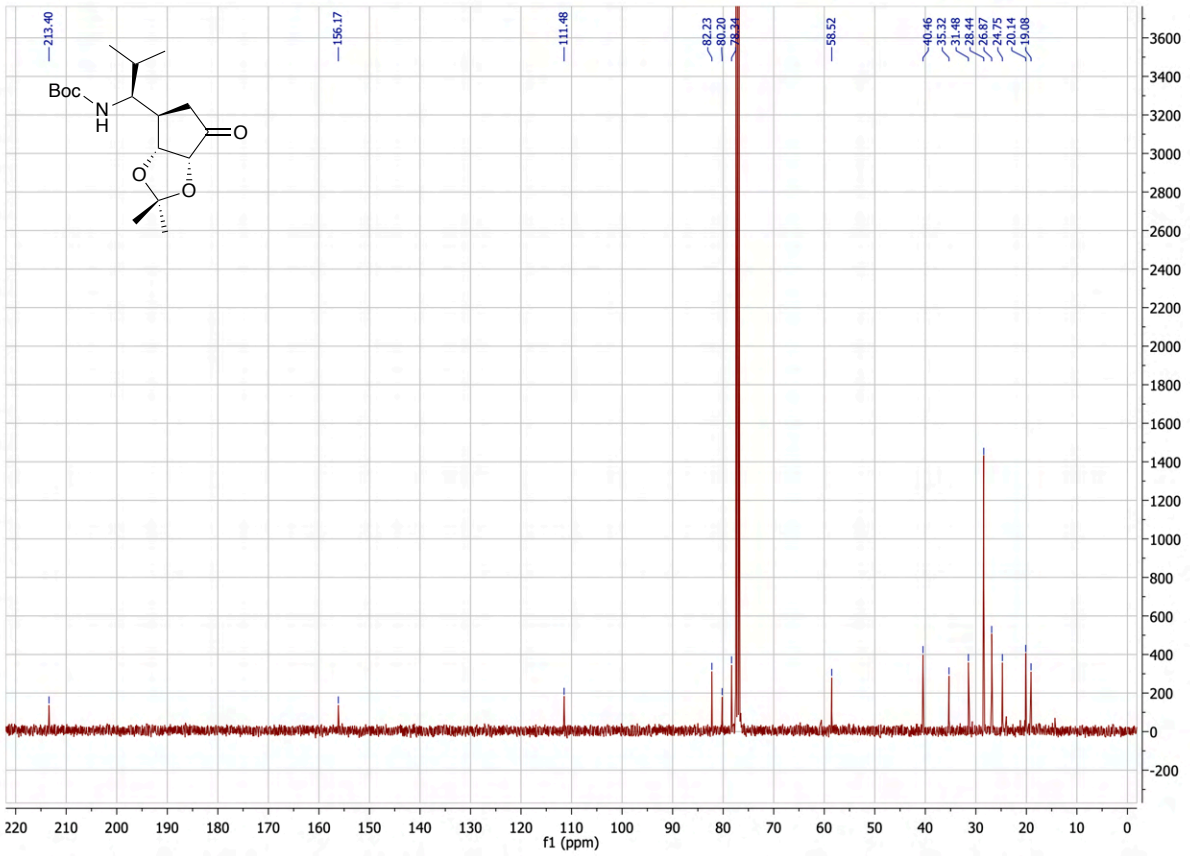
Compound 3c



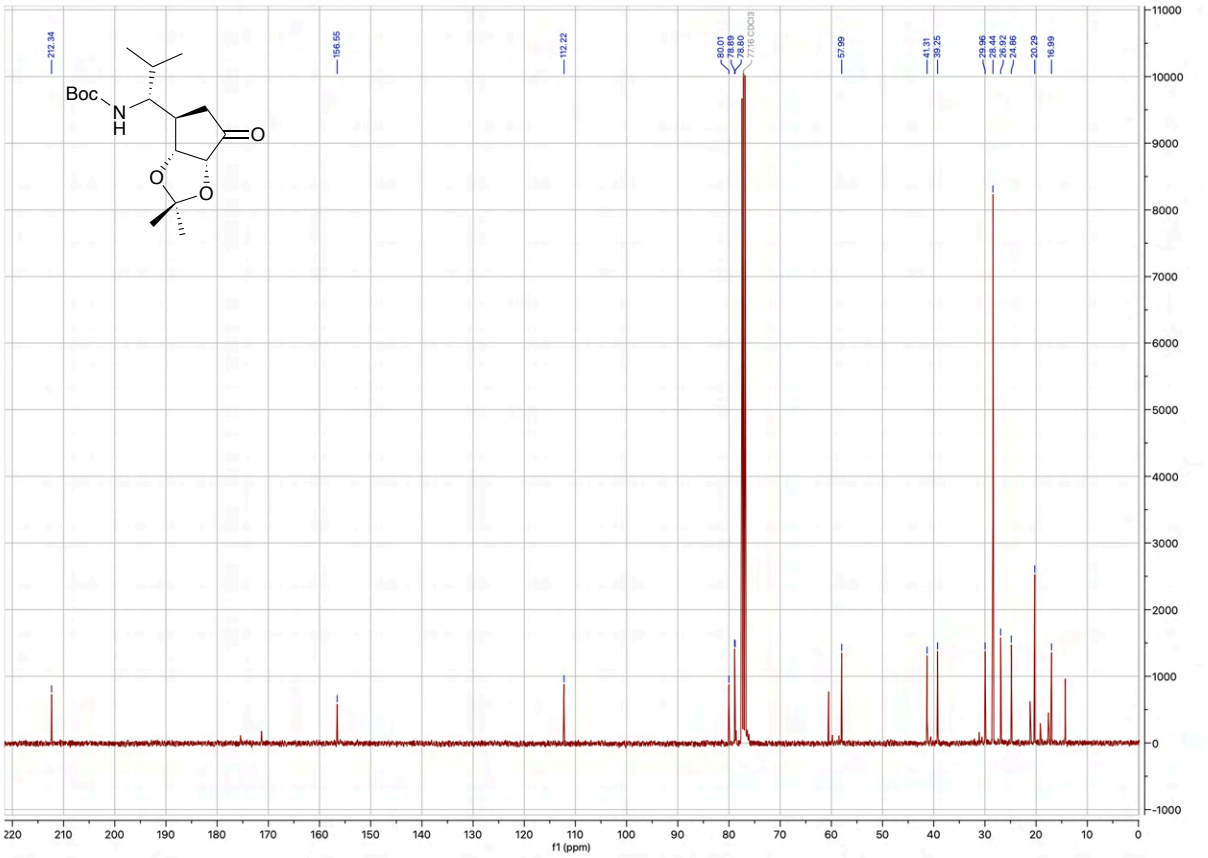
Compound 3d



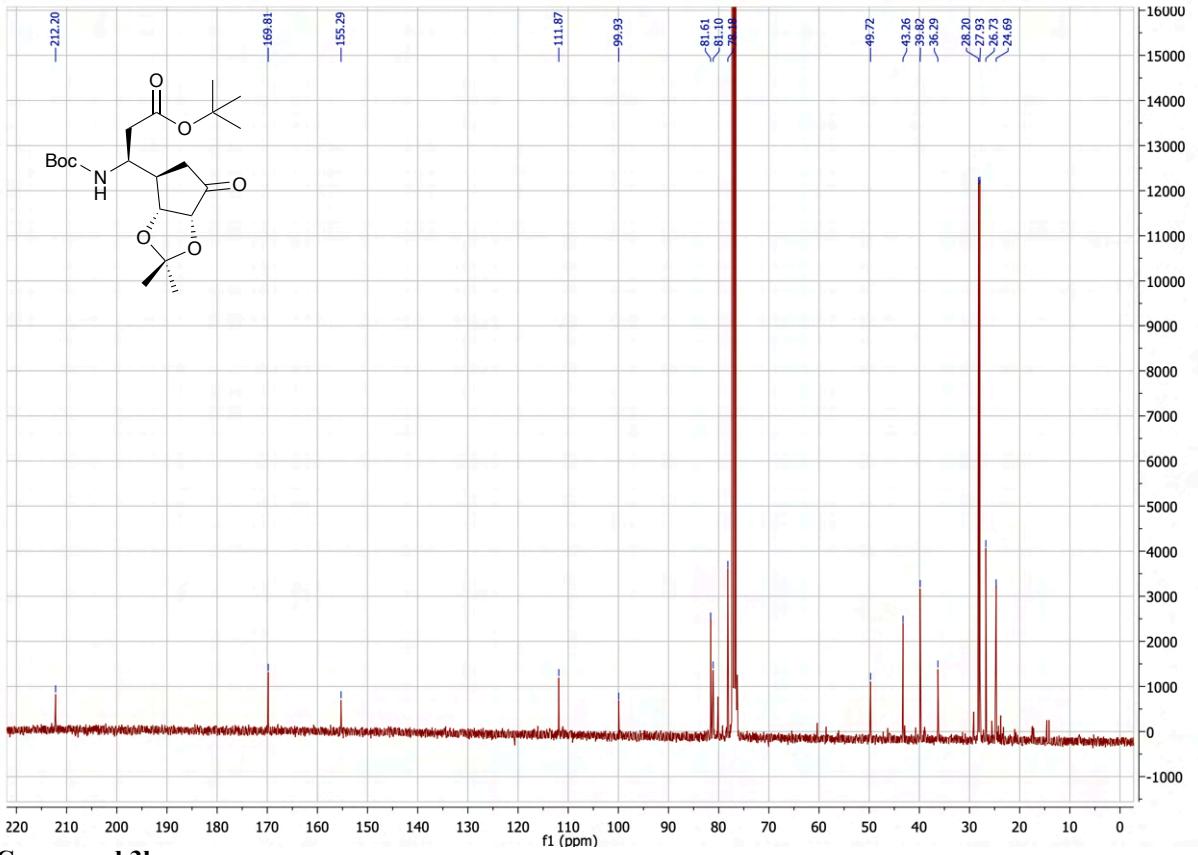
Compound 3e



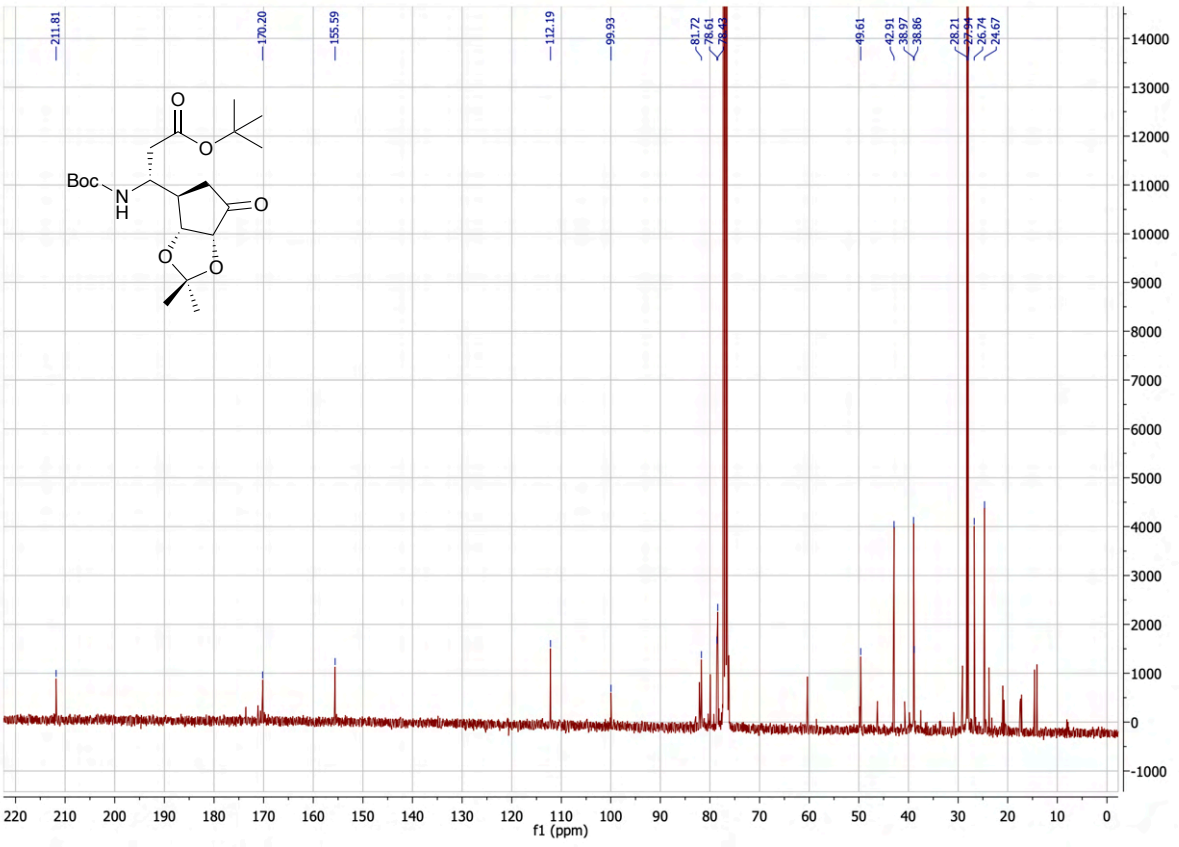
Compound 3f



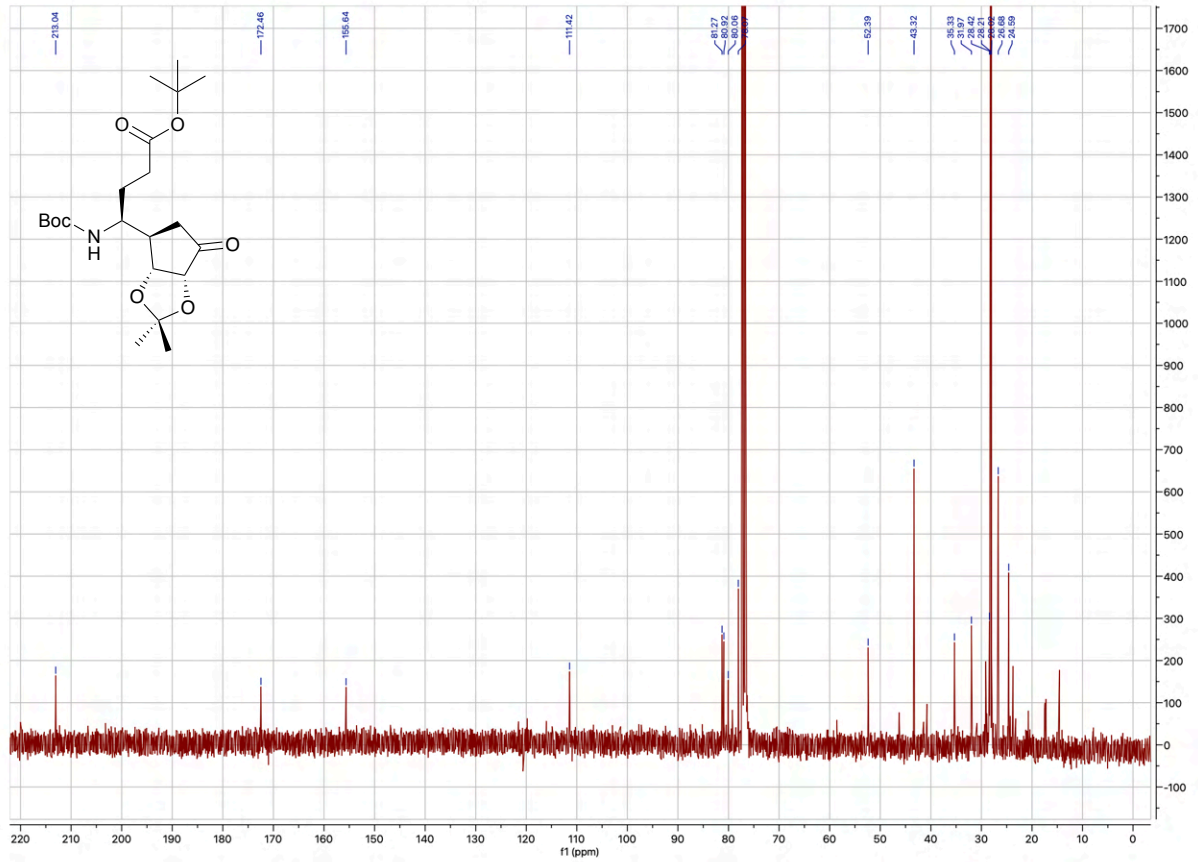
Compound 3g



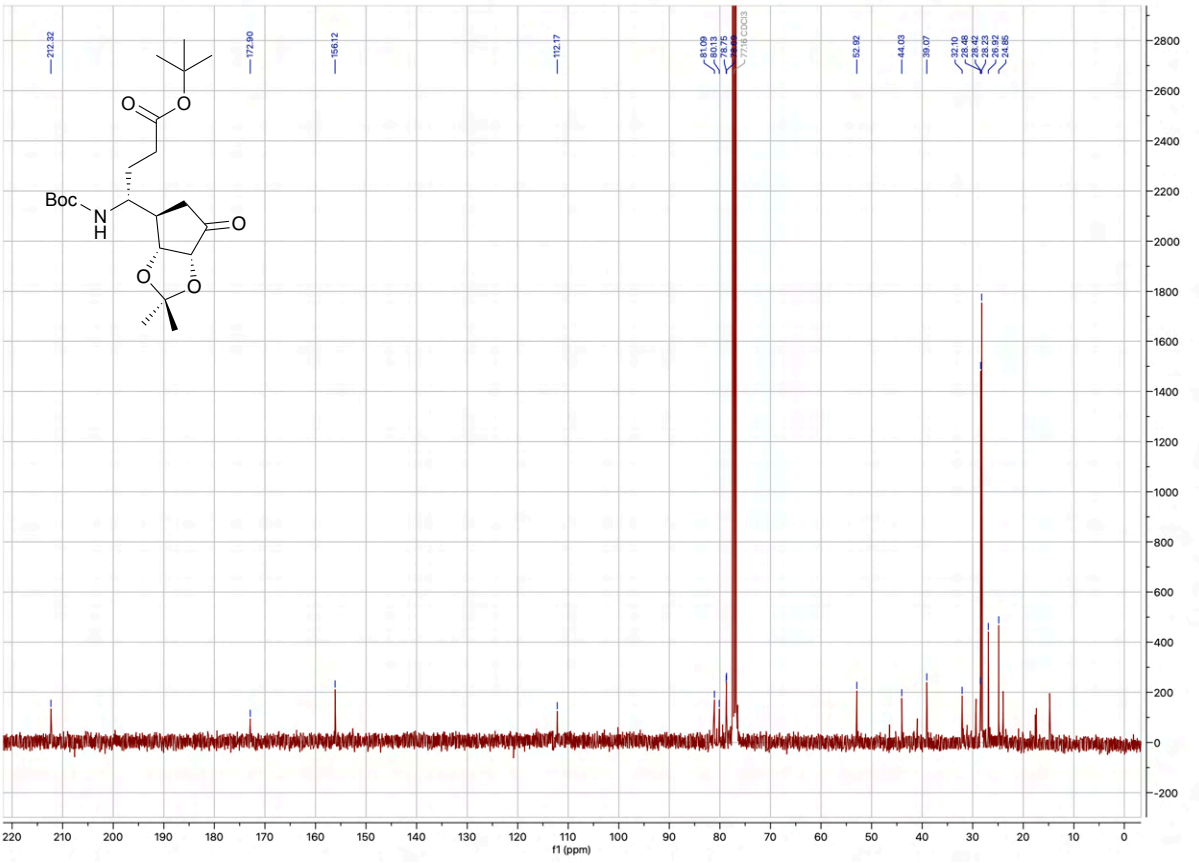
Compound 3h



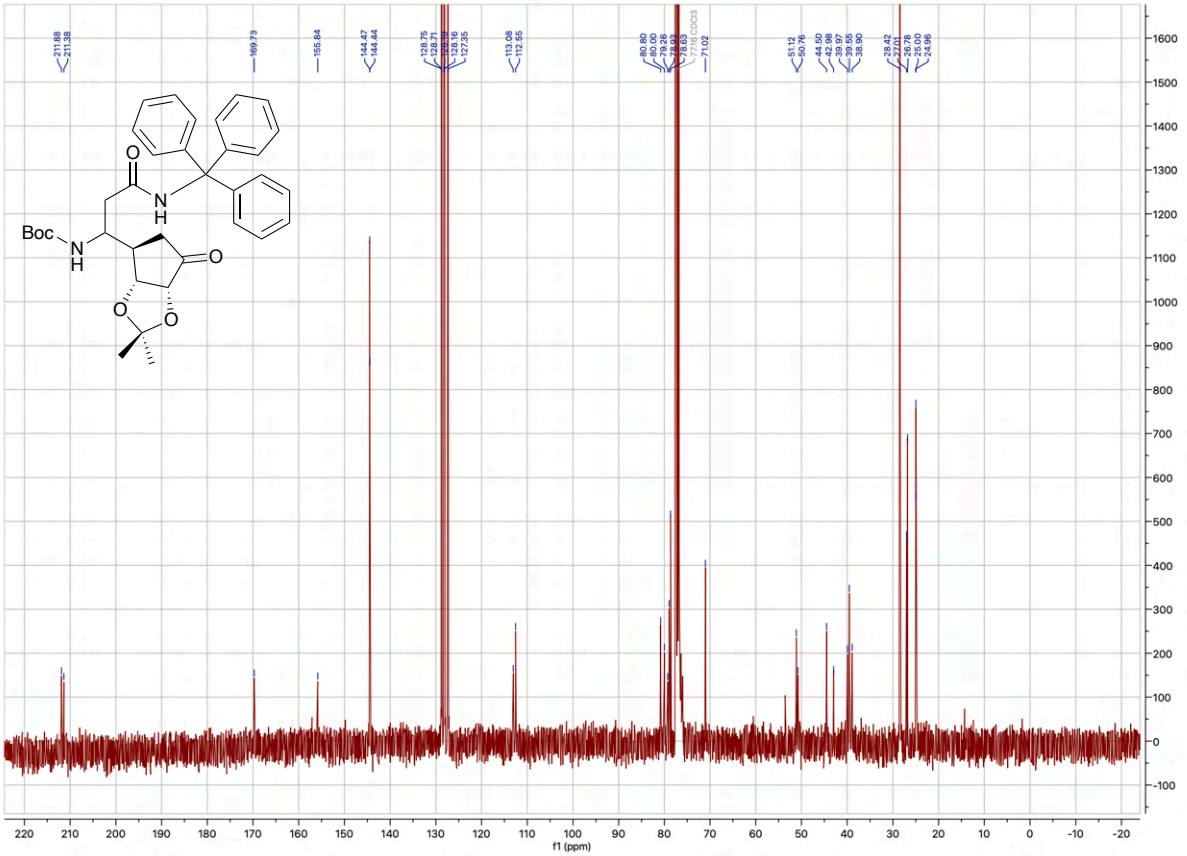
Compound 3i



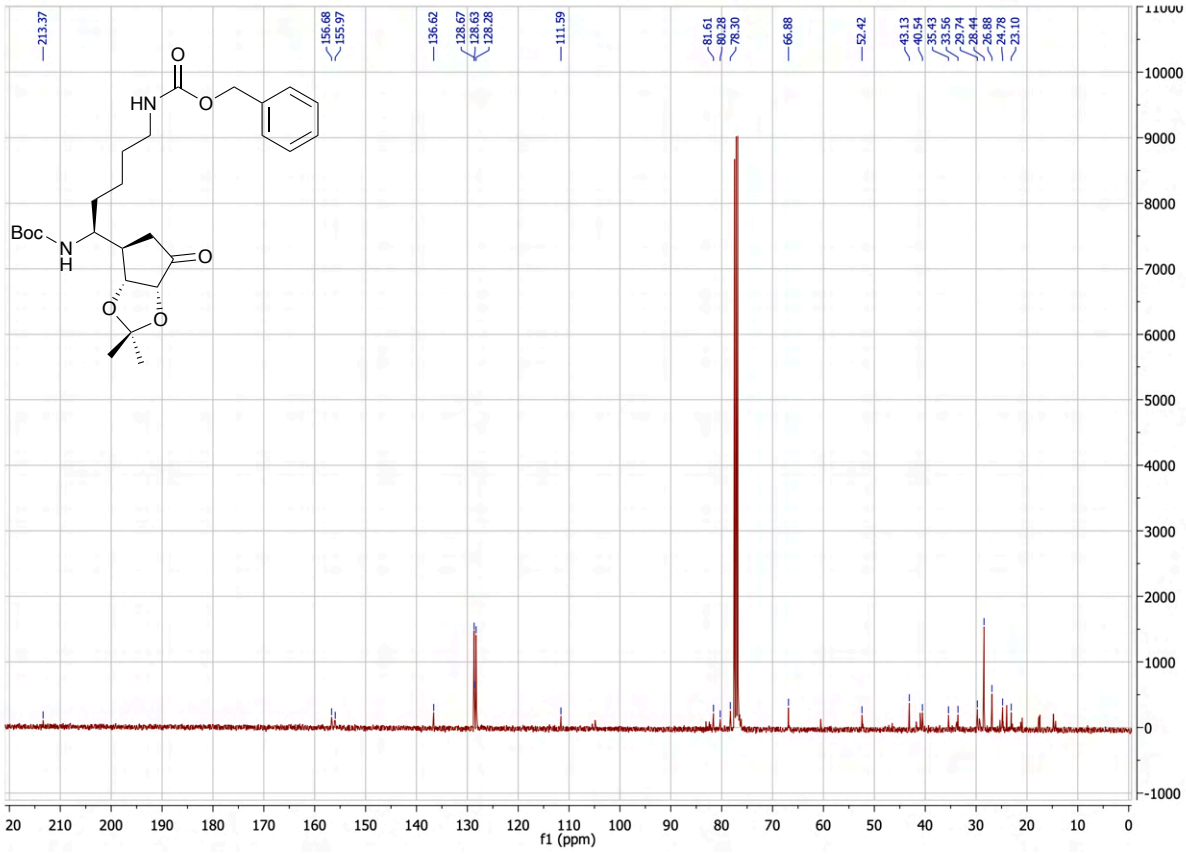
Compound 3j



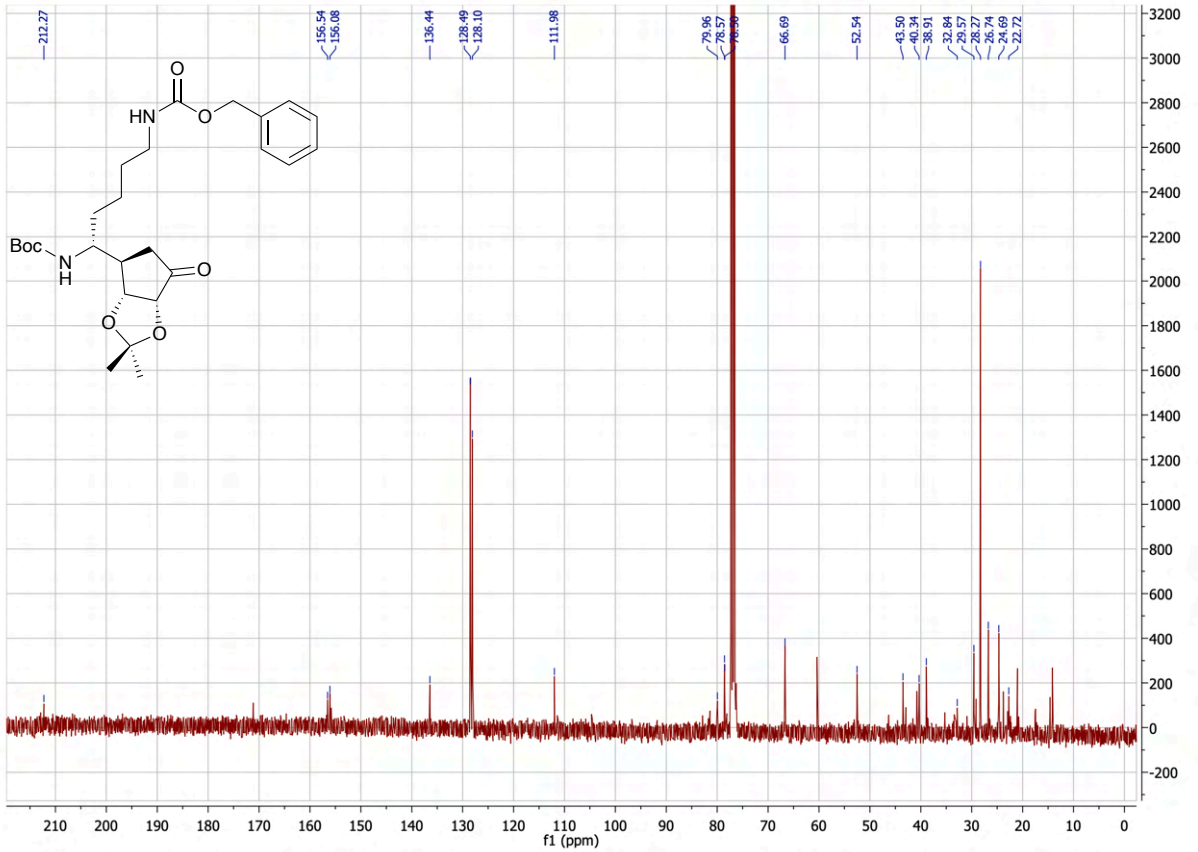
Compound 3k



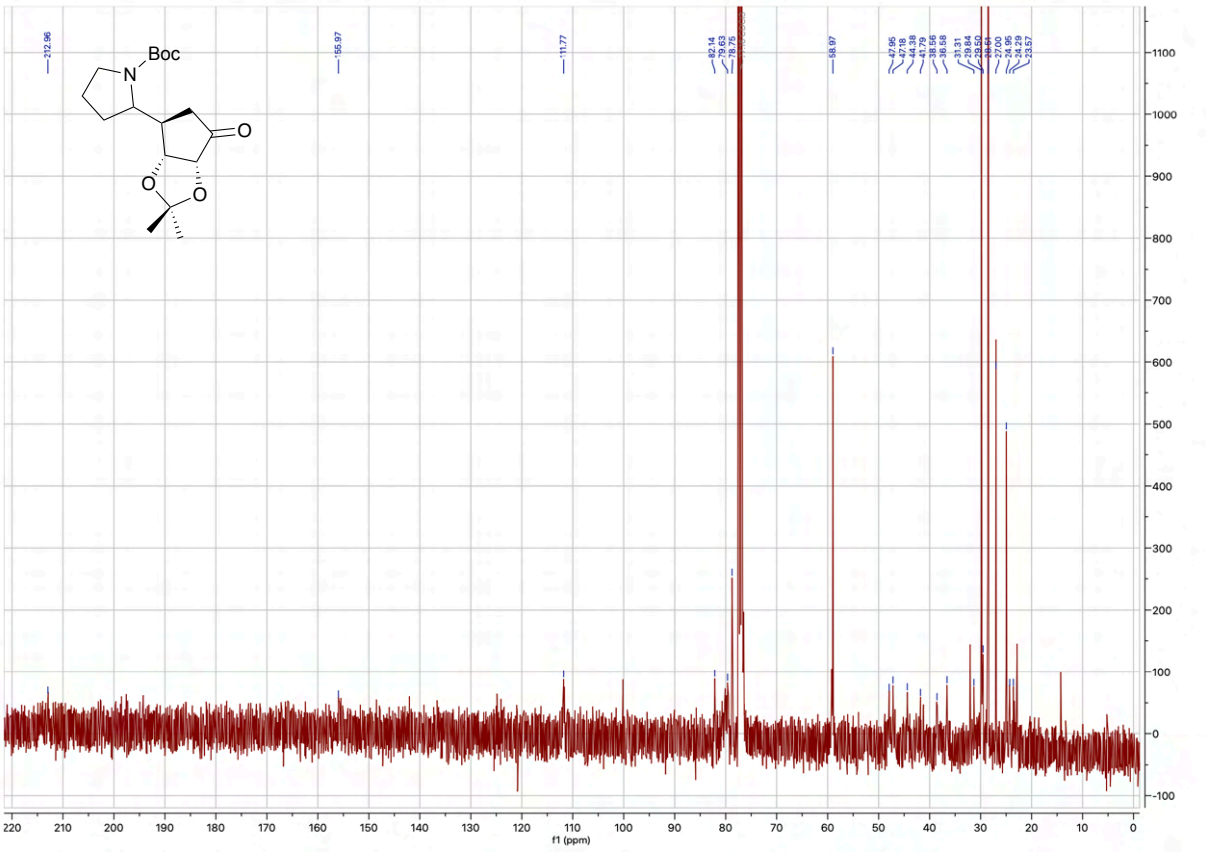
Compound 3l



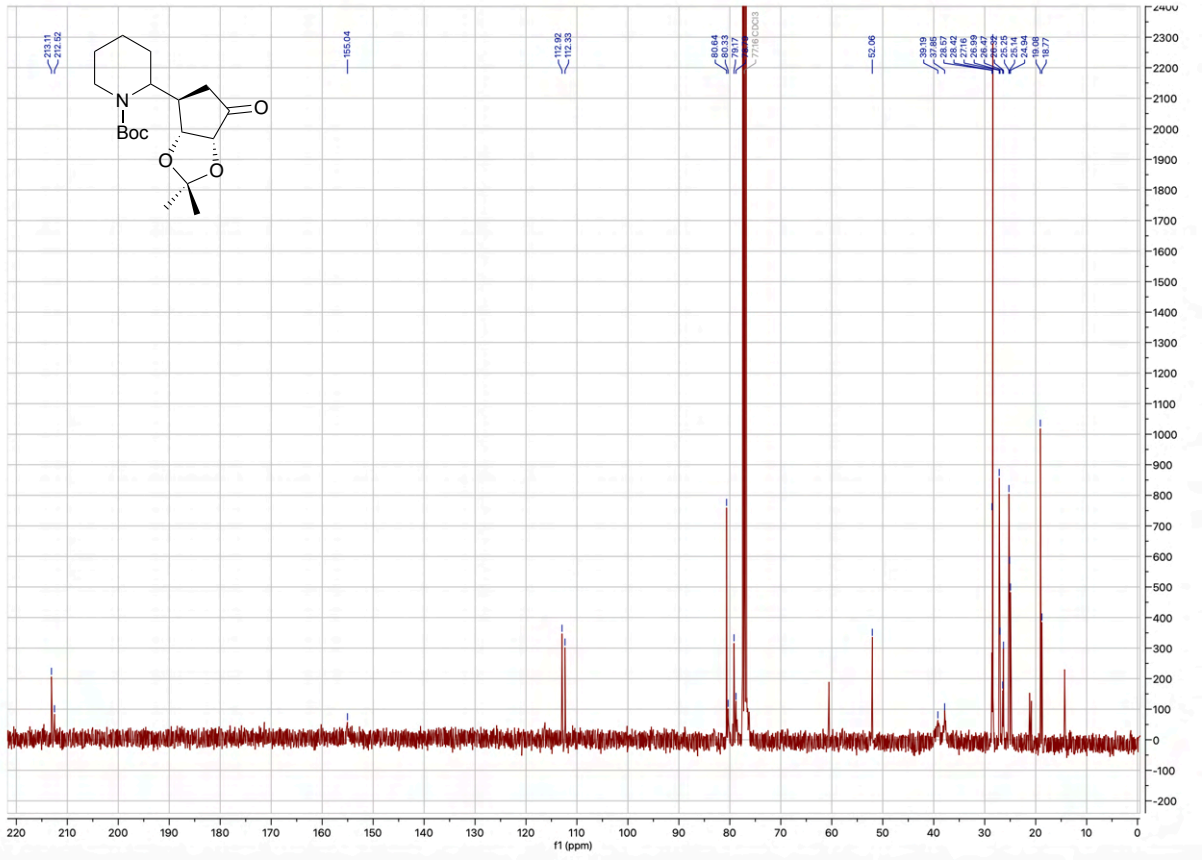
Compound 3m



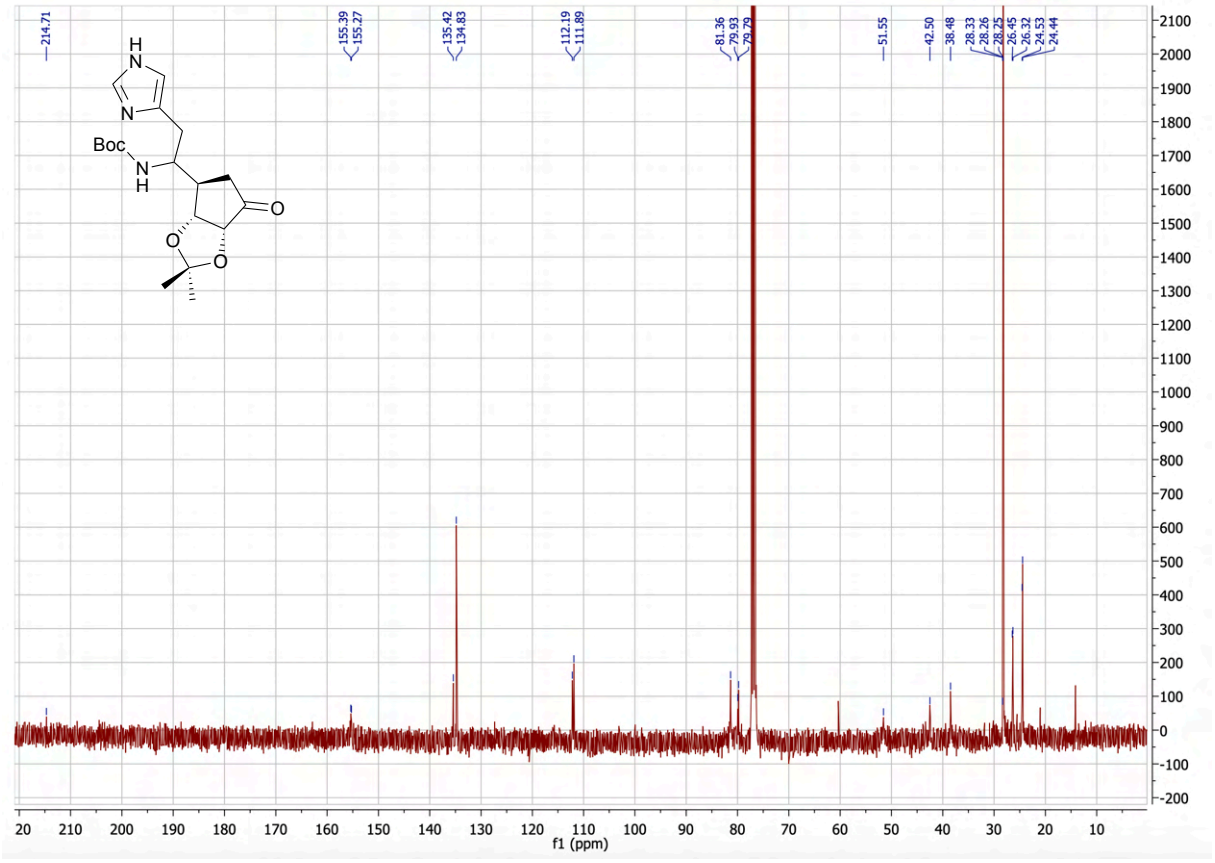
Compound 3n



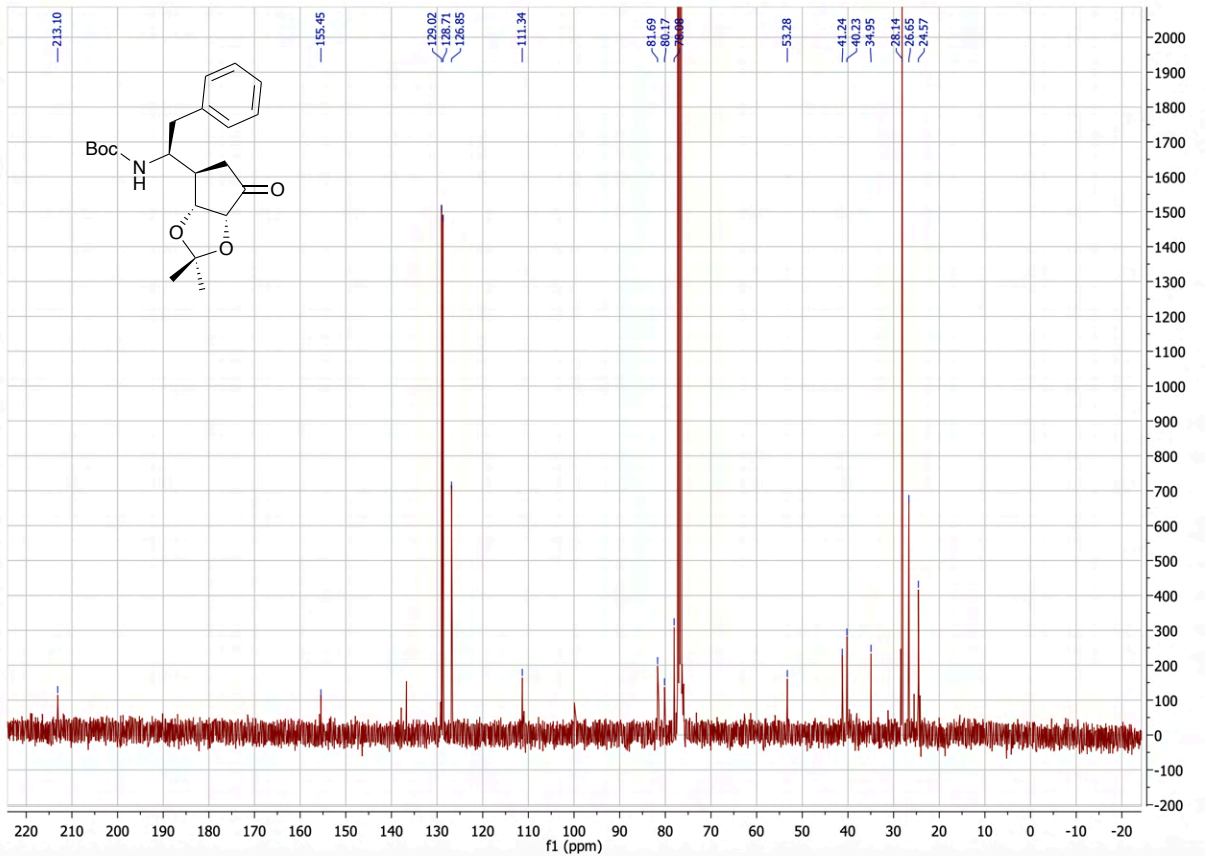
Compound 3o



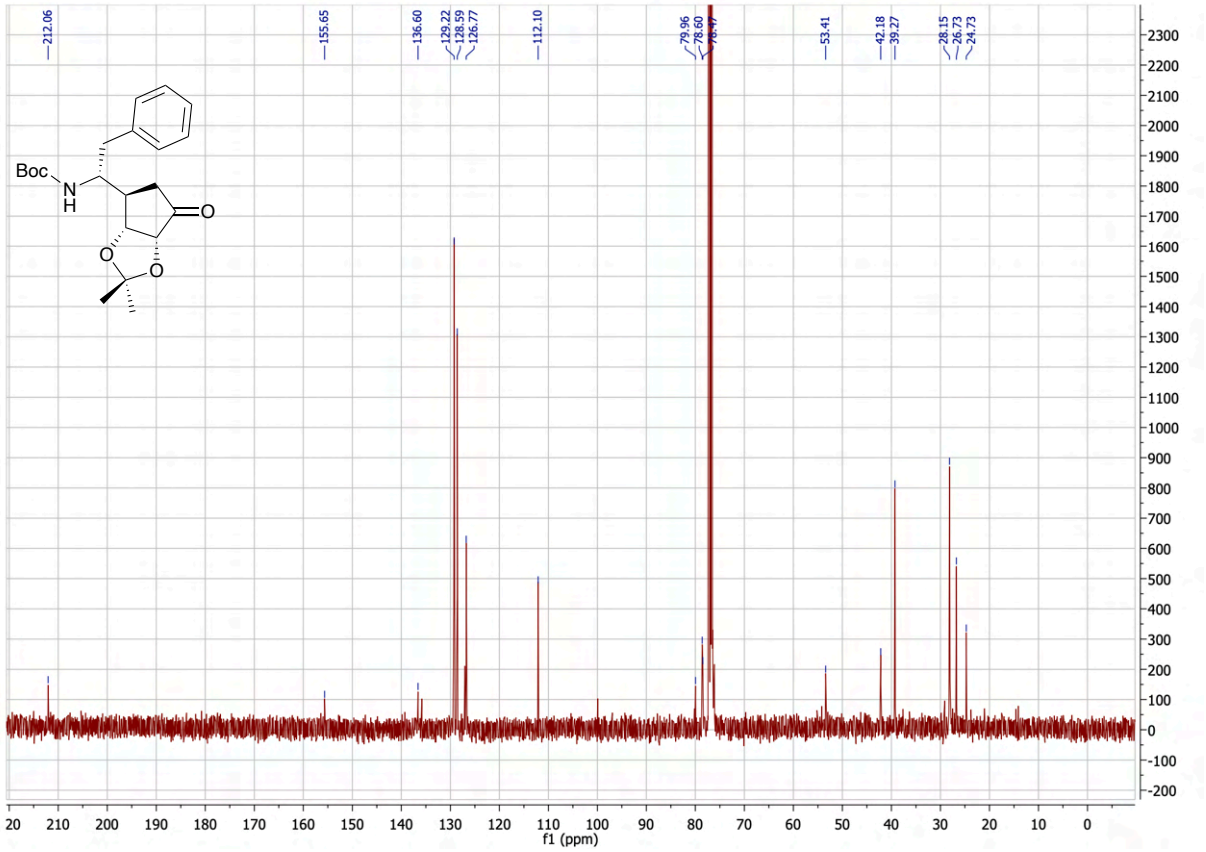
Compound 3p



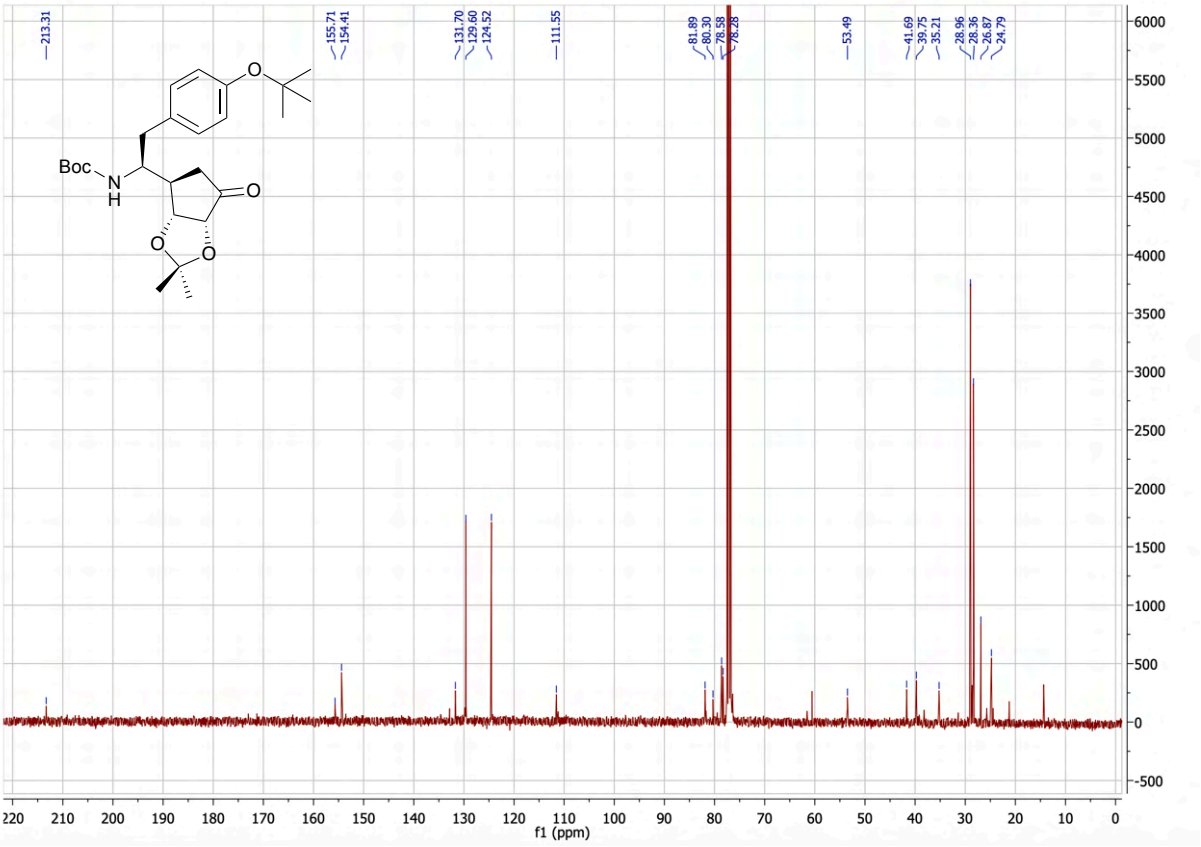
Compound 3q



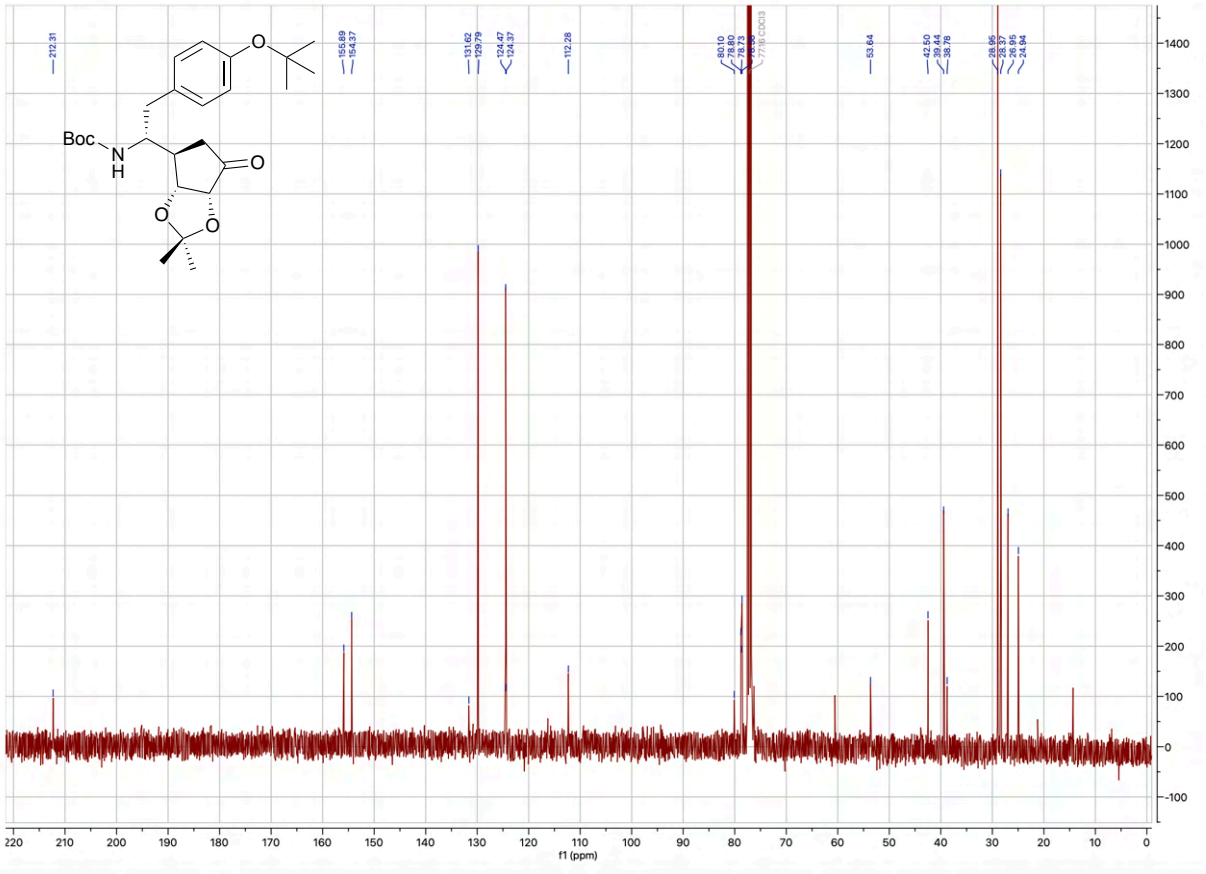
Compound 3r



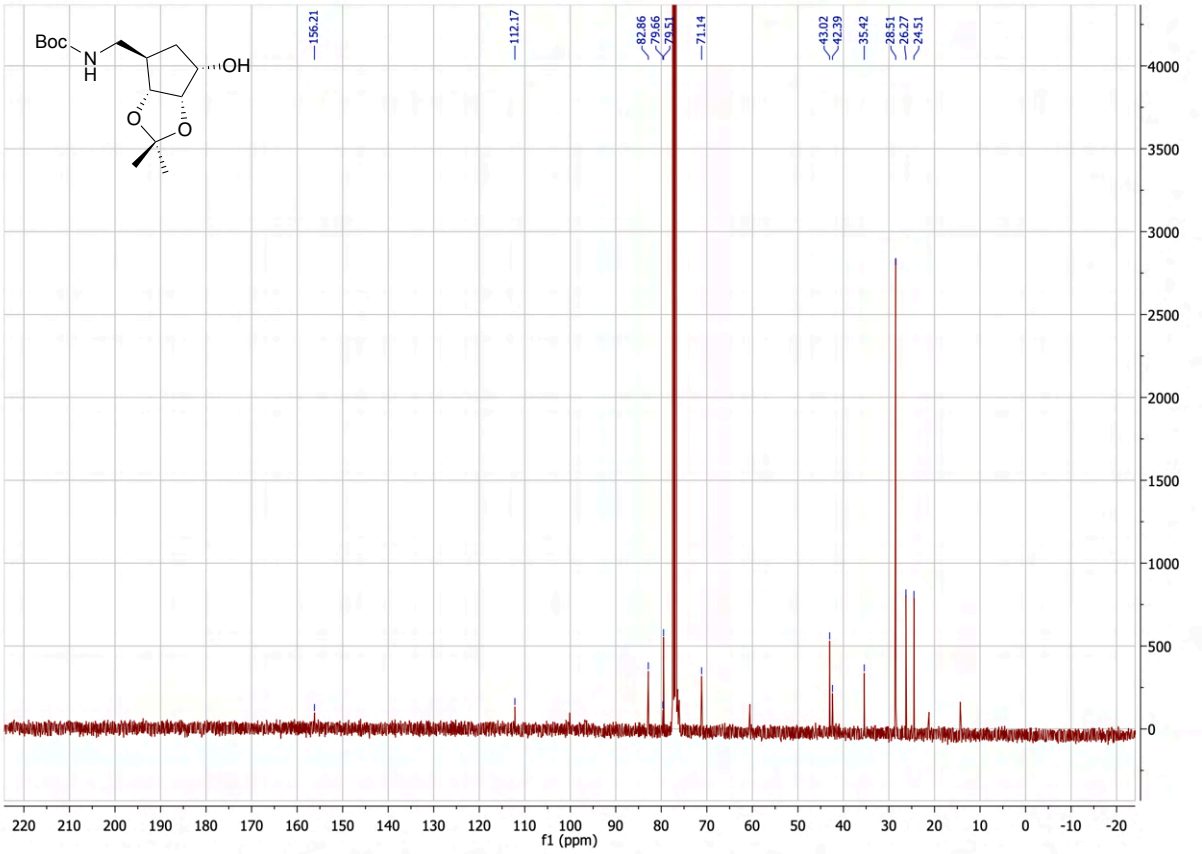
Compound 3s



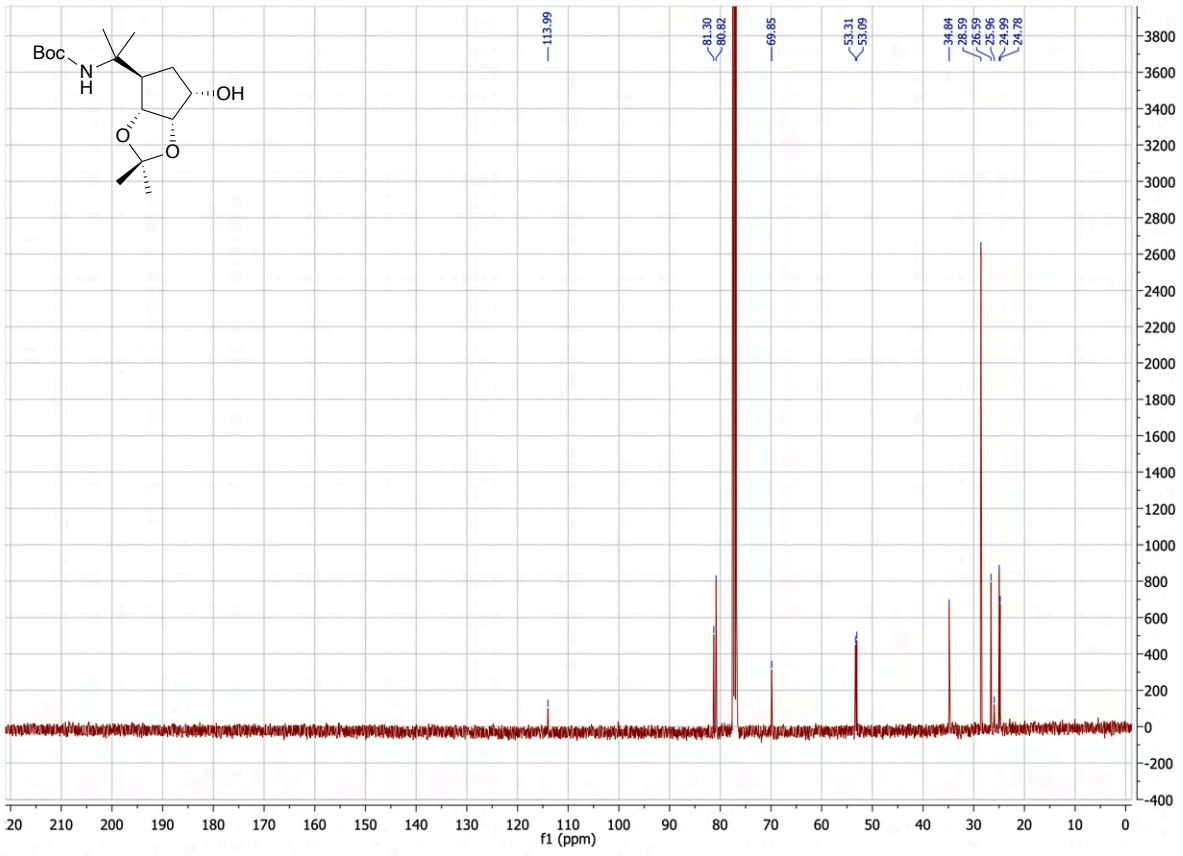
Compound 3t



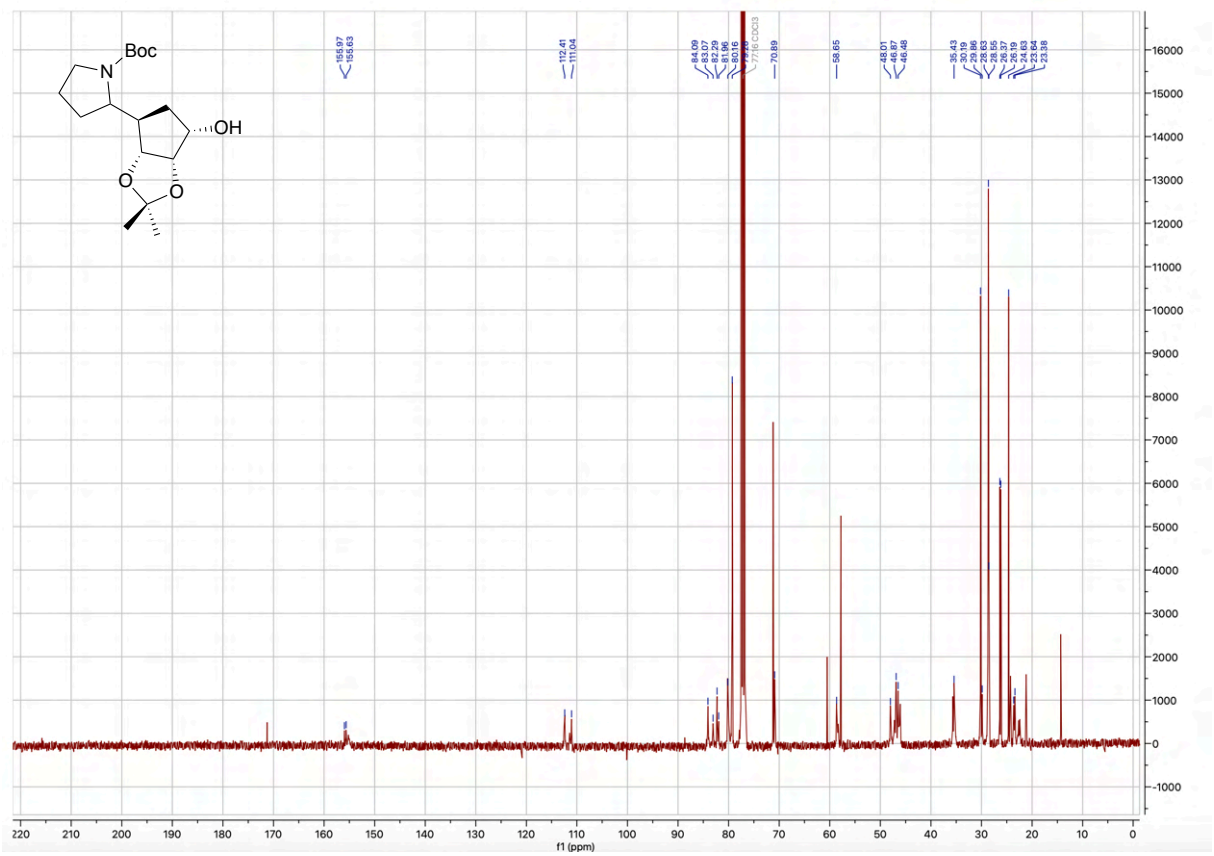
Compound 4a



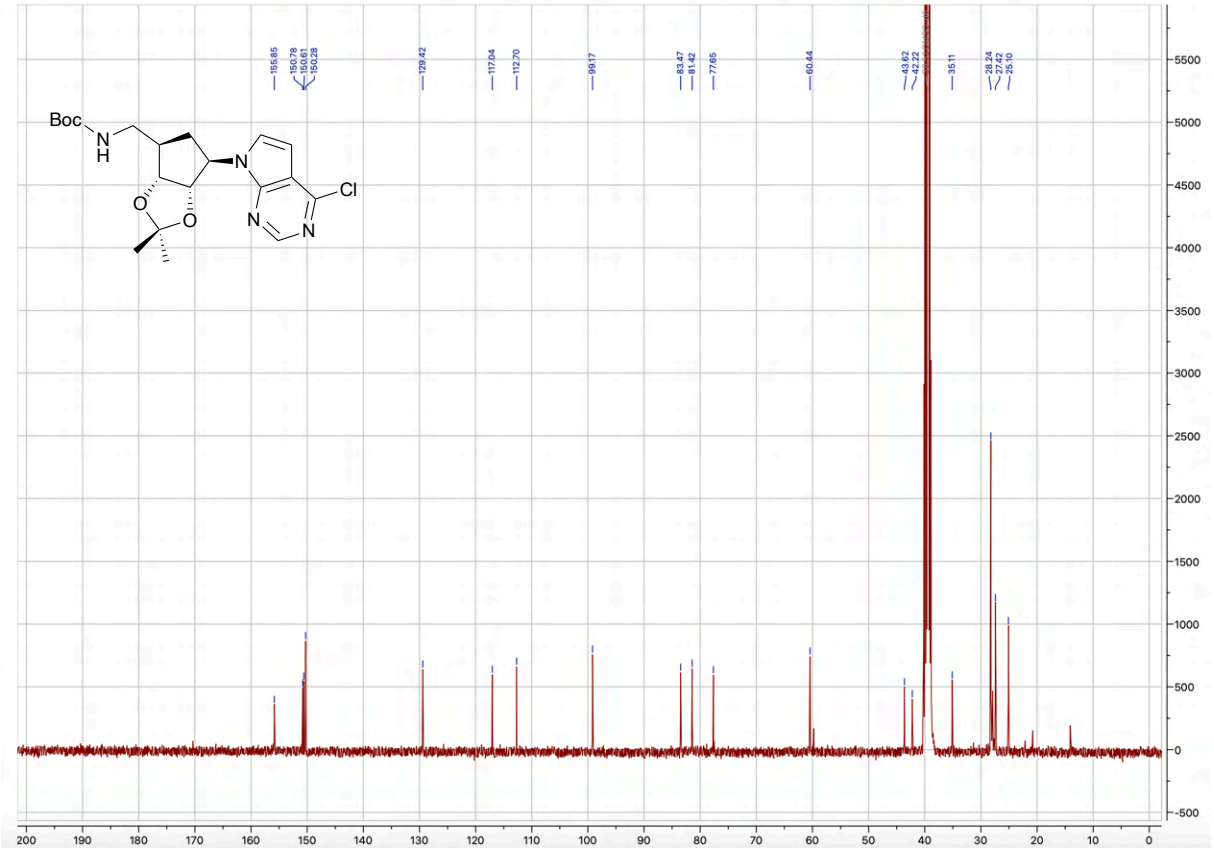
Compound 4b



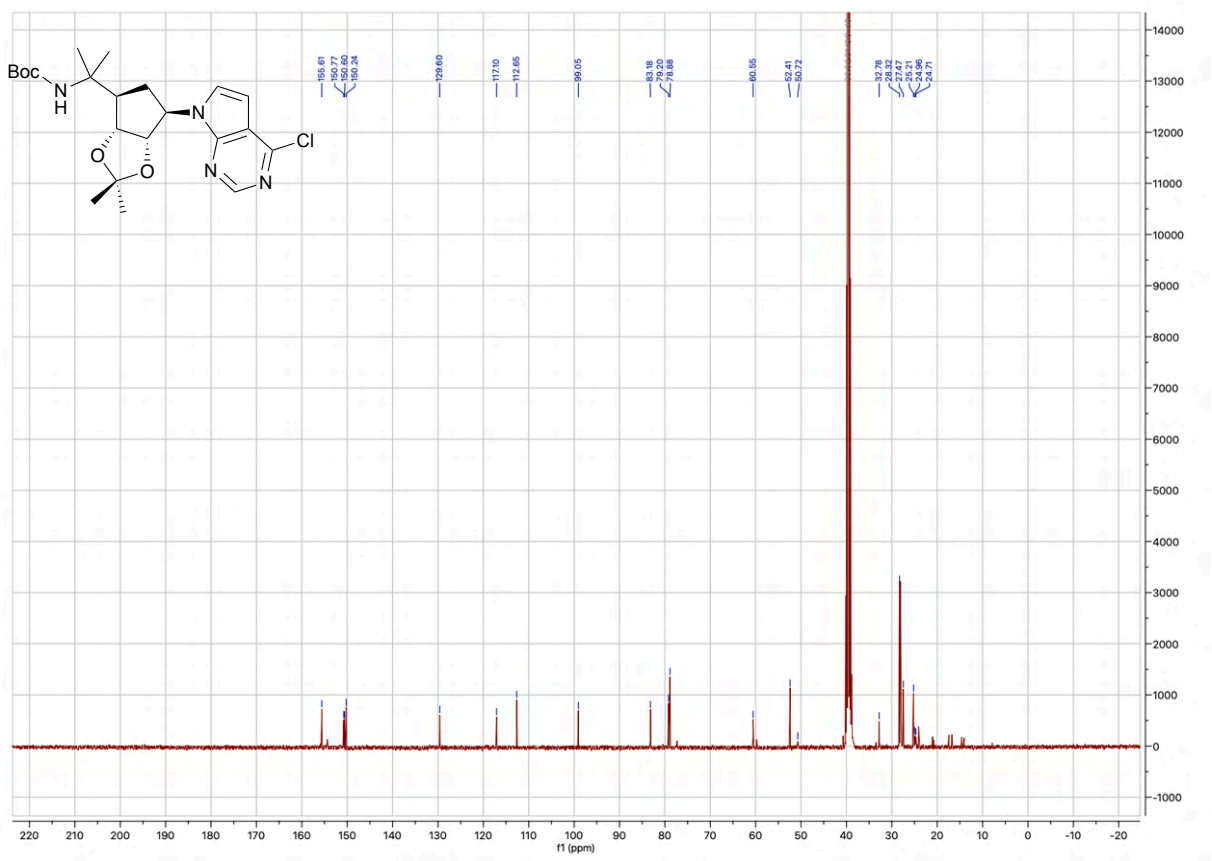
Compound 4c



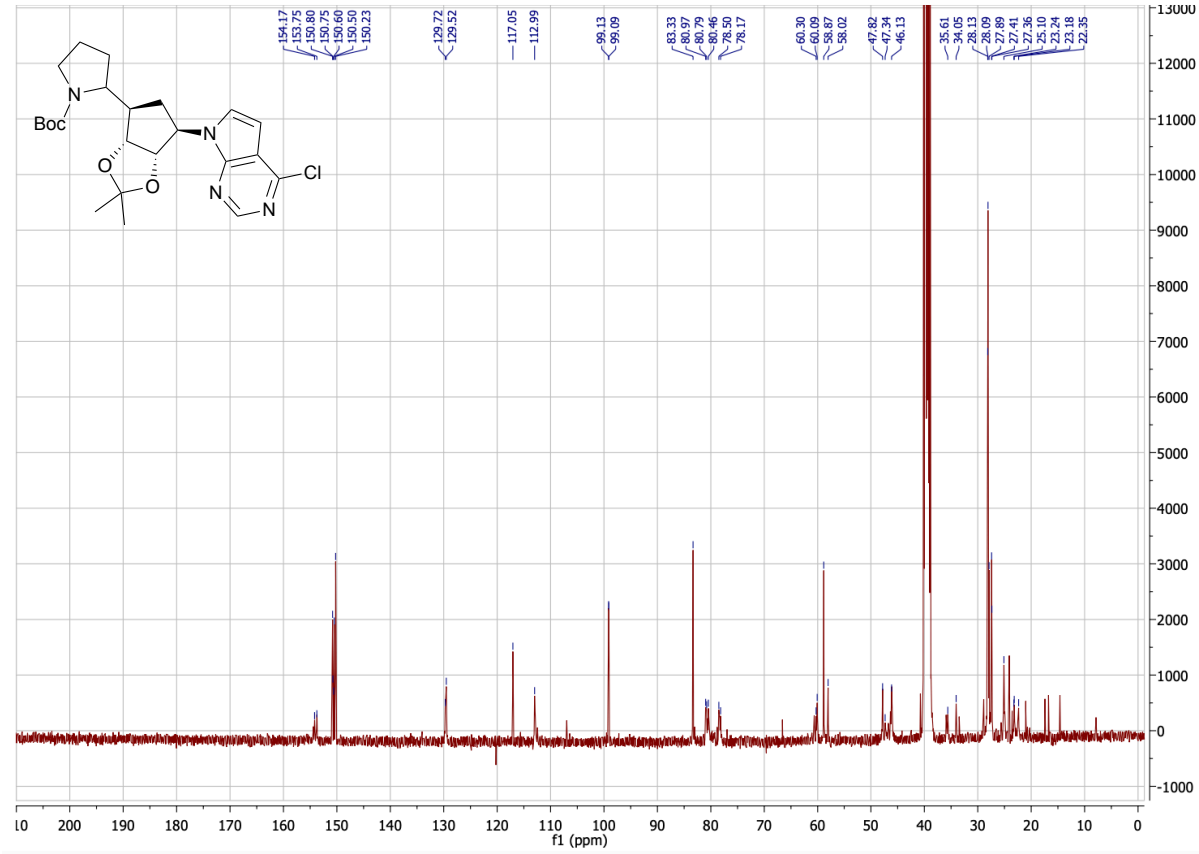
Compound 5a



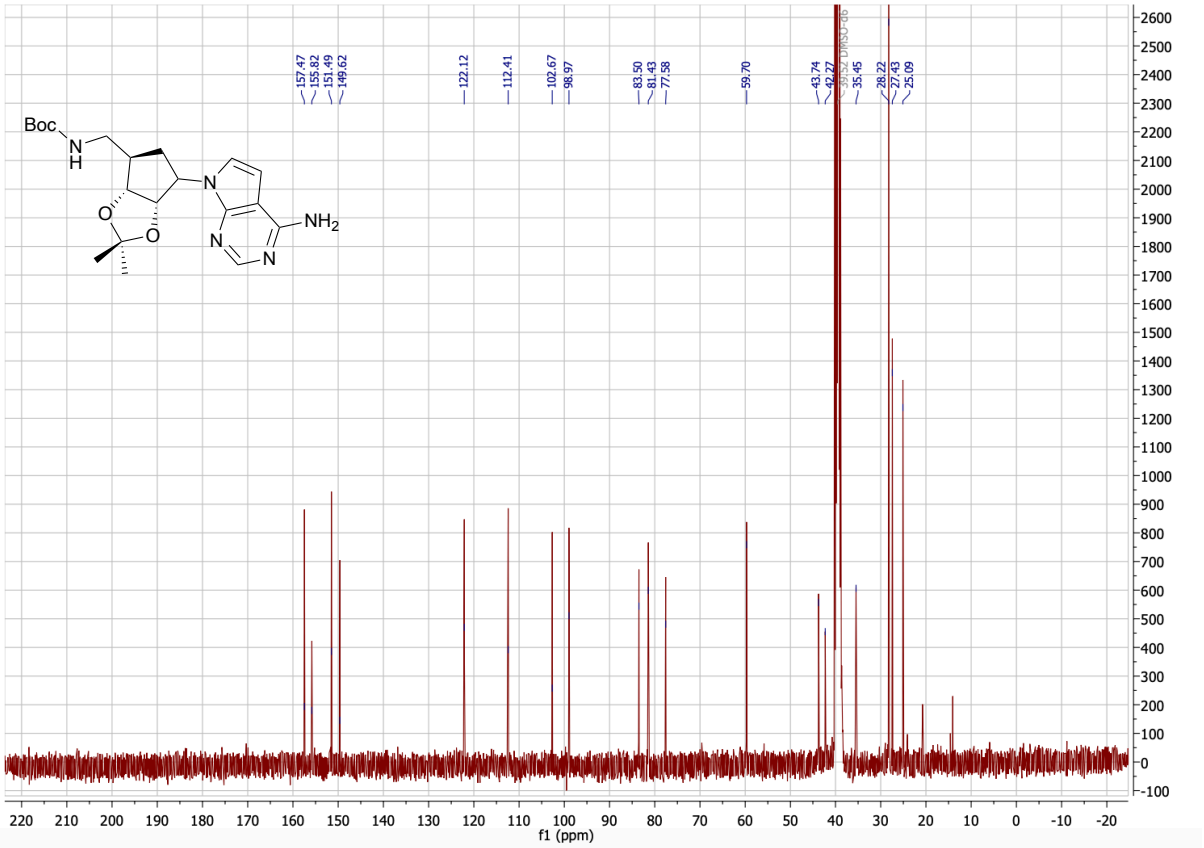
Compound 5b



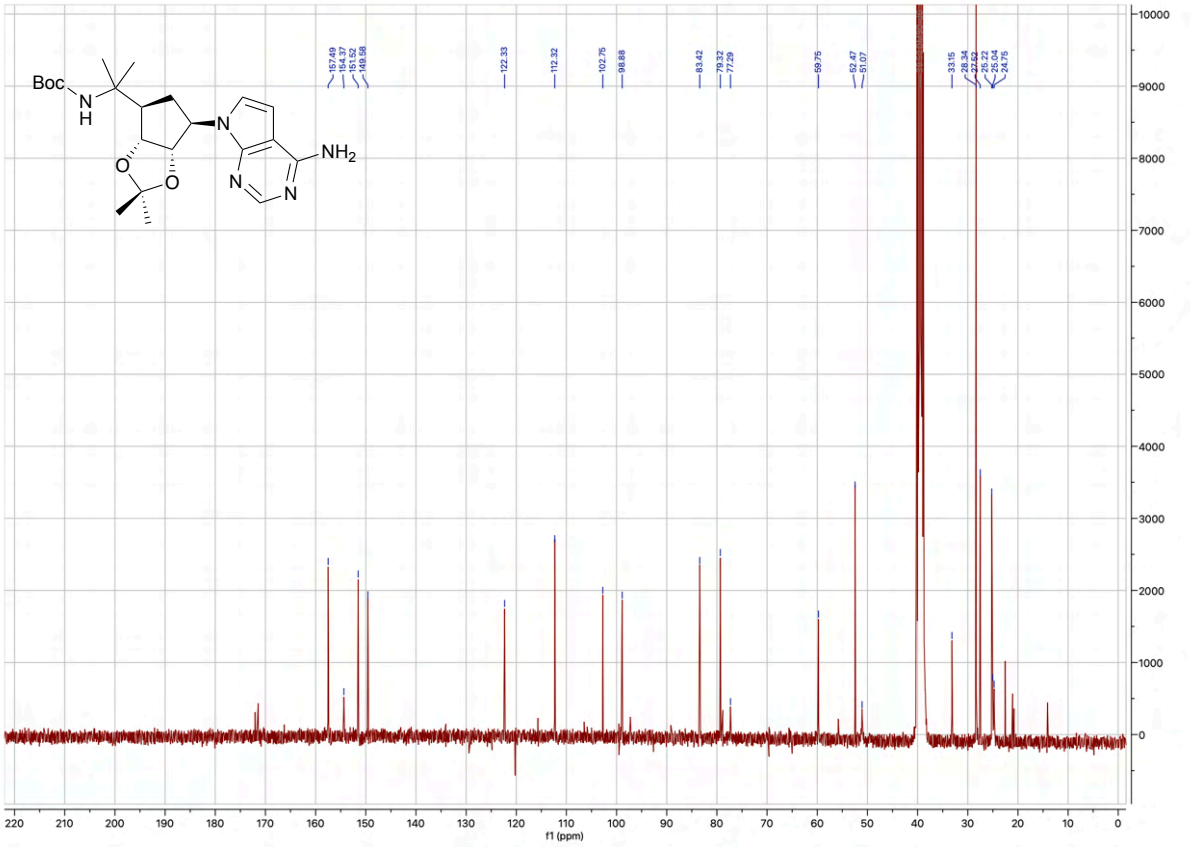
Compound 5c



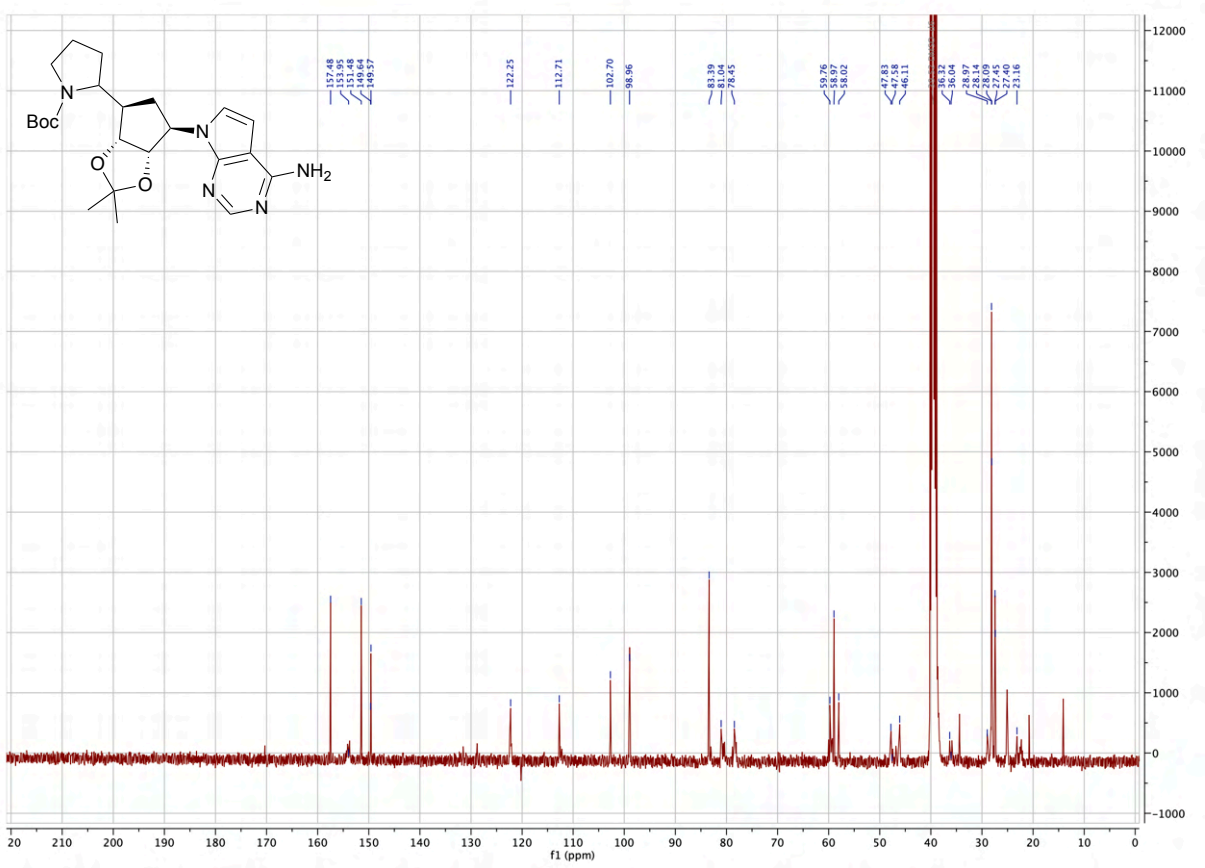
Compound 6a



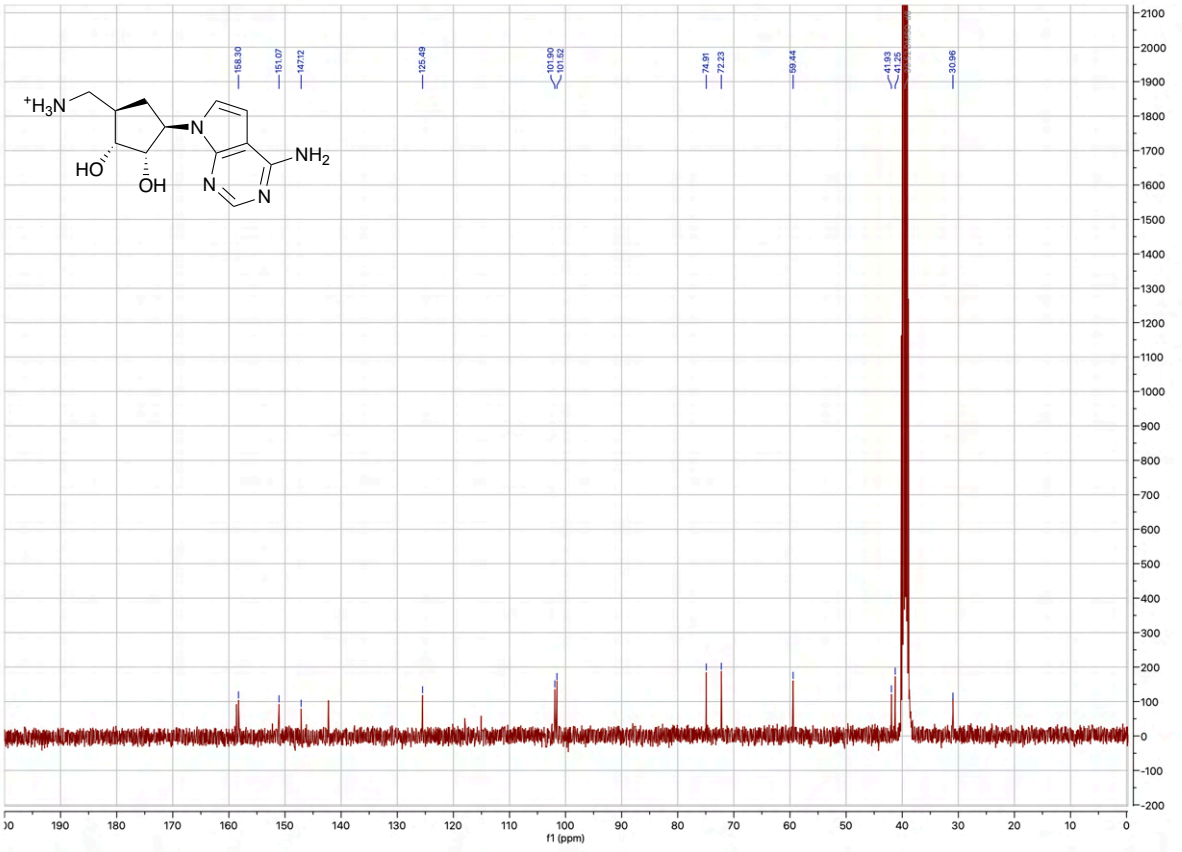
Compound 6b



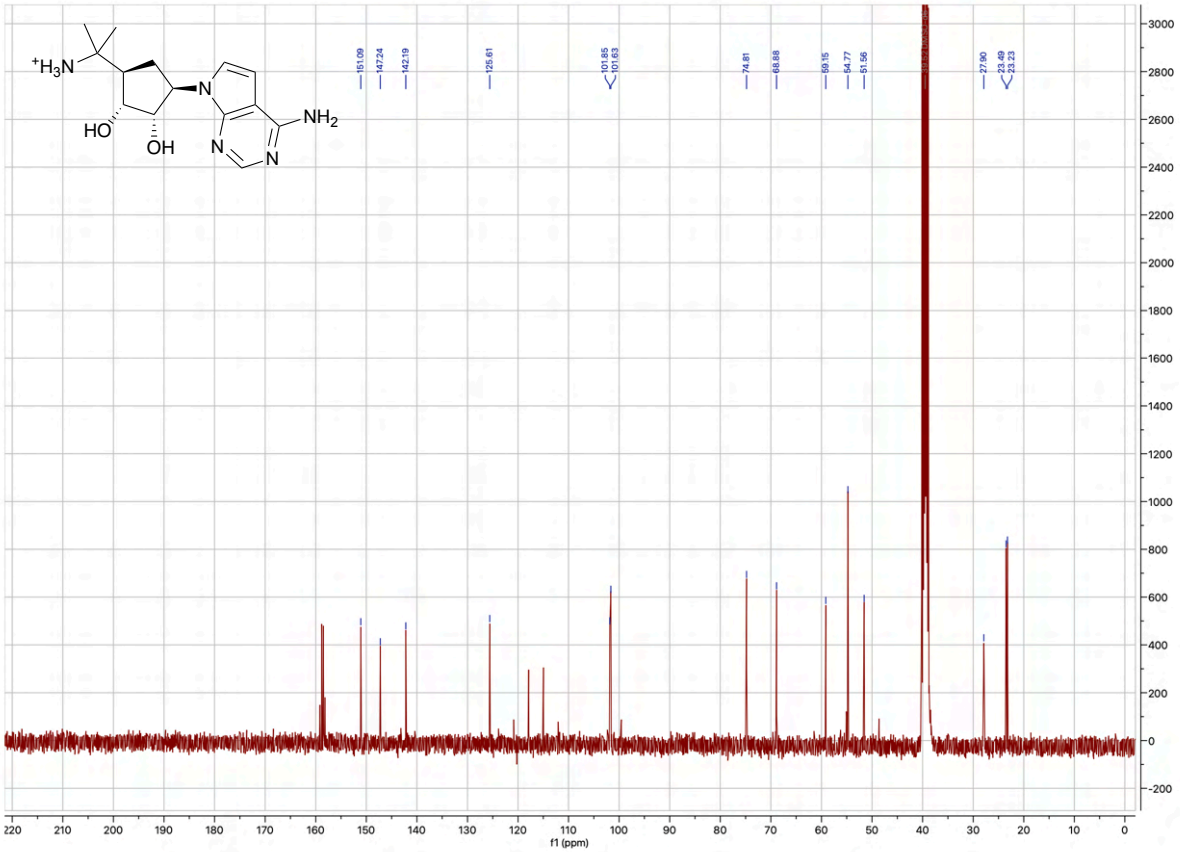
Compound 6c



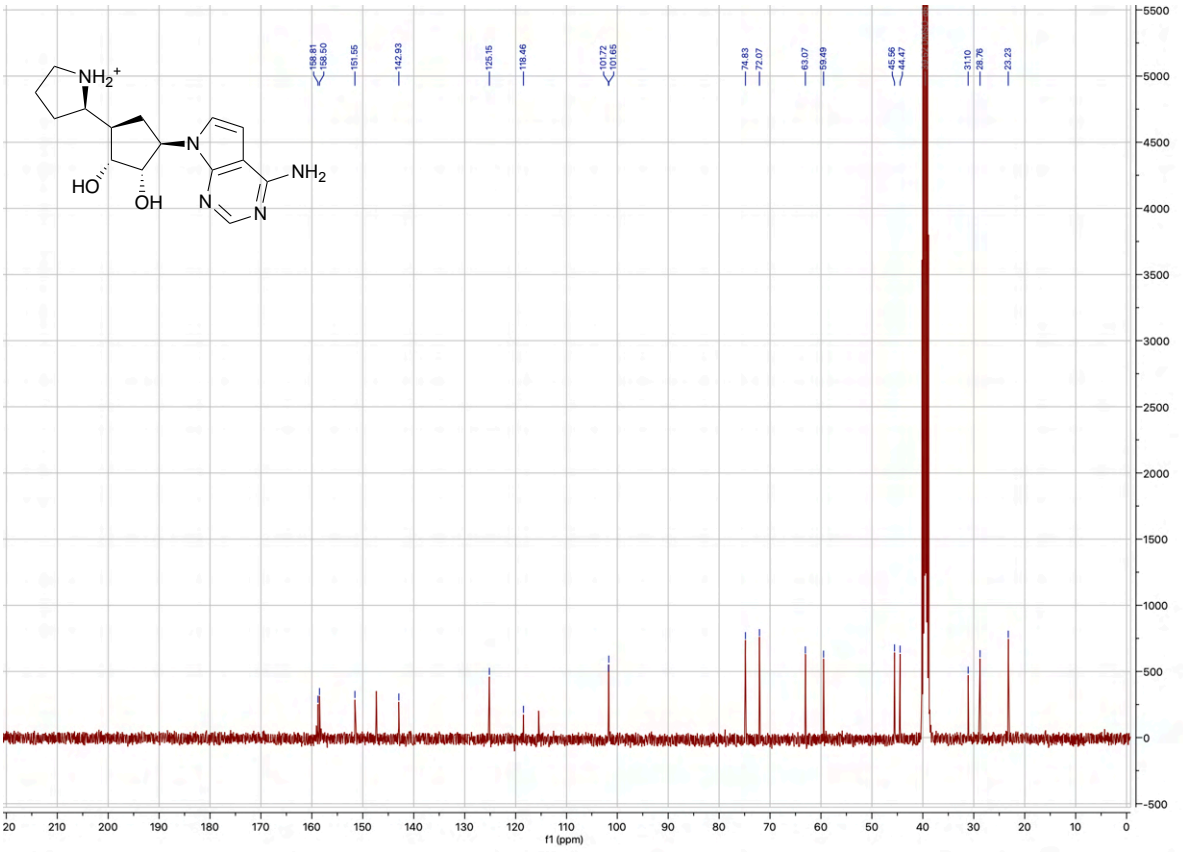
Compound 7a



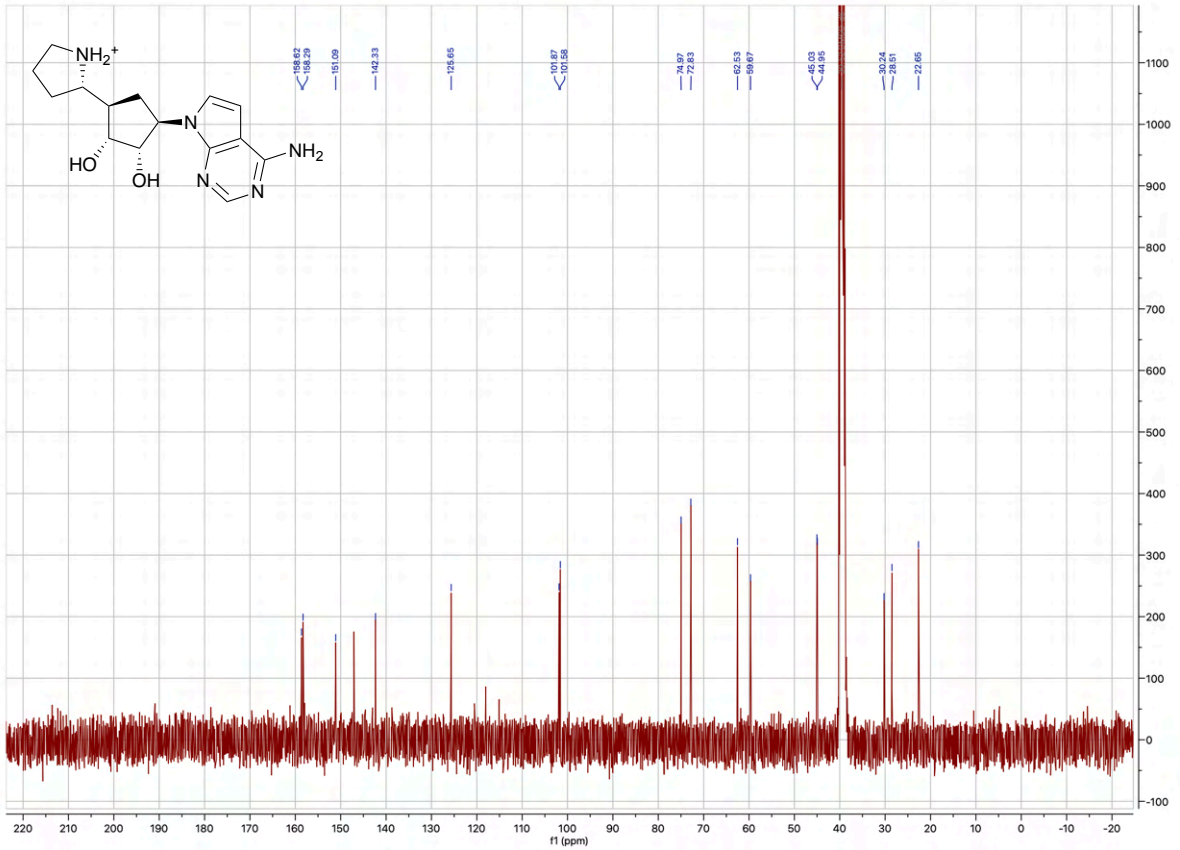
Compound 7b



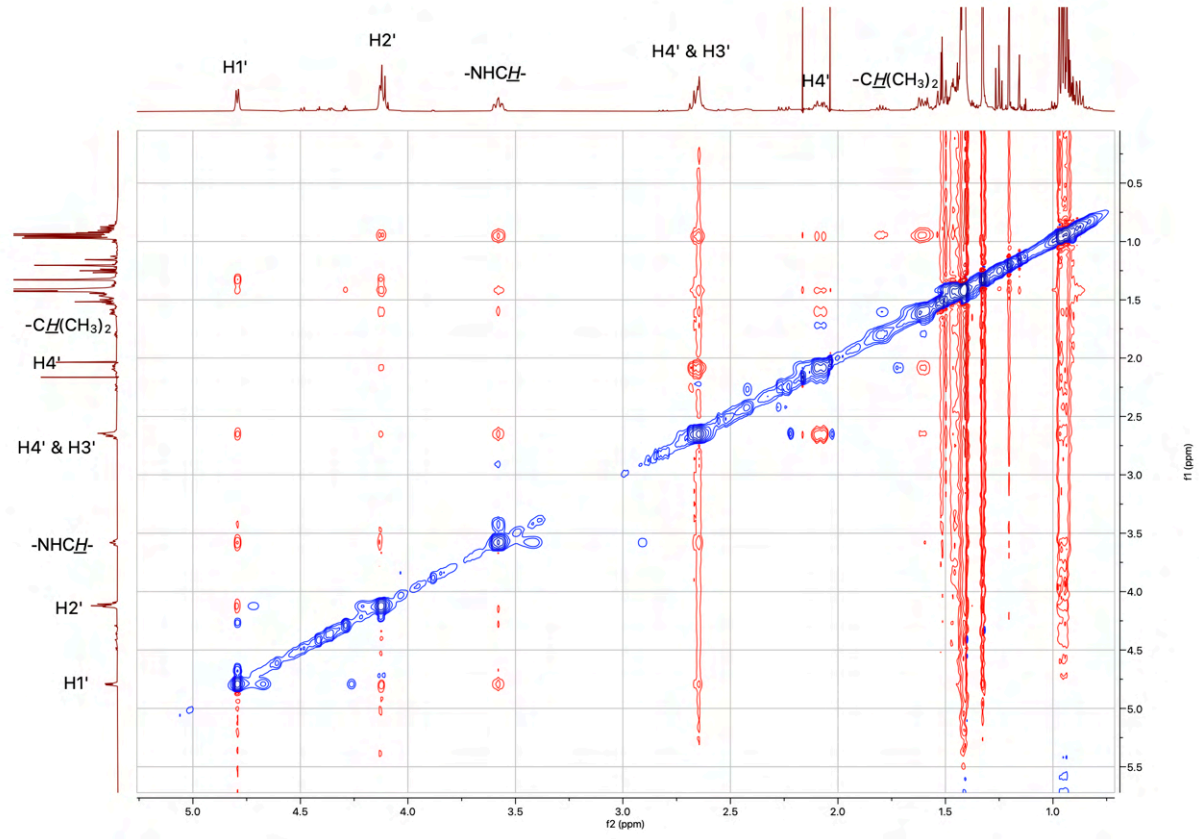
Compound 7c



Compound 7d



2D-NOESY experiment of compound 3e



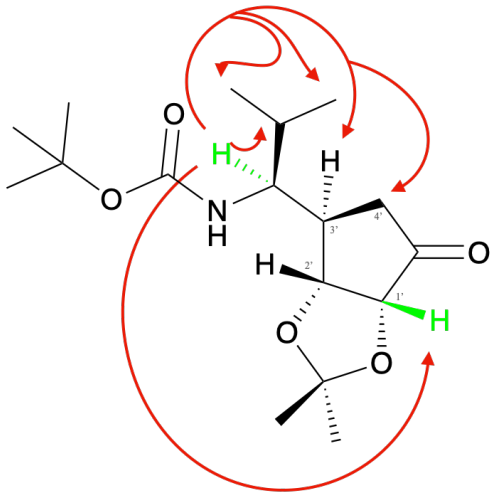
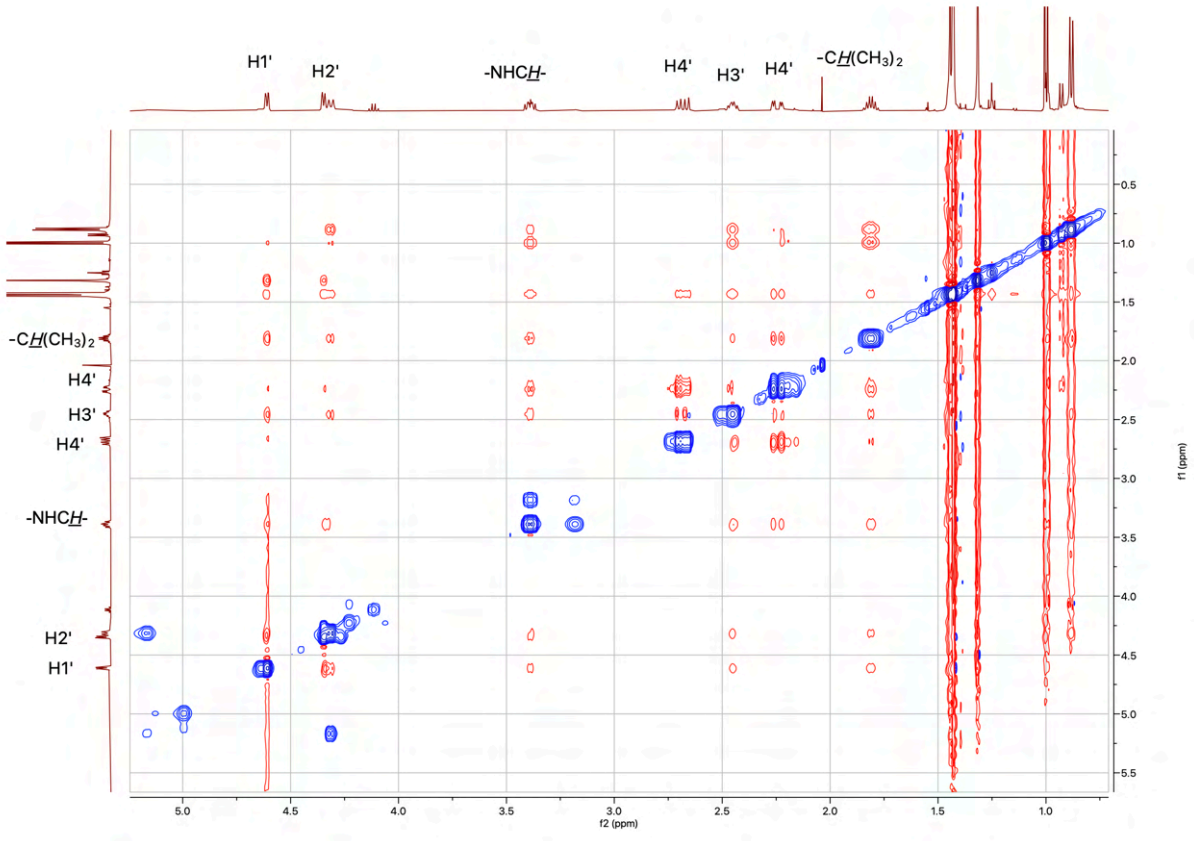


Figure 3 NOESY correlations of compound 3e. Experiments showed no to very weak correlation between -NHCH- and H2' thus we postulate the S-isomer.

2D-NOESY experiment of compound 3f



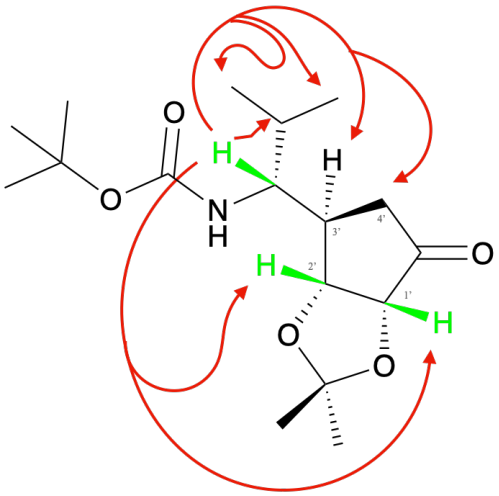
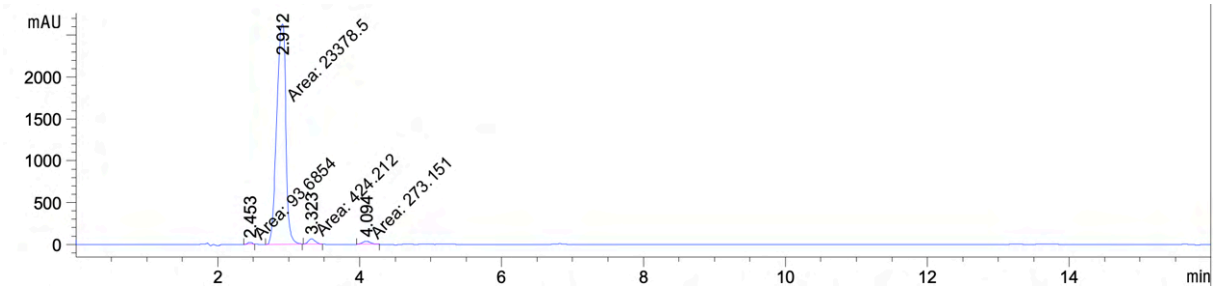


Figure 4 NOESY correlations of compound 3f. Experiments showed clear correlation between -NHCH- and H2' and H1' thus we postulate the R-isomer.

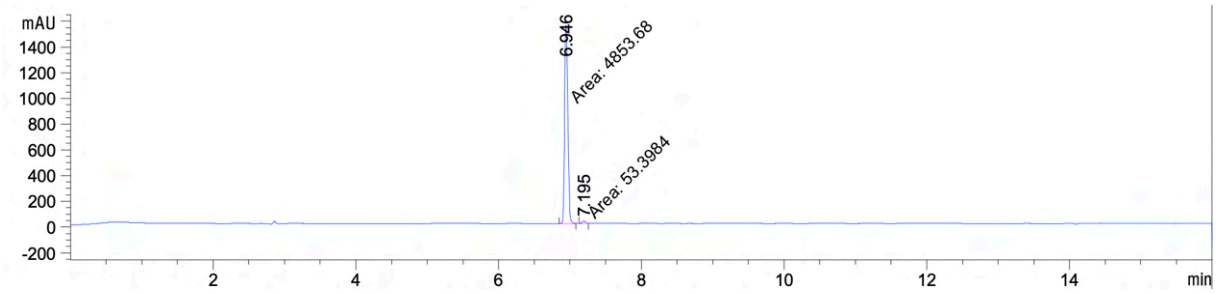
Chromatograms of compound 7a-7d

Compound 7a



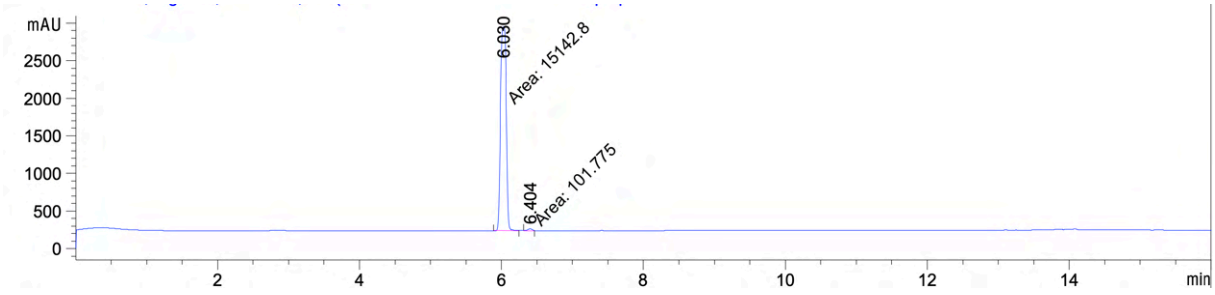
RT [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area%
2.453	0.0664	93.68536	23.50908	0.3876
2.912	0.1479	2.33785e4	2633.78540	97.7271
3.323	0.1120	424.21182	63.14731	1.7552
4.094	0.1316	273.15063	34.59356	1.1301

Compound 7b



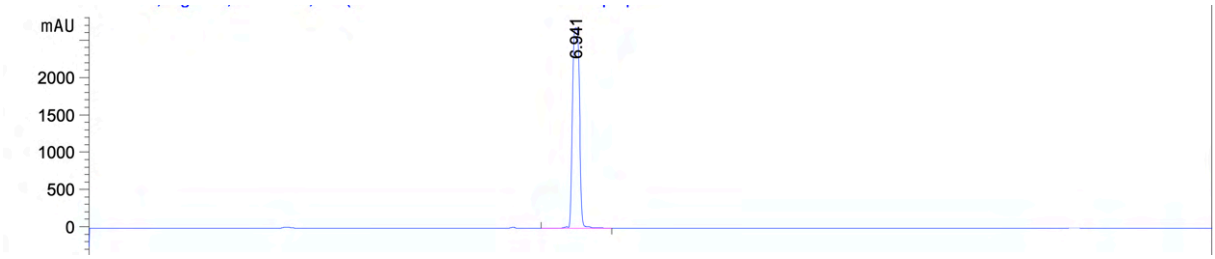
RT [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area%
6.946	0.0522	4853.6846	1548.7003	98.9118
7.195	0.0512	53.3984	17.3923	1.0882

Compound 7c



RT [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area%
6.030	0.0930	1.51428e4	2714.24829	99.3324
6.404	0.0662	101.77538	25.60650	0.6676

Compound 7d

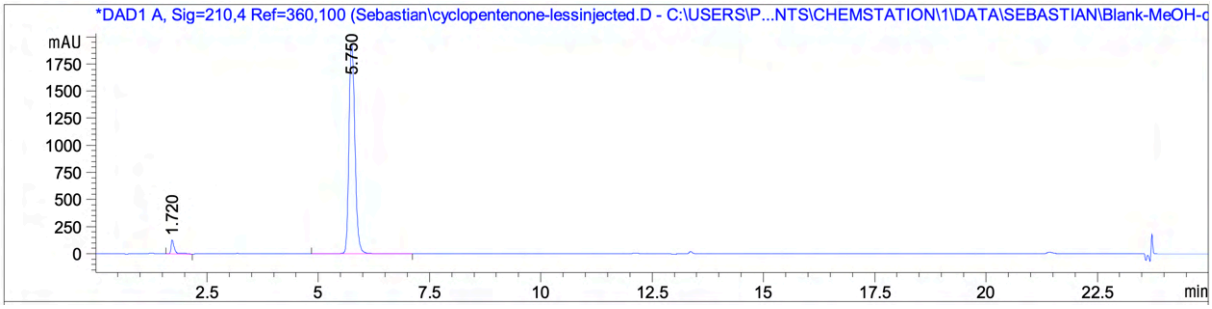


RT [min]	Width [min]	Area [mAU*s]	Height [mAU]	Area%
6.941	0.1141	1.85841e4	2685.35181	100.0000

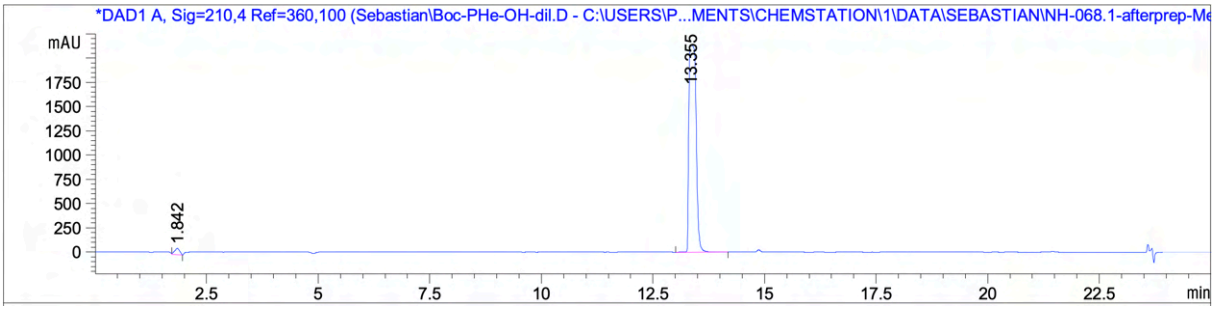
Negative control experiments

Analytical method: XBridge® Shield RP18 5µm XB-C18 100 Å 150 x 4.6 mm column and eluent A was H_2O containing 0.05 % trifluoracetic acid (TFA) and eluent B was CH_3CN containing 0.05 % TFA. Linear gradient conditions were as follows: 0–4 min: 90:10 (A/B); 4–19 min: 90:0→100 (A/B); 19–21 min: 0:100; (A/B); 21–31.5 min: 90:10 (A/B); 31.5–25 min: 90:10 (A/B) with a flowrate of 1.00 mL.min^{-1}.

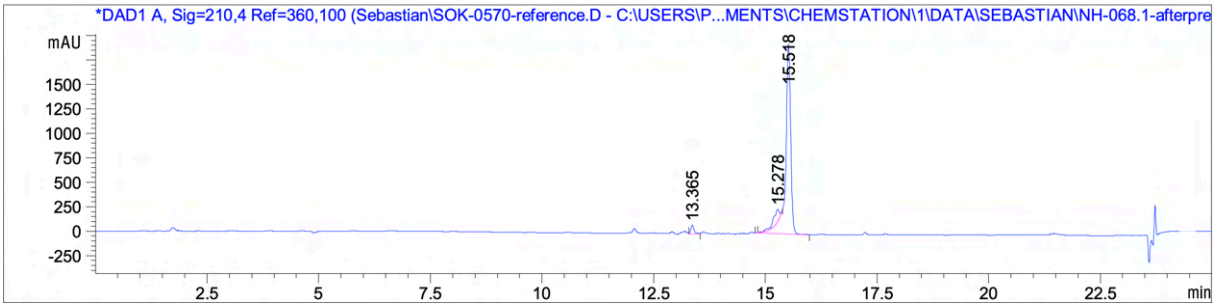
Reference chromatogram of (-)-(3aR,6aR)-3a,6a-dihydro-2,2-dimethyl-4H-cyclopenta-1,3-dioxol-4-one: (**1**)



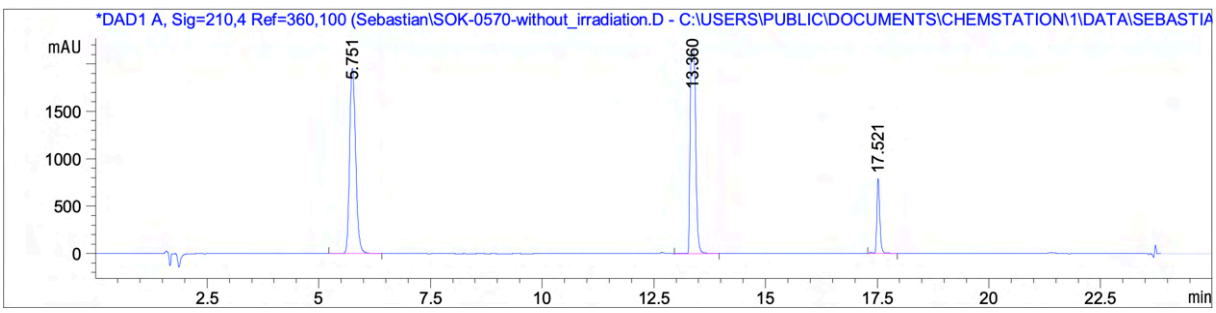
Reference chromatogram of Boc-Phe-OH (**2l**):



Reference chromatogram of the mixture of products **3q** and **3r**:



Chromatogram of the reaction mixture with photocatalyst but without irradiation after 17 h: no **3g**/**3r**



Chromatogram of the reaction mixture without photocatalyst but with irradiation after 17 h: no **3g/3r**