

Total Synthesis and Stereochemical Assignment of Penicitide A

*Dhiman Saha, Sandip Guchhait and Rajib Kumar Goswami**

School of Chemical Sciences,
Indian Association for the Cultivation of Science, Jadavpur,
Kolkata-700032, India.
Email: ocrkg@iacs.res.in

Supporting Information

- 1. General Experimental Procedure: S2**
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1. General Experimental Procedure:

All moisture sensitive reactions were performed in oven or flame-dried glassware with Teflon coated magnetic stirring bar under argon atmosphere using dry, freshly distilled solvents, unless otherwise noted. Air- and moisture-sensitive liquids were transferred via a gastight syringe and a stainless-steel needle. Reactions were monitored by thin layer chromatography (TLC, Silica gel 60 F254) plates with UV light, ethanolic anisaldehyde (with 1% AcOH and 3.3% conc. H₂SO₄)-heat and aqueous KMnO₄ (with K₂CO₃ and 10% aqueous NaOH solution) as developing agents. All workup and purification procedures were carried out with reagent-grade solvents under ambient atmosphere unless otherwise stated. Column chromatography was performed using silica gel 60-120 mesh, 100-200 mesh and 230-400 mesh. Yields mentioned as chromatographically and spectroscopically homogeneous materials unless otherwise stated. Optical rotations were measured only for pure compounds and not for mixtures using sodium (589, D line; Anton paar MCP 200 system) lamp and are reported as follows: $[\alpha]^{25}_D = (c = \text{g}/100 \text{ mL, solvent})$. IR spectra were recorded as neat (for liquids). HRMS were taken using Quadrupole-TOF (Q-TOF) micro MS system using electrospray ionization (ESI) technique. ¹H NMR spectra were recorded on 300 MHz spectrometers in appropriate solvents and calibrated using residual undeuterated solvent as an internal reference, and the chemical shifts are shown in ppm scales. Multiplicities of NMR signals are designated as s (singlet), d (doublet), t (triplet), q (quartet), br (broad), m (multiplet, for unresolved lines) etc. ¹³C and 2D NMR spectra were recorded on 75 MHz spectrometers.

2. ^1H and ^{13}C NMR Comparison between Synthetic Compounds and Isolated Peniciltide A:

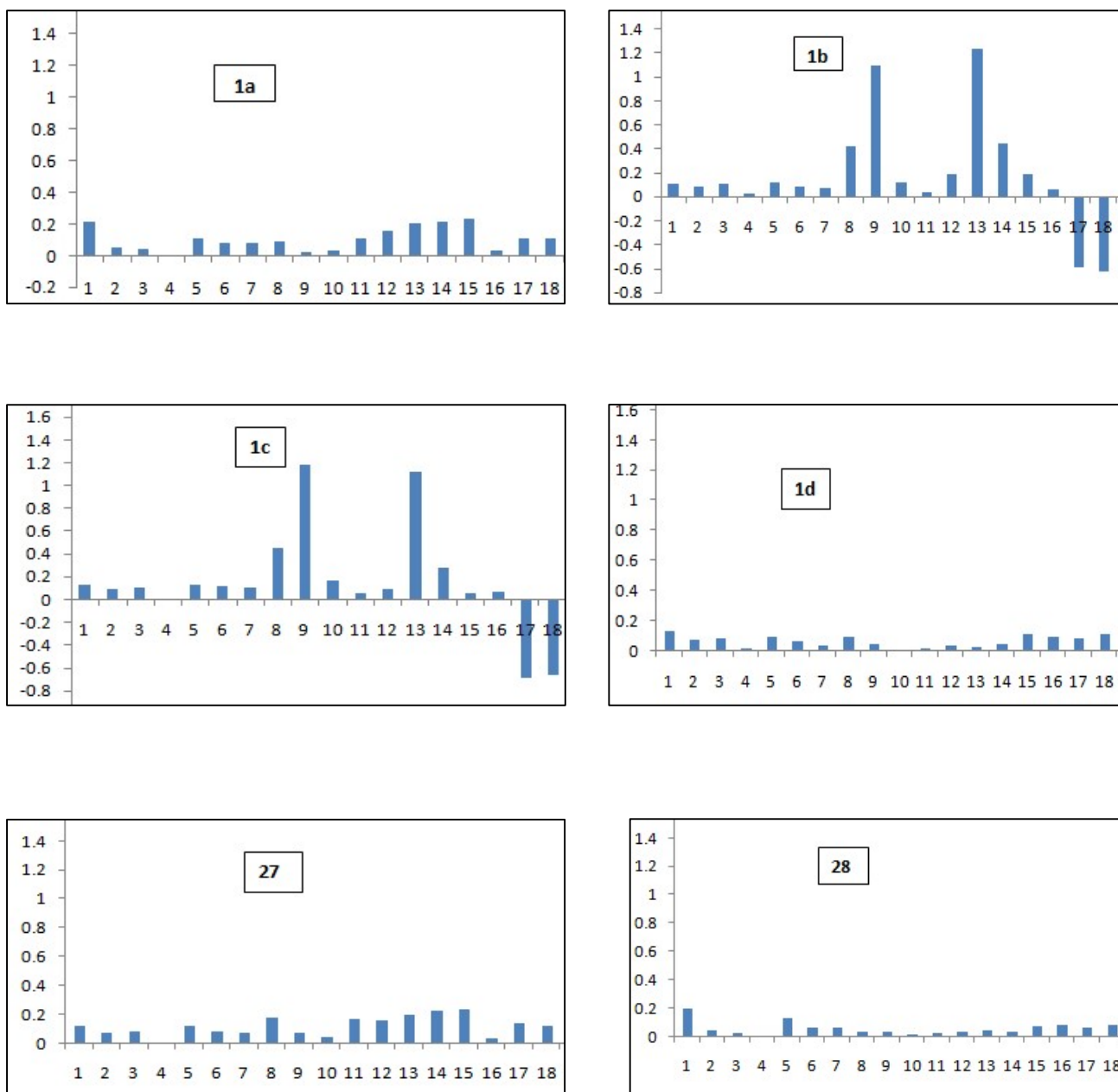
(i) **Table S1:** ^1H NMR comparison of synthetic compounds **1(a-d)**, **27** and **28** with isolated peniciltide A in CDCl_3 .

δ_{H} in ppm (Multiplicity, J in Hz)							
Numbering	Isolated Compound A (500 MHz)	Synthetic compounds (300 MHz)					
		Compound 1a	Compound 1b	Compound 1c	Compound 1d	Compound 27	Compound 28
1							
	2.61 dd (17.6, 5.1)	2.61 ddd (17.6, 3.8, 1.6)	2.61 dd (17.7, 3.8)	2.61 ddd (17.6, 3.8, 1.6)	2.61 ddd (17.7, 3.8, 1.6)	2.61 ddd (17.6, 3.8, 1.6)	2.61 ddd (17.6, 3.8, 1.6)
2	2.73 dd (17.6, 3.1)	2.74 dd (17.6, 5.1)	2.74 dd (17.6, 5.0)	2.74 dd (17.6, 5.0)	2.74 dd (17.6, 5.0)	2.74 dd (17.6, 5.0)	2.74 dd (17.6, 5.0)
3	4.38 m	4.37 dt (7.4, 3.7)	4.38 t (4.2)	4.38 t (4.1)	4.42-4.34 m	4.38 p (3.9)	4.43-4.34 m
	1.73 m,	1.80-1.68 m	1.73 td (11.2, 5.7)	1.79-1.69 m	1.74 ddd (14.6, 11.3, 3.5)	1.79-1.70 m	1.77-1.70 m
4	1.95 m	1.95 ddd (14.4, 3.4, 1.6)	2.00-1.91 m	2.00-1.93 m	2.00-1.93 m	1.99-1.93 m	1.99-1.92 m
5	4.68 tdd (7.9, 5.2, 3.0)	4.68 dddd (11.0, 7.9, 5.0, 3.1)	4.69 dt (7.8, 3.8)	4.74-4.64 m	4.69 ddt (11.3, 8.0, 4.1)	4.74-4.63 m	4.69 t (7.9, 3.7)
	1.59 m,	1.59 d (3.0)	1.59-1.57 m	1.56 q (6.7, 5.9)	1.58-1.54 m	1.64-1.59 m	1.63-1.55 m
6	1.73 m	1.80-1.68 m	1.73 td (11.2, 5.7)	1.79-1.69 m	1.79-1.69 m	1.79-1.70 m	1.77-1.70 m
7	1.41 m,	1.43 d (3.9)	1.44-1.40 m	1.45-1.41 m	1.44-1.39 m	1.45-1.41 m	1.44-1.39 m
8	1.30 m	1.30 dq (7.3, 2.3)	1.29 d (7.4)	1.33-1.27 m	1.33-1.27 m	1.34-1.28 m	1.33-1.27 m
	1.08 m,	1.14-1.03 m	1.06 t (6.9)	1.06 d (6.7, 0)	1.15-1.03 m	1.14-1.04 m	1.15-1.06 m
9	1.30 m	1.30 dq (7.3, 2.3)	1.29 d (7.4)	1.33-1.27 m	1.33-1.27 m	1.34-1.28 m	1.33-1.27 m
10	1.54 m	1.56 dd (4.0, 1.8)	1.59-1.52 m	1.56 q (6.7, 5.9)	1.58-1.54 m	1.64-1.59 m	1.63-1.55 m
	0.93 m,	0.94 dd (13.7, 6.9)	1.06 t (6.9)	1.06 t (7.0)	0.94 dd (13.8, 7.0)	0.98-0.9 m	0.97-0.90 dd (13.9, 7.1)
11	1.22 m	1.25-1.22 m	1.26-1.23 m	1.24-1.21 m	1.23 d (1.3)	1.24-1.22 m	1.24-1.21 m
12	1.45 m	1.48-1.44 m	1.47 d (7.2)	1.50-1.45 m	1.49-1.45 m	1.52-1.48 m	1.49-1.45 m
	1.14 m,	1.14-1.03 m	1.14-1.10 m	1.16-1.10 m	1.15-1.03 m	1.14-1.04 m	1.15-1.06 m
13	1.35 m	1.36 d (2.5)	1.37 d (5.7)	1.40-1.34 m	1.34 d (5.0)	1.40-1.34 m	1.38-1.34 m
	1.38 m,	1.39-1.38 m	1.37 d (5.7)	1.40-1.34 m	1.38-1.36 m	1.40-1.34 m	1.38-1.34 m
14	1.48 m	1.48-1.44 m	1.47 d (7.2)	1.50-1.45 m	1.49-1.45 m	1.52-1.48 m	1.49-1.45 m
15	3.76 m	3.81-3.70 m	3.76 q (6.0)	3.782-3.72 m	3.77 q (6.1)	3.76 q (6.0)	3.76 p (6.2)
16	1.19 d (6.9)	1.19 d (6.2)	1.19 d (6.2)	1.19 d (6.2)	1.19 d (6.1)	1.19 d (6.2)	1.19 d (6.2)
17	0.85 d (6.4)	0.86 d (5.7)	0.86 d (6.7)	0.83 d (5.2)	0.86 d (3.9)	0.86 d (6.1)	0.86 d (6.5)
18	0.84 d (6.4)	0.84 d (5.8)	0.81 d (6.9)	0.81 d (5.2)	0.84 d (4.1)	0.84 d (6.4)	0.84 d (6.5)

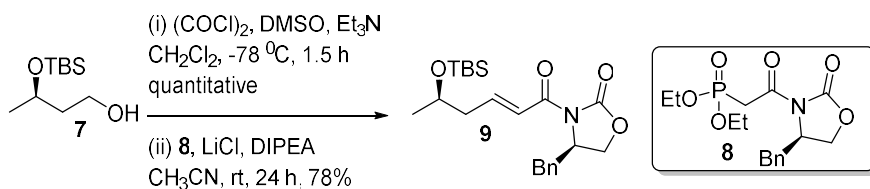
(ii) **Table S2:** ^{13}C NMR comparison of synthetic compounds **1(a-d)**, **27** and **28** with isolated penicillide A in CDCl_3 .

δ_{H} (in ppm)							
Numbering	Isolated Compound A (125 MHz) (multiplicity)	Synthetic compounds (75 MHz)					
		Compound 1a	Compound 1b	Compound 1c	Compound 1d	Compound 27	Compound 28
1	170.33 s	170.54	170.44	170.46	170.46	170.45	170.53
2	38.66 t	38.71	38.74	38.75	38.74	38.74	38.71
3	62.83 d	62.87	62.94	62.94	62.92	62.92	62.86
4	36.13 t	36.12	36.15	36.14	36.15	36.14	36.13
5	75.68 d	75.79	75.80	75.81	75.78	75.80	75.81
6	35.49 t	35.57	35.57	35.61	35.56	35.58	35.56
7	25.11 t	25.19	25.18	25.21	25.15	25.19	25.18
8	26.39 t	26.48	26.81	26.84	26.49	26.57	26.43
9	36.55 t	36.57	37.64	37.73	36.60	36.63	36.59
10	29.88 d	29.91	30.00	30.05	29.88	29.93	29.90
11	44.79 t	44.90	44.83	44.84	44.81	44.96	44.82
12	30.11 d	30.26	30.30	30.20	30.15	30.27	30.15
13	32.67 t	32.87	33.90	33.79	32.70	32.87	32.72
14	36.55 t	36.76	36.99	36.83	36.60	36.78	36.59
15	68.56 d	68.79	68.75	68.62	68.67	68.80	68.64
16	23.54 q	23.57	23.60	23.61	23.64	23.58	23.63
17	20.28 q	20.39	19.69	19.59	20.37	20.42	20.35
18	20.26 q	20.37	19.63	19.59	20.37	20.38	20.35

(iii) **Figure S1:** Differences (in ppm) in the ^{13}C NMR chemical shifts between synthesized compounds **1(a-d)**, **27** & **28** with isolated penicillidene A.



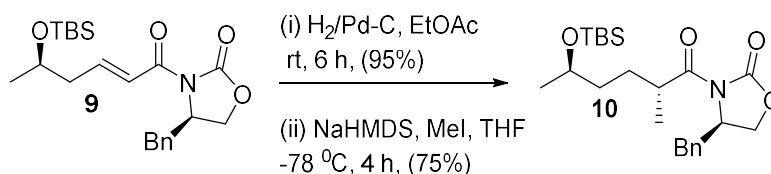
3. Experimental Procedure:



(R)-4-Benzyl-3-((R,E)-5-((tert-butyldimethylsilyl)oxy)hex-2-en-1-yn-1-ol)oxazolidin-2-one (9): To a stirred solution of $(\text{COCl})_2$ (4.13 mL, 47.8 mmol, 1.5 equiv.) in anhydrous CH_2Cl_2 (100 mL) under argon at $-78\text{ }^\circ\text{C}$, DMSO (6.77 mL, 95.58 mmol, 3.0 equiv.) was added drop wise over 2 min. After 15 min, a solution of compound **7** (6.5 g, 31.86 mmol, dissolved in 20 mL anhydrous CH_2Cl_2 , 1.0 equiv.) was cannulated into the reaction mixture and stirred further for 30 min at the same temperature. Et_3N (22.2 mL, 159 mmol, 5.0 equiv.) was then added and stirred further for 15 min at the same temperature. The reaction mixture was then warmed to $0\text{ }^\circ\text{C}$ and quenched with saturated aqueous solution of NH_4Cl (25 mL). The resultant mixture was extracted with CH_2Cl_2 ($2 \times 200\text{ mL}$), washed with water, brine, dried over Na_2SO_4 and concentrated in *vacuo*. Flash chromatography of the crude residue using a short pad of silica gave the corresponding aldehyde (6.45 g, quantitative) as a yellow liquid which was taken for the next step without further characterizations.

To a stirred suspension of activated LiCl (5.32 g, 126.7 mmol, 4.0 equiv.) in anhydrous CH_3CN (75 mL) under argon at room temperature, phosphonate **8** (12.38 g, 34.8 mmol, 1.1 equiv.) and DIPEA (5.51 mL, 31.68 mmol, 1.0 equiv.) were added sequentially and the mixture was stirred for 30 min prior to cannulate the above aldehyde (6.4 g, 31.68 mmol, dissolved in 20 mL anhydrous CH_3CN , 1.0 equiv.). The reaction was continued further for 24 h at the same temperature and diluted with water (60 mL). The resultant mixture was extracted with EtOAc ($2 \times 100\text{ mL}$), washed with water, brine, dried over Na_2SO_4 and concentrated in *vacuo*. Flash

column chromatography (SiO₂, 60-120 mesh, 5-6% EtOAc in hexane as eluent) purification of the crude residue provided coupled product **9** (10 g, 78%) as a yellowish liquid. R_f = 0.6 (15% EtOAc/hexane); $[\alpha]^{25}_D$ = -32.7 (c 3.0, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.31 (dtd, J = 8.5, 6.8, 5.6 Hz, 4H), 7.25 – 7.19 (m, 3H), 4.78 – 4.69 (m, 1H), 4.22 – 4.14 (m, 2H), 3.99 (q, J = 6.0 Hz, 1H), 3.37 – 3.19 (m, 1H), 2.80 (dd, J = 13.4, 9.5 Hz, 1H), 2.43 (t, J = 5.9 Hz, 2H), 1.18 (d, J = 6.1 Hz, 3H), 0.89 (s, 9H), 0.06 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 164.8, 153.5, 148.7, 135.4, 129.5, 129.0, 127.4, 122.1, 67.8, 66.1, 55.4, 42.8, 37.9, 26.4, 25.9, 18.1, -4.5, -4.7 ppm; IR(neat) ν_{max} 2958, 2857, 1720, 1652, 1472, 1255, 1207, 1044 cm⁻¹; HRMS (ESI) m/z calcd for C₂₂H₃₅NO₄SiNa [M + Na]⁺ 426.2037, found 426.2031.

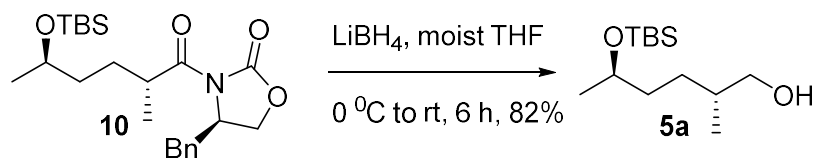


(R)-4-Benzyl-3-((2R,5R)-5-((tert-butyldimethylsilyl)oxy)-2-methylhexanoyl)oxazolidin-2-one

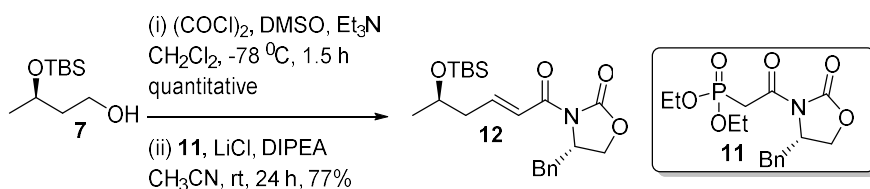
(10): To a stirred solution of compound **9** (8.65 g, 21.46 mmol, 1.0 equiv.) in EtOAc (30 mL), 10% Pd/C (870 mg) was added under hydrogen atmosphere (balloon) at room temperature and stirred for overnight. The reaction mixture was then filtered using a short bed of celite and washed with EtOAc (100 mL). The combined organic layers were concentrated under reduced pressure and purified by flash column chromatography (SiO₂, 60-120 mesh, 10% EtOAc in hexane as eluent) to provide the corresponding saturated product (8.5 g, 95%) as a colorless oil. R_f = 0.5 (10% EtOAc/hexane); $[\alpha]^{25}_D$ = -50.1 (c 0.75, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.38 – 7.27 (m, 3H), 7.21 (dt, J = 7.7, 2.2 Hz, 2H), 4.68 (ddd, J = 9.6, 4.9, 2.2 Hz, 1H), 4.22 – 4.11 (m, 2H), 3.84 (q, J = 6.0 Hz, 1H), 3.30 (dd, J = 13.3, 3.3 Hz, 1H), 3.03 – 2.85 (m, 2H), 2.76 (dd, J = 13.3, 9.7 Hz, 1H), 1.81 – 1.62 (m, 2H), 1.55 – 1.44 (m, 2H), 1.15 (d, J = 6.1 Hz, 3H), 0.89 (s, 9H), 0.06 (d, J = 0.8 Hz, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 173.3, 153.6, 135.4, 129.5,

129.0, 127.4, 68.4, 66.3, 55.2, 39.0, 38.0, 35.6, 26.0, 23.8, 20.5, 18.2, -4.3, -4.6 ppm; IR (neat) ν_{\max} 2953, 2932, 2856, 1785, 1459, 1253, 1210 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{22}\text{H}_{35}\text{NO}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 428.2233, found 428.2232.

To a stirred solution of the above hydrogenated compound (8.2 g, 20.25 mmol, 1.0 equiv.) in anhydrous THF (50 mL) at $-78\text{ }^{\circ}\text{C}$ under argon, NaHMDS (30.38 mL, 30.38 mmol 1.0 M solution in THF, 1.5 equiv.) was added drop wise over 10 min. After 30 min, freshly distilled MeI (3.8 mL, 60.75 mmol, 3 equiv.) was added and the reaction mixture was stirred further for 3.5 h at the same temperature. The reaction was quenched with saturated NH_4Cl solution (10 mL) and warmed up to room temperature before extracting with EtOAc (2 x 100 mL). The combined organic extracts were washed with water, brine, dried over Na_2SO_4 and concentrated in *vacuo*. Purification of the crude residue by flash column chromatography (SiO_2 , 230-400 mesh, 5% EtOAc in hexane as eluent) gave the methylated compound **10** (6.15 g, 75%) as a colorless oil. $R_f = 0.6$ (15% EtOAc/hexane); $[\alpha]_D^{25} = -32.9$ (c 0.9, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.35 – 7.27 (m, 3H), 7.24 – 7.19 (m, 2H), 4.72 – 4.62 (m, 1H), 4.20 – 4.14 (m, 2H), 3.79 (q, $J = 5.9$ Hz, 1H), 3.69 (q, $J = 6.6$ Hz, 1H), 3.25 (ddd, $J = 13.6, 10.3, 3.3$ Hz, 1H), 2.76 (dd, $J = 13.3, 9.6$ Hz, 1H), 1.88 – 1.73 (m, 1H), 1.48 – 1.41 (m, 3H), 1.23 (d, $J = 6.9$ Hz, 3H), 1.12 (d, $J = 6.1$ Hz, 3H), 0.88 (s, 9H), 0.04 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 173.3, 153.5, 135.4, 129.4, 129.0, 127.4, 68.4, 66.2, 55.2, 39.0, 38.0, 35.6, 27.3, 26.0, 23.8, 20.5, 18.2, -4.3, -4.6 ppm; IR (neat) ν_{\max} 2928, 1771, 1689, 1435, 1267, 1215, 1066 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{23}\text{H}_{37}\text{NO}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 442.2390, found 442.2391.



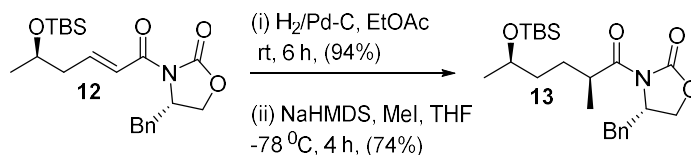
(2*R*,5*R*)-5-((*tert*-Butyldimethylsilyl)oxy)-2-methylhexan-1-ol (5a) : To an ice cold solution of compound **10** (6.1 g, 14.53 mmol, 1.0 equiv.) in anhydrous THF (40 mL, moist with a catalytic amount of water), LiBH₄ (640 mg, 29.5 mmol, 2.0 equiv.) was added portion wise over 5 min. under argon. After 6 h of stirring at the same temperature, the reaction mixture was quenched cautiously with saturated NH₄Cl solution (10 mL) at 0 °C, extracted with EtOAc (2 x 75 mL), washed with water, brine, dried (Na₂SO₄) and concentrated in *vacuo*. Purification of the crude residue by flash column chromatography (SiO₂, 100-200 mesh, 8% EtOAc in hexane as eluent) provided pure compound **5a** (2.9 g, 82%) as a colorless liquid. *R_f* = 0.35 (10% EtOAc/hexane); $[\alpha]_D^{25} = -1.3$ (*c* 1.6, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 3.82 – 3.70 (m, 1H), 3.56 – 3.46 (m, 1H), 3.41 (ddd, *J* = 10.5, 6.5, 1.0 Hz, 1H), 1.62 – 1.52 (m, 1H), 1.52 – 1.29 (m, 4H), 1.11 (d, *J* = 6.1 Hz, 3H), 0.91 (d, *J* = 6.6 Hz, 3H), 0.88 (s, 9H), 0.04 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 69.0, 68.3, 37.0, 35.9, 29.2, 26.0, 23.8, 18.2, 16.7, -4.3, -4.6 ppm; IR (neat) ν_{max} 3345, 2955, 2929, 1462, 1253, 1033 cm⁻¹; HRMS (ESI) *m/z* calcd for C₁₃H₃₁O₂Si [M + H]⁺ 247.2093, found 247.2086.



(*S*)-4-Benzyl-3-((*R,E*)-5-((*tert*-butyldimethylsilyl)oxy)hex-2-enoyl)oxazolidin-2-one (12):

Following the same experimental procedure as described in the preparation of compound **9**, alcohol **7** (8.3 g, 40.7 mmol) was converted to the corresponding aldehyde (8.2 g, quantitative, purification by flash column chromatography, SiO₂, 60-120 mesh, 8% EtOAc in hexane as eluent) furnished as a yellowish oil which was directly used for the next step without further characterizations.

The above aldehyde (8.2 g, 40.7 mmol) was then coupled with phosphonate **11** (15.9 g, 44.7 mmol) to get coupled product **12** as a yellowish oil (9.25 g, 77%, purification by flash column chromatography, SiO₂, 60-120 mesh, 10% EtOAc in hexane as eluent) following the same experimental procedure of compound **9**. R_f = 0.6 (15% EtOAc/hexane); $[\alpha]_D^{25}$ = +16.0 (c 0.5, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.38 – 7.27 (m, 4H), 7.25 – 7.20 (m, 3H), 4.79 – 4.64 (m, 1H), 4.24 – 4.14 (m, 2H), 3.99 (q, J = 6.0 Hz, 1H), 3.38 – 3.19 (m, 1H), 2.88 – 2.74 (m, 1H), 2.43 (t, J = 6.0 Hz, 2H), 1.19 (d, J = 6.0 Hz, 3H), 0.89 (s, 9H), 0.07 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) 164.9, 153.5, 148.7, 135.6, 129.5, 129.0, 127.4, 122.2, 67.8, 66.2, 55.4, 42.9, 38.0, 25.9, 23.9, 18.2, -4.5, -4.7 ppm; IR (neat) ν_{max} 2955, 2928, 1781, 1699, 1455, 1350, 1253, 1193, 1048 cm⁻¹; HRMS (ESI) m/z calcd for C₂₂H₃₅NO₄SiNa [M + Na]⁺ 426.2037, found 426.2035.

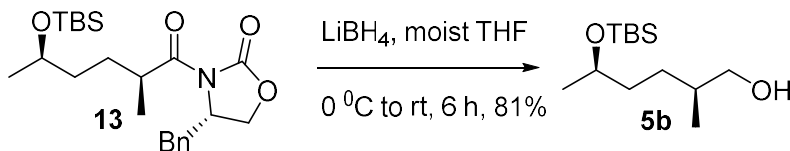


(S)-4-Benzyl-3-((2S,5R)-5-((tert-butyldimethylsilyl)oxy)-2-methylhexanoyl)oxazolidin-2-one

(13): Following the same experimental procedure of compound **10**, Compound **12** (8.5 g, 21.08 mmol) was reduced under hydrogen atmosphere in presence of Pd-C catalyst to get the corresponding saturated product (8.0 g, 94%, purification by flash column chromatography, SiO₂, 60-120 mesh, 8% EtOAc in hexane as eluent) as a yellowish oil. R_f = 0.5 (10% EtOAc/hexane); $[\alpha]_D^{25}$ = +30.5 (c 1.3, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.31 (dq, J = 11.9, 6.6 Hz, 3H), 7.25 – 7.16 (m, 2H), 4.67 (ddt, J = 10.2, 7.0, 3.3 Hz, 1H), 4.22 – 4.13 (m, 2H), 3.84 (h, J = 6.1 Hz, 1H), 3.30 (dd, J = 13.3, 3.3 Hz, 1H), 3.04 – 2.84 (m, 2H), 2.76 (dd, J = 13.4, 9.6 Hz, 1H), 2.07 (d, J = 18.9 Hz, 1H), 1.80 – 1.72 (m, 1H), 1.57 – 1.37 (m, 2H), 1.15 (d, J = 6.1 Hz,

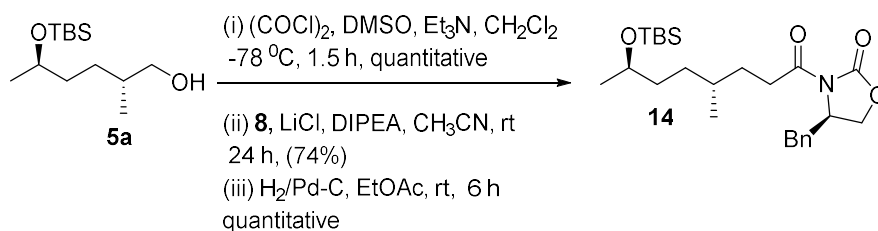
3H), 0.89 (s, 9H), 0.06 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 173.3, 153.5, 135.4, 129.5, 129.0, 127.4, 68.4, 66.2, 55.2, 39.0, 38.0, 35.6, 26.0, 23.8, 20.6, 18.2, -4.3, -4.6 ppm; IR (neat) ν_{max} 2955, 2928, 1781, 1699, 1455, 1350, 1253, 1193, 1048 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{22}\text{H}_{35}\text{NO}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 428.2233, found 428.2231.

Following the same experimental procedure as described in the preparation of compound **10**, the above hydrogenated compound (8.3 g, 20.5 mmol) was converted to the methylated compound **13** (6.35 g, 74%, purification by flash column chromatography, SiO_2 , 60-120 mesh, 8% EtOAc in hexane as eluent) as a yellowish oil. R_f = 0.5 (10% EtOAc/hexane), $[\alpha]_{\text{D}}^{25}$ = +40.0 (c 0.3, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.36 – 7.28 (m, 3H), 7.23 – 7.19 (m, 2H), 4.73 – 4.64 (m, 1H), 4.21 – 4.13 (m, 2H), 3.77 (dt, J = 12.1, 5.7 Hz, 1H), 3.66 (p, J = 6.9 Hz, 1H), 3.25 (ddd, J = 13.5, 10.3, 3.3 Hz, 1H), 2.76 (dd, J = 13.3, 9.6 Hz, 1H), 1.82 – 1.44 (m, 4H), 1.22 (d, J = 6.8 Hz, 3H), 1.12 (d, J = 6.1 Hz, 3H), 0.88 (s, 9H), 0.04 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 177.2, 153.1, 135.4, 129.5, 129.0, 127.4, 68.3, 66.25, 57.5, 39.0, 38.0, 37.0, 35.6, 29.8, 26.0, 23.6, 18.2, -4.3, -4.6 ppm; IR (neat) ν_{max} 2951, 2929, 1736, 1645, 1495, 1361, 1256, 1042 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{23}\text{H}_{37}\text{NO}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 442.2390, found 442.2393.



(2S,5R)-5-((tert-Butyldimethylsilyl)oxy)-2-methylhexan-1-ol (5b): Compound **13** (6.2 g, 14.79 mmol) was reduced to alcohol **5b** (3.0 g, 81%, purification by flash column chromatography, SiO_2 , 60-120 mesh, 8% EtOAc in hexane as eluent) as a colorless oil using LiBH_4 following the same experimental procedure as described in the preparation of compound **5a**. R_f = 0.4 (10%

EtOAc/hexane), $[\alpha]_D^{25} = +90.0$ (c 0.04, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 3.80 – 3.72 (m, 1H), 3.49 (dd, $J = 10.5, 5.8$ Hz, 1H), 3.40 (dd, $J = 10.5, 6.5$ Hz, 1H), 1.63 – 1.54 (m, 1H), 1.52 – 1.40 (m, 2H), 1.40 – 1.30 (m, 2H), 1.11 (d, $J = 6.1$ Hz, 3H), 0.90 (d, $J = 6.7$ Hz, 3H), 0.87 (s, 9H), 0.03 (d, $J = 0.7$ Hz, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 68.9, 68.2, 36.9, 35.8, 29.1, 26.0, 23.9, 18.2, 16.7, -4.3, -4.6 ppm; IR (neat) ν_{max} 3350, 2929, 2857, 1462, 1254, 1077, 1032 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{31}\text{O}_2\text{Si}$ $[\text{M} + \text{H}]^+$ 247.2093, found 247.2086.



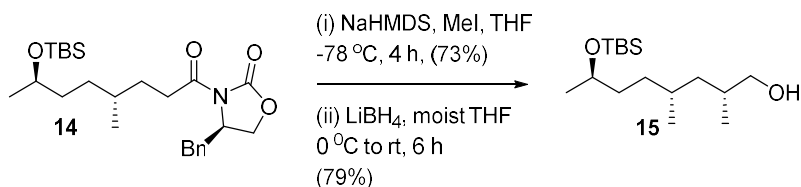
(R)-4-Benzyl-3-((4R,7R)-7-((tert-butyldimethylsilyl)oxy)-4-methyloctanoyl)oxazolidin-2-one

(14): Following the same Swern oxidation conditions as described in the preparation of compound **9**, alcohol **5a** (1.4 g, 5.7 mmol) was transformed to the corresponding aldehyde (1.4 g, quantitative, purified by flash column chromatography using a short pad of 60–120 silica, 10% EtOAc in hexane as eluent) as a yellowish liquid which was taken for the next step without further characterizations.

Following the same experimental procedure as described in the preparation of compound **9**, the above aldehyde of **5a** (1.4 g, 5.68 mmol) was coupled with compound **8** (2.2 g, 6.28 mmol) to get the corresponding coupled product (1.87 g, 74%, purification by flash column chromatography, SiO_2 , 100-200 mesh, 5% EtOAc in hexane as eluent) as a yellowish oil. $R_f = 0.5$ (10% EtOAc/hexane); $[\alpha]_D^{25} = -42.7$ (c 1.75, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.32 (dddt, $J = 8.9, 6.2, 3.7, 1.6$ Hz, 3H), 7.25 – 7.05 (m, 4H), 4.72 (tdd, $J = 7.4, 5.2, 3.4$ Hz, 1H),

4.22 – 4.15 (m, 2H), 3.79 (dt, $J = 9.3, 5.9$ Hz, 1H), 3.39 – 3.21 (m, 1H), 2.78 (ddd, $J = 13.3, 9.6, 6.6$ Hz, 1H), 2.46 – 2.27 (m, 1H), 1.56 – 1.41 (m, 3H), 1.28–1.26 (m, 1H), 1.18 – 1.04 (m, 6H), 0.89 (s, 9H), 0.05 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 165.3, 157.1, 153.5, 135.5, 129.5, 129.0, 127.4, 118.9, 68.7, 66.2, 55.4, 38.0, 37.3, 37.2, 32.3, 26.0, 23.9, 19.6, 18.2, -4.3, -4.6; IR (neat) ν_{max} 2957, 2928, 1780, 1683, 1351, 1193, 1098 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{25}\text{H}_{40}\text{NO}_4\text{Si}$ $[\text{M} + \text{H}]^+$ 446.2727, found 446.2724.

The above couple product (1.8 g, 4.04 mmol, 1.0 equiv.) was converted to compound **14** (1.81 g, quantitative) using 10% Pd-C/ H_2 (180 mg) following the same experimental procedure of compound **10** and purified by flash column chromatography (SiO_2 , 60–120 mesh, 10% EtOAc in hexane as eluent) to furnish as a colorless oil. $R_f = 0.5$ (10% EtOAc/hexane); $[\alpha]_D^{25} = -29.4$ (c 2.12, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.38 – 7.27 (m, 3H), 7.23 – 7.19 (m, 2H), 4.74 – 4.64 (m, 1H), 4.20 – 4.14 (m, 2H), 3.81 – 3.72 (m, 1H), 3.34 – 3.20 (m, 1H), 3.06 – 2.83 (m, 2H), 2.76 (ddd, $J = 13.1, 9.6, 2.7$ Hz, 1H), 1.78 – 1.63 (m, 1H), 1.56 – 1.40 (m, 5H), 1.25 (d, $J = 1.1$ Hz, 1H), 1.12 (d, $J = 6.1$ Hz, 3H), 0.92 (d, $J = 6.0$ Hz, 3H), 0.89 (s, 9H), 0.05 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 173.77, 155.09, 135.43, 129.51, 129.04, 127.43, 77.52, 77.10, 76.68, 68.98, 66.24, 55.27, 38.04, 37.07, 33.50, 32.86, 32.60, 31.38, 26.01, 23.87, 19.50, 18.26, -4.30, -4.57 ppm; IR (neat) ν_{max} 2956, 2928, 1787, 1698, 1350, 1194 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{25}\text{H}_{42}\text{NO}_4\text{Si}$ $[\text{M} + \text{H}]^+$ 448.2883, found 448.2877.

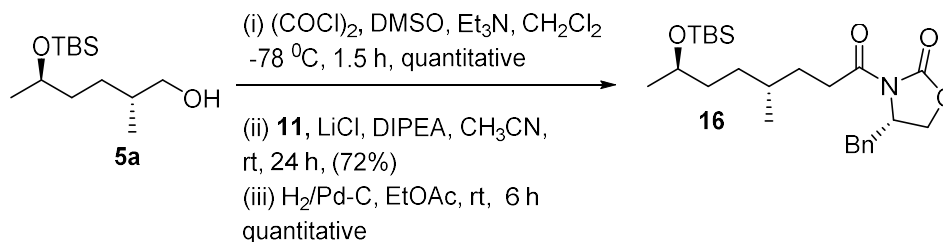


(2R,4R,7R)-7-((tert-Butyldimethylsilyl)oxy)-2,4-dimethyloctan-1-ol (15): Following the same experimental procedure as described in the preparation of compound **10**, compound **14** (1.52g,

tert-Butyl(((2*R*,5*R*,7*R*)-5,7-dimethylnon-8-en-2-yl)oxy)dimethylsilane (3a): To an ice cold solution of compound **16** (450 mg, 1.56 mmol, 1.0 equiv.) in anhydrous CH₂Cl₂ (5 mL), NaHCO₃ (655 mg, 7.8 mmol, 5.0 equiv.) and DMP (1.32 g, 3.12 mmol, 2.0 equiv.) were added sequentially. The reaction mixture was warmed gradually to room temperature and stirred further for 1 h. The reaction was then quenched with saturated aqueous solution of Na₂S₂O₃ (5 mL) and NaHCO₃ (5 mL) and then diluted with CH₂Cl₂ (20 mL) and stirred further the two phases were separated. The resultant mixture was extracted with CH₂Cl₂ (2 x 20 mL), washed with water, brine, dried over Na₂SO₄ and concentrated in *vacuo*. The crude residue was subjected to flash column chromatography (using a short pad of 60-120 silica and EtOAc as eluent) to get the corresponding aldehyde (quantitative) as a colorless liquid which was taken for the next reaction without further characterizations.

To a suspension of Ph₃PCH₃Br (1.226 g, 3.42 mmol, 2.2 equiv.) in anhydrous THF (10 mL) at 0 °C under argon, ^tBuOK (350 mg, 4.52 mmol, 3.12 equiv.) was added and stirred for 30 min at the same temperature. The above aldehyde (446 mg, 1.56 mmol, dissolved in 5 mL of anhydrous THF, 1.0 equiv.) was cannulated into it at the same temperature. The reaction mixture was allowed to stir for another 1 h at room temperature and then quenched with saturated aqueous NH₄Cl solution (5 mL). The resultant mixture was extracted with EtOAc (2 x 25 mL), washed with water, brine, dried (Na₂SO₄) and concentrated in *vacuo*. Flash column chromatography (SiO₂, 60-120 mesh, 1% EtOAc in hexane as eluent) of the crude residue gave compound **3a** (283 mg, 64%) as a yellowish oil. *R*_f = 0.6 (2% EtOAc/hexane); [α]_D²⁵ = -40.0 (*c* 0.22, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 5.63 (m, 1H), 5.00 – 4.85 (m, 2H), 3.73 (q, *J* = 5.9 Hz, 1H), 2.29 – 2.16 (m, 1H), 1.44 – 1.33 (m, 4H), 1.32 – 1.22 (m, 2H), 1.11 (d, *J* = 6.1 Hz, 3H), 1.07 – 1.02 (m, 1H), 0.97 (d, *J* = 6.6 Hz, 3H), 0.89 (s, 9H), 0.84 (d, *J* = 6.3 Hz, 3H), 0.04 (s, 6H);

^{13}C NMR (CDCl_3 , 75 MHz) δ 145.0 , 112.5 , 69.1 , 44.5 , 37.1 , 35.6 , 33.5 , 30.4 , 26.0 , 23.9 , 21.3 , 19.6 , 18.3 , -4.3 , -4.6 ppm; IR (neat) ν_{max} 2960, 2926, 1259, 1093, 1017 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{36}\text{OSiNa}$ $[\text{M} + \text{Na}]^+$ 307.2433, found 307.2432.



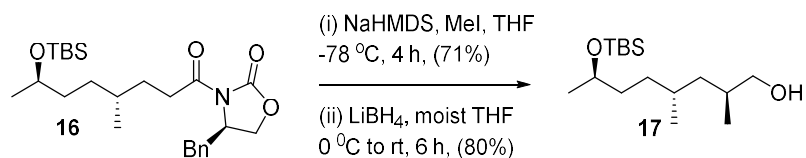
(*S*)-4-Benzyl-3-((4*R*,7*R*)-7-((*tert*-butyldimethylsilyl)oxy)-4-methyloctanoyl)oxazolidin-2-one

(16): Following the same Swern oxidation conditions as described in the preparation of compound **9**, the alcohol **5a** (1.5 g) was transformed to the corresponding aldehyde (1.4 g, quantitative, purified by flash column chromatography using a short pad of 60–120 silica, 10% EtOAc in hexane as eluent) as a yellowish liquid which was taken for the next step without further characterizations.

Following the same experimental procedure as described in the preparation of compound **9**, the above aldehyde (1.4 g, 5.68 mmol) was couple with compound **11** (2.2 g, 6.25 mmol) to get the corresponding coupled product (1.81 g, 72%, purification by flash column chromatography, SiO_2 , 100-200 mesh, 5% EtOAc in hexane as eluent) as a yellowish oil. R_f = 0.5 (10% EtOAc/hexane); $[\alpha]_D^{25} = +14.8$ (c 1.0, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.37 – 7.28 (m, 3H), 7.24 – 7.05 (m, 4H), 4.78 – 4.67 (m, 1H), 4.21 – 4.14 (m, 2H), 3.77 (dd, J = 11.0, 5.0 Hz, 1H), 3.39 – 3.28 (m, 1H), 2.85 – 2.71 (m, 1H), 2.40 (t, J = 6.7 Hz, 1H), 1.47 – 1.40 (m, 3H), 1.30 – 1.25 (m, 1H), 1.11 (dd, J = 8.8, 6.4 Hz, 6H), 0.89 (s, 9H), 0.05 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 165.3, 157.1, 153.5, 135.5, 129.5, 129.0, 127.4, 118.9, 68.5, 66.2, 55.5, 38.1, 37.1, 37.1, 32.1, 26.0, 23.9, 19.5, 18.2, -4.3, -4.6 ppm; IR (neat) ν_{max} 2957, 2928, 1780, 1683,

1351, 1193, 1098 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{25}\text{H}_{40}\text{NO}_4\text{Si}$ $[\text{M} + \text{H}]^+$ 446.2727, found 446.2724.

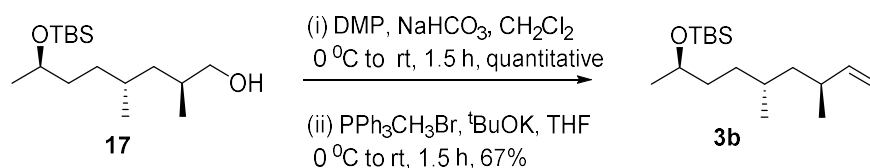
The above coupled product (1.6 g, 3.59 mmol, 1.0 equiv.) was converted to compound **16** (1.58 g, quantitative, purification by flash column chromatography, SiO_2 , 60-120 mesh, 10% EtOAc in hexane as eluent) as a colorless oil using 10% Pd-C/ H_2 (160 mg) following the same experimental procedure of compound **10**. R_f = 0.5 (10% EtOAc/hexane); $[\alpha]_D^{25}$ = +12.3 (c 1.75, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.36 – 7.28 (m, 3H), 7.24 – 7.20 (m, 2H), 4.71 – 4.63 (m, 1H), 4.21 – 4.14 (m, 2H), 3.76 (q, J = 5.9 Hz, 1H), 3.34 – 3.19 (m, 1H), 2.93 (dd, J = 8.5, 6.3 Hz, 1H), 2.76 (dd, J = 13.3, 9.6 Hz, 1H), 1.80 – 1.64 (m, 1H), 1.50–1.40 (m, 6H), 1.28 – 1.17 (m, 1H), 1.12 (d, J = 6.1 Hz, 3H), 0.92 (d, J = 5.2 Hz, 3H), 0.89 (s, 9H), 0.05 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 173.7, 153.5, 135.4, 129.5, 129.0, 127.4, 69.0, 66.2, 55.3, 38.0, 37.0, 33.5, 32.8, 32.6, 31.4, 26.0, 23.9, 19.5, 18.2, -4.3, -4.6 ppm; IR (neat) ν_{max} 2953, 2925, 1795, 1688, 1358, 1197 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{25}\text{H}_{41}\text{NO}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 470.2703, found 470.2704.



(2*S*,4*R*,7*R*)-7-((*tert*-Butyldimethylsilyl)oxy)-2,4-dimethyloctan-1-ol (17): Following the same experimental procedure as described in the preparation of compound **10**, compound **16** (1.52g, 3.35 mmol) was converted to the corresponding methylated compound (1.0 g, 71%, purification by flash column chromatography, SiO_2 , 100-200 mesh, 5% EtOAc in hexane as eluent) as a yellowish oil. R_f = 0.6 (10% EtOAc/hexane); $[\alpha]_D^{25}$ = +61.3 (c 0.32, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.38 – 7.28 (m, 3H), 7.21 (dd, J = 7.9, 1.7 Hz, 2H), 4.66 (ddq, J = 10.1, 6.8, 3.2 Hz, 1H), 4.22 – 4.12 (m, 2H), 3.83 – 3.69 (m, 2H), 3.27 (dd, J = 13.3, 3.3 Hz, 1H), 2.76 (dd, J =

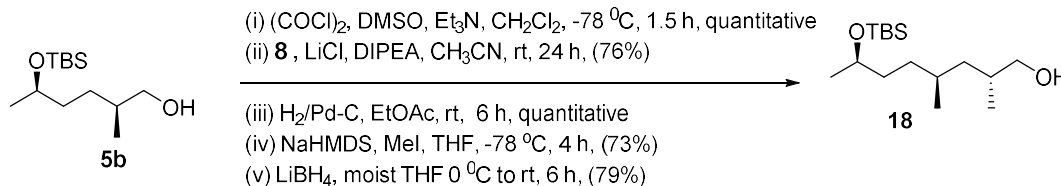
13.3, 9.6 Hz, 1H), 1.58 – 1.49 (m, 1H), 1.44-1.38 (m, 5H), 1.28-1.23 (m, 1H), 1.19 (d, $J = 6.8$ Hz, 3H), 1.10 (d, $J = 6.1$ Hz, 3H), 0.88 (d, $J = 2.1$ Hz, 12H), 0.04 (s, 6H).; ^{13}C NMR (CDCl_3 , 75 MHz) δ 177.8, 153.0, 135.4, 129.5, 129.0, 127.4, 68.9, 66.1, 55.5, 40.5, 38.0, 37.1, 35.5, 33.5, 30.6, 26.0, 23.9, 19.3, 18.2, 17.1, -4.3, -4.6 ppm; IR (neat) ν_{max} 2956, 2929, 2856, 1780, 1455, 1256, 1208, 1193 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{26}\text{H}_{43}\text{NO}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 484.2859, found 484.2858.

Following the same experimental procedure as described in the preparation of compound **5a**, the above methylated compound (1.0g, 2.16 mmol) was converted to the compound **17** (498 mg, 80%, purification by flash column chromatography, SiO_2 , 60-120 mesh, 8% EtOAc in hexane as eluent) as a colorless oil. $R_f = 0.4$ (10% EtOAc/hexane); $[\alpha]_D^{25} = +2.2$ (c 0.37, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 3.78 – 3.71 (m, 1H), 3.53 – 3.37 (m, 2H), 1.77 – 1.63 (m, 1H), 1.46 – 1.33 (m, 4H), 1.33 – 1.23 (m, 2H), 1.22 – 1.15 (m, 1H), 1.11 (d, $J = 6.1$ Hz, 3H), 0.88 (d, $J = 2.3$ Hz, 12H), 0.85 (d, $J = 6.5$ Hz, 3H), 0.04 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 69.2, 69.1, 40.7, 37.2, 34.0, 33.3, 30.1, 26.0, 23.9, 19.5, 18.3, 16.4, -4.3, -4.6 ppm; IR (neat) ν_{max} 3356, 2961, 2946, 1446, 1255, 1035 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{37}\text{O}_2\text{Si}$ $[\text{M} + \text{H}]^+$ 289.2563, found 289.2549.



tert-Butyl(((2*R*,5*R*,7*S*)-5,7-dimethylnon-8-en-2-yl)oxy)dimethylsilane (3b): Following the same oxidation conditions as described in the preparation of compound **3a**, alcohol **17** (450 mg) was transformed to the corresponding aldehyde (450 mg, quantitative, purified by flash column chromatography using a short pad of 60–120 silica, 10% EtOAc in hexane as eluent) as a yellowish liquid which was taken for the next step without further characterizations.

Following the same experimental procedure as described in the preparation of compound **3a**, the above aldehyde of **17** (450 mg, 1.56 mmol) was converted to the corresponding alkene **3b** (297 mg, 67%, purification by flash column chromatography, SiO₂, 60-120 mesh, 1% EtOAc in hexane as eluent) as a colorless oil. R_f = 0.6 (2% EtOAc/hexane); $[\alpha]_D^{29}$ = +3.9 (c 0.37, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 5.69 (ddd, J = 17.5, 10.2, 7.5 Hz, 1H), 4.98 – 4.84 (m, 2H), 3.74 (q, J = 6.0 Hz, 1H), 2.29 – 2.16 (m, 1H), 1.45 – 1.34 (m, 4H), 1.20 – 1.14 (m, 2H), 1.12 (d, J = 6.1 Hz, 3H), 1.01 – 0.97 (m, 1H), 0.95 (d, J = 6.6 Hz, 3H), 0.89 (d, J = 1.3 Hz, 9H), 0.86 (s, 3H), 0.05 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 145.5, 112.0, 69.1, 44.4, 37.0, 35.3, 32.9, 30.3, 26.0, 23.9, 20.2, 20.0, 18.3, -4.3, -4.6 ppm; IR (neat) ν_{max} 2955, 2920, 1728, 1475, 1255, 1087 cm⁻¹; HRMS (ESI) m/z calcd for C₁₇H₃₆OSiNa [M + Na]⁺ 307.2433, found 307.2421.



(2R,4S,7R)-7-((tert-butyldimethylsilyl)oxy)-2,4-dimethyloctan-1-ol (18): Following the same Swern oxidation conditions as described in the preparation of compound **9**, alcohol **5b** (1.5 g, 6.09 mmol) was transformed to the corresponding aldehyde (1.5 g, quantitative, purified by flash column chromatography using a short pad of 60–120 silica, 8% EtOAc in hexane as eluent) as a yellowish liquid which was taken for the next step without further characterizations.

Following the same experimental procedure as described in the preparation of compound **9**, the above aldehyde (1.5 g, 6.09 mmol) and compound **8** (2.4 g, 6.7 mmol) was converted to the corresponding couple product (2.01 g, 76%, purification by flash column chromatography, SiO₂, 100-200 mesh, 5% EtOAc in hexane as eluent) as a yellowish oil. R_f = 0.5 (10%

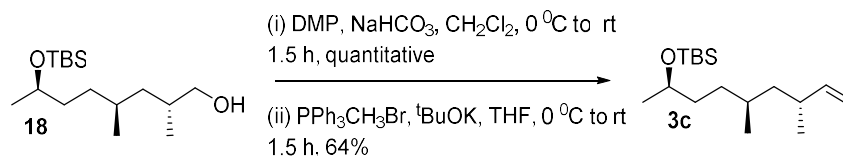
EtOAc/hexane); $[\alpha]_D^{25} = -32.8$ (*c* 3.0, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.37 – 7.28 (m, 3H), 7.23 – 7.05 (m, 4H), 4.76 – 4.68 (m, 1H), 4.21 – 4.14 (m, 2H), 3.78 (qd, *J* = 6.2, 3.4 Hz, 1H), 3.39 – 3.28 (m, 1H), 2.83 – 2.71 (m, 1H), 2.47 – 2.34 (m, 1H), 1.55 – 1.42 (m, 3H), 1.31 – 1.25 (m, 1H), 1.11 (dd, *J* = 10.5, 6.4 Hz, 6H), 0.89 (s, 9H), 0.05 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 165.3, 157.1, 153.5, 135.5, 129.5, 129.0, 127.4, 118.9, 68.7, 66.2, 55.5, 38.0, 37.3, 37.2, 32.3, 26.0, 23.9, 19.6, 18.2, -4.3, -4.6 ppm; IR (neat) ν_{max} 2928, 2856, 1780, 1683, 1359, 1193, 1004 cm⁻¹; HRMS (ESI) *m/z* calcd for C₂₅H₃₉NO₄SiNa [M + Na]⁺ 468.2546, found 468.2814.

The above couple product (1.8 g, 4.04 mmol) was converted to the corresponding saturated compound (1.8 g, quantitative, purification by flash column chromatography, SiO₂, 60-120 mesh, 10% EtOAc in hexane as eluent) as a colorless oil using 10% Pd-C/H₂ (160 mg) following the same experimental procedure as describe for the compound **10**. *R_f* = 0.5 (10% EtOAc/hexane); $[\alpha]_D^{25} = -36.2$ (*c* 1.04, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.37 – 7.28 (m, 3H), 7.21 (ddd, *J* = 7.8, 3.1, 1.7 Hz, 2H), 4.72 – 4.63 (m, 1H), 4.20 – 4.13 (m, 2H), 3.83 – 3.70 (m, 1H), 3.26 (ddd, *J* = 19.5, 13.3, 3.4 Hz, 1H), 2.94 (t, *J* = 7.5 Hz, 2H), 2.76 (dd, *J* = 13.3, 9.6 Hz, 1H), 1.75 (q, *J* = 8.1 Hz, 1H), 1.56 – 1.42 (m, 3H), 1.33 – 1.22 (m, 3H), 1.12 (d, *J* = 6.1 Hz, 3H), 0.93 (d, *J* = 6 Hz, 3H), 0.89 (s, 9H), 0.05 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 173.8, 153.5, 135.4, 129.5, 129.0, 127.4, 69.0, 66.2, 55.3, 38.0, 37.1, 33.4, 32.9, 32.6, 31.4, 26.0, 24.0, 19.5, 18.2, -4.3, -4.6 ppm; IR (neat) ν_{max} 2956, 2928, 1781, 1698, 1384, 1349, 1194, 1076, 1049 cm⁻¹; HRMS (ESI) *m/z* calcd for C₂₅H₄₁NO₄SiNa [M + Na]⁺ 470.2703, found 470.2704.

Following the same experimental procedure as described in the preparation of compound **10**, the above hydrogenated compound (1.6 g, 3.57 mmol) was converted to the corresponding methylated product (1.2 g, 73%, purification by flash column chromatography, SiO₂, 60-120 mesh, 8% EtOAc in hexane as eluent) as a yellowish oil. *R_f* = 0.6 (10% EtOAc/hexane); $[\alpha]_D^{25} =$

-22.2 (*c* 0.54, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.37 – 7.27 (m, 3H), 7.24 – 7.19 (m, 2H), 4.66 (td, *J* = 6.7, 3.4 Hz, 1H), 4.21 – 4.14 (m, 2H), 3.87 – 3.67 (m, 2H), 3.27 (dd, *J* = 13.3, 3.4 Hz, 1H), 2.76 (dd, *J* = 13.3, 9.6 Hz, 1H), 1.55 – 1.41 (m, 4H), 1.37 – 1.23 (m, 3H), 1.20 (d, *J* = 6.8 Hz, 3H), 1.11 (d, *J* = 6.1 Hz, 3H), 0.92 – 0.87 (m, 12H), 0.04 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 177.5, 153.1, 135.5, 129.6, 129.1, 127.5, 69.1, 66.1, 55.5, 41.0, 38.0, 37.2, 35.5, 33.4, 31.1, 26.1, 24.0, 20.0, 18.7, 18.3, -4.3, -4.5 ppm; IR (neat) ν_{max} 2956, 2929, 1780, 1698, 1383, 1208, 1194, 1006 cm⁻¹; HRMS (ESI) *m/z* calcd for C₂₆H₄₃NO₄SiNa [M + Na]⁺ 484.2859, found 484.2858.

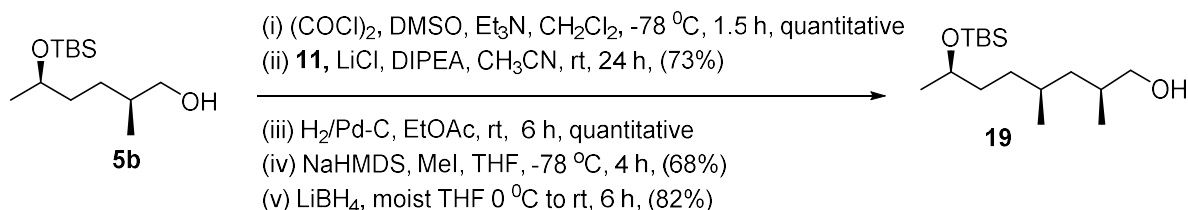
Following the same experimental procedure as described in the preparation of compound **5a**, the above methylated compound (1.1 g, 2.38 mmol) was converted to compound **18** (542 mg, 79%, purification by flash column chromatography, SiO₂, 60-120 mesh, 8% EtOAc in hexane as eluent) as a colorless oil. *R_f* = 0.4 (10% EtOAc/hexane); [α]_D²⁵ = +8.0 (*c* 0.3, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 3.80 – 3.70 (m, 1H), 3.52 – 3.37 (m, 2H), 1.75 – 1.68 (m, 1H), 1.51 – 1.44 (m, 2H), 1.40 (dd, *J* = 5.4, 2.6 Hz, 1H), 1.37 – 1.34 (m, 1H), 1.31 – 1.27 (m, 1H), 1.24 – 1.18 (m, 2H), 1.11 (d, *J* = 6.0 Hz, 3H), 0.91 (d, *J* = 4.1 Hz, 3H), 0.88 (s, 9H), 0.84 (d, *J* = 6.5 Hz, 3H), 0.04 (d, *J* = 0.7 Hz, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 69.2, 69.0, 40.7, 37.2, 34.0, 33.4, 30.1, 26.0, 23.9, 19.4, 18.3, 16.4, -4.3, -4.6 ppm; IR (neat) ν_{max} 3340, 2955, 2933, 1436, 1233, 1087 cm⁻¹; HRMS (ESI) *m/z* calcd for C₁₆H₃₇O₂Si [M + H]⁺ 289.2563, found 289.2551.



***tert*-Butyl(((2*R*,5*S*,7*R*)-5,7-dimethylnon-8-en-2-yl)oxy)dimethylsilane (**3c**):** Following the same DMP oxidation conditions as described in the preparation of compound **3a**, alcohol **18** (500 mg, 1.73 mmol) was transformed to the corresponding aldehyde (500 mg, quantitative, purified

by flash column chromatography using a short pad of 60–120 silica, 5% EtOAc in hexane as eluent) as a yellowish liquid which was taken for the next step without further characterizations.

Following the same experimental procedure as described in the preparation of compound **3a**, the above aldehyde (495 mg, 1.73 mmol) was converted to alkene **3c** (315 mg, 64%, purification by flash column chromatography, SiO₂, 60-120 mesh, 1% EtOAc in hexane as eluent) as a colorless oil. $R_f = 0.6$ (2% EtOAc/hexane); $[\alpha]_D^{25} = +14.6$ (c 0.3, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 5.79 – 5.59 (m, 1H), 5.01 – 4.83 (m, 2H), 3.83 – 3.67 (m, 1H), 2.26 – 2.17 (m, 1H), 1.53 – 1.34 (m, 3H), 1.32 – 1.27 (m, 1H), 1.24 – 1.14 (m, 3H), 1.12 (d, $J = 6.1$ Hz, 3H), 0.95 (d, $J = 6.7$ Hz, 3H), 0.89 (s, 9H), 0.85 (d, $J = 6.6$ Hz, 3H), 0.05 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 145.5, 112.0, 69.1, 44.3, 36.9, 35.3, 32.9, 30.3, 26.0, 23.9, 20.1, 19.9, 18.3, -4.3, -4.6 ppm; IR (neat) ν_{max} 2957, 2855, 1641, 1375, 1083 cm⁻¹; HRMS (ESI) m/z calcd for C₁₇H₃₆OSiNa $[M + Na]^+$ 307.2433, found 307.2432.



(2S,4S,7R)-7-((tert-Butyldimethylsilyl)oxy)-2,4-dimethyloctan-1-ol (19): Following the same Swern oxidation conditions as described in the preparation of compound **9**, alcohol **5b** (1.4 g) was transformed to the corresponding aldehyde (1.4 g, quantitative, purified by flash column chromatography using a short pad of 60–120 silica, 10% EtOAc in hexane as eluent) as a yellowish liquid which was taken for the next step without further characterizations.

Following the same experimental procedure as described in the preparation of compound **9**, the above aldehyde (1.4 g, 5.68 mmol) was coupled with compound **11** (2.2g, 6.24 mmol) to get the corresponding product (1.84 g, 73%, purification by flash column chromatography, SiO₂,

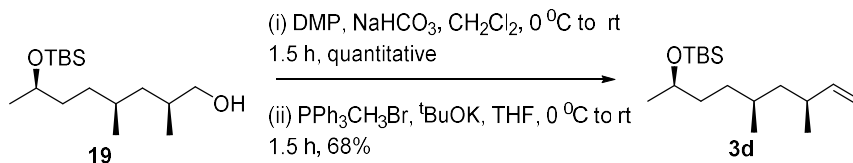
100-200 mesh, 5% EtOAc in hexane as eluent) as a yellowish oil. $R_f = 0.5$ (10% EtOAc/hexane); $[\alpha]_D^{25} = +56.0$ (c 0.8, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.36 – 7.28 (m, 3H), 7.25 – 7.05 (m, 4H), 4.72 (dq, $J = 10.2, 3.5$ Hz, 1H), 4.22 – 4.12 (m, 2H), 3.85 – 3.68 (m, 1H), 3.35 (dd, $J = 13.3, 3.2$ Hz, 1H), 2.86 – 2.74 (m, 1H), 2.46 – 2.32 (m, 1H), 1.55 – 1.41 (m, 3H), 1.28 – 1.25 (m, 1H), 1.11 (dd, $J = 6.4, 4.0$ Hz, 6H), 0.88 (s, 9H), 0.04 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 165.3, 157.1, 135.6, 129.5, 129.0, 127.4, 118.9, 68.7, 66.2, 55.5, 38.0, 37.3, 32.4, 27.1, 26.0, 23.9, 19.6, 18.2, -4.3, -4.6 ppm; IR(neat) ν_{\max} 2928, 2856, 1780, 1683, 1359, 1193, 1004 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{25}\text{H}_{39}\text{NO}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+ 468.2546$, found 468.2849.

Following the same experimental procedure of compound **10**, the above couple product (1.8 g, 4.04 mmol) was hydrogenated to obtain the corresponding saturated compound (1.8 g, quantitative, purification by flash column chromatography, SiO_2 , 60-120 mesh, 10% EtOAc in hexane as eluent) as a colorless oil using 10% Pd-C/ H_2 (180 mg).. $R_f = 0.5$ (10% EtOAc/hexane); $[\alpha]_D^{25} = +24.8$ (c 0.5, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.35 – 7.27 (m, 3H), 7.23 – 7.19 (m, 2H), 4.67 (ddd, $J = 9.5, 5.6, 2.2$ Hz, 1H), 4.22 – 4.14 (m, 2H), 3.81 – 3.71 (m, 1H), 3.30 (dd, $J = 13.3, 3.3$ Hz, 1H), 3.02 – 2.83 (m, 2H), 2.80 – 2.71 (m, 1H), 1.78 – 1.66 (m, 1H), 1.47 (ddd, $J = 12.7, 8.9, 5.5$ Hz, 4H), 1.28 – 1.24 (m, 1H), 1.21-1.19 (m, 1H), 1.12 (d, $J = 6.1$ Hz, 3H), 0.92 (d, $J = 6.2$ Hz, 3H), 0.88 (d, $J = 1.1$ Hz, 9H), 0.05 (d, $J = 2.7$ Hz, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 173.8, 153.5, 135.5, 129.5, 129.0, 127.4, 69.0, 66.2, 55.3, 38.1, 37.1, 33.5, 32.9, 32.7, 31.4, 26.0, 24.0, 19.5, 18.3, -4.3, -4.6 ppm; IR(neat) ν_{\max} 2956, 2928, 1781, 1699, 1351, 1251, 1209, 1050 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{25}\text{H}_{42}\text{NO}_4\text{Si}$ $[\text{M} + \text{H}]^+ 448.2883$, found 448.2877.

Following the same experimental procedure as described in the preparation of compound **10**, the above hydrogenated compound (1.6 g, 3.52 mmol) was transformed to the corresponding methylated product (1.1 g, 68%, purification by flash column chromatography, SiO_2 , 100-200

mesh, 8% EtOAc in hexane as eluent) as a yellowish oil. $R_f = 0.6$ (10% EtOAc/hexane); $[\alpha]_D^{25} = +80.0$ (c 0.6, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.36 – 7.27 (m, 3H), 7.24 – 7.18 (m, 2H), 4.68 (ddd, $J = 9.7, 6.8, 3.4$ Hz, 1H), 4.22 – 4.15 (m, 2H), 3.92 – 3.82 (m, 1H), 3.75 (q, $J = 6.0$ Hz, 1H), 3.26 (dd, $J = 13.3, 3.4$ Hz, 1H), 2.76 (dd, $J = 13.3, 9.6$ Hz, 1H), 1.88 (ddd, $J = 13.7, 9.0, 4.9$ Hz, 1H), 1.53 – 1.26 (m, 6H), 1.22 (d, $J = 6.9$ Hz, 3H), 1.12 (d, $J = 6.0$ Hz, 3H), 0.89 – 0.84 (m, 12H), 0.05 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 177.4, 153.1, 135.4, 129.5, 129.0, 127.4, 69.1, 66.1, 55.4, 40.9, 38.0, 37.1, 35.5, 33.3, 31.1, 26.0, 23.9, 19.9, 18.7, 18.3, -4.3, -4.6 ppm; IR (neat) ν_{max} 2957, 2925, 2855, 1723, 1462, 1256, 1026 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{26}\text{H}_{43}\text{NO}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 484.2859, found 484.2858.

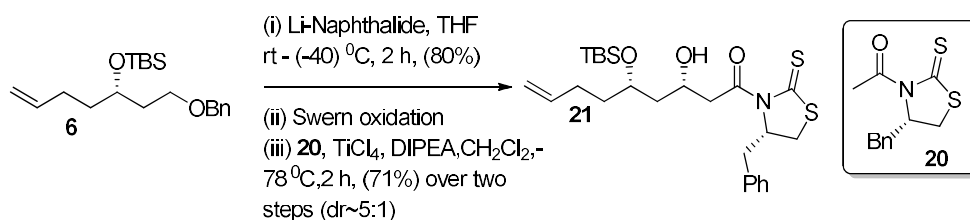
Following the same experimental procedure as described in the preparation of compound **5a**, the above methylated compound (1.0 g, 2.16 mmol) was converted to compound **19** (512 mg, 82%, purification by flash column chromatography, SiO_2 , 100-200 mesh, 8% EtOAc in hexane as eluent) as a colorless oil. $R_f = 0.4$ (10% EtOAc/hexane); $[\alpha]_D^{25} = +62.5$ (c 0.32, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 3.74 (td, $J = 6.3, 4.9$ Hz, 1H), 3.52 (dd, $J = 10.5, 5.1$ Hz, 1H), 3.36 (dd, $J = 10.4, 6.8$ Hz, 1H), 1.76 – 1.68 (m, 1H), 1.46 (dddd, $J = 13.2, 12.0, 5.5, 3.7$ Hz, 3H), 1.36 – 1.26 (m, 3H), 1.22 – 1.15 (m, 1H), 1.11 (d, $J = 6.1$ Hz, 3H), 0.91 (d, $J = 6.6$ Hz, 3H), 0.89-0.85 (m, 12H), 0.04 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 69.1, 68.4, 41.0, 36.9, 33.2, 32.6, 30.2, 26.0, 23.9, 20.4, 18.2, 17.4, -4.3, -4.6 ppm; IR (neat) ν_{max} 3392, 2961, 2926, 1255, 1037 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{37}\text{O}_2\text{Si}$ $[\text{M} + \text{H}]^+$ 289.2563, found 289.2556.



tert-Butyl(((2R,5S,7S)-5,7-dimethylnon-8-en-2-yl)oxy)dimethylsilan (3d): Following the same DMP oxidation conditions as described in the preparation of compound **3a**, alcohol **19** (450 mg,

1.56 mmol) was transformed to the corresponding aldehyde (447 mg, quantitative, purified by flash column chromatography using a short pad of 60–120 silica, 10% EtOAc in hexane as eluent) as a yellowish liquid which was taken for the next step without further characterizations.

Following the same experimental procedure as described in the preparation of compound **3a**, the above aldehyde (450 mg, 1.56 mmol) was converted to alkene **3d** (300 mg, 68%, purification by flash column chromatography, SiO₂, 60-120 mesh, 1% EtOAc in hexane as eluent) as a colorless liquid. $R_f = 0.6$ (2% EtOAc/hexane); $[\alpha]_D^{25} = +72.0$ (c 0.1, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 5.71 – 5.56 (m, 1H), 4.99 – 4.85 (m, 2H), 3.73 (dt, $J = 12.1, 6.0$ Hz, 1H), 2.29 – 2.16 (m, 1H), 1.41 (ddd, $J = 13.0, 6.5, 3.6$ Hz, 3H), 1.33 (d, $J = 5.2$ Hz, 1H), 1.28 – 1.20 (m, 3H), 1.11 (d, $J = 6.1$ Hz, 3H), 0.97 (d, $J = 6.6$ Hz, 3H), 0.89 (s, 9H), 0.84 (d, $J = 6.5$ Hz, 3H), 0.05 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 144.9, 112.5, 69.0, 44.5, 37.0, 35.7, 33.5, 30.3, 26.0, 23.9, 21.4, 19.5, 18.3, -4.3, -4.6 ppm; IR (neat) ν_{max} 2957, 2924, 1732, 1461, 1256, 1086 cm⁻¹; HRMS (ESI) m/z calcd for C₁₇H₃₆OSiNa [M + Na]⁺ 307.2433, found 307.2431.



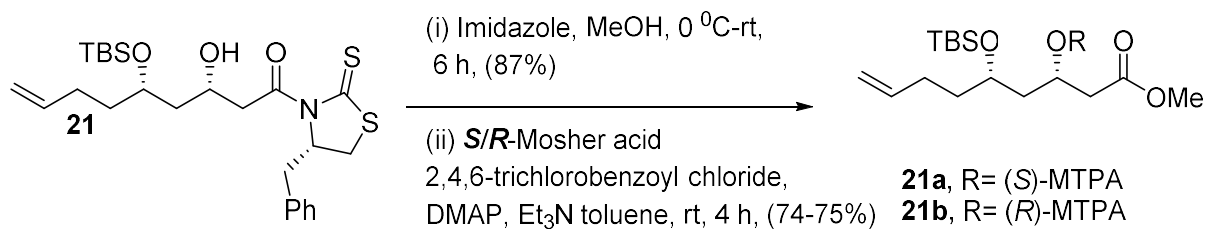
(3*S*,5*S*)-1-((*S*)-4-Benzyl-2-thioxothiazolidin-3-yl)-5-((tert-butyldimethylsilyl)oxy)-3-hydroxy non-8-en-1-one (21): To a solution of naphthalene (8.6 g, 67.25 mmol, 5 equiv) in anhydrous THF (120 mL) under argon, Li was added (465 mg, 67.25 mmol, 5 equiv) as small pieces. After it was stirred for 1 h at room temperature, the reaction mixture was cooled to -40 °C and subsequently a solution of compound **6** (4.5 g, 13.45 mmol, dissolved in 20 mL of anhydrous THF, 1.0 equiv) was cannulated into it. The reaction was continued further for 1 h at the same

temperature and then quenched with saturated aqueous solution of NH_4Cl (25 mL). The resultant mixture was extracted with EtOAc (2 x 150 mL), washed with water and brine, dried over anhydrous Na_2SO_4 , and concentrated under reduced pressure. The residue was purified by flash column chromatography (SiO_2 , 60-120 mesh, 5% EtOAc in hexane as eluent) to give the corresponding alcohol (2.6 g, 80%) as colorless oil: $R_f = 0.3$ (10% EtOAc in hexane); $[\alpha]_D^{25} = +21.9$ (c 0.1, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 5.80 (ddt, $J = 16.9, 10.2, 6.6$ Hz, 1H), 5.08 – 4.89 (m, 2H), 3.92 (tt, $J = 6.2, 3.1$ Hz, 1H), 3.88 – 3.78 (m, 1H), 3.70 (dddd, $J = 10.8, 5.8, 5.1, 0.7$ Hz, 1H), 2.37 (s, 1H), 2.13 – 1.99 (m, 2H), 1.88 – 1.76 (m, 1H), 1.71 – 1.54 (m, 3H), 0.89 (s, 9H), 0.08 (d, $J = 4.2$ Hz, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 138.4, 114.7, 71.3, 60.2, 37.8, 36.0, 29.6, 25.9, 18.0, -4.4, -4.6 ppm; IR (neat) ν_{max} 3425, 2957, 2855, 1641, 1375, 1083 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{28}\text{O}_2\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 267.1756, found 267.1725.

Following the same experimental procedure as compound **10**, the above alcohol (2.5 g, 10.26 mmol) was converted to the corresponding aldehyde (2.5 g, quantitative, purification by flash column chromatography, SiO_2 , 60-120 mesh, 5% EtOAc in hexane as eluent) as a colorless oil. It was taken for the next step without further characterizations.

To a solution of thiazolidinethione **20** (3.1 g, 12.31 mmol) in anhydrous CH_2Cl_2 (30 mL) at -40 °C under argon, freshly distilled TiCl_4 (1.4 mL, 12.83 mmol) was added dropwise. The yellowish slurry was stirred for 5 min at the same temperature, and DIPEA (2.4 mL, 13.34 mmol) was added dropwise. The deep reddish solution was stirred for another 1 h at -40 °C before being cooled to -78 °C, and the above aldehyde (2.5 g, 10.25 mmol dissolved in 15 mL of CH_2Cl_2) was cannulated. Stirring was continued at -78 °C for 20 min and the was quenched by saturated aqueous NH_4Cl (10 mL). The resultant mixture was extracted with CH_2Cl_2 (2 x 50), washed with water and brine, dried (Na_2SO_4), filtered, and concentrated in *vacuo*. Purification by

column chromatography (SiO₂, 230–400 mesh, 5–10% EtOAc in hexane) separated the two diastereomers with 71% total yield (*dr* =5:1). Isolated major isomer **21** (3.5 g, 59%) was obtained as a yellowish liquid; *R_f* = 0.45 (20% EtOAc in hexane); [α]²⁵_D = +162.6 (*c* 0.1 CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.38 – 7.26 (m, 5H), 5.81 (m, 1H), 5.39 (m, 1H), 5.09 – 4.92 (m, 2H), 4.40 – 4.28 (m, 1H), 3.98 (dq, *J* = 7.4, 5.7 Hz, 1H), 3.54 (dd, *J* = 17.7, 3.1 Hz, 1H), 3.38 (m, 1H), 3.29 – 3.17 (m, 2H), 3.03 (dd, *J* = 13.2, 10.4 Hz, 1H), 2.93 – 2.82 (m, 1H), 2.16 – 2.06 (m, 2H), 1.81 – 1.54 (m, 4H), 0.90 (s, 9H), 0.10 (d, *J* = 3.4 Hz, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 201.2, 172.5, 138.4, 136.4, 129.4, 128.9, 127.2, 114.6, 70.9, 68.3, 66.4, 46.2, 42.6, 36.7, 36.5, 32.1, 29.1, 25.9, 18.0, -4.1, -4.5 ppm; IR (neat) ν_{\max} 3490, 2925, 2854, 1782, 1696, 1367, 1257, 1138 cm⁻¹; HRMS (ESI) *m/z* calcd for C₂₅H₃₉NO₃S₂SiNa [M + Na]⁺ 516.2038, found 516.2038.



Methyl- (3*S*,5*S*)-5-((*tert*-butyldimethylsilyl)oxy)-3-(((*S*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoyl)oxy)non-8-enoate (21a**):** To a solution of compound **21** (0.3 g, 0.65 mmol) in anhydrous methanol (3 mL) at 0 °C imidazole was added (89 mg, 1.3 mmol), and the mixture was stirred 6 h at rt. The reaction mixture was then quenched with a saturated solution of NH₄Cl (1 mL). Methanol was removed in vacuo and extracted with EtOAc (2 × 10 mL), washed with water and brine, dried (Na₂SO₄), and concentrated in vacuo. Purification by column chromatography (SiO₂, 100–200 mesh, 10% EtOAc in hexane) afforded pure methyl ester (178 mg, 87%) as a colorless oil. *R_f* = 0.5 (30% EtOAc in hexane); [α]²⁵_D = +12.3 (*c* 1.3, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 5.78 (ddt, *J* = 16.9, 10.2, 6.6 Hz, 1H), 5.06 – 4.91 (m, 2H), 4.24 – 4.10 (m, 1H), 3.94 (dq, *J* = 7.4, 5.7 Hz, 1H), 3.69 (s, 3H), 2.47 (d, *J* = 6.2 Hz, 2H), 2.14 – 2.00

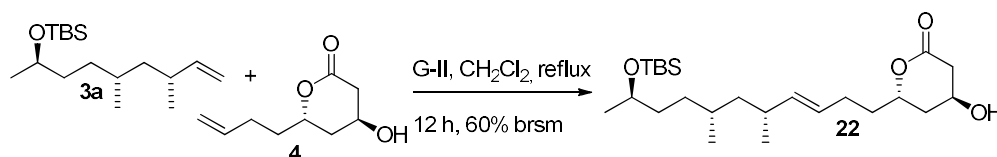
(m, 2H), 1.70 – 1.53 (m, 4H), 0.88 (s, 9H), 0.08 (d, $J = 2.2$ Hz, 6H).; ^{13}C NMR (CDCl_3 , 75 MHz) δ 172.8, 138.4, 114.7, 71.2, 66.8, 51.7, 42.7, 41.8, 36.6, 29.1, 25.9, 18.0, -4.1, -4.5 ppm; IR (neat) ν_{max} 3509, 2927, 2855, 1733, 1699, 1257, 1085, 1005 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{32}\text{O}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 339.1967, found 339.1966.

To solution of (*S*)-Mosher's acid (11 mg, 0.05 mmol) in anhydrous toluene (1 mL) at room Et_3N (0.01 mL, 0.08 mmol), and 2,4,6-trichlorobenzoyl chloride (7 μL , 0.05 mmol) were added. The mixture was stirred for 30 min then a solution of above alcohol (10 mg, 0.03 mmol) and DMAP (4 mg, 0.03 mmol,) in dry toluene (0.5 mL) was then cannulated. After being stirred for 4 h at room temperature, the reaction mixture was quenched with saturated aqueous NH_4Cl (0.5 mL) and extracted with EtOAc. The combined organic extracts were washed with water and brine, dried (Na_2SO_4), and concentrated in vacuo. Purification by column chromatography (silica gel, 100–200mesh, 10% EtOAc in hexane) gave (*S*)-MTPA ester **21a** (12 mg, 75%) as a colorless oil: $R_f = 0.4$ (10% EtOAc in hexane); $[\alpha]_D^{25} = -26.6$ (c 0.2, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.52 (dd, $J = 6.9, 2.9$ Hz, 2H), 7.39 (dd, $J = 4.9, 1.9$ Hz, 3H), 5.78 (ddt, $J = 16.9, 10.3, 6.6$ Hz, 1H), 5.54 (dt, $J = 11.8, 5.9$ Hz, 1H), 5.06 – 4.91 (m, 2H), 3.66 (s, 3H), 3.62 (d, $J = 6.0$ Hz, 1H), 3.54 (s, 3H), 2.78 (dd, $J = 16.1, 4.7$ Hz, 1H), 2.68 (dd, $J = 16.0, 8.0$ Hz, 1H), 2.04 (dq, $J = 14.7, 7.4$ Hz, 2H), 1.94 – 1.83 (m, 1H), 1.72 (dt, $J = 14.5, 6.3$ Hz, 1H), 1.58 – 1.40 (m, 2H), 0.86 (s, 9H), -0.03 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.4, 165.9, 138.4, 132.3, 129.7, 128.5, 127.4, 114.8, 71.1, 68.2, 55.5, 51.9, 40.5, 39.2, 35.6, 29.3, 25.9, 18.0, -4.5, -4.6 ppm; IR (neat) ν_{max} 2953, 2928, 1748, 1472, 1256, 1170 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{26}\text{H}_{40}\text{F}_3\text{O}_6\text{Si}$ $[\text{M} + \text{H}]^+$ 533.2546, found 533.2543.

Methyl-(3*S*,5*S*)-5-(((*tert*-butyldimethylsilyl)oxy)-3-(((*R*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoyl)oxy)non-8-enoate (21b): Following the same experimental procedure as described in the preparation of compound (21a), the above methyl ester (10 mg, 0.03 mmol) obtain from compound 21 was converted to the (*R*)-MTPA ester (21b) (12 mg, 74%, purification by flash column chromatography, SiO₂, 100-200 mesh, 5% EtOAc in hexane as eluent). *R_f* = 0.4 (10% EtOAc/hexane); $[\alpha]_D^{25} = +8.8$ (*c* 0.9, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.52 (dd, *J* = 6.9, 3.1 Hz, 2H), 7.41 (q, *J* = 3.8 Hz, 3H), 5.79 (ddt, *J* = 16.9, 10.2, 6.6 Hz, 1H), 5.56 (qd, *J* = 7.0, 4.7 Hz, 1H), 5.07 – 4.92 (m, 2H), 3.76 (p, *J* = 5.8 Hz, 1H), 3.58 (s, 3H), 3.50 (s, 3H), 2.77 (dd, *J* = 16.0, 4.7 Hz, 1H), 2.64 (dd, *J* = 16.0, 8.0 Hz, 1H), 2.05 (d, *J* = 21.7 Hz, 2H), 2.00 – 1.90 (m, 1H), 1.87 – 1.76 (m, 1H), 1.75 – 1.59 (m, 2H), 0.89 (d, *J* = 2.0 Hz, 9H), 0.03 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 170.3, 165.8, 138.3, 132.1, 129.7, 128.5, 127.6, 114.9, 71.3, 68.5, 55.4, 51.9, 40.6, 38.9, 35.7, 29.4, 25.9, 18.1, -4.4, -4.5 ppm; IR (neat) ν_{max} 3022, 2931, 2857, 1748, 1256, 1170, 747 cm⁻¹; HRMS (ESI) *m/z* calcd for C₂₆H₄₀F₃O₆Si [M + H]⁺ 533.2546, found 533.2542.2431.

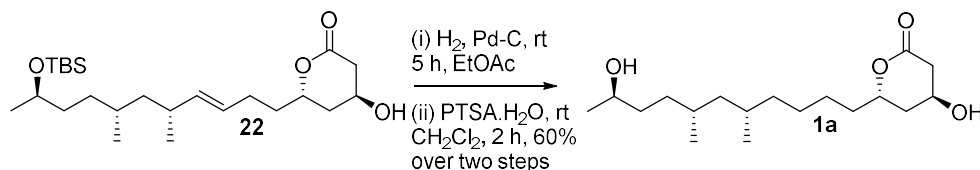
(4*S*,6*S*)-6-(But-3-en-1-yl)-4-hydroxytetrahydro-2H-pyran-2-one (4): To a stirred solution of compound **21** (1.1 g, 3.47 mmol) in distilled CH₂Cl₂ (10 mL) was added *p*-toluenesulfonic acid monohydrate (298 mg, 1.76 mmol) at room temperature. The reaction mixture was stirred for 4 h at the same temperature. It was quenched Et₃N (1 mL) at 0 °C, extracted with CH₂Cl₂ and concentrated in vacuum. Purification by column chromatography (SiO₂, 230–400 mesh, 20–25% EtOAc in hexane eluent) afforded pure compound **3a** (380 mg, 65%) as a colorless oil. *R*_F=

0.25 (60% EtOAc in hexane); $[\alpha]_D^{29} = -36.8$ (c 1.0, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 5.89 – 5.73 (m, 1H), 5.14 – 4.95 (m, 2H), 4.71 (m, 1H), 4.42 – 4.34 (m, 1H), 2.78 – 2.57 (m, 2H), 2.31 – 2.16 (m, 2H), 2.03 – 1.92 (m, 1H), 1.89 – 1.60 (m, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 171.2, 137.3, 115.5, 75.5, 62.5, 38.6, 35.8, 34.7, 29.0 ppm; IR (neat) ν_{max} 3404, 2924, 2860, 1715, 1450, 1247, 1068 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_9\text{H}_{14}\text{O}_3\text{Na}$ $[\text{M} + \text{Na}]^+ 193.0841$, 193.0842.



(4*S*,6*S*)-6-((5*R*,7*R*,10*R*,*E*)-10-((*tert*-Butyldimethylsilyl)oxy)-5,7-dimethylundec-3-en-1-yl)-4-hydroxytetrahydro-2H-pyran-2-one (22): To a solution of alkenes **4** (85 mg, 0.3 mmol) and **3a** (50 mg, 0.29 mmol) in degassed CH_2Cl_2 (15 mL) under argon, G-II catalyst (36 mg, 0.15 mmol) was added at room temperature. The reaction mixture was then refluxed for 12 h. The solvent was removed under reduced pressure, and the crude residue was purified by flash column chromatography (SiO_2 , 60–120 mesh, 30–40% EtOAc in hexane as the eluent) to obtain the cross coupled product **22** (76 mg, 60% brsm) as a colorless liquid. $R_f = 0.6$ (60% EtOAc in hexane); $[\alpha]_D^{29} = -15.4$ (c 0.13, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 5.39 – 5.21 (m, 2H), 4.76 – 4.65 (m, 1H), 4.42–4.35 (m, 1H), 3.72 (q, $J = 5.9$ Hz, 1H), 2.70 (dd, $J = 22.1, 17.4$ Hz, 2H), 2.16 (p, $J = 7.8$ Hz, 3H), 1.95 (d, $J = 15.0$ Hz, 1H), 1.84 – 1.73 (m, 2H), 1.68–1.56 (m, 3H), 1.41 – 1.31 (m, 4H), 1.22 – 1.17 (m, 1H), 1.11 (d, $J = 6.1$ Hz, 3H), 0.93 (d, $J = 6.6$ Hz, 3H), 0.88 (s, 9H), 0.82 (d, $J = 6.3$ Hz, 3H), 0.04 (d, $J = 1.2$ Hz, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.8, 137.8, 126.8, 75.3, 69.2, 62.7, 44.8, 38.7, 37.1, 36.0, 35.5, 34.4, 33.6, 30.5, 27.9, 26.0, 23.9, 21.8, 19.5, 18.3, -

4.3, -4.6 ppm; IR (neat) ν_{\max} 3426, 2955, 2928, 1712, 1461, 1253, 1072 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{24}\text{H}_{46}\text{O}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 449.3063, found 449.3066.

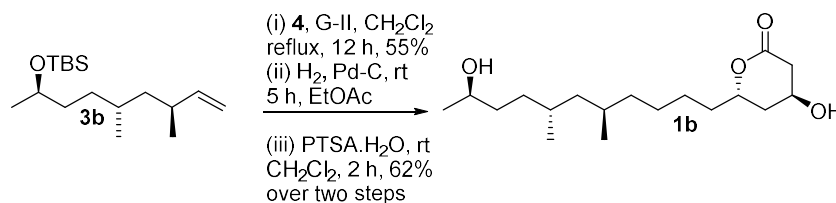


(4*S*,6*S*)-4-Hydroxy-6-((5*S*,7*R*,10*R*)-10-hydroxy-5,7-dimethylundecyl)tetrahydro-2*H*-pyran-

2-one (1a): Following the same experimental procedure as for compound **12**, compound **22** (55 mg, 0.13 mmol) was treated with Pd-C/ H_2 . Some deprotection of TBS occurred additionally during hydrogenation. The mixture of crude products were filtered and taken for the next reaction without further separation and characterizations.

Following the same experimental procedure as for compound **4**, the above mixture of compounds (0.13 mmol) was converted to compound **1a** (25 mg, 60% over two steps, purification by flash column chromatography, SiO_2 , 60–120 mesh, 40–50% EtOAc in hexane as eluent) as a colorless oil. R_f = 0.2 (60% EtOAc in hexane); $[\alpha]_{\text{D}}^{20}$ = -45.7 (c 0.35, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 4.68 (dddd, J = 11.0, 7.9, 5.0, 3.1 Hz, 1H), 4.37 (dt, J = 7.4, 3.7 Hz, 1H), 3.81 – 3.70 (m, 1H), 2.74 (dd, J = 17.6, 5.1 Hz, 1H), 2.61 (ddd, J = 17.6, 3.8, 1.6 Hz, 1H), 1.95 (dtd, J = 14.4, 3.4, 1.6 Hz, 1H), 1.80 – 1.68 (m, 2H), 1.59 (d, J = 3.0 Hz, 1H), 1.56 (dd, J = 4.0, 1.8 Hz, 1H), 1.48 – 1.44 (m, 2H), 1.43 (d, J = 3.9 Hz, 2H), 1.39–1.38 (m, 1H), 1.36 (d, J = 2.5 Hz, 1H), 1.30 (dq, J = 7.3, 2.3 Hz, 3H), 1.25 – 1.22 (m, 1H), 1.19 (d, J = 6.2 Hz, 3H), 1.07 (dtd, J = 7.3, 3.5, 2.2 Hz, 2H), 0.94 (dd, J = 13.7, 6.9 Hz, 1H), 0.86 (d, J = 5.7 Hz, 3H), 0.84 (d, J = 5.8 Hz, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.54, 75.79, 68.79, 62.87, 44.90, 38.71, 36.76, 36.57, 36.12, 35.57, 32.87, 30.26, 29.91, 26.48, 25.19, 23.57, 20.39, 20.37 ppm; IR (neat) ν_{\max}

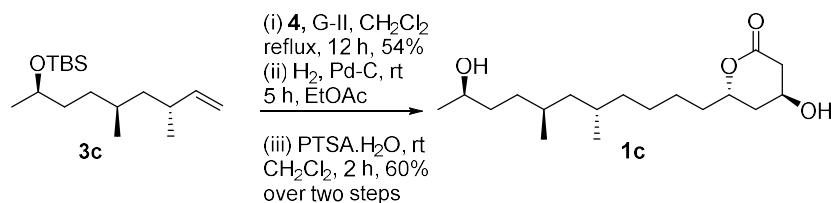
3499, 2957, 2957, 1735, 1472, 1255, 1041, 835, 704 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{18}\text{H}_{34}\text{O}_4\text{Na}$ $[\text{M} + \text{Na}]^+$ 337.2355, found 337.2356.



(4*S*,6*S*)-4-Hydroxy-6-((5*R*,7*R*,10*R*)-10-hydroxy-5,7-dimethylundecyl)tetrahydro-2*H*-pyran-2-one (1b): Following the same experimental procedure as described in the preparation of compound **22**, alkenes **3b** (35 mg, 0.12 mmol) and **4** (21 mg, 0.12 mmol) were converted to the corresponding coupled product. Purification by flash column chromatography (SiO_2 , 60–120 mesh, 30–40% EtOAc in hexane as the eluent) provided pure compound (28 mg, 55% brsm) as a colorless liquid. R_f = 0.6 (60% EtOAc in hexane); $[\alpha]_D^{29} = -4.5$ (c 0.4, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 5.39 – 5.25 (m, 2H), 4.70 (dq, J = 12.3, 4.6, 4.0 Hz, 1H), 4.43 – 4.34 (m, 1H), 3.73 (q, J = 5.9 Hz, 1H), 2.78 – 2.58 (m, 2H), 2.17 (td, J = 8.6, 8.2, 4.0 Hz, 3H), 1.95 (d, J = 13.4 Hz, 2H), 1.82 – 1.72 (m, 2H), 1.69 – 1.63 (m, 1H), 1.62–1.55 (m, 1H), 1.43 – 1.32 (m, 4H), 1.17 (d, J = 7.5 Hz, 1H), 1.11 (d, J = 6.1 Hz, 3H), 0.88 (m, 12H), 0.83 (d, J = 6.3 Hz, 3H), 0.04 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.7, 138.2, 126.4, 75.4, 69.1, 63.8, 44.8, 38.7, 37.0, 36.0, 35.5, 34.2, 32.8, 30.3, 27.9, 26.0, 23.9, 20.8, 20.0, 18.3, -4.3, -4.6 ppm; IR (neat) ν_{max} 3436, 2926, 2856, 1787, 1475, 1132, 1005 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{24}\text{H}_{46}\text{O}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 449.3063, found 449.3064.

Following the same experimental procedure as describe for compound **1a**, the above couple product (20 mg, 0.07 mmol) was treated with $\text{Pd-C}/\text{H}_2$. Some deprotection of TBS occurred additionally during hydrogenation. The mixture of crude products were filtered and taken for the next reaction without further separation and characterizations.

Following the same experimental procedure as described in the preparation of compound **4**, the above mixture of compounds (0.07 mmol) was converted to compound **1b** (10 mg, 62% over two steps, purification by column chromatography, SiO₂, 100–200 mesh, 40% EtOAc in hexane eluent) afforded pure compound as a colorless oil. $R_f = 0.2$ (60% EtOAc in hexane); $[\alpha]_D^{20} = -3.9$ (c 0.31, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 4.69 (dt, $J = 7.8, 3.8$ Hz, 1H), 4.38 (t, $J = 4.2$ Hz, 1H), 3.76 (q, $J = 6.0$ Hz, 1H), 2.74 (dd, $J = 17.6, 5.0$ Hz, 1H), 2.61 (dd, $J = 17.7, 3.8$ Hz, 1H), 2.00 – 1.91 (m, 1H), 1.73 (td, $J = 11.2, 5.7$ Hz, 2H), 1.59–1.52 (m, 2H), 1.47 (d, $J = 7.2$ Hz, 2H), 1.44 – 1.40 (m, 2H), 1.37 (d, $J = 5.7$ Hz, 2H), 1.29 (d, $J = 7.4$ Hz, 3H), 1.26–1.23 (m, 1H), 1.19 (d, $J = 6.2$ Hz, 3H), 1.14 – 1.10 (m, 1H), 1.08–1.04 (m, 2H), 0.86 (d, $J = 6.7$ Hz, 3H), 0.81 (d, $J = 6.9$ Hz, 3H); ¹³C NMR (CDCl₃, 75 MHz) δ 170.44, 75.80, 68.75, 62.94, 44.83, 38.74, 37.64, 36.99, 36.15, 35.57, 33.90, 30.30, 30.00, 26.81, 25.18, 23.60, 19.69, 19.63 ppm; IR (neat) ν_{max} 3496, 2955, 2855, 1693, 1471, 1254, 1041 cm⁻¹; HRMS (ESI) m/z calcd for C₁₈H₃₄O₄Na [M + Na]⁺ 337.2355, found 337.2353.



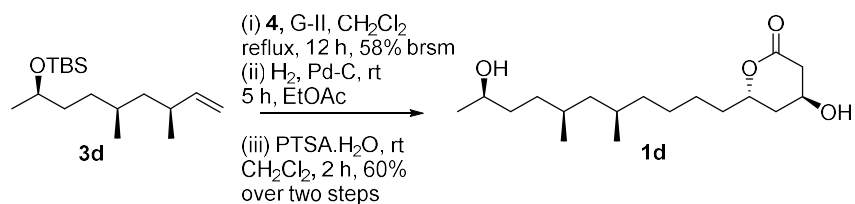
(4*S*,6*S*)-4-Hydroxy-6-((5*S*,7*S*,10*R*)-10-hydroxy-5,7-dimethylundecyl)tetrahydro-2H-pyran-

2-one (1c): Following the same experimental procedure as described in the preparation of compound **22**, alkenes **3c** (55 mg, 0.19 mmol) and **4** (32 mg, 0.19 mmol) were converted to the corresponding coupled product. Purification by flash column chromatography (SiO₂, 60–120 mesh, 30–40% EtOAc in hexane as the eluent) provided pure compound (43 mg, 54% brsm) as a colorless liquid. $R_f = 0.6$ (60% EtOAc in hexane); $[\alpha]_D^{20} = +3.0$ (c 0.6, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 5.44 – 5.21 (m, 2H), 4.70 (dddd, $J = 10.8, 7.7, 4.9, 3.1$ Hz, 1H), 4.38 (bs, 1H), 3.73

(h, $J = 6.0, 5.6$ Hz, 1H), 2.79 – 2.56 (m, 2H), 2.25 – 2.07 (m, 3H), 2.02 – 1.90 (m, 2H), 1.82 – 1.68 (m, 2H), 1.49 – 1.35 (m, 2H), 1.35 – 1.22 (m, 3H), 1.22 – 1.14 (m, 2H), 1.11 (d, $J = 6.0$ Hz, 3H), 0.91 (d, $J = 6.6$ Hz, 3H), 0.88 (s, 9H), 0.83 (d, $J = 6.6$ Hz, 3H), 0.04 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.4, 138.4, 126.3, 75.2, 69.2, 62.9, 44.7, 38.7, 36.9, 36.1, 35.5, 34.3, 32.8, 30.4, 27.9, 26.0, 23.9, 20.8, 20.0, 18.3, -4.3, -4.6 ppm; IR (neat) ν_{max} 3445, 2978, 2959, 1725, 1471, 1284, 1077 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{24}\text{H}_{46}\text{O}_4\text{SiNa}$ $[\text{M} + \text{Na}]^+$ 449.3063, found 449.3064.

Following the same experimental procedure as for compound **1a**, the above couple product (40 mg, 0.09 mmol) was treated with Pd-C/ H_2 . Some deprotection of TBS occurred additionally during hydrogenation. The mixture of crude products were filtered and taken for the next reaction without further separation and characterizations.

Following the same experimental procedure as described in the preparation of compound **4**, the above compound (0.09 mmol) was converted to compound **1c** (17 mg, 60%, purification by column chromatography, SiO_2 , 100–200 mesh, 30–35% EtOAc in hexane eluent) afforded pure compound as a colorless oil. $R_f = 0.2$ (60% EtOAc in hexane); $[\alpha]_{\text{D}}^{20} = +5.0$ (c 0.4, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 4.74 – 4.64 (m, 1H), 4.38 (t, $J = 4.1$ Hz, 1H), 3.82–3.72 (m, 1H), 2.74 (dd, $J = 17.6, 5.0$ Hz, 1H), 2.61 (ddd, $J = 17.6, 3.8, 1.6$ Hz, 1H), 2.00 – 1.93 (m, 1H), 1.79 – 1.69 (m, 2H), 1.56 (q, $J = 6.7, 5.9$ Hz, 2H), 1.50 – 1.45 (m, 2H), 1.45 – 1.41 (m, 2H), 1.40 – 1.34 (m, 2H), 1.33 – 1.27 (m, 3H), 1.24 – 1.21 (m, 1H), 1.19 (d, $J = 6.2$ Hz, 3H), 1.16 – 1.11 (m, 1H), 1.10–1.04 (m, 2H), 0.83 (d, $J = 5.2$ Hz, 3H), 0.81 (d, $J = 5.2$ Hz, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.46, 75.81, 68.62, 62.94, 44.84, 38.75, 37.73, 36.83, 36.14, 35.61, 33.79, 30.20, 30.05, 26.84, 25.21, 23.61, 19.59 ppm; IR (neat) ν_{max} 3356, 2954, 2857, 1716, 1466, 1258, 1093 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{18}\text{H}_{34}\text{O}_4\text{Na}$ $[\text{M} + \text{Na}]^+$ 337.2355, found 337.2312.



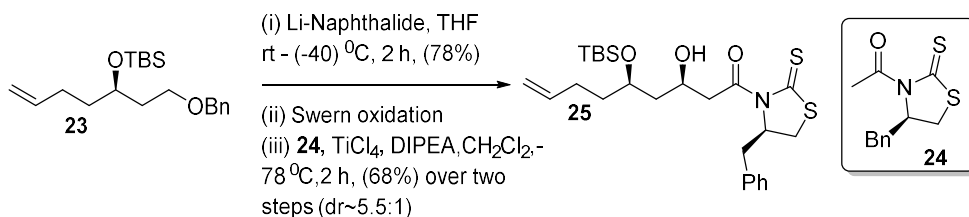
(4*S*,6*S*)-4-Hydroxy-6-((5*R*,7*S*,10*R*)-10-hydroxy-5,7-dimethylundecyl)tetrahydro-2*H*-pyran-

2-one (1d): Following the same experimental procedure as described in the preparation of compound **22**, alkenes **3d** (45 mg, 0.16 mmol) and **4** (25 mg, 0.15 mmol) were converted to the corresponding coupled product. Purification by flash column chromatography (SiO₂, 60–120 mesh, 30–40% EtOAc in hexane as the eluent) gave the pure compound (40 mg, 58% brsm) as a colorless liquid. $R_f = 0.6$ (60% EtOAc in hexane); $[\alpha]_D^{20} = +16.0$ (c 0.2, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 5.41 – 5.21 (m, 2H), 4.70 (td, $J = 9.5, 7.7, 3.8$ Hz, 1H), 4.37 (t, $J = 4.4$ Hz, 1H), 3.74 (p, $J = 6.0$ Hz, 1H), 2.78 – 2.56 (m, 2H), 2.24 – 2.09 (m, 3H), 2.00 – 1.92 (m, 1H), 1.84 – 1.71 (m, 2H), 1.66 (ddt, $J = 11.6, 4.9, 2.3$ Hz, 2H), 1.44 – 1.27 (m, 4H), 1.23 – 1.15 (m, 2H), 1.11 (d, $J = 6.0$ Hz, 3H), 0.94 (s, 3H), 0.88 (s, 9H), 0.81 (d, $J = 6.5$ Hz, 3H), 0.04 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 170.5, 137.8, 126.8, 75.3, 69.1, 62.8, 44.7, 38.8, 37.1, 36.0, 35.5, 34.5, 33.6, 30.4, 27.9, 26.0, 24.0, 21.9, 19.5, 18.3, -4.3, -4.6 ppm; IR (neat) ν_{max} 3429, 2955, 2924, 1709, 1467, 1266, 1068 cm⁻¹; HRMS (ESI) m/z calcd for C₂₄H₄₆O₄SiNa [M + Na]⁺ 449.3063, found 449.3061.

Following the same experimental procedure as for compound **1a**, the above couple product (35 mg, 0.08 mmol) was treated with Pd-C/H₂. Some deprotection of TBS occurred additionally during hydrogenation. The mixture of crude products was filtered and taken for the next reaction without further separation and characterizations.

Following the same experimental procedure as described in the preparation of compound **4**, the above mixture of compounds (0.08 mmol) was converted to compound **1d** (15 mg, 60%,

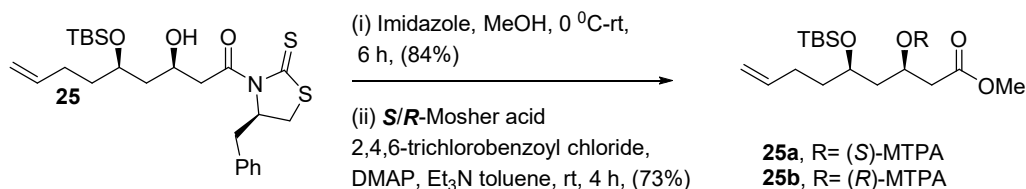
purification by column chromatography, SiO₂, 100–200 mesh, 30–35% EtOAc in hexane eluent) as a colorless oil. $R_f = 0.2$ (60% EtOAc in hexane); $[\alpha]_D^{20} = +21.0$ (c 0.38, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 4.69 (ddt, $J = 11.3, 8.0, 4.1$ Hz, 1H), 4.42 – 4.34 (m, 1H), 3.77 (q, $J = 6.1$ Hz, 1H), 2.74 (dd, $J = 17.6, 5.0$ Hz, 1H), 2.61 (ddd, $J = 17.7, 3.8, 1.6$ Hz, 1H), 2.00 – 1.93 (m, 1H), 1.74 (ddd, $J = 14.6, 11.3, 3.5$ Hz, 2H), 1.58–1.54 (m, 2H), 1.49 – 1.45 (m, 2H), 1.44 – 1.39 (m, 2H), 1.38–1.36 (m, 1H), 1.36–1.33 (m, 1H), 1.33 – 1.27 (m, 3H), 1.24–1.22 (m, 1H), 1.19 (d, $J = 6.1$ Hz, 3H), 1.15 – 1.03 (m, 2H), 0.94 (dd, $J = 13.8, 7.0$ Hz, 1H), 0.86 (d, $J = 3.9$ Hz, 3H), 0.84 (d, $J = 4.1$ Hz, 3H); ¹³C NMR (CDCl₃, 75 MHz) δ 170.46, 75.78, 68.67, 62.92, 44.84, 38.74, 36.60, 36.15, 35.56, 32.70, 30.15, 29.88, 26.49, 25.15, 23.64, 20.37 ppm; IR (neat) ν_{max} 3446, 2947, 2942, 1716, 1459, 1248, 1065 cm⁻¹; HRMS (ESI) m/z calcd for C₁₈H₃₄O₄Na [M + Na]⁺ 337.2355, found 337.2320.



(3R,5R)-1-((R)-4-Benzyl-2-thioxothiazolidin-3-yl)-5-((tert-butyldimethylsilyl)oxy)-3-hydroxy non-8-en-1-one (25): Following the same experimental procedure as described in the preparation of compound **21**, compound **23** (4.0 g, 12 mmol) was reacted with lithium naphthalide. Purification by flash column chromatography (SiO₂, 60–120 mesh, 5% EtOAc in hexane as eluent) provided the corresponding benzyl deprotected compound (2.24 g, 78%). $R_f = 0.3$ (10% EtOAc/hexane); $[\alpha]_D^{25} = -25.3$ (c 0.3, CHCl₃); ¹H NMR & ¹³C NMR data are exactly same to that of alcohol obtain from compound **6**; IR (neat) ν_{max} 3502, 2965, 2946, 1466, 1259, 1017 cm⁻¹; HRMS (ESI) m/z calcd for C₁₃H₂₈O₂SiNa [M + Na]⁺ 267.1756, found 267.1715.

Following the same Swern oxidation conditions as described in the preparation of compound **10**, the above alcohol (2.3 g, 9.4 mmol) was transformed to the corresponding aldehyde (2.2 g, quantitative, purified by flash column chromatography using a short pad of 60–120 silica, 10% EtOAc in hexane as eluent) as a yellowish liquid which was taken for the next step without further characterizations.

Following the same aldol conditions as described in the preparation of compound **21**, The above aldehyde (2.2 g, 9.4 mmol) was converted to the aldol product (3.15 g, 68%, *dr* = 5.5:1). Compound **25** was obtained as a major isomer (2.66 g, 58%, purification by column chromatography, SiO₂, 230–400 mesh, 5% EtOAc in hexane as eluent) which was a yellowish oil. *R_f* = 0.49 (20% EtOAc/hexane); [α]_D²⁵ = +13.5 (*c* 1.8, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.38 – 7.27 (m, 5H), 5.82 (ddt, *J* = 16.8, 10.1, 6.6 Hz, 1H), 5.40 (ddd, *J* = 10.7, 7.1, 4.1 Hz, 1H), 5.08 – 4.94 (m, 2H), 4.33 (tt, *J* = 8.6, 3.7 Hz, 1H), 3.98 (dq, *J* = 7.2, 5.5 Hz, 1H), 3.55 (dd, *J* = 17.7, 3.2 Hz, 1H), 3.39 (ddd, *J* = 11.5, 7.2, 1.0 Hz, 1H), 3.30 – 3.20 (m, 2H), 3.09 – 2.98 (m, 1H), 2.89 (dd, *J* = 11.6, 0.7 Hz, 1H), 2.17 – 2.05 (m, 2H), 1.73 – 1.60 (m, 4H), 0.90 (s, 9H), 0.10 (d, *J* = 3.4 Hz, 6H).; ¹³C NMR (CDCl₃, 75 MHz) δ 201.4, 172.6, 138.5, 136.5, 129.5, 129.0, 127.3, 114.7, 71.1, 68.4, 66.6, 46.3, 42.7, 36.9, 36.6, 32.2, 29.2, 26.0, 18.1, -4.1, -4.4 ppm; IR (neat) ν_{max} 3419, 2910, 2838, 1706, 1641, 1253, 1066 cm⁻¹; HRMS (ESI) *m/z* calcd for C₂₅H₄₀NO₃S₂Si [M + H]⁺ 494.2219, found 494.2293.



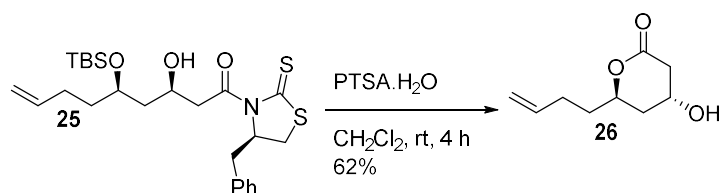
Methyl-(3*R*,5*R*)-5-((*tert*-butyldimethylsilyl)oxy)-3-(((*S*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoyl)oxy)non-8-enoate (25a**):** Following the same experimental procedure as described in

the preparation of compound **(21a)**, compound **25** (0.4 g, 0.8 mmol) was converted to the corresponding methyl ester (215 mg, 84%, purification by flash column chromatography, SiO₂, 100-200 mesh, 10% EtOAc in hexane as eluent). $R_f = 0.5$ (30% EtOAc/hexane); $[\alpha]_D^{25} = -14.5$ (c 1.1, CHCl₃); ¹H NMR & ¹³C NMR data are exactly same to that of methyl ester obtain from compound **21**; IR (neat) ν_{max} 3508, 2952, 2856, 1737, 1641, 1254, 1084, 1084 cm⁻¹; HRMS (ESI) m/z calcd for C₁₆H₃₂O₄SiNa [M + Na]⁺ 339.1967, found 339.1966.

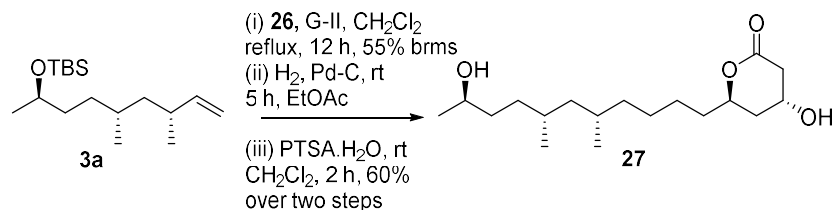
Following the same experimental procedure as described in the preparation of compound **(21a)**, the above methyl ester (10 mg, 0.03 mmol) obtain from compound **25** was converted to the (*S*)-MTPA ester (**25a**) (11 mg, 73%, purification by flash column chromatography, SiO₂, 100-200 mesh, 5% EtOAc in hexane as eluent). $R_f = 0.5$ (15% EtOAc/hexane); $[\alpha]_D^{25} = -7.3$ (c 1.1, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 7.57 – 7.48 (m, 2H), 7.44 – 7.33 (m, 3H), 5.79 (ddt, $J = 16.9, 10.3, 6.6$ Hz, 1H), 5.56 (dt, $J = 11.6, 5.8$ Hz, 1H), 5.07 – 4.92 (m, 2H), 3.76 (p, $J = 5.9$ Hz, 1H), 3.58 (s, 3H), 3.50 (s, 3H), 2.77 (dd, $J = 16.0, 4.6$ Hz, 1H), 2.64 (dd, $J = 16.0, 8.0$ Hz, 1H), 2.07 (t, $J = 8.5$ Hz, 2H), 2.02 – 1.91 (m, 1H), 1.86 – 1.76 (m, 1H), 1.75 – 1.59 (m, 2H), 0.88 (s, 9H), 0.03 (s, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 170.3, 165.8, 138.3, 132.1, 129.7, 128.5, 127.6, 114.9, 71.3, 68.5, 55.4, 51.9, 40.6, 38.9, 35.7, 29.4, 25.9, 18.1, -4.4, -4.5 ppm; IR (neat) ν_{max} 2952, 2859, 1746, 1442, 1261, 1014 cm⁻¹; HRMS (ESI) m/z calcd for C₂₆H₄₀F₃O₆Si [M + H]⁺ 533.2546, found 533.2539.

Methyl-(3*R*,5*R*)-5-((*tert*-butyldimethylsilyl)oxy)-3-(((*R*)-3,3,3-trifluoro-2-methoxy-2-phenyl propanoyl)oxy)non-8-enoate (25b**):** Following the same experimental procedure as described in the preparation of compound **(21a)**, the above methyl ester (10 mg, 0.03 mmol) obtain from compound **25** was converted to the (*R*)-MTPA ester (**25b**) (12 mg, 73%, purification by flash column chromatography, SiO₂, 100-200 mesh, 5% EtOAc in hexane as eluent). $R_f = 0.4$ (10%

EtOAc/hexane); $[\alpha]_D^{25} = +32.7$ (c 1.1, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 7.52 (dd, $J = 6.8$, 3.0 Hz, 2H), 7.39 (dd, $J = 5.0$, 1.9 Hz, 3H), 5.78 (ddt, $J = 16.9$, 10.2, 6.5 Hz, 1H), 5.55 (qd, $J = 6.9$, 4.6 Hz, 1H), 5.05 – 4.91 (m, 2H), 3.66 (s, 3H), 3.62– 3.60 (m, 1H), 3.54 (s, 3H), 2.78 (dd, $J = 16.0$, 4.7 Hz, 1H), 2.68 (dd, $J = 15.9$, 8.0 Hz, 1H), 2.04 (dq, $J = 14.6$, 7.4 Hz, 2H), 1.93 – 1.83 (m, 1H), 1.72 (dt, $J = 13.6$, 6.4 Hz, 1H), 1.58 – 1.40 (m, 2H), 0.86 (s, 9H), -0.03 (s, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.5, 165.9, 138.4, 132.3, 129.7, 128.5, 127.4, 114.8, 71.1, 68.2, 55.5, 52.0, 40.5, 39.2, 35.6, 29.3, 25.9, 18.0, -4.5, -4.6 ppm; IR (neat) ν_{max} 2934, 2858, 1745, 1256, 1016 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{26}\text{H}_{40}\text{F}_3\text{O}_6\text{Si}$ $[\text{M} + \text{H}]^+$ 533.2546, found 533.2539



(4*R*,6*R*)-6-(But-3-en-1-yl)-4-hydroxytetrahydro-2H-pyran-2-one (26): Following the same experimental procedure as described in the preparation of compound **4**, compound **25** (1.52 g, 3.04 mmol) was converted to compound **26** (320 mg, 62%, purification by column chromatography, SiO_2 , 230–400 mesh, 25% EtOAc in hexane as eluent) as a light yellowish oil. $R_f = 0.25$ (60% EtOAc/hexane); $[\alpha]_D^{25} = +42.0$ (c 0.7, CHCl_3); ^1H NMR & ^{13}C NMR data are exactly same as that of compound **4**; IR (neat) ν_{max} 3509, 2954, 2930, 1737, 1438, 1256, 1086 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_9\text{H}_{14}\text{O}_3\text{Na}$ $[\text{M} + \text{Na}]^+$ 193.0841, found 193.0842.

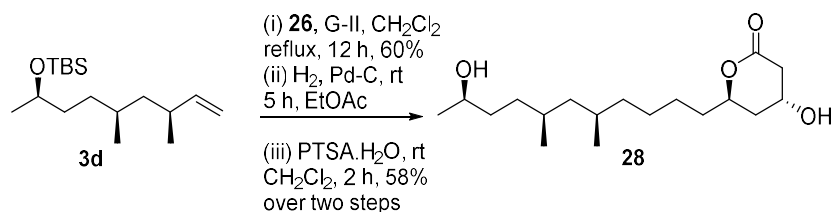


(4R,6R)-4-hydroxy-6-((5S,7R,10R)-10-hydroxy-5,7-dimethylundecyl)tetrahydro-2H-pyran-2-one (27): Following the same experimental procedure as described in the preparation of compound **22**, alkenes **3a** (25 mg, 0.09 mmol) and **26** (15 mg, 0.09 mmol) were converted to the corresponding coupled product. Purification by flash column chromatography (SiO₂, 60–120 mesh, 30–40% EtOAc in hexane as the eluent) provide the corresponding metathesized product (21 mg, 55% brsm) a colorless liquid. $R_f = 0.6$ (60% EtOAc in hexane); $[\alpha]_D^{25} = +21.9$ (c 1.0, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 5.39 – 5.20 (m, 2H), 4.70 (td, $J = 7.5, 4.1$ Hz, 1H), 4.38 (bs, 1H), 3.71 (p, $J = 6.0$ Hz, 1H), 2.76 – 2.56 (m, 2H), 2.25–2.21 (m, 3H), 2.00–1.93 (m, 2H), 1.81 – 1.71 (m, 2H), 1.43 – 1.35 (m, 3H), 1.35–1.27 (d, $J = 2.2$ Hz, 2H), 1.22–1.17 (m, 2H), 1.11 (d, $J = 6.1$ Hz, 3H), 0.93 (d, $J = 6.6$ Hz, 3H), 0.88 (d, $J = 1.0$ Hz, 9H), 0.84 – 0.80 (m, 3H), 0.04 (d, $J = 1.2$ Hz, 6H); ¹³C NMR (CDCl₃, 75 MHz) δ 170.3, 137.9, 126.7, 75.2, 69.3, 62.9, 44.9, 38.8, 37.2, 36.0, 35.4, 34.5, 33.7, 30.5, 27.9, 26.0, 24.0, 21.8, 19.6, 18.3, -4.3, -4.6 ppm; IR (neat) ν_{max} 3485, 2959, 2938, 1722, 1451, 1226, 1062 cm⁻¹; HRMS (ESI) m/z calcd for C₂₄H₄₆O₄SiNa [M + Na]⁺ 449.3063, found 449.3035.

Following the same experimental procedure of compound **1a**, the above coupled product (18 mg, 0.04 mmol) was treated with Pd-C/H₂. Some deprotection of TBS occurred additionally during hydrogenation. The mixture of crude products were filtered and taken for the next reaction without further separation and characterizations.

Following the same experimental procedure as described in the preparation of compound **4**, the above mixture of compound (0.04 mmol) was converted to compound **27** (8 mg, 60%, purification by column chromatography, SiO₂, 100–200 mesh, 30–35% EtOAc in hexane eluent) as a colorless oil. $R_f = 0.2$ (60% EtOAc in hexane); $[\alpha]_D^{20} = +42.1$ (c 0.38, CHCl₃); ¹H NMR (CDCl₃, 300 MHz) δ 4.74 – 4.63 (m, 1H), 4.38 (p, $J = 3.9$ Hz, 1H), 3.76 (q, $J = 6.0$ Hz, 1H), 2.74

(dd, $J = 17.6, 5.0$ Hz, 1H), 2.61 (ddd, $J = 17.6, 3.8, 1.6$ Hz, 1H), 1.99 – 1.93 (m, 1H), 1.79 – 1.70 (m, 2H), 1.64 – 1.59 (m, 2H), 1.52 – 1.48 (m, 2H), 1.45 – 1.41 (m, 2H), 1.40 – 1.34 (m, 2H), 1.34 – 1.28 (m, 3H), 1.24–1.22 (m, 1H), 1.19 (d, $J = 6.2$ Hz, 3H), 1.14 – 1.04 (m, 2H), 0.98 – 0.90 (m, 1H), 0.86 (d, $J = 6.1$, 3H), 0.84 (d, $J = 6.4$ Hz, 3H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.45, 75.80, 68.80, 62.92, 44.96, 38.74, 36.78, 36.63, 36.14, 35.58, 32.87, 30.27, 29.93, 26.57, 25.19, 23.58, 20.42, 20.38 ppm; IR (neat) ν_{max} 3368, 2954, 2926, 1717, 1458, 1252, 1070, 808cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{18}\text{H}_{34}\text{O}_4\text{Na}$ $[\text{M} + \text{Na}]^+$ 337.2355, found 337.2353.



(4R,6R)-4-hydroxy-6-((5R,7S,10R)-10-hydroxy-5,7-dimethylundecyl)tetrahydro-2H-pyran-2-one (28): Following the same experimental procedure as described in the preparation of compound **22**, alkenes **3d** (20 mg, 0.07 mmol) and **26** (12 mg, 0.07 mmol) were converted to the corresponding coupled product (17 mg, 60% brsm, purification by flash column chromatography, SiO_2 , 60–120 mesh, 30–40% EtOAc in hexane as the eluent) gave a colorless liquid. $R_f = 0.6$ (60% EtOAc in hexane); $[\alpha]_{\text{D}}^{25} = +14.3$ (c 0.4, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 5.41 – 5.14 (m, 2H), 4.71 (dd, $J = 9.7, 5.5$ Hz, 1H), 4.38 (q, $J = 4.0$ Hz, 1H), 3.73 (q, $J = 5.4$ Hz, 1H), 2.77 – 2.57 (m, 2H), 2.25–2.10 (m, 3H), 2.04 – 1.91 (m, 2H), 1.76 (ddd, $J = 14.3, 7.0, 4.7$ Hz, 2H), 1.56–1.50 (m, 1H), 1.37 (tdq, $J = 11.3, 5.6, 3.2$ Hz, 4H), 1.22 – 1.17 (m, 2H), 1.11 (d, $J = 6.1$ Hz, 3H), 0.93 (d, $J = 6.7$ Hz, 3H), 0.88 (s, 9H), 0.82 (d, $J = 6.4$ Hz, 3H), 0.04 (d, $J = 1.5$ Hz, 6H); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.4, 137.9, 126.8, 75.1, 69.3, 62.9, 44.6, 38.8, 37.1, 36.1, 35.5, 34.6, 33.6, 30.6, 27.9, 26.0, 24.0, 21.9, 19.6, 18.3, -4.3, -4.6 ppm; IR (neat) ν_{max}

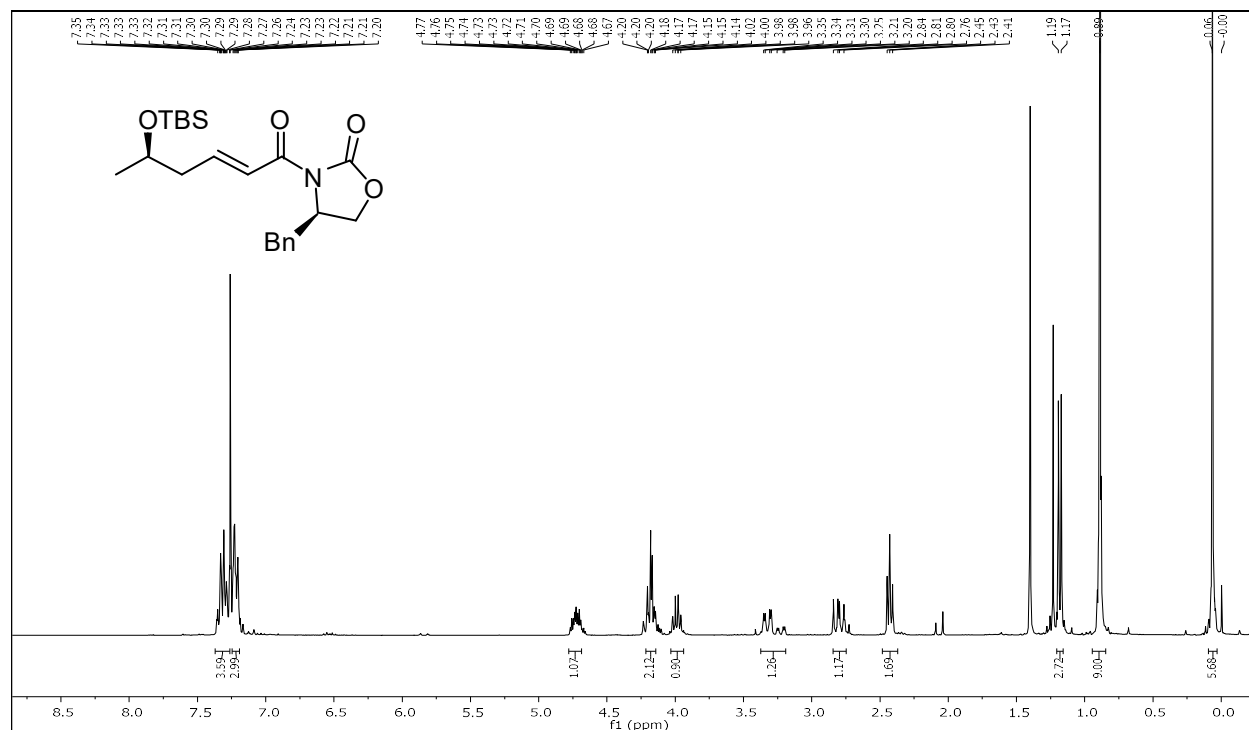
3505, 2979, 2924, 1721, 1451, 1252, 1122 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{24}\text{H}_{46}\text{O}_4\text{SiNa}$ [$\text{M} + \text{Na}$] $^{+}$ 449.3063, found 449.3067.

Following the same experimental procedure as for compound **1a**, the above couple product (15 mg, 0.04 mmol) was treated with Pd-C/ H_2 . Some deprotection of TBS occurred additionally during hydrogenation. The mixture of crude products were filtered and taken for the next reaction without further separation and characterizations.

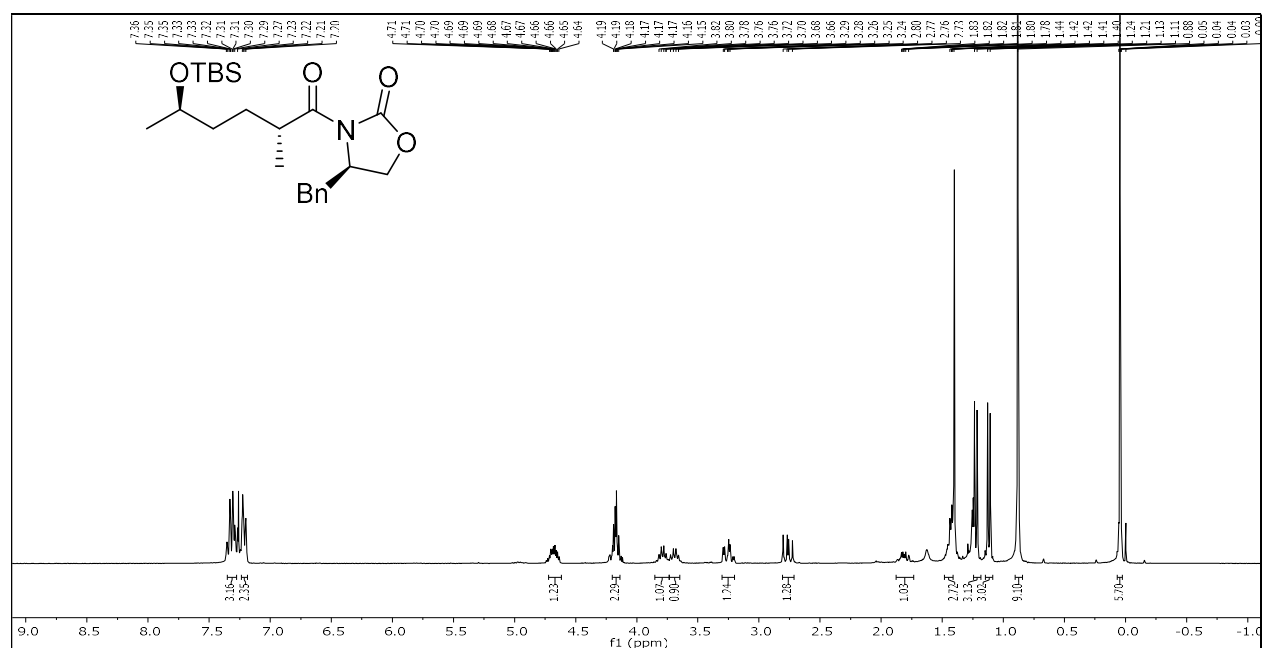
Following the same experimental procedure as described in the preparation of compound **4**, the above mixture of compounds (0.04 mmol) was converted to compound **28** (7 mg, 58%, purification by column chromatography, SiO_2 , 100–200 mesh, 20–25% EtOAc in hexane eluent) as a colorless oil. $R_f = 0.2$ (60% EtOAc in hexane); $[\alpha]_D^{20} = +38.4$ (c 0.52, CHCl_3); ^1H NMR (CDCl_3 , 300 MHz) δ 4.69 (td, $J = 7.9, 3.7$ Hz, 1H), 4.43 – 4.34 (m, 1H), 3.76 (p, $J = 6.2$ Hz, 1H), 2.74 (dd, $J = 17.6, 5.0$ Hz, 1H), 2.61 (ddd, $J = 17.6, 3.8, 1.6$ Hz, 1H), 1.99 – 1.92 (m, 1H), 1.77 – 1.70 (m, 2H), 1.63 – 1.55 (m, 2H), 1.49 – 1.45 (m, 2H), 1.44 – 1.39 (m, 2H), 1.38 – 1.34 (m, 2H), 1.33 – 1.27 (m, 3H), 1.24 – 1.21 (m, 1H), 1.19 (d, $J = 6.2$ Hz, 3H), 1.15 – 1.06 (m, 2H), 0.97 – 0.90 (dd, $J = 13.9, 7.1$ Hz, 1H), 0.86 (d, $J = 3.8$ Hz, 3H), 0.84 (d, $J = 3.7$ Hz, 3H.); ^{13}C NMR (CDCl_3 , 75 MHz) δ 170.53, 75.81, 68.64, 62.86, 44.82, 38.71, 36.59, 36.13, 35.56, 32.72, 30.15, 29.90, 26.43, 25.18, 23.63, 20.35 ppm; IR (neat) ν_{max} 3356, 2951, 2926, 1716, 1456, 1262, 1033, 752 cm^{-1} ; HRMS (ESI) m/z calcd for $\text{C}_{18}\text{H}_{35}\text{O}_4$ [$\text{M} + \text{H}$] $^{+}$ 314.2500, found 314.2532.

4. Copies of ^1H -NMR, ^{13}C -NMR, 2D-NMR and HRMS Spectra:

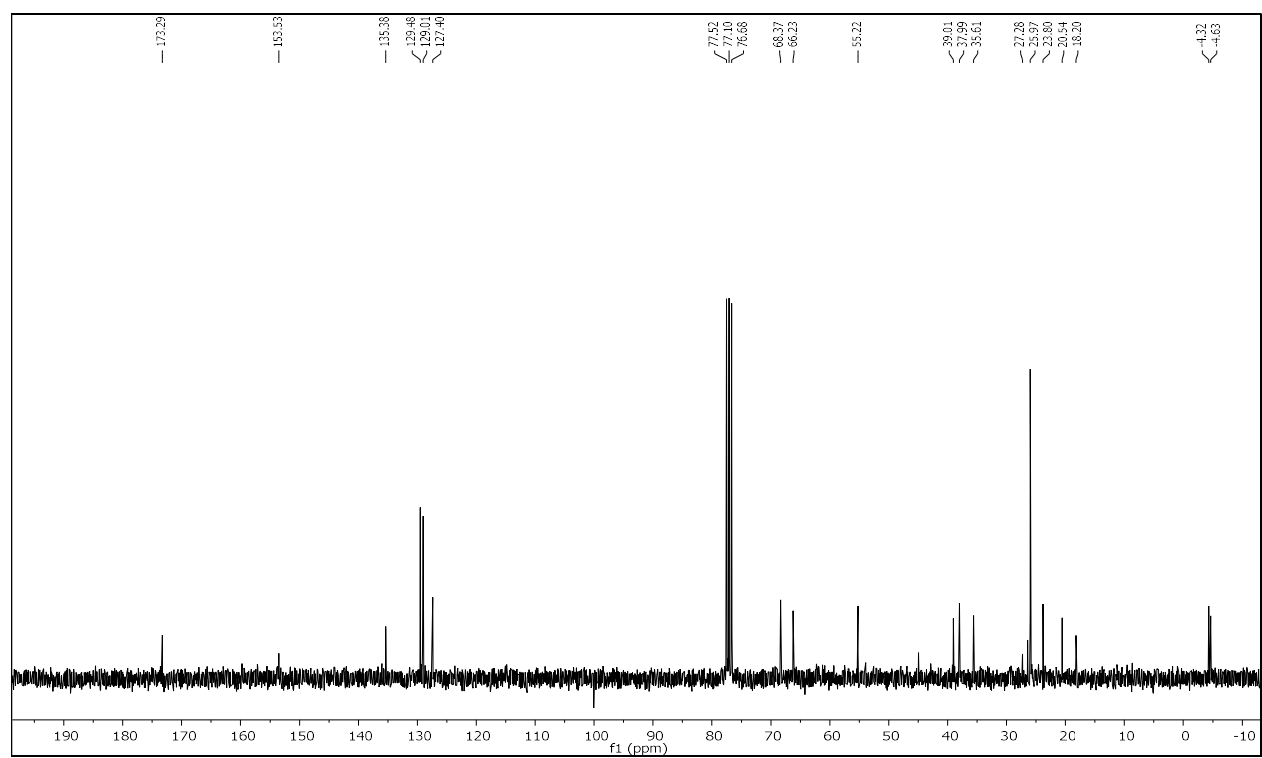
^1H -NMR spectrum of compound 9 (300 MHz, CDCl_3):



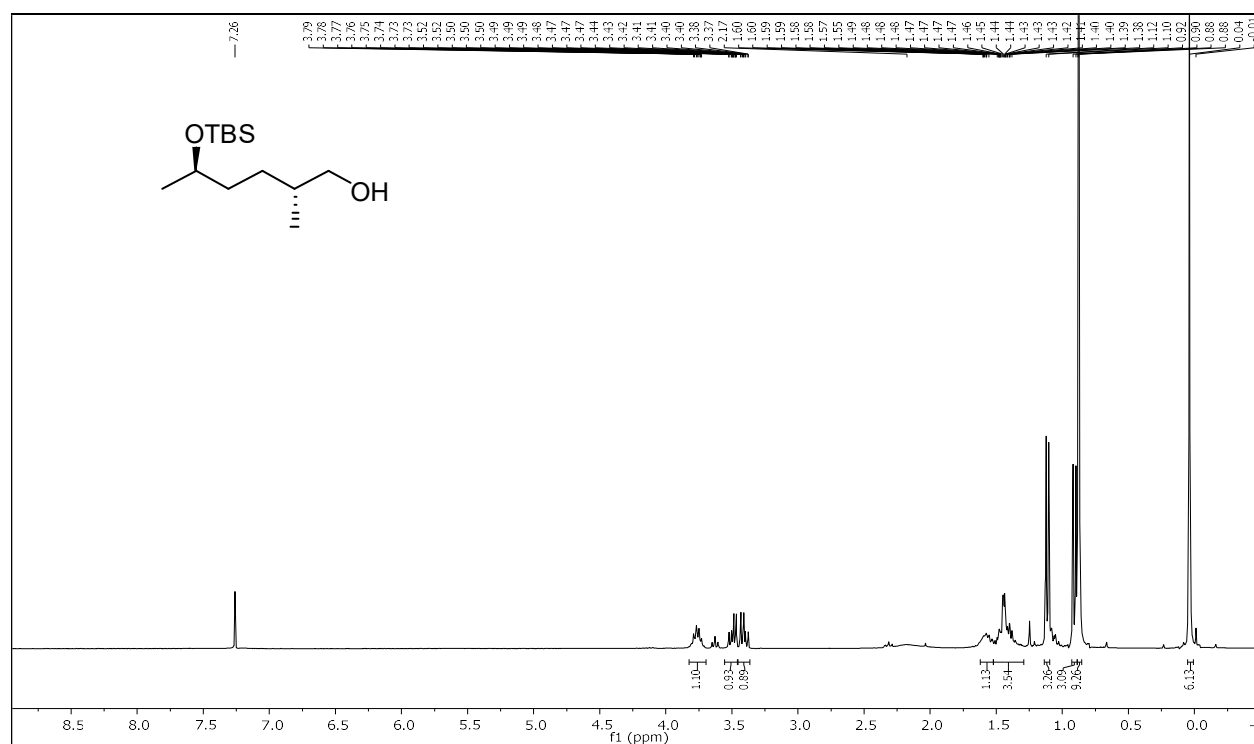
¹H-NMR spectrum of compound 10 (300 MHz, CDCl₃):



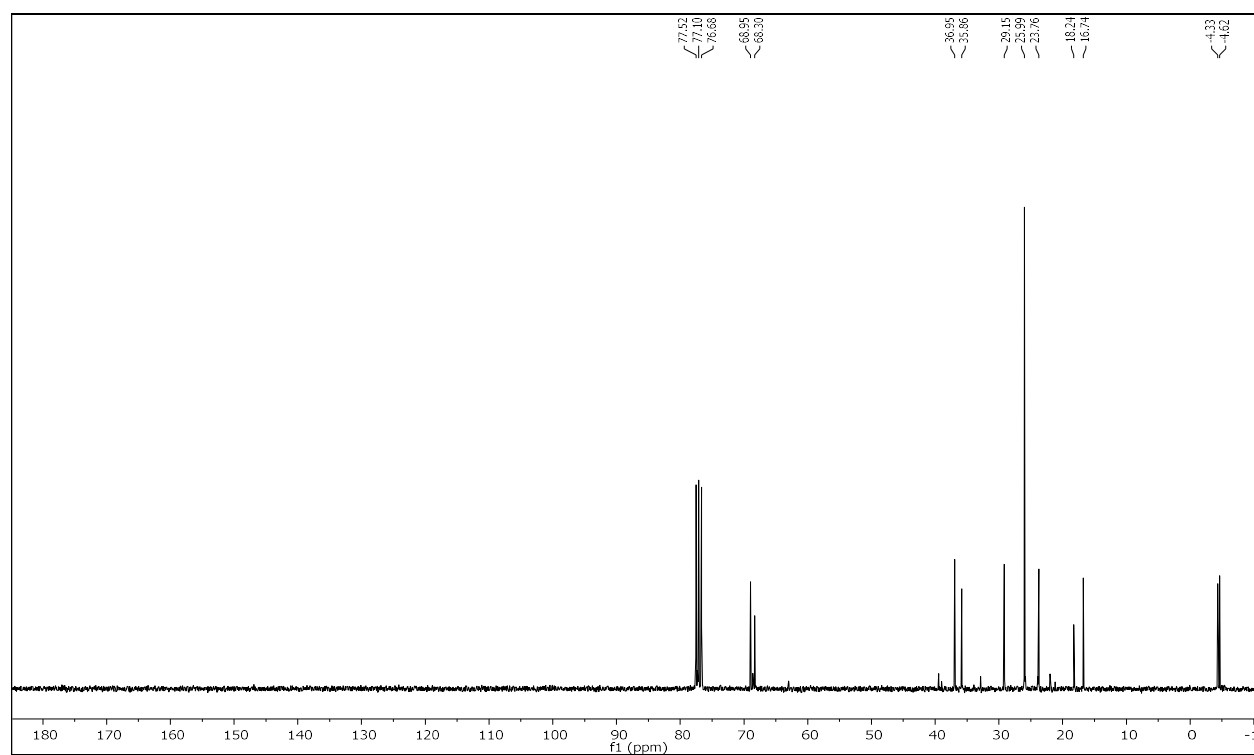
¹³C-NMR spectrum of compound 10 (300 MHz, CDCl₃):



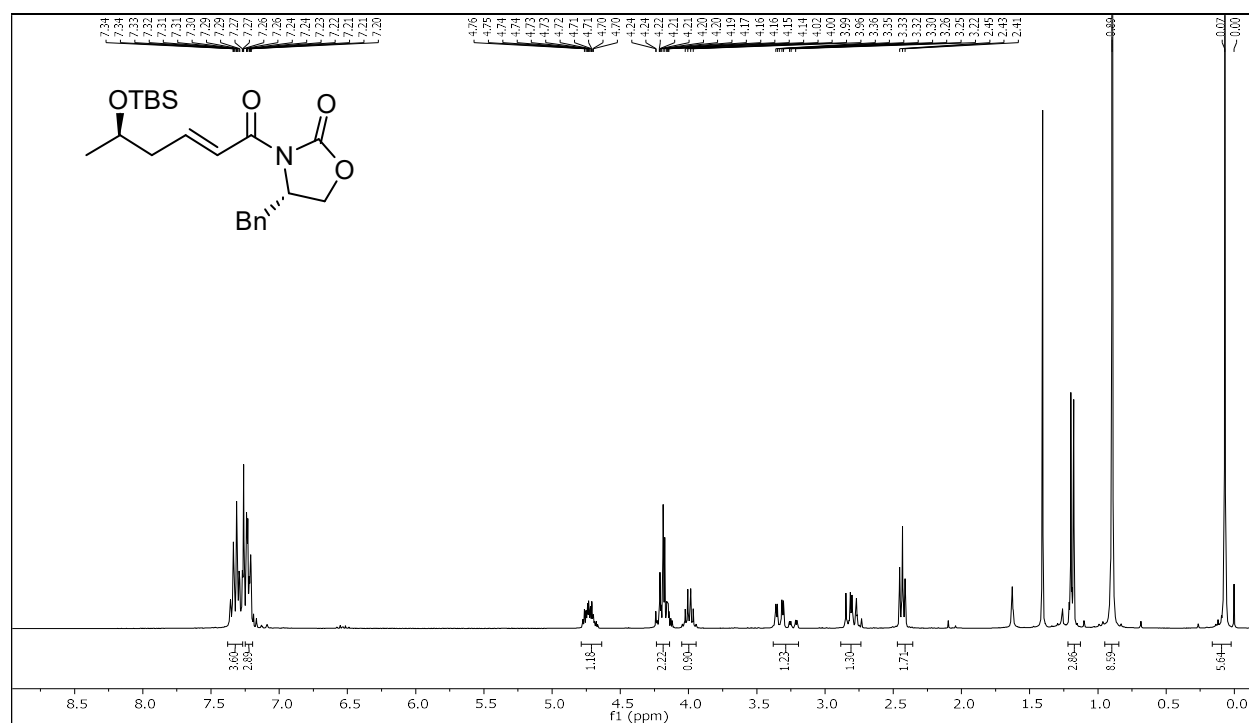
¹H-NMR spectrum of compound 5a (300 MHz, CDCl₃):



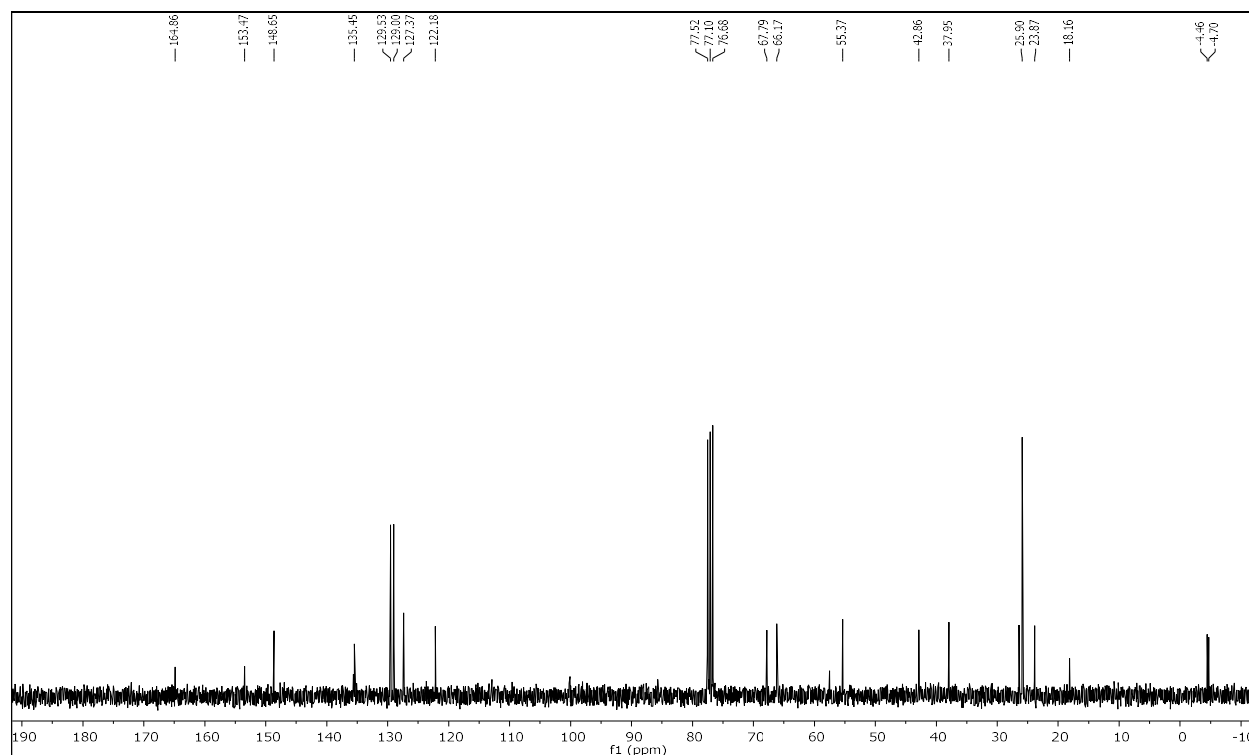
¹³C-NMR spectrum of compound 5a (75 MHz, CDCl₃):



¹H-NMR spectrum of compound 12 (300 MHz, CDCl₃):



¹³C-NMR spectrum of compound 12 (75 MHz, CDCl₃):



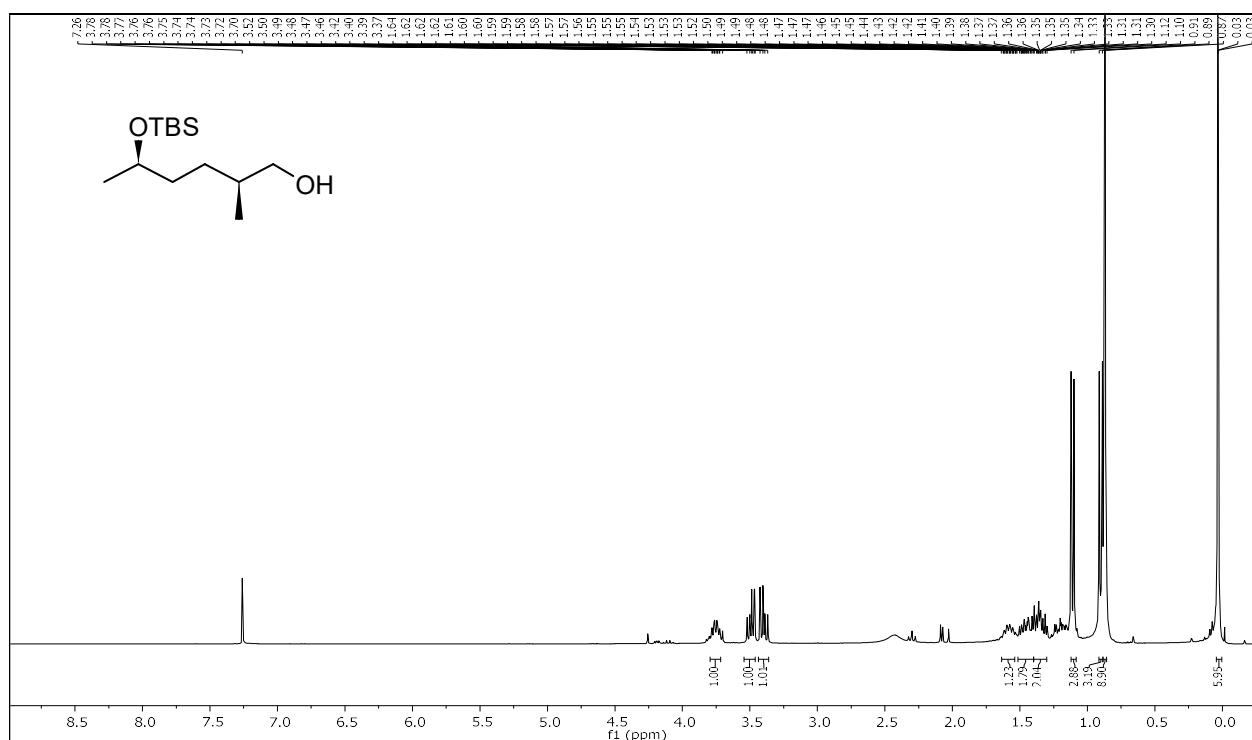
Chemical Structure:

C[C@H](OSi(C)(C)C(C)(C)C)[C@@H](C)[C@@H]1CCOC(=O)N1Cc2ccccc2

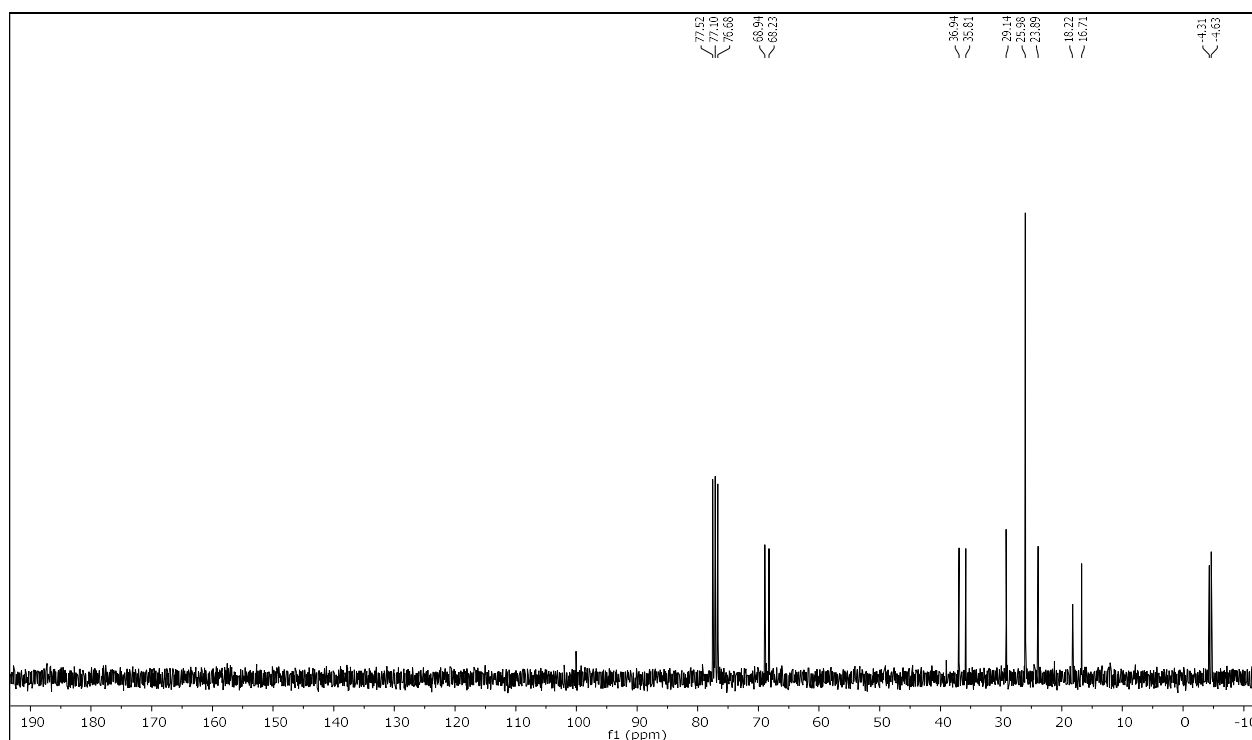
¹H NMR Spectrum Data (CDCl₃):

Chemical Shift (ppm)	Multiplicity	Integration
~7.2	m	3.06H, 2.09H
~4.6	m	1.15H
~4.2	m	2.36H
~3.5	m	0.88H, 0.88H
~2.8	m	1.38H
~2.2	m	1.29H
~1.4	m	3.99H
1.0	d	2.61H
0.9	d	2.88H
-0.1	s	8.90H
0.0	s	5.76H

¹H-NMR spectrum of compound 5b (300 MHz, CDCl₃):



¹³C-NMR spectrum of compound 5b (75 MHz, CDCl₃):



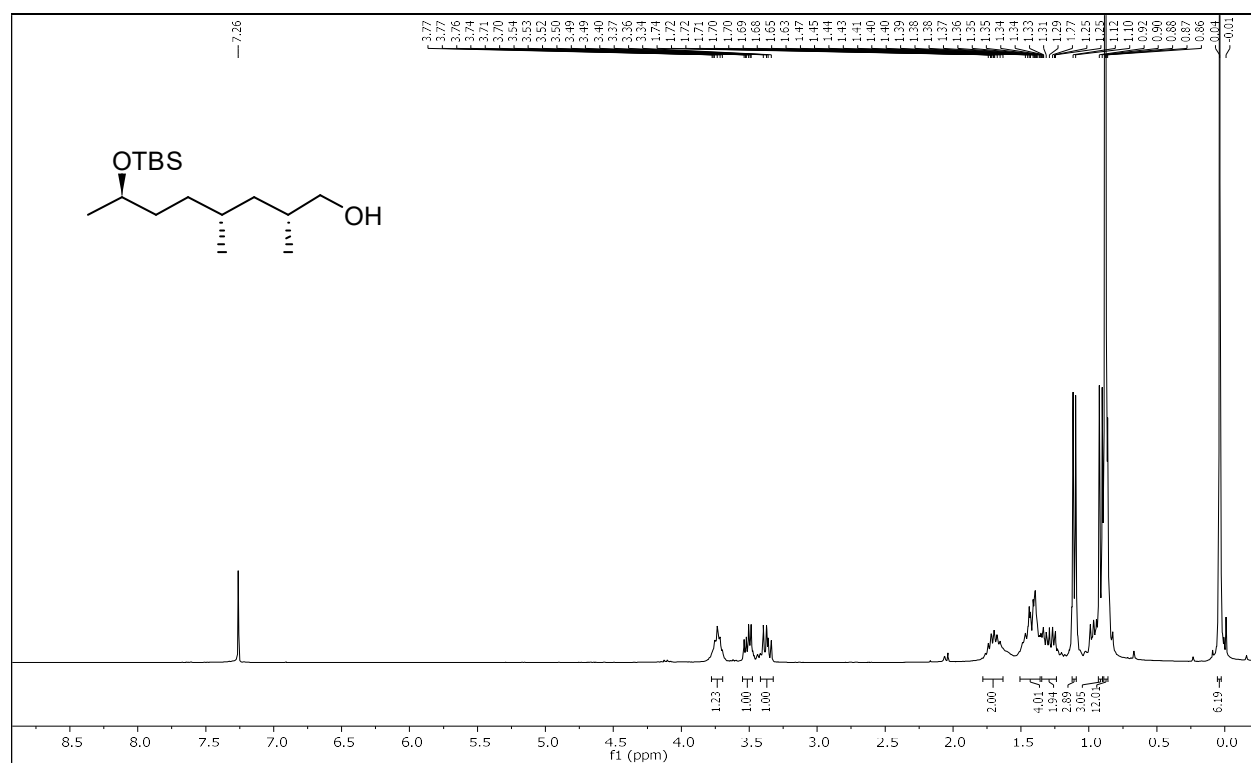
Chemical structure of compound 10 is shown above the spectrum. The structure is a 1,3-dioxolane ring with a benzyl group (Bn) at position 2 and a 4-(4-(tert-butyldimethylsilyl)phenyl)butyryl group at position 4.

¹H NMR spectrum (CDCl₃) of compound 10. The x-axis represents the chemical shift in ppm (f1), ranging from 9.0 to -0.5. The spectrum shows several peaks, with integration values provided below the baseline.

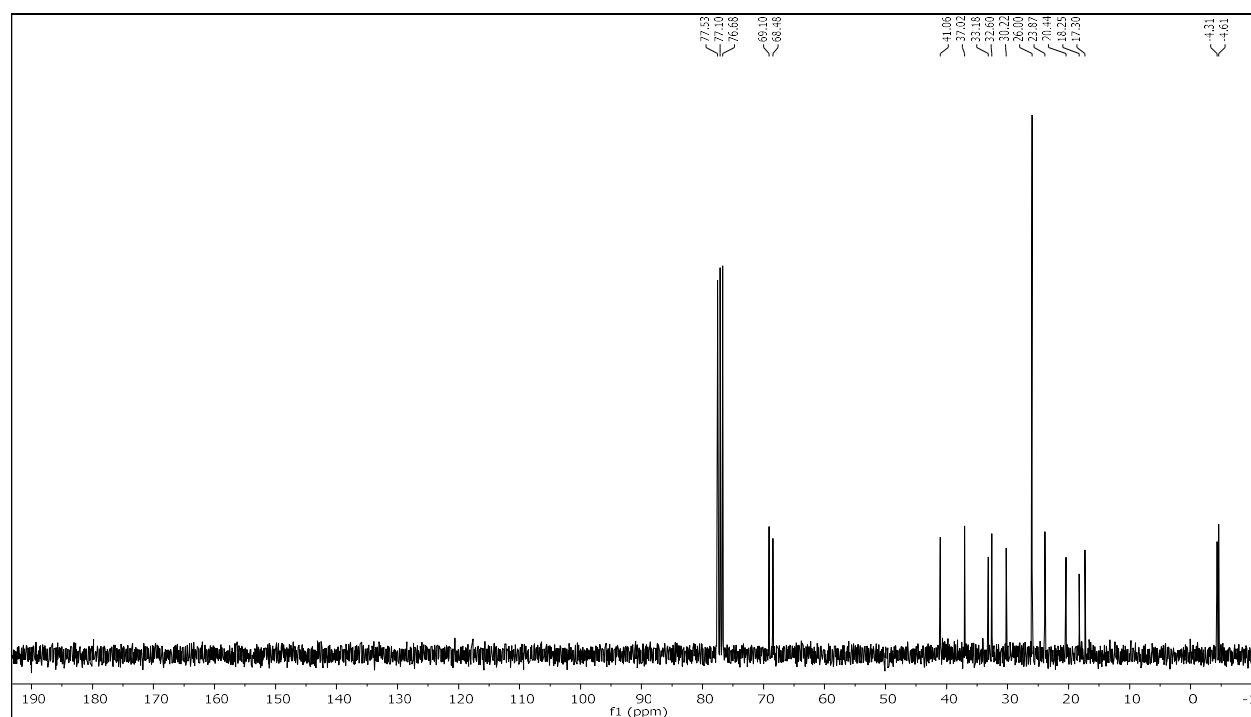
Integration values (from left to right): 3.20, 2.17, 1.10, 2.15, 1.18, 1.28, 1.89, 1.25, 1.25, 4.55, 1.12, 3.16, 2.69, 8.78, 5.92.

13C NMR spectrum of compound 10. The x-axis is labeled 'f1 (ppm)' and ranges from 50 to -40. The spectrum shows several peaks, with the most prominent ones at 136.4271, 134.4562, 130.1358, 127.4885, 77.5338, 76.6774, 68.9774, 66.2365, 55.2714, 38.0422, 37.0611, 33.5941, 32.8603, 32.5979, 31.3817, 26.0146, 23.8750, 19.9002, 18.2550, -4.2011, and -4.5695. A peak at 173.7716 is also labeled.

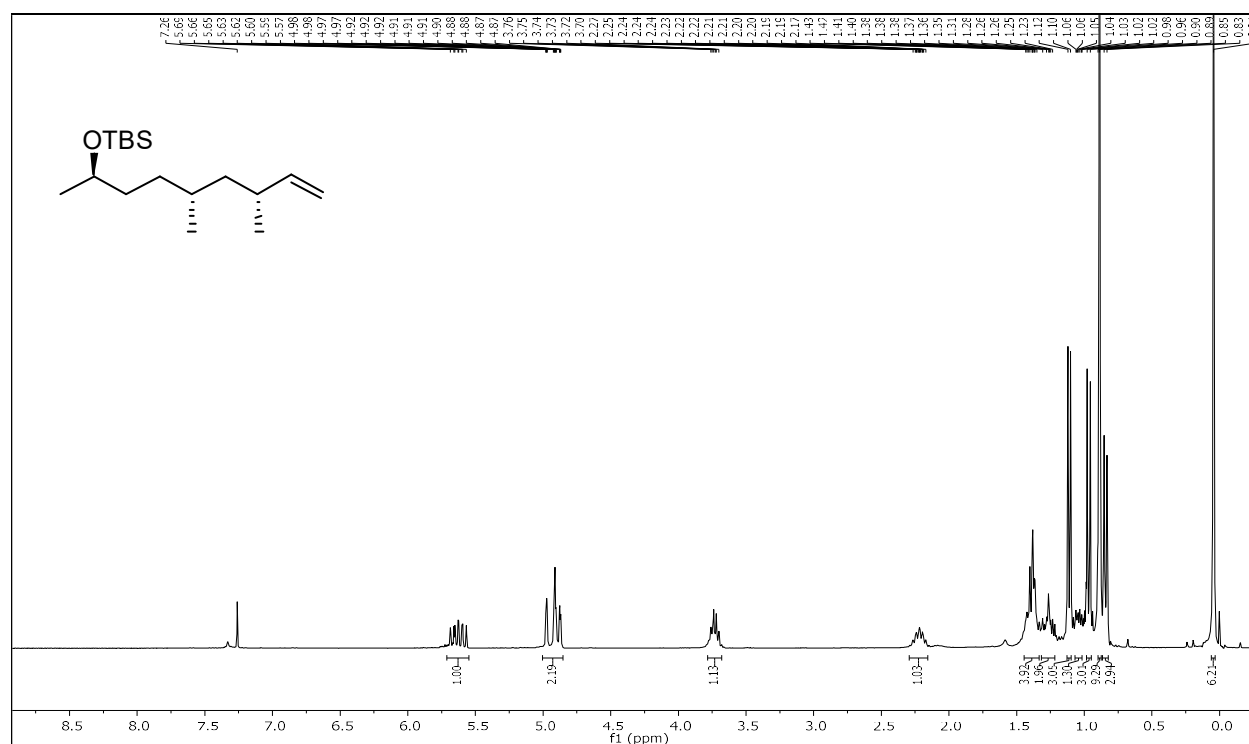
¹H-NMR spectrum of compound 15 (300 MHz, CDCl₃):



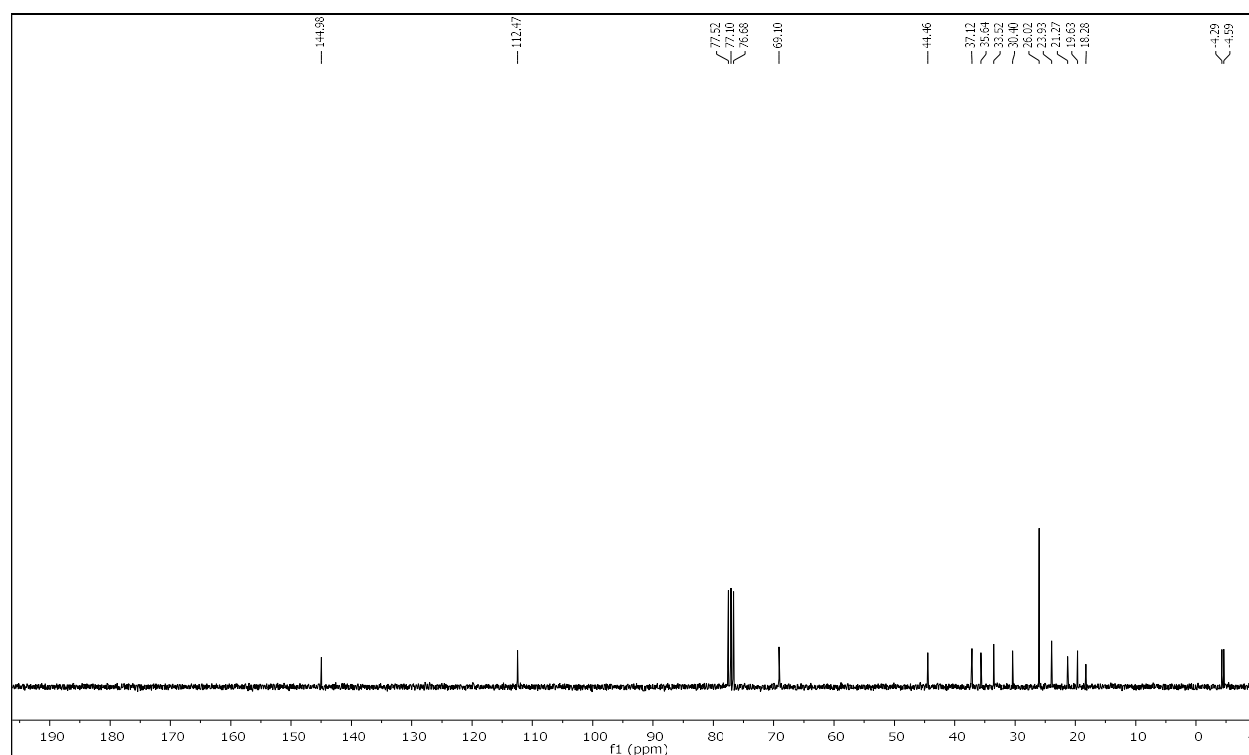
¹³C-NMR spectrum of compound 15 (75 MHz, CDCl₃):



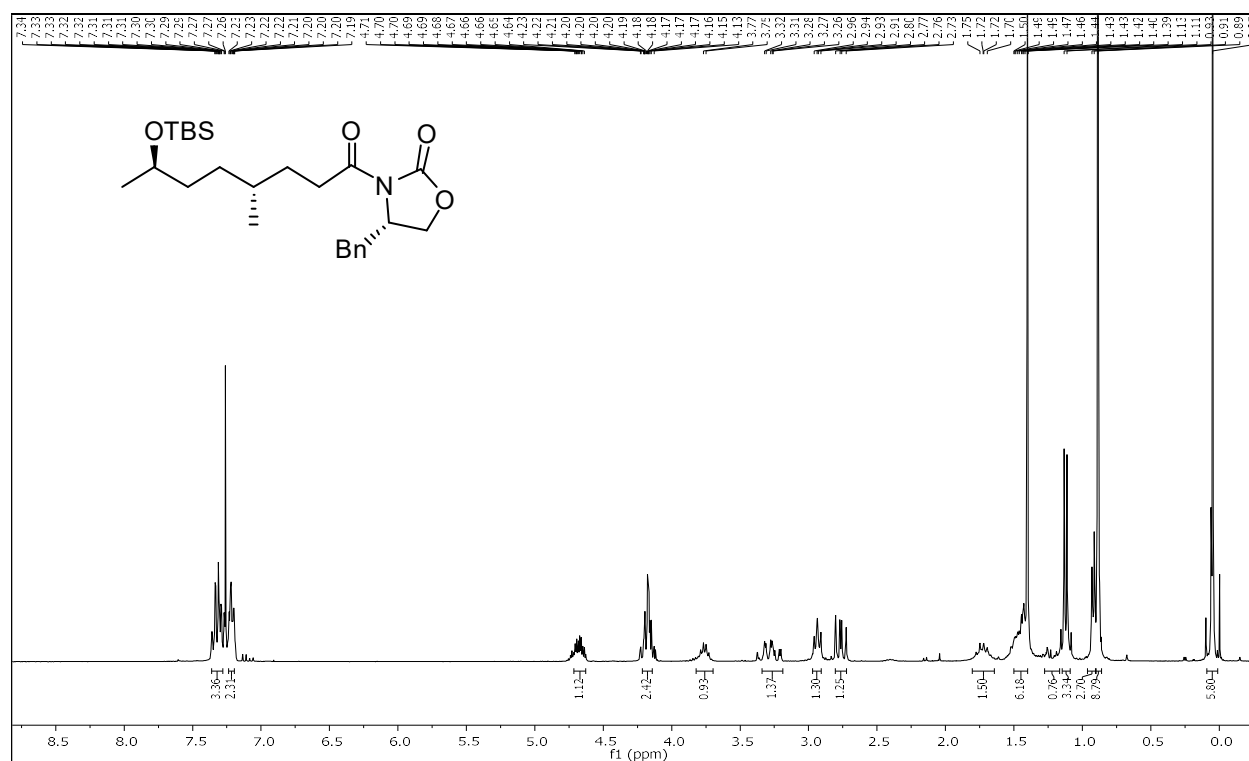
¹H-NMR spectrum of compound 3a (300 MHz, CDCl₃):



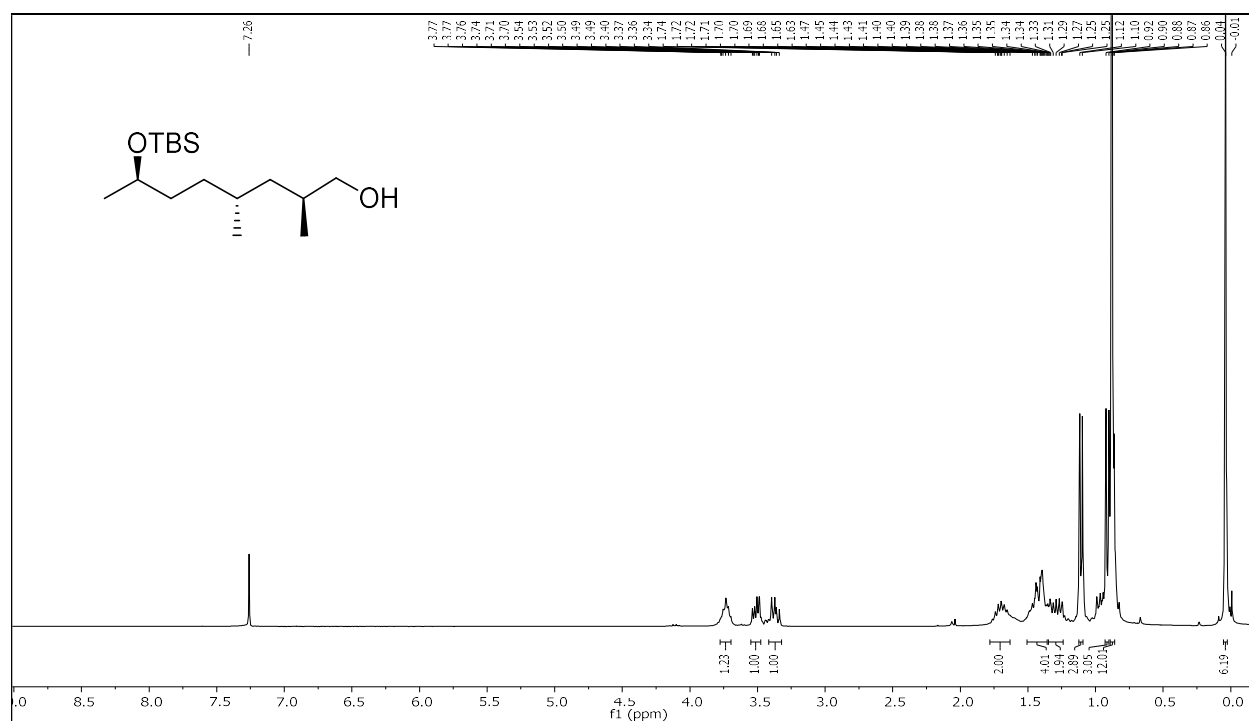
¹³C-NMR spectrum of compound 3a (75 MHz, CDCl₃):



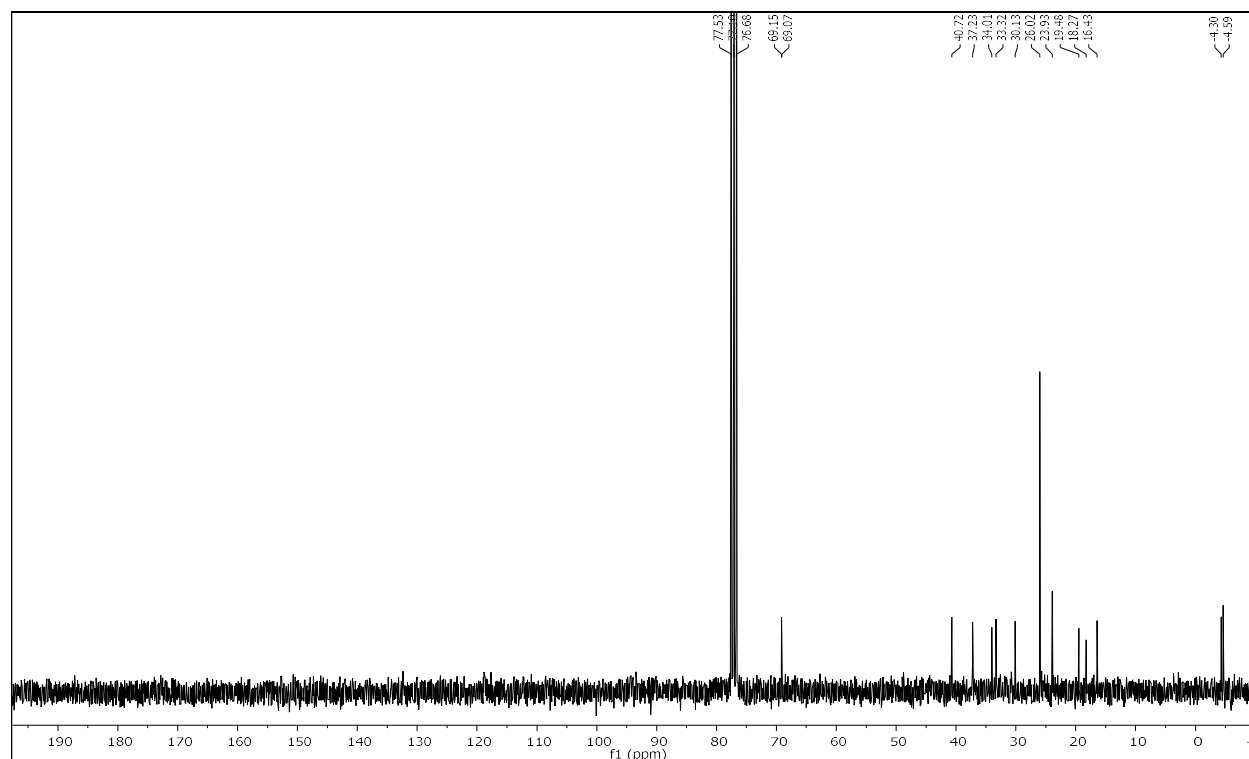
¹H-NMR spectrum of compound 16 (300 MHz, CDCl₃):



^1H -NMR spectrum of compound 17 (300 MHz, CDCl_3):



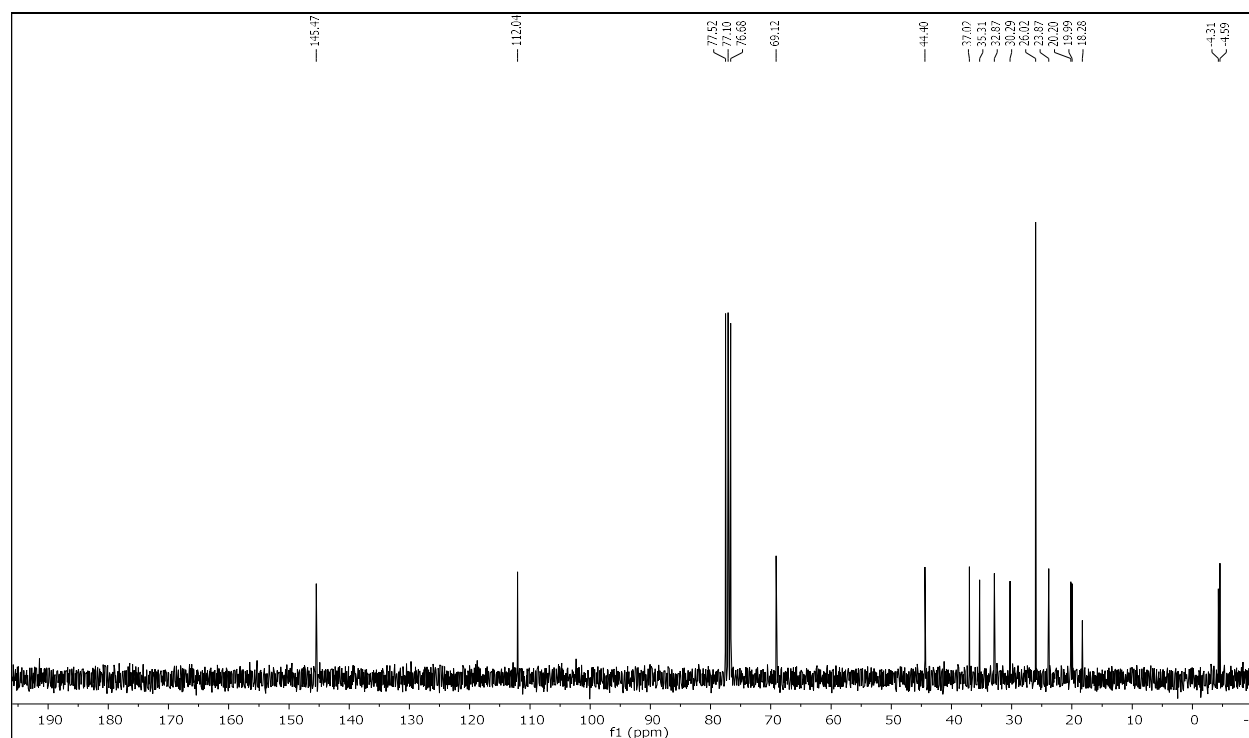
^{13}C -NMR spectrum of compound 17 (75 MHz, CDCl_3):



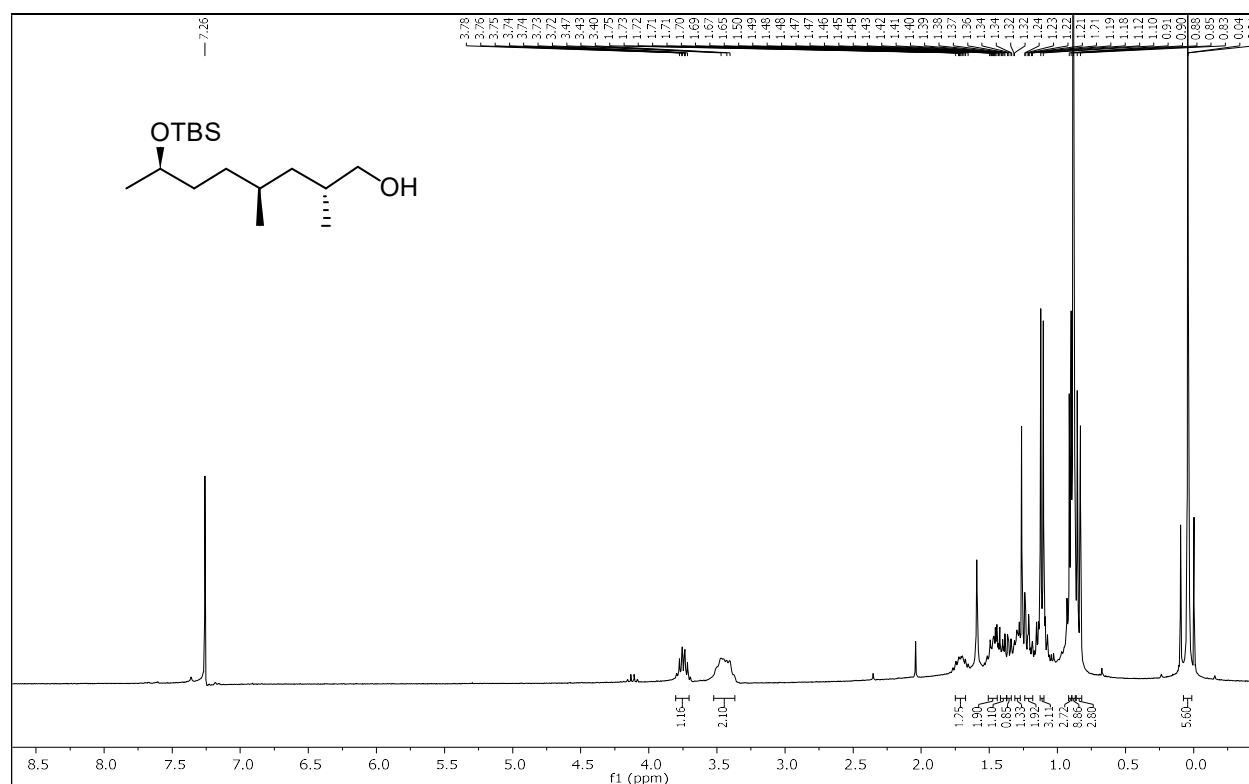
¹H-NMR spectrum of compound 3b (300 MHz, CDCl₃):



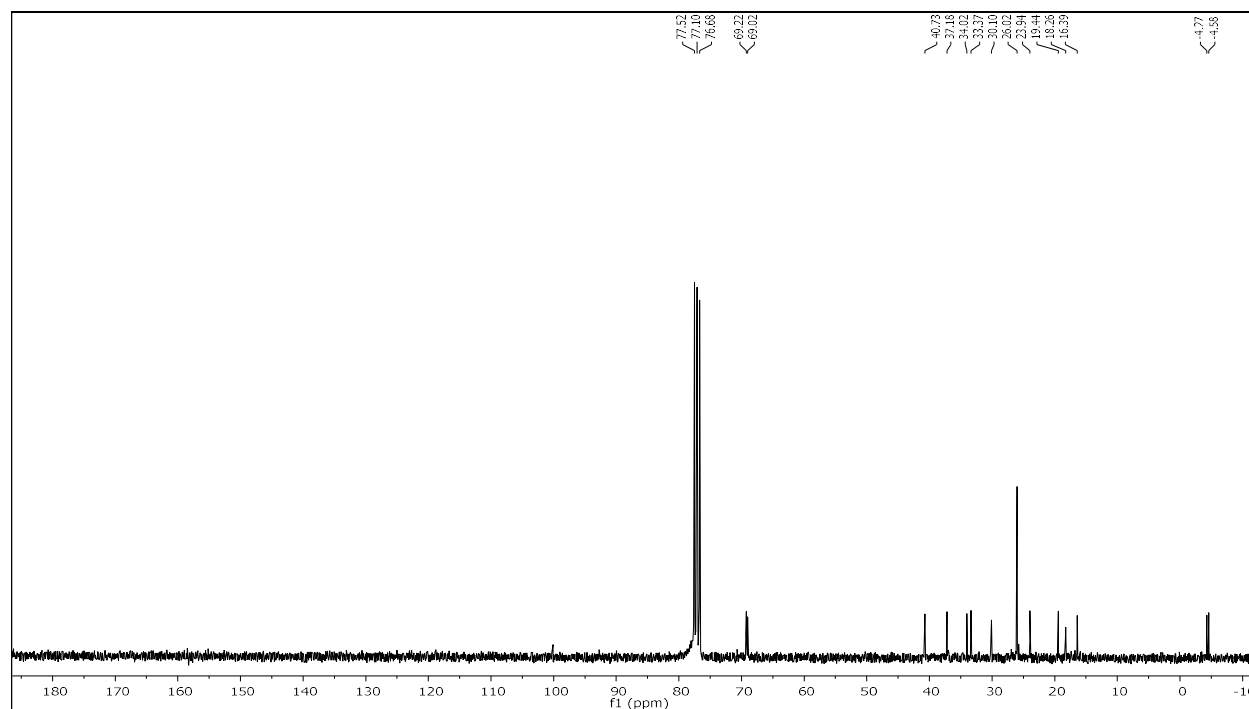
¹³C-NMR spectrum of compound 3b (75 MHz, CDCl₃):



¹H-NMR spectrum of compound 18 (300 MHz, CDCl₃):



¹³C-NMR spectrum of compound 18 (75 MHz, CDCl₃):

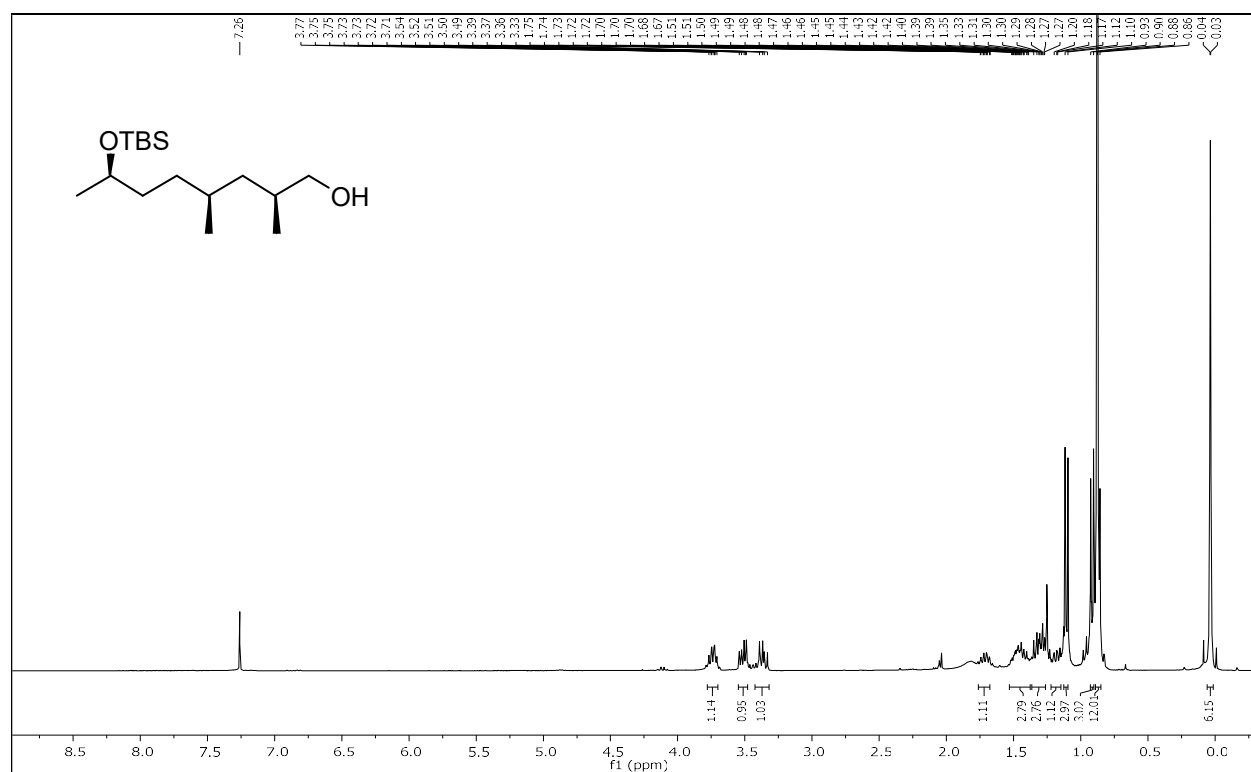


CC(C)[C@H](O)CC[C@H](C)CC(=O)C

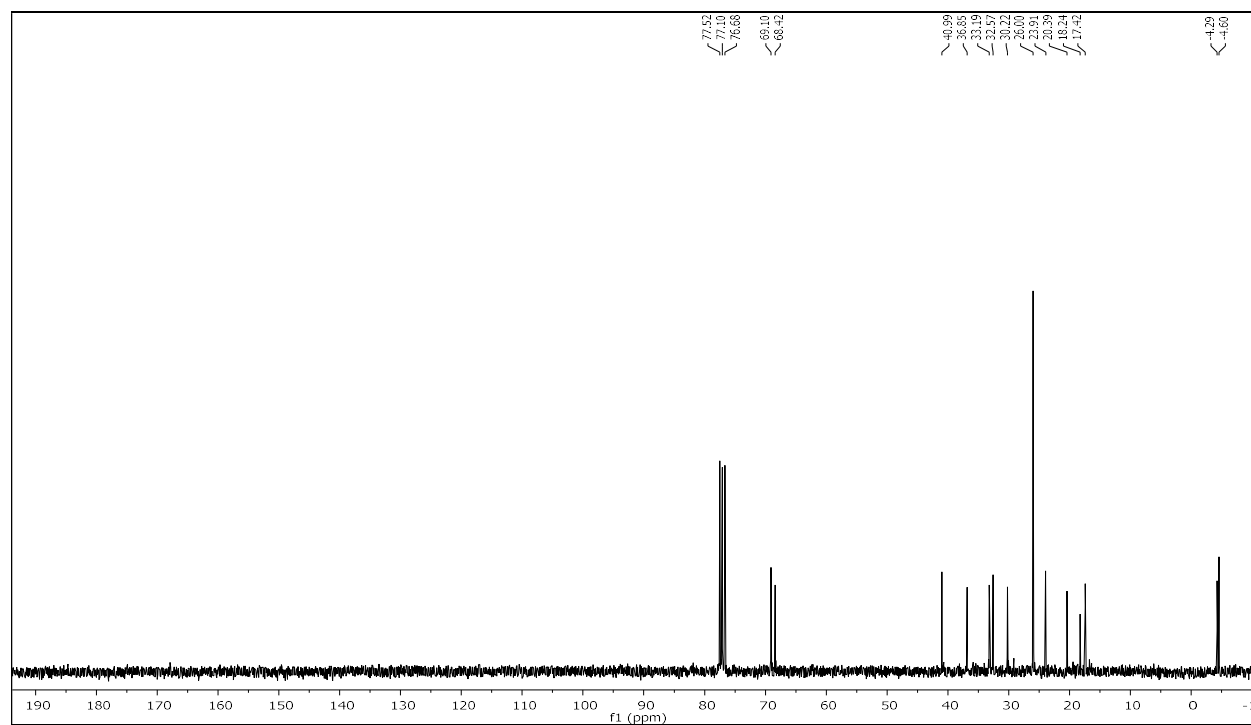
1H NMR spectrum (400 MHz, CDCl₃) of (S)-2-methyl-4-((S)-2-methyl-3-oxobutyl)pentan-3-ol. The spectrum shows peaks from 0.0 to 7.26 ppm. Key features include a large peak at 0.9 ppm (6H, t), a multiplet at 1.0-1.4 ppm (10H), a multiplet at 1.8-2.0 ppm (4H), a multiplet at 3.5-3.8 ppm (2H), and a multiplet at 5.5-5.7 ppm (2H). Integration values are provided below the baseline.

13C NMR spectrum of compound 10. The x-axis is labeled 'f1 (ppm)' and ranges from 190 to -10. The spectrum shows several peaks, with the most intense at approximately 27 ppm. Other significant peaks are at 145.54, 111.97, 77.52, 77.10, 76.68, 69.13, 41.28, 36.93, 35.28, 32.99, 30.21, 28.68, 23.93, 20.09, 19.91, 18.28, -4.28, and -4.57 ppm.

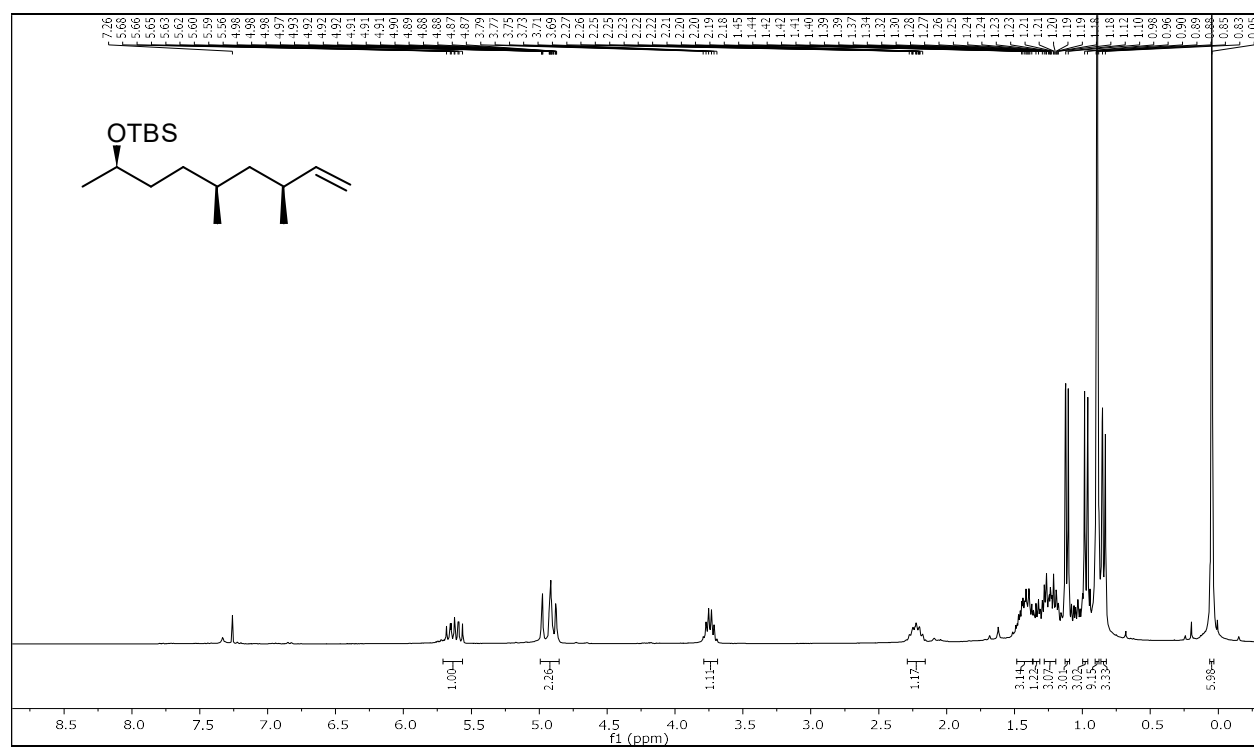
^1H -NMR spectrum of compound 19 (300 MHz, CDCl_3):



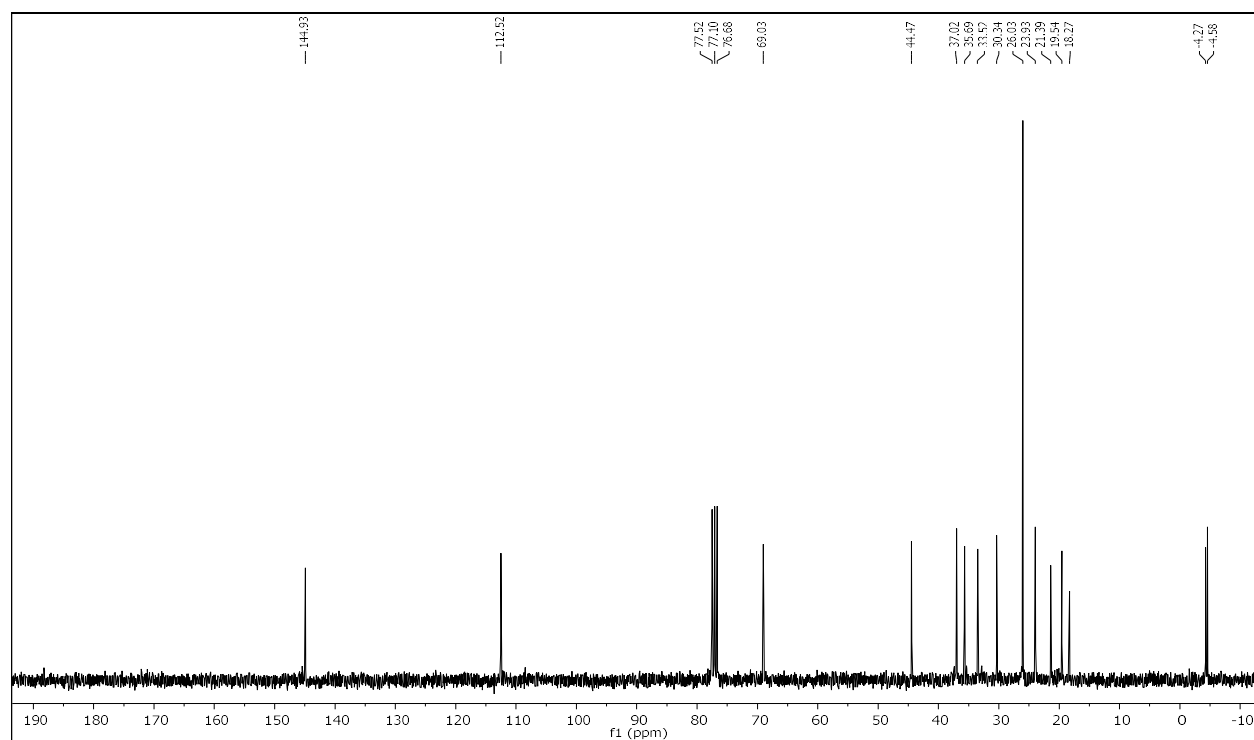
^{13}C -NMR spectrum of compound 19 (75 MHz, CDCl_3):



¹H-NMR spectrum of compound 3d (300 MHz, CDCl₃):



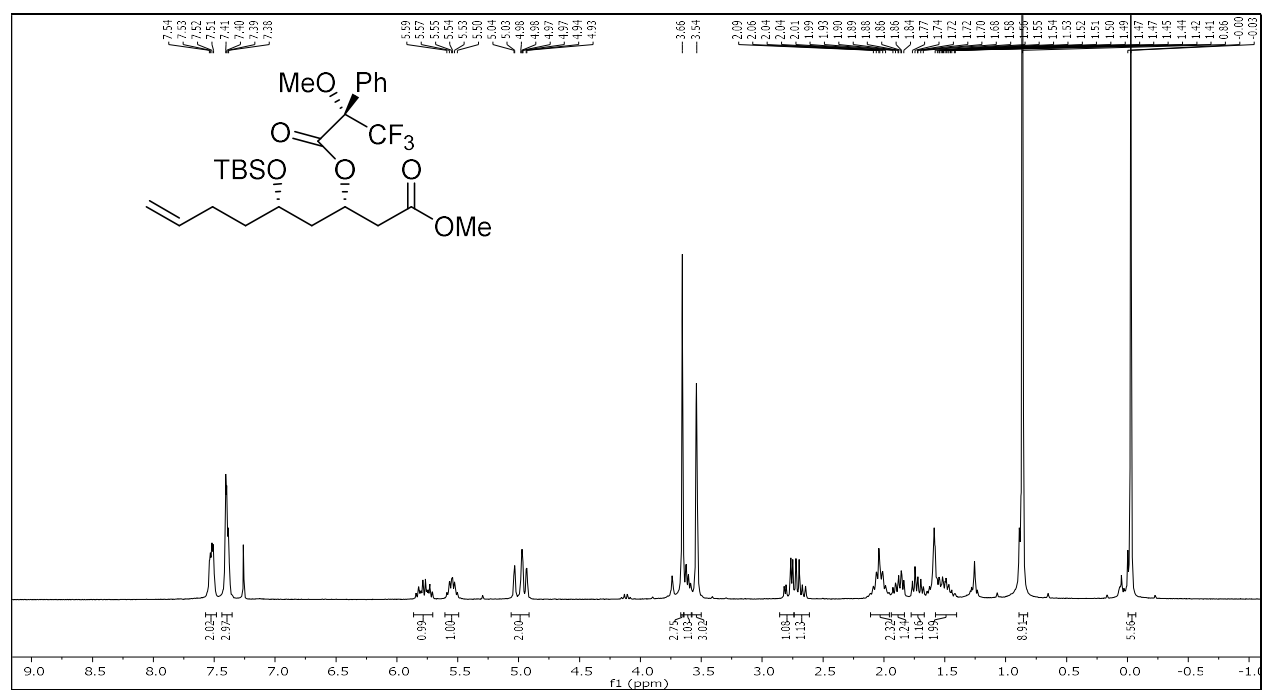
¹³C-NMR spectrum of compound 3d (75 MHz, CDCl₃):



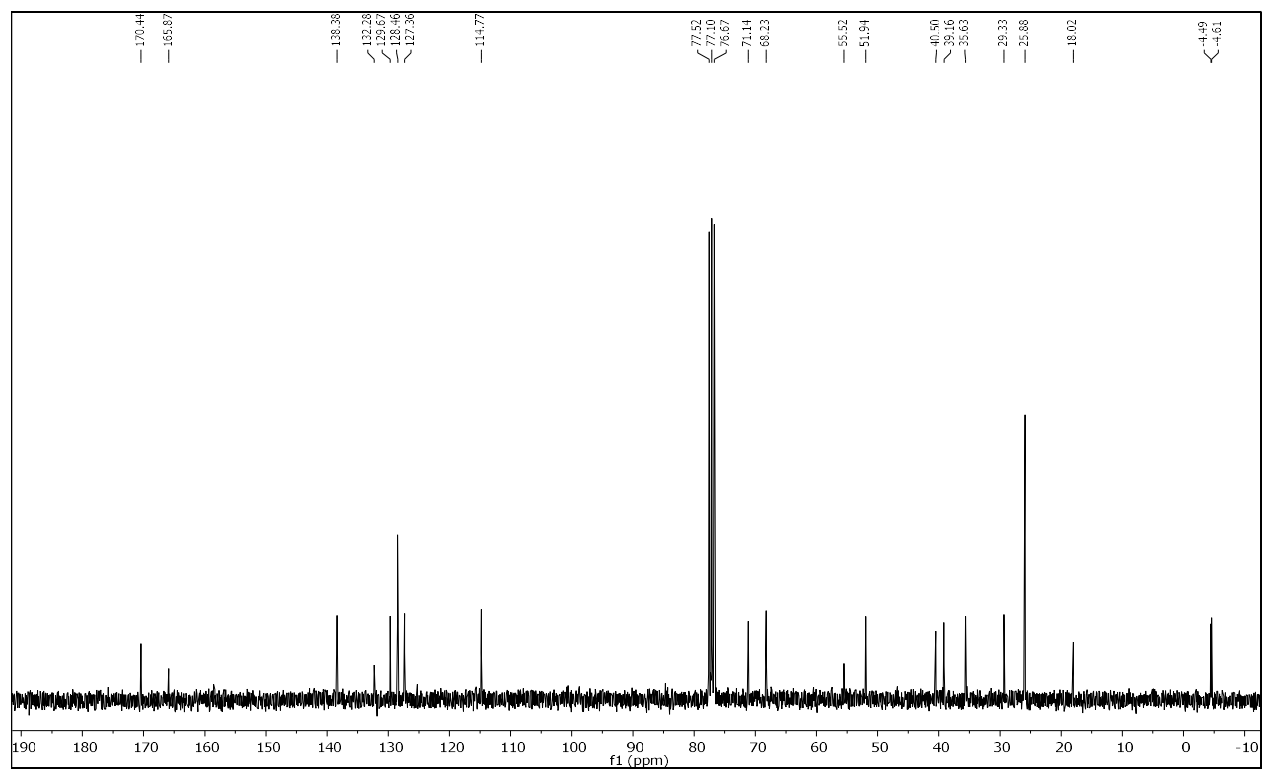
[illegible]

Chemical shifts (ppm): 201.23, 172.48, 138.37, 136.42, 128.43, 128.09, 127.22, 114.64, 77.52, 77.10, 76.68, 70.90, 68.32, 66.45, 46.22, 42.60, 36.72, 36.45, 32.05, 29.06, 25.88, 17.98, -1.14, -4.50.

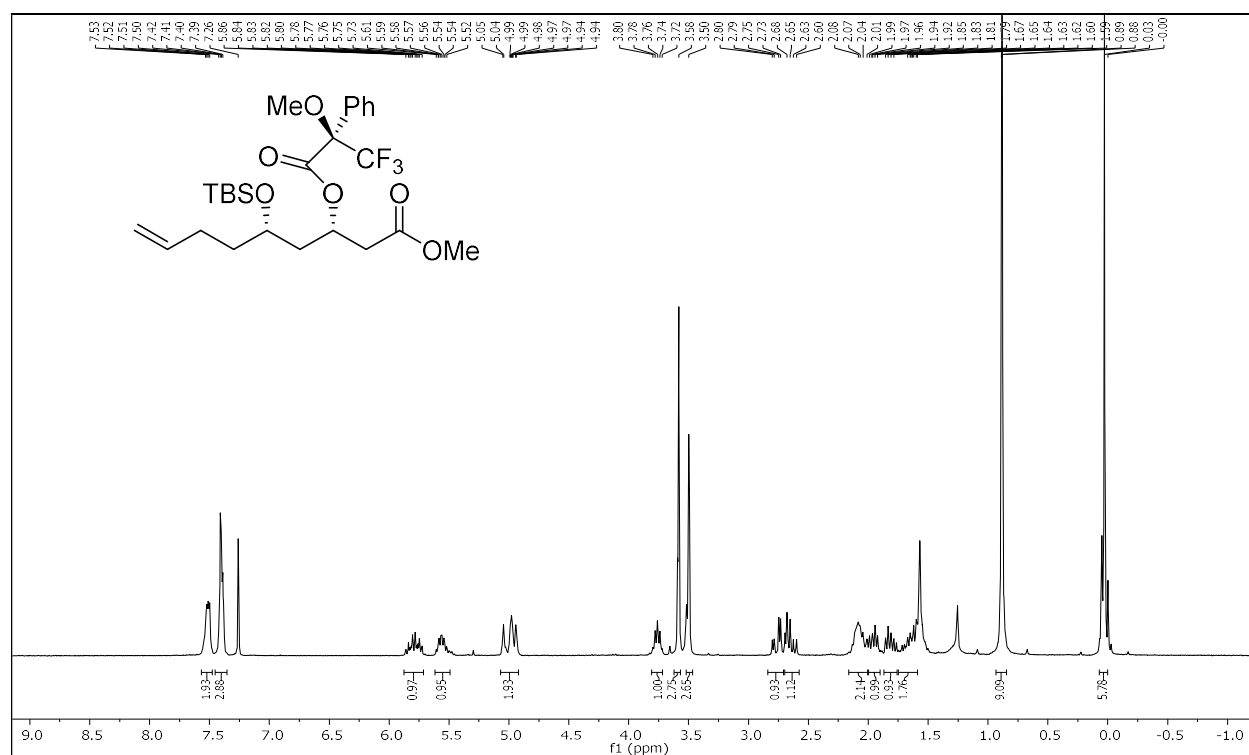
¹H-NMR spectrum of compound 21a (300 MHz, CDCl₃):



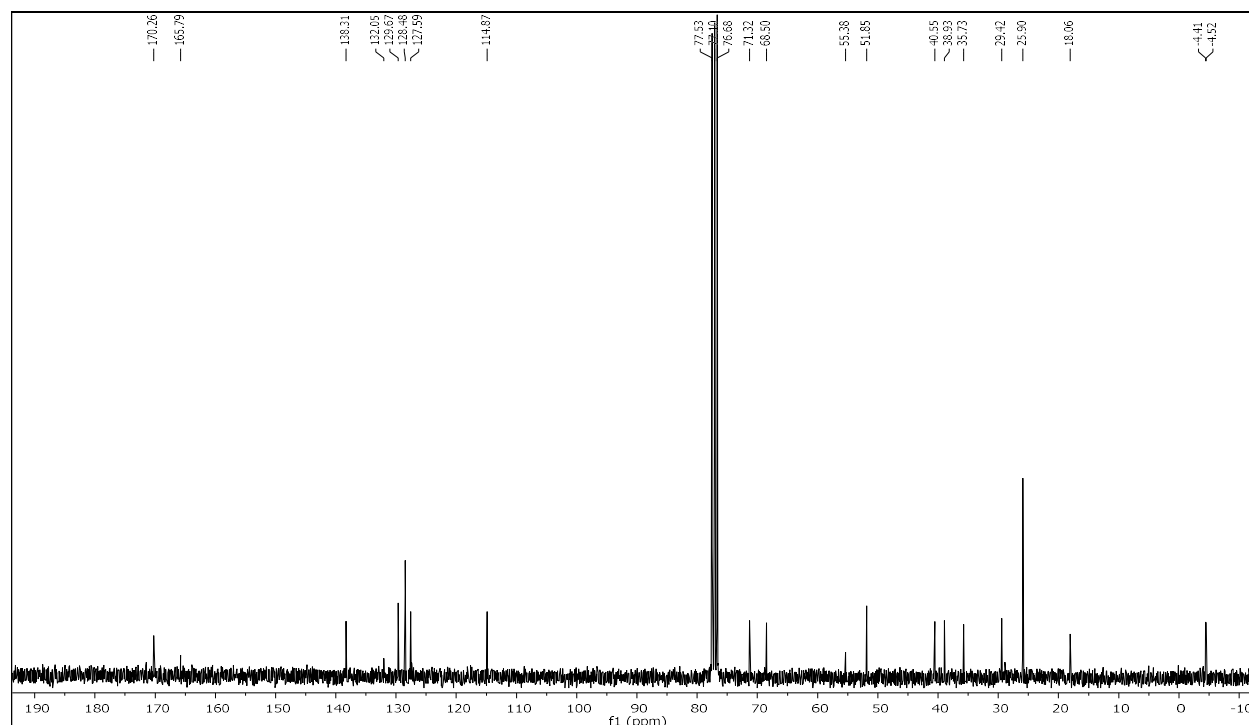
¹³C-NMR spectrum of compound 21a (75 MHz, CDCl₃):



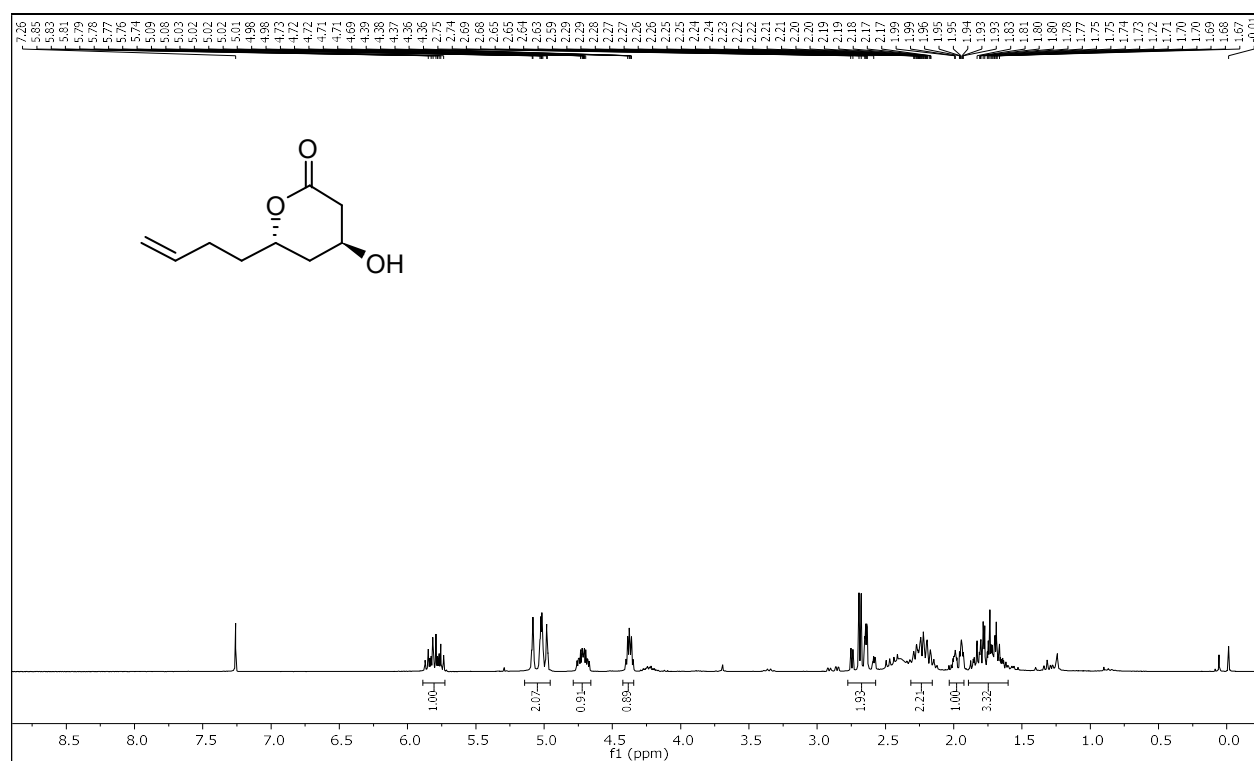
¹H-NMR spectrum of compound 21b (300 MHz, CDCl₃):



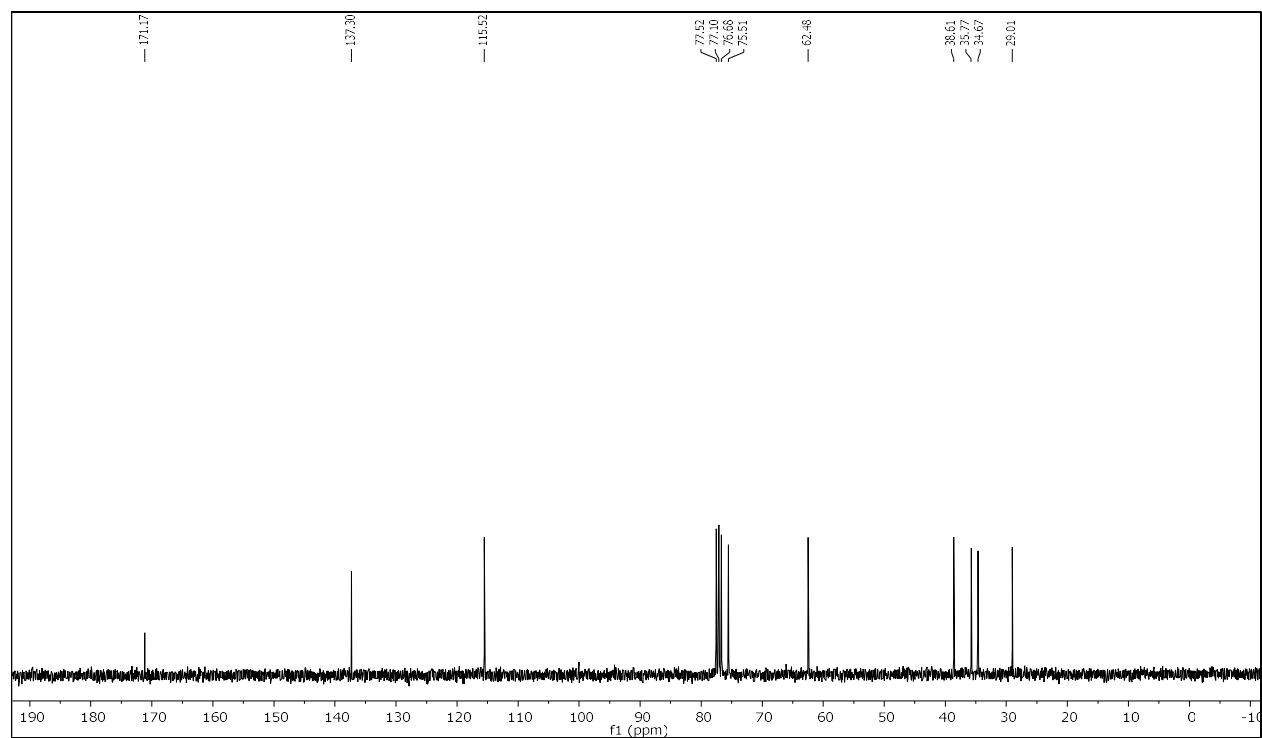
¹³C-NMR spectrum of compound 21b (75 MHz, CDCl₃):



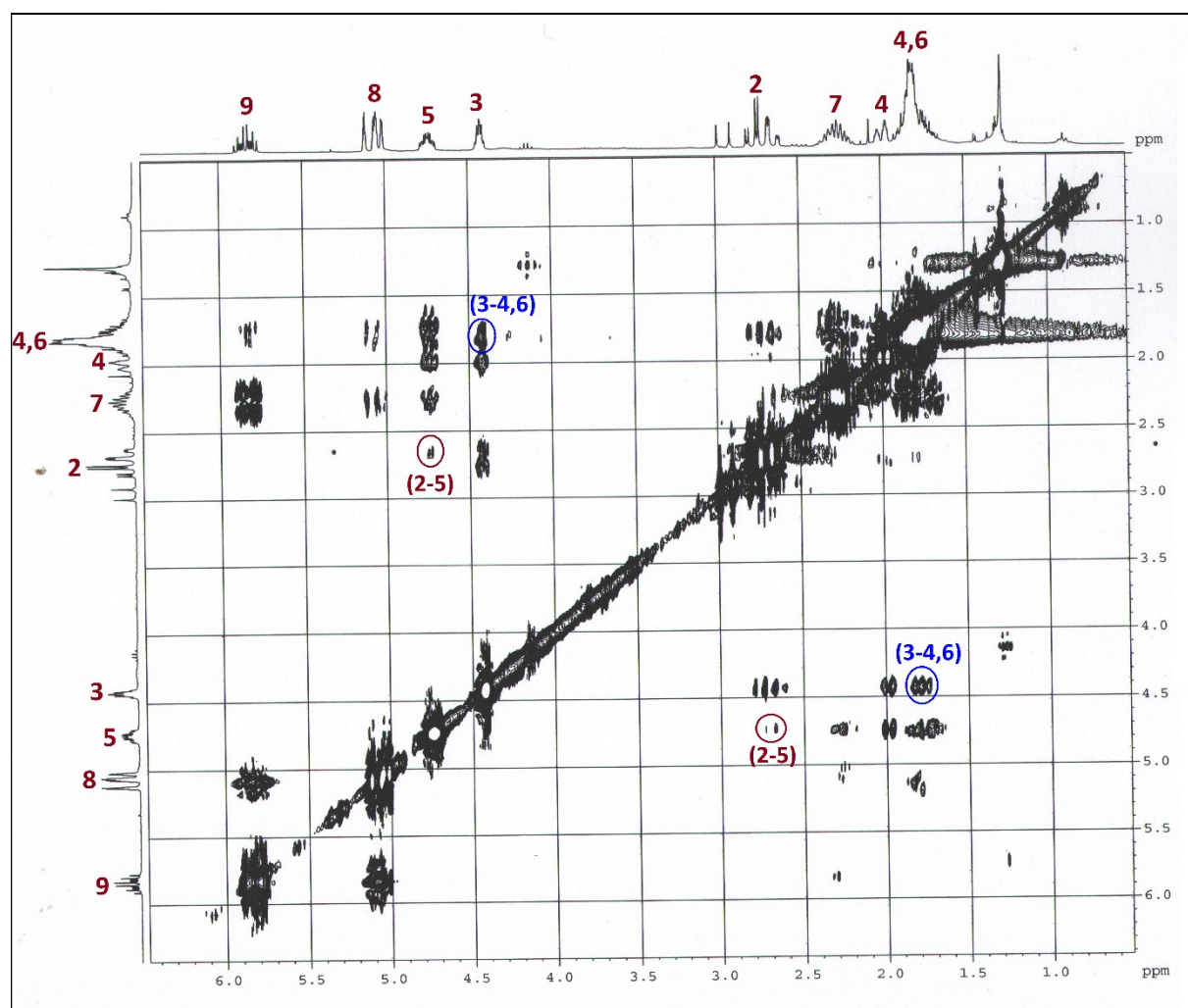
¹H-NMR spectrum of compound 4 (300 MHz, CDCl₃):



¹³C-NMR spectrum of compound 4 (75 MHz, CDCl₃):

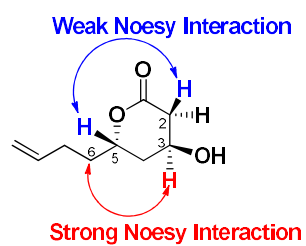


NOESY spectrum of compound 4 (300 MHz, CDCl₃)

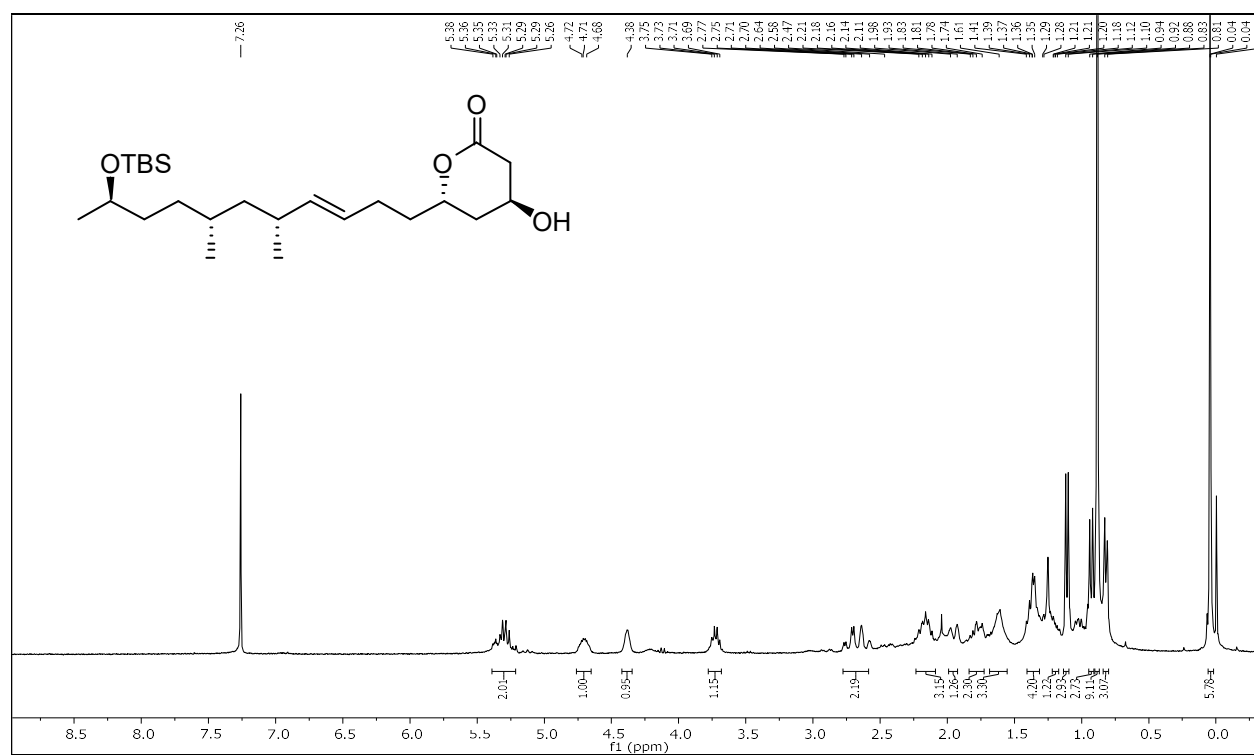


○ Strong Noesy Interaction

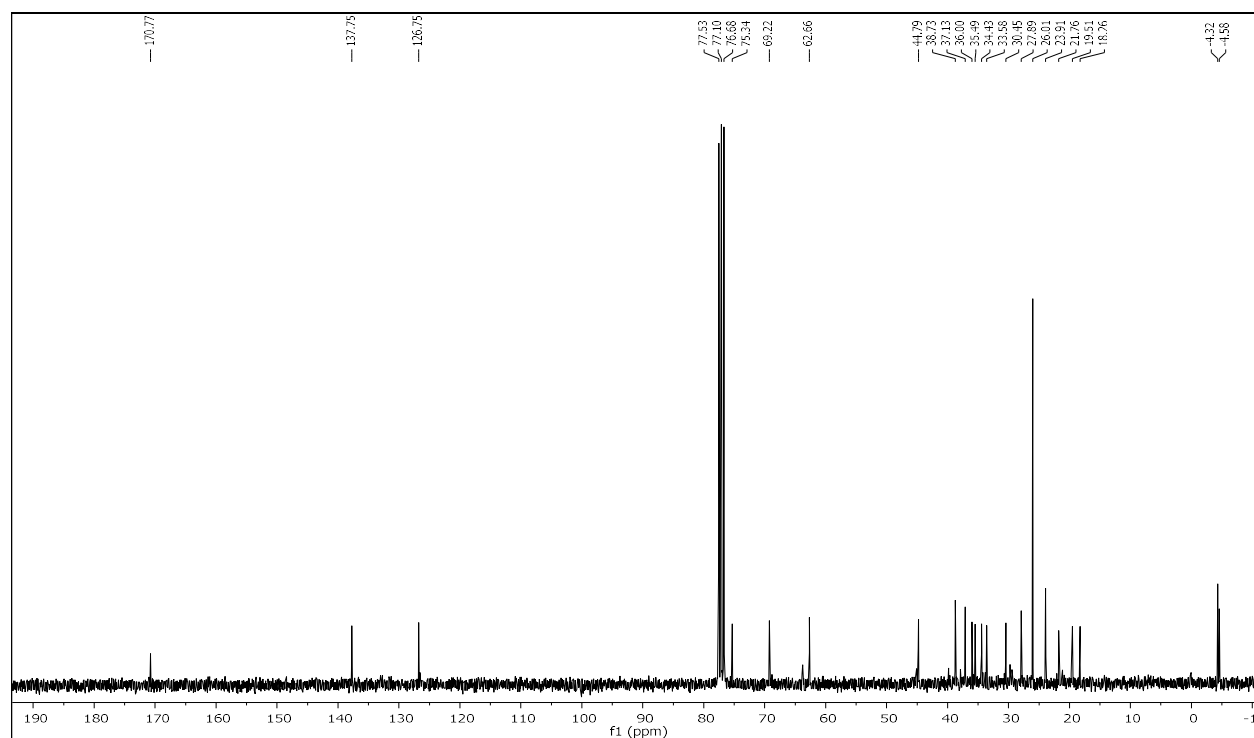
○ Weak Noesy Interaction



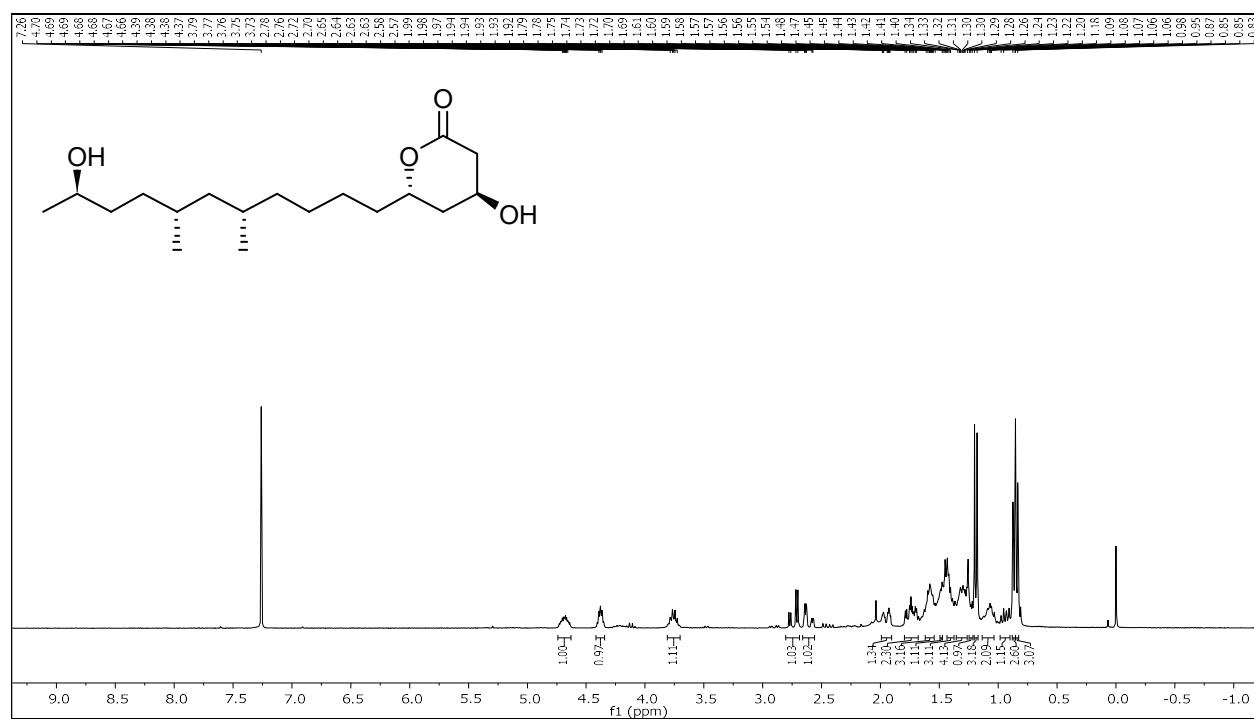
^1H -NMR spectrum of compound 22 (300 MHz, CDCl_3):



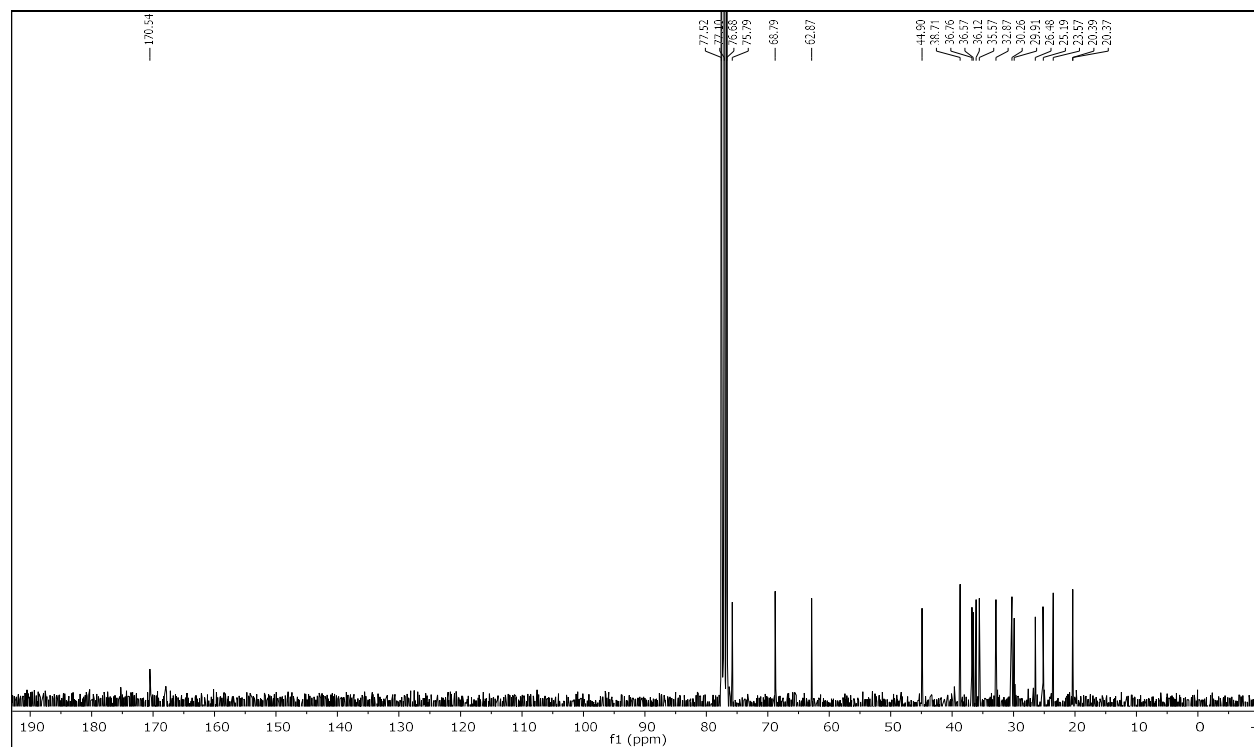
^{13}C -NMR spectrum of compound 22 (75 MHz, CDCl_3):



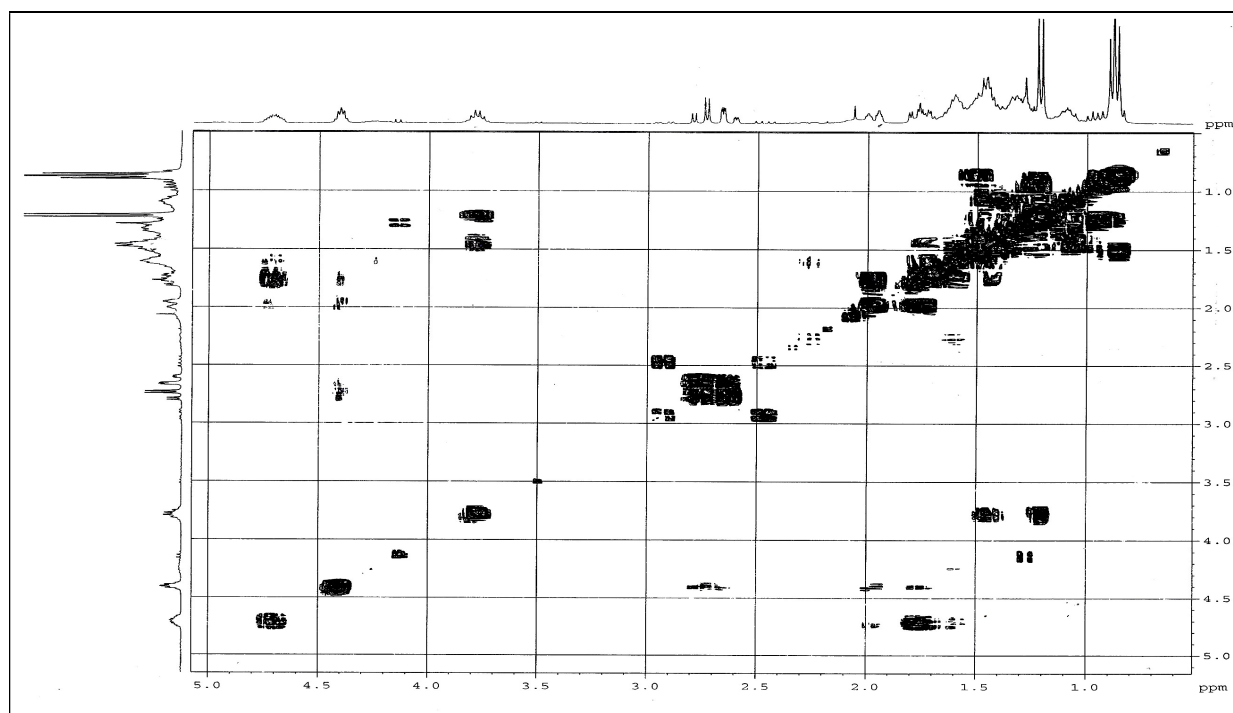
¹H-NMR spectrum of compound 1a (300 MHz, CDCl₃):



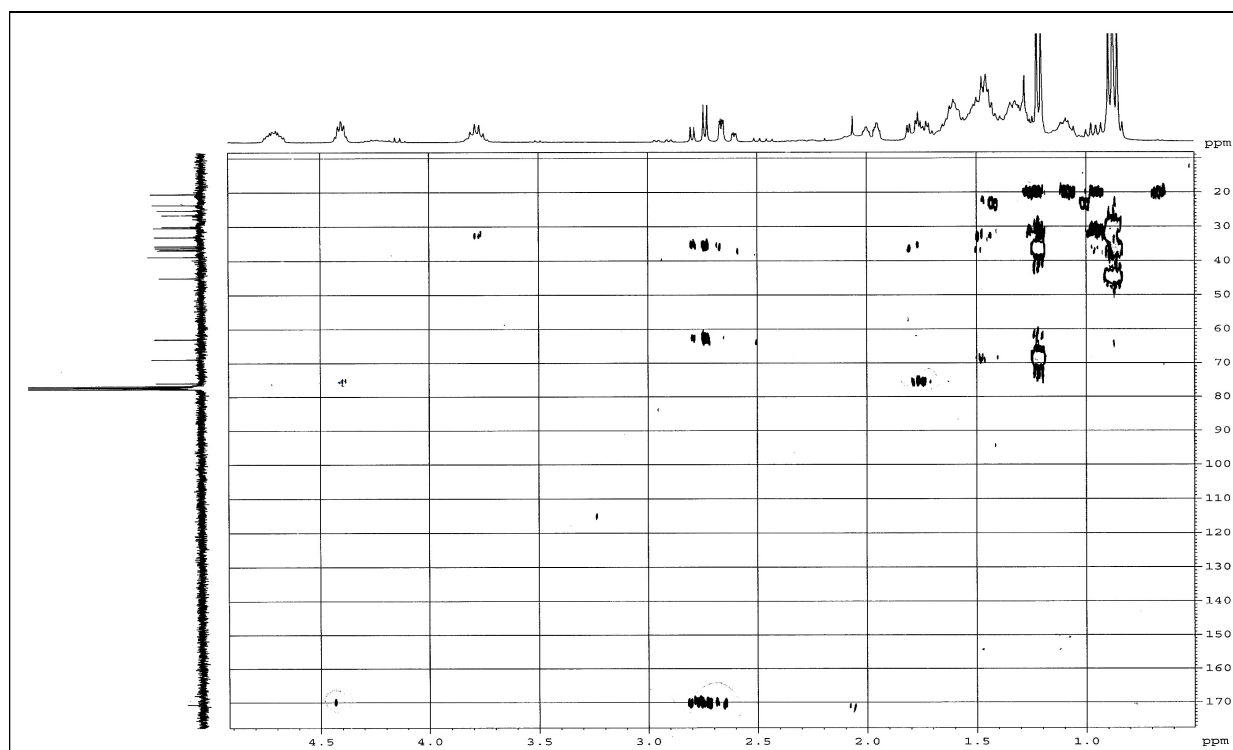
¹³C-NMR spectrum of compound 1a (75 MHz, CDCl₃):



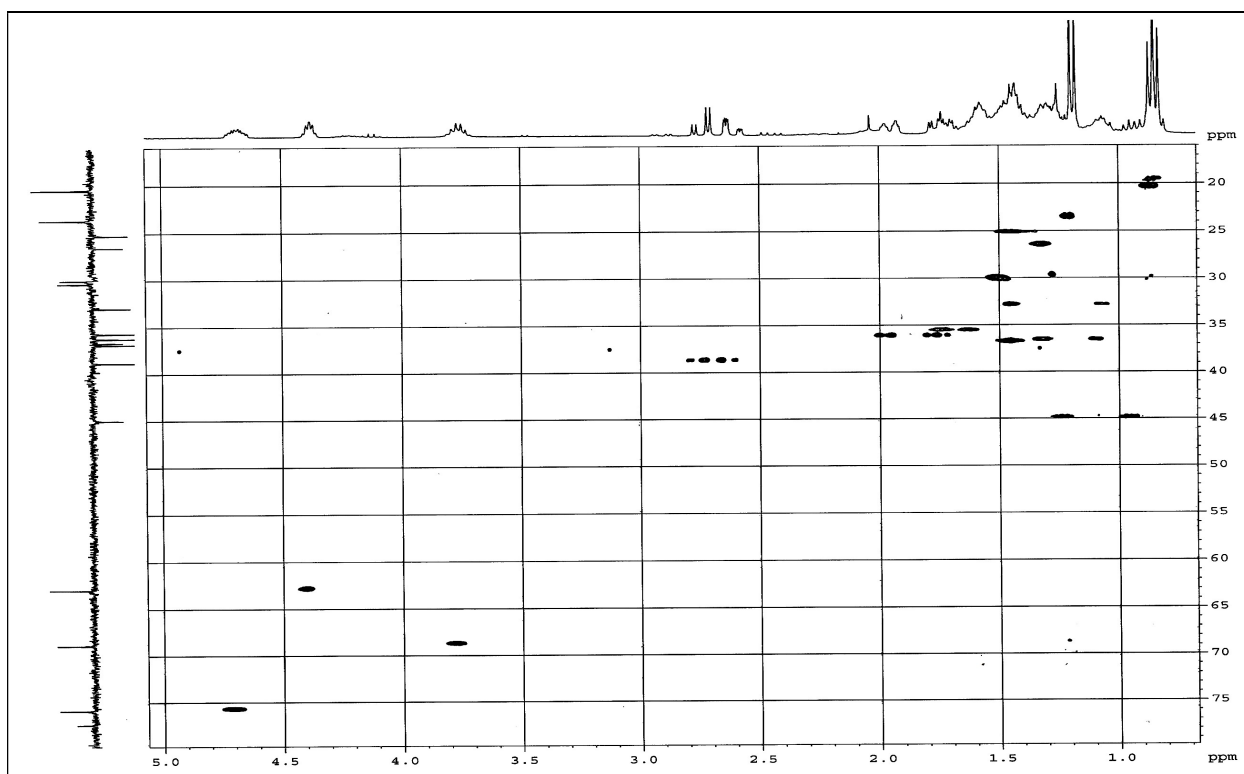
^1H -COSY spectrum of compound 1a (300 MHz, CDCl_3):



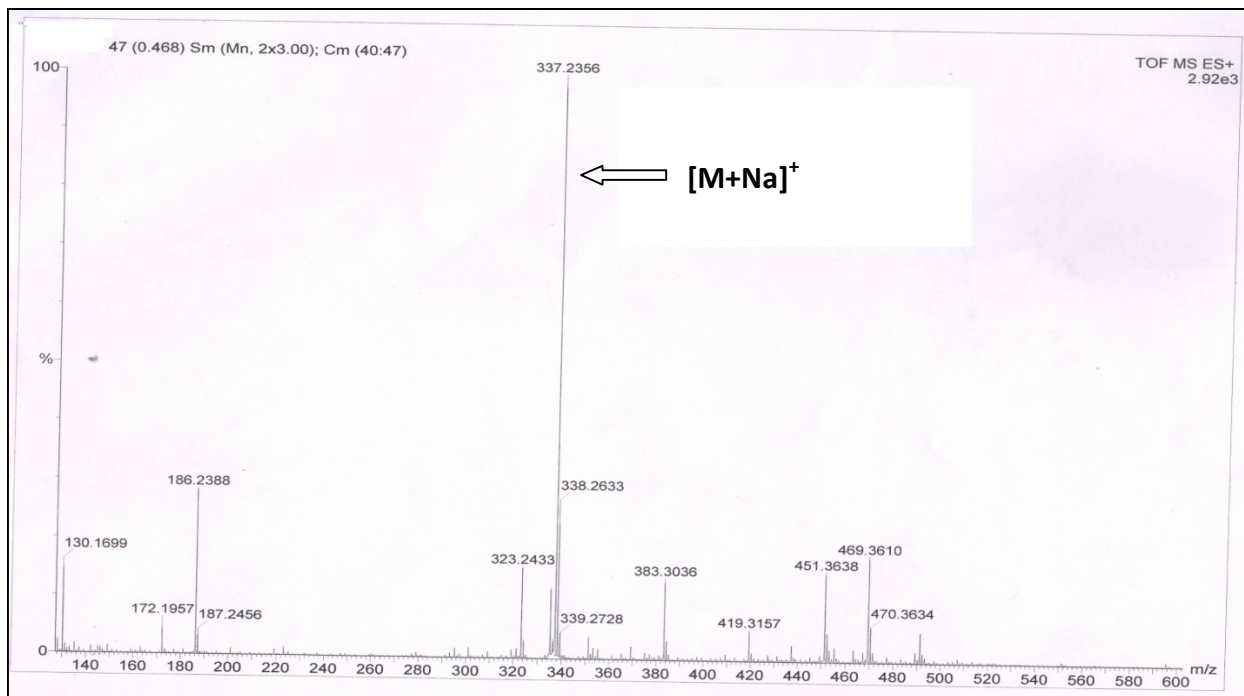
HMBC spectrum of compound 1a (75 MHz, CDCl_3):



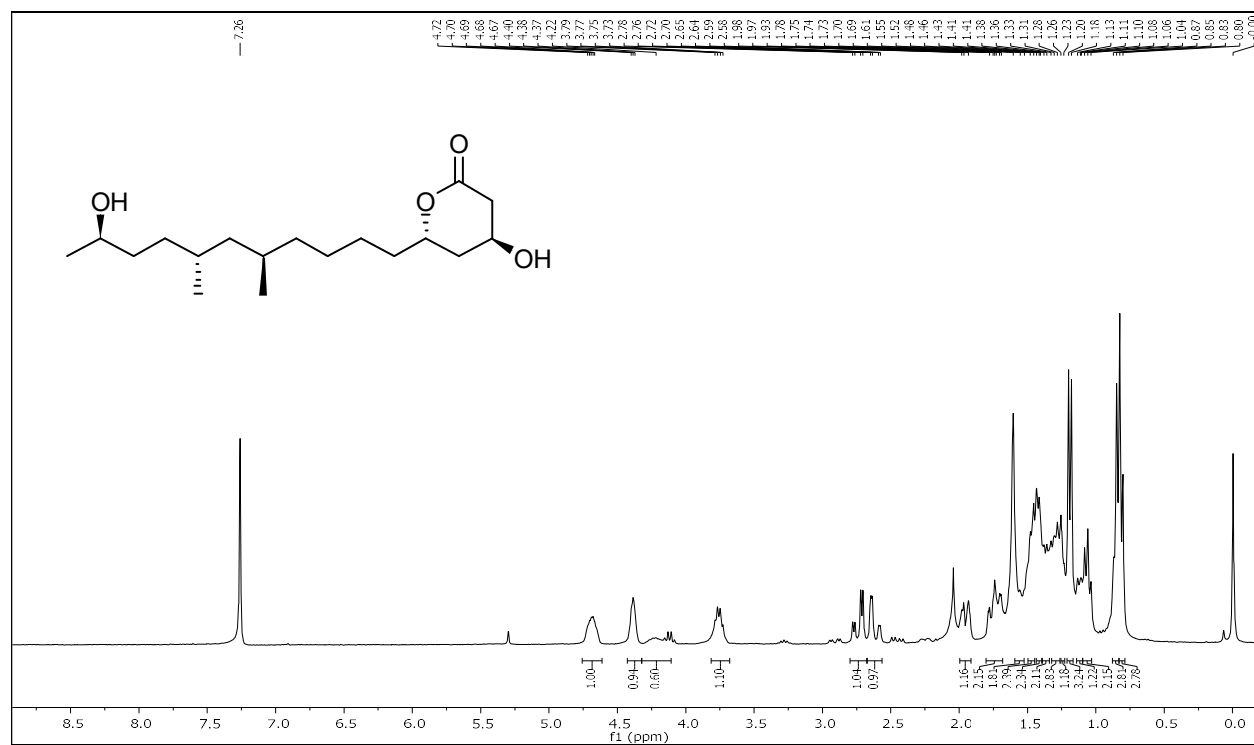
HSQC spectrum of compound 1a (75 MHz, CDCl₃):



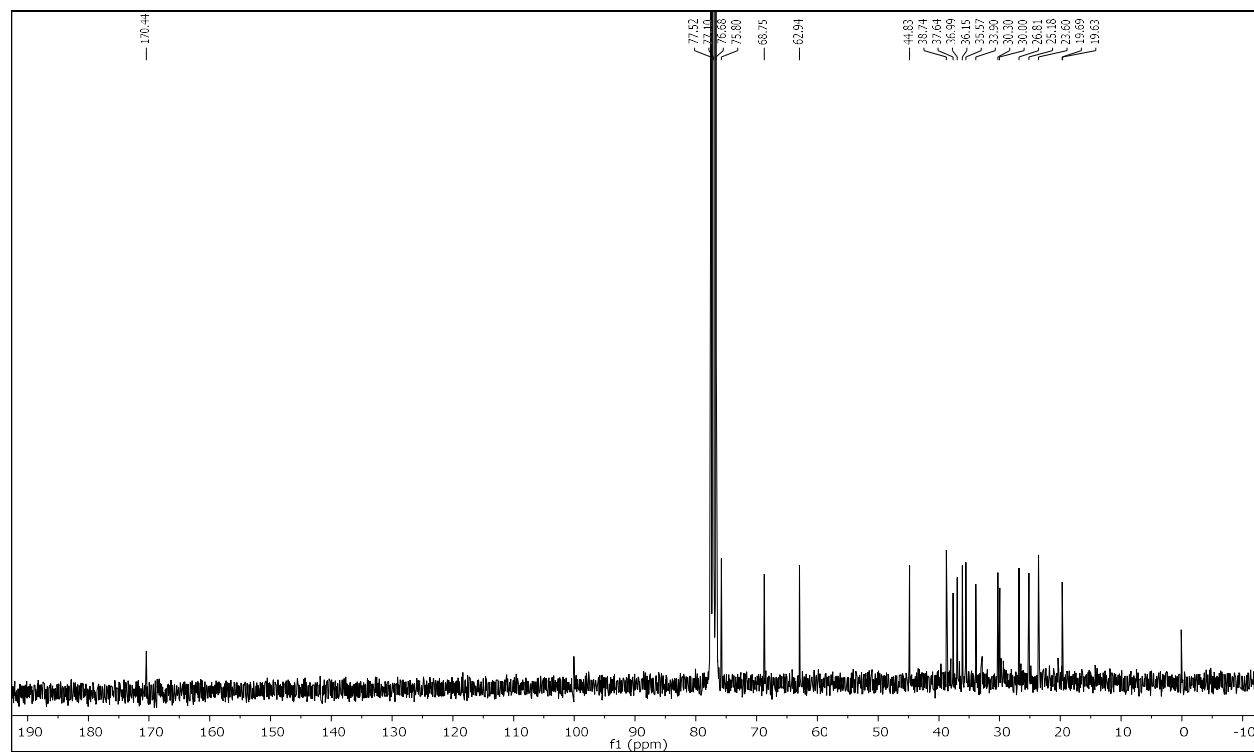
HRMS spectrum of compound 1a:



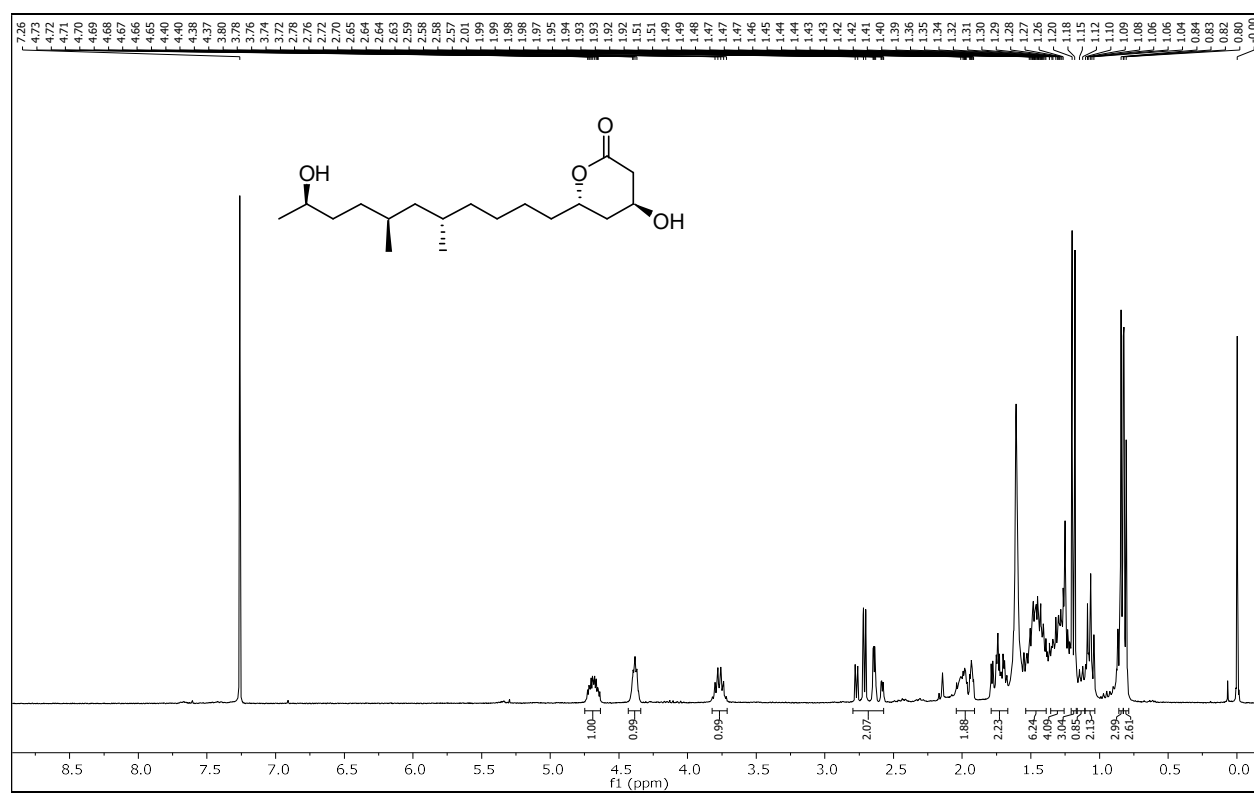
¹H-NMR spectrum of compound 1b (300 MHz, CDCl₃):



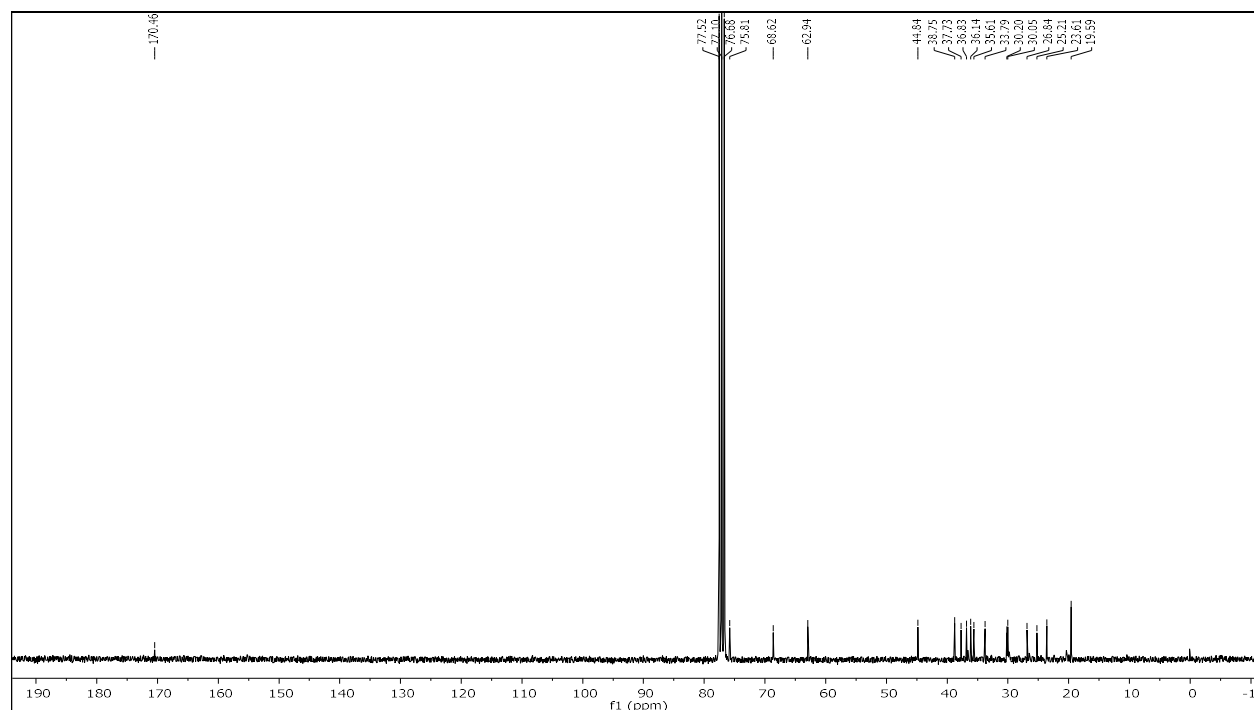
¹³C-NMR spectrum of compound 1b (75 MHz, CDCl₃):



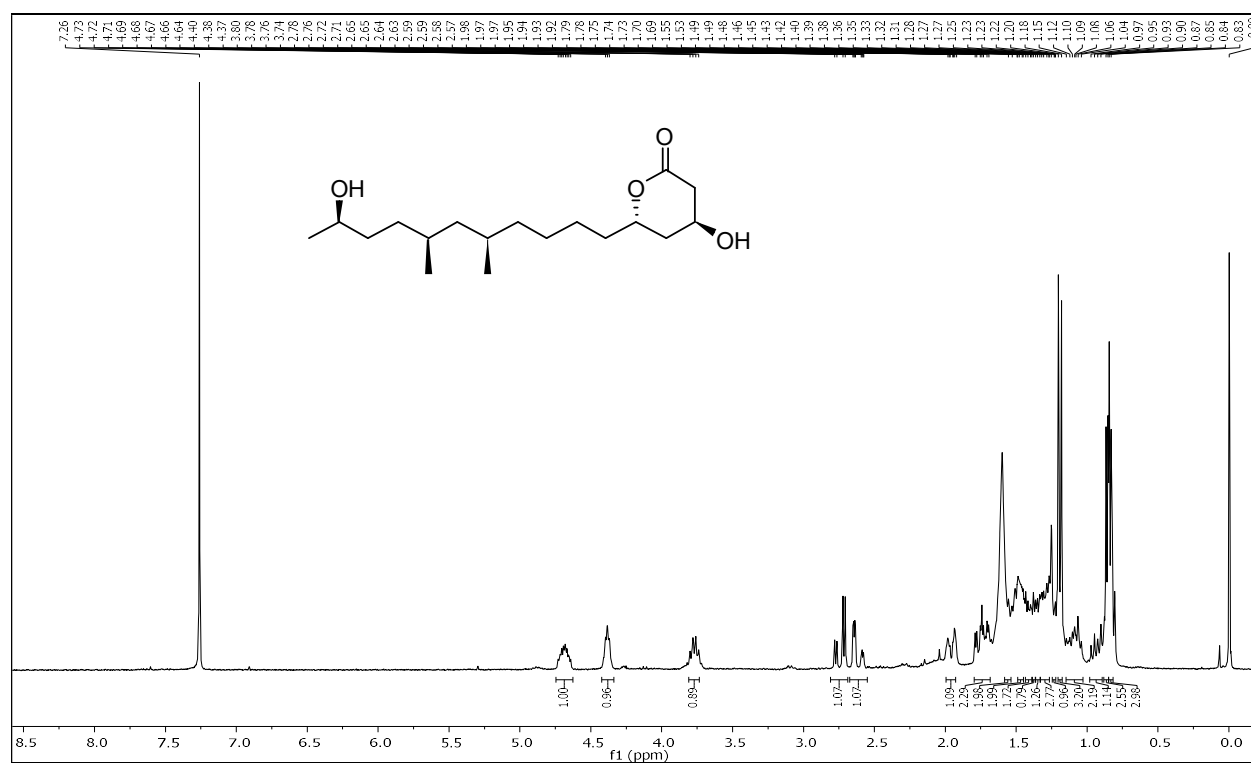
¹H-NMR spectrum of compound 1c (300 MHz, CDCl₃):



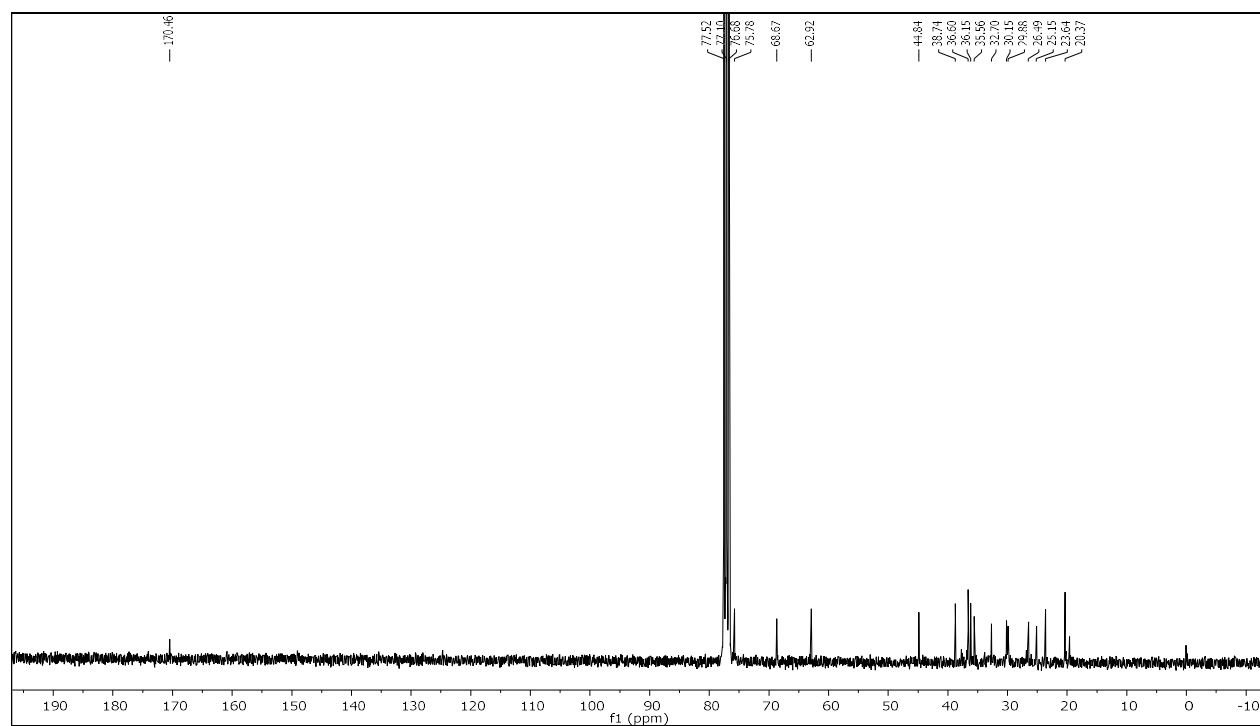
¹³C-NMR spectrum of compound 1c (75 MHz, CDCl₃):



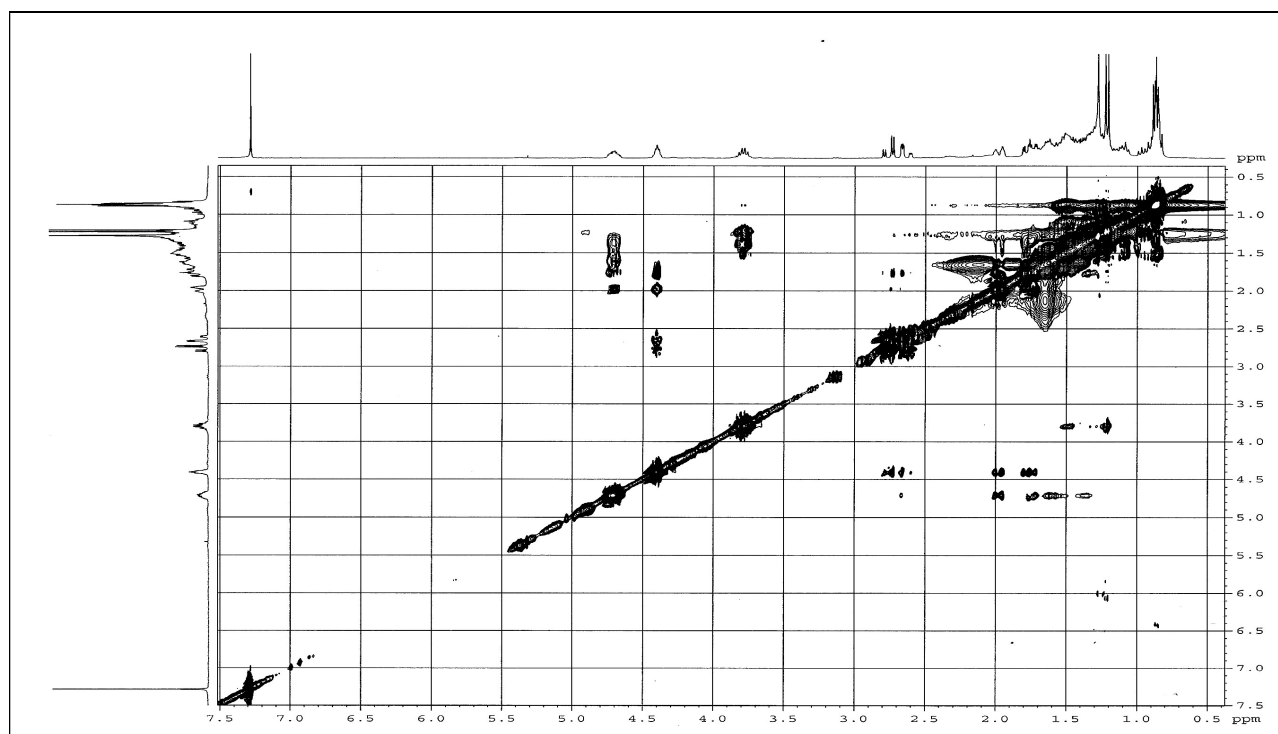
¹H-NMR spectrum of compound 1d (300 MHz, CDCl₃):



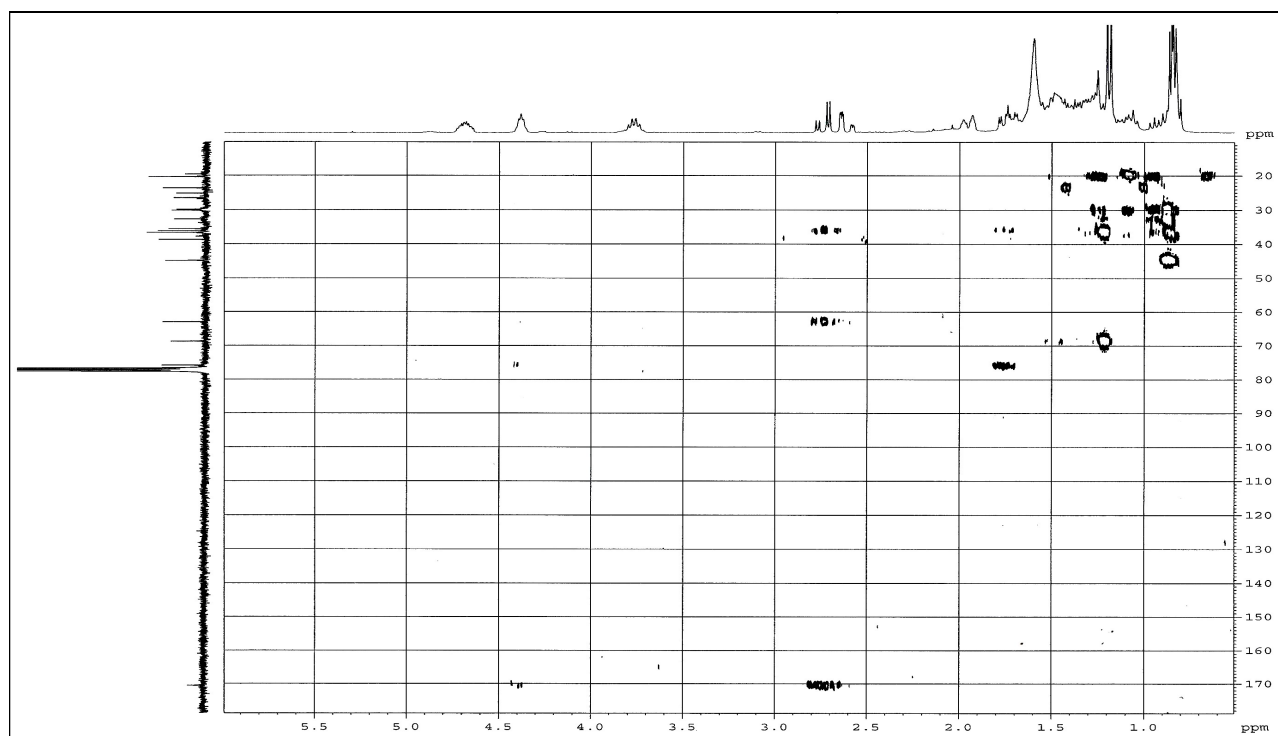
¹³C-NMR spectrum of compound 1d (75 MHz, CDCl₃):



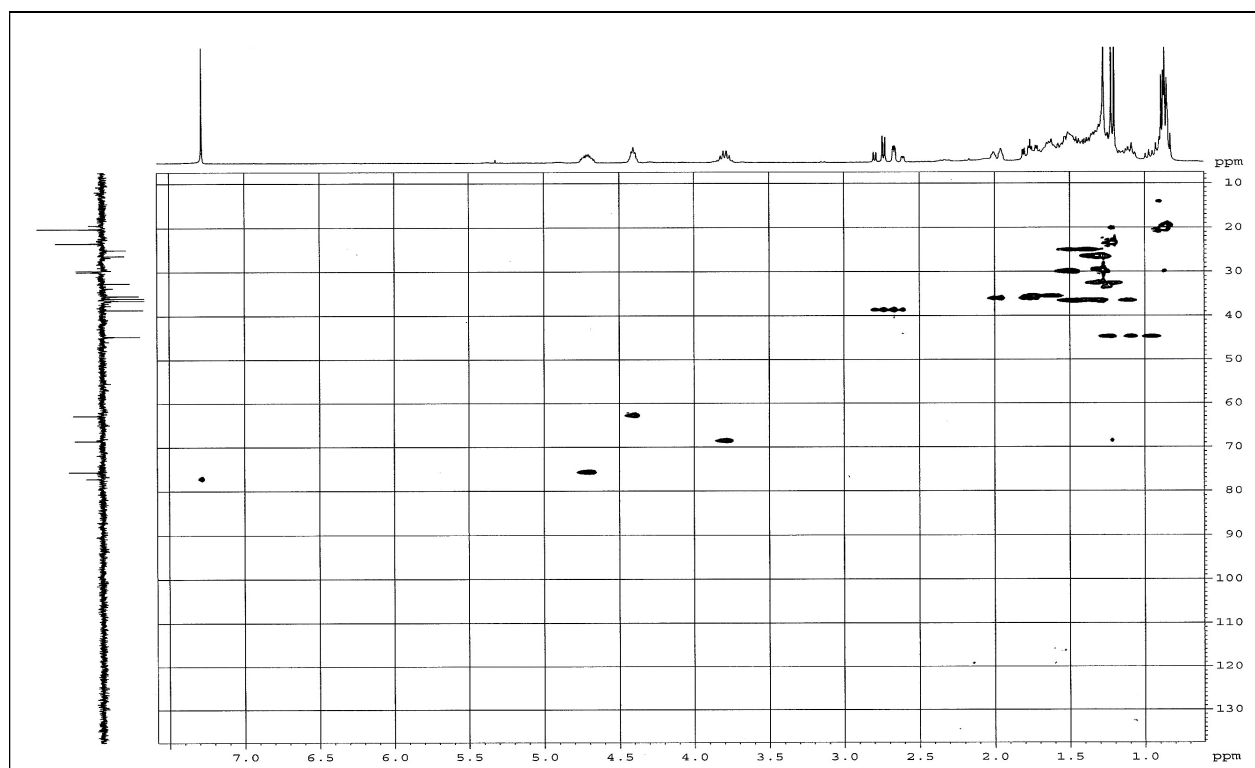
¹H-NOSEY spectrum of compound 1d (300 MHz, CDCl₃):



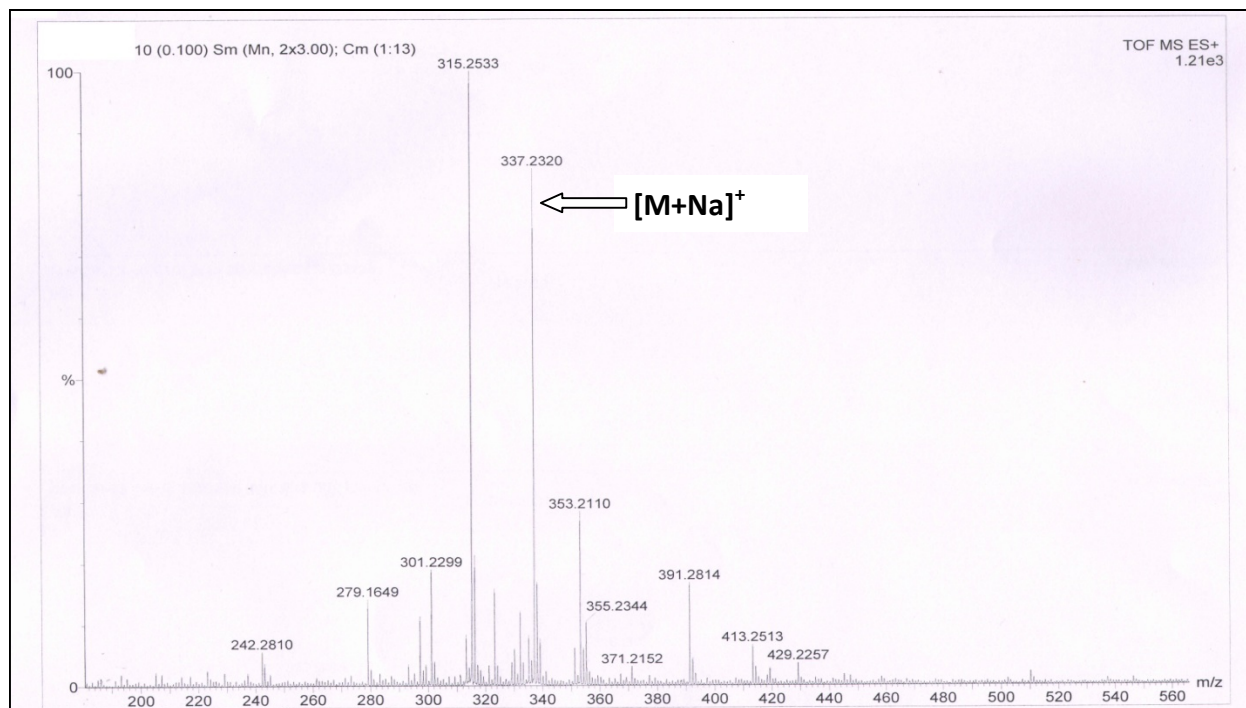
HMBC spectrum of compound 1d (75 MHz, CDCl₃):



HSQC spectrum of compound 1d (75 MHz, CDCl₃):



HRMS spectrum of compound 1d:



Chemical structure of compound 10 is shown above the spectrum. The structure is a 1,3-dithiane derivative with a benzyl group at the 2-position, a carbonyl group at the 4-position, and a side chain at the 5-position containing a hydroxyl group, a TBSO group, and a terminal vinyl group.

¹H NMR spectrum (CDCl₃) of compound 10. The x-axis is labeled f1 (ppm) and ranges from 0.00 to 8.50. The spectrum shows several peaks, with integration values indicated below the baseline:

- 5.16 (multiplet, ~7.2 ppm)
- 1.02 (multiplet, ~5.8 ppm)
- 1.00 (multiplet, ~5.5 ppm)
- 2.05 (multiplet, ~5.0 ppm)
- 1.01 (multiplet, ~4.2 ppm)
- 1.02 (multiplet, ~3.9 ppm)
- 1.05 (multiplet, ~3.5 ppm)
- 1.25 (multiplet, ~3.3 ppm)
- 2.40 (multiplet, ~3.1 ppm)
- 1.21 (multiplet, ~2.9 ppm)
- 1.12 (multiplet, ~2.8 ppm)
- 2.12 (multiplet, ~2.0 ppm)
- 4.35 (multiplet, ~1.6 ppm)
- 8.87 (sharp singlet, ~1.0 ppm)
- 5.88 (multiplet, ~0.1 ppm)

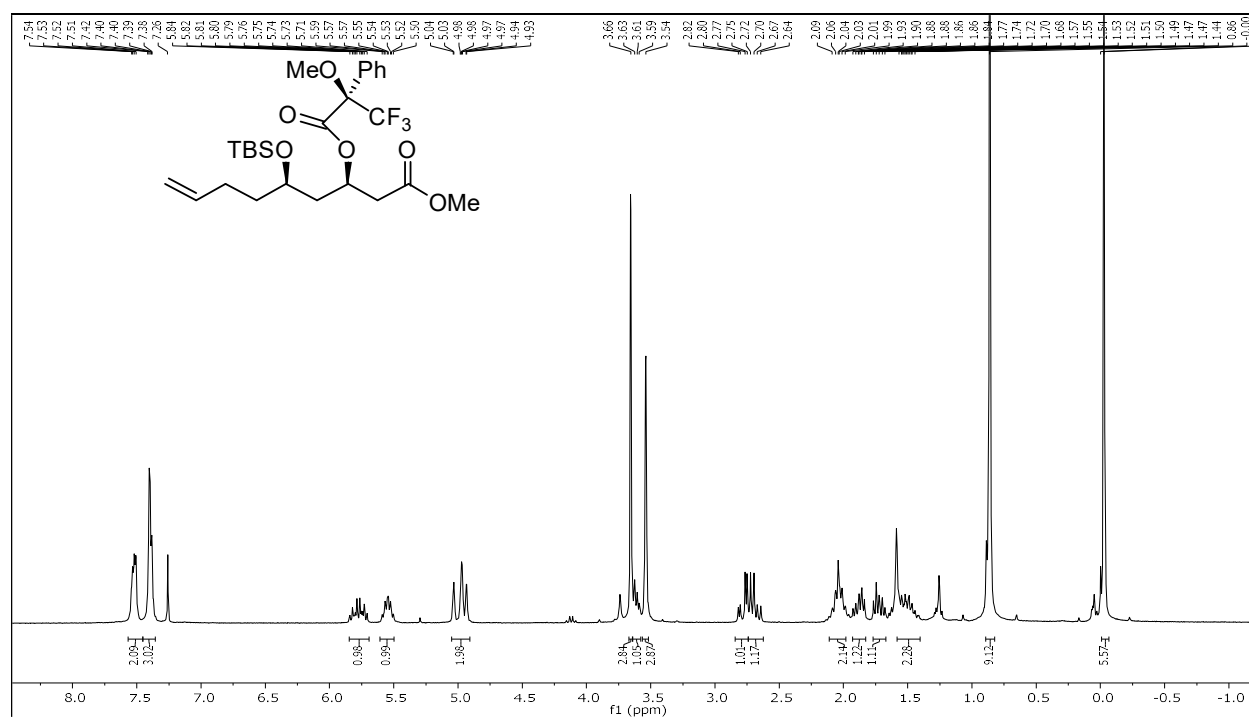
13C NMR spectrum of compound 10a in CDCl₃. The x-axis is labeled 'f1 (ppm)' and ranges from 220 to -10. The spectrum shows several peaks, with the most prominent ones around 77 ppm (solvent triplet) and 130-140 ppm. Other significant peaks are at 201.39, 172.63, 138.48, 136.53, 129.53, 128.99, 127.33, 114.71, 77.52, 77.14, 76.68, 71.06, 68.44, 66.59, 46.32, 42.71, 36.85, 36.60, 32.14, 29.15, 25.96, 18.09, -1.06, and -1.42 ppm.

Chemical structure of compound 10 is shown above the spectrum. The structure is a complex molecule with a central carbon atom bonded to a methoxy group (MeO), a phenyl group (Ph), a trifluoromethyl group (CF₃), and a carbonyl group (C=O). The carbonyl group is part of a chain that includes a TBSO group, a chiral center, and a methyl ester group (OMe).

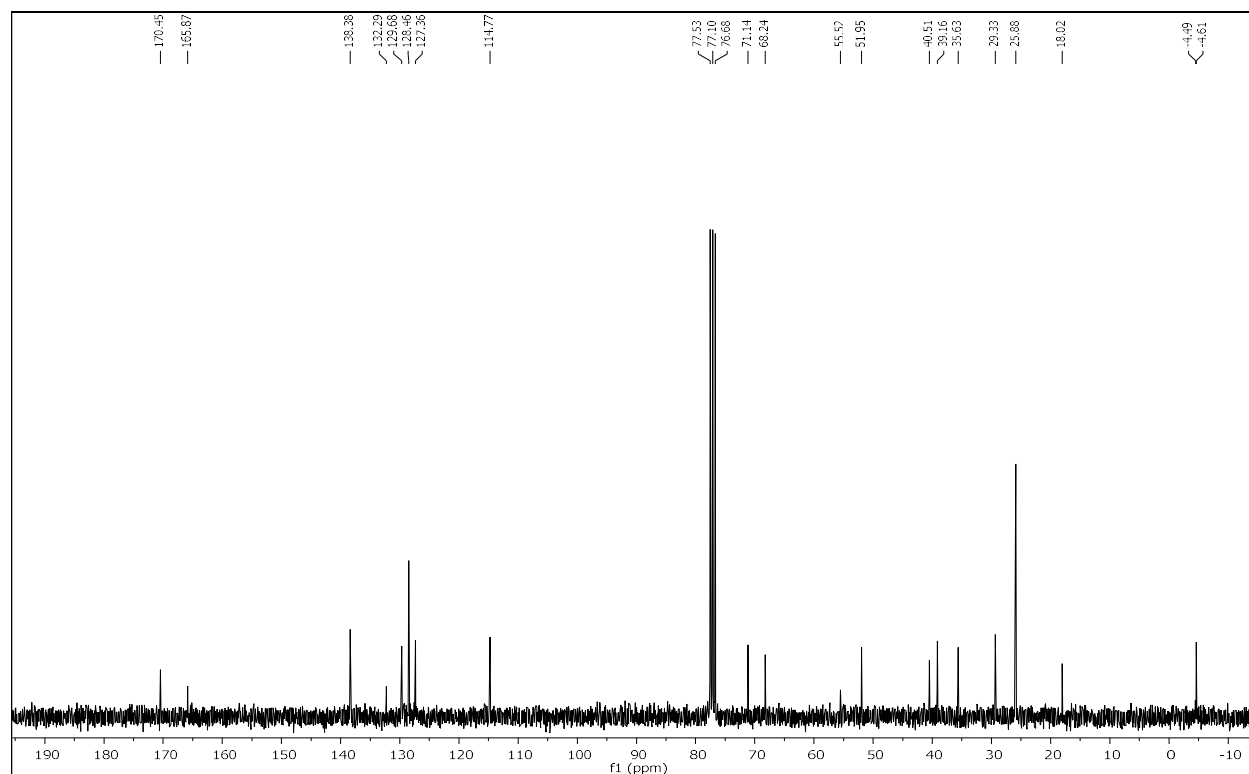
¹H NMR spectrum (CDCl₃) of compound 10. The x-axis represents the chemical shift in ppm, ranging from 9.0 to -1.0. The spectrum shows several peaks, with the following chemical shifts (ppm) labeled above the peaks: 7.52, 7.51, 7.50, 7.41, 7.40, 7.39, 7.36, 5.86, 5.84, 5.83, 5.82, 5.80, 5.78, 5.77, 5.75, 5.73, 5.61, 5.58, 5.57, 5.56, 5.54, 5.52, 5.51, 5.04, 4.99, 4.96, 4.94, 3.80, 3.78, 3.76, 3.74, 3.73, 3.56, 3.50, 2.80, 2.79, 2.75, 2.73, 2.68, 2.65, 2.63, 2.60, 2.10, 2.04, 1.99, 1.97, 1.96, 1.94, 1.86, 1.83, 1.81, 1.79, 1.07, 1.65, 1.64, 1.63, 1.62, 1.60, 1.59, 0.03, and -0.00. Integration values are provided below the peaks: 2.03, 3.04, 1.02, 1.07, 2.03, 1.08, 2.03, 1.10, 1.07, 2.13, 1.22, 1.09, 1.84, 9.32, and 5.08.

Chemical shifts (ppm): 170.25, 165.99, 138.30, 132.06, 129.67, 128.49, 127.60, 114.87, 77.52, 76.68, 71.32, 68.50, 55.37, 51.85, 40.56, 38.93, 35.74, 29.42, 25.90, 18.06, -4.40, -4.51.

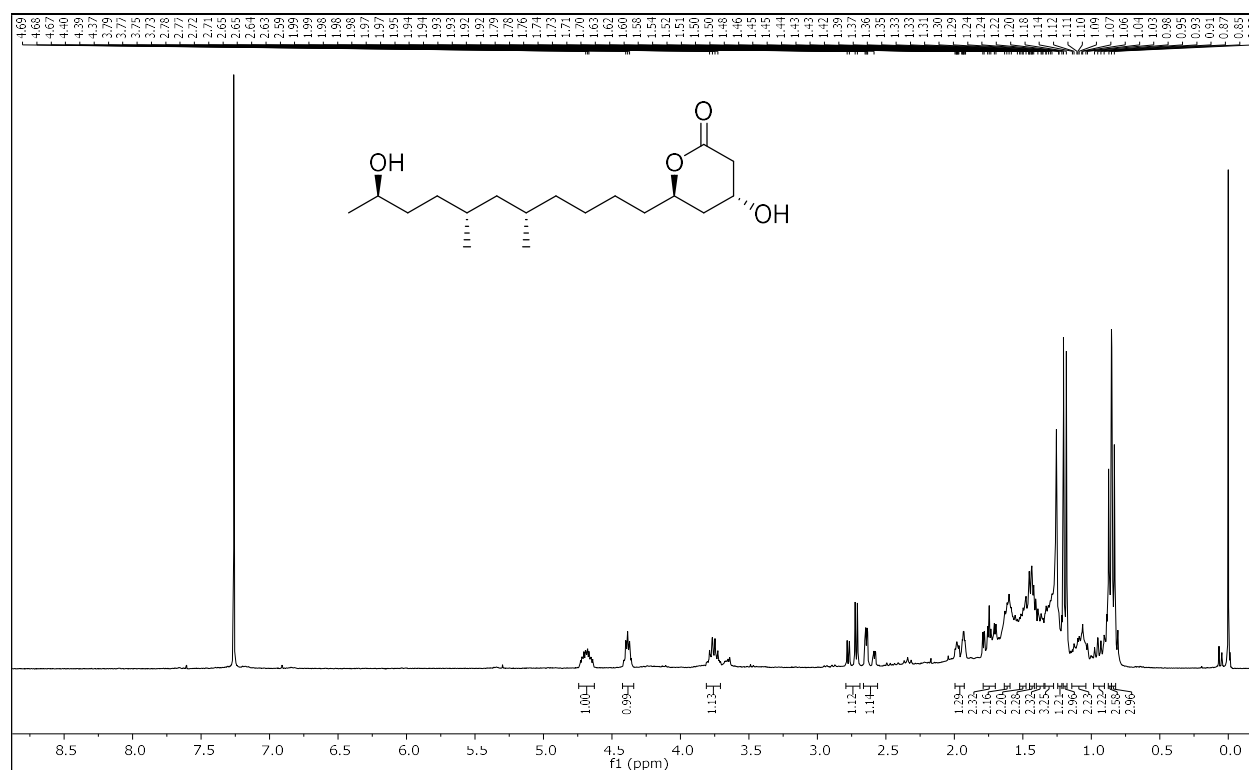
¹H-NMR spectrum of compound 25b (300 MHz, CDCl₃):



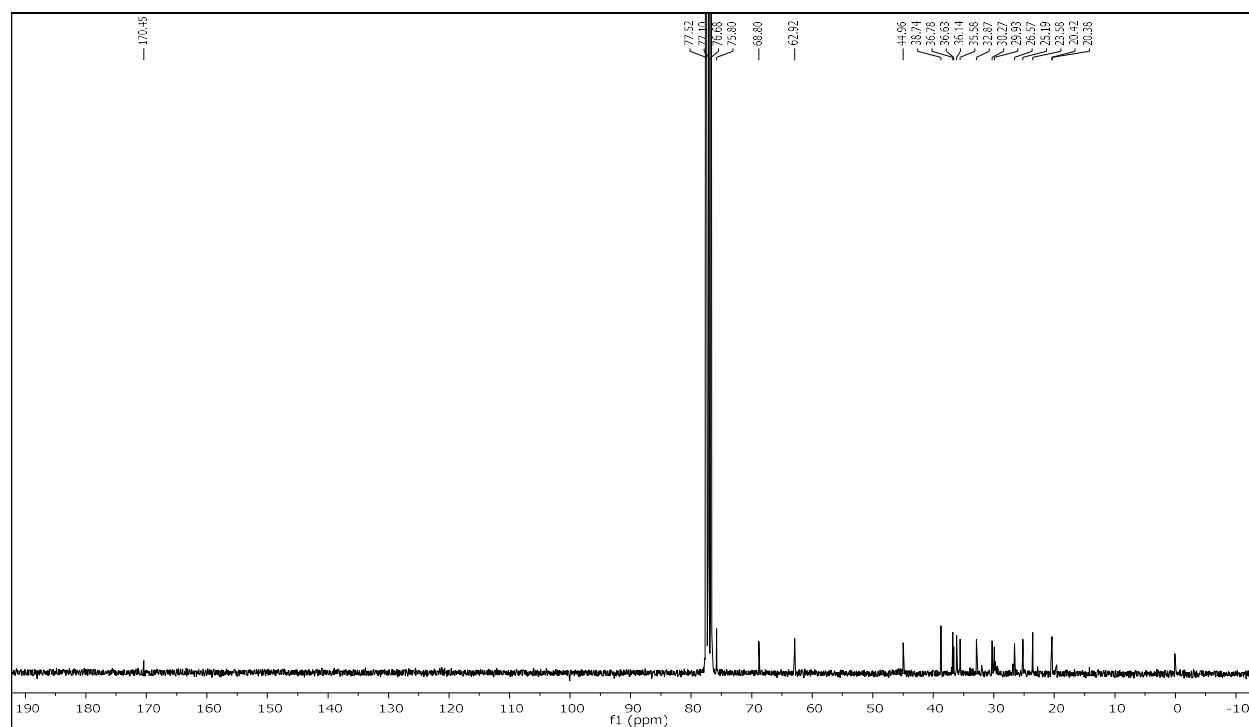
¹³C-NMR spectrum of compound 25b (75 MHz, CDCl₃):



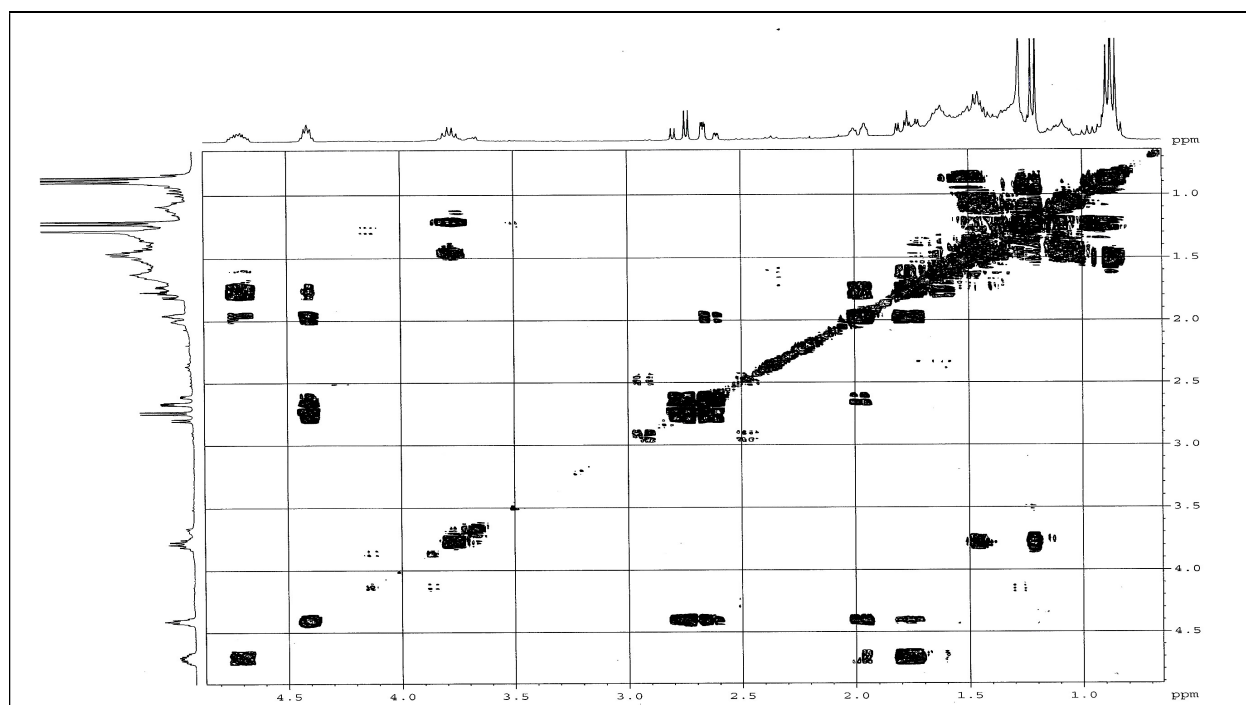
¹H-NMR spectrum of compound 27 (300 MHz, CDCl₃):



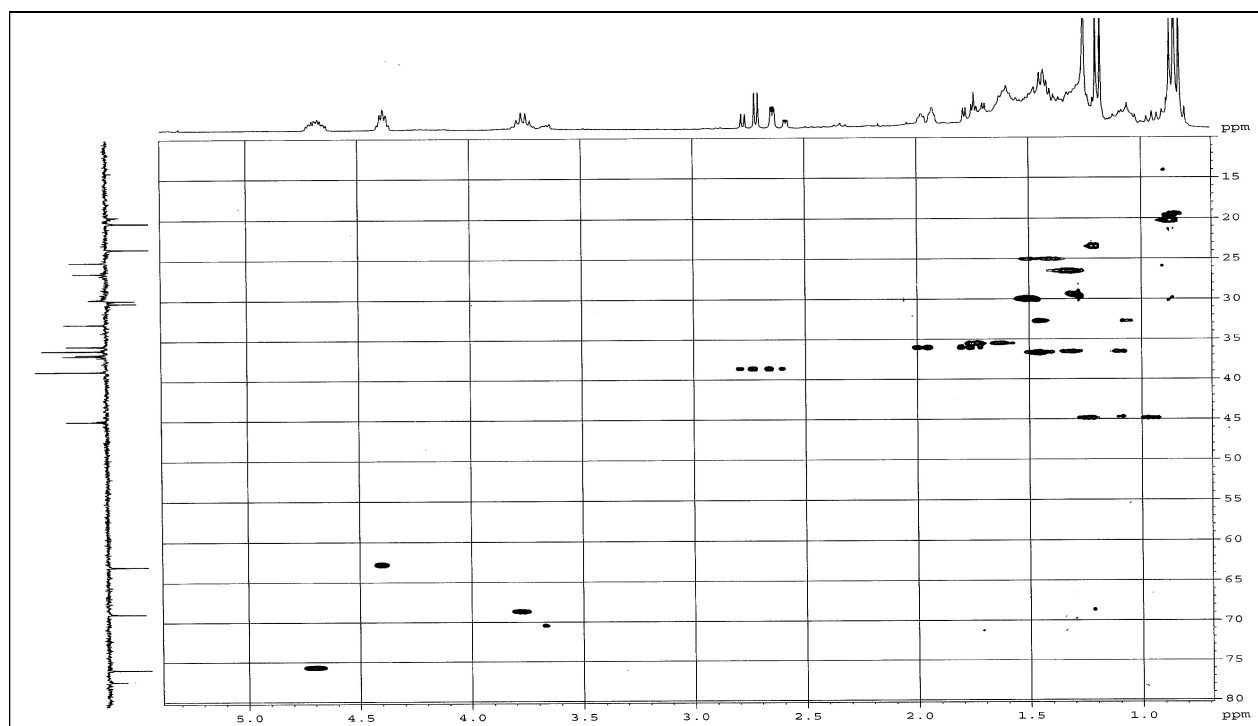
¹³C-NMR spectrum of compound 27 (75 MHz, CDCl₃):



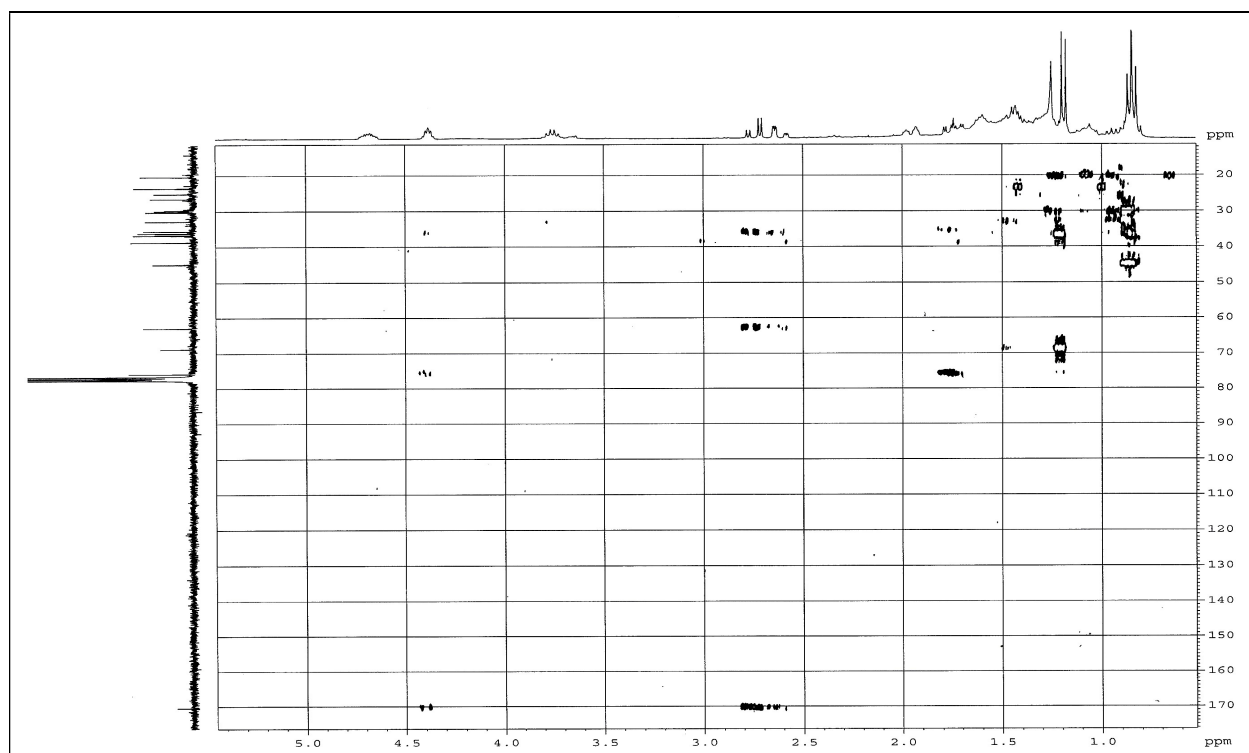
COSY spectrum of compound 27 (300 MHz, CDCl₃):



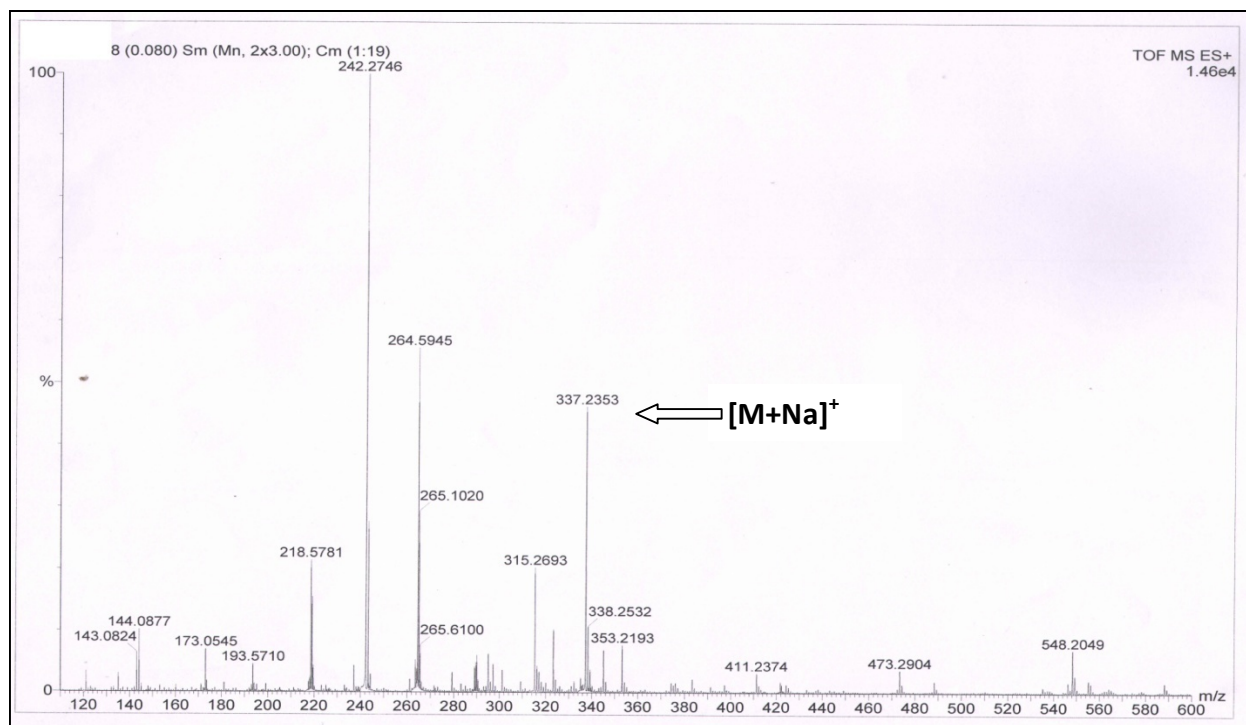
HSQC spectrum of compound 27 (75 MHz, CDCl₃):



HMBC spectrum of compound 27 (75 MHz, CDCl₃):



HRMS spectrum of compound 27:



Chemical structure: CC(C)(C)C[C@H](O)CC[C@H]1CC[C@@H](O)CC1=O

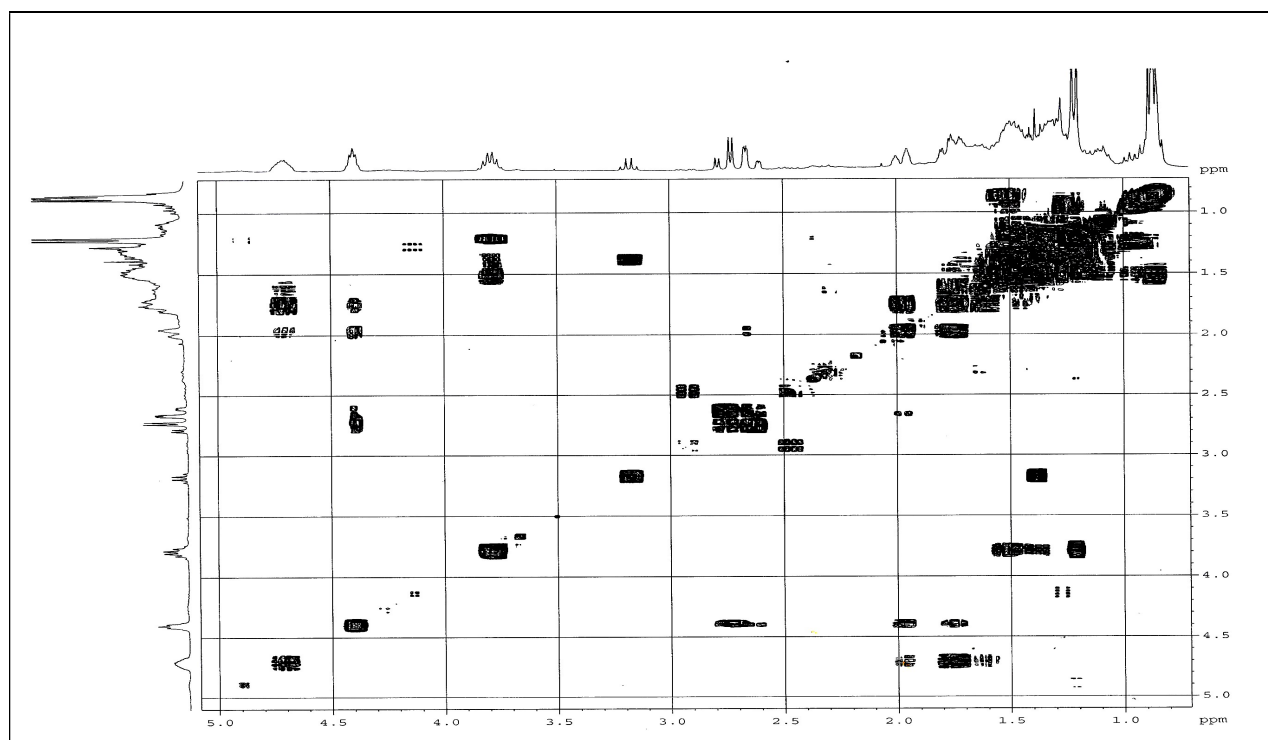
¹H NMR spectrum (400 MHz, CDCl₃) showing peaks from 0.0 to 7.26 ppm. Integration values are provided below the baseline.

Chemical Shift (ppm)	Integration
7.26	1.00
4.50	1.00
3.80	1.12
2.50	1.06
2.00	1.06
1.50	1.11
1.00	2.40
0.50	2.03
0.00	2.44
0.00	1.86
0.00	3.37
0.00	1.38
0.00	3.28
0.00	2.06
0.00	1.18
0.00	2.83
0.00	3.18

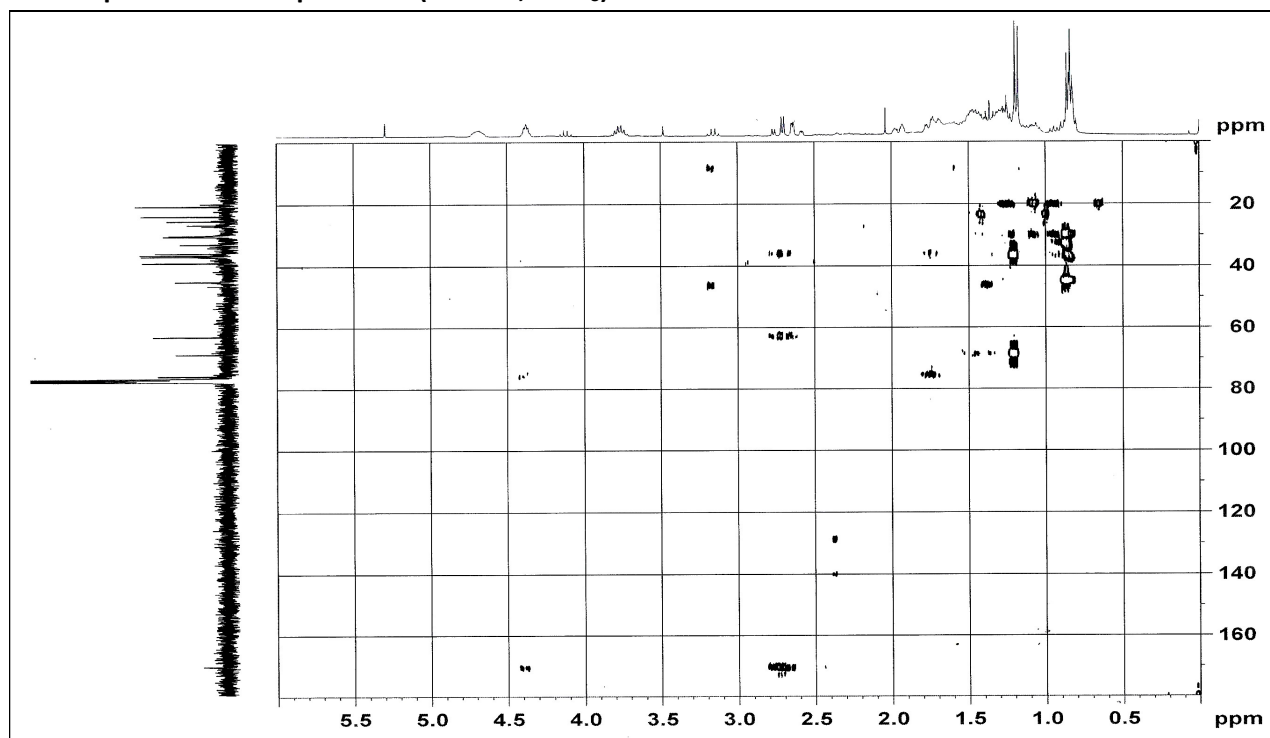
170.53
77.52
77.01
76.68
75.81
68.64
62.86
44.82
38.71
36.79
36.13
35.56
32.72
30.15
29.60
28.54
25.68
23.63
20.35

f1 (ppm)

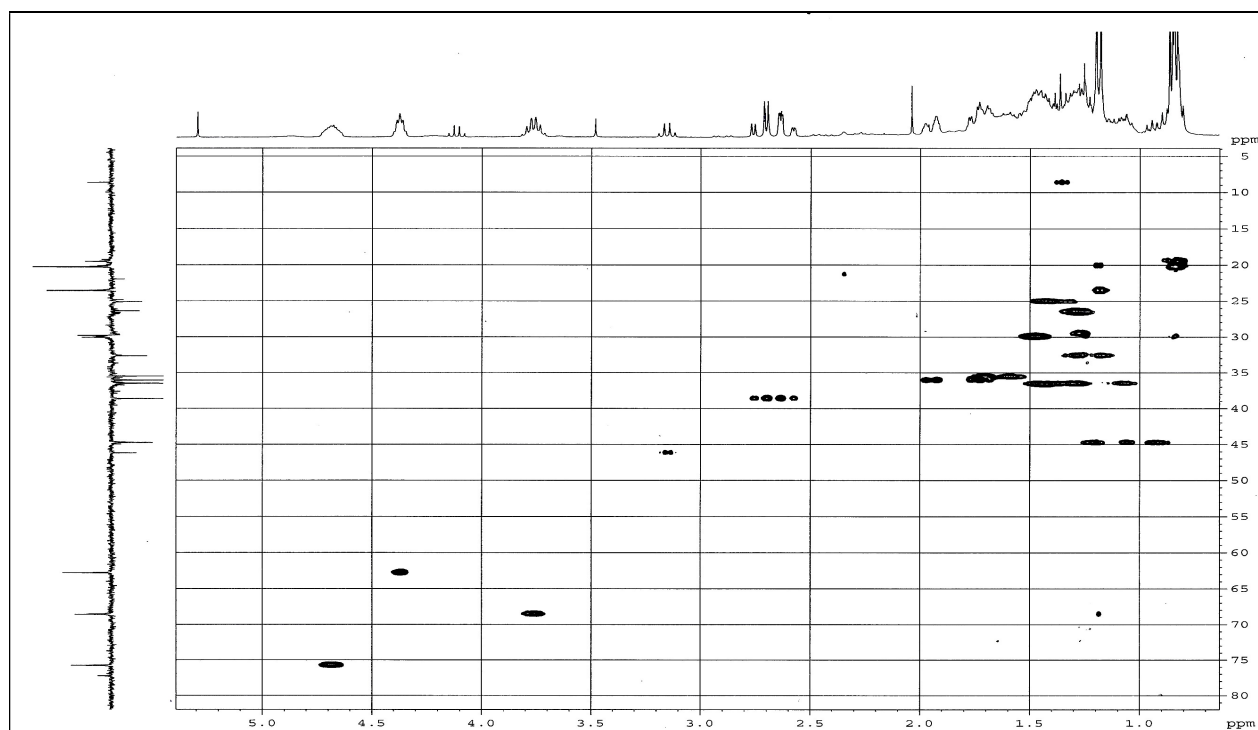
^1H -COSY spectrum of compound 28 (300 MHz, CDCl_3):



HMBC spectrum of compound 28 (75 MHz, CDCl_3):



HSQC spectrum of compound 28 (75 MHz, CDCl₃):



HRMS spectrum of compound 28:

