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Electronic Supplementary Information

Stereoselective Aldol Reactions Using Pseudo C_2 Symmetric 1-Benzyl-4-(trifluoromethyl)piperidine-2,6-dione

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1. General Information

^{1}H (300.40 MHz), ^{13}C (75.45 Hz), and ^{19}F (282.65 Hz) NMR spectra were recorded on a JEOL AL 300 spectrometer in $CDCl_3$ unless otherwise noted and chemical shifts were recorded in parts per million (ppm), downfield from internal tetramethylsilane (Me_4Si: δ 0.00, for ^{1}H and ^{13}C) or hexafluorobenzene (C_6F_6: δ –163.00 for ^{19}F). Data were tabulated in the following order: number of protons, multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; quint, quintet; sex, sextet; m, multiplet; b, broad peak), coupling constants in Hertz. Infrared (IR) spectra were obtained on a JASCO A-302 spectrometer and reported in wave numbers (cm^{-1}). Elemental analyses were performed by Perkin-Elmer SeriesII CHNS/O analyzer. JEOL JMS-700 was used for obtaining high resolution mass spectrometry data by the positive ionization mode. Full NMR data were described only for the major stereoisomers with the additional 19F NMR information for the minor components.

Most of reactions where an organic solvent was employed were performed under argon with magnetic stirring using flame-dried glassware. Anhydrous THF, Et_2O, and CH_2Cl_2 were purchased and used without further purification. Unless otherwise noted, materials were obtained from commercial suppliers and were used without further purification. Analytical thin-layer chromatography (TLC) was routinely used for monitoring reactions by generally using a mixture of hexane (Hex) and ethyl acetate (AcOEt) (v/v). Spherical neutral silica gel (63-210 μm or 40-50 μm) was employed for column chromatography and flush chromatography, respectively.

2. Experimental Procedures and Characterization Data

N-Benzyl-3-(trifluoromethyl)glutarimide 2

To a 200 mL round-bottomed flask was added 3-(trifluoromethyl)glutaric anhydride 3.7982 g (20.858 mmol), benzylamine 2.41 mL (23.0 mmol), and DCE 70 mL and the whole mixture was stirred for 0.5 h at room temperature where AcCl 2.2mL (31 mmol) and Et_3N 8.7 mL (60 mmol) was added and the mixture was refluxed for 9 h. The reaction was quenched with 1 *M* HCl, and extraction was carried out with AcOEt three times with controlling the pH at around 6. After dried by anhydrous Na_2SO_4 and filtration, the collected organic layer was evaporated. The obtained crude mixture was chromatographed on silica gel (hexane:AcOEt=4:1) to afford the title compound **2** as a white solid (4.7321 g, 17.446 mmol, 84% yield). mp. 91-94 °C, Rf=0.71 (hexane:AcOEt= 1:1). ^{1}H NMR: δ 2.71 (2H, dd, *J*=15.9, 9.3 Hz), 2.75-2.85 (1H, m), 2.98 (2H, dd, *J*=15.9, 4.0 Hz), 4.96 (2H, s), 7.25-7.37 (5H, m). ^{13}C NMR: δ 31.5, 34.0 (q, *J*=30.0 Hz), 43.1, 125.5 (q, *J*=278.3 Hz), 127.7, 128.4, 128.9, 136.5, 168.8. ^{19}F NMR: δ –75.17 (d, *J*=7.1 Hz). IR (KBr) ν 3399, 3094, 3064, 3037, 2997, 2962, 2915, 1956, 1735, 1671 cm^{-1}. Anal. Calcd for $C_{13}H_{12}F_3NO_2$: C, 57.75; H, 4.46; N, 5.16; Found: C, 58.02; H, 4.58; N, 5.10.

General procedure for the crossed aldol reaction by way of the boron enolate: (2*R**,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxy-3-phenylpropyl)-3-(trifluoromethyl)glutarimide 4e

To a 30 mL two-necked flask containing *N*-benzyl-3-(trifluoromethyl)glutarimide **1** 0.1085 g (0.4000 mmol) and CH_2Cl_2 4 mL were introduced Bu_2BOTf 0.88 mL (1.00 *M* in CH_2Cl_2, 0.88 mmol) and DIPEA 0.21 mL (1.2 mmol) at 0 °C and the whole mixture was stirred at that temperature for 0.5 h. After addition of 0.21 mL of

TEA (0.80 mmol) and stirring for 5 min, 3-phenylpropionaldehyde 0.11 mL (0.80 mmol) was added at –80 °C and the stirring was continued for further 0.5 h. To this flask, MeOH (3 mL) was introduced and after 15 min, sat. $NaHCO_3$ aq. and 30% H_2O_2 (3 mL each) was added and stirring was continued for 1 h at 0 °C. Extraction with CH_2Cl_2 furnished a crude mixture which was chromatographed on silica gel (hexane : AcOEt=7:3) to yield 0.1380 g of the title compound **4e** (0.3404 mmol, 85% yield) as an inseparable 91:4:3:2 diastereomer mixture. mp. 96.8-102.3 ºC, Rf=0.69 (hexane:AcOEt=1:1). ^{1}H NMR: δ 1.78 (1H, s), 1.85-2.03 (2H, m), 2.74 (2H, t, *J*=7.7 Hz), 2.82-2.70 (1H, m), 2.86 (1H, d, *J*=18.3 Hz), 3.01 (1H, br), 3.21 (1H, dd, *J*=18.3, 7.7 Hz), 3.93 (1H, s), 4.98 (2H, s), 7.13-7.32 (10H, m). ^{13}C NMR: δ 29.1, 31.9, 37.1, 38.4 (q, *J*=27.7 Hz), 43.2, 44.7, 74.2, 126.2, 126.4 (q, *J*=280.8 Hz), 127.3, 127.97, 127.99, 128.3, 128.6, 136.5, 140.4, 169.8, 169.9. ^{19}F NMR: δ –73.47 (d, *J*=11.3 Hz). IR (KBr): ν 3486, 3087, 3065, 3027, 2946, 2863, 1726, 1672, 1392, 1356, 1218, 1188, 1126, 1078, 754 cm^{-1}. HRMS (FAB+, m/z): $[M+H]^+$ calcd for $C_{22}H_{22}F_3NO_3$, 405.1630; Found, 405.1614.

Minor diastereomer

^{19}F NMR: δ –73.60 (d, *J*=9.1 Hz), –72.46 (d, *J*=7.1 Hz), –73.13 (d, *J*=11.3 Hz).

(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxypropyl)-3-(trifluoromethyl)glutarimide 4a**

Yield 61%, DR 93:4:3:0. Rf=0.51 (hexane:AcOEt=1:1). ^{1}H NMR: δ 0.98 (3H, t, *J*=7.3 Hz), 1.53-1.76 (2H, m), 2.05 (1H, brs), 2.78 (1H, t, *J*=8.6 Hz), 2.88 (1H, d, *J*=18.7 Hz), 3.01 (1H, brs), 3.28 (1H, dd, *J*=18.3, 7.7 Hz)) 3.87-3.91 (1H, m), 4.95 (1H, d, *J*=14.1 Hz), 5.01 (1H, d, *J*=14.3 Hz), 7.20-7.31 (5H, m). ^{13}C NMR: δ 10.0, 28.7, 29.1, 38.7 (q, *J*=27.7 Hz), 43.2, 44.3, 76.5, 126.4 (q, *J*=280.0 Hz), 127.2, 127.93, 128.2, 136.50, 169.85, 169.88. ^{19}F NMR: δ –73.47 (d, *J*=9.0 Hz). IR (neat): ν 3612, 3498, 3020, 2970, 2935, 2878, 1727, 1974, 1390, 1355, 1216, 1190, 1138, 1121, 757 cm^{-1}. HRMS (FAB+, m/z): $[M]^+$ calcd for $C_{16}H_{18}F_3NO_3$, 329.1239; Found, 329.1193.

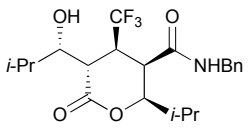
Minor diastereomer

^{19}F NMR: δ –73.21 (d, *J*=9.0 Hz), –72.43 (d, *J*=6.8 Hz).

(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxy-2-methylpropyl)-3-(trifluoromethyl)glutarimide 4b**

Yield 37%, DR >97:<1: <1: <1. Rf=0.54 (hexane: AcOEt=1:1) ^{1}H NMR: δ 0.96 (3H, d, *J*=6.6 Hz), 1.04 (3H, d, *J*=6.6 Hz), 1.85-2.01 (1H, m), 2.11 (1H, brs), 2.65-2.80 (1H, m), 2.87 (1H, d, *J*= 18.1 Hz), 3.18 (1H, s), 3.27 (1H, dd, *J*=18.3, 7.7 Hz), 3.47 (1H, dd, *J*=8.2, 2.9 Hz), 4.94 (1H, d, *J*= 14.1 Hz), 5.01 (1H, d, *J*=14.1 Hz), 7.20- 7.32 (5H, m). ^{13}C NMR: δ 18.0, 19.2, 29.0, 32.0, 39.3 (q, *J*=27.5 Hz), 42.3, 43.2, 80.8, 126.4 (q, *J*=280.8 Hz), 127.2, 128.0, 128.2, 136.6, 169.8, 170.0. ^{19}F NMR: δ –73.33 (d, *J*=9.0 Hz). IR(neat): ν 3508, 3066, 3035, 2873, 2254, 1727, 1674, 1430, 1354, 1191, 1119, 1052, 910, 736, 501 cm^{-1}. HRMS (FAB+, m/z): $[M+H]^+$ calcd for $C_{17}H_{20}F_3NO_3$, 344.1474; Found, 344.1488.

In addition to **4b**, *N*-benzyl-tetrahydro-5-(1-hydroxy-2-methylpropyl)-2-isopropyl-6-oxo-4-trifluoromethyl)-2*H*-pyran-3-carboxylate **6b** was also obtained in 25% yield as a single stereoisomer whose stereochemistry was deduced as follows. White solid, mp. 224.6 ºC, Rf=0.33 (hexane:AcOEt=1:1). ^{1}H NMR (acetone-d_6): δ 0.92-1.06 (12H, m), 1.81 (1H, br) , 2.21 (1H, br), 3.21 (1H, d, *J*=7.5 Hz), 3.27-3.40 (3H, m), 4.16 (1H, dd, *J*=9.7, 1.5 Hz), 4.37 (1H, d, *J*=2.4 Hz) , 4.39 (1H, d, *J*=2.6 Hz), 4.60 (1H, br), 7.21-7.30 (5H, m), 8.12 (1H, br). ^{13}C NMR (acetone-d_6): δ 18.7, 19.5, 19.6, 20.3, 31.4, 31.9, 39.8, 42.6, 43.4, 45.4 (q, *J*=25.5 Hz), 80.8, 84.5, 127.7 (q, *J*=280.2 Hz), 127.8,



128.5, 129.1, 139.8, 168.5, 169.0. ^{19}F NMR (acetone-d_6): δ –66.94 (d, *J*=9.1 Hz). IR (KBr): ν 3589, 3341, 2964, 1712, 1670, 1555, 1266, 1112, 1052, 854, 821, 736 cm^{-1}. HRMS (FAB+, m/z): $[M+H]^+$ calcd for $C_{21}H_{29}F_3NO_4$, 416.2049; Found, 416.2046.

(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxy-2,2-dimethylpropyl)-3-(trifluoromethyl)glutarimide 4c**

Yield 89%, DR 96: 2: 2: 0. White solid, mp. 124.0-125.2 ºC, Rf=0.60 (hexane: AcOEt=1:1). ^{1}H NMR: δ 1.00 (9H, s), 1.89 (1H, d, *J*=9.0 Hz), 2.55 (1H, s), 2.98 (1H, s), 3.08 (1H, s), 3.31 (1H, br), 3.40 (1H, dd, *J*=8.9, 2.8 Hz), 4.92 (1H, d, *J*=14.1 Hz), 5.02 (1H, d, *J*=13.9 Hz), 7.28-7.26 (5H, m). ^{13}C NMR: δ 25.2, 27.6, 36.9, 41.0 (q, *J*=27.7 Hz), 41.9, 43.3, 81.1, 126.1 (q, *J*=280.8 Hz), 127.2, 128.2, 128.5, 136.7, 169.9, 170.0. ^{19}F NMR: δ –72.84 (d, *J*=9.1 Hz). IR (KBr): ν 3477, 3065, 3032, 3032, 2969, 2882, 1956, 1733, 1666, 1403, 1125, 1074,746, 616 cm^{-1}. Anal. Calcd. for $C_{18}H_{22}F_3NO_3$: C, 60.50; H, 6.21; N, 3.92; Found: C, 60.58; H, 6.11; N, 4.20.

Minor diastereomer

^{19}F NMR: δ –72.15 (d, *J*=6.8 Hz), –72.96 (d, *J*=9.1 Hz).

(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxyheptyl)-3-(trifluoromethyl)glutarimide 4d**

Yield 70%, DR 91:5:3:1. Rf=0.68 (hexane:AcOEt=1:1). ^{1}H NMR: δ 0.88 (3H, t, *J*=9.2 Hz), 1.25-1.32 (6H, m) 1.32-1.68 (4H, m), 2.25 (1H, bs), 2.68-2.94 (1H, m), 2.87 (1H, d, *J*=18.3 Hz), 2.99 (1H, bs), 3.25 (1H, dd, *J*=18.3, 7.7 Hz), 3.87-3.96 (1H, m), 4.94 (1H, d, *J*=14.3 Hz), 5.00 (1H, d, *J*=14.7 Hz), 7.18-7.39 (5H, m). ^{13}C NMR: δ 14.0, 22.5, 25.5, 28.9, 29.2, 29.5, 31.6, 35.8, 38.6 (q, *J*=27.7 Hz), 44.9, 75.1, 126.4 (q, *J*=280.1 Hz), 127.3, 128.2, 128.3, 136.6, 169.7, 169.8. ^{19}F NMR: δ –73.55 (d, *J*=9.0 Hz). IR (neat): ν 3497, 3066, 3031, 2994, 2930, 2858, 2357, 2333, 1727, 1668, 1391, 1356, 1221, 1186, 1119, 702 cm^{-1}. HRMS (FAB+, m/z): $[M+H]^+$ calcd for $C_{20}H_{26}F_3NO_3$, 386.1943; Found, 386.1956.

Minor diastereomer

^{19}F NMR: δ –74.20 (d, *J*=9.3 Hz), –72.28 (d, *J*=9.3 Hz), –73.90 (d, *J*=9.0 Hz),.

(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxy-1-phenylmethyl)-3-(trifluoromethyl)glutarimide 4f**

Yield 56%, DR >97:<1: <1:<1. Rf=0.54 (hexane:AcOEt=2:1). ^{1}H NMR: δ 2.06 (1H, dd, *J*=18.6, 7.5 Hz), 2.60 (1H, d, *J*=3.0 Hz), 2.68 (1H, d, *J*=18.0 Hz), 2.71- 2.80 (1H, m), 3.38 (1H, d, *J*=5.7 Hz), 4.93 (1H, d, *J*=13.8 Hz), 5.01 (1H, d, *J*=13.8 Hz), 5.29 (1H, dd, *J*=5.4, 2.7 Hz), 7.20-7.50 (10H, m). ^{13}C NMR: δ 28.2, 34.3 (q, *J*=27.1 Hz), 43.1, 47.3, 73.1, 125.2, 126.5 (q, *J*=279.5 Hz), 126.6, 127.5, 128.1, 128.4, 128.7, 128.8, 136.1, 136.4, 139.2, 170.0, 171.6. ^{19}F NMR: δ –73.66 (d, *J*=9.0 Hz). IR (neat): ν 3458, 3088, 3065, 3033, 2945, 2880, 1728, 1674, 1393, 1356, 1186, 1125, 739, 701 cm^{-1}. HRMS (FAB+, m/z): $[M]^+$ calcd for $C_{20}H_{18}F_3NO_3$, 377.1239; Found, 377.1287.

(2*R,3*R**)-*N*-Benzyl-2-[(*S**)-1-(4-bromophenyl)-1-hydroxymethyl]-3-(trifluoromethyl)glutarimide 4g**

Yield 67%, DR 93:5:2:0. White solid, mp. 94.7-103.3 ºC, Rf=0.43 (hexane:AcOEt=2:1). ^{1}H NMR: δ 2.19 (1H, dd, *J*=18.3, 7.7 Hz), 2.47-2.62 (1H, m), 2.70 (1H, d, *J*=18.3 Hz), 2.73-2.87 (1H, m), 3.10 (1H, br), 3.32 (1H, dd, *J*=14.8, 6.4 Hz), 4.87 (1H, d, *J*=13.7 Hz), 4.98 (1H, d, *J*=13.7 Hz), 7.22-7.36 (9H, m). ^{13}C NMR: δ 28.5, 34.9 (q, *J*=28.6 Hz), 43.4, 47.1, 73.2, 126.4 (q, *J*=281.4 Hz), 126.9, 127.1, 127.7, 128.3, 128.9, 132.1, 136.1,

138.3, 168.8, 169.8. ^{19}F NMR: δ –73.49 (d, *J*=9.0 Hz). IR (KBr): ν 3486, 3088, 3064, 3034, 2948, 1728, 1673, 1487, 1430, 1393, 1356, 125, 1192, 1126, 107, 1011, 965 cm^{-1}. HRMS (FAB+, m/z): $[M]^+$ calcd for $C_{20}H_{17}BrF_3NO_3$, 455.0344; Found, 455.0338.

Minor diastereomer

^{19}F NMR: δ –73.31 (d, *J*=9.3 Hz), –73.92 (d, *J*=9.3 Hz).

(2*R,3*R**)-*N*-Benzyl-2-[(*S**)-1-hydroxy-(4-methoxy-phenyl)-methyl)]-3-(trifluoromethyl)glutarimide 4h**

Yield 97%, DR 70:13:12:5. Rf=0.57 (hexane:AcOEt=1:1). ^{1}H NMR: δ 2.13 (1H, dd, *J*=18.4, 7.6 Hz), 2.56-2.80 (3H, m), 3.34 (1H, d, *J*=5.7 Hz), 3.77 (3H, s), 4.94 (1H, d, *J*=13.9 Hz), 5.01 (1H, d, *J*=13.9 Hz), 5.22 (1H, dd, *J*=5.6, 2.5 Hz), 6.71-6.75(2H, m), 7.03-7.08 (2H, m), 7.22-7.36 (5H, m). ^{13}C NMR: δ 20.9, 40.5 (q, *J*=26.7 Hz), 44.3, 46.4, 55.1, 75.7, 113.9, 126.2 (q *J*=280.2 Hz), 127.5, 128.0, 128.2, 128.3, 128.9, 131.7, 136.3, 159.5, 171.6. ^{19}F NMR: δ –73.53 (d, *J*=9.0 Hz). IR (neat): ν 3474, 3066, 3019, 2960, 2936, 2840, 1727, 1674, 1613, 1513, 1392, 1357, 1216, 1183, 1127, 747 cm^{-1}. HRMS (FAB+, m/z): $[M]^+$ calcd for $C_{21}H_{20}F_3NO_4$, 377.1239; Found, 377.1287.

Minor diastereomer

^{19}F NMR: δ –73.60 (d, *J*=9.0 Hz), –74.02 (d, *J*=9.0 Hz).

(2*R,3*R**)-*N*-Benzyl-2-((1*R**,2*S**)-1-hydroxy-2-phenylpropyl)-3-(trifluoromethyl)glutarimide 4i**

Yield 96%, DR 85:12:2:1. White solid, mp. 135.7-136.4 ºC, Rf=0.63 (hexane:AcOEt=1:1). ^{1}H NMR: δ 1.34 (3H, d, *J*=7.5 Hz), 1.57 (1H, s), 2.06 (1H, d, *J*=6.4 Hz), 2.60-2.67 (1H, m), 2.76 (1H, dd, *J*=17.9, 3.6 Hz), 2.85 (1H, s), 3.17-3.34 (2H, m), 3.90-3.95 (1H, m), 4.95 (1H, d, *J*=14.1 Hz), 5.00 (1H, d, *J*=14.1 Hz), 7.22-7.35 (10H, m). ^{13}C NMR: δ 18.2, 29.4, 39.5 (q, *J*=27.7 Hz), 43.4, 43.3, 43.9, 80.4, 126.0, 127.1, 127.3, 127.7, 128.0 (q, *J*=280.8 Hz), 128.3, 128.9, 136.6, 142.9, 169.7, 170.0. ^{19}F NMR: δ –72.95 (d, *J*=9.0 Hz). IR (KBr): ν 3498, 3067, 2971, 2936, 2879, 1958, 1732, 1669, 1604, 1494, 1455, 1354, 1181, 1040, 1014 cm^{-1}. HRMS (FAB+, m/z): $[M+H]^+$ calcd for $C_{22}H_{23}F_3NO_3$, 406.1625; Found, 406.1668, $[M+2H]^+$ calcd for $C_{22}H_{24}F_3NO_3$, 407.1708; Found, 407.1732.

Minor diastereomer

^{19}F NMR: δ –73.65 (d, *J*=9.3 Hz), –72.43 (d, *J*=9.1 Hz), –73.15 (d, *J*=9.3 Hz).

(2*S*,3*S*)-*N*-Benzyl-2-((1*R*,2*R*)-1-hydroxy-2-(methoxymethoxy)-2-phenylethyl)-3-(trifluoromethyl)-glutarimide 4j

Yield quant, DR 83:17:0:0 (81:19:0:0 when the racemic aldehyde was used). White solid, mp. 109.0-109.8 ºC, Rf=0.18 (CH_2Cl_2). ^{1}H NMR: δ 2.62 (1H, br), 2.75 (1H, br), 2.85 (1H, d, *J*=18.0 Hz), 3.27 (3H, s), 3.45 (1H, dd, *J*=18.1, 7.3 Hz), 3.61 (1H, s), 3.98 (1H, d, *J*=9.2 Hz), 4.55 (2H, s), 4.83 (1H, d, *J*=9.2 Hz), 4.99 (1H, d, *J*=14.1 Hz) , 5.06 (1H, d, *J*=14.5 Hz), 7.22-7.51 (10H, m). ^{13}C NMR: δ 29.2, 29.3, 40.3 (d, *J*=28.0 Hz), 43.3, 55.9, 80.1, 80.2, 95.0, 126.1 (q, *J*=280.2 Hz), 127.4, 128.0, 128.2, 128.3, 128.7, 128.8, 136.7, 136.8, 169.4, 169.5 ^{19}F NMR: δ –73.49 (d, *J*=9.3 Hz). IR (KBr): ν 3491, 3065, 2929, 2823, 2776, 1965, 1732, 1672, 1499, 1354, 1285, 1082, 1044, 972, 917 cm^{-1}. HRMS (FAB+, m/z): $[M+2H]^+$ calcd for $C_{23}H_{26}F_3NO_5$, 453.1763; Found, 405.1771. $[\alpha]_D^{16}$ –10.4 (*c* 0.95, $CHCl_3$), HPLC retention times: 22.1 min (minor)、24.5 min (major) by DAICEL ChiralPak OD (hexane/2-propanol= 90/10, 0.5 mL/min).

Minor diastereomer

^{19}F NMR: δ –73.24 (d, *J*=9.1 Hz).

(2*R,3*R**)-*N*-Benzyl-2-{(1*R**,2*S**)-(2,2-dimethyl-1,3-dioxolan-4-yl)-1-hydroxymethyl}-3-(trifluoromethyl)glutarimide 4k**

Yield 87%, DR 81:13:4:2. Rf=0.17(CH_2Cl_2). ^{1}H NMR: δ 1.26 (3H, s), 1.28 (3H, s), 2.75 (1H, d, *J*=4.9 Hz), 2.85-3.03 (2H, m), 3.17-3.22 (2H, m), 3.83 (1H, dd, *J*=8.9, 4.5 Hz), 3.99-4.11 (2H, m), 4.13-4.21 (1H, m), 4.90-5.01 (2H, m), 7.21-7.32 (5H, m). ^{13}C NMR: δ 24.7, 26.1, 29.5, 36.1 (q, *J*=28.2 Hz), 43.3, 44.0, 66.8, 74.6, 76.1, 109.8, 126.4 (q, *J*=280.8 Hz), 127.4, 128.3, 136.3, 169.5, 170.2. ^{19}F NMR: δ –73.29 (d, *J*=9.3 Hz). IR (neat): ν 3575, 3989, 2939, 1727, 1675, 1497, 1455, 1430, 1356, 1253, 1186, 1123, 1070, 963, 916 cm^{-1}. HRMS (FAB+, m/z): $[M+2H]^+$ calcd for $C_{19}H_{24}F_3NO_5$, 403.1607; Found, 403.1626.

Minor diastereomer

^{19}F NMR: δ –73.64 (d, *J*=9.31 Hz), –73.03 (d, *J*=9.3 Hz), –73.38 (d, *J*=11.3 Hz).

General procedure for the base-promoted isomerization: (2*S,3*R**,4*R**)-*N*-Benzyl-tetrahydro-6-oxo-2-phenethyl-4-(trifluoromethyl)-2*H*-pyran-3-carboxamide 5e**

To a 50 mL round-bottomed flask containing 0.1907g (0.4704 mmol) of (2*R**,3*R**)-*N*-benzyl-2-{(*S**)- 1-hydroxy-3-phenylpropyl}-3-(trifluoromethyl)glutarimide **4e** in 5 mL each of MeOH and H_2O 5 mL was added at 0 °C a solution of 0.0513g (1.22 mmol) of LiOH· H_2O in 1.6 mL each of MeOH and H_2O, and the mixture was stirred for 30 min at that temperature. After extraction with $CHCl_3$ and washing the organic layer with H_2O, the aqueous solution was acidified by the addition of 6 *M* HCl aq. to ca. pH=1 and extraction was carried out by AcOEt. After dried over anhydrous Na_2SO_4 and concentration afforded crude materials, its washing with hexane:CH_2Cl_2=1:1 furnished 0.0805 g (0.199 mmol) of **5e** in 42% yield. White sold, mp. 116.5-119.5 ºC, Rf=0.50 (hexane:AcOEt=1:1). ^{1}H NMR (acetone-d_6): δ 1.92-2.00 (2H, m), 2.67-2.90 (3H, m), 3.08 (1H, m), 3.14 (1H, t, *J*=2.9 Hz), 3.36-3.46 (1H, m), 4.33 (1H, dd, *J*=14.7, 5.7 Hz), 4.46 (1H, dd, *J*=14.8, 6.0 Hz), 4.57-4.63 (1H, m), 7.14-7.29 (10H, m), 8.15 (1H, br). ^{13}C NMR (acetone-d_6): δ 27.6 (q, *J*=2.5 Hz), 32.0, 35.7, 40.6 (q, *J*=28.4 Hz), 40.7(q, *J*=1.9 Hz), 43.4, 80.1, 126.8, 127.1 (q, *J*=278.9 Hz), 127.9, 128.6, 129.16, 129.22, 139.8, 142.0, 167.8, 168.7. ^{19}F NMR: δ –72.65 (d, *J*=9.1 Hz). IR (KBr): ν 3331, 3031, 2928, 1944, 1715, 1670, 1554, 1496, 1454, 1245, 1170, 1126, 1028, 957, 907 cm^{-1}. HRMS (FAB+, m/z): $[M+2H]^+$ calcd for $C_{22}H_{24}F_3NO_3$, 407.1708; Found, 407.1743.

(2*S,3*R**,4*R**)-*N*-Benzyl-2-(*tert*-butyl)-tetrahydro-6-oxo-4-(trifluoromethyl)-2*H*-pyran-3-carboxamide 5c**

Yield 65% as a white solid, mp. 195.7-197.9 ºC, Rf=0.50 (hexane:AcOEt=1:1). ^{1}H NMR (acetone-d_6): δ 1.09 (9H, s), 2.46 (1H, dd, *J*=17.8, 7.7 Hz), 2.99 (1H, dd, *J*=17.9, 12.0 Hz), 3.21 (1H, br), 3.32-3.42 (1H, m), 4.27 (1H, d, *J*=2.2 Hz), 4.27 (1H, dd, *J*=14.7, 5.3 Hz), 4.45 (1H, dd, *J*=14.7, 6.2 Hz), 7.26-7.36 (5H, m), 8.21(1H, br). ^{13}C NMR (acetone-d_6): δ 26.3, 27.7 (q, *J*=2.5 Hz), 35.6, 37.62 (q, *J*=1.9 Hz), 41.8 (q, *J*=28.0 Hz), 43.7, 88.1, 127.1 (q, *J*=278.9 Hz), 127.9, 128.9, 129.1, 139.1, 168.3, 169.0. ^{19}F NMR: δ –72.50 (d, *J*=6.8 Hz). IR (KBr): ν 3406, 3071, 2929, 2702, 1962, 1903, 1724, 1672, 1518, 1479, 1433, 1246, 1131, 1026, 943 cm^{-1}. HRMS (FAB+, m/z): $[M+H]^+$ calcd for $C_{18}H_{23}F_3NO_3$, 358.1631; Found, 358.1649.

(2*R,3*R**,4*R**)-*N*-benzyl-6-oxo-2-{(*S**)-1-phenylethyl}-4-(trifluoromethyl)tetrahydro-2*H*-pyran-3-carboxamide 5i**

83% yield as a white solid, mp. 172.9 ºC, Rf=0.33 (hexane:AcOEt=1:1). ^{1}H NMR (acetone-d_6): δ 1.33 (3H, d, *J*=6.8 Hz), 2.71-2.81 (2H, m), 2.82-3.08 (2H, m), 3.29-3.52 (1H, m), 4.32 (1H, dd, *J*=14.4, 5.8 Hz), 4.48 (1H, dd, *J*=14.5, 6.0 Hz), 4.84 (1H, dd, *J*=10.3, 2.6 Hz), 7.00-7.42 (10H, m), 7.63-7.73 (1H, br). ^{13}C NMR (acetone-d_6): δ 20.6, 27.5 (q, *J*=2.5 Hz), 39.1, 40.7 (q, *J*=28.4 Hz), 43.5, 43.6, 81.4, 126.9 (q, *J*=279.1 Hz), 127.6, 127.9, 128.4, 129.1, 129.2, 129.5, 139.6, 143.3, 167.8, 168.2. ^{19}F NMR: δ –72.42 (d, *J*=6.8 Hz). IR (KBr): ν 3413, 3029, 2988, 2948, 1725, 1671, 1602, 1518, 1235, 1131, 1026, 944 cm^{-1}. HRMS (FAB+, m/z): $[M+H]^+$ calcd for $C_{22}H_{23}F_3NO_3$, 406.1630; Found, 406.1614.

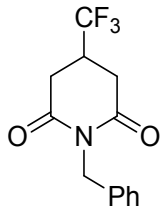
***N*-Benzyl-2-(3-phenylpropanoyl)-3-(trifluoromethyl)glutarimide 7e**

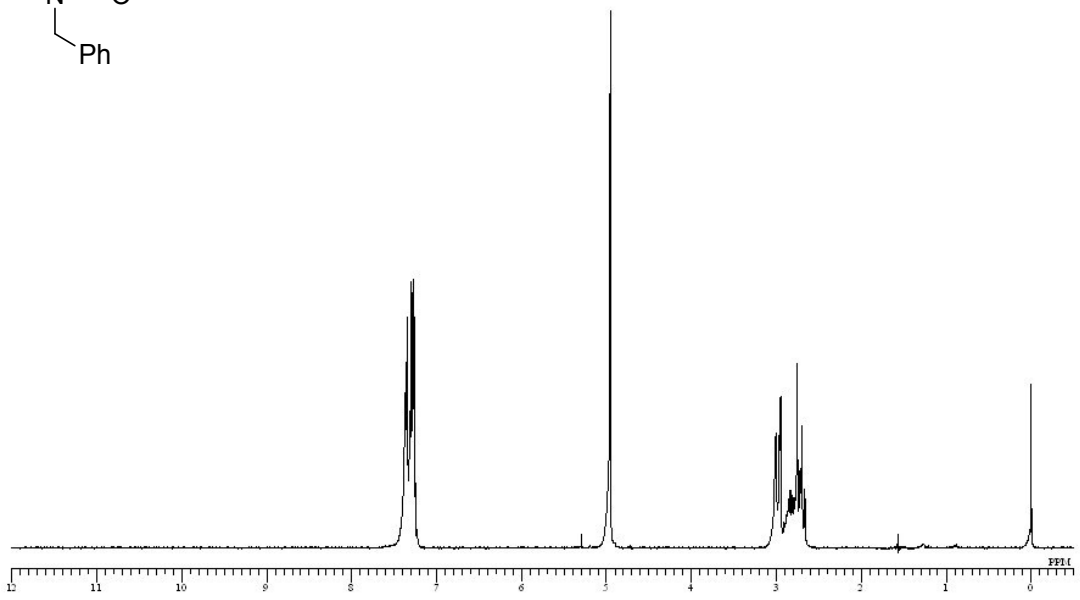
To a 30 mL two-necked flask were added under an argon Dess-Martin periodinane 1.8147g (4.28 mmol) and CH_2Cl_2 (16 mL) and after 5 min stirring, (2*R**,3*R**)-*N*-Benzyl-2-{(*S**)-1-hydroxy-3-phenylpropyl}-3-(trifluoromethyl)glutarimide **4e** 0.8683 g (2.142 mmol) was added as a CH_2Cl_2 solution (1 mL). Stirring for 3 h at 30 ºC, the mixture was quenched with $NaHCO_3$ aq., and further stirring was continued for 1 h after addition of $Na_2S_2O_3$ 3.384 g (21.4 mmol). The usual workup and purification by silica gel column chromatography using CH_2Cl_2 as an eluent afforded the title compound **7e** (0.6031 g, 1.495 mmol, 70% yield). White solid, DR: 88:12. m.p. 88.5-86.0 ºC, Rf=0.80 (CH_2Cl_2). ^{1}H NMR: δ 2.28 (1H, dd, *J*=17.1, 7.1 Hz), 2.67 (2H, t, *J*=7.3 Hz), 2.81 (1H, d, *J*=17.2 Hz), 2.89-3.14 (3H, m), 4.94 (1H, d, *J*=14.5 Hz), 5.00 (1H, d, *J*=14.3 Hz), 7.15-7.50 (10H, m), 14.75 (1H, br). ^{13}C NMR: δ 31.0 (q, *J*=2.1 Hz), 32.3, 34.6, 35.3 (q, *J*=29.1 Hz), 42.8, 126.0 (q, *J*=281.4 Hz), 126.6, 127.4, 128.2, 128.3, 128.4, 128.6, 136.5, 140.0, 168.2, 171.2, 180.8. ^{19}F NMR: δ –74.14 (d, *J* = 9.1 Hz). IR (KBr): ν 3424, 3031, 1955, 1722, 1613, 1496, 1413, 1344, 1185, 1119, 1079, 1024, 960, 901, 838 cm^{-1}. HRMS (FAB+, m/z): $[M+2H]^+$ calcd for $C_{22}H_{22}F_3NO_3$, 405.1552; Found, 405.1571.

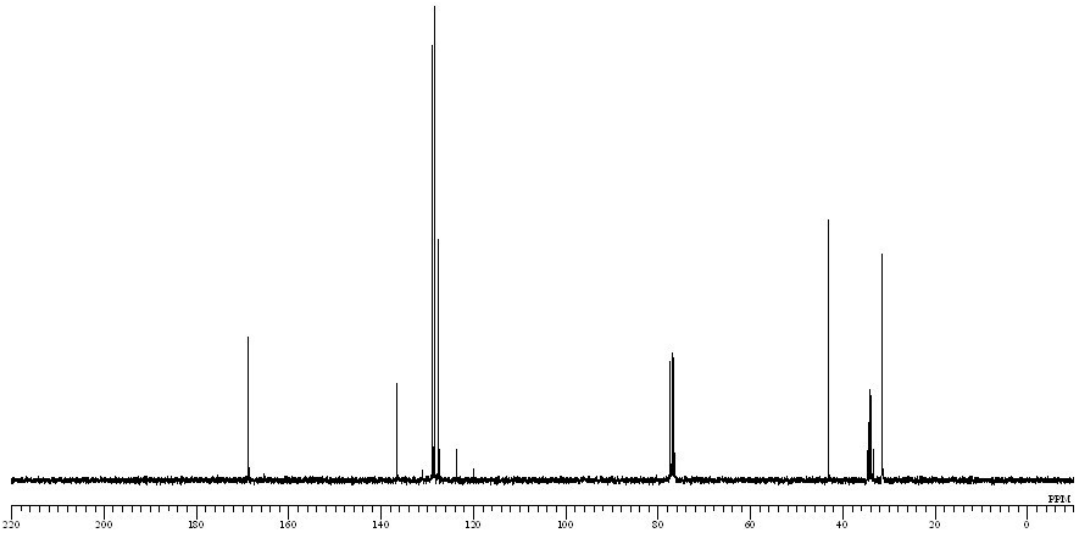
Minor diastereomer

^{13}C NMR: δ 91.1 (q, *J*=1.7 Hz). ^{19}F NMR: δ –72.94 (d, *J*=9.1 Hz).

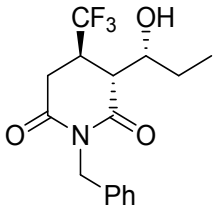
***N*-Benzyl-3-(trifluoromethyl)glutarimide 3**

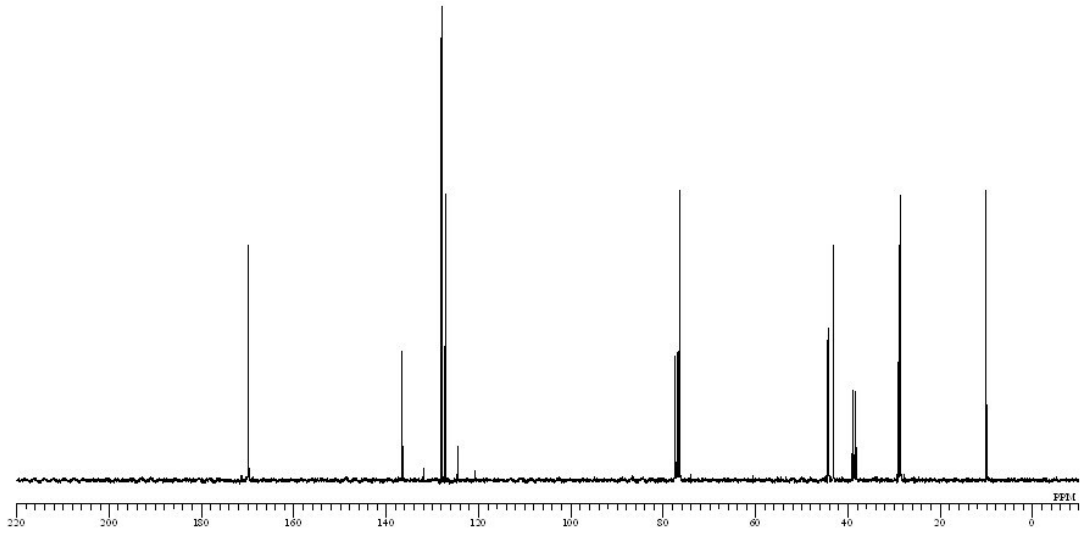


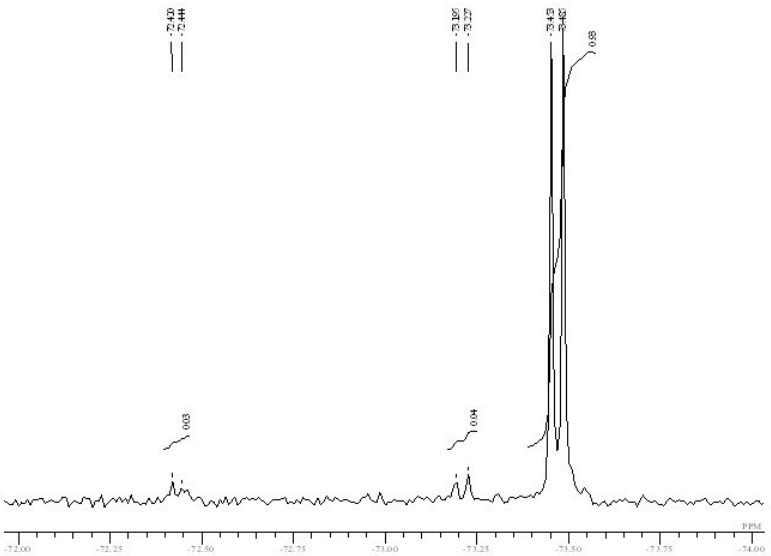




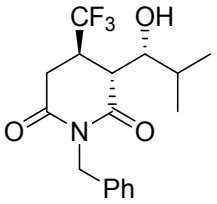
(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxypropyl)-3-(trifluoromethyl)glutarimide 4a**

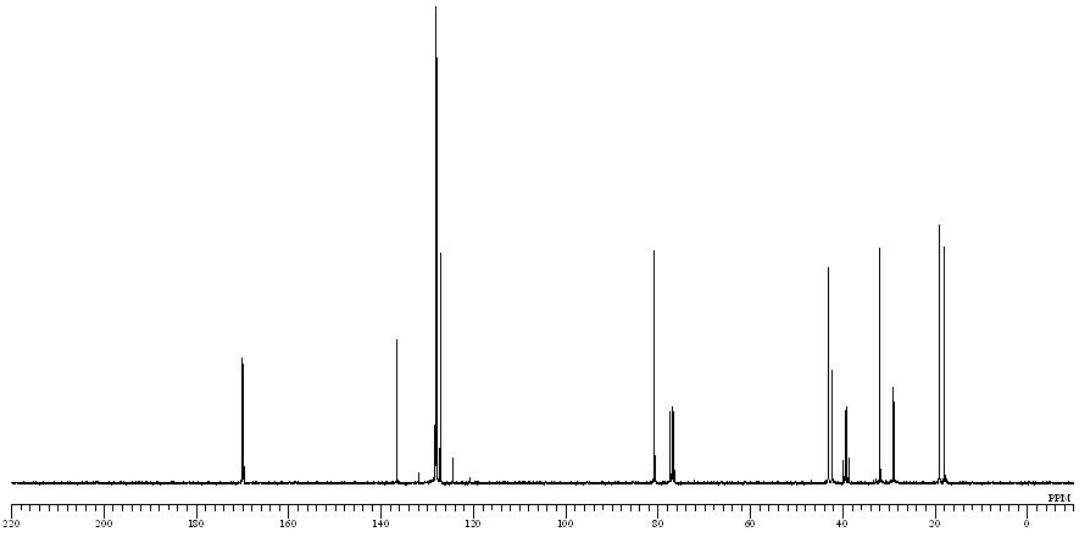


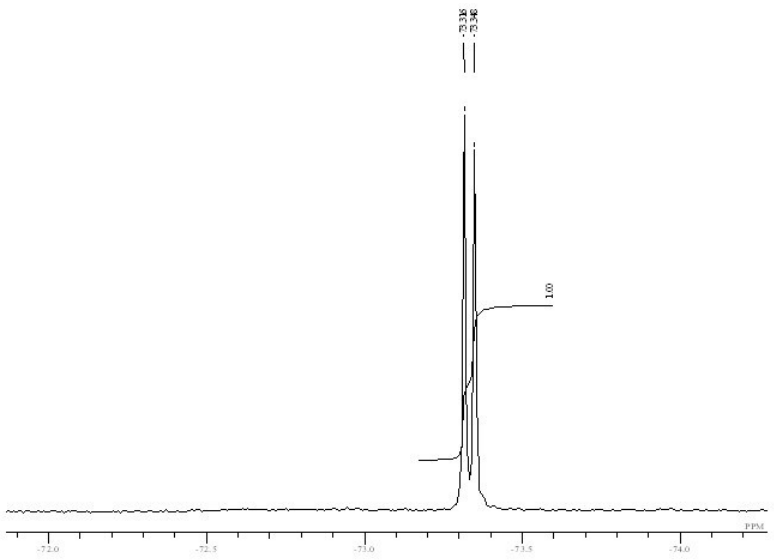




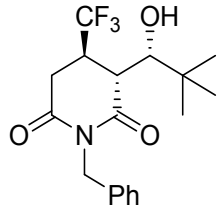
(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxy-2-methylpropyl)-3-(trifluoromethyl)glutarimide 4b**

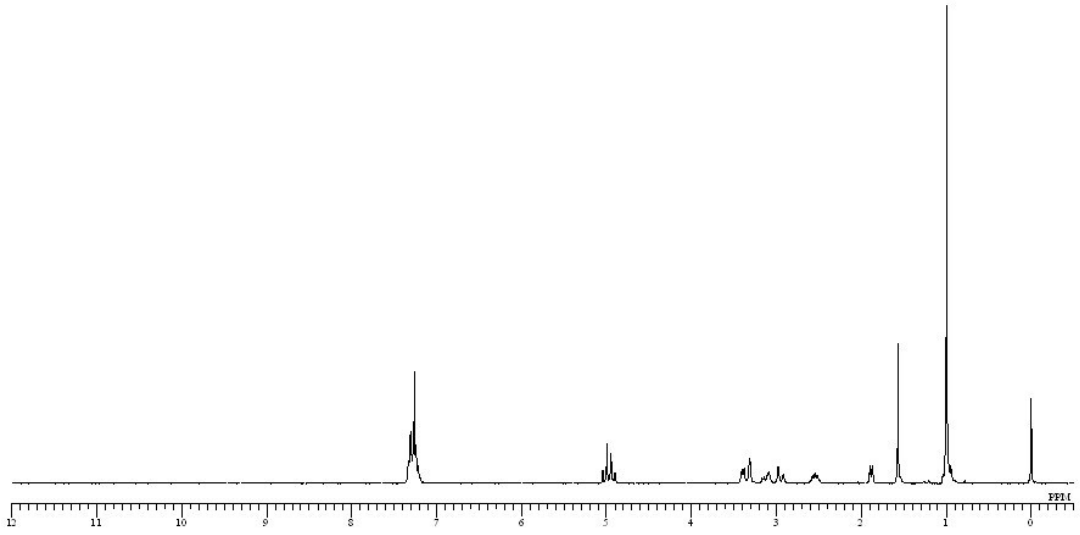


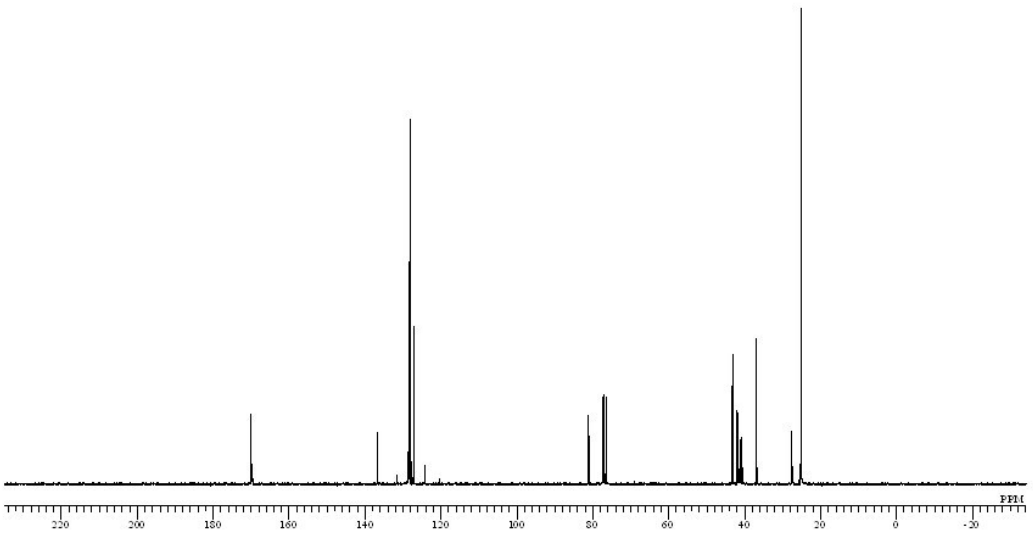




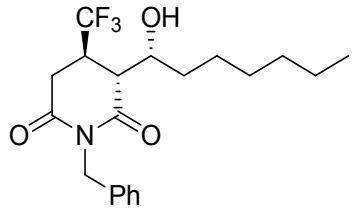
(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxy-2,2-dimethylpropyl)-3-(trifluoromethyl)glutarimide 4c**

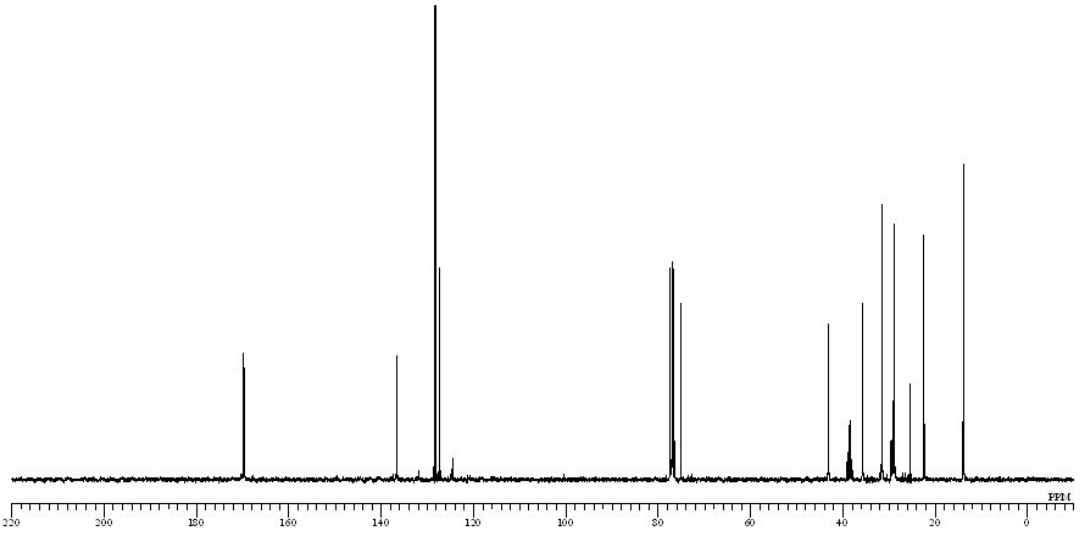


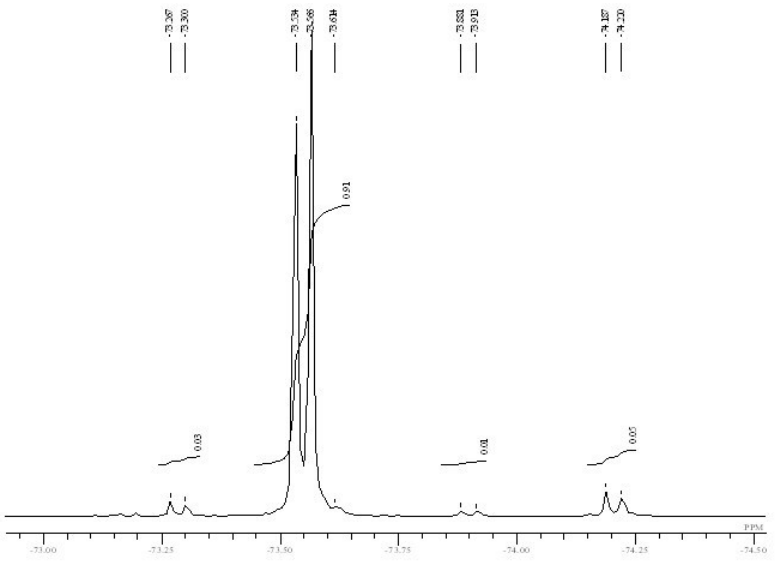




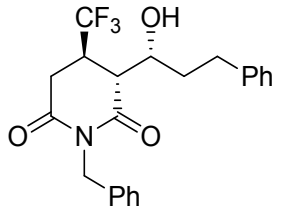
(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxyheptyl)-3-(trifluoromethyl)glutarimide 4d**

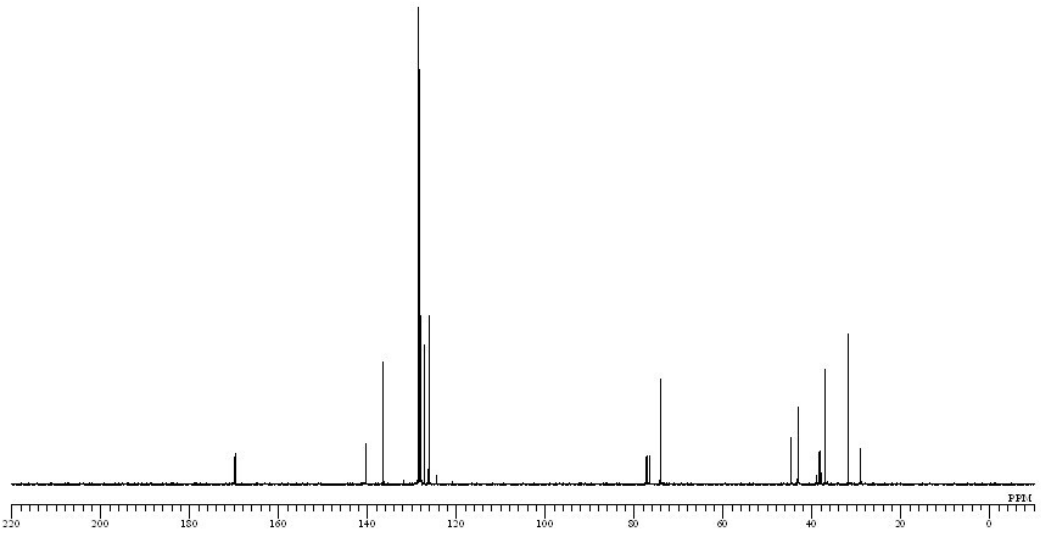


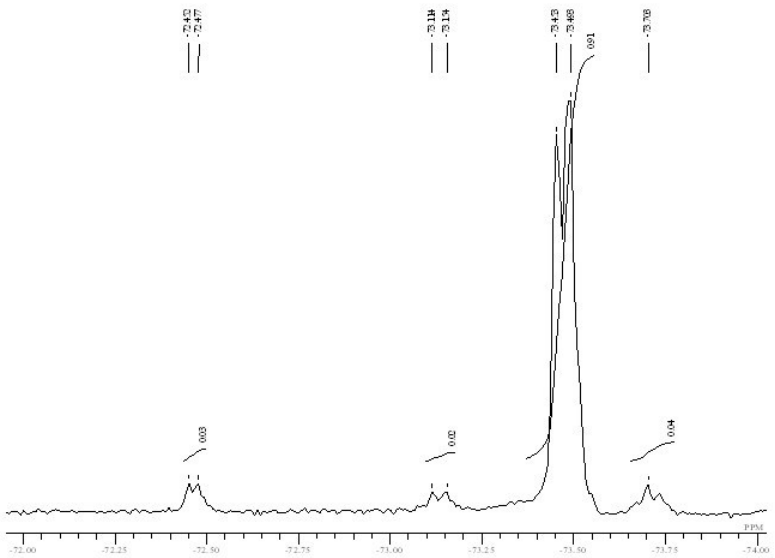




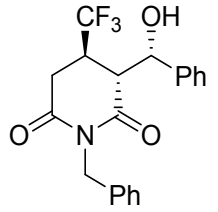
(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxy-3-phenylpropyl)-3-(trifluoromethyl)glutarimide 4e**

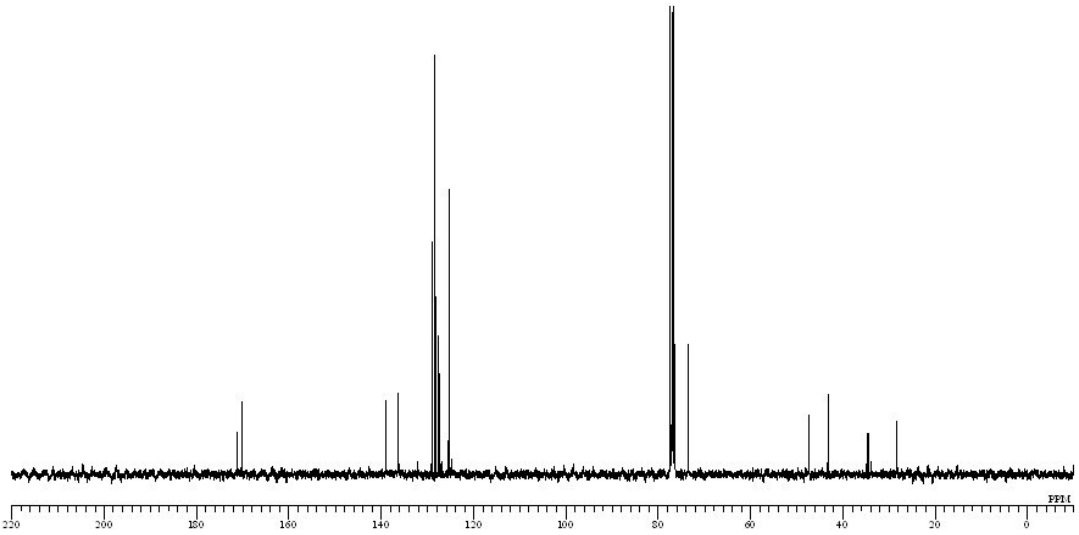


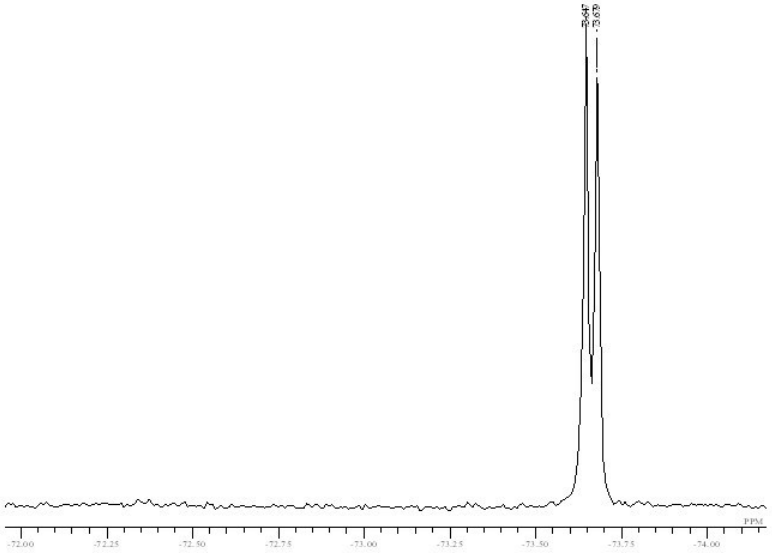




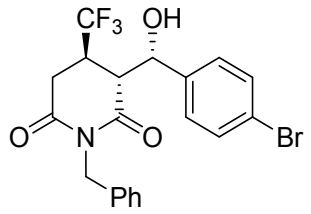
(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxy-1-phenylmethyl)-3-(trifluoromethyl)glutarimide 4f**

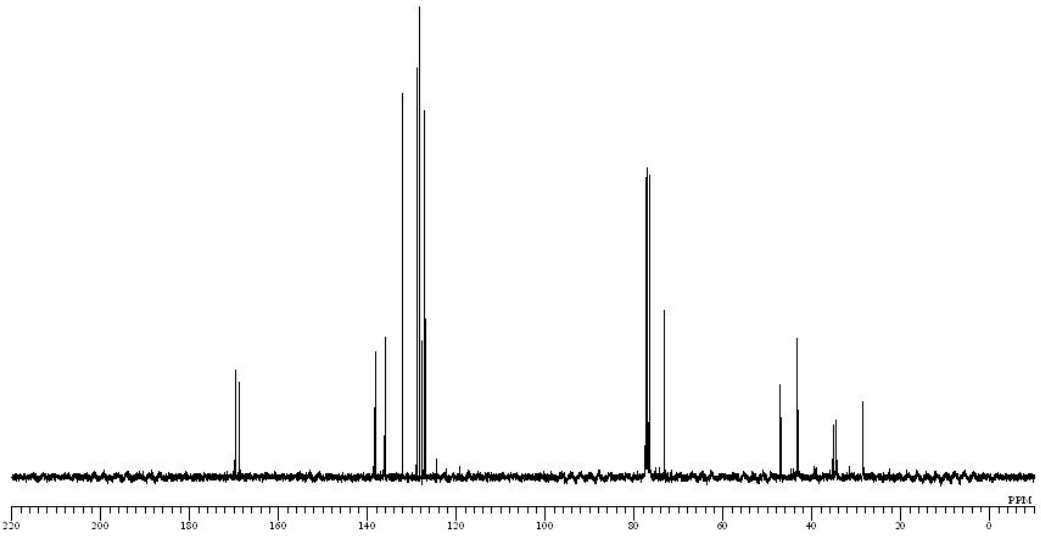


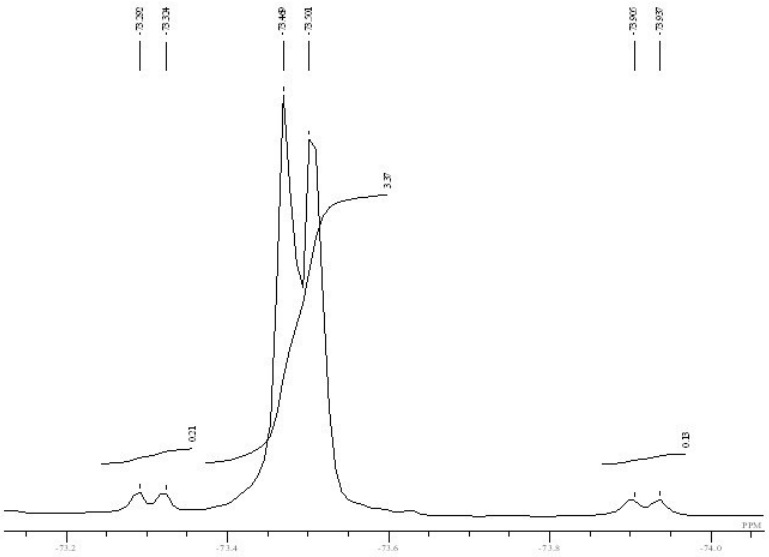




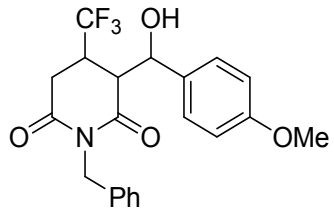
(2*R,3*R**)-*N*-Benzyl-2-[(*S**)-1-(4-bromophenyl)-1-hydroxymethyl]-3-(trifluoromethyl)glutarimide 4g**

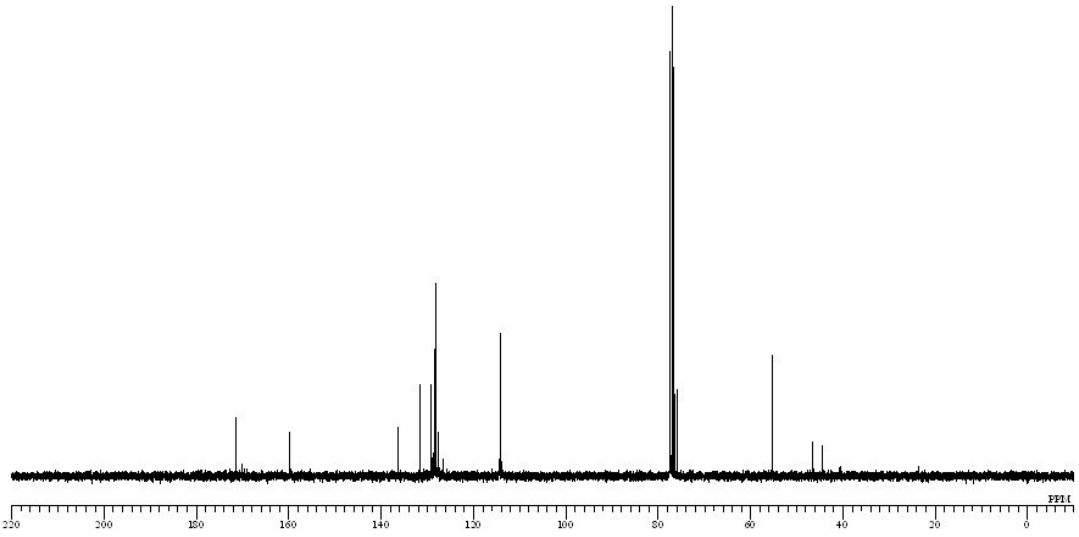


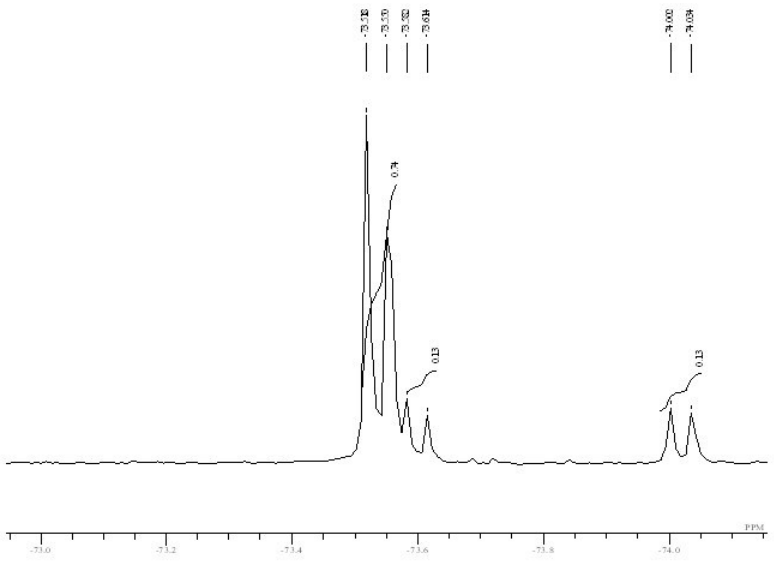




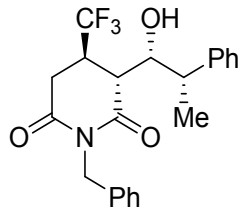
(2*R,3*R**)-*N*-Benzyl-2-[(*S**)-1-hydroxy-(4-methoxy-phenyl)-methyl)]-3-(trifluoromethyl)glutarimide 4h**

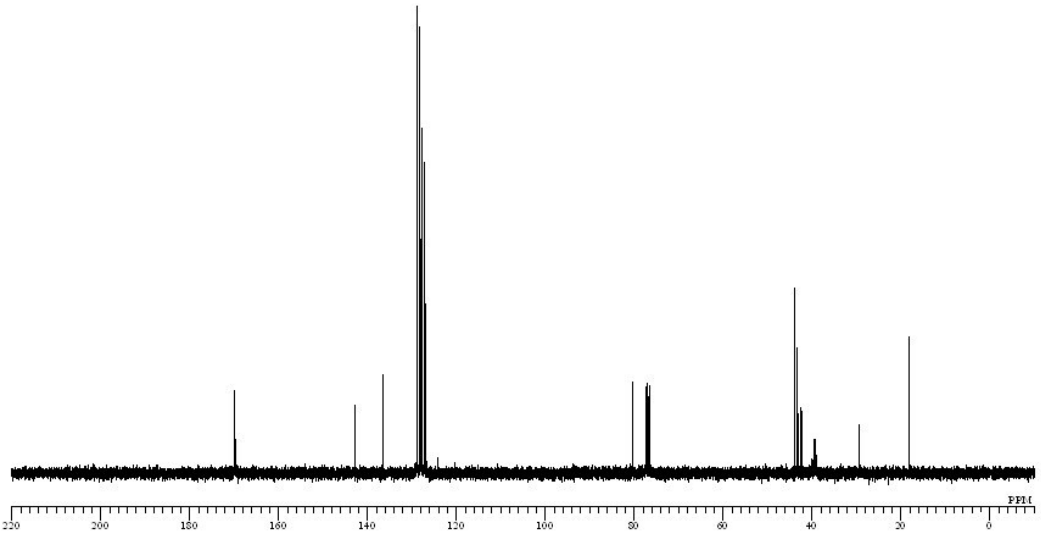


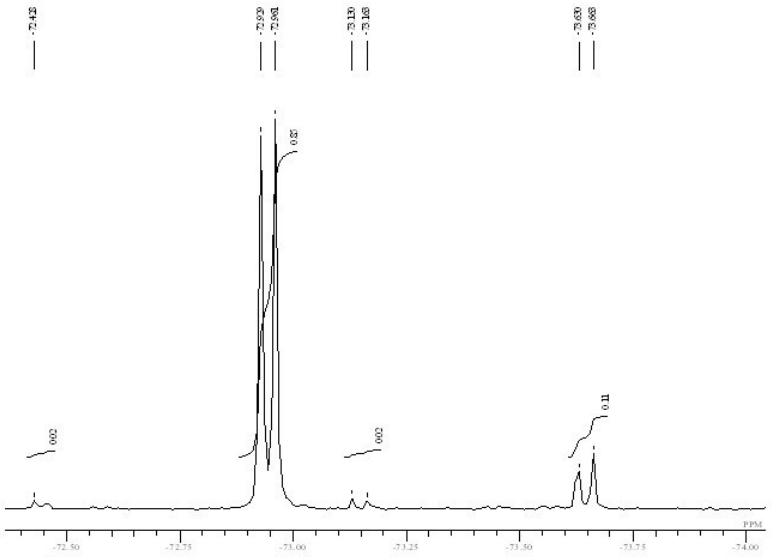




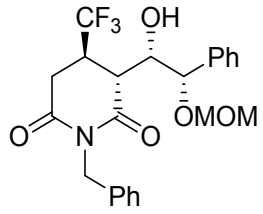
(2*R,3*R**)-*N*-Benzyl-2-((1*R**,2*S**)-1-hydroxy-2-phenylpropyl)-3-(trifluoromethyl)glutarimide 4i**

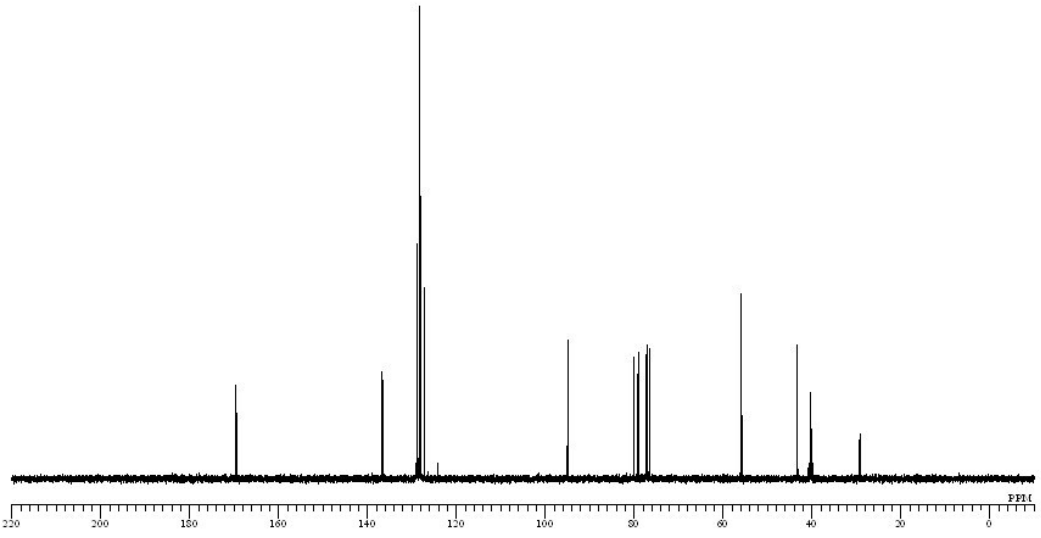


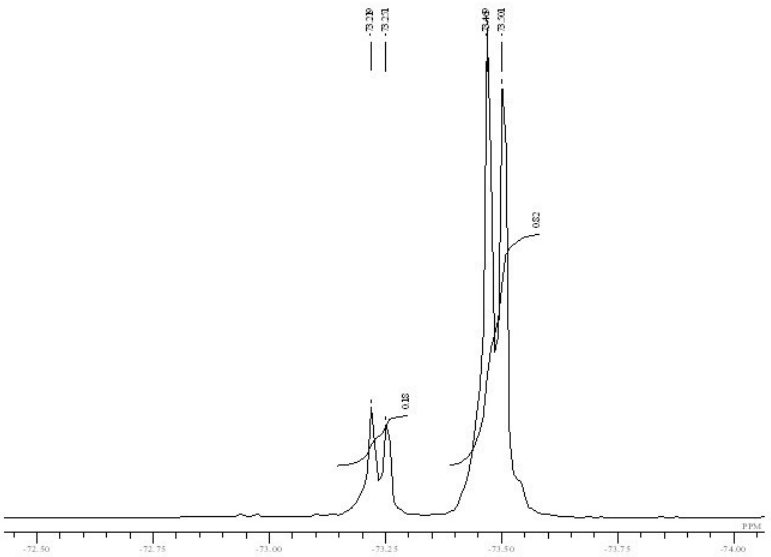




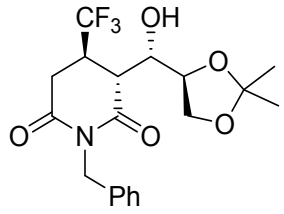
(2*R,3*R**)-*N*-Benzyl-2-((1*R**,2*S**)-1-hydroxy-2-(methoxymethoxy)-2-phenylethyl)-3-(trifluoromethyl)-glutarimide 4j**

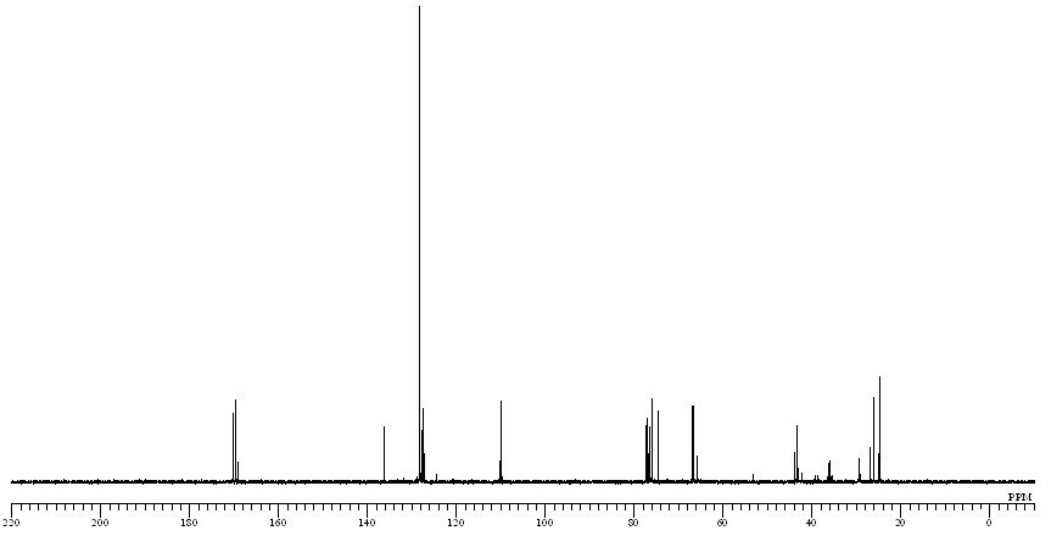


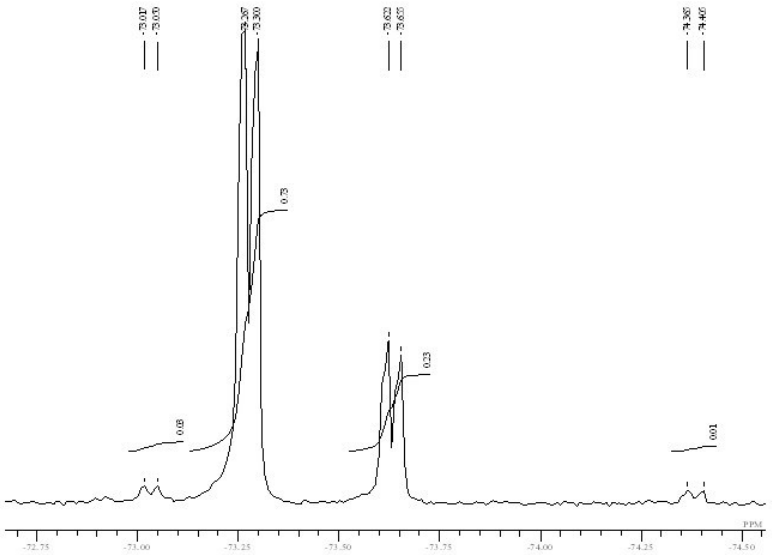




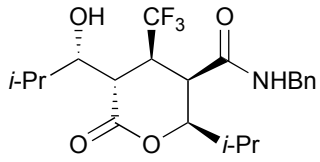
(2*R,3*R**)-*N*-Benzyl-2-{(1*R**,2*S**)-(2,2-dimethyl-1,3-dioxolan-4-yl)-1-hydroxymethyl}-3-(trifluoro-methyl)glutarimide 4k**

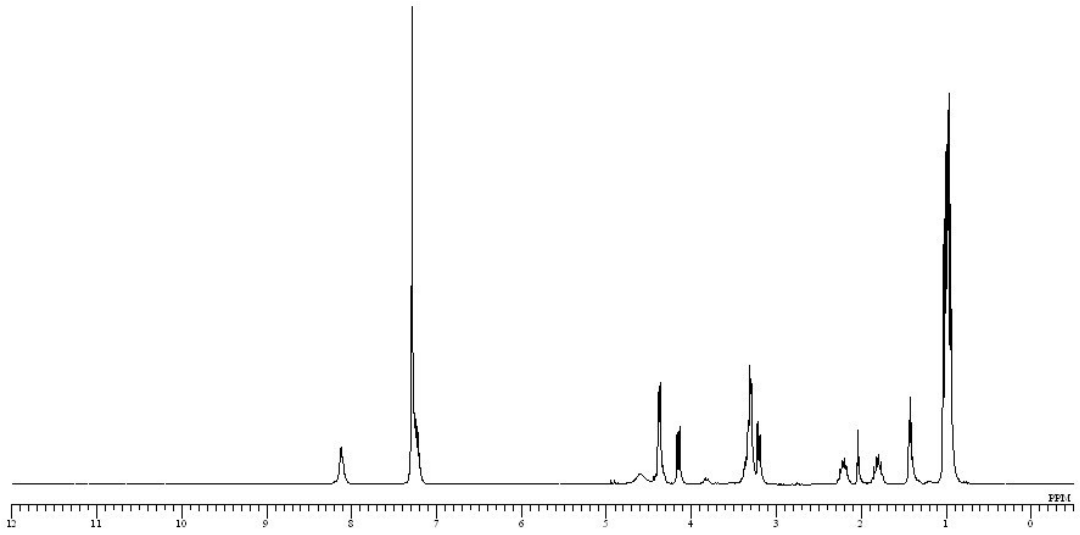


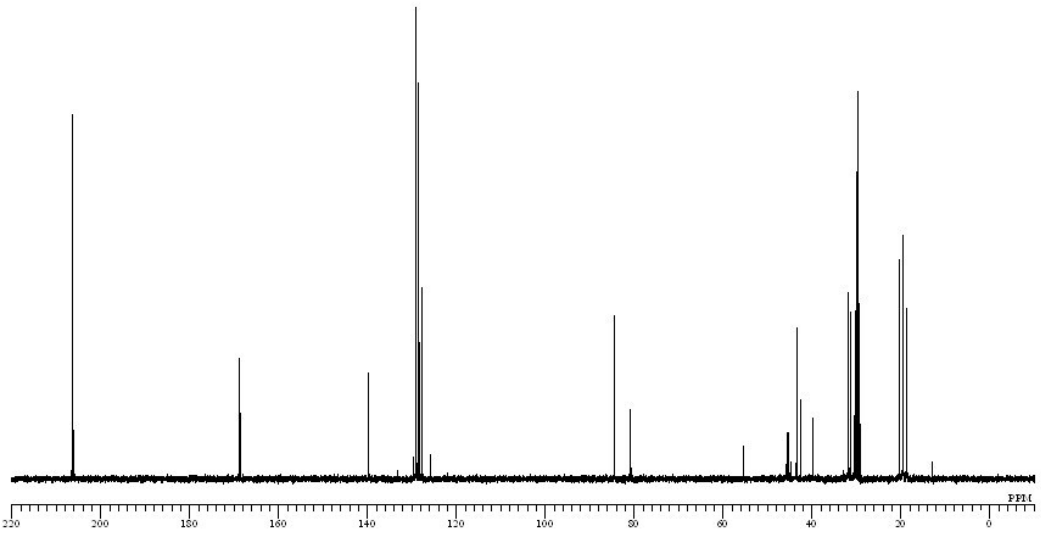




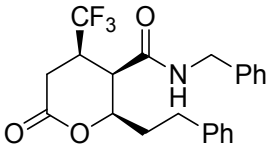
***N*-Benzyl-tetrahydro-5-(1-hydroxy-2-methylpropyl)-2-isopropyl-6-oxo-4-(trifluoromethyl)-2*H*-pyran-3-carboxamide 6b**

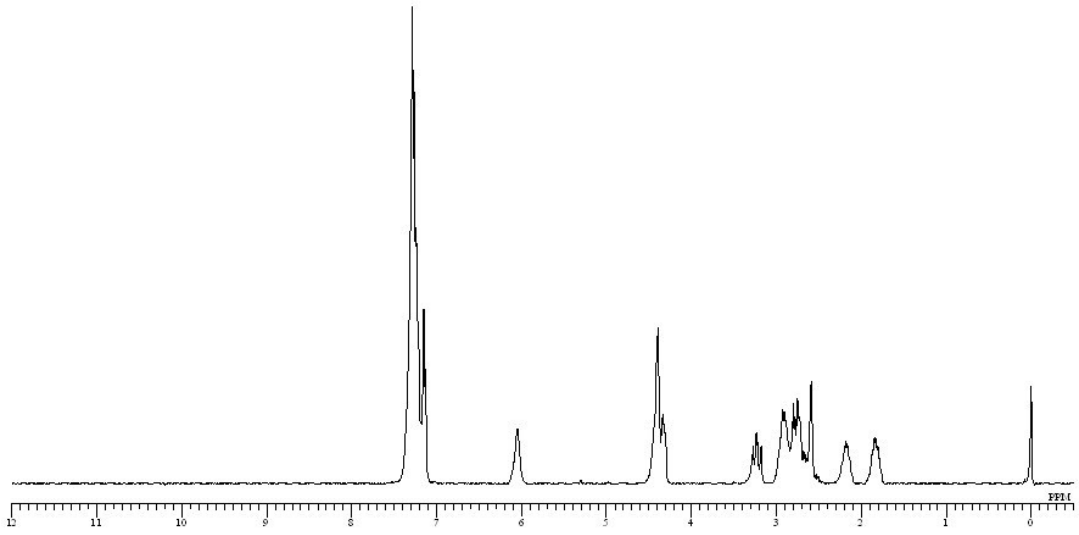


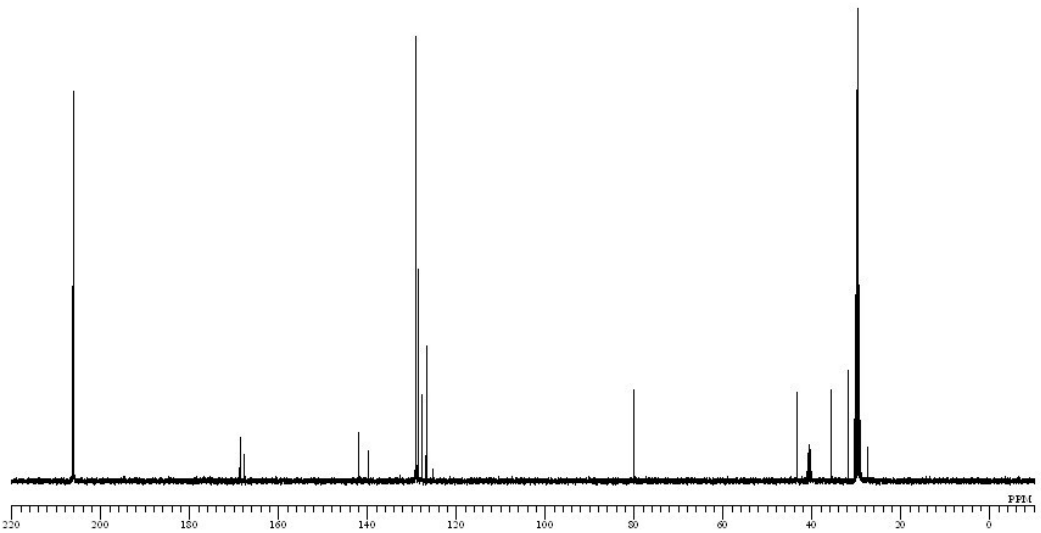




(2*S,3*R**,4*R**)-*N*-Benzyl-tetrahydro-6-oxo-2-phenethyl-4-(trifluoromethyl)-2*H*-pyran-3-carboxamide 5e**

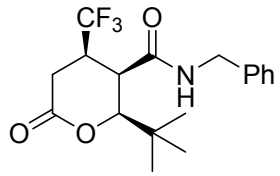


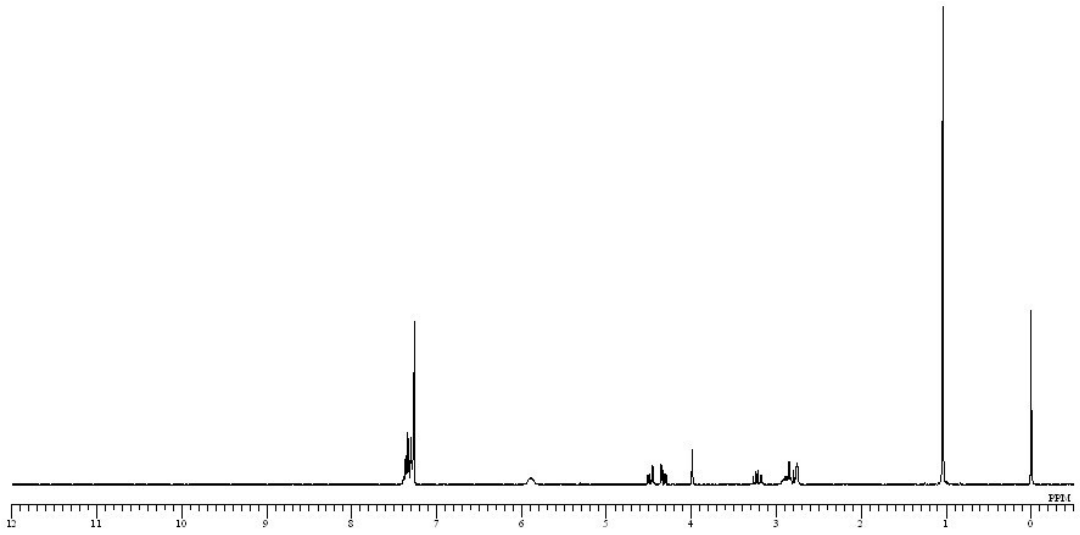


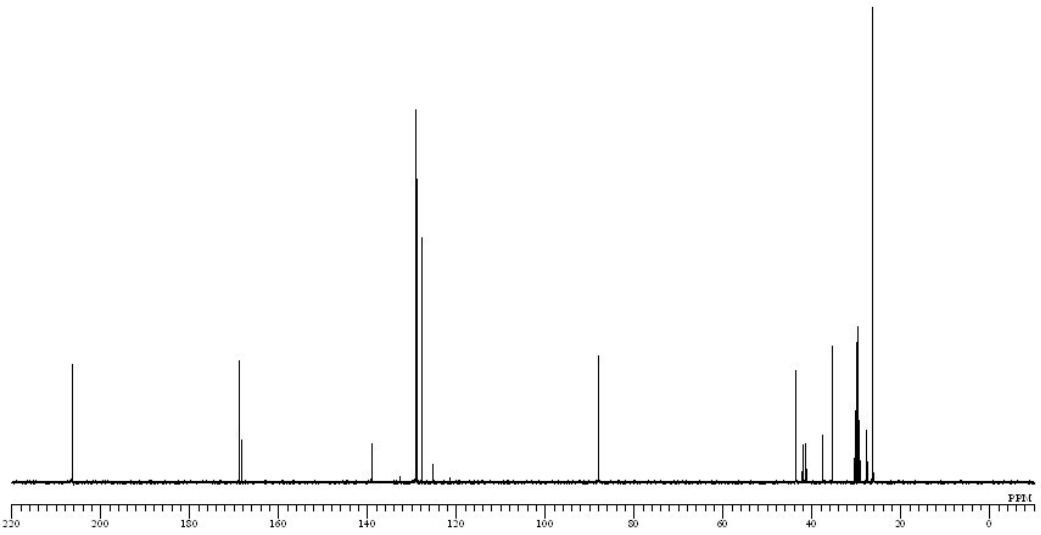


(2*S,3*R**,4*R**)-*N*-Benzyl-2-(*tert*-butyl)-tetrahydro-6-oxo-4-(trifluoromethyl)-2*H*-pyran-3-carboxamide**

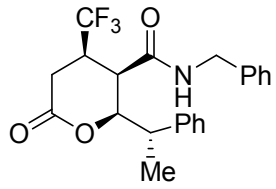
5c

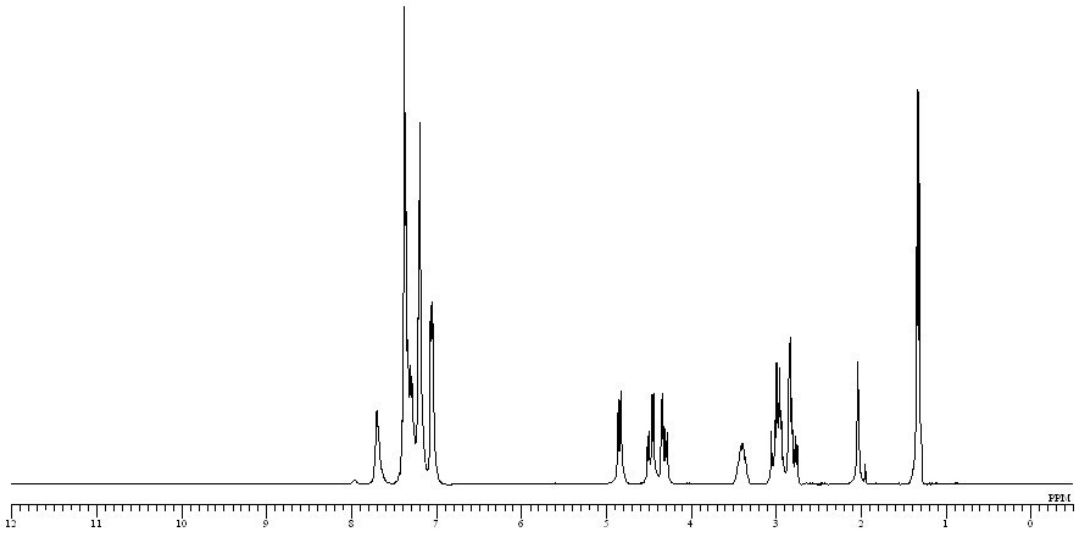


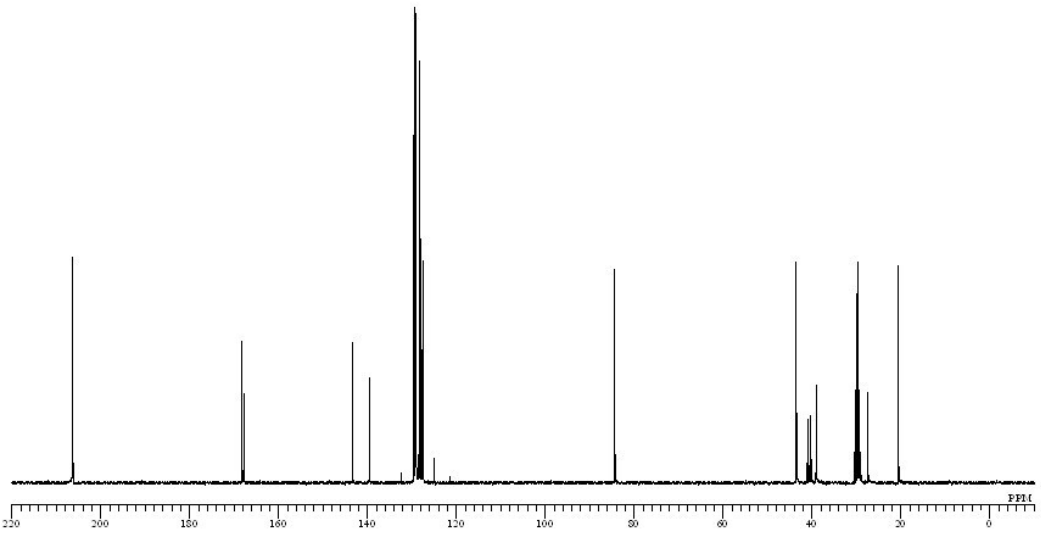




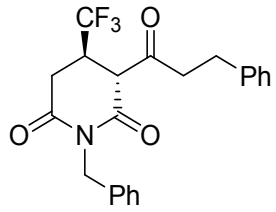
(2*R,3*R**,4*R**)-*N*-benzyl-6-oxo-2-{(*S**)-1-phenylethyl}-4-(trifluoromethyl)tetrahydro-2*H*-pyran-3-carboxamide 5i**

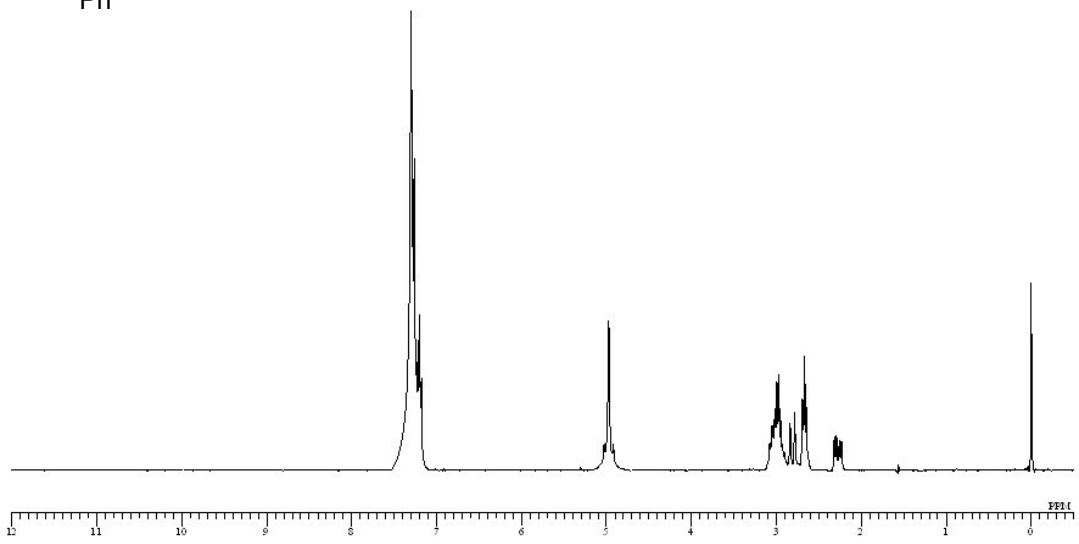


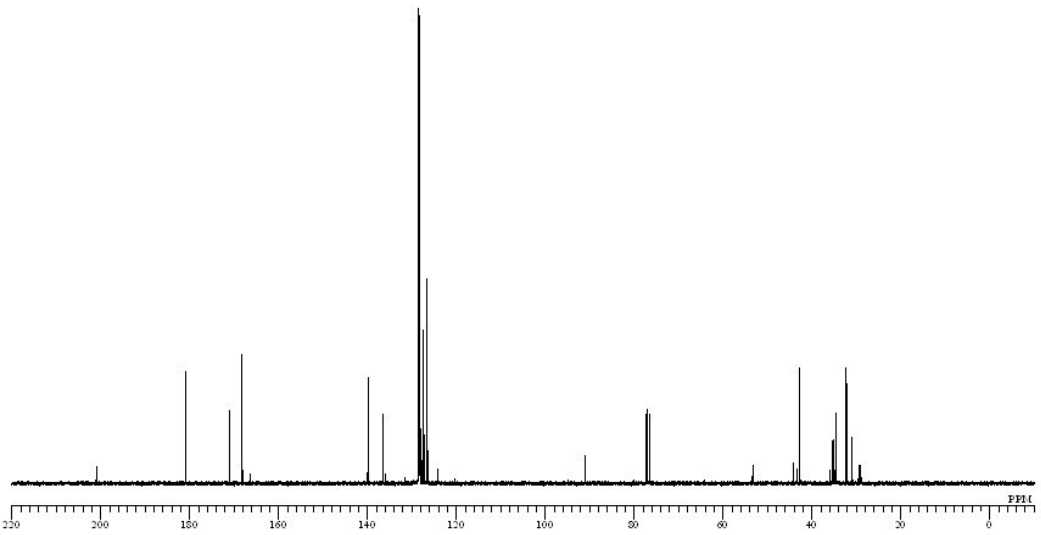




***N*-Benzyl-2-(3-phenylpropanoyl)-3-(trifluoromethyl)glutarimide 7e**





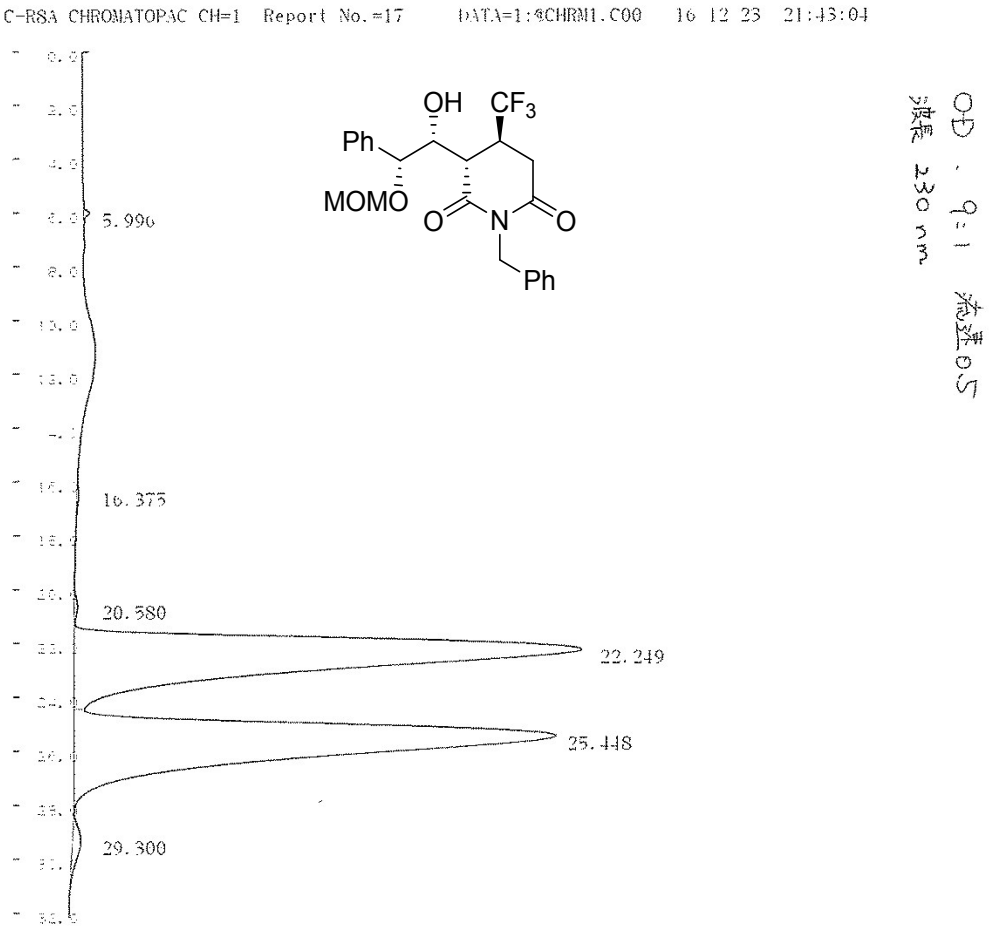


4. HPLC Charts

(2*R,3*R**)-*N*-Benzyl-2-((1*R**,2*S**)-1-hydroxy-2-(methoxymethoxy)-2-phenylethyl)-3-(trifluoromethyl)glutarimide 4j**

Conditions: DAICEL ChiralPak OD, Hexane/2-propanol=90/10, 0.5mL/min

4j from the racemic 2-(methoxymethoxy)-2-phenylacetaldehyde



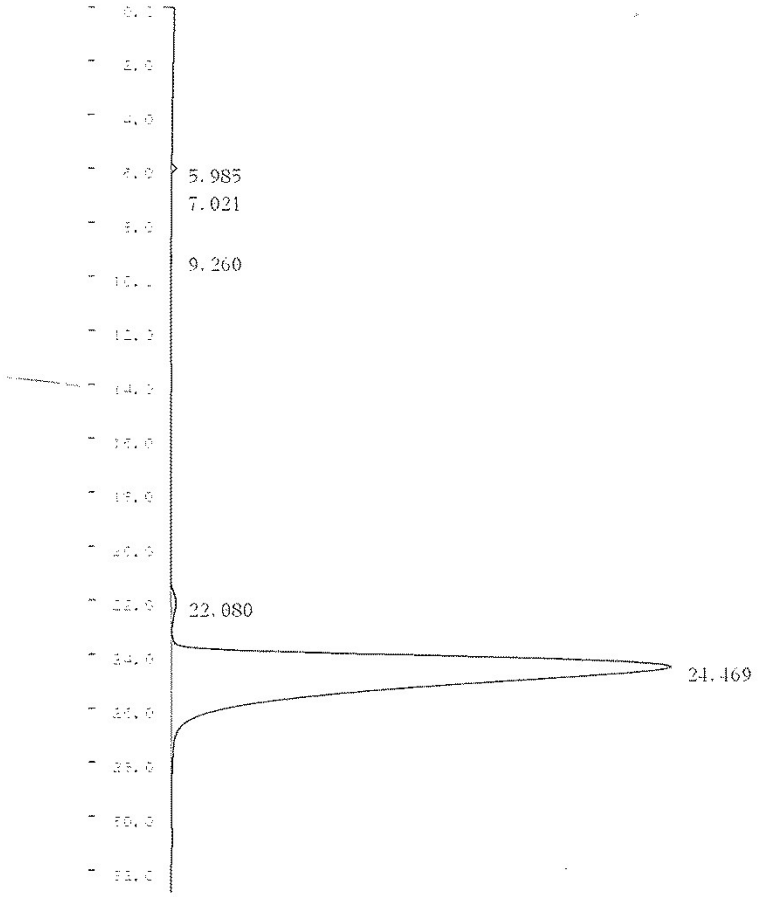
OD - 9:1 流速 0.5 230 nm

** CALCULATION REPORT **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	2	5.996	1956	132	V		0.117	
	5	16.375	1644	38			0.0984	
	6	20.58	3287	73			0.1966	
	8	22.249	825369	10748	V		49.3687	
	9	25.448	824383	10205	V		49.3097	
	10	29.3	15209	179			0.9097	
		TOTAL	1671847	21375			100	

4j from (*R*)-2-(methoxymethoxy)-2-phenylacetaldehyde[1]

C-RSA CHROMATOPAC CH=1 Report No.=2 DATA=1:¥CHRM1.C00 16 12 24 10:54:48



OD, 9:1 流速 0.5 波長 230 nm

** CALCULATION REPORT **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	1	5.985	21251	1735			0.1633	
	2	7.021	2557	191			0.0196	
	3	9.26	3445	188			0.0265	
	4	22.08	92594	1685			0.7115	
	5	24.469	12894837	168707	V		99.0791	
		TOTAL	13014684	172506			100	

5. Crystallographic Data

(2*R**,3*R**)-*N*-Benzyl-2-{(*S**)-1-hydroxy-2,2-dimethylpropyl}-3-(trifluoromethyl)glutarimide 4c

A. Crystal Data

Empirical Formula	$4(C_{18}\ H_{21}\ F_3\ N\ O_3),4(C_{18}\ H_{22}\ F_3\ N\ O_3)$
Formula Weight	340.32
Crystal Color, Habit	colorless, prism
Crystal System	*monoclinic*
Lattice Parameters	
a (Å)	24.4074(15)
b (Å)	9.2168(6)
c (Å)	24.4780(17)
α (deg.)	90
β (deg.)	140.715(10)
γ (deg.)	90
V (Å^3)	3486.61
Space Group	P 2 /a
Z value	1
D_{calc} (g/cm^3)	0.162
F_{000}	177
Radiation (cm^{-1})	□(MoK□) 0.71075
temp.(ºC)	20
Scan type	*ω*
diffrn reflns number	35604
reflns number total	7970
reflns number gt	4858
R1(wR2)	0.0551 (0.1398)
GOF	1.020

(2*R,3*R**)-*N*-Benzyl-2-((*S**)-1-hydroxy-3-phenylpropyl)-3-(trifluoromethyl)glutarimide 4e**

A. Crystal Data

Empirical Formula	C_{22} H_{22} F_3 N O_3
Formula Weight	405.40
Crystal Color, Habit	colorless, prism
Crystal System	*triclinic*
Lattice Parameters	
a (Å)	9.8654(11)
b (Å)	10.7372(12)
c (Å)	11.1375(13)
α (deg.)	66.630(5)
β (deg.)	79.912(6)
γ (deg.)	63.756(5)
V (Å^3)	971.3(2)
Space Group	P -1
Z value	2
D_{calc} (g/cm^3)	1.386
F_{000}	424
Radiation (cm^{-1})	□(MoK□) 0.71075
temp.(ºC)	20
Scan type	*ω*
diffrn reflns number	9629
reflns number total	4416
reflns number gt	3659
R1(wR2)	0.0415 (0.1031)
GOF	1.025

(2*R,3*R**)-*N*-Benzyl-2-{(1*R**,2*S**)-1-hydroxy-2-phenylpropyl)-3-(trifluoromethyl)- glutarimide 4i**

A. Crystal Data

Empirical Formula	C_{22} H_{22} F_3 N O_3
Formula Weight	405.40
Crystal Color, Habit	colorless, prism
Crystal System	*triclinic*
Lattice Parameters	
a (Å)	9.9948(5)
b (Å)	23.4736(12)
c (Å)	16.9093(9)
α (deg.)	90
β (deg.)	92.259(5)
γ (deg.)	90
V (Å^3)	3964.1(4)
Space Group	$P2_1/c$
Z value	8
D_{calc} (g/cm^3)	1.359
F_{000}	1696
Radiation (cm^{-1})	□(MoK□) 0.71073
temp.(ºC)	20
Scan type	*ω*
diffrn reflns number	71529
reflns number total	7374
reflns number gt	4546
R1(wR2)	0.0517 (0.1253)
GOF	1.013

(2*R,3*R**)-*N*-Benzyl-2-{(1*R**,2*S**)-1-hydroxy-2-(methoxymethoxy)-2-phenylethyl}-3-(trifluoromethyl)glutarimide 4j**

A. Crystal Data

Empirical Formula	C_{23} H_{24} F_3 N O_5
Formula Weight	451.43
Crystal Color, Habit	colorless, prism
Crystal System	*monoclinic*
Lattice Parameters	
a (Å)	9.9904(3)
b (Å)	10.9743(3)
c (Å)	19.9416(7)
α (deg.)	90
β (deg.)	79.912(6)
γ (deg.)	90
V (Å^3)	2161.83(12)
Space Group	P 2_1/c
Z value	4
D_{calc} (g/cm^3)	1.387
F_{000}	944
Radiation (cm^{-1})	□(MoK□) 0.71073
temp.(ºC)	20
Scan type	*ω*
diffrn reflns number	27070
reflns number total	4016
reflns number gt	3227
R1(wR2)	0.0364 (0.0896)
GOF	1.011

(2*S,3*R**,4*R**)-*N*-Benzyl-2-*tert*-butyl-tetrahydro-6-oxo-4-(trifluoromethyl)-2*H*-pyran-3- carboxamide 5c**

A. Crystal Data

Empirical Formula	$2(C_{18}\ H_{22}\ F_3\ N\ O_3)$
Formula Weight	714.73
Crystal Color, Habit	colorless, prism
Crystal System	*triclinic*
Lattice Parameters	
a (Å)	11.0908(7)
b (Å)	9.2610(6)
c (Å)	16.8687(12)
α (deg.)	90
β (deg.)	94.711(7)
γ (deg.)	90
V ($Å^3$)	1726.8(2)
Space Group	P 2_1/n
Z value	2
D_{calc} (g/cm^3)	1.375
F_{000}	752
Radiation (cm^{-1})	□(MoK□) 0.71075
temp.(ºC)	20
Scan type	*ω*
diffrn reflns number	17619
reflns number total	3941
reflns number gt	3320
R1(wR2)	0.0385 (0.0974)
GOF	1.036

(2*S,3*R**,4*R**)-*N*-Benzyl-2-{(*S**)-1-phenylethyl)-tetrahydro-6-oxo-4-(trifluoromethyl)-2*H*-pyran-3-carboxamide 5i**

A. Crystal Data

Empirical Formula	C_{22} H_{22} F_3 N O_3
Formula Weight	405.40
Crystal Color, Habit	colorless, prism
Crystal System	*monoclinic*
Lattice Parameters	
a (Å)	10.8871(6)
b (Å)	9.3186(5)
c (Å)	19.1257(12)
α (deg.)	90
β (deg.)	101.892(6)
γ (deg.)	90
V (Å^3)	1898.71
Space Group	P 2_1/n
Z value	4
D_{calc} (g/cm^3)	1.418
F_{000}	848
Radiation (cm^{-1})	□(MoK□) 0.71075
temp.(ºC)	–100
Scan type	*ω*
diffrn reflns number	22079
reflns number total	3520
reflns number gt	2940
R1(wR2)	0.0328 (0.0741)
GOF	1.025

6. Computational Details

Full optimization for each compounds was carried out by Gaussian 09W(Rev. D.01)[2] software using the B3LYP/6-31+G* level of theory. Frequency calculation was also performed for confirmation of optimized stationary points by no negative frequency as well as for obtaining free energy at 298 K.

Compound 4c

E (RB3LYP) = –1279.20130140 hartree, G (at 298 K) = –1278.875672 hartree

	Coordinates (Å)		
	X	Y	Z
C1	1.912051	1.191352	0.221074
H2	1.739653	–1.072934	1.295644
C3	3.422140	–1.305791	0.045000
C4	1.347172	0.062534	–0.509373
H5	2.045183	0.380805	–1.287648
C6	1.248342	–2.504804	–0.216161
H7	1.507435	–3.323224	0.457354
H8	1.581961	–2.784689	–1.225017
C9	–0.261746	–2.409687	–0.261423
C10	0.026316	–0.180295	–1.251588
N11	–0.771494	–1.273525	–0.891399
C12	–2.187370	–1.291896	–1.345360
H13	–2.200198	–0.851256	–2.343190
H14	–2.467222	–2.343979	–1.412667
C15	–3.132759	–0.547975	–0.422491
C16	–3.625045	0.713818	–0.779912
C17	–3.548109	–1.122843	0.788274
C18	–4.513913	1.394398	0.057570
H19	–3.306786	1.166170	–1.715906
C20	–4.432655	–0.442466	1.627362
H21	–3.174055	–2.104339	1.067822
C22	–4.918178	0.818410	1.264353
H23	–4.890603	2.371583	–0.234824
H24	–4.748975	–0.899830	2.561732
H25	–5.611551	1.344836	1.915771
O26	–0.345389	0.597828	–2.115722

O27	–0.985650	–3.313130	0.124043
F28	3.778644	–1.496782	–1.252418
F29	3.926259	–2.348634	0.750023
F30	4.080072	–0.194492	0.466882
C31	1.228050	1.221844	0.533504
H32	2.176110	1.170999	1.087927
C33	1.116913	2.715722	0.071058
O34	0.163448	0.814069	1.400523
H35	0.111728	1.416241	2.158082
C36	1.525684	3.579219	1.291905
H37	1.494626	4.642750	1.029341
H38	0.844400	3.448451	2.144497
H39	2.543447	3.348304	1.631835
C40	2.120406	2.990771	–1.066518
H41	2.177897	4.068439	–1.261136
H42	3.132639	2.650200	–0.809869
H43	1.814052	2.504403	–1.998300
C44	–0.298909	3.143664	–0.362187
H45	–0.312332	4.228584	–0.526987
H46	–0.606917	2.655412	–1.287054
H47	–1.043414	2.912462	0.407187

Compound **5c**

E (RB3LYP) = –1279.20657501 hartree, G (at 298 K) = –1278.881808 hartree

	Coordinates (Å)		
	X	Y	Z
C1	–2.168358	–1.184412	0.569551
H2	–2.777196	–1.036012	1.471384
C3	–1.563914	–2.569883	0.763239
C4	–1.122947	–0.037569	0.552051
H5	–0.577814	–0.066895	1.500611
C6	–3.079228	–1.124615	–0.665537
H7	–3.977603	–1.731883	–0.525540
H8	–2.555590	–1.509649	–1.546168
C9	–3.534374	0.276634	–1.048801
C10	–0.134772	–0.173910	–0.617091

N11	1.168297	–0.348601	–0.258087
C12	2.216169	–0.610934	–1.251687
H13	2.145974	–1.650163	–1.598716
H14	2.007079	0.027941	–2.114537
C15	3.588413	–0.334018	–0.677830
C16	4.421806	–1.386482	–0.276955
C17	4.046205	0.984566	–0.530137
C18	5.686655	–1.130264	0.262637
H19	4.082677	–2.413730	–0.394888
C20	5.307521	1.244163	0.008383
H21	3.411515	1.809856	–0.846014
C22	6.131307	0.185715	0.407143
H23	6.322876	–1.958172	0.564822
H24	5.651229	2.270415	0.110303
H25	7.115478	0.387146	0.822185
O26	-0.496511	–0.128891	–1.790430
O27	–4.430868	0.459811	–1.838239
F28	–0.831676	–2.996845	–0.291669
F29	–2.530432	–3.496784	0.975765
F30	–0.741737	–2.603051	1.850389
C31	–1.953423	1.269861	0.572329
H32	–2.560132	1.204665	1.489299
C33	–1.221231	2.640625	0.649620
O34	–2.887718	1.349516	–0.528402
H35	1.399225	–0.509958	0.713884
C36	–2.296078	3.719973	0.915690
H37	–1.820331	4.701892	1.021950
H38	–3.016512	3.774859	0.094850
H39	–2.849106	3.515087	1.842066
C40	–0.240595	2.622387	1.840880
H41	0.167549	3.627371	1.998132
H42	–0.737520	2.321951	2.773383
H43	0.609533	1.952009	1.671065
C44	–0.469853	3.000325	–0.647148
H45	–0.100592	4.030764	–0.577160
H46	0.394271	2.352798	–0.819993
H47	–1.126286	2.930129	–1.518928

7. References

1) E. J. Corey, F. J. Hannona, and N. W. Boaza, *Tetrahedron,* 1989, **45**, 545–555.
2) Gaussian 09W (Rev. D.01), M. J. Frisch, G. W. Trucks, H. B. Schlegel, G. E. Scuseria, M. A. Robb, J. R. Cheeseman, G. Scalmani, V. Barone, B. Mennucci, G. A. Petersson, H. Nakatsuji, M. Caricato, X. Li, H. P. Hratchian, A. F. Izmaylov, J. Bloino, G. Zheng, J. L. Sonnenberg, M. Hada, M. Ehara, K. Toyota, R. Fukuda, J. Hasegawa, M. Ishida, T. Nakajima, Y. Honda, O. Kitao, H. Nakai, T. Vreven, J. A. Montgomery, Jr., J. E. Peralta, F. Ogliaro, M. Bearpark, J. J. Heyd, E. Brothers, K. N. Kudin, V. N. Staroverov, R. Kobayashi, J. Normand, K. Raghavachari, A. Rendell, J. C. Burant, S. S. Iyengar, J. Tomasi, M. Cossi, N. Rega, N. J. Millam, M. Klene, J. E. Knox, J. B. Cross, V. Bakken, C. Adamo, J. Jaramillo, R. Gomperts, R. E. Stratmann, O. Yazyev, A. J. Austin, R. Cammi, C. Pomelli, J. W. Ochterski, R. L. Martin, K. Morokuma, V. G. Zakrzewski, G. A. Voth, P. Salvador, J. J. Dannenberg, S. Dapprich, A. D. Daniels, O. Farkas, J. B. Foresman, J. V. Ortiz, J. Cioslowski and D. J. Fox, Gaussian: Wallingford, CT, 2009.