Supporting Information
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An Efficient Method for Constructing Cyclic β-Amino Acids Bearing Quaternary Stereocenters

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1. General Information

All reactions were carried out under an argon atmosphere with dry, freshly distilled solvents under anhydrous conditions, unless otherwise noted. Yields refer to chromatographically and spectroscopically (1H NMR) homogeneous materials, unless otherwise stated. The used solvents were purified and dried according to common procedures. Other chemicals and solvents were commercially available. High-resolution mass spectra (HRMS) were obtained with a FTICR-MS (Ion spec 7.0T) spectrometer. 1H NMR spectra were obtained by using a Bruker AV 400 or AV 600. Chemical shifts are reported in parts per million (ppm) relative to either a tetramethylsilane internal standard or solvent signals. Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, br = broad, m = multiplet), coupling constants and integration. 13C NMR spectra were recorded using a Bruker AV 400 spectrometer (100 MHz) using CDCl3 as the solvent. Chemical shifts (δ) are reported in parts per million measured relative to the solvent peak. Melting points (m.p.) were obtained on a Mel-Temp capillary melting point apparatus.

2. Preparation of compounds 3a-3u

Synthesis of Sulfinimines 3a-3u was based on the reported procedure. [1]

Analysis data of β-sulfinimine ester 3a-3u:

(S, E)-Allyl-1-benzyl-2-(((S)-tert-butylsulfinyl) imino) cyclopentanecarboxylate 3a: [α]D = -102.43 (c 1.0, CHCl3). IR (KBr) νmax: 3062, 3029, 1733, 1640, 1495, 1474, 1390, 1263, 1219, 1146, 1084, 931, 795, 770, 703 cm⁻¹. 1H NMR (400 MHz, CDCl3) δ 7.26 – 7.18 (m, 3H), 7.17 – 7.11 (m, 2H), 5.89 (ddt, J = 17.1, 10.4, 5.9 Hz, 1H), 5.28 (ddq, J = 24.0, 10.4, 1.3 Hz, 2H), 4.58 (ddt, J = 5.9, 4.6, 1.3 Hz, 2H), 3.32 (d, J = 13.7 Hz, 1H), 3.16 – 3.04 (m, 2H), 2.52 (ddd, J = 14.9, 9.4, 7.9 Hz, 1H), 2.26 (dt, J = 12.7, 6.4 Hz, 1H), 1.89 – 1.74 (m, 2H), 1.56 – 1.47 (m, 1H), 1.29 (s, 9H). 13C NMR (100 MHz, CDCl3) δ 188.5, 172.1, 137.2, 131.8, 130.4, 128.4, 126.9, 119.1, 66.3, 62.8, 58.4, 40.9, 33.4, 31.9, 22.9, 22.7. HRMS (ESI) calculated for C20H27NNaO3S+ [M+Na]+: 384.1604, found 384.1603.
(S, E)-Allyl-2-(((R)-tert-butylsulfinyl) imino)-1-(3-chlorobenzyl) cyclopentane- carboxylate 3b: $[\alpha]_D^{23} = -104.25$ (c 0.5, CHCl$_3$). IR (KBr) $\nu_{\max}$: 2959, 2926, 2867, 1733, 1641, 1475, 1455, 1362, 1260, 1214, 1147, 1083, 996, 932, 788, 705, 684 cm$^{-1}$. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.22 – 7.14 (m, 3H), 7.03 (d, $J = 6.2$ Hz, 1H), 5.93 – 5.82 (m, 1H), 5.29 (dd, $J = 23.9$, 13.8 Hz, 2H), 4.57 (d, $J = 5.9$ Hz, 2H), 3.31 (d, $J = 13.7$ Hz, 1H), 3.10 (ddd, $J = 24.7$, 16.6, 11.1 Hz, 2H), 2.55 (dt, $J = 19.4$, 7.8 Hz, 1H), 2.28 (dt, $J = 12.6$, 6.2 Hz, 1H), 1.94 – 1.83 (m, 1H), 1.78 – 1.69 (m, 1H), 1.32 – 1.20 (m, 10H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 187.9, 171.8, 139.3, 134.2, 131.6, 130.6, 129.6, 128.6, 127.2, 119.4, 66.4, 62.7, 58.4, 40.5, 33.3, 32.1, 22.8, 22.7. HRMS (ESI) calculated for C$_{20}$H$_{26}$ClNNaO$_3$S$^+$ [M+Na]$^+$: 418.1214, found 418.1210.

(S, E)-Allyl-2-(((R)-tert-butylsulfinyl) imino)-1-(3-methylbenzyl) cyclopentane- carboxylate 3c: $[\alpha]_D^{23} = -94.93$ (c 0.3, CHCl$_3$). IR (KBr) $\nu_{\max}$: 1960, 2925, 2856, 1731, 1606, 1456, 1262, 1086, 1019, 800 cm$^{-1}$. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.14 (t, $J = 7.5$ Hz, 1H), 7.02 (d, $J = 7.5$ Hz, 1H), 6.98 – 6.90 (m, 2H), 5.89 (ddd, $J = 16.5$, 11.1, 5.8 Hz, 1H), 5.28 (dd, $J = 28.0$, 13.8 Hz, 2H), 4.57 (d, $J = 5.7$ Hz, 2H), 3.28 (d, $J = 13.6$ Hz, 1H), 3.14 – 3.03 (m, 2H), 2.51 (dt, $J = 19.4$, 7.8 Hz, 1H), 2.30 (s, 3H), 2.25 (dd, $J = 12.3$, 6.7 Hz, 1H), 1.89 – 1.74 (m, 2H), 1.57 – 1.51 (m, 1H), 1.29 (s, 9H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 188.6, 172.2, 137.9, 137.1, 131.8, 131.3, 128.3, 127.7, 127.4, 119.1, 66.3, 62.9, 58.3, 40.9, 33.4, 31.9, 22.9, 22.7, 21.6. HRMS (ESI) calculated for C$_{21}$H$_{29}$NNaO$_3$S$^+$ [M+Na]$^+$: 398.1760, found 398.1757.

(E)-Allyl-2-(((R)-tert-butylsulfinyl) imino)-1-(4-(trifluoromethyl) benzyl) cyclopentane- carboxylate 3d: $[\alpha]_D^{23} = -80.43$ (c 1.0, CHCl$_3$). IR (KBr) 2961, 2928, 1733, 1618, 1583, 1456, 1418, 1326, 1164, 1123, 1068, 993 $\nu_{\max}$ cm$^{-1}$. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.52 (d, $J = 8.2$ Hz, 2H), 7.28 (d, $J = 9.2$ Hz, 2H), 5.87 (ddt, $J = 16.6$, 10.6, 5.9 Hz, 1H), 5.38 – 5.20 (m, 2H), 4.58 (dd, $J = 5.5$, 4.6 Hz, 2H), 3.39 (d, $J = 13.7$ Hz, 1H), 3.21 – 3.03 (m, 2H), 2.57 (dt, $J = 19.6$, 7.8 Hz, 1H), 2.27 (dt, $J = 17.4$, 5.6 Hz, 1H), 1.89 (m, 1H), 1.78 – 1.69 (m, 1H),...
1.63 (ddd, \( J = 15.1, 10.4, 6.2 \) Hz, 1H), 1.28 (s, 9H).  \(^{13}\text{C} \) NMR (100 MHz, CDCl\(_3\)) \( \delta \) 187.7, 171.8, 141.4, 131.6, 130.8, 129.1, 125.7, 125.3, 125.2, 123.0, 119.4, 119.0, 66.4, 62.7, 58.5, 40.6, 33.2, 32.1, 22.8, 22.7.  \(^{19}\text{F} \) NMR (376 MHz, CDCl\(_3\)) \( \delta \) -62.5 (s). HRMS (ESI) calculated for C\(_{21}\)H\(_{26}\)F\(_3\)NNaO\(_3\)S\(^+\) [M+Na]\(^+\): 452.1478, found 452.1477.

(S, \( E \))-Allyl-1-benzyl-2-(((S)-tert-butylsulfinyl) imino) cyclopentanecarboxylate 3e:

\( [\alpha]_D^{23} = -134.43 \) (c 1.0, CHCl\(_3\)). IR (KBr) \( \nu_{\text{max}}: 2963, 2937, 1733, 1644, 1484, 1379, 1271, 1197, 1153, 1091, 1019, 937, 866, 802 \text{ cm}^{-1}.  \(^{1}\text{H} \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 5.88 (ddd, \( J = 22.6, 10.9, 5.7 \) Hz, 1H), 5.27 (dd, \( J = 31.1, 13.8 \) Hz, 2H), 5.06 (t, \( J = 7.3 \) Hz, 1H), 4.56 (t, \( J = 5.3 \) Hz, 2H), 3.11 (ddd, \( J = 19.4, 8.7, 6.2 \) Hz, 1H), 2.68 (dt, \( J = 18.5, 7.3 \) Hz, 2H), 2.41 (dd, \( J = 14.4, 7.5 \) Hz, 1H), 2.33 – 2.23 (m, 1H), 1.95 (dd, \( J = 14.2, 6.9 \) Hz, 1H), 1.85 (dd, \( J = 14.3, 6.5 \) Hz, 1H), 1.79 (s, 1H), 1.69 (s, 3H), 1.61 (s, 3H), 1.24 (s, 9H).  \(^{13}\text{C} \) NMR (101 MHz, CDCl\(_3\)) \( \delta \) 188.9, 172.5, 135.3, 131.9, 119.3, 118.8, 66.1, 62.0, 58.2, 33.9, 33.4, 32.2, 26.1, 22.9, 22.8, 18.2. HRMS (ESI) calculated for C\(_{18}\)H\(_{29}\)NNaO\(_3\)S\(^+\) [M+Na]\(^+\): 362.1760, found 362.1761.

(S, \( E \))-Allyl-1-allyl-2-(((S)-tert-butylsulfinyl) imino) cyclopentanecarboxylate 3f:

\( [\alpha]_D^{23} = -130.32 \) (c 1.0, CHCl\(_3\)). IR (KBr) \( \nu_{\text{max}}: 2960, 2936, 1733, 1641, 1453, 1366, 1263, 1201, 1139, 1067, 1009, 853, 801 \text{ cm}^{-1}.  \(^{1}\text{H} \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 5.86 (ddt, \( J = 17.1, 10.4, 5.8 \) Hz, 1H), 5.78 – 5.66 (m, 1H), 5.34 – 5.18 (m, 2H), 5.12 – 5.03 (m, 2H), 4.55 (ddt, \( J = 5.8, 2.5, 1.4 \) Hz, 2H), 3.20 – 3.02 (m, 1H), 2.79 – 2.61 (m, 2H), 2.40 (dd, \( J = 13.9, 7.5 \) Hz, 1H), 2.33 – 2.23 (m, 1H), 2.02 – 1.90 (m, 1H), 1.89 – 1.77 (m, 2H), 1.22 (s, 9H).  \(^{13}\text{C} \) NMR (100 MHz, CDCl\(_3\)) \( \delta \) 188.6, 172.1, 133.7, 131.8, 119.0, 118.9, 77.5, 77.2, 76.8, 66.1, 61.4, 58.2, 39.7, 33.3, 32.1, 22.7, 22.7. HRMS (ESI) calculated for C\(_{16}\)H\(_{25}\)NNaO\(_3\)S\(^+\) [M+Na]\(^+\): 334.1447, found 334.1449.

(S, \( E \))-Allyl-1-((but-2-yn-1-yl)-2-(((S)-tert-butylsulfinyl) imino) cyclopentanecarboxylate 3g:

\( [\alpha]_D^{20} = -99.34 \) (c 1.0, CHCl\(_3\)). IR (KBr) \( \nu_{\text{max}}: 2962, 2922, 1735, 1642, 1362, 1261, 1224, 1087, 1020, 801 \text{ cm}^{-1}.  \(^{1}\text{H} \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 5.26 (dd, \( J = 32.6, 13.8 \) Hz, 2H), 4.57 (t, \( J = 5.6 \) Hz, 2H), 3.16 (dt, \( J = 13.8, 6.6 \) Hz, 1H), 2.79 – 2.60 (m, 3H), 2.31 (dt, \( J = 12.1, 6.1 \) Hz, 1H), 2.13 – 1.94 (m, 3H), 1.73 (s, 3H), 1.22 (s, 9H).  \(^{13}\text{C} \) NMR (100 MHz, CDCl\(_3\)) \( \delta \) 188.4, 171.8, 131.7, 118.9, 77.9, 75.1, 66.2, 60.8,
58.2, 33.7, 32.7, 25.6, 23.1, 22.7, 3.6. HRMS (ESI) calculated for C_{17}H_{25}NNaO_{3}S^{+} [M+Na]^+: 346.1447, found 346.1449.

(S, E)-Allyl-2-(((S)-tert-butylsulfinyl) imino)-1-(prop-2-yn-1-yl) cyclopentanecarboxylate 3h: 
[α]^D_20 = - 121.17 (c 1.0, CHCl₃). IR (KBr) ν max: 2963, 2927, 1735, 1642, 1456, 1363, 1261, 1225, 1151, 1085, 1019, 801 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 5.95 – 5.84 (m, 1H), 5.38 – 5.21 (m, 2H), 4.60 (td, J = 5.8, 1.2 Hz, 2H), 3.29 – 3.13 (m, 1H), 2.85 (dt, J = 5.2, 2.6 Hz, 1H), 2.78 – 2.63 (m, 2H), 2.43 – 2.31 (m, 1H), 2.17 – 1.96 (m, 4H), 1.25 (s, 9H). ¹³C NMR (100 MHz, CDCl₃) δ 187.9, 171.5, 131.6, 119.1, 80.5, 70.6, 66.3, 60.4, 58.2, 33.5, 32.6, 25.2, 23.1, 22.7. HRMS (ESI) calculated for C_{16}H_{23}NNaO_{3}S^{+} [M+Na]^+: 332.1291, found 332.1289.

(R, E)-Allyl 1-butyl-2-(((S)-tert-butylsulfinyl) imino) cyclopentanecarboxylate 3i: 
[α]^D_23 = - 48.49 (c 0.25, CHCl₃). IR (KBr) ν max: 2962, 2927, 2858, 1732, 1641, 1457, 1261, 1090, 1021, 801 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 5.87 (ddd, J = 22.8, 11.0, 5.8 Hz, 1H), 5.26 (dd, J = 31.4, 13.8 Hz, 2H), 4.56 (m, 2H), 3.13 (ddd, J = 19.5, 8.5, 5.9 Hz, 1H), 2.65 (dt, J = 19.4, 7.9 Hz, 1H), 2.36 (dt, J = 12.7, 6.2 Hz, 1H), 1.70 – 1.63 (m, 2H), 1.58 (dd, J = 13.2, 4.2 Hz, 1H), 1.34 – 1.26 (m, 2H), 1.24 (d, J = 5.5 Hz, 9H), 0.96 (dd, J = 14.6, 7.1 Hz, 1H), 0.88 (t, J = 6.9 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 189.0, 172.4, 131.9, 118.8, 66.0, 62.0, 58.2, 35.3, 33.2, 32.6, 27.3, 23.9, 23.3, 22.8, 14.1. HRMS (ESI) calculated for C_{17}H_{25}NNaO_{3}S^{+} [M+Na]^+: 350.1760, found 350.1757.

(R, E)-allyl 1-butyl-2-(((R)-tert-butylsulfinyl) imino)cyclohexanecarboxylate 3j: 
[α]^D_23 = - 104.36 (c 1.0, CHCl₃). IR (KBr) ν max: 2968, 2871, 1752, 1469, 1363, 1239, 1086, 796 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 5.88 (dq, J = 10.8, 5.7 Hz, 1H), 5.28 (dd, J = 35.2, 13.8 Hz, 2H), 4.60 (d, J = 5.7 Hz, 2H), 3.55 – 3.44 (m, 1H), 2.42 (ddd, J = 15.9, 12.6, 7.5 Hz, 2H), 1.88 (ddd, J = 17.4, 12.9, 4.9 Hz, 2H), 1.70 – 1.63 (m, 2H), 1.55 – 1.37 (m, 2H), 1.31 – 1.17 (m, 14H), 0.87 (t, J = 6.9 Hz, 3H). ¹³C NMR (101 MHz, CDCl₃) δ 184.7, 172.7, 131.9, 119.0, 65.8, 35.9, 35.5, 32.2, 27.5, 26.6, 23.3, 22.8, 22.4, 14.0. HRMS (ESI) calculated for C_{18}H_{31}NNaO_{3}S^{+} [M+Na]^+: 364.1917, found 364.1915.
Allyl-(S, E)-2-(((R)-tert-butylsulfinyl) imino)-1-(3-methylbut-2-en-1-yl) cyclohexane-1-carboxylate 3k (320 mg, 82% yield) as a pale yellow oil: \([\alpha]_D^{23} = -117.60 \text{ (c } 0.84, \text{ CHCl}_3)\). IR (KBr) \(\nu_{\text{max}}: 2930, 2866, 1734, 1629, 1511, 1452, 1213, 1179, 1081, 987 \text{ cm}^{-1}\). 1H NMR (400 MHz, CDCl3) \(\delta 5.86 \text{ (ddd, } J = 16.5, 10.6, 5.3 \text{ Hz, 1H}), 5.31 \text{ (d, } J = 16.8 \text{ Hz, 1H}), 5.23 \text{ (d, } J = 10.5 \text{ Hz, 1H}), 5.08 \text{ (d, } J = 7.8 \text{ Hz, 1H}), 4.58 \text{ (t, } J = 5.1 \text{ Hz, 2H}), 3.66 – 3.55 \text{ (m, 1H)}, 2.62 \text{ (dd, } J = 14.4, 7.3 \text{ Hz, 1H}), 2.38 \text{ (m, 3H)}, 1.95 – 1.77 \text{ (m, 2H)}, 1.74 – 1.62 \text{ (m, 6H)}, 1.46 \text{ (m, 3H)}, 1.27 \text{ (s, 9H)}. 13C NMR (400 MHz, CDCl3) \(\delta 184.1, 172.3, 134.8, 131.8, 119.0, 65.9, 59.6, 58.0, 35.6, 34.5, 32.3, 27.4, 26.2, 22.8, 22.4, 18.1\). HRMS (ESI) calculated for C19H31NNaO3S+: [M+Na]+: 376.1917, found 376.1915.

(S, E)-Allyl-2-(((R)-tert-butylsulfinyl) imino)-1-(3-chlorobenzyl) cycloheptane-carboxylate 3l: \([\alpha]_D^{20} = -104.62 \text{ (c } 1.0, \text{ CHCl}_3\). IR (KBr) \(\nu_{\text{max}}: 2959, 2930, 2862, 1735, 1621, 1597, 1572, 1475, 1456, 1261, 1231, 1197, 1173, 1146, 1081, 1023, 994, 876, 703, 686 \text{ cm}^{-1}\). 1H NMR (400 MHz, CDCl3) \(\delta 7.18 \text{ (d, } J = 4.9 \text{ Hz, 2H}), 7.09 \text{ (s, 1H)}, 6.96 \text{ (d, } J = 6.0 \text{ Hz, 1H}), 5.89 \text{ (dq, } J = 10.3, 6.0 \text{ Hz, 1H}), 5.30 \text{ (dd, } J = 25.7, 13.8 \text{ Hz, 2H}), 4.59 \text{ (qd, } J = 12.9, 5.8 \text{ Hz, 2H}), 3.35 \text{ (d, } J = 13.7 \text{ Hz, 1H}), 3.10 – 3.02 \text{ (m, 1H)}, 2.90 \text{ (d, } J = 13.8 \text{ Hz, 1H}), 2.57 \text{ (t, } J = 11.1 \text{ Hz, 1H}), 2.06 – 1.97 \text{ (m, 1H)}, 1.85 – 1.70 \text{ (m, 4H)}, 1.63 – 1.43 \text{ (m, 3H)}, 1.29 \text{ (s, 9H)}. 13C NMR (100 MHz, CDCl3) \(\delta 184.6, 172.2, 139.3, 134.1, 131.6, 130.7, 129.5, 128.8, 127.1, 119.6, 66.3, 63.0, 58.3, 41.6, 32.7, 32.0, 29.9, 26.3, 23.6, 23.0\). HRMS (ESI) calculated for C22H30ClNNaO3S+: [M+Na]+: 446.1527, found 446.1523.

(S, E)-Allyl-2-(((R)-tert-butylsulfinyl) imino)-1-(3-methylbenzyl) cycloheptane-carboxylate 3m: \([\alpha]_D^{20} = -102.82 \text{ (c } 1.0, \text{ CHCl}_3\). IR (KBr) \(\nu_{\text{max}}: 2928, 2861, 1735, 1620, 1456, 1389, 1261, 1231, 1195, 1175, 1146, 1081, 1037, 992, 933, 796, 703 \text{ cm}^{-1}\). 1H NMR (400 MHz, CDCl3) \(\delta 7.14 \text{ (t, } J = 7.2 \text{ Hz, 1H}), 7.02 \text{ (d, } J = 7.4 \text{ Hz, 1H}), 6.88 \text{ (d, } J = 9.1 \text{ Hz, 2H}), 5.96 – 5.84 \text{ (m, 1H)}, 5.29 \text{ (dd, } J = 29.4, 13.8 \text{ Hz, 2H}), 4.60 \text{ (qd, } J = 13.1, 5.7 \text{ Hz, 2H}), 3.34 \text{ (d, } J = 13.6 \text{ Hz, 1H}), 2.94 \text{ (dd, } J = 23.2, 12.7 \text{ Hz, 2H}), 2.58 \text{ (t, } J = 11.1 \text{ Hz, 1H}), 2.30 \text{ (s, 3H)}, 2.01 \text{ (dd, } J = 22.7, 9.0 \text{ Hz, 1H}), 1.87 – 1.70 \text{ (m, 4H)}, 1.62 \text{ (m, 1H)}, 1.54 – 1.45 \text{ (m, 2H)}, 1.30 \text{ (s, 9H)}. 13C NMR (100 MHz, CDCl3) \(\delta 185.3, 172.6, 137.8, 137.0, 131.8, 131.4, 128.2, 127.6, 127.1, 119.6, 66.3, 63.0, 58.3, 41.6, 32.7, 32.0, 29.9, 26.3, 23.6, 23.0\). HRMS (ESI) calculated for C19H31NNaO3S+: [M+Na]+: 376.1917, found 376.1915.
127.6, 119.1, 66.1, 63.0, 58.2, 42.1, 32.9, 31.9, 29.9, 26.3, 23.7, 23.0, 21.5. HRMS (ESI) calculated for C_{23}H_{33}NNaO_3S^+ [M+Na]^+: 426.2073, found 426.2070.

(S, E)-Allyl-2-(((R)-tert-butylsulfinyl) imino) -1-(4-nitrobenzyl) cycloheptane- carboxylate 3n: [α]_D^20 = -100.65 (c 2.0, CHCl_3). IR (KBr) ν_{max}: 2959, 2930, 2860, 1734, 1622, 1605, 1521, 1456, 1346, 1261, 1174, 1080, 994, 856, 802, 741, 701 cm^{-1}. ^1H NMR (400 MHz, CDCl_3) δ 8.12 (d, J = 7.6 Hz, 2H), 7.28 (d, J = 7.7 Hz, 2H), 5.89 (dq, J = 11.0, 5.8 Hz, 1H), 5.31 (dd, J = 21.7, 13.8 Hz, 2H), 4.65 (dd, J = 12.4, 4.4 Hz, 1H), 4.57 (dd, J = 12.4, 5.3 Hz, 1H), 3.47 (d, J = 13.6 Hz, 1H), 3.09 (dd, J = 20.2, 12.2 Hz, 2H), 2.62 (t, J = 11.0 Hz, 1H), 2.09 – 2.00 (m, 1H), 1.85 – 1.65 (m, 5H), 1.51 (dd, J = 22.1, 12.1 Hz, 2H), 1.29 (s, 9H). ^13C NMR (100 MHz, CDCl_3) δ 184.1, 172.0, 147.0, 145.3, 131.5, 131.4, 123.4, 119.6, 66.4, 62.9, 58.4, 41.7, 32.6, 32.4, 29.8, 26.3, 23.7, 22.9. HRMS (ESI) calculated for C_{22}H_{30}N_2NaO_5S^+ [M+Na]^+: 457.1768, found 457.1767.

(S, E)-Allyl-2-(((R)-tert-butylsulfinyl) imino)-1-(4-(trifluoromethyl) benzyl) cycloheptane-carboxylate 3o: [α]_D^20 = -97.23 (c 1.0, CHCl_3). IR (KBr) ν_{max}: 2958, 2933, 2860, 1731, 1620, 1601, 1519, 1454, 1350, 1260, 1180, 1083, 993, 853, 801, 744, 701 cm^{-1}. ^1H NMR (400 MHz, CDCl_3) δ 7.50 (d, J = 7.0 Hz, 2H), 7.21 (d, J = 7.1 Hz, 2H), 5.94 – 5.82 (m, 1H), 5.29 (dd, J = 23.0, 13.7 Hz, 2H), 4.64 (dd, J = 13.0 Hz, 1H), 4.55 (dd, J = 13.1 Hz, 1H), 3.42 (d, J = 13.5 Hz, 1H), 3.02 (t, J = 11.8 Hz, 2H), 2.61 (t, J = 10.9 Hz, 1H), 2.01 (d, J = 11.6 Hz, 1H), 1.74 (m, 5H), 1.50 (d, J = 11.5 Hz, 2H), 1.29 (s, 9H). ^13C NMR (100 MHz, CDCl_3) δ 184.5, 172.2, 141.5, 131.5, 130.9, 129.0, 125.7, 125.2, 125.2, 123.0, 119.4, 66.3, 62.9, 58.3, 41.8, 32.7, 32.2, 29.9, 26.3, 23.7, 22.9. ^19F NMR (376 MHz, CDCl_3) δ -62.4 (s). HRMS (ESI) calculated for C_{23}H_{30}F_3NNaO_3S^+ [M+Na]^+: 480.1791, found 480.1788.

(S,E)-allyl 2-(((R)-tert-butylsulfinyl)imino) -1-(naphthalen-2-ylmethyl) cycloheptane carboxylate 3p (350 mg, 88% yield) as a pale yellow oil: [α]_D^20 = -86.52 (c 1.0, CHCl_3). IR (KBr)
\( \nu_{\text{max}}: \) 2953, 2943, 2871, 1736, 1621, 1603, 1521, 1465, 1267, 1175, 1064, 983, 854, 807, 751, 712 cm\(^{-1}\).\(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.67 – 7.56 (m, 3H), 7.42 (s, 1H), 7.29 (p, \( J = 7.5 \) Hz, 2H), 7.07 (d, \( J = 8.4 \) Hz, 1H), 5.76 (dq, \( J = 11.0, 5.9 \) Hz, 1H), 5.13 (dt, \( J = 17.7, 12.3 \) Hz, 2H), 4.48 (qd, \( J = 13.1, 6.1 \) Hz, 2H), 3.40 (d, \( J = 13.7 \) Hz, 1H), 2.99 (d, \( J = 13.7 \) Hz, 1H), 2.82 (t, \( J = 8.8 \) Hz, 1H), 2.56 – 2.41 (m, 1H), 1.89 (dd, \( J = 13.3, 9.9 \) Hz, 1H), 1.77 – 1.46 (m, 5H), 1.42 – 1.28 (m, 2H), 1.17 (s, 9H).\(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 185.2, 172.6, 134.7, 133.4, 132.4, 131.8, 129.4, 128.7, 127.8, 127.7, 126.1, 125.7, 119.2, 66.1, 63.2, 58.2, 42.4, 33.0, 32.2, 29.9, 26.4, 23.8, 23.0. HRMS (ESI) calculated for C\(_{26}\)H\(_{33}\)NNaO\(_3\)S\(^{+}\) [M+Na\(^+\)]: 462.2073, found 462.2075.

(S, E)-Allyl-2-(((R)-tert-butylsulfinyl) imino)-1-isopentylcycloheptane-carboxylate 3q: [\( \alpha \)]\(_D\)\(^{26}\) = - 55.64 (c 2.0, CHCl\(_3\)). IR (KBr) \( \nu_{\text{max}}: \) 2960, 2931, 2862, 1733, 1638, 1603, 1455, 1269, 1203, 1100, 802 cm\(^{-1}\).\(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 5.88 (qd, \( J = 10.9, 5.7 \) Hz, 1H), 5.26 (dd, \( J = 33.3, 13.8 \) Hz, 2H), 4.65 – 4.53 (m, 2H), 2.98 (t, \( J = 10.3 \) Hz, 1H), 2.72 (t, \( J = 10.6 \) Hz, 1H), 2.19 (dd, \( J = 14.2, 8.8 \) Hz, 1H), 1.95 (t, \( J = 12.7 \) Hz, 1H), 1.84 (s, 1H), 1.72 (m, 3H), 1.60 (m, 2H), 1.54 – 1.42 (m, 3H), 1.25 (s, 9H), 1.22 – 1.15 (m, 1H), 1.09 – 1.00 (m, 1H), 0.86 (d, \( J = 6.5 \) Hz, 6H).\(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 186.1, 173.3, 132.0, 118.7, 65.7, 62.0, 57.9, 35.0, 33.7, 33.6, 33.1, 30.2, 28.8, 27.0, 24.5, 22.9, 22.7. HRMS (ESI) calculated for C\(_{20}\)H\(_{35}\)NNaO\(_3\)S\(^{+}\) [M+Na\(^+\)]: 392.2230, found 392.2229.

(R, E)-Allyl-1-butyl-2-(((R)-tert-butylsulfinyl)imino) cycloheptanecarboxylate 3r: [\( \alpha \)]\(_D\)\(^{20}\) = - 287.27 (c 0.5, CHCl\(_3\)). IR (KBr) \( \nu_{\text{max}}: \) 2962, 2937, 2860, 1732, 1649, 1607, 1456, 1263, 1200, 1091, 1019, 801 cm\(^{-1}\).\(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 5.88 (dd, \( J = 16.3, 10.9, 5.8 \) Hz, 1H), 5.37 – 5.18 (m, 2H), 4.61 (dd, \( J = 13.3, 5.7 \) Hz, 1H), 4.55 (dd, \( J = 13.3, 5.8 \) Hz, 1H), 3.05 – 2.93 (m, 2H), 2.72 (dd, \( J = 12.3, 9.2, 3.0 \) Hz, 1H), 2.20 (dd, \( J = 14.1, 8.9 \) Hz, 1H), 1.97 – 1.79 (m, 2H), 1.78 – 1.59 (m, 5H), 1.49 (dd, \( J = 22.4, 14.5 \) Hz, 2H), 1.33 – 1.19 (m, 13H), 0.88 (t, \( J = 7.0 \) Hz, 3H).\(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 186.1, 173.4, 132.0, 118.7, 65.7, 62.0, 57.9, 35.0, 33.9, 33.1, 30.2, 26.9, 24.6, 23.4, 22.9, 14.1. HRMS (ESI) calculated for C\(_{19}\)H\(_{33}\)NNaO\(_3\)S\(^{+}\) [M+Na\(^+\)]: 378.2076, found 378.2076.

(S, E)-Allyl-1-(but-2-yn-1-yl)-2-(((R)-tert-butylsulfinyl) imino) cycloheptane-carboxylate 3s: [\( \alpha \)]\(_D\)\(^{29}\) = - 142.84 (c 2.0, CHCl\(_3\)). IR (KBr) \( \nu_{\text{max}}: \) 2926, 2860, 1737, 1621, 1455, 1361, 1260, 1192, 1178, 1082, 994, 932, 802 cm\(^{-1}\).\(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 5.86 (dq, \( J = 10.7, 5.7 \) Hz, 1H), 5.12 (dt, \( J = 17.7, 12.3 \) Hz, 2H), 4.92 (qd, \( J = 13.1, 6.1 \) Hz, 2H), 3.40 (d, \( J = 13.7 \) Hz, 1H), 2.99 (d, \( J = 13.7 \) Hz, 1H), 2.82 (t, \( J = 8.8 \) Hz, 1H), 2.56 – 2.41 (m, 1H), 1.89 (dd, \( J = 13.3, 9.9 \) Hz, 1H), 1.77 – 1.46 (m, 5H), 1.42 – 1.28 (m, 2H), 1.17 (s, 9H).\(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 185.2, 172.6, 134.7, 133.4, 132.4, 131.8, 129.4, 128.7, 127.8, 127.7, 126.1, 125.7, 119.2, 66.1, 63.2, 58.2, 42.4, 33.0, 32.2, 29.9, 26.4, 23.8, 23.0. HRMS (ESI) calculated for C\(_{26}\)H\(_{33}\)NNaO\(_3\)S\(^{+}\) [M+Na\(^+\)]: 462.2073, found 462.2075.
Hz, 1H), 5.25 (dd, J = 39.1, 13.8 Hz, 2H), 4.59 (m, 2H), 3.29 (dd, J = 11.2, 5.0 Hz, 1H), 2.90 (d, J = 16.6 Hz, 1H), 2.55 – 2.37 (m, 2H), 2.23 (dd, J = 14.9, 9.6 Hz, 1H), 2.08 (dd, J = 14.8, 9.7 Hz, 1H), 1.82 – 1.72 (m, 6H), 1.63 – 1.49 (m, 2H), 1.41 – 1.31 (m, 1H), 1.24 (s, 9H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 183.9, 171.9, 131.8, 118.6, 78.6, 75.2, 66.1, 61.6, 58.2, 32.5, 32.4, 30.1, 26.8, 26.1, 23.8, 22.8, 3.6. HRMS (ESI) calculated for C\(_{19}\)H\(_{29}\)NNaO\(_3\)S\(^+\) [M+Na\(^+\)]: 374.1760, found 374.1759.

\(3t\) (S, E)-Allyl-2-(((R)-tert-butylsulfinyl)imino)-1-(prop-2-yn-1-yl) cycloheptane-carboxylate \(3t\):

\([\alpha]_D^20 = -198.40\) (c 1.0, CHCl\(_3\)). IR (KBr) \(\nu\) max: 2928, 2859, 1737, 1621, 1455, 1362, 1260, 1191, 1151, 1082, 936, 802, 688, 641 cm\(^{-1}\). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 5.86 (dq, J = 11.0, 5.8 Hz, 1H), 5.26 (dd, J = 36.2, 13.8 Hz, 2H), 4.66 – 4.60 (dd, J = 13.3, 5.8 Hz, 1H), 4.58-4.55 (dd, J = 13.3, 5.8 Hz, 1H), 3.41 – 3.30 (m, 1H), 2.98 (d, J = 16.8 Hz, 1H), 2.57 – 2.46 (m, 2H), 2.29 (dd, J = 14.8, 9.8 Hz, 1H), 2.12 (dd, J = 14.7, 9.6 Hz, 1H), 2.00 (s, 1H), 1.80 (m, 2H), 1.66 – 1.53 (m, 2H), 1.44 – 1.29 (m, 2H), 1.25 (s, 9H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 183.5, 171.6, 131.6, 118.9, 80.7, 71.3, 66.3, 61.3, 58.3, 32.3, 32.3, 30.1, 26.3, 26.1, 23.8, 22.9. HRMS (ESI) calculated for C\(_{18}\)H\(_{27}\)NNaO\(_3\)S\(^+\) [M+Na\(^+\)]: 360.1604, found 360.1601.

\(3u\) (S, E)-Allyl-2-(((R)-tert-butylsulfinyl)imino)-1-(3-methylbut-2-en-1-yl) cycloheptancarboxylate \(3u\):

\([\alpha]_D^27 = -69.25\) (c 1.0, CHCl\(_3\)). IR (KBr) \(\nu\) max: 2937, 2866, 1730, 1618, 1462, 1359, 1257, 1201, 1079, 1019, 921, 801 cm\(^{-1}\). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 5.85 (ddd, J = 16.0, 10.7, 5.5 Hz, 1H), 5.29 (d, J = 17.2 Hz, 1H), 5.21 (d, J = 10.4 Hz, 1H), 5.04 (s, 1H), 4.56 (ddd, J = 33.0, 13.1, 5.4 Hz, 2H), 3.20 – 3.05 (m, 1H), 2.73 – 2.54 (m, 2H), 2.35 (dd, J = 14.0, 8.2 Hz, 1H), 2.15 – 2.06 (m, 1H), 1.73 (d, J = 12.3 Hz, 5H), 1.63 (m, 7H), 1.42 (d, J = 9.0 Hz, 1H), 1.26 (s, 9H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 185.3, 173.0, 135.1, 131.9, 119.4, 118.8, 65.9, 62.2, 58.1, 35.0, 32.8, 30.2, 26.5, 26.2, 24.1, 22.9, 22.5, 18.1. HRMS (ESI) calculated for C\(_{20}\)H\(_{33}\)NNaO\(_3\)S\(^+\) [M+Na\(^+\)]: 390.2073, found 390.2077.

References:
3. The reduction of N-tert-butanesulfinyl imines

Representative Procedure:
In a round bottom flask, a solution of compound 3a (0.2 g, 0.63 mmol) in THF: MeOH (10:1) (7.5 mL) was added NaBH₄ (61.8 mg, 1.62 mmol) in a nitrogen atmosphere at 0 °C. The mixture was kept stirring at room temperature 0.5 hours. After the substrate was completely consumed (monitored by TLC analysis), the reaction mixture was quenched with saturated NH₄Cl (50 mL), and extracted by ethyl acetate (3 x 50 mL). The combined organic phase was dried over Na₂SO₄, and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel (petroleum ether: ethyl acetate = 4:1) to furnish the desired compound 2a (268 mg, 91% yield) as a colorless oil: [α]_D^25 = -99.42 (c 0.31, CHCl₃). IR (KBr) ν_max: 2958, 2926, 2856, 1729, 1456, 1261, 1074, 702 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 7.21 (ddd, J = 10.1, 8.5, 5.4 Hz, 3H), 7.06 (d, J = 6.6 Hz, 2H), 5.81 (ddt, J = 16.4, 10.5, 5.9 Hz, 1H), 5.30 – 5.16 (m, 2H), 4.57 – 4.44 (m, 2H), 4.35 (d, J = 1.7 Hz, 1H), 3.84 (dd, J = 11.9, 3.9 Hz, 1H), 3.23 (d, J = 13.8 Hz, 1H), 2.54 (d, J = 13.8 Hz, 1H), 2.36 – 2.23 (m, 1H), 1.95 (dd, J = 12.2, 6.5 Hz, 1H), 1.86 – 1.73 (m, 4H), 1.27 (s, 9H). ¹³C NMR (101 MHz, CDCl₃) δ 175.4, 137.5, 131.7, 129.9, 128.4, 126.8, 119.1, 65.7, 59.9, 57.9, 55.8, 36.1, 29.4, 28.7, 22.8, 19.5. HRMS (ESI) calculated for C₂₀H₂₉NNaO₃S⁺ [M+Na]+: 386.1760, found 386.1758.

(1S,2R)-allyl 1-(3-chlorobenzyl)-2-((R)-1,1-dimethylethylsulfinamido)cyclopentane-carboxylate 2b: Prepared using the representative procedure above from compound 3b (0.30 g, 0.75mmol). Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2b (284 mg, 95% yield) as a pale yellow oil: [α]_D^25 = -104.43 (c 3.9, CHCl₃). IR (KBr) ν_max: 2958, 2926, 2856, 1729, 1456, 1261, 1074, 702 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 7.20 – 7.13 (m, 2H), 7.05 (s, 1H), 6.94 (d, J = 4.5 Hz, 1H), 5.81 (dq, J = 10.9, 6.0 Hz, 1H), 5.30 – 5.17 (m, 2H), 4.51 (d, J = 5.9 Hz, 2H), 4.30 (s, 1H), 3.82 (t, J = 7.4 Hz, 1H), 3.20 (d, J = 13.7 Hz, 1H), 2.49 (d, J = 13.7 Hz, 1H), 2.29 (dd, J = 14.3, 7.4 Hz, 1H), 2.02 – 1.78 (m, 3H), 1.77 – 1.67 (m, 2H), 1.25 (s, 9H). ¹³C NMR (101 MHz, CDCl₃) δ 175.1, 139.6, 134.2, 131.5, 129.9, 129.6, 128.1, 127.0, 119.5, 65.9, 60.0, 57.7, 55.9, 35.8, 29.3, 28.7, 22.8, 19.5. HRMS (ESI) calculated for C₂₀H₂₆ClNNaO₃S⁺ [M+Na]+: 420.1371, found 420.1374.
(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-(3-methylbenzyl) cyclopentane-carboxylate 2c: Prepared using the representative procedure above from compound 3c (0.30 g, 0.80 mmol). Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2c (295 mg, 98% yield) as a pale yellow oil: [α]25° = -140.83 (c 2.5, CHCl3). IR (KBr) νmax: 2958, 2926, 2856, 1729, 1456, 1261, 1074, 702 cm⁻¹. ¹H NMR (400 MHz, CDCl3) δ 7.12 (t, J = 7.5 Hz, 1H), 7.01 (d, J = 7.5 Hz, 1H), 6.85 (d, J = 7.9 Hz, 2H), 5.81 (dq, J = 10.6, 5.9 Hz, 1H), 5.22 (t, J = 13.1 Hz, 2H), 4.51 (d, J = 5.8 Hz, 2H), 4.36 (s, 1H), 3.82 (t, J = 7.2 Hz, 1H), 3.19 (d, J = 13.7 Hz, 1H), 2.50 (d, J = 13.7 Hz, 1H), 2.34 – 2.24 (m, 4H), 1.96 – 1.90 (m, 1H), 1.85 – 1.72 (m, 4H), 1.26 (s, 9H). ¹³C NMR (101 MHz, CDCl3) δ 175.4, 137.9, 137.4, 131.7, 130.6, 128.2, 127.5, 126.9, 119.1, 65.6, 59.9, 57.8, 55.8, 36.0, 29.3, 28.7, 22.8, 21.5, 19.5. HRMS (ESI) calculated for C21H31NNaO3S⁺ [M+Na⁺]: 400.1917, found 400.1919.

(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-(4-(trifluoromethyl) benzyl) cyclopentane-carboxylate 2d: Prepared using the representative procedure above from compound 3d (0.30 g, 0.699 mmol). Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2d (296 mg, 98% yield) as a pale yellow oil: [α]25° = -53.41 (c 2.1, CHCl3). IR (KBr) νmax: 2961, 1727, 1619, 1326, 1164, 1117, 1068, 600 cm⁻¹. ¹H NMR (400 MHz, CDCl3) δ 7.50 (d, J = 8.1 Hz, 2H), 7.19 (d, J = 8.0 Hz, 2H), 5.79 (ddt, J = 16.4, 10.5, 5.9 Hz, 1H), 5.26 – 5.16 (m, 2H), 4.51 (d, J = 5.9 Hz, 2H), 4.26 (d, J = 2.6 Hz, 1H), 3.92 – 3.78 (m, 1H), 3.29 (d, J = 13.7 Hz, 1H), 2.60 (d, J = 13.7 Hz, 1H), 2.40 – 2.24 (m, 1H), 1.99 (dt, J = 12.2, 8.2 Hz, 1H), 1.84 – 1.72 (m, 4H), 1.26 (s, 9H). ¹³C NMR (101 MHz, CDCl3) δ 175.0, 141.9, 131.5, 130.2, 129.0, 125.7, 125.3, 123.0, 120.3, 119.3, 65.8, 60.3, 57.8, 55.9, 36.0, 29.6, 28.8, 22.8, 19.6. ¹⁹F NMR (376 MHz, CDCl3) δ -62.4 (s). HRMS (ESI) calculated for C21H28F3NNaO3S⁺ [M+Na⁺]: 454.1634, found 454.1635.

(1S,2R)-allyl 2-((R)-1,1-dimethylethyl- sulfinamido) -1- (3-methylbut-2-en-1-yl) cyclopentane-carboxylate 2e: Prepared using the representative procedure above from compound 3e (0.30 g, 0.88 mmol). Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2e (244 mg, 81% yield) as a pale yellow oil: [α]25° = -53.41 (c
2.1, CHCl₃). IR (KBr) ν max: 2959, 2926, 2876, 1728, 1454, 1378, 1226, 1175, 1075, 932, 592 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 5.97 – 5.82 (m, 1H), 5.28 (dd, J = 30.8, 13.8 Hz, 2H), 5.03 (t, J = 7.0 Hz, 1H), 4.62 – 4.50 (m, 2H), 4.11 (s, 1H), 3.83 (d, J = 8.9 Hz, 1H), 2.50 (dd, J = 14.5, 6.7 Hz, 1H), 2.27 – 2.15 (m, 1H), 2.08 (dd, J = 13.5, 7.1 Hz, 2H), 1.82 – 1.69 (m, 4H), 1.68 (s, 3H), 1.59 (s, 3H), 1.22 (s, 9H).¹³C NMR (101 MHz, CDCl₃) δ 175.6, 134.8, 132.1, 119.4, 118.8, 65.6, 59.6, 56.7, 55.7, 30.9, 29.5, 29.4, 26.1, 22.8, 20.0, 18.1. HRMS (ESI) calculated for C₁₈H₃₁NNaO₃S⁺ [M+Na]+: 364.1917, found 364.1918.

(1S,2R)-allyl 1-allyl-2-((R)-1,1-dimethylethylsulfinamido) cyclopentanecarboxylate 2f:
Prepared using the representative procedure above from compound 3f (0.30 g, 0.96 mmol). Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2f (280 mg, 93% yield) as a pale yellow oil: [α]²⁵D = -79.76 (c 1.5, CHCl₃). IR (KBr) ν max: 2961, 2936, 2897, 1735, 1464, 1348, 1235, 1196, 1077, 940, 593 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 5.90 (ddt, J = 16.3, 10.4, 5.8 Hz, 1H), 5.77 – 5.63 (m, 1H), 5.36 – 5.21 (m, 2H), 5.11 – 5.01 (m, 2H), 4.58 (d, J = 5.8 Hz, 2H), 4.05 (s, 1H), 3.90 – 3.72 (m, 1H), 2.58 (dd, J = 13.6, 6.3 Hz, 1H), 2.25 – 2.18 (m, 1H), 2.13 – 2.04 (m, 2H), 1.82 (dt, J = 13.2, 6.7 Hz, 2H), 1.75 – 1.71 (m, 1H), 1.67 – 1.59 (m, 1H), 1.22 (s, 9H).¹³C NMR (100 MHz, CDCl₃) δ 175.3, 134.1, 132.0, 119.0, 118.4, 65.7, 59.9, 56.2, 55.7, 35.5, 30.8, 29.4, 22.8, 19.8. HRMS (ESI) calculated for C₁₆H₂₇NNaO₃S⁺ [M+Na]+: 336.1604, found 336.1605.

(1S,2S)-allyl 1-(but-2-yn-1-yl)-2-((R)-1,1-dimethylethylsulfinamido) cyclopentanecarboxylate 2g:
Prepared using the representative procedure above from compound 3g (0.30 g, 0.93 mmol). Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2g (275 mg, 91% yield) as a pale yellow oil: [α]²⁷D = -80.69 (c 2.69, CHCl₃). IR (KBr) ν max: 2972, 2954, 2887, 1765, 1473, 1368, 1259, 1146, 1067, 965, 613 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 5.90 (ddt, J = 22.7, 10.9, 5.7 Hz, 1H), 5.33 (dd, J = 17.2, 1.2 Hz, 1H), 5.22 (d, J = 10.4 Hz, 1H), 4.68 – 4.54 (m, 2H), 4.24 (d, J = 4.7 Hz, 1H), 4.00 (dt, J = 12.2, 6.2 Hz, 1H), 2.59 (dd, J = 16.7, 2.4 Hz, 1H), 2.42 (dd, J = 16.7, 2.5 Hz, 1H), 2.27 – 2.08 (m, 2H), 2.04 – 1.93 (m, 1H), 1.74 (t, J = 2.4 Hz, 3H), 1.72 – 1.56 (m, 3H), 1.20 (s, 9H).¹³C NMR (101 MHz, CDCl₃) δ 175.1, 132.1, 118.5, 78.5, 76.0, 65.8, 60.5, 55.7, 55.4, 33.5, 31.3, 22.8, 22.8, 20.9, 3.6. HRMS (ESI) calculated for C₁₇H₂₇NNaO₃S⁺ [M+Na]+: 348.1604, found 348.1601.
(1S,2S)-allyl 2-((R)-1,1-dimethylsulfinamido)-1-(prop-2-yn-1-yl) cyclopentane-2-carboxylate 2h: Prepared using the representative procedure above from compound 3h (0.30 g, 0.96 mmol). Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2h (254 mg, 85% yield) as a pale yellow oil: [α]_D^25 = -97.97 (c 0.73, CHCl_3). IR (KBr) ν_max: 2978, 2964, 2891, 1772, 1359, 1263, 1151, 1086, 971, 653 cm⁻¹. ¹H NMR (400 MHz, CDCl_3) δ 5.92 (ddt, J = 16.2, 10.5, 5.7 Hz, 1H), 5.34 (dd, J = 17.2, 2.9, 1.4 Hz, 1H), 5.24 (dd, J = 10.4, 1.2 Hz, 1H), 4.63 (dt, J = 5.7, 1.3 Hz, 2H), 4.15 (d, J = 5.1 Hz, 1H), 4.03 (ddd, J = 9.3, 7.5, 5.3 Hz, 1H), 2.69 (dd, J = 16.9, 2.6 Hz, 1H), 2.50 (dd, J = 17.0, 2.7 Hz, 1H), 2.30 – 2.13 (m, 2H), 2.10 – 1.99 (m, 1H), 1.82 – 1.62 (m, 4H), 1.21 (s, 9H). ¹³C NMR (101 MHz, CDCl_3) δ 174.8, 132.0, 118.8, 81.5, 71.2, 66.0, 60.8, 55.9, 55.1, 33.4, 31.2, 22.8, 22.4, 20.8. HRMS (ESI) calculated for C_{16}H_{25}NNaO_{3}S^+ [M+Na]^+: 334.1447, found 334.1449.

(1R,2R)-allyl 1-butyl-2-((R)-1,1-dimethylsulfinamido) cyclopentane-2-carboxylate 2i: Prepared using the representative procedure above from compound 3i (0.30 g, 0.91 mmol). Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2i (285 mg, 90% yield) as a pale yellow oil: [α]_D^25 = -75.80 (c 2.3, CHCl_3). IR (KBr) ν_max: 2938, 2891, 1736, 1458, 1324, 1217, 1095, 812 cm⁻¹. ¹H NMR (400 MHz, CDCl_3) δ 5.92 (dq, J = 10.6, 5.8 Hz, 1H), 5.29 (dd, J = 31.6, 13.8 Hz, 2H), 4.60 (dt, J = 9.3 Hz, 2H), 4.00 (s, 1H), 3.79 (d, J = 8.4 Hz, 1H), 2.26 – 2.07 (m, 2H), 1.89 – 1.61 (m, 6H), 1.34 – 1.27 (m, 4H), 1.23 (s, 9H), 0.88 (t, J = 6.5 Hz, 3H). ¹³C NMR (101 MHz, CDCl_3) δ 175.9, 132.0, 118.9, 65.5, 59.7, 56.7, 55.7, 30.8, 30.6, 29.3, 27.2, 23.3, 22.8, 20.1, 14.1. HRMS (ESI) calculated for C_{17}H_{31}NNaO_{3}S^+ [M+Na]^+: 352.1917, found 352.1919.

Allyl-(1R,2R)-1-butyl-2-(((R)-tert-butylsulfinyl) amino) cyclohexane-1-carboxylate 2j: Prepared using the representative procedure above from compound 3j (0.30 g, 0.87 mmol). Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2j (245 mg, 82% yield) as a pale yellow oil: [α]_D^25 = -81.10 (c 0.79, CHCl_3). IR (KBr) ν_max: 2958, 2874, 1731, 1463, 1357, 1231, 1068, 786 cm⁻¹. ¹H NMR (400 MHz, CDCl_3) δ 5.91 (qd, J = 11.0, 5.8 Hz, 1H), 5.38 – 5.18 (m, 2H), 4.60 (d, J = 5.8 Hz, 2H), 4.01 (s, 1H), 3.74 – 3.60 (m, 1H), 1.93 – 1.76 (m, 2H), 1.70 – 1.53 (m, 5H), 1.42 – 1.36 (m, 2H), 1.34 –
1.23 (m, 3H), 1.21 (s, 9H), 1.19 – 1.10 (m, 2H), 0.87 (t, J = 7.3 Hz, 3H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 175.6, 132.2, 118.8, 65.8, 55.6, 55.2, 50.5, 29.8, 28.1, 26.2, 23.3, 22.8, 22.3, 21.5, 14.1. HRMS (ESI) calculated for C\(_{18}\)H\(_{33}\)NNaO\(_3\)S\(^+\) [M+Na\(^+\)]: 366.2073, found 366.2075.

(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-(3-methylbut-2-en-1-yl) cyclohexancarboxylate 2\(k\): Prepared using the representative procedure above from compound 3\(k\) (0.30 g, 0.84 mmol). Purified by column chromatography silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2\(k\) (250.5 mg, 83% yield) as a pale yellow oil: [\(\alpha\)]\(^D\) = -69.13 (c 0.92, CHCl\(_3\)). IR (KBr) \(\nu_{\text{max}}\): 2931, 2864, 1729, 1453, 1363, 1223, 1070, 796 cm\(^{-1}\). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 5.90 (ddt, \(J\) = 16.3, 10.4, 5.8 Hz, 1H), 5.40 – 5.17 (m, 2H), 5.11 – 5.00 (m, 1H), 4.58 (ddd, \(J\) = 5.8, 3.2, 1.5 Hz, 2H), 4.24 (s, 1H), 3.69 (dt, \(J\) = 7.4, 3.6 Hz, 1H), 2.46 (dd, \(J\) = 14.8, 6.9 Hz, 1H), 2.32 (dd, \(J\) = 14.8, 7.8 Hz, 1H), 2.01 – 1.86 (m, 1H), 1.80 – 1.69 (m, 3H), 1.67 (d, \(J\) = 0.7 Hz, 3H), 1.60 (s, 3H), 1.56 – 1.29 (m, 4H), 1.22 (s, 9H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 175.5, 134.6, 132.2, 119.0, 118.7, 66.0, 59.9, 55.9, 54.6, 41.3, 33.8, 29.6, 29.2, 26.0, 23.1, 22.9. HRMS (ESI) calculated for C\(_{19}\)H\(_{33}\)NNaO\(_3\)S\(^+\) [M+Na\(^+\)]: 378.2073, found 378.2071.

(1S,2R)-allyl 1-(3-chlorobenzyl)-2-((R)-1,1-dimethylethylsulfinamido) cycloheptancarboxylate 2\(l\): Prepared using the representative procedure above from compound 3\(l\) (0.30 g, 0.72 mmol) with 5 equivalents of NaBH\(_4\). Purified by column chromatography silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2\(l\) (196 mg, 64% yield) as a pale yellow oil: [\(\alpha\)]\(^D\) = 73.18 (c 1.1, CHCl\(_3\)). IR (KBr) \(\nu_{\text{max}}\): 2930, 2865, 1637, 1460, 1326, 1164, 1124, 1068, 602 cm\(^{-1}\). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.48 (d, \(J\) = 7.8 Hz, 2H), 7.22 (d, \(J\) = 7.8 Hz, 2H), 5.82 (dq, \(J\) = 10.9, 5.9 Hz, 1H), 5.22 (dd, \(J\) = 13.1, 9.8 Hz, 2H), 4.56 (d, \(J\) = 5.8 Hz, 2H), 4.23 (d, \(J\) = 2.5 Hz, 1H), 3.85 (d, \(J\) = 4.2 Hz, 1H), 3.29 (d, \(J\) = 13.5 Hz, 1H), 2.79 (d, \(J\) = 13.5 Hz, 1H), 2.02 (dd, \(J\) = 14.8, 7.9 Hz, 1H), 1.89 (d, \(J\) = 5.9 Hz, 1H), 1.79 (d, \(J\) = 5.6 Hz, 3H), 1.62 (s, 1H), 1.52 (dd, \(J\) = 22.6, 11.9 Hz, 2H), 1.27 (s, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 175.6, 141.6, 131.6, 130.6, 125.1, 125.1, 119.2, 66.0, 59.9, 55.9, 54.6, 41.3, 33.8, 29.6, 29.2, 26.0, 23.1, 22.9. HRMS (ESI) calculated for C\(_{22}\)H\(_{32}\)ClINaO\(_3\)S\(^+\) [M+Na\(^+\)]: 448.1684, found 448.1682.
(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-(3-methylbenzyl) cycloheptane- carboxylate 2m: Prepared using the representative procedure above from compound 3m (0.30 g, 0.75mmol) with 5 equivalents of NaBH₄. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2m (249.3 mg, 82% yield) as a pale yellow oil: [α]²⁵D = -77.57 (c 2.8, CHCl₃). IR (KBr) νmax: 2931, 2875, 1652, 1447, 1319, 1175, 1128, 1069, 638 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ: 7.11 (t, J = 7.4 Hz, 1H), 7.00 (d, J = 7.4 Hz, 1H), 6.89 (d, J = 8.7 Hz, 2H), 5.85 (d, J = 10.9, 5.8 Hz, 1H), 5.23 (dd, J = 18.3, 14.0 Hz, 2H), 4.57 (d, J = 5.7 Hz, 2H), 4.40 (s, 1H), 3.81 (d, J = 6.9 Hz, 1H), 3.22 (d, J = 13.5 Hz, 1H), 2.66 (d, J = 13.5 Hz, 1H), 2.28 (s, 3H), 2.04 (dd, J = 14.7, 8.1 Hz, 1H), 1.92 (dd, J = 10.8, 4.3 Hz, 1H), 1.79 (dd, J = 17.9, 11.7 Hz, 3H), 1.71 – 1.59 (m, 1H), 1.49 (dd, J = 22.6, 10.7 Hz, 2H), 1.35 – 1.27 (m, 2H), 1.26 (s, 9H). ¹³C NMR (101 MHz, CDCl₃) δ: 176.1, 137.7, 137.1, 131.8, 131.0, 128.0, 127.4, 127.3, 118.9, 65.8, 59.5, 55.8, 54.3, 41.1, 33.9, 29.8, 28.9, 26.5, 23.1, 22.9, 21.5. HRMS (ESI) calculated for C₂₃H₃₅NNaO₃S⁺ [M+Na⁺]: 428.2230, found 428.2231.

(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-(4-nitrobenzyl) cycloheptane-carboxylate 2n: Prepared using the representative procedure above from compound 3n (0.30 g, 0.69 mmol) with 5 equivalents of NaBH₄. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2n (195 mg, 65% yield) as a pale yellow oil: [α]²⁵D = -64.25 (c 1.2, CHCl₃). IR (KBr) νmax: 2942, 2819, 1643, 1458, 1326, 1185, 1101, 1035, 738 cm⁻¹. ¹H NMR (400 MHz, Chloroform-d) δ: 8.09 (d, J = 8.6 Hz, 2H), 7.28 (d, J = 8.4 Hz, 2H), 5.84 (ddt, J = 16.5, 10.6, 5.9 Hz, 1H), 5.29 – 5.21 (m, 2H), 4.57 (dd, J = 5.8, 1.4 Hz, 2H), 4.16 (d, J = 4.4 Hz, 1H), 3.88 (dd, J = 7.9, 4.4 Hz, 1H), 3.33 (d, J = 13.3 Hz, 1H), 2.87 (d, J = 13.4 Hz, 1H), 2.00 (ddd, J = 14.9, 7.9, 2.1 Hz, 1H), 1.95 – 1.87 (m, 1H), 1.83 – 1.74 (m, 3H), 1.64 – 1.51 (m, 3H), 1.36 – 1.29 (m, 2H), 1.27 (s, 9H). ¹³C NMR (100 MHz, Chloroform-d) δ: 175.3, 147.0, 145.5, 131.5, 131.2, 123.4, 119.4, 66.1, 60.1, 56.0, 54.8, 41.6, 33.7, 29.5, 29.3, 25.7, 23.1, 22.9. HRMS (ESI) calculated for C₂₂H₂₃N₂NaO₅S⁺ [M+Na⁺]: 459.1924, found 459.1926.

(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-(4-(trifluoromethyl)benzyl) cycloheptane-carboxylate 2o: Prepared using the representative procedure above from compound 3o (0.30 g, 0.66 mmol) with 5 equivalents of NaBH₄. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2o (269.7 mg, 89% yield) as a pale yellow oil: [α]²⁵D = -76.77 (c 2.0, CHCl₃). IR (KBr)
$\nu_{\text{max}}$: 2987, 2859, 1673, 1462, 1351, 1169, 1045, 801 cm$^{-1}$. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.48 (d, $J$ = 8.1 Hz, 2H), 7.22 (d, $J$ = 8.0 Hz, 2H), 5.82 (ddt, $J$ = 16.3, 10.5, 5.9 Hz, 1H), 5.28 – 5.16 (m, 2H), 4.56 (d, $J$ = 5.9 Hz, 2H), 4.23 (d, $J$ = 3.8 Hz, 1H), 3.88 – 3.81 (m, 1H), 3.29 (d, $J$ = 13.5 Hz, 1H), 2.79 (d, $J$ = 13.5 Hz, 1H), 2.07 – 1.96 (m, 1H), 1.96 – 1.84 (m, 1H), 1.78 (td, $J$ = 11.2, 8.0 Hz, 4H), 1.69 – 1.60 (m, 1H), 1.56 – 1.46 (m, 2H), 1.27 (s, 9H).

$13$C NMR (101 MHz, CDCl$_3$) $\delta$ 175.6, 141.6, 131.6, 130.6, 129.2, 128.9, 125.7, 125.1, 125.1, 123.0, 120.3, 119.2, 66.0, 59.9, 59.89, 55.99, 54.7, 41.37, 33.8, 29.6, 29.2, 26.0, 23.1, 22.9. $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -62.4 (s). HRMS (ESI) calculated for C$_{23}$H$_{32}$F$_3$NNaO$_3$S$^+$ [M+Na$^+$]: 482.1947, found 482.1946.

(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-(naphthalen-2-ylmethyl) cycloheptane carboxylate **2p**: Prepared using the representative procedure above from compound 3p (0.30 g, 0.69 mmol) with 5 equivalents of NaBH$_4$. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2p (201 mg, 66% yield) as a pale yellow oil: $[\alpha]_D^{25} = -51.16$ (c 0.91, CHCl$_3$). IR (KBr) $\nu_{\text{max}}$: 3054, 2926, 2858, 1735, 1704, 1459, 1364, 1261, 819 cm$^{-1}$. $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.75 (ddd, $J$ = 21.5, 11.0, 7.5 Hz, 3H), 7.58 (s, 1H), 7.47 – 7.40 (m, 2H), 7.23 (dd, $J$ = 8.4, 1.6 Hz, 1H), 5.83 (ddt, $J$ = 16.5, 11.1, 5.9 Hz, 1H), 5.27 – 5.13 (m, 2H), 4.64 – 4.54 (m, 2H), 4.43 (d, $J$ = 3.2 Hz, 1H), 3.87 (dd, $J$ = 8.3, 3.1 Hz, 1H), 3.43 (d, $J$ = 13.6 Hz, 1H), 2.89 (d, $J$ = 13.5 Hz, 1H), 2.06 (dd, $J$ = 14.7, 8.1 Hz, 1H), 1.95 (dd, $J$ = 13.2, 8.8 Hz, 1H), 1.82 (dq, $J$ = 19.1, 10.2, 9.8 Hz, 3H), 1.62 – 1.33 (m, 5H), 1.29 (s, 9H). $^{13}$C NMR (100 MHz, Chloroform-$d$) $\delta$ 176.2, 134.9, 133.4, 132.4, 131.8, 129.0, 128.6, 127.7, 126.1, 125.6, 119.0, 66.0, 59.7, 55.9, 54.6, 41.4, 33.9, 29.9, 29.1, 26.5, 23.2, 22.9. HRMS (ESI) calculated for C$_{26}$H$_{35}$NNaO$_3$S$^+$ [M+Na$^+$]: 464.2230, found 464.2231.

(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-isopentyl cycloheptane carboxylate **2q**: Prepared using the representative procedure above from compound 3q (0.30 g, 0.81 mmol) with 5 equivalents of NaBH$_4$. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2q (280 mg, 93% yield) as a pale yellow oil: $[\alpha]_D^{25} = -85.51$ (c 1.6, CHCl$_3$). IR (KBr) $\nu_{\text{max}}$: 2953, 2867, 1730, 1464, 1365, 1075, 802 cm$^{-1}$. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 5.92 (dq, $J$ = 10.9, 5.7 Hz, 1H), 5.28 (dd, $J$ = 36.1, 13.8 Hz, 2H), 4.67 – 4.53 (m, 2H), 3.89 (d, $J$ = 2.8 Hz, 1H), 3.73 (d, $J$ = 6.6 Hz, 1H), 2.36 – 2.20 (m, 1H), 1.89 – 1.81 (m, 1H), 1.78 – 1.67 (m, 4H), 1.65 – 1.42 (m, 5H), 1.38 – 1.26 (m, 2H), 1.21 (s, 9H), 1.17 – 1.06 (m, 1H), 1.01 (dt, $J$ = 14.1, 6.4 Hz, 1H), 0.86 (d, $J$ = 6.6 Hz, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 176.1, 132.2, 118.7, 65.6, 59.0, 55.7, 53.6, 33.4, 33.4,
(1R,2R)-allyl 1-butyl-2-((R)-1,1-dimethylethylsulfinamido) cycloheptanecarboxylate 2r:
Prepared using the representative procedure above from compound 3r (0.30 g, 0.84 mmol) with 5 equivalents of NaBH₄. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2r (273 mg, 91% yield) as a pale yellow oil: [α]²⁵D = -57.60 (c 0.66, CHCl₃). IR (KBr) νmax: 2955, 2929, 2863, 1730, 1461, 1364, 1261, 1075, 801 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 5.78 (dq, J = 11.1, 5.8 Hz, 1H), 5.18 (d, J = 17.2 Hz, 1H), 5.09 (d, J = 10.4 Hz, 1H), 4.52 – 4.43 (m, 2H), 3.74 (d, J = 2.8 Hz, 1H), 3.60 – 3.58 (m, 1H), 2.13 (dd, J = 13.8, 7.3 Hz, 1H), 1.69 (dd, J = 16.4, 11.8, 5.2 Hz, 2H), 1.62 – 1.57 (m, 3H), 1.49 – 1.27 (m, 4H), 1.16 (dd, J = 20.4, 12.1, 7.5 Hz, 5H), 1.07 (s, 9H), 0.98 (ddd, J = 14.2, 9.6, 4.9 Hz, 1H), 0.73 (t, J = 7.1 Hz, 3H). ¹³C NMR (101 MHz, CDCl₃) δ 176.2, 132.2, 118.7, 65.7, 59.0, 55.8, 53.6, 34.9, 33.4, 29.9, 29.0, 26.7, 25.2, 23.4, 23.1, 22.9, 14.1. HRMS (ESI) calculated for C₁₉H₃₅NNaO₃S⁺ [M+Na]⁺: 380.2230, found 380.2231.

(1S,2R)-allyl 1-(but-2-yn-1-yl)-2-((R)-1,1-dimethylethylsulfinamido) cycloheptanecarboxylate 2s:
Prepared using the representative procedure above from compound 3s (0.30 g, 0.84 mmol) with 5 equivalents of NaBH₄. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2s (271 mg, 90% yield) as a pale yellow oil: [α]²⁵D = -82.34 (c 0.73, CHCl₃). IR (KBr) νmax: 2926, 2861, 1730, 1459, 1364, 1172, 1071, 599 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 5.94 (ddd, J = 16.2, 10.9, 5.7 Hz, 1H), 5.34 (dd, J = 17.2, 1.5 Hz, 1H), 5.23 (dd, J = 10.4, 1.2 Hz, 1H), 4.65 (dt, J = 5.7, 1.3 Hz, 2H), 4.16 (d, J = 5.0 Hz, 1H), 3.93 (ddd, J = 7.7, 5.1, 2.4 Hz, 1H), 2.68 – 2.55 (m, 1H), 2.47 (dt, J = 14.2, 2.5 Hz, 1H), 2.27 (dd, J = 13.9, 7.9 Hz, 1H), 1.87 – 1.77 (m, 3H), 1.75 (t, J = 2.5 Hz, 4H), 1.71 – 1.39 (m, 5H), 1.21 (s, 9H). ¹³C NMR (101 MHz, CDCl₃) δ 175.2, 132.2, 118.3, 78.8, 75.7, 65.0, 59.5, 55.7, 53.4, 35.0, 30.9, 29.4, 26.6, 25.1, 23.0, 22.8, 3.7. HRMS (ESI) calculated for C₁₉H₃₁NNaO₃S⁺ [M+Na]⁺: 376.1917, found 376.1919.

(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-(prop-2-yn-1-yl) cycloheptanecarboxylate 2t:
Prepared using the representative procedure above from compound 3t (0.30 g, 0.84 mmol) with 5 equivalents of NaBH₄. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2t (273 mg, 91% yield) as a pale yellow oil: [α]²⁵D = -57.60 (c 0.66, CHCl₃). IR (KBr) νmax: 2955, 2929, 2863, 1730, 1461, 1364, 1261, 1075, 801 cm⁻¹. ¹H NMR (400 MHz, CDCl₃) δ 5.78 (dq, J = 11.1, 5.8 Hz, 1H), 5.18 (d, J = 17.2 Hz, 1H), 5.09 (d, J = 10.4 Hz, 1H), 4.52 – 4.43 (m, 2H), 3.74 (d, J = 2.8 Hz, 1H), 3.60 – 3.58 (m, 1H), 2.13 (dd, J = 13.8, 7.3 Hz, 1H), 1.69 (dd, J = 16.4, 11.8, 5.2 Hz, 2H), 1.62 – 1.57 (m, 3H), 1.49 – 1.27 (m, 4H), 1.16 (dd, J = 20.4, 12.1, 7.5 Hz, 5H), 1.07 (s, 9H), 0.98 (ddd, J = 14.2, 9.6, 4.9 Hz, 1H), 0.73 (t, J = 7.1 Hz, 3H). ¹³C NMR (101 MHz, CDCl₃) δ 176.2, 132.2, 118.7, 65.7, 59.0, 55.8, 53.6, 34.9, 33.4, 29.9, 29.0, 26.7, 25.2, 23.4, 23.1, 22.9, 14.1. HRMS (ESI) calculated for C₁₉H₃₅NNaO₃S⁺ [M+Na]⁺: 380.2230, found 380.2231.
g, 0.9 mmol) with 5 equivalents of NaBH₄. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2t (232 mg, 76% yield) as a pale yellow oil: [α]₀²⁵ = -72.85 (c 0.63, CHCl₃). IR (KBr) νₚₑₐₓₐ: 2928, 2864, 1729, 1460, 1172, 1066, 640 cm⁻¹. 

¹H NMR (400 MHz, CDCl₃) δ 6.00 – 5.85 (m, 1H), 5.33 (dt, J = 11.0, 5.5 Hz, 1H), 5.28 – 5.18 (m, 1H), 4.66 (dd, J = 5.7, 1.3 Hz, 2H), 4.02 (d, J = 5.4 Hz, 1H), 3.93 (dd, J = 7.4, 5.5, 1.8 Hz, 1H), 2.70 (dd, J = 16.9, 2.7 Hz, 1H), 2.54 (dd, J = 16.9, 2.7 Hz, 1H), 2.36 – 2.25 (m, 1H), 2.02 (t, J = 7.2 Hz, 1H), 1.93 – 1.84 (m, 1H), 1.84 – 1.72 (m, 3H), 1.73 – 1.62 (m, 3H), 1.61 – 1.48 (m, 2H), 1.21 (s, 9H). ¹³C NMR (101 MHz, CDCl₃) δ 174.8, 132.0, 118.5, 81.1, 71.3, 66.0, 59.6, 55.7, 53.1, 34.7, 30.9, 29.2, 26.4, 24.5, 22.8, 22.7. HRMS (ESI) calculated for C₁₈H₂₉NNaO₃S⁺ [M+Na⁺]: 362.1760, found 362.1763.

NH₂
S
O
O
2u
(1S,2R)-allyl 2-((R)-1,1-dimethylethylsulfinamido)-1-(3-methylbut-2-en-1-yl) cycloheptane-carboxylate 2u: Prepared using the representative procedure above from compound 3u (0.30 g, 0.81 mmol) with 5 equivalents of NaBH₄. Purified by column chromatography on silica gel (petroleum ether: ethyl acetate = 5:1) to afford 2u (239 mg, 80% yield) as a pale yellow oil: [α]₀²⁵ = -69.38 (c 1.1, CHCl₃). IR (KBr) νₚₑₐₓₐ: 2927, 2863, 1731, 1457, 1169, 1074, 600 cm⁻¹. 

4. The construction of cyclic β-amino acids

Representative Procedure:

In a round bottom flask, a solution of compound 2a (0.20 g, 0.55 mmol) in THF (5.5 mL) was added Morpholine (96 µL, 1.1 mmol), Pd(PPh₃)₄ (32 mg, 0.027 mmol). The mixture was kept stirring at room temperature 5 hours. After the substrate was completely consumed (monitored by TLC analysis), the reaction mixture was washed with 1N HCl (15 mL), and extracted by ethyl acetate (3 x 15 mL). The combined organic phase was dried over Na₂SO₄, and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel (DCM: MeOH = 50: 1) obtain the intermediate acid-M.

The acid-M was then treated with 4N HCl in dioxane (1.7 mL), and was kept stirring at
room temperature 3 hours. After the substrate was completely consumed (monitored by TLC analysis), added ethyl acetate to induce precipitation, then filtrated to get the desired compound 1a (121 mg) as pale yellow solid with an overall yield of 87% of two steps: [α]$_{25}$D = -43.23 (c 0.54, H$_2$O). m. p. 215-217 °C. IR (KBr) v$_{max}$: 2829, 2579, 1737, 1625, 1336, 1191, 1107, 1059, 860 cm$^{-1}$. 1H NMR (400 MHz, D$_2$O) δ 7.50 – 7.35 (m, 3H), 7.35 – 7.25 (m, 2H), 3.99 (t, J = 7.9 Hz, 1H), 3.15 (d, J = 12.9 Hz, 1H), 2.88 (d, J = 12.9 Hz, 1H), 2.31 (dd, J = 12.8, 8.8, 4.7 Hz, 1H), 2.10 – 1.72 (m, 5H). 13C NMR (101 MHz, D$_2$O) δ 178.1, 136.0, 129.9, 128.7, 127.4, 57.2, 56.1, 36.0, 30.2, 27.8, 19.0. HRMS (ESI) calculated for C$_{13}$H$_{18}$NO$_2^+$ [M+H]$^+$: 220.1332, found 220.1334.

(1S,2R)-2-amino-1-(4-(trifluoromethyl) benzyl) cyclopentanecarboxylic acid hydrochloride 1d: Prepared using the representative procedure above from compound 2d (0.20 g, 0.46 mmol), compound 1d (126 mg) was obtained as pale yellow solid with an overall yield of 85% of two steps. [α]$_{25}$D = -29.56 (c 0.32, H$_2$O). m. p. 177-178 °C. IR (KBr) v$_{max}$: 2833, 2585, 1727, 1614, 1496, 1326, 1171, 1107, 1067, 849 cm$^{-1}$. 1H NMR (400 MHz, D$_2$O) δ 7.70 (d, J = 8.1 Hz, 2H), 7.43 (d, J = 8.0 Hz, 2H), 4.00 (t, J = 7.8 Hz, 1H), 3.22 (d, J = 12.9 Hz, 1H), 2.94 (d, J = 12.9 Hz, 1H), 2.39 – 2.23 (m, 1H), 2.02 – 1.88 (m, 3H), 1.89 – 1.74 (m, 2H). 13C NMR (101 MHz, D$_2$O) δ 177.5, 140.3, 130.3, 129.0, 125.6, 125.3, 122.9, 120.2, 57.2, 56.0, 35.7, 29.2, 27.8, 19.0. 19F NMR (376 MHz, D$_2$O) δ -62.4 (s). HRMS (ESI) calculated for C$_{14}$H$_{17}$F$_3$NO$_2^+$ [M+H]$^+$: 288.1206, found 288.1208.

(1S,2R)-1-allyl-2-aminocyclopentanecarboxylic acid hydrochloride 1f: Prepared using the representative procedure above from compound 2f (0.20 g, 0.64 mmol), compound 1f (107 mg) was obtained as pale yellow solid with an overall yield of 81% of two steps. [α]$_{25}$D = -22.77 (c 0.16, H$_2$O). m. p. 176-178 °C. IR (KBr) v$_{max}$: 2975, 2881, 1726, 1603, 1577, 1499, 1376, 1197, 1155, 924 cm$^{-1}$. 1H NMR (400 MHz, D$_2$O) δ 5.82 (td, J = 17.0, 7.2 Hz, 1H), 5.22 (t, J = 13.6 Hz, 2H), 3.93 (t, J = 7.5 Hz, 1H), 2.50 (dd, J = 13.6, 7.1 Hz, 1H), 2.37 (dd, J = 13.6, 7.3 Hz, 1H), 2.29 – 2.06 (m, 2H), 1.94 – 1.67 (m, 4H). 13C NMR (101 MHz, D$_2$O) δ 178.4, 132.4, 119.4, 56.7, 54.6, 35.2, 31.0, 28.2, 19.4. HRMS (ESI) calculated for C$_9$H$_{16}$NO$_2^+$ [M+H]$^+$: 170.1176, found 170.1174.

(1S,2R)-2-amino-1-(but-2-yn-1-yl)cyclopentanecarboxylic acid hydrochloride 1g: Prepared by using the representative procedure above from compound 2g (0.20 g, 0.61 mmol), compound 1g (105 mg) was obtained as pale yellow solid with an overall yield of
79% of two steps. [α]$_D^{25}$ = -24.84 (c 0.66, H$_2$O). m. p. 141-142 °C. IR (KBr) $\nu_{\text{max}}$: 2981, 2913, 1706, 1399, 1234, 1187, 855 cm$^{-1}$. $^1$H NMR (400 MHz, D$_2$O) δ 4.06 (t, $J = 8.0$ Hz, 1H), 2.74 – 2.57 (m, 2H), 2.37 – 2.11 (m, 2H), 1.96 – 1.72 (m, 7H). $^{13}$C NMR (101 MHz, D$_2$O) δ 78.6, 71.9, 53.7, 51.5, 31.5, 25.6, 19.4, 17.0, 0.0. HRMS (ESI) calculated for C$_{10}$H$_{16}$NO$_2^+$ [M+H]$^+$: 182.1176, found 182.1175.

$\text{1i} \quad \text{(1R,2R)-2-amino-1-butylcyclopentanecarboxylic acid hydrochloride 1i:}$ Prepared using the representative procedure above from compound 2i (0.20 g, 0.61 mmol), compound 1i (122 mg) was obtained as pale yellow solid with an overall yield of 90% of two steps. [α]$_D^{25}$ = -11.20 (c 0.2, H$_2$O). m. p. 224-225 °C. IR (KBr) $\nu_{\text{max}}$: 2961, 2930, 2872, 1729, 1616, 1499, 1383, 1206, 1149, 852 cm$^{-1}$. $^1$H NMR (400 MHz, D$_2$O) δ 3.88 (t, $J = 7.3$ Hz, 1H), 2.20 (dd, $J = 10.3, 6.3$ Hz, 2H), 1.91 – 1.67 (m, 5H), 1.63 – 1.52 (m, 1H), 1.46 – 1.30 (m, 3H), 1.30 – 1.14 (m, 1H), 0.90 (t, $J = 7.1$ Hz, 3H). $^{13}$C NMR (101 MHz, D$_2$O) δ 179.1, 57.0, 54.9, 30.8, 30.6, 28.4, 26.5, 22.4, 19.7, 13.0. HRMS (ESI) calculated for C$_{10}$H$_{20}$NO$_2^+$ [M+H]$^+$: 186.1489, found 186.1487.

$\text{1j} \quad \text{(1R,2R)-2-amino-1-butylcyclohexanecarboxylic acid hydrochloride 1j:}$ Prepared using the representative procedure above from compound 2j (0.20 g, 0.58 mmol), compound 1j (104 mg) was obtained as pale yellow solid with an overall yield of 76% of two steps. [α]$_D^{25}$ = -2.75 (c 0.19, H$_2$O). m. p. 206-207 °C. IR (KBr) $\nu_{\text{max}}$: 2952, 2929, 2864, 1727, 1613, 1493, 1379, 1240, 1208, 854 cm$^{-1}$. $^1$H NMR (400 MHz, D$_2$O) δ 3.64 (dd, $J = 9.4, 3.9$ Hz, 1H), 1.98 – 1.66 (m, 6H), 1.61 – 1.29 (m, 7H), 1.26 – 1.14 (m, 1H), 0.91 (t, $J = 7.0$ Hz, 3H). $^{13}$C NMR (101 MHz, D$_2$O) δ 179.4, 53.5, 47.5, 29.0, 28.9, 26.3, 25.4, 22.4, 22.2, 20.1, 13.1. HRMS (ESI) calculated for C$_{11}$H$_{22}$NO$_2^+$ [M+H]$^+$: 200.1645, found 200.1646.

$\text{1m} \quad \text{(1S, 2R)-2-amino-1-(3-methylbenzyl) cycloheptanecarboxylic acid hydrochloride 1m:}$ Prepared using the representative procedure above from compound 2m (0.20 g, 0.49 mmol), compound 1m (121 mg) was obtained as white solid with an overall yield of 83% of two steps. [α]$_D^{25}$ = 11.43 (c 0.14, H$_2$O). m. p. 205-207 °C. IR (KBr) $\nu_{\text{max}}$: 2926, 2864, 1702, 1487, 1461, 1032, 787 cm$^{-1}$. $^1$H NMR (400 MHz, D$_2$O) δ 7.30 (t, $J = 7.5$ Hz, 1H), 7.21 (d, $J = 7.7$ Hz, 1H), 7.14 – 7.04 (m, 2H), 3.79 (d, $J = 9.7$ Hz, 1H), 3.07 (d, $J = 12.7$ Hz, 1H), 2.82 (d, $J = 12.7$ Hz, 1H), 2.36 (s, 3H), 2.18 (dd, $J = 25.4, 11.3$ Hz, 1H), 1.94 (dd, $J = 15.0, 9.0$ Hz, 2H), 1.88 – 1.65 (m, 3H), 1.59 – 1.41 (m, 2H), 1.29 (dt, $J = 23.1, 12.2$ Hz, 2H). $^{13}$C NMR (101 MHz, D$_2$O) δ 179.3, 138.5, 135.5, 130.9, 128.4, 127.8, 127.1, 57.4, 51.3, 38.4, 32.7, 29.2, 28.1, 27.3, 22.0, 20.4. HRMS (ESI) calculated for C$_{16}$H$_{20}$NO$_2^+$ [M+H]$^+$:
(1S,2R)-2-amino-1-(4-(trifluoromethyl)benzyl)cycloheptanecarboxylic acid hydrochloride

1o: Prepared using the representative procedure above from compound 2o (0.20 g, 0.43 mmol), compound 1o (124 mg) was obtained as pale yellow solid with an overall yield of 82% of two steps. \([\alpha]_{D}^{25} = 4.50 \text{ (c 0.24, } \text{H}_2\text{O)}\). m. p. 138.4-139.9 °C. IR (KBr) \(\nu_{\text{max}}\): 2976, 2851, 1461, 1439, 1042, 791 cm\(^{-1}\). \(^1\)H NMR (400 MHz, D\(_2\)O) \(\delta\) 7.66 (d, \(J = 7.7 \text{ Hz, 2H}\)), 7.38 (d, \(J = 7.7 \text{ Hz, 2H}\)), 3.79 (d, \(J = 9.4 \text{ Hz, 1H}\)), 3.13 (d, \(J = 12.6 \text{ Hz, 1H}\)), 2.90 (d, \(J = 12.6 \text{ Hz, 1H}\)), 2.23 – 1.58 (m, 6H), 1.33 (ddd, \(J = 31.1, 23.4, 10.4 \text{ Hz, 4H}\)). \(^{13}\)C NMR (101 MHz, D\(_2\)O) \(\delta\) 178.5, 139.7, 130.6, 128.8, 128.5, 125.1, 123.3, 120.2, 100, 57.6, 51.2, 38.2, 32.6, 29.2, 28.0, 27.3, 21.9. \(^{19}\)F NMR (376 MHz, D\(_2\)O) \(\delta\) -62.4 (s). HRMS (ESI) calculated for C\(_{16}\)H\(_{21}\)F\(_3\)NO\(_2\) \([\text{M+H}]^+\): 316.3437, found 316.3431.

(1R,2R)-2-amino-1-butylcycloheptanecarboxylic acid hydrochloride 1r: Prepared using the representative procedure above from compound 2r (0.20 g, 0.56 mmol), compound 1r (120 mg) was obtained as pale yellow solid with an overall yield of 86% of two steps. \([\alpha]_{D}^{25} = 14.87 \text{ (c 0.40, } \text{H}_2\text{O)}\). m. p. 225-227 °C. IR (KBr) \(\nu_{\text{max}}\): 2932, 2867, 2592, 1701, 1594, 1481, 1461, 1396, 1227, 1212, 874 cm\(^{-1}\). \(^1\)H NMR (400 MHz, D\(_2\)O) \(\delta\) 3.70 (d, \(J = 9.6 \text{ Hz, 1H}\)), 2.39 (dd, \(J = 14.8, 9.0 \text{ Hz, 1H}\)), 2.04 – 1.84 (m, 2H), 1.84 – 1.66 (m, 3H), 1.63 – 1.55 (m, 2H), 1.52 – 1.25 (m, 7H), 1.22 – 1.11 (m, 1H), 0.89 (t, \(J = 7.2 \text{ Hz, 3H}\)).\(^{13}\)C NMR (101 MHz, D\(_2\)O) \(\delta\) 179.9, 57.1, 50.3, 32.5, 32.3, 28.9, 28.1, 26.7, 25.6, 22.5, 22.0, 13.0. HRMS (ESI) calculated for C\(_{12}\)H\(_{24}\)NO\(_2\) \([\text{M+H}]^+\): 214.1802, found 214.1803.

5. Crystal data of Compound 1i
Figure 1. ORTEP representation of the compound with thermal ellipsoids at 50% probability

Identification code 1i
Empirical formula C₁₀H₂₀ClNO₂
Formula weight 221.72
Temperature/K 100(2)
Crystal system monoclinic
Space group C2
a/Å 21.025(6)
b/Å 7.6662(15)
c/Å 7.7365(15)
α/° 90
β/° 90.15(3)
γ/° 90
Volume/Å³ 1247.0(5)
Z 4
ρ calc g/cm³ 1.181
μ/mm⁻¹ 0.286
F(000) 480.0
Crystal size/mm³ 0.280 × 0.150 × 0.120
Radiation MoKα (λ = 0.71073)
2Θ range for data collection/° 5.656 to 55.54
Index ranges -27 ≤ h ≤ 27, -10 ≤ k ≤ 10, -10 ≤ l ≤ 10
Reflections collected 7358
Independent reflections 2880 [Rint = 0.0527, Rsigma = 0.0723]
Data/restraints/parameters 2880/1/129
Goodness-of-fit on F² 0.943
Final R indexes [I>2σ (I)] R₁ = 0.0360, wR₂ = 0.0677
Final R indexes [all data] R₁ = 0.0427, wR₂ = 0.0693
Largest diff. peak/hole / e Å⁻³ 0.33/-0.22
Flack parameter -0.04(5)
6. NMR Spectrums of Compounds

![NMR Spectrum of Compound 3a](image)