Stereoselective Synthesis of Tetrasubstituted 2,3-Dihydrofurans by One-Step Cyclization of β -Ketosulfides of Benzothiazole and Aldehydes in Ionic Liquids

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Supporting information section

Physical and spectral data of compounds **3a-i**, **6a**, **8g**, **9a** and **10a** are given below:

***trans*-(±)-2-acetyl-4-(benzothiazol-2-yl)sulfanyl-5-methyl-3-phenyl-2,3-dihydrofuran (3a).**

After recrystallization from ethanol, white solid (m.p. 114 °C) – ¹H NMR δ = 2.25 (d, J = 1.5 Hz, 3 H, 5CH₃), 2.46 (s, 3 H, CH₃CO), 4.45 (dq, J = 5.2 and 1.5 Hz, 1 H, 3H), 4.94 (d, J = 5.2 Hz, 1 H, 2H), 7.18-7.23 (m, 2 H, Ph), 7.25-7.36 (m, 4 H, Ph and Btz), 7.37-7.44 (m, 1 H, Btz), 7.75 (d, J = 7.9 Hz, 1 H, Btz), 7.82 (d, J = 8.1 Hz, 1 H, Btz) – ¹³C NMR δ = 12.71, 26.04, 53.90, 91.69, 100.81, 120.87, 121.67, 124.10, 126.02, 127.50, 127.67, 128.90, 135.14, 140.75, 154.28, 165.21, 169.61, 206.07 – MS: m/z (%): 324 (14) [M⁺-43 (M⁺-CH₃CO)], 282 (1), 249 (1), 201 (17) [M⁺-166 (M⁺-Btz-S)], 185 (3), 167 (15), 157 (14), 129 (9), 103 (2), 91 (1), 77 (5), 63 (1), 43 (100) – IR (KBr) ν = 3061, 2969, 2932, 1702, 1645, 1510, 1493, 1457, 1427, 1379, 1238, 1217, 1180, 1007, 986, 758, 728, 701 cm⁻¹ – C₂₀H₁₇NO₂S₂ (367.07): calcd. C, 65.37; H, 4.66; N, 3.81; O, 8.71; S, 17.45; found: C, 65.55; H, 4.60; N, 3.70; O, 8.60; S, 17.35.

***trans*-(±)-2-acetyl-4-(benzothiazol-2-yl)sulfanyl-3-heptyl-5-methyl-2,3-dihydrofuran (3b).**

After recrystallization from ethanol, yellow solid (m.p. 109 °C) – ¹H NMR δ = 0.85 (t, J = 7.1 Hz, 3 H, CH₃ heptyl), 1.15-1.42 (m, 10 H, CH₂ heptyl), 1.43-1.56 (m, 1H, CH₂ heptyl), 1.72-1.83 (m, 1H, CH₂ heptyl), 2.12 (d, J = 1.5 Hz, 3 H, 5CH₃), 2.36 (s, 3 H, CH₃CO), 3.13-3.19 (m, 1 H, 3H), 4.64 (d, J = 5.2 Hz, 1 H, 2H), 7.24-7.29 (m, 2 H, Btz), 7.70-7.74 (m, 1 H, Btz), 7.79-7.84 (m, 1 H, Btz) – ¹³C NMR δ = 12.67, 14.00, 22.53, 25.82, 25.99, 29.05, 29.34, 31.67, 33.54, 48.47, 89.32, 100.06, 120.86, 121.68, 124.09, 126.037, 135.14, 154.38, 164.52, 170.34, 207.56 – MS: m/z (%): 346 (18)

[M⁺-43 (M⁺-CH₃CO)], 314 (1), 248 (1), 223 (12) [M⁺-166 (M⁺- Btz-S)], 205 (1), 186 (2), 167 (18), 151 (2), 136 (2), 109 (1), 95 (15), 81 (6), 55 (5), 43 (100) – IR (KBr) ν = 3062, 2954, 2855, 1718, 1673, 1645, 1531, 1461, 1427, 1379, 1238, 1006, 757, 727 cm⁻¹ – C₂₁H₂₇NO₂S₂ (389.15) calcd. C, 64.74; H, 6.99; N, 3.60; O, 8.21; S, 16.46; found: C, 64.86; H, 6.92; N, 3.60; O, 8.12; S, 16.40.

***trans*-(±)-2-acetyl-4-(benzothiazol-2-yl)sulfanyl-5-methyl-3-tridecyl-2,3-dihydrofuran**

(3c). Oil – ¹H NMR δ = 0.79 (t, J = 7.1 Hz, 3 H, CH₃ tridecyl), 1.04-1.33 (m, 22 H, CH₂ tridecyl), 1.34-1.46 (m, 1H, CH₂ tridecyl), 1.60-1.75 (m, 1H, CH₂ tridecyl), 2.03 (d, J = 1.7 Hz, 3 H, 5CH₃), 2.28 (s, 3 H, CH₃CO), 3.06-3.12 (m, 1 H, 3H), 4.57 (d, J = 5.2 Hz, 1 H, 2H), 7.15-7.21 (m, 1 H, Btz), 7.27-7.33 (m, 1 H, Btz), 7.62-7.65 (m, 1 H, Btz), 7.73-7.76 (m, 1 H, Btz) – ¹³C NMR δ = 12.64, 14.04, 22.61, 25.77, 25.97, 29.27, 29.38, 29.48, 29.52, 29.55, 29.58, 31.83, 33.53, 48.45, 89.29, 100.03, 120.82, 121.65, 124.06, 126.02, 135.10, 154.34, 164.48, 170.30, 207.49 – MS: m/z (%): 430 (10) [M⁺-43 (M⁺-CH₃CO)], 307 (7) [M⁺-166 (M⁺- Btz-S)], 248 (2), 207 (1), 167 (14), 154 (2), 136 (1), 109 (1), 95 (7), 81 (2), 55 (8), 43 (100) – IR (KBr) ν = 3061, 2922, 2851, 1710, 1641, 1577, 1461, 1426, 1357, 1181, 1006, 756, 726 cm⁻¹ – C₂₇H₃₉NO₂S₂ (473.24) calcd. C, 68.45; H, 8.30; N, 2.96; O, 6.75; S, 13.54; found: C, 68.29; H, 8.16; N, 2.85; O, 6.79; S, 13.46.

***trans*-(±)-2-acetyl-4-(benzothiazol-2-yl)sulfanyl-5-methyl-3-(4-nitrophenyl)-2,3-**

dihydrofuran (3d). After recrystallization from ethanol/hexane yellow solid (m.p. 42 °C) – ¹H NMR δ = 2.26 (d, J = 1.7 Hz, 3 H, 5CH₃), 2.47 (s, 3 H, CH₃CO), 4.60 (dq, J = 5.2 and 1.7 Hz, 1 H, 3H), 4.88 (d, J = 5.2 Hz, 1 H, 2H), 7.20-7.54 (m, 4 H, Ph and Btz), 7.72-7.77 (m, 1 H, Btz), 7.80-7.84 (m, 1 H, Btz), 8.15-8.21 (m, 2 H, Ph) – ¹³C NMR δ = 12.92, 26.32, 53.63, 91.11, 100.24, 112.02, 120.99, 121.32, 121.90, 124.19, 124.50, 126.28, 127.07, 128.69, 135.17, 165.84, 190.84, 206.22 – MS: m/z (%): 369 (21) [M⁺-43 (M⁺-CH₃CO)], 310 (1), 280 (1), 246 (2) [M⁺-166 (M⁺- Btz-S)], 202 (3), 187 (1), 167 (36), 146 (1), 109 (4), 102 (5), 91 (1), 63 (4), 43 (100) – IR (KBr) ν = 3110, 3066, 2959, 2924, 2854, 2254, 1719, 1641, 1599, 1520, 1493, 1427, 1348, 1320, 1231, 1190, 1008, 910, 757, 730 cm⁻¹ – C₂₀H₁₆N₂O₄S₂ (412.06) calcd. C, 58.24; H, 3.91; N, 6.79; O, 15.52; S, 15.55; found: C, 58.06; H, 3.96; N, 6.85; O, 15.47; S, 15.60.

***trans*-(±)-2-acetyl-4-(benzothiazol-2-yl)sulfanyl-3-(4-chlorophenyl)-5-methyl-2,3-**

dihydrofuran (3e). Oil – ¹H NMR δ = 2.23 (d, J = 1.6 Hz, 3 H, 5CH₃), 2.43 (s, 3 H, CH₃CO), 4.42 (dq, J = 5.3 and 1.6 Hz, 1 H, 3H), 4.87 (d, J = 5.3 Hz, 1 H, 2H), 7.10-7.15 (m, 2 H, Ph), 7.20-7.33 (m, 2 H, Ph and Btz), 7.38-7.45 (m, 2 H, Ph and Btz), 7.73-7.76 (m, 1 H, Btz) 7.80-7.84 (m, 1 H, Btz) – ¹³C NMR δ = 12.85, 26.20, 53.39, 91.60, 100.65, 112.14, 120.94, 121.80, 124.29, 126.17,

128.98, 129.11, 133.57, 135.16, 139.26, 154.20, 165.41, 206.25 – MS: m/z (%): 358 (21) [M^+ -43 (M^+ -CH₃CO)], 316 (1), 283 (1), 235 (10) [M^+ -166 (M^+ - Btz-S)], 219 (3), 191 (11), 167 (33), 149 (3), 128 (8), 102 (2), 89 (1), 69 (1), 43 (100) – IR (KBr) ν = 3062, 2965, 2921, 1712, 1640, 1598, 1561, 1494, 1381, 1239, 1080, 943, 837, 755, 705 cm⁻¹ – C₂₀H₁₆ClNO₂S₂ (401,03), calcd. C, 59.76; H, 4.01; Cl, 8.82; N, 3.48; O, 7.96; S, 15.96; found: C, 59.60; H, 3.96; Cl, 8.75; N, 3.53; O, 7.90; S, 15.93.

***trans*-(±)-2-acetyl-4-(benzothiazol-2-yl)sulfanyl-3-(4-methoxyphenyl)-5-methyl-2,3-dihydrofuran (3f).** Oil – ¹H NMR δ = 2.23 (d, J = 1.6 Hz, 3 H, 5CH₃), 2.42 (s, 3 H, CH₃CO), 3.78, (s, 3 H, OCH₃), 4.39 (dq, J = 5.3 and 1.6 Hz, 1 H, 3H), 4.92 (d, J = 5.3 Hz, 1 H, 2H), 6.75-6.84 (m, 2 H, Ph), 7.22-7.35 (m, 2 H, Ph and Btz), 7.37-7.48 (m, 2 H, Ph and Btz), 7.71-7.75 (m, 1 H, Btz) 7.79-7.84 (m, 1 H, Btz) – ¹³C NMR δ = 12.84, 26.19, 54.02, 55.24, 91.74, 100.79, 111.98, 112.90, 113.51, 119.87, 120.94, 121.33, 121.52, 121.78, 124.18, 124.49, 127.07, 130.05, 142.44, 160.04, 206.16 – MS: m/z (%): 354 (27) [M^+ -43 (M^+ -CH₃CO)], 312 (2), 279 (2), 231 (20) [M^+ -166 (M^+ - Btz-S)], 215 (6), 199 (1), 187 (15), 167 (11), 159 (8), 145 (5), 115 (6), 91 (1), 77 (3), 63 (2), 43 (100) – IR (KBr) ν = 3063, 2963, 2836, 1714, 1644, 1599, 1488, 1455, 1427, 1356, 1320, 1320, 1260, 1078, 1036, 936, 871, 787, 756, 727 cm⁻¹ – C₂₁H₁₉NO₃S₂ (397,08), calcd. C, 63.45; H, 4.82; N, 3.52; O, 12.07; S, 16.13; found: C, 63.21; H, 4.70; N, 3.48; O, 12.11; S, 16.20.

***trans*-(±)-4-(benzothiazol-2-yl)sulfanyl-2-benzoyl-3,5-diphenyl-2,3-dihydrofuran (3g).** Oil – ¹H NMR δ = 4.65 (d, J = 4.7 Hz, 1 H, 3H), 6.03 (d, J = 4.7 Hz, 1 H, 2H), 7.23-7.45 (m, 10 H, Ph and Btz), 7.47-7.52 (m, 2 H, Ph), 7.59-7.65 (m, 1 H, Ph), 7.70-7.74 (m, 1 H, Btz), 7.77-7.80 (m, 1 H, Btz), 7.96-8.00 (m, 2 H, Ph), 8.08-8.12 (m, 2 H, Ph) – ¹³C NMR δ = 55.90, 87.80, 91.74, 100.60, 121.01, 121.66, 124.03, 125.98, 127.98, 128.08, 128.33, 128.54, 128.88, 128.98, 129.18, 130.70, 133.54, 133.97, 135.52, 140.61, 154.39, 162.45, 169.58, 193.99 – MS: m/z (%): 386 (92) [M^+ -105 (M^+ -PhCO)], 324 (52) [M^+ -167 (M^+ - Btz-SH)], 220 (36), 220 (20), 191 (42), 115 (6), 105 (100), 91 (6), 77 (79), 51 (23), 40 (79) – IR (KBr) ν = 3056, 2928, 2854, 1693, 1596, 1492, 1455, 1425, 1224, 1205, 1103, 1006, 754, 693 cm⁻¹ – C₃₀H₂₁NO₂S₂ (491,10), calcd. C, 73.29; H, 4.31; N, 2.85; O, 6.51; S, 13.04; found: C, 73.44; H, 4.20; N, 2.62; O, 6.46; S, 13.15.

***trans*-(±)-4-(benzothiazol-2-yl)sulfanyl-2-benzoyl-3-heptyl-5-phenyl-2,3-dihydrofuran (3h).** Oil – ¹H NMR δ = 0.86 (t, J = 7.1 Hz, 3 H, CH₃ heptyl), 1.16-1.36 (m, 8 H, CH₂ heptyl), 1.37-1.48 (m, 2 H, CH₂ heptyl), 1.72-1.81 (m, 1H, CH₂ heptyl), 1.87-2.01 (m, 1H, CH₂ heptyl), 3.71 (ddd, J = 8.0 5.2 4.1 Hz, 1 H, 3H), 5.69 (d, J = 5.2 Hz, 1 H, 2H), 7.23-7.28 (m, 1 H, Btz), 7.33-7.41

(m, 4 H, Ph and Btz), 7.53 (t, J = 7.7 Hz, 2 H, Ph), 7.63 (t, J = 7.5 Hz, 1 H, Ph), 7.70 (d, J = 7.9 Hz, 1 H, Btz), 7.83 (d, J = 8.4 Hz, 1 H, Btz), 7.95-8.01 (m, 2 H, Ph), 8.07-8.13 (m, 2 H, Ph) – ^{13}C NMR δ = 14.06, 22.58, 25.93, 29.13, 29.53, 31.74, 32.92, 48.96, 85.66, 99.60, 120.98, 121.65, 124.02, 125.98, 128.08, 128.21, 128.76, 128.99, 130.35, 133.65, 134.47, 135.58, 154.37, 161.49, 169.79, 195.52 – MS: m/z (%): 408 (5) [M^+ -105 (M^+ -PhCO)], 347 (6) [M^+ -166 (M^+ - Btz-S)], 311 (12), 281 (6), 262 (2), 238 (1), 193 (2), 163 (4), 150 (11), 120 (5), 105 (14), 92 (6), 77 (9), 50 (6), 43 (100) – IR (KBr) ν = 3079, 3041, 2959, 2853, 1690, 1597, 1497, 1456, 1428, 1321, 1077, 1035, 1013, 751, 669 cm^{-1} – $\text{C}_{31}\text{H}_{31}\text{NO}_2\text{S}_2$ (513.18), calcd. C, 72.48; H, 6.08; N, 2.73; O, 6.23; S, 12.48; found: C, 72.60; H, 6.12; N, 2.70; O, 6.18; S, 12.35.

***trans*-(±)-4-(benzothiazol-2-yl)sulfanyl-2-benzoyl-5-phenyl-3-tridecyl-2,3-dihydrofuran**

(3i). Oil – ^1H NMR δ = 0.89 (t, J = 7.1 Hz, 3 H, CH_3 tridecyl), 1.17-1.48 (m, 22 H, CH_2 heptyl), 1.72-1.82 (m, 1H, CH_2 tridecyl), 1.90-1.99 (m, 1H, CH_2 tridecyl), 3.72 (ddd, J = 8.1 5.2 4.2 Hz, 1 H, 3H), 5.69 (d, J = 5.2 Hz, 1 H, 2H), 7.23-7.28 (m, 1 H, Btz), 7.36-7.40 (m, 4 H, Ph and Btz), 7.51-7.56 (m, 2 H, Ph), 7.63 (t, J = 7.5 Hz, 1 H, Ph), 7.71 (d, J = 7.9 Hz, 1 H, Btz), 7.83 (d, J = 8.1 Hz, 1 H, Btz), 7.95-7.99 (m, 2 H, Ph), 8.08-8.12 (m, 2 H, Ph) – ^{13}C NMR δ = 12.52, 14.12, 22.69, 26.98, 29.35, 29.42, 29.45, 29.49, 29.57, 29.60, 29.64, 31.92, 33.53, 40.97, 85.69, 101.69, 111.96, 121.05, 121.32, 121.47, 124.38, 124.47, 126.01, 127.05, 128.57, 128.78, 133.77, 133.81, 135.49, 152.82, 165.20, 179.63, 195.54 – IR (KBr) ν = 3061, 2923, 2852, 1681, 1596, 1579, 1492, 1459, 1426, 1320, 1238, 1035, 999, 753, 689 cm^{-1} – $\text{C}_{37}\text{H}_{43}\text{NO}_2\text{S}_2$ (597.27), calcd. C, 74.33; H, 7.25; N, 2.34; O, 5.35; S, 10.73 found: C, 74.20; H, 7.10; N, 2.18; O, 5.40; S, 10.60.

(E)-3-(Benzothiazol-2-ylsulfanyl)-4-phenyl-but-3-en-2-one (6a). This reaction intermediate was isolated from the reaction mixture by silica gel preparative TLC (eluent hexane:ethyl ether 5:1). Yellow oil – ^1H NMR δ = 3.55 (s, 3 H, CH_3CO), 7.28-7.32 (m, 1 H, Btz), 7.39-7.43 (m, 4 H, Ph and Btz), 7.70-7.74 (m, 1 H, Btz), 7.82-7.86 (m, 2 H, Ph), 7.87-7.90 (m, 1 H, Btz) 8.19 (s, 1 H, vinyl proton) – ^{13}C NMR δ = 27.22, 120.99, 122.04, 124.61, 126.30, 128.63, 129.05, 130.97, 131.12, 133.52, 135.50, 148.19, 153.74, 165.39, 196.79 – MS: m/z (%): 311 (17, M^+) 268 (14) [M^+ -43 (M^+ - CH_3CO)], 234 (13) [M^+ -77 (M^+ -Ph)], 207 (10), 167 (57, Btz-SH), 134 (9), 108 (10), 89 (7), 63 (6), 43 (100) – IR (KBr) ν = 3060, 2923, 2851, 1684, 1643, 1591, 1567, 1457, 1426, 1356, 1238, 1180, 998, 756, 727, 690 cm^{-1} – $\text{C}_{17}\text{H}_{13}\text{NOS}_2$ (311.04), calcd. C, 65.56; H, 4.21; N, 4.50; O, 5.14; S, 20.59; found: C, 65.56; H, 4.21; N, 4.50; O, 5.14; S, 20.59.

4-(benzothiazol-2-yl)sulfanyl-2-benzoyl-3,5-diphenyl-furan (8g). Yellow oil – ^1H NMR δ = 7.19-7.53 (m, 13 H, Ph and Btz), 7.66 (d, J = 7.9 Hz, 1 H, Btz), 7.83 (d, J = 8.3 Hz, 1 H, Btz), 7.86-7.90 (m, 2 H, Ph), 8.18-8.22 (m, 2 H, Ph) – ^{13}C NMR δ = 110.03, 120.94, 121.90, 124.31, 126.23, 127.36, 127.94, 128.10, 128.25, 128.31, 128.38, 128.58, 128.90, 129.59, 129.70, 130.18, 130.55, 132.56, 136.99, 146.77, 154.21, 159.16, 168.26, 183.25 – MS: m/z (%): 384 (100) [M^+ -105 (M^+ -PhCO)], 323 (22) [M^+ -166 (M^+ - Btz-S)], 221 (24), 189 (28), 145 (12), 121 (15), 105 (45), 77 (68) – IR (KBr) ν = 3025, 2930, 1689, 1596, 1015, 751 cm^{-1} – $\text{C}_{30}\text{H}_{19}\text{NO}_2\text{S}_2$ (489,09) calcd. C, 73,59; H, 3,91; N, 2,86; O, 6,54; S, 13,10 found: C, 73,55; H, 3,87; N, 2,80; O, 6,59; S, 13,10.

***trans*-($\pm$)-4-(benzothiazol-2-yl)sulfanyl-2(2-methyl-[1,3]dioxolan-2-yl)-5-methyl-3-phenyl-2,3-dihydrofuran (9a).** After recrystallization from methanol/ethyl ether, pale yellow solid (m.p. 108-110 $^{\circ}\text{C}$). ^1H NMR δ = 1.52 (s, 3 H, CH_3), 2.16 (d, J = 2.0 Hz, 3 H, 5CH_3), 4.01-4.15 (m, 4 H, dioxolane), 4.36 (dq, J = 6.8 2.0 Hz, 1 H, 3H), 4.59 (d, J = 6.8 Hz, 1 H, 2H), 7.16-7.33 (m, 6 H), 7.36-7.41 (m, 1 H), 7.74-7.77 (m, 1 H), 7.80-7.83 (m, 1 H) – ^{13}C NMR δ = 12.89, 20.09, 52.75, 65.53, 65.57, 91.92, 100.28, 109.39, 120.81, 121.66, 123.94, 125.94, 127.20, 128.01, 128.74, 135.44, 142.27, 154.42, 165.69, 170.67 – MS: m/z (%): 411 (M^+ , 2), 324 (25), 191 (1), 167 (2), 147 (1), 115 (3), 96 (1), 87 (42), 77 (1), 43 (100) – IR (KBr) ν = 3061, 2890, 1650, 1427, 1214, 1020, 702 cm^{-1} – $\text{C}_{22}\text{H}_{21}\text{NO}_3\text{S}_2$ (411,10) calcd. C, 64,21; H, 5,14; N, 3,40; O, 11,66; S, 15,58 found C, 64,12; H, 5,09; N, 3,35; O, 11,60; S, 15,53.

***trans*-($\pm$)-2-methyl-5-(2-methyl-[1,3]dioxolan-2-yl)-4-phenyl-4,5-dihydro-furan-3-thiol (10a).** ^1H NMR δ = 1.25 (s, 3 H, CH_3), 2.07 (d, J = 1.7 Hz, 3 H, 2CH_3), 3.48 (br s, 1 H, SH, exchange with D_2O), 3.88-4.04 (m, 4 H, dioxolane), 4.20 (dq, J = 6.8 1.7 Hz, 1 H, 4H), 4.39 (d, J = 6.8 Hz, 1 H, 5H), 7.13-7.32 (m, 5 H) – ^{13}C NMR δ = 12.27, 19.66, 52.95, 65.37, 65.41, 90.97, 106.52, 109.45, 126.81, 128.27, 128.56, 142.69, 161.85 – MS: m/z (%): 278 (M^+ , 1), 185 (3), 147, (2), 115 (1), 100 (1), 87 (67), 77 (1), 43 (100) – IR (KBr) ν = 3028, 2985, 1635, 1377, 1241, 1047, 701 cm^{-1} – $\text{C}_{15}\text{H}_{18}\text{O}_3\text{S}$ (278,10) calcd. C, 64,72; H, 6,52; O, 17,24; S, 11,52 found C, 64,72; H, 6,52; O, 17,24; S, 11,52.

The *trans* stereochemistry of dihydrofurans **3a-i** was assigned on the basis of the following experimental evidences:

1. The NMR 3J constants relative to H2-H3 coupling in the 2,3-dihydrofuran ring can be easily assigned to *E*- or *Z*-isomer by comparison of their values with those of analogous compounds reported in the literature [Arai, S.; Nakayama, K.; Suzuki, Y.; Hatano, K.-i., Shiori, T. *Tetrahedron Lett.*, **1998**, 39, 9739-9742]. The following figure S1 shows the observed ranges of *J* values for both *E* and *Z* isomers of furans **3a-i**.

Figure S1

2. A phase-sensitive NOESY experiment was carried out on dihydrofuran **3b** to confirm the *trans*-stereochemistry. The two-dimensional spectrum, reported in figure S2, clearly shows the lack of a cross-peak relative to the Ha-Hb interaction, while a cross-peak accountable with an interaction between Ha and the alkyl chain (C₇H₁₅) can be observed.

Figure S2. Phase-sensitive NOESY-¹H NMR experiment of dihydrofuran **3b**.

3. In order to unambiguously assign the stereochemistry of dihydrofurans **3a-i**, an X-ray diffraction experiment has been carried out on product **3a**. Results are listed below:

The compound $C_{20}H_{17}O_2S_2N$, $367.49 \text{ g mol}^{-1}$, $F(000) = 768$, crystallizes in the monoclinic system with $2/m$ symmetry. Space group $P2_1/c$ (n. 14), cell constants: $a = 10.460(7)$, $b = 11.854(3)$, $c = 16.211(13) \text{ \AA}$, $\beta = 117.96(7)$, $V = 1775.4(19) \text{ \AA}^3$, $Z = 4$, $\rho_{\text{calc}} = 1.38 \text{ g cm}^{-3}$, $\mu = 3.012 \text{ cm}^{-1}$ crystal dimensions $0.75 \times 0.50 \times 0.20 \text{ mm}$.

Figure S3. Representation of the structure of dihydrofuran **3a** [$C_{20}H_{17}O_2S_2N$]. For clarity sake H atoms are not shown.

Data collection was carried out on a Huber four circles diffractometer with graphite-monochromated MoK_{α} radiation ($\lambda = 0.71073 \text{ \AA}$); measurement range: $2^{\circ} < \theta < 30^{\circ}$; mode: ω scan; scan time: max 120 s, scan width 1.2° ; absorption correction: ψ -scan; two reflections were used to check the intensity every 300 measurements; 5531 collected reflections, 5040 independent reflections, out of which 1329 with $I > 3\sigma(I)$ were used in the refinement. Structure solution by direct methods (SIR97), refinement with the program CRYSTALS. Structure refinement with O, N and S atoms anisotropic

(126 parameters) converged at $R = \Sigma (||F_o| - |F_c||) / \Sigma |F_o| = 0.067$, $R_w = [\Sigma w (||F_o| - |F_c|)^2 / \Sigma w F_o^2]^{1/2} = 0.074$. Hydrogen atoms were initially located geometrically, yielding $R = 0.058$ and $R_w = 0.059$. The relevant positions are reported at the bottom of Table 1. Subsequently their coordinates have been refined, whereas their displacement parameters were made to ride those of the carbon atoms to which they are bonded (176 parameters). The final agreement indexes are $R = 0.044$, $R_w = 0.044$. Residual electron density: min $-0.24 \text{ e}\text{\AA}^{-3}$, max $+0.35 \text{ e}\text{\AA}^{-3}$.

Atomic coordinates and displacement parameters after the last step of refinement are reported in Table 1, whereas distances and angles are in Table 2.

TABLE 1
Atomic positions and displacement parameters

Atom	x/a	y/b	z/c	U(iso)
S(1)	0.1345(1)	0.1898(1)	0.8450(1)	0.0489
S(2)	0.3793(2)	0.0947(2)	0.8129(1)	0.0553
C(3)	0.3426(6)	0.3304(5)	0.9650(4)	0.047(1)
C(4)	0.1969(6)	0.1020(5)	0.7853(4)	0.047(1)
C(5)	0.2915(5)	0.2264(5)	0.9453(3)	0.041(1)
O(6)	0.4516(4)	0.3433(3)	1.0546(3)	0.0517
C(7)	0.2638(5)	0.1182(5)	1.0697(3)	0.040(1)
C(8)	0.2368(6)	0.0067(5)	1.0779(4)	0.050(2)
C(9)	0.1820(6)	-0.0181(5)	0.6791(4)	0.051(2)
N(10)	0.1078(5)	0.0416(4)	0.7157(3)	0.0525
C(11)	0.3647(5)	0.1523(5)	1.0310(4)	0.042(1)
C(12)	0.4880(6)	0.2304(5)	1.0954(4)	0.044(1)
C(13)	0.1941(6)	0.1997(6)	1.0946(4)	0.056(2)
C(14)	0.6356(6)	0.2044(6)	1.1027(4)	0.055(2)
C(15)	0.3312(6)	-0.0018(5)	0.7221(4)	0.052(2)
C(16)	0.0772(7)	0.0585(6)	1.1395(4)	0.064(2)
C(17)	0.1007(7)	0.1690(6)	1.1295(4)	0.063(2)
C(18)	0.4204(8)	-0.0598(6)	0.6950(5)	0.070(2)
C(19)	0.1186(7)	-0.0939(7)	0.6034(5)	0.071(2)
C(20)	0.2983(9)	0.4355(7)	0.9106(5)	0.071(2)
C(22)	0.1420(7)	-0.0213(6)	1.1140(5)	0.065(2)
O(23)	0.6500(5)	0.1382(5)	1.0543(4)	0.0857
C(24)	0.7604(9)	0.2690(8)	1.1738(6)	0.080(2)
C(25)	0.3523(8)	-0.1362(8)	0.6204(6)	0.0829
C(28)	0.2091(9)	-0.1507(7)	0.5776(5)	0.081(2)
H(81)	0.285(5)	-0.047(4)	1.063(3)	0.051(2)
H(111)	0.404(5)	0.089(4)	1.019(3)	0.042(1)
H(121)	0.489(5)	0.248(4)	1.154(3)	0.047(1)
H(131)	0.208(5)	0.284(5)	1.085(3)	0.058(2)
H(161)	0.008(6)	0.050(5)	1.162(3)	0.065(2)
H(171)	0.045(5)	0.233(5)	1.134(3)	0.064(2)
H(181)	0.516(6)	-0.039(5)	0.724(4)	0.071(2)
H(191)	0.022(6)	-0.092(5)	0.580(3)	0.069(2)
H(201)	0.377(6)	0.462(5)	0.903(4)	0.069(2)
H(202)	0.272(6)	0.479(5)	0.939(4)	0.069(2)
H(203)	0.234(6)	0.424(5)	0.848(4)	0.069(2)
H(221)	0.148(5)	-0.099(5)	1.116(4)	0.064(2)
H(241)	0.808(6)	0.282(5)	1.141(4)	0.074(2)
H(242)	0.766(6)	0.257(6)	1.225(4)	0.074(2)
H(243)	0.730(6)	0.331(5)	1.195(4)	0.074(2)
H(251)	0.415(6)	-0.144(6)	0.622(4)	0.0773

H(281) 0.157(6) -0.206(5) 0.529(4) 0.083(2)

Atom	U(11)	U(22)	U(33)	U(23)	U(13)	U(12)
S(1)	0.0381(7)	0.060(1)	0.0446(8)	-0.0028(8)	0.0127(6)	-0.0048(8)
S(2)	0.0449(8)	0.067(1)	0.0522(9)	-0.0061(9)	0.0186(7)	-0.0055(8)
O(6)	0.051(2)	0.044(2)	0.057(2)	-0.007(2)	0.015(2)	-0.012(2)
N(10)	0.045(3)	0.060(3)	0.050(3)	-0.007(3)	0.014(2)	-0.013(2)
O(23)	0.053(3)	0.132(5)	0.120(4)	-0.050(4)	0.043(3)	-0.012(3)
*H(81)	0.28576	-0.05554		1.05848	0.051	
*H(111)	0.39832	0.07562		1.01718	0.042	
*H(121)	0.49331	0.22702		1.16037	0.047	
*H(131)	0.21284	0.28390		1.08791	0.058	
*H(161)	0.01199	0.03595		1.16732	0.065	
*H(171)	0.04422	0.22984		1.14559	0.064	
*H(181)	0.53159	-0.04909		0.72924	0.071	
*H(191)	0.00852	-0.10711		0.56892	0.069	
*H(201)	0.36146	0.50126		0.94681	0.069	
*H(202)	0.19468	0.45593		0.89299	0.069	
*H(203)	0.30529	0.42847		0.85022	0.069	
*H(221)	0.12255	-0.10609		1.12052	0.064	
*H(241)	0.85193	0.24985		1.17532	0.073	
*H(242)	0.76874	0.25539		1.23921	0.073	
*H(243)	0.74211	0.35465		1.16248	0.073	
*H(251)	0.41685	-0.18155		0.59878	0.077	
*H(281)	0.16541	-0.20686		0.52301	0.081	

* Hydrogen atoms positions as obtained by geometrical location

TABLE 2

Selected geometric parameters

C19-C28	1.377(9)	O6-C12	1.462(6)
C28-C25	1.334(9)	C12-C11	1.532(7)
C25-C18	1.408(10)	C11-C5	1.513(7)
C18-C15	1.386(8)	C11-H111	0.919(47)
C15-C9	1.392(7)	C12-H121	0.968(44)
C9-C19	1.411(8)	C12-C14	1.524(8)
C19-H191	0.898(51)	C14-O23	1.168(7)
C28-H281	0.972(60)	C14-C24	1.486(10)
C25-H251	0.651(61)	C24-H241	0.896(56)
C18-H181	0.917(54)	C24-H242	0.817(59)
N10-C9	1.374(7)	C24-H243	0.928(6)
C15-S2	1.742(6)	C13-C7	1.380(8)
S2-C4	1.746(5)	C7-C8	1.371(8)
C4-N10	1.292(6)	C8-C22	1.407(8)
S1-C4	1.743(6)	C22-C16	1.337(9)
C20-H203	0.928(53)	C16-C17	1.356(9)
C20-H201	0.942(56)	C17-C13	1.388(8)
C20-H202	0.820(58)	C13-H131	1.032(52)
C20-C3	1.470(9)	C8-H81	0.912(49)
C5-C3	1.322(7)	C22-H221	0.923(57)
C5-S1	1.739(5)	C16-H161	0.956(52)
C3-O6	1.371(6)	C17-H171	0.980(55)
C9-C19-C28	117.8(7)	C11-C12-O6	106.7(4)
C19-C28-C25	122.9(8)	C12-O6-C3	106.7(4)
C28-C25-C18	121.5(8)	O6-C3-C5	113.7(5)
C25-C18-C15	116.5(6)	C3-C5-C11	110.3(5)
C18-C15-C9	122.4(3)	C5-C11-C12	100.2(4)
C15-C9-C19	118.9(6)	S2-C15-C9	109.0(4)

C16-C22-C8	121.3 (7)	C15-C9-N10	116.1 (5)
C22-C8-C7	119.0 (6)	C9-N10-C4	109.9 (5)
C8-C7-C13	119.0 (5)	S2-C15-C4	46.0 (2)
C7-C13-C17	120.4 (6)	H242-C24-H241	146.9 (60)
C13-C17-C16	120.3 (7)	H241-C24-H243	117.8 (59)
C17-C16-C22	120.0 (7)	H202-C20-H201	114.1 (51)
C7-C11-C5	112.6 (4)	H201-C20-H203	97.8 (43)
C7-C11-C12	114.0(4)		