SUPPORTING INFORMATION**Thiophenol Mediated Hydrogen Atom Abstraction: An Efficient Tin-Free
Procedure for the Preparation of Cyclopentane Derivatives**

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Dimethyl 2-(1,3-dioxolan-2-ylmethyl)-2-prop-2-ynylmalonate (1a):

Prepared according literature: see ref. [1].

2-[2-(*tert*-Butyldimethylsilyloxy)ethyl]-2-prop-2-ynylmalonic acid dimethyl ester (1b):

To a suspension of NaH (750 mg, 15.4 mmol, 55-65% dispersion in mineral oil) in DMF (20 mL) was added dropwise at 0°C a solution of dimethylpropargyl malonate (1.8 mL, 13 mmol) in DMF (5 mL). The cold bath was removed and the reaction mixture stirred at rt for 1 h. A solution of (2-bromoethoxy)-*tert*-butyldimethylsilane (3.22 g, 13 mmol) in DMF (5 mL) was added dropwise and the mixture stirred at rt for 16 h. The reaction was treated with brine (70 mL). Et₂O (20 mL) was added and the aqueous layer extracted with Et₂O. The combined organic layers were washed with brine, dried over Na₂SO₄, and the solvent removed under reduced pressure. The residue was purified by FC (cyclohexane/*t*BuOMe 95:5) to give **1b** (2.1 g, 49%). ¹H NMR (300 MHz) δ 3.72 (s, 6H), 3.58 (t, *J* = 6.4, 2H), 2.91 (d, *J* = 2.7 Hz, 2H), 2.35 (t, *J* = 6.4 Hz, 2H), 1.98 (t, *J* = 2.8 Hz, 1H), 0.84 (s, 9H), 0.30 (s, 6H). ¹³C NMR (75 MHz) δ 170.4, 78.9, 71.3, 58.9, 55.0, 52.6, 34.3, 25.7, 22.6, 18.2, -5.6. IR: 3263, 2954, 2927, 2856, 2879, 1756, 1730, 1435, 1317, 1282, 1179, 1022, 1927, 824, 771, 618. EI (MS) *m/z* (%): 327 (2), 313 (40), 297 (99), 271 (77), 239 (16), 137 (20), 89 (100), 73 (62). 59(60). HRMS for C₁₂H₁₉O₅Si [M⁺-*t*Bu]: calcd, 271.1002 found 271.1003.

2-(2-Phenylsulfanylethyl)-2-prop-2-ynylmalonic acid dimethyl ester (1c):

To a solution of dimethyl propargylmalonate (0.63 mL, 4.13 mmol) in THF (5 mL) were added phenyl vinylsulfoxide (0.55 mL, 4.13 mmol) and DBU (0.62 mL, 4.13 mmol) at rt. After stirring at rt for 10 h, the mixture was concentrated under reduced pressure. The residue was purified by FC (hexane/EtOAc 1:1) to give 2-(2-benzenesulfinylethyl)-2-prop-2-ynylmalonic acid dimethyl ester as a colorless oil (1.22 g, 92%). ¹H NMR (300 MHz, CDCl₃) δ 7.48-7.63 (m, 5H), 3.71 (s, 6H), 2.89-2.97 (m, 1H), 2.78 (d, 2H, *J* = 2.69), 2.78-2.70 (m, 1H), 2.40-2.49 (m, 1H), 2.25-2.34 (m, 1H), 1.97 (t, 1H, *J* = 2.69). ¹³C NMR (100 MHz, CDCl₃) δ 23.7, 25.1, 51.7, 53.1, 55.9, 72.2, 77.7, 124.1, 129.3, 131.1, 143.2, 169.7. IR (solide) 3295, 3003, 2960, 1746, 1717, 1477, 1431, 1304, 1277, 1257, 1215, 1172, 1121, 1078, 1034, 983, 957, 871, 822, 745, 694, 661, 638. EI (MS) *m/z* (%): 322 (M⁺, 3), 305 (9), 291 (34), 197 (100), 137 (62), 125 (24), 109 (26), 91 (24), 77 (48), 59 (56), 45 (16). HRMS for C₁₆H₁₈O₅S [M⁺]: calcd 322.0875, found 322.0859.

To a solution of 2-(2-benzenesulfinylethyl)-2-prop-2-ynylmalonic acid dimethyl ester (3.56 g, 11.06 mmol) and sodium iodide (5.55 g, 38.5 mmol) in CH₃CN (20 mL) at 0°C was added a solution of BF₃•Et₂O (4.14 mL, 33 mmol) in CH₃CN (5 mL) during 15 min. The reaction mixture was then warm up to rt and stirred for 5 h. The reaction mixture was poured into ice cold H₂O (50 mL), treated with Na₂S₂O₃ aq. (15%) and extracted with Et₂O. The combined ether extracts were washed with H₂O and brine, and dried over Na₂SO₄. After evaporation of the solvent, the residue was purified by FC (hexane/EtOAc 6:1) to give **1c** (2.4 g, 70%) as a colorless oil. ¹H NMR (300 MHz, CDCl₃) δ 7.15-7.39 (m, 5H), 3.72 (s, 6H), 2.86-2.91 (m, 2H), 2.85 (d, 2H, *J* = 2.69), 2.38-2.43 (m, 2H), 2.01 (t, 1H, *J* = 2.69). ¹³C NMR (100 MHz, CDCl₃) δ 23.3, 28.4, 32.3, 52.9, 56.5, 71.9, 78.2, 126.1, 128.9, 129.1, 135.7, 170.1. IR (film) 3288, 3003, 2952, 2842, 1732, 1583, 1481, 1434, 1301, 1277, 1205, 1080, 1058, 1025, 978, 865, 740, 691. EI (MS) *m/z* (%): 306 (M⁺, 57), 275 (31), 247 (58), 197 (77), 170 (65), 137 (84), 123 (80), 110 (70), 77 (80), 59 (100), 51 (63), 45 (66), 39 (61). HRMS for C₁₆H₁₈O₄S [M⁺]: calcd 306.0926, found 306.0925.

2-Phenethyl-2-prop-2-ynylmalonic acid dimethyl ester (1d):

To the anion solution of dimethyl propargylmalonate, prepared by the addition of the ester (2.3 mL, 15 mmol) in DMF (15 mL) to a suspension of NaH (22.5 mmol, 1.08 mg) in DMF (10 mL) at 0°C, was added dropwise 2-bromoethylbenzene (2.77 g, 15 mmol) in DMF (10 mL) at 0°C. After stirring at 85°C for 6 h, the mixture was poured into a 1:1 mixture of H₂O and Et₂O. The aqueous layer were extracted with Et₂O (3×). The combined organic phases were washed with H₂O and brine, and dried over Na₂SO₄. After concentration, the residue was purified by FC (hexane/EtOAc 6:1) to give **1d** (822 mg, 20%) as a colorless oil. ¹H NMR (300 MHz, CDCl₃) δ 7.15-7.33 (m, 5H), 3.72 (s, 6H), 2.96 (d, 2H, *J* = 2.69), 2.51-2.59 (m, 2H), 2.35-2.42 (M, 2H), 2.05 (t, 1H, *J* = 2.69). ¹³C NMR (100 MHz, CDCl₃) δ 23.1, 30.5, 33.9, 52.8, 56.7, 71.6, 78.6, 126.1, 128.4, 140.9, 170.5. IR (film): cm⁻¹ 3287, 3027, 2953, 1735, 1603, 1496, 1437, 1269, 1205, 1091, 1054, 1019, 973, 868, 751, 700. EI (MS) *m/z* (%): 274 (M⁺, 42), 243 (12), 183 (8), 170 (100), 138 (28), 110 (39), 91 (67), 80 (21), 65 (26), 39 (12). HRMS for C₁₆H₁₈O₄ [M⁺]: calcd 274.1205, found 274.1204.

2-(2-Cyanoethyl)-2-prop-2-ynylmalonic acid diethyl ester (**1e**):

To the anion solution of diethyl 2-(2-cyanoethyl)malonate, prepared by the addition of a solution of the ester (2.13 g, 10 mmol) in DMF (10 mL) to a suspension of NaH (15 mmol, 720 mg) in DMF (10 mL) at 0°C, was added propargyl bromide (1.2 mL, 10.9 mmol) in DMF (5 mL) dropwise at 0°C. After stirring at 85°C for 6 h, the mixture was poured into a 1:1 mixture of H₂O and Et₂O. The aqueous layers were extracted with Et₂O (3×). The combined organic phases were washed with H₂O and brine, and dried over Na₂SO₄. After concentration, the residue was purified by FC (hexane/EtOAc 6:1) to give **1e** (1.13 g, 45%) as a colorless oil. ¹H NMR (300 MHz, CDCl₃) δ 4.17-4.29 (m, 4H), 2.84 (d, 2H, *J* = 2.69), 2.4-2.5 (m, 4H), 2.07 (t, 1H, *J* = 2.69), 1.27 (t, 6H, *J* = 7.09). ¹³C NMR (100 MHz, CDCl₃) δ 12.9, 13.9, 23.4, 28.5, 55.6, 62.3, 72.4, 77.7, 118.8, 169.0. IR (film): cm⁻¹ 3284, 2983, 2249, 1731, 1446, 1369, 1207, 1094, 1020, 859. EI (MS) *m/z* (%): 251 (M⁺, 8), 206 (57), 178 (84), 150 (89), 132 (52), 111 (100), 106 (65), 79 (66), 69 (77), 65 (51), 53 (22), 41 (31), 39 (36). HRMS for C₁₃H₁₇O₄N [M⁺]: calcd 251.1158, found 251.1158.

2-Methoxycarbonyl-2-prop-2-ynylpentanedioic acid 5-ethyl ester 1-methyl ester (**1f**):

To a suspension of NaH (1.04 g, 24 mmol, 55-65% dispersion in mineral oil) in DMF (10 mL) was added dropwise at 0°C a solution of dimethyl propargylmalonate (4.40 g, 20 mmol) in DMF (10 mL). The cold bath was removed and the reaction mixture stirred at rt for 1 h. A solution of 3-bromopropionic acid ethyl ester (5.43 g, 30 mmol) in DMF (10 mL) was added dropwise at rt. The reaction mixture was stirred at rt for 6 h and treated with brine (70 mL). Et₂O (20 mL) was added and the aqueous layers extracted with Et₂O. The combined organic layers were washed with brine (6x), dried over Na₂SO₄, and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 6:1) to give **1f** (3.35 g, 62%). ¹H NMR (300 MHz) δ 4.04 (q, *J* = 7.2 Hz, 2H), 3.66 (s, 6H), 2.73 (d, *J* = 2.6 Hz, 2H), 2.34-2.21 (m, 4H), 1.98 (t, *J* = 2.6 Hz, 1H), 1.17 (t, *J* = 7.2 Hz, 3H). ¹³C NMR (75 MHz) δ 172.4, 170.1, 78.2, 71.8, 60.5, 56.1, 52.8, 29.3, 27.5, 23.4, 14.1. IR (film) 3284, 2983, 2956, 1735, 1436, 1379, 1202, 1092, 1019, 973, 797. EI (MS) *m/z* (%): 271 (MH⁺, 0.1), 239 (25), 226 (10), 225 (80), 224 (15), 211 (55), 197 (35), 196 (30), 183 (5), 179 (25), 169 (15), 165 (90), 164 (95), 153 (14), 151 (20), 149 (19), 139 (13), 138 (30), 137 (100), 136 (55), 123 (25), 110 (10), 109 (20), 105 (40), 95 (15), 79 (30), 77 (40), 71

(10), 65 (11), 59 (37), 55 (22), 51 (10), 39 (11). HRMS (ESI-MS positive mode) for $C_{13}H_{18}O_6Na$ $[MNa^+]$: calcd 293.1001, found 293.0992.

2-Isobutyl-2-prop-2-ynylmalonic acid dimethyl ester (1g):

To a suspension of NaH (785 mg, 18 mmol, 55-65% dispersion in mineral oil) in DMF (10 mL) was added dropwise at 0°C a solution of dimethyl propargylmalonate (2.55 g, 15 mmol) in DMF (5 mL). The cold bath was removed and the reaction mixture stirred at rt for 1 h. A solution of isobutylbromide (3.08g, 22.5 mmol) in DMF (15 mL) was added dropwise and the mixture stirred at 70°C for 8 h. After cooling down to rt, the reaction was treated with brine (70 mL). Et₂O (20 mL) was added and the aqueous layer extracted with Et₂O. The combined organic layers were washed with brine (6×), dried over Na₂SO₄, and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 6:1) to give **1g** (2.14 g, 63%) as a colorless oil. ¹H NMR (300 MHz) δ 3.68 (s, 6H), 2.82 (d, *J* = 2.8 Hz, 2H), 2.00 (d, *J* = 6.4 Hz, 2H), 1.97 (m, 1H), 1.60 (m, 1H), 0.84 (d, *J* = 6.6 Hz, 6H). ¹³C NMR (75 MHz) δ 171.1, 79.0, 71.2, 56.3, 52.7, 40.3, 24.1, 23.6, 23.1. IR (film) 3286, 2957, 2872, 2130, 1735, 1437, 1388, 1368, 1288, 1227, 1130, 1051, 977, 852. EI (MS) *m/z* (%): 226 (*M*⁺, 0.6), 211 (1), 195 (1), 170 (75), 169 (62), 167 (37), 166 (32), 155 (30), 151 (60), 139 (20), 138 (40), 137 (31), 125 (20), 124 (30), 123 (55), 113 (36), 110 (69), 107 (100), 96 (29), 93 (34), 91 (64), 81 (32), 79 (56), 66 (27), 65 (62), 59 (89), 55 (39), 53 (28), 51 (20), 43 (52), 41 (65), 39 (50). HRMS for $C_{12}H_{18}O_4$ $[M^+]$: calcd 226.1205, found 226.1206.

2-Butyl-2-prop-2-ynylmalonic acid dimethyl ester (1h):

To a suspension of NaH (1.04 g, 24 mmol, 55-65% dispersion in mineral oil) in DMF (10 mL) was added dropwise at 0°C a solution of diethyl butylmalonate (4.33 g, 20 mmol) in DMF (10 mL). The cold bath was removed and the reaction mixture stirred at rt for 1 h. A solution of propargylbromide (4.46 g, 30 mmol, 80% in weight) in DMF (10 mL) was added dropwise at rt and the reaction mixture stirred at rt for 1 h. The reaction was treated with brine (70 mL). Et₂O (20 mL) was added and the aqueous layer extracted with Et₂O. The combined organic layers were washed with brine (6×), dried over Na₂SO₄, and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 6:1) to give **1h** (3.81 g, 75%). ¹H NMR (300 MHz) δ 4.18 (q, *J* = 7.1 Hz, 4H), 2.80 (t, *J* = 2.8 Hz, 2H), 2.03 (m, 2H), 1.97 (t, *J* = 2.8 Hz, 1H), 1.33 (m,

2H), 1.23 (t, $J = 7.1$ Hz, 6H), 1.14 (m, 2H), 0.89 (t, $J = 7.3$ Hz, 3H). ^{13}C NMR (75 MHz) δ 170.5, 79.1, 71.2, 61.6, 56.9, 31.6, 26.1, 22.9, 22.7, 14.2, 14.0. IR (film) 3282, 2961, 2936, 2873, 2130, 1735, 1467, 1367, 1300, 1268, 1210, 1129, 1051, 1035, 951, 858. EI (MS) m/z (%): 254 (M^+ , 0.4), 225 (5), 215 (21), 209 (15), 198 (100), 181 (16), 180 (17), 169 (25), 153 (25), 151 (27), 135 (13), 125 (20), 124 (36), 123 (47), 111 (65), 107 (52), 97 (24), 96 (76), 93 (27), 91 (22), 79 (48), 77 (22), 67 (45), 65 (35), 55 (56), 43 (30), 41 (32), 39 (23). HRMS for $\text{C}_{14}\text{H}_{22}\text{O}_4$ [M^+]: calcd 254.1518, found 254.1517.

2-Ethyl-2-prop-2-ynylmalonic acid dimethyl ester (**1i**):

To a suspension of NaH (1.04 g, 24 mmol, 55-65% dispersion in mineral oil) in DMF (10 mL) was added dropwise at 0°C a solution of dimethyl ethylmalonate (3.20 g, 20 mmol) in DMF (10 mL). The cold bath was removed and the reaction mixture stirred at rt for 1 h. A solution of propargylbromide (4.46 g, 30 mmol, 80% in weight) in DMF (10 mL) was added dropwise at rt and the reaction mixture stirred at rt for 1 h. The reaction was treated with brine (70 mL). Et_2O (20 mL) was added and the aqueous layer extracted with Et_2O . The combined organic layers were washed with brine (6×), dried over Na_2SO_4 , and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 6:1) to give **1i** (3.09 g, 78%). ^1H NMR (300 MHz) δ 3.69 (s, 6H), 2.77 (d, $J = 2.7$ Hz, 2H), 2.06 (q, $J = 7.6$ Hz, 2H), 1.96 (t, $J = 2.7$ Hz, 1H), 0.80 (t, $J = 7.6$ Hz, 3H). ^{13}C NMR (75 MHz) δ 170.7, 78.9, 71.2, 57.4, 52.7, 25.2, 22.3, 8.4. IR (solide) 3283, 2975, 2881, 2124, 1726, 1449, 1436, 1386, 1325, 1298, 1267, 1230, 1202, 1159, 1123, 1091, 1026, 973, 951, 892, 867, 802, 746, 687, 669. EI (MS) m/z (%): 198 (M^+ , 12), 170 (55), 169 (71), 167 (50), 155 (8), 140 (12), 139 (84), 138 (85), 137 (35), 127 (35), 123 (18), 111 (27), 110 (40), 107 (18), 95 (37), 79 (80), 77 (50), 65 (20), 59 (100), 55 (21), 53 (20), 41 (23), 39 (45). HRMS for $\text{C}_{10}\text{H}_{14}\text{O}_4$ [M^+]: calcd 198.0892, found 198.0892.

9-Phenylsulfanylmethyl-1,4-dioxaspiro[4.4]nonane-7,7-dicarboxylic acid dimethyl ester (**2a**):

According to the general procedure, from **1a** (256 mg, 1 mmol). FC (hexane/AcOEt 6:1) gave **2a** (329 mg, 90%).

^1H NMR (400 MHz, CDCl_3) δ 7.12-7.36 (m, 5H), 3.82 (m, 4H), 3.71 (s, 3H), 3.69 (s, 3H), 3.14 (dd, 1H, $J = 4.89, 2.71$), 2.80 (dd, 1H $J = 9.78, 12.72$), 2.67 (dd, 1H, $J = 8.07, 13.44$), 2.58 (d, 1H,

$J = 14.19$), 2.45 (m, 1H), 2.41 (d, 1H, $J = 14.19$), 2.17 (d, 1H, $J = 11.01$, 12.7). ^{13}C NMR (100 MHz, CDCl_3) δ 32.7, 36.8, 42.9, 44.7, 52.9, 53.0, 55.5, 64.7, 65.1, 115.5, 125.9, 128.9, 129.2, 136.4, 171.9, 172.2. IR (film): cm^{-1} 2953, 2888, 1735, 1582, 1481, 1437, 1372, 1264, 1160, 1091, 1025, 948, 878, 741, 692. EI (MS) m/z (%): 366 (M^+ , 9), 335 (6), 257 (94), 197 (53), 123 (16), 73 (100), 43 (56). HRMS for $\text{C}_{18}\text{H}_{22}\text{O}_6\text{S}$ [M^+]: calcd 366.1137, found 366.1134.

3-(*tert*-Butyldimethylsilyloxy)-4-phenylsulfanylmethylcyclopentane-1,1-dicarboxylic acid dimethyl ester (2b):

According to the general procedure, from **1b** (328 mg, 1 mmol). FC (hexane/*t*BuOMe 95:5) gave **2b** (390 mg, 89%) as a mixture of 2 diastereomers in a 62/38 ratio.

^1H NMR (300 MHz) for the mixture of the 2 diastereomers I (62% ds) and i (38% ds) δ : 7.12-7.38 (m, 10H, I+i), 4.29 (m, 1H, i), 3.97 (q, $J = 6.48$, 1H, I), 3.68 (m, 12H, I+i), 3.15 (dd, $J = 5.01$, 13.84 Hz, 1H, I), 3.09 (dd, $J = 8.07$, 12.61 Hz, 1H, i), 2.93 (dd, $J = 6.36$, 12.60 Hz, 1H, i), 2.75 (m, 2H, I+i), 2.58 (dd, $J = 6.24$, 13.57 Hz, 1H, I), 2.39 (m, , 3H, I+i), 2.15 (m, 3H, I+i), 1.81 (dd, $J = 9.04$, 14.06 Hz, 1H, I), 0.85 (m, 18H, I+i), 0.8 (m, 12H, I+i). ^{13}C NMR (75 MHz) δ 173.4, 173.0, 172.2, 136.8, 136.6, 129.3, 128.8, 125.8, 125.7, 76.5, 73.6, 58.3, 56.7, 52.8, 52.8, 52.7, 46.8, 45.1, 43.4, 42.1, 37.1, 36.3, 36.2, 32.8, 25.8, 25.7, -4.5, -4.6, -4.8, -4.9. IR: 2951, 2927, 2855, 1732, 1583, 1434, 1361, 1251, 1196, 1099, 1024, 939, 833, 775, 690. EI (MS) m/z (%): 381 (21), 271 (10), 246 (22), 177 (42), 119 (41), 110 (100), 91 (16), 69 (26), 41 (19). HRMS for $\text{C}_{18}\text{H}_{25}\text{O}_5\text{SSi}$ [$\text{M}^+ - \text{tBu}$]: calcd 381.1192, found 381.1192.

3-Phenylsulfanyl-4-phenylsulfanylmethylcyclopentane-1,1-dicarboxylic acid dimethyl ester (2c):

According to the general procedure, from **1c** (306 mg, 1 mmol). FC (hexane/AcOEt 6:1) gave **2c** (366 mg, 88%) as a mixture of 2 diastereomers in a 69:31 ratio. The two diastereomers were separated by preparative GC (column: 20% carbowax, 20M, chromosorb A, 60/80 mesh).

Isomer 1 (69% ds): ^1H NMR (400 MHz, CDCl_3) δ 7.12-7.40 (m, 10H), 3.82 (m, 1H), 3.75 (s, 3H), 3.72 (s, 3H), 3.27 (dd, 1H, $J = 5.84$, 13.19), 2.88 (dd, 1H, $J = 8.67$, 13.38), 2.58 (dd, 1H, $J = 6.22$, 14.32), 2.5 (m, 4H). ^{13}C NMR (100 MHz, CDCl_3) δ 34.8, 38.1, 40.4, 42.7, 51.1, 52.9, 53.0, 58.2, 126.1, 126.8, 128.9, 129.0, 129.4, 131.2, 135.0, 136.0, 172.1, 172.7.

Isomer 2 (31% ds): ^1H NMR (400 MHz, CDCl_3) δ 7.15-7.39 (m, 10H), 3.73 (s, 3H), 3.68 (s, 3H), 3.30 (m, 2H), 2.82 (m, 3H), 2.20 (m, 1H), 2.20 (dd, 1H, $J = 11.23, 13.94$), 2.04 (dd, 1H, $J = 11.23, 13.57$). ^{13}C NMR (100 MHz, CDCl_3) δ 37.1, 38.5, 41.7, 44.5, 50.5, 52.9, 53.0, 57.8, 126.2, 127.2, 128.9, 129.0, 129.6, 132.0, 134.0, 171.8. EI (MS) m/z (%): 416 (M^+ , 16), 338 (14), 246 (39), 166 (14), 123 (26), 110 (23), 69 (100), 41 (54). HRMS for $\text{C}_{22}\text{H}_{24}\text{O}_4\text{S}_2$ [M^+]: calcd 416.1116, found 416.1117.

3-Phenyl-4-phenylsulfanylmethylcyclopentane-1,1-dicarboxylic acid dimethyl ester (2d):

According to the general procedure, from **1d** (274 mg, 1 mmol). FC (hexane/AcOEt 6:1) gave **2d** (326 mg, 85%) as a mixture of 2 diastereomers in a 78:22 ratio. The two diastereomers were separated by preparative GC (column: 20% carbowax, 20M, chromosorb A, 60/80 mesh).

Isomer 1 (78% ds): ^1H NMR (400 MHz, CDCl_3) δ 7.10-7.36 (m, 10H), 3.79 (s, 3H), 3.75 (s, 3H), 3.45 (m, 1H), 2.72 (dd, 1H, $J = 7.35, 13.75$), 2.30-2.80 (m, 6H). ^{13}C NMR (100 MHz, CDCl_3) δ 34.9, 37.6, 38.6, 42.3, 47.2, 52.9, 58.8, 125.9, 126.7, 128.2, 128.4, 128.8, 129.2, 136.1, 172.8, 172.9.

Isomer 2 (22% ds): ^1H NMR (100 MHz, CDCl_3) δ 7.08-7.34 (m, 10H), 3.74 (s, 3H), 3.71 (s, 3H), 3.04 (dd, 1H, $J = 3.20, 12.81$), 2.64-2.90 (m, 4H), 2.35 (dd, 2H, $J = 11.49, 13.19$), 2.13 (dd, 1H, $J = 13.56, 10.55$). ^{13}C NMR (400 MHz, CDCl_3) δ 36.5, 39.6, 42.7, 46.3, 51.1, 52.9, 58.1, 126.9, 127.6, 128.2, 128.7, 128.8, 128.9, 136.6, 141.2, 172.8. IR (film) 3026, 2951, 1732, 1603, 1583, 1495, 1437, 1268, 1197, 1168, 1080, 1025, 911, 733, 696. EI (MS) m/z (%): 384 (M^+ , 32), 274 (8), 246 (9), 219 (10), 119 (26), 110 (28), 84 (29), 69 (100), 54 (35), 41 (59). HRMS for $\text{C}_{22}\text{H}_{24}\text{O}_4\text{S}$ [M^+]: calcd 384.1395, found 384.1396.

3-Cyano-4-phenylsulfanylmethylcyclopentane-1,1-dicarboxylic acid diethyl ester (2e):

According to the general procedure, from **1e** (251 mg, 1 mmol). FC (hexane/AcOEt 6:1) gave **2e** (253 mg, 70 %) as a mixture of 2 diastereomers in a 69:31 ratio. The major isomer was isolated by preparative GC (column: 20% carbowax, 20M, chromosorb A, 60/80 mesh).

Isomer 1 (69% ds): ^1H NMR (300 MHz) δ : 7.40-7.19 (m, 5H), 4.11-4.29 (m, 4H), 3.25-2.17 (m, 8H), 1.31-1.15 (m, 6H). ^{13}C NMR (75 MHz) δ 13.9, 33.2, 35.7, 37.2, 38.4, 41.1, 44.1, 58.8, 62.1, 119.2, 126.9, 129.1, 130.3, 134.8, 170.4, 171.2. IR (film) 3278, 2980, 2238, 1727, 1583, 1465, 1440, 1257, 1188, 1081, 1023, 853, 743, 690. EI (MS) m/z (%): 361 (M^+ , 30), 316 (9), 252 (14),

224 (16), 178 (27), 173 (24), 123 (100), 110 (77), 79 (37), 45 (39). HRMS for $C_{19}H_{23}NO_4SNa$ $[M+Na^+]$: calcd 384.1245, found 384.1236.

4-Phenylsulfanylmethylcyclopentane-1,1,3-tricarboxylic acid 3-ethyl ester 1,1-dimethyl ester (1f):

According to the general procedure, from **1f** (270 mg, 1 mmol). FC (hexane/AcOEt 6:1) gave **2f** (217 mg, 57 %) as a mixture of 2 diastereomers in a 76:24 ratio.

Major diastereomer (76% ds): 1H NMR (400 MHz) (*characteristic signals*) δ 7.29-7.17 (m, 4H), 7.15-7.08 (m, 1H), 4.07 (q, $J = 7.1$ Hz, 2H), 3.67 (s, 3H), 3.64 (s, 3H), 3.03-2.93 (m, 1H), 2.71 (dd, $J = 13.0, 8.8$ Hz, 1H), 2.66-2.50 (m, 1H), 2.49-2.39 (m, 2H), 1.19 (t, $J = 7.2$ Hz, 3H).

Minor diastereomer (24% ds): 1H NMR (400 MHz) (*characteristic signals*) δ 7.29-7.17 (m, 4H), 7.15-7.08 (m, 1H), 4.06 (q, $J = 7.1$ Hz, 2H), 3.02 (dd, $J = 13.1, 4.8$ Hz, 1H), 2.81 (dd, $J = 13.0, 8.1$ Hz, 1H), 1.97 (dd, $J = 13.3, 8.9$ Hz, 1H), 1.16 (t, $J = 7.2$ Hz, 3H). EI (MS) m/z (%): 380 (M^+ , 32), 349 (7), 335 (13), 306 (7), 271 (23), 246 (18), 225 (14), 211 (53), 197 (17), 187 (14), 183 (28), 179 (35), 165 (52), 151 (56), 137 (55), 124 (61), 123 (100), 110 (36), 109 (37), 107 (25), 93 (18), 79 (55), 77 (44), 65 (20), 59 (42), 45 (43). ^{13}C NMR (100 MHz) (*characteristic signals-mixture of diastereomers*) δ 173.6, 173.3, 172.9, 172.4, 172.0, 171.9, 136.3, 136.0, 129.8, 129.5, 129.1, 129.0, 126.4, 126.3, 61.0, 60.8, 59.0, 58.8, 53.1, 53.0, 52.7, 48.9, 48.8, 42.4, 41.6, 39.3, 38.8, 38.1, 37.6, 36.4, 35.2, 14.4, 14.3. IR (film) 2952, 1726, 1583, 1437, 1376, 1253, 1196, 1092, 1024, 858, 739, 690. EI (MS) m/z (%): 380 (M^+ , 10), 349 (7), 335 (10), 271 (93), 246 (6), 243 (23), 211 (100), 197 (5), 187 (10), 179 (13), 165 (22), 151 (25), 137 (38), 124 (11), 123 (62), 110 (17), 109 (29), 107 (66), 93 (16), 79 (66), 77 (30), 65 (15), 59 (33), 45 (35). HRMS for $C_{19}H_{24}O_6S$ $[M^+]$: calcd 380.1294, found 380.1296.

3,3-Dimethyl-4-phenylsulfanylmethylcyclopentane-1,1-dicarboxylic acid dimethyl ester (2g):

According to the general procedure, from **1g** (226 mg, 1 mmol). FC (hexane/AcOEt 9:1) gave **2g** (279 mg, 83%).

1H NMR (300 MHz) δ 7.37-7.26 (m, 4H), 7.22-7.16 (m, 1H), 3.73 (s, 3H), 3.71 (s, 3H), 3.08 (dd, $J = 12.1, 4.1$ Hz, 1H), 2.70 (dd, $J = 13.7, 7.0$ Hz, 1H), 2.67 (dd, $J = 12.1, 10.7$ Hz, 1H), 2.29 (d, $J = 14.0$ Hz, 1H), 2.19 (d, $J = 14.0$ Hz, 1H), 2.18 (dd, $J = 13.7, 11.9$ Hz, 1H), 1.99-1.87 (m, 1H),

1.08 (s, 3H), 0.88 (s, 3H). ^{13}C NMR (75 MHz) δ 173.2, 173.1, 136.8, 129.2, 128.9, 126.0, 57.3, 52.8, 52.8, 49.1, 48.3, 41.6, 39.2, 34.3, 27.9, 22.2. IR (film) 2953, 1731, 1582, 1480, 1436, 1388, 1369, 1267, 1211, 1156, 1070, 1025, 740, 691. EI (MS) m/z (%): 336 (M^+ , 40), 305 (7), 227 (29), 177 (26), 167 (99), 153 (7), 139 (15), 135 (37), 123 (67), 110 (73), 107 (100), 93 (37), 91 (25), 79 (27), 77 (20), 59 (28), 45 (28), 41 (24). HRMS for $\text{C}_{18}\text{H}_{24}\text{O}_4\text{S}$ [M^+]: calcd 336.1395, found 336.1396.

3-Ethyl-4-phenylsulfanylmethylcyclopentane-1,1-dicarboxylic acid diethyl ester (2h):

According to the general procedure, from **1h** (254 mg, 1 mmol). FC (hexane/AcOEt 9:1) gave **2h**. 26% of benzothiophene product **4h** were observed but not isolated. In order to prove the structure of **4h**, the compound was prepared from 3-chloromethylbenzo[*b*]thiophene and the ^1H NMR and the GC-MS spectra compared.

^1H NMR (300 MHz) δ 7.34-7.23 (m, 4H), 7.19-7.13 (m, 1H), 4.20-4.12 (m, 4H), 3.01 (dd, J = 12.2, 5.2 Hz, 1H), 2.70 (dd, J = 12.4, 5.2 Hz, 1H), 2.49-2.22 (m, 4H), 2.10-1.94 (m, 2H), 1.50-1.39 (m, 1H), 1.22 (t, J = 7.1 Hz, 3H), 1.22 (t, J = 7.1 Hz, 3H), 1.24-1.01 (m, 1H), 0.90 (t, J = 7.3 Hz, 3H). ^{13}C NMR (100 MHz) δ 173.0, 172.9, 136.8, 129.6, 129.0, 126.1, 61.6, 61.5, 44.2, 41.2, 38.6, 38.3, 34.4, 22.1, 14.2, 12.8. IR (film) 2969, 1725, 1583, 1438, 1365, 1247, 1178, 1093, 1024, 909, 860, 808, 733, 689, 648. EI (MS) m/z (%): 364 (M^+ , 20), 319 (5), 255 (10), 209 (10), 181 (50), 177 (12), 173 (5), 153 (5), 135 (15), 123 (30), 121 (22), 119 (30), 107 (50), 101 (15), 88 (20), 86 (85), 84 (100), 51 (5), 49 (35), 47 (40). HRMS for $\text{C}_{20}\text{H}_{28}\text{O}_4\text{S}$ [M^+]: calcd 364.1708, found 364.1705.

2-Ethyl-2-(3-phenylsulfanylallyl)-malonic acid dimethyl ester (3i):

According to the general procedure, from **1i** (198 mg, 1 mmol). FC (hexane/AcOEt 9:1) gave **3i** (167 mg, 54%) as a 1:1 mixture of *E*:*Z* diastereomers. Traces of benzothiophene product **4i** were observed but not isolated. The structure of **4i** was determined by chemical correlation.

^1H NMR (400 MHz) (*mixture of diastereomers*) δ 7.33-7.28 (m, 8H), 7.24-7.18 (m, 2H), 6.33 (dt, J = 9.3, 1.4 Hz, 1H_(*Z* isomer)), 6.23 (dt, J = 14.9, 1.2 Hz, 1H_(*E* isomer)), 5.74 (dt, J = 14.9, 7.5 Hz, 1H_(*E* isomer)), 5.63 (dt, J = 9.3, 7.5 Hz, 1H_(*Z* isomer)), 3.73 (s, 6H), 3.72 (s, 6H), 2.88 (dd, J = 7.5, 1.4 Hz, 2H_(*Z* isomer)), 2.73 (dd, J = 7.5, 1.2 Hz, 2H_(*E* isomer)), 1.99-1.92 (m, 4H), 0.88 (t, J = 7.5 Hz, 3H), 0.85 (t, J = 7.6 Hz, 3H). ^{13}C NMR (100 MHz) (*mixture of diastereomers, characteristic signals*) δ

171.8, 171.6, 136.0, 135.6, 129.4, 129.2, 129.1, 128.8, 127.2, 126.7, 126.6, 126.4, 126.3, 58.4, 58.1, 52.6, 52.5, 36.0, 31.9, 26.0, 25.8, 8.8, 8.6. IR (film) 2951, 1732, 1583, 1479, 1439, 1386, 1296, 1236, 1122, 1091, 1024, 803, 740, 691. EI (MS) m/z (%): 308 (M^+ , 27), 247 (5), 151 (6), 150 (15), 149 (100), 139 (87), 134 (22), 116 (55), 115 (42), 109 (17), 105 (6), 91 (6), 79 (15), 77 (14), 65 (12), 59 (22), 51 (12), 45 (14), 41 (6). HRMS for $C_{16}H_{20}O_4S$ [M^+]: calcd 308.1082, found 308.1082.

Synthesis of benzothiophene product **4h** and **4i**:

2-Butyl-2-(3*H*-inden-1-ylmethyl)-malonic acid diethyl ester (4h):

A solution of thianaphtene (1.34 g, 10 mmol), HCHO (2 mL, 24 mmol, 37% weight), HCl (2 mL, 20 mmol, 36% weight) was heated at 60°C for 1 h. The aqueous layer was extracted with *t*BuOMe (3×). The combined organic layers were washed with a saturated solution of Na_2CO_3 , brine, dried over Na_2SO_4 and the solvent removed under reduced pressure. The residue was purified by FC (cyclohexane, then cyclohexane/*t*BuOMe 95:5) to give 3-chloromethylbenzo[*b*]thiophene (146 mg, 8%). 1H NMR (300 MHz) δ 7.92 (m, 2H), 7.49 (s, 1H), 7.48-7.36 (m, 2H), 4.86 (s, 2H).

To a suspension of NaH (26 mg, 0.6 mmol, 55-65% dispersion in mineral oil) in DMF (2 mL) was added dropwise at rt a solution of diethyl butylmalonate (108 mg, 0.5 mmol) in DMF (1 mL). The reaction mixture was stirred at rt for 1 h. A solution of 3-chloromethylbenzo[*b*]thiophene (27 mg, 0.15 mmol) in DMF (2 mL) was added dropwise at rt. The reaction mixture was stirred at rt for 4 h. The reaction was treated with HCl 1N (10 mL). *t*BuOMe (4 mL) was added and the aqueous layer extracted with *t*BuOMe (3×). The combined organic layer was washed with brine (2×), dried over Na_2SO_4 , and the solvent removed under reduced pressure. The residue was purified by FC (cyclohexane, and cyclohexane/*t*BuOMe 97:3) to give **4h** (51 mg, 95%). 1H NMR (300 MHz) δ 7.87-7.80 (m, 1H), 7.78-7.70 (m, 1H), 7.40-7.27 (m, 2H), 7.17 (s, 1H), 4.19-3.98 (m, 4H), 3.49 (s, 2H), 2.01-1.87 (m, 2H), 1.41-1.22 (m, 4H), 1.15 (t, J = 7.2 Hz, 6H), 0.89 (t, J = 6.9 Hz, 3H). ^{13}C NMR (75 MHz) δ 171.7, 140.0, 139.8, 131.1, 124.3, 124.1, 123.9, 122.8, 121.8, 61.4, 58.4, 32.7, 30.6, 26.7, 23.0, 14.0 (2C). EI (MS) m/z (%): 362 (M^+ , 23), 288 (11), 259 (7), 243 (12), 214 (8), 187 (3), 173 (7), 172 (6), 171 (9), 149 (13), 148 (38), 147

(100), 134 (10), 115 (8), 113 (5), 89 (3), 81 (3), 69 (4), 55 (3), 45 (3). HRMS for $C_{20}H_{26}O_4S$ [M^+]: calcd 362.1552, found 362.1551.

2-Ethyl-2-(3*H*-inden-1-ylmethyl)-malonic acid dimethyl ester (4i):

To a suspension of NaH (26 mg, 0.6 mmol, 55-65% dispersion in mineral oil) in DMF (2 mL) was added dropwise at rt a solution of dimethyl ethylmalonate (80 mg, 0.5 mmol) in DMF (1 mL). The reaction mixture stirred at rt for 1 h. A solution of 3-chloromethyl-benzo[*b*]thiophene (27 mg, 0.15 mmol) in DMF (2 mL) was added dropwise at rt. The reaction mixture was stirred at rt for 4 h. The reaction was treated with HCl 1N (10 mL). *t*BuOMe (4 mL) was added and the aqueous layer extracted with *t*BuOMe (3×). The combined organic layer was washed with brine (2×), dried over Na_2SO_4 , and the solvent removed under reduced pressure. The residue was purified by FC (cyclohexane, and cyclohexane/*t*BuOMe 97:3) to give **4i** (42 mg, 92%). 1H NMR (300 MHz) δ 7.87-7.81 (m, 1H), 7.77-7.71 (m, 1H), 7.40-7.28 (m, 2H), 7.14 (s, 1H), 3.65 (s, 6H), 3.50 (d, J = 0.8 Hz, 2H), 1.99 (q, J = 7.5 Hz, 2H), 0.93 (t, J = 7.5 Hz, 3H). ^{13}C NMR (75 MHz) δ 171.9, 140.1, 139.6, 130.8, 124.3, 124.2, 124.0, 122.9, 121.8, 59.0, 52.5, 30.4, 26.1, 9.1. EI (MS) m/z (%): 306 (M^+ , 15), 246 (5), 215 (8), 187 (7), 186 (8), 171 (10), 149 (12), 148 (25), 147 (100), 115 (6), 103 (5), 89 (3), 77 (4), 69 (5), 59 (6), 45 (5). HRMS for $C_{16}H_{18}O_4S$ [M^+]: calcd 306.0926, found 306.0927.

2-*tert*-Butyl-2-prop-2-ynylmalonic acid diethyl ester (5):

To a suspension of NaH (1.04 g, 24 mmol, 55-65% dispersion in mineral oil) in DMF (10 mL) was added dropwise at 0°C a solution of diethyl *tert*-butylmalonate (4.33 g, 20 mmol) in DMF (10 mL). The cold bath was removed and the reaction mixture stirred at rt for 1 h. A solution of propargylbromide (4.46 g, 30 mmol, 80% in weight) in DMF (15 mL) was added dropwise at rt. The reaction mixture was stirred at rt for 16 h. The reaction was treated with brine (70 mL). Et_2O (20 mL) was added and the aqueous layer extracted with Et_2O . The combined organic layer was washed with brine (6×), dried over Na_2SO_4 , and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 6:1) and isolated by preparative GC (column: 20% carbowax, 20M, chromosorb A, 60/80 mesh) to give **5** (2.39 g, 47%). 1H NMR (300 MHz) δ 4.30 (q, J = 7.11 Hz, 4H), 2.73 (d, J = 2.69 Hz, 2H), 2.04 (t, J = 2.69 Hz, 1H), 1.25 (t, J = 7.22 Hz, 6H), 1.10 (s, 9H). ^{13}C NMR (100 MHz) δ 13.0, 21.6, 26.4, 35.4, 60.0, 62.6, 69.4, 80.4, 168.8. IR :

3282, 2977, 1724, 1466, 1400, 1366, 1278, 1240, 1182, 1094, 1064, 1025, 860, 645. EI (MS) m/z (%): 254 (M^+ , 1), 199 (6), 198 (58), 197 (28), 169 (11), 153 (43), 151 (42), 141 (14), 139 (10), 125 (34), 124 (50), 123 (36), 107 (11), 97 (17), 96 (100), 91 (20), 79 (15), 77 (17), 57 (58), 41 (25). HRMS for $C_{14}H_{22}O_4$ [M^+]: calcd 254.1518, found 254.1152.

2,2-Dimethyl-4-phenylsulfanylmethylcyclopentane-1,1-dicarboxylic acid dimethyl ester (6):

According to the general procedure, from **5** (254 mg, 1 mmol). FC (cyclohexane/*t*BuOMe 95:5) gave **6** (160 mg, 48%).

1H NMR (300 MHz) δ 7.37-7.27 (m, 4H), 7.21-7.16 (m, 1H), 4.24-4.16 (m, 4H), 3.05 (d, $J = 7.5$ Hz, 2H), 2.66 (dd, $J = 14.5, 10.2$ Hz, 1H), 2.56-2.40 (m, 1H), 2.11 (dd, $J = 14.5, 6.4$ Hz, 1H), 1.94 (dd, $J = 12.7, 8.5$ Hz, 1H), 1.83 (dd, $J = 12.7, 8.7$ Hz, 1H), 1.28 (t, $J = 7.1$ Hz, 6H), 1.20 (s, 3H), 1.09 (s, 3H). ^{13}C NMR (75 MHz) δ 172.1, 170.9, 136.9, 129.1, 128.9, 125.9, 66.5, 61.0, 60.9, 47.1, 45.9, 40.5, 38.9, 34.1, 25.6, 25.2, 14.2, 14.1. IR (film) 2977, 1727, 1584, 1480, 1438, 1386, 1366, 1262, 1237, 1152, 1095, 1025, 738, 691. EI (MS) m/z (%): 364 (M^+ , 13), 319 (5), 255 (17), 209 (12), 181 (64), 163 (16), 153 (11), 149 (19), 135 (21), 123 (37), 110 (23), 107 (100), 99 (11), 95 (14), 93 (25), 79 (21), 77 (17), 67 (19), 65 (9), 55 (14), 53 (7). HRMS for $C_{20}H_{28}O_4S$ [M^+]: calcd 364.1708, found 364.1708.

Synthesis of compounds **7a-d** necessitated the preparation of 2-hexylidenemalonic acid diethyl ester, 2-(1-ethynylhexyl)-malonic acid diethyl ester and 2-(1-isopropylprop-2-ynyl)-malonic acid dimethyl ester.

2-Hexylidenemalonic acid diethyl ester :

Prepared according to literature procedure: see ref. [2].

1H NMR (300 MHz) δ 6.98 (t, $J = 7.9$ Hz, 1H), 4.29 (q, $J = 7.1$ Hz, 2H), 4.22 (q, $J = 7.2$ Hz, 2H), 2.28 (q, $J = 7.5$ Hz, 2H), 1.55-1.43 (m, 2H), 1.33-1.25 (m, 4H), 1.31 (t, $J = 7.2$ Hz, 3H), 1.28 (t, $J = 7.2$ Hz, 3H), 0.86 (t, $J = 7.1$ Hz, 3H). ^{13}C NMR (75 MHz) δ 165.7, 164.2, 149.6, 128.8, 61.3, 61.2, 31.5, 29.8, 28.1, 22.5, 14.3, 14.2, 14.0. IR (film) 2932, 2860, 1731, 1645, 1467, 1376, 1255, 1143, 1095, 1059, 865, 795, 726. EI (MS) m/z (%): 243 (M^+ , 2), 242 (3), 213 (1), 198 (15), 197 (76), 196 (55), 186 (6), 173 (20), 168 (22), 167 (85), 160 (30), 154 (40), 153 (70), 151 (56), 150 (86), 141 (20), 139 (12), 127 (86), 125 (75), 122 (75), 121 (50), 111 (20), 109 (45), 108 (100), 99

(76), 95 (94), 85 (75), 81 (45), 68 (50), 55 (90), 53 (35), 41 (96), 39 (45). HRMS for $C_{13}H_{22}O_4$ [M^+]: calcd 242.1518, found 242.1518.

2-(1-Ethynylhexyl)-malonic acid diethyl ester:

To a solution of 2-hexylidenemalonic acid diethyl ester (20 mmol) in THF (20 mL) was added dropwise a solution of ethynylmagnesium chloride (40 mmol, 0.5 N in THF) at 0°C. The cold bath was removed and the reaction mixture stirred at rt for 16 h. The reaction was treated with HCl (1 N), extracted with Et₂O. The combined organic layers were washed with a saturated aqueous solution of Na₂CO₃, followed by a saturated aqueous solution of NH₄Cl/NH₃ (3:1), and brine, dried over Na₂SO₄, and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 6:1) to give the desired product (3.06 g, 57%). ¹H NMR (300 MHz) δ 4.20 (q, *J* = 7.2 Hz, 2H), 4.19 (q, *J* = 7.2 Hz, 2H), 3.42 (d, *J* = 9.4 Hz, 1H), 3.15-3.07 (m, 1H), 2.09 (d, *J* = 2.4 Hz, 1H), 1.58-1.36 (m, 4H), 1.27-1.21 (m, 4H), 1.26 (t, *J* = 7.2 Hz, 3H), 1.25 (t, *J* = 7.2 Hz, 3H), 0.86 (t, *J* = 6.8 Hz, 3H). ¹³C NMR (75 MHz) δ 167.6, 167.5, 83.7, 71.2, 61.7, 61.6, 61.5, 56.5, 32.4, 31.7, 31.4, 26.7, 22.5, 14.2, 14.1. IR (film) 3281, 2932, 1735, 1456, 1368, 1234, 1176, 1032. EI (MS) *m/z* (%): 269 (MH⁺, 0.5), 239 (2.5), 223 (7), 211 (82), 197 (45), 195 (60), 193 (30), 177 (20), 169 (95), 167 (85), 165 (830), 160 (50), 152 (15), 151 (25), 149 (26), 141 (55), 133 (35), 125 (100), 123 (55), 115 (30), 111 (20), 107 (15), 105 (10), 97 (83), 93 (25), 88 (17), 86 (15), 79 (30), 69 (5), 67 (30), 55 (15), 43 (25), 41 (15). ESI-MS positive mode for $C_{15}H_{25}O_4$ [MH^+]: calcd 269.1742, found 269.1742.

2-(1-Isopropylprop-2-ynyl)-malonic acid dimethyl ester:

To a solution of 2-isobutylidene malonic acid dimethyl ester (50 mmol) in THF (50 mL) was added dropwise a solution of ethynylmagnesium chloride (80 mmol, 0.5 N in THF) at 0°C. The cold bath was removed and the reaction mixture stirred at rt for 16 h. The reaction was treated with HCl (1 N), extracted with Et₂O. The combined organic layers were washed with a saturated aqueous solution of Na₂CO₃, followed by a saturated aqueous solution of NH₄Cl/NH₃ (3:1), and brine, dried over Na₂SO₄, and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 6:1) to give the desired product (6.00 g, 57%). ¹H NMR (300 MHz) δ 3.72 (s, 3H), 3.71 (s, 3H), 3.53 (d, *J* = Hz, 1H), 3.12 (ddd, *J* = 10.6, 3.8, 2.6 Hz, 1H), 2.08 (d, *J* = 2.6 Hz, 1H), 1.77-1.66 (m, 1H), 1.00 (d, *J* = 6.8 Hz, 3H), 0.92 (d, *J* = 6.8 Hz, 3H).

^{13}C NMR (75 MHz) δ 168.0, 167.8, 81.1, 72.5, 54.7, 52.7, 52.7, 38.5, 28.7, 21.5, 16.8. IR (film) 3285, 2962, 2876, 1740, 1435, 1324, 1260, 1195, 1164. EI (MS) m/z (%): 211 (M-H^+ , 5), 187 (15), 181 (28), 170 (18), 169 (25), 165 (10), 155 (10), 153 (55), 152 (15), 139 (5), 138 (10), 137 (20), 132 (15), 127 (10), 123 (5), 111 (100), 110 (70), 109 (10), 101 (25), 95 (10), 93 (35), 91 (5), 83 (10), 81 (20), 79 (50), 77 (15), 69 (10), 66 (12), 59 (20), 55 (5), 53 (15), 51 (10), 43 (25), 41 (30).

2-(1-Ethynylhexyl)-2-isobutylmalonic acid diethyl ester (7a):

To a suspension of NaH (0.52 g, 12 mmol, 55-65% dispersion in mineral oil) in DMF (5 mL) was added dropwise at 0°C a solution of 2-(1-ethynylhexyl)-malonic acid diethyl ester (2.68 g, 10 mmol) in DMF (5 mL). The cold bath was removed and the reaction mixture stirred at rt for 1 h. A solution of isobutyl iodide (2.3 mL, 20 mmol) in DMF (10 mL) was added dropwise and the mixture stirred at rt for 16 h. The reaction was treated with brine (70 mL). Et_2O (20 mL) was added and the aqueous layer extracted with Et_2O . The combined organic layers were washed with brine (6 $\times$), dried over Na_2SO_4 , and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 6:1) to give **7a** (2.07 g, 64%) as a colorless oil. ^1H NMR (300 MHz) δ 4.25-4.13 (m, 4H), 3.03-2.98 (m, 1H), 2.13 (d, J = 2.6 Hz, 1H), 2.10 (dd, J = 14.5, 5.5 Hz, 1H), 1.96 (dd, J = 14.5, 6.6 Hz, 1H), 1.85-1.72 (m, 1H), 1.71-1.59 (m, 2H), 1.44-1.22 (6H), 1.27 (t, J = 7.2 Hz, 3H), 1.26 (t, J = 7.0 Hz, 3H), 0.96-0.81 (m, 3H), 0.92 (d, J = 6.6 Hz, 3H), 0.86 (d, J = 6.6 Hz, 3H). ^{13}C NMR (75 MHz) δ 170.9, 170.1, 83.8, 71.7, 61.1, 61.0, 59.9, 42.8, 37.1, 31.6, 31.5, 28.1, 24.5, 24.4, 23.5, 22.6, 14.2, 14.1, 14.0. IR (film) 3277, 2959, 2871, 2130, 1465, 1388, 1367, 1228, 1121, 1039, 862. EI (MS) m/z (%): 325 (MH^+ , 0.5), 309 (1.5), 295 (2), 281 (15), 251 (50), 235 (5), 225 (20), 223 (35), 221 (33), 207 (20), 197 (60), 181 (60), 173 (100), 153 (45), 151 (50), 127 (75), 123 (35), 121 (17), 109 (35), 107 (25), 99 (21), 91 (21), 81 (18), 79 (29), 69 (18), 67 (26), 55 (20), 43 (30), 41 (26). HRMS (ESI-MS positive mode) for $\text{C}_{19}\text{H}_{33}\text{O}_4$ [MH^+]: calcd 325.2378, found 325.2379.

2-(1-Ethynylhexyl)-2-pentylmalonic acid diethyl ester (7b):

To a suspension of NaH (0.52 g, 12 mmol, 55-65% dispersion in mineral oil) in DMF (5 mL) was added dropwise at 0°C a solution of 2-(1-ethynylhexyl)malonic acid diethyl ester (2.68 g, 10 mmol) in DMF (5 mL). The cold bath was removed and the reaction mixture stirred at rt for 1 h.

A solution of pentyl iodide (2.6 mL, 20 mmol) in DMF (10 mL) was added dropwise at rt and the reaction mixture stirred at rt for 1 h. Then, the reaction was treated with brine (70 mL). Et₂O (20 mL) was added and the aqueous layer extracted with Et₂O. The combined organic layers were washed with brine (6×), dried over Na₂SO₄, and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 6:1) to give **7b** (2.84 g, 84%). ¹H NMR (300 MHz) δ 4.21-4.14 (m, 4H), 2.99-2.96 (m, 1H), 2.11-1.91 (m, 2H), 2.08 (d, *J* = 2.5 Hz, 1H), 1.68-1.54 (m, 2H), 1.42-1.15 (m, 18H), 0.89-0.83 (m, 6H). ¹³C NMR (75 MHz) δ 170.6, 170.1, 83.7, 71.5, 61.2, 61.1, 60.6, 36.5, 34.1, 32.2, 31.5, 31.4, 28.1, 24.2, 22.7, 22.4, 14.3, 14.2, 14.1, 14.0. IR (film) 3277, 2958, 2930, 2860, 1731, 1467, 1367, 1298, 1209, 1119, 1096, 1039, 861. EI (MS) *m/z* (%): 338 (M⁺, 3), 309 (23), 293 (36), 281 (30), 266 (6), 265 (42), 237 (36), 235 (27), 221 (11), 207 (8), 197 (52), 195 (47), 193 (20), 173 (100), 167 (44), 165 (14), 151 (45), 137 (20), 127 (34), 123 (22), 109 (30), 107 (20), 93 (23), 91 (20), 81 (27), 79 (34), 69 (29), 55 (50), 43 (38), 41 (35). HRMS for C₂₀H₃₄O₄ [M⁺]: calcd 338.2457, found 338.2456.

2-Ethyl-2-(1-isopropylprop-2-ynyl)malonic acid dimethyl ester (7c):

To a suspension of NaH (502 mg, 12 mmol, 55-65% dispersion in mineral oil) in DMF (5 mL) was added dropwise at 0°C a solution of 2-(1-isopropylprop-2-ynyl)-malonic acid dimethyl ester (2.12 g, 10 mmol) in DMF (5 mL). The cold bath was removed and the reaction mixture stirred at rt for 1 h. A solution of ethyl iodide (1.2 mL, 12 mmol) in DMF (5 mL) was added dropwise and the mixture stirred at rt for 16 h. The reaction was treated with brine (70 mL). Et₂O (20 mL) was added and the aqueous layer extracted with Et₂O. The combined organic layers were washed with brine (6×), dried over Na₂SO₄, and the solvent removed under reduced pressure. The residue was purified by FC (cyclohexane/*t*BuOMe 95:5) to give **7c** (1.63 g, 68%). ¹H NMR (300 MHz) δ 3.59 (s, 3H), 3.58 (s, 3H), 2.97 (t, *J* = 2.5 Hz, 1H), 2.10 (dt, *J* = 14.1, 7.1 Hz, 1H), 2.02 (d, *J* = 2.5 Hz, 1H), 1.94-1.83 (m, 2H), 0.91 (d, *J* = 6.8 Hz, 3H), 0.71 (t, *J* = 7.3 Hz, 3H), 0.70 (d, *J* = 7.2 Hz, 3H). ¹³C NMR (75 MHz) δ 171.3, 170.7, 80.7, 73.1, 60.5, 52.3, 52.2, 42.1, 27.8, 27.7, 23.9, 18.5, 9.0. IR (film) 3282, 2967, 2880, 2114, 1731, 1434, 1388, 1367, 1302, 1238, 1117, 1010, 918, 808. EI (MS) *m/z* (%): 225 (2), 211 (3), 209 (6), 198 (10), 193 (6), 181 (33), 169 (60), 165 (15), 145 (15), 139 (100), 138 (57), 137 (39), 128 (16), 123 (22), 121 (26), 110 (22), 107 (21), 95 (32), 79 (48), 77 (55), 69 (20), 59 (45), 43 (25), 41 (31), 39 (19). HRMS for C₁₃H₂₀O₄ [M⁺]: calcd 240.1362, found 240.1352.

2-(1-Isopropylprop-2-ynyl)-2-methoxycarbonylpentanedioic acid 5-ethyl ester 1-methyl ester (7d):

To a solution of 2-(1-isopropylprop-2-ynyl)-malonic acid dimethyl ester (1.56 g, 5 mmol) and ethylacrylate (2.5 g, 25 mmol) in DMF (10 mL) was added DBU (5 mmol). The reaction mixture was stirred at rt for 7 h and treated with brine (70 mL). Et₂O (20 mL) was added and the aqueous layer extracted with Et₂O. The combined organic layers were washed with brine (6×), dried over Na₂SO₄, and the solvent removed under reduced pressure. The residue was purified by FC (hexane/AcOEt 4:1) to give **7d** (1.53 g, 98%). ¹H NMR (300 MHz) δ 4.06 (q, *J* = 7.2 Hz, 2H), 3.68 (s, 6H), 3.06 (t, *J* = 2.6 Hz, 1H), 2.47-2.18 (m, 4H), 2.15 (d, *J* = 2.6 Hz, 1H), 1.99-1.89 (m, 1H), 1.19 (t, *J* = 7.2 Hz, 3H), 0.98 (d, *J* = 6.8 Hz, 3H), 0.84 (d, *J* = 6.6 Hz, 3H). ¹³C NMR (75 MHz) δ 172.7, 170.6, 170.1, 80.4, 73.7, 60.5, 59.6, 52.5, 43.1, 29.9, 29.0, 28.0, 23.8, 18.8, 14.2. IR (solide) 3268, 2956, 2870, 1740, 1731, 1719, 1464, 1447, 1418, 1386, 1350, 1291, 1256, 1229, 1205, 1181, 1144, 1096, 1081, 1036, 1015, 997, 969, 947, 888, 826, 811, 702, 681. EI (MS) *m/z* (%): 313 (MH⁺, 0.1), 297 (1.2), 281 (10), 267 (35), 254 (10), 253 (60), 238 (8), 225 (10), 224 (50), 212 (20), 211 (100), 207 (30), 196 (25), 192 (12), 179 (40), 169 (35), 165 (70), 164 (85), 155 (20), 149 (25), 147 (27), 137 (92), 136 (45), 126 (15), 123 (20), 119 (25), 113 (20), 105 (40), 91 (15), 79 (15), 77 (20), 69 (5), 65 (5), 59 (20), 55 (10), 43 (14), 41 (15). HRMS for C₁₆H₂₄O₆ [M⁺]: calcd 312.1573, found 312.1556.

4,4-Dimethyl-2-pentyl-3-phenylsulfanylmethylcyclopentane-1,1-dicarboxylic acid diethyl ester (8a):

According to the general procedure, from **7a** (324 mg, 1 mmol). FC (cyclohexane/*t*BuOMe 95:5) gave **8a** (366 mg, 90%) as a mixture of two diastereomers in a 88:12 ratio.

major isomer (88% ds): ¹H NMR (300 MHz) δ 7.37-7.28 (m, 4H), 7.21-7.17 (m, 1H), 4.27-4.10 (m, 4H), 3.04-2.93 (m, 2H), 2.73-2.65 (m, 1H), 2.44 (d, *J* = 13.8 Hz, 1H), 2.09 (d, *J* = 13.8 Hz, 1H), 1.82-1.74 (m, 1H), 1.60-1.50 (m, 1H), 1.47-1.21 (m, 7H), 1.29 (t, *J* = 7.0 Hz, 3H), 1.26 (t, *J* = 7.0 Hz, 3H), 1.19 (s, 3H), 0.91 (s, 3H), 0.89 (t, *J* = 7.0 Hz, 3H). ¹³C NMR (75 MHz) δ 173.4, 171.9, 137.7, 129.1, 128.9, 125.9, 62.2, 61.3, 61.3, 53.2, 50.3, 50.1, 40.4, 34.1, 32.5, 31.2, 29.4, 28.2, 23.1, 22.6, 14.2, 14.1, 14.0. IR (film) 2955, 2870, 1727, 1583, 1479, 1464, 1438, 1388, 1366, 1255, 1182, 1095, 1068, 1025, 861, 738, 691. EI (MS) *m/z* (%): 434 (M⁺, 13), 325 (17),

252 (13), 251 (100), 235 (14), 207 (8), 205 (13), 177 (90), 173 (33), 163 (15), 135 (15), 123 (85), 121 (44), 109 (32), 107 (39), 93 (20), 81 (14), 79 (17), 69 (27), 67 (20), 55 (26), 45 (14), 41 (16). HRMS for $C_{25}H_{38}O_4S$ [M^+]: calcd 434.2491, found 434.2489.

2-Pentyl-3-phenylsulfanylmethyl-4-propylcyclopentane-1,1-dicarboxylic acid diethyl ester (8b):

According to the general procedure, from **7b** (338 mg, 1 mmol). FC (cyclohexane/*t*BuOMe 95:5) gave **8b** (378 mg, 90%) as a mixture of 4 diastereomers in a 45:45:5:5 ratio. The 2 major isomers were separated by HPLC (Nucleosil 100-7, hexane/*t*BuOMe 98:2, flow 8 mL/min, pressure 14 bars) on 50 mg scale.

Isomer A (45% ds, ret. time 40.92) 1H NMR (400 MHz) δ 7.37-7.34 (m, 2H), 7.31-7.26 (m, 2H), 7.19-7.15 (m, 1H), 4.28-4.09 (m, 4H), 3.20-3.10 (m, 2H), 2.70-2.67 (m, 1H), 2.34 (dd, $J = 13.2$, 6.8 Hz, 1H), 2.0 (dd, $J = 13.2$, 11.2 Hz, 1H), 1.70-1.59 (m, 2H), 1.43-1.20 (m, 12H), 1.27 (t, $J = 7.0$ Hz, 3H), 1.26 (t, $J = 7.2$ Hz, 3H), 0.89 (t, $J = 7.2$ Hz, 3H), 0.87 (t, $J = 6.9$ Hz, 3H). ^{13}C NMR (100 MHz) δ 172.8, 171.0, 137.6, 129.0, 128.9, 125.7, 64.0, 61.5, 61.2, 50.1, 48.7, 43.1, 39.6, 38.3, 37.4, 32.6, 32.3, 27.3, 22.7, 21.4, 14.4, 14.2. EI (MS) m/z (%): 448 (M^+ , 18), 339 (27), 293 (10), 266 (10), 265 (91), 251 (10), 243 (17), 221 (12), 219 (15), 208 (15), 197 (15), 191 (100), 173 (15), 149 (18), 135 (27), 123 (87), 121 (28), 109 (26), 95 (15), 93 (25), 91 (13), 81 (20), 79 (27), 69 (17), 67 (23), 57 (12), 55 (37), 45 (21), 43 (31), 41 (23).

Isomer B (45% ds, ret. time 41.14)

1H NMR (400 MHz) δ 7.36-7.33 (m, 2H), 7.31-7.27 (m, 2H), 7.10-7.16 (m, 1H), 4.26-4.09 (m, 4H), 2.98 (dd, $J = 12.5$, 7.3 Hz, 1H), 2.86-2.79 (m, 1H), 2.81 (dd, $J = 12.5$, 7.5 Hz, 1H), 2.58 (dd, $J = 13.6$, 7.0 Hz, 1H), 2.26-2.35 (m, 1H), 1.99-2.11 (m, 1H), 1.82 (dd, $J = 13.6$, 8.3 Hz, 1H), 1.49-1.08 (m, 12H), 1.27 (t, $J = 7.0$ Hz, 3H), 1.26 (t, $J = 7.0$ Hz, 3H), 0.93 (t, $J = 7.2$ Hz, 3H), 0.87 (t, $J = 6.7$ Hz, 3H). ^{13}C NMR (100 MHz) δ 173.3, 171.9, 137.3, 129.2, 129.0, 125.9, 63.2, 61.4, 61.2, 48.8, 46.9, 40.2, 39.7, 34.1, 32.3, 31.7, 31.4, 28.6, 22.7, 21.4, 14.4, 14.2, 14.1. IR (film) 2955, 2929, 2870, 1728, 1583, 1479, 1465, 1366, 1249, 1136, 1095, 1025, 862, 738, 691. EI (MS) m/z (%): 448 (M^+ , 10), 403 (5), 339 (27), 293 (5), 266 (12), 265 (100), 249 (10), 243 (8), 221 (12), 219 (17), 208 (12), 191 (93), 177 (16), 173 (11), 149 (17), 135 (25), 123 (73), 109 (26), 107 (20), 95 (13), 93 (23), 91 (11), 81 (18), 79 (25), 69 (16), 67 (23), 57 (12), 55 (34), 45 (20), 43 (31), 41 (23). HRMS for $C_{26}H_{40}O_4S$ [M^+]: calcd 448.2647, found 448.2649.

5-Isopropyl-4-phenylsulfanylmethylcyclopentane-1,1,3-tricarboxylic acid 3-ethyl ester 1,1-dimethyl ester (8d):

According to the general procedure, from **7d** (312 mg, 1 mmol). FC (hexane/AcOEt 9:1) gave **8d** (408 mg, 97%) as a mixture of diastereomers in a 85:15 ratio.

Major isomer (85% ds): ^1H NMR (300 MHz) δ 7.36-7.24 (m, 4H), 7.20-7.14 (m, 1H), 4.22-4.05 (m, 2H), 3.73 (s, 3H), 3.71 (s, 3H), 3.25 (dd, $J = 13.0, 4.5$ Hz, 1H), 3.11 (dd, $J = 13.0, 9.0$ Hz, 1H), 2.80-2.38 (m, 5H), 1.94-1.84 (m, 1H), 1.23 (t, $J = 7.2$ Hz, 3H), 0.90 (d, $J = 7.0$ Hz, 3H), 0.82 (d, $J = 6.8$ Hz, 3H). ^{13}C NMR (75 MHz) δ 174.1, 172.4, 170.1, 136.4, 129.5, 128.8, 126.0, 64.3, 60.7, 53.4, 52.4, 48.2, 41.4, 40.4, 38.3, 28.7, 23.4, 22.8, 17.2, 14.1. IR (film) 2955, 1734, 1583, 1437, 1392, 1377, 1257, 1200, 1088, 1026, 741, 691. EI (MS) m/z (%) 422 (M^+ , 26), 377 (8), 313 (12), 299 (6), 274 (6), 267 (16), 253 (28), 239 (13), 225 (16), 221 (50), 207 (29), 190 (32), 179 (30), 175 (11), 165 (27), 155 (22), 147 (35), 137 (17), 124 (48), 123 (100), 119 (26), 109 (47), 105 (19), 93 (16), 91 (19), 79 (28), 77 (22), 59 (29), 55 (14), 45 (28). HRMS for $\text{C}_{22}\text{H}_{30}\text{O}_6\text{S}$ [M^+]: calcd 422.1763, found 422.1764.

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