Synthesis of Highly Functionalized Pyrrolidines *via* a Mild One-Pot, Three-Component 1,3-Dipolar Cycloaddition Process

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Supporting Information

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General Methods. Reagent grade solvents were used for reactions, chromatography and extraction. Dimethyl 2-aminomalonate (**2**) was synthesized according to the literature method.¹ The progress of reactions were checked by analytical thin-layer chromatography (TLC). The plates were visualized first with UV illumination followed by charring with ninhydrin (0.3% ninhydrin (w/v), 97/3 EtOH/AcOH).

¹ Yamada, K.; Kurokawa, T.; Tokuyama, H.; Fukuyama, T. *J. Am. Chem. Soc.* **2003**, *125*, 6630.

Flash column chromatography was performed using silica gel (230-400 mesh). The solvent compositions reported for all chromatographic separations are on a volume/volume (v/v) basis. ^1H NMR spectra were recorded at 400 MHz are reported in parts per million (ppm) on the δ scale relative to residual CHCl_3 (δ 7.25). ^{13}C NMR spectra were recorded at 100 MHz and are reported in parts per million (ppm) on the δ scale relative to CDCl_3 (δ 77.00). High resolution mass spectra (HRMS) were recorded using electron impact (EI) or fast electron bombardment (FAB) ionization methods.

Experimental Section²

Reaction conditions A: Aldehyde **4** (1 equiv), dimethyl 2-aminomalonate **2**, (2 equiv), and N-phenylmaleimide **5**, (2 equiv) were combined in THF (2.5 mL per mmol of **4**) and the mixture was stirred at rt for the indicated time. The reactions were concentrated and the products **6** purified by flash chromatography.

Reaction conditions B: Aldehyde **4** (4 equiv), amine **2** (1 equiv), and dipolarphile **7** (1 equiv) were combined in THF (1.25 mL per mmol **2**) and the mixture was stirred at rt for the indicated time. The reactions were concentrated, and then quickly filtered through a short plug of silica gel to remove the maleamic acid byproduct **9**.

Reaction conditions C: Aldehyde **4** (1 equiv), amine **2** (2 equiv), and catalyst (10 mol% AgOAc + 20 mol% Ph_3P) were combined in methyl acrylate (**10**, 20 equiv) and the mixture was stirred at rt for the indicated time. After concentration, the products **11** and **12** were purified by flash chromatography.

² The numbering system used in this paper corresponds to IUPAC numbering system for structures **i-iii** as shown below.

Dimethyl-*rel*-(3*S*,3*aR*,6*aS*)-4,6-dioxo-3,5-diphenylhexahydropyrrolo[3,4-*c*]pyrrole-1,1(2*H*)-

dicarboxylate (6a). White solid, yield: 100%, mp 158-160 °C, *R*_f 0.52 (1:1 hexanes/EtOAc). ¹H-NMR δ 7.39-7.36 (m, 2H), δ 7.31-7.20 (m, 6H), δ 7.03-7.00 (m, 2H), 4.43 (dd, *J* = 9.0, 3.6 Hz, 1H), 4.14 (dd, *J* = 7.7, 1.7 Hz, 1H), 3.81 (s, 3H), 3.78 (s, 3H), 3.56 (dd, *J* = 9.0, 7.8 Hz, 1H), 2.92 (br d, *J* = 2.0 Hz, 1H). ¹³C-NMR δ 174.2, 173.2, 169.7, 167.2, 136.4, 131.5, 129.0, 128.7, 128.5, 127.1, 126.1, 73.8, 61.9, 53.6, 53.1, 50.3, 48.7. HRMS (EI) *m/z* (%) for C₂₂H₂₀N₂O₆ (MH⁺) calc. 409.1400, found 409.1400.

Dimethyl-*rel*-(3*R*,3*aR*,6*aS*)-4,6-dioxo-3-[(*E*)-2-phenylvinyl]-5-phenylhexahydropyrrolo[3,4-

***c*]pyrrole-1,1(2*H*)-dicarboxylate (6b).** White solid, yield: 100%, mp 164-166 °C, *R*_f 0.21 (2:1 hexanes/EtOAc). ¹H-NMR δ 7.44-7.21 (m, 10H), 6.74 (d, *J* = 15.8 Hz, 1H), 6.26 (dd, *J* = 15.8, 7.2 Hz, 1H), 4.26 (dd, *J* = 7.9, 1.3 Hz, 1H), 4.04-4.00 (m, 1H), 3.88 (s, 3H), 3.87 (s, 3H), 3.57 (t, *J* = 7.9 Hz, 1H), 2.88 (br s, 1H). ¹³C-NMR δ 174.3, 173.7, 169.6, 167.3, 136.1, 133.1, 131.5, 129.1, 128.8, 128.5, 128.0, 126.8, 126.4, 125.0, 74.4, 60.4, 53.7, 53.3, 50.4, 48.2. HRMS (EI) *m/z* (%) for C₂₄H₂₂N₂O₆ (M⁺) calc. 434.1478, found 434.1467.

Dimethyl-*rel*-(3*R*,3*aR*,6*aS*)-3-isopropyl-4,6-dioxo-5-phenylhexahydropyrrolo[3,4-*c*]pyrrole-

1,1(2*H*)-dicarboxylate (6c). White solid, yield: 90%, mp 130-133 °C, *R*_f 0.65 (1:1 hexanes/EtOAc). ¹H-NMR δ 7.45-7.41 (m, 2H), 7.38-7.33 (m, 1H), 7.25-7.23 (m, 2H), 4.24 (d, *J* = 7.8 Hz, 1H), 3.85 (s, 3H), 3.83 (s, 3H), 3.44 (t, *J* = 7.8 Hz, 1H), 2.78-2.71 (m, 2H), 2.00-1.89 (m, 1H), 1.16 (d, *J* = 6.4 Hz, 3H), 1.00 (d, *J* = 6.6 Hz, 3H). ¹³C-NMR δ 174.4, 174.2, 169.9, 167.5, 131.6, 129.1, 128.7, 126.4, 74.6, 66.9, 53.7, 53.3, 50.6, 46.2, 29.4, 20.7, 20.5. HRMS (EI) *m/z* (%) for C₁₉H₂₂N₂O₆ (MH⁺) calc. 375.1556, found 375.1553.

Dimethyl-*rel*-(3*R*,3*aR*,6*aS*)-4,6-dioxo-3-(2-phenylethyl)-5-phenylhexahydropyrrolo[3,4-*c*]pyrrole-

1,1(2*H*)-dicarboxylate (6d). White solid, yield: 100%, mp 148-150 °C, *R*_f 0.26 (2:1 hexanes/EtOAc). ¹H-NMR δ 7.46-7.35 (m, 3H), δ 7.28-7.18 (m, 7H), 4.23 (d, *J* = 7.8 Hz, 1H), 3.84 (s, 3H), 3.80 (s, 3H), 3.39 (t, *J* = 8.0 Hz, 1H), 3.21-3.11 (m, 1H), 3.06 (t, *J* = 7.7 Hz, 3H), 2.27-2.18 (m, 1H), 1.90-1.81 (m, 1H). ¹³C-NMR δ 174.5, 174.2, 169.6, 167.4, 140.7, 131.5, 129.2, 128.8, 128.4, 126.4, 126.2, 74.8, 58.4,

53.6, 53.3, 50.9, 47.0, 33.3, 32.8. HRMS (EI) m/z (%) for $C_{24}H_{24}N_2O_6$ (M^+) calc. 436.1634, found 436.1642.

Dimethyl-*rel*-(3*R*,3*aR*,6*aS*)-3-butyl-4,6-dioxo-5-phenylhexahydropyrrolo[3,4-*c*]pyrrole-1,1(2*H*)-dicarboxylate (6e). Colorless oil, yield: 83%, R_f 0.69 (1:1 hexanes/EtOAc). 1H -NMR δ 7.46-7.34 (m, 3H), 7.25-7.22 (m, 2H), 4.22 (d, J = 8.0 Hz, 1H), 3.84 (s, 6H), 3.39 (t, J = 8.0 Hz, 1H), 3.20-3.18 (m, 1H), 2.77 (br s, 1H), 2.03-1.87 (m, 1H), 1.59-1.30 (m, 5H), 0.09 (t, J = 7.2 Hz, 3H). ^{13}C -NMR δ 174.5, 174.2, 169.8, 167.5, 131.5, 129.1, 128.7, 126.4, 74.7, 59.5, 53.6, 53.3, 50.9, 47.1, 31.1, 29.6, 22.6, 13.9. HRMS (EI) m/z (%) for $C_{20}H_{24}N_2O_6$ (M^+) calc. 388.1634, found 388.1634.

Dimethyl-*rel*-(3*R*,3*aR*,6*aS*)-3-methyl-4,6-dioxo-5-phenylhexahydropyrrolo[3,4-*c*]pyrrole-1,1(2*H*)-dicarboxylate (6f). White solid, yield: 100 %, mp 58-60 °C, R_f 0.38 (1:1 hexanes/EtOAc). 1H -NMR δ 7.46-7.41 (m, 2H), 7.39-7.34 (m, 1H), 7.24-7.22 (m, 2H), 4.24 (d, J = 7.4 Hz, 1H), 3.84 (s, 3H), 3.83 (s, 3H), 3.44-3.41 (m, 1H), 3.37 (dd, J = 8.4, 7.4 Hz, 1H), 2.74 (br s, 1H), 1.39 (d, J = 6.6 Hz, 3H). ^{13}C -NMR δ 174.5, 174.2, 169.6, 167.4, 131.5, 129.1, 128.8, 126.4, 74.9, 54.5, 53.7, 53.3, 51.5, 47.9, 16.7. HRMS (EI) m/z (%) for $C_{17}H_{18}N_2O_6$ (M^+) calc. 346.1165, found 346.1163.

Dimethyl-*rel*-(3*S*,3*aR*,6*aS*)-3-[(*tert*-butoxycarbonyl)amino]methyl}-methyl-4,6-dioxo-5-phenylhexahydropyrrolo [3,4-*c*]pyrrole-1,1(2*H*)-dicarboxylate (6g). Colorless oil, yield: 50 %, R_f 0.42 (1:1 hexanes/EtOAc). 1H -NMR δ 7.47-7.43 (m, 2H), 7.41-7.36 (m, 1H), 7.25-7.22 (m, 2H), 5.40 (br s, 1H), 4.23 (d, J = 7.6 Hz, 1H), 3.83 (s, 3H), 3.82 (s, 3H), 3.78-3.69 (m, 1H), 3.51-3.42 (m, 2H), 3.18-3.02 (m, 1H), 1.42 (s, 9H). ^{13}C -NMR δ 174.2, 173.4, 169.4, 167.2, 156.0, 131.3, 129.2, 128.9, 126.4, 79.6, 74.3, 58.7, 53.8, 53.3, 50.1, 45.9, 41.4, 28.3. HRMS (EI) m/z (%) for $C_{22}H_{27}N_3O_8$ (MH^+) calc. 462.1876, found 462.1877.

Dimethyl-*rel*-(3*aS*,6*R*,6*aR*)-1,3-dioxo-6-[(*E*)-2-phenylvinyl]hexahydro-4*H*-furo[3,4-*c*]pyrrole-4,4-dicarboxylate (8b). Colorless oil, yield: 58%, R_f (1:1 hexanes/EtOAc). 1H -NMR δ 7.38-7.24 (m, 5H), 6.71 (d, J = 15.6 Hz, 1H), 6.13 (dd, J = 15.6, 7.6 Hz, 1H), 4.31 (dd, J = 8.4, 1.0 Hz, 1H), 4.00-3.95 (m, 1H), 3.87 (s, 3H), 3.85 (s, 3H), 3.64 (t, J = 8.4 Hz, 1H), 2.89 (br s, 1H). ^{13}C -NMR δ 169.4, 168.8, 168.3,

166.3, 135.6, 134.6, 128.6, 128.4, 126.8, 123.6, 74.6, 60.7, 53.9, 53.6, 51.0, 48.7. HRMS (EI) m/z (%) for $C_{18}H_{17}NO_7$ (M^+) calc. 359.1005, found 359.1008.

Dimethyl-*rel*-(3*aS*,6*R*,6*aR*)-1,3-dioxo-6-isopropylhexahydro-4H-furo[3,4-*c*]pyrrole-4,4-

dicarboxylate (8c). White solid, yield: 64 %, mp 130-132 °C, R_f 0.69 (1:1 hexanes/EtOAc). 1H -NMR δ 4.30 (d, J = 8.4 Hz, 1H), 3.84 (s, 3H), 3.83 (s, 3H), 3.54 (dd, J = 8.4, 7.8 Hz, 1H), 2.72 (dd, J = 9.8, 7.6 Hz, 1H), 1.92-1.84 (m, 1H), 1.11 (d, J = 6.4 Hz, 3H), 1.01 (d, J = 6.6 Hz, 3H). ^{13}C -NMR δ 169.5, 169.1, 168.9, 166.5, 74.8, 66.7, 53.9, 53.5, 51.2, 46.9, 29.7, 20.5, 20.2. HRMS (EI) m/z (%) for $C_{13}H_{17}NO_7$ (MH^+) calc. 300.1083, found 300.1086.

Dimethyl-*rel*-(3*aS*,6*R*,6*aR*)-1,3-dioxo-6-(2-phenylethyl)hexahydro-4H-furo[3,4-*c*]pyrrole-4,4-

dicarboxylate (8d). White solid, yield: 100 %, mp 132-134 °C, R_f 0.51 (2:1 hexanes/EtOAc). 1H -NMR δ 7.29-7.25 (m, 2H), 7.21-7.16 (m, 3H), 4.29 (d, J = 8.4 Hz, 1H), 3.86 (s, 3H), 3.77 (s, 3H), 3.48 (t, J = 8.4 Hz, 1H), 3.13 (dt, J = 8.4, 5.3 Hz, 1H), 2.780-2.75 (m, 3H), 2.18-2.09 (m, 1H), 1.90-1.81 (m, 1H). ^{13}C -NMR δ 169.5, 169.1, 168.4, 166.4, 140.2, 128.5, 128.4, 126.4, 75.0, 58.3, 53.8, 53.6, 51.5, 47.6, 33.0, 32.8. HRMS (EI) m/z (%) for $C_{18}H_{19}NO_7$ (M^+) calc. 361.1162, found 361.1163.

Dimethyl-*rel*-(3*aS*,6*R*,6*aR*)-6-butyl-1,3-dioxohexahydro-4H-furo[3,4-*c*]pyrrole-4,4-dicarboxylate

(8e). Colorless oil, yield: 96 %, R_f 0.69 (1:1 hexanes/EtOAc). 1H -NMR δ 4.30 (d, J = 8.4 Hz, 1H), 3.85 (s, 3H), 3.82 (s, 3H), 3.50 (t, J = 8.4 Hz, 1H), 3.21-3.15 (m, 1H), 1.83-1.74 (m, 1H), 1.56-1.47 (m, 1H), 1.44-1.28 (m, 4H), 0.89 (t, J = 7.2 Hz, 3H). ^{13}C -NMR δ 169.6, 169.0, 168.9, 166.4, 74.9, 59.5, 53.8, 53.5, 51.6, 47.7, 31.1, 29.3, 22.5, 13.8. HRMS (EI) m/z (%) for $C_{14}H_{19}NO_7$ (M^+) calc. 314.1240, found 314.1235.

Dimethyl-*rel*-(3*aS*,6*R*,6*aR*)-6-methyl-1,3-dioxohexahydro-4H-furo[3,4-*c*]pyrrole-4,4-dicarboxylate

(8f). Yellowish solid, yield: 92 %, mp 82-85 °C, R_f 0.48 (1:1 hexanes/EtOAc). 1H -NMR δ 4.31 (d, J = 8.0 Hz, 1H), 3.86 (s, 3H), 3.81 (s, 3H), 3.46 (t, J = 8.2 Hz, 1H), 3.44-3.38 (m, 1H), 1.36 (d, J = 6.2 Hz, 3H). ^{13}C -NMR 169.6, 169.0, 168.9, 166.4, 75.2, 54.6, 53.9, 53.5, 52.0, 48.5, 16.6. HRMS (EI) m/z (%) for $C_{11}H_{13}NO_7$ (M^+) calc. 272.0770, found 272.0783.

Trimethyl-*rel*-(4*R*,5*S*)-5-phenylpyrrolidine-2,2,4-tricarboxylate (11a). White solid, yield: 95 %, mp 92-94 °C, R_f 0.72 (1:1 hexanes/EtOAc). $^1\text{H-NMR}$ δ 7.28-7.20 (m, 5H), 4.73 (d, J = 8.4 Hz, 1H), 3.85 (s, 3H), 3.79 (s, 3H), 3.38 (app. q, ave. J = 7.7 Hz, 1H), 3.20 (s, 3H), 2.87 (dd, J = 13.9, 7.4 Hz, 1H), 2.68 (dd, J = 13.7, 7.6 Hz, 1H). $^{13}\text{C-NMR}$ δ 172.3, 172.0, 170.7, 139.4, 128.1, 127.8, 126.9, 72.1, 64.4, 53.2, 53.1, 51.3, 49.3, 34.7. HRMS (FAB) m/z (%) for $\text{C}_{16}\text{H}_{19}\text{NO}_6$ (MH^+) calc. 322.1291, found 322.1287.

Trimethyl-*rel*-(3*S*,5*S*)-5-phenylpyrrolidine-2,2,3-tricarboxylate (12a). Characterized from $^1\text{H-NMR}$ of mixture with **11a**, yield: 4.5 %. $^1\text{H-NMR}$ δ 7.42-7.24 (m, 5H), 4.22 (dd, J = 10.3, 6.0 Hz, 1H), 3.88 (dd, J = 10.3, 7.4 Hz, 1H), 3.82 (s, 3H), 3.77 (s, 3H), 3.70 (s, 3H), 2.53-2.47 (m, 1H), 2.20 (dt, J = 12.7, 10.3 Hz, 1H).

Trimethyl-*rel*-(4*R*,5*R*)-5-[(*E*)-2-phenylvinyl] phenylpyrrolidine-2,2,4-tricarboxylate (11b). Colorless oil, yield: 90 %, R_f 0.62 (1:1 hexanes/EtOAc). $^1\text{H-NMR}$ δ 7.33-7.20 (m, 5H), 6.54 (d, J = 15.8 Hz, 1H), 6.04 (dd, J = 15.8, 8.0 Hz, 1H) 4.20 (t, J = 8.0 Hz, 1H), 3.82 (s, 3H), 3.77 (s, 3H), 3.59 (s, 3H), 3.32 (app. q, ave. J = 7.7 Hz, 1H), 3.12 (s, 1H), 2.74 (dd, J = 13.9, 7.4 Hz, 1H), 2.67 (dd, J = 13.9, 8.5 Hz, 1H). $^{13}\text{C-NMR}$ δ 172.0, 171.7, 171.3, 136.5, 132.5, 128.5, 127.8, 126.8, 126.5, 71.6, 63.2, 53.2, 51.8, 48.3, 34.5. HRMS (EI) m/z (%) for $\text{C}_{18}\text{H}_{21}\text{NO}_6$ (M^+) calc. 347.1369, found 347.1371.

Trimethyl-*rel*-(3*S*,5*S*)-5-[(*E*)-2-phenylvinyl]phenylpyrrolidine-2,2,3-tricarboxylate (12b). Characterized from $^1\text{H-NMR}$ of mixture with **12a**, yield: 9 %, R_f 0.60 (1:1 hexanes/EtOAc). $^1\text{H-NMR}$ δ 7.37-7.20 (m, 5H), 6.56 (d, J = 16.0 Hz, 1H), 6.13 (dd, J = 15.8, 7.6 Hz, 1H) 4.08 (t, J = 8.2 Hz, 1H), 3.82 (s, 3H), 3.79 (s, 3H), 3.66 (s, 3H), 2.95-2.85 (m, 2H), 2.57-2.49 (m, 1H).

Trimethyl-*rel*-(4*R*,5*R*)-5-(2-phenylethyl)pyrrolidine-2,2,4-tricarboxylate (11d). Colorless oil, yield: 73 %, R_f 0.69 (1:1 hexanes/EtOAc). $^1\text{H-NMR}$ δ 7.27-7.24 (m, 2H), 7.18-7.14 (m, 3H), 3.80 (s, 3H), 3.75 (s, 3H), 3.65 (s, 3H), 3.43-3.38 (m, 1H), 3.09-3.04 (m, 1H), 2.82-2.64 (m, 2H), 2.74 (dd, J = 14.1, 7.4 Hz, 1H), , 2.65 (dd, J = 14.1, 5.4 Hz, 1H), 1.67(m, 2H). $^{13}\text{C-NMR}$ δ 173.2, 171.8, 171.2, 141.4, 128.4, 125.9, 71.9, 61.4, 53.2, 53.1, 51.6, 47.3, 35.7, 33.3, 33.2. HRMS (EI) m/z (%) for $\text{C}_{18}\text{H}_{23}\text{NO}_6$ (M^+) calc. 349.1525, found 349.1523.

Trimethyl-*rel*-(3*S*,5*R*)-5-(2-phenylethyl)pyrrolidine-2,2,3-tricarboxylate (12d). Colorless oil, yield: 12 %, R_f 0.62 (1:1 hexanes/EtOAc). $^1\text{H-NMR}$ δ 7.29-7.25 (m, 3H), 7.18-7.14 (m, 2H), 3.80 (dd, J = 9.2, 8.0 Hz, 1H), 3.77 (s, 3H), 3.73 (s, 3H), 3.67 (s, 3H), 3.12-3.05 (m, 1H), 2.74-2.63 (m, 2H), 2.32-2.25 (m, 1H), 2.04-1.94 (m, 1H), 1.85-1.72 (m, 2H). $^{13}\text{C-NMR}$ δ 172.8, 170.6, 169.8, 141.4, 128.4, 128.3, 125.9, 75.2, 57.7, 53.4, 53.2, 52.2, 50.0, 36.8, 36.4, 33.3. HRMS (EI) m/z (%) for $\text{C}_{18}\text{H}_{23}\text{NO}_6$ (M^+) calc. 349.1525, found 349.1520.

Trimethyl-*rel*-(4*R*,5*R*)-5-butylpyrrolidine-2,2,4-tricarboxylate (11e). Colorless oil, yield 61 %, R_f 0.66 (1:1 hexanes/EtOAc). $^1\text{H-NMR}$ δ 3.78 (s, 3H), 3.74 (s, 3H), 3.64 (s, 3H), 3.40-3.35 (m, 1H), 3.04 (dt, J = 7.0, 5.1 Hz, 1H), 2.96 (br s, 1H), 2.71 (dd, J = 14.1, 7.5 Hz, 1H), 2.60 (dd, J = 14.1, 5.1 Hz, 1H), 1.46-1.24 (m, 6H), 0.86 (t, J = 7.0 Hz, 3H). $^{13}\text{C-NMR}$ δ 173.4, 171.9, 171.3, 71.9, 62.2, 53.2, 53.1, 51.6, 47.3, 35.8, 31.1, 29.1, 22.6, 13.9. HRMS (EI) m/z (%) for $\text{C}_{14}\text{H}_{23}\text{NO}_6$ (M^+) calc. 302.1604, found 302.1607.

Trimethyl-*rel*-(3*S*,5*R*)-5-butylpyrrolidine-2,2,3-tricarboxylate (12e). Characterized from $^1\text{H-NMR}$ of mixture with **11e**, yield: 9 %, R_f 0.64 (1:1 hexanes/EtOAc), $^1\text{H-NMR}$ δ 3.80 (dd, J = 9.4, 7.8 Hz, 1H), 3.76 (s, 3H), 3.72 (s, 3H), 3.66 (s, 3H), 3.07-3.00 (m, 1H), 2.32-2.22 (m, 2H), 1.71-1.60 (m, 3H), 1.34-1.24 (m, 3H), 0.86 (t, J = 6.8 Hz, 3H).

Trimethyl-*rel*-(4*R*,5*R*)-5-[(*tert*-butoxycarbonyl)amino]methyl}pyrrolidine-2,2,4-tricarboxylate (11g). Colorless oil, yield 48 %, R_f 0.31 (2:1 hexanes/EtOAc). $^1\text{H-NMR}$ δ 4.99 (br s, 1H), 3.75 (s, 3H), 3.72 (s, 3H), 3.66 (s, 3H), 3.20-3.06 (m, 2H), 2.96-2.89 (m, 1H), 2.70-2.59 (m, 2H), 1.40 (s, 9H). $^{13}\text{C-NMR}$ δ 172.0, 171.6, 171.4, 155.7, 79.3, 71.2, 59.5, 53.2, 52.0, 51.6, 45.4, 41.8, 34.4, 28.3. HRMS (EI) m/z (%) for $\text{C}_{16}\text{H}_{26}\text{N}_2\text{O}_6$ (M^+) calc. 375.1767, found 375.1755.

400 MHz ¹H NMR of compound **6a** in CDCl₃

400 MHz ^1H NMR of compound **6b** in CDCl_3

100 MHz ¹³C-NMR of compound **6b** in CDCl₃

400 MHz ¹H NMR of compound **6c** in CDCl₃

100 MHz ¹³C-NMR of compound **6c** in CDCl₃

100 MHz ^{13}C -NMR of compound **6d** in CDCl_3

400 MHz ^1H NMR of compound **6e** in CDCl_3

100 MHz ¹³C-NMR of compound **6e** in CDCl₃

400 MHz ¹H NMR of compound **6f** in CDCl₃

100 MHz ¹³C-NMR of compound **6f** in CDCl₃

100 MHz ^{13}C -NMR of compound **6g** in CDCl_3

400 MHz ¹H NMR of compound **8b** in CDCl₃

100 MHz ¹³C-NMR of compound **8b** in CDCl₃

400 MHz ¹H NMR of compound **8c** in CDCl₃

100 MHz ¹³C-NMR of compound **8c** in CDCl₃

400 MHz ^1H NMR of compound **8d** in CDCl_3

100 MHz ¹³C-NMR of compound **8d** in CDCl₃

400 MHz ^1H NMR of compound **8e** in CDCl_3

100 MHz ¹³C-NMR of compound **8e** in CDCl₃

400 MHz ^1H NMR of compound **8f** in CDCl_3

100 MHz ^{13}C -NMR of compound **8f** in CDCl_3

400 MHz ¹H NMR of compound **11a** in CDCl₃

100 MHz ^{13}C -NMR of compound **11a** in CDCl_3

400 MHz ¹H NMR of compound **11b** in CDCl₃

100 MHz ^{13}C -NMR of compound **11b** in CDCl_3

400 MHz ¹H NMR of compound **11d** in CDCl₃

100 MHz ^{13}C -NMR of compound **11d** in CDCl_3

400 MHz ¹H NMR of compound **12d** in CDCl₃

100 MHz ^{13}C -NMR of compound **12d** in CDCl_3

400 MHz ^1H NMR of compound **11e** in CDCl_3

100 MHz ^{13}C -NMR of compound **11e** in CDCl_3

400 MHz ^1H NMR of compound **11g** in CDCl_3

100 MHz ¹³C-NMR of compound **11g** in CDCl₃