Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

"On water" catalytic enantioselective sulfenylation of deconjugated butyrolactams

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SUPPORTING INFORMATION: PART A

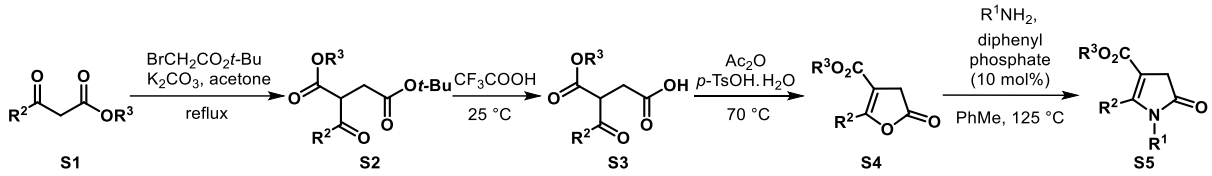
General information: Unless stated otherwise, all reactions were carried out with distilled and dried solvents under an atmosphere of N_2 or argon; oven (120 °C) dried glassware with standard vacuum line techniques was used. Organic solvents used for carrying out reactions were dried using standard methods.[1] All work up and purifications were carried out with reagent grade solvents in air. Thin-layer chromatography was performed using Merck silica gel 60 F_{254} pre-coated plates (0.25 mm). Column chromatography was performed using silica gel (230-400). Infrared (FT-IR) spectra were recorded on a Perkin Elmer Spectrum BX spectrophotometer, ν_{max} in cm^{-1} and the bands are characterized as broad (br), strong (s), medium (m), and weak (w). NMR spectra were recorded on Bruker Ultrashield spectrometer at 400MHz (^{1}H), 100 MHz (^{13}C) and 76.28 MHz (^{77}Se). Chemical shifts are reported in ppm from tetramethylsilane (δ 0.00) with the solvent resonance as internal standard ($CDCl_3$: δ 7.26 for ^{1}H-NMR and $CDCl_3$: δ 77.0 for ^{13}C NMR); Me_2Se was used as the external reference for ^{77}Se NMR. For ^{1}H-NMR, data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, dd = double doublet, t = triplet, dt =doublet of a triplet, q = quartet, br = broad, m = multiplet), coupling constants (Hz) and integration. High-resolution mass spectrometry was performed on Micromass Q-TOF Micro instrument. Optical rotations were measured on JASCO P-2000 polarimeter. Melting points were measured in open glass capillaries using ANALAB μ-Thermocal 10 melting point apparatus. All melting points were measured in open glass capillary and values are uncorrected. Enantiomeric ratios were determined by Shimadzu LC-20AD HPLC instrument and SPD-20A UV/Vis detector using stationary phase chiral columns (25 cm × 0.46 cm) in comparison with authentic racemic compounds. All aldehydes were purified before use. Thiols, *N*-chlorosuccinimide and *t*-BuPh were used as obtained from the commercial suppliers. *N*-(Phenylseleno)succinimide was prepared according to the procedure reported by Sharpless et al.[2]

(1) W. L. F. Armarego, D. D. Perrin and C.L.L. Chai, *Purification of Laboratory Chemicals*, 5th ed., Butterworth Heinemann, Boston, 2003.

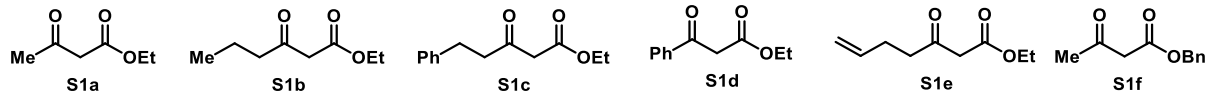
(2) T. Hori and K. B. Sharpless, *J. Org. Chem.*, 1979, **44**, 4208-4210.

A. Preparation of α-unsubstituted deconjugated butyrolactams

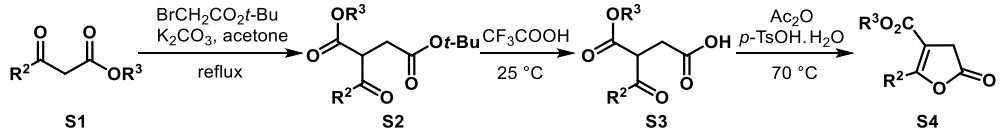
α-Unsubstituted deconjugated butyrolactam **S5** were prepared from β-ketoesters (**S1**) according to the following sequence:



β-Ketoesters **S1b**,[3] **S1c**,[4] **S1d**,[5] and **S1e**[6] were prepared following the literature procedure:



S4: Deconjugated butyrolactones (**S4)** were synthesized from corresponding β-ketoesters (**S1**) in a three step sequence:



To a solution of β-ketoester **S1** (1.1 equiv.) in dry acetone (2.0 mL/1.0 mmol of β-ketoester), anh. K_2CO_3 (5.0 equiv.) and *tert*-butyl bromoacetate (1.0 equiv.) were added. The resulting heterogeneous mixture was refluxed until full consumption of the *tert*-butyl bromoacetate (TLC). After cooling the reaction mixture to room temperature, acetone was evaporated under reduced pressure. To the heterogeneous mixture, water (1.6 mL/1.0 mmol of β-ketoester) and CH_2Cl_2 (2.2 mL/1.0 mmol of β-ketoester) was added. Organic phase was separated and the aq. layer was re-extracted with CH_2Cl_2 (2.2 mL/1.0 mmol of β-ketoester). Combined organic layer was washed with brine (0.6 m/1.0 mmol of β-ketoester), dried over anh. Na_2SO_4 and concentrated under reduced pressure to obtain a yellow oil in all cases.

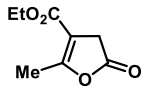
The crude oil (containing **S2**) was dissolved in CH_2Cl_2. To this homogeneous mixture, CF_3COOH (0.2 mL/1.0 mmol of β-ketoester) was added at 0 °C and the reaction mixture was allowed to attain room temperature and stirring was continued at room temperature for 3 h. The reaction mixture was concentrated under reduced pressure to get an oil. The crude oil was passed through a short silica gel (230-400) column to remove the relatively non-polar unreacted (excess)

(3) M. B. Stringer, J. H. Bowie and J. L. J. Holmes, *Am. Chem. Soc*., 1986, **108**, 3888-3893
(4) M. B. Dewal, A. S. Wani, C. Vidaillac, D. Oupický, M. J. Rybak and S. M. Firestine, *Eur. J. Med. Chem*., 2012, **51**, 145- 153.
(5) M. D. Keranen, K. Kot, C. Hollmann and P. Eilbracht, *Org. Biomol. Chem*., 2004, **2**, 3379-3384.
(6) C. Wang, Z. Li, Y. Ju and S. Koo, *Eur. J. Org. Chem.*, 2012, 6976-6985.

β-ketoester (R_f ~ 0.2 in 5% EtOAc in pet ether) and isolate the polar (R_f ~ 0.2 in 15% EtOAc in $CHCl_3$) products comprising of mostly (~95% by ^{1}HNMR) **S3** as an oil in all the cases. This relatively impure keto-acid (**S3**) was subjected to the lactonization step without further purification.

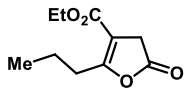
The oil was dissolved in acetic anhydride (1.5 mL/1.0 mmol of β-ketoester) and *p*-TsOH·H_2O (12 mg/1.0 mmol of β-ketoester) was added. The resulting mixture was heated at 70 °C until full consumption of the keto-acid was observed by TLC (typically 2-4 h). The reaction mixture was cooled to room temperature and Ac_2O was evaporated under reduced pressure to get a yellow oil which was dissolved in Et_2O (3.5 mL Et_2O/1.0 mmol of β-ketoester). The etherial solution was washed carefully with 20% aq. Na_2CO_3 solution until the cessation of the effervescence and then dried over anh. Na_2SO_4 and concentrated under reduced pressure to an oil in all the cases. The oil was purified by column chromatography to get pure deconjugated butyrolactone **S4**.

Compound S4a: It was prepared following the aforementioned three step sequence starting with



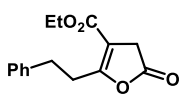
5.03 g (4.9 mL, 38.65 mmol) ethyl acetoacetate (**S1a**) and 5.2 mL (35.14 mmol) *tert*-butyl bromoacetate; 3.98 g intermediate keto-acid (**S3a**) was obtained, which on cyclization produced the lactone **S4a**. Purification by silica gel (230-400 mesh) column chromatography (10% EtOAc in pet ether) afforded pure **S4a** as a colorless oil (3.05 g, 17.93 mmol; 51% yield, over 3 steps). **R_f:** 0.25 (10% EtOAc in pet ether); **FT-IR (neat):** 1815 (s), 1709 (s), 1667 (m), 1338 (m), 1224 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** 4.18 (q, *J* = 7.1 Hz; 2H), 3.39 (s; 2H), 2.35 (s; 3H), 1.26 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 172.69, 163.18, 162.95, 106.13, 60.39, 33.43, 14.10, 13.53. Product is unstable under HRMS conditions. [*Note*: Evaporation of solvent was performed at 30 °C and under 400 mbar vacuum as the product **S4a** is volatile]

Compound S4b: It was prepared following the aforementioned three step sequence starting with



1.54 g (9.73 mmol) **S1b** and 1.3 mL (8.85 mmol) *tert*-butyl bromoacetate; 1.23 g intermediate keto-acid (**S3b**) was obtained, which on cyclization produced the lactone **S4b**. Purification by silica gel (230-400 mesh) column chromatography (10% EtOAc in pet ether) afforded pure **S4b** as a colorless oil (796 mg, 4.01 mmol; 45% yield, over 3 steps). **R_f:** 0.3 (10% EtOAc in pet ether); **FT-IR (neat):** 2970 (s), 2938 (s), 2878 (m), 1819 (s), 1710 (s), 1663 (s), 1463 (m), 1382 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** 4.18 (q, *J* = 7.1 Hz; 2H), 3.40 (s; 2H), 2.75 (t, *J* = 7.5 Hz; 2H), 1.57-1.67 (m; 2H), 1.26 (t, *J* = 7.1 Hz; 3H), 0.94 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 172.95, 166.77, 162.93, 105.99, 60.39, 33.58, 29.04, 19.80, 14.13, 13.50. Product is unstable under HRMS conditions.

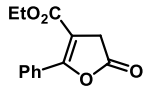
Compound S4c: It was prepared following the aforementioned 3 step sequence starting with 2.3



g (10.4 mmol) **S1c** and 1.4 mL (9.5 mmol) *tert*-butyl bromoacetate; 1.81 g intermediate keto-acid **S3c** was obtained, which on cyclization produced **S4c**. Purification by silica gel (230-400 mesh) column chromatography (5% EtOAc in pet ether) afforded pure **S4c** as a yellow oil (1.21 g, 4.65 mmol; 49% yield, over 3 steps). **R_f:**

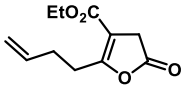
0.1 (5% EtOAc in pet ether); **FT-IR (neat):** 2985 (w), 1815 (s), 1800 (m), 1659 (m), 1216 (m), 1117 (m), 1025 (m), 961 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.27-7.31 (m; 2H), 7.19-7.22 (m; 3H), 4.19 (q, *J* = 7.1 Hz; 2H); 3.41 (s; 2H), 3.11-3.15 (m; 2H), 2.92-2.96 (m; 2H), 1.29 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 172.78, 165.51, 162.74, 139.79, 128.45, 128.25, 126.38, 106.51, 60.53, 33.61, 32.43, 29.17, 14.21. Product is unstable under HRMS conditions.

Compound S4d: It was prepared following the aforementioned 3 step sequence starting with



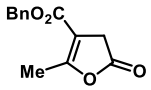
300 mg (1.56 mmol) **S1d** and 215 μL (1.42 mmol) *tert*-butyl bromoacetate; 351 mg keto-acid **S3d** was obtained, which on cyclization produced **S4d**. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: 3-5% EtOAc in pet ether) afforded pure **S4d** as a light yellow semisolid (251 mg, 1.08 mmol; 76% yield, over 3 steps). **R_f:** 0.50 (10% EtOAc in pet ether); **FT-IR (neat):** 2923 (m), 1804 (s), 1704 (s), 1614 (m), 1230 (s), 1188 (s), 1120 (m), 1023 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$)**: δ 7.91-7.73 (m; 2H), 7.40-7.49 (m; 3H), 4.20 (q, *J* = 7.1 Hz; 2H); 3.67 (s; 2H), 1.25 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$)**: δ 172.11, 162.33, 160.24, 131.36, 129.23, 127.89, 127.23, 105.68, 60.75, 35.39, 14.00; **HRMS (ESI+)**: Calculated for $C_{13}H_{12}O_4Na$ ($[M + Na]^+$): 255.0633, found: 255.0634.

Compound S4e: It was prepared following the aforementioned 3 step sequence starting with



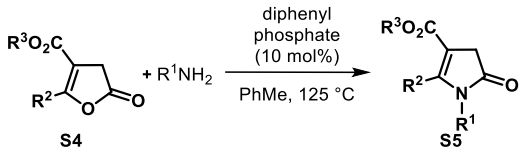
2.15 g (12.6 mmol) **S1e** and 1.7 mL (11.45 mmol) *tert*-butyl bromoacetate; 1.88 g keto-acid **S3e** was obtained, which on cyclization produced **S4e**. Purification by silica gel (230-400 mesh) column chromatography (3% EtOAc in pet ether) afforded pure **S4e** as a light yellow oil (1.405 g, 6.68 mmol; 58% yield, over 3 steps). **R_f:** 0.40 (10% EtOAc in pet ether); **FT-IR (neat):** 2983 (m), 2931 (m), 1819 (s), 1710 (s), 1621 (m), 1382 (m), 1231 (s), 1119 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 5.71-5.81 (m; 1H), 4.96-5.06 (m; 2H), 4.18 (q, *J* = 7.1 Hz; 2H); 3.39-3.40 (m; 2H), 2.86-2.90 (m; 2H), 2.31-2.37 (m; 2H), 1.26 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 172.74, 165.86, 162.81, 136.04, 115.89, 106.31, 60.45, 33.53, 30.22, 26.68, 14.11; **HRMS (ESI+):** Calculated for $C_{11}H_{14}O_4Na$ ($[M + Na]^+$): 233.0790, found: 233.0789.

Compound S4f: It was prepared following the aforementioned 3 step sequence starting with 3.2



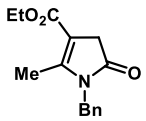
g (16.65 mmol) **S1f** and 2.2 mL (15.14 mmol) *tert*-butyl bromoacetate; 1.8 g keto-acid **S3f** was obtained, which on cyclization produced **S4f**. Purification by silica gel (230-400 mesh) column chromatography (5% EtOAc in pet ether) afforded pure **S4f** as a yellow semisolid (1.12 g, 4.82 mmol; 32% yield, over 3 steps). **R_f:** 0.30 (10% EtOAc in pet ether); **FT-IR (neat):** 1817 (s), 1710 (s), 1669 (m), 1221 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$)**: 7.33-7.40 (m; 5H), 5.21 (s; 2H), 3.43-3.46 (m; 2H), 2.39-2.40 (m; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 172.64, 163.97, 135.60, 128.65, 128.41, 128.20, 105.96, 66.32, 33.57, 13.84; **HRMS (ESI+):** Calculated for $C_{13}H_{12}O_4Na$ ($[M + Na]^+$): 255.0633, found: 255.0638.

Preparation of S5: The α-unsubstituted deconjugated butyrolactams (**S5**) were prepared from the corresponding butyrolactones (**S4)** by the following procedure:

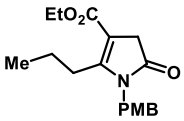


To a solution of the butyrolactone **S4** (1.0 equiv.) in dry toluene (5 mL toluene/1.0 mmol of the lactone) diphenyl phosphate (0.1 equiv.) and the corresponding amine (1.1 equiv.) were added sequentially. The resulting solution was refluxed under inert atmosphere for the specified time. After cooling to the room temperature, the solvent was evaporated under reduced pressure to get a semi-solid residue. This residue was dissolved in CH_2Cl_2 (8 mL/1.0 mmol of the lactone) and was washed with sat. aq. $NaHCO_3$ (2.5 mL/1.0 mmol of the lactone). The organic layer was concentrated to obtain a semi-solid which was purified by silica gel column chromatography to afford pure deconjugated butyrolactams **S5**.

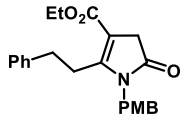
Compound S5a: Started with 3.0 g (17.6 mmol) lactone **S4a**. Reaction time = 12 h. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: 10-25% EtOAc in pet ether) afforded pure **S5a** as a light yellow solid (3.51 g, 13.53 mmol; 77% yield). **R_f:** 0.3 (20% EtOAc in pet ether); **Melting point:** 106-107 °C; **FT-IR (neat):** 2985 (w), 1704 (m), 1673 (s), 1620 (m), 1399 (m), 1336 (s), 1237 (m), 1193 (m), 1130 (m), 1052 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$)**: δ 7.22-7.31 (m; 3H), 7.16-7.18 (m; 2H), 4.74 (s; 2H), 4.16 (q, *J* = 7.1 Hz; 2H); 3.34-3.35 (m; 2H); 2.32 (s; 3H), 1.26 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$)**: δ 175.92, 164.07, 153.94, 136.40, 128.76, 127.59, 126.72, 103.58, 59.68, 43.33, 36.49, 14.31, 12.52; **HRMS (ESI+):** Calculated for $C_{15}H_{17}NO_3Na$ ([M + Na]$^+$): 282.1106, found: 282.1107.



Compound S5b: Started with 250 mg (1.26 mmol) lactone **S4b**. Reaction time = 12 h. Purification by silica gel (230-400 mesh) column chromatography (10% EtOAc in pet) afforded pure **S5b** as a bright yellow oil (371 mg, 1.17 mmol; 93% yield). **R_f:** 0.50 (25% EtOAc in pet ether); **FT-IR (neat):** 1726 (s), 1691 (s), 1618 (m), 1513 (s), 1293 (m), 1178 (m), 1027 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.10 (d, *J* = 8.5 Hz; 2H), 6.83 (d, *J* = 8.5 Hz; 2H), 4.68 (s; 2H); 4.16 (q, *J* = 7.1 Hz; 2H), 3.77 (s; 3H), 3.34 (s; 2H), 2.68-2.27 (m; 2H), 1.37-1.46 (m; 2H), 1.27 (t, *J* = 7.1 Hz; 3H), 0.93 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.40, 163.82, 159.06, 158.27, 128.77, 128.09, 114.16, 103.33, 59.67, 55.23, 42.96, 36.61, 28.04, 21.76, 14.33, 14.05; **HRMS (ESI+):** Calculated for $C_{18}H_{23}NO_4Na$ ([M + Na]$^+$): 340.1525, found: 340.1534.



Compound S5c: Started with 280 mg (1.07 mmol) lactone **S4c**. Reaction time = 9 h. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: 3-15% EtOAc in pet ether) afforded pure **S5c** as a bright yellow oil (277 mg, 0.73 mmol; 68% yield). **R_f:** 0.45 (20% EtOAc in pet ether); **FT-IR**

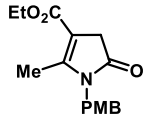


(neat): 2937 (w), 1724 (s), 1690 (s), 1618 (m), 1513 (m), 1237 (m), 1128 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.27-7.30 (m; 2H), 7.19-7.23 (m; 1H), 7.09-7.13 (m; 4H), 6.84-6.86 (m; 2H), 4.57 (s; 2H); 4.20 (q, *J* = 7.1 Hz; 2H), 3.78 (s; 3H), 3.39 (s; 2H), 2.98-3.02 (m; 2H), 2.64-2.68 (m; 2H), 1.30 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.29, 163.66, 159.15, 157.63, 140.37, 128.71, 128.56, 128.32, 128.18, 126.47, 114.29, 103.77, 59.83, 55.28, 42.84, 36.65, 34.53, 28.70, 14.46; **HRMS (ESI+):** Calculated for $C_{23}H_{25}NO_4Na$ ($[M + Na]^+$): 402.1681, found: 402.1682.

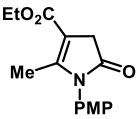
Compound S5d: Started with 320 mg (1.37 mmol) lactone **S4d**. Reaction time = 10 h. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: 3-15% EtOAc in pet ether) afforded pure **S5d** as a brown solid (259 mg, 0.81 mmol; 59% yield). **R_f:** 0.10 (10% EtOAc in pet ether); **Melting point:** 80-81 °C; **FT-IR (neat):** 2984 (w), 1694 (s), 1630 (m), 1588 (w), 1444 (m), 1220 (s), 1112 (m), 1018 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.39-7.43 (m; 1H), 7.32-7.36 (m; 2H), 7.17-7.18 (m; 3H), 7.09-7.11 (m; 2H), 6.83-6.85 (m; 2H), 4.54 (s; 2H); 3.99 (q, *J* = 7.1 Hz; 2H), 3.54 (s; 2H), 1.00 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.25, 163.64, 159.07, 157.47, 136.42, 128.17, 115.74, 114.15, 103.64, 59.70, 55.19, 42.97, 36.56, 32.12, 25.69, 14.30; **HRMS (ESI+):** Calculated for $C_{20}H_{19}NO_3Na$ ($[M + Na]^+$): 344.1263, found: 344.1263.

Compound S5e: Started with 400 mg (1.90 mmol) lactone **S4e**. Reaction time = 8 h**.** Purification by silica gel (230-400 mesh) column chromatography (10% EtOAc in pet ether) afforded pure **S5e** as an orange-yellow oil (501 mg, 1.52 mmol; 80% yield). **R_f:** 0.10 (10% EtOAc in pet ether);); **FT-IR (neat):** 2933 (w), 1725 (s), 1690 (s), 1619 (m), 1513 (s), 1232 (s), 1178 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.09 (d, *J* = 8.5 Hz, 2H), 6.83 (d, *J* = 8.5 Hz, 2H), 5.70-5.80 (m; 1H), 4.93-4.98 (m; 2H), 4.69 (s; 2H), 4.16 (q, *J* = 7.1 Hz; 2H), 3.76 (s; 3H), 3.304 (s; 2H), 2.79-2.83 (m; 2H), 2.06-2.12 (m; 2H), 1.26 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.25, 163.64, 159.07, 157.47, 136.42, 128.17, 115.74, 114.15, 103.64, 59.70, 55.19, 42.97, 36.56, 32.12, 25.69, 14.30; **HRMS (ESI+):** Calculated for $C_{19}H_{23}NO_4Na$ ($[M + Na]^+$): 352.1525, found: 352.1523.

Compound S5f: Started with 295 mg (1.27 mmol) lactone **S4f**. Reaction time = 12h. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: 50-70% CH_2Cl_2/pet ether) afforded pure **S5f** as a yellow solid (413 mg, 1.17 mmol; 92% yield). **R_f:** 0.30 (6% EtOAc in pet ether); **Melting point:** 92-93 °C; **FT-IR (neat):** 2924 (m), 1676 (s), 1618 (s), 1510 (s), 1391 (s), 1238 (s), 1023 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.28-7.36 (m; 5H), 7.13 (d, *J* = 8.3 Hz; 2H), 6.84 (d, *J* = 8.3 Hz; 2H), 5.18 (s; 2H); 4.68 (s; 2H), 3.77 (s; 3H), 3.37-3.38 (m; 2H), 2.36 (s; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 175.93, 163.82, 159.11, 154.81, 136.31, 128.49, 128.31, 128.04, 127.94, 114.21, 103.14, 65.48, 55.24, 42.97, 36.53, 12.75; **HRMS (ESI+):** Calculated for $C_{21}H_{21}NO_4Na$ ($[M + Na]^+$): 374.1368, found: 374.1370.

Compound S5g: Started with 250 mg (1.47 mmol) lactone **S4a.** Reaction time = 10 h. 

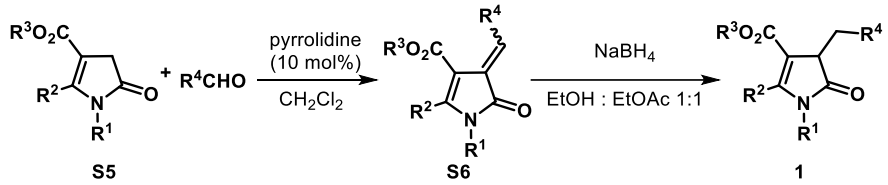
Purification by silica gel (230-400 mesh) column chromatography (gradient elution:10-20% EtOAc in pet ether) afforded pure **S5g** as a yellow solid (297 mg, 1.03 mmol; 70% yield). **R_f:** 0.10 (20% EtOAc in pet ether); **Melting point:** 85-86 °C; **FT-IR (neat):** 2973 (w), 1706 (s), 1667 (s), 1613 (m), 1512 (s), 1342 (s), 1239 (s), 1192 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.12 (d, *J* = 8.1 Hz; 2H), 6.83 (d, *J* = 8.1 Hz; 2H), 4.68 (s; 2H); 4.16 (q, *J* = 7.1 Hz; 2H), 3.77 (s; 3H), 3.34 (s; 2H), 2.34 (s; 3H), 1.27 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 175.98, 164.12, 159.01, 154.05, 128.52, 128.24, 114.13, 103.52, 59.68, 55.19, 42.87, 36.53, 14.33, 12.58; **HRMS (ESI+):** Calculated for $C_{16}H_{19}NO_4Na$ ($[M + Na]^+$): 312.1212, found: 312.1210.

Compound S5h: Started with 250 mg (1.47 mmol) lactone **S4a**. Reaction time = 10 h. 

Purification by silica gel (230-400 mesh) column chromatography (gradient elution:10-20% EtOAc in pet ether) afforded pure **S5h** as a brown solid (298 mg, 1.08 mmol; 73% yield). **R_f:** 0.10 (20% EtOAc in pet ether); **Melting point:** 104-105 °C; **FT-IR (neat):** 2973 (w), 1723 (s), 1682 (s), 1627 (s), 1512 (s), 1244 (s), 1186 (s), 1058 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.07 (d, *J* = 8.7 Hz; 2H), 6.95 (d, *J* = 8.7 Hz; 2H), 4.21 (q, *J* = 7.1 Hz; 2H), 3.81 (s; 3H), 3.41 (s; 2H), 2.20 (s; 3H), 1.29 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 175.71, 164.18, 159.60, 154.42, 129.14, 126.34, 114.72, 103.73, 59.77, 55.40, 36.62, 14.36, 13.36; **HRMS (ESI+):** Calculated for $C_{15}H_{17}NO_4Na$ ($[M + Na]^+$): 298.1055, found: 298.1054.

B. Preparation of α-monosubstituted deconjugated butyrolactams (1)

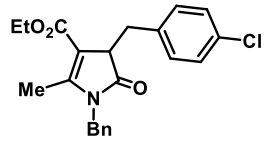
Procedure A: For the preparation of **1a-o** and **1q-t**, the following two-step procedure was used which comprises of a Knoevenagel condensation followed by the conjugate reduction of the resulting alkylidene butyrolactams:



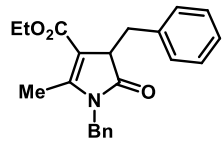
In an oven-dried round bottom flask fitted with a magnetic stir-bar, α-monosubstituted deconjugated butyrolactam **S5** (1.0 equiv.) and aldehyde (1.1 equiv.) were sequentially mixed in CH_2Cl_2 (1.0 mL/1.0 mmol aldehyde). To the resulting solution, pyrrolidine (0.1 equiv.) was added and stirring was continued at 25 °C. After the full consumption of the butyrolactam **S5**, the mixture was concentrated to obtain bright yellow/orange oil which was purified by silica gel (230-400 mesh) column chromatography affording a mixture of *E* and *Z* alkylidene butyrolactam **S6**. The Knoevenagel adduct **S6** was subjected to the subsequent conjugate reduction step without further characterization.

S6 was dissolved in 1:1 EtOAc/EtOH (5.0 mL). While cooled to 0 °C, $NaBH_4$ was added to it. The resulting heterogeneous mixture was stirred vigorously while allowing to warm up to the room temperature. When the full consumption of the alkylidene butyrolactam **S6** was observed by TLC (typically 30-45 min from the addition of $NaBH_4$), sat. aq. NH_4Cl (15 mL) was added to it at 0 °C along with 15 mL EtOAc. The organic phase was separated and the aqueous phase was extracted with EtOAc (5×15 mL). Combined organic layer was washed with brine (15 mL), dried over anh. Na_2SO_4 and concentrated in vacuo. The resulting crude oil was purified by silica gel (230-400 mesh) column chromatography to obtain the α-monosubstituted deconjugated butyrolactam **1**.

Compound 1a: Corresponding Knoevenagel adduct (**S6a**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright yellow oil which on conjugate reduction afforded a light yellow solid. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1a** as a white solid (825 mg, 2.15 mmol; 46% yield over two steps). **R_f:** 0.60 and 0.55 (20% EtOAc in pet ether) for the *E/Z* isomers of alkylidene butyrolactam and **R_f:** 0.45 (20% EtOAc in pet ether) for **1a**; **Melting point:** 99-100 °C; **FT-IR (KBr):** 2937 (w), 1720 (s), 1682 (s), 1624 (m), 1400 (m), 1246 (m), 1211 (m), 1066 (m), 812 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.12-7.21 (m; 5H), 6.99 (d, *J* = 8.3 Hz; 2H), 6.56-6.58 (m; 2H), 4.90 (d, *J* = 16.2 Hz; 1H), 4.22-4.36 (m; 3H), 3.63-3.67 (m; 1H), 3.46 (dd, *J* = 4.9, 13.3; 1H), 3.28 (dd, *J* = 4.3, 13.4 Hz; 1H), 2.12 (d, *J* = 2.2 Hz; 3H), 1.36 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.79, 164.29, 154.71, 135.78, 135.22, 132.43, 131.13, 128.64, 128.23, 127.40, 126.06, 106.16, 59.79, 47.99, 43.10, 33.93, 14.51, 12.60; **HRMS (ESI+):** Calculated for $C_{22}H_{22}NO_3ClNa$ ($[M+Na]^+$): 406.1186, found: 406.1184.

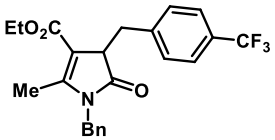


Compound 1b: Corresponding Knoevenagel adduct (**S6b**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright yellow semisolid which on conjugate reduction afforded a yellow semisolid. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1b** as a thick light yellow oil (171 mg, 0.99 mmol; 61% yield, over two steps). **R_f:** 0.60 (20% EtOAc in pet ether) for the *E/Z* isomers of alkylidene butyrolactam and **R_f:** 0.45 (20% EtOAc in pet ether) for **1b**; **FT-IR (Thin film):** 2983 (m), 1689 (s), 1698 (s), 1618 (s) 1496 (m), 1230 (m), 744 (m), 698 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.07-7.25 (m; 8H), 6.85 (d, *J* = 7.0 Hz; 2H), 4.86 (d, *J* = 16.2 Hz; 1H), 4.22-4.36 (m; 3H), 3.64-3.68 (m; 1H), 3.49 (dd, *J* = 5.0, 13.2 Hz; 1H), 3.32 (dd, *J* = 4.2, 13.2 Hz; 1H), 2.09 (d,



J = 1.6 Hz; 3H), 1.36 (t, *J* = 7.2 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.98, 164.30, 154.40, 136.63, 135.86, 129.66, 128.56, 128.01, 127.09, 126.43, 126.01, 106.42, 59.62, 48.08, 42.93, 34.66, 14.43, 12.41; **HRMS (ESI+):** Calculated for $C_{22}H_{23}NO_3Na$ ($[M + Na]^+$): 372.1576, found: 372.1575.

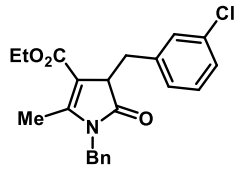
Compound 1c: Corresponding Knoevenagel adduct (**S6c**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright orange-yellow oil which on conjugate reduction afforded a yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1c** as a yellow oil that solidified on prolonged standing (290 mg, 0.69 mmol; 45% yield, over two steps). **R_f:** 0.50 (20% EtOAc in pet ether) for the *E/Z* isomers of alkylidene butyrolactam and **R_f:** 0.33 (20% EtOAc in pet ether) for **1c**; **Melting point:** 66-67 °C; **FT-IR (Thin film):** 2937 (w), 1714 (s), 1674 (s), 1618 (m), 1452 (w), 1321 (s), 1250 (m), 1160 (s), 1111 (m), 1059 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.44 (d, *J* = 8.1 Hz; 2H), 7.11-7.19 (m; 5H), 6.65 (d, *J* = 8.1 Hz; 2H), 4.86 (d, *J* = 16.1 Hz; 1H), 4.22-4.36 (m; 3H); 3.67-3.69 (m; 1H); 3.53 (dd, *J* = 5.2, 13.2 Hz; 1H), 3.37 (dd, *J* = 4.2, 13.2 Hz; 1H), 2.13 (d, *J* = 2.2 Hz; 3H), 1.35 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.67, 164.19, 154.67, 141.03, 135.77, 130.01, 128.74 (q, *J*=32 Hz), 128.57, 127.44, 126.13, 124.91 (q, *J* = 4 Hz), 124.22 (q, *J* = 272 Hz), 106.03, 59.80, 47.80, 43.13, 34.33, 14.42, 12.56; **HRMS (ESI+):** Calculated for $C_{23}H_{22}NO_3F_3Na$ ($[M + Na]^+$): 440.1449, found: 440.1449.



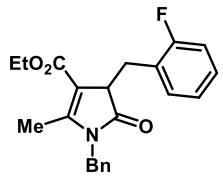
Compound 1d: Corresponding Knoevenagel adduct (**S6d**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as an orange colored oil which on conjugate reduction afforded a yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1d** as a yellow oil (303 mg, 0.80 mmol; 52% yield, over two steps). **R_f:** 0.6 and 0.55 (30% EtOAc in pet ether) for the *E/Z* isomers of alkylidene butyrolactam and **R_f:** 0.45 (30% EtOAc in pet ether) for **1d**; **FT-IR (Thin film):** 2927 (m), 1723 (s), 1670 (s), 1612 (m), 1510 (m), 1380 (m), 1249 (s), 1065 (s), 1025 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.07-7.15 (m; 3H), 6.97 (d, *J* = 8.5 Hz; 2H), 6.71 (d, *J* = 8.5 Hz; 2H), 6.52 (d, *J* = 7.2 Hz; 2H), 4.87 (d, *J* = 16.3 Hz; 1H), 4.19-4.35 (m; 3H), 3.73 (s; 3H), 3.58-3.60 (m; 1H), 3.42 (dd, *J* = 4.8, 13.5 Hz; 1H), 3.24 (dd, *J* = 4.3, 13.5 Hz; 1H), 2.07 (d, *J* = 2.1 Hz; 3H), 1.33 (t *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.88, 164.17, 158.11, 154.31, 135.77, 130.53, 128.49, 128.29, 126.98, 125.89, 113.22, 106.27, 59.45, 54.78, 48.11,

42.74, 33.60, 14.31, 12.29; **HRMS (ESI+):** Calculated for $C_{23}H_{25}NO_4K$ ($[M + K]^+$): 418.1421, found: 418.1426.

Compound 1e: Corresponding Knoevenagel adduct (**S6e**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright yellow oil which on conjugate reduction afforded a yellow semisolid. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1e** as a yellow solid (283 mg, 0.74 mmol; 58% yield, over two steps). **R_f:** 0.6 and 0.53 (30% EtOAc in pet ether) for the *E/Z* isomers of alkylidene butyrolactam and **R_f:** 0.45 (20% EtOAc in pet ether) for **1e**; **Melting point:** 76-77 °C; **FT-IR (KBr)**: 2930 (m), 1715 (s), 1675 (s), 1621 (m), 1372 (s), 1066 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.16-7.19 (m; 3H), 7.07-7.7.11 (m; 2H), 6.92-6.94 (m; 2H), 6.67-6.69 (m; 2H), 4.86 (d, *J* = 16.2 Hz; 1H), 4.35 (d, *J* = 16.2 Hz; 1H), 4.21-4.33 (m; 1H), 3.62-3.64 (m; 1H), 3.44 (dd, *J* = 5.3, 13.3 Hz; 1H), 3.28 (dd, *J* = 4.1, 13.3 Hz; 1H), 2.11 (d, *J* = 2.1 Hz; 3H), 1.34 (t *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.71, 164.12, 154.52, 138.90, 135.85, 133.69, 129.59, 129.20, 128.63, 127.76, 127.26, 126.64, 126.08, 106.10, 59.68, 47.80, 43.06, 34.23, 14.41, 12.49; **HRMS (ESI+):** Calculated for $C_{22}H_{22}ClNO_3Na$ ($[M+H]^+$): 406.1186, Found: 406.1187.



Compound 1f: Corresponding Knoevenagel adduct (**S6f**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright orange colored oil which on conjugate reduction afforded a yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 15% EtOAc/pet ether) afforded **1f** as a yellow oil (102 mg, 0.74 mmol; 58% yield, over two steps). **R_f:** 0.70 and 0.60 (30% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.45 (30% EtOAc in pet ether) for **1f**; **FT-IR (Thin film):** 2927 (w), 1988 (s), 1681 (s), 1624 (m), 1491 (m), 1450 (m), 1384 (s), 1250 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.12-7.23 (m; 5H), 6.95-7.00 (m; 2H), 6.67-6.70 (m; 2H), 4.84 (d, *J* = 16.2 Hz; 1H), 4.39 (d, *J* = 16.2 Hz; 1H), 4.17-4.30 (m; 2H); 3.68-3.72 (m; 1H); 3.56 (dd, *J* = 5.3, 13.5 Hz; 1H), 3.28 (dd, *J* = 4.5, 13.5 Hz; 1H), 2.14 (d, *J* = 2.2 Hz; 3H), 1.33 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.89, 164.25, 162.65, 160.21, 153.95, 136.10, 132.33 (d, *J*= 4 Hz), 128.66, 128.28 (d, *J* = 8 Hz), 127.27, 126.24, 123.98 (d, *J* = 16 Hz), 123.81 (d, *J* = 3 Hz), 107.13, 59.69, 47.50, 43.06, 28.34, 14.32, 12.39; **HRMS (ESI+):** Calculated for $C_{22}H_{22}NO_3FNa$ ($[M + Na]^+$): 390.1481, found: 390.1481.



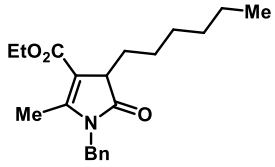
Compound 1g: Corresponding Knoevenagel adduct (**S6g**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright red oil which on conjugate reduction afforded an orange-yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 15% EtOAc/pet ether) afforded **1g** as a yellow oil (219 mg, 0.56 mmol; 48% yield, over two steps). **R_f:** 0.70 and 0.58 (30% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.48 (30% EtOAc in pet ether) for **1g**; **FT-IR (Thin film):** 2929 (w), 1722 (m), 1689 (s), 1624 (m), 1490 (m), 1444 (m), 1388 (m), 1240 (m), 1035 (m), 931 (m), 804 (w) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.15-7.17 (m; 3H), 6.62-6.67 (m; 3H), 6.52-6.56 (m; 2H), 5.87 (s; 2H), 4.90 (d, *J* = 16.2 Hz; 1H), 4.19-4.34 (m; 3H), 3.57-3.60 (m; 1H), 3.39 (dd, *J* = 5.0, 13.5 Hz; 1H), 3.23 (dd, *J* = 4.2, 13.5 Hz; 1H), 2.12 (d, *J* = 2.2 Hz; 3H), 1.34 (t *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.92, 164.22, 154.42, 147.07, 146.10, 135.97, 130.41, 128.44, 127.18, 126.09, 122.66, 110.02, 107.80, 106.36, 100.58, 59.60, 48.18, 42.94, 34.24, 14.39, 12.48; **HRMS (ESI+):** Calculated for $C_{23}H_{23}NO_5Na$ ($[M + Na]^+$): 416.1474, found: 416.1479.

Compound 1h: Corresponding Knoevenagel adduct (**S6h**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as an orange-red oil which on conjugate reduction afforded a yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1h** as a yellow oil (173 mg, 0.51 mmol; 51% yield, over two steps). **R_f:** 0.70 and 0.68 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.45 (20% EtOAc in pet ether) for **1h**; **FT-IR (Thin film):** 2926 (w), 1728 (m), 1690 (s), 1626 (m), 1391 (m), 1229 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.20-7.35 (m; 3H), 7.17-7.18 (m; 1H), 6.97-6.99 (m; 2H), 6.20-6.21 (m; 1H), 5.95 (d, *J* = 3.1 Hz; 1H), 4.91 (d, *J* = 16.0 Hz; 1H), 4.49 (d, *J* = 16.0 Hz; 1H), 4.14-4.31 (m; 2H), 3.49-3.58 (m; 2H), 3.37 (dd, *J* = 3.4, 14.3 Hz; 1H), 2.21 (d, *J* = 1.9 Hz; 3H), 1.32 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 178.04, 164.08, 154.22, 151.61, 141.30, 136.16, 128.61, 127.35, 126.59, 109.88, 107.01, 106.83, 59.56, 46.33, 43.19, 27.66, 14.35, 12.45; **HRMS (ESI+):** Calculated for $C_{20}H_{21}NO_4Na$ ($[M + Na]^+$): 362.1368, found: 362.1368.

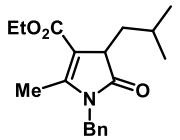
Compound 1i: Corresponding Knoevenagel adduct (**S6i**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright red oil which on conjugate reduction afforded a yellow semisolid. Purification by silica gel

(230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1i** as a yellow solid (219 mg, 0.56 mmol; 48% yield, over two steps). **R_f:** 0.72 and 0.67 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.47 (20% EtOAc in pet ether) for **1i**; **Melting point:** 65-66 °C; **FT-IR (Thin film):** 2925 (w), 1719 (m), 1683 (s), 1617 (m), 1386 (m), 1225 (m), 1051 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.14-7.19 (m; 3H), 7.09-7.10 (m; 1H), 6.87-6.90 (m; 1H), 6.78 (d, *J* = 3.3 Hz; 1H), 6.66-6.68 (m; 2H), 4.89 (d, *J* = 16.2 Hz; 1H), 4.39 (d, *J* = 16.2 Hz; 1H), 4.20-4.35 (m; 2H), 3.70 (dd, *J* = 6.2, 15.4 Hz; 1H), 3.58-3.62 (m; 2H), 2.18 (d, *J* = 2.0 Hz; 3H), 1.35 (t *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.82, 164.18, 155.23, 138.22, 135.97, 128.67, 127.23, 126.52, 126.50, 126.21, 124.21, 124.10, 106.35, 59.73, 47.96, 43.16, 29.02, 14.48, 12.60; **HRMS (ESI+):** Calculated for $C_{20}H_{21}NO_3SNa$ ($[M + Na]^+$): 378.1140, found: 378.1142.

Compound 1j: Corresponding Knoevenagel adduct (**S6j**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 3% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a yellow oil which on conjugate reduction afforded a light yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 8% EtOAc/pet ether) afforded **1j** as a colorless oil (161 mg, 0.47 mmol; 42% yield, over two steps). **R_f:** 0.78 and 0.74 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.50 (20% EtOAc in pet ether) for **1j**; **FT-IR (Thin film):** 2926 (m), 2858 (m), 1715 (m), 1706 (s), 1457 (m), 1396 (m), 1231 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.22-7.31 (m; 3H), 7.16-7.18 (m; 2H), 4.83 (d, *J* = 15.9 Hz; 1H), 4.66 (d, *J* = 15.9 Hz; 1H), 4.10-4.27 (m; 2H), 3.36-3.39 (m; 1H), 2.33 (d, *J* = 2.2 Hz; 3H), 1.94-2.02 (m; 2H), 1.19-1.30 (m; 11H), 0.83-0.87 (m; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 179.41, 164.32, 153.67, 136.65, 128.74, 127.57, 126.81, 107.69, 59.52, 46.61, 43.29, 31.53, 29.40, 29.17, 24.78, 22.44, 14.32, 13.96, 12.60; **HRMS (ESI+):** Calculated for $C_{21}H_{29}NO_3K$ ($[M + K]^+$): 382.1785, found: 382.1783.



Compound 1k: Corresponding Knoevenagel adduct (**S6k**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a yellow oil which on conjugate reduction afforded a light yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1k** as a colorless oil (78 mg, 0.25 mmol; 29% yield, over two steps). **R_f:** 0.65 and 0.61 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.46 (20% EtOAc in pet ether) for **1k**; **FT-IR (Thin film):** 2951 (w), 1694 (s), 1628 (m), 1397 (m), 1043 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.20-7.33 (m; 5H), 4.74 (d, *J* = 15.6 Hz; 1H), 4.48 (d,



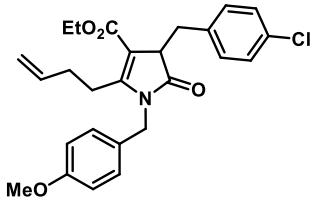
J =15.6 Hz; 1H), 4.27-4.36 (m; 2H), 3.53-3.56 (m; 1H), 2.56-2.57 (m; 2H), 1.95-2.05 (m; 1H), 1.51 (s; 3H), 1.35 (d, *J* = 7.1 Hz; 3H), 0.94 (s; 3H), 0.92 (s; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 168.37, 163.44, 146.02, 142.22, 138.08, 128.36, 127.25, 127.10, 88.71, 61.18, 42.17, 33.47, 28.45, 24.47, 22.56, 14.02; **HRMS (ESI+):** Calculated for $C_{19}H_{25}NO_3Na$ ([M + Na]$^+$): 338.1732, found: 338.1733.

Compound 1l: Corresponding Knoevenagel adduct (**S6l**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a yellow oil which on conjugate reduction afforded a light yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1l** as a colorless oil (112 mg, 0.34 mmol; 47% yield, over two steps). **R_f:** 0.50 and 0.40 (10% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.33 (20% EtOAc in pet ether) for **1l**; **FT-IR (Thin film):** 2958 (w), 1696 (s), 1625 (m), 1391 (m), 1237 (m), 1066 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.24-7.33 (m; 3H), 7.28-7.20 (m; 2H), 4.85 (d, *J* = 15.9 Hz; 1H), 4.68 (d, *J* =15.9 Hz; 1H), 4.22-4.30 (m; 1H), 4.10-4.18 (m; 1H), 3.38-3.41 (m; 1H), 2.35 (d, *J* = 2.0 Hz; 3H), 1.99-2.05 (m; 2H), 1.47-1.54 (m; 1H), 1.29 (t, *J* =7.1 Hz; 3H), 0.99-1.12 (m; 3H), 0.84-0.87 (m, 6H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 179.38, 164.35, 153.84, 136.66, 128.76, 127.61, 126.85, 107.53, 59.54, 46.57, 43.30, 33.63, 27.97, 27.24, 22.63, 22.15, 14.38, 12.62; **HRMS (ESI+):** Calculated for $C_{20}H_{27}NO_3Na$ ([M + Na]$^+$): 352.1889, found: 352.1890.

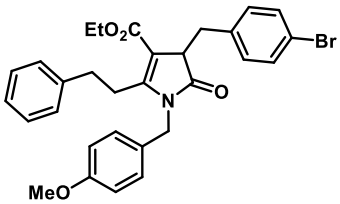
Compound 1m: Corresponding Knoevenagel adduct (**S6m**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright yellow oil which on conjugate reduction afforded a light yellow semisolid. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1m** as a white solid (91 mg, 0.22 mmol; 48% yield, over two steps). **R_f:** 0.50 and 0.45 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.35 (20% EtOAc in pet ether) for **1m**; **Melting point:** 94-95 °C; **FT-IR (Thin film):** 2931 (w), 1715 (m), 1687 (s), 1609 (s), 1512 (m), 1238 (s); **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.15 (d, *J* = 8.3 Hz; 2H), 6.98 (d, *J* = 8.3 Hz; 2H), 6.72 (d, *J* = 8.6 Hz; 2H), 6.53 (d, *J* = 8.6 Hz; 2H), 4.74 (d, *J* = 15.9 Hz; 1H), 4.21-4.35 (m; 3H), 3.77 (s; 3H), 3.62 (t, *J* = 4.5 Hz; 1H), 3.46 (dd, *J* = 4.9, 13.3 Hz; 1H), 3.27 (dd, *J* = 4.2, 13.3 Hz; 1H), 2.49 (t, *J* =7.9 Hz; 2H), 1.35 (t, *J* =7.1 Hz; 3H), 1.18-1.30 (m; 1H), 0.95-1.08 (m; 1H), 0.76 (t, *J* =7.3 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 178.20, 163.96, 159.16, 158.83, 135.16, 132.38, 131.16, 128.09, 128.03, 127.51, 113.93, 105.76, 59.70,

55.20, 47.81, 42.63, 34.03, 28.02, 21.65, 14.46, 13.94; **HRMS (ESI+):** Calculated for $C_{25}H_{28}NO_4ClNa$ ($[M + Na]^+$): 464.1605, found: 464.1609.

Compound 1n: Corresponding Knoevenagel adduct (**S6n**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright yellow oil which on conjugate reduction afforded a light yellow solid. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1n** as a white solid (110 mg, 0.24 mmol; 46% yield, over two steps). **R_f:** 0.65 and 0.60 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.50 (20% EtOAc in pet ether) for **1n**; **Melting point:** 87-88 °C; **FT-IR (Thin film):** 2929 (w), 1724 (m), 1688 (m), 1616 (m), 1516 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.16 (d, *J* = 8.3 Hz; 2H), 6.98 (d, *J* = 8.3 Hz; 2H), 6.72 (d, *J* = 8.6 Hz; 2H), 6.52 (d, *J* = 8.6 Hz; 2H), 5.51-5.61 (m; 1H), 4.88-4.90 (m; 1H), 4.81-4.86 (m; 1H), 4.78 (d, *J* = 15.9 Hz; 1H), 4.21-4.35 (m; 3H), 3.77 (s; 3H) 3.63 (t, *J* = 4.5 Hz; 1H), 3.47 (dd, *J* = 4.8, 13.3 Hz; 1H), 3.27 (dd, *J* = 4.3, 13.3 Hz; 1H), 2.53-2.67 (m; 2H), 1.92-2.01 (m; 1H), 1.76-1.77 (m; 1H), 1.59-1.68 (m; 1H), 1.35 (t, *J* =7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 178.07, 163.81, 158.86, 158.41, 136.35, 135.10, 132.42, 131.17, 128.11, 127.91, 127.61, 115.62, 113.96, 106.08, 59.78, 55.20, 47.81, 42.67, 33.96, 31.96, 25.75, 14.45; **HRMS (ESI+):** Calculated for $C_{26}H_{28}NO_4ClNa$ ($[M + Na]^+$): 476.1605, found: 476.1605.

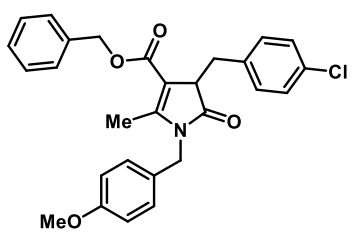


Compound 1o: Corresponding Knoevenagel adduct (**S6o**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright yellow oil which on conjugate reduction afforded a yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1o** as a yellow oil (61 mg, 0.11 mmol; 42% yield, over two steps). **R_f:** 0.58 and 0.55 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.45 (20% EtOAc in pet ether) for **1o**; **FT-IR (Thin film):** 2927 (w), 1726 (m), 1687 (m), 1618 (s), 1512 (m), 1215 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.35 (d, *J* = 8.0 Hz; 2H), 7.15-7.25 (m; 3H), 6.97 (d, *J* = 8.0 Hz; 2H), 6.92 (d, *J* =7.3 Hz; 2H), 6.76 (d, *J* = 8.2 Hz; 2H), 6.48 (d, *J* =8.2 Hz; 2H), 4.61 (d, *J* =16.1 Hz; 1H), 4.26-4.40 (m; 2H), 4.08 (d, *J* =16.1 Hz; 1H), 3.78 (s; 3H), 3.65-3.68 (m; 2H), 3.49 (dd, *J* = 4.6, 13.3 Hz; 1H), 3.29 (dd, *J* = 4.1, 13.3 Hz; 1H), 2.81-2.88 (m; 1H), 2.68-2.75 (m; 1H), 2.55-2.62 (m; 1H), 2.11-2.18 (m; 1H), 1.38 (t, *J* =7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.98, 163.76, 158.93, 158.63, 140.30, 135.67, 131.68, 131.14, 128.47, 128.17,

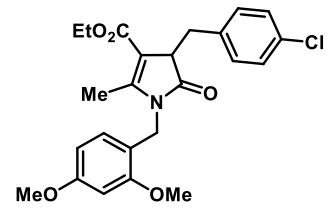


127.91, 127.55, 126.37, 120.65, 114.10, 106.12, 59.85, 55.31, 47.81, 42.48, 34.36, 34.04, 14.59; **HRMS (ESI+):** Calculated for $C_{30}H_{30}NO_4BrNa$ ($[M + Na]^+$): 570.1256, found: 570.1254.

Compound 1q: Corresponding Knoevenagel adduct (**S6q**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright yellow solid which on conjugate reduction afforded a yellow semisolid. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1q** as a yellow solid (174 mg, 0.36 mmol; 51% yield, over two steps). **R_f:** 0.65 and 0.55 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.45 (20% EtOAc in pet ether) for **1q**; **Melting point:** 97-98 °C; **FT-IR (Thin film):** 2934 (w), 1718 (m), 1683 (s), 1618 (m), 1512 (m), 1235 (s), 1056 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.34-7.44 (m; 5H), 7.10 (d, *J* = 8.4 Hz; 2H), 6.87 (d, *J* = 8.4 Hz; 1H), 6.71 (d, *J* = 8.7 Hz; 1H), 6.47 (d, *J* = 8.7 Hz; 2H), 5.33 (d, *J* = 12.3 Hz; 2H), 5.23 (d, *J* = 12.3 Hz; 2H), 4.85 (d, *J* = 16.0 Hz; 1H), 4.22 (d, *J* = 16.0 Hz; 1H), 3.77 (s; 3H), 3.63-3.66 (m; 1H), 3.42 (dd, *J* = 4.9, 13.3 Hz; 1H), 3.25 (dd, *J* = 4.3, 13.3 Hz; 1H), 2.14 (d, *J* = 2.2 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.74, 164.02, 158.84, 155.53, 136.24, 135.14, 132.35, 131.18, 128.65, 128.44, 128.32, 128.20, 127.68, 127.41, 114.00, 105.68, 65.71, 55.24, 47.94, 42.62, 33.87, 12.78; **HRMS (ESI+):** Calculated for $C_{28}H_{26}NO_4ClNa$ ($[M + Na]^+$): 498.1448, found: 498.1443.



Compound 1r: Corresponding Knoevenagel adduct (**S6r**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright yellow solid which on conjugate reduction afforded a light yellow semisolid. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1r** as a white solid (152 mg, 0.30 mmol; 39% yield, over two steps). **R_f:** 0.40 and 0.33 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.20 (20% EtOAc in pet ether) for **1r**; **Melting point:** 117-118 °C; **FT-IR (Thin film):** 2933 (w), 1724 (m), 1689 (s), 1621 (s), 1306 (m), 1208 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.13 (d, *J* = 8.4 Hz; 2H), 6.96 (d, *J* = 8.4 Hz; 2H), 6.35 (d, *J* = 2.3 Hz; 1H), 6.21 (dd, *J* = 2.3, 8.4 Hz; 1H), 5.75 (d, *J* = 8.4 Hz; 1H), 4.70 (d, *J* = 16.6 Hz; 1H), 4.21-4.37 (m; 3H), 3.77 (s; 3H), 3.72 (s; 3H), 3.59-3.61 (m; 1H), 3.45 (dd, *J* = 4.9, 13.3 Hz; 1H), 3.25 (dd, *J* = 4.3, 13.3 Hz; 1H), 2.14 (d, *J* = 2.1 Hz; 3H), 1.36 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 117.93, 164.38, 160.03, 157.09, 155.48, 135.29, 132.21, 131.17, 128.16, 127.33, 116.06, 105.62, 103.63, 98.30, 59.66,

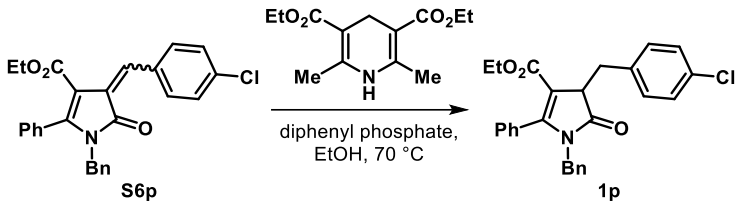


55.27, 55.05, 47.98, 37.74, 33.85, 14.49, 12.13; **HRMS (ESI+):** Calculated for $C_{24}H_{26}NO_5ClNa$ ($[M + Na]^+$): 466.1397, found: 466.1395.

Compound 1s: Corresponding Knoevenagel adduct (**S6s**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a yellow oil which on conjugate reduction afforded a light yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1s** as a colorless oil (73 mg, 0.25 mmol; 30% yield, over two steps). **R_f:** 0.60 and 0.53 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.30 (20% EtOAc in pet ether) for **1s**; **FT-IR (Thin film):** 2927 (w), 1724 (m), 1691 (s), 1627 (m), 1275 (m), 1224 (s), 1062 (m), 935 (w) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.23-7.33 (m; 3H), 7.18 (d, *J* = 7.3 Hz; 2H), 4.84 (d, *J* =15.9 Hz; 1H), 4.67 (d, *J* =15.9 Hz; 1H), 4.11-4.27 (m; 2H), 3.37-3.38 (m; 1H), 2.34 (d, *J* = 1.4 Hz; 3H), 2.03-2.10 (m; 2H), 1.28 (t, *J* = 7.1 Hz; 3H), 0.79 (t, *J* = 7.4 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 179.31, 164.35, 154.02, 136.66, 128.80, 127.61, 126.81, 107.17, 59.59, 47.46, 43.33, 22.53, 14.35, 12.66, 9.12; **HRMS (ESI+):** Calculated for $C_{17}H_{21}NO_3Na$ ($[M + Na]^+$): 310.1419, found: 310.1415.

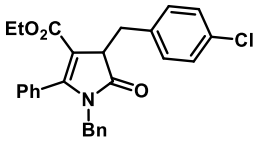
Compound 1t: Corresponding Knoevenagel adduct (**S6t**) was purified by silica gel (230-400 mesh) column chromatography (gradient elution: CH_2Cl_2 to 5% EtOAc/CH_2Cl_2) to obtain the alkylidene butyrolactam as a yellow solid which on conjugate reduction afforded a yellow semisolid. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: CH_2Cl_2 to 10% EtOAc/CH_2Cl_2) afforded **1t** as a white solid (306 mg, 1.04 mmol; 46% yield, over two steps). **R_f:** 0.73 and 0.65 (10% EtOAc in CH_2Cl_2) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.40 (10% EtOAc in CH_2Cl_2) for **1t**; **Melting point:** 128-129 °C; **FT-IR (Thin film):** 2982 (w), 1718 (m), 1687 (s), 1633 (m), 1334 (m), 1211 (s), 1074 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.90 (br; 1H), 7.15 (d, *J* = 8.2 Hz; 2H), 6.99 (d, *J* = 8.2 Hz; 2H), 4.20-4.32 (m; 2H), 3.54-3.57 (m; 1H), 3.33 (dd, *J* = 5.7, 13.5 Hz; 1H), 3.21 (dd, *J* = 3.9, 13.5 Hz; 1H), 2.18 (d, *J* = 2.0 Hz; 3H), 1.34 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 180.18, 164.20, 151.86, 135.39, 132.33, 130.61, 128.08, 106.97, 59.82, 48.90, 34.07, 14.46, 13.49; **HRMS (ESI+):** Calculated for $C_{15}H_{16}NO_3ClNa$ ($[M + Na]^+$): 316.0716, found: 316.0720.

Procedure B: For the preparation of the butyrolactam **1p**, $NaBH_4$ reduction of the corresponding Knoevenagel adduct turned out to be unsuccessful. Therefore, Hantzsch ester was used for this conjugate reduction:



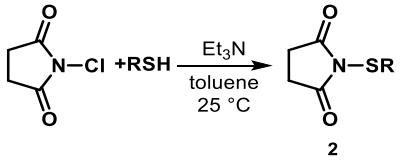
The Hantzsch ester (0.74 mmol, 1.2 equiv.), **S6p** (0.36 mmol, 1.0 equiv.), and diphenyl phosphate (0.36 mmol, 1.0 equiv.) were sequentially mixed in 2 mL abs. EtOH. The resulting solution was heated at 70 °C for 8 h until complete consumption of **S6p**. The reaction mixture was then cooled to room temperature and EtOH was evaporated under reduced pressure. The resulting semisolid residue was dissolved in EtOAc (40 mL), washed successively with aq. 2 N HCl (2×10 mL), sat. aq. $NaHCO_3$ (10 mL), brine (10 mL) and then dried over anh. Na_2SO_4. Concentration under reduced pressure afforded a yellow oil which was purified by silica gel (230-400 mesh) column chromatography to obtain **1p**.

Compound 1p: Corresponding Knoevenagel adduct **S6p** was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 5% EtOAc/pet ether) to obtain the alkylidene butyrolactam as a bright yellow solid which on conjugate reduction afforded a yellow oil. Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether to 10% EtOAc/pet ether) afforded **1p** as a yellow solid (131 mg, 0.29 mmol; 76% yield, over two steps). **R_f:** 0.65 and 0.50 (20% EtOAc in pet ether) for the *E/Z* isomers of the alkylidene butyrolactam and **R_f:** 0.60 (20% EtOAc in pet ether) for **1p**; **Melting point:** 105-106 °C; **FT-IR (Thin film):** 2926 (w), 1706 (s), 1697 (s), 1220 (s), 1123 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.31-7.35 (m; 1H), 7.21-7.28 (m; 3H), 7.16-7.18 (m; 2H), 7.10-7.14 (m; 1H), 7.04-7.07 (m; 4H), 6.66-6.85 (m; 1H), 6.36 (d, *J* = 7.6 Hz; 2H), 4.56 (d, *J* = 15.3 Hz; 1H), 4.11 (d, *J* = 15.3 Hz; 1H), 3.98-4.08 (m; 2H), 3.79-3.81 (m; 1H), 3.55 (dd, *J* = 5.0, 13.4 Hz; 1H), 3.37 (d, *J* = 4.1, 13.4 Hz; 1H), 1.02 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.96, 163.34, 155.44, 135.95, 135.04, 132.59, 131.16, 129.91, 129.31, 128.14, 127.88, 127.17, 127.12, 108.24, 59.73, 48.18, 44.00, 34.30, 13.95; **HRMS (ESI+):** Calculated for $C_{27}H_{24}NO_3ClNa$ ($[M + Na]^+$): 468.1342, found: 468.1340.



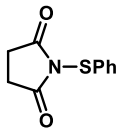
C. Preparation of the sulfenylating agents

N-(Sulfanyl)succinimides (**2a-h**) were prepared following the modified literature procedure[7] as follows:

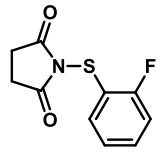


2

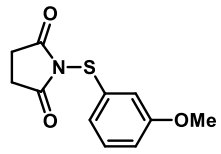
N-Chlorosuccinimide (1.0 equiv.) was added to a stirred solution of thiol (1.0 equiv.) in abs. toluene (4 mL toluene/1.0 mmol thiol) at 25 °C under an argon atmosphere. The color of the resulting heterogenous mixture was transformed to yellow-orange after stirring at 25 °C for 45 min. A solution of Et_3N (1.0 equiv.) in abs. toluene (1.6 mL toluene/1.0 mmol of Et_3N) was then added over 45 min with a syringe pump. The resulting heterogeneous mixture was stirred at 25 °C for 12 h and then diluted with diethyl ether (12 mL ether/1.0 mmol of thiol). The resulting white precipitate was filtered off. The filtrate was concentrated under reduced pressure to produce a yellow/orange semisolid residue, which was purified by silica gel (230-400 mesh) column chromatography to obtain the *N*-(sulfanyl)succinimides **2**.



Compound 2a: Purification by silica gel (230-400 mesh) column chromatography (30% EtOAc/pet ether) afforded **2a**[8] as a white solid (2.81 g, 13.56 mmol; 69% yield). **Melting point:** 112-113 °C; **R_f:** 0.20 (30% EtOAc in pet ether); **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.61-7.63 (m; 2H), 7.31-7.37 (m; 3H), 2.81 (s; 4H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.36, 133.86, 132.32, 129.91, 129.33, 28.56.



Compound 2b: Purification by silica gel (230-400 mesh) column chromatography (30-40% EtOAc/pet ether) afforded pure **2b** as a white solid (126 mg, 0.56 mmol; 62% yield). **R_f:** 0.20 (30% EtOAc in pet ether); **Melting point:** 85-86 °C; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.42-7.64 (m; 1H), 7.31-7.36 (m; 1H), 7.00-7.18 (m; 2H), 2.83 (s; 4H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 175.93, 160.78 (d, *J*= 249 Hz), 133.59, 131.85 (d, *J* = 8 Hz), 124.78 (d, *J* = 4 Hz), 120.72 (d, *J* = 17 Hz), 116.27 (d, *J* = 22 Hz), 28.53.



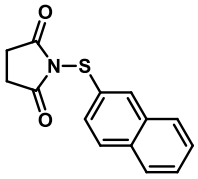
Compound 2c: Purification by silica gel (230-400 mesh) column chromatography (30-40% EtOAc/pet ether) afforded pure **2c**[7] as a white solid (1.39 g, 5.86 mmol; 73% yield). **R_f:** 0.20 (40% EtOAc in pet ether); **Melting point:** 151-153 °C; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.23 (d, *J* = 8.0 Hz; 1H), 7.13-7.17 (m; 2H),

(7) C. Savarin, J. Srogl and L. S. Liebeskind, *Org. Lett.*, 2002, **4**, 4309-4312.

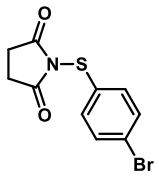
(8) T. Hostier, V. Ferey, G. Ricci, D. G. Pardo and J. Cossy, *Chem. Commun.*, 2015, **51**, 13898-13901.

6.87-6.89 (m; 1H), 3.79 (s; 3H), 2.83 (m; 4H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.35, 159.90, 134.92, 130.17, 123.94, 116.69, 115.92, 55.42, 28.58.

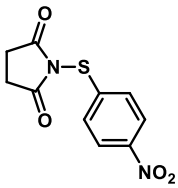
Compound 2d: Purification by silica gel (230-400 mesh) column chromatography (35% EtOAc/pet ether) afforded pure **2d**[7] as a white solid (573 mg, 2.23 mmol; 67% yield). **Melting point:** 155-157 °C; **R_f:** 0.50 (50% EtOAc in pet ether); **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 8.18 (s; 1H), 7.77-7.83 (m; 3H), 7.64-7.66 (m; 1H), 7.49-7.54 (m; 2H), 2.79 (s; 4H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.45, 133.51, 133.12, 132.73, 130.94, 129.20, 128.92, 128.18, 127.67, 127.50, 126.88, 28.55.



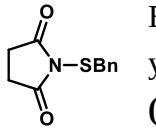
Compound 2e: Purification by silica gel (230-400 mesh) column chromatography (30% EtOAc/pet ether) afforded pure **2e**[7] as a white solid (1.14 g, 3.98 mmol; 76% yield). **Melting point:** 143-146 °C; **R_f:** 0.30 (40% EtOAc in pet ether); **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 8.18 (d, *J* = 8.5 Hz; 2H), 7.45 (d, *J* = 8.5 Hz; 2H), 2.97 (s; 4H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.15, 134.18, 132.76, 132.50, 124.71, 28.54.



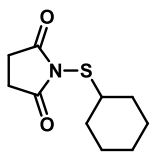
Compound 2f: Purification by silica gel (230-400 mesh) column chromatography (30-40% EtOAc/pet ether) afforded pure **2f**[7] as a white solid (735 mg, 2.91 mmol; 41% yield). **Melting point:** 172-175 °C; **R_f:** 0.40 (50% EtOAc in pet ether); **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 8.18 (d, *J* = 8.5 Hz; 2H), 7.45 (d, *J* = 8.5 Hz; 2H), 2.97 (s; 4H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 175.63, 147.24, 142.95, 127.42, 124.39, 28.70.



Compound 2g: Purification by silica gel (230-400 mesh) column chromatography (30% EtOAc/pet ether) afforded pure **2g**[9] as a white solid (878 mg, 3.97 mmol; 31% yield). **Melting point:** 159-161 °C; **R_f:** 0.20 (30% EtOAc in pet ether); **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.26-7.33 (m; 5H), 4.10 (s; 2H), 2.63 (s; 4H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.53, 133.87, 129.62, 128.58, 128.05, 40.96, 28.36.



Compound 2h: Purification by silica gel (230-400 mesh) column chromatography (30% EtOAc/pet ether) afforded pure **2h**[10] as a white solid (2.1 g, 9.85 mmol; 61% yield). **R_f:** 0.20 (30% EtOAc in pet ether); **Melting point:** 102-104 °C**; ^{1}H-NMR (400 MHz, $CDCl_3$):** δ 3.14-3.21 (m; 1H), 2.84 (s; 4H), 1.77-1.83 (m; 4H), 1.58-1.63 (m; 1H), 1.62-1.35 (m; 5H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.44, 48.42,



(9) P. Saravanan and P. Anbarasan, *Org. Lett.*, 2014, **16**, 848-851.

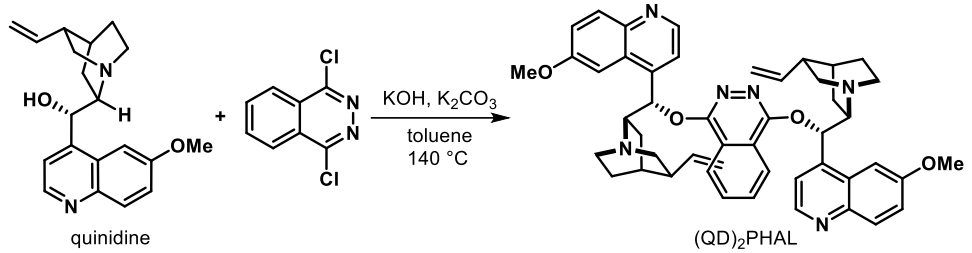
(10) S. Torii, H. Tanaka and M. Ukida, *J. Org. Chem.*, 1979, **44**, 1554-1557.

30.89, 28.51, 25.39.

D. Preparation of catalysts

The catalysts $(QD)_2PHAL$[11] and $(Q)_2PHAL$ were prepared according to the modified literature procedure as follows:

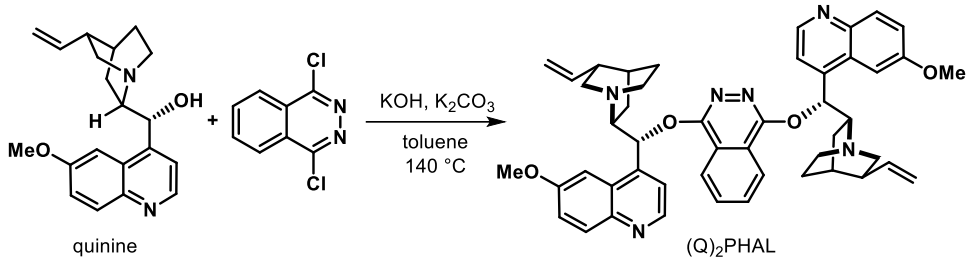
Preparation of $(QD)_2PHAL$:



In a 50 mL 2-neck round-bottom flask equipped with a Dean-Stark apparatus and a condenser, 1,4-dichlorophthalazine (400 mg, 2.00 mmol, 1.0 equiv.), quinidine (1.27 g, 3.91 mmol, 1.96 equiv.) and K_2CO_3 (833 mg, 6.00 mmol, 3.0 equiv.) were taken under argon atmosphere. Abs. toluene (25 mL) was added and the resulting mixture was allowed to reflux at 140 °C for 2 h. The reaction mixture was then cooled to room temperature and KOH (338 mg, 6.00 mmol, 3.0 equiv.) was added. The reaction mixture was refluxed at 140 °C under argon atmosphere for 24 h. After cooling to the room temperature, 20 mL distilled water was added to the reaction mixture followed by the addition of 40 mL of EtOAc. The organic layer was collected and the aqueous layer was extracted with EtOAc (3×20 mL). The combined organic layer was dried over anh. Na_2SO_4 and concentrated in vacuo to obtain a yellowish solid which was purified by two sequential silica gel (230-400 mesh) column chromatography, first with $CHCl_3$/2-3% MeOH in $CHCl_3$ and then with EtOAc/2-3% MeOH in EtOAc to obtain $(QD)_2PHAL$ as a white solid (712 mg, 0.92 mmol; 47% yield). **Melting point:** 158-159 °C; **FT-IR (thin film):** 2930 (m), 2864 (s), 1620 (m), 1388 (s), 1359 (s), 1221 (s), 1089 (m), 1026 (m); **^{1}H-NMR (400 MHz, CD_3OD):** δ 8.62 (d, *J* = 4.5 Hz, 1H), 8.32-8.36 (m; 1H), 7.97 (d, *J* = 9.2 Hz, 1H), 7.90-7.94 (m; 1H), 7.54 (d, *J* = 2.5 Hz, 1H), 7.41 (d, *J* = 4.6 Hz, 1 H), 7.35 (d, *J* = 2.5 Hz, 1 H), 7.33 (d, *J* = 2.5 Hz, 1 H), 7.07 (d, *J* = 5.6 Hz, 1 H), 5.89-5.98 (m, 1 H), 4.95-4.99 (m, 2H), 3.89 (s, 3H), 3.37-3.43 (m, 1H), 2.95-3.00 (m, 1H), 2.79-2.87 (m, 2H), 2.64-2.72 (m, 1H), 2.18-2.24 (m, 1H), 1.81 (s; 1H), 1.50-1.55 (m; 3H); **^{13}C-NMR (100 MHz, CD_3OD):** δ 157.64, 156.26, 147.16, 144.63, 144.50, 140.10, 132.08, 131.36, 127.12, 122.90, 122.31, 121.82, 118.11, 114.63, 101.89, 75.82, 59.81, 55.58, 49.62, 49.25, 39.39, 27.63, 26.24, 22.94; **HRMS (ESI+):** Calculated for $C_{48}H_{50}N_6O_4Na$ ($[M+H]^+$): 797.3791, Found: 797.3790; **Optical rotation:** $[\alpha]_D^{26}$ –132.4 (*c* 1.0, $CHCl_3$).

(11) A. R. Choudhury and S. Mukherjee, *Org. Biomol. Chem.*, 2012, **10**, 7313-7320.

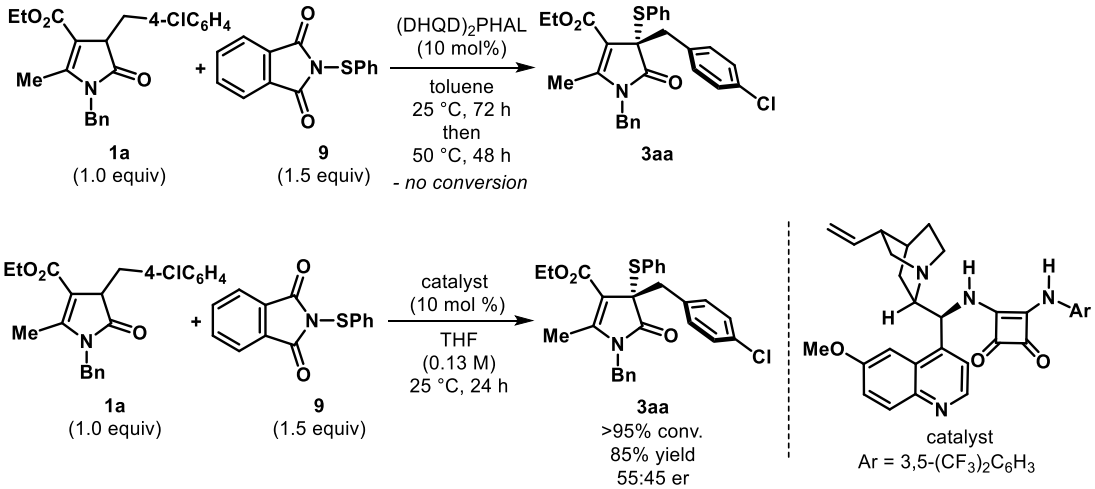
Preparation of $(Q)_2$PHAL:



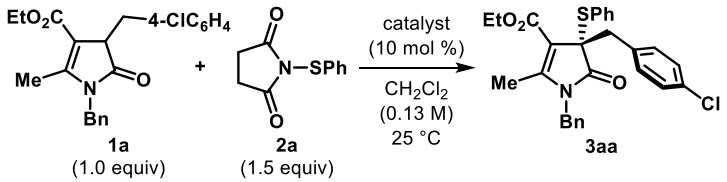
Same procedure as above was followed with quinine (1.27 g, 3.91 mmol) instead of quinidine. After working up the reaction as above, a yellow semisolid crude was obtained. The crude was purified by silica gel (230-400 mesh) column chromatography with EtOAc/2-3% MeOH in EtOAc followed by recrystallization from Et_2O/EtOAc to obtain $(Q)_2$PHAL as a white solid (496 mg, 0.64 mmol; 33% yield); **Melting point:** 160-161 °C; **FT-IR (Thin film):** 2928 (m), 2861 (s), 1627 (m), 1373 (m), 1354 (s), 1227 (m); **^{1}H-NMR (400 MHz, CD_3OD):** δ 8.64 (d, *J* = 4.5 Hz, 1H), 8.31-8.33 (m; 1H), 7.99 (d, *J* = 9.2 Hz, 1H), 7.93-7.95 (m; 1H), 7.57 (d, *J* = 1.9 Hz, 1H), 7.43 (d, *J* = 4.5 Hz, 1 H), 7.36 (dd, *J* = 2.2, 9.2 Hz, 1 H), 7.01 (d, *J* = 5.8 Hz, 1 H), 5.78-5.87 (m, 1 H), 4.95-5.01 (m, 2H), 3.92 (s, 3H), 3.47-3.52 (m, 1H), 3.09-3.16 (m, 1H), 3.00-3.06 (m, 1H), 2.53-2.62 (m, 2H), 2.22-2.27 (m, 1H), 1.78-1.91 (m, 3H), 1.68-1.74 (m, 1H), 1.45-1.51 (m, 1H); **^{13}C-NMR (100 MHz, CD_3OD):** δ 157.70, 156.42, 147.37, 144.74, 144.68, 141.94, 132.32, 131.56, 127.24, 122.81, 122.49, 121.88, 118.49, 114.33, 101.99, 76.23, 60.20, 56.78, 55.68, 42.67, 39.88, 27.93, 27.76, 23.83; **HRMS (ESI+):** Calculated for $C_{48}H_{50}N_6O_4Na$ ($[M+H]^+$): 797.3791, Found: 797.3787. **Optical rotation:** $[\alpha]_D^{26}$ +167.6 (*c* 1.0, $CHCl_3$).

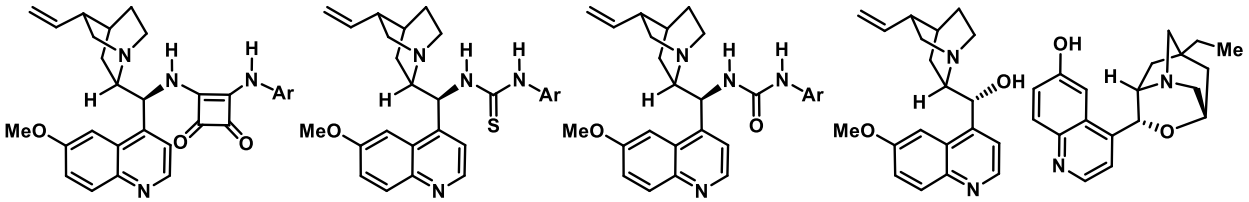
E. Optimization of catalyst and reaction conditions

- **Initial results:**

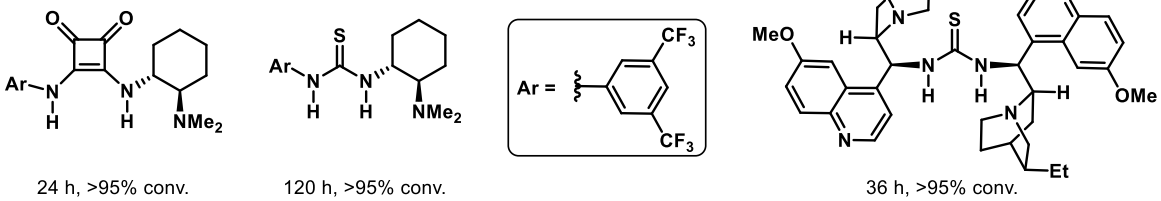


- **Catalyst screening:**[a-c]



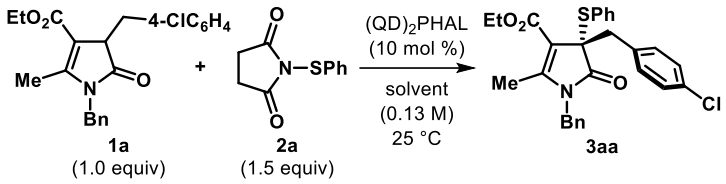


if THF is used instead of CH_2Cl_2 :
5 h, >95% conv.
59:41 er



[a]All reactions were carried out on a 0.026 mmol scale. [b]Conversion was determined by ^{1}H-NMR analysis of the crude reaction mixture. [c]Enantiomeric ratio (er) was determined by HPLC analysis using a stationary phase chiral column.

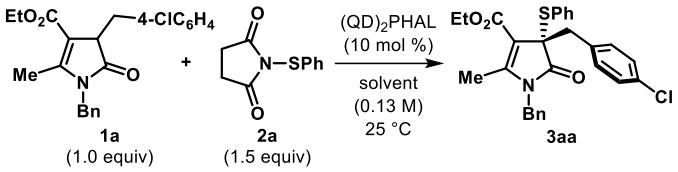
- **Solvent screening:**[a]



entry	solvent	t/h[b]	er[c]
1	CH_2Cl_2	24	88:12
2	$CHCl_3$	72	96:4
3	EtOAc	72	95.5:4.5
4	1,4-dioxane	72	95.5:4.5
5	MeCN	16	87:13
6	acetone	72	92.5:7.5
7	2-MeTHF	96	92.5:7.5
8	TBME	96	95.5:4.5
9	toluene	96	93.5:6.5
10	$PhCF_3$	96	91.5:8.5
11	*o*-xylene	120	95.5:4.5
12	*m*-xylene	96	96:4
13	*p*-xylene	96	96:4
14	mesitylene	120	96:4
15	*t*-BuPh	96	96.5:3.5
16[d]	*t*-BuPh	80	97:3
17[e]	*t*-BuPh	80	96.5:3.5

[a]Reactions were carried out on a 0.026 mmol scale. [b]Time required for complete consumption of **1a**. [c]Enantiomeric ratio (er) determined by HPLC analysis using a stationary phase chiral column. [d]Reaction was carried out at 15 °C with 0.5 M concentration. [e]25 mg 4Å molecular sieve was used as an additive.

- **Acceleration of reaction rate in water-enriched media:**[a]

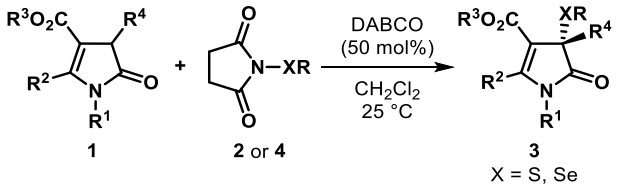


entry	solvent	t/h[b]	er[c]
1	*t*-BuPh	96	96.5:3.5
2	*t*-BuPh:H_2O (1:1)	36	96.5:3.5
3	*t*-BuPh:H_2O (3:1)	72	97:3
4	*t*-BuPh:H_2O (1:3)	36	97:3
5	*t*-BuPh:H_2O (1:9)	12	96.5:3.5
6[d]	*t*-BuPh:H_2O (1:9)	12	96.5:3.5
7[d,e]	*t*-BuPh:H_2O (1:9)	48	97.5:2.5
8[d,f]	*t*-BuPh:H_2O (1:9)	24	98:2
9[d,e]	*t*-BuPh:brine (1:9)	30	97:3
10	H_2O	6	96:4
11[g]	H_2O	3	95.5:4.5
12	brine	12	97:3
13	sat. aq. $LiClO_4$	80	86.5:13.5 (78%)[h]

[a]All reactions were carried out on a 0.026 mmol scale. [b]Time required for complete consumption of **1a**. [c]Enantiomeric ratio (er) determined by HPLC analysis using a stationary phase chiral column. [d]Reaction was carried out on a 0.1 mmol scale. [e]Reaction at 0.05 M concentration. [f]Reaction at 0.1 M concentration. [g]Reaction was performed under sonication. [h]Value in the parentheses represents the isolated yield after column chromatography.

F. Preparation of racemic products (*rac*-3 and *rac*-5)

General procedure for the preparation of racemic products:



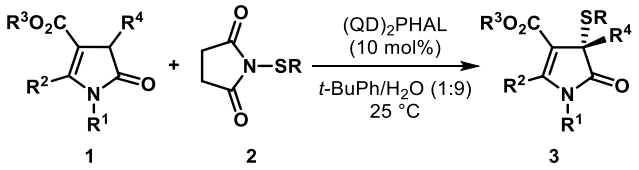
In a glass-vial, **1** (0.020 mmol, 1.0 equiv.), **2** (0.030 mmol, 1.5 equiv.) and DABCO (0.010 mmol, 0.5 equiv.) were sequentially mixed in 0.1 mL of CH_2Cl_2. The resulting solution was stirred at 25 °C until TLC revealed complete consumption of **1**. The crude

mixture was purified by preparative TLC (Merck silica-gel 60 F254 pre-coated plates of 0.25 mm thickness) to obtain HPLC samples for the racemic sulfenylated products (*rac*-**3**).

For preparation of *rac*-**5**, **4** (0.030 mmol, 1.5 equiv.) was used instead of **2** and the same procedure as above was followed.

G. Procedure for catalytic enantioselective sulfenylation of 1 with 2

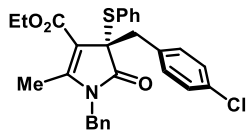
General procedure for the sulfenylation of the deconjugated butyrolactams (**1**) with *N*-(sulfanyl)succinimides (**2**):



In a round bottom flask fitted with a magnetic stir bar, deconjugated butyrolactam **1** (0.1 mmol, 1.0 equiv.) was taken along with $(QD)_2PHAL$ (7.7 mg, 0.01 mmol, 0.1 equiv.) in a 1:9 mixture of *t*-BuPh/H_2O (1.0 mL). *N*-(Sulfanyl)succinimide **2** (0.15 mmol, 1.5 equiv.) was added to it at 0 °C. The resulting heterogenous mixture was vigorously stirred at 25 °C until the full consumption of **1**, as revealed by TLC analysis. The reaction mixture was diluted with 30 mL EtOAc. The organic phase was washed with brine (5 mL), dried over anh. Na_2SO_4 and concentrated to obtain a semisolid which was purified by silica gel column chromatography affording the sulfenylated product **3**. Detailed characterization data of the products (**3**) are provided below.

H. Characterization data of the sulfenylated lactams (3)

Compound 3aa: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether) afforded **3aa** as a yellow solid (43.5 mg, 0.088 mmol; 88% yield). **R_f:** 0.50 (20% EtOAc in pet ether); recrystallization from 5:1 pet ether/CH_2Cl_2 at –20 °C afforded X-ray diffraction quality crystals. **Melting point:** 127 °C; **FT-IR (Thin film):** 2931 (w), 1726 (m), 1693 (s), 1624 (s), 1386 (m), 1228 (m), 1303 (m), 1091 (s), 744 (m), 692 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.39-7.43 (m; 2H), 7.36-7.39 (m; 1H), 7.26-7.30 (m; 2H), 7.05-7.07 (m; 2H), 7.10-7.17 (m; 5H), 6.37 (d, *J* = 7.0 Hz; 2H), 4.67 (d, *J* = 16.4 Hz; 1H), 4.42 (q, *J* = 7.1 Hz; 2H), 3.77 (d, *J* = 12.7 Hz; 1H), 3.75 (d, *J* = 16.4 Hz; 1H), 3.32 (d, *J* = 12.7 Hz; 1H), 1.80 (s; 3H), 1.46 (t, *J* =7.1 Hz; 3H), **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.72, 163.67, 155.08, 137.13, 135.38, 134.46, 132.74, 131.46, 129.76, 129.57, 128.54, 128.33, 128.30, 127.33, 125.70, 106.90, 61.90, 59.93, 42.73, 37.78, 14.54, 12.34; **HRMS (ESI+):** Calculated for $C_{28}H_{26}NO_3ClSNa$ ($[M + Na]^+$): 514.1220, found: 514.1215; **Optical rotation:** $[\alpha]_D^{22}$ +283.9 (*c*



1.0, $CHCl_3$) for an enantiomerically enriched sample with >99.9:0.1 er obtained after a single recrystallization of the product (with 98:2 er). Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/EtOH = 90:10, 1.0 mL min^{-1}, τ_{major} = 11.57 min, τ_{minor} = 14.83 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3aa** is established by single crystal X-ray diffraction analysis.

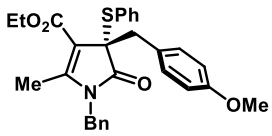
Compound *ent*-3aa: Reaction was performed under the identical condition as that of **3aa** using the pseudoenantiomeric catalyst $(Q)_2PHAL$. Purification by silica gel (230-400 mesh) column chromatography afforded *ent*-**3aa** as a yellow solid (44 mg, 0.089 mmol; 89% yield) with 97:3 er. **Optical rotation:** $[\alpha]_D^{23}$ –284.8 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with >99.5:0.5 er obtained through a single recrystallization of the product (with 97:3 er). Enantiomeric purity was determined by HPLC analysis under identical conditions as that of **3aa** (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/EtOH = 90:10, 1.0 mL min^{-1}). See Supporting Information: Part B for HPLC chromatograms.

Compound 3ba: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether) afforded pure **3ba** as white crystalline solid (40 mg, 0.087 mmol; 87% yield). **R_f:** 0.50 (20% EtOAc in pet ether); **Melting point:** 103-104 °C; **FT-IR (Thin film):** 2927 (w), 1728 (s), 1685 (s), 1620 (m), 1386 (m), 1296 (m), 1230 (m), 1182 (w), 1089 (s), 746 (s), 696 (s), 617 (w) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.42-7.44 (m; 2H), 7.36-7.40 (m; 1H), 7.26-7.30 (m; 2H), 7.17-7.22 (m; 3H), 7.10-7.15 (m; 3H), 7.03-7.07 (m; 2H) 6.36 (d, *J* = 7.6 Hz; 2H), 4.63 (d, *J* = 16.4 Hz; 1H), 4.43 (q, *J* = 7.0 Hz; 2H), 3.74-3.81 (m; 2H), 3.37 (d, *J* = 12.7 Hz; 1H), 1.77 (s; 3H), 1.48 (t, *J* =7.0 Hz; 3H), **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.94, 163.83, 154.98, 137.14, 135.94, 135.53, 130.07, 129.81, 129.68, 128.55, 128.29, 128.21, 127.12, 126.80, 125.76, 107.20, 62.21, 59.88, 42.71, 38.61, 14.57, 12.27; **HRMS (ESI+):** Calculated for $C_{28}H_{27}NO_3SNa$ ([M + Na]$^+$): 480.1609, found: 480.1511; **Optical rotation:** $[\alpha]_D^{22}$ +248.2 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with >98:2 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 240 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{minor} = 15.41 min, τ_{major} = 17.57 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ba** is assigned in analogy with **3aa**.

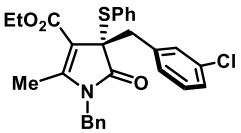
Compound 3ca: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether) afforded **3ca** as a yellow thick oil (47 mg, 0.089 mmol; 89% yield). **R_f:** 0.30 (10% EtOAc in pet ether); **FT-IR (Thin film):** 2927 (w), 1728 (m), 1691 (s), 1612 (s), 1323 (s),

1298 (m), 1230 (m), 1091 (s), 731 (m), 692 (m), 636 (w) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.40-7.47 (m; 5H), δ 7.26-7.33 (m; 4H), δ 7.14-7.18 (m; 1H), δ 7.06-7.10 (m; 2H), 6.42 (d, *J* = 7.7 Hz; 2H), 4.67 (d, *J* = 16.3 Hz; 1H), 4.44 (q, *J* = 7.1 Hz; 2H), 3.87 (d, *J* = 12.7 Hz; 1H), 3.76 (d, *J* = 16.3 Hz; 1H), 3.43 (d, *J* = 12.6 Hz; 1H), 1.81 (s; 3H), 1.49 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.67, 163.67, 155.17, 140.21, 137.26, 135.41, 130.47, 129.90, 129.52, 129.14 (q, *J*=32 Hz), 128.56, 128.37, 127.47, 125.79, 125.10 (q, *J* = 4 Hz), 124.20 (q, *J* = 272 Hz), 106.84, 61.80, 60.03, 42.87, 38.20, 14.58, 12.43; **HRMS (ESI+):** Calculated for $C_{29}H_{26}F_3NO_3SNa$ ($[M + Na]^+$): 548.1483, found: 548.1479; **Optical rotation:** $[\alpha]_D^{23}$ +245.2 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 98:2 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 240 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{major} = 8.80 min, τ_{minor} = 11.58 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ca** is assigned in analogy with **3aa**.

Compound 3da: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether) afforded **3da** as a light yellow solid (45 mg, 0.092 mmol; 92% yield). **R_f:** 0.60 (20% EtOAc in pet ether); **Melting point:** 80-81 °C; **FT-IR (Thin film):** 2924 (w), 1726 (m), 1691 (s), 1612 (m), 1510 (m), 1247 (m), 1091 (m), 1022 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.42-7.44 (m; 2H), 7.36-7.40 (m; 1H), 7.26-7.30 (m; 2H), 7.11-7.15 (m; 1H), 7.04-7.08 (m; 4H), 6.72-6.74 (m; 2H), 6.35-6.37 (m; 2H), 4.67 (d, *J* = 16.4 Hz; 1H), 4.40-4.47 (m; 2H), 3.76-3.78 (m; 4H), 7.73-7.74 (m; 1H), 3.31 (d, *J* = 12.9 Hz; 1H), 1.79 (s; 3H), 1.48 (t, *J* = 7.1 Hz; 3H), **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.03, 163.84, 158.46, 154.97, 137.07, 135.54, 131.11, 129.87, 129.61, 128.44, 128.26, 127.96, 127.15, 125.77, 113.51, 107.24, 62.28, 59.84, 55.05, 42.66, 37.74, 14.56, 12.29; **HRMS (ESI+):** Calculated for $C_{29}H_{29}NO_4SNa$ ($[M + Na]^+$): 510.1715, found: 510.1711; **Optical rotation:** $[\alpha]_D^{22}$ +257.1 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 97.5:2.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{major} = 14.16 min, τ_{minor} = 21.07 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3da** is assigned in analogy with **3aa**.

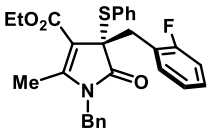


Compound 3ea: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/4% EtOAc in pet ether) afforded **3ea** as a white solid (43 mg, 0.087 mmol; 87% yield). **R_f:** 0.58 (20% EtOAc in pet ether); **Melting point:** 93-94 °C; **FT-IR (Thin film):** 2924 (m), 1726 (m), 1691 (s), 1614 (m), 1386 (m), 1224 (m), 1089 (m), 1020 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.37-7.43 (m; 3H), 7.26-7.30 (m; 2H), 7.07-7.19 (m; 6H), 6.99-7.01 (m; 1H), 6.49-6.50 (m; 2H), 4.65 (d, *J* = 16.3 Hz; 1H), 4.41 (q, *J* = 7.1 Hz; 2H), 3.75 (d, *J* = 16.3 Hz; 1H), 3.73

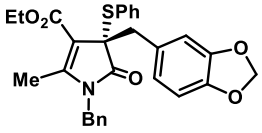


(d, *J* = 12.7 Hz; 1H), 3.35 (d, *J* = 12.7 Hz; 1H), 1.80 (s; 3H), 1.46 (t, *J* = 7.1 Hz; 3H), **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.75, 163.65, 155.10, 138.14, 137.22, 135.54, 133.91, 130.00, 129.83, 129.55, 129.44, 128.69, 128.33, 128.18, 127.32, 127.06, 125.90, 106.93, 61.84, 59.97, 42.91, 38.13, 14.59, 12.40; **HRMS (ESI+):** Calculated for $C_{28}H_{26}NO_3ClSNa$ ($[M + Na]^+$): 514.1220, found: 514.1216; **Optical rotation:** $[\alpha]_D^{23}$ +223.3 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 96:4 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/EtOH = 90:10, 1.0 mL min^{-1}, τ_{minor} = 11.09 min, τ_{major} =14.63 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ea** is assigned in analogy with **3aa**.

Compound 3fa: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether) afforded **3fa** as a white solid (43 mg, 0.090 mmol; 90% yield). **R_f:** 0.52 (20% EtOAc in pet ether); **Melting point:** 112-113 °C; **FT-IR (Thin film):** 2931 (w), 1726 (m), 1683 (s), 1618 (m), 1494 (m), 1386 (m), 1238 (m), 1093 (m), 760 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.41-7.43 (m; 2H), 7.35-7.39 (m; 1H), 7.25-7.29 (m; 2H), 7.17-7.22 (m; 2H), 7.10-7.14 (m; 1H), 7.03-7.06 (m; 2H), 6.92-6.97 (m; 2H), 6.39 (d, *J* = 7.5 Hz; 2H), 4.63 (d, *J* = 16.3 Hz; 1H), 4.38 (q, *J* = 7.1 Hz; 2H), 3.92 (d, *J* = 13.1 Hz; 1H), 3.78 (d, *J* = 16.3 Hz; 1H), 3.33 (d, *J* = 13.1 Hz; 1H), 1.82 (s; 3H), 1.45 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.82, 163.74, 161.22 (d, *J*= 247 Hz), 155.02, 137.06, 135.61, 132.76 (d, *J* = 4 Hz), 129.80, 129.72, 128.63 (d, *J* = 8 Hz), 128.55, 128.30, 127.16, 125.86, 123.83 (d, *J* = 3 Hz), 122.92 (d, *J* = 16 Hz), 115.37 (d, *J* = 23 Hz), 107.28, 61.55, 59.82, 42.74, 31.87, 14.39, 12.21; **HRMS (ESI+):** Calculated for $C_{28}H_{26}NO_3FSNa$ ($[M + Na]^+$): 498.1515, found: 498.1513; **Optical rotation:** $[\alpha]_D^{22}$ +296.4 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 98:2 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 240 nm, *n*-Hexane /IPA = 90:10, 1.0 mL min^{-1}, τ_{minor} = 17.50 min, τ_{major} = 20.91 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3fa** is assigned in analogy with **3aa**.

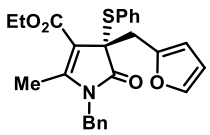


Compound 3ga: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether/10% EtOAc in pet ether) afforded pure **3ga** as a yellow solid (43.5 mg, 0.087 mmol; 87% yield). **R_f:** 0.58 (20% EtOAc in pet ether); **Melting point:** 90-91 °C; **FT-IR (Thin film):** 2922 (w), 1723 (m), 1680 (s), 1610 (m), 1488 (m), 1439 (m), 1381 (m), 1087 (s), 1027 (s), 802 (s), 691 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.36-7.43 (m; 3H), 7.26-7.30 (m; 2H), 7.09-7.15 (m; 3H), 6.63-6.66 (m; 3H), 6.48-6.50 (m; 2H), 5.90 (s; 2H), 4.69 (d, *J* = 16.4 Hz; 1H), 4.41 (q, *J* = 7.1 Hz; 2H), 3.77 (d, *J* = 16.4 Hz; 1H), 3.70 (d, *J* =

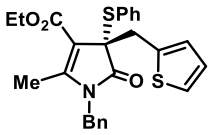


12.9 Hz; 1H), 3.30 (d, *J* = 12.9 Hz; 1H), 1.82 (s; 3H), 1.46 (t, *J* = 7.1 Hz; 3H), **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.97, 163.77, 154.96, 147.20, 146.38, 137.13, 135.65, 129.74, 129.68, 128.50, 128.27, 127.25, 125.91, 123.32, 110.37, 107.99, 107.23, 107.75, 62.20, 59.89, 42.76, 38.21, 14.55, 12.38; **HRMS (ESI+):** Calculated for $C_{29}H_{27}NO_5SNa$ ([M + Na]$^+$): 524.1508, found: 524.1505; **Optical rotation:** $[\alpha]_D^{23}$ +244.0 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 98:2 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 240 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{major} = 26.41 min, τ_{minor} = 28.96 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ga** is assigned in analogy with **3aa**.

Compound 3ha: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/15% EtOAc in pet ether) afforded pure **3ha** as a light yellow solid (36 mg, 0.080 mmol; 80% yield). **R_f:** 0.20 (15% EtOAc in pet ether); **Melting point:** 69-70 °C; **FT-IR (Thin film):** 2923 (w), 1726 (s), 1686 (w), 1617 (m), 1388 (m), 1221 (s), 1089 (s), 771 (s), 731 (m), 691 (s) 603 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.37-7.44 (m; 3H), 7.26-7.30 (m; 2H), 7.16-7.19 (m; 4H), 6.76-6.78 (m; 2H), 6.18-6.19 (m; 1H), 5.97-5.98 (m; 1H), 4.68 (d, *J* = 16.1 Hz; 1H), 4.29-4.41 (m; 2H), 3.90 (d, *J* = 16.3 Hz; 1H), 3.77 (d, *J* = 14.1 Hz; 1H), 3.44 (d, *J* = 14.1 Hz; 1H), 1.90 (s; 3H), 1.42 (t, *J* = 7.1 Hz; 3H), **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.98, 163.59, 154.91, 150.65, 141.63, 137.25, 135.91, 129.79, 129.49, 128.60, 128.33, 127.36, 126.36, 110.03, 107.75, 107.64, 59.93, 59.77, 42.99, 32.14, 14.48, 12.31; **HRMS (ESI+):** Calculated for $C_{26}H_{25}NO_4SNa$ ([M + Na]$^+$): 470.1402, found: 470.1406; **Optical rotation:** $[\alpha]_D^{23}$ +210.2 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 97.5:2.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 240 nm, *n*-Hexane/EtOH = 75:25, 1.0 mL min^{-1}, τ_{minor} = 11.17 min, τ_{major} = 31.77 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ha** is assigned in analogy with **3aa**.



Compound 3ia: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether) afforded pure **3ia** as a yellow solid (42 mg, 0.090 mmol; 90% yield). **R_f:** 0.40 (20% EtOAc in pet ether); **Melting point:** 97-98 °C; **FT-IR (Thin film):** 2929 (w), 1728 (s), 1689 (s), 1618 (s), 1222 (s), 1186 (m), 1089 (s), 746 (m), 698 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.42-7.44 (m; 2H), 7.36-7.40 (m; 1H), 7.26-7.30 (m; 2H), 7.08-7.16 (m; 4H), 6.85-6.87 (m; 1H), 6.80-6.81 (m; 1H), 6.48-6.49 (m; 2H), 4.65 (d, *J* = 16.2 Hz; 1H), 4.34-4.46 (m; 2H), 3.93 (q, *J* = 13.8 Hz; 1H), 3.86 (d, *J* = 16.3 Hz; 1H), 3.63 (d, *J* = 13.8 Hz; 1H), 1.87 (s; 3H), 1.45 (t, *J* = 7.1 Hz; 3H), **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.77, 163.66, 155.53, 137.42, 137.24, 135.62, 129.78, 129.51, 128.60, 128.35, 127.30, 127.20, 126.51, 125.92, 124.65, 107.35,



61.47, 59.94, 42.85, 33.30, 14.52, 12.32; **HRMS (ESI+):** Calculated for $C_{26}H_{25}NO_3S_2Na$ ([M + Na]$^+$): 486.1174, found: 486.1175; **Optical rotation:** $[\alpha]_D^{22}$ +210.2 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 97.5:2.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{minor} = 19.07 min, τ_{major} = 26.03 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ia** is assigned in analogy with **3aa**.

Compound 3ja: Purification by silica gel (230-400mesh) column chromatography (gradient elution: pet ether/5% EtOAc in pet ether) afforded pure **3ja** as a colorless oil (37 mg, 0.082 mmol; 82% yield). **R_f:** 0.30 (10% EtOAc in pet ether); **FT-IR (Thin film):** 2926 (w), 1726 (m), 1691 (s), 1616 (m), 1386 (m), 1217 (m), 1091 (m), 754 (w) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.35-7.38 (m; 3H), 7.22-7.26 (m; 5H), 6.93-6.95 (m; 2H), 4.64 (d, *J* = 16.0 Hz; 1H), 4.24-4.38 (m; 2H), 4.02 (d, *J* = 16.0 Hz; 1H), 2.37 (dt, *J* = 4.5, 12.4 Hz; 1H), 2.04-2.12 (m; 1H), 2.04 (s; 3H), 1.37 (t, *J* = 7.0 Hz; 3H), 1.20-1.32 (m; 6H), 1.06-1.18 (m; 1H), 0.92-1.03 (m; 1H), 0.84-0.87 (m; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.79, 163.72,154.52, 137.11, 136.22, 129.88, 129.56, 128.74, 128.23, 127.52, 126.63, 107.95, 61.04, 59.72, 43.21, 33.62, 31.45, 29.12, 25.61, 22.41, 14.43, 13.99, 12.45; **HRMS (ESI+):** Calculated for $C_{27}H_{33}NO_3SNa$ ([M + Na]$^+$): 474.2079, found: 474.2077; **Optical rotation:** $[\alpha]_D^{23}$ +263.8 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 96.5:3.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{minor} = 7.67 min, τ_{major} = 11.09 min). Absolute stereochemistry of **3ja** is assigned in analogy with **3aa**.

Compound 3la: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 8% EtOAc in pet ether) afforded pure **3la** as a colorless oil (36 mg, 0.082 mmol; 82% yield). **R_f:** 0.35 (10 % EtOAc in pet ether); **FT-IR (Thin film):** 2928 (w), 1727 (m), 1690 (s), 1616 (m), 1389 (m), 1219 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.36-7.40 (m; 3H), 7.22-7.28 (m; 5H), 6.94-6.96 (m; 2H), 4.65 (d, *J* = 16.0 Hz; 1H), 4.25-4.39 (m; 2H), 4.05 (d, *J* =16.0 Hz; 1H), 2.42 (dt, *J* = 4.8, 12.3 Hz; 1H), 2.09-2.13 (m; 1H), 2.06 (s; 3H), 1.49-1.59 (m; 1H), 1.39 (t, *J* =7.1 Hz; 3H), 0.90-1.05 (m; 2H), 0.88 (d, *J* =3.1 Hz; 3H), 0.86 (t, *J* =3.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.76, 163.73, 154.61, 137.07, 136.20, 129.86, 129.56, 128.72, 128.24, 127.52, 126.62, 107.90, 61.07, 59.73, 43.19, 34.46, 31.67, 28.08, 22.67, 22.06, 14.44, 12.41; **HRMS (ESI+):** Calculated for $C_{26}H_{31}NO_3SNa$ ([M + Na]$^+$): 460.1922, found: 460.1927; **Optical rotation:** $[\alpha]_D^{21}$ +194.1 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 97.5:2.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H

column, 254 nm, *n*-Hexane/EtOH = 90:10, 1.0 mL min^{-1}, τ_{minor} = 6.18 min, τ_{major} = 7.82 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3la** is assigned in analogy with **3aa**.

Compound 3bb: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 15% EtOAc in pet ether) afforded pure **3bb** as a yellow oil (41 mg, 0.086 mmol; 86% yield). **R_f:** 0.50 (20% EtOAc in pet ether); **FT-IR (Thin film):** 1724 (s), 1692 (m), 1621 (m), 1375 (m), 1221 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.48-7.52 (m; 1H), 7.36-7.41 (m; 1H), 7.14-7.23 (m; 3H), 7.04-7.12 (m; 7H), 6.40 (d, *J* = 7.5 Hz; 2H), 4.73 (d, *J* = 16.4 Hz; 1H), 4.33-4.45 (m; 2H), 3.92 (d, *J* = 16.4 Hz; 1H), 3.87 (d, *J* = 12.6 Hz; 1H), 3.35 (d, *J* = 12.6 Hz; 1H), 1.84 (s; 3H), 1.46 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.69, 164.22 (d, *J*= 249 Hz), 163.71, 155.15, 139.72, 135.82, 135.58, 132.25 (d, *J* = 8 Hz), 130.11, 128.59, 128.23, 127.18, 126.84, 125.86, 123.95 (d, *J* = 4 Hz), 117.08 (d, *J* = 18 Hz), 115.66 (d, *J* = 24 Hz), 107.08, 61.65, 59.90, 42.93, 38.75, 14.46, 12.36; **HRMS (ESI+):** Calculated for $C_{28}H_{26}NO_3FNa$ ($[M + Na]^+$): 498.1515, found: 498.1514; **Optical rotation:** $[\alpha]_D^{23}$ +217.5 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 99.5:0.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 240 nm: *n*-Hexane/IPA = 95:05, 1.0 mL min^{-1}, τ_{major} = 30.41 min, τ_{minor} = 35.08 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3bb** is assigned in analogy with **3aa**.

Compound 3bc: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 10% EtOAc in pet ether) afforded pure **3bc** as a yellow oil (41 mg, 0.084 mmol; 84% yield). **R_f:** 0.20 (10% EtOAc in pet ether); **FT-IR (Thin film):** 2929 (w), 1728 (m), 1691 (s), 1617 (m), 1586 (m), 1232 (s), 1092 (s), 1032 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.16-7.22 (m; 4H), 7.10-7.15 (m; 3H), 6.98-7.07 (m; 4H), 6.91-6.94 (m; 1H), 6.35 (d, *J* = 7.2 Hz; 2H), 4.62 (d, *J* = 16.4 Hz; 1H), 4.42 (q, *J* = 7.1 Hz; 1H), 3.77-3.85 (m; 2H), 3.76 (s; 3H), 3.36 (d, *J* = 12.6 Hz; 1H), 1.80 (s; 3H), 1.46 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.95, 163.81, 159.14, 155.04, 135.87, 135.52, 130.79, 130.07, 129.23, 128.96, 128.56, 128.20, 127.13, 126.82, 125.72, 121.24, 116.52, 107.28, 62.28, 59.88, 55.32, 42.75, 38.72, 14.56, 12.34; **HRMS (ESI+):** Calculated for $C_{29}H_{29}NO_4SNa$ ($[M + Na]^+$): 510.1715, found: 510.1710; **Optical rotation:** $[\alpha]_D^{23}$ +234.8 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 98.5:1.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/EtOH = 60:40, 1.0 mL min^{-1}, τ_{minor} = 6.93 min, τ_{major} = 12.26 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3bc** is assigned in analogy with **3aa**.

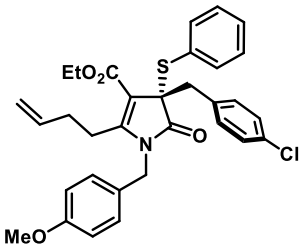
Compound 3ad: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 10% EtOAc in pet ether) afforded pure **3ad** as a yellow oil (41 mg, 0.076 mmol; 76% yield). **R_f:** 0.55 (20% EtOAc in pet ether); **FT-IR (Thin film):** 2925 (w), 1727 (m), 1691 (s), 1616 (m), 1388 (m), 1228 (m), 1090 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.98 (s; 1H), 7.79-7.84 (m; 2H), 7.73 (d, *J* = 8.5 Hz; 1H), 7.48-7.56 (m; 2H), 7.45 (dd, *J* = 1.7, 8.5 Hz; 1H), 7.14-7.16 (m; 2H), 7.05-7.10 (m; 3H), 6.95-6.99 (m; 2H), 6.27 (d, *J* = 7.4 Hz; 2H), 4.56 (d, *J* = 16.4 Hz; 1H), 4.40-4.48 (m; 2H), 3.82 (d, *J* = 12.7 Hz; 1H), 3.70 (d, *J* = 16.4 Hz; 1H), 3.36 (d, *J* = 12.7 Hz; 1H), 1.70 (s; 3H), 1.48 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.86, 163.75, 1155.20, 137.32, 135.32, 134.47, 133.48, 133.29, 133.14, 132.80, 131.49, 128.48, 128.36, 128.07, 127.69, 127.61, 127.31, 127.24, 126.99, 126.47, 125.68, 107.06, 62.05, 60.01, 42.81, 38.07, 14.62, 12.41; **HRMS (ESI+):** Calculated for $C_{32}H_{28}NO_3ClSNa$ ([M + Na]$^+$): 564.1376, found: 564.1375; **Optical rotation:** $[\alpha]_D^{23}$ +162.0 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 96.5:3.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 220 nm, *n*-Hexane/EtOH = 75:25, 1.0 mL min^{-1}, τ_{minor} = 11.08 min, τ_{major} = 15.21 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ad** is assigned in analogy with **3aa**.

Compound 3ae: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether) afforded pure **3ae** as a yellow solid (53 mg, 0.093 mmol; 93% yield). **R_f:** 0.57 (30% EtOAc in pet ether); **Melting point:** 109-110 °C **FT-IR (Thin film):** 2922 (m), 1724 (s), 1691 (s), 1617 (m), 1232 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.40 (d, *J* = 8.2 Hz; 2H), 7.27 (d, *J* = 8.2 Hz; 2H), 7.14-7.21 (m; 5H), 7.02 (d, *J* = 8.2 Hz; 2H), 6.40 (d, *J* = 7.0 Hz; 2H), 4.62 (d, *J* = 16.3 Hz; 1H), 4.40 (q, *J* = 7.0 Hz; 1H), 3.94 (d, *J* = 16.2 Hz; 1H), 3.74 (d, *J* = 12.7 Hz; 1H), 3.26 (t, *J* = 12.7 Hz; 1H), 1.87 (s; 3H), 1.44 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.49, 163.55, 155.31, 138.57, 135.20, 134.12, 132.83, 131.58, 131.39, 128.61, 128.58, 128.37, 127.46, 125.79, 124.69, 106.74, 61.57, 60.04, 42.88, 37.99, 14.53, 12.51; **HRMS (ESI+):** Calculated for $C_{28}H_{25}NO_3ClBrSNa$ ([M + Na]$^+$): 592.0325, found: 592.0327; **Optical rotation:** $[\alpha]_D^{22}$ +173.0 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 97.5:2.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 210 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{major} = 16.96 min, τ_{minor} = 22.29 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ae** is assigned in analogy with **3aa**.

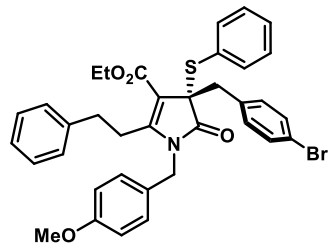
Compound 3af: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 15% EtOAc in pet ether) afforded pure **3af** as a yellow oil (46 mg, 0.085 mmol; 85% yield). **R_f:** 0.40 (30% EtOAc in pet ether); **FT-IR (Thin film):** 2927 (w), 1722 (s), 1691 (s), 1614 (m), 1381 (m), 1346 (m), 1232 (w), 1157 (m), 1087 (s), 813 (m), 731 (w), 698 (w), 648 (w), 615 (w) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 8.08 (d, *J* = 8.9 Hz; 2H), 7.58 (d, *J* = 8.9 Hz; 2H), 7.12-7.21 (m; 5H), 7.01 (d, *J* = 8.4 Hz; 2H), 6.48 (d, *J* = 7.2 Hz; 2H), 4.61 (d, *J* = 16.1 Hz; 1H), 4.41 (q, *J* = 7.1 Hz; 2H), 4.05 (d, *J* = 16.1 Hz; 1H), 3.79 (d, *J* = 12.7 Hz; 1H), 3.27 (t, *J* = 12.7 Hz; 1H), 1.95 (s; 3H), 1.45 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.19, 163.39, 155.66, 148.52, 138.25, 137.40, 135.06, 133.67, 133.14, 131.14, 128.70, 128.51, 127.73, 126.16, 123.18, 106.68, 61.53, 60.24, 43.19, 38.52, 14.56, 12.71; **HRMS (ESI+):** Calculated for $C_{28}H_{25}N_2O_5ClSNa$ ($[M + Na]^+$): 559.1070, found: 559.1075; **Optical rotation:** $[\alpha]_D^{23}$ +91.2 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 97.5:2.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 240 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{minor} = 22.05 min, τ_{major} = 29.88 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3af** is assigned in analogy with **3aa**.

Compound 3ma: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 10% EtOAc in pet ether) afforded pure **3ma** as a yellow oil (37 mg, 0.067 mmol; 67% yield). **R_f:** 0.30 (10% EtOAc in pet ether); **FT-IR (Thin film):** 2931 (w), 1725 (m), 1691 (s), 1609 (m), 1513 (m), 1245 (s), 1086 (s), 1025 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.40-7.42 (m; 2H), 7.32-7.36 (m; 1H), 7.23-7.27 (m; 2H), 7.14 (d, *J* = 8.3 Hz; 2H), 7.04 (d, *J* = 8.3 Hz; 2H), 6.65 (d, *J* = 8.6 Hz; 2H), 6.28 (d, *J* = 8.6 Hz; 2H), 4.63 (d, *J* = 16.0 Hz; 1H), 4.36-4.44 (m; 2H), 3.76-3.84 (m; 2H), 3.75 (s; 3H), 3.27 (d, *J* = 12.7 Hz; 1H), 2.37-2.44 (m; 1H), 1.94-2.01 (m; 1H), 1.44 (t, *J* =7.1 Hz; 3H), 0.67-0.82 (m; 2H), 0.60-0.64 (m; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.40, 163.39, 159.66, 158.76, 137.06, 134.33, 132.73, 131.56, 129.69, 129.56, 128.53, 128.28, 127.59, 127.13, 113.88, 106.37, 61.54, 59.85, 55.21, 42.45, 38.24, 28.07, 21.34, 14.52, 14.18; **HRMS (ESI+):** Calculated for $C_{31}H_{32}NO_4ClSNa$ ($[M + Na]^+$): 572.1638, found: 572.1642; **Optical rotation:** $[\alpha]_D^{21}$ +145.9 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 93:7 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 240 nm, *n*-Hexane/EtOH = 70:30, 1.0 mL min^{-1}, τ_{minor} = 6.84 min, τ_{major} = 8.83 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ma** is assigned in analogy with **3aa**.

Compound 3na: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether) afforded pure **3na** as a yellow oil (46 mg, 0.082 mmol; 82% yield). **R_f:** 0.35 (10% EtOAc in pet ether); **FT-IR (Thin film):** 2930 (w), 1724 (m), 1692 (s), 1610 (m), 1513 (m), 1245 (m), 1177 (m), 1085 (s), 1028 (m), 915 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.39-7.41 (m; 2H), 7.32-7.35 (m; 1H), 7.22-7.26 (m; 1H), 7.12-7.14 (m; 2H), 7.02-7.04 (m; 2H), 6.62-6.64 (m; 2H), 6.27-6.29 (m; 2H), 5.34-5.44 (m; 1H), 4.81 (dd, *J* = 1.1, 10.1 Hz; 2H), 4.72 (dd, *J* = 1.5, 17.0 Hz; 1H), 4.63 (d, *J* = 16.1 Hz; 1H), 4.35-4.42 (m; 2H), 3.75-3.82 (m; 2H), 3.73 (s; 3H), 3.26 (d, *J* = 12.7 Hz; 1H), 2.44-2.51 (m; 1H), 2.06-2.14 (m; 1H), 1.42 (t, *J* = 7.1 Hz; 3H), 1.32-1.38 (m; 2H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.36, 163.24, 158.84, 158.82, 137.10, 136.37, 134.30, 132.78, 131.56, 129.77, 129.56, 128.55, 128.30, 127.52, 127.29, 115.33, 113.93, 106.76, 61.53, 59.93, 55.21, 42.52, 38.18, 31.46, 25.62, 14.52; **HRMS (ESI+):** Calculated for $C_{32}H_{32}NO_4SClNa$ ($[M + Na]^+$): 584.1638, found: 584.1635; **Optical rotation:** $[\alpha]_D^{21}$ +144.2 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 91:9 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/IPA = 95:5, 1.0 mL min^{-1}, τ_{major} = 19.95 min, τ_{minor} = 23.22 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3na** is assigned in analogy with **3aa**.



Compound 3oa: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 10% EtOAc in pet ether) afforded pure **3oa** as colorless oil (37 mg, 0.056 mmol; 56% yield). **R_f:** 0.25 (10% EtOAc in pet ether); **FT-IR (Thin film):** 2926 (w), 2361 (m), 2335 (m), 1726 (m), 1690 (s), 1609 (m), 1513 (m), 1248 (m), 1083 (s), 1030 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.45 (d, *J* = 7.2 Hz; 2H), 7.28-7.35 (m; 5H), 7.14-7.21 (m; 3H), 7.02 (d, *J* = 8.3 Hz; 2H), 6.84 (d, *J* = 7.2 Hz; 2H), 6.68 (d, *J* = 8.6 Hz; 2H), 6.27 (d, *J* = 8.6 Hz; 2H), 4.60 (d, *J* = 16.1 Hz; 1H), 4.41-4.52 (m; 2H), 3.79-3.83 (m; 2H), 3.76 (s; 3H), 3.29 (d, *J* = 12.7 Hz; 1H), 2.60-2.68 (m; 1H), 2.30-2.38 (m; 1H), 1.93-1.99 (m; 2H), 1.48 (t, *J* =7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.33, 163.27, 158.94, 158.90, 140.26, 137.20, 134.86, 132.02, 131.33, 129.86, 129.55, 128.61, 128.47, 127.93, 127.48, 127.22, 126.34, 121.03, 114.07, 106.79, 61.45, 60.05, 55.33, 42.45, 38.23, 33.75, 28.46, 14.69; **HRMS (ESI+):** Calculated for $C_{36}H_{34}NO_4BrSNa$ ($[M + Na]^+$): 678.1290, found: 678.1293; **Optical rotation:** $[\alpha]_D^{21}$ +157.2 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 88:12 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{minor} = 11.59 min, τ_{major} = 15.25 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3oa** is assigned in analogy with **3aa**.



Compound 3oc: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 10% EtOAc in pet ether) afforded pure **3oc** as a yellow oil (42 mg, 0.061 mmol; 61% yield). **R_f:** 0.25 (10% EtOAc in pet ether); **FT-IR (Thin film):** 2925 (m), 2852 (w), 1726 (m), 1691 (s), 1609 (m), 1587 (m), 1513 (m), 1245 (s), 1083 (s), 1033 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 6.89-6.93 (m; 1H), 6.79-6.82 (m; 1H), 6.74-6.76 (m; 1H), 5.97-6.00 (m; 1H), 5.04-5.11 (m; 1H), 4.69-4.74 (m; 1H), 4.54-4.58 (m; 1H), 4.15-4.20 (m; 2H), 3.95-4.01 (m; 1H), 2.85-2.91 (m; 1H), 2.45-2.50 (m; 1H), 2.07-2.14 (m; 2H), 1.27-1.30 (m; 3H), 0.97-1.01 (m; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.39, 163.28, 159.40, 158.98, 158.95, 140.29, 134.85, 132.03, 131.35, 130.55, 129.31, 129.28, 128.49, 127.91, 127.51, 127.19, 126.35, 121.85, 121.07, 116.27, 114.12, 106.91, 77.20, 61.54, 60.05, 55.33, 42.51, 38.34, 33.79, 28.38, 14.68; **HRMS (ESI+):** Calculated for $C_{37}H_{36}NO_5BrSNa$ ($[M + Na]^+$): 708.1395, found: 708.1395; **Optical rotation:** $[\alpha]_D^{21}$ +147.6 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 95.5:4.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/EtOH = 75:25, 1.0 mL min^{-1}, τ_{minor} = 7.12 min, τ_{major} = 10.44 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3oc** is assigned in analogy with **3aa**.

Compound 3pa: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 10% EtOAc in pet ether) afforded pure **3pa** as a yellow oil (39 mg, 0.070 mmol; 70% yield). **R_f:** 0.50 (15% EtOAc in pet ether); **FT-IR (Thin film):** 2925 (w), 1699 (s), 1491 (m), 1377 (m), 1283 (w) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.43-7.50 (m; 3H), 7.29-7.33 (m; 2H), 7.05-7.24 (m; 8H), 6.95-6.98 (m; 2H), 6.19 (d, *J* = 7.6 Hz; 2H), 6.13 (d, *J* = 7.5 Hz; 1H), 4.36 (d, *J* = 15.4 Hz; 1H), 4.12 (q, *J* = 7.1 Hz; 1H), 3.84 (d, *J* = 12.6 Hz; 1H), 3.63 (d, *J* = 15.4 Hz; 1H), 3.39 (d, *J* = 12.6 Hz; 1H), 1.04 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.27, 162.68, 155.43, 137.21, 135.50, 134.26, 132.96, 131.55, 129.84, 129.76, 129.63, 129.11, 128.67, 128.26, 127.99, 127.68, 127.08, 126.93, 108.93, 62.03, 59.73, 43.80, 38.31, 13.94; **HRMS (ESI+):** Calculated for $C_{33}H_{28}NO_3ClSNa$ ($[M + Na]^+$): 576.1376, found: 576.1379; **Optical rotation:** $[\alpha]_D^{21}$ +167.2 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 73.5:26.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{minor} = 9.09 min, τ_{major} = 10.16 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3pa** is assigned in analogy with **3aa**.

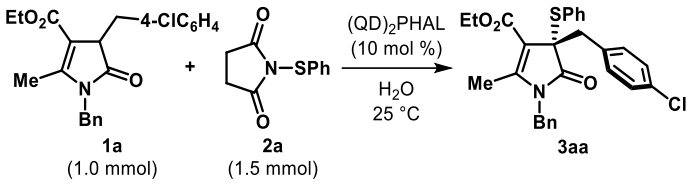
Compound 3qa: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 4% EtOAc in pet ether) afforded pure **3qa** as a yellow solid (48 mg, 0.082 mmol; 82% yield). **R_f:** 0.30 (10% EtOAc in pet ether); **Melting point:** 89-90 °C; **FT-IR (Thin film):** 2925 (w), 1721 (m), 1683 (s), 1609 (m), 1511 (m), 1380 (m), 1244 (s), 1081 (s), 985 (m), 811 (s), 747 (m), 694 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.54-7.56 (m; 2H), 7.33-7.44 (m; 6H), 7.20-7.26 (m; 2H) 7.07 (d, *J* = 8.4 Hz; 2H), 6.92 (d, *J* = 8.4 Hz; 2H), 6.64 (d, *J* = 8.7 Hz; 2H), 6.27 (d, *J* = 8.7 Hz; 2H), 5.40 (q, *J* = 12.3 Hz; 2H), 4.62 (d, *J* = 16.1 Hz; 1H), 3.74 (s; 3H), 3.65-3.74 (m; 2H), 3.27 (d, *J* = 12.7 Hz; 1H), 1.80 (s; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.80, 163.40, 158.78, 155.90, 137.13, 136.21, 134.38, 132.65, 131.52, 129.76, 129.52, 128.65, 128.62, 128.33, 128.31, 127.29, 127.07, 113.93, 106.48, 65.85, 61.81, 55.21, 42.28, 37.70, 12.51; **HRMS (ESI+):** $C_{34}H_{30}NO_4ClSNa$ ([M + Na]$^+$): 606.1482, found: 606.1478; **Optical rotation:** $[\alpha]_D^{23}$ +207.8 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 98:2 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/EtOH = 60:40, 1.0 mL min^{-1}, τ_{minor} = 15.96 min, τ_{major} = 25.54 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3qa** is assigned in analogy with **3aa**.

Compound 3ra: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 10% EtOAc in pet ether) afforded pure **3ra** as a light yellow solid (39 mg, 0.070 mmol; 70% yield). **R_f:** 0.40 (20% EtOAc in pet ether); **Melting point:** 118-119 °C; **FT-IR (Thin film):** 2924 (w), 1723 (m), 1683 (s), 1613 (s), 1587 (m), 1503 (m), 1211 (s), 1088 (s), 1035 (m), 822 (m), 753 (s), 692 (s), 639 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.39-7.41 (m; 2H), 7.35-7.36 (m; 1H), 7.25-7.29 (m; 2H), 7.13 (d, *J* = 8.3 Hz; 2H), 7.04 (d, *J* = 8.3 Hz; 2H), 6.30 (d, *J* = 1.9 Hz; 1H), 6.12 (dd, *J* = 1.9, 8.4 Hz; 1H), 5.46 (d, *J* = 8.4 Hz; 1H), 4.39-4.45 (m; 3H), 3.78-3.82 (m; 2H), 3.75 (s; 3H), 3.68 (s; 3H), 3.28 (d, *J* = 12.7 Hz; 1H), 1.81 (s; 3H), 1.46 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 176.92, 163.82, 160.01, 156.92, 155.86, 137.08, 134.58, 132.59, 131.60, 129.72, 129.61, 128.37, 128.29, 126.82, 115.75, 106.46, 103.54, 98.28, 61.90, 59.87, 55.32, 55.05, 37.74, 37.52, 14.59, 11.96; **HRMS (ESI+):** Calculated for $C_{30}H_{30}NO_5SClNa$ ([M + Na]$^+$): 574.1431, found: 574.1431; **Optical rotation:** $[\alpha]_D^{23}$ +179.1 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 92:8 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 220 nm, *n*-Hexane/EtOH = 70:30, 1.0 mL min^{-1}, τ_{minor} = 5.69 min, τ_{major} = 6.99 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ra** is assigned in analogy with **3aa**.

Compound 3se: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 10% EtOAc in pet ether) afforded pure **3se** as a colorless oil (38 mg, 0.080 mmol; 80% yield). **R_f:** 0.25 (10% EtOAc in pet ether); **FT-IR (Thin film):** 2928 (w), 2326 (w), 1728 (m), 1691 (s), 1617 (m), 1457 (m), 1387 (m), 1213 (m), 1094 (m), 1063 (w), 1009 (w) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.36 (d, *J* = 8.4 Hz; 2H), 7.22-7.30 (m; 5H), 6.94-6.96 (m; 2H), 4.60 (d, *J* = 16.0 Hz; 1H), 2.04-2.12 (m; 1H), 1.36 (t, *J* = 7.1 Hz; 3H), 0.73 (t, *J* = 7.4 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.46, 163.54, 155.01, 138.54, 136.03, 131.52, 128.99, 128.83, 127.69 126.70, 124.46, 107.38, 61.47, 59.84, 43.40, 27.22, 14.41, 12.68, 9.79; **HRMS (ESI+):** Calculated for $C_{23}H_{24}NO_3BrSNa$ ($[M + Na]^+$): 496.0558, found: 496.0559; **Optical rotation:** $[\alpha]_D^{23}$ +190.2 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 94:6 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/EtOH = 80:20, 1.0 mL min^{-1}, τ_{major} = 6.56 min, τ_{minor} = 7.94 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3se** is assigned in analogy with **3aa**.

Compound 3ta: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 20% EtOAc in pet ether) afforded pure **3ta** as a yellow solid (38 mg, 0.094 mmol; 94% yield). **R_f:** 0.30 (20% EtOAc in pet ether); **Melting point:** 156-157 °C; **FT-IR (Thin film):** 3256 (br), 2922 (w), 1738 (m), 1694 (s), 1623 (s), 1423 (s), 1247 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.43-7.45 (m; 2H), 7.35-7.39 (m; 1H), 7.25-7.30 (m; 2H), 7.13 (d, *J* = 8.5 Hz; 2H), 7.03 (d, *J* = 8.5 Hz; 2H), 6.94 (br; 1H), 4.39 (q, *J* = 7.1 Hz; 2H), 3.64 (d, *J* = 13.0 Hz; 1H), 3.25 (d, *J* = 13.0 Hz; 1H), 1.92 (s; 3H), 1.45 (t, *J* =7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.85, 163.47, 152.03, 137.03, 134.50, 132.72, 131.00, 129.81, 129.45, 128.51, 128.30, 107.42, 62.35, 59.97, 37.94, 14.55, 13.71; **HRMS (ESI+):** Calculated for $C_{21}H_{20}NO_3SClNa$ ($[M + Na]^+$): 424.0750, found: 424.0752; **Optical rotation:** $[\alpha]_D^{22}$ +72.5 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with 80.5:19.5 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 230 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{minor} = 10.43 min, τ_{major} = 13.22 min). See Supporting Information: Part B for HPLC chromatograms. Absolute stereochemistry of **3ta** is assigned in analogy with **3aa**.

I. "On water" catalytic enantioselective sulfenylation in mmol scale



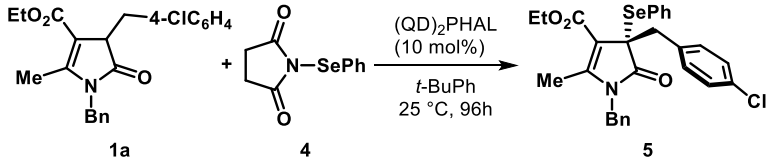
In a round bottom flask fitted with a magnetic stir bar, **1a** (384 mg, 1.0 mmol, 1.0 equiv.) was taken along with $(QD)_2$PHAL (77 mg, 0.1 mmol, 0.1 equiv.) in 10 mL H_2O. The heterogenous mixture was cooled to 0 °C and **2a** (311 mg, 1.5 mmol, 1.5 equiv.) was added to it. The cooling bath was removed and the resulting heterogenous mixture was vigorously stirred at 25 °C for 24 h. The reaction mixture was diluted with 50 mL EtOAc. The organic phase was separated and aqueous phase was extracted with (2×30 mL) EtOAc. Combined organic layer was washed with brine (10 mL), dried over anh. Na_2SO_4 and concentrated to obtain a semisolid which was purified by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/10% EtOAc in pet ether) affording sulfenylated product **3aa** (364 mg, 0.74 mmol, 74% yield) as a yellow solid (with 96.5:3.5 er).

The product (with 96.5:3.5 er) obtained after column chromatography was recrystallized affording 211 mg **3aa** (0.43 mmol, 58 % recovery, 43% yield) with >99.9:0.1 er.

Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/EtOH = 90:10, 1.0 mL min^{-1}, τ_{major} = 11.57 min, τ_{minor} = 14.83 min). See Supporting Information: Part B for HPLC chromatograms.

J. Catalytic enantioselective selenylation

Procedure for the enantioselective selenylation of the deconjugated butyrolactam (**1a**) with *N*-(phenylseleno)succinimide (**4**):



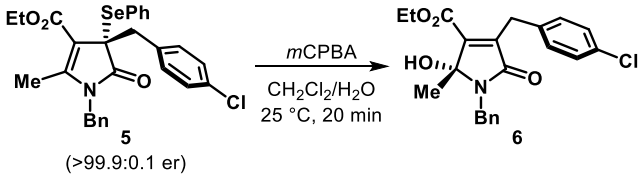
In a round bottom flask fitted with a magnetic stir bar, **1a** (0.1 mmol, 1.0 equiv.) was taken along with $(QD)_2$PHAL (7.7 mg, 0.01 mmol, 0.1 equiv.) in *t*-BuPh (1.0 mL). *N*-(Phenylseleno)succinimide **4** (0.15 mmol, 1.5 equiv.) was added at 0 °C. Resulting homogeneous mixture was stirred at 25 °C for 96 h. The reaction was quenched with 10 mL H_2O and extracted with (3×15 mL) EtOAc. The combined organic layer was dried over anh. Na_2SO_4

and concentrated to a yellow oil which was purified by silica gel column chromatography to obtain **5**.

Compound 5: Purification by silica gel (230-400 mesh) column chromatography (gradient elution: pet ether/ 2% EtOAc in pet ether) afforded **5** as a yellow solid (39 mg, 0.072 mmol; 72% yield). **R_f:** 0.75 (20% EtOAc in pet ether); recrystallization from 5:1 hexane/$CHCl_3$ at –20 °C afforded X-ray diffraction quality crystals. **Melting point:** 112-113 °C; **FT-IR (Thin film):** 2979 (w), 1716 (m), 1685 (s), 1613 (m), 1488 (m), 1225 (s), 1089 (s), 733 (s), 690 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.84 (d, *J* = 7.8 Hz; 2H), 7.68 (t, *J* = 7.4 Hz; 1H), 7.53 (d, *J* = 7.8 Hz; 2H), 7.10-7.20 (m; 7H), 6.34 (d, *J* = 7.3 Hz; 2H), 4.70 (d, *J* = 16.4 Hz; 1H), 4.24-4.39 (m; 2H), 4.15 (d, *J* = 12.7 Hz; 1H), 3.83 (d, *J* = 16.4 Hz; 1H), 3.72 (d, *J* = 12.7 Hz; 1H), 1.93 (s; 3H), 1.41 (t, *J* =7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 177.03, 163.70, 154.00, 138.13, 135.54, 135.20, 132.60, 131.34, 129.62, 128.54, 128.37, 128.33, 127.35, 126.31, 125.74, 107.29, 59.92, 56.10, 42.69, 37.35, 14.53, 12.39; **^{77}Se-NMR (76.29 MHz, $CDCl_3$):** 591.98; **HRMS (ESI+):** Calculated for $C_{28}H_{26}NO_3ClSeNa$ ($[M + Na]^+$): 562.0700, found: 562.0701; **Optical rotation:** $[\alpha]_D^{21}$ +287.7 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with >99.9:0.1 er obtained after a single recrystallization of the product (with 94.5:5.5 er). Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 210 nm, *n*-Hexane/IPA = 90:10, 1.0 mL min^{-1}, τ_{major} = 12.45 min, τ_{minor} = 15.71 min). See Supporting Information: Part B for HPLC chromatograms.

K. Formal γ-hydroxylation of deconjugated butyrolactam

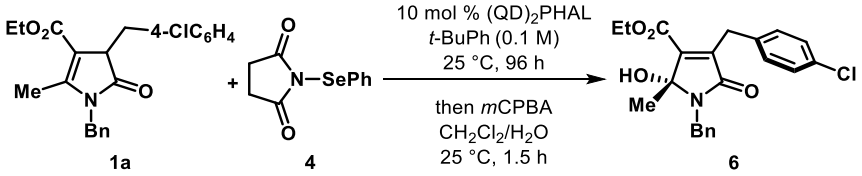
Conversion of **5** to **6**:



An enantiopure (>99.9:0.01 er) sample of **5** (40 mg, 0.074 mmol, 1.0 equiv.) was taken in 2 mL CH_2Cl_2/H_2O (1:1). To this, *m*-CPBA (51 mg, 55% in water; 0.162 mmol, 2.2 equiv.) was added at 0 °C. The cooling bath was removed and the resulting mixture was stirred at 25 °C. After 20 min complete consumption of **5** was observed. 10 mL CH_2Cl_2 and 5 mL water was added. Organic phase was separated and aqueous phase was extracted with (3×10 mL) CH_2Cl_2. Combined organic layer was washed with 10 mL brine, dried over anh. Na_2SO_4 and concentrated under reduced pressure to a colorless oil which was purified by silica gel (230-400 mess) column

chromatography (gradient elution: pet ether to 25% EtOAc in pet ether) to obtain **6** as a white solid (28 mg, 0.070 mmol; 94% yield). **R_f:** 0.15 (30% EtOAc in pet ether); recrystallization from 6:1 *n*-Hexane/EtOAc by slow evaporation at the room temperature afforded X-ray diffraction quality crystals. **Melting point:** 76-77 °C; **FT-IR (Thin film):** 3312 (br), 2930 (w), 1679 (s), 1670 (m), 1430 (m), 1293 (m), 1246 (m), 1090 (m), 1042 (m), 1016 (m), 935 (m), 696 (m) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.21-7.32 (m; 9H), 4.70 (d, *J* = 15.6 Hz; 1H), 4.49 (d, *J* =15.6 Hz; 1H), 4.27-4.39 (m; 2H), 3.97 (s; 3H), 3.35 (br; 1H), 1.53 (s; 3H), 1.35 (t, *J* = 7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 167.80, 162.84, 144.21, 142.10, 137.74, 135.84, 132.37, 130.38, 128.58, 128.44, 127.83, 127.26, 88.97, 61.58, 42.34, 29.92, 24.22, 14.13; **HRMS (ESI+):** Calculated for $C_{22}H_{22}NO_4ClNa$ ($[M + Na]^+$): 422.1135, found: 422.1138; **Optical rotation:** $[\alpha]_D^{23}$ +20.7 (*c* 2.0, $CHCl_3$) for an enantiomerically enriched sample with >99.9:0.1 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AS-H column, 254 nm, *n*-Hexane/IPA = 93:7, 1.0 mL min^{-1}, τ_{major} = 13.37 min, τ_{minor} = 17.09 min). See Supporting Information: Part B for HPLC chromatograms.

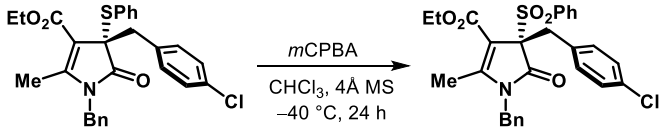
L. One-pot synthesis of γ-hydroxy butyrolactam from 1a



In a round bottom flask fitted with a magnetic stir bar, deconjugated butyrolactam **1a** (0.1 mmol, 1.0 equiv.) was taken along with the catalyst $(QD)_2PHAL$ (7.7 mg, 0.01 mmol, 0.1 equiv.) in *t*-BuPh (1.0 mL). *N*-(Phenylseleno)succinimide **4** (0.15 mmol, 1.5 equiv.) was added to it at 0 °C. The cooling bath was removed and the resulting mixture was vigorously stirred for 96 h by which time **1a** was consumed and selenyl butyrolactam **6** was formed (as indicated by TLC analysis). The reaction mixture was then cooled to 0 °C. 3 mL CH_2Cl_2/H_2O (1:1) was added to it followed immediately by the addition of *m*-CPBA (70 mg, 55% in water, 0.223 mmol, 2.2 equiv.). The cooling bath was removed and the resulting mixture was stirred at 25 °C. After 90 min complete consumption of the selenyl butyrolactam (**6**) was observed. The reaction mixture was then diluted with 20 mL CH_2Cl_2 and 5 mL water. The organic phase was separated and the aqueous phase was extracted with (3×10 mL) CH_2Cl_2. Combined organic layer was washed with 10 mL brine, dried over anh. Na_2SO_4 and concentrated under reduced pressure to a colorless oil. Purification by silica gel (230-400 mess) column chromatography (gradient elution: pet ether to 25% EtOAc in pet ether) afforded **6** as a white solid (26.5 mg, 0.066 mmol; 66% yield). Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AS-H column, 254

nm, *n*-Hexane/IPA = 93:7, 1.0 mL min^{-1}, τ_{major} = 13.39 min, τ_{minor} = 17.15 min) and found to be 95:5 er.

M. Oxidation of 3aa to sulfone 8



An enantiopure (>99.9:0.1 er) sample of **3aa** (40 mg, 0.081 mmol, 1.0 equiv.) was taken in 2 mL abs. $CHCl_3$ along with 120 mg activated 4Å MS and was cooled to –40 °C. To the resulting heterogeneous mixture, *m*-CPBA (102 mg, 55% in water, 0.325 mmol, 4.0 equiv.) was added. The resulting mixture was stirred at –40 °C for 24 h, by which time complete consumption of the starting material **3aa** was observed. 200 mg solid K_2CO_3 was added to the reaction mixture at –40 °C and was stirred for 20 min at –40 °C. 25 mL $CHCl_3$ was then added followed by 5 mL 20% aq. K_2CO_3 at –40 °C and the reaction mixture was brought to the room temperature. The organic phase was separated and the aqueous phase was re-extracted with (2×10 mL) $CHCl_3$. Combined organic layer was washed with brine (10 mL), dried over anh. Na_2SO_4 and concentrated under reduced pressure to a white solid. This crude solid was purified by silica gel (230-400 mess) column chromatography (gradient elution: pet ether to 20% EtOAc in pet ether) to obtain pure **8** as a white solid (39.5 mg, 0.075 mmol; 92% yield). **R_f:** 0.20 (25% EtOAc in pet ether); **Melting point:** 133-134 °C; **FT-IR (KBr):** 1728 (s), 1683 (s), 1610 (s), 1300 (s), 1229 (s), 1147 (m), 1085 (s) cm^{-1}; **^{1}H-NMR (400 MHz, $CDCl_3$):** δ 7.84 (d, *J* = 7.8 Hz; 2H), 7.68 (t, *J* = 7.4 Hz; 1H), 7.53 (d, *J* = 7.8 Hz; 2H), 7.10-7.20 (m; 7H), 6.34 (d, *J* = 7.3 Hz; 2H), 4.70 (d, *J* = 16.4 Hz; 1H), 4.24-4.39 (m; 2H), 4.15 (d, *J* = 12.7 Hz; 1H), 3.83 (d, *J* = 16.4 Hz; 1H), 3.72 (d, *J* = 12.7 Hz; 1H), 1.93 (s; 3H), 1.41 (t, *J* =7.1 Hz; 3H); **^{13}C-NMR (100 MHz, $CDCl_3$):** δ 170.59, 163.49, 158.80, 135.03, 134.61, 134.36, 133.16, 132.36, 131.87, 130.31, 128.68, 128.51, 128.42, 127.59, 125.62, 102.13, 79.03, 60.65, 43.18, 32.69, 14.22, 12.77; **HRMS (ESI+):** Calculated for $C_{28}H_{26}NO_5ClSNa$ ($[M + Na]^+$): 546.1118, found: 546.1114; **Optical rotation:** $[\alpha]_D^{26}$ +211.0 (*c* 1.0, $CHCl_3$) for an enantiomerically enriched sample with >99.9:0.1 er. Enantiomeric purity was determined by HPLC analysis (Daicel Chiralpak AD-H column, 254 nm, *n*-Hexane/EtOH = 65:35, 1.0 mL min^{-1}, τ_{minor} = 9.30 min, τ_{major} = 12.67 min). See Supporting Information: Part B for HPLC chromatograms.

N. Single crystal X-ray diffraction analysis of 3aa

A single crystal of **3aa** (recrystallization from 5:1 *n*-Hexane/CH_2Cl_2 at –20 °C) was mounted and the diffraction data were collected on a Bruker D8 Quest CMOS diffractometer using SMART/SAINT software. Intensity data were collected using graphite-monochromatized Mo-Ka radiation (0.71073 Å) at 140 K. The structures were solved by direct methods using SHELX-97 and refined by full matrix leastsquare F^2. Empirical absorption corrections were applied with SADABS. All non-hydrogen atoms were refined anisotropically and hydrogen atoms were included in geometric positions. Structure was drawn using ORTEP. The crystallographic refinement parameters are given below:

Table 1. Crystal data and structure refinement for **3aa**

Identification code	**3aa**
CCDC number	CCDC 1549957
Empirical formula	$C_{28}H_{26}ClNO_3S$
Formula weight	492.01
Temperature	140 K
Crystal system	Orthorhombic
Space group	$P2_12_12_1$
Unit cell dimensions	a = 8.373(4) Å α = 90.00°
	b = 11.816(5) Å β = 90.00(7)°
	c = 25.567(12) Å γ = 90.00°
Volume	2530(2) $Å^3$
Z	4
Density (calculated) (ρ_{calc})	1.292 g/cm^3
Absorption coefficient	0.263 mm^{-1}
F(000)	1032.0
Radiation	MoKα (λ = 0.71073 $Å^3$)
Theta range for data collection	6.172 to 55.278°
Index ranges	$-10 \le h \le 10$, $-15 \le k \le 15$, $-33 \le l \le 33$
Reflections collected	70980
Independent reflections	5838 [R_{int} = 0.0861]
Data/restraints/parameters	5838/0/309
Goodness-of-fit on F^2	1.023
Final R indexes [I>2σ (I)]	R_1 = 0.0475, ωR_2 = 0.0803
Final R indexes [all data]	R_1 = 0.0988, ωR_2 = 0.0939
Largest diff. peak and hole	0.20 and -0.21 e.$Å^{-3}$
Flack parameter/ absolute structure parameter	-0.01(2)

Table 2 Fractional Atomic Coordinates ($\times 10^4$) and Equivalent Isotropic Displacement Parameters ($Å^2 \times 10^3$) for **3aa**. U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor

Atom	***x***	***Y***	***Z***	**U(eq)**
Cl1	5457.8(12)	9159.9(9)	2418.0(4)	66.4(3)
S1	8849(1)	4124.0(8)	281.5(3)	47.8(2)
O1	9065(3)	6884.9(19)	205.9(8)	49.8(6)
O2	10577(4)	3542(2)	1848.1(11)	75.5(8)
O3	8096(3)	3511(2)	1526.8(10)	61.7(7)
N1	10784(3)	6524(2)	883.3(9)	38.1(6)
C1	14144(5)	4123(4)	-67.1(17)	67.3(11)
C2	13569(5)	3455(4)	326.7(16)	65.4(11)
C3	11942(5)	3443(3)	438.3(14)	53.1(9)
C4	10932(4)	4126(3)	153.5(11)	41.8(8)
C5	8706(4)	5240(2)	784.9(11)	35.8(7)
C6	9484(4)	6313(3)	575.1(12)	36.1(7)
C7	11818(4)	7490(3)	794.8(14)	50.1(9)
C8	11488(4)	8501(3)	1139.6(13)	45.0(8)
C9	10504(5)	8466(3)	1573.3(14)	57.6(10)
C10	10307(6)	9409(4)	1887.3(18)	81.2(13)
C11	11113(7)	10388(4)	1774(3)	106(2)
C12	5944(4)	8092(3)	1977.4(12)	40.6(8)
C13	5882(4)	8317(3)	1448.2(13)	45.2(8)
C14	6215(4)	7466(3)	1095.8(12)	41.6(8)
C15	6605(3)	6386(3)	1264.0(12)	34.6(7)
C16	6680(4)	6193(3)	1801.3(13)	42.0(8)
C17	6359(4)	7040(3)	2157.3(13)	48.3(9)
C18	6920(4)	5457(3)	872.7(13)	40.0(8)
C19	13141(5)	4792(4)	-349.8(17)	71.3(12)
C20	11544(4)	4794(3)	-240.2(14)	57.4(10)
C21	9727(4)	4960(3)	1248.1(11)	35.8(7)
C22	10940(3)	5707(3)	1275.1(11)	38.7(7)
C23	12247(5)	9508(4)	1023(2)	73.3(13)
C24	12059(6)	10434(4)	1335(3)	103(2)
C25	12331(4)	5747(4)	1633.4(14)	63.7(11)
C26	9566(5)	3950(3)	1575.1(13)	48.7(9)

C27	7754(6)	2460(4)	1798(2)	88.4(15)
C28	6278(7)	1991(4)	1563(2)	107.1(19)

Table 3 Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for **3aa**. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\ldots]$

Atom	**U_{11}**	**U_{22}**	**U_{33}**	**U_{23}**	**U_{13}**	**U_{12}**
Cl1	79.2(7)	61.0(6)	59.0(6)	-19.4(5)	0.7(5)	9.7(5)
S1	41.0(4)	50.2(5)	52.2(5)	-17.3(4)	0.5(4)	-5.3(4)
O1	54.6(16)	54.2(13)	40.6(12)	9.7(11)	-8.3(12)	-4.0(12)
O2	79(2)	68.9(17)	78.2(18)	28.6(16)	-14.9(17)	8.6(16)
O3	53.6(16)	42.2(13)	89.2(19)	20.9(13)	12.1(14)	-1.7(12)
N1	30.6(15)	47.7(15)	36.1(13)	0.6(12)	-0.6(12)	-8.1(12)
C1	45(2)	80(3)	77(3)	-36(3)	6(2)	-4(2)
C2	60(3)	69(3)	67(3)	-25(2)	-15(2)	25(2)
C3	63(2)	42.3(19)	54(2)	-6.8(17)	4.6(19)	11.4(19)
C4	40.6(18)	44.5(18)	40.5(17)	-13.3(16)	0.7(15)	-1.2(17)
C5	30.8(16)	37.1(17)	39.5(17)	-3.9(14)	0.8(14)	-0.8(14)
C6	33.9(17)	43.1(18)	31.3(16)	-5.1(15)	-1.3(14)	-0.1(15)
C7	38.6(19)	64(2)	48(2)	3.5(18)	5.6(17)	-20.2(18)
C8	35.1(19)	48.3(19)	52(2)	13.4(17)	-15.9(17)	-9.9(16)
C9	65(2)	52(2)	56(2)	-0.2(19)	-6(2)	-6(2)
C10	86(3)	80(3)	78(3)	-28(3)	-23(3)	19(3)
C11	87(4)	62(3)	167(6)	-44(4)	-68(4)	18(3)
C12	34.3(18)	46.4(19)	41.1(18)	-5.8(15)	-0.4(15)	2.1(16)
C13	48(2)	35.9(18)	51(2)	4.4(16)	-1.8(17)	5.4(16)
C14	40.6(19)	48.7(19)	35.5(17)	2.9(15)	-3.1(16)	1.1(17)
C15	22.5(16)	39.3(18)	42.0(18)	1.5(15)	-0.2(13)	-2.7(13)
C16	36.7(18)	38.5(18)	51(2)	7.8(15)	7.7(15)	7.3(14)
C17	49(2)	59(2)	36.5(17)	4.5(17)	0.3(17)	10.6(18)
C18	30.9(16)	40.4(18)	48.7(19)	-5.8(15)	-1.1(15)	-2.9(14)
C19	61(3)	83(3)	69(3)	-1(2)	16(2)	-9(2)
C20	53(2)	68(2)	51(2)	2.2(19)	7.8(19)	7.2(19)
C21	34.9(17)	37.1(16)	35.3(17)	-3.3(14)	1.5(14)	3.4(15)
C22	34.2(18)	46.5(18)	35.4(16)	-1.3(15)	-2.1(14)	5.7(16)

C23	49(2)	55(3)	116(4)	29(3)	-18(2)	-12(2)
C24	69(3)	42(3)	197(7)	15(4)	-50(4)	-11(3)
C25	46(2)	82(3)	64(2)	7(2)	-17.5(18)	-6(2)
C26	53(2)	45(2)	48(2)	2.4(17)	7.4(19)	9.8(18)
C27	88(3)	51(2)	126(4)	39(3)	23(3)	4(3)
C28	149(5)	61(3)	111(4)	-4(3)	38(4)	-46(3)

Table 4 Bond Lengths for **3aa**

Atom	**Atom**	**Length/Å**	**Atom**	**Atom**	**Length/Å**
Cl1	C12	1.740(3)	C8	C23	1.381(5)
S1	C4	1.774(3)	C8	C9	1.382(5)
S1	C5	1.846(3)	C9	C10	1.383(6)
O1	C6	1.213(3)	C10	C11	1.370(7)
O2	C26	1.198(4)	C11	C24	1.375(8)
O3	C26	1.341(4)	C12	C17	1.369(5)
O3	C27	1.452(4)	C12	C13	1.380(4)
N1	C6	1.366(4)	C13	C14	1.379(4)
N1	C22	1.398(4)	C14	C15	1.385(4)
N1	C7	1.450(4)	C15	C16	1.394(4)
C1	C19	1.362(6)	C15	C18	1.509(4)
C1	C2	1.367(6)	C16	C17	1.379(4)
C2	C3	1.392(6)	C19	C20	1.366(5)
C3	C4	1.377(5)	C21	C22	1.347(4)
C4	C20	1.378(5)	C21	C26	1.464(4)
C5	C21	1.497(4)	C22	C25	1.482(4)
C5	C6	1.523(4)	C23	C24	1.363(7)
C5	C18	1.534(4)	C27	C28	1.482(7)
C7	C8	1.511(5)			

Table 5 Bond Angles for **3aa**

Atom	**Atom**	**Atom**	**Angle/°**	**Atom**	**Atom**	**Atom**	**Angle/°**
C4	S1	C5	101.03(13)	C10	C11	C24	119.3(5)
C26	O3	C27	117.9(3)	C17	C12	C13	120.9(3)

C6	N1	C22	111.2(2)	C17	C12	Cl1	120.0(3)
C6	N1	C7	121.9(3)	C13	C12	Cl1	119.1(2)
C22	N1	C7	126.8(3)	C14	C13	C12	119.5(3)
C19	C1	C2	120.6(4)	C13	C14	C15	121.1(3)
C1	C2	C3	120.1(4)	C14	C15	C16	117.8(3)
C4	C3	C2	119.1(4)	C14	C15	C18	120.4(3)
C3	C4	C20	119.6(3)	C16	C15	C18	121.8(3)
C3	C4	S1	120.3(3)	C17	C16	C15	121.5(3)
C20	C4	S1	120.1(3)	C12	C17	C16	119.1(3)
C21	C5	C6	102.6(2)	C15	C18	C5	112.9(2)
C21	C5	C18	118.5(3)	C1	C19	C20	119.7(4)
C6	C5	C18	109.2(3)	C19	C20	C4	120.9(4)
C21	C5	S1	110.9(2)	C22	C21	C26	125.0(3)
C6	C5	S1	108.7(2)	C22	C21	C5	109.1(3)
C18	C5	S1	106.5(2)	C26	C21	C5	125.4(3)
O1	C6	N1	125.3(3)	C21	C22	N1	110.2(3)
O1	C6	C5	127.9(3)	C21	C22	C25	130.2(3)
N1	C6	C5	106.8(3)	N1	C22	C25	119.6(3)
N1	C7	C8	115.0(3)	C24	C23	C8	120.8(5)
C23	C8	C9	118.3(4)	C23	C24	C11	120.8(5)
C23	C8	C7	118.1(3)	O2	C26	O3	123.1(3)
C9	C8	C7	123.6(3)	O2	C26	C21	126.5(3)
C8	C9	C10	120.8(4)	O3	C26	C21	110.3(3)
C11	C10	C9	119.9(5)	O3	C27	C28	106.9(4)

Table 6 Hydrogen Bonds for **3aa**

D	**H**	**A**	**d(D-H)/Å**	**d(H-A)/Å**	**d(D-A)/Å**	**D-H-A/°**
C7	H16	O1[1]	0.97	2.60	3.261(4)	125.6
C18	H6	O3	0.97	2.45	3.009(4)	116.2
C25	H19	Cl1[2]	0.96	2.93	3.581(4)	126.1
C25	H19	O2	0.96	2.43	3.040(5)	120.8
C7	H16	O1[1]	0.97	2.60	3.261(4)	125.6
C18	H6	O3	0.97	2.45	3.009(4)	116.2
C25	H19	Cl1[2]	0.96	2.93	3.581(4)	126.1

C25	H19	O2	0.96	2.43	3.040(5)	120.8

Table 7 Torsion Angles for **3aa**

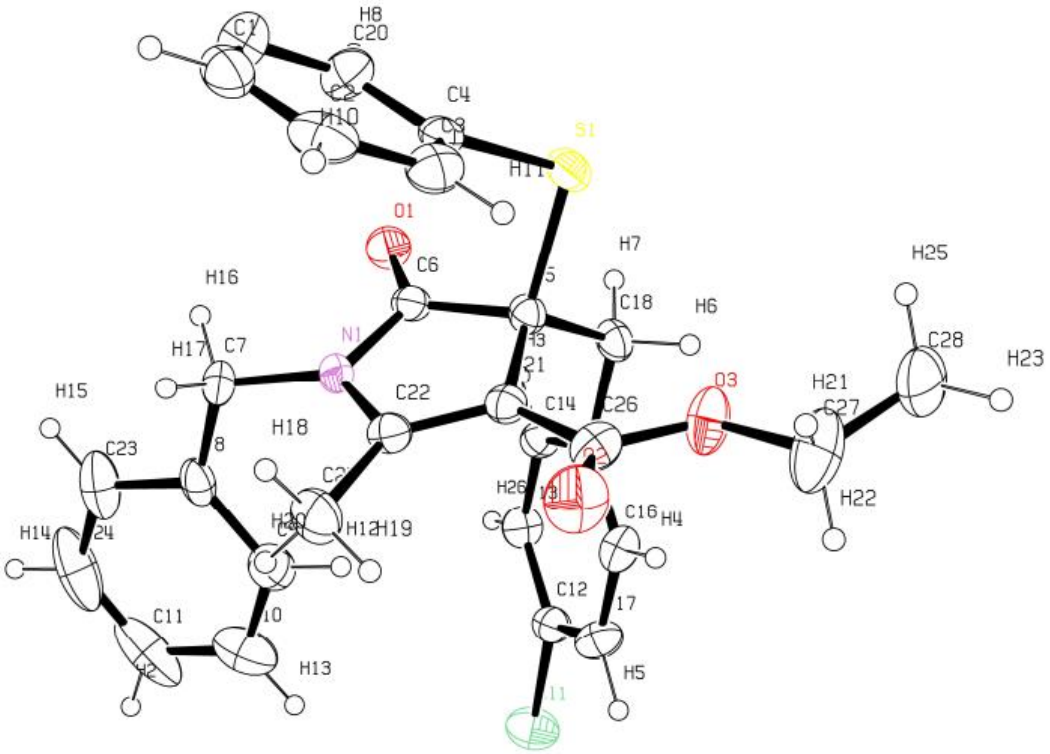
A	**B**	**C**	**D**	**Angle/°**	**A**	**B**	**C**	**D**	**Angle/°**
C19	C1	C2	C3	0.8(6)	C15	C16	C17	C12	0.6(5)
C1	C2	C3	C4	-1.2(5)	C14	C15	C18	C5	100.3(3)
C2	C3	C4	C20	0.9(5)	C16	C15	C18	C5	-80.3(4)
C2	C3	C4	S1	179.5(3)	C21	C5	C18	C15	56.2(4)
C5	S1	C4	C3	89.5(3)	C6	C5	C18	C15	-60.7(3)
C5	S1	C4	C20	-91.9(3)	S1	C5	C18	C15	-178.0(2)
C4	S1	C5	C21	-58.2(2)	C2	C1	C19	C20	-0.2(6)
C4	S1	C5	C6	53.9(2)	C1	C19	C20	C4	0.0(6)
C4	S1	C5	C18	171.5(2)	C3	C4	C20	C19	-0.3(5)
C22	N1	C6	O1	-180.0(3)	S1	C4	C20	C19	-178.9(3)
C7	N1	C6	O1	0.2(5)	C6	C5	C21	C22	-3.5(3)
C22	N1	C6	C5	-0.3(3)	C18	C5	C21	C22	-123.8(3)
C7	N1	C6	C5	179.9(3)	S1	C5	C21	C22	112.5(2)
C21	C5	C6	O1	-178.1(3)	C6	C5	C21	C26	-175.6(3)
C18	C5	C6	O1	-51.5(4)	C18	C5	C21	C26	64.0(4)
S1	C5	C6	O1	64.4(4)	S1	C5	C21	C26	-59.7(3)
C21	C5	C6	N1	2.2(3)	C26	C21	C22	N1	175.7(3)
C18	C5	C6	N1	128.8(3)	C5	C21	C22	N1	3.5(3)
S1	C5	C6	N1	-115.3(2)	C26	C21	C22	C25	-2.8(5)
C6	N1	C7	C8	98.3(4)	C5	C21	C22	C25	-175.0(3)
C22	N1	C7	C8	-81.5(4)	C6	N1	C22	C21	-2.1(3)
N1	C7	C8	C23	-169.9(3)	C7	N1	C22	C21	177.8(3)
N1	C7	C8	C9	12.0(5)	C6	N1	C22	C25	176.6(3)
C23	C8	C9	C10	-1.1(5)	C7	N1	C22	C25	-3.6(5)
C7	C8	C9	C10	177.0(4)	C9	C8	C23	C24	1.5(6)
C8	C9	C10	C11	-1.0(6)	C7	C8	C23	C24	-176.7(4)
C9	C10	C11	C24	2.7(7)	C8	C23	C24	C11	0.2(7)
C17	C12	C13	C14	1.2(5)	C10	C11	C24	C23	-2.3(8)
Cl1	C12	C13	C14	-177.9(3)	C27	O3	C26	O2	-3.3(5)
C12	C13	C14	C15	0.2(5)	C27	O3	C26	C21	176.1(3)

C13	C14	C15	C16	-1.2(5)	C22	C21	C26	O2	-12.8(5)
C13	C14	C15	C18	178.3(3)	C5	C21	C26	O2	158.1(3)
C14	C15	C16	C17	0.8(5)	C22	C21	C26	O3	167.8(3)
C18	C15	C16	C17	-178.7(3)	C5	C21	C26	O3	-21.3(4)
C13	C12	C17	C16	-1.6(5)	C26	O3	C27	C28	-163.6(4)
Cl1	C12	C17	C16	177.5(3)					

Table 8 Hydrogen Atom Coordinates (Å×10^4) and Isotropic Displacement Parameters (Å^2×10^3) for **3aa**

Atom	***x***	***y***	***Z***	**U(eq)**
H1	15231	4120	-143	81
H10	14266	3008	520	78
H11	11543	2980	702	64
H16	11714	7721	432	60
H17	12915	7254	849	60
H12	9967	7800	1655	69
H13	9628	9378	2175	97
H2	11021	11015	1992	127
H26	5619	9038	1330	54
H3	6177	7619	739	50
H4	6952	5477	1923	50
H5	6424	6900	2515	58
H7	6430	5659	542	48
H6	6421	4765	994	48
H9	13541	5247	-616	86
H8	10862	5253	-434	69
H15	12895	9555	729	88
H14	12577	11105	1250	123
H19	12127	5276	1932	96
H20	12502	512	1746	96
H18	13264	5478	1454	96
H22	7597	2600	2169	106
H21	8632	1932	1757	106
H24	5430	2533	1594	161

H23	5985	1308	1742	161
H25	6463	1827	1200	161



ORTEP diagram of **3aa** (thermal ellipsoids at 30% probability)

O. Single crystal X-ray diffraction analysis of 5:

A single crystal of **5** (recrystallization from 5:1 *n*-Hexane/$CHCl_3$ at –20 °C) was mounted and the diffraction data were collected on a Bruker D8 Quest CMOS diffractometer using SMART/SAINT software. Intensity data were collected using graphite-monochromatized Mo-Ka radiation (0.71073 Å) at 150 K. The structures were solved by direct methods using SHELX-97 and refined by full matrix leastsquare F^2. Empirical absorption corrections were applied with SADABS. All non-hydrogen atoms were refined anisotropically and hydrogen atoms were included in geometric positions. Structure was drawn using Olex-2. The crystallographic refinement parameters are given below:

Table 9 Crystal data and structure refinement for 5

Identification code	**5**
CCDC number	CCDC 1549958
Empirical formula	$C_{28}H_{26}ClNO_3Se$
Formula weight	538.94
Temperature	150 K
Crystal system	Orthorhombic
Space group	$P2_12_12_1$
Unit cell dimensions	a = 8.2689(5) Å α = 90.00°
	b = 16.0494(5) Å β = 90.00°
	c = 18.5290(5) Å γ = 90.00°
Volume	2459.0(18) $Å^3$
Z	4
Density (calculated) (ρ_{calc})	1.4556 g/cm^3
Absorption coefficient	1.666 mm^{-1}
F(000)	1104.7
Radiation	MoKα (λ = 0.71073 $Å^3$)
2Θ range for data collection	5.96 to 50.00°
Index ranges	$-9 \le h \le 9$, $-19 \le k \le 19$, $-22 \le l \le 22$
Reflections collected	52923
Independent reflections	5655 [R_{int} = 0.0661]
Data/restraints/parameters	4302/0/308
Goodness-of-fit on F^2	1.124
Final R indexes [I>2σ (I)]	R_1 = 0.0263, ωR_2 = 0.0649
Final R indexes [all data]	R_1 = 0.0328, ωR_2 = 0.0751

Largest diff. peak and hole	0.49/-0.45 e.Å^{-3}
Flack parameter/ absolute structure parameter	0.020(11)

Table 10 Fractional Atomic Coordinates (×10^4) and Equivalent Isotropic Displacement Parameters (Å^2×10^3) for **5**. U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor

Atom	***X***	***Y***	***z***	**U(eq)**
Se1	4931.7(3)	1706.37(15)	2264.21(13)	17.86(8)
Cl1	1174(1)	-2744.3(4)	181.1(4)	29.59(18)
O1	3175(2)	1519.3(12)	630.8(11)	21.5(4)
O2	1279(3)	214.4(13)	3502.6(10)	24.5(4)
O3	3757(2)	-145.8(11)	3111.5(9)	15.9(4)
N1	1033(3)	1351.5(14)	1408.4(12)	15.7(5)
C1	3317(3)	2519.4(16)	2499.5(14)	16.4(5)
C2	2719(4)	2554.1(18)	3197.1(16)	23.3(6)
C3	1583(4)	3146(2)	3385.7(17)	30.0(7)
C4	1021(4)	3702.4(19)	2872.3(17)	29.5(7)
C5	1626(4)	3674.6(18)	2174.1(17)	25.0(6)
C6	2763(3)	3083.8(17)	1986.1(15)	19.2(6)
C7	3499(3)	836.4(16)	1814.7(14)	14.8(5)
C8	2155(3)	631.7(16)	2329.2(14)	14.8(5)
C9	766(3)	976.3(17)	2082.7(14)	16.0(6)
C10	2628(3)	1274.8(16)	1199.3(15)	15.8(5)
C11	-185(3)	1738.8(16)	956.0(15)	19.6(5)
C12	-1204(3)	1122.3(17)	530.9(15)	17.2(5)
C13	-2519(3)	1418.7(18)	144.3(16)	21.4(6)
C14	-3459(3)	889.5(19)	-260.2(15)	23.1(6)
C15	-3082(3)	44.2(18)	-300.0(15)	21.6(6)
C16	-1773(4)	-256.1(18)	90.2(15)	22.1(6)
C17	-842(3)	278.2(17)	501.5(15)	19.7(6)
C18	-869(4)	1026.6(19)	2406.1(16)	22.2(6)
C19	2306(3)	223.8(16)	3039.4(15)	16.0(5)
C20	4035(4)	-552.1(17)	3802.3(14)	22.0(6)
C21	3214(4)	-1383.7(19)	3850.6(17)	28.3(7)
C22	4662(3)	157.7(16)	1544.0(14)	15.9(5)

C23	3806(3)	-571.6(16)	1204.0(14)	16.7(5)
C24	3300(3)	-541.2(17)	482.0(15)	18.9(6)
C25	2510(3)	-1207.1(17)	166.1(16)	21.3(6)
C26	2201(3)	-1910.7(16)	571.2(16)	19.4(6)
C27	2699(4)	-1964.6(18)	1283.1(16)	24.8(7)
C28	3493(4)	-1292.5(17)	1591.8(15)	21.1(6)

Table 11 Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for **5**. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\ldots]$

Atom	**U_{11}**	**U_{22}**	**U_{33}**	**U_{12}**	**U_{13}**	**U_{23}**
Se1	12.18(13)	15.26(13)	26.15(14)	-1.04(12)	-2.17(13)	-1.13(10)
Cl1	35.3(4)	19.6(3)	33.9(4)	-5.9(3)	1.6(4)	-8.8(3)
O1	23.6(10)	20.1(10)	20.7(10)	-0.4(8)	3.9(8)	4.5(8)
O2	22.6(11)	31.4(11)	19.4(10)	6.5(9)	5.9(9)	3.2(9)
O3	15.4(9)	16.2(9)	16.1(9)	2.8(7)	-1.4(8)	1.7(7)
N1	13.4(11)	15.7(10)	18.1(11)	1.6(9)	-2.5(9)	0.2(9)
C1	15.6(13)	13.8(12)	19.8(13)	-2.3(10)	-2.2(10)	-2.3(10)
C2	29.0(16)	19.9(14)	20.9(14)	-0.7(12)	-2.8(13)	2.1(12)
C3	34.7(17)	31.9(17)	23.5(15)	0.7(14)	10.7(13)	-5.0(13)
C4	29.2(16)	22.0(15)	37.4(18)	8.6(13)	6.4(15)	-4.5(13)
C5	29.6(16)	18.0(14)	27.4(15)	3.7(12)	-1.7(13)	2.0(12)
C6	18.6(14)	18.8(14)	20.1(13)	-3.3(11)	0.5(11)	-2.4(11)
C7	13.0(12)	14.8(12)	16.7(12)	-1.6(10)	-0.9(10)	0.8(10)
C8	15.4(12)	12.0(11)	17.1(12)	-0(1)	1.7(11)	-2.5(11)
C9	15.3(13)	15.0(13)	17.7(14)	-1.6(10)	-0.5(10)	-2.6(10)
C10	16.1(13)	12.1(12)	19.3(13)	-1.4(10)	-1.9(11)	-2.5(11)
C11	19.3(13)	15.0(11)	24.6(13)	2.9(13)	-4.6(11)	-1.8(10)
C12	16.0(13)	19.8(13)	15.6(12)	-2.6(11)	1.5(11)	0.8(10)
C13	20.5(14)	18.8(13)	24.8(14)	3.3(11)	-2.1(12)	1.7(11)
C14	16.8(14)	34.2(15)	18.3(14)	-1.6(12)	-6.3(12)	3.1(12)
C15	19.4(14)	27.5(15)	17.9(13)	-5.1(12)	-0.9(11)	-1.7(12)
C16	26.3(15)	18.0(13)	21.9(14)	-0.4(12)	-0.3(12)	1.2(11)
C17	18.8(14)	19.5(13)	20.8(14)	0.9(11)	-5.4(12)	2.7(11)
C18	18.0(14)	20.8(14)	27.8(16)	2.3(12)	1.5(12)	-1.6(12)

C19	15.5(13)	11.9(12)	20.5(13)	-0.9(10)	-1.5(11)	-1.5(10)
C20	28.3(16)	23.9(14)	13.8(12)	6.7(12)	-4.3(12)	1.5(11)
C21	37.1(18)	22.4(14)	25.2(15)	6.5(14)	3.4(14)	3.6(12)
C22	12.2(13)	17.8(12)	17.7(12)	1.7(10)	2.7(10)	-0.2(10)
C23	13.6(13)	16.3(12)	20.2(13)	4.0(11)	3.5(11)	-1.5(11)
C24	19.5(14)	17.8(13)	19.3(13)	1.9(11)	1.6(11)	5.3(11)
C25	23.3(14)	23.8(14)	16.8(13)	4.1(12)	-3.5(12)	-1.9(12)
C26	20.2(14)	12.0(12)	25.8(14)	0.7(10)	4.5(12)	-5.3(11)
C27	34.1(17)	16.5(13)	23.8(15)	-2.3(12)	3.7(14)	0.8(11)
C28	26.6(15)	20.7(14)	16.1(13)	5.5(12)	1.0(12)	1.3(11)

Table 12 Bond Lengths for **5**

Atom	**Atom**	**Length/Å**	**Atom**	**Atom**	**Length/Å**
Se1	C1	1.917(3)	C8	C9	1.354(4)
Se1	C7	2.012(3)	C8	C19	1.475(4)
Cl1	C26	1.742(3)	C9	C18	1.481(4)
O1	C10	1.212(3)	C11	C12	1.520(4)
O2	C19	1.208(3)	C12	C13	1.386(4)
O3	C19	1.345(3)	C12	C17	1.389(4)
O3	C20	1.455(3)	C13	C14	1.374(4)
N1	C9	1.404(3)	C14	C15	1.394(4)
N1	C10	1.380(4)	C15	C16	1.388(4)
N1	C11	1.450(3)	C16	C17	1.381(4)
C1	C2	1.385(4)	C20	C21	1.500(4)
C1	C6	1.391(4)	C22	C23	1.506(4)
C2	C3	1.381(4)	C23	C24	1.403(4)
C3	C4	1.385(5)	C23	C28	1.387(4)
C4	C5	1.388(4)	C24	C25	1.382(4)
C5	C6	1.380(4)	C25	C26	1.380(4)
C7	C8	1.500(4)	C26	C27	1.385(4)
C7	C10	1.521(4)	C27	C28	1.386(4)
C7	C22	1.537(3)			

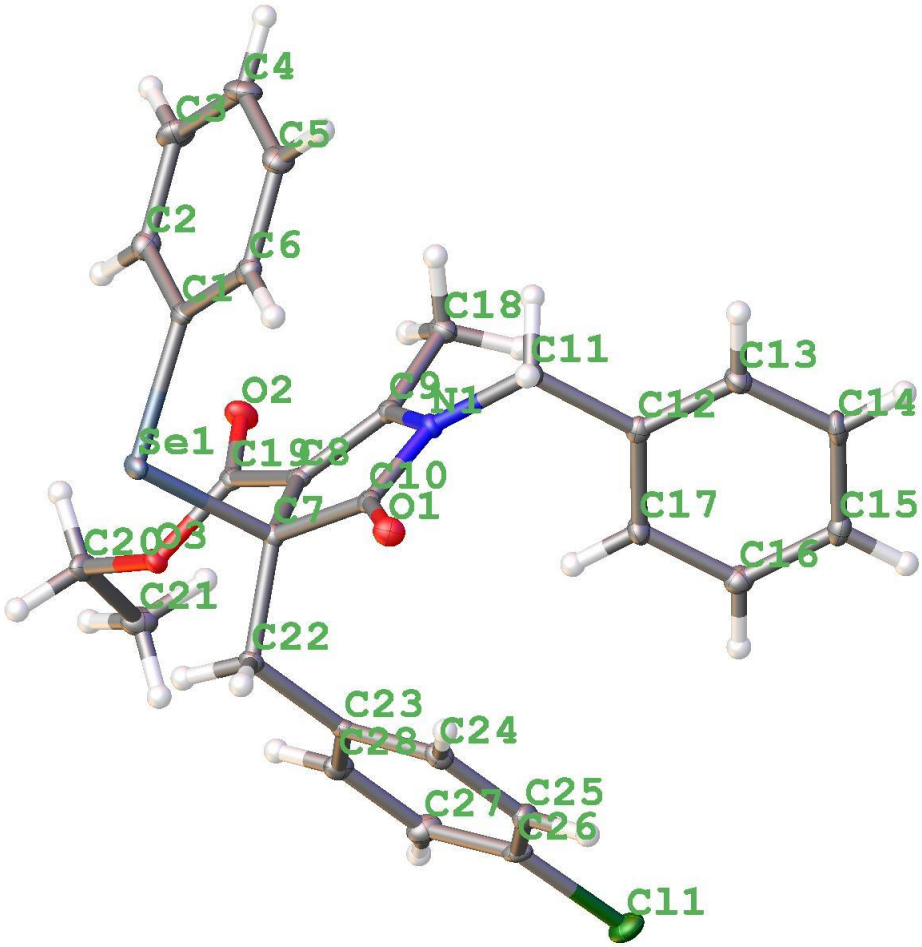
Table 13 Bond Angles for **5**

Atom	**Atom**	**Atom**	**Angle/°**	**Atom**	**Atom**	**Atom**	**Angle/°**
C7	Se1	C1	99.01(11)	C7	C10	O1	128.7(2)
C20	O3	C19	115.2(2)	C7	C10	N1	106.5(2)
C10	N1	C9	111.2(2)	C12	C11	N1	113.9(2)
C11	N1	C9	126.1(2)	C13	C12	C11	118.6(2)
C11	N1	C10	122.6(2)	C17	C12	C11	122.4(3)
C2	C1	Se1	119.2(2)	C17	C12	C13	118.9(3)
C6	C1	Se1	121.1(2)	C14	C13	C12	120.9(3)
C6	C1	C2	119.6(3)	C15	C14	C13	120.3(3)
C3	C2	C1	120.4(3)	C16	C15	C14	119.0(3)
C4	C3	C2	119.9(3)	C17	C16	C15	120.4(3)
C5	C4	C3	119.9(3)	C16	C17	C12	120.5(3)
C6	C5	C4	120.2(3)	O3	C19	O2	123.5(2)
C5	C6	C1	119.9(3)	C8	C19	O2	125.4(2)
C8	C7	Se1	108.97(17)	C8	C19	O3	111.1(2)
C10	C7	Se1	105.56(17)	C21	C20	O3	112.3(2)
C10	C7	C8	103.1(2)	C23	C22	C7	113.2(2)
C22	C7	Se1	104.98(16)	C24	C23	C22	120.8(2)
C22	C7	C8	121.0(2)	C28	C23	C22	121.3(2)
C22	C7	C10	112.3(2)	C28	C23	C24	117.9(3)
C9	C8	C7	108.9(2)	C25	C24	C23	121.2(3)
C19	C8	C7	127.0(2)	C26	C25	C24	119.3(3)
C19	C8	C9	123.6(2)	C25	C26	Cl1	119.6(2)
C8	C9	N1	110.0(2)	C27	C26	Cl1	119.5(2)
C18	C9	N1	118.7(2)	C27	C26	C25	120.9(3)
C18	C9	C8	131.3(2)	C28	C27	C26	119.0(3)
N1	C10	O1	124.9(3)	C27	C28	C23	121.6(3)

Table 14 Hydrogen Atom Coordinates ($Å \times 10^4$) and Isotropic Displacement Parameters ($Å^2 \times 10^3$) for **5**

Atom	***X***	***Y***	***z***	**U(eq)**
H2	3084(4)	2176.1(18)	3540.8(16)	27.9(7)
H3	1196(4)	3172(2)	3856.6(17)	36.1(9)

H4	239(4)	4094.1(19)	2995.3(17)	35.4(8)
H5	1263(4)	4055.0(18)	1831.9(17)	30.0(8)
H6	3159(3)	3063.1(17)	1516.7(15)	23.0(7)
H11a	-893(3)	2071.2(16)	1257.9(15)	23.5(6)
H11b	347(3)	2112.9(16)	620.1(15)	23.5(6)
H13	-2768(3)	1983.6(18)	158.8(16)	25.6(7)
H14	-4350(3)	1096.0(19)	-508.5(15)	27.7(7)
H15	-3698(3)	-313.2(18)	-583.7(15)	25.9(7)
H16	-1521(4)	-820.5(18)	74.7(15)	26.5(7)
H17	33(3)	71.0(17)	760.5(15)	23.6(7)
H18a	-891(8)	714(11)	2848(6)	33.3(9)
H18b	-1129(11)	1598(2)	2505(10)	33.3(9)
H18c	-1648(5)	801(12)	2075(5)	33.3(9)
H20a	5189(4)	-626.6(17)	3872.1(14)	26.4(7)
H20b	3639(4)	-195.7(17)	4186.4(14)	26.4(7)
H21a	2072(5)	-1314(3)	3777(12)	42.4(10)
H21b	3640(20)	-1748(5)	3487(8)	42.4(10)
H21c	3400(20)	-1621(7)	4319(5)	42.4(10)
H22a	5394(3)	400.3(16)	1193.1(14)	19.0(7)
H22b	5306(3)	-40.5(16)	1946.7(14)	19.0(7)
H24	3499(3)	-64.5(17)	210.8(15)	22.7(7)
H25	2191(3)	-1181.1(17)	-314.6(16)	25.6(7)
H27	2504(4)	-2444.7(18)	1550.2(16)	29.8(8)
H28	3823(4)	-1325.9(17)	2070.8(15)	25.3(7)



X-ray structure of **5** (thermal ellipsoids at 30% probability)

P. Single crystal X-ray diffraction analysis of 6:

A single crystal of **6** (recrystallization from 6:1 *n*-Hexane/EtOAc by slow evaporation at room temperature) was mounted and the diffraction data were collected on a Bruker D8 Quest CMOS diffractometer using SMART/SAINT software. Intensity data were collected using graphite-monochromatized Mo-Ka radiation (0.71073 Å) at 150 K. The structures were solved by direct methods using SHELX-97 and refined by full matrix leastsquare F^2. Empirical absorption corrections were applied with SADABS. All non-hydrogen atoms were refined anisotropically and hydrogen atoms were included in geometric positions. Structure was drawn using ORTEP. The crystallographic refinement parameters are given below:

Table 15 Crystal data and structure refinement for **6**

Identification code	**6**
CCDC number	CCDC 1549959
Empirical formula	$C_{22}H_{22}NO_4Cl$
Formula weight	399.88
Temperature	150 K
Crystal system	Orthorhombic
Space group	$P2_12_12$
Unit cell dimensions	a = 13.4035(11) Å α = 90.00°
	b = 28.882(2) Å β = 90.00°
	c = 5.1236(4) Å γ = 90.00°
Volume	1983.4(3) $Å^3$
Z	4
Density (calculated) (ρ_{calc})	1.3390 g/cm^3
Absorption coefficient (μ)	0.221mm^{-1}
F(000)	841.0
Radiation	Mo Kα (λ = 0.71073 Å)
2Θ range for data collection	6.08 to 49.996°
Index ranges	$-15 \le h \le 15$, $-34 \le k \le 34$, $-6 \le l \le 6$
Reflections collected	60586
Independent reflections	3474 [R_{int} = 0.0780, R_{sigma} =0.0287]
Data/restraints/parameters	3474/0/258
Goodness-of-fit on F^2	0925
Final R indexes [I>=2σ (I)]	R_1 = 0.0311, ωR_2 = 0.0752

Final R indexes [all data]	R_1 = 0.0400, ωR_2 = 0.0793
Largest diff. peak and hole	0.23 and -0.224 e Å^{-3}
Flack parameter/ absolute structure parameter	0.02(8)

Table 16 Fractional Atomic Coordinates ($\times 10^4$) and Equivalent Isotropic Displacement Parameters (Å$^2\times 10^3$) for **6**. U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor

Atom	***X***	***Y***	***Z***	**U(eq)**
Cl1	2929.3(4)	-143.94(18)	3260.2(13)	38.75(18)
O1	2133.1(9)	2432.0(5)	3028(3)	21.3(3)
O2	-903.2(11)	2211.5(5)	6222(3)	20.6(3)
O3	-1918(1)	1744.0(5)	1347(3)	26.7(3)
O4	-657.4(10)	1307.0(5)	-175(3)	26.3(4)
N1	517.8(11)	2557.8(5)	4440(3)	17.5(4)
C1	2450.1(16)	385.7(7)	2189(4)	26.4(5)
C2	1672.7(16)	586.9(7)	3511(4)	29.6(5)
C3	1318.0(16)	1014.2(7)	2699(4)	26.5(5)
C4	1728.0(14)	1240.5(7)	571(4)	19.7(4)
C5	1327.9(14)	1696.2(6)	-468(4)	19.0(4)
C6	732.4(13)	1979.9(6)	1432(4)	16.2(4)
C7	1236.1(14)	2345.0(6)	3028(4)	17.4(4)
C8	710.6(15)	2937.9(7)	6241(4)	21.1(4)
C9	589.2(15)	3414.1(7)	5018(4)	20.8(4)
C10	-68.5(17)	3736.9(7)	6050(5)	29.6(5)
C11	-157.1(18)	4174.8(8)	4944(5)	37.5(6)
C12	392.1(16)	4286.1(7)	2782(5)	33.4(6)
C13	2519.1(16)	1028.6(8)	-706(5)	28.0(5)
C14	2878.2(17)	598.5(8)	82(5)	33.2(5)
C15	-486.8(13)	2377.9(7)	3868(3)	16.5(4)
C16	-1156.1(14)	2745.2(6)	2627(4)	20.7(4)
C17	-242.7(14)	1988.8(6)	1990(4)	17.7(4)
C18	-1040.2(15)	1678.7(7)	1023(4)	19.7(4)
C19	-1369.6(17)	972.0(8)	-1150(6)	39.3(6)
C20	-793(2)	552.0(9)	-1963(9)	68.5(11)

C21	1040.2(16)	3966.0(7)	1691(5)	30.4(5)
C22	1142.3(15)	3531.9(7)	2832(4)	24.4(5)

Table 17 Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for **6**. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\ldots]$

Atom	**U_{11}**	**U_{22}**	**U_{33}**	**U_{12}**	**U_{13}**	**U_{23}**
Cl1	41.5(3)	21.4(3)	53.3(4)	14.1(2)	-9.3(3)	-0.6(3)
O1	14.1(6)	22.1(7)	27.7(7)	-1.3(5)	-1.2(6)	-0.4(6)
O2	16.2(7)	25.8(8)	19.9(7)	3.1(6)	2.0(6)	5.9(6)
O3	16.1(7)	28.5(8)	35.6(8)	-2.8(6)	-0.3(6)	-4.1(7)
O4	18.6(7)	16.8(7)	43.5(9)	-3.2(6)	-2.4(7)	-5.6(7)
N1	14.3(8)	16.9(8)	21.2(8)	0.1(6)	0.6(7)	-2.2(7)
C1	26.4(10)	18.4(10)	34.5(12)	5.3(9)	-9.3(9)	-3.5(10)
C2	32.3(12)	25.5(11)	30.8(11)	7.1(9)	1.9(10)	8.5(10)
C3	25.4(11)	25.1(10)	29.0(11)	10.1(9)	5.0(9)	2.7(9)
C4	17.5(10)	19.1(10)	22.5(10)	1.2(8)	-3.0(8)	-3.8(8)
C5	17.7(10)	17.4(10)	21.8(10)	-0.3(8)	2.2(8)	0.6(8)
C6	16.0(9)	13.5(9)	19.1(9)	0.3(7)	-0.3(8)	4.6(8)
C7	18.0(9)	15.2(9)	18.9(9)	1.1(8)	-0.3(8)	4.9(8)
C8	21.5(10)	21(1)	20.9(10)	-1.6(8)	1.5(8)	-3.3(8)
C9	19.6(10)	19.4(10)	23.5(10)	-2.0(8)	-3.1(8)	-6.0(8)
C10	27.0(11)	28.3(11)	33.6(12)	2.9(9)	0.2(10)	-7.1(10)
C11	32.7(13)	26.1(12)	53.7(16)	8.1(10)	-6.2(12)	-13.1(12)
C12	28.5(12)	16.9(10)	55.0(15)	-1.2(9)	-13.9(11)	3.1(10)
C13	23.2(10)	25.8(11)	35.0(12)	3.1(9)	8.4(10)	0.1(10)
C14	23.5(11)	30.1(12)	45.8(14)	11.6(10)	7.3(11)	-6.8(11)
C15	14.4(9)	18.2(9)	16.9(9)	0.1(8)	-0.5(7)	1.8(7)
C16	19(1)	20.4(10)	22.7(10)	5.6(8)	2.2(8)	2.9(8)
C17	18.3(9)	14.8(9)	19.9(9)	1.4(7)	-0.2(8)	5.8(8)
C18	18.4(10)	18.9(10)	22(1)	1.0(8)	0.3(8)	3.2(8)
C19	28.2(12)	26.9(12)	62.8(17)	-10.6(10)	-2.5(12)	-13.9(12)
C20	45.3(16)	32.0(14)	128(3)	-5.4(12)	-2(2)	-41.0(19)
C21	24.2(11)	25.5(11)	41.6(13)	-6.2(9)	-3.3(11)	6.4(11)
C22	19.4(10)	20.5(10)	33.4(11)	0.1(8)	1.8(9)	-1.9(9)

Table 18 Bond Lengths for **6**

Atom	Atom	Length/Å	Atom	Atom	Length/Å
Cl1	C1	1.747(2)	C5	C6	1.502(3)
O1	C7	1.228(2)	C6	C7	1.496(3)
O2	C15	1.413(2)	C6	C17	1.338(3)
O3	C18	1.203(2)	C8	C9	1.520(3)
O4	C18	1.339(2)	C9	C10	1.388(3)
O4	C19	1.448(3)	C9	C22	1.386(3)
N1	C7	1.352(2)	C10	C11	1.391(3)
N1	C8	1.457(2)	C11	C12	1.368(4)
N1	C15	1.473(2)	C12	C21	1.386(3)
C1	C2	1.372(3)	C13	C14	1.392(3)
C1	C14	1.369(3)	C15	C16	1.528(3)
C2	C3	1.387(3)	C15	C17	1.515(3)
C3	C4	1.385(3)	C17	C18	1.480(3)
C4	C5	1.518(3)	C19	C20	1.498(4)
C4	C13	1.388(3)	C21	C22	1.390(3)

Table 19 Bond Angles for **6**

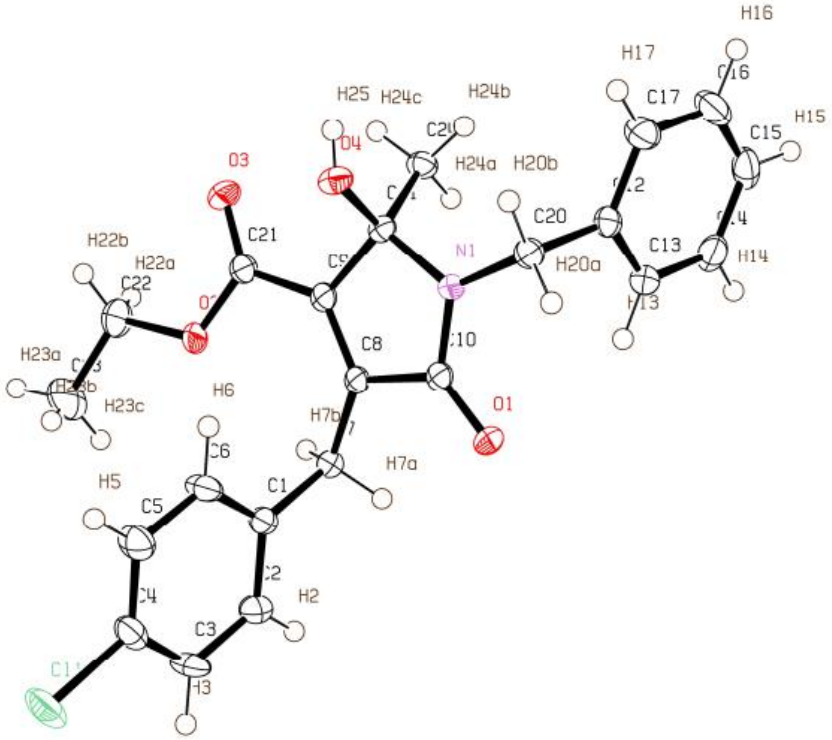
Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
C19	O4	C18	116.19(16)	C22	C9	C10	118.9(2)
C8	N1	C7	123.72(15)	C11	C10	C9	120.7(2)
C15	N1	C7	112.60(15)	C12	C11	C10	119.8(2)
C15	N1	C8	123.63(15)	C21	C12	C11	120.5(2)
C2	C1	Cl1	119.67(18)	C14	C13	C4	121.4(2)
C14	C1	Cl1	119.13(17)	C13	C14	C1	119.0(2)
C14	C1	C2	121.2(2)	N1	C15	O2	108.14(14)
C3	C2	C1	119.3(2)	C16	C15	O2	111.06(15)
C4	C3	C2	121.3(2)	C16	C15	N1	112.00(15)
C5	C4	C3	123.04(18)	C17	C15	O2	112.03(15)
C13	C4	C3	117.79(19)	C17	C15	N1	100.99(14)
C13	C4	C5	119.13(19)	C17	C15	C16	112.18(15)

C6	C5	C4	115.69(16)	C15	C17	C6	111.15(16)
C7	C6	C5	119.94(16)	C18	C17	C6	128.48(18)
C17	C6	C5	131.92(18)	C18	C17	C15	120.37(16)
C17	C6	C7	108.09(16)	O4	C18	O3	124.32(18)
N1	C7	O1	127.17(18)	C17	C18	O3	124.42(18)
C6	C7	O1	125.88(17)	C17	C18	O4	111.22(16)
C6	C7	N1	106.96(15)	C20	C19	O4	107.26(19)
C9	C8	N1	113.66(16)	C22	C21	C12	119.6(2)
C10	C9	C8	121.25(18)	C21	C22	C9	120.58(19)
C22	C9	C8	119.89(18)				

Table 20 Hydrogen Atom Coordinates (Å×10^4) and Isotropic Displacement Parameters (Å^2×10^3) for **6**

Atom	***X***	***Y***	***z***	**U(eq)**
H2	-1436(19)	2300(8)	6350(50)	30.9(5)
H2a	1386.6(16)	438.2(7)	4936(4)	35.5(6)
H3	794.1(16)	1151.8(7)	3602(4)	31.8(6)
H5a	1887.4(14)	1881.1(6)	-1065(4)	22.8(5)
H5b	911.9(14)	1631.5(6)	-1974(4)	22.8(5)
H8a	257.8(15)	2912.0(7)	7711(4)	25.4(5)
H8b	1385.3(15)	2908.9(7)	6907(4)	25.4(5)
H10	-453.9(17)	3659.7(7)	7495(5)	35.6(6)
H11	-588.4(18)	4391.5(8)	5673(5)	45.0(7)
H12	330.1(16)	4578.5(7)	2039(5)	40.1(7)
H13	2815.5(16)	1177.1(8)	-2118(5)	33.6(6)
H14	3401.2(17)	458.0(8)	-810(5)	39.8(6)
H16a	-1778(4)	2606.9(12)	2120(30)	31.0(6)
H16b	-1280(9)	2988(2)	3866(10)	31.0(6)
H16c	-831(5)	2872(4)	1117(17)	31.0(6)
H19a	-1846.4(17)	892.3(8)	201(6)	47.2(8)
H19b	-1730.8(17)	1098.7(8)	-2627(6)	47.2(8)
H20a	-381(15)	627(3)	-3440(30)	102.7(16)
H20b	-379(15)	451(5)	-543(19)	102.7(16)
H20c	-1248(2)	309(3)	-2430(50)	102.7(16)

H21	1404.5(16)	4041.2(7)	206(5)	36.5(6)
H22	1585.8(15)	3318.7(7)	2122(4)	29.3(6)



ORTEP diagram of **6** (thermal ellipsoids at 50% probability)