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L-Pyroglutamic Sulphonamide as Hydrogen-Bonding Organocatalyst: Enantioselective Diels–Alder Cyclization to Construct Carbazolespirooxindoles

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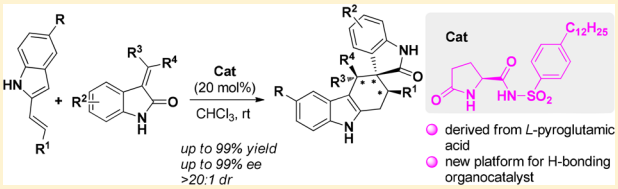
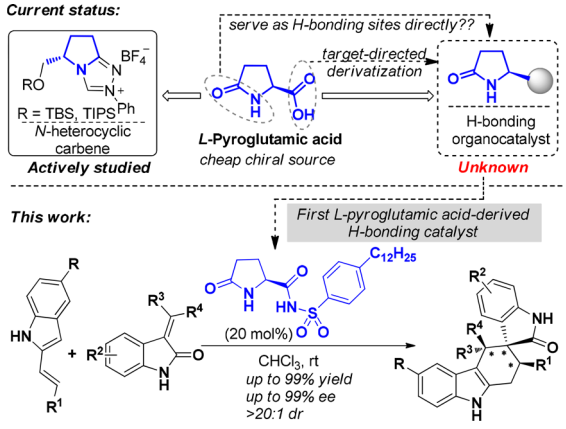
Supporting Information

ABSTRACT: Hydrogen-bonding organocatalysts *L*-pyroglutamic sulphonamides were readily synthesized for the first time by fully exploiting the potentials of *L*-pyroglutamic acid. The newly designed catalyst was successfully applied in catalyzing asymmetric Diels–Alder cyclization of methyleneindolinones with 2-vinyl-1*H*-indoles to efficiently assemble carbazolespirooxindoles in excellent stereoselectivity (up to 99% ee, >20:1 dr) and yields (up to 99%). Mechanistic studies disclosed that the well-designed hydrogen-bonding modes between *L*-pyroglutamic sulphonamide and substrates were crucial for stereocontrol in the cyclization.



Organocatalysis has received considerable attention and experienced booming development in the past decade. Powerful organocatalysts with diverse structural motifs have emerged in a wide range of chemical transformations.[1] In the sense of availability, natural chiral sources such as amino acid, alkaloid, and sugar mainly constituted the arsenal for developing organocatalysts, which received extensive modification to meet the needs for the substrates with specific structural features.[1b−d] Most prominently, *L*-proline has been amenable to numerous derivatizations to create an array of effective and arguably most frequently used organocatalysts[2] since Barbas's group reported their seminal work on the proline-catalyzed direct asymmetric Aldol reaction.[2e] However, the advance of organocatalysis is facing an inherent hurdle: the restricted availability of chiral sources. One viable solution could rely on fully exploiting the potential of currently available chiral sources through rationally designing the structures of chiral catalysts, which might be one of the top urgent tasks for the chemistry community at this stage. Noticeably, pyroglutamic acid, a cheap chiral feedstock with both enantiomeric forms readily available, has been often used as a starting material in asymmetric synthesis owing to its salient features, including a preset chiral stereocenter, five-membered lactam, and carboxylic acid.[3] Encouragingly, the research groups of Ye[4] and Smith[5] successfully transformed *L*-pyroglutamic acid into a variety of *N*-heterocyclic carbene catalysts, which showed attractive catalytic activities in activating enals or aldehydes (Scheme 1). Conceivably, the lactam moiety in pyroglutamic acid offers H-bonding donor and acceptor simultaneously, which could potentially bind to the substrate through double H-bonding. Unfortunately, pyroglutamic acid as a privileged double H-bonding partner was neglected and has never been properly appreciated since. As a consequence, development of a new class of organocatalyst by fully taking advantage of the structural features of pyroglutamic acid would be constructive and beneficial to the advancement of organocatalysis.

Scheme 1. Development of *L*-Pyroglutamic Acid-Based Organocatalyst



Spirooxindoles, possessing a wide spectrum of biological profiles,[6] have gained considerable synthetic interests by starting from isatins and their derivatives as building blocks. Notably, organocatalysis has demonstrated unparalleled capability in the enantioselective construction of spirooxindoles, especially for carbazolespirooxindoles.[7] Despite impressive advances achieved in this journey, it is highly demanding to develop novel and practical organocatalytic systems which can effectively target the parent structure of isatin derivatives to escalate the stereocontrol in enantioselective transformations. Hence, we envisioned that the concurrent presence of lactam moieties in pyroglutamic acid and isatin result in them being

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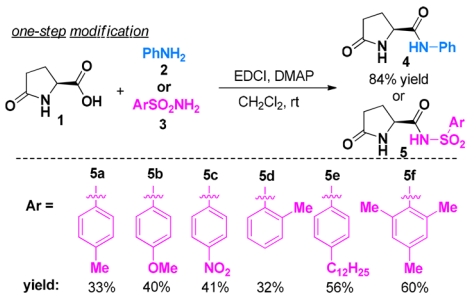
intimately bound via double H-bonding. Considering practicality and accessibility, we designed *L*-pyroglutamic acid sulphonamide bearing two distinct H-bonding sites which can be concisely prepared from inexpensive *L*-pyroglutamic acid and phenylsulfonamide in one step. Herein, we disclose the development and application of the first *L*-pyroglutamic acid-derived H-bonding organocatalyst. Impressively, the newly developed catalyst demonstrated excellent stereocontrol and catalytic activity in the asymmetric Diels–Alder cyclization to construct the spiro[tetrahydrocarbazole-3,3′-oxindole] framework,[8] which presumably benefited from an intimate double H-bonding interaction of isatin core with catalyst as well as a H_2O-relay H-bonding (Scheme 1).

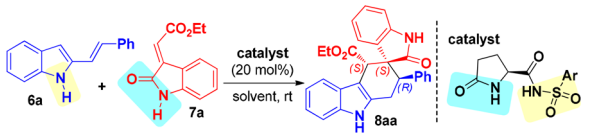
Following the concept of our design, we prepared *L*-pyroglutamic acid amide **4**[9] and a series of sulphonamides **5** with varied electronic and steric effects in which the N–H group of amide or sulphonamide could provide an effective H-bonding site. One-step direct coupling between *L*-pyroglutamic acid and aniline **2** or sulphonamide **3** afforded the desired *L*-pyroglutamic acid derivatives in reasonable yields (Scheme 2).

Scheme 2. Derivatization of *L*-Pyroglutamic Acid for H-Bonding Organocatalyst



Notably, due to the aqueous solubility of *L*-pyroglutamic acid derivative, the isolated yields for monosubstituted sulphonamide **5a–5d** were relatively low, though these reactions proceeded smoothly. According to our previous success on the derivatization of *L*-proline,[10] a long hydrophobic alkyl chain, a dodecyl group, was introduced to mitigate the problematic solubility of sulphonamide in water, leading to an improved yield (**5e**). In addition, more sterically demanding catalyst 2,4,6-trimethyl analogue was also synthesized in moderate yield. Subsequently, these designed catalysts were employed to catalyze the D–A reaction between 2-vinyl-1*H*-indole **6a** and methyleneindolinone **7a** (as shown in Table 1). It is noteworthy that Boc- or Me- protected isatin derivatives were requisite to secure satisfactory stereoselectivity in the D–A cycloadditions, while the unprotected methyleneindolinones were rarely used.[8,11] As can be seen, lactam moiety in **7a** is exposed to be bound by its double H-bonding partner. Initially, in the absence of catalyst, this reaction proceeded in chloroform at room temperature to give the corresponding cycloadduct spiro[tetrahydrocarbazole-3,3′-oxindole] **8aa** in excellent yield (99%) and diastereoselectivity (>20:1 dr) (entry 1). Then, *L*-pyroglutamic acid (**1**) as well as its amide derivative **4** were tested, leading to faster reaction with frustrating enantioselectivities (entries 2 and 3). To our delight, use of *L*-pyroglutamic acid sulfonamide **5** gave cycloadduct **8aa** in excellent yield with moderate enantioselectivity (58–66% ee) and excellent diastereoselectivity (>20:1 dr) (entries 4–9). Interestingly, steric and electronic effects of substituents on the

Table 1. Screening the Designed Catalysts for Organocatalytic D–A Cyclization[a]



	catalyst	solvent	time (h)	yield[b,c] (%)	ee[c] (%)
1	none	$CHCl_3$	30	99	0
2	**1**	$CHCl_3$	24	90	0
3	**4**	$CHCl_3$	24	99	12
4	**5a**	$CHCl_3$	24	99	65
5	**5b**	$CHCl_3$	24	99	66
6	**5c**	$CHCl_3$	24	99	58
7	**5d**	$CHCl_3$	24	99	66
8	**5e**	$CHCl_3$	24	99	65
9	**5f**	$CHCl_3$	24	99	61
10	**5e**	CH_2Cl_2	24	99	52
11	**5e**	DCE	24	99	51
12	**5e**	toluene	24	99	54
13[d]	**5e**	$CHCl_3$	48	97	88
14[d,e]	**5e**	**$CHCl_3$**	**17**	**99**	**90**
15[d,f]	**5e**	$CHCl_3$	17	99	85
16[d,e,g]	**5e**	$CHCl_3$	30	99	86

[a]Unless otherwise noted, all reactions were carried out using 2-vinyl-1*H*-indole **6a** (0.20 mmol, 1.0 equiv), methyleneindolinone **7a** (0.20 mmol, 1.0 equiv), and catalyst (0.04 mmol, 20 mol %) in solvent (0.5 mL). [b]Isolated yields. [c]dr >20:1, determined by HPLC on a chiral stationary phase. [d]Concentration was 0.02 M. [e]Molar ratio of **6a**:**7a** was 2:1. [f]Molar ratio of **6a**:**7a** was 1:2. [g]10 mol % catalyst **5e** was added.

phenyl moiety in **5** had negligible impact on stereoselectivity. Taking into consideration of solubility in ordinary solvent and the preparative yield of sulphonamide **5**, *L*-pyroglutamic acid *p*-dodecylphenylsulfonamide **5e** was employed for further studies. As protic or polar solvents might disturb the H-bonding interaction of the catalyst with the substrate, various nonpolar solvents were evaluated, and chloroform was proven the optimal solvent in terms of stereoselectivity (entries 10–12 vs 8). Given the spontaneous background reaction, the concentration of this reaction was diluted to 0.02 M. Satisfyingly, the corresponding enantioselectivity was significantly improved to 88% ee (entry 13). Finally, the molar ratio of these two substrates was slightly adjusted, affording the optimum results (yield 99%, 90% ee, >20:1 dr) with a molar ratio of **6a**:**7a** (2:1) (entry 14). Actually, lower catalyst loading (10 mol %) was also evaluated in the model reaction. An elongated reaction time (30 h) was needed to achieve the completion of the reaction, and a reduced enantioselectivity (86% ee) and comparable yield (99%) for cycloadduct **8aa** were obtained (entry 16).

Having the optimal conditions in hand, we sought to examine the substrate tolerance for this newly developed catalytic system. First, diversely substituted 2-vinyl-1*H*-indole derivatives **6** were evaluated under the standard conditions (as shown in Table 2). In general, substituents with different electronic natures at different positions of the *β*-aryl ring were all well-tolerated, and excellent diastereoselectivity and good enantioselectivity were thoroughly achieved (entries 2–9). However, in the presence of a strong electron-withdrawing group ($-NO_2$) on the aryl ring, a relatively low yield (60%) was obtained for **8da** (entry 4). On the other hand, 2-vinylindoles with electron-withdrawing or electron-donating groups at the

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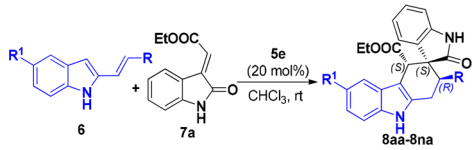
Table 2. Substrate Scope of 2-vinyl-1*H*-indole 6[a]



	R	R^1	time (h)	yield[b] (%)	dr[c]	ee[c] (%)
1	C_6H_5	H	17	99 (**8aa**)	>20:1	90
2	*p*-MeC_6H_4	H	15	99 (**8ba**)	>20:1	90
3	*p*-BrC_6H_4	H	24	99 (**8ca**)	>20:1	86
4	*p*-$NO_2C_6H_4$	H	24	60 (**8da**)	>20:1	84
5	*o*-MeC_6H_4	H	15	99 (**8ea**)	>20:1	94
6	*o*-BrC_6H_4	H	24	84 (**8fa**)	>20:1	>99
7	*m*-MeC_6H_4	H	15	99 (**8ga**)	>20:1	94
8	*m*-BrC_6H_4	H	15	99 (**8ha**)	>20:1	89
9	*m*-MeOC_6H_4	H	15	99 (**8ia**)	>20:1	90
10	C_6H_5	Cl	36	99 (**8ja**)	>20:1	89
11	C_6H_5	Br	36	99 (**8ka**)	>20:1	82
12	C_6H_5	MeO	12	99 (**8la**)	>20:1	>99
13[d]	Me	H	30	98 (**8ma**)	>20:1	85
14[d]	H	H	48	94 (**8na**)	82:18	61/83

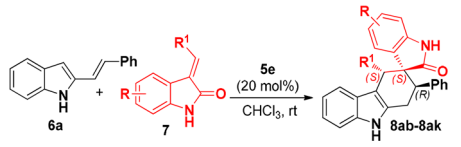
[a]Unless otherwise noted, all reactions were carried out using 2-vinyl-1*H*-indole **6** (0.40 mmol, 2.0 equiv), methyleneindolinone **7a** (0.20 mmol, 1.0 equiv), and **5a** (0.04 mmol, 20 mol %) in $CHCl_3$ (10 mL). [b]Isolated yields. [c]Determined by HPLC on a chiral stationary phase. [d]Concentration of **7a** was 0.04 M.

C5-position of the indole core also gave good stereochemical outcomes and chemical yields (entries 10−12). In addition, switching phenyl to methyl at the terminal double bond also afforded high yield and good stereoselectivity (entry 13). Surprisingly, removal of the terminal substituent on the exocyclic double bond significantly reduced diastereoselectivity (82:18 dr) and enantioselectivity (61% ee) (entry 14). It is worth mentioning that higher concentrations and longer reaction durations were required to secure synthetically useful chemical yields for **8ma** and **8na** as these reactions were sluggish.

Next, various substituted methyleneindolinones **7** were extensively investigated by reacting with 2-vinyl-1*H*-indole **6a**, and the obtained results are illustrated in Table 3. Gratifyingly, methyleneindolinones with a variety of substituents on the phenyl group proceeded the title reaction in excellent diastereo- and enantioselectivities with high yields (entries 1−7). On the other hand, alternative electron-withdrawing groups such as benzoyl, cyano, and acetyl were also tested for methyleneindolinones, and the corresponding cycloadduct **8ai**−**8ak** were achieved in excellent yields (97−99%) with good to excellent enantioselectivities (81−94% ee) (entries 8−10). Moreover, the absolute configuration of cycloadduct **8af** was determined by X-ray crystallographic analysis (see Supporting Information for details).

At this stage, it can be concluded that H-bonding catalyst **5e** demonstrated excellent substrate tolerance in the title reaction, which motivated us to employ more challenging substrates, including **7l** and **7m**, to construct multiple all-carbon quaternary stereocenters enantioselectively (Scheme 3). Disubstituted methyleneindolinone **7l** was subjected to the standard conditions, providing **8al** in high yield (98%) and moderate enantioselectivity (45/83% ee) but low dr (66:34), which was attributed to poor isomeric ratio of **7l** (2:1).

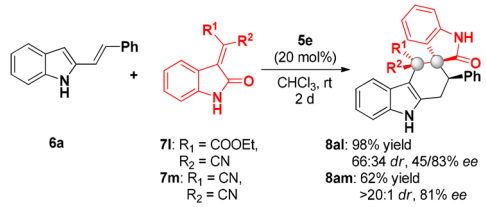
Table 3. Substrate Scope of Methyleneindolinone 7[a]



	R	R^1	time (h)	yield[b] (%)	dr[c]	ee[c] (%)
1	5-F	CO_2Et	7	99 (**8ab**)	>20:1	98
2	5-Cl	CO_2Et	7	99 (**8ac**)	>20:1	96
3	5-Br	CO_2Et	7	99 (**8ad**)	>20:1	94
4	5-Me	CO_2Et	24	99 (**8ae**)	>20:1	96
5	6-Br	CO_2Et	10	99 (**8af**)	>20:1	93
6	7-Br	CO_2Et	7	99 (**8ag**)	>20:1	89
7	7-F	CO_2Et	7	99 (**8ah**)	>20:1	83
8	H	COPh	20	97 (**8ai**)	>20:1	81
9	H	CN	24	99 (**8aj**)	>20:1	94
10	H	Ac	12	99 (**8ak**)	>20:1	89

[a]Unless otherwise noted, all reactions were carried out using 2-vinyl-1*H*-indole **6a** (0.40 mmol, 2.0 equiv), methyleneindolinone **7** (0.20 mmol, 1.0 equiv), and **5a** (0.04 mmol, 20 mol %) in $CHCl_3$ (10 mL). [b]Isolated yields. [c]Determined by HPLC on a chiral stationary phase.

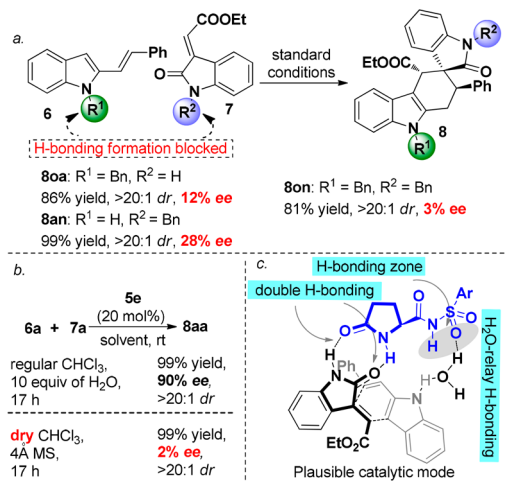
Scheme 3. Construction of Spirooxindole Bearing Two Vicinal All-Carbon Quaternary Stereocenters



Moreover, dicyano methyleneindolinone **7m** gave cycloadduct **8am** in moderate yield (62%) with excellent diastereoselectivity (>20:1 dr) and good enantioselectivity (81% ee).

With an aim to better understand the interaction mode between catalyst and substrates, various control experiments were carried out under the optimal conditions (Schemes 4a and b). First, *N*-protected 2-vinyl-1*H*-indole **6** and/or *N*-protected methyleneindolinone **7** were employed in the title reaction to intentionally mask the hydrogen-bonding sites on these

Scheme 4. Control Experiments and Plausible Catalytic Mode



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substrates (Scheme 4a). Not surprisingly, the corresponding cycloadducts **8oa**, **8an**, and **8on** were obtained in markedly reduced enantioselectivities though in good chemical yields and diastereoselectivities. These results suggested that N−H groups in both 2-vinyl-1*H*-indoles and methyleneindolinones actively interacted with catalyst **5**, having sizable influence on the observed enantioselectivity. Moreover, this statement was also confirmed through ^{1}H NMR spectroscopic studies on the mixture of **5e** with **6a** or **7a** with a molar ratio of 1:1, in which downfield shifts of 0.60 and 0.31 ppm were induced for the N−H signals in **6a** or **7a**, respectively (see Supporting Information for spectra). Further, effects of water on this catalytic system were also investigated. Interestingly, removal of water dramatically degraded the enantioselectivity, while addition of water had a negligible impact on the chemical yield and stereochemical outcomes (Scheme 4b). These results suggested that water played an important role in the interaction between catalyst and substrate. On the basis of these experimental results, a plausible catalytic mode was proposed to illustrate the interaction of catalyst **5** with substrates (Scheme 4c). Presumably, double H-bonds were formed spontaneously between *L*-pyroglutamic acid sulphonamide **5** and isatin derivative **7** through the perfectly matched lactam moieties, while 2-vinyl-1*H*-indole **6** was bound to the sulphonamide moiety of the catalyst via an H_2O-relay H-bond. In this manner, excellent enantioselectivity and diastereoselectivity were achieved through this privileged interaction mode, which is fundamental for the further application of this new class of organocatalyst.

In conclusion, we successfully developed a novel class of hydrogen-bonding organocatalyst: *L*-pyroglutamic acid sulphonamide. Design of this H-bonding catalyst and its catalytic activity features: (i) step-economic and highly accessible preparation, (ii) a new H-bonding platform with minimal modification of *L*-pyroglutamic acid, and (iii) excellent stereocontrol in catalyzing asymmetric Diels−Alder cyclization of methyleneindolinones with 2-vinyl-1*H*-indoles (up to 99% ee, >20:1 dr), affording carbazolespirooxindoles bearing three contiguous chiral centers with one or two quaternary stereocenters. More importantly, the success of this hydrogen-bonding catalyst will greatly inspire the emergence of versatile *L*-pyroglutamic acid-based organocatalysts as well as their broader application in asymmetric synthesis.

EXPERIMENTAL SECTION

General Information. Unless otherwise noted, all of the reagents were purchased from commercial suppliers and used without further purification. ^{1}H NMR spectra were recorded at 400 MHz. The chemical shifts were recorded in ppm relative to tetramethylsilane and with the solvent resonance as the internal standard. Data were reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constants (Hz), integration. ^{13}C NMR data were collected at 100 MHz with complete proton decoupling. Chemical shifts were reported in ppm from tetramethylsilane with the solvent resonance as internal standard. IR spectra were measured using an FT-IR apparatus. HRMS was recorded using a TOF MS ES+ mass spectrometer, and acetonitrile was used to dissolve the sample. Column chromatography was carried out on aluminum oxide (200−300 mesh). All of the substituted 2-vinyl-1*H*-indoles were prepared according to the reported protocol.[12] All of the substituted methyleneindolinones were prepared according to the reported protocol.[13]

Typical Experimental Procedure of Glutamic Sulphonamides 5. To a solution of *L*-pyroglutamic acid **1** (0.65 g, 5.0 mmol) in DCM (10 mL) were added benzene sulphonamide **3** (6.0 mmol, 1.2 equiv), DMAP (0.18 g, 1.5 mmol, 0.3 equiv), and EDCI (1.15 g, 6.0 mmol, 1.2 equiv), respectively. The mixture was stirred for 72 h before being partitioned between EtOAc (100 mL) and HCl (1 M, 15 mL) at room temperature. The organic layer was washed with half-saturated brine (3 × 30 mL), dried over Na_2SO_4, and concentrated in vacuo. The resulting residue was purified via silica gel column chromatography (MeOH/DCM = 1−5%) to yield sulphonamide **5**.

Sulphonamide 5a. White solid (0.46 g, yield 33%); mp 84−85 °C; $[\alpha]_D^{20}$ = −41.4 (*c* = 0.5 in MeOH); IR (KBr) ν 3430, 2921, 1633, 1263, 1010, 896, 843, 812 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.32 (br s, 1H), 7.82 (d, *J* = 8.4 Hz, 2H), 7.77 (s, 1H), 7.44 (d, *J* = 8.4 Hz, 2H), 4.04 (dd, *J* = 9.0, 4.2 Hz, 1H), 2.40 (s, 3H), 2.23−2.33 (m, 1H), 1.99−2.11 (m, 2H), 1.69−1.77 (m, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 177.6, 172.1, 144.9, 136.7, 130.1, 128.0, 56.2, 29.2, 25.0, 21.6; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{12}H_{14}N_2O_4NaS$ 305.0572, found 305.0570.

Sulphonamide 5b. White solid (0.59 g, yield 40%); mp 113−115 °C; $[\alpha]_D^{20}$ = −43.1 (*c* = 0.5 in MeOH); IR (KBr) ν 3417, 1656, 1499, 1262, 1148, 836 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.87 (dd, *J* = 6.8, 2.0 Hz, 2H), 7.76 (s, 1H), 7.14 (dd, *J* = 6.8, 2.0 Hz, 2H), 4.03 (dd, *J* = 8.8, 4.0 Hz, 1H), 3.86 (s, 3H), 2.22−2.32 (m, 1H), 1.97−2.11 (m, 2H), 1.68−1.76 (m, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 177.6, 172.1, 163.6, 131.1, 130.4, 114.7, 56.3, 56.2, 29.2, 25.0; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{12}H_{14}N_2O_5NaS$ 321.0521, found 321.0514.

Sulphonamide 5c. White solid (0.64 g, yield 41%); mp 108−109 °C; $[\alpha]_D^{20}$ = −25.6 (*c* = 0.5 in MeOH); IR (KBr) ν 3392, 2867, 1681, 1352, 1260, 1140, 847, 738 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.74 (br s, 1H), 8.45 (d, *J* = 8.8 Hz, 2H), 8.19 (d, *J* = 8.8 Hz, 2H), 7.77 (s, 1H), 4.07 (dd, *J* = 9.2, 4.4 Hz, 1H), 2.25−2.34 (m, 1H), 1.98−2.12 (m, 2H), 1.73−1.81 (m, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 177.5, 172.8, 150.8, 144.9, 129.7, 125.0, 56.4, 29.2, 24.9; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{11}H_{11}N_3O_6NaS$ 336.0266, found 336.0264.

Sulphonamide 5d. White solid (0.45 g, yield 32%); mp 111−112 °C; $[\alpha]_D^{20}$ = −39.7 (*c* = 0.5 in MeOH); IR (KBr) ν 3423, 1634, 1466, 1338, 1186, 899, 848, 760 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.49 (br s, 1H), 7.96 (d, *J* = 8.0 Hz, 1H), 7.77 (s, 1H), 7.56−7.60 (m, 1H), 7.41−7.45 (m, 2H), 4.08 (dd, *J* = 9.2, 4.4 Hz, 1H), 2.60 (s, 3H), 2.27−2.36 (m, 1H), 1.97−2.12 (m, 2H), 1.72−1.80 (m, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 177.5, 172.2, 137.8, 137.4, 134.1, 132.9, 130.7, 126.7, 56.2, 29.2, 25.1, 20.0; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{12}H_{14}N_2O_4S$ 305.0572, found 305.0580.

Sulphonamide 5e. White solid (1.22 g, yield 56%); mp 32−36 °C; $[\alpha]_D^{20}$ = −40.2 (*c* = 0.5 in MeOH); IR (KBr) ν 3403, 2926, 1694, 1595, 1462, 1255, 1142, 1086, 837, 725 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$, mixture of isomers for dodecyl alkyl chain) δ 7.98 (d, *J* = 8.4 Hz, 2H), 7.26−7.34 (m, 3H), 4.28−4.31 (m, 1H), 2.32−2.49 (m, 3H), 2.06−2.11 (m, 1H), 1.51−1.68 (m, 4H), 1.05−1.29 (m, 15H), 0.72−0.88 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, mixture of isomers for dodecyl alkyl chain) δ 179.8, 171.0, 153.8, 135.7, 128.4, 128.3, 57.8, 46.2, 36.5, 31.8, 31.7, 29.6, 29.5, 29.3, 29.1, 27.6, 27.2, 24.5, 22.7, 22.5, 14.0; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{23}H_{36}N_2O_4NaS$ 459.2293, found 459.2308.

Sulphonamide 5f. White solid (0.93 g, yield 60%); mp 137−138 °C; $[\alpha]_D^{20}$ = −38.5 (*c* = 0.5 in MeOH); IR (KBr) ν 3394, 2981, 1681, 1460, 1340, 1141, 1051, 896, 834 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.33 (br s, 1H), 7.77 (s, 1H), 7.05 (s, 2H), 4.08 (dd, *J* = 9.2, 4.4 Hz, 1H), 2.61 (s, 6H), 2.26−2.34 (m, 4H), 1.98−2.11 (m, 2H), 1.70−1.78 (m, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 177.5, 172.6, 143.4, 140.1, 133.6, 132.1, 56.0, 29.2, 25.1, 22.5, 20.9; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{14}H_{18}N_2O_4NaS$ 333.0885, found 333.0900.

General Procedure for Synthesis of Spirooxindoles 8. 2-Vinyl-1*H*-indoles **6** (0.40 mmol, 2.0 equiv), methyleneindolinones **7** (0.20 mmol, 1.0 equiv), and catalyst **5e** (20 mol %) were dissolved in regular chloroform without drying (10 mL). After completion of the reaction (monitored by TLC), organic solvent was removed in vacuo. Then, the residue was purified via flash chromatography (EtOAc/PE = 10−30%) to yield the corresponding product **8**.

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Spirooxindoles 8aa.[8a] White solid (86.8 mg, yield 99%, >20:1 dr, 90% ee); $[\alpha]_D^{20}$ = −89.0 (*c* = 0.1 in CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08 (s, 1H), 8.05 (s, 1H), 7.40 (d, *J* = 7.6 Hz, 1H), 7.24−7.29 (m, 2H), 7.02−7.15 (m, 7H), 6.93−6.97 (m, 1H), 6.85 (t, *J* = 7.6 Hz, 1H), 6.46 (d, *J* = 7.6 Hz, 1H), 4.43−4.47 (m, 1H), 4.14 (s, 1H), 4.08−4.12 (m, 1H), 3.97−4.05 (m, 1H), 3.72 (dd, *J* = 16.4, 10.8 Hz, 1H), 3.11 (dd, *J* = 16.8, 5.6 Hz, 1H), 1.10 (t, *J* = 7.0 Hz, 3H); HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.74 min (major), 19.87 min (minor).

Spirooxindoles 8ba. White solid (89.8 mg, yield 99%, >20:1 dr, 90% ee); mp 156−158 °C; $[\alpha]_D^{20}$ = −65.1 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3356, 2919, 1728, 1699, 1470, 1176, 818, 754, cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 11.02 (s, 1H), 10.42 (s, 1H), 7.34 (d, *J* = 8.0 Hz, 1H), 7.25 (d, *J* = 7.6 Hz, 1H), 7.14 (d, *J* = 7.6 Hz, 1H), 7.01−7.08 (m, 4H), 6.90−6.98 (m, 3H), 6.84 (t, *J* = 7.6 Hz, 1H), 6.63 (d, *J* = 7.6 Hz, 1H), 4.32 (q, *J* = 5.4 Hz, 1H), 4.01−4.09 (m, 1H), 3.90−3.99 (m, 1H), 3.88 (s, 1H), 3.62 (dd, *J* = 16.4, 11.2 Hz, 1H), 3.03 (dd, *J* = 16.8, 5.6 Hz, 1H), 2.15 (s, 3H), 1.04 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 178.6, 172.3, 142.1, 138.2, 136.7, 136.4, 136.0, 130.2, 129.0, 128.7, 128.5, 126.9, 125.4, 121.3, 121.0, 119.0, 117.3, 111.4, 109.6, 103.5, 60.7, 52.1, 46.3, 42.2, 27.9, 21.0, 14.5; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{29}H_{26}N_2O_3Na$ 473.1841, found 473.1825; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.60 min (major), 14.95 min (minor).

Spirooxindoles 8ca. White solid (102.3 mg, yield 99%, >20:1 dr, 86% ee); mp 140−142 °C; $[\alpha]_D^{20}$ = −53.8 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3401, 2924, 1712, 1468, 1326, 1178, 1013, 826, 746 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 11.05 (s, 1H), 10.48 (s, 1H), 7.30−7.36 (m, 3H), 7.25 (d, *J* = 8.0 Hz, 1H), 7.15 (d, *J* = 7.6 Hz, 1H), 7.05−7.09 (m, 4H), 6.96 (t, *J* = 7.6 Hz, 1H), 6.86 (t, *J* = 7.6 Hz, 1H), 6.66 (d, *J* = 8.0 Hz, 1H), 4.31−4.35 (m, 1H), 4.01−4.09 (m, 1H), 3.92−3.99 (m, 1H), 3.90 (s, 1H), 3.57 (dd, *J* = 16.2, 11.0 Hz, 1H), 3.09 (dd, *J* = 16.6, 5.8 Hz, 1H), 1.04 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 178.2, 172.2, 142.1, 140.6, 136.4, 136.2, 131.3, 131.1, 129.9, 128.7, 126.8, 125.4, 121.4, 121.1, 120.3, 119.1,117.4, 111.4, 109.8, 103.6, 60.8, 52.0, 46.0, 42.2, 27.4, 14.5; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{28}H_{23}N_2O_3NaBr$ 537.0790, found 537.0775; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.97 min (major), 13.56 min (minor).

Spirooxindoles 8da. Yellow solid (57.5 mg, yield 60%, >20:1 dr, 84% ee); mp 177−178 °C; $[\alpha]_D^{20}$ = −53.2 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3367, 2976, 1725, 1698, 1519, 1468, 1346, 1178, 856, 744 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.24 (s, 1H), 9.53 (s, 1H), 8.00 (dd, *J* = 7.2, 2.0 Hz, 2H), 7.52 (dd, *J* = 6.8, 2.0 Hz, 2H), 7.39−7.42 (m, 2H), 7.34 (d, *J* = 7.6 Hz, 1H), 7.06−7.12 (m, 2H), 6.99−7.03 (m, 1H), 6.91 (td, *J* = 7.6, 1.2 Hz, 1H), 6.73 (d, *J* = 8.0 Hz, 1H), 4.73 (dd, *J* = 10.8, 5.6 Hz, 1H), 4.02−4.17 (m, 3H), 3.79−3.86 (m, 1H), 3.25 (dd, *J* = 16.4, 6.0 Hz, 1H), 1.13 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.5, 171.8, 149.1, 146.8, 141.7, 136.6, 135.4, 130.0, 129.4, 128.4, 126.9, 125.5, 122.9, 121.3, 120.9, 118.9, 117.4, 110.9, 109.4, 104.0, 60.4, 52.0, 46.0, 42.8, 26.9, 13.6; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{28}H_{23}N_3O_5Na$ 504.1535, found 504.1526; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 9.52 min (major), 14.40 min (minor).

Spirooxindoles 8ea. White solid (90.2 mg, yield 99%, >20:1 dr, 94% ee); mp >300 °C; $[\alpha]_D^{20}$ = −118.1 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3354, 1712, 1470, 1333, 1187, 1028, 741 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 11.04 (s, 1H), 10.59 (s, 1H), 7.34 (d, *J* = 8.0 Hz, 1H), 7.25 (d, *J* = 7.6 Hz, 1H), 7.15−7.17 (m, 1H), 6.93−7.11 (m, 7H), 6.78 (t, *J* = 7.6 Hz, 1H), 6.67 (d, *J* = 7.6 Hz, 1H), 4.84 (q, *J* = 5.2 Hz, 1H), 4.03−4.09 (m, 1H), 3.93−3.99 (m, 1H), 3.86 (s, 1H), 3.39−3.46 (m, 1H), 2.99 (dd, *J* = 16.4, 5.6 Hz, 1H), 2.35 (s, 3H), 1.05 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 178.9, 172.4, 142.1, 140.5, 136.9, 136.4, 136.1, 130.6, 130.4, 128.7, 126.9, 126.8, 126.5, 125.7, 124.3, 121.4, 121.0, 119.1, 117.4, 111.4, 109.7, 103.5, 60.8, 52.0, 46.6, 36.8, 28.3, 20.3, 14.5; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{29}H_{26}N_2O_3Na$ 473.1841, found 473.1826; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.33 min (major), 16.02 min (minor).

Spirooxindoles 8fa. White solid (86.9 mg, yield 84%, >20:1 dr, >99% ee); mp 252−253 °C; $[\alpha]_D^{20}$ = −120.1 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3329, 2916, 1717, 1620, 1466, 1334, 1183, 1018, 869, 739 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.20 (s, 1H), 9.59 (s, 1H), 7.38−7.47 (m, 5H), 7.15−7.19 (m, 1H), 7.06−7.11 (m, 2H), 6.98−7.03 (m, 2H), 6.83−6.87 (m, 1H), 6.79 (d, *J* = 8.0 Hz, 1H), 5.42 (dd, *J* = 11.2, 5.6 Hz, 1H), 4.11−4.18 (m, 1H), 4.01−4.07 (m, 2H), 3.63 (dd, *J* = 16.0, 11.2 Hz, 1H), 3.15 (dd, *J* = 16.0, 5.6 Hz, 1H), 1.14 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 178.1, 171.6, 141.6, 141.2, 136.6, 135.8, 132.8, 129.8, 128.5, 128.3, 127.8, 127.7, 127.0, 125.3, 125.2, 121.1, 120.9, 118.9, 117.3, 110.9, 109.1, 104.0, 60.3, 52.0, 47.0, 40.6, 27.6, 13.7; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{28}H_{23}N_2O_3NaBr$ 537.0790, found 537.0775; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.98 min (major), 18.47 min (minor).

Spirooxindoles 8ga. White solid (90.1 mg, yield 99%, >20:1 dr, 94% ee); mp 177−179 °C; $[\alpha]_D^{20}$ = −100.2 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3409, 3219, 2919, 1705, 1468, 1176, 1035, 794, 747 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.17 (s, 1H), 9.41 (s, 1H), 7.37−7.40 (m, 2H), 7.29 (d, *J* = 7.6 Hz, 1H), 6.96−7.09 (m, 6H), 6.85−6.90 (m, 2H), 6.70 (d, *J* = 8.0 Hz, 1H), 4.54 (q, *J* = 5.6 Hz, 1H), 4.11−4.17 (m, 1H), 4.01−4.07 (m, 2H), 3.83 (dd, *J* = 16.4, 11.2 Hz, 1H), 3.12 (dd, *J* = 16.0, 5.2 Hz, 1H), 2.17 (s, 3H), 1.14 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 178.0, 172.0, 141.8, 141.1, 137.1, 136.6, 136.4, 130.1, 129.6, 128.0, 127.8, 127.3, 127.1, 125.6, 120.9, 120.7, 118.8, 117.2, 110.8, 109.1, 104.0, 60.2, 52.1, 46.5, 42.6, 27.6, 20.5, 13.6; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{29}H_{26}N_2O_3Na$ 473.1841, found 473.1845; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.43 min (major), 13.11 min (minor).

Spirooxindoles 8ha. White solid (102.8 mg, yield 99%, >20:1 dr, 89% ee); mp 165−166 °C; $[\alpha]_D^{20}$ = −65.4 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3396, 2924, 1710, 1620, 1469, 1323, 1179, 877, 746 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.20 (s, 1H), 9.49 (s, 1H), 7.43 (t, *J* = 1.8 Hz, 1H), 7.38−7.40 (m, 2H), 7.31 (d, *J* = 7.6 Hz, 1H), 7.23−7.26 (m, 2H), 7.06−7.11 (m, 3H), 6.98−7.02 (m, 1H), 6.92 (t, *J* = 7.6 Hz, 1H), 6.75 (d, *J* = 7.6 Hz, 1H), 4.56 (dd, *J* = 11.2, 5.6 Hz, 1H), 4.10−4.17 (m, 1H), 4.01−4.08 (m, 2H), 3.78 (dd, *J* = 16.4, 11.2 Hz, 1H), 3.19 (dd, *J* = 16.4, 5.6 Hz, 1H), 1.13 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.7, 171.9, 143.9, 141.7, 136.6, 135.8, 131.6, 129.8, 129.7(4), 129.7(0), 128.3, 127.8, 127.0, 125.5, 121.5, 121.2, 120.8, 118.8, 117.3, 110.9, 109.3, 104.0, 60.3, 52.0, 46.2, 42.4, 27.2, 13.6; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{28}H_{23}N_2O_3NaBr$ 537.0790, found 537.0779; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.74 min (major), 11.44 min (minor).

Spirooxindoles 8ia. White solid (93.0 mg, yield 99%, >20:1 dr, 90% ee); mp 98−100 °C; $[\alpha]_D^{20}$ = −74.7 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3418, 3214, 2986, 1737, 1683, 1464, 1180, 1032, 745 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.17 (s, 1H), 9.44 (s, 1H), 7.37−7.40 (m, 2H), 7.30 (d, *J* = 7.6 Hz, 1H), 6.98−7.10 (m, 4H), 6.89 (td, *J* = 7.6, 1.2 Hz, 1H), 6.82−6.84 (m, 2H), 6.72 (d, *J* = 7.6 Hz, 1H), 6.60−6.63 (m, 1H), 4.56 (q, *J* = 5.6 Hz, 1H), 4.10−4.18 (m, 1H), 3.99−4.07 (m, 2H), 3.83 (dd, *J* = 16.4, 11.6 Hz, 1H), 3.67 (s, 3H), 3.15 (dd, *J* = 16.8, 6.0 Hz, 1H), 1.13 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 178.1, 172.0, 159.3, 142.8, 141.8, 136.6, 136.3, 130.1, 128.8, 128.0, 127.1, 125.6, 121.0, 120.9, 120.7, 118.8, 117.2, 114.3, 112.2, 110.8, 109.1, 103.9, 60.2, 54.3, 52.1, 46.4, 42.7, 27.6, 13.6; HRMS (TOF-ES+) *m*/*z*: [M + Na]$^+$ calcd for $C_{29}H_{26}N_2O_4Na$ 489.1790, found 489.1772; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.37 min (major), 15.79 min (minor).

Spirooxindoles 8ja. White solid (92.9 mg, yield 99%, >20:1 dr, 89% ee); mp 186−188 °C; $[\alpha]_D^{20}$ = −102.4 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3441, 3246, 2907, 1737, 1701, 1617, 1472, 1147, 860, 807, 752 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.39 (s, 1H), 9.44 (s, 1H), 7.39 (d, *J* = 5.6 Hz, 1H), 7.38 (s, 1H), 7.30 (d, *J* = 7.6 Hz, 1H), 7.23−7.25 (m, 2H), 7.03−7.13 (m, 5H), 6.88 (td, *J* = 7.6, 1.2 Hz, 1H),

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6.70 (d, J = 8.4 Hz, 1H), 4.57 (dd, J = 11.2, 5.6 Hz, 1H), 4.14−4.22 (m, 1H), 4.01−4.09 (m, 2H), 3.82 (dd, J = 16.4, 11.2 Hz, 1H), 3.16 (dd, J = 16.4, 5.6 Hz, 1H), 1.15 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.9, 171.8, 141.8, 141.0, 138.4, 135.0, 129.9, 128.7, 128.2, 128.1, 127.9, 126.7, 125.6, 124.1, 121.0, 120.7, 116.7, 112.2, 109.2, 104.0, 60.4, 52.0, 46.1, 42.6, 27.5, 13.6; HRMS (TOF-ES+) m/z: [M + Na]$^+$ calcd for $C_{28}H_{23}N_2O_3NaCl$ 493.1295, found 493.1274; HPLC analysis: (CHIRALCEL OD-H, 30% i-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.46 min (major), 8.14 min (minor).

Spirooxindoles 8ka. White solid (101.9 mg, yield 99%, >20:1 dr, 82% ee); mp 181−182 °C; $[\alpha]_D^{20}$ = −118.0 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3439, 2906, 1737, 1699, 1616, 1471, 1147, 859, 805, 751 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.41 (s, 1H), 9.44 (s, 1H), 7.54 (d, J = 2.0 Hz, 1H), 7.35 (d, J = 8.8 Hz, 1H), 7.30 (d, J = 7.2 Hz, 1H), 7.23−7.25 (m, 2H), 7.19 (dd, J = 8.8, 2.0 Hz, 1H), 7.03−7.13 (m, 4H), 6.88 (td, J = 7.6, 0.8 Hz, 1H), 6.70 (d, J = 7.6 Hz, 1H), 4.57 (dd, J = 11.6, 6.0 Hz, 1H), 4.15−4.23 (m, 1H), 4.00−4.08 (m, 2H), 3.82 (dd, J = 16.4, 11.2 Hz, 1H), 3.16 (dd, J = 16.8, 5.6 Hz, 1H), 1.16 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.9, 171.7, 141.8, 140.9, 138.2, 135.2, 129.9, 128.8, 128.7, 128.1, 127.9, 126.7, 125.6, 123.3, 121.1, 119.8, 112.7, 111.7, 109.2, 103.9, 60.4, 52.0, 46.1, 42.6, 27.4, 13.6; HRMS (TOF-ES+) m/z: [M + Na]$^+$ calcd for $C_{28}H_{23}N_2O_3NaBr$ 537.0790, found 537.0765; HPLC analysis: (CHIRALCEL OD-H, 30% i-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.51 min (major), 8.06 min (minor).

Spirooxindoles 8la. White solid (91.9 mg, yield 99%, >20:1 dr, > 99% ee); mp 173−174 °C; $[\alpha]_D^{20}$ = −117.8 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3386, 2903, 1697, 1479, 1174, 1019, 840, 805, 751 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.00 (s, 1H), 9.40 (s, 1H), 7.23−7.31 (m, 4H), 7.09−7.13 (m, 2H), 7.02−7.06 (m, 2H), 6.85−6.90 (m, 2H), 6.73 (dd, J = 8.8, 2.4 Hz, 1H), 6.69 (d, J = 7.6 Hz, 1H), 4.58 (dd, J = 11.2, 5.6 Hz, 1H), 4.14−4.22 (m, 1H), 3.98−4.06 (m, 2H), 3.81−3.85 (m, 1H), 3.77 (s, 3H), 3.11 (dd, J = 16.4, 5.6 Hz, 1H), 1.16 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 178.0, 172.0, 153.9, 141.8, 141.2, 137.0, 131.6, 130.1, 128.7, 128.0, 127.9, 127.5, 126.6, 125.6, 121.0, 111.4, 110.3, 109.1, 103.9, 99.7, 60.2, 54.9, 52.1, 46.4, 42.7, 27.6, 13.8; HRMS (TOF-ES+) m/z: [M + Na]$^+$ calcd for $C_{29}H_{26}N_2O_4Na$ 489.1790, found 489.1768; HPLC analysis: (CHIRALCEL OD-H, 30% i-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.69 min (major), 20.05 min (minor).

Spirooxindoles 8ma. White solid (73.4 mg, yield 98%, >20:1 dr, 85% ee); mp 141−142 °C; $[\alpha]_D^{20}$ = −55.6 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3422, 2922, 1701, 1622, 1459, 1180, 865, 802, 743 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.94 (s, 1H), 10.47 (s, 1H), 7.31 (d, J = 8.0 Hz, 1H), 7.18−7.24 (m, 2H), 6.99−7.05 (m, 2H), 6.87−6.94 (m, 3H), 3.94 (s, 1H), 3.81−3.93 (m, 2H), 2.99−3.04 (m, 1H), 2.81−2.87 (m, 2H), 0.92 (t, J = 7.2 Hz, 3H), 0.82 (d, J = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 178.6, 171.9, 142.7, 136.5, 135.6, 131.0, 128.7, 127.1, 124.9, 121.6, 120.8, 118.8, 117.9, 111.3, 109.9, 103.7, 60.5, 52.4, 44.4, 32.0, 28.0, 16.3, 14.3; HRMS (TOF-ES+) m/z: [M + Na]$^+$ calcd for $C_{23}H_{22}N_2O_3Na$ 397.1528, found 397.1511; HPLC analysis: (CHIRALCEL OD-H, 30% i-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.10 min (major), 9.05 min (minor).

Spirooxindoles 8na. Major diastereomer: white solid (55.8 mg, yield 77%, 61% ee); mp 251−252 °C; $[\alpha]_D^{20}$ = −82.8 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3375, 2941, 1733, 1700, 1620, 1464, 1297, 1023, 916, 742 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ 10.96 (s, 1H), 10.71 (s, 1H), 7.22 (d, J = 8.0 Hz, 1H), 7.14−7.18 (m, 1H), 7.05 (d, J = 7.2 Hz, 1H), 6.90−6.95 (m, 2H), 6.70−6.81 (m, 3H), 3.69 (dd, J = 14.4, 7.2 Hz, 2H), 3.27 (dd, J = 12.0, 4.4 Hz, 1H), 2.85−2.98 (m, 2H), 2.30−2.37 (m, 2H), 0.81 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 180.4, 171.8, 142.6, 136.6, 136.4, 132.4, 128.6, 125.3, 125.0, 121.7, 121.0, 118.9, 117.5, 111.3, 109.6, 107.8, 60.3, 51.0, 47.7, 22.7, 22.1, 13.8; HRMS (TOF-ES+) m/z: [M + Na]$^+$ calcd for $C_{22}H_{20}N_2O_3Na$ 383.1372, found 383.1361; HPLC analysis: (CHIRALCEL OD-H, 30% i-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 7.53 min (minor), 17.74 min (major). Minor diastereomer: white solid (12.1 mg, yield 17%, 83% ee); mp 232−233 °C; $[\alpha]_D^{20}$ = −143.8 (c = 0.02 in CH_2Cl_2); IR (KBr) ν 3392, 2925, 1709, 1617, 1465, 1172, 1022, 814, 757, 734 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 (br s, 1H), 8.02 (br s, 1H), 7.34 (d, J = 8.4 Hz, 2H), 7.15−7.22 (m, 2H), 7.06−7.10 (m, 2H), 6.93 (d, J = 8.0 Hz, 1H), 6.87 (t, J = 7.6 Hz, 1H), 4.58 (s, 1H), 3.79−3.87 (m, 2H), 3.02−3.11 (m, 1H), 2.89 (dd, J = 16.0, 4.0 Hz, 1H), 2.35−2.42 (m, 1H), 1.93−1.98 (m, 1H), 0.80 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 181.3, 170.5, 140.6, 136.2, 133.5, 130.2, 128.5, 127.3, 125.7, 122.2, 121.8, 119.8, 119.6, 110.6, 109.7, 106.1, 60.6, 51.0, 44.8, 31.4, 19.7, 13.6; HRMS (TOF-ES+) m/z: [M + Na]$^+$ calcd for $C_{22}H_{20}N_2O_3Na$ 383.1372, found 383.1389; HPLC analysis: (CHIRALCEL AD-H, 30% i-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 10.28 min (minor), 12.03 min (major).

Spirooxindoles 8ab. White solid (90.5 mg, yield 99%, >20:1 dr, 98% ee); mp 266−268 °C; $[\alpha]_D^{20}$ = −67.5 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3423, 3211, 2908, 1706, 1479, 1183, 1030, 888, 828, 744 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.19 (s, 1H), 9.44 (s, 1H), 7.37−7.42 (m, 2H), 7.27−7.29 (m, 2H), 7.13−7.16 (m, 2H), 7.07−7.10 (m, 3H), 6.99−7.02 (m, 1H), 6.81−6.86 (m, 1H), 6.68−6.71 (m, 1H), 4.57 (dd, J = 11.4, 5.8 Hz, 1H), 4.13−4.20 (m, 1H), 4.07−4.12 (m, 2H), 3.82 (dd, J = 16.4, 11.6 Hz, 1H), 3.16 (dd, J = 16.4, 6.0 Hz, 1H), 1.17 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.8, 172.0, 158.1 (d, $^1J_{C-F}$ = 234 Hz), 140.8, 138.0, 136.6, 136.2, 131.9 (d, $^3J_{C-F}$ = 8 Hz), 128.7, 128.0, 127.0, 126.8, 120.8, 118.8, 117.3, 114.2 (d, $^2J_{C-F}$ = 23 Hz), 113.3 (d, $^2J_{C-F}$ = 25 Hz), 110.9, 109.7 (d, $^3J_{C-F}$ = 8 Hz), 103.6, 60.4, 52.7, 46.3, 42.7, 27.4, 13.6; HRMS (TOF-ES+) m/z: [M + Na]$^+$ calcd for $C_{28}H_{23}N_2O_3NaF$ 477.1590, found 477.1575; HPLC analysis: (CHIRALCEL OD-H, 30% i-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.57 min (major), 12.58 min (minor).

Spirooxindoles 8ac. White solid (93.0 mg, yield 99%, >20:1 dr, 96% ee); mp 274−275 °C; $[\alpha]_D^{20}$ = −96.4 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3433, 3216, 2910, 1738, 1699, 1456, 1308, 1145, 827, 754, 704 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.19 (s, 1H), 9.55 (s, 1H), 7.38 (d, J = 6.4 Hz, 1H), 7.38 (s, 1H), 7.26−7.30 (m, 3H), 7.14−7.18 (m, 2H), 7.07−7.11 (m, 3H), 6.99−7.03 (m, 1H), 6.72 (d, J = 8.4 Hz, 1H), 4.55 (dd, J = 11.2, 5.6 Hz, 1H), 4.09−4.19 (m, 2H), 4.08 (s, 1H), 3.82 (dd, J = 16.4, 11.6 Hz, 1H), 3.17 (dd, J = 16.6, 5.6 Hz, 1H), 1.18 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.5, 172.0, 140.8, 140.7, 136.6, 136.2, 132.1, 128.6, 128.1, 127.9, 127.0, 126.9, 125.8(1), 125.7(6), 120.9, 118.9, 117.2, 110.9, 110.4, 103.6, 60.5, 52.5, 46.2, 42.7, 27.4, 13.7; HRMS (TOF-ES+) m/z: [M + Na]$^+$ calcd for $C_{28}H_{23}N_2O_3NaCl$ 493.1295, found 493.1295; HPLC analysis: (CHIRALCEL OD-H, 30% i-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.50 min (major), 11.63 min (minor).

Spirooxindoles 8ad. White solid (102.7 mg, yield 99%, >20:1 dr, 94% ee); mp 276−277 °C; $[\alpha]_D^{20}$ = −100.0 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3433, 3210, 2909, 1736, 1698, 1457, 1173, 1145, 825, 752, 704 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.20 (s, 1H), 9.57 (s, 1H), 7.43 (d, J = 2.0 Hz, 1H), 7.37−7.41 (m, 2H), 7.26 (d, J = 7.6 Hz, 2H), 7.23 (dd, J = 8.4, 2.0 Hz, 1H), 7.16 (t, J = 7.2 Hz, 2H), 7.07−7.11 (m, 2H), 6.99−7.03 (m, 1H), 6.68 (d, J = 8.4 Hz, 1H), 4.54 (dd, J = 11.2, 5.6 Hz, 1H), 4.10−4.19 (m, 2H), 4.08 (s, 1H), 3.81 (dd, J = 16.4, 11.2 Hz, 1H), 3.17 (dd, J = 16.4, 5.6 Hz, 1H), 1.19 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.4, 172.0, 141.1, 140.7, 136.6, 136.2, 132.5, 130.8, 128.6, 128.5, 128.1, 127.0, 126.9, 120.9, 118.9, 117.2, 113.1, 110.9, 103.6, 60.5, 52.5, 46.2, 42.7, 27.4, 13.7; HRMS (TOF-ES+) m/z: [M + Na]$^+$ calcd for $C_{28}H_{23}N_2O_3NaBr$ 537.0790, found 537.0768; HPLC analysis: (CHIRALCEL OD-H, 30% i-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.55 min (major), 11.76 min (minor).

Spirooxindoles 8ae. White solid (90.0 mg, yield 99%, >20:1 dr, 96% ee); mp 269−270 °C; $[\alpha]_D^{20}$ = −90.2 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3446, 3221, 2920, 1737, 1685, 1493, 1458, 1181, 826, 740, 700 cm^{-1}; ^{1}H NMR (400 MHz, acetone-d_6) δ 10.15 (s, 1H), 9.29 (s, 1H), 7.38 (d, J = 8.4 Hz, 2H), 7.24−7.26 (m, 2H), 7.05−7.13 (m, 5H), 6.97−7.01 (m, 1H), 6.86 (dd, J = 8.0, 0.8 Hz, 1H), 6.58 (d, J = 7.6 Hz, 1H), 4.54 (dd, J = 11.2, 5.6 Hz, 1H), 4.03−4.16 (m, 2H), 4.03 (s, 1H), 3.83 (dd, J = 16.4, 11.6 Hz, 1H), 3.13 (dd, J = 16.6, 5.8 Hz, 1H), 2.24 (s, 3H), 1.14 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 178.0, 172.1, 141.3, 139.3, 136.6, 136.3, 130.1, 130.0,

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128.7, 128.2, 127.9, 127.1, 126.6, 126.1, 120.7, 118.8, 117.2, 110.8, 108.8, 104.1, 60.2, 52.1, 46.5, 42.7, 27.6, 20.3, 13.6; HRMS (TOF-ES+) m/z: $[M + Na]^+$ calcd for $C_{29}H_{26}N_2O_3Na$ 473.1841, found 473.1829; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.49 min (major), 13.00 min (minor).

Spirooxindoles 8af. White solid (101.8 mg, yield 99%, >20:1 dr, 93% ee); mp 278−279 °C; $[\alpha]_D^{20}$ = −84.8 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3366, 2922, 2922, 1722, 1702, 1604, 1452, 1329, 1184, 847, 809, 746 cm^{-1}; ^1H NMR (400 MHz, acetone-d_6) δ 10.19 (s, 1H), 9.56 (s, 1H), 7.39 (t, J = 8.0 Hz, 2H), 7.24 (d, J = 7.6 Hz, 3H), 7.12−7.16 (m, 2H), 7.07−7.10 (m, 3H), 6.98−7.02 (m, 1H), 6.89 (d, J = 2.0 Hz, 1H), 4.57 (dd, J = 11.2, 6.0 Hz, 1H), 4.13−4.19 (m, 1H), 4.03−4.09 (m, 2H), 3.81 (dd, J = 16.4, 11.2 Hz, 1H), 3.16 (dd, J = 16.6, 5.6 Hz, 1H), 1.16 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.6, 171.9, 143.5, 140.8, 136.6, 136.2, 129.4, 128.6, 128.0, 127.4, 127.0, 126.8, 123.7, 121.1, 120.8, 118.9, 117.3, 112.2, 110.9, 103.7, 60.4, 52.1, 46.1, 42.6, 27.4, 13.6; HRMS (TOF-ES+) m/z: $[M + Na]^+$ calcd for $C_{28}H_{23}N_2O_3NaBr$ 537.0790, found 537.0764; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.89 min (major), 15.98 min (minor).

Spirooxindoles 8ag. White solid (102.0 mg, yield 99%, >20:1 dr, 89% ee); mp 271−272 °C; $[\alpha]_D^{20}$ = −55.4 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3434, 2978, 1711, 1612, 1457, 1335, 1178, 782, 739 cm^{-1}; ^1H NMR (400 MHz, acetone-d_6) δ 10.20 (s, 1H), 9.58 (s, 1H), 7.39 (t, J = 7.2 Hz, 2H), 7.30 (d, J = 7.2 Hz, 1H), 7.23−7.27 (m, 3H), 7.06−7.15 (m, 4H), 6.99−7.03 (m, 1H), 6.87 (t, J = 7.8 Hz, 1H), 4.56 (dd, J = 11.0, 5.6 Hz, 1H), 4.12−4.17 (m, 1H), 4.11 (s, 1H), 4.02−4.06 (m, 1H), 3.80 (dd, J = 16.4, 11.2 Hz, 1H), 3.18 (dd, J = 16.6, 5.6 Hz, 1H), 1.13 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.2, 171.8, 141.2, 140.8, 136.6, 136.1, 131.8, 131.0, 128.6, 128.0, 127.0, 126.9, 124.7, 122.6, 120.9, 118.9, 117.3, 110.9, 103.6, 101.7, 60.4, 53.5, 46.3, 42.8, 27.4, 13.6; HRMS (TOF-ES+) m/z: $[M + Na]^+$ calcd for $C_{28}H_{23}N_2O_3NaBr$ 537.0790, found 537.0783; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.42 min (major), 8.57 min (minor).

Spirooxindoles 8ah. White solid (90.8 mg, yield 99%, >20:1 dr, 83% ee); mp 266−268 °C; $[\alpha]_D^{20}$ = −85.9 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3368, 3306, 2910, 1717, 1645, 1494, 1333, 1192, 859, 776, 737 cm^{-1}; ^1H NMR (400 MHz, acetone-d_6) δ 10.19 (s, 1H), 9.83 (s, 1H), 7.40 (t, J = 7.2 Hz, 2H), 7.23−7.26 (m, 2H), 7.07−7.17 (m, 5H), 6.99−7.03 (m, 1H), 6.90−6.93 (m, 2H), 4.58 (dd, J = 11.2, 5.6 Hz, 1H), 4.13−4.18 (m, 1H), 4.10 (s, 1H), 4.02−4.06 (m, 1H), 3.82 (dd, J = 16.4, 11.2 Hz, 1H), 3.17 (dd, J = 16.6, 5.6 Hz, 1H), 1.14 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 177.4, 171.9, 147.7, 145.3, 140.8, 136.6, 136.1, 133.1, 128.9, 128.6, 128.0, 126.8, 121.7, 121.6, 120.8, 118.9, 117.3, 114.8, 110.9, 103.7, 60.4, 52.7, 46.2, 42.8, 27.3, 13.6; HRMS (TOF-ES+) m/z: $[M + Na]^+$ calcd for $C_{28}H_{23}N_2O_3NaF$ 477.1590, found 477.1599; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 5.71 min (major), 8.80 min (minor).

Spirooxindoles 8ai. White solid (90.9 mg, yield 97%, >20:1 dr, 81% ee); mp 167−168 °C; $[\alpha]_D^{20}$ = −112.9 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3421, 3372, 2923, 1691, 1622, 1468, 1209, 807, 749 cm^{-1}; ^1H NMR (400 MHz, acetone-d_6) δ 10.16 (s, 1H), 9.46 (s, 1H), 7.81−7.83 (m, 2H), 7.54−7.59 (m, 1H), 7.43 (t, J = 7.8 Hz, 2H), 7.34 (d, J = 8.4 Hz, 1H), 7.27−7.29 (m, 2H), 7.08−7.12 (m, 2H), 6.95−7.06 (m, 3H), 6.81−6.86 (m, 2H), 6.73−6.77 (m, 1H), 6.65 (d, J = 8.0 Hz, 1H), 6.53 (td, J = 7.6, 1.2 Hz, 1H), 5.34 (s, 1H), 4.67 (dd, J = 11.4, 6.0 Hz, 1H), 3.92 (dd, J = 16.2, 11.4 Hz, 1H), 3.20 (dd, J = 16.6, 5.8 Hz, 1H); ^{13}C NMR (100 MHz, acetone-d_6) δ 200.9, 178.4, 141.7, 141.2, 138.9, 136.7, 136.5, 132.9, 129.3, 128.8, 128.6, 128.2, 127.8, 127.7, 127.0, 126.6, 126.4, 120.6, 120.5, 118.5, 117.0, 110.8, 108.9, 105.4, 52.7, 44.8, 42.8, 27.7; HRMS (TOF-ES+) m/z: $[M + Na]^+$ calcd for $C_{32}H_{24}N_2O_2Na$ 491.1735, found 491.1756; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.08 min (major), 13.85 min (minor).

Spirooxindoles 8aj. White solid (77.7 mg, yield 99%, >20:1 dr, 94% ee); mp 261−262 °C; $[\alpha]_D^{20}$ = −110.5 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3366, 2879, 1702, 1621, 1458, 1180, 752, 703 cm^{-1}; ^1H NMR (400 MHz, acetone-d_6) δ 10.37 (s, 1H), 9.57 (s, 1H), 7.61 (t, J = 8.0 Hz, 2H), 7.44−7.46 (m, 1H), 7.25−7.28 (m, 2H), 7.08−7.18 (m, 6H), 6.97 (td, J = 7.6, 0.8 Hz, 1H), 6.77 (d, J = 8.0 Hz, 1H), 4.58 (s, 1H), 3.97 (dd, J = 10.2, 5.8 Hz, 1H), 3.74 (dd, J = 16.6, 10.2 Hz, 1H), 3.27 (dd, J = 16.8, 6.0 Hz, 1H); ^{13}C NMR (100 MHz, acetone-d_6) δ 176.6, 141.7, 140.3, 136.7, 135.8, 129.2, 128.6, 128.4, 128.0, 127.0, 126.3, 126.1, 121.4, 121.2, 119.3, 118.5, 117.3, 111.1, 109.3, 101.0, 51.1, 44.5, 32.4, 27.5; HRMS (TOF-ES+) m/z: $[M + Na]^+$ calcd for $C_{26}H_{19}N_3ONa$ 412.1426, found 412.1411; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.54 min (major), 25.13 min (minor).

Spirooxindoles 8ak. White solid (80.8 mg, yield 99%, >20:1 dr, 89% ee); mp 234−236 °C; $[\alpha]_D^{20}$ = −75.0 (c = 0.1 in CH_2Cl_2); IR (KBr) ν 3404, 2921, 1704, 1620, 1468, 1350, 1161, 741, 701 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ 11.01 (s, 1H), 10.48 (s, 1H), 7.33 (d, J = 8.0 Hz, 1H), 7.23 (d, J = 8.0 Hz, 1H), 6.92−7.13 (m, 9H), 6.82 (t, J = 7.4 Hz, 1H), 6.63 (d, J = 7.6 Hz, 1H), 4.20−4.23 (m, 2H), 3.59 (dd, J = 16.2, 11.4 Hz, 1H), 3.05 (dd, J = 16.6, 5.8 Hz, 1H), 2.00 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 209.4, 178.8, 142.0, 141.3, 136.4, 129.5, 128.9, 128.4(0), 128.3(5), 127.1, 126.9, 125.7, 121.2, 120.9, 119.0, 117.6, 111.4, 109.7, 104.4, 52.3, 51.1, 42.5, 33.5, 27.8; HRMS (TOF-ES+) m/z: $[M + Na]^+$ calcd for $C_{27}H_{22}N_2O_2Na$ 429.1579, found 429.1559; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.70 min (major), 18.89 min (minor).

Spirooxindoles 8al. Major diastereomer: white solid (60.1 mg, yield 65%, 45% ee); mp 224−225 °C; $[\alpha]_D^{20}$ = 49.9 (c = 0.1 in acetone); IR (KBr) ν 3397, 2982, 1728, 1616, 1464, 1266, 913, 760, 706 cm^{-1}; ^1H NMR (400 MHz, acetone-d_6) δ 10.37 (s, 1H), 9.89 (s, 1H), 7.72−7.74 (m, 2H), 7.48 (d, J = 7.6 Hz, 1H), 7.33−7.41 (m, 4H), 7.27 (td, J = 7.6, 1.2 Hz, 1H), 6.93−7.06 (m, 4H), 6.83−6.87 (m, 1H), 4.56 (dd, J = 12.0, 5.6 Hz, 1H), 3.47−3.67 (m, 4H), 0.80 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 174.7, 164.5, 141.4, 139.5, 136.8, 134.8, 130.2, 129.3, 129.1, 128.2, 127.8, 126.9, 125.1, 121.8, 121.5, 119.1, 117.6, 115.7, 111.1, 109.5, 106.7, 61.9, 57.5, 54.5, 42.5, 12.7; HRMS (TOF-ES+) m/z: $[M + Na]^+$ calcd for $C_{29}H_{23}N_3O_3Na$ 484.1637, found 484.1655; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 7.37 min (major), 11.35 min (minor). Minor diastereomer: white solid (30.3 mg, yield 33%, 83% ee); mp 272−273 °C; $[\alpha]_D^{20}$ = 297.0 (c = 0.05 in acetone); IR (KBr) ν 3358, 2919, 1695, 1621, 1456, 1227, 1009, 853, 743 cm^{-1}; ^1H NMR (400 MHz, acetone-d_6) δ 10.53 (s, 1H), 9.71 (s, 1H), 7.65 (d, J = 7.6 Hz, 1H), 7.45 (d, J = 8.0 Hz, 1H), 7.32 (d, J = 8.0 Hz, 1H), 7.23−7.25 (m, 2H), 7.07−7.18 (m, 6H), 6.94−6.98 (m, 1H), 6.70 (d, J = 7.6 Hz, 1H), 4.76 (dd, J = 12.0, 5.6 Hz, 1H), 4.38−4.42 (m, 1H), 4.25−4.30 (m, 1H), 3.95−4.02 (m, 1H), 3.17 (dd, J = 16.8, 5.6 Hz, 1H), 1.26 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 175.1, 167.2, 142.6, 139.2, 137.3, 136.4, 129.2, 129.0, 127.9, 127.1, 127.0, 125.5, 125.2, 121.5, 119.5, 117.4, 116.6, 111.3, 109.6, 109.5, 100.9, 62.9, 56.2, 51.0, 42.6, 26.2, 13.5; HRMS (TOF-ES+) m/z: $[M + Na]^+$ calcd for $C_{29}H_{23}N_3O_3Na$ 484.1637, found 484.1625; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.20 min (major), 24.56 min (minor).

Spirooxindoles 8am. White solid (51.7 mg, yield 62%, >20:1 dr, 81% ee); mp 229−230 °C; $[\alpha]_D^{20}$ = 145.1 (c = 0.05 in acetone); IR (KBr) ν 3383, 1719, 1619, 1455, 1321, 1186, 749, 700, 482 cm^{-1}; ^1H NMR (400 MHz, acetone-d_6) δ 10.64 (s, 1H), 10.28 (s, 1H), 7.67−7.69 (m, 2H), 7.47−7.58 (m, 5H), 7.42 (d, J = 8.4 Hz, 1H), 7.29 (d, J = 8.0 Hz, 1H), 7.16−7.21 (m, 1H), 7.05−7.09 (m, 1H), 6.75−6.79 (m, 1H), 6.14 (d, J = 8.0 Hz, 1H), 5.28 (dd, J = 12.0, 5.2 Hz, 1H), 3.82 (dd, J = 17.2, 12.0 Hz, 1H), 3.52 (dd, J = 17.2, 5.2 Hz, 1H); ^{13}C NMR (100 MHz, acetone-d_6) δ 175.0, 142.9, 137.1, 136.8, 135.6, 130.9, 129.1(4), 129.0(5), 129.0, 127.0, 126.6, 124.9, 122.8, 121.9, 119.5, 117.6, 113.4, 113.0, 111.4, 110.6, 103.3, 53.7, 47.7, 41.0, 26.1; HRMS (TOF-ES+) m/z: $[M + H]^+$ calcd for $C_{27}H_{19}N_4O$ 415.1559, found 415.1572; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.95 min (minor), 11.78 min (major).

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Spirooxindoles 8oa. White solid (90.2 mg, yield 86%, >20:1 dr, 12% ee); mp 253−255 °C; $[\alpha]_D^{20}$ = −2.7 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3371, 2982, 1717, 1616, 1465, 1170, 845, 803, 743, 698, cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ 10.44 (s, 1H), 7.39 (d, *J* = 8.4 Hz, 1H), 7.27−7.33 (m, 3H), 7.20−7.24 (m, 1H), 6.99−7.15 (m, 11H), 6.83 (td, *J* = 7.6, 0.8 Hz, 1H), 6.62 (d, *J* = 7.6 Hz, 1H), 5.45 (d, *J* = 2.0 Hz, 2H), 4.38−4.42 (m, 1H), 3.96−4.10 (m, 3H), 3.54 (dd, *J* = 16.4, 11.2 Hz, 1H), 3.17 (dd, *J* = 16.8, 6.0 Hz, 1H), 1.06 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 178.3, 172.2, 142.1, 141.1, 138.8, 137.8, 136.9, 129.9, 129.0, 128.9, 128.6, 128.4, 127.5, 127.2, 126.7, 125.3, 121.3(4), 121.2(8), 119.6, 117.6, 110.3, 109.7, 104.1, 60.8, 51.9, 46.3, 46.1, 42.5, 26.8, 14.5; HRMS (TOF-ES+) *m*/*z*: $[M + Na]^+$ calcd for $C_{35}H_{30}N_2O_3Na$ 549.2154, found 549.2144; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 6.94 min (major), 9.15 min (minor).

Spirooxindoles 8an.[8a] White solid (104.6 mg, yield 99%, >20:1 dr, 28% ee); $[\alpha]_D^{20}$ = −14.5 (*c* = 0.1 in CH_2Cl_2); ^1H NMR (400 MHz, $CDCl_3$) δ 8.05 (s, 1H), 7.43 (d, *J* = 7.6 Hz, 1H), 7.35 (dd, *J* = 7.6, 0.4 Hz, 1H), 7.24−7.31 (m, 3H), 7.12−7.15 (m, 3H), 7.07−7.11 (m, 3H), 6.96−7.05 (m, 4H), 6.89 (td, *J* = 7.6, 0.8 Hz, 1H), 6.52 (d, *J* = 8.0 Hz, 1H), 4.86 (d, *J* = 15.6 Hz, 1H), 4.71 (d, *J* = 15.6 Hz, 1H), 4.58 (dd, *J* = 10.8, 6.0 Hz, 1H), 4.13−4.17 (m, 1H), 4.10 (s, 1H), 4.00−4.04 (m, 1H), 3.84 (dd, *J* = 16.4, 11.2 Hz, 1H), 3.15 (dd, *J* = 16.4, 6.0 Hz, 1H), 1.13 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.6, 172.4, 142.6, 140.1, 136.2, 135.7(2), 135.6(6), 129.3, 128.9, 128.6, 128.2, 128.0, 127.6, 127.5, 126.9, 125.5, 121.9, 121.5, 119.5, 117.9, 110.9, 108.8, 104.6, 60.9, 52.3, 46.2, 43.7, 42.7, 27.3, 14.2; HRMS (TOF-ES+) *m*/*z*: $[M + Na]^+$ calcd for $C_{35}H_{30}N_2O_3Na$ 549.2154, found 549.2133; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 7.51 min (minor), 9.22 min (major).

Spirooxindoles 8on. White solid (99.8 mg, yield 81%, >20:1 dr, 3% ee); mp 187−188 °C; $[\alpha]_D^{20}$ = 0 (*c* = 0.1 in CH_2Cl_2); IR (KBr) ν 3426, 2920, 1704, 1608, 1461, 1361, 1168, 916, 841, 746, 697 cm^{-1}; ^1H NMR (400 MHz, acetone-d_6) δ 7.45 (d, *J* = 7.6 Hz, 1H), 7.25−7.38 (m, 9H), 7.21 (d, *J* = 7.2 Hz, 2H), 7.14−7.16 (m, 2H), 7.02−7.12 (m, 6H), 6.91−6.95 (m, 1H), 6.69 (d, *J* = 8.0 Hz, 1H), 5.54 (d, *J* = 3.2 Hz, 2H), 4.88 (d, *J* = 2.0 Hz, 2H), 4.66−4.70 (m, 1H), 4.16−4.20 (m, 1H), 4.04−4.09 (m, 2H), 3.74−3.81 (m, 1H), 3.20−3.25 (m, 1H), 1.15 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, acetone-d_6) δ 176.2, 171.9, 142.8, 140.7, 138.5, 137.6, 137.0, 136.5, 129.2, 128.8, 128.6, 128.5, 128.1, 127.9, 127.5, 127.3, 127.0, 126.9, 126.7, 126.3, 125.3, 121.6, 120.9, 119.2, 117.5, 109.6, 108.8, 104.2, 60.4, 51.9, 46.7, 45.9, 43.1, 42.5, 26.7, 13.6; HRMS (TOF-ES+) *m*/*z*: $[M + Na]^+$ calcd for $C_{42}H_{36}N_2O_3Na$ 639.2624, found 639.2633; HPLC analysis: (CHIRALCEL OD-H, 30% *i*-propanol/hexanes, 0.8 mL/min, UV: 254 nm), t_R = 10.04 min (minor), 15.20 min (major).

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acs.joc.7b00733.

Copies of NMR and HPLC analysis spectra of all compounds (PDF)

X-ray structural data for compound **8af** (CIF)

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Notes

The authors declare no competing financial interest.

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