Organic & Biomolecular Chemistry



View Article Online

PAPER



Cite this: Org. Biomol. Chem., 2024, **22**, 621

Diastereoselective synthesis of *trans*-2,3dihydroindoles *via* formal [4 + 1] annulation reactions of a sulfonium ylide[†]

approach was broadened to synthesize dihydrobenzofurans.

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We have established an *in situ* generated sulfonium-ylide mediated annulation to construct 2,3-disubstituted-2,3-dihydroindoles. The [4 + 1] annulation approach relied on Michael addition/substitution

reactions. These reactions were carried out at ambient temperature to deliver dihydroindoles with excel-

lent yields and diastereoselectivities. Moreover, the versatility of this approach allows for the introduction

of various functional groups, enabling further diversification of the dihydroindoles. Also, the cascade

Received 2nd November 2023, Accepted 15th December 2023

DOI: 10.1039/d3ob01793a

rsc.li/obc

Introduction

[4 + 1] Annulation is an effective technique that enables the construction of diversely substituted five-membered rings in a one-pot operation.¹⁻⁴ It is successfully mediated by a number of combinations of A4- and A1-synthons (Scheme 1), which produce a variety of five-membered heterocyclic compounds, including fused and spirocyclic frameworks.¹⁻⁴ Various Michael acceptors, including conjugated carbonyl compounds, conjugated imines, azoalkenes, and many more, often serve as A4-synthons in [4 + 1] annulation reactions.^{5,6} Besides a variety of A1-synthons,⁷⁻⁹ ylides are one of the most powerful and versatile synthons in synthetic organic chemistry, offering a wide range of reactivity patterns and functional group compatibility.^{10,11} Consequently, they hold great potential for synthesizing complex natural and biologically active compounds.¹² They have both electrophilic and nucleophilic centers localized on the same carbon atom. Among the manifold applications of ylides, their participation in formal [4 + 1]annulation reactions stands out as the most prominent and promising area of research. Several cascade approaches have been established utilizing ylide chemistry to access N-heterocycles with remarkable efficiency and selectivity.10,11,13-18

N-heterocycles have significant importance in medicinal chemistry, drug discovery, and the synthesis of natural products.^{19–21} In particular, 2,3-disubstituted dihydroindoles

(DHIs) play key roles in the development of new pharmacological drugs. DHIs are prevalent in various bioactive compounds and alkaloids, *e.g.*, vindoline,²² aspidospermidine,²³ strychnine,²⁴ flustramine B,²⁵ physostigmine,²⁶ and WAY-163909²⁷ (Fig. 1).

The majorly reported strategy for the synthesis of DHIs is reduction of indoles *via* catalytic hydrogenation or dearomative annulation.^{28,29} In the last decade, synthetic techniques for dihydroindoles have expanded to other organo- as well as metal-catalysed approaches.^{30–33} Recently, our group has demonstrated a supported pyridinium ylide-mediated cascade synthesis of *trans*-2,3-dihydroindoles³⁴ and *trans*-2,3-dihydrobenzofurans.³⁵ In continuation of our study, we hypothesized that a sulfonium salt would participate in the *in situ* generation of a sulfonium ylide. This sulfonium ylide might then undergo a 1,4-conjugate addition with an *ortho*-aminochalcone followed by subsequent cyclization through *N*-substitution, yielding the corresponding DHIs.

Results and discussion

At the outset, an experiment was conducted wherein a reaction was performed using phenacyl sulfonium salt **1a** and *ortho*aminochalcone **2aa** in the presence of triethylamine as a base



Scheme 1 General strategy of the [4 + 1] annulation.

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[†]Electronic supplementary information (ESI) available. CCDC 2178470. For ESI and crystallographic data in CIF or other electronic format see DOI: https://doi.org/10.1039/d3ob01793a





reaction led to 2,3-disubstituted dihydroindole 3aaa in a viable vield (Table 1, entry 1). The structure of product 3aaa as a trans-isomer was confirmed by single crystal X-ray analysis.

Next, we conducted a systematic investigation of several organic and inorganic bases and solvents to determine the optimal reaction conditions for this cascade approach. Almost a similar outcome was observed with N-ethyl diisopropylamine as the base (Table 1, entry 2). When the reaction was carried out with stronger bases, namely 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) and 1,5-diazabicyclo[4.3.0]non-5-ene (DBN), significant reduction in the reaction time was observed (Table 1, entries 3 and 4). However, the yield of the desired product was unaltered. A slight increment in the yield was noted with N-methyl pyrrolidine (NMP) and N-methyl piperidine (NMPPR) (Table 1, entries 5 and 6). The yield of product 3aaa was drastically decreased with the inorganic base sodium carbonate (Table 1, entry 7). Notably, cesium carbonate was identified as an appropriate base in terms of yield and time. Subsequently, several solvents were evaluated (Table 2). Eventually, toluene emerged as the most favourable solvent for this cascade

at ambient temperature in toluene. Pleasingly, the cascade

Cs₂CO₃, solvent, r 2aa 3aaa Entry Solvent R Time (h) Yield (%) 1 Toluene 97 Me 24 2 CH₃CN 24 80 Me CH₂Cl₂ 32 85 3 Me 4 EtOAc Me 28 89 5 THF Me 38 75 64 H_2O Me 48 41 7 Toluene -CH2(CH2)2CH2-28 94 -CH(CH)2CH-92 8 Toluene 28

Table 2 Effect of solvents

Reaction conditions: 1 (0.3 mmol), 2aa (0.2 mmol), Cs₂CO₃ (0.2 mmol), and solvent (2 mL), unless specified. Diastereoisomeric ratios for all entries (>99:1) were determined by ¹H-NMR analysis. ^a dr = 20:1.

approach. To further check the reactivity and selectivity of the reaction, we explored the cyclic sulfonium salt of phenacyl bromide (Table 2, entries 7 and 8). Remarkably, the cascade reaction proceeded smoothly, albeit with a slight reduction in the yield. After thorough evaluation, the dimethyl sulfonium salt 1a was identified as the optimal A1-synthon for this cascade approach, offering maximum efficiency.

Having established the optimal reaction conditions, we explored the substrate generality of this [4 + 1] annulation reaction (Tables 3 and 4). At first, we examined the effect of the substitution pattern on the phenacyl sulfonium salt (Table 3). Specifically, we investigated the effects of introducing halogens

Table 3 Substrate scope of sulfonium salts



Table 1 Optimization of the cascade reaction conditions with different

Reaction conditions: 1a (0.3 mmol), 2aa (0.2 mmol), base (0.2 mmol), and toluene (2 mL), unless specified. Diastereoisomeric ratios for all entries (>99:1) were determined by ¹H-NMR analysis.



Reaction conditions: 1 (0.3 mmol), 2aa (0.2 mmol), Cs₂CO₃ (0.2 mmol), and toluene (2 mL), unless specified. Diastereoisomeric ratios for all entries (>99:1) were determined by ¹H-NMR analysis.

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Table 4 Substrate scope of ortho-aminochalcones



Reaction conditions: **1a** (0.3 mmol), **2** (0.2 mmol), Cs_2CO_3 (0.2 mmol), and toluene (2 mL), unless specified. Diastereoisomeric ratios for all entries (>99:1) were determined by ¹H-NMR analysis.

(1b-d) (fluoro, chloro, and bromo), electron-withdrawing groups (1e and 1f) (cyano and nitro), and the methyl group 1g at the *para*-position of the aryl ring of compound 1. Remarkably, all of these led to the corresponding DHIs (3baa-gaa) in excellent yields.

The introduction of an electron-donating group, specifically methoxy (1h-j), at the ortho-, meta- and para-positions of the aryl ring was observed to be well tolerated under the optimized conditions. Excellent yields were observed when dichloro-substitution was introduced at both the 2,5- and 3,4-positions (1k and 11) of the aryl ring in sulfonium salt 1. Importantly, 2-naphthyl (1m) and biphenyl (1n) substituted sulfonium salts also resulted in the formation of the corresponding DHIs (3maa and 3naa) in excellent yields. Additionally, we discovered that sterically and electronically diverse R¹ groups, including heterocycles (10 and 1p) i.e., 2-furyl and 2-thiophenyl, and aliphatic groups (1q-s) i.e., adamantyl, tert-butyl, and methyl, were also well suited for the reaction and successfully transformed into the desired dihydroindoles. Next, our investigation focused on elucidating the effect of substitution on ortho-aminochalcones 2 (Table 4). To begin with, the influence of halogens on the 5-position of the aryl ring was investigated and fluoro, chloro, and bromo substituted DHIs were constructed (3aba-3ada). To further expand the scope of the [4 + 1] annulation reaction, we varied the R² group of *ortho*aminochalcone 2. For instance, halogen, cyano, and methyl were strategically introduced at the para-positions of the aryl ring of compound 2. Remarkably, all of these substitutions were well tolerated. Amenable outcomes were obtained when the R² group was represented by differently substituted methoxy groups on the aryl ring. Additionally, a favourable



Reaction conditions: 1 (0.3 mmol), 2 (0.2 mmol), Cs_2CO_3 (0.2 mmol), and toluene (2 mL), unless specified. ^{*a*} The reaction was conducted at 80 °C and the formation of a trace amount of the product was confirmed by HRMS analysis and ¹H NMR of the crude reaction mixture.

outcome was observed with R^2 groups as 2-naphthyl, biphenyl, heteroaryl, and alkyl. Notably, it was seen that all the dihydroindoles were obtained exclusively as a single *trans*-isomer.

Furthermore, we explored various sulfonium salt derivatives (1t-1v) including secondary sulfonium salt 1w (Table 5). Among them, ester-derived sulfonium salt 1t was found to be efficient, leading to dihydroindole 3taa. However, the cascade reaction with other salts (1u-1w) did not yield the anticipated products. Next, the reaction with the electronically distinct *ortho*-aminochalcone bearing ester functionality 2ap provided a trace amount of the corresponding DHI at elevated temperatures.

Drawing upon insights from the previous reports,^{34,35} a plausible mechanism for this [4 + 1] annulation reaction was proposed, as shown in Fig. 2. The cascade reaction is initiated with base promoted in situ generation of a sulfonium ylide, which functioned as the active A1 synthon. The in situ generated sulfonium ylide then reacts with aminochalcone 2 in a conjugate addition fashion, forming intermediate A. Notably, the sulfonium ylide can also be prepared and later used in the cascade reaction with or without any base to provide the same products (Table 6). This suggests that the base has a minimal role in the subsequent steps. A proton is transferred from -NHTs to the enolate/carbanion leading to B. HRMS data analysis of the crude reaction mixture showed the presence of a protonated form of intermediate A (or B). Finally, an intramolecular nucleophilic substitution by an amine led to the formation of trans-DHIs 3 with the removal of dimethyl sulfide.



Fig. 2 Plausible mechanism of the [4 + 1] annulation approach.

Table 6 Study of the protecting amino group of 2



Reaction conditions: 1 (0.3 mmol), 2 (0.2 mmol), and toluene (2 mL), unless specified. ^a The reaction was conducted with 10 mol% of Cs₂CO₃ and the reaction was completed in 24 h.

To demonstrate the practicality and scalability of the developed methodology, the [4 + 1] annulation reaction was carried out at the gram-scale, resulting in the formation of product 3aaa in excellent yield and dr (Scheme 2).

Furthermore, the [4 + 1] annulation reaction was also evaluated using the preformed sulfonium ylide 1a'. Although, the reaction took a longer time to achieve completion in the absence of any base, the desired DHI 3aaa was formed in a comparable yield (Table 6). With a catalytic amount of Cs_2CO_3 (10 mol%), the reaction was relatively faster. Next, we tested a variety of protecting groups including Bn and Boc on the nitrogen of ortho-aminochalcone 2. However, the corresponding DHIs did not form with the Bn- and Boc-groups. Surprisingly, the Boc-group protected amine yielded a three-membered product (6aaa') in a moderate yield.

Next, product 3aaa was transformed into tricyclic diazepino-indole derivative 4aaa. Interestingly, during this transformation, an intriguing observation on the removal of the tosyl group was made (Scheme 3).



Asymmetric variant of the cascade [4 + 1] annulation Scheme 4 approach.

To access enantioenriched DHIs, reactions were carried out with sulfonium salt 1a and ortho-aminochalcone 2aa in the presence of chiral cyclohexane-diamine derived H-bond donor catalysts C1-C3 (Scheme 4). Pleasingly, the cascade reaction proceeded smoothly at room temperature to afford the desired product 3aaa in a good vield. However, no enantiofacial selectivity was achieved. On the other hand, a similar outcome was observed in the reaction of the preformed sulfur ylide 1a' and ortho-aminochalcone 2aa in the presence of Cinchona-derived bifunctional catalysts C4-C6 (Scheme 4).

Furthermore, the scope of the reaction was expanded by replacing the aminochalcone with an ortho-hydroxychalcone. To our delight, the corresponding DHBs 8 were formed in excellent yields and diastereomeric ratios (Table 7).







Scheme 3 Synthetic transformations.



Reaction conditions: 1 (0.3 mmol), 7 (0.2 mmol), Cs₂CO₃ (0.2 mmol), and toluene (2 mL), unless specified. Diastereoisomeric ratios for all entries (>99:1) were determined by ¹H-NMR analysis.

Conclusions

We have developed a [4 + 1] annulation reaction of *in situ* generated sulfonium ylides with ortho-aminochalcones for the synthesis of trans-dihydroindoles at room temperature. This cascade approach exhibited tolerance towards a wide variety of substrate groups, demonstrating its ability and versatility to accommodate diverse chemical functionalities. Additionally, successful gram-scale synthesis demonstrates its feasibility and scalability in large-scale manufacturing processes, highlighting its potential for future applications. Importantly, this cascade [4 + 1] annulation reaction was found to be efficient at room temperature under mild reaction conditions. Unlike ammonium ylides which are relatively unstable and cannot be isolated, sulfur ylides can easily be prepared and the same can later be employed in the reactions. All the synthesized dihydroindole derivatives might have significant potential as good candidates for drug discovery and synthetic manipulations. Furthermore, the developed methodology was extended to construct dihydrobenzofurans.

Experimental section

General information

Unless otherwise noted, all reactions were carried out in a closed vial. ¹H NMR spectra were recorded on a 500 MHz spectrometer (125 MHz for ${}^{13}C{}^{1}H$ NMR). The following abbreviations were used to designate chemical shift multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, and m =multiplet. An oil bath on top of a hot plate was used for heating wherever required. TLC was performed using silica gel GF₂₅₄ precoated on aluminium plates and spots were visualized with UV. Flash column chromatography was performed on silica gel with the use of CombiFlash. IR spectra were recorded on a FT-IR spectrometer and only major peaks were reported in cm⁻¹. High-resolution mass spectra were obtained by the ESI-TOF method (Agilent LC/Q-TOF 6546). Sulfonium salt 1, ortho-aminochalcones 2 and ortho-hydroxychalcones 7 were prepared according to the reported methods.³⁶ All the other reagents were purchased from commercial sources and used as received, unless specified.

General procedure for the synthesis of product 3

The pre-formed sulfonium salt **1** (0.3 mmol) and *ortho*-aminochalcone **2** (0.2 mmol) were added to toluene (2 mL). After stirring the mixture for 5 min, Cs_2CO_3 (65.2 mg, 0.2 mmol) was added and stirring was continued at rt. The progress of the reaction was monitored by TLC. After the completion of the reaction, the crude product **3** was purified by flash column chromatography on a silica support (hexane/ethyl acetate = 5:1).

Synthetic procedure for the asymmetric synthesis of product 3aaa. The pre-formed sulfonium salt 1a (0.3 mmol) and *ortho*-aminochalcone 2aa (0.2 mmol) were added to toluene (2 mL). The catalyst (C1–C6) (0.02 mmol, 10 mol%) was then added.

After stirring the mixture for 5 min, K_2CO_3 (0.2 mmol) was added and stirring was continued at rt. The progress of the reaction was monitored by TLC. After the completion of the reaction, the crude product **3aaa** was purified using flash chromatography with hexane/ethyl acetate (5:1) as eluents and silica gel (100–200 mesh) as the stationary solid phase.

Synthetic procedure for the scale-up synthesis of product 3aaa. The pre-formed sulfonium salt 1a (1.04 g, 3.98 mmol) and *ortho*-aminochalcone 2aa (1.0 g, 2.65 mmol) were added to toluene (25 mL). After stirring the mixture for 5 min, Cs_2CO_3 (0.86 g, 2.65 mmol) was added and stirring was continued at rt. The progress of the reaction was monitored by TLC. After the completion of the reaction, the crude product 3aaa was purified by flash column chromatography on a silica support (hexane/ethyl acetate = 5 : 1).

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-phenylethan-1-one (3aaa). White solid, yield = 97% (96.1 mg); ¹H NMR (500 MHz, CDCl₃) δ 7.98 (d, *J* = 7.6 Hz, 2H), 7.64–7.61 (m, 5H), 7.56–7.46 (m, 2H), 7.43–7.40 (m, 2H), 7.37–7.34 (m, 2H), 7.21 (t, *J* = 7.9 Hz, 1H), 7.11 (d, *J* = 7.8 Hz, 2H), 7.03 (d, *J* = 7.3 Hz, 1H), 6.96 (t, *J* = 7.4 Hz, 1H), 5.32 (d, *J* = 2.7 Hz, 1H), 3.82 (s, 1H), 2.89 (dd, *J* = 17.8, 6.0 Hz, 1H), 2.50 (dd, *J* = 17.8, 7.7 Hz, 1H), 2.27 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.01, 195.58, 144.47, 141.61, 136.24, 135.18, 134.79, 133.74, 133.71, 133.70, 129.98, 129.32, 128.94, 128.81, 128.76, 128.10, 127.50, 125.11, 124.76, 116.13, 69.80, 44.87, 41.09, 21.70; IR (ATR): ν 3187, 3103, 2980, 2888, 1795, 1772, 1738, 1716, 1695, 1683, 1651, 1634, 1557, 1520, 1506, 1474, 1420, 1362, 1275 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₆NO₄S [M + H]⁺: 496.1577, found: 496.1585.

Enantioenriched **3aaa** was isolated as a white solid. Enantiomeric excess of the product was determined by chiral stationary phase HPLC analysis using a ChiralPak IA column (70:30 hexane/i-PrOH at 1 mL min⁻¹, $\lambda = 254$ nm); major enantiomer: $t_{\rm R} = 15.522$ min, minor enantiomer: $t_{\rm R} = 28.131$ min.

2-(2-(4-Fluorobenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3baa). White solid, yield = 91% (93.5 mg); ¹H NMR (500 MHz, $CDCl_3$) δ 8.19–8.05 (m, 2H), 7.68 (dd, J = 15.5, 7.7 Hz, 5H), 7.58 (t, J = 7.3 Hz, 1H), 7.44 (t, J = 7.7 Hz, 2H), 7.29 (t, J = 7.6 Hz, 1H), 7.21–7.12 (m, 4H), 7.10 (d, J = 7.2 Hz, 1H), 7.05 (t, J = 7.4 Hz, 1H), 5.30 (d, J = 3.3 Hz, 1H), 3.92–3.79 (m, 1H), 3.01 (dd, J = 18.0, 5.4 Hz, 1H), 2.50 (dd, *J* = 18.0, 8.5 Hz, 1H), 2.33 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.16, 194.38, 166.23 ($J_{(C-F)}$ = 253.75 Hz), 144.57, 141.55, 136.16, 134.97, 133.80, 133.77, 132.2 ($J_{(C-F)}$ = 10.00 Hz), 131.25 ($J_{(C-F)}$ = 2.50 Hz), 130.01, 129.00, 128.81, 128.11, 127.49, 124.95, 124.90, 116.17 ($J_{(C-F)}$ = 23.75 Hz), 115.90, 69.58, 44.80, 41.10, 21.71; IR (ATR): v 3168, 3140, 3138, 3006, 2990, 1796, 1771, 1736, 1716, 1699, 1684, 1652, 1595, 1560, 1541, 1516, 1474, 1415, 1275, 1264 cm⁻¹; HRMS (ESI⁺) calc. for $C_{30}H_{25}FNO_4S [M + H]^+$: 514.1483, found: 514.1472.

2-(2-(4-Chlorobenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3caa). White solid, yield = 94% (99.6 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.01 (d, *J* = 8.6 Hz, 2H), 7.74–7.62 (m, 5H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.49–7.39 (m, 4H), 7.34–7.27 (m, 1H), 7.16 (d, *J* = 8.1 Hz, 2H), 7.10 (d, *J* = 7.3 Hz, 1H), 7.08–7.02 (m, 1H), 5.29

(d, J = 3.4 Hz, 1H), 3.92–3.77 (m, 1H), 3.01 (dd, J = 18.0, 5.4 Hz, 1H), 2.49 (dd, J = 18.0, 8.6 Hz, 1H), 2.33 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.12, 194.85, 144.59, 141.50, 140.22, 136.12, 134.89, 133.80, 133.69, 133.25, 130.84, 130.01, 129.13, 129.01, 128.95, 128.80, 128.10, 127.47, 124.93, 116.27, 69.60, 44.77, 41.05, 21.70; IR (ATR): ν 3158, 3122, 3009, 2988, 1790, 1776, 1735, 1718, 1695, 1652, 1636, 1617, 1560, 1474, 1457, 1419, 1362, 1276, 1263 cm⁻¹; HRMS (ESI⁺) calc. for $C_{30}H_{24}$ ClNNaO₄S [M + Na]⁺: 552.1007, found: 552.1005.

2-(2-(4-Bromobenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3daa). White solid, yield = 95% (109.2 mg); ¹H NMR (500 MHz, CDCl₃) δ 7.93 (d, J = 8.6 Hz, 2H), 7.75–7.60 (m, 7H), 7.61–7.54 (m, 1H), 7.43 (t, J = 7.8 Hz, 2H), 7.33–7.27 (m, 1H), 7.16 (d, J = 8.0 Hz, 2H), 7.10 (d, J = 7.3 Hz, 1H), 7.05 (td, J = 7.4, 0.8 Hz, 1H), 5.28 (d, J = 3.5 Hz, 1H), 3.90–3.77 (m, 1H), 3.01 (dd, J = 18.0, 5.4 Hz, 1H), 2.48 (dd, J = 18.1, 8.6 Hz, 1H), 2.33 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.11, 195.06, 144.60, 141.47, 136.09, 134.86, 133.80, 133.67, 133.66, 132.10, 130.90, 130.01, 129.02, 129.00, 128.79, 128.09, 127.45, 124.94, 124.93, 116.26, 69.57, 44.75, 41.03, 21.69; IR (ATR): ν 3150, 3101, 3066, 3006, 2990, 2834, 1795, 1772, 1734, 1717, 1699, 1636, 1559, 1542, 1507, 1474, 1276, 1252 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₅BrNO₄S [M + H]⁺: 574.0682, found: 574.0676.

4-(3-(2-Oxo-2-phenylethyl)-1-tosylindoline-2-carbonyl)benzo nitrile (3eaa). White solid, yield = 89% (92.7 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.16 (d, *J* = 8.3 Hz, 2H), 7.79 (d, *J* = 8.3 Hz, 2H), 7.69 (dd, *J* = 7.7, 2.3 Hz, 3H), 7.61 (dd, *J* = 16.6, 7.8 Hz, 3H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.37–7.28 (m, 1H), 7.18–7.04 (m, 4H), 5.25 (d, *J* = 3.6 Hz, 1H), 3.87 (dt, *J* = 8.7, 4.2 Hz, 1H), 3.07 (dd, *J* = 18.2, 4.8 Hz, 1H), 2.39 (dd, *J* = 18.2, 9.3 Hz, 1H), 2.32 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.18, 195.35, 144.78, 141.30, 138.51, 135.96, 134.51, 133.94, 133.47, 132.52, 130.09, 129.80, 129.15, 128.85, 128.09, 127.46, 125.18, 124.85, 118.18, 116.67, 116.49, 69.73, 44.64, 40.86, 21.70; IR (ATR): ν 3141, 3115, 3079, 3005, 2990, 1792, 1774, 1734, 1717, 1699, 1635, 1617, 1541, 1505, 1489, 1474, 1419, 1396, 1362, 1274 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₂₅N₂O₄S [M + H]⁺: 521.1530, found: 521.1534.

2-(2-(4-Nitrobenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3faa). White solid, yield = 85% (91.9 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.33 (d, J = 8.7 Hz, 2H), 8.22 (d, J = 8.7 Hz, 2H), 7.77–7.66 (m, 3H), 7.61 (dd, J = 17.7, 7.8 Hz, 3H), 7.44 (t, J = 7.8 Hz, 2H), 7.38–7.28 (m, 1H), 7.21–7.05 (m, 4H), 5.26 (d, J = 3.6 Hz, 1H), 3.95–3.83 (m, 1H), 3.08 (dd, J = 18.3, 4.7 Hz, 1H), 2.38 (dd, J = 18.3, 9.4 Hz, 1H), 2.32 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.19, 195.35, 150.51, 144.83, 141.27, 140.16, 135.93, 134.44, 133.96, 133.44, 130.42, 130.10, 129.19, 128.85, 128.09, 127.46, 125.22, 124.85, 123.85, 116.52, 69.92, 44.65, 40.85, 21.70; IR (ATR): ν 3130, 3115, 3005, 2989, 2879, 1790, 1771, 1750, 1733, 1716, 1634, 1684, 1663, 1617, 1559, 1522, 1489, 1474, 1434, 1397, 1275, 1262 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₅N₂O₆S [M + H]⁺: 541.1428, found: 541.1420.

2-(2-(4-Methylbenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (**3gaa**). White solid, yield = 93% (94.8 mg); ¹H NMR (500 MHz, CDCl₃) δ 7.94 (d, *J* = 8.0 Hz, 2H), 7.77–7.61 (m, 5H), 7.56 (t, *J* =

6.8 Hz, 1H), 7.42 (t, *J* = 7.1 Hz, 2H), 7.33–7.24 (m, 3H), 7.18 (d, *J* = 7.8 Hz, 2H), 7.08 (d, *J* = 7.4 Hz, 1H), 7.01 (t, *J* = 7.4 Hz, 1H), 5.35 (d, *J* = 3.3 Hz, 1H), 3.87 (s, 1H), 2.95 (dd, *J* = 17.8, 6.2 Hz, 1H), 2.60 (dd, *J* = 17.8, 7.6 Hz, 1H), 2.42 (s, 3H), 2.34 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.04, 195.12, 144.67, 144.41, 141.67, 136.29, 135.26, 133.83, 133.67, 132.18, 129.96, 129.56, 129.47, 128.90, 128.76, 128.12, 127.51, 125.10, 124.69, 116.07, 69.72, 44.89, 41.17, 21.90, 21.71; IR (ATR): ν 3123, 3099, 3006, 2989, 1792, 1771, 1735, 1718, 1698, 1685, 1640, 1620, 1542, 1517, 1474, 1419, 1263 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₂₇NNaO₄S [M + Na]⁺: 532.1553, found: 532.1550.

2-(2-(2-Methoxybenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3haa). White solid, yield = 90% (94.6 mg); ¹H NMR (500 MHz, CDCl₃) δ 7.76–7.67 (m, 3H), 7.67–7.60 (m, 3H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.53–7.47 (m, 1H), 7.41 (t, *J* = 7.7 Hz, 2H), 7.26–7.20 (m, 3H), 7.10–7.01 (m, 2H), 6.98–6.91 (m, 2H), 5.50 (d, *J* = 2.8 Hz, 1H), 4.01–3.93 (m, 1H), 3.70 (s, 3H), 2.74 (qd, *J* = 17.4, 6.8 Hz, 2H), 2.40 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.05, 196.81, 158.40, 144.22, 141.87, 136.53, 135.84, 134.19, 134.17, 133.51, 131.77, 129.85, 128.75, 128.69, 128.04, 127.55, 125.80, 125.43, 124.48, 121.33, 115.97, 111.49, 73.69, 55.59, 45.74, 40.38, 21.76; IR (ATR): ν 3110, 3079, 3055, 3006, 2990, 2888, 1792, 1774, 1750, 1717, 1699, 1679, 1653, 1617, 1521, 1489, 1473, 1419, 1263 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₂₈NO₅S [M + H]⁺: 526.1683, found: 526.1691.

2-(2-(3-Methoxybenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3iaa). White solid, yield = 94% (98.8 mg); ¹H NMR $(500 \text{ MHz}, \text{CDCl}_3) \delta$ 7.69 (dd, J = 13.1, 4.7 Hz, 5H), 7.62 (d, J = 13.1, 4.7 Hz, 5H)7.7 Hz, 1H), 7.60–7.53 (m, 2H), 7.40 (dt, J = 19.4, 7.9 Hz, 3H), 7.30–7.26 (m, 1H), 7.19 (d, J = 8.0 Hz, 2H), 7.14 (ddd, J = 8.2, 2.6, 0.6 Hz, 1H), 7.09 (d, J = 7.5 Hz, 1H), 7.02 (td, J = 7.5, 0.8 Hz, 1H), 5.35 (d, J = 3.3 Hz, 1H), 3.89 (td, J = 7.0, 3.3 Hz, 1H), 3.83 (s, 3H), 2.95 (dd, J = 17.8, 6.3 Hz, 1H), 2.60 (dd, J = 17.8, 7.7 Hz, 1H), 2.34 (s, 3H); 13 C NMR (125 MHz, CDCl₃) δ 196.97, 195.33, 159.94, 144.46, 141.62, 136.25, 136.03, 135.24, 133.71, 133.69, 129.98, 129.77, 128.95, 128.76, 128.10, 127.49, 125.15, 124.74, 121.84, 120.59, 116.09, 113.34, 70.07, 55.52, 44.89, 41.16, 21.70; IR (ATR): ν 3115, 3098, 3006, 2989, 1792, 1770, 1734, 1717, 1699, 1684, 1636, 1559, 1541, 1507, 1489, 1457, 1369, 1275 cm⁻¹; HRMS (ESI⁺) calc. for $C_{31}H_{28}NO_5S [M + H]^+$: 526.1683, found: 526.1684.

2-(2-(4-Methoxybenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3jaa). White solid, yield = 96% (100.9 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.05 (d, J = 8.8 Hz, 2H), 7.69 (dt, J = 13.1, 5.9 Hz, 5H), 7.57 (t, J = 7.4 Hz, 1H), 7.43 (t, J = 7.7 Hz, 2H), 7.28 (d, J = 7.6 Hz, 1H), 7.18 (d, J = 8.1 Hz, 2H), 7.09 (d, J = 7.4 Hz, 1H), 7.02 (t, J = 7.5 Hz, 1H), 6.97 (d, J = 8.9 Hz, 2H), 5.34 (d, J = 3.3 Hz, 1H), 3.88 (s, 4H), 2.98 (dd, J = 17.9, 6.0 Hz, 1H), 2.58 (dd, J = 17.9, 7.9 Hz, 1H), 2.34 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.15, 194.02, 164.12, 144.39, 141.72, 136.30, 135.24, 133.97, 133.68, 131.79, 129.95, 128.87, 128.77, 128.13, 127.59, 127.52, 125.04, 124.69, 116.08, 114.11, 69.47, 55.64, 44.88, 41.29, 21.71; IR (ATR): ν 3135, 3109, 3081, 3066, 3006, 2990, 1792, 1772, 1734, 1699, 1684, 1636, 1559, 1541, 1507, 1473, 1457, 1276, 1261 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₂₈NO₅S [M + H]⁺: 526.1683, found: 526.1676. **2-(2-(2,4-Dichlorobenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3kaa).** White solid, yield = 84% (94.8 mg); ¹H NMR (500 MHz, CDCl₃) δ 7.66 (d, J = 8.1 Hz, 1H), 7.63–7.54 (m, 5H), 7.49 (d, J = 8.3 Hz, 1H), 7.46–7.38 (m, 3H), 7.33 (dd, J = 8.3, 1.9 Hz, 1H), 7.31–7.26 (m, 1H), 7.13 (d, J = 7.4 Hz, 1H), 7.12–7.04 (m, 3H), 5.22 (d, J = 2.2 Hz, 1H), 4.04–3.94 (m, 1H), 2.81 (dd, J = 17.9, 5.3 Hz, 1H), 2.29 (s, 3H), 2.06 (dd, J = 17.9, 9.4 Hz, 1H); ¹³C NMR (125 MHz, CDCl₃) δ 197.24, 196.79, 144.65, 140.97, 137.35, 136.01, 135.81, 134.83, 134.13, 133.68, 132.44, 130.33, 130.20, 130.03, 129.02, 128.73, 127.99, 127.40, 127.13, 125.43, 125.05, 117.24, 72.02, 44.82, 39.33, 21.69; IR (ATR): ν 3121, 3103, 3081, 3006, 2991, 1790, 1772, 1749, 1734, 1717, 1670, 1653, 1617, 1565, 1542, 1490, 1457, 1420, 1400, 1261 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₄Cl₂NO₄S [M + H]⁺: 564.0798, found: 564.0793.

2-(2-(3,4-Dichlorobenzoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3laa). White solid, yield = 91% (102.7 mg); ¹H NMR (500 MHz, $CDCl_3$) δ 8.14 (d, J = 2.0 Hz, 1H), 7.92 (dd, J = 8.4, 2.0 Hz, 1H), 7.70 (dd, J = 9.7, 8.3 Hz, 3H), 7.64 (d, J = 8.3 Hz, 2H), 7.59 (dd, J = 14.3, 7.9 Hz, 2H), 7.44 (t, J = 7.8 Hz, 2H), 7.34–7.27 (m, 1H), 7.15 (d, J = 8.1 Hz, 2H), 7.08 (dt, J = 14.6, 7.0 Hz, 2H), 5.23 (d, J = 3.5 Hz, 1H), 3.85 (dt, J = 8.7, 4.3 Hz, 1H), 3.05 (dd, J = 18.1, 5.0 Hz, 1H), 2.45 (dd, J = 18.1, 9.2 Hz, 1H), 2.33 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.19, 194.13, 144.70, 141.41, 138.29, 136.05, 134.76, 134.63, 133.89, 133.52, 133.50, 131.43, 130.83, 130.05, 129.10, 128.84, 128.48, 128.13, 127.48, 125.04, 124.87, 116.36, 69.58, 44.70, 41.03, 21.71; IR (ATR): v 3102, 3080, 3006, 2990, 2926, 1790, 1775, 1734, 1717, 1698, 1684, 1641, 1617, 1560, 1510, 1473, 1419, 1260 cm⁻¹; HRMS (ESI⁺) calc. for $C_{30}H_{24}Cl_2NO_4S$ [M + H]⁺: 564.0798, found: 564.0795.

2-(2-(2-Naphthoyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3maa). White solid, yield = 94% (102.6 mg); ¹H NMR $(500 \text{ MHz}, \text{CDCl}_3) \delta 8.66 \text{ (s, 1H)}, 8.03 \text{ (dd}, J = 8.6, 1.7 \text{ Hz}, 1\text{H}),$ 7.97 (d, J = 8.1 Hz, 1H), 7.89 (dd, J = 11.0, 8.6 Hz, 2H), 7.77-7.65 (m, 5H), 7.65-7.59 (m, 1H), 7.57-7.50 (m, 2H), 7.41 (t, J = 7.8 Hz, 2H), 7.30 (t, J = 7.8 Hz, 1H), 7.18 (d, J = 8.0 Hz, 2H), 7.11 (d, J = 7.5 Hz, 1H), 7.04 (td, J = 7.5, 0.9 Hz, 1H), 5.56 (d, *J* = 3.2 Hz, 1H), 3.98–3.91 (m, 1H), 3.04 (dd, *J* = 17.8, 5.8 Hz, 1H), 2.68 (dd, J = 17.8, 8.2 Hz, 1H), 2.33 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.11, 195.52, 144.45, 141.71, 136.24, 135.96, 135.37, 133.78, 133.70, 132.61, 132.05, 131.44, 130.09, 129.97, 128.97, 128.85, 128.77, 128.66, 128.13, 127.89, 127.50, 126.84, 125.06, 124.74, 124.71, 116.04, 69.98, 44.93, 41.39, 21.69; IR (ATR): v 3135, 3102, 3067, 3006, 2990, 1795, 1772, 1749, 1734, 1717, 1698, 1684, 1636, 1559, 1541, 1457, 1257 cm⁻¹; HRMS (ESI⁺) calc. for $C_{34}H_{28}NO_4S [M + H]^+$: 546.1734, found: 546.1730.

2-(2-([1,1'-Biphenyl]-4-carbonyl)-1-tosylindolin-3-yl)-1-phenylethan-1-one (3naa). White solid, yield = 93% (106.3 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.14 (d, *J* = 8.3 Hz, 2H), 7.78–7.67 (m, 7H), 7.67–7.61 (m, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.48 (t, *J* = 7.5 Hz, 2H), 7.42 (dd, *J* = 15.9, 7.9 Hz, 3H), 7.30 (t, *J* = 7.8 Hz, 1H), 7.19 (d, *J* = 8.1 Hz, 2H), 7.11 (d, *J* = 7.4 Hz, 1H), 7.04 (t, *J* = 7.2 Hz, 1H), 5.40 (d, *J* = 3.4 Hz, 1H), 3.97–3.89 (m, 1H), 3.01 (dd, *J* = 17.9, 6.0 Hz, 1H), 2.62 (dd, *J* = 17.9, 7.9 Hz, 1H), 2.35 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.08, 195.21, 146.34, 144.48, 141.64, 140.04, 136.23, 135.13, 133.79, 133.71, 133.43, 129.98, 129.96, 129.07, 128.94, 128.77, 128.38, 128.11, 127.51, 127.47, 127.45, 125.08, 124.77, 116.12, 69.78, 44.87, 41.19, 21.70; IR (ATR): ν 3152, 3113, 3006, 2989, 1792, 1773, 1734, 1717, 1699, 1653, 1603, 1559, 1541, 1507, 1489, 1419, 1397, 1262 cm⁻¹; HRMS (ESI⁺) calc. for C₃₆H₃₀NO₄S [M + H]⁺: 572.1890, found: 572.1877.

2-(2-(Furan-2-carbonyl)-1-tosylindolin-3-yl)-1-phenylethan-1one (30aa). White solid, yield = 88% (85.5 mg); ¹H NMR (500 MHz, CDCl₃) δ 7.76–7.63 (m, 5H), 7.60–7.56 (m, 2H), 7.48 (dd, *J* = 3.6, 0.5 Hz, 1H), 7.43 (t, *J* = 7.8 Hz, 2H), 7.31–7.26 (m, 1H), 7.21 (d, *J* = 8.0 Hz, 2H), 7.09 (d, *J* = 7.5 Hz, 1H), 7.02 (td, *J* = 7.5, 0.9 Hz, 1H), 6.58 (dd, *J* = 3.6, 1.7 Hz, 1H), 5.09 (d, *J* = 3.7 Hz, 1H), 3.95 (td, *J* = 6.9, 3.7 Hz, 1H), 2.89 (dd, *J* = 17.7, 6.7 Hz, 1H), 2.67 (dd, *J* = 17.8, 7.2 Hz, 1H), 2.36 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.89, 184.10, 150.54, 147.45, 144.56, 141.59, 136.34, 134.88, 133.70, 133.69, 129.99, 128.94, 128.79, 128.10, 127.63, 125.18, 124.86, 120.20, 116.19, 112.87, 70.41, 45.08, 41.18, 21.74; IR (ATR): ν 3019, 3006, 2990, 2925, 2856, 1793, 1770, 1749, 1734, 1684, 1653, 1559, 1507, 1458, 1276, 1259 cm⁻¹; HRMS (ESI⁺) calc. for C₂₈H₂₄NO₅S [M + H]⁺: 486.1370, found: 486.1384.

1-Phenyl-2-(2-(thiophene-2-carbonyl)-1-tosylindolin-3-yl)ethan-1-one (3paa). White solid, yield = 87% (87.3 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.05 (dd, J = 3.8, 1.0 Hz, 1H), 7.74–7.68 (m, 6H), 7.56 (dd, J = 10.5, 4.3 Hz, 1H), 7.42 (t, J = 7.8 Hz, 2H), 7.29 (t, J = 7.7 Hz, 1H), 7.25–7.13 (m, 3H), 7.09 (d, J = 7.4 Hz, 1H), 7.04 (dd, J = 10.8, 4.1 Hz, 1H), 5.06 (d, J = 3.8 Hz, 1H), 3.95 (dd, J = 10.4, 6.8 Hz, 1H), 2.94 (dd, J = 18.0, 6.3 Hz, 1H), 2.57 (dd, J = 18.0, 7.6 Hz, 1H), 2.33 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.94, 188.84, 144.65, 141.48, 140.74, 136.17, 135.34, 134.45, 134.33, 133.79, 133.66, 129.97, 128.88, 128.73, 128.47, 128.03, 127.52, 125.05, 124.97, 116.20, 71.19, 44.71, 41.50, 21.66; IR (ATR): ν 3130, 3095, 3005, 2988, 1791, 1772, 1735, 1716, 1699, 1683, 1652, 1616, 1560, 1541, 1505, 1489, 1456, 1360, 1263 cm⁻¹; HRMS (ESI⁺) calc. for C₂₈H₂₄NO₄S₂ [M + H]⁺: 502.1141, found: 502.1138.

2-(2-((1*S***,3***S***)-Adamantane-1-carbonyl)-1-tosylindolin-3-yl)-1phenylethan-1-one (3qaa). White solid, yield = 85% (94.1 mg); ¹H NMR (500 MHz, CDCl₃) \delta 7.68 (d,** *J* **= 8.2 Hz, 2H), 7.63 (dd,** *J* **= 12.7, 4.7 Hz, 3H), 7.57 (t,** *J* **= 7.4 Hz, 1H), 7.42 (t,** *J* **= 7.8 Hz, 2H), 7.26–7.19 (m, 3H), 7.05 (d,** *J* **= 7.4 Hz, 1H), 6.94 (t,** *J* **= 7.5 Hz, 1H), 5.00 (d,** *J* **= 1.8 Hz, 1H), 3.62 (t,** *J* **= 6.3 Hz, 1H), 2.60 (dd,** *J* **= 17.5, 8.1 Hz, 1H), 2.54–2.42 (m, 1H), 2.36 (d,** *J* **= 16.2 Hz, 3H), 2.04 (dd,** *J* **= 24.6, 7.3 Hz, 6H), 1.93 (d,** *J* **= 12.2 Hz, 3H), 1.80–1.72 (m, 6H); ¹³C NMR (125 MHz, CDCl₃) \delta 208.55, 196.84, 144.31, 141.86, 136.34, 135.76, 134.26, 133.68, 129.96, 128.81, 128.74, 128.07, 127.31, 125.45, 124.66, 116.23, 67.50, 46.31, 45.33, 40.64, 38.27, 36.51, 27.99, 21.71; IR (ATR):** *ν* **3069, 3005, 2990, 2910, 2851, 1792, 1770, 1724, 1717, 1700, 1683, 1653, 1559, 1541, 1507, 1455, 1277 cm⁻¹; HRMS (ESI⁺) calc. for C₃₄H₃₆NO₄S [M + H]⁺: 554.2360, found: 554.2370.**

2,2-Dimethyl-1-(3-(2-oxo-2-phenylethyl)-1-tosylindolin-2-yl) propan-1-one (3raa). White solid, yield = 90% (85.6 mg); ¹H NMR (500 MHz, $CDCl_3$) δ 7.65 (dd, J = 12.0, 8.2 Hz, 3H), 7.63–7.59 (m, 2H), 7.57 (t, J = 7.4 Hz, 1H), 7.42 (t, J = 7.8 Hz, 2H), 7.22 (dd, J = 14.0, 8.1 Hz, 3H), 7.05 (d, J = 7.5 Hz, 1H), 6.97 (t, J = 7.5 Hz, 1H), 4.97 (d, J = 1.8 Hz, 1H), 3.64 (t, J = 6.4 Hz, 1H), 2.60 (dd, J = 17.7, 7.6 Hz, 1H), 2.45–2.28 (m, 4H), 1.31 (s, 9H); ¹³C NMR (125 MHz, CDCl₃) δ 209.87, 196.83, 144.37, 141.91, 136.33, 135.65, 134.51, 133.70, 129.98, 128.87, 128.77, 128.06, 127.36, 125.31, 124.86, 116.59, 68.03, 45.40, 44.14, 41.04, 26.93, 21.73; IR (ATR): ν 3066, 3005, 2965, 2921, 2851, 1772, 1716, 1681, 1653, 1634, 1597, 1579, 1559, 1540, 1530, 1507, 1477, 1459, 1398, 1355, 1275, 1257 cm⁻¹; HRMS (ESI⁺) calc. for C₂₈H₃₀NO₄S [M + H]⁺: 476.1890, found: 476.1875.

2-(2-Acetyl-1-tosylindolin-3-yl)-1-phenylethan-1-one (3saa). White solid, yield = 89% (77.2 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.05–7.95 (m, 2H), 7.72 (d, *J* = 8.3 Hz, 2H), 7.60 (t, *J* = 8.5 Hz, 2H), 7.48 (t, *J* = 7.7 Hz, 2H), 7.26 (dd, *J* = 12.9, 5.2 Hz, 3H), 7.07–6.97 (m, 2H), 5.23 (d, *J* = 4.0 Hz, 1H), 3.78–3.53 (m, 1H), 2.48 (dd, *J* = 17.9, 6.5 Hz, 1H), 2.40 (s, 3H), 2.28 (dd, *J* = 17.9, 7.4 Hz, 1H), 1.97 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 205.70, 195.55, 144.56, 141.51, 135.10, 134.68, 133.73, 133.06, 129.90, 129.23, 128.93, 128.82, 127.61, 124.95, 124.54, 115.55, 70.12, 49.25, 40.77, 30.18, 21.68; IR (ATR): *ν* 3065, 3005, 2991, 1790, 1764, 1733, 1685, 1617, 1594, 1540, 1474, 1420, 1362, 1262 cm⁻¹; HRMS (ESI) *m/z*: [M + H]⁺ calcd for C₂₅H₂₄NO₄S: 434.1421; found: 434.1430.

Ethyl 3-(2-oxo-2-phenylethyl)-1-tosylindoline-2-carboxylate (3taa). White solid, yield = 87% (80.7 mg); ¹H NMR (500 MHz, CDCl₃) δ 7.69–7.65 (m, 5H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.8 Hz, 2H), 7.25 (dd, *J* = 9.6, 5.4 Hz, 1H), 7.16 (d, *J* = 8.1 Hz, 2H), 7.10 (d, *J* = 7.5 Hz, 1H), 7.01 (t, *J* = 7.5 Hz, 1H), 4.48 (d, *J* = 3.4 Hz, 1H), 4.27–4.23 (m, 2H), 4.03–3.88 (m, 1H), 2.83 (dd, *J* = 17.8, 6.2 Hz, 1H), 2.41 (dd, *J* = 17.8, 8.0 Hz, 1H), 2.33 (s, 3H), 1.29 (t, *J* = 7.1 Hz, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.71, 170.33, 144.46, 141.19, 136.28, 135.00, 133.62, 133.57, 129.93, 128.83, 128.74, 128.05, 127.46, 124.94, 124.78, 116.30, 77.41, 77.16, 76.91, 67.99, 62.02, 44.96, 41.03, 21.67, 14.19; IR (ATR): ν 3168, 3112, 3068, 3010, 2995, 1842, 1801, 1778, 1760, 1735, 1716, 1684, 1541, 1475, 1332 cm⁻¹; HRMS (ESI⁺) calc. for C₂₆H₂₆NO₅S⁺ [M + H]⁺: 464.1526, found: 464.1530.

2-(2-Benzoyl-5-fluoro-1-tosylindolin-3-yl)-1-phenylethan-1-one (3aba). White solid, yield = 90% (92.4 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.03 (dd, J = 8.2, 0.9 Hz, 2H), 7.76–7.54 (m, 7H), 7.47 (dt, J = 32.5, 7.8 Hz, 4H), 7.19 (d, J = 8.1 Hz, 2H), 6.98 (td, J = 8.8, 2.6 Hz, 1H), 6.83 (dd, J = 8.1, 2.5 Hz, 1H), 5.39 (d, J = 3.0 Hz, 1H), 3.94–3.75 (m, 1H), 2.88 (dd, J = 18.0, 6.3 Hz, 1H), 2.48 (dd, J = 18.0, 7.8 Hz, 1H), 2.35 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.67, 195.38, 160.37 ($J_{(C-F)}$ = 242.50 Hz), 144.68, 137.66, 136.22 ($J_{(C-F)}$ = 8.75 Hz), 136.05, 134.79 ($J_{(C-F)}$ = 26.25 Hz), 133.88, 133.84, 130.09, 129.33, 128.88, 128.81, 128.09, 127.52, 117.62 ($J_{(C-F)}$ = 7.5 Hz), 115.60 ($J_{(C-F)}$ = 22.50 Hz), 112.69, 112.49, 69.66, 44.53, 40.89, 21.73; IR (ATR): ν 3136, 3006, 2990, 1792, 1770, 1717, 1698, 1652, 1597, 1558, 1540, 1517, 1474, 1415, 1263 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₅FNO₄S [M + H]⁺: 514.1483, found: 514.1482.

2-(2-Benzoyl-5-chloro-1-tosylindolin-3-yl)-1-phenylethan-1-one (3aca). White solid, yield = 90% (95.4 mg); ¹H NMR (500 MHz,

CDCl₃) δ 8.07–8.00 (m, 2H), 7.73–7.64 (m, 4H), 7.62–7.59 (m, 3H), 7.50 (t, J = 7.8 Hz, 2H), 7.44 (t, J = 7.8 Hz, 2H), 7.26–7.23 (m, 1H), 7.19 (d, J = 8.1 Hz, 2H), 7.09 (d, J = 1.7 Hz, 1H), 5.40 (d, J = 3.1 Hz, 1H), 3.88–3.72 (m, 1H), 2.92 (dd, J = 18.0, 6.1 Hz, 1H), 2.52 (dd, J = 18.0, 7.9 Hz, 1H), 2.35 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.61, 195.27, 144.76, 140.42, 136.02, 135.89, 134.95, 134.62, 133.91, 133.86, 130.12, 130.04, 129.33, 129.01, 128.89, 128.82, 128.10, 127.46, 125.44, 117.24, 69.60, 44.60, 40.87, 21.73; IR (ATR): ν 3120, 3005, 2989, 1792, 1771, 1733, 1716, 1699, 1636, 1617, 1559, 1475, 1457, 1418, 1362, 1264 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₅ClNO₄S [M + H]⁺: 530.1187, found: 530.1163.

2-(2-Benzoyl-5-bromo-1-tosylindolin-3-yl)-1-phenylethan-1-one (3ada). White solid, yield = 94% (108.0 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.07–7.99 (m, 2H), 7.71–7.65 (m, 4H), 7.65–7.54 (m, 3H), 7.50 (t, J = 7.8 Hz, 2H), 7.46–7.37 (m, 3H), 7.23 (d, J = 1.5 Hz, 1H), 7.19 (d, J = 8.1 Hz, 2H), 5.40 (d, J = 3.1 Hz, 1H), 3.89–3.78 (m, 1H), 2.93 (dd, J = 18.0, 6.0 Hz, 1H), 2.52 (dd, J = 18.0, 8.0 Hz, 1H), 2.35 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.60, 195.23, 144.77, 140.94, 136.23, 135.98, 134.91, 134.58, 133.90, 133.85, 131.88, 130.12, 129.31, 128.87, 128.81, 128.29, 128.08, 127.41, 117.62, 117.50, 69.50, 44.62, 40.82, 21.71; IR (ATR): ν 3101, 3005, 2990, 2835, 1795, 1771, 1734, 1717, 1698, 1636, 1559, 1542, 1507, 1473, 1276, 1234 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₅BrNO₄S [M + H]⁺: 574.0682, found: 574.0688.

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(4-fluorophenyl)ethan-1-one (3aab). White solid, yield = 95% (97.6 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.03 (d, *J* = 8.1 Hz, 2H), 7.79–7.68 (m, 4H), 7.65 (d, *J* = 8.1 Hz, 1H), 7.63–7.57 (m, 1H), 7.55–7.45 (m, 2H), 7.34–7.27 (m, 1H), 7.20 (d, *J* = 8.0 Hz, 2H), 7.09 (t, *J* = 7.7 Hz, 3H), 7.02 (t, *J* = 7.5 Hz, 1H), 5.36 (d, *J* = 3.5 Hz, 1H), 3.89 (dd, *J* = 9.4, 6.9 Hz, 1H), 2.97 (dd, *J* = 17.7, 6.1 Hz, 1H), 2.62 (dd, *J* = 17.7, 7.7 Hz, 1H), 2.36 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 195.57, 195.43, 166.09 (*J*_(C-F) = 255.00 Hz), 144.45, 141.62, 135.24, 134.78, 133.75, 133.52, 132.53 (*J*_(C-F) = 3.75 Hz), 130.82 (*J*_(C-F) = 8.75 Hz), 129.96, 129.32, 129.02, 128.83, 127.59, 124.01 (*J*_(C-F) = 43.75 Hz), 116.03, 116.01, 115.83, 69.91, 44.71, 41.10, 21.73; IR (ATR): ν 3005, 2990, 2980, 1790, 1735, 1716, 1684, 1652, 1636, 1559, 1542, 1457, 1276, 1263 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₅FNO₄S [M + H]⁺: 514.1483, found: 514.1484.

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(4-chlorophenyl)ethan-1-one (3aac). White solid, yield = 93% (98.6 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.03 (d, J = 7.3 Hz, 2H), 7.70 (d, J = 8.2 Hz, 2H), 7.68–7.56 (m, 4H), 7.49 (t, J = 7.8 Hz, 2H), 7.39 (d, J = 8.5 Hz, 2H), 7.28 (t, J = 7.8 Hz, 1H), 7.19 (d, J = 8.1 Hz, 2H), 7.08 (d, J = 7.4 Hz, 1H), 7.02 (t, J = 7.4 Hz, 1H), 5.35 (d, J = 3.5 Hz, 1H), 3.88 (td, J = 7.2, 3.6 Hz, 1H), 2.96 (dd, J = 17.8, 6.1 Hz, 1H), 2.61 (dd, J = 17.8, 7.8 Hz, 1H), 2.36 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 195.85, 195.54, 144.47, 141.62, 140.25, 135.22, 134.77, 134.56, 133.76, 133.46, 129.97, 129.53, 129.32, 129.10, 129.04, 128.84, 127.57, 125.06, 124.75, 116.06, 69.87, 44.75, 41.05, 21.74; IR (ATR): ν 3064, 3006, 2990, 2956, 2923, 2852, 1791, 1778, 1751, 1735, 1698, 1685, 1652, 1636, 1558, 1541, 1458, 1276, 1255 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₅ClNO₄S [M + H]⁺: 530.1187, found: 530.1160. **2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(4-bromophenyl)ethan-1-one** (**3aad**). White solid, yield = 97% (111.5 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.07–8.00 (m, 2H), 7.70 (d, *J* = 8.3 Hz, 2H), 7.66 (d, *J* = 8.1 Hz, 1H), 7.63–7.58 (m, 1H), 7.58–7.53 (m, 4H), 7.48 (dd, *J* = 10.7, 4.8 Hz, 2H), 7.33–7.26 (m, 1H), 7.19 (d, *J* = 8.0 Hz, 2H), 7.07 (d, *J* = 7.4 Hz, 1H), 7.02 (td, *J* = 7.5, 0.9 Hz, 1H), 5.35 (d, *J* = 3.5 Hz, 1H), 3.88 (td, *J* = 7.3, 3.5 Hz, 1H), 2.96 (dd, *J* = 17.8, 6.1 Hz, 1H), 2.60 (dd, *J* = 17.9, 7.8 Hz, 1H), 2.36 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.06, 195.54, 144.47, 141.60, 135.20, 134.95, 134.76, 133.76, 133.44, 132.09, 129.96, 129.61, 129.31, 129.04, 128.98, 128.83, 127.56, 125.05, 124.75, 116.05, 69.84, 44.72, 41.03, 21.73; IR (ATR): ν 3105, 3057, 3004, 2988, 1789, 1776, 1750, 1730, 1717, 1636, 1607, 1522, 1489, 1437, 1361, 1220 cm⁻¹; HRMS (ESI⁺) calc. for C₃₀H₂₅BrNO₄S [M + H]⁺: 574.0682, found: 574.0686.

4-(2-(2-Benzoyl-1-tosylindolin-3-yl)acetyl)benzonitrile (3aae). White solid, yield = 90% (93.7 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.02 (d, *J* = 7.6 Hz, 2H), 7.79 (d, *J* = 8.2 Hz, 2H), 7.75–7.66 (m, 4H), 7.66–7.57 (m, 2H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.33–7.26 (m, 1H), 7.20 (d, *J* = 7.9 Hz, 2H), 7.07 (d, *J* = 7.5 Hz, 1H), 7.02 (t, *J* = 7.4 Hz, 1H), 5.35 (d, *J* = 1.5 Hz, 1H), 3.90 (dd, *J* = 9.9, 6.7 Hz, 1H), 3.04 (dd, *J* = 18.0, 6.1 Hz, 1H), 2.73 (dd, *J* = 18.0, 7.5 Hz, 1H), 2.36 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 195.84, 195.44, 144.51, 141.60, 139.01, 135.19, 134.71, 133.83, 133.05, 132.61, 129.95, 129.27, 129.17, 128.86, 128.54, 127.63, 125.03, 124.74, 117.79, 116.99, 115.96, 69.93, 44.94, 40.89, 21.73; IR (ATR): ν 3110, 3066, 3004, 2990, 2891, 1792, 1771, 1750, 1718, 1683, 1634, 1617, 1571, 1507, 1472, 1430, 1390, 1278 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₂₅N₂O₄S [M + H]⁺: 521.1530, found: 521.1535.

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(*p***-tolyl)ethan-1-one (3aaf).** White solid, yield = 92% (93.8 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.17–7.94 (m, 2H), 7.69 (dd, *J* = 12.8, 8.2 Hz, 3H), 7.59 (t, *J* = 8.8 Hz, 3H), 7.48 (t, *J* = 7.7 Hz, 2H), 7.28 (d, *J* = 7.5 Hz, 1H), 7.20 (dd, *J* = 10.0, 8.5 Hz, 4H), 7.09 (d, *J* = 7.4 Hz, 1H), 7.02 (dd, *J* = 7.5, 6.9 Hz, 1H), 5.37 (d, *J* = 3.4 Hz, 1H), 3.88 (td, *J* = 7.4, 3.4 Hz, 1H), 2.94 (dd, *J* = 17.7, 6.2 Hz, 1H), 2.57 (dd, *J* = 17.7, 7.8 Hz, 1H), 2.41 (s, 3H), 2.35 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.63, 195.61, 144.62, 144.43, 141.61, 135.21, 134.80, 133.85, 133.81, 133.69, 129.97, 129.43, 129.33, 128.90, 128.80, 128.25, 127.51, 125.12, 124.71, 116.06, 69.87, 44.76, 41.17, 21.82, 21.72; IR (ATR): ν 3115, 3006, 2988, 1793, 1734, 1716, 1699, 1653, 1636, 1606, 1522, 1507, 1489, 1474, 1438, 1397, 1274 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₂₈NO₄S [M + H]⁺: 510.1734, found: 510.1709.

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(2-methoxyphenyl)ethan-1one (3aag). White solid, yield = 90% (94.6 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.08–7.97 (m, 2H), 7.73 (d, *J* = 8.3 Hz, 2H), 7.61–7.57 (m, 3H), 7.52–7.42 (m, 3H), 7.27–7.22 (m, 1H), 7.17 (d, *J* = 8.1 Hz, 2H), 7.08 (d, *J* = 7.4 Hz, 1H), 7.01–6.97 (m, 2H), 6.91 (d, *J* = 8.3 Hz, 1H), 5.41 (d, *J* = 4.0 Hz, 1H), 3.97–3.82 (m, 1H), 3.77 (s, 3H), 3.17 (dd, *J* = 17.4, 5.9 Hz, 1H), 2.81 (dd, *J* = 17.4, 8.0 Hz, 1H), 2.32 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 199.07, 196.04, 158.75, 144.28, 141.64, 135.22, 134.89, 134.27, 133.59, 133.57, 130.61, 129.80, 129.29, 128.75, 128.68, 127.57, 127.37, 125.01, 124.28, 120.91, 115.18, 111.65, 70.10, 55.54, 49.92, 41.66, 21.67; IR (ATR): ν 3080, 3064, 3005, 2989, 1794, 1765, 1734, 1716, 1683, 1616, 1560, 1521, 1490, 1458, 1398, 1261 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₂₈NO₅S [M + H]⁺: 526.1683, found: 526.1696.

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(3-methoxyphenyl)ethan-1one (3aah). White solid, yield = 93% (97.8 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.08–7.97 (m, 2H), 7.69 (t, *J* = 8.3 Hz, 3H), 7.60 (t, *J* = 7.4 Hz, 1H), 7.49 (t, *J* = 7.7 Hz, 2H), 7.36–7.26 (m, 3H), 7.20 (d, *J* = 8.0 Hz, 3H), 7.10 (dd, *J* = 13.5, 5.0 Hz, 2H), 7.03 (t, *J* = 7.5 Hz, 1H), 5.36 (d, *J* = 3.4 Hz, 1H), 3.92–3.72 (m, 4H), 2.95 (dd, *J* = 17.8, 6.1 Hz, 1H), 2.58 (dd, *J* = 17.8, 7.8 Hz, 1H), 2.35 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.87, 195.61, 160.02, 144.57, 141.63, 137.62, 135.16, 134.82, 133.74, 133.73, 130.01, 129.72, 129.34, 128.97, 128.83, 127.51, 125.11, 124.77, 120.66, 119.86, 116.16, 112.73, 69.84, 55.63, 45.02, 41.14, 21.67; IR (ATR): ν 3120, 3101, 3080, 3004, 2989, 1794, 1770, 1730, 1716, 1698, 1684, 1635, 1505, 1457, 1275, 1259 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₂₈NO₅S [M + H]⁺: 526.1683, found: 526.1689.

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(4-methoxyphenyl)ethan-1one (3aai). White solid, yield = 95% (99.9 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.07–7.96 (m, 2H), 7.71 (d, *J* = 8.3 Hz, 2H), 7.69–7.64 (m, 3H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.48 (t, *J* = 7.7 Hz, 2H), 7.31–7.26 (m, 1H), 7.20 (d, *J* = 8.0 Hz, 2H), 7.09 (d, *J* = 7.5 Hz, 1H), 7.04–6.98 (m, 1H), 6.91–6.85 (m, 2H), 5.38 (d, *J* = 3.4 Hz, 1H), 3.91–3.85 (m, 4H), 2.93 (dd, *J* = 17.5, 6.2 Hz, 1H), 2.57 (dd, *J* = 17.5, 7.8 Hz, 1H), 2.36 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 195.62, 195.47, 163.94, 144.40, 141.61, 135.25, 134.80, 133.82, 133.68, 130.45, 129.96, 129.41, 129.33, 128.88, 128.80, 127.54, 125.14, 124.67, 115.98, 113.89, 69.92, 55.68, 44.51, 41.29, 21.74; IR (ATR): ν 3115, 3055, 3005, 2988, 2895, 1792, 1734, 1716, 1684, 1636, 1601, 1576, 1473, 1456, 1320, 1261 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₂₈NO₅S [M + H]⁺: 526.1683, found: 526.1690.

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(naphthalen-2-yl)ethan-1one (3aaj). White solid, yield = 94% (102.6 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.20 (s, 1H), 8.14-8.00 (m, 2H), 7.89 (dd, J = 15.0, 8.3 Hz, 3H), 7.81 (dd, J = 8.6, 1.6 Hz, 1H), 7.72 (d, J = 8.3 Hz, 2H), 7.68 (d, J = 8.1 Hz, 1H), 7.66–7.54 (m, 3H), 7.50 (t, J = 7.7 Hz, 2H), 7.29 (t, J = 7.8 Hz, 1H), 7.20–7.10 (m, 3H), 7.08-6.98 (m, 1H), 5.45 (d, J = 3.5 Hz, 1H), 4.01-3.87 (m, 1H), 3.17 (dd, J = 17.7, 6.0 Hz, 1H), 2.77 (dd, J = 17.7, 8.0 Hz, 1H), 2.26 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 197.03, 195.70, 144.50, 141.67, 135.86, 135.25, 134.85, 133.74, 133.71, 133.62, 132.51, 129.95, 129.66, 129.40, 128.99, 128.97, 128.84, 128.70, 128.62, 127.99, 127.57, 127.19, 125.12, 124.70, 123.66, 116.00, 69.90, 44.95, 41.29, 21.68; IR (ATR): v 3095, 3052, 3005, 2988, 1790, 1770, 1750, 1735, 1686, 1652, 1575, 1540, 1507, 1485, 1457, 1419, 1362, 1262 cm⁻¹; HRMS (ESI⁺) calc. for $C_{34}H_{28}NO_4S[M + H]^+$: 546.1735, found: 546.1731.

1-([1,1'-Biphenyl]-4-yl)-2-(2-benzoyl-1-tosylindolin-3-yl)ethan-1-one (3aak). White solid, yield = 96% (109.8 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.06 (d, *J* = 7.3 Hz, 2H), 7.77 (d, *J* = 8.4 Hz, 2H), 7.71 (dd, *J* = 14.9, 8.2 Hz, 3H), 7.68–7.58 (m, 5H), 7.49 (td, *J* = 7.9, 1.7 Hz, 4H), 7.42 (t, *J* = 7.3 Hz, 1H), 7.29 (t, *J* = 7.8 Hz, 1H), 7.21 (d, *J* = 8.1 Hz, 2H), 7.12 (d, *J* = 7.4 Hz, 1H), 7.04 (t, *J* = 7.5 Hz, 1H), 5.41 (d, J = 3.4 Hz, 1H), 3.99–3.87 (m, 1H), 3.01 (dd, J = 17.7, 6.1 Hz, 1H), 2.63 (dd, J = 17.7, 7.8 Hz, 1H), 2.36 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 196.59, 195.61, 146.39, 144.45, 141.62, 139.70, 135.20, 134.92, 134.80, 133.73, 133.71, 129.99, 129.33, 129.17, 128.94, 128.82, 128.72, 128.60, 127.52, 127.36, 127.35, 125.12, 124.75, 116.09, 69.83, 44.89, 41.16, 21.74; IR (ATR): ν 3145, 3095, 3005, 2991, 1791, 1772, 1731, 1719, 1617, 1545, 1501, 1473, 1420, 1360, 1261 cm⁻¹; HRMS (ESI⁺) calc. for C₃₆H₃₀NO₄S [M + H]⁺: 572.1890, found: 572.1896.

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(furan-2-yl)ethan-1-one (3aal). White solid, yield = 89% (86.4 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.04–7.98 (m, 2H), 7.74 (d, *J* = 8.3 Hz, 2H), 7.64 (d, *J* = 8.1 Hz, 1H), 7.61–7.56 (m, 1H), 7.52 (d, *J* = 1.0 Hz, 1H), 7.46 (t, *J* = 7.8 Hz, 2H), 7.27 (dd, *J* = 11.9, 3.7 Hz, 1H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.07 (d, *J* = 7.5 Hz, 1H), 7.04–6.97 (m, 2H), 6.50 (dd, *J* = 3.6, 1.7 Hz, 1H), 5.45 (d, *J* = 3.5 Hz, 1H), 3.82 (td, *J* = 7.2, 3.4 Hz, 1H), 2.87 (dd, *J* = 17.1, 6.4 Hz, 1H), 2.54 (dd, *J* = 17.1, 7.9 Hz, 1H), 2.36 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 195.36, 186.09, 152.28, 146.81, 144.48, 141.53, 135.25, 134.61, 133.71, 133.14, 129.92, 129.21, 128.97, 128.82, 127.52, 125.11, 124.55, 117.73, 115.71, 112.58, 69.78, 44.39, 40.97, 21.69; IR (ATR): ν 3100, 3078, 2989, 1790, 1771, 1732, 1701, 1686, 1673, 1634, 1616, 1607, 1540, 1498, 1472, 1419, 1395, 1262 cm⁻¹; HRMS (ESI⁺) calc. for C₂₈H₂₄NO₅S [M + H]⁺: 486.1370, found: 486.1356.

2-(2-Benzoyl-1-tosylindolin-3-yl)-1-(thiophen-2-yl)ethan-1-one (3aam). White solid, yield = 87% (87.3 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.04–7.97 (m, 2H), 7.74 (d, *J* = 8.3 Hz, 2H), 7.68–7.63 (m, 2H), 7.61–7.55 (m, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.37 (dd, *J* = 3.8, 1.0 Hz, 1H), 7.27 (s, 1H), 7.23 (d, *J* = 8.4 Hz, 2H), 7.11–7.06 (m, 2H), 7.01 (dd, *J* = 7.9, 7.1 Hz, 1H), 5.44 (d, *J* = 3.3 Hz, 1H), 3.85 (td, *J* = 7.1, 3.4 Hz, 1H), 2.90 (dd, *J* = 17.0, 6.4 Hz, 1H), 2.62 (dd, *J* = 17.0, 7.7 Hz, 1H), 2.38 (d, *J* = 8.7 Hz, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 195.33, 189.84, 144.49, 143.58, 141.59, 135.33, 134.60, 134.54, 133.76, 133.23, 132.38, 129.99, 129.26, 129.04, 128.86, 128.25, 127.55, 125.15, 124.64, 115.87, 69.82, 45.23, 41.35, 21.72; IR (ATR): ν 3133, 3096, 3006, 2989, 1792, 1772, 1734, 1717, 1699, 1684, 1653, 1617, 1559, 1541, 1507, 1489, 1457, 1361, 1262 cm⁻¹; HRMS (ESI⁺) calc. for C₂₈H₂₄NO₄S₂ [M + H]⁺: 502.1141, found: 502.1152.

1-(2-Benzoyl-1-tosylindolin-3-yl)-3,3-dimethylbutan-2-one (3aan). White solid, yield = 89% (84.7 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.00–7.92 (m, 2H), 7.73 (d, *J* = 8.2 Hz, 2H), 7.65 (d, *J* = 8.1 Hz, 1H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.26 (dd, *J* = 11.5, 5.0 Hz, 3H), 7.03–6.94 (m, 2H), 5.18 (d, *J* = 3.7 Hz, 1H), 3.76 (td, *J* = 6.8, 3.8 Hz, 1H), 2.48–2.29 (m, 5H), 0.94 (s, 9H); ¹³C NMR (125 MHz, CDCl₃) δ 212.71, 195.38, 144.53, 141.55, 135.26, 134.70, 133.69, 133.52, 129.96, 129.15, 128.94, 128.85, 127.59, 125.17, 124.56, 115.75, 70.66, 44.10, 43.23, 40.95, 26.07, 21.70; IR (ATR): ν 3065, 3007, 2990, 1798, 1771, 1752, 1731, 1685, 1616, 1595, 1540, 1477, 1415, 1362, 1266 cm⁻¹; HRMS (ESI⁺) calc. for C₂₈H₃₀NO₄S [M + H]⁺: 476.1890, found: 476.1905.

1-(2-Benzoyl-1-tosylindolin-3-yl)propan-2-one (3aao). White solid, yield = 87% (75.4 mg); ¹H NMR (500 MHz, $CDCl_3$) δ 7.77 (d, *J* = 8.2 Hz, 1H), 7.63 (d, *J* = 8.0 Hz, 2H), 7.57 (t, *J* = 7.5 Hz,

3H), 7.43 (t, J = 7.8 Hz, 2H), 7.30 (t, J = 7.6 Hz, 1H), 7.12–7.03 (m, 4H), 4.38 (d, J = 2.9 Hz, 1H), 3.99–3.89 (m, 1H), 2.72 (dd, J = 18.2, 5.8 Hz, 1H), 2.50 (s, 3H), 2.29 (s, 3H), 2.06 (dd, J = 18.2, 8.6 Hz, 1H); ¹³C NMR (125 MHz, CDCl₃) δ 205.60, 196.98, 144.67, 140.87, 136.19, 134.36, 134.33, 133.63, 130.02, 128.92, 128.73, 128.00, 127.49, 125.42, 125.12, 117.22, 73.70, 44.60, 39.02, 27.09, 21.68; IR (ATR): ν 3065, 3008, 2996, 1793, 1760, 1756, 1733, 1685, 1616, 1595, 1541, 1476, 1420, 1362, 1261 cm⁻¹; HRMS (ESI) m/z: [M + H]⁺ calcd for C₂₅H₂₄NO₄S: 434.1421; found: 434.1430.

Procedure for the synthesis of 1,4-diphenyl-3,10-dihydro-[1,2]diazepino[4,5-*b*]indole 4aaa. A solution of DHI 3aaa (99.1 mg, 0.2 mmol) in ethyl acetate (1 ml) was added to 24% aq. solution of hydrazine hydrate (19.2 mg, 0.6 mmol). The biphasic solution was vigorously stirred at 95 °C for 30 h. The reaction was monitored by TLC. After the complete consumption of reactant 3aaa, ethyl acetate was added and the organic phase was separated and dried over Na₂SO₄. The organic phase was purified using flash chromatography with hexane/ ethyl acetate (5 : 1) as eluents and silica gel (100–200 mesh) as the stationary solid phase. The product 4aaa was obtained as an off-white solid (56.2 mg, 79%).

1,4-Diphenyl-3,10-dihydro-[1,2]diazepino[**4,5-***b*]indole (4aaa). White solid, yield = 79% (53.0 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.27 (s, 1H), 8.02–7.96 (m, 2H), 7.95–7.88 (m, 3H), 7.53–7.47 (m, 3H), 7.43–7.34 (m, 5H), 7.35–7.27 (m, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 152.08, 148.97, 138.17, 137.25, 136.40, 130.48, 129.93, 129.29, 129.16, 128.98, 128.81, 127.64, 127.19, 125.24, 124.15, 120.78, 119.30, 119.05, 112.19; IR (ATR): ν 3310, 3188, 3102, 3006, 1684, 1653, 1636, 1559, 1521, 1507, 1474, 1419, 1362, 1276 cm⁻¹; HRMS (ESI) *m/z*: [M + H]⁺ calcd for C₂₃H₁₈N₃: 336.1495; found: 336.1497.

tert-Butyl (2-(2,3-dibenzoylcyclopropyl)phenyl)carbamate (6aaa'). White solid, yield = 42% (37.1 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.09 (d, *J* = 8.1 Hz, 1H), 8.02–8.00 (m, 4H), 7.58–7.53 (m, 2H), 7.51 (s, 1H), 7.44 (t, *J* = 7.8 Hz, 4H), 7.34–7.28 (m, 1H), 7.23 (d, *J* = 7.6 Hz, 1H), 7.04 (td, *J* = 7.5, 1.0 Hz, 1H), 3.37–3.31 (m, 3H), 1.46 (s, 9H); ¹³C NMR (125 MHz, CDCl₃) δ 194.67, 153.12, 138.65, 136.77, 133.48, 128.71, 128.48, 128.36, 126.67, 125.78, 122.67, 119.79, 80.36, 77.28, 77.03, 76.77, 34.94, 28.23, 27.30; HRMS (ESI⁺) calc. for C₂₈H₂₈NO₄⁺ [M + H]⁺: 442.2013, found: 442.2010.

General procedure for the synthesis of product 8. The preformed sulfonium salt 1 (0.3 mmol) and *ortho*-hydroxychalcone 7 (0.2 mmol) were added to toluene (2 mL). After stirring the mixture for 5 min, Cs_2CO_3 (65.2 mg, 0.2 mmol) was added and stirring was continued at rt. The progress of the reaction was monitored by TLC. After the completion of the reaction, the crude product 8 was purified by flash column chromatography on a silica support (hexane/ethyl acetate = 5 : 1).

2-(2-Benzoyl-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one (8aaa). White solid, yield = 94% (64.4 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.10 (d, *J* = 7.4 Hz, 2H), 7.96 (d, *J* = 7.4 Hz, 2H), 7.66–7.53 (m, 2H), 7.52–7.44 (m, 4H), 7.23 (d, *J* = 7.4 Hz, 1H), 7.17 (t, *J* = 7.7 Hz, 1H), 6.95–6.82 (m, 2H), 5.66 (d, *J* = 5.5 Hz, 1H), 4.56 (dd, J = 13.5, 5.9 Hz, 1H), 3.64 (dd, J = 17.7, 6.0 Hz, 1H), 3.44 (dd, J = 17.7, 8.1 Hz, 1H); ¹³C NMR (125 MHz, CDCl₃) δ 197.89, 194.90, 158.74, 136.56, 135.13, 133.70, 133.65, 129.52, 128.98, 128.86, 128.79, 128.25, 124.93, 121.55, 110.11, 87.78, 77.41, 77.16, 76.91, 44.23, 39.76; IR (ATR): ν 3050, 3003, 2991, 1731, 1686, 1650, 1600, 1580, 1555, 1541, 1506, 1473, 1443, 1280, 1258, 1210 cm⁻¹; HRMS (ESI⁺) calc. for C₂₃H₁₉O₃⁺ [M + H]⁺: 343.1329, found: 343.1320.

2-(2-Benzoyl-5,7-di-*tert***-butyl-2,3-dihydrobenzofuran-3-yl)-1**phenylethan-1-one (8aba). White solid, yield = 89% (80.9 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.15–8.07 (m, 2H), 8.02–7.90 (m, 2H), 7.61–7.55 (m, 2H), 7.47 (dd, *J* = 16.2, 8.1 Hz, 4H), 7.15 (d, *J* = 1.9 Hz, 1H), 7.13–7.07 (m, 1H), 5.62 (d, *J* = 5.3 Hz, 1H), 4.54–4.50 (m, 1H), 3.63 (dd, *J* = 17.5, 5.5 Hz, 1H), 3.45 (dd, *J* = 17.5, 8.6 Hz, 1H), 1.30 (s, 9H), 1.29 (s, 9H); ¹³C NMR (125 MHz, CDCl₃) δ 198.33, 195.40, 154.17, 144.19, 136.80, 135.26, 133.50, 133.46, 132.57, 129.56, 128.82, 128.71, 128.62, 128.29, 122.85, 119.19, 87.96, 77.41, 77.16, 76.91, 44.44, 39.60, 34.71, 34.37, 31.92, 29.51; IR (ATR): ν 3101, 3064, 2992, 1830, 1790, 1778, 1730, 1715, 1665, 1639, 1620, 1577, 1541, 1503, 1485, 1472, 1421, 1341, 1230 cm⁻¹; HRMS (ESI⁺) calc. for C₃₁H₃₅O₃⁺ [M + H]⁺: 455.2581, found: 455.2579.

2-(2-Benzoyl-2,3-dihydrobenzofuran-3-yl)-1-(naphthalen-1-yl) ethan-1-one (8aab). White solid, yield = 91% (71.4 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.64 (d, *J* = 8.5 Hz, 1H), 8.20–8.06 (m, 2H), 8.01 (d, *J* = 8.2 Hz, 1H), 7.93–7.86 (m, 2H), 7.66–7.45 (m, 6H), 7.27 (d, *J* = 6.0 Hz, 1H), 7.18 (t, *J* = 7.7 Hz, 1H), 6.90 (dd, *J* = 17.2, 7.8 Hz, 2H), 5.74 (d, *J* = 5.6 Hz, 1H), 4.64 (dd, *J* = 13.4, 6.2 Hz, 1H), 3.71 (dd, *J* = 17.5, 6.1 Hz, 1H), 3.56 (dd, *J* = 17.5, 7.9 Hz, 1H); ¹³C NMR (125 MHz, CDCl₃) δ 201.71, 195.07, 158.78, 135.19, 134.99, 134.15, 133.73, 133.53, 130.28, 129.53, 129.01, 128.93, 128.82, 128.63, 128.42, 128.40, 126.74, 125.91, 124.94, 124.44, 121.60, 110.16, 87.81, 77.41, 77.16, 76.91, 47.19, 40.33; IR (ATR): ν 3001, 2878, 2832, 1850, 1750, 1725, 1710, 1684, 1640, 1520, 1475, 1460, 1268 cm⁻¹; HRMS (ESI⁺) calc. for C₂₇H₂₁O₃⁺ [M + H]⁺: 393.1485, found: 393.1489.

1-(2-Benzoyl-2,3-dihydrobenzofuran-3-yl)propan-2-one (8aac). White solid, yield = 87% (48.7 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.07 (dd, *J* = 8.3, 1.2 Hz, 2H), 7.64–7.57 (m, 1H), 7.49 (dd, *J* = 10.8, 4.7 Hz, 2H), 7.19–7.13 (m, 2H), 6.93–6.82 (m, 2H), 5.54 (d, *J* = 5.8 Hz, 1H), 4.35 (dd, *J* = 13.5, 6.4 Hz, 1H), 3.08 (dd, *J* = 17.7, 6.3 Hz, 1H), 2.90 (dd, *J* = 17.7, 7.8 Hz, 1H), 2.19 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 206.60, 195.04, 158.62, 135.03, 133.76, 129.46, 128.98, 128.80, 128.72, 124.73, 121.55, 110.10, 87.65, 77.41, 77.16, 76.91, 48.76, 39.55, 30.37; IR (ATR): ν 3174, 3140, 3068, 3008, 2984, 2955, 1796, 1769, 1738, 1710, 1670, 1635, 1592, 1541, 1449, 1278 cm⁻¹; HRMS (ESI⁺) calc. for C₁₈H₁₇O₃⁺ [M + H]⁺: 281.1172, found: 281.1179.

2-(2-(4-Bromobenzoyl)-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one (8daa). White solid, yield = 92% (77.5 mg); ¹H NMR (500 MHz, CDCl₃) δ 8.23–7.80 (m, 4H), 7.58 (q, *J* = 7.2 Hz, 1H), 7.51–7.39 (m, 4H), 7.23 (t, *J* = 6.5 Hz, 1H), 7.17 (q, *J* = 7.1 Hz, 1H), 6.94–6.90 (m, 1H), 6.89–6.80 (m, 1H), 5.59 (d, *J* = 5.5 Hz, 1H), 4.60–4.49 (m, 1H), 3.64 (dt, *J* = 17.8, 6.2 Hz, 1H), 3.48–3.36 (m, 1H); ¹³C NMR (125 MHz, CDCl₃) δ 197.94, 193.84, 158.55, 140.20, 136.48, 133.73, 133.51, 131.01, 129.12, 129.04, 128.90, 128.86, 128.24, 124.86, 121.68, 110.13, 87.78, 77.41, 77.16, 76.91, 44.14, 39.61; IR (ATR): ν 3060, 3002, 2991, 1777, 1760, 1734, 1710, 1684, 1598, 1560, 1510, 1479, 1431, 1276, 1228 cm⁻¹; HRMS (ESI⁺) calc. for C₂₃H₁₇BrO₃⁺ [M]⁺: 420.0361, found: 420.0357.

Conflicts of interest

There are no conflicts to declare.

Acknowledgements

NKR is thankful to the Science and Engineering Research Board (SERB), India (CRG/2020/001940) and the Council of Scientific and Industrial Research (CSIR), India (02(0424)/21/ EMR-II). AJ and AK thank the Ministry of Education, India for research fellowships.

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