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# Stereoselective Synthesis of Fluorinated 2,3-Dihydroquinolin-4(1*H*)-ones via a One-Pot Multistep Transformation

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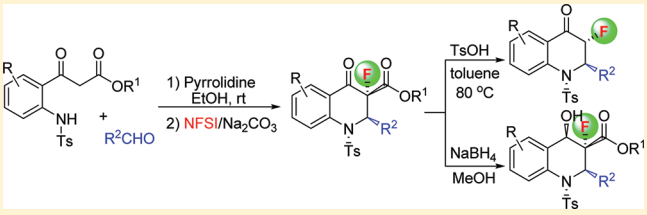
Supporting Information

**ABSTRACT:** A new organocatalytic one-pot multistep transformation via Knoevenagel condensation/aza-Michael addition/electrophilic fluorination has been developed. Simple starting materials were used under mild conditions to construct fluorinated 2,3-dihydroquinolin-4(1*H*)-one derivatives in good to high yields (up to 98%) and diastereoselectivities (dr up to 99/1).




## INTRODUCTION

Fluorinated carbocycles and heterocycles are a common feature of many biologically active synthetic and drug targets.[1] Among the possible strategies for assembling such compounds, one-pot multistep reactions constitute a particularly important approach.[2] The advantage of these transformations is the formation of several bonds in one pot without the need for isolation of the intermediates. Furthermore, this approach allows for the step-economical synthesis of complex and diverse compounds from readily available starting materials.[3] Over the past decades, a number of one-pot multistep transformations have been invented in accord with the increasing need for medicinal agents and the rapid advancement of the field of organofluorine chemistry.[4] Despite this impressive progress, the development of novel one-pot multistep transformations that provide efficiently new ways of accessing fluorinated carbocycles and heterocycles is still in great demand.

2,3-Dihydroquinolin-4(1*H*)-one scaffolds are present in many natural and unnatural compounds that exhibit important biological activities.[5] Therefore, a large number of methods have been developed for the synthesis of dihydroquinolinone derivatives.[6] The cyclization of 2′-aminochalcone derivatives or 3-(substituted anilino)propionic acids is a widely used pathway. However, a survey of the literature reveals that one-pot multistep transformations for the construction of these compounds are relatively rare. Hamada and co-workers reported the Pd-catalyzed allylic amination−thiazolium salt-catalyzed Stetter reaction cascade via a one-pot sequential multicatalytic process that provides 3-substituted 2,3-dihydroquinolin-4(1*H*)-ones,[7a] and Alper developed the multicomponent cyclocarbonylation of *o*-iodoanilines with allenes and CO using palladium complex and ionic liquid.[7b] The Chandrasekhar[8a] and Lu[8b] groups disclosed organocatalytic one-pot multistep reactions for the synthesis of 2- or 3-substituted 2,3-disubstituted dihydroquinolin-4(1*H*)-ones. Recently, a novel strategy for accessing various *trans*-2,3-disubstituted dihydroquinolin-4(1*H*)-ones is the Lewis acid-promoted one-pot multistep transformations of 2-alkynylanilines or -benzamides with aldehydes.[9] Encouraged by these results and as a part of our continued interest in the stereoselective synthesis of organofluorine compounds,[4d,e,10] we envisioned that fluorinated dihydroquinolinones could be constructed through a one-pot sequential Knoevenagel condensation/aza-Michael addition/electrophilic fluorination transformation directly from *β*-(2′-anilino)-*β*-ketoesters **1** and aldehydes (Figure 1).

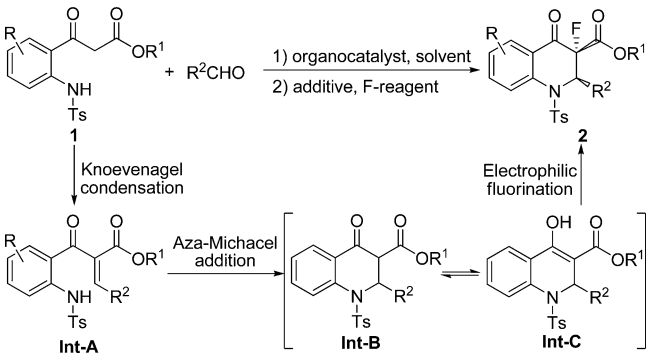



**Figure 1.** One-pot sequential Knoevenagel condensation/aza-Michael addition/electrophilic fluorination transformation.

Herein, we report the successful implementation of this process to provide fluorinated 2,3-dihydroquinolin-4(1*H*)-one derivatives and significant opportunities for structural diversification.

## RESULTS AND DISCUSSION

We initiated our studies by evaluating the reaction between Ts-protected *β*-(2′-anilino)-*β*-ketoester **1a** and benzaldehyde using organocatalyst in ethanol at room temperature. After substrate **1a** completely disappeared (monitored by TLC), additives and electrophilic fluorinating reagents were then added to the reaction system. In the presence of L-proline, no desired fluorinated product was observed; accordingly, two intermedi-

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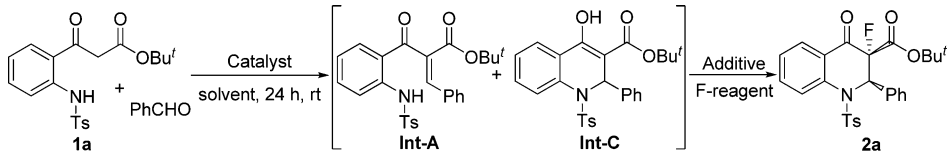
**Table 1. Effect of Catalysts, Additives, and Electrophilic Fluorinating Reagents on the One-Pot Multistep Transformation**[a]




| entry | catalyst (mol %) | solvent | additive/F-reagent | yield[b] (%) Int-A | Int-C | product 2a[c] |
|---|---|---|---|---|---|---|
| 1 | L-proline (20) | EtOH | no additive/NFSI | 30 | 69 | 0 |
| 2 | L-proline (20) | EtOH | $CH_3CO_2H$/NFSI | 30 | 39 | 0 |
| 3 | pyrrolidine (20) | EtOH | no additive/NFSI | trace | 97 | 0 |
| 4 | pyrrolidine (20) | EtOH | $CH_3CO_2H$/NFSI | 52 | 34 | 0 |
| 5 | piperidine (20) | EtOH | no additive/NFSI | trace | 96 | 0 |
| 6 | piperidine (20) | EtOH | $CH_3CO_2H$/NFSI | 50 | 28 | 0 |
| 7 | pyrrolidine (20) | EtOH | DABCO/NFSI | trace | 97 | 0 |
| 8 | pyrrolidine (20) | EtOH | DBU/NFSI | trace | 97 | 0 |
| 9 | DABCO (100) | EtOH | | trace | trace | |
| 10 | DBU (100) | EtOH | | trace | trace | |
| 11 | L-proline (20) | EtOH | $Li_2CO_3$/NFSI | 0 | 0 | 85 |
| 12 | pyrrolidine (20) | EtOH | $Li_2CO_3$/NFSI | 0 | 0 | 90 |
| 13 | pyrrolidine (20) | EtOH | $Na_2CO_3$/NFSI | 0 | 0 | 94 |
| 14 | pyrrolidine (20) | EtOH | $K_2CO_3$/NFSI | 0 | 0 | 93 |
| 15 | pyrrolidine (20) | EtOH | $Cs_2CO_3$/NFSI | 0 | 0 | 82 |
| 16 | pyrrolidine (20) | EtOH | NaOH/NFSI | 0 | 0 | 86 |
| 17 | pyrrolidine (20) | EtOH | LiOH/NFSI | 0 | 0 | 85 |
| 18 | pyrrolidine (20) | EtOH | $Na_2CO_3$/Selectfluor | 0 | 15 | 80 |
| 19 | pyrrolidine (20) | EtOH | $Na_2CO_3$/NFPY | 0 | 16 | 77 |
| 20 | pyrrolidine (20) | THF | $Na_2CO_3$/NFSI | 0 | 0 | 80 |
| 21 | pyrrolidine (20) | toluene | | trace | 28 | |
| 22 | pyrrolidine (20) | $CH_2Cl_2$ | | 23 | trace | |
| 23 | pyrrolidine (20) | $CH_3CN$ | $Na_2CO_3$/NFSI | 0 | 0 | 90 |
| 24 | pyrrolidine (10) | EtOH | $Na_2CO_3$/NFSI | 0 | 0 | 85 |

[a] **1a**/benzaldehyde/additive/F-reagent =1: 1.2: 1.2: 1.2 in 1.5 mL of solvents. [b] Isolated yield. [c] The dr value (95/5–97/3) was determined by $^{19}F$ NMR analysis of the crude product.

ates **A** and **C** were obtained in the yield of 30% and 69%, respectively (Table 1, entries 1 and 2). It is interesting that the intermediate **B** was not detected by $^1H$ NMR. The use of pyrrolidine and piperidine gave the similar results (entries 3–8). However, the addition of DABCO or DBU failed to produce any detectable products (entries 9 and 10).[11] These results show that strong base additives are necessary for reasonable reaction rates of the electrophilic fluorination step. Next, we decided to employ the inorganic bases as additives (entries 11–17). We were delighted to find that the one-pot multistep transformation could be performed at room temperature providing the desired fluorinated product **2a** with high diastereoselectivity (dr up to 97/3, determined by $^{19}F$ NMR), and the best yield was obtained with $Na_2CO_3$. Furthermore, crystals suitable for X-ray crystallographic analysis were obtained.[12] The stereochemical assignment indicated that the trans-product was predominantly formed. A substantial change of the fluorinating reagent and the solvent had a significant effect on the yield (entries 13 and 18–23). Good results were attained when *N*-fluorobenzenesulfonimide (NFSI) and ethanol were used in this one-pot multistep transformation. Last, the effect of organocatalyst loading was examined, and reducing the amount of catalyst from 20 to 10 mol % caused a drop in yield (94% to 85%), although without any influence on the stereoselectivity (entry 24).

Under the optimized experimental conditions, the scope of the one-pot multistep transformation was explored, and the results are summarized in Table 2. First, the reaction of Ts-protected *β*-(2′-anilino)-*β*-ketoester **1a** with a variety of aldehydes was examined. Electron-neutral and electron-donating groups at different positions on the aromatic ring were tolerated for this one-pot multistep transfomation to give the fluorinated 2,3-dihydroquinolin-4(1*H*)-one derivatives **2a–g** in 84–98% yields with excellent diastereoselectivities (trans/cis: 96/4 to 99/1) (entries 1–7). For the aromatic aldehyde with multisubstituents, relatively low yield was obtained probably owing to steric hindrance (entry 8). Aromatic aldehydes possessing electron-withdrawing substitutents on the aromatic rings were transformed into the desired product **2j–q** in good to high yields, albeit with a lower diastereoselectivity (entries 9–17). 2-Naphthaldehyde, heteroaromatic aldehydes, and aliphatic aldehydes were also viable substrates, affording the corresponding fluorinated products **2r–v** with high diastereoselectivities (entres 18–22). To further define the scope of our methodology, the reactions of other Ts-protected *β*-(2′-anilino)-*β*-ketoesters **1b–e** with benzaldehyde were also tested. The transformation proceeded well in 86–97% yields with high dr values (entries 23–26).

These fluorinated products **2** are versatile synthetic intermediates and can be readily transformed into functionalized heterocycle derivatives that are otherwise difficult to


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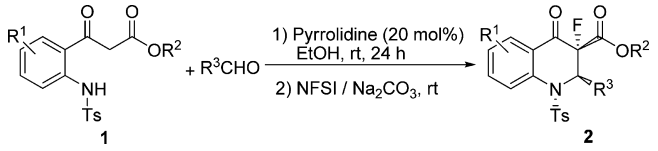
**Table 2. Scope of the One-Pot Multistep Transformation for the Synthesis of Fluorinated 2,3-Dihydroquinolin-4(1*H*)-ones[a]**




| | | | | | product 2 | | |
|---|---|---|---|---|---|---|---|
| entry | substrate 1 | $R^1$ | $R^2$ | $R^3$ | | yield[b] (%) | -trans/cis[c] |
| 1 | **1a** | H | $^t$Bu | $C_6H_5$ | **2a** | 94 | 97/3 |
| 2 | **1a** | H | $^t$Bu | 4-Me$C_6H_4$ | **2b** | 93 | 98/2 |
| 3 | **1a** | H | $^t$Bu | 4-MeO$C_6H_4$ | **2c** | 93 | 97/3 |
| 4 | **1a** | H | $^t$Bu | 2-MeO$C_6H_4$ | **2d** | 84 | 98/2 |
| 5 | **1a** | H | $^t$Bu | 3-MeO$C_6H_4$ | **2e** | 85 | 96/4 |
| 6 | **1a** | H | $^t$Bu | 3-PhO$C_6H_4$ | **2f** | 98 | 96/4 |
| 7 | **1a** | H | $^t$Bu | 3,4-$OCH_2OC_6H_3$ | **2g** | 92 | 99/1 |
| 8 | **1a** | H | $^t$Bu | 2,4,6-$(MeO)_3C_6H_2$ | **2h** | 52 | 98/2 |
| 9 | **1a** | H | $^t$Bu | 4-F$C_6H_4$ | **2i** | 85 | 97/3 |
| 10 | **1a** | H | $^t$Bu | 4-Cl$C_6H_4$ | **2j** | 92 | 94/6 |
| 11 | **1a** | H | $^t$Bu | 4-Br$C_6H_4$ | **2k** | 89 | 93/7 |
| 12 | **1a** | H | $^t$Bu | 2-Cl$C_6H_4$ | **2l** | 86 | 87/13 |
| 13 | **1a** | H | $^t$Bu | 2-Br$C_6H_4$ | **2m** | 83 | 75/25 |
| 14 | **1a** | H | $^t$Bu | 4-$NO_2C_6H_4$ | **2n** | 83 | 80/20 |
| 15 | **1a** | H | $^t$Bu | 4-$CF_3C_6H_4$ | **2o** | 82 | 90/10 |
| 16 | **1a** | H | $^t$Bu | 3,4-$Cl_2C_6H_3$ | **2p** | 84 | 85/15 |
| 17 | **1a** | H | $^t$Bu | 3,5-$(CF_3)_2C_6H_3$ | **2q** | 88 | 70/30 |
| 18 | **1a** | H | $^t$Bu | 2-naphthyl | **2r** | 97 | 94/6 |
| 19 | **1a** | H | $^t$Bu | 2-furanyl | **2s** | 85 | 99/1 |
| 20 | **1a** | H | $^t$Bu | 2-thiophene-yl | **2t** | 90 | 98/2 |
| 21 | **1a** | H | $^t$Bu | Et | **2u** | 80 | 98/2 |
| 22 | **1a** | H | $^t$Bu | $^n$Pr | **2v** | 72 | 99/1 |
| 23 | **1b** | H | Et | $C_6H_5$ | **2w** | 95 | 93/7 |
| 24 | **1c** | 4,5-$(MeO)_2$ | $^t$Bu | $C_6H_5$ | **2x** | 86 | 99/1 |
| 25 | **1d** | 4-Cl | $^t$Bu | $C_6H_5$ | **2y** | 92 | 98/2 |
| 26 | **1e** | 5-F | $^t$Bu | $C_6H_5$ | **2z** | 97 | 99/1 |

[a]Substrate **1**/aldehyde/$Na_2CO_3$/NFSI = 1:1.2:1.2:1.2 in EtOH (1.5 mL). [b]Isolated yield after flash chromatography. [c]Determined by $^{19}$F NMR analysis of the crude product.

access. For example, decarboxylation of compound **2a** gave 3-fluoro-2-phenyl-1-tosyl-2,3-dihydroquinolin-4(1*H*)-one **3** in 98% yield with 70:30 dr (Scheme 1). In addition, a reduction process using $NaBH_4$ gives rise to the corresponding *α*-fluoro-*β*-hydroxyesters **4** in high yield and excellent diastereoselectivity. Furthermore, the single stereoisomer of **4** proved to be crystalline, thus allowing the determination of the relative configuration of three adjacent stereogenic centers by means of X-ray crystallographic analysis.[12]

This methodology was further extended to electrophilic chlorinating and brominating reagents to demonstrate the scope of this one-pot multistep transformation (Scheme 2).[13] It was found that in the presence of pyrrolidine and $Na_2CO_3$, the reaction of Ts-protected *β*-(2′-anilino)-*β*-ketoester **1a** and benzaldehyde with NCS and NBS affords the corresponding chlorinated and brominated products **5** and **6** in high yields with excellent diastereoselectivities.

## CONCLUSION

In summary, we have developed a novel and efficient one-pot multistep procedure for the facile synthesis of fluorinated 2,3-dihydroquinolin-4(1*H*)-one derivatives. When pyrrolidine was used as the organocatalyst and $Na_2CO_3$ as the base additive, this convenient process provided the products in good to high yields and diastereoselectivities (dr up to 99/1) from simple starting materials and under mild conditions. The further development of catalytic enantioselective systems and the full extension of this one-pot multistep transformation with other halogenation agents will be reported in due course.

## EXPERIMENTAL SECTION

**General Information.** $^1$H, $^{13}$C, and $^{19}$F NMR were recorded at 400 MHz ($^1$H NMR), 100 MHz ($^{13}$C NMR), as well as 376 MHz ($^{19}$F NMR). Chemical shifts were reported in ppm downfield from internal $Me_4Si$ and external $CCl_3F$, respectively. Multiplicity was indicated as follows: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), dd (doublet of doublet), br (broad). Coupling constants were reported in hertz (Hz).

**Materials.** Tetrahydrofuran (THF) and toluene were distilled from sodium/benzophenone; $CH_2Cl_2$ (DCM) were distilled from $CaH_2$; $CH_3CN$ were distilled from $P_2O_5$; EtOH were distilled from sodium prior to use. All commercially available reagents were used without further purification. Analytical thin-layer chromatography was performed on 0.20 mm silica gel plates. Silica gel (200−300 mesh) was used for flash chromatography.

**Representative Procedure for the Preparation of the Starting Materials 1.** (1) Preparation of methyl 2-(4-methylphenylsulfonamido)benzoate: To a solution of methyl 2-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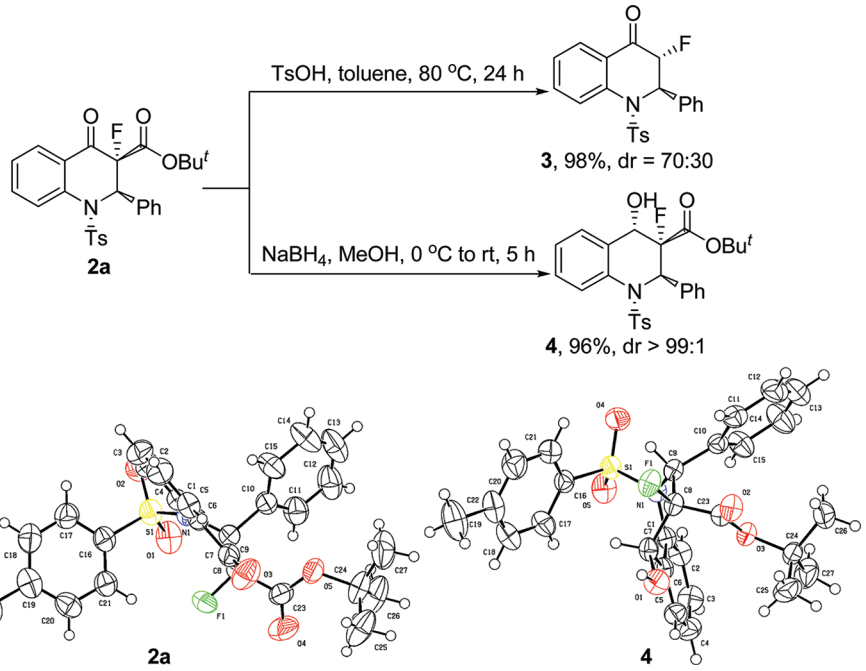
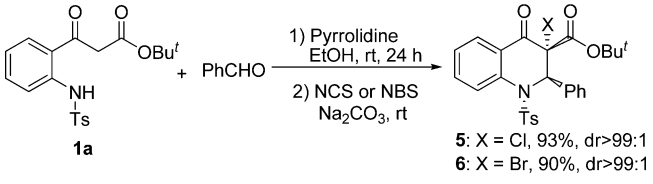
**Scheme 1. Synthetic Transformation of 2a and the Crystal Structures of the Compounds 2a and 4**




**Scheme 2. Organocatalytic One-Pot Multistep Transformation via Knoevenagel Condensation/Aza-Michael Addition/Electrophilic Chlorination and Bromination**




aminobenzoate (7.56 g, 50 mmol) in $CH_2Cl_2$ (50 mL) was added pyridine (4.85 mL, 60 mmol) dropwise over 10 min. The reaction mixture was stirred for 60 min, and a solution of 4-methylbenzene-1-sulfonyl chloride (11.44 g, 60 mmol) in $CH_2Cl_2$ was added dropwise. After being stirred overnight, the reaction was quenched with the addition of saturated aqueous $NH_4Cl$ (100 mL). The layers were separated, and the aqueous layer was extracted with $CH_2Cl_2$ several times. The combined organic layers were washed with brine (100 mL) and dried over $MgSO_4$. Evaporation of the solvent under the reduced pressure and purification by column chromatography (EtOAc/petroleum ether =1/8 to 1/2) afforded the desired compound as a white solid (12.8 g, 84% yield): mp 115−116 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 2.38 (s, 3H), 3.89 (s, 3H), 7.03−7.06 (m, 1H), 7.23−7.24 (m, 2H), 7.29 (m, 1H), 7.45−7.47 (m, 1H), 7.70−7.77 (m, 2H), 7.92−7.94 (m, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 168.3, 143.9, 140.6, 136.5, 134.5, 131.2, 129.6, 127.3, 122.8, 119.0, 115.9, 52.4, 21.5; MS (ESI) found $m/z$ 328.0 $[M + Na]^+$; HRMS (ESI) found $m/z$ 328.0624 $[M + Na]^+$, calcd for $C_{15}H_{15}NO_4S$ + Na 328.0619.

(2) Preparation of *tert*-butyl 3-(2-(4-methylphenylsulfonamido)-phenyl)-3-oxopropanoate **1a**:[6m] To a $N_2$-purged 250 mL round-bottom flask were added anhydrous THF (40 mL) and diisopropylamine (10.1 mL, 72 mmol). The solution was cooled to −78 °C, *n*-BuLi (31.3 mL, 2.4 M in hexane) was added, and the resulting solution was warmed slowly to 0 °C over 60 min. The solution was cooled to −78 °C, and *tert*-butyl acetate (6.5 mL, 48 mmol) in THF (40 mL) was added dropwise over 30 min. After 90 min, methyl 2-(4-methylphenylsulfonamido)benzoate (3.67 g, 12 mmol) in THF (30 mL) was added. The solution was allowed to warm to room temperature overnight and quenched by adding aqueous $NH_4Cl$ (satd), extracted with EtOAc (2 × 50 mL), washed with brine (60 mL), dried over $Na_2SO_4$, filtered, and concentrated. Purification by column chromatography (EtOAc/petroleum ether = 1/8) yielded **1a** (2.43 g, 52% yield) as a white solid: mp 130−131 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.43 (s, 9H), 2.37 (s, 3H), 3.85 (s, 2H), 7.06 (t, $J$ = 7.2 Hz, 1H), 7.24 (d, $J$ = 8.0 Hz, 2H), 7.47 (t, $J$ = 7.2 Hz, 1H), 7.72 (t, $J$ = 8.0 Hz, 2H), 7.76 (d, $J$ = 8.4 Hz, 2H), 11.28 (s, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 196.8, 166.0, 143.9, 140.5, 136.5, 135.2, 131.5, 130.0, 127.2, 122.4, 121.2, 118.7, 82.4, 77.4, 76.9, 76.5, 48.3, 27.8, 21.4; IR (KBr) $\nu$ 2980, 2937, 1735, 1650, 1576, 1496, 1452, 1328, 1165, 1121, 1083, 1013, 942, 669, 568 cm$^{-1}$; MS (ESI) found $m/z$ 407.1 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 412.1338 $[M + Na]^+$, calcd for $C_{20}H_{23}NO_5S$ + Na 412.1326.

*Ethyl 3-(2-(4-Methylphenylsulfonamido)phenyl)-3-oxopropanoate (**1b**).* Compound **1b** was prepared according to the above-mentioned procedure: white solid; 2.64 g, 61% yield; mp 85−86 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.24 (t, $J$ = 7.2 Hz, 3H), 2.35 (s, 3H), 3.93 (s, 2H), 4.16−4.22 (m, 2H), 7.06 (t, $J$ = 7.2 Hz, 1H), 7.23 (d, $J$ = 8.0 Hz, 2H), 7.44−7.48 (m, 1H), 7.67−7.74 (m, 4H), 11.21 (s, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 196.6, 166.9, 144.0, 140.5, 136.3, 135.5, 131.6, 129.7, 127.2, 122.6, 121.1, 118.8, 61.6, 47.0, 21.5, 14.0; IR (KBr) $\nu$ 2978, 2937, 1739, 1652, 1602, 1576, 1494, 1452, 1327, 1161, 1091, 1033, 917, 659, 565 cm$^{-1}$; MS (ESI) found $m/z$ 379.1 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 384.0878 $[M + Na]^+$, calcd for $C_{18}H_{19}NO_5S$ + Na 384.0882.

*tert-Butyl 3-(4,5-Dimethoxy-2-(4-methylphenylsulfonamido)-phenyl)-3-oxopropanoate (**1c**).* Compound **1c** was prepared according to the above-mentioned procedure: white solid, 2.68 g, 50% yield; mp 120−121 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.38 (s, 9H), 2.33 (s, 3H), 3.74 (s, 2H), 3.80 (s, 3H), 3.89 (s, 3H), 7.09 (s, 1H), 7.19 (d, $J$ = 8.0 Hz, 2H), 7.27 (s, 1H), 7.67 (d, $J$ = 8.0 Hz, 2H), 11.37 (s, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 194.8, 166.2, 154.7, 144.1, 143.9, 136.8, 136.3, 129.6, 127.2, 114.1, 112.9, 102.2, 82.2, 56.2, 56.1, 48.7, 27.8, 21.4; IR (KBr) $\nu$ 2978, 2937, 1730, 1639, 1575, 1520, 1448, 1399, 1355, 1264, 1160, 1090, 993, 909, 676, 546 cm$^{-1}$; MS (ESI) found $m/z$ 467.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 472.1412 $[M + Na]^+$, calcd for $C_{22}H_{27}NO_7S$ + Na 472.1406.

*tert-Butyl 3-(4-Chloro-2-(4-methylphenylsulfonamido)phenyl)-3-oxopropanoate (**1d**).* Compound **1d** was prepared according to the above-mentioned procedure: pink solid, 2.84 g, 56% yield; mp 113−114 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.42 (s, 9H), 2.37 (s, 3H), 3.85 (s, 2H), 7.00−7.02 (m, 2H), 7.25 (d, $J$ = 8.0 Hz, 2H), 7.56 (d, $J$ =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8.8 Hz, 1H), 7.73 (s, 1H), 7.77 (d, $J$ = 8.4 Hz, 2H), 11.35 (s, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 196.2, 170.4, 166.0, 144.4, 141.7, 136.1, 132.8, 129.8, 127.3, 122.6, 119.3, 118.3, 82.7, 48.2, 27.8, 21.5; IR (KBr) $\nu$ 2980, 2933, 1731, 1654, 1597, 1562, 1494, 1396, 1330, 1164, 1092, 936, 667, 573 cm$^{-1}$; MS (ESI) found $m/z$ 441.1 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 446.0817 $[M + Na]^+$, calcd for $C_{20}H_{22}ClNO_5S$ + Na 446.0805.

*tert-Butyl 3-(5-Fluoro-2-(4-methylphenylsulfonamido)phenyl)-3-oxopropanoate (**1e**).* Compound **1e** was prepared according to the above-mentioned procedure: pink solid, 2.35 g, 48% yield; mp 117−118 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.42 (s, 9H), 2.36 (s, 3H), 3.77 (s, 2H), 7.19−7.23 (m, 3H), 7.39 (dd, $J$ = 9.2 Hz, 2.8 Hz, 1H), 7.69 (d, $J$ = 8.0 Hz, 2H), 7.72 (dd, $J$ = 9.2 Hz, 4.8 Hz, 1H), 10.87 (s, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 195.9, 165.5, 157.5 (d, $^1J_{CF}$ = 243.4 Hz), 144.1, 136.5, 136.1, 129.7, 127.2, 122.7 (d, $^3J_{CF}$ = 5.7 Hz), 122.5 (d, $^2J_{CF}$ = 22.4 Hz), 121.5 (d, $^3J_{CF}$ = 7.2 Hz), 117.4 (d, $^2J_{CF}$ = 23.4 Hz), 82.7, 48.3, 27.8, 21.5; IR (KBr) $\nu$ 2980, 2933, 1732, 1661, 1598, 1585, 1496, 1395, 1335, 1163, 1090, 900, 668, 549 cm$^{-1}$; MS (ESI) found $m/z$ 425.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 430.1103 $[M + Na]^+$, calcd for $C_{20}H_{22}FNO_5S$ + Na 430.1100.

**General Procedure for One-Pot Multistep Transformation via Knoevenagel Condensation/Aza-Michael Addition/Electrophilic Halogenation.** To a solution of **1a** (116.9 mg, 0.3 mmol) and benzaldehyde (38.3 mg, 0.36 mmol) in ethanol (1.5 mL) was added pyrrolidine (4.3 mg, 20 mol %) at room temperature, and the mixture was stirred for 24 h. Then sodium carbonate (38.2 mg, 0.36 mmol) and electrophilic halogenating reagent (0.36 mmol) were added sequentially to the reaction mixture. Upon completion of the reaction (monitored by TLC), the solvent was removed in vacuum. The residue was mixed with 5 mL of water and extracted with $CH_2Cl_2$ (3 × 10 mL). The combined organic phases were washed with brine (10 mL) and dried over anhydrous $Na_2SO_4$. Filtration and concentration of the filtrate gave the crude product, which was purified by column chromatography on silica gel (petroleum ether/ethyl acetate 10/1) to provide the desired product as a white solid.

*tert-Butyl 3-fluoro-4-oxo-2-phenyl-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2a**):* white solid; 139.7 mg, 94% yield; 97:3 dr; mp 140−141 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ (ppm) 1.02 (s, 9H), 2.33 (s, 3H), 6.16 (d, $J$ = 21.2 Hz, 1H), 7.15−7.19 (m, 4H), 7.23 (t, $J$ = 7.6 Hz, 2H), 7.28−7.31 (m, 2H), 7.58 (d, $J$ = 8.4 Hz, 2H), 7.61−7.65 (m, 1H), 7.94 (d, $J$ = 8.0 Hz, 1H), 7.98 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ (ppm) 183.8 (d, $^2J_{CF}$ = 20.0 Hz), 162.9 (d, $^2J_{CF}$ = 26.2 Hz), 144.7, 141.1, 136.1, 135.7, 135.6, 134.8, 129.6, 129.0, 128.7, 128.5, 128.2, 127.8, 125.6, 124.2, 123.8, 92.6 (d, $^1J_{CF}$ = 192.9 Hz), 84.4, 66.2 (d, $^2J_{CF}$ = 26.9 Hz), 27.1, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ (ppm) −141.2 (d, $J$ = 21.0 Hz), −169.4; IR (KBr) $\nu$ 2981, 2931, 1753, 1696, 1599, 1477, 1457, 1359, 1304, 1166, 1088, 662, 569 cm$^{-1}$; MS (ESI) found $m/z$ 513.1 $[M + NH_4]^+$, HRMS (ESI) found $m/z$ 518.1421 $[M + Na]^+$, calcd for $C_{27}H_{26}FNO_5S$ + Na 518.1413.

*tert-Butyl 3-fluoro-4-oxo-2-(p-tolyl)-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2b**):* white solid; 142.1 mg, 93% yield; 98:2 dr; mp 66−67 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.05 (s, 9H), 2.28 (s, 3H), 2.32 (s, 3H), 6.14 (d, $J$ = 20.8 Hz, 1H), 7.02−7.07 (m, 4H), 7.16 (d, $J$ = 8.0 Hz, 2H), 7.28 (t, $J$ = 7.2 Hz, 1H), 7.58−7.63 (m, 3H), 7.93−7.97 (m, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.9 (d, $^2J_{CF}$ = 20.2 Hz), 163.0 (d, $^2J_{CF}$ = 26.2 Hz), 144.6, 141.1, 138.9, 136.1, 135.0, 132.6, 132.5, 129.5, 129.3, 128.5, 128.1, 127.8, 125.4, 124.1, 123.7, 92.6 (d, $^1J_{CF}$ = 192.7 Hz), 84.3, 66.0 (d, $^2J_{CF}$ = 26.8 Hz), 27.1, 21.5, 21.0; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.3 (d, $J$ = 20.7 Hz), 169.2; IR (KBr) $\nu$ 2980, 2930, 1752, 1698, 1598, 1476, 1458, 1357, 1302, 1165, 1088, 1060, 660, 572 cm$^{-1}$; MS (ESI) found $m/z$ 527.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 532.1581 $[M + Na]^+$, calcd for $C_{28}H_{28}FNO_5S$ + Na 532.1570.

*tert-Butyl 3-fluoro-2-(4-methoxyphenyl)-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2c**):* white solid; 146.6 mg, 93% yield; 97:3 dr; mp 144−145 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.08 (s, 9H), 2.30 (s, 3H), 3.72 (s, 3H), 6.13 (d, $J$ = 20.4 Hz, 1H), 6.74 (d, $J$ = 8.4 Hz, 2H), 7.08 (d, $J$ = 8.8 Hz, 2H), 7.15 (d, $J$ = 8.0 Hz, 2H), 7.27 (t, $J$ = 7.6 Hz, 1H), 7.57−7.62 (m, 3H), 7.92−7.95 (m, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.9 (d, $^2J_{CF}$ = 20.1 Hz), 163.1 (d, $^2J_{CF}$ = 26.1 Hz), 160.1, 144.6, 141.0, 136.2, 135.0, 129.5, 129.3, 128.6, 127.8, 125.4, 123.9, 123.6, 114.0, 92.5 (d, $^1J_{CF}$ = 192.6 Hz), 84.3, 65.7 (d, $^2J_{CF}$ = 26.7 Hz), 55.3, 27.2, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.3 (d, $J$ = 20.3 Hz), −169.1; IR (KBr) $\nu$ 2980, 2934, 1752, 1698, 1599, 1515, 1459, 1369, 1306, 1256, 1165, 1059, 661, 567 cm$^{-1}$; MS (ESI) found $m/z$ 543.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 548.1513 $[M + Na]^+$, calcd for $C_{28}H_{28}FNO_6S$ + Na 548.1519.

*tert-Butyl 3-fluoro-2-(2-methoxyphenyl)-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2d**):* white solid; 132.4 mg, 84% yield; 98:2 dr; mp 72−73 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.08 (s, 9H), 2.32 (s, 3H), 3.68 (s, 3H), 6.75−6.80 (m, 2H), 6.83 (d, $J$ = 8.4 Hz, 1H), 7.03 (d, $J$ = 7.6 Hz, 1H), 7.16 (d, $J$ = 8.4 Hz, 2H), 7.21−7.26 (m, 2H), 7.59 (t, $J$ = 7.2 Hz, 1H), 7.64 (d, $J$ = 8.0 Hz, 2H), 7.97 (t, $J$ = 8.8 Hz, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.1 (d, $^2J_{CF}$ = 20.9 Hz), 162.9 (d, $^2J_{CF}$ = 25.9 Hz), 156.9, 144.5, 141.7, 135.7, 135.2, 130.0, 129.5, 128.6, 128.3, 127.9, 124.7, 122.5, 120.7, 110.8, 91.9 (d, $^1J_{CF}$ = 190.5 Hz), 83.7, 60.4 (d, $^2J_{CF}$ = 29.9 Hz), 55.0, 27.1, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.5 (d, $J$ = 21.8 Hz), −171.2; IR (KBr) $\nu$ 2980, 2937, 1755, 1696, 1599, 1459, 1357, 1306, 1249, 1165, 1088, 1059, 1027, 660, 570 cm$^{-1}$; MS (ESI) found $m/z$ 543.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 548.1534 $[M + Na]^+$, calcd for $C_{28}H_{28}FNO_6S$ + Na 548.1519.

*tert-Butyl 3-fluoro-2-(3-methoxyphenyl)-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2e**):* white solid; 133.9 mg, 85% yield; 96:4 dr; mp 102−103 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.04 (s, 9H), 2.32 (s, 3H), 3.64 (s, 3H), 6.02 (d, $J$ = 21.6 Hz, 1H), 6.70 (s, 1H), 6.76 (d, $J$ = 8.0 Hz, 1H), 6.84 (dd, $J$ = 8.0 Hz, 1.6 Hz, 1H), 7.12−7.17 (m, 3H), 7.29 (t, $J$ = 7.6 Hz, 1H), 7.57 (d, $J$ = 8.0 Hz, 2H), 7.60−7.65 (m, 1H), 7.91−7.93 (m, 1H), 7.98 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.9 (d, $^2J_{CF}$ = 20.0 Hz), 162.9 (d, $^2J_{CF}$ = 26.7 Hz), 159.6, 144.7, 141.1, 136.9, 136.1, 134.8, 129.8, 129.6, 128.4, 127.8, 125.6, 124.4, 123.9, 120.4, 114.5, 113.9, 92.7 (d, $^1J_{CF}$ = 193.0 Hz), 84.3, 66.0 (d, $^2J_{CF}$ = 27.2 Hz), 55.1, 27.1, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −140.9 (d, $J$ = 21.4 Hz), 169.3; IR (KBr) $\nu$ 2980, 2935, 1754, 1699, 1599, 1458, 1369, 1303, 1166, 1088, 1060, 662, 575 cm$^{-1}$; MS (ESI) found $m/z$ 543.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 548.1509 $[M + Na]^+$, calcd for $C_{28}H_{28}FNO_6S$ + Na 548.1519.

*tert-Butyl 3-fluoro-4-oxo-2-(3-phenoxyphenyl)-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2f**):* white solid; 172.7 mg, 98% yield; 96:4 dr; mp 69−70 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.12 (s, 9H), 2.32 (s, 3H), 6.13 (d, $J$ = 21.2 Hz, 1H), 6.75 (s, 1H), 6.89 (d, $J$ = 7.6 Hz, 2H), 6.93−6.96 (m, 2H), 7.11 (t, $J$ = 7.6 Hz, 1H), 7.16 (d, $J$ = 8.0 Hz, 2H), 7.19−7.24 (m, 2H), 7.29 (t, $J$ = 7.6 Hz, 2H), 7.55−7.58 (m, 1H), 7.82−7.84 (m, 1H), 7.93 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.7 (d, $^2J_{CF}$ = 19.9 Hz), 162.8 (d, $^2J_{CF}$ = 26.4 Hz), 157.9, 155.8, 144.7, 140.9, 137.4, 137.3, 136.1, 134.7, 130.1, 129.9, 129.6, 128.4, 127.8, 125.7, 124.3, 123.9, 123.8, 122.7, 119.6, 118.4, 117.3, 92.6 (d, $^1J_{CF}$ = 193.8 Hz), 84.5, 65.8 (d, $^2J_{CF}$ = 27.3 Hz), 27.2, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.1 (d, $J$ = 21.0 Hz), 169.3; IR (KBr) $\nu$ 2980, 2931, 1754, 1698, 1488, 1458, 1369, 1304, 1255, 1167, 1088, 662, 572 cm$^{-1}$; MS (ESI) found $m/z$ 605.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 610.1680 $[M + Na]^+$, calcd for $C_{33}H_{30}FNO_6S$ + Na 610.1676.

*tert-Butyl 2-(benzo[d][1,3]dioxol-5-yl)-3-fluoro-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2g**):* white solid; 148.9 mg, 92% yield; 99:1 dr; mp 126−127 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.13 (s, 9H), 2.32 (s, 3H), 5.88 (s, 2H), 6.09 (d, $J$ = 20.8 Hz, 1H), 6.56 (s, 1H), 6.69 (d, $J$ = 8.0 Hz, 1H), 6.75 (dd, $J$ = 8.0 Hz, 1.2 Hz, 1H), 7.17 (t, $J$ = 7.2 Hz, 3H), 7.26−7.33 (m, 2H), 7.58−7.64 (m, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.7 (d, $^2J_{CF}$ = 20.1 Hz), 163.0 (d, $^2J_{CF}$ = 26.4 Hz), 148.2, 147.7, 144.7, 140.9, 136.3, 134.8, 129.6, 129.4, 128.6, 127.8, 125.5, 124.6, 123.6, 122.5, 119.5, 108.3, 101.3, 92.5 (d, $^1J_{CF}$ = 192.9 Hz), 84.5, 67.9, 65.8 (d, $^2J_{CF}$ = 27.1 Hz), 27.3, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.3 (d, $J$ = 20.7 Hz), −169.1; IR (KBr) $\nu$ 2981, 2931, 2908, 1753, 1698, 1599, 1490, 1458, 1362, 1300, 1251, 1167, 1035, 929, 662, 569 cm$^{-1}$; MS (ESI) found $m/z$ 557.1 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 562.1313 $[M + Na]^+$, calcd for $C_{28}H_{26}FNO_7S$ + Na 562.1312.


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*tert-Butyl 3-fluoro-4-oxo-1-tosyl-2-(2,4,6-trimethoxyphenyl)-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2h**):* white solid; 91.3 mg, 52% yield; 98:2 dr; mp 76−77 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.16 (s, 9H), 2.32 (s, 3H), 2.99 (s, 3H), 3.76 (s, 3H), 3.90 (s, 3H), 5.89 (s, 1H), 6.14 (s, 1H), 7.01 (d, $J$ = 25.6 Hz, 1H), 7.10 (t, $J$ = 7.6 Hz, 1H), 7.15 (d, $J$ = 8.4 Hz, 2H), 7.41−7.45 (m, 1H), 7.66 (d, $J$ = 8.0 Hz, 2H), 7.82 (d, $J$ = 8.4 Hz, 1H), 7.98 (dd, $J$ = 7.6 Hz, 1.2 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 181.8 (d, $^2J_{CF}$ = 22.7 Hz), 163.2 (d, $^2J_{CF}$ = 24.7 Hz), 161.8, 160.0, 159.1, 144.0, 142.2, 135.9, 134.3, 129.3, 127.9, 127.2, 123.1, 123.0, 121.1, 106.5, 106.4, 91.4 (d, $^1J_{CF}$ = 185.3 Hz), 90.8, 90.6, 83.1, 57.6 (d, $^2J_{CF}$ = 29.7 Hz), 56.3, 55.4, 53.5, 27.2, 21.4; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.5 (d, $J$ = 25.6 Hz), −169.8; IR (KBr) $\nu$ 2978, 2939, 1751, 1700, 1601, 1459, 1359, 1309, 1228, 1207, 1161, 1049, 659, 569 cm$^{-1}$; MS (ESI) found $m/z$ 608.2 [M + Na]$^+$; HRMS (ESI) found $m/z$ 608.1725 [M + Na]$^+$, calcd for $C_{30}H_{32}FNO_8S$ + Na 608.1730.

*tert-Butyl 3-fluoro-2-(4-fluorophenyl)-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2i**):* white solid; 130.9 mg, 85% yield; 97:3 dr; mp 71−72 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.06 (s, 9H), 2.32 (s, 3H), 6.15 (d, $J$ = 21.2 Hz, 1H), 6.94 (t, $J$ = 8.4 Hz, 2H), 7.16−7.21 (m, 4H), 7.29 (d, $J$ = 7.6 Hz, 1H), 7.58 (d, $J$ = 8.0 Hz, 2H), 7.63 (t, $J$ = 7.6 Hz, 1H), 7.93 (d, $J$ = 8.0 Hz, 1H), 7.98 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.7 (d, $^2J_{CF}$ = 20.1 Hz), 164.2, 162.8 (d, $^2J_{CF}$ = 26.0 Hz), 161.7, 144.8, 140.8, 136.2, 130.1, 130.0, 129.6, 128.6, 127.8, 125.7, 124.1, 123.8, 115.7, 115.5, 92.5 (d, $^1J_{CF}$ = 193.3 Hz), 84.6, 65.4 (d, $^2J_{CF}$ = 27.3 Hz), 27.2, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.6 (d, $J$ = 20.7 Hz), −169.2, −111.9, −112.1; IR (KBr) $\nu$ 2981, 2934, 1754, 1699, 1630, 1601, 1511, 1458, 1364, 1304, 1164, 667, 571 cm$^{-1}$; MS (ESI) found $m/z$ 531.2 [M + $NH_4$]$^+$; HRMS (ESI) found $m/z$ 536.1306 [M + Na]$^+$, calcd for $C_{27}H_{25}F_2NO_5S$ + Na 536.1319.

*tert-Butyl 2-(4-chlorophenyl)-3-fluoro-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2j**):* white solid; 146.2 mg, 92% yield; 94:6 dr; mp 146−147 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.06 (s, 9H), 2.32 (s, 3H), 6.13 (d, $J$ = 21.2 Hz, 1H), 7.14−7.18 (m, 4H), 7.23 (d, $J$ = 8.4 Hz, 2H), 7.27−7.31 (m, 1H), 7.57 (d, $J$ = 8.4 Hz, 2H), 7.61−7.65 (m, 1H), 7.91−7.93 (m, 1H), 7.98 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.6 (d, $^2J_{CF}$ = 20.2 Hz), 162.7 (d, $^2J_{CF}$ = 26.3 Hz), 144.9, 140.7, 136.3, 135.0, 134.5, 134.4, 134.3, 129.6, 129.5, 128.8, 128.5, 127.8, 125.7, 124.1, 123.8, 92.4 (d, $^1J_{CF}$ = 194.0 Hz), 84.8, 65.3 (d, $^2J_{CF}$ = 27.6 Hz), 27.2, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.9 (d, $J$ = 20.7 Hz), −169.2; IR (KBr) $\nu$ 2980, 2933, 1756, 1699, 1598, 1494, 1477, 1459, 1370, 1307, 1166, 1089, 1061, 661, 570 cm$^{-1}$; MS (ESI) found $m/z$ 547.1 [M + $NH_4$]$^+$; HRMS (ESI) found $m/z$ 552.1034 [M + Na]$^+$, calcd for $C_{27}H_{25}ClFNO_5S$ + Na 552.1024.

*tert-Butyl 2-(4-bromophenyl)-3-fluoro-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2k**):* white solid; 153.3 mg, 89% yield; 93:7 dr; mp 147−148 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.06 (s, 9H), 2.31 (s, 3H), 6.11 (d, $J$ = 21.2 Hz, 1H), 7.09 (d, $J$ = 8.8 Hz, 2H), 7.16 (d, $J$ = 8.0 Hz, 2H), 7.26−7.30 (m, 1H), 7.38 (d, $J$ = 8.4 Hz, 2H), 7.57 (d, $J$ = 8.4 Hz, 2H), 7.60−7.65 (m, 1H), 7.91 (d, $J$ = 7.6 Hz, 1H), 7.98 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.6 (d, $^2J_{CF}$ = 20.1 Hz), 162.6 (d, $^2J_{CF}$ = 26.2 Hz), 144.9, 140.7, 136.3, 134.9, 134.8, 134.5, 131.8, 129.8, 129.6, 128.5, 127.8, 125.8, 124.1, 123.8, 123.1, 92.4 (d, $^1J_{CF}$ = 194.1 Hz), 84.8, 65.4 (d, $^2J_{CF}$ = 27.5 Hz), 27.2, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.9 (d, $J$ = 20.7 Hz), −169.1; IR (KBr) $\nu$ 2981, 2932, 1755, 1697, 1651, 1633, 1457, 1371, 1165, 1088, 668, 571 cm$^{-1}$; MS (ESI) found $m/z$ 591.1 [M + $NH_4$]$^+$; HRMS (ESI) found $m/z$ 596.0529 [M + Na]$^+$, calcd for $C_{27}H_{25}BrFNO_5S$ + Na 596.0519.

*tert-Butyl 2-(2-chlorophenyl)-3-fluoro-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2l**):* white solid; 136.7 mg, 86% yield; 87:13 dr; mp 52−53 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.14 (s, 9H), 2.35 (s, 3H), 6.98−7.03 (m, 2H), 7.19−7.31 (m, 5H), 7.42 (d, $J$ = 8.0 Hz, 1H), 7.66 (t, $J$ = 8.0 Hz, 3H), 7.98 (dd, $J$ = 8.0 Hz, 1.6 Hz, 1H), 8.03 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.3 (d, $^2J_{CF}$ = 20.7 Hz), 162.5 (d, $^2J_{CF}$ = 25.5 Hz), 144.8, 141.8, 136.4, 134.4, 130.0, 129.9, 129.7, 129.6, 128.9, 127.9, 127.1, 125.2, 122.8, 122.6, 92.0 (d, $^1J_{CF}$ = 195.1 Hz), 84.4, 61.5 (d, $^2J_{CF}$ = 29.1 Hz), 27.5, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −1416 (d, $J$ = 19.9 Hz), −171.5; IR (KBr) $\nu$ 2982, 2931, 1758, 1699, 1599, 1476, 1459, 1358, 1301, 1168, 1067, 660, 570 cm$^{-1}$; MS (ESI) found $m/z$ 547.1 [M + $NH_4$]$^+$; HRMS (ESI) found $m/z$ 552.1029 [M + Na]$^+$, calcd for $C_{27}H_{25}ClFNO_5S$ + Na 552.1024.

*tert-Butyl 2-(2-bromophenyl)-3-fluoro-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2m**):* white solid; 142.9 mg, 83% yield; 75:25 dr; mp 144−145 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.13 (s, 9H), 2.34 (s, 3H), 6.98 (d, $J$ = 5.2 Hz, 1H), 7.16−7.21 (m, 5H), 7.32 (t, $J$ = 8.0 Hz, 2H), 7.60−7.67 (m, 3H), 7.97−8.05 (m, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.3 (d, $^2J_{CF}$ = 20.7 Hz), 162.5 (d, $^2J_{CF}$ = 25.8 Hz), 144.9, 141.7, 136.5, 133.3, 130.3, 129.7, 129.4, 128.9, 128.0, 127.9, 127.8, 125.3, 124.7, 122.8, 119.6, 91.5 (d, $^1J_{CF}$ = 194.2 Hz), 84.5, 64.2 (d, $^2J_{CF}$ = 28.8 Hz), 27.2, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.2 (d, $J$ = 20.3 Hz), −171.0; IR (KBr) $\nu$ 2982, 2932, 1757, 1699, 1599, 1459, 1359, 1300, 1169, 1064, 658, 569 cm$^{-1}$; MS (ESI) found $m/z$ 591.0 [M + $NH_4$]$^+$; HRMS (ESI) found $m/z$ 596.0524 [M + Na]$^+$, calcd for $C_{27}H_{25}BrFNO_5S$ + Na 596.0519.

*tert-Butyl 3-fluoro-2-(4-nitrophenyl)-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2n**):* white solid; 134.5 mg, 83% yield; 80:20 dr; mp 146−147 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.02 (s, 9H), 2.34 (s, 3H), 6.20 (d, $J$ = 21.2 Hz, 1H), 7.19 (d, $J$ = 8.4 Hz, 2H), 7.34 (t, $J$ = 7.6 Hz, 1H), 7.47 (d, $J$ = 8.4 Hz, 2H), 7.55 (d, $J$ = 8.4 Hz, 2H), 7.69 (d, $J$ = 6.8 Hz, 1H), 7.89 (d, $J$ = 7.6 Hz, 1H), 8.02 (d, $J$ = 8.8 Hz, 1H), 8.14 (d, $J$ = 8.8 Hz, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.3 (d, $^2J_{CF}$ = 20.0 Hz), 162.2 (d, $^2J_{CF}$ = 26.4 Hz), 148.0, 145.2, 142.9, 140.5, 136.4, 133.8, 129.8, 129.0, 128.5, 127.8, 127.4, 126.2, 124.1, 123.8, 92.5 (d, $^1J_{CF}$ = 196.6 Hz), 85.3, 65.1 (d, $^2J_{CF}$ = 28.5 Hz), 27.2, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −142.9 (d, $J$ = 21.1 Hz), −168.8; IR (KBr) $\nu$ 2981, 2933, 1759, 1701, 1599, 1526, 1476, 1459, 1349, 1306, 1167, 1088, 661, 569 cm$^{-1}$; MS (ESI) found $m/z$ 558.0 [M + $NH_4$]$^+$; HRMS (ESI) found $m/z$ 563.1268 [M + Na]$^+$, calcd for $C_{27}H_{25}FN_2O_7S$ + Na 563.1264.

*tert-Butyl 3-fluoro-4-oxo-1-tosyl-2-(4-(trifluoromethyl)phenyl)-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2o**):* white solid; 138.6 mg, 82% yield; 90:10 dr; mp 60−61 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.01 (s, 9H), 2.35 (s, 3H), 6.20 (d, $J$ = 21.2 Hz, 1H), 7.19 (d, $J$ = 8.0 Hz, 2H), 7.33 (t, $J$ = 7.2 Hz, 1H), 7.38 (d, $J$ = 8.0 Hz, 2H), 7.54−7.59 (m, 4H), 7.68 (t, $J$ = 6.8 Hz, 1H), 7.92 (d, $J$ = 7.6 Hz, 1H), 8.03 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.5 (d, $^2J_{CF}$ = 19.9 Hz), 162.5 (d, $^2J_{CF}$ = 26.3 Hz), 145.0, 140.8, 139.9, 136.3, 134.2, 129.7, 128.5, 128.4, 127.8, 127.4, 125.9, 125.7, 125.6, 124.4, 124.0, 92.6 (d, $^1J_{CF}$ = 194.8 Hz), 84.9, 65.4 (d, $^2J_{CF}$ = 27.7 Hz), 27.1, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −142.0 (d, $J$ = 21.1 Hz), −169.4, −62.9; IR (KBr) $\nu$ 2981, 2934, 1758, 1700, 1599, 1477, 1459, 1370, 1327, 1167, 1069, 1017, 667, 569 cm$^{-1}$; MS (ESI) found $m/z$ 581.2 [M + $NH_4$]$^+$; HRMS (ESI) found $m/z$ 586.1279 [M + Na]$^+$, calcd for $C_{28}H_{25}F_4NO_5S$ + Na 586.1287.

*tert-Butyl 2-(3,4-dichlorophenyl)-3-fluoro-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2p**):* white solid; 142.2 mg, 84% yield; 85:15 dr; mp 155−156 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.09 (s, 9H), 2.36 (s, 3H), 6.05 (d, $J$ = 20.8 Hz, 1H), 7.06 (dd, $J$ = 8.4 Hz, 2.0 Hz, 1H), 7.18−7.22 (m, 3H), 7.31−7.35 (m, 2H), 7.56 (d, $J$ = 8.0 Hz, 2H), 7.66−7.70 (m, 1H), 7.91 (dd, $J$ = 7.6 Hz, 1.2 Hz, 1H), 8.03 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.4 (d, $^2J_{CF}$ = 19.7 Hz), 162.4 (d, $^2J_{CF}$ = 26.5 Hz), 145.1, 140.6, 136.3, 133.3, 132.7, 130.6, 130.2, 129.7, 128.5, 127.8, 127.4, 127.1, 126.0, 124.0, 118.8, 92.5 (d, $^1J_{CF}$ = 195.5 Hz), 85.1, 64.8 (d, $^2J_{CF}$ = 28.3 Hz), 27.2, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −142.2 (d, $J$ = 21.1 Hz), −169.0; IR (KBr) $\nu$ 2981, 2933, 1756, 1699, 1599, 1473, 1458, 1354, 1306, 1287, 1169, 666, 572 cm$^{-1}$; MS (ESI) found $m/z$ 581.0 [M + $NH_4$]$^+$; HRMS (ESI) found $m/z$ 586.0627 [M + Na]$^+$, calcd for $C_{27}H_{24}Cl_2FNO_5S$ + Na 586.0634.

*tert-Butyl 2-(3,5-bis(trifluoromethyl)phenyl)-3-fluoro-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2q**):* white solid; 166.7 mg, 88% yield; 70:30 dr; mp 157−158 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 0.96 (s, 9H), 2.38 (s, 3H), 6.16 (d, $J$ = 21.6 Hz, 1H), 7.21 (d, $J$ = 8.0 Hz, 2H), 7.41 (t, $J$ = 7.2 Hz, 1H), 7.52 (d, $J$ = 8.0 Hz, 2H), 7.72−7.77 (m, 3H), 7.87 (d, $J$ = 8.4 Hz, 2H), 8.08 (d, $J$ = 8.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.5 (d, $^2J_{CF}$ = 19.4 Hz), 162.0 (d,


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$^2J_{CF}$ = 26.8 Hz), 145.4, 140.5, 139.0, 138.9, 136.4, 133.4, 132.2 (q, $J_{CF}$ = 33.5 Hz), 129.8, 128.3, 127.9, 127.8, 126.7, 125.3, 124.9, 124.1, 122.8, 121.4, 93.0 (d, $^1J_{CF}$ = 198.2 Hz), 85.4, 64.9 (d, $^2J_{CF}$ = 29.3 Hz), 26.9, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −142.2 (d, $J$ = 21.8 Hz), −6.31; IR (KBr) $\nu$ 2981, 2931, 1762, 1717, 1600, 1462, 1372, 1352, 1279, 1229, 1167, 1138, 681, 665 cm$^{-1}$; MS (ESI) found $m/z$ 649.1 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 654.1148 $[M + Na]^+$, calcd for $C_{29}H_{24}F_7NO_5S$ + Na 654.1161.

*tert-Butyl 3-fluoro-2-(naphthalen-2-yl)-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3- carboxylate (**2r**):* white solid; 158.7 mg, 97% yield; 94:6 dr; mp 79−80 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 0.88 (s, 9H), 2.30 (s, 3H), 6.39 (d, $J$ = 21.2 Hz, 1H), 7.16 (d, $J$ = 8.4 Hz, 2H), 7.20−7.22 (m, 1H), 7.32 (t, $J$ = 7.6 Hz, 1H), 7.457.48 (m, 2H), 7.62−7.70 (m, 4H), 7.72−7.77 (m, 3H), 7.99−8.04 (m, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.9 (d, $^2J_{CF}$ = 19.9 Hz), 163.0 (d, $^2J_{CF}$ = 26.5 Hz), 144.7, 141.2, 136.3, 134.8, 133.2, 132.9, 129.6, 128.6, 128.5, 128.2, 128.1, 127.8, 127.5, 126.8, 126.6, 125.6, 124.9, 124.2, 123.8, 92.7 (d, $^1J_{CF}$ = 193.1 Hz), 84.5, 66.4 (d, $^2J_{CF}$ = 27.0 Hz), 27.0, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −141.1 (d, $J$ = 21.4 Hz), −168.9; IR (KBr) $\nu$ 2980, 2931, 1753, 1698, 1598, 1458, 1368, 1299, 1165, 1061, 662, 570 cm$^{-1}$; MS (ESI) found $m/z$ 563.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 568.1573 $[M + Na]^+$, calcd for $C_{31}H_{28}FNO_5S$ + Na 568.1570.

*tert-Butyl 3-fluoro-2-(furan-2-yl)-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2s**):* white solid; 123.8 mg, 85% yield; 99:1 dr; mp 159−160 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.28 (s, 9H), 2.33 (s, 3H), 6.24 (d, $J$ = 3.2 Hz, 1H), 7.27 (d, $J$ = 1.6 Hz, 1H), 6.38 (d, $J$ = 14.4 Hz, 1H), 7.17−7.24 (m, 4H), 7.53−7.57 (m, 1H), 7.66 (d, $J$ = 8.0 Hz, 2H), 7.88 (d, $J$ = 8.4 Hz, 1H), 7.98−8.00 (m, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 182.9 (d, $^2J_{CF}$ = 20.1 Hz), 162.9 (d, $^2J_{CF}$ = 25.5 Hz), 148.0, 147.9, 144.6, 142.9, 140.6, 135.9, 135.3, 129.5, 128.8, 127.9, 124.9, 122.7, 122.1, 110.5, 110.2, 90.5 (d, $^1J_{CF}$ = 192.9 Hz), 84.3, 59.1 (d, $^2J_{CF}$ = 27.8 Hz), 27.5, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −148.1 (d, $J$ = 14.7 Hz); IR (KBr) $\nu$ 2982, 2933, 1754, 1700, 1599, 1477, 1459, 1368, 1302, 1166, 1085, 664, 568 cm$^{-1}$; MS (ESI) found $m/z$ 508.0 $[M + Na]^+$; HRMS (ESI) found $m/z$ 508.1204 $[M + Na]^+$, calcd for $C_{25}H_{24}FNO_6S$ + Na 508.1206.

*tert-Butyl 3-fluoro-4-oxo-2-(thiophene-2-yl)-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2t**):* white solid; 135.4 mg, 90% yield; 98:2 dr; mp 147−148 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.17 (s, 9H), 2.32 (s, 3H), 6.56 (d, $J$ = 16.0 Hz, 1H), 6.90 (dd, $J$ = 5.2 Hz, 4.0 Hz, 1H), 7. 01 (d, $J$ = 2.8 Hz, 1H), 7.14−7.18 (m, 3H), 7.30 (t, $J$ = 7.6 Hz, 1H), 7.59−7.64 (m, 3H), 7.92 (d, $J$ = 8.4 Hz, 1H), 7.98−8.00 (m, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.2 (d, $^2J_{CF}$ = 19.6 Hz), 162.9 (d, $^2J_{CF}$ = 25.8 Hz), 144.6, 140.2, 136.3, 136.1, 136.0, 135.4, 129.6, 129.0, 128.9, 127.8, 126.5, 126.1, 125.7, 123.7, 123.6, 91.7 (d, $^1J_{CF}$ = 193.0 Hz), 84.4, 61.9 (d, $^2J_{CF}$ = 28.1 Hz), 27.3, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −144.0 (d, $J$ = 4.2 Hz), −167.7; IR (KBr) $\nu$ 2979, 2932, 1751, 1699, 1598, 1459, 1361, 1299, 1165, 1088, 660, 563 cm$^{-1}$; MS (ESI) found $m/z$ 524.0 $[M + Na]^+$; HRMS (ESI) found $m/z$ 524.0972 $[M + Na]^+$, calcd for $C_{25}H_{24}FNO_5S_2$ + Na 524.0978.

*tert-Butyl 2-ethyl-3-fluoro-4-oxo-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2u**):* white solid; 107.4 mg, 80% yield; 98:2 dr; mp 145−146 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 0.74 (t, $J$ = 7.6 Hz, 3H), 1.38−1.44 (m, 11H), 2.43 (s, 3H), 5.07 (dd, $J$ = 9.6 Hz, 4.4 Hz, 1H), 7.15−7.19 (m, 1H), 7.35 (d, $J$ = 8.0 Hz, 2H), 7.49−7.55 (m, 2H), 7.91 (d, $J$ = 8.0 Hz, 2H), 8.03 (d, $J$ = 7.2 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 186.8 (d, $^2J_{CF}$ = 17.3 Hz), 164.6 (d, $^2J_{CF}$ = 26.2 Hz), 144.7, 140.0, 137.1, 135.2, 129.9, 127.8, 124.2, 124.0, 121.3, 93.2 (d, $^1J_{CF}$ = 202.1 Hz), 85.7, 62.1 (d, $^2J_{CF}$ = 26.5 Hz), 27.7, 21.5, 20.7, 10.9; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −170.3 (d, $J$ = 3.8 Hz), −145.3 (d, $J$ = 16.2 Hz); IR (KBr) $\nu$ 2978, 2934, 2879, 1756, 1707, 1601, 1477, 1459, 1361, 1292, 1166, 1087, 659, 574 cm$^{-1}$; MS (ESI) found $m/z$ 465.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 470.1418 $[M + Na]^+$, calcd for $C_{23}H_{26}FNO_5S$ + Na 470.1413.

*tert-Butyl 3-fluoro-4-oxo-2-propyl-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2v**):* white solid; 99.7 mg, 72% yield; 99:1 dr; mp 133−134 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 0.74 (t, $J$ = 7.2 Hz, 3H), 1.15−1.29 (m, 2H), 1.34−1.42 (m, 10H), 1.71−1.79 (m, 1H), 2.42 (s, 3H), 5.15 (dd, $J$ = 9.2 Hz, 4.8 Hz, 1H), 7.14−7.18 (m, 1H), 7.34 (d, $J$ = 8.0 Hz, 2H), 7.47−7.54 (m, 2H), 7.89 (d, $J$ = 8.4 Hz, 2H), 8.02 (d, $J$ = 7.6 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 186.8 (d, $^2J_{CF}$ = 17.1 Hz), 164.6 (d, $^2J_{CF}$ = 26.2 Hz), 144.7, 140.1, 137.1, 135.2, 129.9, 127.9, 127.8, 124.1, 123.9, 121.2, 93.2 (d, $^1J_{CF}$ = 202.1 Hz), 85.7, 60.7 (d, $^2J_{CF}$ = 26.9 Hz), 29.9, 27.6, 21.5, 19.8, 13.8; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −170.1 (d, $J$ = 1.5 Hz); IR (KBr) $\nu$ 2966, 2934, 2875, 1758, 1709, 1600, 1460, 1369, 1300, 1167, 1087, 659, 574 cm$^{-1}$; MS (ESI) found $m/z$ 479.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 484.1578 $[M + Na]^+$, calcd for $C_{24}H_{28}FNO_5S$ + Na 484.1570.

*Ethyl 3-fluoro-4-oxo-2-phenyl-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2w**):* white solid; 133.2 mg, 95% yield; 93:7 dr; mp 87−88 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 0.81 (t, $J$ = 7.2 Hz, 3H), 2.33 (s, 3H), 3.74−3.82 (m, 1H), 3.91−3.99 (m, 1H), 6.25 (d, $J$ = 20.4 Hz, 1H), 7.13−7.24 (m, 6H), 7.27−7.31 (m, 2H), 7.62−7.66 (m, 3H), 7.98−8.02 (m, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.1 (d, $^2J_{CF}$ = 20.0 Hz), 164.5 (d, $^2J_{CF}$ = 25.9 Hz), 144.7, 141.2, 136.5, 135.0, 134.9, 134.8, 129.6, 129.1, 128.9, 128.7, 127.9, 125.4, 123.2, 92.7 (d, $^1J_{CF}$ = 193.7 Hz), 66.1 (d, $^2J_{CF}$ = 26.2 Hz), 62.4, 21.5, 13.2; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −142.4 (d, $J$ = 20.3 Hz), −169.2; IR (KBr) $\nu$ 2982, 2926, 1757, 1697, 1596, 1457, 1359, 1294, 1166, 1085, 697, 569 cm$^{-1}$; MS (ESI) found $m/z$ 490.1 $[M + Na]^+$; HRMS (ESI) found $m/z$ 490.1100 $[M + Na]^+$, calcd for $C_{25}H_{22}FNO_5S$ + Na 490.1100.

*tert-Butyl 3-fluoro-6,7-dimethoxy-4-oxo-2-phenyl-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2x**):* white solid; 143.3 mg, 86% yield; 99:1 dr; mp 185−186 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.04 (s, 9H), 2.36 (s, 3H), 3.93 (s, 3H), 3.99 (s, 3H), 6.09 (d, $J$ = 20.8 Hz, 1H), 7.15−7.20 (m, 4H), 7.25 (t, $J$ = 7.6 Hz, 2H), 7.32 (t, $J$ = 7.2 Hz, 1H), 7.38 (s, 1H), 7.54 (s, 1H), 7.60 (d, $J$ = 8.0 Hz, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 182.1 (d, $^2J_{CF}$ = 20.1 Hz), 163.5 (d, $^2J_{CF}$ = 26.2 Hz), 155.7, 147.2, 144.6, 136.8, 135.7, 135.6, 135.0, 128.5, 129.0, 128.7, 128.4, 127.8, 117.0, 108.7, 106.7, 92.1 (d, $^1J_{CF}$ = 191.6 Hz), 84.2, 66.7 (d, $^2J_{CF}$ = 26.8 Hz), 56.5, 56.1, 27.1, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −138.7 (d, $J$ = 20.7 Hz), −168.9; IR (KBr) $\nu$ 2980, 2932, 1750, 1683, 1602, 1508, 1455, 1419, 1274, 1164, 1087, 661, 570 cm$^{-1}$; MS (ESI) found $m/z$ 578.1 $[M + Na]^+$; HRMS (ESI) found $m/z$ 578.1623 $[M + Na]^+$, calcd for $C_{29}H_{30}FNO_7S$ + Na 578.1625.

*tert-Butyl 7-chloro-3-fluoro-4-oxo-2-phenyl-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2y**):* white solid; 146.2 mg, 92% yield; 98:2 dr; mp 150−151 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.06 (s, 9H), 2.34 (s, 3H), 6.20 (d, $J$ = 19.6 Hz, 1H), 7.16−7.27 (m, 7H), 7.33 (t, $J$ = 7.2 Hz, 1H), 7.65 (d, $J$ = 8.4 Hz, 2H), 7.92 (d, $J$ = 8.8 Hz, 1H), 8.02 (d, $J$ = 1.6 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 182.5 (d, $^2J_{CF}$ = 20.5 Hz), 162.7 (d, $^2J_{CF}$ = 25.8 Hz), 145.1, 142.8, 141.9, 135.2, 135.1, 134.6, 129.9, 129.7, 129.3, 128.9, 128.2, 127.9, 125.7, 122.8, 121.6, 91.7 (d, $^1J_{CF}$ = 191.9 Hz), 84.6, 66.3 (d, $^2J_{CF}$ = 26.3 Hz), 27.2, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −142.0 (d, $J$ = 19.9 Hz), −169.8; IR (KBr) $\nu$ 2981, 2932, 1753, 1702, 1592, 1456, 1417, 1370, 1305, 1168, 1083, 1057, 666, 571 cm$^{-1}$; MS (ESI) found $m/z$ 552.1 $[M + Na]^+$; HRMS (ESI) found $m/z$ 552.1027 $[M + Na]^+$, calcd for $C_{27}H_{25}ClFNO_5S$ + Na 552.1024.

*tert-Butyl 3,6-difluoro-4-oxo-2-phenyl-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**2z**):* white solid; 149.4 mg, 97% yield; 99:1 dr; mp 140−141 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 1.00 (s, 9H), 2.34 (s, 3H), 6.12 (d, $J$ = 21.6 Hz, 1H), 7.15−7.19 (m, 4H), 7.25 (t, $J$ = 7.6 Hz, 2H), 7.31 (t, $J$ = 7.2 Hz, 1H), 7.34−7.39 (m, 1H), 7.55 (d, $J$ = 8.0 Hz, 2H), 7.59 (dd, $J$ = 8.0 Hz, 3.2 Hz, 1H), 8.02 (dd, $J$ = 9.2 Hz, 4.4 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 183.3 (d, $^2J_{CF}$ = 20.3 Hz), 162.6 (d, $^2J_{CF}$ = 26.3 Hz), 160.0 (d, $J_{CF}$ = 247.8 Hz), 144.9, 137.3 (d, $J_{CF}$ = 2.5 Hz), 135.5 (d, $J_{CF}$ = 8.8 Hz), 134.4, 129.7, 129.1, 128.8, 128.1, 127.8, 126.8 (d, $J_{CF}$ = 7.3 Hz), 126.1 (d, $J_{CF}$ = 6.6 Hz), 123.4 (d, $J_{CF}$ = 23.0 Hz), 114.2 (d, $J_{CF}$ = 21.4 Hz), 92.5 (d, $^1J_{CF}$ = 193.5 Hz), 84.7, 66.3 (d, $^2J_{CF}$ = 27.0 Hz), 27.1, 21.5; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −140.3 (d, $J$ = 5.7 Hz), −169.4, −114.1, −118.1; IR (KBr) $\nu$ 2981, 2932, 1755, 1702, 1485, 1436, 1370, 1307, 1156, 1067, 659, 592 cm$^{-1}$; MS (ESI) found $m/z$ 536.0 $[M + Na]^+$; HRMS (ESI) found $m/z$ 536.1312 $[M + Na]^+$, calcd for $C_{27}H_{25}F_2NO_5S$ + Na 536.1319.

*tert-Butyl 3-chloro-4-oxo-2-phenyl-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**5**):* 142.8 mg, 93% yield; >99:1 dr; mp 160−161 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ (ppm) 1.12 (s, 9H), 2.31 (s,

3H), 6.32 (s, 1H), 7.16−7.19 (m, 7H), 7.28 (d, $J$ = 5.6 Hz, 1H), 7.46−7.50 (m, 1H), 7.64−7.69 (m, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ (ppm) 182.4, 162.9, 144.7, 140.3, 136.3, 136.2, 135.8, 129.6, 129.4, 128.9, 128.3, 127.8, 127.6, 122.9, 121.2, 117.9, 85.5, 68.4, 67.0, 27.3, 21.4; IR (KBr) $\nu$ 2982, 2931, 1748, 1696, 1598, 1478, 1456, 1358, 1279, 1164, 1087, 1027, 658, 568 cm$^{-1}$; MS (ESI) found $m/z$ 534.1 $[M + Na]^+$; HRMS (ESI) found $m/z$ 534.1117 $[M + Na]^+$, calcd for $C_{27}H_{26}ClNO_5S$ + Na 534.1118.

*tert-Butyl 3-bromo-4-oxo-2-phenyl-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate (**6**):* 150.2 mg, 90% yield; >99:1 dr; mp 178−179 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ (ppm) 1.40 (s, 9H), 2.32 (s, 3H), 6.69 (s, 1H), 7.08 (d, $J$ = 8.0 Hz, 2H), 7.11−7.15 (m, 1H), 7.21−7.23 (m, 4H), 7.31−7.37 (m, 3H), 7.40−7.46 (m, 2H), 8.07−8.09 (m, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ (ppm) 183.2, 165.2, 144.5, 140.9, 136.5, 135.4, 134.7, 129.6, 129.4, 129.0, 128.8, 128.7, 127.6, 122.9, 121.2, 117.9, 85.5, 68.4, 67.0, 27.3, 21.4; IR (KBr) $\nu$ 2981, 2931, 1732, 1715, 1598, 1456, 1359, 1255, 1186, 936, 663, 567 cm$^{-1}$; MS (ESI) found $m/z$ 573.1 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 578.0621 $[M + Na]^+$, calcd for $C_{27}H_{26}BrNO_5S$ + Na 578.0613.

**Procedure for the Decarboxylation of Sequential Product.** *p*-Toluenesulfonic acid (17.3 mg, 0.1 mmol) was added to a solution of *tert*-butyl 3-fluoro-4-oxo-2-phenyl-1-tosyl-1,2,3,4-tetrahydroquinoline-3-carboxylate **2a** (49.6 mg, 0.1 mmol) in toluene (10 mL), and the solution was heated at 80 °C for 24 h. The mixture was then allowed to cool to room temperature, diluted with EtOAc (15 mL), and washed with brine. The combined organic layers were dried over anhydrous $Na_2SO_4$. After concentration, the residue was purified by flash column chromatography (petroleum ether/EtOAc 10/1) to afford **3** (38.8 mg, 98% yield, 70:30 dr) as a pale yellow solid: mp 166−167 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ (ppm) 2.43 (s, 3H), 5.20 (dd, $J$ = 46.0 Hz, 6.0 Hz, 1H), 6.22 (d, $J$ = 8.0 Hz, 1H), 7.21−7.24 (m, 4H), 7.28−7.31 (m, 4H), 7.57 (t, $J$ = 8.0 Hz, 1H), 7.69 (d, $J$ = 8.0 Hz, 2H), 7.91 (t, $J$ = 8.4 Hz, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ (ppm) 188.8 (d, $^2J_{CF}$ = 14.0 Hz), 145.2, 140.2, 136.4, 135.7, 133.2, 130.3, 128.6, 128.5, 127.8, 127.7, 126.9, 125.8, 124.5, 124.1, 88.8 (d, $^1J_{CF}$ = 200.0 Hz), 61.4 (d, $^2J_{CF}$ = 22.2 Hz), 21.6; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ −197.7 (d, $J$ = 45.9 Hz), −179.4 (dd, $J$ = 46.6 Hz, 13.9 Hz); IR (KBr) $\nu$ 2893, 1702, 1598, 1476, 1459, 1351, 1164, 1089, 1057, 662, 569 cm$^{-1}$; MS (ESI) found $m/z$ 418.1 $[M + Na]^+$; HRMS (ESI) found $m/z$ 418.0888 $[M + Na]^+$, calcd for $C_{22}H_{18}FNO_3S$ + Na 418.0889.

**Procedure for the Reduction of Sequential Product.** To a solution of **2a** (99.2 mg, 0.2 mmol) in 3 mL of MeOH was added $NaBH_4$ (76 mg, 2.0 mmol) in portions at 0 °C. The resultant mixture was stirred overnight at room temperature (monitored by TLC). The mixture was evaporated in vacuum. The residue was treated with water (10 mL), and extracted with dichloromethane (10 mL × 3). The organic layer was washed with brine and dried over $MgSO_4$. Concentration and flash chromatography (petroleum ether/ethyl acetate 10/1 as eluant) afforded **4** (95.6 mg, 96% yield, >99:1 dr) as a white solid: mp 193−194 °C; $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ (ppm) 0.59 (s, 9H), 2.41 (s, 3H), 2.85 (d, $J$ = 3.6 Hz, 1H), 3.93 (d, $J$ = 13.2 Hz, 2.8 Hz, 1H), 5.73 (d, $J$ = 30.4 Hz, 1H), 7.21−7.26 (m, 3H), 7.30−7.37 (m, 3H), 7.41−7.49 (m, 6H), 7.95 (d, $J$ = 8.0 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ (ppm) 163.5 (d, $^2J_{CF}$ = 31.7 Hz), 144.3, 138.5, 135.3, 134.5, 132.5 (q, $^3J_{CF}$ = 6.0 Hz), 129.8, 128.3, 128.1, 127.7, 127.1, 127.0, 126.1, 124.0, 102.5 (d, $^1J_{CF}$ = 191.7 Hz), 82.7, 70.7 (q, $^2J_{CF}$ = 23.9 Hz), 64.6 (d, $^2J_{CF}$ = 31.2 Hz), 26.6, 21.6; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ (ppm) −197.7 (d, $J$ = 46.2 Hz), −179.4 (dd, $J$ = 47.0 Hz, 14.7 Hz); IR (KBr) $\nu$ 3442, 2918, 2850, 1727, 1496, 1458, 1361, 1157, 666, 567 cm$^{-1}$; MS (ESI) found $m/z$ 515.2 $[M + NH_4]^+$; HRMS (ESI) found $m/z$ 520.1571 $[M + Na]^+$, calcd for $C_{27}H_{28}FNO_5S$ + Na 520.1570.

## ■ ASSOCIATED CONTENT

### Supporting Information

$^1$H, $^{13}$C, and $^{19}$F NMR spectra for intermediates **1a−e** and the products **2a−z** and **3−6**. Crystallographic data for compounds **2a** and **4** (CIF). This material is available free of charge via the Internet at http://pubs.acs.org.

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### Notes

The authors declare no competing financial interest.

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(11) The use of inorganic bases, such as LiOH, NaOH, $Li_2CO_3$, $Na_2CO_2$, and $K_2CO_2$, failed to give any intermediates (**A**, **B**, or **C**) under the present conditions.

(12) The relative configuration of compounds **2a** and **4** was confirmed by X-ray crystal structure analysis. CCDC 844931 (**2a**) and CCDC 846735 (**4**) contain the supplementary crystallographic data for this paper (see the Supporting Information). These data can be obtained free of charge from the Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

(13) For one-pot multistep syntheses of chlorinated and brominated carbonyl compounds, see: (a) Yang, D.; Yan, Y.-L.; Lui, B. *J. Org. Chem.* **2002**, *67*, 7429. (b) Marigo, M.; Bachmann, S.; Halland, N.; Braunton, A.; Jørensen, K. A. *Angew. Chem., Int. Ed.* **2004**, *43*, 5507. (c) Brochu, M. P.; Brown, S. P.; MacMillan, D. W. C. *J. Am. Chem. Soc.* **2004**, *126*, 4108. (d) Halland, N.; Lie, M. A.; Kjæsgaard, A.; Marigo, M.; Schiøt, B.; Jørgensen, K. A. *Chem.—Eur. J.* **2005**, *11*, 7083. (e) Meketa, M. L.; Mahajan, Y. R.; Weinreb, S. M. *Tetrahedron Lett.* **2005**, *46*, 4749. (f) Bartoli, G.; Bosco, M.; Carlone, A.; Locatelli, M.; Melchiorre, P.; Sambri, L. *Angew. Chem., Int. Ed.* **2005**, *44*, 6219. (g) Meshram, H. M.; Reddy, P. N.; Sadashiv, K.; Yadav, J. S. *Tetrahedron Lett.* **2005**, *46*, 623. (h) Meshram, H. M.; Reddy, P. N.; Vishnu, P.; Sadashiv, K.; Yadav, J. S. *Tetrahedron Lett.* **2006**, *47*, 991. (i) Mei, Y.; Bentley, P. A.; Du, J. *Tetrahedron Lett.* **2008**, *49*, 3802. (j) Mei, Y.; Bentley, P. A.; Du, J. *Tetrahedron Lett.* **2008**, *49*, 3802. (k) Cui, H.-F.; Dong, K.-Y.; Nie, J.; Zheng, Y.; Ma, J.-A. *Tetrahedron Lett.* **2010**, *51*, 2374.