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ARTICLE

Clickable coupling of carboxylic acids and amines at room temperature mediated by SO_2F_2: A significant breakthrough for the construction of amides and peptide linkages

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The construction of amide bonds and peptide linkages is one of the most fundamental transformations in all life processes and organic synthesis. The synthesis of the structurally ubiquitous amide motifs is essential in assembly of numerous important molecules such as peptides, proteins, alkaloids, pharmaceutical agents, polymers, peptides, ligands and agrochemicals. A method of SO_2F_2 mediated direct clickable coupling of carboxylic acids with amines was developed for the synthesis of a broad scope of amides in a simple, mild, high-efficiency, robust and practical manner (>110 examples, >90% yields in most cases). The direct click reactions of acids and amines in grams-scale are also demonstrated using an extremely easy work-up and purification process of washing with 1M aqueous HCl to provide the desired amides in greater than 99% purity and excellent yields.

Introduction

As the fundamental structural unit of proteins, amide bonds are the basis of all life processes. They also present in a vast number of synthetic structures, such as polymers, biologically active compounds and pharmaceutical products.[1] The amide moieties are also prevalent in up to 25% of all pharmaceuticals,[2] for example (Fig. 1), Atorvastatin (a top selling drug worldwide since 2003),[3] Imatinib (a specific inhibitor of tyrosine kinase enzymes),[4] and Valsartan (a angiotensin-II receptor antagonist).[5] Indeed, amide formations are among the most useful tools since it accounts for 16% of all reactions in the synthesis of pharmaceuticals.[6]

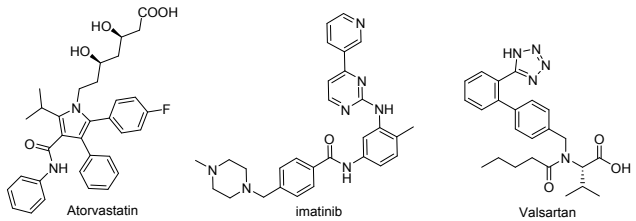

Figure 1. Representative drugs containing amide motifs.

Although many new strategies for amide formation from nitriles, alcohols, aldehydes, or alkynes have been reported,[7] direct condensation of a carboxylic acid and amine is still the most common and predominating approach for amide synthesis. As the most straightforward way for preparing amides, the thermal amidation through the direct condensation of carboxylic acids and amines typically requires very harsh conditions (T > 180 °C).[8] To avoid the thermal conditions, therefore, the pre- or *in situ* activations of the carboxylic acids in the presence of stoichiometric "coupling" reagents have become the most prevailing processes. The coupling reagents such as carbodiimides, boronic acid derivatives, phosphonium salts, uronium (or guanidinium) salts and many other coupling reagents are highly efficient,[9] as verified by the incredible success of amides and peptides synthesis. However, most of the amide synthesis processes through the use of organic coupling agents generally suffer from large amount of organic waste production, high-cost, hazardous-conditions, tedious workup and purification which have significantly limited their industry application. In fact, even some simple amides may resist formation through coupling the corresponding acids with amines because of the steric hindrance effects of the starting materials and poor nucleophilicity of some electron-deficient amines, especially the anilines, which will in turn force scientist to use more exotic and expensive reagents and harsh conditions for overcoming the synthetic issues.[10] From green, sustainable and processing-chemistry prospects, the ideal "perfect" coupling reagent should be inorganic, which produces the lowest amount of total organic carbon (TOC) in the waste together with easy work-up and purification. Therefore, finding a "perfect" coupling reagent capable of negating most of these drawbacks while still allows smooth couplings of all types of carboxylic acids with all types of amines would be highly desirable for the synthesis of amides and peptide linkages in an atom-economical and industry-applicable manner for laboratorial and industrial chemistry, and this general coupling method if achieved will unquestionably make a significant

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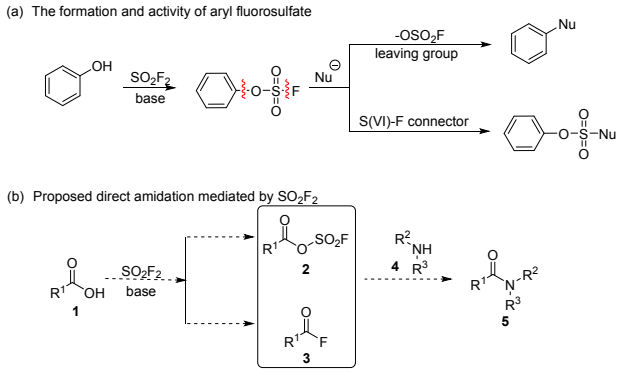
breakthrough for the synthesis of the extremely important amide moieties.



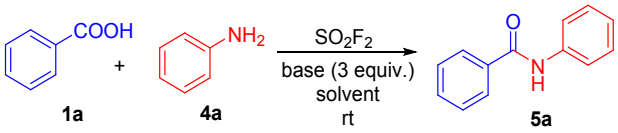
Scheme 1. The proposed direct amidation of carboxylic acids with amines mediated by SO_2F_2

On the other hand, click chemistry comprises a series of reactions that feature in mild conditions, high yields, rapid kinetics and broad substrates scope,[11] since the seminal work by Sharpless.[12] Many types of robust reactions meet the criteria of "click chemistry" for assembly of various chemical functionalities, such as the copper (I)-catalyzed azide-alkyne cycloaddition (the CuAAC click reaction),[12, 13] the Thiol-addition chemistry (Thiol-ene, Thiol-yne),[14] the cycloaddition reactions (Diels–Alder and 1,3-dipolar-cycloadditions).[15] In 2014, a new family of click reactions, the sulfur(VI) fluoride exchange (SuFEx), to create molecular connections with excellent reliability and unprecedented efficiency through a sulfur(VI) hub was introduced by the Sharpless group and has been widely used in many research fields.[16] Sulfuryl fluoride (SO_2F_2), a colorless, odorless, inexpensive (about 1$/kg),[17] abundant (millions-kilograms annual production),[17] and relatively inert gas (stable up to 400 °C when dry) has recently attracted significant attention as a S(VI)−F connective linkers for SuFEx click chemistry and other transformations.[16,17] Based on the success of application of SO_2F_2 as an electrophile to react with hydroxyl groups of phenols (or alcohols) for generating fluorosulfates to be used as versatile building blocks with two selectively addressable handles (-OSO_2F, -F) for nucleophilic substitutions and SuFEx click chemistry (Scheme 1a),[16a, 18] we envision that the hydroxyl groups of carboxylic acids **1** would also proceed nucleophilic attack to SO_2F_2 in the presence of base to form intermediates of carboxylic sulfurofluoridic anhydrides **2** and/or acyl fluorides **3**,[19] both of which would further undergo nucleophilic substitutions with amine **4** to generate the desired amide product **5** with SuFEx clickable efficiency. Notably, since SO_2F_2 is an inorganic reagent which together with the base can be easily removed through simple washing with aqueous HCl, therefore, the designed protocol would offer an ideal strategy for amide bonds construction.

Results and discussion

To test the feasibility of the proposed process, we initially examined benzoic acid (**1a**) and aniline (**4a**) as the model substrates for the formation of amide in the presence of *N,N*-diisopropylethylamine (DIPEA) in MeCN under SO_2F_2 atmosphere (balloon) at room temperature. Excitingly, within 5 h, the desired amide **5a** was formed in 82% yield (Table 1, entry 1). Encouraged by this preliminary successful result, we further screened a variety of common bases and conditions (see supporting information for details). The examination indicated that the performance of organic bases was superior to that of inorganic bases which could partially be attributed to the solubility of bases. DIPEA was found to be the ideal base for constructing the desired amide **5a**. The investigation of solvents effect (Table 1, entry 1-6) revealed that in acetyl nitrile the clickable amidation performed the best. One particular importance in organic synthesis is reducing the amounts of solvents for maximizing environmental and economic benefits. Therefore, the influence of reaction concentrations for the efficiency of amide formation also examined. Increasing the concentration of 0.2 M to 0.5 M, the yields of amide **5a** were elevated from 85% to 95% (Table 1, entry 7-10). When the concentrations were further increased to 0.6 M and 1.0 M the yields of amide **5a** were slightly decreased to 93% and 91%, respectively (Table 1, entry 11-12) due to the uncomplete dissolving starting materials. Therefore, 0.3 M was chosen as the reaction concentration.

Table 1. Optimization of the amidation conditions.[a]



1a 4a 5a

Entry	Base	Solvent	Concentration (mol/L)	Yield [b] (**5a**, %)
1	DIPEA	MeCN	0.15	82
2	DIPEA	dioxane	0.15	59
3	DIPEA	toluene	0.15	67
4	DIPEA	DMSO	0.15	26
5	DIPEA	NMP	0.15	45
6	DIPEA	DCM	0.15	36
7	DIPEA	MeCN	0.20	85
8	DIPEA	MeCN	0.30	94
9	DIPEA	MeCN	0.40	94
10	DIPEA	MeCN	0.50	95
11	DIPEA	MeCN	0.60	93
12	DIPEA	MeCN	1.0	91

[a] General conditions: a mixture of benzoic acid (**1a**, 0.3 mmol), aniline (**4a**, 0.6 mmol) and DIPEA (3.0 mmol, 3 equiv) in MeCN (reaction diluted to the specified concentration) under a SO_2F_2 atmosphere (balloon) was stirred at room temperature for 5 h. [b] The yield was determined by HPLC using *N*-phenylbenzamide (**5a**, t_R = 3.807 min, λ_{max} = 263.0 nm, water/methanol = 30 : 70 (v/v)) as the external standard.

With the optimized conditions in hand, we subsequently explored the substrate scope and functional-group tolerance of the amidation process by coupling of aniline **4a** with a variety of carboxylic acids **1** (Table 2). Accordingly, twenty-nine different

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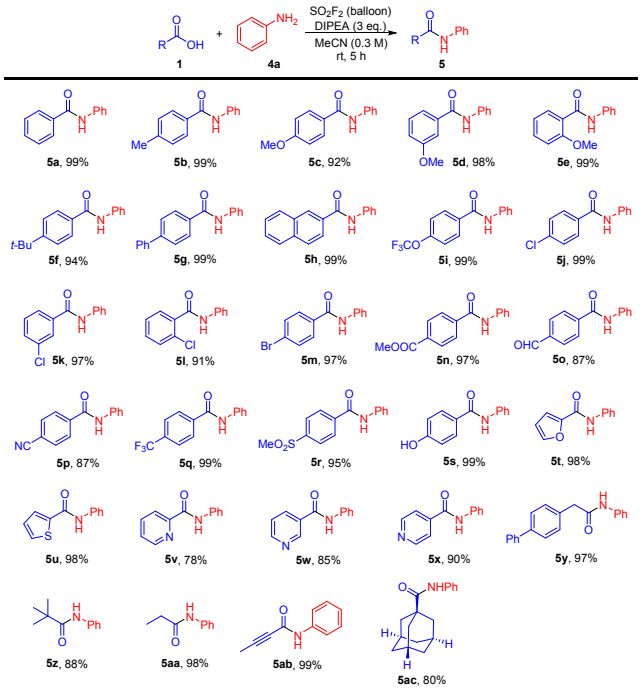
acids were smoothly converted to the corresponding amides in excellent to quantitative yields after the simple clickable couplings. For aromatic carboxylic acids, both electron-donating (**1b**-**1h**) and electron-withdrawing (**1j**-**1r**) groups were compatible well. It was worth noting that the substitutions on *para*-(**1c**, **1j**), *meta*- (**1d**, **1k**) and *ortho*- (**1e**, **1l**) of carboxylic acids did not affect the efficiency of amidation. Interestingly, phenolic hydroxy group (**5s**) which was reported [16a] to be very reactive to SO_2F_2 remained untouched during this process. In addition, heterocyclic carboxylic acids, including thiophene, furan, and pyridine were also smoothly transformed to their corresponding amides in excellent to quantitative yields (**5t**-**5x**). Not surprisingly, aliphatic carboxylic acids (**1y**-**1ac**) were also transformed smoothly into the corresponding amides, even with the sterically hindering effects (**5y**-**5ac**). Carboxylic acid possessing a reactive alkyne moiety **1ab** was also converted to the desired amide **5ab** in quantitative yield.

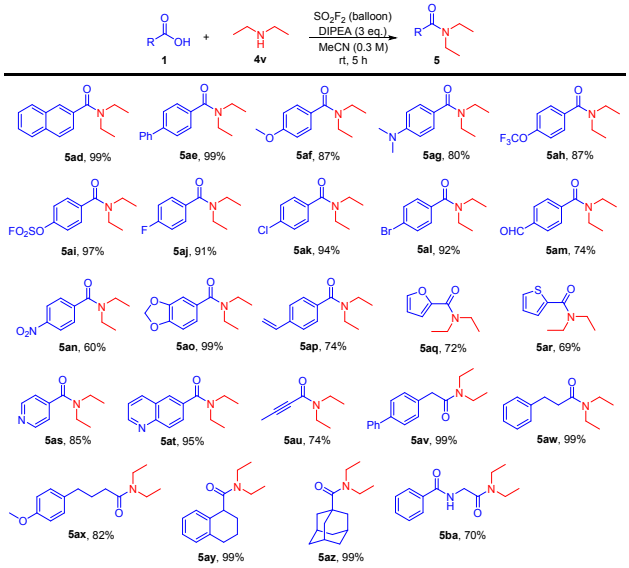
Table 2. The scope of couplings of carboxylic acids with (aromatic amine) aniline 4a. [a]



[a] Reaction conditions: a mixture of carboxylic acid (**1**, 1.0 mmol), aniline (**4a**, 2.0 mmol) and DIPEA (3.0 mmol, 3 equiv) in MeCN (0.3 M) under a SO_2F_2 atmosphere (balloon) was stirred at room temperature for 5 h.

The general applicability of the simple, clickable amide bond formation strategy was further evaluated with secondary aliphatic amine **4v** to evaluate the scope of carboxylic acids. Accordingly, a variety of carboxylic acids were screened, excitingly, the corresponding amides were generated in good to excellent yields (Table 3). Electron-donating groups such as 2-naphthyl (**5ad**), phenyl group (**5ae**), OMe (**5af**) and NMe_2 (**5ag**), and electron-withdrawing groups, such as halogen atoms (**5aj**-**5al**), formyl group (**5am**) and NO_2 (**5an**), were tolerated well on the aryl rings. Phenolic hydroxy substrate was converted into corresponding fluorosulfate substituted amide (**5ai**) and vinyl moiety (**5ap**) were also tolerable to this process. Carboxylic acids possessing heteroarenes were also compatible, furnishing the corresponding products **5aq**-**5at** in satisfying yields. Aliphatic and unsaturated acids reacted smoothly with **4v** to afford the corresponding products (**5au**-**5ba**) in excellent yields. Remarkably, sterically hindered substrates **5ay** and **5az**, which typically required very harsh condition to synthesize, were generated in quantitative yields using this method.

Table 3. The scope of couplings of carboxylic acids with aliphatic amine 4v.[a]

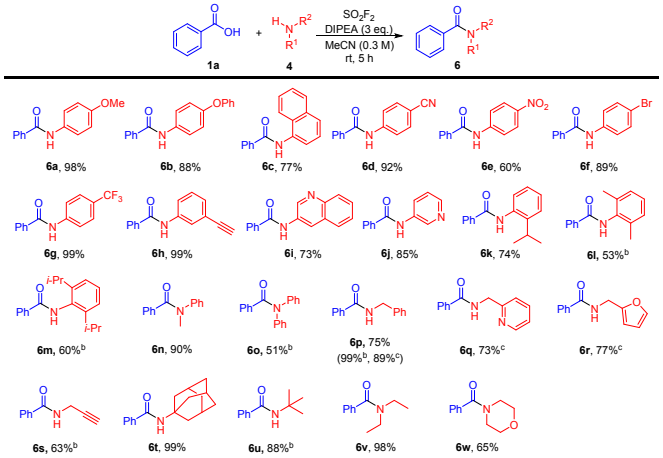


[a] Reaction conditions: a mixture of carboxylic acid (**1**, 1.0 mmol), diethylamine (**4v**, 2.0 mmol) and DIPEA (3.0 mmol, 3 equiv) in MeCN (0.3 M) under a SO_2F_2 atmosphere (balloon) was stirred at room temperature for 5 h.

To further explore the scope and functional-group compatibility of amines for this clickable coupling reaction, various amines **4** were examined for coupling with benzoic acid **1a**. Excitingly, as illustrated in Table 4, most of the amines provided the desired amides in excellent to quantitative yield smoothly. Aromatic amines (anilines) bearing electron-donating (**6a**-**6c**) or electron-withdrawing groups (**6d**-**6h**) generated their corresponding amides efficiently in good to excellent yields. The more electron deficient substrate **6e** was obtained in relatively decreased yield due to its strong electron-withdrawing property. The heterocyclic amines **4i** and **4j** tolerated well to provide the desired amides **6i** and **6j** in 73% and 85% yields respectively. The sterically hindered aromatic amines **4k**, **4l** and **4m** were smoothly transformed to their corresponding amides **6k**, **6l** and **6m** in moderate yields. Aromatic secondary amines **4n** and **4o** were compatible under this the conditions to provide their products in 90% and 51% yields respectively. Remarkably, benzylic amine **4p** were transformed to amide **6p** in 75% yield under the standard conditions, and it was elevated to quantitative yield when the amount of amine was increased to 3.0 equivalent. Notably, heteroaromatic-benzylic amine **4q** and **4r** generated their corresponding amides **6q** and **6r** in satisfying

yields when the amines were added after the mixture of benzoic acid **1a** and DIPEA in MeCN stirred for 2 h under SO_2F_2 atmosphere, and the SO_2F_2 need to be pumped out of the system because they were reported to be active enough to react with SO_2F_2 under the standard conditions.[16a] Aliphatic amines **4s**-**4w** were also testified with good to perfect compatibility. Propargyl amine **4s** provided the desired amide in 63% yield. Sterically hindered aliphatic primary amines **4t** and **4u** were smoothly transformed to their corresponding amides **6t** and **6u** in 99% and 88% yields respectively. Secondary aliphatic amines **4v** and **4w** were converted to their amides in the yields of 98% and 65% after coupling with benzoic acid **1a**.

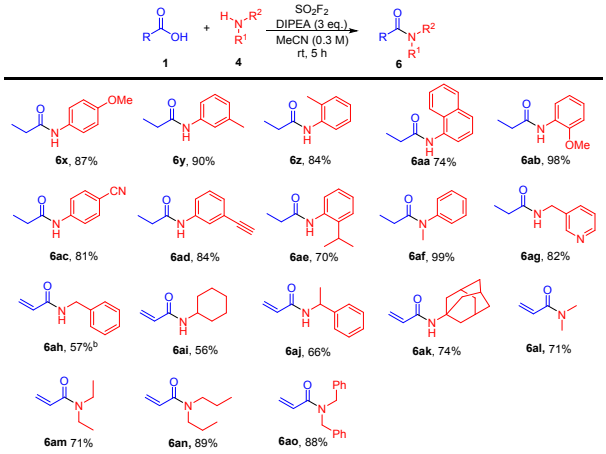
Table 4. The scope of couplings of amines with aromatic carboxylic acid 1a.[a]



[a] Reaction conditions: a mixture of benzoic acid (**1a**, 1.0 mmol), amine (**4**, 2.0 mmol) and DIPEA (3.0 mmol, 3 equiv) in MeCN (0.3 M) under a SO_2F_2 atmosphere (balloon) was stirred at room temperature for 5 h. [b] 3 equiv of amine was used. [c] Reaction conditions: a mixture of benzoic acid (**1a**, 1.0 mmol) and DIPEA (3.0 mmol, 3 equiv) in MeCN (0.3 M) under SO_2F_2 atmosphere (balloon) stirred at room temperature for 2 h and SO_2F_2 was pumped out of the system, then amine (**4**, 2.0 mmol) was added into the mixture and stirred for another 3 h.

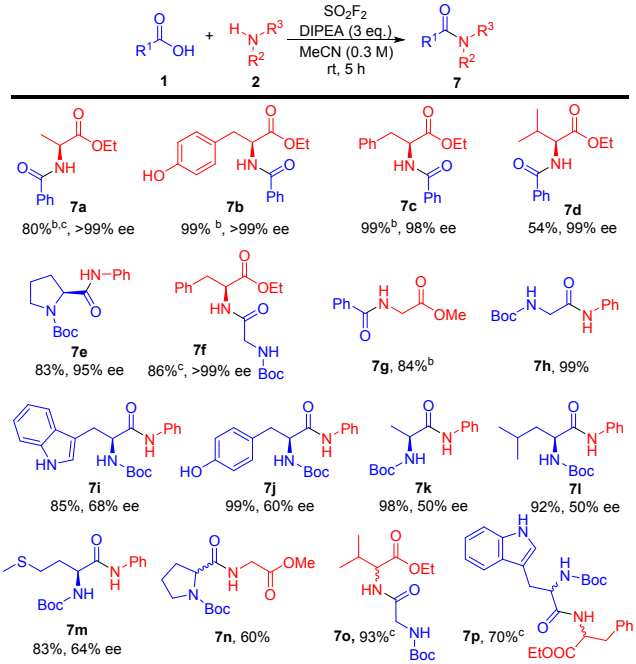
To adequately demonstrate the generality and broad substrates scope of the amidation process, we subsequently examined the amidation of aliphatic carboxylic, the propionic acid **1aa** for coupling with various amines (Table 5). Aromatic amines with either electron-donating (**6x**-**6ab**) or electron-withdrawing (**6ac**-**6ad**) groups reacted with **1aa** smoothly providing the corresponding amides in good to excellent yields. Sterically hindered aromatic amines and secondary aromatic amine were transformed smoothly into the target amides **6ae** and **6af** in 70% and 99% yield respectively. Aliphatic amine **4ag** bearing a pyridine moiety was also amenable to the amidation system to provide amides **6ag** in 82% yield. More importantly and challengeably, acrylic acid, a non-aromatic carboxylic acid bearing an activated terminal olefin functionality, which has been proved to be very reactive with aliphatic amines to undergo aza-Michael additions,[20] proceeded the coupling process very smoothly without formation of aza-Michael addition products. The primary amines provided corresponding amides **6ah**-**6ak** in moderate yields. Especially, the sterically very hindered **6ak** was generated in 74% yield smoothly. Some more reactive secondary amines (**4al**-**4ao**) were also testified for couplings with acrylic acid, and their amides products were generated in good to excellent yields (71% to 89%) without undergoing aza-Michael additions.

Table 5. The scope of couplings of amines with aliphatic carboxylic acids. [a]



[a] Reaction conditions: a mixture of carboxylic acid (**1aa** or **1ad**, 1.0 mmol), amine (**4**, 2.0 mmol) and DIPEA (3.0 mmol, 3 equiv) in MeCN (0.3 M) under a SO_2F_2 atmosphere (balloon) was stirred at room temperature for 5 h. [b] 3 equiv of amine was used.

Table 6. Application to peptide linkages constructions.[a]



[a] Reaction conditions: a mixture of carboxylic acid (**1**, 1.0 mmol), amine (**4**, 2.0 mmol) and DIPEA (3.0 mmol, 3 equiv) in MeCN (0.3 M) under SO_2F_2 atmosphere (balloon) was stirred at room temperature for 5 h. [b] Toluene was used as solvent. [c] 3 equiv of amine was used.

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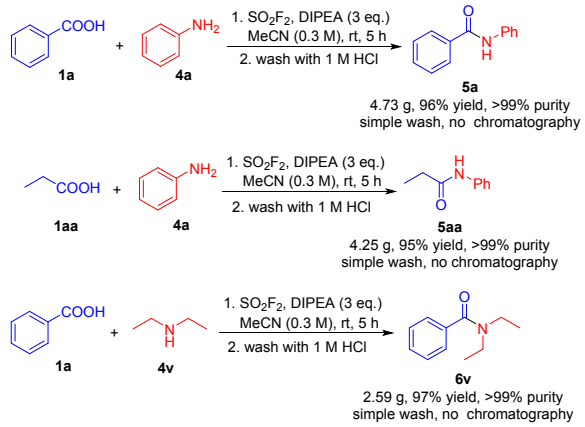
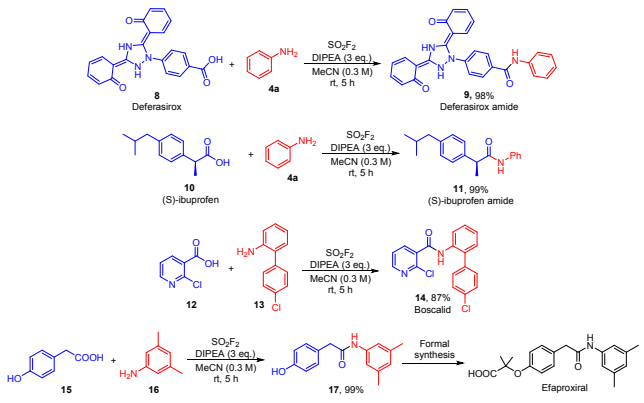
The generality of the newly developed amidation protocol was also evaluated in the peptides-related synthesis for the possible assembly of one of the most important moieties in life and pharmaceutical industry. The results were summarized in Table 6. The amino esters of Alanine, Tyrosine, Phenylalanine, Valine and Glycine generated their corresponding peptides **7a**, **7b**, **7c**, **7d** and **7g** in up to quantitative yields (54% to 99%) after coupling with benzoic acid **1a**. The Boc- protected amino acids of Proline, Glycine, Tryptophan, Tyrosine, Alanine, Leucine and Methionine were smoothly reacted with aniline **4a** to generate the corresponding amides **7e** and **7h-7m** in excellent yields (83% to 99%). And to our delight, the synthesis of dipeptides **7f**, **7n**, **7o** and **7p** were also achieved with satisfying yields. It is very worthy noting that the desired peptides **7a**-**7f** was obtained in very high enantiopurity (95%-99% ee) without undergoing racemerization while slight to moderate racemization was observed in **7i**-**7m**.



Scheme 2. Gram scale reactions

In order to demonstrate the practicality of this method, several gram-scale reactions were performed under standard conditions as shown in Scheme 2. Remarkably, the pure products **5a**, **5aa** and **6v** were obtained in nearly quantitative yields and greater than 99% purity directly after simple aqueous workup, revealing that the new amidation procedure has significant advantages over many current methods for further practical applications.



Scheme 3. Application of the developed protocol for the modification and synthesis of biologically active molecules

We were pleased to find that the described new methodology is applicable to the synthesis and modification of biologically active molecules (Scheme 3). Deferasirox **8** (an oral iron chelator) and Ibuprofen **10** (a nonsteroidal anti-inflammatory drug) were successfully converted to their amide forms after coupling with aniline **4a** to afford **9** and **11** in quantitative yields. In addition, the synthesis of Boscalid **14**, a fungicide was achieved in 87% yield through coupling of the corresponding carboxylic acid and amine using this method. Notably, the synthesis of amide **17**, a key precursor for the synthesis of cholesterol drug Efaproxiral,[21] was also accomplished in 99% yield. Remarkably, the phenol group of carboxylic acid **15** remained untouched during the amidation process.

Conclusions

In summary, a mild, simple, highly efficient, clickable and robust protocol for assembly of amides and peptide linkages through direct coupling of carboxylic acids with amines using SO_2F_2 as easily removable coupling agent was discovered and developed. Gram-scale reactions with simple aqueous-wash as work-up provided the desired amides in nearly quantitative yields and very high purity revealing this new method has irreplaceably advantages over many other amides synthesis procedures for practical processes. The robustness of this method was proved though successful couplings of all types of amines with all types of carboxylic acids in more than 110 examples (>90% in most cases). The modification and synthesis of complicated biologically active molecules were also accomplished. We anticipate that this method will practically applicable to a wide range of fields involving amides and peptides syntheses.

Experimental

All reactions were carried out under an air atmosphere. Unless otherwise specified, NMR spectra were recorded in $CDCl_3$ on a 500 MHz (for ^1H), 471 MHz (for ^{19}F), and 126 MHz (for ^{13}C) spectrometer. All chemical shifts were reported in ppm relative to TMS (^1H NMR, 0 ppm) and $CFCl_3$ (^{19}F NMR, 0 ppm) as internal standards. The HPLC experiments were carried out on a Waters e2695 instrument (column: J&K, RP-C18, 5 μm, 4.6 × 150 mm), and the yields of the products were determined by using the corresponding pure compounds as the external standards. Enantiomeric excesses were determined on HPLC using Chiralcel OD, IA or IC column with UV detector. Optical rotations were measured on a Roudolph Autopl IV. Melting points of the products were measured on a micro melting point apparatus (SGW X-4) and uncorrected. High resolution mass spectra (HRMS) were obtained on an Agilent 1260-6221 TOF mass spectrometry. Reagents used in the reactions were all purchased from commercial sources and used without further purification.

General procedure for amidation reaction of 1 with 2

Carboxylic acid (**1**, 1.0 mmol, 1.0 equiv), amine (**2**, 2.0 mmol, 2.0 equiv), DIPEA (3.0 mmol, 3.0 equiv) and MeCN (reaction mixture was diluted to 0.3 M) were added to an oven-dried 25 mL reaction flask equipped with a stirring bar and covered with a rubber stopper. Sulfuryl fluoride gas was introduced into the stirred reaction mixture by slowly bubbling from a balloon. The reaction mixture was stirred at room temperature for 5 h. After the reaction was completed, 1 M aqueous HCl solution (20 mL) was added to remove the excess amine and the reaction mixture was extracted with ethyl acetate (3 × 20 mL). The extracts were dried over anhydrous Na_2SO_4, and concentrated under reduced pressure. (For substrates **5v**, **5w**, **5x, 5as, 5at**, **6i**, **6j** and **6ag**, the reaction mixture was directly concentrated under vacuum without washing with aqueous HCl solution). The residue was purified by column chromatography on silica gel using a mixture of petroleum ether and ethyl acetate as eluents to give the desired product.

For substates **6q** and **6r**, carboxylic acid (**1a**, 1.0 mmol, 1.0 equiv), DIPEA (3.0 mmol, 3.0 equiv) and MeCN (reaction mixture was diluted to 0.3 M) were added to an oven-dried 25 mL reaction flask equipped with a stirring bar and covered with a rubber stopper. Sulfuryl fluoride gas was introduced into the stirred reaction mixture by slowly bubbling from a balloon. The reaction mixture was stirred at room temperature until carboxylic acid was completely consumed (about 2 h). The sulfuryl fluoride gas was pumped out of the reaction system and then amine (**4q** or **4r**, 2.0 mmol, 2.0 equiv) was added. The mixture was stirred at room temperature for 3 h and then was directly concentrated under vacuum. The residue was purified by column chromatography on silica gel using a mixture of petroleum ether and ethyl acetate as eluents to give the desired product.

***N*-Phenylbenzamide** (**5a**).[7d] Petroleum ether / ethyl acetate = 5 : 1 (v /v) as eluent for column chromatography. White solid, 195.3 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.99 (s, 1H), 7.86 (d, *J* = 7.4 Hz, 2H), 7.64 (d, *J* = 7.9 Hz, 2H), 7.53 (t, *J* = 7.3 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 7.35 (t, *J* = 7.9 Hz, 2H), 7.15 (t, *J* = 7.5 Hz, 1H).

4-Methyl-*N*-phenylbenzamide (**5b**).[7d] Petroleum ether / ethyl acetate = 5 : 1 (v /v) as eluent for column chromatography. White solid, 211.1 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (s, 1H), 7.77 (d, *J* = 8.2 Hz, 2H), 7.64 (d, *J* = 7.6 Hz, 2H), 7.37 (t, *J* = 7.9 Hz, 2H), 7.29 (d, *J* = 7.9 Hz, 2H), 7.14 (t, *J* = 7.4 Hz, 1H), 2.43 (s, 3H).

4-Methoxy-*N*-phenylbenzamide (**5c**).[7d] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 209.1 mg, 92% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.8 Hz, 2H), 7.82 (s, 1H), 7.63 (d, *J* = 7.6 Hz, 2H), 7.36 (t, *J* = 8.0 Hz, 2H), 7.14 (t, *J* = 7.4 Hz, 1H), 6.96 (d, *J* = 8.8 Hz, 2H), 3.87 (s, 3H).

3-Methoxy-*N*-phenylbenzamide (**5d**).[22] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 222.7 mg, 98% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (s, 1H), 7.64 (d, *J* = 7.7 Hz, 2H), 7.43 (s, 1H), 7.40-7.32 (m, 4H), 7.15 (t, *J* = 7.4 Hz, 1H), 7.06 (d, *J* = 7.9 Hz, 1H), 3.84 (s, 3H).

2-Methoxy-*N*-phenylbenzamide (**5e**). [23] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. Brown oil, 225.0 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.81 (s, 1H), 8.29 (dd, *J* = 7.8, 1.8 Hz, 1H), 7.68 (dd, *J* = 8.4, 0.9 Hz, 2H), 7.48 (td, *J* = 7.7, 1.7 Hz, 1H), 7.36 (t, *J* = 8.0 Hz, 2H), 7.14-7.11 (m, 2H), 7.02 (d, *J* = 8.3 Hz, 1H), 4.03 (s, 3H).

4-(*Tert*-Butyl)-*N*-phenylbenzamide (**5f**). [18g] Petroleum ether / ethyl acetate = 5 : 1 (v /v) as eluent for column chromatography. White solid, 238.1 mg, 94% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.90 (s, 1H), 7.81 (d, *J* = 8.5 Hz, 2H), 7.64 (d, *J* = 7.6 Hz, 2H), 7.49 (d, *J* = 8.5 Hz, 2H), 7.36 (t, *J* = 8.0 Hz, 2H), 7.14 (t, *J* = 7.4 Hz, 1H), 1.35 (s, 9H).

***N*-Phenyl-[1,1'-biphenyl]-4-carboxamide** (**5g**).[24] Petroleum ether / ethyl acetate = 4 : 1 (v /v) as eluent for column chromatography. White solid, 270.6 mg, 99% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.28 (s, 1H), 8.06 (d, *J* = 8.4 Hz, 2H), 7.84 (d, *J* = 8.4 Hz, 2H), 7.80 (d, *J* = 7.6 Hz, 2H), 7.76 (d, *J* = 7.2 Hz, 2H), 7.51 (t, *J* = 7.6 Hz, 2H), 7.43 (t, *J* = 7.4 Hz, 1H), 7.36 (t, *J* = 7.9 Hz, 2H), 7.11 (t, *J* = 7.4 Hz, 1H).

***N*-Phenyl-2-naphthamide** (**5h**).[25] Petroleum ether / ethyl acetate = 4 : 1 (v /v) as eluent for column chromatography. White solid, 244.8 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.36 (s, 1H), 8.07 (s, 1H), 7.93-7.88 (m, 4H), 7.70 (d, *J* = 7.7 Hz, 2H), 7.57 (dtd, *J* = 16.2, 6.9, 1.3 Hz, 2H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.17 (t, *J* = 7.4 Hz, 1H).

***N*-Phenyl-4-(trifluoromethoxy)benzamide** (**5i**).[25] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 278.4 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.91 (d, *J* = 8.7 Hz, 2H), 7.82 (s, 1H), 7.62 (d, *J* = 7.8 Hz, 2H), 7.38 (t, *J* = 7.9 Hz, 2H), 7.31 (d, *J* = 8.2 Hz, 2H), 7.17 (t, *J* = 7.4 Hz, 1H). ^{19}F NMR (471 MHz, $CDCl_3$) δ -57.7 (s, 3F).

4-Chloro-*N*-phenylbenzamide (**5j**).[26] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 229.4 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.5 Hz, 2H), 7.77 (s, 1H), 7.62 (d, *J* = 7.8 Hz, 2H), 7.46 (d, *J* = 8.5 Hz, 2H), 7.38 (t, *J* = 7.9 Hz, 2H), 7.17 (t, *J* = 7.4 Hz, 1H).

3-Chloro-*N*-phenylbenzamide (**5k**).[27] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 224.7 mg, 97% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.87 (s, 1H), 7.84 (s, 1H), 7.73 (d, *J* = 7.7 Hz, 1H), 7.62 (d, *J* = 7.8 Hz, 2H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.41 (t, *J* = 7.9 Hz, 1H), 7.37 (t, *J* = 7.9 Hz, 2H), 7.17 (t, *J* = 7.4 Hz, 1H).

2-Chloro-*N*-phenylbenzamide (**5l**).[28] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. Brown solid, 210.8 mg, 91% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.93 (s, 1H), 7.75 (dd, *J* = 7.5, 1.7 Hz, 1H), 7.64 (d, *J* = 7.8 Hz, 2H), 7.44 (t, *J* = 7.8 Hz, 1H), 7.41-7.35 (m, 4H), 7.17 (t, *J* = 7.4 Hz, 1H).

4-Bromo-*N*-phenylbenzamide (**5m**).[25] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 267.8 mg, 97% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.77 (s, 1H), 7.74 (d, *J* = 8.5 Hz, 2H), 7.64-7.61 (m, 4H), 7.38 (t, *J* = 7.9 Hz, 2H), 7.17 (t, *J* = 7.4 Hz, 1H).

Methyl 4-(phenylcarbamoyl)benzoate (**5n**). [28] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 247.6 mg, 97% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.14 (d, *J* = 8.5 Hz, 2H), 7.92 (d, *J* = 8.4 Hz,

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2H), 7.88 (s, 1H), 7.65 (d, *J* = 7.8 Hz, 2H), 7.38 (t, *J* = 8.0 Hz, 2H), 7.18 (t, *J* = 7.4 Hz, 1H), 3.96 (s, 3H).

4-Formyl-*N*-phenylbenzamide (5o).[29] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 196.0 mg, 87% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 10.10 (s, 1H), 8.03-7.98 (m, 4H), 7.93 (s, 1H), 7.65 (d, *J* = 7.9 Hz, 2H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.19 (t, *J* = 7.4 Hz, 1H).

4-Cyano-*N*-phenylbenzamide (5p).[30] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 193.4 mg, 87% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.3 Hz, 2H), 7.92 (s, 1H), 7.77 (d, *J* = 8.5 Hz, 2H), 7.62 (d, *J* = 7.9 Hz, 2H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.20 (t, *J* = 7.4 Hz, 1H).

***N*-Phenyl-4-(trifluoromethyl)benzamide (5q)**. [25] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 262.6 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.99 (d, *J* = 8.1 Hz, 2H), 7.81 (s, 1H), 7.76 (d, *J* = 8.2 Hz, 2H), 7.64 (d, *J* = 7.9 Hz, 2H), 7.40 (t, *J* = 7.9 Hz, 2H), 7.19 (t, *J* = 7.4 Hz, 1H). ^{19}F NMR (471 MHz, $CDCl_3$) δ -63.0 (s, 3F).

4-(Methylsulfonyl)-*N*-phenylbenzamide (5r). Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 261.6 mg, 95% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.48 (s, 1H), 8.17 (d, *J* = 8.5 Hz, 2H), 8.08 (d, *J* = 8.5 Hz, 2H), 7.77 (d, *J* = 7.6 Hz, 2H), 7.38 (t, *J* = 7.5 Hz, 2H), 7.14 (t, *J* = 7.4 Hz, 1H), 3.28 (s, 3H). ^{13}C NMR (126 MHz, DMSO-d6) δ 164.9 (s), 143.6 (s), 140.0 (s), 139.2 (s), 129.2 (s), 129.1 (s), 127.6 (s), 124.6 (s), 121.0 (s), 43.8 (s). Mp 207-208 °C. HRMS ESI (m/z): $[M+Na]^+$ calcd for $C_{14}H_{13}NNaO_3S$: 298.0508; found: 298.0505.

4-Hydroxy-*N*-phenylbenzamide (5s).[7d] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 211.1 mg, 99% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.41 (s, 1H), 8.14 (d, *J* = 8.8 Hz, 2H), 7.77 (dd, *J* = 8.0, 5.2 Hz, 4H), 7.37 (t, *J* = 7.9 Hz, 2H), 7.12 (t, *J* = 7.4 Hz, 1H).

***N*-phenylfuran-2-carboxamide (5t)**.[7d] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Brown solid, 183.5 mg, 98% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.09 (s, 1H), 7.65 (d, *J* = 7.7 Hz, 2H), 7.51 (s, 1H), 7.36 (t, *J* = 7.9 Hz, 2H), 7.24 (d, *J* = 3.5 Hz, 1H), 7.14 (t, *J* = 7.4 Hz, 1H), 6.55 (dd, *J* = 3.5, 1.7 Hz, 1H).

***N*-phenylthiophene-2-carboxamide (5u)**.[28] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 199.2 mg, 98% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.88 (s, 1H), 7.64 (dd, *J* = 3.7, 1.1 Hz, 1H), 7.61 (d, *J* = 7.6 Hz, 2H), 7.53 (dd, *J* = 5.0, 1.1 Hz, 1H), 7.34 (t, *J* = 8.0 Hz, 2H), 7.14 (t, *J* = 7.4 Hz, 1H), 7.10 (dd, *J* = 5.0, 3.8 Hz, 1H).

***N*-phenylpicolinamide (5v)**.[31] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. Brown solid, 154.6 mg, 78% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 10.03 (s, 1H), 8.61 (s, 1H), 8.30 (d, *J* = 7.6 Hz, 1H), 7.89 (t, *J* = 7.6 Hz, 1H), 7.78 (d, *J* = 7.8 Hz, 2H), 7.48-7.46 (m, 1H), 7.39 (t, *J* = 7.9 Hz, 2H), 7.15 (t, *J* = 7.4 Hz, 1H).

***N*-phenylnicotinamide (5w)**. [7d] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 168.5 mg, 85% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.08 (s, 1H), 8.75 (d, *J* = 3.4 Hz, 1H), 8.20 (d, *J* = 7.9 Hz, 1H), 8.12 (s, 1H), 7.64 (d, *J* = 7.9 Hz, 2H), 7.42 (dd, *J* = 7.9, 4.8 Hz, 1H), 7.38 (t, *J* = 7.9 Hz, 2H), 7.18 (t, *J* = 7.4 Hz, 1H).

***N*-phenylisonicotinamide (5x)**. [31] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 178.4 mg, 90% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.48 (s, 1H), 8.78 (dd, *J* = 4.4, 1.6 Hz, 2H), 7.86 (dd, *J* = 4.4, 1.6 Hz, 2H), 7.77 (d, *J* = 7.6 Hz, 2H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.14 (t, *J* = 7.4 Hz, 1H).

2-([1,1'-Biphenyl]-4-yl)-*N*-phenylacetamide (5y).[32] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 278.7 mg, 97% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.19 (s, 1H), 7.65-7.59 (m, 6H), 7.47-7.42 (m, 4H), 7.34 (t, *J* = 7.4 Hz, 1H), 7.30 (t, *J* = 7.9 Hz, 2H), 7.04 (t, *J* = 7.4 Hz, 1H), 3.68 (s, 2H).

***N*-Phenylpivalamide (5z)**. [7d] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 156.0 mg, 88% yield. ^{1}H NMR (500 MHz, DMSO-d6) δ 9.15 (s, 1H), 7.63 (dd, *J* = 8.5, 1.0 Hz, 2H), 7.28 (t, *J* = 7.8 Hz, 2H), 7.03 (t, *J* = 7.4 Hz, 1H), 1.22 (s, 9H).

***N*-Phenylpropionamide (5aa)**. [26] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 146.2 mg, 98% yield. ^{1}H NMR (500 MHz, DMSO-d6) δ 9.83 (s, 1H), 7.58 (d, *J* = 7.7 Hz, 2H), 7.27 (t, *J* = 7.8 Hz, 2H), 7.01 (t, *J* = 6.9 Hz, 1H), 2.31 (q, *J* = 7.6 Hz, 2H), 1.08 (t, *J* = 7.6 Hz, 3H).

***N*-Phenylbut-2-ynamide (5ab)**.[33] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 157.6 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (s, 1H), 7.51 (d, *J* = 7.8 Hz, 2H), 7.31 (t, *J* = 7.9 Hz, 2H), 7.11 (t, *J* = 7.4 Hz, 1H), 1.97 (s, 3H).

(3r,5r,7r)-*N*-Phenyladamantane-1-carboxamide (5ac).[31] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 204.3 mg, 80% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.07 (s, 1H), 7.64 (d, *J* = 7.6 Hz, 2H), 7.27 (t, *J* = 8.0 Hz, 2H), 7.02 (t, *J* = 7.4 Hz, 1H), 2.02 (s, 3H), 1.91 (d, *J* = 2.8 Hz, 6H), 1.71 (d, *J* = 2.8 Hz, 6H).

***N*,*N*-Diethyl-2-naphthamide (5ad)**.[34] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow liquid, 226.4 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) *δ* 7.85 (dt, *J* = 6.7, 4.4 Hz, 4H), 7.54-7.48 (m, 2H), 7.47 (dd, *J* = 8.5, 1.3 Hz, 1H), 3.60 (br s, 2H), 3.29 (br s, 2H), 1.28 (br s, 3H), 1.12 (br s, 3H).

***N*,*N*-Diethyl-[1,1'-biphenyl]-4-carboxamide (5ae)**.[18g] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 252.0 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.63-7.58 (m, 4H), 7.46-7.45 (m, 4H), 7.37 (t, J = 7.2 Hz, 1H), 3.57 (br s, 2H), 3.32 (br s, 2H), 1.30-1.10 (m, 6H).

***N*,*N*-diethyl-4-methoxybenzamide (5af)**.[34] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 179.6 mg, 87% yield. ^{1}H NMR (500 MHz, $CDCl_3$) *δ* 7.31 (d, *J* = 8.7 Hz, 2H), 6.87 (d, *J* = 8.7 Hz, 2H), 3.79 (s, 3H), 3.39 (br s, 4H), 1.15 (br s, 6H).

4-(Dimethylamino)-*N*,*N*-diethylbenzamide (5ag).[35] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Light yellow liquid, 175.2 mg, 80% yield. ^{1}H NMR (500 MHz, $CDCl_3$) *δ* 7.30 (d, *J* = 8.8 Hz, 2H), 6.66 (d, *J* = 8.7 Hz, 2H), 3.42 (q, *J* = 6.0 Hz, 4H), 2.96 (s, 6H), 1.17 (t, *J* = 7.0 Hz, 6H).

***N,N*-Diethyl-4-(trifluoromethoxy)benzamide (5ah)**. Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 227.8 mg, 87% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41 (d, J = 8.5 Hz, 2H), 7.23 (d, J = 8.1 Hz, 2H), 3.54 (br s, 2H), 3.25 (br s, 2H), 1.25 (br s, 3H), 1.12 (br s, 3H). ^{19}F NMR (476 MHz, $CDCl_3$) δ -57.8 (s, 3F). ^{13}C NMR (126 MHz, $CDCl_3$) δ 170.1 (s), 149.8 (s), 136.0 (s), 128.3 (s), 120.9 (s), 120.5 (q, J = 258 Hz), 43.5 (s), 39.6 (s), 14.3 (s), 13.0 (s). HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{12}H_{15}F_3NO_2$: 262.1049; found: 262.1051.

***N,N*-Diethyl-4-hydroxybenzamide (5ai)**. Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 186.8 mg, 97% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (d, J = 8.4 Hz, 2H), 7.37 (d, J = 8.4 Hz, 2H), 3.54 (br s, 2H), 3.23 (br s, 2H), 1.24 (br s, 3H), 1.12 (br s, 3H). ^{19}F NMR (476 MHz, $CDCl_3$) δ 37.6 (s, 1F). ^{13}C NMR (126 MHz, $CDCl_3$) δ 169.29 (s), 150.16 (s), 137.88 (s), 128.65 (s), 121.11 (s), 43.36 (s), 39.50 (s), 14.17 (s), 12.81 (s). HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{12}H_{15}F_3NO_2$: 242.0691; found: 242.0694.

***N,N*-Diethyl-4-fluorobenzamide (5aj)**.[34] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Light yellow liquid, 177.8 mg, 91% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.39-7.33 (m, 2H), 7.07 (d, J = 8.7 Hz, 1H), 7.05 (d, J = 8.6 Hz, 1H), 3.51 (br s, 2H), 3.25 (br s, 2H), 1.20 (br s, 3H), 1.12 (br s, 3H). ^{19}F NMR (476 MHz, $CDCl_3$) δ -111.4 (s, 1F).

4-Chloro-*N,N*-diethylbenzamide (5ak).[36] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 198.0 mg, 94% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (d, J = 8.5 Hz, 2H), 7.31 (d, J = 8.5 Hz, 2H), 3.52 (br s, 2H), 3.23 (br s, 2H), 1.22 (br s, 3H), 1.10 (br s, 3H).

4-Bromo-*N,N*-diethylbenzamide (5al).[34] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 235.4 mg, 92% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.53 (d, J = 8.3 Hz, 2H), 7.25 (d, J = 8.3 Hz, 2H), 3.53 (br s, 2H), 3.24 (br s, 2H), 1.24 (br s, 3H), 1.11 (br s, 3H).

***N,N*-Diethyl-4-formylbenzamide (5am)**.[37] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow liquid, 151.3 mg, 74% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 10.00 (s, 1H), 7.89 (d, J = 8.1 Hz, 2H), 7.49 (d, J = 8.1 Hz, 2H), 3.53 (q, J = 6.5 Hz, 2H), 3.19 (q, J = 6.4 Hz, 2H), 1.23 (t, J = 6.2 Hz, 3H), 1.08 (t, J = 6.7 Hz, 3H).

***N,N*-Diethyl-4-nitrobenzamide (5an)**.[34] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow solid, 133.0 mg, 60% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.25 (d, J = 8.7 Hz, 2H), 7.53 (d, J = 8.7 Hz, 2H), 3.56 (q, J = 6.6 Hz, 2H), 3.20 (q, J = 6.6 Hz, 2H), 1.25 (t, J = 6.6 Hz, 3H), 1.11 (t, J = 6.2 Hz, 3H).

***N,N*-Diethylbenzo[*d*][1,3]dioxole-5-carboxamide (5ao)**.[38] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Light yellow liquid, 220.9 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.90-6.82 (m, 2H), 6.79 (d, J = 7.7 Hz, 1H), 5.96 (s, 2H), 3.38 (br s, 4H), 1.15 (br s, 6H).

***N,N*-Diethyl-4-vinylbenzamide (5ap)**.[39] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow liquid, 149.8 mg, 74% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 (d, J = 8.1 Hz, 2H), 7.33 (d, J = 8.1 Hz, 2H), 6.71 (dd, J = 17.6, 10.9 Hz, 1H), 5.78 (d, J = 17.6 Hz, 1H), 5.29 (d, J = 10.9 Hz, 1H), 3.53 (br s, 2H), 3.26 (br s, 2H), 1.23 (br s, 3H), 1.11 (br s, 3H).

***N,N*-Diethylfuran-2-carboxamide (5aq)**.[38] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 119.6 mg, 72% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (d, J = 0.8 Hz, 1H), 6.98 (d, J = 3.4 Hz, 1H), 6.43 (dd, J = 3.4, 1.7 Hz, 1H), 3.52 (br s, 4H), 1.22 (br s, 6H).

***N,N*-Diethylthiophene-2-carboxamide (5ar)**.[38] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. Light yellow liquid, 125.5 mg, 69% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.40 (dd, J = 5.0, 0.9 Hz, 1H), 7.31 (dd, J = 3.6, 0.9 Hz, 1H), 7.01 (dd, J = 4.9, 3.7 Hz, 1H), 3.52 (q, J = 7.1 Hz, 4H), 1.23 (t, J = 7.1 Hz, 6H).

***N,N*-Diethylisonicotinamide (5as)**.[40] Petroleum ether / ethyl acetate = 1 : 2 (v /v) as eluent for column chromatography. Colorless liquid, 151.8 mg, 85% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.68 (d, J = 5.3 Hz, 2H), 7.28 (d, J = 5.9 Hz, 2H), 3.52 (q, J = 7.0 Hz, 2H), 3.17 (q, J = 7.0 Hz, 2H), 1.22 (t, J = 7.0 Hz, 3H), 1.09 (t, J = 7.0 Hz, 3H).

***N,N*-Diethylquinoline-6-carboxamide (5at)**. Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Light brown liquid, 217.3 mg, 95% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.91 (d, J = 2.8 Hz, 1H), 8.14 (d, J = 8.2 Hz, 1H), 8.10 (d, J = 8.6 Hz, 1H), 7.82 (d, J = 1.5 Hz, 1H), 7.67 (dd, J = 8.6, 1.8 Hz, 1H), 7.40 (dd, J = 8.3, 4.2 Hz, 1H), 3.57 (br s, 2H), 3.26 (br s, 2H), 1.25 (br s, 3H), 1.10 (br s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 170.6 (s), 151.3 (s), 148.2 (s), 136.4 (s), 135.5 (s), 129.9 (s), 127.9 (s), 127.6 (s), 125.8 (s), 121.9 (s), 43.5 (s), 39.5 (s), 14.3 (s), 13.0 (s). HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{14}H_{17}N_2O$: 229.1335; found: 229.1333.

***N,N*-Diethylbut-2-ynamide (5au)**.[41] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow liquid, 149.8 mg, 74% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 3.55 (q, J = 7.1 Hz, 2H), 3.39 (q, J = 7.1 Hz, 2H), 1.98 (s, 3H), 1.19 (t, J = 7.1 Hz, 3H), 1.11 (t, J = 7.2 Hz, 3H).

2-([1,1'-Biphenyl]-4-yl)-*N,N*-diethylacetamide (5av).[42] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 234.1 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61-7.53 (m, 4H), 7.43 (t, J = 7.7 Hz, 2H), 7.37-7.30 (m, 3H), 3.74 (s, 2H), 3.41 (q, J = 7.1 Hz, 2H), 3.33 (q, J = 7.1 Hz, 2H), 1.14 (q, J = 7.3 Hz, 6H).

***N,N*-Diethyl-3-phenylpropanamide (5aw)**.[43] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 204.1 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.28 (t, J = 7.5 Hz, 2H), 7.24-7.17 (m, 3H), 3.37 (q, J = 7.1 Hz, 2H), 3.22 (q, J = 7.1 Hz, 2H), 3.01-2.95 (m, 2H), 2.62-2.56 (m, 2H), 1.15-1.09 (m, 6H).

***N,N*-Diethyl-4-(4-methoxyphenyl)butanamide (5ax)**. Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 205.4 mg, 82% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.10 (d, J = 8.4 Hz, 2H), 6.82 (d, J = 8.5 Hz, 2H), 3.78 (s, 3H), 3.36 (q, J = 7.1 Hz, 2H), 3.22 (q, J = 7.1 Hz, 2H), 2.61 (t, J = 7.5 Hz, 2H), 2.28 (t, J = 7.5 Hz, 2H), 1.98-1.91 (m, 2H), 1.10 (dd, J = 13.2, 6.9 Hz, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 172.1 (s), 158.0 (s), 134.1 (s), 129.5 (s), 113.9 (s), 55.4 (s), 42.1 (s), 40.2 (s), 34.6 (s), 32.3 (s), 27.2 (s), 14.4 (s), 13.2 (s). HRMS

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ESI (m/z): $[M+H]^+$ calcd for $C_{15}H_{24}NO_2$: 250.1802; found: 250.1800.

***N,N*-Diethyl-1,2,3,4-tetrahydronaphthalene-1-carboxamide (5ay)**. Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 229.8 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.15-7.07 (m, 3H), 6.93 (d, *J* = 7.2 Hz, 1H), 4.04-3.98 (m, 1H), 3.56-3.38 (m, 4H), 2.94-2.85 (m, 1H), 2.80-2.74 (m, 1H), 2.10-1.99 (m, 3H), 1.79-1.70 (m, 1H), 1.24 (t, *J* = 7.1 Hz, 3H), 1.19 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) *δ* 174.7 (s), 137.5 (s), 135.8 (s), 129.5 (s), 127.7 (s), 126.5 (s), 126.1 (s), 43.9 (s), 42.6 (s), 40.7 (s), 29.4 (s), 27.7 (s), 21.7 (s), 15.2 (s), 13.2 (s). HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{15}H_{22}NO_2$: 232.1696; found: 232.1695.

(3*r*,5*r*,7*r*)-*N*,*N*-Diethyladamantane-1-carboxamide (5az).[44] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 234.1 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) *δ* 3.41 (tt, *J* = 7.2, 3.6 Hz, 4H), 2.12-1.88 (m, 9H), 1.77-1.71 (m, 6H), 1.25 (t, *J* = 7.2 Hz, 4H), 1.12 (t, *J* = 7.0 Hz, 2H).

***N*-(2-(Diethylamino)-2-oxoethyl)benzamide (5ba)**. Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow solid, 163.0 mg, 70% yield. M.p. 75-77 °C. ^{1}H NMR (500 MHz, $CDCl_3$) *δ* 7.83 (d, *J* = 7.2 Hz, 2H), 7.48 (t, *J* = 7.4 Hz, 1H), 7.44-7.38 (m, *J* = 7.5 Hz, 3H), 4.22 (d, *J* = 3.9 Hz, 2H), 3.43 (q, *J* = 7.1 Hz, 2H), 3.32 (q, *J* = 7.2 Hz, 2H), 1.21 (t, *J* = 7.2 Hz, 3H), 1.15 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) *δ* 167.3 (s), 167.2 (s), 134.1 (s), 131.7 (s), 128.6 (s), 127.2 (s), 41.8 (s), 41.2 (s), 40.7 (s), 14.1 (s), 13.0 (s). HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{13}H_{19}N_2O_2$: 235.1441; found: 235.1440.

***N*-(4-Methoxyphenyl)benzamide (6a)**.[7d] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 222.7 mg, 98% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.86 (s, 1H), 7.85 (d, *J* = 7.4 Hz, 2H), 7.52 (t, *J* = 7.8 Hz, 3H), 7.45 (t, *J* = 7.5 Hz, 2H), 6.89 (d, *J* = 9.0 Hz, 2H), 3.80 (s, 3H).

***N*-(4-Phenoxyphenyl)benzamide (6b)**. [18g] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 254.6 mg, 88% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.29 (s, 1H), 7.97 (d, *J* = 7.6 Hz, 2H), 7.82 (d, *J* = 7.0 Hz, 2H), 7.59 (t, *J* = 7.1 Hz, 1H), 7.53 (t, *J* = 7.4 Hz, 2H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.11 (t, *J* = 7.3 Hz, 1H), 7.04 (d, *J* = 8.8 Hz, 2H), 7.00 (d, *J* = 8.0 Hz, 2H).

***N*-(Naphthalen-1-yl)benzamide (6c)**.[18g] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 190.4 mg, 77% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.45 (s, 1H), 8.12 (d, *J* = 7.1 Hz, 2H), 8.03-7.98 (m, 2H), 7.88 (d, *J* = 8.1 Hz, 1H), 7.65-7.62 (m, 2H), 7.59-7.55 (m, 5H).

***N*-(4-Cyanophenyl)benzamide (6d)**.[18g] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 204.5 mg, 92% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.13 (s, 1H), 7.88-7.86 (m, 2H), 7.81-7.79 (m, 2H), 7.65-7.63 (m, 2H), 7.65 (tt, *J* = 7.4, 1.1 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H).

***N*-(4-Nitrophenyl)benzamide (6e)**.[18g] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow solid, 145.3 mg, 60% yield. ^{1}H NMR (500 MHz, DMSO-d6) δ 10.79 (s, 1H), 8.26 (d, *J* = 9.1 Hz, 2H), 8.07 (d, *J* = 9.2 Hz, 2H), 7.98 (d, *J* = 7.2 Hz, 2H), 7.63 (t, *J* = 7.3 Hz, 1H), 7.56 (t, *J* = 7.5 Hz, 2H).

***N*-(4-Bromophenyl)benzamide (6f)**. [18g] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 245.8 mg, 89% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.86 (d, J = 7.1 Hz, 2H), 7.82 (s, 1H), 7.58-7.54 (m, 3H), 7.51-7.47 (m, 4H).

***N*-(4-(Trifluoromethyl)phenyl)benzamide (6g)**.[7d] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 262.6 mg, 99% yield. ^{1}H NMR (500 MHz, DMSO-d6) δ 10.43 (s, 1H), 7.96 (d, *J* = 7.1 Hz, 2H), 7.91 (d, *J* = 9.1 Hz, 2H), 7.60 (t, *J* = 7.3 Hz, 1H), 7.54 (t, *J* = 7.4 Hz, 2H), 7.36 (d, *J* = 8.5 Hz, 2H). ^{19}F NMR (471 MHz, DMSO-d6) δ -57.1 (s, 3F).

***N*-(3-Ethynylphenyl)benzamide (6h)**.[9n] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 219.1 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.99 (s, 1H), 7.84 (d, *J* = 8.6 Hz, 2H), 7.76 (s, 1H), 7.68 (d, *J* = 7.8 Hz, 1H), 7.54 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 7.30 (t, *J* = 7.7 Hz, 1H), 7.27 (d, *J* = 6.1 Hz, 1H), 3.07 (s, 1H).

***N*-(Quinolin-3-yl)benzamide (6i)**.[45] Petroleum ether / ethyl acetate = 1 : 1 (v /v) as eluent for column chromatography. White solid, 181.2 mg, 73% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.71 (s, 1H), 9.16 (d, *J* = 2.5 Hz, 1H), 8.86 (d, *J* = 2.3 Hz, 1H), 8.05 (d, *J* = 7.1 Hz, 2H), 7.99 (d, *J* = 8.4 Hz, 1H), 7.96 (d, *J* = 7.9 Hz, 1H), 7.67 (t, *J* = 7.0 Hz, 1H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.58 (q, *J* = 7.6 Hz, 3H).

***N*-(Pyridin-3-yl)benzamide (6j)**.[18g] Petroleum ether / ethyl acetate = 1 : 1 (v /v) as eluent for column chromatography. White solid, 168.5 mg, 85% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.68 (d, *J* = 2.4 Hz, 1H), 8.52 (s, 1H), 8.32 (d, *J* = 4.8 Hz, 1H), 8.30 (dd, *J* = 8.4, 2.4 Hz, 1H), 7.88 (d, *J* = 7.2 Hz, 2H), 7.54 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.7 Hz, 2H), 7.29 (dd, *J* = 8.3, 4.8 Hz, 1H).

***N*-(2-Isopropylphenyl)benzamide (6k)**.[18g] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 177.1 mg, 74% yield. ^{1}H NMR (500 MHz, DMSO-d6) δ 9.92 (s, 1H), 7.99 (d, *J* = 7.2 Hz, 2H), 7.59 (t, *J* = 7.3 Hz, 1H), 7.53 (t, *J* = 7.4 Hz, 2H), 7.37 (d, *J* = 7.3 Hz, 1H), 7.28 (td, *J* = 7.1, 2.5 Hz, 1H), 7.25-7.20 (m, 2H), 3.18 (dt, *J* = 13.7, 6.9 Hz, 1H), 1.16 (d, *J* = 6.9 Hz, 6H).

***N*-(2,6-Dimethylphenyl)benzamide (6l)**.[7d] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 92.4 mg, 41% yield (119.4 mg, 53% yield when 3 equiv of amine was used). ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.77 (s, 1H), 8.01 (d, *J* = 7.8 Hz, 2H), 7.59 (t, *J* = 7.3 Hz, 1H), 7.53 (t, *J* = 7.4 Hz, 2H), 7.13 (s, 3H), 2.19 (s, 6H).

***N*-(2,6-Diisopropylphenyl)benzamide (6m)**.[7d] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 115.4 mg, 41% yield (168.8 mg, 60% yield when 3 equiv of amine was used). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.91 (d, *J* = 7.1 Hz, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.46 (s, 1H), 7.35 (t, *J* = 7.9 Hz, 1H), 7.23 (d, *J* = 7.7 Hz, 2H), 3.15 (dt, *J* = 13.7, 6.9 Hz, 2H), 1.22 (d, *J* = 6.9 Hz, 12H).

***N*-Methyl-*N*-phenylbenzamide (6n)**.[7d] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 190.1 mg, 90% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.19 (d, *J* = 7.1 Hz, 2H), 7.13-7.09 (m, 3H), 7.06-7.00 (m, 3H), 6.92 (d, *J* = 7.4 Hz, 2H), 3.39 (s, 3H).

***N,N*-Diphenylbenzamide (6o)**.[23] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 90.2 mg, 33% yield (112.1 mg, 41% yield when 3 equiv of amine was used). ^{1}H NMR (500 MHz, DMSO-d_6) δ 7.42 (d, *J* = 8.5 Hz, 2H), 7.34-7.29 (m, 5H), 7.26-7.18 (m, 8H).

***N*-Benzylbenzamide (6p)**.[9n] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 147.9 mg, 70% yield (209.2 mg, 99% yield when 3 equiv of amine was used). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (d, *J* = 7.2 Hz, 2H), 7.50 (t, *J* = 7.4 Hz, 1H), 7.42 (t, *J* = 7.5 Hz, 2H), 7.35 (d, *J* = 4.4 Hz, 4H), 7.31 (dd, *J* = 7.8, 3.6 Hz, 1H), 6.50 (s, 1H), 4.64 (d, *J* = 5.7 Hz, 2H).

***N*-(Pyridin-2-ylmethyl)benzamide (6q)**.[46] Petroleum ether / ethyl acetate = 1 : 1 (v /v) as eluent for column chromatography. Pale yellow solid, 76.4 mg, 36% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.53 (d, *J* = 4.7 Hz, 1H), 7.86 (d, *J* = 7.2 Hz, 2H), 7.72 (s, 1H), 7.66 (td, *J* = 7.7, 1.7 Hz, 1H), 7.48 (t, *J* = 7.3 Hz, 1H), 7.41 (t, *J* = 7.5 Hz, 2H), 7.31 (d, *J* = 7.8 Hz, 1H), 7.19 (dd, *J* = 7.1, 5.2 Hz, 1H), 4.74 (d, *J* = 4.9 Hz, 2H).

***N*-(Furan-2-ylmethyl)benzamide (6r)**.[46] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 76.5 mg, 38% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 7.3 Hz, 2H), 7.49 (t, *J* = 7.4 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.37 (d, *J* = 1.0 Hz, 1H), 6.53 (s, 1H), 6.33 (t, *J* = 2.5 Hz, 1H), 6.29 (d, *J* = 3.1 Hz, 1H), 4.63 (d, *J* = 5.5 Hz, 2H).

***N*-(Prop-2-yn-1-yl)benzamide (6s)**.[9n] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 84.4 mg, 53% yield (100.3 mg, 63% yield when 3 equiv of amine was used). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (d, *J* = 7.1 Hz, 2H), 7.51 (t, *J* = 7.3 Hz, 1H), 7.43 (t, *J* = 7.6 Hz, 2H), 6.47 (s, 1H), 4.25 (dd, *J* = 5.2, 2.6 Hz, 2H), 2.28 (t, *J* = 2.6 Hz, 1H).

***N*-((3S,5S,7S)-adamantan-1-yl)benzamide (6t)**.[9k] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 252.8 mg, 99% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 9.07 (s, 1H), 7.64 (d, *J* = 7.6 Hz, 2H), 7.27 (t, *J* = 8.1 Hz, 2H), 7.02 (t, *J* = 7.4 Hz, 1H), 2.02-2.01 (m, 3H), 1.90 (d, *J* = 2.9 Hz, 6H), 1.71-1.70 (m, 6H).

***N*-(*Tert*-butyl)benzamide (6u)**. [9j] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 99.3 mg, 56% yield (156.0 mg, 88% yield when 3 equiv of amine was used). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 (d, *J* = 7.1 Hz, 2H), 7.45 (t, *J* = 7.3 Hz, 1H), 7.39 (t, *J* = 7.4 Hz, 2H), 5.97 (s, 1H), 1.46 (s, 9H).

***N,N*-Diethylbenzamide (6v)**.[9j] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 173.7 mg, 98% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37-7.33 (m, 5H), 3.53 (s, 2H), 3.23 (s, 2H), 1.15 (d, *J* = 71.1 Hz, 6H).

Morpholino(phenyl)methanone (6w). [7d] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 124.3 mg, 65% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.12 (dd, *J* = 8.3, 1.3 Hz, 2H), 7.61 (t, *J* = 7.4 Hz, 1H), 7.48 (t, *J* = 7.8 Hz, 2H), 3.80 (t, *J* = 4.7 Hz, 4H), 3.44 (t, *J* = 4.9 Hz, 4H).

***N*-(4-Methoxyphenyl) propionamide (6x)**.[47] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 155 mg, 87% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 (br s, 1H), 7.39 (d, *J* = 8.9 Hz, 2H), 6.81 (d, *J* = 8.8 Hz, 2H), 3.76 (s, 3H), 2.33 (q, *J* = 7.6 Hz, 2H), 1.20 (t, *J* = 7.6 Hz, 3H).

***N*-(*m*-Tolyl) propionamide (6y)**.[48] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Pale yellow solid, 146 mg, 90% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (br s, 1H), 7.39 (s, 1H), 7.30 (d, *J* = 7.8 Hz, 1H), 7.17 (t, *J* = 7.6 Hz, 1H), 6.90 (d, *J* = 7.3 Hz, 1H), 2.37 (q, *J* = 7.6 Hz, 2H), 2.31 (s, 3H),1.23 (s, 3H).

***N*-(*o*-Tolyl) propionamide (6z)**.[48] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Pale yellow solid, 136 mg, 84% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 (d, *J* = 7.5 Hz, 1H), 7.19-7.16 (m, 3H), 7.06 (t, *J* = 7.1 Hz, 1H), 2.39 (q, *J* = 7.1 Hz, 2H), 2.22 (s, 3H),1.24 (t, *J* = 7.5 Hz, 3H).

***N*-(Naphthalen-1-yl) propionamide (6aa)**. [49]Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Pink solid, 146 mg, 74% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.86-7.80 (m, 3H), 7.76 (d, *J* = 6.6 Hz, 1H), 7.65 (d, *J* = 7.8 Hz, 1H), 7.45 (s, 2H), 7.38 (t, *J* = 7.3 Hz, 1H), 2.44 (q, *J* = 7.0 Hz, 2H), 1.25 (t, *J* = 6.7 Hz, 3H).

***N*-(2-Methoxyphenyl) propionamide (6ab)**.[48] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Orange liquid, 175 mg, 98% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.38 (d, *J* = 7.8 Hz, 1H), 7.79 (br s, 1H), 7.02 (t, *J* = 6.8 Hz, 1H), 6.94 (td, *J* = 7.7, 1.0 Hz, 1H), 6.86 (d, *J* = 8.1 Hz, 1H), 3.86 (s, 3H), 2.41 (q, *J* = 7.6 Hz, 2H), 1.24 (t, *J* = 7.5 Hz, 3H).

***N*-(4-Cyanophenyl) propionamide (6ac)**.[50] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White powder, 140 mg, 81% yield. ^{1}H NMR (500 MHz, DMSO-d_6) δ 10.28 (s, 1H), 7.77 (d, *J* = 8.9 Hz, 2H), 7.73 (d, *J* = 8.7 Hz, 2H), 2.37 (q, *J* = 7.4 Hz, 2H), 1.08 (t, *J* = 7.7 Hz, 3H).

***N*-(3-Ethynylphenyl) propionamide (6ad)**. Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Brown solid, 145 mg, 84% yield. Mp. 78-80℃. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (br s, 1H), 7.54 (d, *J* = 7.8 Hz, 2H), 7.26-7.20 (m,
2H), 3.05 (s, 1H), 2.38 (q, *J* = 7.5 Hz, 2H), 1.23 (t, *J* = 7.7 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) *δ* 172.4 (s), 138.1 (s), 129.0 (s), 127.9 (s), 123.4 (s), 122.8 (s), 120.5 (s), 83.2 (s), 77.4 (s), 30.7 (s), 9.6 (s). HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{11}H_{11}NO$: 174.0913; found: 174.0916.

***N*-(2-Isopropylphenyl) propionamide (6ae)**. Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Pale pink solid, 133 mg, 70% yield. Mp. 61-63 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (br s, 1H), 7.28 (s, 1H), 7.18-7.17 (m, 3H), 3.03 (hept, *J* = 6.5 Hz, 1H), 2.41 (q, *J* = 7.2 Hz, 2H), 1.28-1.23 (m, 9H). ^{13}C NMR (126 MHz, $CDCl_3$) *δ* 172.4 (s), 140.7 (s), 134.2 (s), 126.3 (s), 126.0 (s), 125.6 (s), 125.1 (s), 30.5 (s), 28.0 (s), 23.0 (s), 9.9 (s). HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{12}H_{17}NO$: 192.1383; found: 192.1382.

***N*-Methyl-*N*-phenylpropionamide (6af)**.[51] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Orange solid, 161.6 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41 (t, *J* = 7.5 Hz, 2H), 7.33 (t, *J* = 7.2 Hz, 1H), 7.18 (d, *J* = 7.7 Hz, 2H), 3.26 (s, 3H), 2.08 (q, *J* = 6.2 Hz, 2H), 1.05 (t, *J* = 7.2 Hz, 3H).

***N*-(Pyridin-3-ylmethyl) propionamide (6ag)**.[52] Petroleum ether / ethyl acetate = 1 : 2 (v /v) as eluent for column chromatography. Orange liquid, 135 mg, 82% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.47 (s, 1H), 8.41 (d, *J* = 4.1 Hz, 1H), 7.64 (d,

J = 8.0 Hz, 1H), 7.22 (dd, *J* = 7.8, 4.9 Hz, 1H), 6.92 (br s, 1H), 4.37 (d, *J* = 5.9 Hz, 2H), 2.21 (q, *J* = 7.6 Hz, 2H), 1.09 (t, *J* = 7.7 Hz, 3H).

***N*-Benzylacrylamide (6ah)**.[53] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 92 mg, 57% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (t, *J* = 7.3 Hz, 2H), 7.29-7.26 (m, 3H), 6.30 (dd, *J* = 16.9, 1.2 Hz, 1H), 6.12 (dd, *J* = 16.9, 10.2 Hz, 2H), 5.64 (dd, *J* = 10.2, 1.2 Hz, 1H), 4.49 (d, *J* = 5.7 Hz, 2H).

***N*-Cyclohexylacrylamide (6ai)**.[54] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 85 mg, 56% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.24 (dd, *J* = 17.1 Hz, 1.3 Hz, 1H), 6.08 (dd, *J* = 17.1, 10.2 Hz, 1H), 5.74 (br s, 1H), 5.58 (dd, *J* = 10.3, 1.1 Hz, 1H), 3.86-3.79 (m, 1H), 1.95-1.91 (m, 2H), 1.72-1.68 (m, 2H), 1.62-1.60 (m, 1H), 1.40-1.31 (m, 2H), 1.19-1.11 (m, 3H).

***N*-(1-Phenylethyl) acrylamide (6aj)**.[54] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow liquid, 115 mg, 66% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.32 (d, *J* = 4.4 Hz, 4H), 7.25 (t, *J* = 4.3 Hz, 1H), 6.34 (br s, 1H), 6.26 (dd, *J* = 17.0, 1.3 Hz, 1H), 6.12 (dd, *J* = 17.0, 10.3 Hz, 1H), 5.60 (dd, *J* = 10.3, 1.3 Hz, 1H), 5.19 (hept, *J* = 7.4 Hz, 1H), 1.50 (d, *J* = 6.8 Hz, 3H).

***N*-((3S,5S,7S)-adamantan-1-yl) acrylamide (6ak)**.[55] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 151.6 mg, 74% yield.^{1}H NMR (500 MHz, $CDCl_3$) δ 6.24 (dd, *J* = 16.9, 1.5 Hz, 1H), 6.15 (dd, *J* = 17.0, 10.0 Hz, 1H), 6.06 (s, 1H), 5.59 (dd, *J* = 10.1, 0.8 Hz, 1H), 1.93-1.61 (m, 15H).

***N*,*N*-Dimethylacrylamide (6al)**.[56] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless liquid, 70 mg, 71% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.54 (dd, *J* = 16.8, 10.4 Hz, 1H), 6.24 (dd, *J* = 16.7, 1.9 Hz, 1H), 5.62 (dd, *J* = 10.6, 2.0 Hz, 1H), 3.04 (s, 3H), 2.97 (s, 3H).

***N*,*N*-Diethylacrylamide (6am)**.[57] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow liquid, 90 mg, 71% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.52 (dd, *J* = 16.8, 10.5 Hz, 1H), 6.32 (dd, *J* = 16.6, 2.0 Hz, 1H), 5.64 (dd, *J* = 10.5, 1.9 Hz, 1H), 3.43 (q, *J* = 7.0 Hz, 2H), 3.37 (q, *J* = 7.0 Hz, 2H), 1.18 (t, *J* = 7.2 Hz, 3H), 1.14 (t, *J* = 7.2 Hz, 3H).

***N*,*N*-Dipropylacrylamide (6an)**.[56] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Pale yellow liquid, 137 mg, 89% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.53 (dd, *J* = 16.6, 10.4 Hz, 1H), 6.32 (dd, *J* = 16.8, 2.0 Hz, 1H), 5.64 (dd, *J* = 10.4, 1.9 Hz, 1H), 3.33 (t, *J* = 7.5 Hz, 2H), 3.26 (t, *J* = 7.6 Hz, 2H), 1.59 (hept, *J* = 7.6 Hz, 4H), 0.90 (dd, *J* = 12.9, 7.2 Hz, 6H).

***N*,*N*-Dibenzylacrylamide (6ao)**.[58] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Yellow liquid, 220 mg, 88% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38-7.26 (m, 8H), 7.18 (d, *J* = 7.2 Hz, 2H), 6.32 (dd, *J* = 16.8, 10.4 Hz, 1H), 6.50 (dd, *J* = 16.8, 2.2 Hz, 1H), 5.74 (dd, *J* = 10.4, 2.1 Hz, 1H), 4.67 (s, 2H), 4.53 (s, 2H).

Ethyl benzoyl-L-alaninate (7a).[59] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 177.0 mg, 80% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.80 (d, *J* = 7.2 Hz, 2H), 7.50 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.5 Hz, 2H), 6.79 (s, 1H), 4.78 (p, *J* = 7.2 Hz, 1H), 4.24 (q, *J* = 7.1 Hz, 2H), 1.52 (d, *J* = 7.1 Hz, 3H), 1.30 (t, *J* = 7.1 Hz, 3H). $[\alpha]_D^{25}$ = +18.7 (c = 1.0, $CHCl_3$), >99% ee was determined by chiral HPLC (chiralcel OD-H, n-hexane/2-propanol = 80/20, 0.5 mL/min, 254 nm). t_R = 9.92 min (minor) and 12.32 min (major). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

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Ethyl benzoyl-L-tyrosinate (7b).[60] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 310.3 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.74 (d, *J* = 7.3 Hz, 2H), 7.52 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.29-7.27 (m, 4H), 6.74 (s, 1H), 5.06 (dd, *J* = 12.9, 6.2 Hz, 1H), 4.22 (q, *J* = 6.9 Hz, 2H), 3.30 (ddd, *J* = 19.4, 14.0, 5.9 Hz, 2H), 1.26 (t, *J* = 7.1 Hz, 3H). $[\alpha]_D^{25}$ = -43.2 (c = 0.10, CH_3OH), >99% ee was determined by chiral HPLC (chiralcel OD-H, n-hexane/2-propanol = 80/20, 0.5 mL/min, 254 nm). t_R = 14.79 min (minor) and 23.29 min (major). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

Ethyl benzoyl-L-phenylalaninate (7c).[59] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 294.4 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 (d, *J* = 7.1 Hz, 2H), 7.50 (t, *J* = 7.4 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.30-7.27 (m, 2H), 7.26-7.22 (m, 1H), 7.15 (d, *J* = 8.2 Hz, 2H), 6.61 (d, *J* = 7.2 Hz, 1H), 5.07 (dt, *J* = 7.5, 5.7 Hz, 1H), 4.21 (q, *J* = 7.1 Hz, 2H), 3.26 (qd, *J* = 13.8, 5.7 Hz, 2H), 1.28 (t, *J* = 7.1 Hz, 3H). $[\alpha]_D^{25}$ = -35.1 (c = 0.10, CH_3OH), 98% ee was determined by chiral HPLC (chiralcel OD-H, n-hexane/2-propanol = 90/10, 1.0 mL/min, 254 nm). t_R = 8.93 min (minor) and 11.58 min (major). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

Ethyl benzoyl-L-valinate (7d).[61] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 134.6 mg, 54% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.81 (d, *J* = 7.1 Hz, 2H), 7.52 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.5 Hz, 2H), 6.65 (d, *J* = 8.0 Hz, 1H), 4.77 (dd, *J* = 8.6, 4.8 Hz, 1H), 4.29-4.18 (m, 2H), 2.42-2.04 (m, 1H), 1.31 (t, *J* = 7.1 Hz, 3H), 1.01 (dd, *J* = 12.7, 6.9 Hz, 6H). $[\alpha]_D^{25}$ = +22.0 (c = 0.10, $CHCl_3$). 99% ee was determined by chiral HPLC (chiralcel OD-H, n-hexane/2-propanol = 90/10, 1.0 mL/min, 254 nm). t_R = 5.36 min (minor) and 6.62 min (major). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

***Tert*-butyl (S)-2-(phenylcarbamoyl)pyrrolidine-1-carboxylate (7e)**.[62] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 241.0 mg, 83% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.47 (s, 1H), 7.51 (d, *J* = 7.7 Hz, 2H), 7.30 (s, 2H), 7.08 (s, 1H), 4.47 (s, 1H), 3.39 (d, *J* = 26.7 Hz, 2H), 2.55 (s, 1H), 2.04-1.72 (m, 3H), 1.49 (s, 9H). $[\alpha]_D^{25}$ = -136.0 (c = 0.10, $CHCl_3$). 95% ee was determined by chiral HPLC (chiralcel OD-H, n-hexane/2-propanol = 90/10, 1.0 mL/min, 254 nm). t_R = 5.31 min. (minor) and 6.49 min. (major). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

Ethyl (tert-butoxycarbonyl)glycyl-L-phenylalaninate (7f).[63] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Colorless oil, 301.4 mg, 86% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.25 (d, *J* = 7.4 Hz, 2H), 7.21 (t, *J* = 7.2

Hz, 1H), 7.10 (d, *J* = 6.9 Hz, 2H), 6.68 (s, 1H), 5.25 (s, 1H), 4.83 (dd, *J* = 13.6, 6.1 Hz, 1H), 4.13 (dd, *J* = 14.6, 7.4 Hz, 2H), 3.81-3.70 (m, 2H), 3.09 (t, *J* = 5.3 Hz, 2H), 1.42 (s, 9H), 1.20 (t, *J* = 7.2 Hz, 3H). $[\alpha]_D^{25}$ = -14.7 (c = 0.10, MeOH). >99% ee was determined by chiral HPLC (chiralcel IC, n-hexane/2-propanol = 80/20, 1.0 mL/min, 254 nm). t_R = 8.96 min (major) and 13.58 min (minor). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

Methyl benzoylglycinate (7g).[64] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 162.3 mg, 84% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.80 (d, *J* = 7.2 Hz, 2H), 7.50 (t, *J* = 7.4 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 6.82 (s, 1H), 4.23 (d, *J* = 5.1 Hz, 2H), 3.78 (s, 3H).

***Tert*-butyl (2-oxo-2-(phenylamino)ethyl)carbamate (7h)**.[65] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 247.8 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.55 (s, 1H), 7.50 (d, *J* = 7.8 Hz, 2H), 7.29 (t, *J* = 7.9 Hz, 2H), 7.09 (t, *J* = 7.4 Hz, 1H), 5.59 (t, *J* = 5.3 Hz, 1H), 3.94 (d, *J* = 4.0 Hz, 2H), 1.46 (s, 9H).

***Tert*-butyl-(3-(1H-indol-3-yl)-1-oxo-1-(phenylamino)propan-2-yl)carbamate (7i)**.[62] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 322.6 mg, 85% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.30 (s, 1H), 7.95 (s, 1H), 7.67 (d, *J* = 7.8 Hz, 1H), 7.34 (d, *J* = 8.1 Hz, 1H), 7.28 (d, *J* = 7.8 Hz, 2H), 7.23 (t, *J* = 7.7 Hz, 2H), 7.19 (t, *J* = 7.6 Hz, 1H), 7.10 (t, *J* = 7.5 Hz, 1H), 7.06 (t, *J* = 7.2 Hz, 1H), 6.98 (s, 1H), 5.39 (s, 1H), 4.63 (s, 1H), 3.30 (d, *J* = 31.0 Hz, 2H), 1.42 (s, 9H). $[\alpha]_D^{25}$ = -26.3 (c = 0.10, $CHCl_3$). 68% ee was determined by chiral HPLC (chiralcel IA, n-hexane/2-propanol = 80/20, 1.0 mL/min, 254 nm). t_R = 8.98 min (major) and 14.90 min (minor). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

***Tert*-butyl-(3-(4-hydroxyphenyl)-1-oxo-1-(phenylamino) propan -2-yl)carbamate (7j)**.[62] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 352.9 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.31 (s, 1H), 7.39 (d, *J* = 7.4 Hz, 2H), 7.35 (d, *J* = 8.4 Hz, 2H), 7.31-7.26 (m, 2H), 7.23 (d, *J* = 8.5 Hz, 2H), 7.11 (d, *J* = 7.2 Hz, 1H), 5.40 (d, *J* = 8.0 Hz, 1H), 4.57 (s, 1H), 3.29-3.16 (m, 1H), 3.08 (dd, *J* = 13.6, 7.1 Hz, 1H), 1.39 (s, 9H). $[\alpha]_D^{25}$ = -61.4 (c = 0.10, $CHCl_3$). 60% ee was determined by chiral HPLC (chiralcel IA, n-hexane/2-propanol = 80/20, 1.0 mL/min, 254 nm). t_R = 6.91 min (major) and 9.94 min (minor). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

***Tert*-butyl-(1-oxo-1-(phenylamino)propan-2-yl)carbamate (7k)**.[62] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 259.0 mg, 98% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.75 (s, 1H), 7.50 (d, *J* = 7.9 Hz, 2H), 7.29 (t, *J* = 8.1 Hz, 1H), 7.25 (d, *J* = 7.6 Hz, 1H), 7.10-7.04 (m, 1H), 5.41 (d, *J* = 5.2 Hz, 1H), 4.40 (s, 1H), 1.45 (s, 9H), 1.43 (d, *J* = 7.1 Hz, 3H). $[\alpha]_D^{25}$ = +12.6 (c = 0.10, MeOH). 50% ee was determined by chiral HPLC (chiralcel IA, n-hexane/2-propanol = 80/20, 1.0 mL/min, 254 nm). t_R = 5.62 min (minor) and 6.32 min (major). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

***Tert*-butyl-(4-methyl-1-oxo-1-(phenylamino)pentan-2-yl)carbamate (7l)**.[62] Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. White solid, 281.9 mg, 92% yield. ^{1}H NMR (500 MHz, DMSO-d6) δ 9.92 (s, 1H), 7.60 (d, *J* = 7.8 Hz, 2H), 7.29 (t, *J* = 7.9 Hz, 2H), 7.03 (t, *J* = 7.4 Hz, 1H), 6.99 (d, *J* = 8.0 Hz, 1H), 4.13 (dd, *J* = 13.7, 9.0 Hz, 1H), 1.67-1.62 (m, 1H), 1.56-1.50 (m, 1H), 1.44 (dd, *J* = 8.3, 5.6 Hz, 1H), 1.38 (s, 9H), 0.89 (dd, *J* = 6.3, 4.2 Hz, 6H). $[\alpha]_D^{25}$ = +36.6 (c = 0.10, MeOH). 50% ee was determined by chiral HPLC (chiralcel IA, n-hexane/2-propanol = 80/20, 1.0 mL/min, 254 nm). t_R = 4.65 min (minor) and 5.66 min (major). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

***Tert*-butyl-(4-(methylthio)-1-oxo-1-(phenylamino)butan-2-yl)carbamate (7m)**. [62] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. White solid, 269.3 mg, 83% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.63 (s, 1H), 7.50 (d, *J* = 7.9 Hz, 2H), 7.29 (t, *J* = 6.5 Hz, 2H), 7.08 (t, *J* = 7.4 Hz, 1H), 5.50 (d, *J* = 0.5 Hz, 1H), 4.47 (s, 1H), 2.61 (dd, *J* = 12.4, 6.6 Hz, 2H), 2.18 (td, *J* = 13.5, 6.7 Hz, 1H), 2.10 (s, 3H), 2.01 (dd, *J* = 14.3, 7.0 Hz, 1H), 1.44 (s, 9H). $[\alpha]_D^{25}$ = -5.9 (c = 0.10, MeOH). 64% ee was determined by chiral HPLC (chiralcel IA, n-hexane/2-propanol = 90/10, 1.0 mL/min, 254 nm). t_R = 10.97 min (major) and 12.17 min (minor). Authentic samples were independently prepared from L- and D-amino acids and their mixture was used as reference racemate.

***Tert*-butyl-2-((2-methoxy-2-oxoethyl)carbamoyl)pyrrolidine-1-carboxylate (7n)**.[66] Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. Colorless oil, 171.8 mg, 60% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 5.05 (dt, *J* = 8.2, 3.9 Hz, 1H), 4.70 (dd, *J* = 51.9, 17.7 Hz, 1H), 4.44 (dd, *J* = 38.3, 17.7 Hz, 1H), 3.79 (s, 3H), 3.64-3.53 (m, 1H), 3.50-3.39 (m, 1H), 2.43-1.88 (m, 5H), 1.40 (s, 9H).

Ethyl (*tert*-butoxycarbonyl)glycyl-valinate (7o). Petroleum ether / ethyl acetate = 3 : 1 (v /v) as eluent for column chromatography. Colorless oil, 281.2 mg, 93% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.80 (s, 1H), 5.42 (s, 1H), 4.48 (s, 1H), 4.15 (t, *J* = 6.7 Hz, 2H), 3.79 (qd, *J* = 16.4, 4.6 Hz, 2H), 2.13 (dq, *J* = 13.4, 6.7 Hz, 1H), 1.41 (s, 9H), 1.23 (t, *J* = 7.1 Hz, 3H), 0.90 (d, *J* = 6.8 Hz, 3H), 0.86 (d, *J* = 6.9 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.7 (s), 169.4 (s), 156.1 (s), 80.3 (s), 61.2 (s), 57.0 (s), 44.5 (s), 31.3 (s), 28.3 (s), 18.9 (s), 14.2 (s). HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{14}H_{27}N_2O_5$: 303.1914; found: 303.1917.

Ethyl (*tert*-butoxycarbonyl)-tryptophyl-phenylalaninate (7p). Petroleum ether / ethyl acetate = 2 : 1 (v /v) as eluent for column chromatography. Pale yellow solid, 335.7 mg, 70% yield. Mp 105-107 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.25 (s, 1H), 7.66 (d, *J* = 7.9 Hz, 1H), 7.34 (d, *J* = 8.1 Hz, 1H), 7.22-7.09 (m, 5H), 7.01 (s, 1H), 6.85 (d, *J* = 6.9 Hz, 2H), 6.27 (s, 1H), 5.14 (s, 1H), 4.71 (s, 1H), 4.45 (s, 1H), 4.06 (t, *J* = 6.1 Hz, 2H), 3.29 (s, 1H), 3.15 (dd, *J* = 14.5, 7.0 Hz, 1H), 2.95 (d, *J* = 5.9 Hz, 2H), 1.42 (s, 9H), 1.17 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.5 (s), 171.2 (s), 170.9 (s), 155.4 (s), 136.3 (s), 135.8 (s), 129.3 (s), 128.4 (s), 127.5 (s), 126.9 (s), 123.3 (s), 122.3 (s), 119.8 (s), 118.9 (s), 111.2 (s), 110.6 (s), 80.1 (s), 61.4 (s), 55.2 (s), 53.3 (s), 38.0 (s), 28.3 (s), 14.0 (s). HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{27}H_{34}N_3O_5$: 480.2493; found: 480.2490.

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4-((3Z,5E)-3,5-bis(6-oxocyclohexa-2,4-dien-1-ylidene)-1,2,4-triazolidin-1-yl)-N-phenylbenzamide (9). White solid, 439.53 mg, 98% yield. ^{1}H NMR (500 MHz, DMSO-d6) δ 10.38 (s, 1H), 8.08-8.06 (m, 3H), 7.84-7.65 (m, 8H), 7.60 (d, *J* = 8.5 Hz, 1H), 7.55 (d, *J* = 8.5 Hz, 1H), 7.40 (t, *J* = 8.4 Hz, 1H), 7.36 (t, *J* = 7.8 Hz, 2H), 7.12 (t, *J* = 7.3 Hz, 1H), 7.05 (t, *J* = 8.7 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-d6) δ 164.7 (s), 160.9 (s), 158.1 (s), 156.7 (s), 149.8 (s), 148.8 (s), 147.1 (s), 139.5 (s), 139.3 (s), 136.0 (s), 134.3 (s), 133.3 (s), 132.3 (s), 131.0 (s), 130.3 (s), 129.6 (s), 129.1 (s), 127.7 (s), 124.9 (s), 124.4 (s), 124.2 (s), 123.1 (s), 123.0 (s), 121.0 (s), 120.3 (s), 117.7 (s), 114.0 (s). Mp 94-95 °C. HRMS ESI (m/z): $[M+H]^+$ calcd for $C_{27}H_{21}N_4O_3$: 449.1608; found: 449.1610.

(*S*)-2-(4-isobutylphenyl)-*N*-phenylpropanamide (11).[67] White solid, 278.6 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41 (d, *J* = 7.9 Hz, 2H), 7.28-7.25 (m, 4H), 7.16 (d, *J* = 7.9 Hz, 2H), 7.10 (s, 1H), 7.06 (t, *J* = 7.4 Hz, 1H), 3.70 (q, *J* = 7.1 Hz, 1H), 2.48 (d, *J* = 7.2 Hz, 2H), 1.87 (dp, *J* = 13.5, 6.7 Hz, 1H), 1.59 (d, *J* = 7.2 Hz, 3H), 0.92 (d, *J* = 6.6 Hz, 6H). $[\alpha]_D^{25}$ = +59.1 (c = 0.10, CH_2Cl_2).

2-Chloro-N-(4'-chloro-[1,1'-biphenyl]-2-yl)nicotinamide (14).[31] White solid, 298.6 mg, 87% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.43 (dd, *J* = 4.7, 1.9 Hz, 1H), 8.40 (d, *J* = 8.2 Hz, 1H), 8.15 (s, 1H), 8.13 (dd, *J* = 7.7, 1.8 Hz, 1H), 7.45-7.41 (m, 3H), 7.36-7.32 (m, 3H), 7.26 (d, *J* = 4.2 Hz, 2H).

***N*-(3,5-dimethylphenyl)-2-(4-hydroxyphenyl)acetamide (17)**.[68] White solid, 252.8 mg, 99% yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (d, *J* = 8.6 Hz, 2H), 7.34 (d, *J* = 8.5 Hz, 2H), 7.16 (s, 1H), 7.09 (s, 2H), 6.76 (s, 1H), 3.71 (s, 2H), 2.27 (s, 6H).

Conflicts of interest

There are no conflicts to declare.

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