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PAPER

Selective synthesis of poly-substituted fluorine-containing pyridines and dihydropyrimidines *via* cascade C–F bond cleavage protocol†

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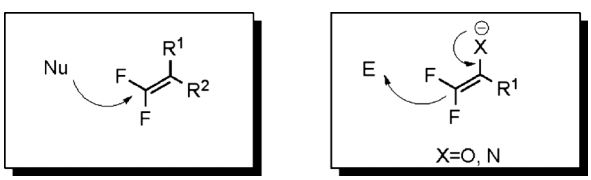
Fluorinated azaheterocycles are frequently found in pharmaceuticals, drug candidates, ligands for transition metal catalysts, and other molecular functional materials, so efficient methods for the synthesis of these compounds are of significant value. We herein describe a selective strategy for the synthesis of poly-substituted pyridines and fluoroalkyl dihydropyrimidines based on C–F bond breaking of the anionically activated fluoroalkyl group. An array of pyridines and dihydropyrimidines were prepared through this domino process in high yields under noble metal catalyst-free conditions, making this method a valuable supplement to azaheterocycle synthesis.

Introduction

Nitrogen-containing heterocycles, such as pyridines and pyrimidines,[1] frequently show up as substructures in lots of natural products, biologically relevant compounds and ligands of transition metal catalysis. Therefore, there has been much interest in the development of new methods for the synthesis of these types of cyclic subunits.

It is well known that the incorporation of fluorine or fluorine-containing groups into an organic molecule often drastically alters its chemical, pharmacological and biological properties,[2] and many organofluorine compounds exhibit unique properties in life science and materials science-related applications. The rationale behind fluorine substitution has been discussed extensively in the literature.[3] Studies suggest that the van der Waals radius of fluorine (1.47 Å) is between that of oxygen (1.52 Å) and hydrogen (1.2 Å), and thus fluorine appears to have a particularly close isosteric relationship to oxygen, and is the smallest substituent to replace hydrogen in C–H bonds.[4] The high electronegativity of fluorine has been commonly used in many ways to develop enzyme inhibitors or to induce resistance to chemical degradation,[5] because the fluorine substitutions of the natural compounds are generally recognized by macromolecular recognition sites. Similarly, the CF_2H moiety is known to be isosteric and isopolar with a carbinol (CH_2OH) unit and can also act as a more lipophilic hydrogen bond donor (rather than typical donors such as OH and NH),[6] which makes it a property imparting building block in the designing of bioactive molecules.

In general, it is hard to cleave a C–F bond due to its large bond energy (*ca.* 552 kJ mol^{-1}). However, reports published recently showed that C–F bond cleavage easily occurs when the CF_3 group is attached to a π-electron system, because of electron pair acceptance into the π-system and subsequent extrusion of a fluoride ion providing the driving force.[7] The formed intermediary *gem*-difluorovinyl can react with various nucleophiles,[8] or react with electrophiles when it is attached to an anion,[9] leading to various difluoromethylene building blocks (Scheme 1). This methodology has great utility in the synthesis fluorine-containing compounds,[10] which provides us an opportunity to synthesize some nonfluorinated products or partially fluorinated compounds.[11]



Scheme 1 Nucleophilic or electrophilic attack of *gem*-difluorovinyl substrates.

On the other hand, domino reactions have recently attracted considerable attention due to their high efficiency in constructing complex molecular architectures from readily available building blocks.[12] Multiple new bonds are formed in a single step under identical reaction conditions minimizing requisite reagents, separation processes, waste, energy, time, and cost. Hence, developing new domino processes with high efficiency is of great significance to the synthetic community. Despite significant efforts being devoted to azaheterocycles preparation,[13] certain lines of fluorinated

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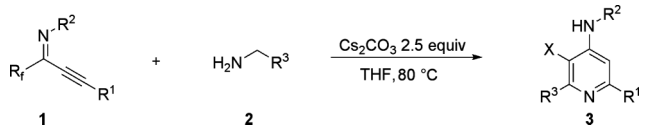
Table 1 Synthesis of various pyridines[a]



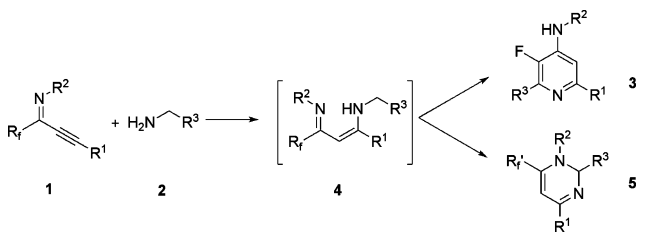
1 2 3

Entry	R_f	R^1	R^2	R^3	X	Product	Yield[b] (%)
1	CF_3	Ph	Ph	Ph	F	**3a**	98
2	CF_3	4-MeC_6H_4	Ph	Ph	F	**3b**	99
3	CF_3	4-FC_6H_4	Ph	Ph	F	**3c**	84
4	CF_3	*n*-Butyl	Ph	Ph	F	**3d**	59
5	CF_3	COOMe	Ph	Ph	F	**3e**	60
6	CF_3	Ph	4-$MeOC_6H_4$	Ph	F	**3f**	97
7	CF_3	Ph	4-CNC_6H_4	Ph	F	**3g**	96
8	CF_3	Ph	Ph	4-MeC_6H_4	F	**3h**	98
9	CF_3	Ph	Ph	2-MeC_6H_4	F	**3i**	89
10	CF_3	Ph	Ph	4-ClC_6H_4	F	**3j**	85
11	CF_3	Ph	Ph	2-$CF_3C_6H_4$	F	**3k**	50
12	CF_3	Ph	Ph	2-Thienyl	F	**3l**	96
13	CF_3	Ph	Ph	2-Pyridyl	F	**3m**	62
14	CF_2Br	Ph	Ph	Ph	F	**3a**	80
15	CF_2Cl	Ph	Ph	Ph	F	**3a**	64
16	CF_2H	Ph	Ph	Ph	H	**3n**	80
17	CF_3CF_2	Ph	Ph	Ph	CF_3	**3o**	74
18	CF_3CF_2	4-BrC_6H_4	Ph	Ph	CF_3	**3p**	82
19	CF_3CF_2	3-$MeOC_6H_4$	Ph	Ph	CF_3	**3q**	69
20	CF_3CF_2	2-Naphthyl	Ph	Ph	CF_3	**3r**	70
21	CF_3CF_2	Ph	Ph	4-MeC_6H_4	CF_3	**3s**	65
22	CF_3CF_2	Ph	Ph	4-ClC_6H_4	CF_3	**3t**	65
23	CF_3CF_2	Ph	Ph	2-Thienyl	CF_3	**3u**	92
24	CF_3CF_2 CF_2	Ph	Ph	Ph	CF_3CF_2	**3v**	60

[a] Reactions were carried out on a 0.4 mmol scale in THF (2 mL) with **2a** (3.0 equiv.) and base (2.5 equiv.) at 80 °C unless otherwise stated. [b] Isolated yields.

heterocycles are still in need of effective synthetic methods,[14] especially domino based ones.

As part of our ongoing program on the synthesis of fluorine-containing heterocycles,[15] we have reported several efficient methods for the synthesis of fluorinated indoles, quinolines, benzothiazoles and benzimidazoles. Very recently, we communicated a new cascade process for the synthesis of an array of fluoro-substituted pyridines.[16] By reacting fluoroalkyl alkynylimines **1** with primary amines **2** we obtained intermediary **4** which underwent one-pot fluorine elimination and nucleophilic cyclization in the presence of a base affording the desired pyridines **3** in high yields (Scheme 2), and two dihydropyrimidine compounds **5** were also obtained through an unexpected pathway during the previous investigations. Herein, we wish to report a detailed investigation of the scope and limitations of this chemoselective process.



1 2 4 3 5

Scheme 2 Chemoselective synthesis of fluorinated azines.

Results and discussion

The starting fluoroalkyl alkynylimines **1** were prepared from the CuI-catalyzed coupling of terminal alkynes with fluoroalkylimidoyl chlorides in high yields,[15a] and primary amines **2** were all commercially available.

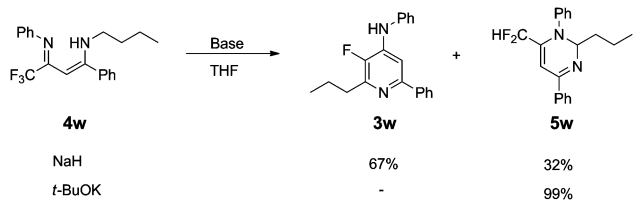
Synthesis of 3-F, 3-CF_3, 3-H pyridines

As we previously communicated, the optimal reaction conditions for pyridine synthesis were using alkynylimines and amine (3 equiv.) in THF at 80 °C, with 2.5 equiv. of Cs_2CO_3 as the base.

We examined the generality of the reaction. All alkynylimine substrates with various alkynyl moieties and *N*-aryl groups could provide the target molecules in moderate to good yields (Table 1, entries 1–7). When a hexyne group is attached, a longer reaction time (24 h) was required with reduced yield (Table 1, entry 4). An ester group also afforded the desired products in moderate yield (Table 1, entry 5). A variety of substituted benzylamines and hetarylmethylamines tested revealed that the reactivity was induced by electronic effects. Amines with electron-donating groups gave good yields (Table 1, entries 8–9), while electron-withdrawing groups slightly less (Table 1, entries 10–11). Alkynylimines containing CF_2Br and CF_2Cl groups were also examined; the corresponding product was formed in acceptable yield (Table 1, entries 14–15). Interestingly, when CF_2H and CF_3CF_2 substrates were examined, 3-H pyridine and 3-trifluoromethyl

pyridine were obtained, respectively, in favorable yields (Table 1, entries 16–17). Then we synthesized a series of 3-CF_3 pyridines through this process, and yields for all the substrates tested were moderate to good (Table 1, entries 18–23). Alkynylimine with a perfluoropropyl group also gave an acceptable yield (Table 1, entry 24).

Next, we sought to investigate the possibility of the process with an alkyl amine; when the reaction of **1a** with n-butylamine was examined, the cyclization process did not occur, providing **4w** as a sole product in quantitative yield. Obviously, a stronger base is needed to deprotonate the α-H of the n-butyl group; indeed, pyridine **3w** was formed when NaH was used as the base (Scheme 3). However, a byproduct dihydropyrimidine **5w** was isolated in 32% yield in addition to the desired compound, while use of a soluble base *t*-BuOK yield **5w** as the sole product. Attempts to improve the yield for **3w** using LDA, LiHMDS and n-butyllithium as the base were unsuccessful, suggesting that **4w** was inert to them. Then we went back to study the cyclization reaction of **4a** under the above conditions. Amazingly, cyclization of **4a** at room temperature also gave a mixture of **3a** and **5a** in a different ratio as expected (confirmed by crystal diffraction).



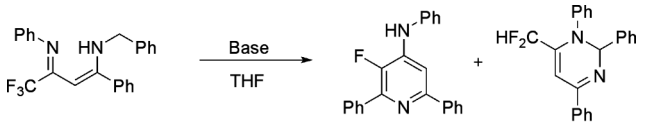
Scheme 3 Base-controlled cyclization reaction.

Synthesis of fluoroalkyl dihydropyrimidines

The previous results encouraged us to investigate the chemoselective synthesis of this dihydropyrimidine product. After optimization (Table 2), a stepwise procedure was established as the starting material is sensitive to stronger bases. The first step is the hydroamination of alkynylimines in THF at 80 °C. After the completion of the hydroamination as indicated on TLC, the reaction mixture was cooled down to –40 °C, then *t*-BuOK was added, to give the dihydropyrimidines immediately.

The scope of this reaction pathway was also explored. Substrates formerly used for the synthesis of pyridines gave the dihydropyrimidine products in good to excellent yields. As shown in Table 3, most of the alkynylimines could give the desired products with high yields (Table 3, entries 2–7). Remarkably, a CH_2F- dihydropyrimidine was also obtained, although with a moderate yield (Table 3, entry 1). However, the alkynyl moiety with an n-butyl group was not an ideal candidate (Table 2, substrate in entry 4), as there are two hydrogens sensitive to the base in the intermediate, complicating the reaction. The result for alkynylimine with an acetylenecarboxylate group was disappointing as well (Table 2, substrate in entry 5). Compared with the electron-rich amines, the amines with electron-withdrawing groups consistently gave reduced yields (Table 3, entries 8–12). As expected, various hetarylmethylamines also afforded the products in 70–92% yields (Table 3, entries 13–15). In most cases, dihydropyrimidine was the

Table 2 Optimization for dihydropyrimidine synthesis[a]

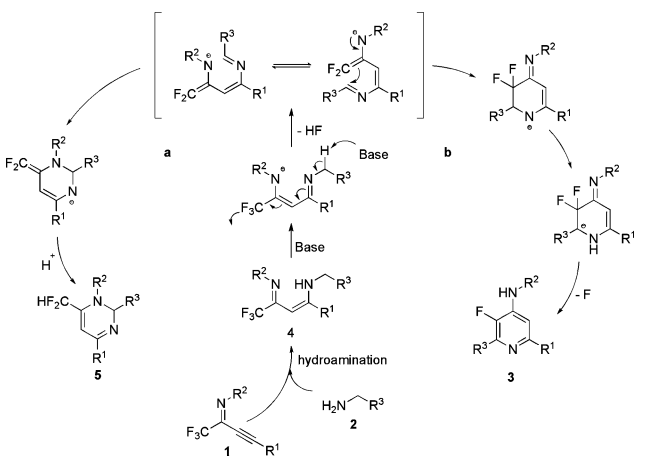


Entry	Base	*T*/°C	Time/min	Yield (%)[b] 3	5
1	*t*-BuOK	80	<1	**3a**/47	**5a**/53
2	*t*-BuOK	rt	<1	**3a**/33	**5a**/66
3	*t*-BuOK	–20	<1	**3a**/15	**5a**/85
4	*t*-BuOK	–40	5	0	**5a**/98
5	*t*-BuONa	–40	10	0	**5a**/98

[a] Reactions were carried out on a 0.4 mmol scale in THF (2 mL) with base (2.0 equiv.) unless otherwise stated. [b] Isolated yields.

only detectable product as seen on the crude ^{19}F NMR spectrum, indicating the good selectivity of this process.

A possible mechanism of this transformation is suggested in Scheme 4. After hydroamination of alkynylimine with amine forming the intermediate vinylogous amidine **4**, the deprotonation and dehydrofluorination process occurs generating an anion and an imine coexisting in one molecule. When the reaction is carried out at a low temperature with a soluble base (path a), the *in situ* generated amide nucleophilic attacks the imine immediately without isomerization to form dihydropyrimidine through a kinetically controlled pathway. However, carbon nucleophilic addition becomes an option when the reaction temperature rises (path b), providing a 1,2-dihydropyridine ring under thermodynamic control, and the subsequent proton migration, β-F elimination and final aromatization to form the pyridine ring also provides a driving force. Meanwhile, an insoluble base can effectively inhibit the kinetic pathway.

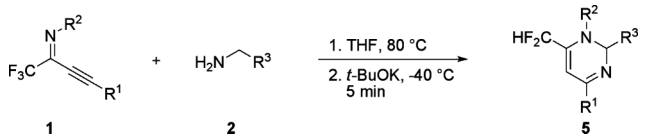


Scheme 4 Proposed mechanism.

Conclusion

In conclusion, we have synthesized a series fluorine-containing azaheterocycles through a selective domino process based on anionic C–F bond cleavage. A lot of products with one or

Table 3 Synthesis of various dihydropyrimidines[a]



1 2 5

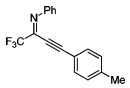
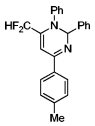
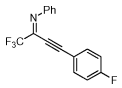
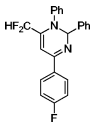
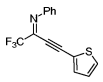
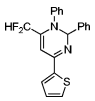
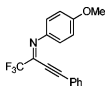
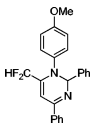
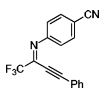
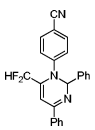
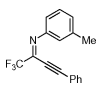
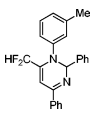
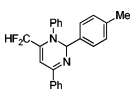
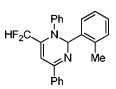
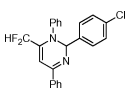
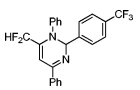
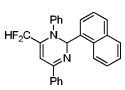
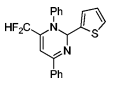
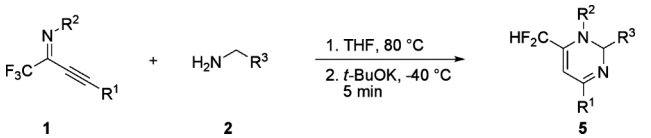
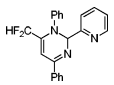
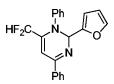
Entry	1	2	Product	Yield (%)[b]
1				(**5b**) 67
2				(**5c**) 97
3				(**5d**) 92
4				(**5e**) 88
5				(**5f**) 96
6				(**5g**) 93
7				(**5h**) 98
8	**1a**			(**5i**) 94
9				(**5j**) 97
10				(**5k**) 89
11				(**5l**) 74
12				(**5m**) 89
13				(**5n**) 87

Table 3 *(Contd.)*

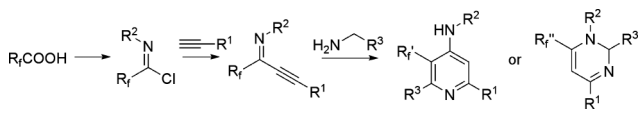


1 2 5

Entry	1	2	Product	Yield (%)[b]
14				(**5o**) 70
15				(**5p**) 92
16				(**5q**) 99[c]

[a] Reactions were carried out on a 0.3 mmol scale in THF (2 mL) with amines (2.0 equiv.) and base (2.0 equiv.) unless otherwise stated. [b] Isolated yields. [c] The second step of the reaction was conducted at rt.

two fluorine atoms were formed in good yields from easily accessible trifluoromethyl-containing materials. Substrates with various substituents can be tolerated in this reaction, which can be introduced stepwise from initial fluoroalkyl acids in high yields (Scheme 5).[15a,17] Further investigations of the intermolecular *gem*-difluoromethylation based on this strategy are currently underway in our laboratory.



Scheme 5 Stepwise synthesis of fluorinated azines.

Experimental section

General experimental

Melting points were measured on a Melt-Temp apparatus and are uncorrected. ^{1}H NMR spectra were recorded in $CDCl_3$ and d-DMSO on a Bruker AM-300 spectrometer (300 MHz) with TMS as internal standard. ^{19}F NMR spectra were taken on a Bruker AM-300 (282 MHz) spectrometer using $CFCl_3$ as external standard. ^{13}C NMR spectra were taken on a Bruker AM-400 (100 MHz) spectrometer. IR spectra were obtained with a Nicolet AV-360 spectrophotometer. Elemental analysis was performed by the Analytical Laboratory of Shanghai Institute of Organic Chemistry. Mass spectra were recorded by EI and ESI methods, HRMS (ESI) was measured on Bruker Daltonics APEXIII 7.0 TESLA FTMS. Solvents and reagents were purchased from commercial sources and used as received. All reactions were monitored by TLC with silica gel coated plates. Flash column chromatography was carried out using 300–400 mesh silica gel at increased pressure and petroleum ether/ethyl acetate combination was used as the eluent.

Representative procedure for pyridine 3 synthesis

Alkynylimine **1** (0.4 mmol) was added to a solution of amines **2** (3 equiv.), Cs_2CO_3 (2.5 equiv.) in THF (2.0 mL). The solution was then stirred at 80 °C. After completion of reaction as indicated by TLC, the reaction crude was filtered and the filtrate evaporated. The residue was purified by flash chromatography on silica gel to provide the desired product **3**.

3-Fluoro-*N*,2,6-triphenylpyridin-4-amine (3a)

White solid, mp 127–129 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.02 (d, J = 7.1 Hz, 2H), 7.95 (d, J = 7.6 Hz, 2H), 7.56–7.14 (m, 12H), 6.34 (d, J = 3.3 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –152.37; ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.3 (d, J = 5.9 Hz), 146.9 (d, J = 253.1 Hz), 144.0 (d, J = 8.1 Hz), 140.6 (d, J = 10.2 Hz), 139.5, 139.2, 136.0 (d, J = 5.1 Hz), 129.8, 129.0, 129.0 (d, J = 5.9 Hz), 128.7, 128.6, 128.4, 127.0, 124.7, 122.2, 104.3; LRMS (EI) m/z (relative intensity) 340 (99) [M$^+$], 39 (100); Anal. Calcd. for $C_{23}H_{17}FN_2$: C, 81.16; H, 5.03; N, 8.23. Found: C, 80.89; H, 5.14; N, 8.15. IR(KBr): 3409, 3060, 1610, 1595, 1579, 1514, 1498, 1466, 1409, 1242, 694 cm^{-1}.

3-Fluoro-*N*,2-diphenyl-6-*p*-tolylpyridin-4-amine (3b)

White solid, mp 166–168 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.08 (d, J = 7.6 Hz, 2H), 7.84 (d, J = 7.9 Hz, 2H), 7.58–7.12 (m, 11H), 6.32 (d, J = 3.0 Hz, 1H), 2.37 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –152.69; ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.3 (d, J = 5.8 Hz), 146.8 (d, J = 252.3 Hz), 143.9 (d, J = 8.8 Hz), 140.5 (d, J = 11.0 Hz), 139.3, 138.6, 136.7, 136.1 (d, J = 5.1 Hz), 129.8, 129.3, 129.0 (d, J = 5.8 Hz), 129.0, 128.4, 126.8, 124.5, 122.1, 104.0, 21.3; LRMS-ESI (m/z): $C_{24}H_{20}FN_2$ [M + H]$^+$ calcd 355.2; found 355.0; Anal. Calcd. for $C_{24}H_{19}FN_2$: C, 81.33; H, 5.40; N, 7.90. Found: C, 81.61; H, 5.36; N, 7.85. IR(KBr): 3420, 1610, 1593, 1573, 1510, 1466, 1242, 1207, 817, 697 cm^{-1}.

3-Fluoro-6-(4-fluorophenyl)-*N*,2-diphenylpyridin-4-amine (3c)

White solid, mp 154–156 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.06 (d, J = 7.3 Hz, 2H), 7.92 (dd, J = 8.5 Hz, J = 5.5 Hz, 2H); 7.56–7.03 (m, 11H), 6.34 (d, J = 3.5 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –113.91—114.13 (m, 1F), –152.47 (s, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.4 (d, J = 247.9 Hz), 152.2 (d, J = 5.1 Hz), 146.8 (d, J = 253.1 Hz), 144.0 (d, J = 8.8 Hz), 140.7 (d, J = 11.0 Hz), 139.1, 135.9 (d, J = 5.1 Hz), 135.6 (d, J = 2.9 Hz), 129.8, 129.1, 129.0 (d, J = 5.9 Hz), 128.7 (d, J = 8.1 Hz), 128.4, 124.8, 122.3, 115.4 (d, J = 22.0 Hz), 103.8; LRMS (EI) m/z (relative intensity) 358 (100) [M$^+$], 359 (24), 357 (95); Anal. Calcd. for $C_{23}H_{16}F_2N_2$: C, 77.08; H, 4.50; N, 7.82. Found: C, 77.24; H, 4.66; N, 7.75. IR(KBr): 3409, 1612, 1585, 1508, 1465, 1444, 1398, 1221, 1205, 827, 754, 701 cm^{-1}.

6-Butyl-3-fluoro-*N*,2-diphenylpyridin-4-amine (3d)

White solid, mp 79–80 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.92 (d, J = 7.0 Hz, 2H), 7.52–7.35 (m, 5H), 7.29–7.12 (m, 3H), 6.92 (d, J = 5.9 Hz, 1H), 6.27 (d, J = 2.1 Hz, 1H), 2.68 (t, J = 7.7 Hz, 2H), 1.76–1.62 (m, 2H), 1.46–1.31 (m, 2H), 0.93 (t, J = 7.3 Hz, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –154.47; ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.4 (d, J = 6.6 Hz), 145.9 (d, J = 249.4 Hz), 143.8 (d, J = 8.8 Hz), 139.9 (d, J = 10.2 Hz), 139.4, 136.1 (d, J = 5.2 Hz), 129.7, 128.9 (d, J = 5.1 Hz), 128.7, 128.3, 124.3, 121.9, 106.0, 38.1, 32.1, 22.5, 14.0; LRMS (EI) m/z (relative intensity) 320 (4) [M$^+$], 305 (9), 291 (14), 278 (100); Anal. Calcd. for $C_{21}H_{21}FN_2$: C, 78.72; H, 6.61; N, 8.74. Found: C, 79.13; H, 6.89; N, 8.72. IR(KBr): 3227, 2954, 2866, 1610, 1589, 1517, 1490, 1442, 1222, 1017, 698 cm^{-1}.

Methyl-5-fluoro-6-phenyl-4-(phenylamino)picolinate (3e)

Light green solid, mp 213–214 °C; ^{1}H NMR (300 MHz, d-DMSO) δ 9.05 (br, 1H), 7.85 (d, 2H), 7.65 (d, 1H), 7.57–7.25 (m, 7H), 7.17 (t, 1H), 3.80 (s, 3H); ^{19}F NMR (282 MHz, d-DMSO) δ –141.25; ^{13}C NMR (100 MHz, d-DMSO) δ 165.4, 148.4 (d, J = 258.9 Hz), 144.8 (d, J = 10.3 Hz), 144.1 (d, J = 4.4 Hz), 141.5 (d, J = 11.8 Hz), 139.8, 135.3 (d, J = 4.4 Hz), 130.0, 129.8, 129.2 (d, J = 5.9 Hz), 128.9, 124.9, 122.9, 109.7, 52.9; HRMS-ESI (m/z): $C_{19}H_{16}FN_2O_2$ [M + H]$^+$ calcd 323.11903; found 323.11997; IR(KBr): 3314, 3058, 2949, 1703, 1614, 1597, 1587, 1524, 1494, 1445, 1424, 1376, 1298, 1238, 1121, 1015, 696 cm^{-1}.

3-Fluoro-*N*-(4-methoxyphenyl)-2,6-diphenylpyridin-4-amine (3f)

Yellow solid, mp 110–112 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.08 (d, J = 7.9 Hz, 2H), 7.92 (d, J = 6.7 Hz, 2H), 7.57–7.29 (m, 6H), 7.27–7.18 (m, 3H), 6.95 (d, J = 8.8 Hz, 2H), 6.18 (d, J = 3.5 Hz, 1H), 3.83 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –153.53; ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.4, 153.2 (d, J = 5.1 Hz), 146.6 (d, J = 251.6 Hz), 143.6 (d, J = 8.8 Hz), 142.0 (d, J = 11.0 Hz), 139.6, 136.2 (d, J = 5.2 Hz), 131.7, 129.0 (d, J = 5.9 Hz), 128.9, 128.6, 128.5, 128.3, 126.9, 125.6, 115.0, 103.7, 55.6; LRMS-ESI (m/z): $C_{24}H_{20}FN_2O$ [M + H]$^+$ calcd 371.2; found 371.1; Anal. Calcd. for $C_{24}H_{19}FN_2O$: C, 77.82; H, 5.17; N, 7.56. Found: C, 78.22; H, 5.20; N, 7.50. IR(KBr): 3413, 3035, 2951, 2835, 1606, 1578, 1515, 1500, 1434, 1240, 1033, 831, 770, 735, 691 cm^{-1}.

4-(3-Fluoro-2,6-diphenylpyridin-4-ylamino)benzonitrile (3g)

Yellow solid, mp 199–201 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.07 (d, J = 7.9 Hz, 2H), 7.97 (d, J = 6.8 Hz, 2H), 7.70–7.57 (m, 3H), 7.56–7.26 (m, 8H), 6.61 (d, J = 2.9 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –149.15; ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.4 (d, J = 5.9 Hz), 147.4 (d, J = 254.5 Hz), 144.9 (d, J = 9.5 Hz), 144.1, 138.8, 138.0 (d, J = 11.1 Hz). 135.5 (d, J = 5.1 Hz), 134.0, 129.4, 129.1, 129.0 (d, J = 5.9 Hz), 128.7, 128.5, 126.9, 119.3, 118.9, 106.0, 106.0; LRMS-ESI (m/z): $C_{24}H_{17}FN_3$ [M + H]$^+$ calcd 366.1; found 366.0; Anal. Calcd. for $C_{24}H_{16}FN_3$: C, 78.89; H, 4.41; N, 11.50. Found: C, 78.88; H, 4.59; N, 11.48. IR(KBr): 3329, 3058, 2222, 1615, 1598, 1516, 1433, 1398, 1176, 956, 831, 766, 690 cm^{-1}.

3-Fluoro-*N*,6-diphenyl-2-*p*-tolylpyridin-4-amine (3h)

White solid, mp 135–137 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.05–7.90 (m, 4H), 7.52–7.10 (m, 11H), 6.31 (d, J = 6.7 Hz, 1H), 2.42 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –152.28; ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.1 (d, J = 5.1 Hz), 146.8 (d, J = 252.4 Hz), 144.0 (d, J = 8.8 Hz), 140.5 (d, J = 11.0 Hz), 139.6, 139.3, 139.0, 133.3 (d, J = 5.1 Hz), 129.8, 129.1, 128.9 (d, J = 6.6 Hz), 128.6, 128.6, 127.0, 124.6, 122.1, 104.1, 21.4; LRMS (EI) m/z (relative intensity) 354 (96) [M$^+$], 355 (24), 353 (100); Anal. Calcd. for $C_{24}H_{19}FN_2$: C, 81.33; H, 5.40; N, 7.90. Found: C, 81.03; H,

5.54; N, 7.80. IR(KBr): 3431, 1611, 1594, 1581, 1520, 1504, 1461, 1407, 1242, 828, 757, 748, 693 cm^{-1}.

3-Fluoro-*N*,6-diphenyl-2-o-tolylpyridin-4-amine (3i)

White solid, mp 129–130 °C; ^1H NMR (300 MHz, $CDCl_3$) δ 7.87 (d, J = 6.7 Hz, 2H), 7.55–7.15 (m, 13H), 6.35 (s, 1H), 2.40 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –150.56; ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.5 (d, J = 5.8 Hz), 146.3 (d, J = 13.2 Hz), 146.1 (d, J = 248.7 Hz), 140.1 (d, J = 11.0 Hz), 139.5, 139.1, 136.9, 135.5 (d, J = 2.2 Hz), 130.5, 130.0 (d, J = 2.2 Hz), 129.8, 128.8, 128.7, 128.6, 127.1, 125.7, 124.7, 122.2, 104.4, 20.0 (d, J = 2.2 Hz); HRMS-ESI (m/z): $C_{24}H_{20}FN_2$ $[M + H]^+$ calcd 355.16050; found 355.16009; IR(KBr): 3409, 3060, 1612, 1596, 1581, 1513, 1497, 1462, 1408, 1240, 750, 697 cm^{-1}.

2-(4-Chlorophenyl)-3-fluoro-*N*,6-diphenylpyridin-4-amine (3j)

White solid, mp 140–141 °C; ^1H NMR (300 MHz, $CDCl_3$) δ 8.04 (d, J = 7.0 Hz, 2H), 7.92 (d, J = 6.4 Hz, 2H), 7.55–7.16 (m, 11H), 6.33 (d, J = 3.2 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –152.06; ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.4 (d, J = 5.9 Hz), 146.8 (d, J = 253.1 Hz), 142.6 (d, J = 8.8 Hz), 140.7 (d, J = 10.3 Hz), 139.3, 139.1, 135.0, 134.5 (d, J = 5.8 Hz), 130.3 (d, J = 5.9 Hz), 129.9, 128.8, 128.6, 128.6, 126.9, 124.8, 122.3, 104.4; LRMS (EI) m/z (relative intensity) 374 (100) [M^+], 377 (7), 376 (34), 375 (51), 373 (88); Anal. Calcd. for $C_{23}H_{16}ClFN_2$: C, 73.70; H, 4.30; N, 7.47. Found: C, 73.86; H, 4.33; N, 7.32. IR(KBr): 3421, 1611, 1596, 1581, 1492, 1462, 1409, 1243, 1082, 751, 696 cm^{-1}.

3-Fluoro-*N*,6-diphenyl-2-(2-(trifluoromethyl)phenyl)pyridin-4-amine (3k)

White solid, mp 157–158 °C; ^1H NMR (300 MHz, $CDCl_3$) δ 7.89–7.77 (m, 3H), 7.68–7.15 (m, 12H), 6.33 (s, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –58.86 (s, 3F), –150.44 (s, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.6 (d, J = 5.8 Hz), 146.0 (d, J = 249.4 Hz), 144.4 (d, J = 13.2 Hz), 139.9 (d, J = 10.3 Hz), 139.4, 138.9, 134.7 (d, J = 2.2 Hz), 131.6, 131.5 (d, J = 7.3 Hz), 129.8, 129.4 (q, J = 30.8 Hz), 128.9, 128.7, 128.6, 127.1, 126.7 (q, J = 4.2 Hz), 124.9, 124.1 (q, J = 273.7 Hz), 122.3, 105.1; LRMS-ESI (m/z): $C_{24}H_{17}F_4N_2$ $[M + H]^+$ calcd 409.1; found 409.0; Anal. Calcd. for $C_{24}H_{16}F_4N_2$: C, 70.58; H, 3.95; N, 6.86. Found: C, 70.60; H, 3.91; N, 6.78. IR(KBr): 3421, 3064, 1615, 1596, 1579, 1518, 1498, 1465, 1409, 1315, 1267, 1171, 1131, 1035, 762, 697 cm^{-1}.

3-Fluoro-*N*,6-diphenyl-2-(thiophen-2-yl)pyridin-4-amine (3l)

White solid, mp 108–110 °C; ^1H NMR (300 MHz, $CDCl_3$) δ 7.94 (d, J = 6.5 Hz, 2H), 7.83 (s, 1H), 7.50–7.11 (m, 11H), 6.31 (d, J = 3.0 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –150.07; ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.0 (d, J = 5.1 Hz), 145.2 (d, J = 254.6 Hz), 140.8 (d, J = 8.1 Hz), 140.4 (d, J = 9.6 Hz), 139.1, 139.1 (d, J = 9.5 Hz), 139.0, 129.8, 128.8, 128.6, 128.1, 127.9 (d, J = 3.7 Hz), 127.6 (d, J = 12.5 Hz), 126.9, 124.7, 122.2, 103.6; LRMS (EI) m/z (relative intensity) 346 (100) [M^+], 348 (7), 347 (27), 345 (83); Anal. Calcd. for $C_{21}H_{15}FN_2S$: C, 72.81; H, 4.36; N, 8.09. Found: C, 72.92; H, 4.74; N, 7.77. IR(KBr): 3410, 3061, 1611, 1594, 1579, 1509, 1497, 1466, 1406, 1246, 745, 695 cm^{-1}.

3-Fluoro-*N*,6-diphenyl-2,2′-bipyridin-4-amine (3m)

Light yellow solid, mp 153–155 °C; ^1H NMR (300 MHz, $CDCl_3$) δ 8.78 (d, J = 4.4 Hz, 1H), 8.16 (d, J = 7.9 Hz, 1H), 7.97–7.79 (m, 3H), 7.54 (d, J = 5.6 Hz, 1H), 7.48–7.12 (m, 9H), 6.48 (s, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –151.98; ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.4 (d, J = 6.6 Hz), 153.3 (d, J = 5.9 Hz), 149.1, 147.2 (d, J = 257.5 Hz), 143.2 (d, J = 6.6 Hz), 141.3 (d, J = 9.5 Hz), 139.3, 139.1, 136.6, 129.8, 128.7, 128.6, 127.0, 124.8, 124.1, 123.4, 122.4, 105.2; LRMS-ESI (m/z): $C_{22}H_{17}FN_3$ $[M + H]^+$ calcd 342.1; found 342.0; Anal. Calcd. for $C_{22}H_{16}FN_3$: C, 77.40; H, 4.72; N, 12.31. Found: C, 77.21; H, 4.97; N, 12.48. IR(KBr): 3412, 3033, 1611, 1578, 1565, 1496, 1468, 1410, 1247, 749, 694 cm^{-1}.

N,2,6-Triphenylpyridin-4-amine (3n)

White solid, mp 92–94 °C; ^1H NMR (300 MHz, $CDCl_3$) δ 8.05 (d, J = 7.9 Hz, 4H), 7.49–7.07 (m, 13H), 6.13 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.1, 152.0, 140.1, 140.0, 129.7, 128.9, 128.6, 127.1, 123.9, 121.5. 105.2; HRMS-ESI (m/z): $C_{23}H_{19}N_2$ $[M + H]^+$ calcd 323.15428; found 323.15368; IR(KBr): 3394, 3060, 3035, 1607, 1590, 1577, 1509, 1496, 1417, 1267, 987, 776, 694 cm^{-1}.

N,2,6-Triphenyl-3-(trifluoromethyl)pyridin-4-amine (3o)

White solid, mp 113–114 °C; ^1H NMR (300 MHz, $CDCl_3$) δ 7.93–7.81 (m, 2H), 7.61–7.19 (m, 14H), 6.73 (s, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –52.82; ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.0, 158.6, 151.6, 141.6, 139.0, 138.6, 130.0, 129.6, 128.7, 128.6 (q, J = 1.5 Hz), 128.3, 127.8, 127.3, 125.9, 125.5 (q, J = 273.6 Hz), 124.3, 107.9 (q, J = 29.4 Hz), 104.2; HRMS-ESI (m/z): $C_{24}H_{18}F_3N_2$ $[M + H]^+$ calcd 391.14166, found 391.14130; IR(KBr): 3464, 3060, 3036, 1578, 1563, 1498, 1446, 1418, 1405, 1302, 1257, 1225, 1091, 1022, 764, 697 cm^{-1}.

6-(4-Bromophenyl)-*N*,2-diphenyl-3-(trifluoromethyl)pyridin-4-amine (3p)

Light yellow solid, mp 93–96 °C; ^1H NMR (300 MHz, $CDCl_3$) δ 7.74 (d, J = 8.5 Hz, 2H), 7.57–7.39 (m, 9H), 7.36–7.25 (m, 4H) 6.74 (br, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –52.14 (s, 3F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.1, 157.3, 151.7, 141.5, 138.8, 137.4, 131.8, 130.0, 128.9, 128.5 (q, J = 1.4 Hz), 128.4, 127.8, 126.1, 125.4 (q, J = 274.4 Hz), 124.4, 124.1, 108.1 (q, J = 29.3 Hz), 103.8; HRMS-ESI (m/z): $C_{24}H_{17}BrF_3N_2$ $[M + H]^+$ calcd 469.0522; found 469.0511; IR(KBr): 3462, 3060, 1576, 1558, 1489, 1426, 1385, 1301, 1256, 1223, 1178, 1132, 1091, 1022, 700 cm^{-1}.

6-(3-Methoxyphenyl)-*N*,2-diphenyl-3-(trifluoromethyl)-pyridin-4-amine (3q)

White solid, mp 136–138 °C; ^1H NMR (300 MHz, $CDCl_3$) δ 7.61–7.20 (m, 14H), 6.91 (dd, J = 8.1 Hz, J = 1.8 Hz, 1H) 6.73 (br, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –52.04 (s, 3F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9, 159.9, 158.4, 151.5, 141.6, 140.1, 139.0, 130.0, 129.6, 128.6 (q, J = 1.5 Hz), 128.3, 127.8, 125.9, 125.5 (q, J = 274.3 Hz), 124.3, 119.7, 115.1, 113.1, 108.0 (q, J = 28.6 Hz), 104.3, 55.4; HRMS-ESI (m/z): $C_{25}H_{20}F_3N_2O$ $[M + H]^+$ calcd 421.1522; found 421.1512; IR(KBr): 3446, 3060, 1583, 1558, 1494, 1397, 1300, 1264, 1128, 1095, 1047, 1023, 700 cm^{-1}.

6-(Naphthalen-2-yl)-*N*,2-diphenyl-3-(trifluoromethyl)pyridin-4-amine (3r)

White solid, mp 143–145 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.39 (s, 1H), 8.00–7.94 (m, 1H), 7.90–7.76 (m, 3H), 7.61–7.40 (m, 10H), 7.38–7.25 (m, 3H), 6.75 (br, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –52.00 (s, 3F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.1, 158.5, 151.5, 141.7, 139.0, 135.8, 134.0, 133.3, 130.0, 128.9, 128.6, 128.6, 128.3, 127.8, 127.7, 127.1, 126.8, 126.3, 125.9, 125.5 (q, J = 274.4 Hz), 124.6, 124.3, 108.0 (q, J = 28.7 Hz), 104.4; HRMS-ESI (m/z): $C_{28}H_{20}F_3N_2$ [M + H]$^+$ calcd 441.1573; found 441.1569; IR(KBr): 3463, 3059, 1602, 1576, 1561, 1498, 1439, 1417, 1300, 1190, 1133, 1086, 1023, 702 cm^{-1}.

***N*,6-Diphenyl-2-(*p*-tolyl)-3-(trifluoromethyl)pyridin-4-amine (3s)**

White solid, mp 121–123 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.91–7.85 (m, 2H), 7.50–7.40 (m, 4H), 7.40–7.34 (m, 4H), 7.33–7.21 (m, 5H), 6.71 (br, 1H), 2.42 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –52.00 (s, 3F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.0, 158.5, 151.5, 139.1, 138.9, 138.6, 138.1, 130.0, 129.5, 128.6, 128.5, 128.5, 127.3, 125.8, 125.6 (q, J = 274.4 Hz), 124.3, 107.9 (J = 29.3 Hz), 104.0, 21.4; HRMS-ESI (m/z): $C_{25}H_{20}F_3N_2$ [M + H]$^+$ calcd 405.1573; found 405.1572; IR(KBr): 3466, 3059, 3036, 2922, 1582, 1561, 1498, 1412, 1301, 1257, 1130, 1090, 1021, 695 cm^{-1}.

2-(4-Chlorophenyl)-*N*,6-diphenyl-3-(trifluoromethyl)pyridin-4-amine (3t)

White solid, mp 137–139 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.92–7.80 (m, 2H), 7.55–7.24 (m, 13H), 6.73 (br, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –52.32 (s, 3F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.7, 151.7, 140.1, 138.8, 138.4, 134.4, 130.0, 130.0, 130.0, 129.7, 128.7, 128.1, 127.3, 126.1, 125.4 (q, J = 274.3 Hz), 124.4, 107.8 (q, J = 28.6 Hz), 104.2; HRMS-ESI (m/z): $C_{24}H_{17}ClF_3N_2$ [M + H]$^+$ calcd 425.1027; found 425.1018; IR(KBr): 3460, 3062, 1581, 1558, 1497, 1410, 1304, 1257, 1224, 1087, 1022, 835, 695 cm^{-1}.

***N*,6-Diphenyl-2-(thiophen-2-yl)-3-(trifluoromethyl)pyridin-4-amine (3u)**

White solid, mp 88–90 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.94–7.84 (m, 2H), 7.50–7.21 (m, 11H), 7.12–7.05 (m, 1H) 6.76 (br, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –52.01 (s, 3F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.2, 153.1, 151.9, 143.3, 138.9, 138.1, 130.0, 129.7, 128.7, 128.3 (q, J = 3.6 Hz), 127.6, 127.2, 126.9, 126.0, 125.6 (q, J = 274.3 Hz), 124.4, 107.1 (q, J = 30.1 Hz), 104.0; HRMS-ESI (m/z): $C_{22}H_{16}F_3N_2S$ [M + H]$^+$ calcd 397.0981; found 397.0976; IR(KBr): 3466, 3063, 1580, 1558, 1497, 1447, 1417, 1404, 1299, 1256, 1221, 1156, 1106, 1089, 1021, 695 cm^{-1}.

3-(Perfluoroethyl)-*N*,2,6-triphenylpyridin-4-amine (3v)

White solid, mp 146–148 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.88–7.78 (m, 2H), 7.49–7.20 (m, 14H), 6.83 (br, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –82.59 (s, 3F), –101.54 (s, 2F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.7, 158.5, 152.5, 142.3, 139.2, 138.4, 130.0, 129.6, 128.6, 128.2, 127.6, 127.4, 127.3, 126.0, 124.4, 119.7 (qt, J = 288.3 Hz, J = 38.9 Hz), 115.7 (tq, J = 257.4 Hz, J = 40.4 Hz), 105.6 (t, J = 23.5 Hz), 105.0; HRMS-ESI (m/z): $C_{25}H_{18}F_5N_2$ [M + H]$^+$ calcd 441.1385; found 441.1380; IR(KBr): 3484, 3057, 1578, 1560, 1498, 1413, 1257, 1203, 1161, 1051, 960, 699 cm^{-1}.

Procedure for pyridine 3w synthesis

1a (0.4 mmol) and n-butylamine (2 equiv.) were added to 2.0 mL THF, the mixture was stirred at 80 °C for two hours, then cooled to room temperature, and NaH (2.5 equiv.) was added. The solution was then stirred at 80 °C for 20 min, and quenched with ice water. The mixture was partitioned between ethyl acetate and water, the organic layer was washed with brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by column chromatography on silica gel to provide product **3w** as a yellow oil.

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.81 (d, J = 2.9 Hz, 2H), 7.43–7.03 (m, 9H), 6.23 (s, 1H), 2.90–2.79 (m, 2H), 1.92–1.75 (m, 2H), 1.04 (t, J = 7.4 Hz, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –154.11; ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.3 (d, J = 5.9 Hz), 148.5 (d, J = 14.0 Hz), 146.9 (d, J = 246.5 Hz), 139.9, 139.4, 139.2 (d, J = 10.3 Hz), 129.7, 128.6, 128.5, 127.0, 124.4, 121.9, 103.9, 33.7, 22.0, 14.1; HRMS-ESI (m/z): $C_{20}H_{20}FN_2$ [M + H]$^+$ calcd 307.16050; found 307.16035; IR(KBr): 3415, 3036, 2961, 2930, 2870, 1615, 1597, 1580, 1512, 1496, 1467, 1408, 1249, 1179, 696 cm^{-1}.

Procedure for 4a synthesis

1a (0.4 mmol) and benzylamine (2 equiv.) were added to 2.0 mL THF, the mixture was stirred at 80 °C for two hours. Then the solvent was evaporated, and the residue was purified by flash chromatography on silica providing **4a** as a yellow solid in quantitative yield.

Mp 76–77 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 11.28 (br, 1H), 7.46–6.79 (m, 15H), 5.24 (s, 1H), 4.40 (s, 2H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –62.63; ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.0, 152.6 (q, J = 26.4 Hz), 149.1, 139.0, 135.9, 129.5, 128.7, 128.6, 128.4, 128.0, 127.3, 126.6, 123.1, 120.3, 119.0 (q, J = 290.5 Hz), 89.9 (q, J = 3.7 Hz), 48.4; HRMS-ESI (m/z): $C_{23}H_{20}F_3N_2$ [M + H]$^+$ calcd 381.15731; found 381.15759; IR(KBr): 3029, 2927, 1616, 1554, 1483, 1281, 1231, 1182, 1137, 1089, 695 cm^{-1}.

Representative procedure for dihydropyrimidine 5 synthesis

1 (0.4 mmol) and amine (2 equiv.) were added to 2.0 mL THF, the mixture was stirred at 80 °C for two hours, and then cooled to –40 °C (rt for **5q**, **5w**), and *t*-BuOK (2.0 equiv.) was added slowly, and quenched with ice water after 5 min. The mixture was partitioned between ethyl acetate and water, the organic layer was washed with brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by column chromatography on silica gel to provide **5**.

6-(Difluoromethyl)-1,2,4-triphenyl-1,2-dihydropyrimidine (5a)

Yellow solid, mp 106–107 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.96–7.85 (m, 2H), 7.64 (d, J = 7.5 Hz, 2H), 7.50–7.11 (m, 11H), 6.64 (s, 1H), 6.57 (d, J = 2.5 Hz, 1H), 6.28 (t, J = 54.4 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –112.22 (dd, J_{F-F} = 301.3 Hz, J_{H-F} = 55.5 Hz, 1F), –121.41 (dd, J_{F-F} = 301.2 Hz, J_{H-F} = 53.5 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.1, 143.7, 142.9 (dd, J = 27.9 Hz, J = 22.0 Hz), 140.6, 137.2, 130.5, 129.6, 128.6, 128.3, 128.1, 127.2,

126.5, 126.4, 124.7, 110.2 (t, J = 242.1 Hz), 103.1 (t, J = 5.1 Hz), 79.8; HRMS-ESI (m/z): $C_{23}H_{19}F_2N_2$ [M + H]$^+$ calcd 361.15108; found 361.14966; IR(KBr): 3060, 3032, 2925, 1629, 1580, 1492, 1446, 1376, 1352, 1264, 1125, 1047, 765, 695 cm^{-1}.

6-(Fluoromethyl)-1,2,4-triphenyl-1,2-dihydropyrimidine (5b)

Red oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.01–7.82 (m, 2H), 7.62 (d, J = 7.3 Hz, 2H), 7.48–7.14 (m, 11H), 6.62 (s, 1H), 6.26 (s, 1H), 5.02 (dAB, J_{F-H} = 47.9 Hz, J_{H-H} = 12.3 Hz, 2H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –215.55 (t, J = 47.4 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.7, 145.9 (d, J = 15.4 Hz), 143.6, 141.0, 137.5, 130.2, 129.4, 128.5, 128.2, 127.9, 127.2, 126.6, 126.1, 125.1, 102.8 (d, J = 5.8 Hz), 80.1 (d, J = 173.1 Hz), 79.3; LRMS (EI) m/z (relative intensity) 342 (11) [M$^+$], 341 (15), 265 (100), 104 (19), 77 (34); HRMS-EI (m/z) calcd for $C_{23}H_{19}FN_2$ 342.1532; found 342.1535; IR(KBr): 3059, 2925, 1623, 1596, 1542, 1493, 1266, 1069, 757, 696 cm^{-1}.

6-(Difluoromethyl)-1,2-diphenyl-4-*p*-tolyl-1,2-dihydropyrimidine (5c)

Yellow solid, mp 80–83 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.81 (d, J = 8.1 Hz, 2H), 7.63 (d, J = 7.3 Hz, 2H), 7.42–7.10 (m, 10H), 6.63 (s, 1H), 6.56 (d, J = 2.6 Hz, 1H), 6.27 (t, J = 54.5 Hz, 1H), 2.37 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –112.49 (dd, J_{F-F} = 300.0 Hz, J_{H-F} = 54.7 Hz, 1F), –121.53 (dd, J_{F-F} = 301.0 Hz, J_{H-F} = 53.7 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9, 143.8, 142.8 (dd, J = 28.6 Hz, J = 22.8 Hz), 140.8, 140.7, 134.3, 129.6, 129.3, 128.3, 128.0, 127.2, 126.5, 126.3, 124.7, 110.2 (t, J = 242.1 Hz), 103.2 (t, J = 5.1 Hz), 79.7, 21.4; LRMS (EI) m/z (relative intensity) 374 (15) [M$^+$], 373 (20), 297 (100), 104 (25), 77 (34); HRMS-EI (m/z) calcd for $C_{24}H_{20}F_2N_2$ 374.1595; found 374.1591; IR(KBr): 3030, 1634, 1492, 1448, 1377, 1183, 1041, 813, 742 cm^{-1}.

6-(Difluoromethyl)-4-(4-fluorophenyl)-1,2-diphenyl-1,2-dihydropyrimidine (5d)

Red oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.96–7.83 (m, 2H), 7.70–7.56 (m, 2H), 7.42–6.98 (m, 10H), 6.62 (s, 1H), 6.51 (d, J = 2.5 Hz, 1H), 6.28 (t, J = 54.7 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –110.20––110.40 (m, 1F), –112.78 (dd, J_{F-F} = 301.0 Hz, J_{H-F} = 54.7 Hz, 1F), –121.57 (dd, J_{F-F} = 301.1 Hz, J_{H-F} = 53.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.4 (d, J = 250.9 Hz), 159.0, 143.6, 143.3 (dd, J = 27.2 Hz, J = 23.5 Hz), 140.5, 133.3 (td, J = 2.9 Hz), 129.7, 129.3 (d, J = 8.1 Hz), 128.4, 128.2, 126.5, 126.4, 124.8, 115.5 (d, J = 22.0 Hz), 110.1 (t, J = 242.1 Hz), 102.4 (t, J = 5.1 Hz), 79.8; LRMS (EI) m/z (relative intensity) 378 (10) [M$^+$], 327 (16), 301 (100), 104 (33), 77 (47); HRMS-EI (m/z) calcd for $C_{23}H_{17}F_3N_2$ 378.1344; found 378.1345; IR(KBr): 3063, 1628, 1602, 1510, 1501, 1263, 1157, 1048, 845, 697 cm^{-1}.

6-(Difluoromethyl)-1,2-diphenyl-4-(thiophen-2-yl)-1,2-dihydropyrimidine (5e)

Yellowish brown solid, mp 97–99 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.70 (d, J = 7.2 Hz, 2H), 7.60–7.19 (m, 10H), 7.13 (t, J = 4.8 Hz, 1H), 6.68–6.55 (m, 2H), 6.35 (t, J = 54.5 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –112.86 (dd, J_{F-F} = 301.1 Hz, J_{H-F} = 54.6 Hz, 1F), –122.03 (dd, J_{F-F} = 301.1 Hz, J_{H-F} = 53.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.2, 143.7, 143.0, 142.9 (dd, J = 27.2 Hz, J = 22.8 Hz), 140.5, 129.7, 129.3, 128.3, 128.1, 128.0, 127.8, 126.5, 126.4, 124.8, 110.0 (t, J = 242.1 Hz), 102.4 (t, J = 5.9 Hz), 79.4; LRMS (EI) m/z (relative intensity) 366 (13) [M$^+$], 289 (58), 262 (100), 104 (28), 77 (42); HRMS-EI (m/z) calcd for $C_{21}H_{16}F_2N_2S$ 366.1002; found 366.1006; IR(KBr): 3063, 1625, 1594, 1492, 1427, 1265, 1124, 1049, 697 cm^{-1}.

6-(Difluoromethyl)-1-(4-methoxyphenyl)-2,4-diphenyl-1,2-dihydropyrimidine (5f)

Red oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.03–7.80 (m, 2H), 7.63 (d, J = 7.1 Hz, 2H), 7.53–7.26 (m, 6H), 7.14 (d, J = 8.7 Hz, 2H), 6.85 (d, J = 8.7 Hz, 2H), 6.52 (s, 1H), 6.46 (s. 1H), 6.21 (t, J = 54.2 Hz, 1H), 3.78 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –113.53 (dd, J_{F-F} = 301.0 Hz, J_{H-F} = 54.7 Hz, 1F), –121.49 (dd, J_{F-F} = 301.0 Hz, J_{H-F} = 53.7 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.3, 158.5, 143.4 (dd, J = 27.1 Hz, J = 22.7 H), 140.9, 137.4, 136.3, 130.4, 128.6, 128.4, 128.1, 127.2, 127.2, 126.6, 114.8, 110.5 (t, J = 242.1 Hz), 101.0 (t, J = 5.9 Hz), 80.5, 55.5; LRMS (EI) m/z (relative intensity) 390 (18) [M$^+$], 339 (27), 313 (100), 134 (34), 77 (20); HRMS-EI (m/z) calcd for $C_{24}H_{20}F_2N_2O$ 390.1544; found 390.1548; IR(KBr): 3060, 2933, 1626, 1578, 1509, 1247, 1125, 1037, 695 cm^{-1}.

4-(6-(Difluoromethyl)-2,4-diphenylpyrimidin-1(2*H*)-yl)benzonitrile (5g)

Yellow solid, mp 52–54 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.03–7.03 (m, 14H), 6.74–6.67 (m, 2H), 6.30 (t, J = 54.7 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –110.44 (dd, J_{F-F} = 302.1 Hz, J_{H-F} = 54.7 Hz, 1F), –120.73 (dd, J_{F-F} = 302.1 Hz, J_{H-F} = 54.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.7, 148.1, 141.3 (dd, J = 27.2 Hz, J = 22.8 Hz), 139.4, 136.3, 133.6, 130.9, 128.7, 128.5, 128.5, 127.1, 126.2, 123.4, 118.5, 110.3 (t, J = 243.6 Hz), 108.6, 107.6 (t, J = 5.1 Hz), 79.3; LRMS (EI) m/z (relative intensity) 385 (18) [M$^+$], 384 (21), 308 (100), 281 (28), 129 (41), 102 (37); HRMS-EI (m/z) calcd for $C_{24}H_{17}F_2N_3$ 385.1391; found 385.1389; IR(KBr): 3061, 2226, 1633, 1603, 1504, 1267, 1049, 695 cm^{-1}.

6-(Difluoromethyl)-2,4-diphenyl-1-*m*-tolyl-1,2-dihydropyrimidine (5h)

Red oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.97–7.87 (m, 2H), 7.65 (d, J = 7.3 Hz, 2H), 7.46–7.25 (m, 6H), 7.20 (t, J = 7.5 Hz, 1H), 7.06–6.93 (m, 3H), 6.64 (s, 1H), 6.56 (d, J = 2.8 Hz, 1H), 6.29 (t, J = 54.5 Hz, 1H), 2.30 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –112.48 (dd, J_{F-F} = 300.0 Hz, J_{H-F} = 54.7 Hz, 1F), –121.65 (dd, J_{F-F} = 300.0 Hz, J_{H-F} = 53.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.2, 143.7, 143.1 (dd, J = 27.2 Hz, J = 22.0 H), 140.7, 139.8, 137.1, 130.5, 129.4, 128.6, 128.3, 128.1, 127.3, 127.2, 126.5, 125.3, 121.9, 110.2 (t, J = 241.3 Hz), 102.9 (t, J = 5.9 Hz), 79.7; LRMS (EI) m/z (relative intensity) 374 (15) [M$^+$], 373 (17), 323 (18), 297 (100), 118 (22), 91 (41); HRMS-EI (m/z) calcd for $C_{24}H_{20}F_2N_2$ 374.1595; found 174.1594; IR(KBr): 3060, 2923, 1627, 1604, 1490, 1265, 1122, 1064, 695 cm^{-1}.

6-(Difluoromethyl)-1,4-diphenyl-2-*p*-tolyl-1,2-dihydropyrimidine (5i)

Reddish brown oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.98–7.84 (m, 2H), 7.62–7.07 (m, 12H), 6.61 (s, 1H), 6.58–6.53 (m, 1H), 6.26 (t, J = 54.1 Hz, 1H), 2.32 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –112.39 (dd, J_{F-F} = 301.0 Hz, J_{H-F} = 54.7 Hz, 1F), –121.34 (dd, J_{F-F} = 301.0 Hz, J_{H-F} = 53.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.0, 143.8, 142.9 (dd, J = 27.9 Hz, J = 24.3 Hz), 137.8, 137.7, 137.2, 130.4, 129.6, 129.0, 128.6, 127.2, 126.4, 126.3, 124.7, 110.3 (t, J = 241.4 Hz), 103.0 (t, J = 5.1 Hz), 79.8, 21.2; LRMS (EI) m/z (relative intensity) 374 (26) [M$^+$], 373 (29), 323 (33), 283 (100), 256 (27), 104 (28), 77 (31); HRMS-EI (m/z) calcd for $C_{24}H_{20}F_2N_2$ 374.1595; found 374.1600; IR(KBr): 3060, 2922, 1626, 1538, 1491, 1262, 1120, 1046, 695 cm^{-1}.

6-(Difluoromethyl)-1,4-diphenyl-2-*o*-tolyl-1,2-dihydropyrimidine (5j)

Red oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.94–7.76 (m, 2H), 7.55 (d, J = 6.2 Hz, 1H), 7.45–6.99 (m, 11H), 6.62 (s, 1H), 6.53–6.45 (m, 1H), 6.32 (t, J = 54.0 Hz, 1H), 2.68 (s, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –113.56 (dd, J_{F-F} = 301.0 Hz, J_{H-F} = 54.7 Hz, 1F), –120.53 (dd, J_{F-F} = 302.1 Hz, J_{H-F} = 52.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.8, 144.2 (dd, J = 26.4 Hz, J = 22.0 Hz), 143.2, 138.1, 137.4, 135.9, 131.2, 130.2, 129.5, 128.4, 128.0, 127.1, 126.8, 126.4, 125.8, 125.8, 110.4 (t, J = 241.4 Hz), 99.6 (t, J = 5.8 Hz), 79.5, 20.2; LRMS (EI) m/z (relative intensity) 374 (18) [M$^+$], 323 (21), 283 (100), 256 (32), 104 (31), 77 (33); HRMS-EI (m/z) calcd for $C_{24}H_{20}F_2N_2$ 374.1595; found 374.1603; IR(KBr): 3062, 1632, 1595, 1492, 1264, 1109, 1047, 762, 696 cm^{-1}.

2-(4-Chlorophenyl)-6-(difluoromethyl)-1,4-diphenyl-1,2-dihydropyrimidine (5k)

Red oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.00–7.82 (m, 2H), 7.66–7.10 (m, 12H), 6.63–6.53 (m, 2H), 6.29 (t, J = 54.1 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –112.66 (dd, J_{F-F} = 301.1 Hz, J_{H-F} = 54.7 Hz, 1F), –122.40 (dd, J_{F-F} = 301.1 Hz, J_{H-F} = 53.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.3, 143.5, 142.9 (dd, J = 27.9 Hz, J = 24.3 Hz), 139.1, 136.9, 133.9, 130.6, 129.7, 128.6, 128.5, 127.9, 127.1, 126.6, 124.8, 110.1 (t, J = 242.1 Hz), 103.2 (t, J = 5.1 Hz), 79.3; LRMS (EI) m/z (relative intensity) 394 (22) [M$^+$], 393 (28), 343 (26), 283 (100), 104 (28), 77 (35); HRMS-EI (m/z) calcd for $C_{23}H_{17}ClF_2N_2$ 394.1048; found 394.1052; IR(KBr): 3062, 1629, 1595, 1490, 1446, 1262, 1092, 1049, 696 cm^{-1}.

6-(Difluoromethyl)-1,4-diphenyl-2-(4-(trifluoromethyl)phenyl)-1,2-dihydropyrimidine (5l)

Red oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.91 (d, J = 7.4 Hz, 2H), 7.78 (d, J = 8.1 Hz, 2H), 7.63 (d, J = 8.1 Hz, 2H), 7.54–7.14 (m, 8H), 6.66 (s, 1H), 6.61 (s, 1H), 6.34 (t, J = 53.8 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –62.40 (s, 3F), –112.56 (dd, J_{F-F} = 301.0 Hz, J_{H-F} = 54.7 Hz, 1F), –122.85 (dd, J_{F-F} = 301.0 Hz, J_{H-F} = 52.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.5, 144.7, 143.5, 143.0 (dd, J = 27.2 Hz, J = 22.1 Hz), 136.8, 130.7, 130.3 (q, J = 32.3 Hz), 129.8, 128.7, 127.2, 126.8, 126.7, 125.3 (q, J = 4.4 Hz), 124.7, 124.1 (q, J = 272.1 Hz), 110.0 (t, J = 242.1 Hz), 103.4 (t, J = 5.9 Hz), 79.4; LRMS (EI) m/z (relative intensity) 428 (17) [M$^+$], 427 (22), 377 (24), 283 (100), 104 (21), 77 (29); HRMS-EI (m/z) calcd for $C_{24}H_{17}F_5N_2$ 428.1312; found 428.1313; IR(KBr): 3063, 2928, 1629, 1595, 1493, 1328, 1167, 1129, 1067, 796, 695 cm^{-1}.

6-(Difluoromethyl)-2-(naphthalen-1-yl)-1,4-diphenyl-1,2-dihydropyrimidine (5m)

Red oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.88 (d, J = 8.5 Hz, 1H), 8.01–6.97 (m, 17H), 6.52 (d, J = 2.3 Hz, 1H), 6.45 (t, J = 54.8 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –113.05 (dd, J_{F-F} = 301.1 Hz, J_{H-F} = 54.7 Hz, 1F), –121.08 (dd, J_{F-F} = 302.1 Hz, J_{H-F} = 53.7 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.8, 143.8 (dd, J = 27.1 Hz, J = 22.0 Hz), 143.4, 137.3, 135.0, 134.4, 130.5, 130.3, 129.5, 128.9, 128.6, 128.4, 127.2, 126.7, 126.2, 126.1, 125.8, 125.4, 125.2, 123.8, 110.5 (t, J = 242.1 Hz), 100.0 (t, J = 5.9 Hz), 79.6; LRMS (EI) m/z (relative intensity) 410 (26) [M$^+$], 359 (28), 283 (100), 256 (45), 104 (28), 77 (28); HRMS-EI (m/z) calcd for $C_{27}H_{20}F_2N_2$ 410.1595; found 410.1593; IR(KBr): 3058, 2925, 1632, 1596, 1493, 1359, 1265, 1129, 1045, 766, 695 cm^{-1}.

6-(Difluoromethyl)-1,4-diphenyl-2-(thiophen-2-yl)-1,2-dihydropyrimidine (5n)

Yellow solid, mp 127–129 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.00–7.85 (m, 2H), 7.56–7.13 (m, 10H), 7.03–6.94 (m, 1H), 6.78 (s, 1H), 6.63 (d, J = 2.5 Hz, 1H), 6.22 (t, J = 53.9 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –113.25 (dd, J_{F-F} = 302.0 Hz, J_{H-F} = 54.6 Hz, 1F), –120.62 (dd, J_{F-F} = 302.0 Hz, J_{H-F} = 53.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.9, 144.4, 143.1, 142.6 (dd, J = 27.8 Hz, J = 22.7 Hz), 137.0, 130.6, 129.7, 128.6, 127.3, 126.7, 126.4, 125.5, 125.2, 125.1, 110.1 (t, J = 242.1 Hz), 102.9 (t, J = 5.9 Hz), 77.4; LRMS (EI) m/z (relative intensity) 366 (69) [M$^+$], 365 (84), 315 (100), 289 (29), 256 (40), 104 (45), (60); HRMS-EI (m/z) calcd for $C_{21}H_{16}F_2N_2S$ 366.1002; found 366.1004; IR(KBr): 3063, 2926, 1627, 1579, 1493, 1375, 1263, 1117, 1047, 694 cm^{-1}.

6-(Difluoromethyl)-1,4-diphenyl-2-(pyridin-2-yl)-1,2-dihydropyrimidine (5o)

Yellowgreen solid, mp 117–119 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.67 (d, J = 4.5 Hz, 1H), 8.05–7.93 (m, 2H), 7.66–7.13 (m, 11H), 6.68 (s, 1H), 6.59 (d, J = 1.8 Hz, 1H), 6.15 (t, J = 54.0 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –113.96 (dd, J_{F-F} = 303.1 Hz, J_{H-F} = 54.6 Hz, 1F), –118.05 (dd, J_{F-F} = 303.1 Hz, J_{H-F} = 53.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.4, 158.8, 149.5, 143.4, 143.3 (dd, J = 27.2 Hz, J = 24.2 Hz), 137.0, 136.1, 130.6, 129.4, 128.6, 127.2, 126.4, 125.7, 123.0, 122.0, 110.0 (t, J = 241.4 Hz), 101.5 (t, J = 5.1 Hz), 80.7; LRMS (EI) m/z (relative intensity) 361 (3) [M$^+$], 283 (100), 207 (19), 77 (13); HRMS-EI (m/z) calcd for $C_{22}H_{17}F_2N_3$ 361.1391; found 361.1394; IR(KBr): 3058, 2926, 1625, 1593, 1492, 1374, 1261, 1126, 1048, 764, 696 cm^{-1}.

6-(Difluoromethyl)-2-(furan-2-yl)-1,4-diphenyl-1,2-dihydropyrimidine (5p)

yellowish brown solid, mp 121–123 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.95 (d, J = 5.1 Hz, 2H), 7.60–7.11 (m, 9H), 6.65 (d, J = 9.1 Hz, 1H), 6.39–6.19 (m, 3H), 6.11 (t, J = 54.2 Hz, 1H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –113.38 (dd, J_{F-F} = 302.1 Hz, J_{H-F} = 54.7 Hz, 1F), –119.17 (dd, J_{F-F} = 302.1 Hz, J_{H-F} = 53.6 Hz, 1F);

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.9, 151.3, 143.0, 142.9, 142.1 (dd, J = 28.7 Hz, J = 23.5 Hz), 137.0, 130.6, 129.6, 128.6, 127.2, 126.6, 125.6, 110.2, 109.9 (t, J = 241.3 Hz), 109.4, 101.6 (t, J = 5.9 Hz), 75.1; LRMS (EI) m/z (relative intensity) 350 (38) [M$^+$], 349 (57), 299 (100), 273 (27), 104 (24), 77 (44); HRMS-EI (m/z) calcd for $C_{21}H_{16}F_2N_2O$ 350.1231; found 350.1228; IR(KBr): 3062, 2926, 1626, 1579, 1496, 1373, 1263, 1121, 1048, 693 cm^{-1}.

6-(Difluoromethyl)-2-ethyl-1,4-diphenyl-1,2-dihydropyrimidine (5q)

Dark red oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.93–7.78 (m, 2H), 7.57–7.06 (m, 8H), 6.68 (d, J = 2.7 Hz, 1H), 6.11 (t, J = 54.0 Hz, 1H), 5.46 (t, J = 6.6 Hz, 1H), 2.00–1.78 (m, 2H), 1.15 (t, J = 7.3 Hz, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –111.94 (dd, J_{F-F} = 300.0 Hz, J_{H-F} = 54.6 Hz, 1F), –122.27 (dd, J_{F-F} = 300.0 Hz, J_{H-F} = 53.6 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 129.1, 143.9, 142.7 (dd, J = 26.4 Hz, J = 23.5 Hz), 137.0, 130.4, 129.6, 128.6, 127.1, 126.2, 125.0, 109.9 (t, J = 241.3 Hz), 102.7, 80.6, 24.0, 9.8; HRMS-ESI (m/z): $C_{19}H_{19}F_2N_2$ [M + H]$^+$ calcd 313.15108; found 313.15144; IR(KBr): 3061, 2967, 2933, 1627, 1602, 1539, 1492, 1262, 1118, 1046, 695 cm^{-1}.

6-(Difluoromethyl)-1,4-diphenyl-2-propyl-1,2-dihydropyrimidine (5w)

Yellow oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.90–7.79 (m, 2H), 7.50–7.05 (m, 8H), 6.71 (d, J = 2.9 Hz, 1H), 6.12 (t, J = 53.9 Hz, 1H), 5.53 (t, J = 6.8 Hz, 1H), 1.97–1.74 (m, 2H), 1.73–1.55 (m, 2H), 1.03 (t, J = 7.4 Hz, 3H); ^{19}F NMR (282 MHz, $CDCl_3$) δ –112.58 (dd, J_{F-F} = 299.2 Hz, J_{H-F} = 55.5 Hz, 1F), –122.76 (dd, J_{F-F} = 299.2 Hz, J_{H-F} = 53.5 Hz, 1F); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.9, 144.1, 142.3 (dd, J = 27.8 Hz, J = 22.7 Hz), 137.3, 130.2, 129.5, 128.5, 127.0, 126.0, 124.9, 110.0 (t, J = 241.4 Hz), 102.9 (t, J = 5.1 Hz), 79.5, 33.4, 18.5, 14.1; HRMS-ESI (m/z): $C_{20}H_{21}F_2N_2$ [M + H]$^+$ calcd 327.16673; found 327.16673; IR(KBr): 3064, 2959, 2931, 2872, 1629, 1595, 1580, 1493, 1376, 1269, 1118, 1047, 762, 694 cm^{-1}.

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