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UGI-SMILES ACCESS TO QUINOXALINE DERIVATIVES

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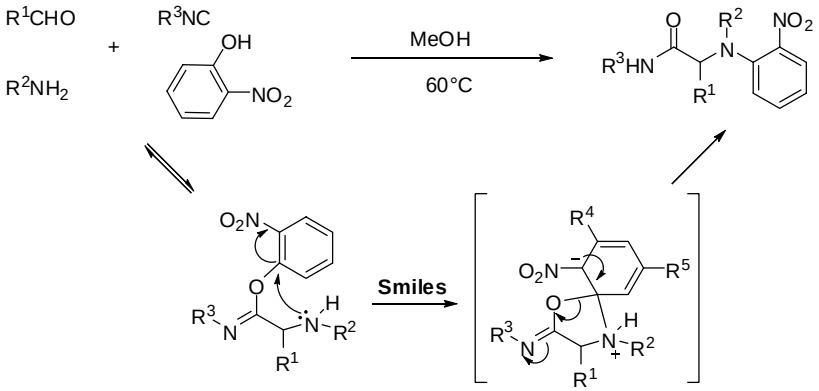
Abstract – Two different Ugi-Smiles post-condensations strategies have been used for new three and four-component formation of quinoxaline scaffolds. In the first approach, a one-pot hydrogenation-cyclization affords the heterocycle with loss of the initial isocyanide moiety. In the second one, the use of *o*-iodonitrophenol as starting phenol, coupled with copper catalyzed cyclization gave us similar quinoxaline derivatives resulting from a four coupling.

INTRODUCTION

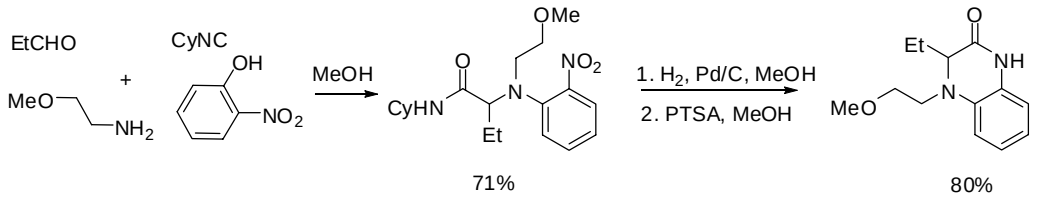
Quinoxaline derivatives represent an important class of biologically active compounds.[1] Their broad spectrum of activity is evidenced by their use as anti HIV agents,[2] angiotensin receptor antagonists,[3] antiviral,[4] antitumoral and antibacterial[5] agents. Being considered as privileged structures in drug discovery, numerous synthesis approaches have been reported[6] and more recently adapted to combinatorial formation of quinoxaline libraries.[7] When combinatorial accesses to heterocycles are needed, one of the most efficient strategies involves the use of Ugi couplings[8] with di-functional components. The desired heterocyclic scaffold is then obtained through post-condensation modifications of the initial Ugi adduct.[9] This strategy has been applied successfully to the formation of quinoxaline derivatives using Ugi/Pd N-arylation,[10] Ugi/S_NAr,[11] or Hulme UDC strategy.[12]

We recently reported a new Ugi type coupling using electron-deficient phenols in place of the traditional carboxylic acids. This reaction introduces a Smiles rearrangement as the key step of the conversion (Scheme 1).[13] First observed with *o*- and *p*-nitrophenols, this study was further extended to the use of salicylates and hydroxy-heterocycles such as pyridine or pyrimidine.[14]



Scheme 1: Ugi/Smiles coupling

In the light of the general structure of the Ugi/Smiles adducts obtained, it seems obvious that post-condensation strategies may bring efficient 4-component formation of various benzofused heterocycles. This was demonstrated on a single example by a hydrogenation/cyclization sequence to give quinoxaline (Scheme 2).[13] We now wish to give a full report on the use of Ugi-Smiles reaction to reach dihydroquinoxaline scaffolds by a three and four component approach.

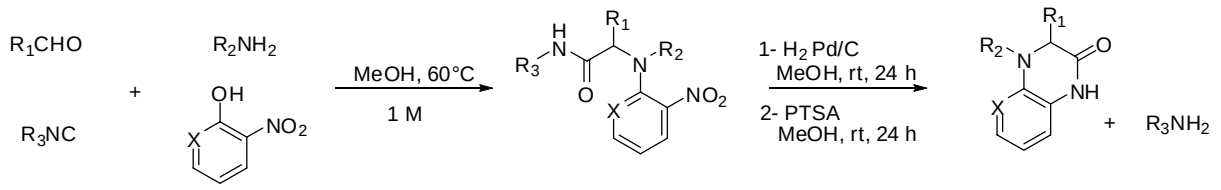


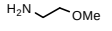
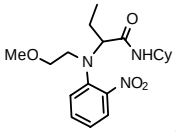
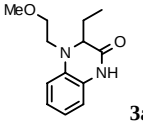
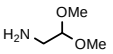
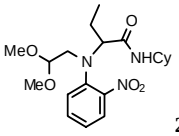
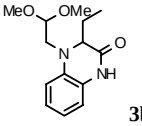
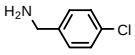
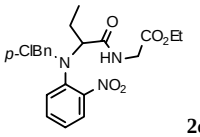
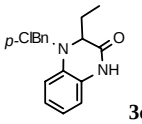
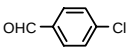
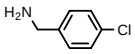
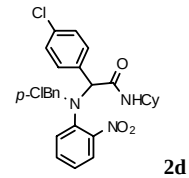
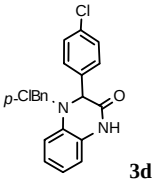
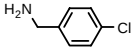
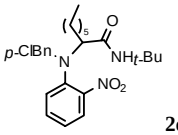
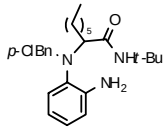
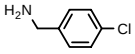
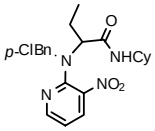
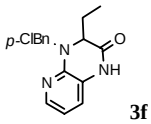
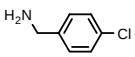
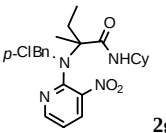
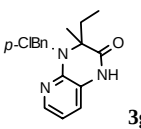
Scheme 2: dehydroquinoxalinone formation

RESULTS AND DISCUSSION

Different dehydroquinoxalines were prepared according to this procedure, varying the aldehyde, the primary amine and the isocyanide partners. The reduction of the intermediate Ugi-Smiles adducts was performed in methanol under hydrogen atmosphere with a catalytic amount of Pd/C (10 mol%). The crude resulting mixture was then submitted to acidic conditions to provide the desired quinoxaline derivatives in good yields (Table 1, entries 1-4). The final step seems to be sensitive to steric hindrance as no cyclized product could be detected with *tert*-butylamide **2e** (Table 1, entry 5). The synthesis of these benzofused heterocycles has been optimized in a three step one-pot procedure for dehydroquinoxaline **3a**. Under these conditions, the desired adduct was obtained in 47% yield, compared to 60% when the Ugi-Smiles intermediate was purified (Table 1, entry 1). This tandem process has been successfully extended to the synthesis of pyridopiperazinone derivatives (Table 1, entries 6-7).

Table 1

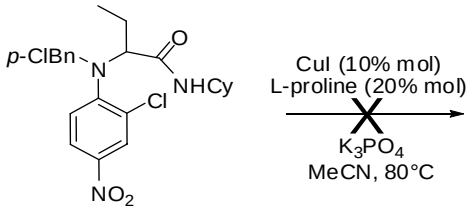


Entry	R_1CHO	R_2NH_2	R_3NC	Phenol **1**	Ugi-Smiles Product (time, yield) **2**	Cyclization Product (yield) **3**
1			CyNC	 **1a**	 **2a** 4 h, 71%	 **3a** 85%[a]
2			CyNC	 **1a**	 **2b** 16 h, 64%	 **3b** 60%
3				 **1a**	 **2c** 16 h, 60%	 **3c** 67%
4			CyNC	 **1a**	 **2d** 20 h, 80%	 **3d** 61%
5			*t*-BuNc	 **1a**	 **2e** 4 h, 79%	 68%
6			CyNC	 **1b**	 **2f** 16 h, 68%	 **3f** 53%
7			CyNC	 **1b**	 **2g** 10 d, 25%	 **3g** 55%

[a] This compound was obtained in 47% yield in one-pot procedure without isolation of the Ugi-Smiles intermediate.

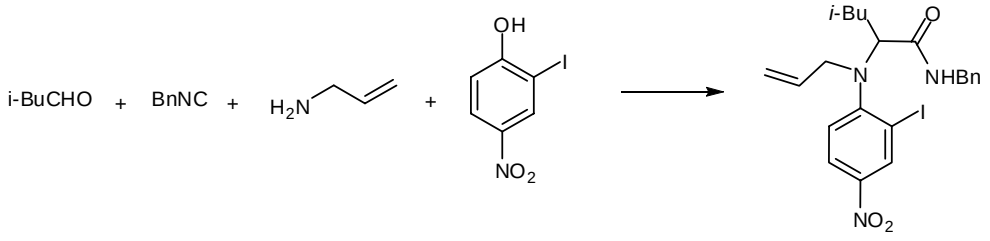
Although this method constitutes an easy and rapid access to those heterocycles, the elimination of the isocyanide moiety during the heterocyclization reduces the diversity of the process from a 4-component to a 3-component coupling. In order to maintain the initial diversity of the Ugi-Smiles reaction, we envisioned

the formation of quinoxalines by a cyclization of the amide onto a properly substituted phenyl core. N-Arylation of amides has been thoroughly reported under palladium[15]or copper[16] catalysis by substitution on a chloro, bromo or iodo benzene. We have already reported the successful coupling of 2-chloro-4-nitrophenol with an isocyanide, a primary amine and an aldehyde. Unfortunately, the adduct did not give any cyclization (Scheme 3). We then focused our efforts on iodinated compounds easily prepared from iodine treatment of nitrophenol.



Scheme 3: N-arylation of amides for chlorinated Ugi-Smiles adduct

The MCR coupling using 2-iodo-4-nitrophenol turned out to be quite inefficient under the classical conditions: when performed in methanol, no adduct could be isolated from the resulting complex mixture. In toluene, the desired adduct was obtained as the major compound but with feeble reproducibility. Adding one equivalent of NH_4Cl as reported by Zhu and coworkers in various Ugi processes[17] slightly improved the yield of the reaction. Finally the best yields resulted in the use of a 10:1 mixture of toluene: water at 100°C with 1 equiv. of NH_4Cl. Under these optimized conditions, the 2-iodo-4-nitrophenol was coupled with allylamine, benzylisocyanide and isovaleraldehyde to afford the desired adduct in a 95% isolated yields (Scheme 4).



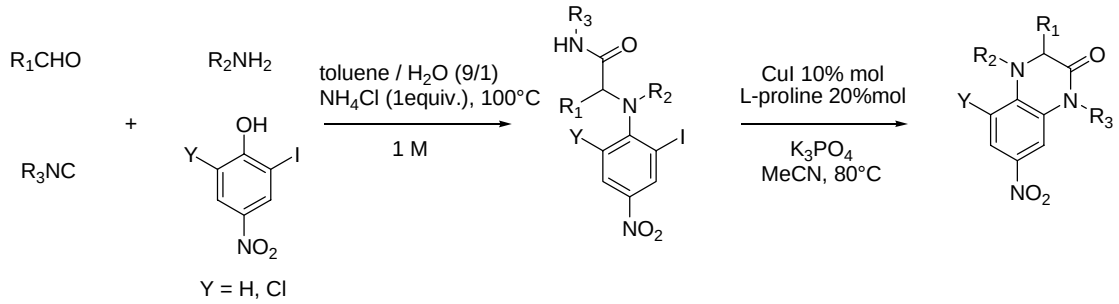
Conditions	Isolated Yield
MeOH, 60°C	-
freshly distilled toluene, 110°C	35%
freshly distilled toluene, NH_4Cl (1 equiv.), 110°C	49%
toluene, 110°C	55%
toluene: H_2O (10:1), 100°C	47%
toluene: H_2O (10:1), NH_4Cl (1 equiv.), 110°C	95%

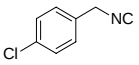
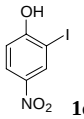
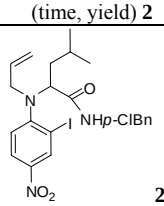
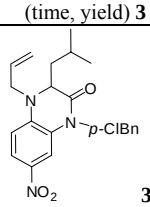
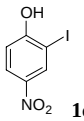
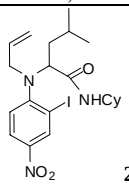
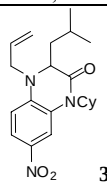
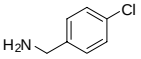
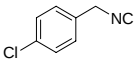
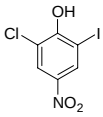
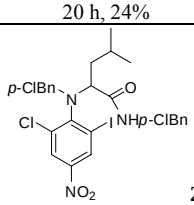
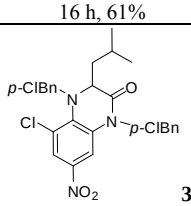
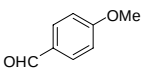
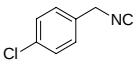
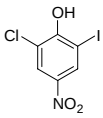
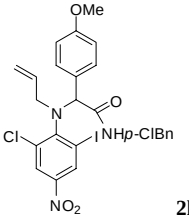
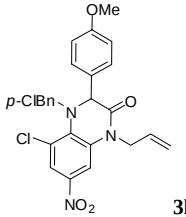
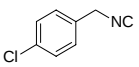
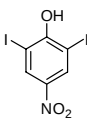
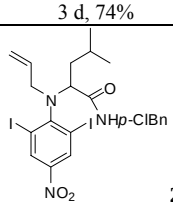
Scheme 4: Ugi-Smiles conditions for iodinated phenols

We thus prepared various iodinated N-aryl amino amides **2h-2k** (Table 2). These latter were then heated in acetonitrile at 80°C in the presence of a catalytic amount of Cu(I) using proline as ligand and K_3PO_4[18] to give the desired quinoxaline derivatives **3h-3k** in moderate to good yields. The commercially available 2,6-diiodo-4-nitrophenol gives the 4-component adduct **2l** in very low yield and this latter gave complex

mixture under cyclization conditions (Table 2, entry 5). When performed under microwaves conditions, the cyclization occurred more rapidly in similar yields (Table 2, entry 1).[18]

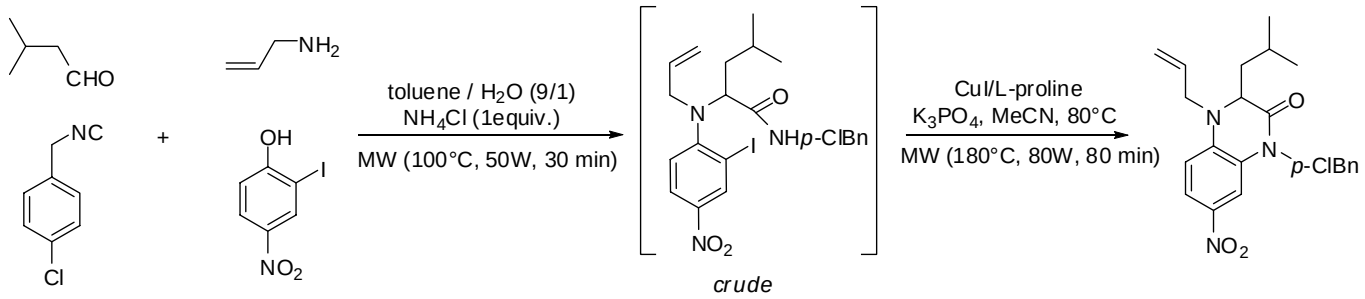
Table 2



Entry	R_1CHO	R_2NH_2	R_3NC	Phenol **1**	Ugi-Smiles Product (time, yield) **2**	Cyclization Product (time, yield) **3**
1				 **1c**	 **2h** 13 h, 64%	 **3h** 18 h, 65%[a]
2			CyNC	 **1c**	 **2i** 20 h, 24%	 **3i** 16 h, 61%
3				 **1d**	 **2j** 20 h, 80%	 **3j** 18 h, 55%
4				 **1d**	 **2k** 3 d, 74%	 **3k** 2 d, 45%
5				 **1e**	 **2l** 20 h, 18%	-

[a] This compound was obtained in 62% yield under microwave conditions (180°C, 80W, 80 min).

Moreover the use of microwave conditions for each step allows an optimization of the whole process: the reaction was performed without purification of the Ugi-Smiles intermediate in a couple of hours to give the desired quinoxaline derivative in a 39% isolated yield (Scheme 5).



Scheme 5: optimization of the whole process using microwaves

In conclusion, we have prepared new quinoxaline derivatives using Ugi-Smiles couplings. The most important feature of these reactions is the involvement of a new rearrangement step in an Ugi type process coupled with easy formation of *N*-arylated derivatives. This reaction is perfectly suited for the formation of fused bicyclic heterocycles. Indeed, different Ugi-Smiles post-condensations can give both three and four-component entries to such heterocyclic scaffolds. Most noteworthy is the successful formation of Ugi-Smiles adduct with *o*-iodophenols which opens the way to a rich variety of organometallic post-condensations.

EXPERIMENTAL

General procedure for *ortho*-nitrophenol and 2-hydroxy-3-nitropyridine induced Ugi-4CR

To a 1 M solution of the aldehyde (0.8 mmol) in methanol were added successively 1.0 equiv. of amine, 1.0 equiv. of isocyanide and 1.0 equiv. of phenol **1** under inert atmosphere. The resulting mixture was stirred at 60°C or 40°C until completion (TLC). It was then concentrated in vacuo and the crude product **2** was purified by flash chromatography on silica gel.

N-Cyclohexyl-2-[*N*-(2-methoxyethyl)-*N*-(2-nitrophenyl)amino]butyramide **2a**

The typical procedure was followed employing the *ortho*-nitrophenol **1a** (110 mg, 0.8 mmol) to afford the compound **2a** (205 mg, 71%, 4 h, 40°C) as an yellow oil by flash chromatography on silica gel (petroleum ether/Et_2O: 60/40). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 7.70 (dd, 1H, *J* = 8.1, 1.5 Hz), 7.50 (td, 1H, *J* = 7.6, 1.5 Hz), 7.43 (br s, 1H), 7.31 (dd, 1H, *J* = 7.6, 1.0 Hz), 7.17 (ddd, 1H, *J* = 8.1, 7.6, 1.0 Hz), 3.81-3.72 (m, 1H), 3.69 (t, 1H, *J* = 6.8 Hz), 3.40-3.28 (m, 4H), 3.22 (s, 3H), 2.06-1.96 (m, 2H), 1.93-1.79 (m, 2H), 1.77-1.65

(m, 4H), 1.42-1.06 (m, 4H), 0.93 (t, 3H, *J* = 7.3 Hz). **^{13}C NMR** ($CDCl_3$, 100.6 MHz) δ 172.2, 146.9, 142.9, 133.1, 125.9, 125.5, 124.1, 70.1, 69.6, 59.1, 49.9, 48.4, 33.2, 33.1, 26.0, 25.3, 24.0, 11.7. **IR** (thin film) 3332, 2936, 1654, 1522, 1359, 1119 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 364. **Anal.** Calcd. for $C_{19}H_{29}N_3O_4$: C, 62.79 ; H, 8.04. Found: C, 62.61 ; H, 8.42.

N-Cyclohexyl-2-[*N*-(2,2-dimethoxyethyl)-*N*-(2-nitrophenyl)amino]butyramide **2b**

The typical procedure was followed employing the *ortho*-nitrophenol **1a** (110 mg, 0.8 mmol) to afford the compound **2b** (206 mg, 64%, 16 hours, 60°C) as an yellow oil by flash chromatography on silica gel (petroleum ether/Et_2O: 60/40). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 7.70 (dd, 1H, *J* = 8.1, 1.5 Hz), 7.52 (td, 1H, *J* = 7.6, 1.5 Hz), 7.39 (dd, 1H, *J* = 7.6, 1.0 Hz), 7.33 (br s, 1H), 7.21 (ddd, 1H, *J* = 8.1, 7.6, 1.0 Hz), 4.24 (dd, 1H, *J* = 6.6, 4.3 Hz), 3.80-3.70 (m, 1H), 3.64 (t, 1H, *J* = 6.6 Hz), 3.36 (dd, 1H, *J* = 13.9, 6.6 Hz), 3.30 (s, 3H), 3.24 (s, 3H), 3.10 (dd, 1H, *J* = 13.9, 4.3 Hz), 2.01-1.81 (m, 2H), 1.78-1.57 (m, 4H), 1.46-1.04 (m, 6H), 0.92 (t, 3H, *J* = 7.6 Hz). **^{13}C NMR** ($CDCl_3$, 100.6 MHz) δ 170.9, 147.1, 143.4, 133.1, 125.8, 125.5, 124.6, 102.6, 70.5, 55.1, 54.3, 52.1, 48.4, 33.4, 33.1, 26.0, 25.3, 23.9, 11.8. **IR** (thin film) 3366, 2931, 2852, 1528, 1450, 1128 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 393. **HRMS** Calcd. for $C_{20}H_{31}N_3O_5$ 393.2264, Found 393.2267.

Ethyl 2-[2-(*N*-(4-chlorobenzyl)-*N*-(2-nitrophenyl)amino)butyramido]acetate **2c**

The typical procedure was followed employing the *ortho*-nitrophenol **1a** (110 mg, 0.8 mmol) to afford the compound **2c** (208 mg, 60%, 16 hours, 60°C) as a brown solid by flash chromatography on silica gel (petroleum ether/ Et_2O: 70/30). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 7.66 (dd, 1H, *J* = 8.1, 1.5 Hz), 7.44 (td, 1H, *J* = 7.6, 1.3 Hz), 7.30-7.08 (m, 7H), 4.35 (d, 1H, *J* = 14.4 Hz), 4.22 (q, 2H, *J* = 7.3 Hz), 4.20 (d, 1H, *J* = 14.4 Hz), 4.11 (d, 2H, *J* = 5.6 Hz), 3.67 (dd, 1H, *J* = 9.3, 4.8 Hz), 2.01-1.89 (m, 1H), 1.73-1.62 (m, 1H), 1.28 (t, 3H, *J* = 7.3 Hz), 0.91 (t, 3H, *J* = 7.3 Hz). **^{13}C NMR** ($CDCl_3$, 100.6 MHz) δ 172.9, 169.9, 147.5, 142.2, 135.2, 133.6, 133.08, 130.5, 128.9, 126.9, 125.6, 125.2, 70.0, 61.9, 54.4, 41.7, 23.3, 14.6, 11.6. **IR** (thin film) 3404, 3054, 2985, 1743, 1679, 1424 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 435. **HRMS** Calcd. for $C_{21}H_{24}ClN_3O_5$ 433.1404, Found 433.1409. **mp** 79°C.

[*N*-(4-Chlorobenzyl)-*N*-(2-nitrophenyl)amino]-2-(4-chlorophenyl)-*N*-cyclohexylacetamide **2d**

The typical procedure was followed employing the *ortho*-nitrophenol **1a** (110 mg, 0.8 mmol) to afford the compound **2d** (328 mg, 80%, 20 hours, 60°C) as an yellow solid by flash chromatography on silica gel (petroleum ether/ Et_2O: 80/20). **^{1}H NMR** ($CDCl_3$, 400 MHz) δ 7.67 (dd, 1H, *J* = 8.1, 1.5 Hz), 7.47-7.33 (m, 4H), 7.28-7.22 (m, 2H), 7.18-7.12 (m, 3H), 6.96 (d, 1H, *J* = 7.1 Hz), 6.65 (d, 2H, *J* = 8.1 Hz), 4.80 (s, 1H), 4.01 (d, 1H, *J* = 14.1 Hz), 3.95 (d, 1H, *J* = 14.1 Hz), 3.53-3.46 (m, 1H), 1.72-1.50 (m, 4H), 1.45-1.25 (m, 4H), 1.15-1.04 (m, 2H). **^{13}C NMR** ($CDCl_3$, 100.6 MHz) δ 169.8, 147.8, 141.9, 135.0, 134.8, 134.4, 132.9, 133.0, 131.2, 130.3, 129.3, 128.9, 127.3, 126.1, 124.9, 71.2, 57.0, 48.2, 32.8, 25.7, 24.9, 22.7. **IR** (thin film) 3332, 2929, 2854, 1662, 1522, 1364, 1090, 1015 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 513 (M+2). **Anal.** Calcd for $C_{27}H_{27}Cl_2N_3O_3$: C, 63.28 ; H, 5.31. Found: C, 63.24 ; H, 5.56. **mp** 156°C.

2-[*N*-(4-chlorobenzyl)-*N*-(3-nitropyridin-2-yl)amino]-*N*-Cyclohexylbutyramide **2f**

The typical procedure was followed employing the *ortho*-nitrophenol **1b** (110 mg, 0.8 mmol) to afford the compound **2f** (234 mg, 68%, 16 hours, 60°C) as an yellow oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 90/10). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.39 (dd, 1H, *J* = 4.5, 1.7 Hz), 8.00 (dd, 1H, *J* = 8.1, 1.7 Hz), 7.32 (br s, 1H), 7.11 (d, 2H, *J* = 8.3 Hz), 6.91 (d, 2H, *J* = 8.3 Hz), 6.81 (dd, 1H, *J* = 8.1, 4.5 Hz), 4.79 (dd, 1H, *J* = 8.8, 6.3 Hz), 4.67 (d, 1H, *J* = 15.8 Hz), 4.55 (d, 1H, *J* = 15.8 Hz), 3.90-3.77 (m, 1H), 2.18-2.00 (m, 1H), 2.06-1.96 (m, 3H), 1.88-1.56 (m, 6H), 1.46-1.14 (m, 2H), 1.00 (t, 3H, *J* = 7.3 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 170.0, 152.4, 151.8, 135.8, 135.1, 134.8, 133.6, 129.9, 128.9, 115.2, 66.1, 49.7, 48.4, 33.5, 33.4, 25.9, 25.0, 22.9, 11.3. **IR** (thin film) 3323, 2935, 2861, 1667, 1515, 1335, 1256, 1092 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 431. **HRMS** Calcd. for $C_{22}H_{27}ClN_4O_3$ 430.1772, Found 430.1782.

2-[*N*-(4-chloro-benzyl)-*N*-(3-nitro-pyridin-2-yl)amino]-*N*-Cyclohexyl-2-methylbutyramide **2g**

The typical procedure was followed employing the *ortho*-nitrophenol **1b** (110 mg, 0.8 mmol) to afford the compound **2g** (180 mg, 25%, 10 days, 60°C) as a yellow oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 80/20). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.58 (dd, 1H, *J* = 4.6, 1.8 Hz), 7.92 (dd, 1H, *J* = 8.1, 1.8 Hz), 7.44 (br s, 1H), 7.12-7.06 (m, 3H), 6.86 (d, 2H, *J* = 8.4 Hz), 4.29 (d, 1H, *J* = 13.8 Hz), 4.20 (d, 1H, *J* = 13.8 Hz), 3.88-3.77 (m, 1H), 1.98-1.91 (m, 1H), 1.90-1.80 (m, 2H), 1.79-1.69 (m, 2H), 1.73 (s, 3H), 1.66-1.60 (m, 2H), 1.44-1.37 (m, 2H), 1.31-1.20 (m, 3H), 0.88 (t, 3H, *J* = 7.4 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 173.5, 153.5, 152.0, 135.6, 134.2, 133.8, 130.7, 129.7, 128.9, 119.9, 70.3, 53.8, 48.4, 33.6, 33.4, 32.3, 25.9, 25.2, 19.0, 9.0. **IR** (thin film) 3387, 2931, 2856, 1668, 1593, 1522, 1451, 1263 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 445. **HRMS** Calcd. for $C_{23}H_{29}ClN_4O_3$ 444.1928, Found 444.1950.

General procedure for synthesis of dehydroquinoxalines 3

A catalytic amount of Pd/C (10%) was added to a solution of the resulting arylamide in MeOH (0.5 M), the mixture was stirred at rt under hydrogen atmosphere for 24 h. Hydrogen was then replaced by argon and a catalytic amount of *p*-toluenesulfonic acid was added. The resulting mixture was stirred at rt for 24 h. After addition of a saturated aqueous solution of $NaHCO_3$, filtration, and extraction with Et_2O, the combined organic layers were washed with brine, dried over anhydrous $MgSO_4$, filtered and concentrated in vacuo. The crude product **3** was purified by flash chromatography on silica gel.

3-Ethyl-3,4-dihydro-4-(2-methoxyethyl)quinoxalin-2(1*H*)-one **3a**

The typical procedure was followed employing the arylamide **2a** (73 mg, 0.2 mmol) to afford the compound **3a** (40 mg, 85%) as an yellow oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 70/30). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.62 (br s, 1H), 7.02-6.96 (m, 1H), 6.80-6.70 (m, 3H), 3.86 (t, 1H, *J* = 6.8 Hz), 3.73-3.63 (m, 1H), 3.57 (t, 2H, *J* = 6.8 Hz), 3.37 (s, 3H), 3.41-3.31 (m, 1H), 1.72-1.60 (m, 2H), 0.95 (t, 3H, *J* = 7.3 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 168.9, 134.2, 126.7, 124.5, 119.1, 115.9, 113.5,

70.5, 64.6, 59.4, 50.1, 24.1, 10.4. **IR** (thin film) 3200, 2925, 1675, 1117 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 235. **HRMS** Calcd. for $C_{13}H_{18}N_2O_2$ 234.1368, found 234.1363.

Furthermore, this compound **3a** was obtained in 47% yield in one-pot procedure without isolation of the Ugi-Smiles intermediate **2a**.

3,4-Dihydro-4-(2,2-dimethoxyethyl)-3-ethylquinoxalin-2(1*H*)-one **3b**

The typical procedure was followed employing the arylamide **2b** (195 mg, 0.5 mmol) to afford the compound **3b** (80 mg, 61%) as a yellow oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 70/30). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 9.06 (br s, 1H), 7.01-6.96 (m, 1H), 6.80-6.73 (m, 3H), 4.47 (dd, 1H, *J* = 6.6, 3.5 Hz), 3.92 (t, 1H, *J* = 6.6 Hz), 3.70 (dd, 1H, *J* = 14.6, 3.5 Hz), 3.41 (s, 3H), 3.39 (s, 3H), 3.23 (dd, 1H, *J* = 14.6, 6.6 Hz), 1.70-1.61 (m, 2H), 0.95 (t, 3H, *J* = 7.8 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 168.9, 134.2, 126.7, 124.5, 119.3, 115.9, 113.8, 103.2, 65.0, 55.5, 54.4, 53.1, 24.3, 10.5. **I.R.** (thin film) 3208, 3057, 2930, 1681, 1440, 1303, 1125 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 265. **HRMS** Calcd. for $C_{14}H_{20}N_2O_3$ 264.1474, Found 264.1484.

4-(4-Chlorobenzyl)-3,4-dihydro-3-ethylquinoxalin-2(1*H*)-one **3c**

The typical procedure was followed employing the arylamide **2c** (82 mg, 0.19 mmol) to afford the compound **3c** (38 mg, 67%) as a brown oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 80/20). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 9.52 (br s, 1H), 7.36-7.24 (m, 4H), 6.96-6.89 (m, 1H), 6.85 (d, 1H, *J* = 7.5 Hz), 6.82-6.76 (m, 1H), 6.65 (d, 1H, *J* = 8.0 Hz), 4.66 (d, 1H, *J* = 15.4 Hz), 4.28 (d, 1H, *J* = 15.4 Hz), 3.83 (dd, 1H, *J* = 6.8, 6.5 Hz), 1.78-1.61 (m, 2H), 0.96 (t, 3H, *J* = 7.5 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 169.2, 139.9, 134.3, 133.6, 129.3, 129.2, 127.9, 126.7, 124.5, 115.9, 112.9, 63.9, 52.9, 23.0, 10.7. **I.R.** (thin film) 3307, 3055, 2977, 1684, 1503, 1431, 1162 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 300. **HRMS** Calcd. for $C_{17}H_{17}ClN_2O$ 300.1029, Found 300.1022.

4-(4-Chlorobenzyl)-3-(4-chlorophenyl)-3,4-dihydroquinoxalin-2(1*H*)-one **3d**

The typical procedure was followed employing the arylamide **2d** (170 mg, 0.35 mmol) to afford the compound **3d** (80 mg, 61%) as a brown oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 80/20). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.81 (br s, 1H), 7.34-7.19 (m, 6H), 7.13 (d, 2H, *J* = 8.3 Hz), 7.02-6.96 (m, 1H), 6.85-6.80 (m, 2H), 6.71 (d, 1H, *J* = 8.3 Hz), 4.93 (s, 1H), 4.65 (d, 1H, *J* = 15.6 Hz), 4.06 (d, 1H, *J* = 15.6 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 166.6, 135.6, 135.0, 134.9, 134.1, 133.9, 129.5, 129.4, 125.6, 125.6, 119.8, 116.1, 112.9, 64.9, 51.7. **I.R.** (thin film) 3417, 3053, 2985, 1687, 1424, 1158, 1098 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 384 (M+2). **HRMS** Calcd. for $C_{21}H_{16}Cl_2N_2O$ 382.0640, Found 382.0631.

4-(4-Chlorobenzyl)-3-ethyl-3,4-dihydropyrido[3,2-*b*]pyrazin-2(1*H*)-one **3f**

The typical procedure was followed employing the arylamide **2f** (110 mg, 0.25 mmol) to afford the compound **3f** (40 mg, 53%) as an yellow oil by flash chromatography on silica gel (petroleum ether/ Et_2O:

70/30). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.65 (br s, 1H), 7.88 (dd, 1H, *J* = 5.3, 1.3 Hz), 7.33-7.26 (m, 4H), 6.92 (dd, 1H, *J* = 7.3, 1.3 Hz), 6.65 (dd, 1H, *J* = 7.3, 5.3 Hz), 5.52 (d, 1H, *J* = 15.4 Hz), 4.18 (d, 1H, *J* = 15.4 Hz), 4.00 (dd, 1H, *J* = 7.1, 4.3 Hz), 1.91-1.69 (m, 2H), 0.91 (t, 3H, *J* = 7.3 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 167.1, 146.3, 142.7, 136.4, 133.6, 129.8, 129.2, 121.0, 120.5, 120.5, 61.5, 48.1, 24.2, 9.7. **IR** (thin film) 3388, 2927, 1686, 1612, 1488, 1159, 1098 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 302. **HRMS** Calcd. for $C_{16}H_{16}ClN_3O$ 301.0982, Found 301.0972.

4-(4-Chlorobenzyl)-3-ethyl-3-methyl-3,4-dihydropyrido[3,2-*b*]pyrazin-2(1*H*)-one **3g**

The typical procedure was followed employing the arylamide **2g** (180 mg, 0.4 mmol) to afford the compound **3f** (70 mg, 55%) as an yellow oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 80/20). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 7.83 (dd, 1H, *J* = 4.2 Hz), 7.40 (br s, 1H), 7.27-7.19 (m, 4H), 6.73 (s, 1H), 5.19 (d, 1H, *J* = 16.1 Hz), 4.27 (d, 1H, *J* = 16.1 Hz), 2.07-1.94 (m, 1H), 1.91-1.81 (m, 1H), 1.57 (s, 3H), 0.81 (t, 3H, *J* = 7.1 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 163.5, 145.8, 143.0, 138.6, 132.7, 128.8, 128.6, 120.3, 118.6, 114.7, 66.8, 45.0, 31.8, 24.7, 9.3. **IR** (thin film) 3412, 2924, 1665, 1473, 1117 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 333 ($M+NH_4^+$). **HRMS** Calcd. for $C_{17}H_{18}ClN_3O$ 315.1138, Found 315.1152.

General procedure for iodinated phenol Ugi-4CR

To a 1 M solution of the aldehyde (0.8 mmol) in a 9:1 mixture of toluene and water were added successively 1.0 equiv. of amine, 1.0 equiv. of isocyanide, 1.0 equiv. of phenol **1c-d** and 1.0 equiv. of ammonium chloride. The resulting mixture was stirred at 100°C until completion (TLC). It was then concentrated in vacuo and the crude products **2h-k** were purified by flash chromatography on silica gel.

2-[*N*-Allyl-*N*-(2-iodo-4-nitrophenyl)amino]-*N*-(4-chlorobenzyl)-4-methylpentanamide **2h**

The typical procedure was followed employing the 2-iodo-4-nitrophenol **1c** (205 mg, 0.8 mmol) to afford the compound **2h** (270 mg, 64%, 13 h) as an yellow oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 90/10). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.68 (d, 1H, *J* = 2.6 Hz), 8.17 (dd, 1H, *J* = 8.9, 2.6 Hz), 7.29-7.28 (m, 2H), 7.19-7.15 (m, 3H), 7.07 (br s, 1H), 5.63 (dddd, 1H, *J* = 17.1, 10.3, 6.0, 5.6 Hz), 5.09 (dd, 1H, *J* = 10.3, 1.2 Hz), 5.03 (dd, 1H, *J* = 17.1, 1.2 Hz), 4.45 (dd, 1H, *J* = 14.7, 6.1 Hz), 4.41 (dd, 1H, *J* = 14.7, 5.9 Hz), 4.03 (dd, 1H, *J* = 8.7, 5.1 Hz), 3.91 (dd, 1H, *J* = 15.9, 6.0 Hz), 3.60 (dd, 1H, *J* = 15.9, 5.6 Hz), 1.93-1.85 (m, 1H), 1.66-1.54 (m, 1H), 1.49-1.40 (m, 1H), 0.81 (d, 3H, *J* = 6.5 Hz), 0.80 (d, 3H, *J* = 6.5 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 171.7, 156.0, 144.4, 136.9, 136.3, 133.8, 132.7, 129.7, 129.2, 124.9, 124.3, 119.5, 97.9, 69.3, 52.3, 43.3, 38.5, 25.9, 23.9, 22.4. **IR** (thin film) 3386, 3083, 1662, 1578, 1515, 1339, 1163 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 542. **HRMS** Calcd. for $C_{22}H_{25}ClN_3O_3$ 541.0629, Found 541.0612.

2-[*N*-Allyl-*N*-(2-iodo-4-nitrophenyl)amino]-*N*-cyclohexyl-4-methylpentanamide **2i**

The typical procedure was followed employing the 2-iodo-4-nitrophenol **1c** (205 mg, 0.8 mmol) to afford the compound **2i** (95 mg, 24%, 20 h) as an yellow oil by flash chromatography on silica gel (petroleum

ether/ Et_2O: 80/20). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.75 (d, 1H, *J* = 2.7 Hz), 8.19 (dd, 1H, *J* = 8.9, 2.7 Hz), 7.19 (d, 1H, *J* = 8.9 Hz), 6.74 (d, 1H, *J* = 8.6 Hz), 5.70 (ddt, 1H, *J* = 17.2, 10.6, 5.7 Hz), 5.13 (dd, 1H, *J* = 10.6, 1.7 Hz), 5.09 (dd, 1H, *J* = 17.1, 1.3 Hz), 3.97 (dd, 1H, *J* = 8.4, 5.3 Hz), 3.95-3.89 (m, 1H), 3.86-3.76 (m, 1H), 3.63 (dd, 1H, *J* = 16.2, 5.7 Hz), 1.91-1.83 (m, 2H), 1.75-1.55 (m, 5H), 1.45-1.32 (m, 2H), 1.23-1.09 (m, 4H), 0.79 (d, 3H, *J* = 6.5 Hz), 0.77 (d, 3H, *J* = 6.5 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 170.5, 156.4, 144.3, 136.3, 133.0, 124.9, 124.3, 119.3, 97.7, 65.4, 52.1, 48.5, 38.6, 33.6, 33.3, 26.0, 25.8, 25.1, 25.0, 23.3, 22.5. **IR** (thin film) 3392, 2931, 2858, 1664, 1595, 1517, 1463, 1340, 1160 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 499. **HRMS** Calcd. for $C_{21}H_{30}IN_3O_3$ 499.1332 , Found 499.1323.

N-(4-Chlorobenzyl)-2-[*N*-(4-chlorobenzyl)-*N*-(6-chloro-2-iodo-4-nitrophenyl)amino]-4-methylpentan-amide **2j**

The typical procedure was followed employing the 2-chloro-6-iodo-4-nitrophenol **1d** (240 mg, 0.8 mmol) to afford a 2:1 mixture of atropomers A:B of the compound **2j** (400 mg, 82%, 24 h) as an yellow oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 95/5). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.05 (d, $1H_A$, *J* = 2.4 Hz), 7.92 (d, $1H_B$, *J* = 2.5 Hz), 7.85 (t, $1H_B$, *J* = 5.4 Hz), 7.61 (d, $1H_B$, *J* = 2.5 Hz), 7.38-7.29 (m, $11H_A$, $6H_B$), 7.07 (d, $2H_B$, *J* = 8.5 Hz), 7.04 (d, $4H_A$, *J* = 8.3 Hz), 6.80 (d, $2H_B$, *J* = 8.5 Hz), 6.46 (d, $4H_A$, *J* = 8.3 Hz), 4.66-4.57 (m, $4H_A$, $1H_B$), 4.50-4.39 (m, $4H_A$, $1H_B$), 4.05 (dd, $1H_B$, *J* = 12.0, 4.1 Hz), 3.96 (d, $1H_B$, *J* = 13.3 Hz), 3.77 (d, $1H_B$, *J* = 13.3 Hz), 3.66 (d, $1H_A$, *J* = 12.6 Hz), 1.72-1.62 (m, $1H_B$, $2H_A$), 1.57-1.49 (m, $1H_B$, $2H_A$), 1.09 (d, $6H_A$, *J* = 6.4 Hz), 1.04 (d, $3H_B$, *J* = 6.4 Hz), 1.02-095 (m, $1H_B$, $2H_A$), 0.84 (d, $3H_B$, *J* = 6.4 Hz), 0.82 (d, $6H_A$, *J* = 6.4 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 173.5 (C_A), 173.0 (C_B), 154.7 (C_A), 151.1 (C_B), 144.4 (C_A), 143.0 (C_B), 139.0 (C_A), 138.7 (C_B), 137.6 (C_A), 137.7 (C_B), 134.5, 134.3, 134.2, 134.0, 133.8 (C_A and C_B), 131.6 (C_B), 131.4 (C_A), 129.9, 129.4 (C_A, C_B), 129.1 (C_A), 128.7, 126.2, 124.4 (C_B), 112.3 (C_B), 98.2 (C_A), 69.9 (C_B), 66.0 (C_A), 57.0 (C_B), 55.8 (C_A), 43.1 (C_B), 42.9 (C_A), 40.9(C_B), 40.8 (C_A), 25.6 (C_B), 25.5 (C_A), 24.7 (C_A), 24.6 (C_B), 21.7 (C_A), 21.5 (C_B). **IR** (thin film) 3389, 3055, 2959, 1671, 1532, 1437, 1356, 1094 cm^{-1}. **HRMS** Calcd. for $C_{26}H_{25}ICl_3N_3O_3$ 659.0006, Found 658.9992.

2-[*N*-Allyl-*N*-(2-chloro-6-iodo-4-nitrophenyl)amino]-*N*-(4-chlorobenzyl)-2-(4-methoxyphenyl)acetamide **2k**

The typical procedure was followed employing the 2-chloro-6-iodo-4-nitrophenol **1d** (240 mg, 0.8 mmol) to afford a 2.5:1 mixture of atropomers A:B of the compound **2k** (360 mg, 74%, 3 days) as an yellow oil by flash chromatography on silica gel (petroleum ether/ Et_2O: 80/20). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.01 (d, $2.5H_A$, *J* = 2.5 Hz), 7.97 (t, $2.5H_A$, *J* = 5.7 Hz), 7.82 (d, $1H_B$, *J* = 2.5 Hz), 7.57 (d, $2.5H_A$, *J* = 2.5 Hz), 7.54 (d, $1H_B$, *J* = 2.5 Hz), 7.48 (d, $2H_B$, *J* = 8.7 Hz), 7.33-7.26 (m, $5H_A$, $3H_B$), 7.21 (d, $5H_A$, *J* = 8.4 Hz), 7.13 (d, $2H_B$, *J* = 8.3 Hz), 6.98 (d, $5H_A$, *J* = 8.7 Hz), 6.73 (d, $2H_B$, *J* = 8.7 Hz), 6.64 (d, $5H_A$, *J* = 8.7 Hz), 5.97 (ddt, $2.5H_A$, *J* = 17.2, 9.9, 7.4 Hz), 5.72 (ddt, $1H_B$, *J* = 16.7, 9.8, 6.6 Hz), 5.23 (s, $1H_A$), 5.29 (dd, $2.5H_A$, *J* = 17.2, 1.2 Hz), 5.07 (dd, $2.5H_A$, *J* = 9.8, 1.2 Hz), 5.00 (d, $1H_B$, *J* = 16.7 Hz), 4.98 (d, $1H_B$, *J* = 9.8 Hz), 4.87 (s,

2.5H_A), 4.48 (dd, 2.5H_A, *J* = 14.7, 5.8 Hz), 4.44 (dd, 2.5H_A, *J* = 14.7, 5.6 Hz), 4.37 (d, 2H_B, *J* = 6.1 Hz), 4.00-3.91 (m, 2.5H_A, 1H_B), 3.87-3.79 (m, 2.5H_A), 3.77 (s, 3H_B), 3.74 (s, 7.5H_A), 3.57-3.49 (m, 1H_B). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 171.4 (C_A), 171.3 (C_B), 160.0 (C_A), 159.9 (C_B), 152.5 (C_B), 149.3 (C_A), 144.3 (C_A), 143.7 (C_B), 141.7 (C_A, C_B), 136.9 (C_A, C_B), 133.8, 133.3 (C_A, C_B), 132.7 (C_A, C_B), 130.7, 129.9, 129.6, 129.2, 129.1 (C_B, C_A), 127.7, 126.9 (C_A, C_B), 126.7, 125.0 (C_B, C_A), 121.2 (C_A), 120.8 (C_B), 114.3 (C_A), 114.1 (C_B), 110.7 (C_A), 72.5 (C_A), 72.0 (C_B), 59.4 (C_A, C_B), 55.6 (C_A, C_B), 43.3 (C_A), 43.1 (C_B). **IR** (thin film) 3368, 2927, 1668, 1526, 1458, 1349, 1176, 1093 cm^{-1}. **HRMS** Calcd. for $C_{25}H_{22}ICl_2N_3O_4$ 625.0032, Found 625.0020.

General procedure for the synthesis of benzopyrazinone by Cu-catalyzed intramolecular amidation

To a solution of arylamide **2h-k** in acetonitrile were added 10% mol of copper iodide, 20% mol of *L*-proline and 1 equiv. of K_3PO_4. The resulting mixture was stirred at 80°C under inert atmosphere until completion (TLC). It was then concentrated in vacuo and the crude products **3h-k** were purified with preparative chromatography.

4-Allyl-1-(4-chlorobenzyl)-3-isobutyl-7-nitro-3,4-dihydroquinoxalin-2(1*H*)-one **3h**

The typical procedure was followed employing the arylamide **2h** (40 mg, 0.074 mmol) to afford the compound **3h** (20 mg, 65%, 18 hours) as an yellow oil with preparative chromatography (petroleum ether/ Et_2O: 50/50). This compound was also obtained in 62% yield under microwave conditions (180°C, 80W, 80 min). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 7.93 (dd, 1H, *J* = 9.0, 2.4 Hz), 7.78 (d, 1H, *J* = 2.4 Hz), 7.34 (d, 2H, *J* = 8.5 Hz), 7.23 (d, 2H, *J* = 8.5 Hz), 6.72 (d, 1H, *J* = 9.0 Hz), 5.88 (dddd, 1H, *J* = 16.1, 10.1, 6.1, 5.4 Hz), 5.41 (dd, 1H, *J* = 16.1, 1.2 Hz), 5.36 (dd, 1H, *J* = 10.1, 1.2 Hz), 4.98 (d, 2H, *J* = 16.1 Hz), 4.24 (dd, 1H, *J* = 9.5, 5.0 Hz), 4.21 (dd, 1H, *J* = 15.5, 5.4 Hz), 3.88 (dd, 1H, *J* = 15.5, 6.1 Hz), 1.76-1.66 (m, 1H), 1.54-1.46 (m, 1H), 1.45-1.36 (m, 1H), 1.00 (d, 3H, *J* = 6.4 Hz), 0.93 (d, 3H, *J* = 6.7 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 166.1, 141.5, 139.6, 134.7, 134.0, 132.3, 129.6, 128.6, 128.1, 121.2, 119.9, 112.3, 111.3, 60.6, 52.6, 45.6, 39.1, 25.2, 23.6, 22.3. **IR** (thin film) 3380, 2959, 1681, 1592, 1518, 1447, 1333, 1116 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 414. **HRMS** Calcd. for $C_{22}H_{24}ClN_3O_2$ 415.1506, Found 413.1515.

4-Allyl-1-cyclohexyl-3-isobutyl-7-nitro-3,4-dihydroquinoxalin-2(1*H*)-one **3i**

The typical procedure was followed employing the arylamide **2i** (40 mg, 0.08 mmol) to afford the compound **3i** (18 mg, 61%, 16 h) as an yellow oil with preparative chromatography (petroleum ether/ Et_2O: 50/50). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 8.04 (d, 1H, *J* = 2.4 Hz), 7.94 (dd, 1H, *J* = 9.0, 2.4 Hz), 6.69 (d, 1H, *J* = 9.0 Hz), 5.88 (dddd, 1H, *J* = 16.3, 10.2, 6.2, 5.5 Hz), 5.33 (dd, 1H, *J* = 16.1, 1.3 Hz), 5.32 (dd, 1H, *J* = 10.2, 1.3 Hz), 4.35-4.25 (m, 1H), 4.12 (dd, 1H, *J* = 15.4, 6.2 Hz), 4.00 (dd, 1H, *J* = 9.3, 5.6 Hz), 3.79 (dd, 1H, *J* = 15.4, 5.5 Hz), 2.54-2.41 (m, 1H), 2.50-2.37 (m, 1H), 1.94-1.67 (m, 3H), 1.50-1.17 (m, 8H), 0.93 (d, 3H, *J* = 6.5 Hz), 0.85 (d, 3H, *J* = 6.5 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 167.4, 143.0, 139.5, 132.6, 128.9,

120.8, 119.7, 112.5, 112.1, 61.5, 58.0, 52.3, 37.9, 30.7, 28.9, 27.0, 26.6, 25.7, 25.2, 23.7, 23.4. **IR** (thin film) 3401, 3054, 2985, 1677, 1587, 1509, 1422, 1161 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 372. **HRMS** Calcd. for $C_{21}H_{29}N_3O_3$ 371.2209, Found 371.2194.

5-Chloro-1,4-bis-(4-chlorobenzyl)-3-isobutyl-7-nitro-3,4-dihydroquinoxalin-2(1*H*)-one **3j**

The typical procedure was followed employing the arylamide **2j** (85 mg, 0.14 mmol) to afford the compound **3j** (41 mg, 55%, 18 h) as an yellow oil with preparative chromatography (petroleum ether/EtOAc: 80/20). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 7.50 (s, 1H), 7.36 (d, 2H, *J* = 8.0 Hz), 7.31 (d, 2H, *J* = 7.9 Hz), 7.17 (d, 2H, *J* = 8.0 Hz), 7.09 (d, 2H, *J* = 7.9 Hz), 7.00 (s, 1H), 5.25 (d, 2H, *J* = 16.1 Hz), 4.81 (d, 1H, *J* = 16.1 Hz), 4.31 (d, 1H, *J* = 14.7 Hz), 4.31 (d, 1H, *J* = 14.7 Hz), 4.03 (d, 1H, *J* = 14.7 Hz), 3.80 (dd, 1H, *J* = 9.8, 5.0 Hz), 1.88-1.77 (m, 1H), 1.47-1.22 (m, 2H), 0.86 (d, 3H, *J* = 6.5 Hz), 0.77 (d, 3H, *J* = 6.5 Hz). **^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 168.8, 145.7, 137.3, 134.7, 134.2, 131.3, 130.7, 129.8, 129.6, 129.4, 128.2, 128.2, 119.7, 119.2, 59.1, 59.0, 53.9, 45.7, 39.9, 24.3, 23.5, 21.7. **IR** (thin film) 3410, 2927, 2857, 1688, 1599, 1533, 1462, 1371, 1095 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 532, 534. **HRMS** Calcd. for $C_{26}H_{24}Cl_3N_3O_3$ 531.0883, Found 531.0864.

1-Allyl-5-chloro-4-(4-chlorobenzyl)-3-(4-methoxyphenyl)-7-nitro-3,4-dihydroquinoxalin-2(1*H*)-one **3k**

The typical procedure was followed employing the arylamide **2k** (50 mg, 0.08 mmol) to afford the compound **3k** (20 mg, 45%, 2 days) as an yellow oil with preparative chromatography (petroleum ether/ Et_2O: 50/50). **^{1}H NMR ($CDCl_3$, 400 MHz)** δ 7.54 (d, 1H, *J* = 2.2 Hz), 7.37 (d, 2H, *J* = 8.7 Hz), 7.28 (d, 2H, *J* = 8.5 Hz), 7.05 (d, 2H, *J* = 8.5 Hz), 6.90 (d, 1H, *J* = 2.2 Hz), 6.83 (d, 2H, *J* = 8.7 Hz), 5.90 (dddd, 1H, *J* = 17.1, 10.0, 7.2, 5.9 Hz), 5.45 (d, 1H, *J* = 16.4 Hz), 5.34 (dd, 1H, *J* = 17.1, 1.1 Hz), 5.30 (dd, 1H, *J* = 10.0, 1.1 Hz), 5.21 (s, 1H), 4.93 (d, 1H, *J* = 16.4 Hz), 3.93 (dd, 1H, *J* = 14.7, 5.9 Hz), 3.78 (s, 3H), 3.77 (dd, 1H, *J* = 14.7, 7.2 Hz).**^{13}C NMR ($CDCl_3$, 100.6 MHz)** δ 168.6, 159.4, 144.9, 139.6, 134.4, 132.9, 132.6, 129.9, 129.6, 129.4, 128.4, 127.6, 127.0, 121.4, 120.4, 115.5, 62.8, 58.9, 55.6, 46.1. **IR** (thin film) 3394, 3053, 2928, 1660, 1603, 1464, 1382, 1161, 1096 cm^{-1}. **MS (DI, CI NH_3)** *m/z* 497, 499. **HRMS** Calcd. for $C_{25}H_{21}Cl_2N_3O_4$ 497.0909, Found 497.0922.

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