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Electrocatalytic Tandem Synthesis of 1,3-Disubstituted Imidazo[1,5-*a*]quinolines via Sequential Dual Oxidative C(sp3)−H Amination in Aqueous Medium

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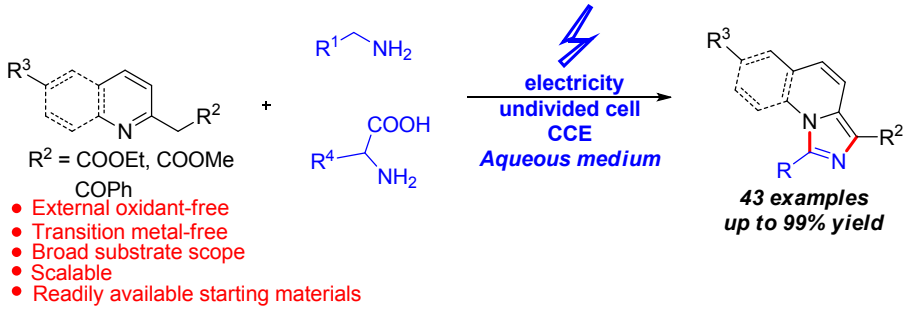


ABSTRACT: An NH_4I-mediated tandem electrosynthesis of 1,3-disubstituted imidazo[1,5-*a*]quinolines was developed from readily available starting materials in aqueous medium, affording a variety of 1,3-disubstituted imidazo[1,5-*a*]quinolines with good to excellent yields.

Introduction

N-containing compounds are widely existed in pharmaceutical, agrochemical and material industries.[1] Methods development for direct C(sp3)−H/N−H oxidative coupling to construct C−N bonds in a more efficient and sustainable manner has been pursued by organic chemists.[2, 3] The rapid growth in direct amination of C(sp3)−H bonds catalysed by transition-metals has been witnessed in recent years.[2d-e] However, the residue of transition metal catalysts on drugs synthesis leads to concern about human healthy. Afterwards, some metal-free amination reactions[3] were reported in the presence of stoichiometric chemical oxidants. Nevertheless, the usage of stoichiometric chemical oxidants inevitably leads to waste, undesired reactions and low atom economy. Therefore, it remains to be desirable and challenging for organic chemists to construct C−N bonds under metal catalysts and chemical oxidants free conditions.

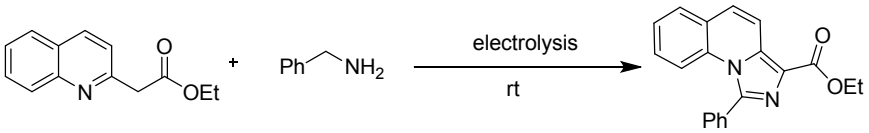
Organic electrochemistry provides the possibility for C−N formation because it employs electrons as reagents.[4, 5] In general, the electrochemical reaction can be performed at room temperature without the use of chemical oxidants, which makes it safety and low cost for large-scale industrial application. Recently, organic electrochemistry has undergone a renaissance. Major elegant contributions have been made by Moeller,[6] Xu,[7] Yoshida[8] Lei,[9] Mei,[10] and Ackermannm[11] for C(sp2)–H amination reactions. However, the direct intermolecular C(sp3)–H amination cyclization of reactions have not been explored yet.

1,3-Disubstituted imidazo[1,5-*a*]quinolines as one of the important scaffolds in N-containing compounds, are widely present in pharmaceutical agent molecules and optoelectronic materials.[12] However, the reported methods[13] usually suffered from the metal catalysts, chemical oxidants and high temperature. To overcome these issues and in continuation of our recent work on electrochemistry in the presence of iodine,[14] we herein report a tandem electrosynthesis of 1,3-disubstituted imidazo[1,5-*a*]quinolines from readily available amines and amino acids under mediation of NH_4I in aqueous medium at room temperature in the absence of metal and external chemical oxidants. To the best of our knowledge, this work should represent one of the most simple, green and efficient approach for the construction of 1,3-disubstituted imidazo[1,5-*a*]quinolines under mild conditions.

Results and Discussion

Initially, the model reaction of ethyl 2-(quinolin-2-yl)acetate **1a** with benzylamine **2a** was electrolyzed in an undivided cell at a constant current density of 15 mA/cm^2, while KI was used as the supporting salt in the co-solvent of CH_3CN/H_2O (5 : 1). Gratifyingly, the desired product was obtained with a yield of 66% (Table 1, entry 1). Inspired by this result, the supporting salts were firstly investigated. All iodide salts could conduct this reaction smoothly while either NH_4Br or $LiClO_4$ hardly afforded the desired products (entries 5 and 6). Among these tested iodide salts,

Table 1. Optimization of the Reaction Conditions[a]



1a **2a** **3aa**

entry	electrolyte	solvent	anode/cathode	j (mA/cm^2)	yield (%)[b]
1	KI	CH_3CN/H_2O	Pt/Pt	15	66
2	Me_4NI	CH_3CN/H_2O	Pt/Pt	15	65
3	*n*-Bu_4NI	CH_3CN/H_2O	Pt/Pt	15	82
4	NH_4I	CH_3CN/H_2O	Pt/Pt	15	95
5	NH_4Br	CH_3CN/H_2O	Pt/Pt	15	trace
6	$LiClO_4$	CH_3CN/H_2O	Pt/Pt	15	n. d.
7[c]	NH_4I	CH_3CN/H_2O	Pt/Pt	15	65
8	NH_4I	CH_3CN/H_2O	Pt/Pt	20	83
9	NH_4I	CH_3CN/H_2O	Pt/Pt	10	92
10	NH_4I	CH_3CN/H_2O	C/Pt	15	65
11	NH_4I	CH_3CN/H_2O	Pt/C	15	71
12	NH_4I	EtOH	Pt/Pt	15	88
13	NH_4I	DMF	Pt/Pt	15	89

14	NH_4I	CH_3CN	Pt/Pt	15	91
15[d]	NH_4I	CH_3CN/H_2O	Pt/Pt	15	93
16[e]	NH_4I	CH_3CN/H_2O	Pt/Pt	15	91
17[f]	NH_4I	CH_3CN/H_2O	Pt/Pt	15	95

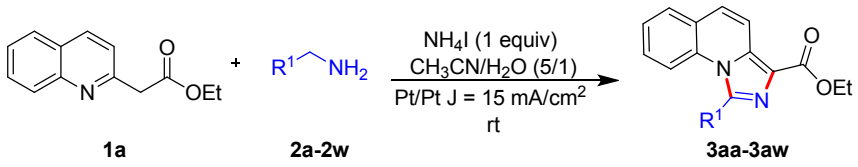
[a]Reaction conditions: **1a** (0.3 mmol), **2a** (1.2 mmol), electrolyte (0.3 mmol), CH_3CN/H_2O = 5:1 (3 mL); the electrolysis was conducted in an undivided cell at room temperature. [b]Yields of the isolated products. [c]The loading of NH_4I was 20 mol %. [d]The ration of CH_3CN/H_2O was 4:1. [e]Under O_2. [f]Under N_2. n. d. = not detected.

NH_4I gave the best result (entries 1−4). When we decreased the loading of NH_4I to 20 mol %, the reaction was still carried smoothly to afford the desired product with a moderate yield (entry 7). A sacrificial yield was observed when the current density was increased or decreased (entries 8 and 9). The experimental results showed that the Pt electrode was the optimal electrode materials both for anode and cathode (entries 10 and 11). Moreover, changing the solvent to EtOH, DMF, CH_3CN or the ration of CH_3CN/H_2O to 4 : 1 had little effect on the yield (entries 12−15). When the reaction was performed under an oxygen atmosphere or nitrogen atmosphere, the desired product can be obtained with yields of 91% and 95%, respectively (entries 16 and 17). These results indicated that the reaction atmosphere also had little influence on the yields. After investigation in detail, the optimal electrolytic conditions were described as entry 4 of table 1.

With the optimized electrolytic conditions established, we investigated the scope of aromatic benzylamines first under the standard conditions. As shown in Table 2, all of the substrates could tolerate this reaction well, providing the desired products **3aa**−**3av** with 78−96% yields. The electronic effect of the substituents on the phenyl ring of the benzylamines had little influence on the reaction. Both electron-donating and electron-withdrawing substitutions afforded the desired products with excellent yields (**3ab**−**3ag** vs **3ap** and **3aq**). Halide substituents, such as F, Cl, Br, were also proceeded smoothly to afford the desired products with 78−93% yields (**3ah**−**3ao**). When the ring-fused and the multi-substituted benzylamines were employed as substrates, the corresponding products can be obtained with 89% and 82% yields (**3ar** and **3as**), respectively. When the phenyl ring of the benzylamines was replaced by the heterocyclic rings, these heterocyclic rings can be compatible with the reaction conditions, giving the corresponding

product in 84−95% yields (**3at**−**3av**). However, for the aliphatic amines with long chain, no desired product was observed (**3aw**).

Table 2. The Scope of Amines[a]



1a **2a-2w** **3aa-3aw**

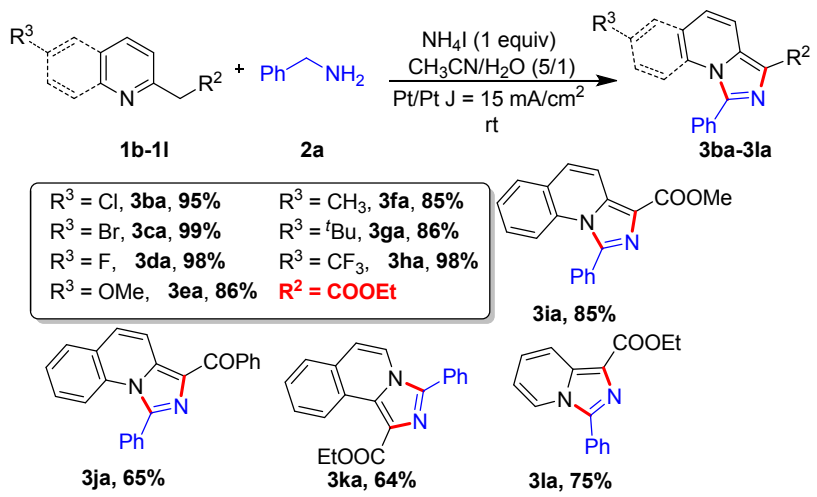
entry	R^1	product	yield (%)[b]
1	Ph (**2a**)	**3aa**	95
2	4-Me-Ph (**2b**)	**3ab**	90
3	3-Me-Ph (**2c**)	**3ac**	90
4	2-Me-Ph (**2d**)	**3ad**	89
5	4-OMe-Ph (**2e**)	**3ae**	91
6	2-OMe-Ph (**2f**)	**3af**	96
7	3,4-CH_2O-Ph (**2g**)	**3ag**	91
8	4-F-Ph (**2h**)	**3ah**	87
9	3-F-Ph (**2i**)	**3ai**	90
10	2-F-Ph (**2j**)	**3aj**	86
11	4-Cl-Ph (**2k**)	**3ak**	89
12	3-Cl-Ph (**2l**)	**3al**	91
13	2-Cl-Ph (**2m**)	**3am**	88
14	4-Br-Ph (**2n**)	**3an**	78
15	2-Br-Ph (**2o**)	**3ao**	93
16	4-CF_3-Ph (**2p**)	**3ap**	96

17	3-CF_3-Ph (**2q**)	**3aq**	90
18	1-naphthyl (**2r**)	**3ar**	89
19	2-Cl-4-F-Ph(**2s**)	**3as**	82
20	2-furyl (**2t**)	**3at**	87
21	2-thienyl (**2u**)	**3au**	84
22	2-pryidyl (**2v**)	**3av**	95
23	Bn (**2w**)	**3aw**	n.d.

[a]Reaction conditions: **1a** (0.3 mmol), **2a**-**2w** (1.2 mmol), NH_4I (0.3 mmol), CH_3CN/H_2O = 5:1 (3 mL); the electrolysis was conducted in an undivided cell at room temperature. [b]The isolated yields after column chromatography. n. d. = not detected.

Subsequently, a variety of ethyl 2-(quinolin-2-yl)acetate derivatives were also examined. As shown in scheme 1, both electron-donating and electron-withdrawing groups on the quinolinyl ring had influence on the reaction (**3ba**−**3ha**). Generally, the withdrawing groups of R^3 gave superior results to the donating groups of R^3 (**3ha** vs **3ea**−**3ga**). When R^2 was varied from COOEt to COOMe or benzoyl group, the reaction also worked well, affording the corresponding products with 85% and 65% yields, respectively (**3ia** and **3ja**). Furthermore, ethyl 2-(isoquinolin-1-yl)acetate **1k** and ethyl 2-(pyridin-2-yl)acetate **1l**, in which the quinolinyl ring was changed, were also good substrates in this reaction, providing the desired products with good yields (**3ka** and **3la**).

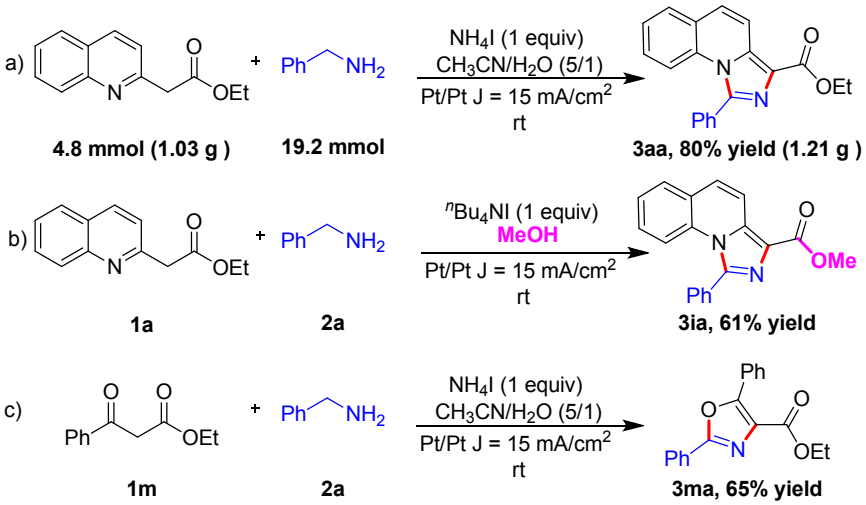
Scheme 1. **The Scope of 1**



[a]Reaction conditions: **1b-1l** (0.3 mmol), **2a** (1.2 mmol), NH_4I (0.3 mmol), CH_3CN/H_2O = 5:1 (3 mL); the electrolysis was conducted in an undivided cell at room temperature; the isolated yields after column chromatography.

To demonstrate the practicality of this reaction, a gram scale experiment was conducted (scheme 2a). Gratifyingly, the desired product **3aa** can be obtained with good yields. It was noted that an unexpected transfer esterification cyclizaiton product was obtained when the co-solvent was replaced by the methanol (scheme 2b). What is more, this electrocatalytic reaction can be also applied to the synthesis of polysubstituted oxazoles **3ma** in aqueous medium (scheme 2c), which further enhanced the practicality of this reaction.

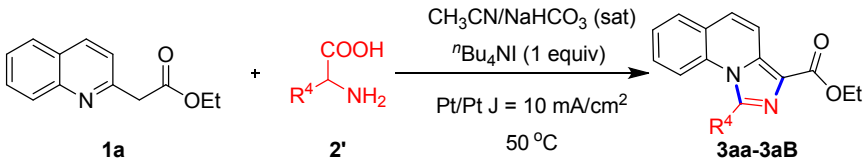
Scheme 2. **Gram-Scale and Transfer Esterification Cyclization Reaction.**



Recently, utilization of α-amino acids for the synthesis of heterocyclic compounds are increasing due to its low cost and readily available. Then we further extended the substrate scope by the use of the amino acids in place of amines with a modified condition (scheme 3). As expected, both aromatic and alkyl amino acids could proceed the reaction smoothly to afford the corresponding

products with moderate yields (**3aa**–**3aB**). The wide scope of amino acids provided a great practicality of this electrocatalytic reaction.

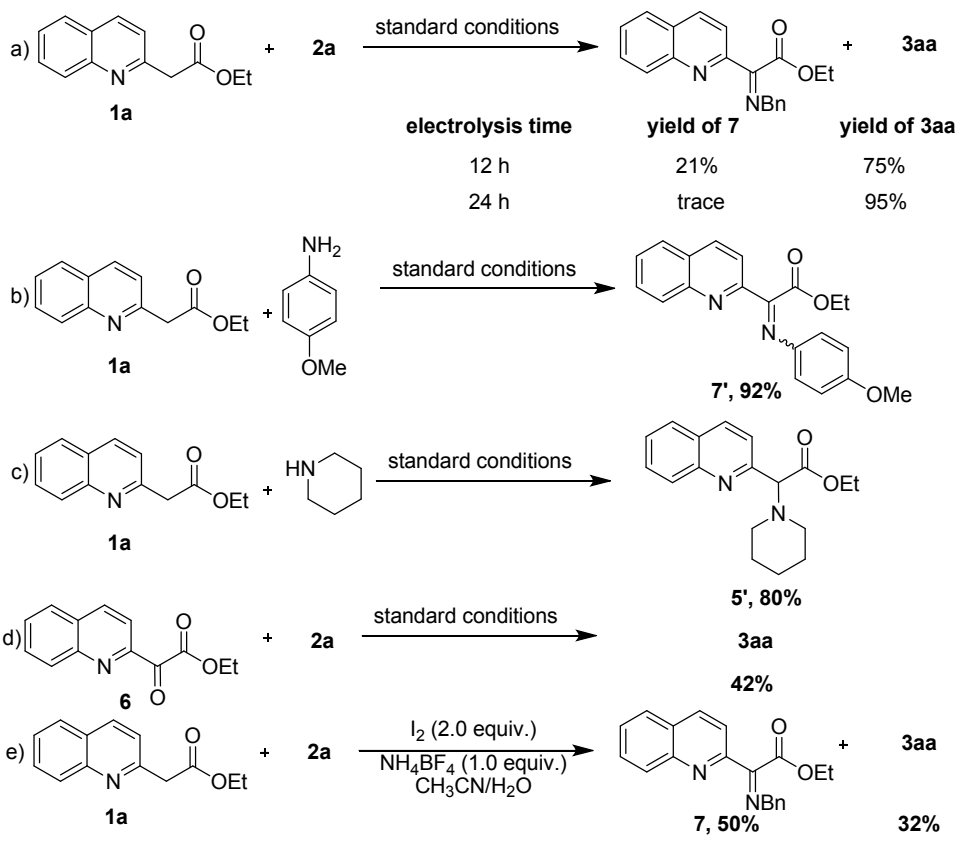
Scheme 3. **Electrosynthesis of 1,3-Disubstituted Imidazo[1,5-*a*]quinolines from Amino Acids.**



R^4 = Ph, **3aa**, **55%** R^4 =4-Me-Ph, **3ab**, **45%**
R^4=4-F-Ph, **3ah**, **51%**
R^4 =2-Cl-Ph, **3am**, **50%** R^4 = H, **3ax**, **50%**
R^4 = ^{n}Pr, **3ay**, **41%** R^4 = ^{i}Pr, **3az**, **38%**
R^4 = ^{s}Bu, **3aA**, **39%** R^4 = ^{i}Bu, **3aB**, **48%**

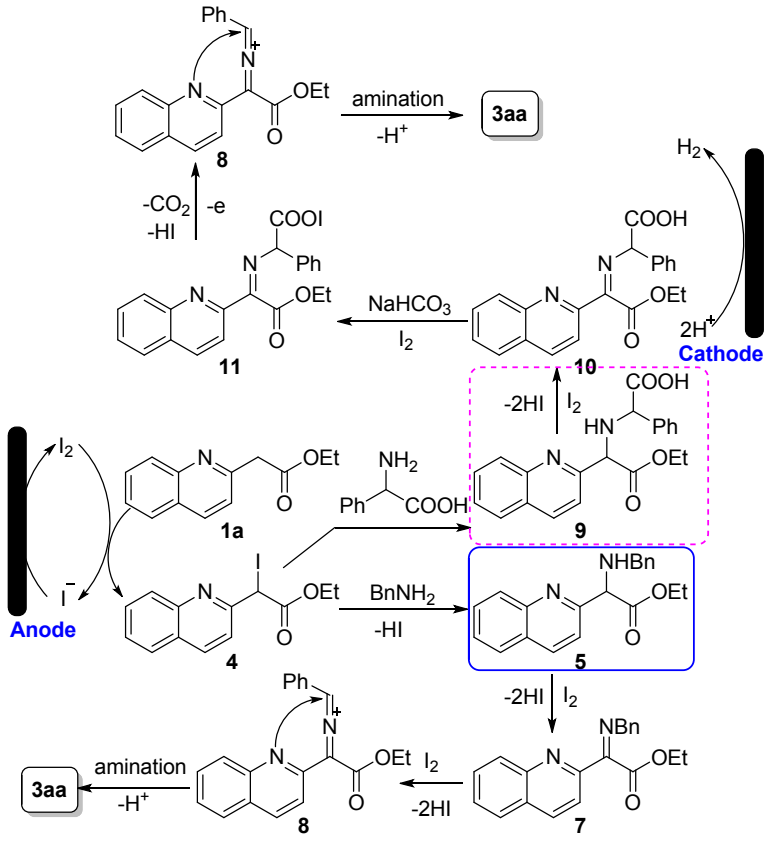
To gain a better understanding of the reaction mechanism, some control experiments were carried out (scheme 4). First, the reaction was intercepted to investigate the possible reaction intermediate. Actually, both amine **7** and desired product **3aa** could be observed when the model substrates were electrolyzed for 12 h. The imine **7** could be further transformed into **3aa** with a prolonged electrolysis time (scheme 4a). The imine intermediate could be further confirmed by the forming of ethyl 2-((4-methoxyphenyl)imino)-2-(quinolin-2-yl)acetate **7'** (scheme 4b). These results indicate that the imine **7** was a key intermediate under our conditions. Furthermore, when the secondary amine, such as piperidine, was used to replace benzylamine, an aminated product **5'** was obtained with 80% yield (scheme 4c). This result implies that the aminated intermediate may be also involved under our conditions, which could be further oxidized into the imine intermediate **7**. On the other hand, the imine intermediate **7** could be also formed via the condensation reaction between **6** and **2a**. When the compound **6** was employed under the standard conditions, only 42% yield of the desired product was obtained and the reaction mixture was messy (scheme 4d). This result indicates that the compound **6** was not the major intermediate in the reaction. When molecular iodine was employed as oxidant, the desired product and intermediate **7** were obtained with the yield of 32% and 50%, respectively (scheme 4e). These results suggest that the *in situ* electrogenerated molecular iodine should be the active specie in the reaction.

Scheme 4.**Control Experiments for the Reaction**



Based on the above-mentioned results and the previous reports,[13] a possible reaction mechanism was proposed and depicted in scheme 5. First, anodically *in situ* generated molecular iodine reacts with substrate **1a** to generate the iodinated intermediate **4**. The reaction between intermediate **4** and benzylamine **2a** gives intermediate **5**. Subsequently, the intermediate **5** could be sequentially oxidized in the presence of molecular iodine to yield intermediate **8**, which could be further converted to the desired product **3aa** through the tandem cyclization process. Meanwhile, the proton is reduced on the cathode surface with the liberation of hydrogen gas. In the case of phenylglycine as the coupling partner, it reacts with the iodinated intermediate **4** to afford intermediate **9**, followed by the oxidation of molecular iodine to give intermediate **10**. The intermediate **10** can convert to intermediate **11** in the presence of molecular iodine and sodium bicarbonate.[15] The intermediate **11** is unstable and easily undergoes decarboxylative/oxidative amination/aromatization process to give the final product **3aa**.

Scheme 5. Proposed Reaction Mechanism for the Formation of 3aa



In summary, we developed a facile and efficient approach for the electrosynthesis of 1,3-disubstituted imidazo[1,5-*a*]quinolines in aqueous medium under the metal and chemical oxidants free conditions. A wide scope of substrates, readily available starting materials and gram-scale experiments made this reaction practicality.

Experimental Section

General Information: All products were characterized by ^{1}H NMR and ^{13}C{^{1}H}NMR, using TMS as an internal reference (^{1}H NMR: 400MHz, ^{13}C{^{1}H}NMR: 100MHz). HRMS (ESI) data were recorded on a Q-TOF Premier. Commercial reagent and solvents were used without purification unless otherwise indicated.

Preparation of Substrates: Substrates **1l**, **1m** and **2** are commercially available. Substrates **1f**, **1i** and **1j** were prepared according to the previously reported procedures.[16-18] Other substrates **1 (1a-1e, 1g, 1h** and **1k)** were synthesized by using our previous literature procedure.[19]

General Procedures for the Synthesis of 1: A mixture of 7.08 g diisopropylamine (9.8 mL, 70 mmol) and 10 mL of dried THF was added to a three-necked flask by syringe under N_2. After cooling down to -78 °C, 28.4 mL of *n*-butyl lithium (2.4 M in hexane, 68 mmol) was slowly added. The mixture was stirred for 30 minutes. Then 3.5 g of 2-methyl quinoline (3.3 mL, 24 mmol) was

slowly added. The colour turned to orange rapidly then dark-brown. After 30 minutes, 10.6 g of diethyl carbonate (11 mL, 90 mmol) was added and the mixture was stirred for 2 hours. The reaction was quenched by 10 mL of water followed by extracted by EtOAc. The combined organic layers were dried over Na_2SO_4 and evaporated in vacuo. The residue was purified by silica gel column chromatography (petroleum ether / ethyl acetate = 20:1) to give **1a** as a light yellow oil: (3.8 g, 74%); ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.14 (d, J = 8.4 Hz, 1H), 8.07 (d, J = 8.7 Hz, 1H), 7.82−7.80 (m, 1H), 7.73−7.68 (m, 1H), 7.55−7.51 (m, 1H), 7.44 (d, J = 8.4 Hz, 1H), 4.20 (q, J = 7.1 Hz, 2H), 4.04 (s, 2H), 1.27 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 170.5, 154.8, 147.8, 136.7, 129.6, 129.1, 127.5, 127.1, 126.4, 121.8, 61.1, 44.8, 14.2. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{13}H_{14}NO_2$ 216.1025; Found 216.1023.

Synthesis of 1b: The title compound was prepared according to the general working procedure for the synthesis of **1** using 6-chloro-2-methylquinoline (10 mmol, 1.77 g) as the starting material in 70% (1.74 g) yield as yellow solid. m.p. 101–103 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.05 (d, J = 8.5 Hz, 1H), 8.00 (d, J = 9.0 Hz, 1H), 7.79−7.78 (m, 1H), 7.65−7.62 (m, 1H), 7.46 (d, J = 8.5 Hz, 1H), 4.20 (q, J = 7.1 Hz, 2H), 4.03 (s, 2H), 1.27 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 170.3, 155.2, 146.1, 135.8, 132.2, 130.7, 130.6, 127.6, 126.2, 122.7, 61.2, 44.7, 14.2. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{13}H_{13}ClNO_2$ 250.0635; Found 250.0634.

Synthesis of 1c: The title compound was prepared according to the general working procedure for the synthesis of **1** using 6-bromo-2-methylquinoline (10 mmol, 2.21 g) as the starting material in 75% (2.20 g) yield as yellow solid. m.p. 104–106 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.05 (d, J = 8.5 Hz, 1H), 7.97−7.93 (m, 2H), 7.78−7.75 (m, 1H), 7.46 (d, J = 8.5 Hz, 1H), 4.20 (q, J = 7.1 Hz, 2H), 4.03 (s, 2H), 1.27 (t, J = 7.2 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 170.2, 155.3, 146.3, 135.7, 133.1, 130.8, 129.6, 128.2, 122.7, 120.3, 61.2, 44.7, 14.2. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{13}H_{13}BrNO_2$ 294.0130; Found 294.0131.

Synthesis of 1d: The title compound was prepared according to the general working procedure for the synthesis of **1** using 6-fluoro-2-methylquinoline (10 mmol, 1.61 g) as the starting material in 60% (1.40 g) yield as yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.08−8.03 (m, 2H), 7.48−7.39 (m, 3H), 4.20 (q, J = 7.1 Hz, 2H), 4.01 (s, 2H), 1.26 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 170.4, 160.4 (d, J = 246.5 Hz), 154.2 (d, J = 2.7 Hz), 144.9, 136.0 (d,

J = 5.2 Hz), 131.6 (d, J = 9.0 Hz), 127.6 (d, J = 9.8 Hz), 122.6, 119.7 (d, J = 25.5 Hz), 110.5 (d, J = 21.7 Hz), 61.2, 44.6, 14.2. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{13}H_{13}FNO_2$ 234.0930; Found 234.0929.

Synthesis of 1e: The title compound was prepared according to the general working procedure for the synthesis of **1** using 6-methoxy-2-methylquinoline (10 mmol, 1.73 g) as the starting material in 65% (1.59 g) yield as yellow solid. m.p. 45–47 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.02 (d, J = 8.5 Hz, 1H), 7.95 (d, J = 9.2 Hz, 1H), 7.39−7.33 (m, 2H), 7.06−7.05 (m, 1H), 4.19 (q, J = 7.1 Hz, 2H), 3.99 (s, 2H), 3.91 (s, 3H), 1.26 (t, J = 7.2 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 170.7, 157.7, 152.2, 143.9, 135.5, 130.4, 128.0, 122.3, 122.0, 105.1, 61.1, 55.5, 44.5, 14.2. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{14}H_{16}NO_3$ 246.1130; Found 246.1128.

Synthesis of 1g: The title compound was prepared according to the general working procedure for the synthesis of **1** using 6-(*tert*-butyl)-2-methylquinoline (10 mmol, 1.99 g) as the starting material in 62% (1.68 g)yield as yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.09 (d, J = 8.4 Hz, 1H), 8.00 (d, J = 8.9 Hz, 1H), 7.81−7.78 (m, 1H), 7.71−7.70 (m, 1H), 7.40 (d, J = 8.4 Hz, 1H), 4.18 (q, J = 7.1 Hz, 2H), 4.02 (s, 2H), 1.41 (s, 9H), 1.25 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 170.6, 154.1, 149.2, 146.4, 136.6, 128.6, 128.6, 126.8, 122.5, 121.7, 61.1, 44.8, 34.9, 31.2, 14.2. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{22}NO_2$ 272.1651; Found 272.1651.

Synthesis of 1h: The title compound was prepared according to the general working procedure for the synthesis of **1** using 2-methyl-6-(trifluoromethyl)quinoline (10 mmol, 2.11 g) as the starting material in 70% (1.98 g) yield as yellow solid. m.p. 105–107 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.22 (d, J = 8.5 Hz, 1H), 8.18−8.12 (m, 2H), 7.88−7.85 (m, 1H), 7.54 (d, J = 8.5 Hz, 1H), 4.21 (q, J = 7.1 Hz, 2H), 4.07 (s, 2H), 1.27 (t, J = 7.2 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 170.1, 157.3, 148.8, 137.3, 130.3, 128.3 (q, J = 32.4 Hz), 126.0, 125.5 (q, J = 4.4 Hz), 125.3 (q, J = 3.1 Hz), 124.0 (q, J = 269.9 Hz), 123.1, 61.3, 44.8, 14.2. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{14}H_{13}F_3NO_2$ 284.0898; Found 284.0899.

Synthesis of 1k: The title compound was prepared according to the general working procedure for the synthesis of **1** using 1-methylisoquinoline (10 mmol, 1.43 g) as the starting material in 64% (1.38 g) yield as yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.47 (d, J = 5.7 Hz, 1H), 8.10−8.07 (m, 1H), 7.84 (d, J = 8.1 Hz, 1H), 7.71−7.67 (m, 1H), 7.64−7.59 (m, 2H), 4.35 (s, 2H),

4.19 (q, J = 7.2 Hz, 2H), 1.23 (t, J = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 170.4, 154.6, 141.9, 136.4, 130.2, 127.6, 127.4, 127.4, 125.2, 120.5, 61.2, 42.2, 14.2. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{13}H_{14}NO_2$ 216.1025; Found 216.1025.

Representative Procedures for the Synthesis of 1,3-Disubstituted Imidazo[1,5-*a*]quinolines from Amines (method A): An undivided cell was equipped with a magnet stirrer, platinum-plate (1.0 x 1.0 cm^2) electrode as the working electrode and counter electrode. In the electrolytic cell, a mixture of ethyl 2-(quinolin-2-yl)acetate derivatives **1** (0.3 mmol), amines **2** (1.2 mmol), NH_4I (0.3 mmol, 43.5 mg), CH_3CN/H_2O= 5:1 (3 mL) was allowed to stir and electrolyze at a constant current conditions (15 mA/cm^2) under room temperature until the reaction intermediate finished (TLC analysis). Then the solvent was removed with a rotary evaporator and the residue was purified by column chromatography on silica gel to afford the desired product. The product was dried under high vacuum for at least 0.5 h before it was weighed and characterized by NMR spectroscopy.

Representative Procedures for the Synthesis of 1,3-Disubstituted Imidazo[1,5-*a*]quinolines from Amino Acids (method B): An undivided cell was equipped with a magnet stirrer, platinum-plate (1.0 x 1.0 cm^2) electrode as the working electrode and counter electrode. In the electrolytic cell, a mixture of ethyl 2-(quinolin-2-yl)acetate **1a**, amino acids **2'** (1.2 mmol), *n*-Bu_4NI (0.3 mmol, 110.8 mg), $CH_3CN/NaHCO_3$ (Sat) = 5:1 (3 mL) was allowed to stir and electrolyze at a constant current conditions (10 mA/cm^2) under 50 ^oC (water bath) until the ethyl 2-(quinolin-2-yl)acetate **1a** finished (TLC analysis). Then the solvent was removed with a rotary evaporator and the residue was purified by column chromatography on silica gel to afford the desired product. The product was dried under high vacuum for at least 0.5 h before it was weighed and characterized by NMR spectroscopy.

Gram-Scale Synthesis of 3aa

An undivided cell was equipped with a magnet stirrer, platinum-plate (1.5 x 1.5 cm^2) electrode as the working electrode and counter electrode. In the electrolytic cell, a mixture of ethyl 2-(quinolin-2-yl)acetate **1a** (4.8 mmol), benzylamine **2a** (19.2 mmol) NH_4I (4.8 mmol, 696 mg), CH_3CN/H_2O= 5:1 (48 mL) was allowed to stir and electrolyze at a constant current conditions (15 mA/cm^2) under room temperature until the reaction intermediate finished (about 3 d). Then the

solvent was removed with a rotary evaporator and the residue was recrystallized by EtOAc to afford the desired product (1.21 g, 80% yield).

Transfer Esterification Cyclizaiton Reaction

An undivided cell was equipped with a magnet stirrer, platinum-plate (1.0 x 1.0 cm^2) electrode as the working electrode and counter electrode. In the electrolytic cell, a mixture of ethyl 2-(quinolin-2-yl)acetate **1a** (0.3 mmol), benzylamine **2a** (1.2 mmol), *n*-Bu_4NI (0.3 mmol, 110.8 mg), MeOH (3 mL) was allowed to stir and electrolyze at a constant current conditions (15 mA/cm^2) under room temperature until the reaction intermediate finished (TLC analysis). Then the solvent was removed with a rotary evaporator and the residue was purified by column chromatography on silica gel to afford the desired product. The product was dried under high vacuum for at least 0.5 h before it was weighed and characterized by NMR spectroscopy.

Ethyl 1-phenylimidazo[1,5-a]quinoline-3-carboxylate (**3aa**)[13a]

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 95% yield, (90 mg), m.p. 167–168 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.20 (d, J = 9.5 Hz, 1H), 7.75−7.73 (m, 1H), 7.66−7.63 (m, 2H), 7.57−7.48 (m, 4H), 7.42−7.38 (m, 2H), 7.28−7.23 (m, 1H), 4.51 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.7, 142.5, 134.6, 133.0, 132.1, 130.0, 129.9, 129.0, 128.9, 128.4, 126.3, 125.9, 125.4, 123.4, 117.7, 117.6, 60.6, 14.7.

Ethyl 1-(p-tolyl)imidazo[1,5-a]quinoline-3-carboxylate (**3ab**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 90% yield, (89 mg) , m.p. 160–163 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.19 (d, J = 9.4 Hz, 1H), 7.74−7.72 (m, 1H), 7.55−7.51 (m, 3H), 7.42−7.38 (m, 2H), 7.34−7.32 (m, 2H), 7.29−7.24 (m, 1H), 4.50 (q, J = 7.1 Hz, 2H), 2.48 (s, 3H),1.47 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.7, 142.7, 140.0, 134.5, 132.2, 130.0, 129.8, 129.6, 128.9, 128.3, 126.2, 125.8, 125.4, 123.2, 117.7, 117.6, 60.6, 21.6, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{19}N_2O_2$ 331.1447; Found 331.1445.

Ethyl 1-(m-tolyl)imidazo[1,5-a]quinoline-3-carboxylate (**3ac**)

The title compound was prepared according to the general working procedure A (28 h, 52.2 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 90% yield, (89 mg) , m.p. 139–141 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.20 (d, J = 9.5 Hz, 1H), 7.74−7.72 (m, 1H), 7.55 (d, J = 8.6 Hz, 1H), 7.50 (s, 1H), 7.44−7.36 (m, 5H), 7.29−7.25 (m, 1H) 4.52 (q, J = 7.1 Hz, 2H), 2.44 (s, 3H),1.48 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.6, 142.6, 138.7, 134.4, 132.7, 132.0, 130.5, 130.5, 128.8, 128.6, 128.2, 126.8, 126.2, 125.7, 125.3, 123.2, 117.5, 60.5, 21.3, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{19}N_2O_2$ 331.1447; Found 331.1447.

Ethyl 1-(o-tolyl)imidazo[1,5-a]quinoline-3-carboxylate (**3ad**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 89% yield, (88 mg), m.p. 142–145 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.22 (d, J = 9.5 Hz, 1H), 7.73 (d, J = 7.8 Hz, 1H), 7.51−7.47 (m, 2H), 7.42−7.35 (m, 4H), 7.28−7.21 (m, 2H), 4.51 (q, J = 7.1 Hz, 2H), 2.02 (s, 3H),1.47 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.7, 141.8, 138.5, 134.1, 133.0, 132.3, 130.6, 130.4, 130.3, 128.9, 126.5, 126.2, 125.8, 125.2, 123.1, 117.7, 116.1, 60.6, 19.6, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{19}N_2O_2$ 331.1447; Found 331.1446.

Ethyl 1-(4-methoxyphenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3ae**)

The title compound was prepared according to the general working procedure A (36 h, 67.2 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 4:1) to give the product as a light yellow solid: 91% yield, (94 mg), m.p. 171–173 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.18 (d, J = 9.4 Hz, 1H), 7.72 (d, J = 7.7 Hz, 1H),, 7.57−7.55 (m, 3H), 7.41−7.37 (m, 2H), 7.29−7.25 (m, 1H), 7.06−7.04 (m, 2H), 4.50 (q, J = 7.1 Hz, 2H), 3.92 (s, 3H),1.47 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.7, 160.8, 142.5, 134.5, 132.3, 131.3, 128.9, 128.3, 126.2, 125.7, 125.4, 125.2, 123.2, 117.7, 117.5, 114.3, 60.6, 55.4, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{19}N_2O_3$ 347.1396; Found 347.1396.

Ethyl 1-(2-methoxyphenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3af**)

The title compound was prepared according to the general working procedure A (36 h, 67.2 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 4:1) to give the product as a light yellow solid: 96% yield, (100 mg), m.p. 173–175 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.21 (d, J = 9.4 Hz, 1H), 7.72−7.70 (m, 1H),, 7.63−7.61 (m, 1H), 7.57−7.52 (m, 1H), 7.49 (d, J = 8.6 Hz, 1H), 7.40−7.36 (m, 2H), 7.27−7.23 (m, 1H), 7.16−7.12 (m, 1H), 7.00−6.98 (m, 1H), 4.54 −4.45 (m, 2H), 3.55 (s, 3H), 1.46 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.8, 158.3, 139.8, 134.5, 132.7, 132.1, 131.7, 128.6, 128.4, 126.2, 125.6, 125.0, 123.1, 122.5, 121.1, 117.7, 116.5, 110.8, 60.5, 55.3, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{19}N_2O_3$ 347.1396; Found 347.1397.

Ethyl 1-(benzo[d][1,3]dioxol-5-yl)imidazo[1,5-a]quinoline-3-carboxylate (**3ag**)

The title compound was prepared according to the general working procedure A (27 h, 50.4 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 3:1) to give the product as a light yellow solid: 91% yield, (98 mg), m.p. 209–212 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.19 (d, J = 9.4 Hz, 1H), 7.75−7.73 (m, 1H), 7.62 (d, J = 8.5 Hz, 1H), 7.44−7.39 (m, 2H), 7.35−7.31 (m, 1H), 7.14−7.12 (m, 1H), 7.07−7.06 (m, 1H), 6.96 (d, J = 8.0 Hz, 1H), 6.10 (s, 2H), 4.50 (d, J = 7.1 Hz, 2H), 1.46 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.6, 149.0, 148.0, 142.0, 134.5, 132.1, 129.0, 128.5, 126.3, 126.3, 125.8, 125.4, 124.2, 123.1, 117.7, 117.6, 110.3, 108.8, 101.6, 60.6, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{17}N_2O_4$ 361.1188; Found 361.1185.

Ethyl 1-(4-fluorophenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3ah**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 87% yield, (87 mg), m.p. 173–176 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.19 (d, J = 9.5 Hz, 1H), 7.76−7.74 (m, 1H), 7.66−7.61 (m, 2H), 7.48−7.40 (m, 3H), 7.32−7.21 (m, 3H), 4.51 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.7, 163.6 (d, J = 249.1 Hz), 141.4, 134.6, 132.0 (d, J = 8.5 Hz), 129.1, 129.1 (d, J = 3.5 Hz), 128.5, 126.4, 126.0, 125.4, 123.4, 117.7, 117.3, 116.2, 116.0, 60.7, 14.7. HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{20}H_{15}FN_2O_2Na$ 357.1015; Found 357.1010.

Ethyl 1-(3-fluorophenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3ai**)

The title compound was prepared according to the general working procedure A (15 h, 28.0 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 90% yield, (90 mg), m.p. 139–142 ^{o}C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.19 (d, J = 9.4 Hz, 1H), 7.76−7.74 (m, 1H), 7.54−7.49 (m, 2H), 7.45−7.38 (m, 4H), 7.33−7.25 (m, 2H), 4.51 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.5, 162.7 (d, J = 246.9 Hz), 140.9 (d, J = 2.7 Hz), 134.8 (d, J = 8.1 Hz), 134.6, 131.8, 130.6 (d, J = 8.3 Hz), 129.1, 128.6, 126.6, 126.1, 125.8 (d, J = 3.2 Hz), 125.4, 123.5, 117.5 (d, J = 15.2 Hz), 117.3, 117.1, 116.9, 60.7, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}FN_2O_2$ 335.1196; Found 335.1194.

Ethyl 1-(2-fluorophenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3aj**)

The title compound was prepared according to the general working procedure A (15 h, 28.0 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 86% yield, (86 mg), m.p. 183–185 ^{o}C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.21 (d, J = 9.5 Hz, 1H), 7.76−7.71 (m, 2H), 7.61−7.56 (m, 1H), 7.51 (d, J = 8.6 Hz, 1H), 7.44−7.40 (m, 2H), 7.39−7.35 (m, 1H), 7.33−7.29 (m, 1H), 7.25−7.20 (m, 1H), 4.54− 7.48 (m, 2H), 1.47 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.5, 160.9 (d, J = 246.8 Hz), 136.7, 134.7, 132.4 (d, J = 1.6 Hz), 132.3, 132.2, 129.0, 128.9, 126.6, 126.0, 125.2, 124.9 (d, J = 3.6 Hz), 123.7, 121.6 (d, J = 15.4 Hz), 117.5, 116.2, 115.9, 60.7, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}FN_2O_2$ 335.1196; Found 335.1193.

Ethyl 1-(4-chlorophenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3ak**)

The title compound was prepared according to the general working procedure A (15 h, 28.0 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 89% yield, (93 mg), m.p. 199–202 ^{o}C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.20 (d, J = 9.4 Hz, 1H), 7.77−7.75 (m, 1H), 7.62−7.59 (m, 2H), 7.54−7.50 (m, 3H), 7.46−7.41 (m, 2H), 7.34−7.30 (m, 1H), 4.51 (q, J = 7.2 Hz, 2H), 1.47 (t, J = 7.1 Hz, 1H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.5, 141.2, 136.0, 134.7, 131.9, 131.4, 131.3, 129.2, 129.1, 128.5, 126.5, 126.0, 125.4, 123.5, 117.6, 117.4, 60.7, 14.6. HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{20}H_{15}ClN_2O_2Na$ 373.0720; Found 373.0723.

Ethyl 1-(3-chlorophenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3al**)

The title compound was prepared according to the general working procedure A (15 h, 28.0 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 91% yield, (95 mg) , m.p. 167–169 ^{o}C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.20 (d, J = 9.5 Hz, 1H), 7.77−7.75 (m, 1H), 7.70−7.69 (m, 1H), 7.56−7.51 (m, 3H), 7.49−7.41 (m, 3H), 7.34−7.30 (m, 1H) 4.51 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.5, 140.8, 134.9, 134.7, 134.6, 131.8, 130.1, 130.1, 130.1, 129.2, 128.6, 128.1, 126.6, 126.1, 125.4, 123.6, 117.6, 117.5, 60.7, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}ClN_2O_2$ 351.0900; Found 351.0896.

Ethyl 1-(2-chlorophenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3am**)

The title compound was prepared according to the general working procedure A (22 h, 41.0 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 88% yield, (92 mg), m.p. 189–192 ^{o}C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.23 (d, J = 9.5 Hz, 1H), 7.76−7.74 (m, 1H), 7.70−7.67 (m, 1H), 7.56−7.54 (m, 2H), 7.50−7.40 (m, 3H), 7.32−7.29 (m, 2H) 4.51 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.6, 139.2, 135.4, 134.3, 132.7, 132.6, 132.1, 131.6, 129.8, 129.0, 129.0, 127.5, 126.6, 126.0, 125.1, 123.3, 117.6, 116.0, 60.7, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}ClN_2O_2$ 351.0900; Found 351.0904.

Ethyl 1-(4-bromophenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3an**)

The title compound was prepared according to the general working procedure A (8 h, 14.9 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 78% yield, (92 mg), m.p. 215–218 ^{o}C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.18 (d, J = 9.4 Hz, 1H), 7.75 (d, J = 7.8 Hz, 1H), 7.68 (d, J = 8.3 Hz, 2H), 7.55−7.50 (m, 3H), 7.45−7.40 (m, 2H), 7.33−7.29 (m, 1H), 4.50 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.5, 141.2, 134.7, 132.1, 131.9, 131.5, 129.2, 128.5, 126.5, 126.1, 125.4, 124.3, 123.7, 117.7, 117.4, 60.7, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}BrN_2O_2$ 395.0395; Found 395.0397.

Ethyl 1-(2-bromophenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3ao**)

The title compound was prepared according to the general working procedure A (12 h, 22.4 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 4:1) to give the product as a light yellow solid: 93% yield, (110 mg), m.p. 184–186 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.23 (d, J = 9.5 Hz, 1H), 7.76−7.73 (m, 2H), 7.67−7.65 (m, 1H), 7.55−7.51 (m, 1H), 7.49−7.40 (m, 3H), 7.30−7.28 (m, 2H), 4.51 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.6, 140.4, 134.8, 134.2, 133.0, 132.7, 132.1, 131.7, 129.0, 129.0, 128.0, 126.6, 126.0, 125.3, 125.1, 123.2, 117.6, 116.2, 60.7, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}BrN_2O_2$ 395.0395; Found 395.0392.

Ethyl 1-(4-(trifluoromethyl)phenyl)imidazo[1,5-*a*]quinoline-3-carboxylate (**3ap**)

The title compound was prepared according to the general working procedure A (10 h, 18.7 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 4:1) to give the product as a light yellow solid: 97% yield, (112 mg), m.p. 215–217 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.22 (d, J = 9.4 Hz, 1H), 7.84−7.78 (m, 5H), 7.49−7.45 (m, 3H), 7.35−7.31 (m, 1H), 4.52 (q, J = 7.1 Hz, 2H), 1.48 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.4, 140.8, 136.5, 134.9, 131.8 (q, J = 32.7 Hz), 131.7, 130.4, 129.3, 128.6, 126.7, 126.2, 125.8 (q, J = 3.7 Hz), 125.5, 123.9, 123.9 (q, J = 270.9 Hz), 117.7, 117.4, 60.7, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{16}F_3N_2O_2$ 385.1164; Found 385.1160.

Ethyl 1-(3-(trifluoromethyl)phenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3aq**)

The title compound was prepared according to the general working procedure A (14 h, 26.1 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 3:1) to give the product as a light yellow solid: 90% yield, (104 mg), m.p. 163–166 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.20 (d, J = 9.6 Hz, 1H), 7.98 (s, 1H) 7.86−7.81 (m, 2H), 7.78−7.75 (m, 1H), 7.69−7.65 (m, 1H), 7.46−7.42 (m, 3H), 7.31−7.27 (m, 1H), 4.51 (q, J = 7.2 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.4, 140.7, 134.8, 133.8, 133.2, 131.7, 131.4 (q, J = 32.6 Hz), 129.4, 129.3, 128.5, 127.0 (q, J = 3.7 Hz), 126.6, 126.6 (q, J = 3.7 Hz), 126.2, 125.5, 123.8, 123.7 (q, J = 270.1 Hz), 117.6, 117.3, 60.7, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{16}F_3N_2O_2$ 385.1164; Found 385.1162.

Ethyl 1-(naphthalen-1-yl)imidazo[1,5-a]quinoline-3-carboxylate (**3ar**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 4:1) to give the product as a light yellow solid: 89% yield, (98 mg), m.p. 196–198 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.30 (d, J = 9.5 Hz, 1H), 8.10 (d, J = 8.3 Hz, 1H), 7.97 (d, J = 8.2 Hz, 1H), 7.78−7.76 (m, 1H), 7.72−7.71 (m, 1H), 7.67−7.63 (m, 1H), 7.52−7.48 (m, 1H), 7.46 (d, J = 9.5 Hz, 1H), 7.35−7.26 (m, 3H), 7.03−6.97 (m, 2H), 4.53 (q, J = 7.1 Hz, 2H), 1.48 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.8, 140.7, 134.4, 133.6, 132.5, 132.0, 130.6, 130.6, 129.2, 128.8, 128.7, 128.5, 127.3, 126.6, 126.5, 125.7, 125.6, 125.3, 125.2, 123.5, 117.7, 117.1, 60.6, 14.7. HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{18}N_2O_2Na$ 389.1266; Found 389.1267.

Ethyl 1-(2-chloro-4-fluorophenyl)imidazo[1,5-a]quinoline-3-carboxylate (**3as**)

The title compound was prepared according to the general working procedure A (16 h, 29.9 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 82% yield, (90 mg), m.p. 218–220 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.24 (d, J = 9.5 Hz, 1H), 7.79−7.77 (m, 1H), 7.71−7.67 (m, 1H), 7.48−7.44 (m, 2H), 7.37−7.30 (m, 3H), 7.25−7.20 (m, 1H), 4.52 (q, J = 7.1 Hz, 2H), 1.48 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.6 (d, J = 253.0 Hz), 163.4, 138.2, 136.7 (d, J = 10.3 Hz), 134.4, 133.9 (d, J = 9.1 Hz), 132.0, 129.1, 129.1, 129.0 (d, J = 3.7 Hz), 126.6, 126.1, 125.1, 123.4, 117.6, 117.5 (d, J = 25.0 Hz), 115.8, 114.9 (d, J = 21.4 Hz), 60.7, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{15}FClN_2O_2$ 369.0806; Found 369.0803.

Ethyl 1-(furan-2-yl)imidazo[1,5-a]quinoline-3-carboxylate (**3at**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 87% yield, (80 mg), m.p. 144–146 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.20 (d, J = 9.4 Hz, 1H), 7.78−7.75 (m, 1H), 7.68−7.67 (m, 1H), 7.49−7.41 (m, 3H), 7.15−7.13 (m, 1H), 6.97−6.96 (m, 1H), 6.69−6.67 (m, 1H), 4.51 (q, J = 7.1 Hz, 2H), 1.48 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.4, 143.9, 143.6, 134.8, 132.5, 131.8,

129.2, 129.0, 127.0, 126.2, 125.3, 123.7, 117.3, 116.9, 114.0, 112.0, 60.7, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{15}N_2O_3$ 307.1083; Found 307.1082.

Ethyl 1-(thiophen-2-yl)imidazo[1,5-a]quinoline-3-carboxylate (**3au**)

The title compound was prepared according to the general working procedure A (14 h, 26.1 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 4:1) to give the product as a light yellow solid: 84% yield, (81 mg), m.p. 165–168 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.20 (d, J = 9.4 Hz, 1H), 7.76−7.74 (m, 1H), 7.62−7.60 (m, 1H), 7.56 (d, J = 8.6 Hz, 1H), 7.45−7.40 (m, 3H), 7.36−7.32 (m, 1H), 7.24−7.22 (m, 1H), 4.50 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.5, 135.2, 134.9, 132.8, 132.1, 130.7, 129.0, 128.9, 128.7, 127.5, 126.7, 126.0, 125.4, 123.6, 117.4, 117.2, 60.7, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{15}N_2SO_2$ 323.0854; Found 323.0850.

Ethyl 1-(pyridin-2-yl)imidazo[1,5-a]quinoline-3-carboxylate (**3av**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 2:1) to give the product as a light yellow solid: 95% yield, (90 mg), m.p. 156–158 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.72−8.70 (m, 1H), 8.17 (d, J = 9.4 Hz, 1H), 7.99−7.97 (m, 1H), 7.94−7.90 (m, 1H), 7.72−7.70 (m, 1H), 7.47−7.38 (m, 4H), 7.32−7.27 (m, 1H), 4.49 (q, J = 7.1 Hz, 2H), 1.46 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.4, 151.5, 149.2, 141.2, 137.3, 135.0, 131.7, 128.7, 128.2, 126.9, 126.0, 125.7, 125.3, 124.3, 123.5, 118.3, 117.3, 60.6, 14.5. HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{19}H_{15}N_3O_2Na$ 340.1062; Found 340.1059.

Ethyl 7-chloro-1-phenylimidazo[1,5-a]quinoline-3-carboxylate (**3ba**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 95% yield, (100 mg), m.p. 177–180 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.22 (d, J = 9.5 Hz, 1H), 7.69−7.68 (m, 1H), 7.62−7.51 (m, 5H), 7.41 (d, J = 9.2 Hz, 1H), 7.29 (d, J = 9.5 Hz, 1H), 7.21−7.18 (m, 1H), 4.50 (q, J = 7.1 Hz, 2H), 1.46 (t, J = 7.1 Hz,

3H); $^{13}C\{^{1}H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.4, 142.5, 134.0, 132.5, 131.4, 130.4, 130.1, 129.8, 129.0, 128.3, 127.9, 126.7, 125.0, 123.8, 118.9, 118.8, 60.7, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}ClN_2O_2$ 351.0900; Found 351.0900.

Ethyl 7-bromo-1-phenylimidazo[1,5-a]quinoline-3-carboxylate (**3ca**)

The title compound was prepared according to the general working procedure A (16 h, 29.9 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 99% yield, (117 mg), m.p. 197–199 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.21 (d, J = 9.5 Hz, 1H), 7.86 (s, 1H), 7.62−7.59 (m, 2H), 7.57−7.51 (m, 3H), 7.34−7.29 (m, 3H), 4.50 (q, J = 7.1 Hz, 2H), 1.46 (t, J = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.4, 142.6, 134.1, 132.5, 131.2, 131.1, 130.9, 130.2, 129.8, 129.1, 127.1, 125.0, 123.8, 119.2, 119.1, 119.0, 60.8, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}BrN_2O_2$ 395.0395; Found 395.0391.

Ethyl 7-fluoro-1-phenylimidazo[1,5-a]quinoline-3-carboxylate (**3da**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a white solid: 98% yield, (98 mg), m.p. 184–186 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.24 (d, J = 9.5 Hz, 1H), 7.65−7.62 (m, 2H), 7.58−7.52 (m, 3H), 7.49−7.46 (m, 1H), 7.42−7.39 (m, 1H), 7.34 (d, J = 9.5 Hz, 1H), 7.01−6.96 (m, 1H), 4.51 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.5, 159.7 (d, J = 245.8 Hz), 142.4, 134.0, 132.6, 130.1, 129.9, 129.0, 128.5(d, J = 2.2 Hz), 127.1 (d, J = 8.6 Hz), 125.4 (d, J = 2.7 Hz), 123.7, 119.4 (d, J = 8.2 Hz), 118.9, 116.1 (d, J = 23.8 Hz), 113.9 (d, J = 22.5 Hz), 60.7, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}FN_2O_2$ 335.1196; Found 335.1198.

Ethyl 7-methoxy-1-phenylimidazo[1,5-a]quinoline-3-carboxylate (**3ea**)

The title compound was prepared according to the general working procedure A (28 h, 52.2 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a white solid: 85% yield, (88 mg), m.p. 168–170 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.18 (d, J = 9.4 Hz, 1H), 7.65−7.62 (m, 2H), 7.55−7.52 (m, 3H), 7.40 (d, J = 9.4 Hz, 1H), 7.34 (d, J = 9.5 Hz, 1H), 7.14−7.13 (m, 1H), 6.85−6.82 (m, 1H), 4.50 (q, J = 7.1 Hz, 2H), 3.86 (s, 3H),

1.46 (t, J = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.7, 157.0, 142.0, 134.2, 133.0, 130.0, 129.9, 128.9, 126.8, 126.4, 126.1, 123.3, 118.9, 118.1, 116.5, 110.6, 60.6, 55.6, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{19}N_2O_3$ 347.1396; Found 347.1399.

Ethyl 7-methyl-1-phenylimidazo[1,5-a]quinoline-3-carboxylate (**3fa**)

The title compound was prepared according to the general working procedure A (28 h, 52.2 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a white solid: 85% yield, (84 mg), m.p. 188–191 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.16 (d, J = 9.4 Hz, 1H), 7.64−7.62 (m, 2H), 7.55−7.50 (m, 4H), 7.36−7.34 (m, 2H), 7.08−7.06 (m, 1H), 4.50 (q, J = 7.1 Hz, 2H), 2.42 (s, 3H), 1.46 (t, J = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.7, 142.3, 135.7, 134.5, 132.9, 130.1, 130.0, 129.9, 129.6, 128.9, 128.8, 126.4, 125.4, 123.2, 117.5, 117.4, 60.6, 20.9, 14.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{19}N_2O_2$ 331.1447; Found 331.1445.

Ethyl 7-(tert-butyl)-1-phenylimidazo[1,5-a]quinoline-3-carboxylate (**3ga**)

The title compound was prepared according to the general working procedure A (28 h, 52.2 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 86% yield, (96 mg), m.p. 134–136 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.18 (d, J = 9.4 Hz, 1H), 7.69 (d, J = 2.4 Hz, 1H), 7.66−7.63 (m, 2H), 7.57−7.51 (m, 3H), 7.42−7.40 (m, 2H), 7.33−7.30 (m, 1H), 4.50 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H), 1.35 (s, 9H); $^{13}C\{^{1}H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.8, 148.9, 142.2, 134.6, 130.1, 130.0, 129.8, 129.0, 128.8, 126.8, 126.3, 125.1, 125.1, 123.1, 117.4, 117.2, 60.6, 34.6, 31.2, 14.7. HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{24}N_2O_2Na$ 395.1735; Found 395.1731.

Ethyl 1-phenyl-7-(trifluoromethyl)imidazo[1,5-a]quinoline-3-carboxylate (**3ha**)

The title compound was prepared according to the general working procedure A (12 h, 22.4 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a yellow solid: 98% yield, (113 mg), m.p. 170–172 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.28 (d, J = 9.5 Hz, 1H), 8.01 (s, 1H), 7.64−7.53 (m, 6H), 7.50−7.47 (m, 1H), 7.43 (d, J = 9.5 Hz, 1H), 4.51 (q, J = 7.1 Hz, 2H), 1.47 (t, J = 7.1 Hz, 3H); $^{13}C\{^{1}H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.3, 142.9, 134.2, 133.8, 132.3, 130.3, 129.8, 129.1, 127.9 (q, J = 33.3 Hz), 126.1 (q,

J = 4.0 Hz), 125.5, 125.3, 124.7 (q, J = 3.5 Hz), 124.0, 123.5 (q, J = 270.6 Hz), 119.2, 118.1, 60.8, 14.6. HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{21}H_{15}F_3N_2O_2$ Na 407.0983; Found 407.0980.

Methyl 1-phenylimidazo[1,5-a]quinoline-3-carboxylate (**3ia**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 85% yield, (77 mg), m.p. 160–162 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.21 (d, J = 9.4 Hz, 1H), 7.76−7.74 (m, 1H), 7.66−7.64 (m, 2H), 7.57−7.51 (m, 4H), 7.43−7.40 (m, 2H), 7.29−7.25 (m, 1H), 4.01 (s, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 164.0, 142.6, 134.7, 132.9, 132.1, 129.9, 129.9, 129.0, 128.9, 128.5, 126.5, 125.9, 125.4, 123.0, 117.6, 117.5, 51.7. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{15}N_2O_2$ 303.1134; Found 303.1130.

Phenyl(1-phenylimidazo[1,5-a]quinolin-3-yl)methanone (**3ja**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 20:1) to give the product as a light yellow solid: 65% yield, (68 mg), m.p. 168–170 °C; ^1H NMR (CD_3SOCD_3, 400 MHz, ppm): δ = 8.37 (d, J = 9.4 Hz, 1H), 8.33−8.31 (m, 2H), 7.99 (d, J = 7.8 Hz, 1H), 7.80 (d, J = 9.5 Hz, 1H), 7.74−7.71 (m, 2H), 7.67−7.58 (m, 4H), 7.54−7.50 (m, 3H), 7.44−7.39 (m, 2H); $^{13}C\{^1H\}$NMR (CD_3SOCD_3, 100 MHz, ppm): δ = 187.6, 141.9, 138.8, 135.6, 133.4, 132.4, 131.8, 130.6, 130.6, 130.3, 129.8, 129.6, 129.4, 128.8, 128.5, 126.7, 125.8, 118.0, 117.4. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{24}H_{17}N_2O$ 349.1341; Found 349.1340.

Ethyl 3-phenylimidazo[5,1-a]isoquinoline-1-carboxylate (**3ka**)

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 6:1) to give the product as a light yellow solid: 94% yield, (61 mg), m.p. 152–154 °C; ^1H NMR ($CDCl_3$, 400 MHz, ppm): δ = 9.85 (d, J = 8.1 Hz, 1H), 7.98 (d, J = 7.4 Hz, 1H), 7.78−7.75 (m, 2H), 7.69−7.65 (m, 2H), 7.60−7.51 (m, 4H), 6.97 (d, J = 7.4 Hz, 1H), 4.57 (q, J = 7.1 Hz, 2H), 1.51 (t, J = 7.1 Hz, 3H); $^{13}C\{^1H\}$NMR ($CDCl_3$, 100 MHz, ppm): δ = 164.3, 140.9, 132.8, 129.8, 129.4, 129.1, 128.9,

128.9, 128.6, 127.8, 126.8, 125.3, 124.3, 120.3, 115.8, 61.0, 14.6. HRMS (ESI-TOF) m/z: [M + Na]$^+$ Calcd for $C_{20}H_{16}N_2O_2$ Na 339.1110; Found 339.1107.

Ethyl 3-phenylimidazo[1,5-a]pyridine-1-carboxylate (**3la**)[13a]

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a light yellow solid: 75% yield, (60 mg), m.p. 129–130 ^{o}C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.30−8.23 (m, 2H), 7.80−7.77 (m, 2H), 7.54−7.45 (m, 3H), 7.14−7.10 (m, 1H), 6.79−6.75 (m, 1H) 4.49 (q, J = 7.1 Hz, 2H), 1.46 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.6, 139.2, 135.4, 129.6, 129.1, 129.0, 128.8, 124.2, 122.5, 121.8, 120.1, 114.4, 60.4, 14.7.

Ethyl 2,5-diphenyloxazole-4-carboxylate (**3ma**)[20]

The title compound was prepared according to the general working procedure A (24 h, 44.8 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 30:1) to give the product as a yellow solid: 65% yield, (57 mg), m.p. 85–86 ^{o}C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.20−8.10 (m, 4H), 7.54−7.46 (m, 6H), 4.47 (q, J = 7.1 Hz, 2H), 1.44 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 162.3, 159.8, 155.1, 131.1, 130.3, 128.8, 128.6, 128.4, 128.3, 127.1, 126.9, 126.4, 61.5, 14.3.

Ethyl imidazo[1,5-a]quinoline-3-carboxylate (**3ax**)

The title compound was prepared according to the general working procedure B (6 h, 7.5 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 2:1) to give the product as a pink solid: 50% yield, (36 mg), m.p. 157–159 ^{o}C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.65 (s, 1H), 8.09−8.04 (m, 2H), 7.80−7.78 (m, 1H), 7.69−7.65 (m, 1H), 7.55−7.51 (m, 1H), 7.41 (d, J = 9.5 Hz, 1H), 4.49 (q, J = 7.1 Hz, 2H), 1.48 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.4, 132.8, 130.6, 129.6, 129.2, 128.0, 126.4, 126.0, 124.4, 124.2, 117.5, 114.9, 60.6, 14.6. HRMS (ESI-TOF) m/z: [M + Na]$^+$ Calcd for $C_{14}H_{12}N_2O_2$ Na 263.0797; Found 263.0794.

Ethyl 1-propylimidazo[1,5-a]quinoline-3-carboxylate (**3ay**)

The title compound was prepared according to the general working procedure B (7 h, 8.7 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a yellow solid: 41% yield, (35 mg), m.p. 127–129 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.18 (d, J = 8.6 Hz, 1H), 8.11 (d, J = 9.5 Hz, 1H), 7.76−7.74 (m, 1H), 7.65−7.61 (m, 1H), 7.51−7.47 (m, 1H), 7.31 (d, J = 9.4 Hz, 1H), 4.48 (q, J = 7.1 Hz, 2H), 3.43−3.39 (m, 2H), 2.04−1.94 (m, 2H), 1.46 (t, J = 7.1 Hz, 3H), 1.13 (t, J = 7.4 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.6, 144.6, 134.6, 132.7, 129.1, 128.8, 125.6, 125.6, 121.9, 117.9, 116.7, 60.5, 34.3, 20.7, 14.7, 13.9. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{19}N_2O_2$ 283.1447; Found 283.1447.

Ethyl 1-isopropylimidazo[1,5-a]quinoline-3-carboxylate (**3az**)[19b]

The title compound was prepared according to the general working procedure B (7 h, 8.7 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a yellow solid: 38% yield, (32 mg), m.p. 118–119 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.29 (d, J = 8.7 Hz, 1H), 8.13 (d, J = 9.4 Hz, 1H), 7.77−7.75 (m, 1H), 7.65−7.61 (m, 1H), 7.51−7.47 (m, 1H), 7.31 (d, J = 9.5 Hz, 1H), 4.49 (q, J = 7.1 Hz, 2H), 3.92−3.82 (m, 1H), 1.62 (d, J = 6.7 Hz, 6H), 1.47 (t, J = 7.4 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.8, 150.0, 134.6, 132.8, 129.2, 128.8, 125.8, 125.6, 125.5, 122.0, 118.1, 117.3, 60.5, 30.3, 21.5, 14.6.

Ethyl 1-(sec-butyl)imidazo[1,5-a]quinoline-3-carboxylate (**3aA**)

The title compound was prepared according to the general working procedure B (7 h, 8.7 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a yellow solid: 39% yield, (35 mg), m.p. 116–118 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.23 (d, J = 8.6 Hz, 1H), 8.12 (d, J = 9.5 Hz, 1H), 7.76−7.73 (m, 1H), 7.64−7.60 (m, 1H), 7.50−7.46 (m, 1H), 7.29 (d, J = 9.4 Hz, 1H), 4.48 (q, J = 7.0 Hz, 2H), 3.64−3.56 (m, 1H), 2.28−2.18 (m, 1H), 1.92−1.81 (m, 1H), 1.59 (d, J = 6.7 Hz, 3H), 1.46 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.8, 149.4, 134.4, 132.8, 129.2, 128.7, 125.8, 125.5, 125.5, 122.1, 118.1, 117.2, 60.4, 37.0, 28.4, 18.6, 14.6, 12.0. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{21}N_2O_2$ 297.1603; Found 297.1602.

Ethyl 1-isobutylimidazo[1,5-a]quinoline-3-carboxylate (**3aB**)

The title compound was prepared according to the general working procedure B (7 h, 8.7 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 5:1) to give the product as a yellow solid: 48% yield, (43 mg), m.p. 140–142 °C; ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.19 (d, J = 8.6 Hz, 1H), 8.13 (d, J = 9.4 Hz, 1H), 7.77−7.75 (m, 1H), 7.66−7.61 (m, 1H), 7.51−7.47 (m, 1H), 7.32 (d, J = 9.4 Hz, 1H), 4.50 (q, J = 7.1 Hz, 2H), 3.35 (d, J = 7.2 Hz, 2H), 2.42−2.32 (m, 1H), 1.46 (t, J = 7.1 Hz, 3H), 1.06 (d, J = 6.6 Hz, 6H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 163.6, 143.8, 134.6, 132.5, 129.1, 128.7, 125.5, 125.5, 121.9, 117.8, 116.7, 60.4, 40.7, 26.4, 22.3, 14.6. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{21}N_2O_2$ 297.1603; Found 297.1602.

Ethyl 2-((4-methoxyphenyl)imino)-2-(quinolin-2-yl)acetate (**7'**)

The title compound was prepared according to the general working procedure A (7 h, 13.1 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 20:1) to give the product as a light yellow oil: 92% yield, (92 mg); ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.33 (d, J = 8.6 Hz, 1H), 8.25 (d, J = 8.5 Hz, 1H), 8.12 (d, J = 8.5 Hz, 1H), 7.87−7.84 (m, 1H), 7.75−7.71 (m, 1H), 7.62−7.58 (m, 1H), 7.17−7.13 (m, 2H), 6.95−6.91 (m, 2H), 4.38 (q, J = 7.1 Hz, 2H), 3.84 (s, 3H), 1.25 (t, J = 7.1 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 165.7, 159.8, 157.9, 153.3, 147.4, 142.2, 136.6, 130.3, 129.6, 128.7, 127.9, 127.5, 121.9, 118.4, 114.1, 61.4, 55.4, 14.1. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{19}N_2O_3$ 335.1396; Found 335.1393.

Ethyl 2-(piperidin-1-yl)-2-(quinolin-2-yl)acetate (**5'**)

The title compound was prepared according to the general working procedure A (2 h, 3.7 F mol^{-1}) and purified by column chromatography (petroleum ether / ethyl acetate = 15:1) to give the product as a light yellow oil: 82% yield, (73 mg); ^{1}H NMR ($CDCl_3$, 400 MHz, ppm): δ = 8.16 (d, J = 8.5 Hz, 1H), 8.10 (d, J = 8.3 Hz, 1H), 7.82−7.76 (m, 2H), 7.72−7.68 (m, 1H), 7.55−7.51 (m, 1H), 4.46 (s, 1H), 4.26−4.15 (m, 2H), 2.57−2.47 (m, 4H), 1.64−1.59 (m, 4H), 1.50−1.43 (m, 2H), 1.23 (t, J = 7.2 Hz, 3H); ^{13}C{^{1}H}NMR ($CDCl_3$, 100 MHz, ppm): δ = 171.0, 157.4, 147.5, 136.5,

129.5, 129.4, 127.6, 127.4, 126.6, 120.6, 76.9, 60.9, 52.2, 25.9, 24.2, 14.2. HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{23}N_2O_2$ 299.1760; Found 299.1757.

ASSOCIATED CONTENT

Supporting Information

^1H NMR and ^{13}C $\{^1H\}$NMR spectra for the substrates **1 (1a-1e, 1g, 1h** and **1k)** and all the products as well as the photographic depiction of the electrolysis setup. This material is available free of charge via the Internet at http://pubs.acs.org.

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Notes

The authors declare no competing financial interest.

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