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H_2O_2/DMSO Promoted Regioselective Synthesis of 3,3′-Bisimidazopyridinylmethanes via Intermolecular Oxidative C(sp^2)-H Bond Activation of Imidazoheterocycles

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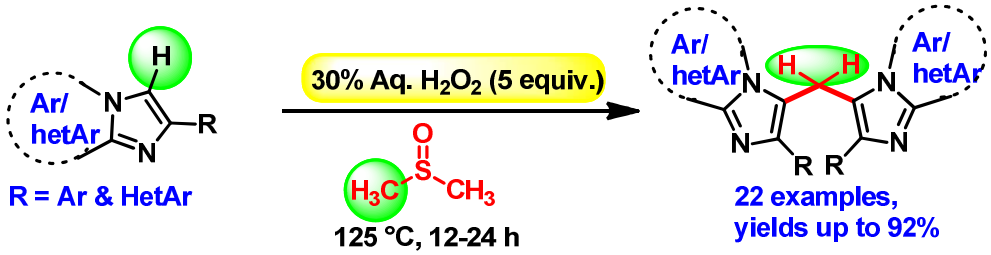


- Metal, ligand, base & additive free C(sp^2)-H and C(sp^3)-H activation
- DMSO as methylene source
- Scope of asymmetrical products (4 examples)
- Atom and step economy
- Under air
- Removal of H_2O as a green byproduct

ABSTRACT: In the past decade, metal-free approaches for C-C bond formation have attracted a great deal of attention due to their friendliness and inexpensiveness. This report represents a novel and metal-free synthesis of 3,3′-bisimidazopyridinylmethanes via intermolecular oxidative C(sp^2)-H bond functionalization of imidazo[1,2-*a*]pyridines with dimethyl sulfoxide (DMSO) as the carbon synthon (CH_2) using H_2O_2 as a mild oxidant under air. A library of 3,3′-bis(2-

arylimidazo[1,2-*a*]pyridine-3-yl)methanes has been achieved in good to excellent yields. The present methodology has been successfully applied to imidazo[2,1-*b*]thiazoles and imidazo[2,1-*b*]benzothiazoles. Furthermore, the current approach was also extended for the synthesis of unsymmetrical 3,3′-bisimidazopyridinylmethanes under optimized reaction conditions. A mechanistic pathway is proposed based on experiments with radical scavengers, DMSO-d_6 and ESI-MS observations.

INTRODUCTION

Dimethyl sulfoxide (DMSO) has been extensively employed as a solvent in organic synthesis due to its rather low cost, relative stability and low toxicity. Besides being an effective polar medium, DMSO is also used as a substrate and synthon in organic transformations.[1] An abundance of recent reports has shown that it has been used as a source of –O, -SMe, -CH_2SMe, -SO_2Me, -Me, -CN, -CHO and CH_2 as a functional unit inserted into target molecules.[1] Currently, our interest is focussed on the functionalization of heteroarenes (imidazoheterocycles) by using DMSO as a carbon synthon. Imidazo[1,2-*a*]pyridines and its derivatives are important structural units found in various natural products and pharmaceuticals such as zolpidem, alpidem, zolimidine, olprinone, saripidem, and necopidem (Figure 1).[2] Therefore, several methodologies have been developed for the preparation and post-transformation of imidazo[1,2-*a*]pyridines and related imidazo[1,2-*a*]heterocycles.[2,3] Due to the electron rich nature of C-3 position of imidazo[1,2-*a*]pyridine, several synthetic methods have emerged for oxidative C-H bond functionalization at C-3 position regioselectively.[3] Very recently, three similar reports were developed for the synthesis of 3,3′-bisimidazopyridinylmethanes.[4] (i) The Sun group successfully realized a H_3PO_4-promoted synthesis of bis(imidazo[1,2-*a*]pyridin-3-yl)methanes using DMSO as the methylene source (Scheme 1, a).[4a] The reaction proceeds through ionic mechanistic

pathway via in situ formation of formaldehyde. (ii) Patel *et. al.*, reported a copper-catalyzed approach to synthesize similar target compounds using dimethylacetamide (DMA) as the carbon synthon (Scheme 1, b).[4b] (iii) Kumar and co-workers also developed a vanadyl acetylacetonate-catalyzed methylenation of imidazo[1,2-a]pyridines by using DMA as a methylene source (Scheme 1, c).[4c] A similar strategy was developed by Cui *et al.*, to synthesize 3,3′-diindolylmethane via palladium catalyzed post-functionalization strategy using DMSO as the methylene source.[5] Despite having a few valuable advantages, these reactions suffer from certain limitations such as the use of metal catalysts,[4b,c,5] inorganic acid,[4a] base and inert atmosphere[5] to catalyze the reaction via an ionic mechanistic pathway.

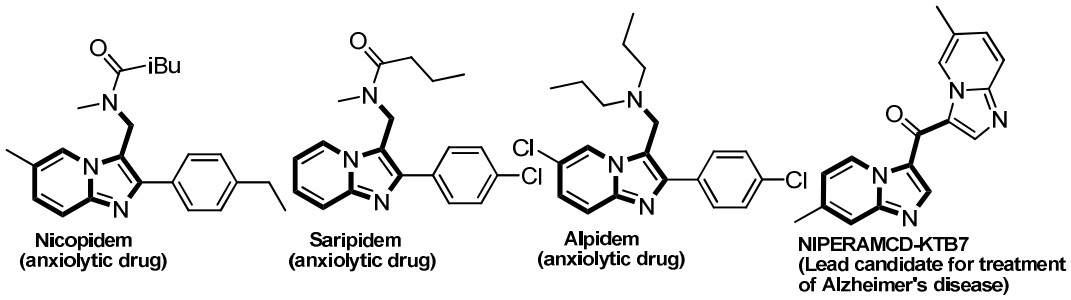
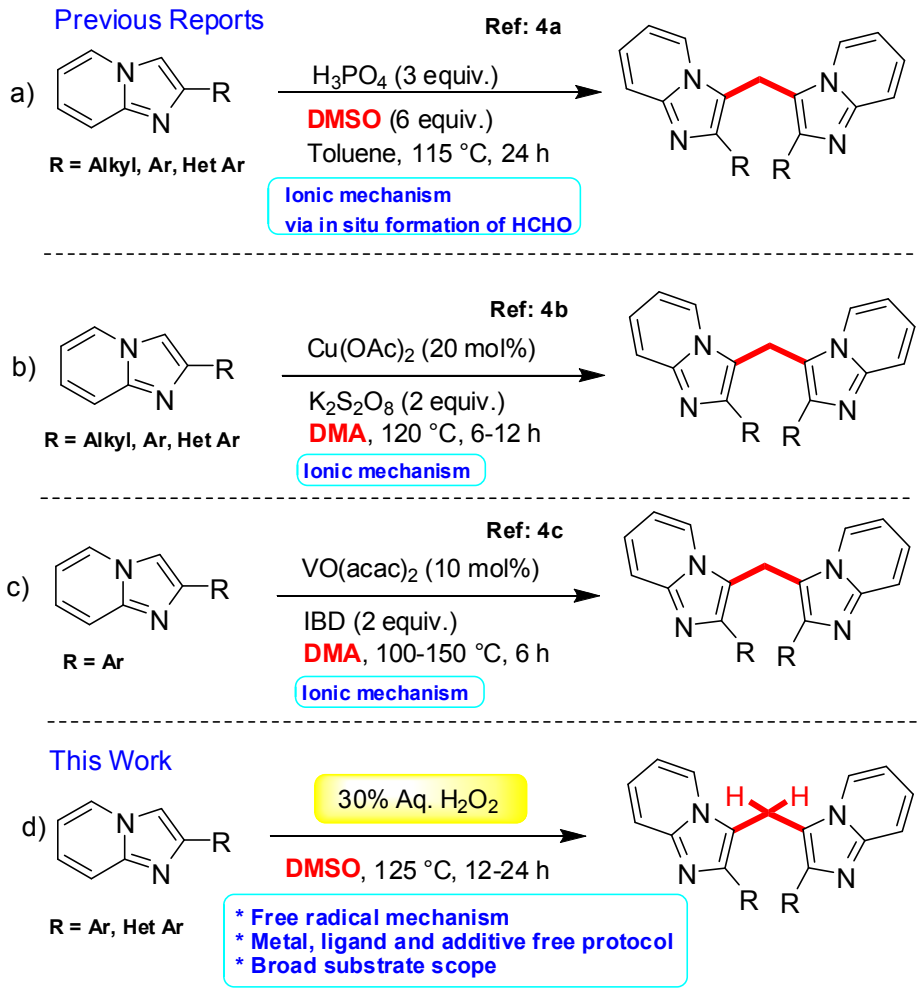


Figure 1. Representative examples of anxiolytic drugs and bioactive agents.[2]

In continuation of our research program for the development of mild and efficient approaches for C-H bond functionalization,[6] herein, we report a unique approach for the synthesis of bis(2-arylimidazo[1,2-*a*]pyridine-3-yl)methanes via C(sp^2)-H bond activation by using H_2O_2 as a mild oxidant and DMSO as the carbon source. The present protocol represents a facile transformation for the construction of 3,3′-bisimidazopyridinylmethanes under metal-free and aerobic conditions and provided a practical yield.

Scheme 1. Recent reports for C-3 functionalization of imidazo[1,2-*a*]pyridines

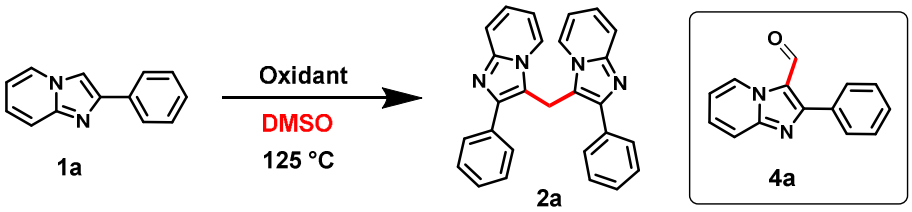


RESULTS AND DISCUSSION

The oxidative coupling reaction condition was optimized using 2-phenyl-imidazo[1,2-*a*]pyridine (**1a**) as the model substrate. The reaction was initially performed in DMSO at 125 °C under air without the use of any external oxidant. The respective product **2a** was formed in 37% yield in 24 h (Table 1, entry 1) and the structure was unambiguously confirmed by 1D, 2D NMR spectroscopy and HRMS analysis (Supporting Information). The initial result prompted us to optimize the reaction conditions to enhance the yield of desired product **2a**. In this perspective, a series of external oxidants namely TBHP, DTBP, TBPB, H_2O_2 and oxone (3 equiv. each) were employed under identical reaction conditions (Table 1, entries 2-6). Pleasingly, only H_2O_2 (3

equiv.) provided the product with 68% yield in 24 h (Table 1, entry 5), whereas, other oxidants were found to diminish the yield of **2a**. It was noticed that in the case of TBHP, DTBP, and TBPB, the reaction produced a complex mixture of products. From this complex mixture the C-3 formylated product, 2-phenylimidazo[1,2-*a*]pyridine-3-carbaldehyde (**4a**), was isolated in 13%, 30% and <5% yields, respectively. By increasing the equiv. of TBHP and DTBP (5 equiv. each) in the reaction, **4a** was formed in an enhanced yield of 22% and 50% respectively, without formation of desired product **2a** (Table 1, entries 7 and 8). The difference in the course of reaction of peroxide oxidants (H_2O_2 vs. TBHP/DTBP) may be due to the in situ formation of *tert*-butoxyl and *tert*-butylperoxy radicals in the case of TBHP/DTBP[7], which leads to C-3 formylation instead of coupling with another mole of 2-phenylimidazo[1,2-*a*]pyridine (**1a**). However, in the case of H_2O_2 ($^{\bullet}OH$) the methylated intermediate undergoes a sequence of hydrogen atom abstraction followed by radical coupling of **1a** to afford the desired final product **2a**. Further, an increase in the amount of H_2O_2 concentration to 5 equiv. facilitated the product **2a** with 82% yield in 18 h (Table 1, entry 10). On decreasing the reaction temperature to 80 °C from 125 °C, the corresponding product **2a** was formed in 11% yield with 80% recovery of **1a** (Table 1, entry 11). No significant enhancement in the yield of **2a** was observed by increasing the H_2O_2 loading to 6 equiv. in the reaction (Table 1, entry 12).

Table1. Optimization of the Reaction Conditions[a]



Entry	Oxidant (equiv.)	Solvent (10 mL)	Time (h)	Yield (%)[b]

1	-	DMSO	24	37
2	TBHP (3)	DMSO	24	0[c]
3	DTBP (3)	DMSO	24	0[d]
4	TBPB (3)	DMSO	24	0[e]
5	H_2O_2 (3)	DMSO	24	68
6	Oxone (3)	DMSO	24	0
7	TBHP (5)	DMSO	18	0[f]
8	DTBP (5)	DMSO	18	0[g]
9	H_2O_2 (5)	DMSO	12	71
10	**H_2O_2 (5)**	**DMSO**	**18**	**82**
11	H_2O_2 (5)	DMSO	20	11[h]
12	H_2O_2 (6)	DMSO	18	81

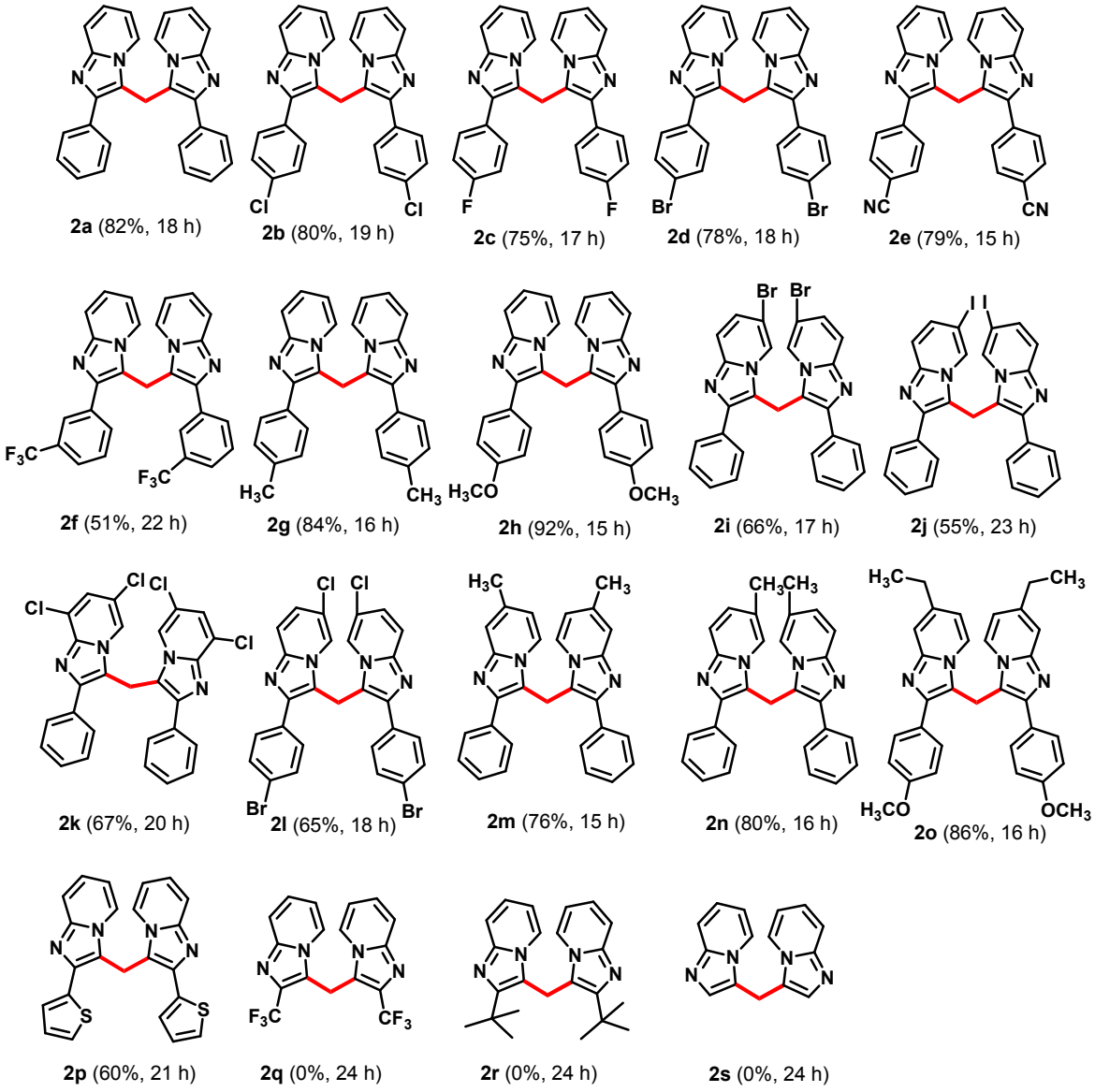
[a]Reaction conditions: **1a** (1 equiv.), oxidant (3-5 equiv.) in 10 mL of DMSO at 125 °C. [b]Isolated yield. [c]2-phenylimidazo[1,2-*a*]pyridine-3-carbaldehyde (**4a**) was formed in 13% yield. [d]**4a** was formed in 30% yield. [e]**4a** was formed in <5% yield. [f]**4a** was formed in 22% yield. [g]**4a** was formed in 50% yield. [h]Reaction performed at 80 °C. TBHP = *tert*-butyl hydroperoxide (70% aq. Solution), DTBP = di-*tert*-butyl peroxide, TBPB = *tert*-butyl peroxybenzoate, DMSO = dimethyl sulfoxide.

Having optimized reaction conditions in hand (Table 1, entry 10), the utility of present approach was systematically investigated by introducing substrates bearing a wide variety of functional groups (electron-withdrawing and electron-donating groups) on the C-2 aryl ring and pyridine ring of imidazo[1,2-*a*]pyridine (Scheme 2). At first, the effect of electron-withdrawing substituents (4-Cl, F, Br, and CN) on the C-2 aryl ring of imidazo[1,2-*a*]pyridine was examined. All the corresponding products (**2a**-**2e**) were formed in good to excellent yields (75%-82%). In the case of CF_3 present on *meta* position of the aryl ring, only 51% yield of **2f** was obtained, perhaps due to the deactivation of C-3 position by the strong electron-withdrawing nature of CF_3 group. Next, the effect of electron-donating groups (*p*-CH_3 and *p*-OCH_3) present on the aryl ring of imidazo[1,2-*a*]pyridine was studied. The respective products **2g** and **2h** were obtained in

excellent yields (84% and 92%, respectively), representing a relatively better yield compared to the electron-neutral 2-phenyl-imidazo[1,2-*a*]pyridine under identical reaction conditions.

Next, the electronic effects of substituents (R^2= EWGs and EDGs) on the pyridine ring of imidazo[1,2-*a*]pyridine at different positions were studied. Interestingly, substrates bearing electron-withdrawing substituents such as 5-Br, 5-I and 5,7-di Cl on the pyridine ring of imidazo[1,2-*a*]pyridine smoothly underwent in the reaction and yielded the corresponding products (**2i**, **2j**, and **2k**, respectively) in moderate to good yields (55%-67%). It is worth noting that halogens (F, Cl, Br, and I) and -CN groups are tolerated under optimized conditions and may serve as crucial substituents for post-functionalization reactions. Further, employing the substrate bearing 5-Cl and *p*-Br on pyridine ring and aryl ring of imidazo[1,2-*a*]pyridine, respectively, furnished the desired product **2l** in 65% yield. On the other hand, substrates containing electron-donating groups (6-CH_3 and 5-CH_3) present on the pyridine ring of imidazo[1,2-*a*]pyridine smoothly participated in the reaction and provided the corresponding products **2m** and **2n** in high yields under optimized reaction conditions. The substrate bearing electron-donating groups such as 6-Et and *p*-OCH_3 present on pyridine and aryl ring of imidazo[1,2-*a*]pyridine, respectively, facilitated the desired product **2o** in about 86% yield. The reaction of hetero-arene (thiophene) at the C-2 position of imidazo[1,2-*a*]pyridine was also carried out. To our delight, the respective product bis(2-(thiophen-2-yl)imidazo[1,2-*a*]pyridine-3-yl)methane (**2p**) was obtained in 60% yield. However, substrates bearing CF_3, *tert*-butyl, and H at C-2 position of imidazo[1,2-*a*]pyridine failed to deliver the corresponding products **2q**-**2s** under identical reaction conditions, indicating that aryl substitution at C-2 position is necessary for the reaction to proceed.[8]

Scheme 2. Substrate Scope of Imidazo[1,2-*a*]pyridine[a,b]

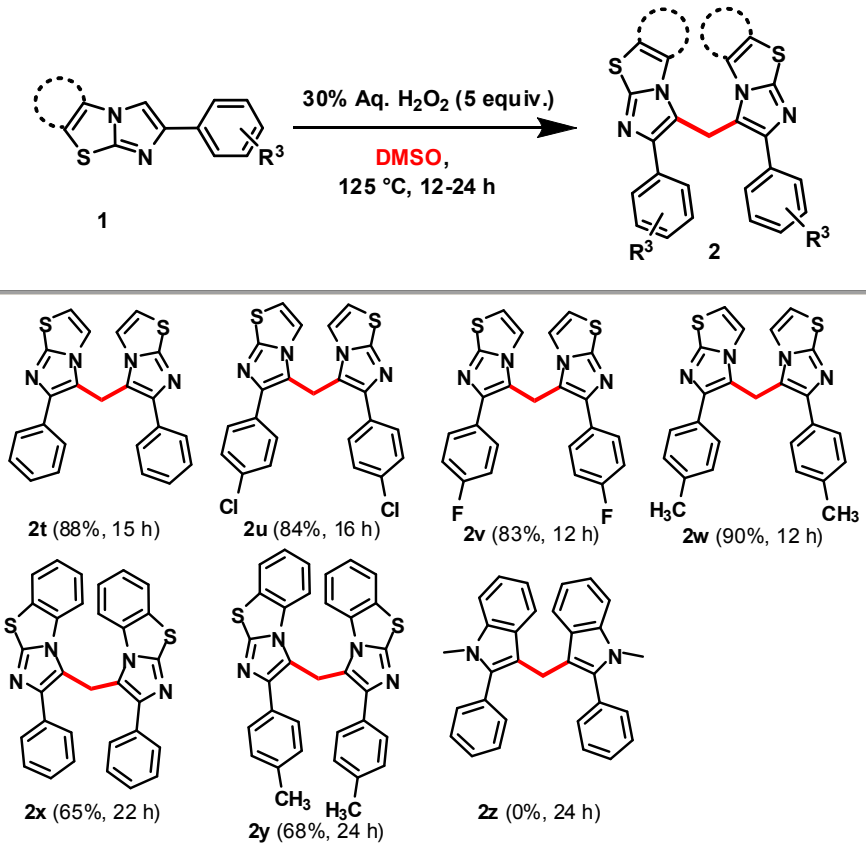


[a]All reactions were performed by using **1** (1 equiv., 300 mg) and 30% aq. H_2O_2 (5 equiv.) in 10 mL of DMSO at 125 °C for 12-24 h. [b]Isolated yields.

The scope of the present protocol was further elaborated with other imidazoheterocycles like

imidazo[2,1-*b*]thiazole and imidazo[2,1-*b*]benzothiazole to the reaction condition (Scheme 3). Gratifyingly, substrates bearing electron-withdrawing (*p*-Cl and *p*-F) and electron-donating groups (*p*–CH_3) present on the aryl ring of imidazo[2,1-*b*]thiazole and imidazo[2,1-*b*]benzothiazole were well-tolerated in the reaction and furnished the corresponding products in good to excellent yields (Scheme 3, entries **2t**-**2y**). We also tried the reaction of 1-methyl-2-phenyl-1*H*-indole (**1z**) under optimal reaction conditions. However, the reaction failed to furnish the respective product **2z**.

Scheme 3. Substrate Scope of Other Heterocycles[a,b]

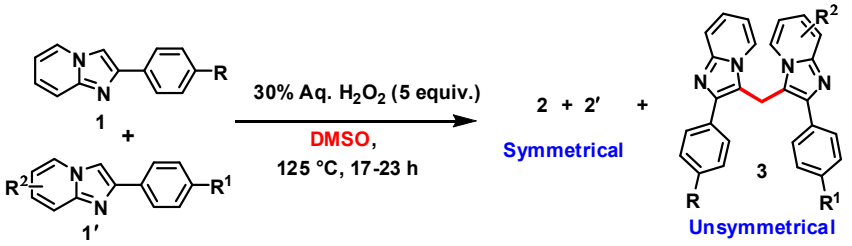


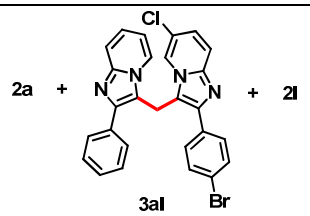
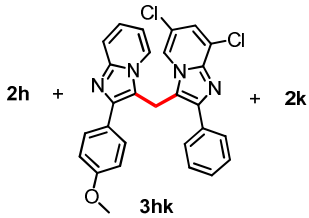
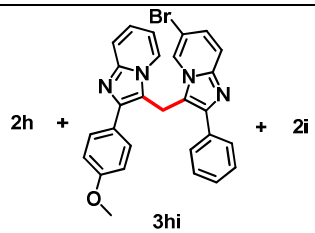
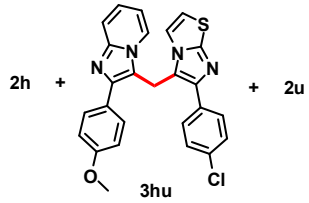
[a]Reaction conditions similar to Scheme 2. [b]Isolated yields

Furthermore, the scope of present method was extended for the synthesis of unsymmetrical 3,3′-bisimidazopyridinyl compounds under optimized reaction conditions. The cross-coupling

reaction of various substituents present on the C-2 aryl ring (-Cl, -Br, and $–OCH_3$) and pyridine ring (-Cl, -dichloro, and –Br) of imidazoheterocycles were amenable to the reaction condition and afforded the respective unsymmetrical products (**3al**, **3hk**, **3hi**, and **3hu**) in good yields compared to corresponding symmetrical products (Scheme 4).

Scheme 4. Substrate Scope of Unsymmetrical Imidazoheterocycles[a,b]



Entry (Product)	Time	Yields (%)[b]
	23 h	16, **31**, 13
	20 h	19, **29**, 14
	19 h	20, **27**, 11
	17 h	21, **35**, 18

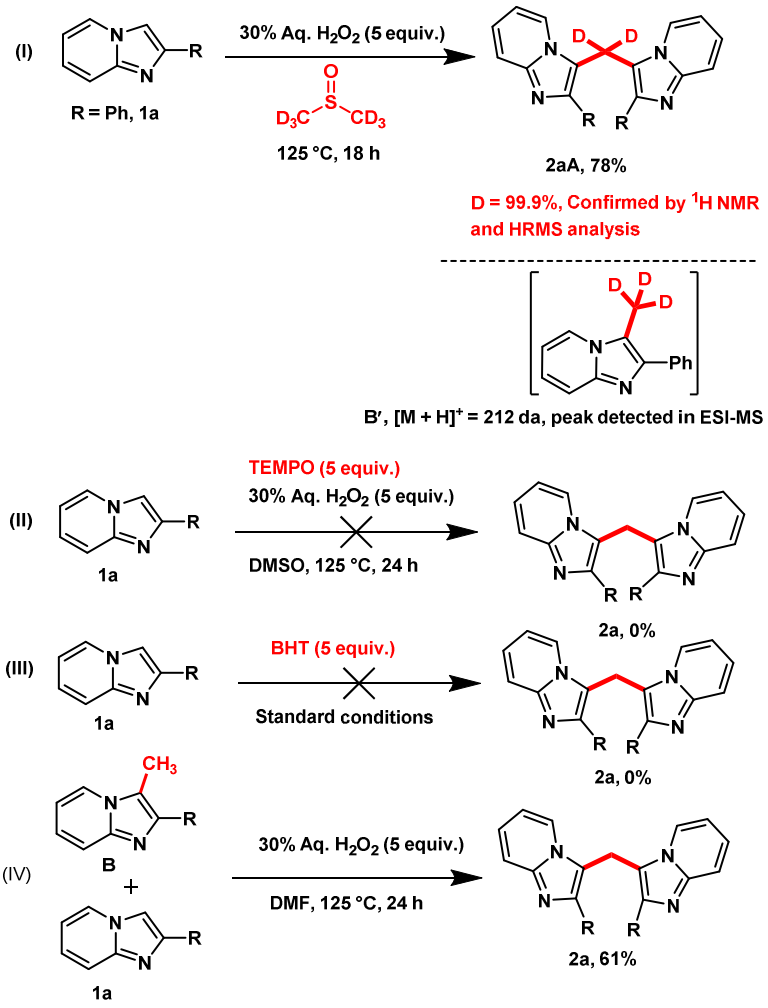
[a]Reaction was performed by using **1** (1 equiv.), **1′** (1 equiv.) and 30% aq. H_2O_2 (5 equiv.) in 10 mL of DMSO at 125 °C for 17-23 h. [b]Isolated yields of each products.

To gain an insight into the mechanism of the oxidative coupling reaction, a series of control experiments were performed. The isotopic labeling experiment was carried out using **1a** in the presence of DMSO-d_6 under the optimized reaction conditions. The deuterated product **2aA** was formed in 78% yield with more than 99% incorporation of deuterium (Scheme 5, eq 1). This study clearly indicated that DMSO is a source of one-carbon synthon. Mass spectrometric analysis of crude reaction mixture after 18 h revealed the presence of methylated intermediate (**B′**), which showed a $[M + H]^+$ peak at 212 da (Scheme 5, eq I). To detect the kind of mechanism involved in this transformation, well known radical scavengers, such as TEMPO (2,2,6,6-tetramethylpiperidine 1-oxy) and BHT (butylated hydroxytoluene) were added to the reaction (Scheme 5, eq II and III). The product formation was completely inhibited, suggesting an involvement of radical-mediated pathway. To further confirm the mechanistic pathway, the reaction of the 3-methyl-2-phenylimidazo[1,2-*a*]pyridine (**B**) with **1a** was carried out in DMF under standard reaction conditions. The respective product **2a** was formed in 61% yield (Scheme 5, eq IV). These experiments together with ESI-MS observation confirm that the reaction may proceed via formation of methylated intermediate **B**.

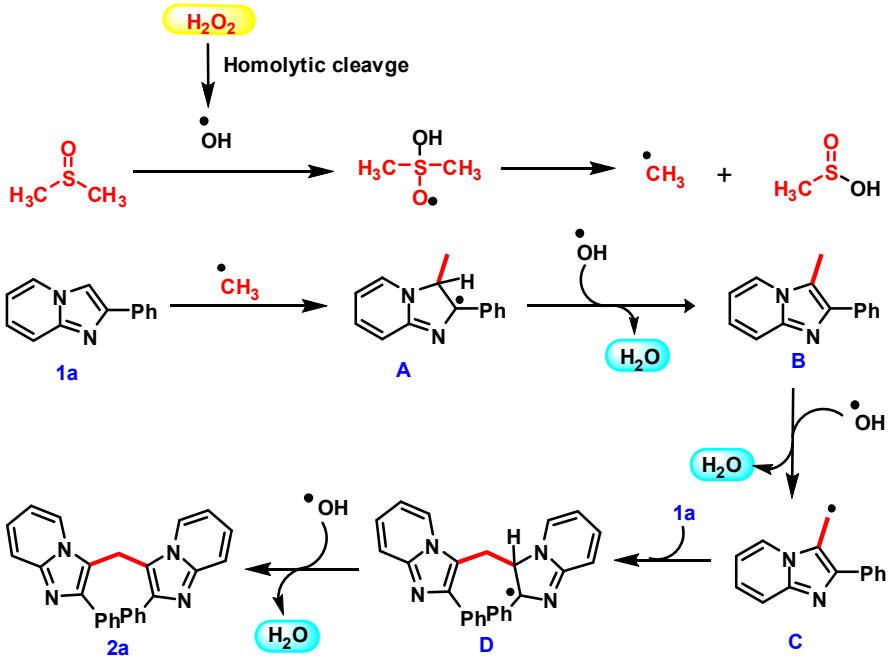
In accordance with the preliminary mechanistic studies and literature precedents[9], a proposed mechanistic pathway is depicted as shown in Scheme 6. Initially, the hydroxyl radical generated through homolytic cleavage of H_2O_2 and subsequently reacts with DMSO to produce methyl radical species.[9a-c] The methyl radical reacts with **1a** to afford the radical intermediate **A**, which could be stabilized by the adjacent phenyl ring. The radical intermediate **A** leads to methylated intermediate **B** via •H abstraction by hydroxyl radical with subsequent loss of H_2O. The hydroxyl radical subsequently abstracts •H from **B** to form the radical intermediate **C** with the removal of

H_2O. The intermediate **C** reacts with another mole of **1a** to afford the radical intermediate **D**, which upon subsequent loss of H_2O in the presence of hydroxyl radical delivers the corresponding final product **2a**.

Scheme 5. Preliminary Mechanistic Studies



Scheme 6. Plausible Mechanistic Pathway



CONCLUSION

In Summary, we have developed a facile, transition metal-free and regioselective approach for the synthesis of 3,3′-bisimidazopyridinylmethanes using DMSO as the methylene source. The radical mechanism was established by experiments with radical scavengers (TEMPO and BHT), DMSO-d_6 and ESI-MS analysis. The use of mild oxidant H_2O_2 to activate C-(sp^2)-H/C(sp^3)-H in a cascade manner under aerobic conditions to furnish symmetrical and unsymmetrical products in good to excellent yields are attractive features of this approach. Moreover, further applications of this approach are ongoing in our laboratory.

EXPERIMENTAL SECTION

General information

Melting points were determined on a capillary melting point apparatus and are uncorrected. All the compounds were fully characterized by ^{1}H, ^{13}C, IR, and further confirmed through ESI-MS and HRMS analysis. ^{1}H NMR spectra were recorded on 400 and 500 MHz in $CDCl_3$, DMSO-d_6

and ^{13}C NMR spectra recorded on 100 and 125 MHz in $CDCl_3$, DMSO-d_6, CD_3OD and TFA using TMS as an internal standard. Multiplicities are reported as follows: singlet (s), doublet (d), broad singlet (br s), doublet of doublets (dd), triplet (t), doublet of doublet of doublet (ddd), doublet of triplet (dt), and multiplet (m). Chemical shift (δ) and coupling constants (J) are reported in parts per million (ppm) relative to the residual signal of TMS in deuterated solvents and hertz, respectively. IR spectra were recorded using an FT-IR spectrophotometer, and values are reported in cm^{-1}. HRMS were recorded using a Q-TOF mass spectrometer. Column chromatography was performed over silica gel (60-120 mesh) using EtOAc-*n*-hexane as an eluent. All chemicals and reagents were purchased from commercial sources and used without further purification.

General experimental procedure for the preparation of starting materials (1). The starting material 2-arylimidazo[1,2-*a*]pyridines **1a-1y** (known compounds)[10,11] and **1o** (unknown) were prepared by a known literature procedure.[11]

Experimental procedure for the synthesis of symmetrical compounds 2a-2z. To a well-stirred solution of substrate (**1**) (300 mg, 1 equiv.) in DMSO (10 mL) placed into a 50 mL, round-bottom flask was added 30% aq. H_2O_2 (5 equiv.) at room temperature. The resulting mixture was heated at 125 °C for 12-24 h. After completion of the reaction monitored by TLC, the reaction mixture was allowed to stand at room temperature for 30 minutes. Then the mixture was with 20 mL of H_2O and extracted with EtOAc (3 x 50 mL) followed by washing with brine (10 mL) and dried over Na_2SO_4. After evaporation of the solvent under reduced pressure, the crude product was purified by silica gel (60-120 mesh) column chromatography eluted with EtOAc and *n*-hexane (8:2 to 1:9) to afford the respective products (**2**).

Experimental procedure for the synthesis of unsymmetrical compounds (3). To a well-

stirred solution of substrate **1** (300 mg, 1 equiv.) and **1′** (1 equiv.) in DMSO (10 mL) placed into a 50 mL, round-bottom flask was added 30% aq. H_2O_2 (5 equiv.) at room temperature. The resulting mixture was heated at 125 °C for 17-23 h. After completion of the reaction monitored by TLC, the reaction mixture was allowed to stand at room temperature for 30 minutes. Then the mixture was mixed with 20 mL of H_2O and extracted with EtOAc (3 x 50 mL) followed by washing with brine (10 mL) and dried over Na_2SO_4. After evaporation of the solvent under reduced pressure, the crude product was purified by silica gel (60-120 mesh) column chromatography eluted with EtOAc and *n*-hexane (8:2 to 1:9) to afford respective products **2**, **3** and **2′**.

Bis(2-phenylimidazo[1,2-a]pyridine-3-yl)methane ***(2a).*** White solid (255 mg, 82%); mp 216-218 ºC; FT-IR (KBr, νmax/cm^{-1}) 3684, 3019, 1602, 1520, 1476, 1334, 1072, 928, 848, 627, 493; δ_H (400 MHz; $CDCl_3$) = 7.78 (4H, dd, J = 8.4, 1.4 Hz), 7.53-7.49 (6H, m), 7.44-7.40 (2H, m), 7.33 (2H, d, J = 6.9 Hz), 7.04 (2H, m), 6.46 (2H, td, J = 6.8, 1.2 Hz), 4.99 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 145.1 (2xC), 144.3 (2xC), 134.4 (2xC), 129.01 (4xCH), 128.9 (4xCH), 128.3 (2xCH), 124.3 (2xCH), 123.8 (2xCH), 117.5 (2xCH), 114.3 (2xC), 112.3 (2xCH) 19.8 (CH_2) ppm; HRMS (ESI): Calcd for $C_{27}H_{21}N_4$ $[M + H]^+$ 401.1766, Found: 401.1755.

Bis(2-(4-chlorophenyl)imidazo[1,2-a]pyridine-3-yl)methane ***(2b).*** White solid (195 mg, 80%); mp 270-272 ºC; FT-IR (KBr, νmax/cm^{-1}) 3683, 3019, 1636, 1522, 1476, 1404, 1022, 928, 669, 626; δ_H (400 MHz; $CDCl_3$) = 7.64 (4H, dt, J = 9, 2.4 Hz), 7.54 (2H, dt, J = 9.0, 1.0 Hz), 7.43 (4H, dt, J = 9.0, 2.4 Hz), 7.38 (2H, dt, J = 6.9, 1.0 Hz), 7.10 (2H, ddd, J = 9, 6.8, 1.2 Hz), 6.55 (2H, td, J = 6.8, 1.2 Hz), 4.90 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 145.1 (2xC), 143.2 (2xC), 134.3 (2xC), 132.7 (2xC), 130.0 (4xCH), 129.0 (4xCH), 124.7 (2xCH), 123.5 (2xCH),

117.7 (2xCH), 114.1 (2xC), 112.7 (2xCH), 20.1 (CH_2) ppm; HRMS (ESI): Calcd for $C_{27}H_{19}Cl_2N_4$ $[M + H]^+$ 469.0987, Found: 469.0976.

Bis(2-(4-fluorophenyl)imidazo[1,2-a]pyridine-3-yl)methane ***(2c).*** White solid (231 mg, 75%); mp 190-192 ºC; FT-IR (KBr, νmax/cm^{-1}) 3745, 3391, 3019, 1637, 1517, 1403, 1047, 928, 669; δ_H (400 MHz; $CDCl_3$) = 7.69-7.66 (4H, m), 7.52 (2H, dd, J = 9.0, 0.1 Hz), 7.38-7.36 (2H, m), 7.17-7.06 (6H, m), 6.54 (2H, t, J = 6.8 Hz), 4.88 (2H, s) ppm; δ_C (125 MHz; $CDCl_3$) = 162.8 ($J_{C\text{-}F}$ = 246.2, 2xC), 145.0 (2xC), 143.4 (2xC), 130.5 ($J_{C\text{-}F}$ = 8.7 Hz, 4xCH), 130.3 ($J_{C\text{-}F}$ = 2.5 Hz, 2xC), 124.5 (2xCH), 123.5 (2xCH), 117.6 (2xCH), 115.8 ($J_{C\text{-}F}$ = 21.2, 4xCH), 113.9 (2xC), 112.6 (2xCH), 20.0 (CH_2) ppm; HRMS (ESI): Calcd for $C_{27}H_{19}F_2N_4$ $[M + H]^+$ 437.1578, Found: 437.1566.

Bis(2-(4-bromophenyl)imidazo[1,2-a]pyridine-3-yl)methane ***(2d).*** White solid (239 mg, 78%); mp 274-276 ºC; FT-IR (KBr, νmax/cm^{-1}) 3390, 3019, 1638, 1402, 1215, 1070, 768, 668; δ_H (400 MHz; $CDCl_3$) = 7.58 (8H, s), 7.54 (2H, dt, J = 9.1, 1 Hz), 7.37 (2H, dd, J = 5.9, 1 Hz), 7.10 (2H, ddd, J = 9.0, 6.8, 1.2 Hz), 6.56 (2H, td, J = 6.8, 1.2 Hz), 4.88 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 145.1 (2xC), 143.2 (2xC), 133.1 (2xC), 131.9 (4xCH), 130.2 (4xCH), 124.7 (2xCH), 123.5 (2xCH), 122.5 (2xC), 117.7 (2xCH), 114.1 (2xC), 112.8 (2xCH), 20.1 (CH_2) ppm; HRMS (ESI): Calcd for $C_{27}H_{19}Br_2N_4$ $[M + H]^+$ 558.9956, Found: 558.9955.

Bis(2-(4-cyanophenyl)imidazo[1,2-a]pyridine-3-yl)methane ***(2e).*** White solid (243 mg, 79%); mp 295-297 ºC; FT-IR (KBr, νmax/cm^{-1}) 3401, 3019, 1635, 1385, 1216, 1070, 669; δ_H (400 MHz; $CDCl_3$) = 7.69 (4H, d, J = 8.2 Hz), 7.63 (4H, d, J = 8.2 Hz), 7.57 (2H, d, J = 9.1 Hz), 7.47 (2H, d, J = 6.9 Hz), 7.19 (2H, t, J = 6.9 Hz), 6.68 (2H, t, J = 6.8 Hz), 4.89 (s, 2H) ppm; δ_C (100 MHz; $CDCl_3$ + CD_3OD) = 145.2 (2xC), 142.3 (2xC), 138.5 (2xC), 132.1 (4xCH), 128.9 (4xCH), 125.5 (2xCH), 123.1 (2xCH), 118.5 (2xC), 117.8 (2xCH), 114.5 (2xC), 113.4 (2xCH),

111.7 (2xC), 20.4 (CH_2) ppm; HRMS (ESI): Calcd for $C_{29}H_{19}N_6$ $[M + H]^+$ 451.1671, Found: 451.1663.

Bis(2-(3-(trifluoromethyl)phenyl)imidazo[1,2-a]pyridine-3-yl)methane ***(2f).*** White solid (157 mg, 51%); mp 186-188 ºC; FT-IR (KBr, νmax/cm^{-1}) 3853, 3745, 3392, 3019, 1638, 1403, 1050, 929, 669; δ_H (400 MHz; $CDCl_3$) = 7.94 (2H, s), 7.75 (2H, d, J = 7.6 Hz), 7.61 (2H, d, J = 7.6 Hz), 7.56-7.49 (4H, m), 7.43 (2H, d, J = 6.9 Hz), 7.14 (2H, td, J = 7.9, 0.1 Hz), 6.64-6.61 (2H, m), 4.89 (2H, s) ppm; δ_C (125 MHz; $CDCl_3$) = 145.1 (2xC), 143.0 (2xC), 135.0 (2xC), 131.7 (2xCH), 131.2 (2xC, q, J_{C-F} = 32.5 Hz), 129.0 (2xCH), 125.6 (2xCH, br q, J_{C-F} = 3.7 Hz), 125.0 (2xCH), 124.9 (2xCH, br q, J_{C-F} = 3.7 Hz), 123.3 (2xCH), 117.8 (2xCH), 114.2 (2xC), 113.0 (2xCH), 20.2 (CH_2) ppm; HRMS (ESI): Calcd for $C_{29}H_{19}F_6N_4$ $[M + H]^+$ 537.1514, Found: 537.1509.

Bis(2-p-tolylimidazo[1,2-a]pyridine-3-yl)methane ***(2g).*** Yellow solid (259 mg, 84%); mp 255-257 ºC; FT-IR (KBr, νmax/cm^{-1}) 3400, 3019, 1634, 1385, 1215, 1070, 769, 669; δ_H (400 MHz; $CDCl_3$) = 7.69 (4H, d, J = 8.0 Hz), 7.51 (2H, d, J = 9.0 Hz), 7.33 (6H, br t, J = 7.6 Hz), 7.03 (2H, t, J = 7.8 Hz), 6.45 (2H, t, J = 6.8 Hz), 4.98 (2H, s), 2.44 (s, 6H) ppm; δ_C (100 MHz; $CDCl_3$) = 145.0 (2xC), 144.3 (2xC), 138.1 (2xC), 131.5 (2xC), 129.6 (4xCH), 128.9 (4xCH), 124.2 (2xCH), 123.9 (2xCH), 117.4 (2xCH), 114.2 (2xC), 112.2 (2xCH), 21.4 (2xCH_3), 19.9 (CH_2) ppm; HRMS (ESI): Calcd for $C_{29}H_{25}N_4$ $[M + H]^+$ 429.2079, Found: 429.2069.

Bis(2-(4-methoxyphenyl)imidazo[1,2-a]pyridine-3-yl)methane ***(2h).*** White solid (296 mg, 92%); mp 214-216 ºC; FT-IR (KBr, νmax/cm^{-1}) 3682, 3391, 3019, 1614, 1474, 1032, 928, 669, 627; δ_H (400 MHz; $CDCl_3$) = 7.74-7.70 (4H, m), 7.50 (2H, d, J = 9.0 Hz), 7.35 (2H, d, J = 6.9 Hz), 7.06-7.0 (6H, m), 6.45 (2H, td, J = 6.8, 1.1 Hz), 4.94 (2H, s), 3.88 (6H, s) ppm; δ_C (100

MHz; $CDCl_3$) = 159.8 (2xC), 145.0 (2xC), 144.1 (2xC), 130.27 (4xCH), 126.9 (2xC), 124.2 (2xCH), 123.9 (2xCH), 117.3 (2xCH), 114.4 (4xCH), 113.9 (2xC), 112.3 (2xCH), 55.5, 19.9 (CH_2) ppm; HRMS (ESI): Calcd for $C_{29}H_{25}N_4O_2$ $[M + H]^+$ 461.1978, Found: 461.1967.

Bis(6-bromo-2-phenylimidazo[1,2-a]pyridine-3-yl)methane ***(2i).*** Orange solid (202 mg, 66%); mp 286-288 ºC; FT-IR (KBr, νmax/cm^{-1}) 3683, 3019, 1602, 1522, 1475, 1023, 928, 669, 626; δ_H (400 MHz; $CDCl_3$) = 7.75 (4H, br d, J = 7.7 Hz), 7.57 (4H, t, J = 7.2 Hz), 7.50-7.46 (2H, m), 7.43-7.39 (4H, m), 7.11 (2H, dd, J = 9.4, 1.8 Hz), 4.92 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 145.2 (2xC), 143.6 (2xC), 133.7 (2xC), 129.3 (4xCH), 129.2 (4xCH), 128.8 (2xCH), 128.0 (2xCH), 124.2 (2xCH), 118.1 (2xCH), 114.6 (2xC), 107.1 (2xC), 19.2 (CH_2) ppm; HRMS (ESI): Calcd for $C_{27}H_{18}Br_2N_4$ $[M + H]^+$ 558.9956, Found: 558.9955.

Bis(6-iodo-2-phenylimidazo[1,2-a]pyridine-3-yl)methane ***(2j).*** White solid (147 mg, 55%); mp 282-284 ºC; FT-IR (KBr, νmax/cm^{-1}) 3684, 3399, 3019, 1635, 1523, 1419, 1069, 928, 669; δ_H (400 MHz; $CDCl_3$) = 7.81-7.79 (4H, m), 7.60-7.56 (6H, m), 7.48 (2H, t, J = 7.4 Hz), 7.31 (2H, d, J = 9.4 Hz), 7.22 (2H, dd, J = 9.4, 1.5 Hz), 4.93 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$ + DMSO-d_6 + TFA) = 138.8 (2xC), 138.4 (2xC), 135.7 (2xC), 129.5 (2xCH), 128.0 (10xCH), 126.7 (2xC), 115.3 (2xCH), 113.7 (2xCH), 79.8 (2xC), 19.1 (CH_2) ppm; HRMS (ESI): Calcd for $C_{27}H_{19}I_2N_4$ $[M + H]^+$ 652.9699, Found: 652.9677.

Bis(6,8-dichloro-2-phenylimidazo[1,2-a]pyridine-3-yl)methane ***(2k).*** White solid (206 mg, 67%); mp 268-270 ºC; FT-IR (KBr, νmax/cm^{-1}) 3390, 3019, 1637, 1402, 1068, 669; δ_H (400 MHz; $CDCl_3$) = 7.77-7.75 (4H, m), 7.58-7.54 (4H, m), 7.51-7.47 (2H, m), 7.24 (2H, d, J = 1.7 Hz), 7.15 (2H, d, J = 1.7 Hz), 4.89 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 146.0 (2xC), 141.1 (2xC), 133.2 (2xC), 129.3 (8xCH), 129.1 (2xCH), 124.9 (2xCH), 123.7 (2xC), 120.8 (2xCH),

119.9 (2xC), 116.3 (2xC), 19.5 (CH_2) ppm; HRMS (ESI): Calcd for $C_{27}H_{17}Cl_4N_4$ $[M + H]^+$ 537.0207, Found: 537.0200.

Bis(2-(4-bromophenyl)-6-chloroimidazo[1,2-a]pyridine-3-yl)methane ***(2l).*** White solid (199 mg, 65%); mp 273-275 ºC; FT-IR (KBr, νmax/cm^{-1}) 3683, 3390, 3019, 1645, 1522, 1403, 1069, 928, 831, 669, 626; δ_H (400 MHz; $CDCl_3$) = 7.65-7.62 (4H, m), 7.57-7.54 (4H, m), 7.47 (2H, dd, J = 9.5, 0.1 Hz), 7.32 (2H, br d, J = 1.2 Hz), 7.07 (2H, dd, J = 9.5, 1.9 Hz), 4.80 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 144.4 (2xC), 143.5 (2xC), 132.6 (2xC), 132.3 (4xCH), 130.4 (4xCH), 126.3 (2xCH), 123.2 (2xC), 121.7 (2xCH), 121.0 (2xC), 118.0 (2xCH), 114.5 (2xC), 19.5 (CH_2) ppm; HRMS (ESI): Calcd for $C_{27}H_{17}Br_2Cl_2N_4$ $[M + H]^+$ 626.9177, Found: 626.9145.

Bis(7-methyl-2-phenylimidazo[1,2-a]pyridine-3-yl)methane ***(2m).*** White solid (234 mg, 76%); mp 215-217 ºC; FT-IR (KBr, νmax/cm^{-1}) 3684, 3019, 1647, 1522, 1475, 1023, 928, 669; δ_H (400 MHz; DMSO-d_6) = 7.61 (2H, d, J = 6.9 Hz), 7.55 (4H, d, J = 6.9 Hz), 7.31-7.25 (8H, m), 6.57 (2H, d, J = 6.9 Hz), 4.97 (2H, s), 2.27 (6H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 145.5 (2xC), 143.8 (2xC), 135.3 (2xC), 134.7 (2xC), 129.0 (4xCH), 128.9 (4xCH), 128.1 (2xCH), 123.1 (2xCH), 115.8 (2xCH), 114.9 (2xCH), 114.0 (2xC), 21.24 (2xCH_3), 19.8 (CH_2) ppm; HRMS (ESI): Calcd for $C_{29}H_{25}N_4$ $[M + H]^+$ 429.2079, Found: 429.2084.

Bis(6-methyl-2-phenylimidazo[1,2-a]pyridine-3-yl)methane ***(2n).*** Yellow solid (246 mg, 80%); mp 273-275 ºC; FT-IR (KBr, νmax/cm^{-1}) 3673, 3391, 3019, 1637, 1402, 1216, 1068, 771, 669; δ_H (400 MHz; $CDCl_3$) = 7.84 (4H, d, J = 7.1 Hz), 7.57 (4H, t, J = 7.4 Hz), 7.49-7.45 (2H, m), 7.38 (2H, d, J = 9.2 Hz), 7.05 (2H, s), 6.86 (2H, dd, J = 9.1, 1.5 Hz), 4.96 (2H, s), 1.89 (6H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 144.1 (2xC), 143.7 (2xC), 135.1 (2xC), 129.1 (8xCH), 128.3

(2xCH), 127.6 (2xCH), 122.1 (2xCH), 121.8 (2xC), 116.6 (2xCH), 114.5 (2xC), 19.1 (CH_2), 18.0 (2xCH_3) ppm; HRMS (ESI): Calcd for $C_{29}H_{25}N_4$ $[M + H]^+$ 429.2079, Found: 429.2072.

Bis(7-ethyl-2-(4-methoxyphenyl)imidazo[1,2-a]pyridine-3-yl)methane ***(2o).*** White solid (264 mg, 86%); mp 217-219 ºC; FT-IR (KBr, νmax/cm^{-1}) 3364, 1640, 1400, 1248, 1067, 837, 769; δ_H (400 MHz; $CDCl_3$) = 7.74 (4H, dt, *J* = 9.6, 2.8 Hz), 7.27-7.24 (4H, m), 7.06 (4H, dt, *J* = 9.6, 2.8 Hz), 6.31 (2H, dd, *J* = 7.0, 1.7 Hz), 4.90 (2H, s), 3.89 (6H, s), 2.55 (4H, q, *J* = 7.5 Hz), 1.17 (6H, t, *J* = 7.5 Hz) ppm; δ_C (100 MHz; $CDCl_3$) = 159.6 (2xC), 145.5 (2xC), 143.6 (2xC), 141.3 (2xC), 130.1 (4xCH), 127.1 (2xC), 123.3 (2xCH), 114.3 (4xCH), 114.2 (2xCH), 113.8 (2xCH), 113.5 (2xC), 55.4, 28.3 (2xCH_2), 19.8 (CH_2), 14.4 (2xCH_3) ppm; HRMS (ESI): Calcd for $C_{33}H_{33}N_4O_2$ $[M + H]^+$ 517.2604, Found: 517.2592.

Bis(2-(thiophen-2-yl)imidazo[1,2-a]pyridine-3-yl)methane ***(2p).*** Off-white solid (185 mg, 60%); mp 259-261 ºC; FT-IR (KBr, νmax/cm^{-1}) 3392, 3019, 1636, 1403, 1215, 1051, 928, 669; δ_H (400 MHz; $CDCl_3$) = 7.59 (2H, d, *J* = 3.4 Hz), 7.53 (4H, br t, *J* = 8.0 Hz), 7.48 (2H, d, *J* = 4.8 Hz), 7.22-7.20 (2H, m), 7.09-7.05 (2H, m), 6.51 (2H, t, *J* = 6.3 Hz) 5.15 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 145.3 (2xC), 138.6 (2xC), 137.0 (2xC), 128.0 (2xCH), 126.6 (2xCH), 125.9 (2xCH), 125.0 (2xCH), 123.9 (2xCH), 117.5 (2xCH), 113.6 (2xC), 112.9 (2xCH), 20.4 (CH_2) ppm; HRMS (ESI): Calcd for $C_{23}H_{17}N_4S_2$ $[M + H]^+$ 413.0895, Found: 413.0887.

Bis(6-phenylimidazo[2,1-b]thiazol-5-yl)methane ***(2t).*** White solid (271 mg, 88%); mp 262-264 ºC; FT-IR (KBr, νmax/cm^{-1}) 3682, 3019, 1635, 1522, 1404, 1070, 928, 830, 669; δ_H (500 MHz; $CDCl_3$) = 7.75 (4H, br d, *J* = 7.7 Hz), 7.51-7.48 (4H, m), 7.41-7.37 (2H, m), 6.56 (2H, d, *J* = 3.6 Hz), 6.55 (2H, d, *J* = 3.6 Hz), 4.83 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$ + CD_3OD) = 149.4 (2xC), 144.4 (2xC), 133.9 (2xC), 128.9 (4xCH), 128.1 (4xCH), 128.0 (2xCH), 117.2

(2xCH and 2xC, overlapped), 113.1 (2xCH), 21.0 (CH_2) ppm; HRMS (ESI): Calcd for $C_{23}H_{17}N_4S_2$ $[M + H]^+$ 413.0895, Found: 413.0888.

Bis(6-(4-chlorophenyl)imidazo[2,1-b]thiazol-5-yl)methane ***(2u).*** White solid (259 mg, 84%); mp 261-263 ºC; FT-IR (KBr, νmax/cm^{-1}) 3392, 3019, 1644, 1402, 1215, 1048, 928, 669; δ_H (400 MHz; $CDCl_3$) = 7.68-7.64 (4H, m), 7.46-7.43 (4H, m), 6.62 (2H, d, J = 4.5 Hz), 6.57 (2H, d, J = 4.5 Hz), 4.76 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 149.6 (2xC), 143.7 (2xC), 133.8 (2xC), 132.8 (2xC), 129.2 (8xCH), 117.0 (2xCH), 113.4 (2xCH), 21.6 (CH_2) ppm; HRMS (ESI): Calcd for $C_{23}H_{15}Cl_2N_4S_2$ $[M + H]^+$ 481.0115, Found: 481.0110.

Bis(6-(4-fluorophenyl)imidazo[2,1-b]thiazol-5-yl)methane ***(2v).*** White solid (256 mg, 83%); mp 253-255 ºC; FT-IR (KBr, νmax/cm^{-1}) 3390, 3019, 1645, 1403, 1215, 1156, 1068, 929, 669; δ_H (400 MHz; $CDCl_3$) = 7.69 (4H, dd, J = 8.3, 5.4 Hz), 7.18 (4H, br t, J = 8.5 Hz), 6.61 (2H, dd, J = 4.5, 0.6 Hz), 6.56 (2H, dd, J = 4.6, 0.6 Hz), 4.75 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 162.5 (J = 246 Hz, 2xC), 149.4 (2xC), 143.9 (2xC), 130.4 (J = 3 Hz, 2xC), 129.7 (J = 8 Hz, 4xCH), 117.0 (2xCH), 116.8 (2xC), 115.9 (J = 22 Hz, 4xCH), 113.1 (2xCH), 21.4 (CH_2) ppm; HRMS (ESI): Calcd for $C_{23}H_{15}F_2N_4S_2$ $[M + H]^+$: 449.0706, Found: 449.0696.

Bis(6-p-tolylimidazo[2,1-b]thiazol-5-yl)methane ***(2w).*** White solid (277 mg, 90%); mp 254-256 ºC; FT-IR (KBr, νmax/cm^{-1}) 3369, 3019, 1637, 1403, 1215, 1069, 831, 769, 668; δ_H (400 MHz; $CDCl_3$) 7.64 (4H, d, J = 8.0 Hz), 7.30 (4H, d, J = 7.9 Hz), 6.56 (2H, d, J = 4.6 Hz), 6.54 (2H, d, J = 4.5 Hz), 4.80 (2H, s), 2.42 (6H, s) ppm; δ_C (100 MHz; $CDCl_3$) 149.3 (2xC), 144.7 (2xC), 137.6 (2xC), 131.5 (2xC), 129.7 (4xCH), 127.9 (4xCH), 117.3 (2xCH), 117.0 (2xC), 112.6 (2xCH), 21.4 (CH_2 and 2xCH_3, overlapped) ppm; HRMS (ESI): Calcd for $C_{25}H_{21}N_4S_2$ $[M + H]^+$ 441.1208, Found: 441.1184.

Bis(2-phenylbenzo[d]imidazo[2,1-b]thiazol-3-yl)methane ***(2x).*** White solid (191 mg, 65%); mp 277-279 ºC; FT-IR (KBr, νmax/cm^{-1}) 3684, 3019, 1604, 1497, 1404, 1215, 1025, 928, 669, 627; δ_H (400 MHz; $CDCl_3$) = 7.68-7.64 (2H, m), 7.45-7.41 (2H, m), 7.32-7.28 (4H, m), 7.26-7.23 (4H, m), 7.18-7.12 (6H, m), 5.18 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 147.3 (2xC), 145.9 (2xC), 133.6 (2xC), 133.2 (2xC), 130.6 (2xC), 128.1 (4xCH), 127.8 (4xCH), 127.6 (2xCH), 126.0 (2xCH), 124.5 (2xCH), 124.3 (2xCH), 118.9 (2xC), 113.0 (2xCH), 24.0 (CH_2) ppm; HRMS (ESI): Calcd for $C_{31}H_{21}N_4S_2$ $[M + H]^+$ 513.1208, Found: 513.1195.

Bis(2-(p-tolyl)phenylbenzo[d]imidazo[2,1-b]thiazol-3-yl)methane ***(2y).*** White solid (208 mg, 68%); mp 314-316 ºC; FT-IR (KBr, νmax/cm^{-1}) 3683, 3392, 3019, 1645, 1522, 1403, 1069, 928, 831, 669, 626; δ_H (400 MHz; $CDCl_3$) 7.66-7.64 (2H, m), 7.43-7.39 (2H, m), 7.30-7.25 (4H, m), 7.12 (4H, d, *J* = 7.9 Hz), 6.93 (4H, d, *J* = 7.8 Hz), 5.13 (2H, s), 2.28 (6H, s) ppm; δ_C (100 MHz; $CDCl_3$) 147.2 (2xC), 145.9 (2xC), 137.2 (2xC), 133.2 (2xC), 130.7 (2xC), 130.5 (2xC), 128.5 (4xCH), 128.0 (4xCH), 125.9 (2xCH), 124.4 (2xCH), 124.2 (2xCH), 118.8 (2xC), 113.0 (2xCH), 24.0 (CH_2), 21.2 (2xCH_3) ppm; HRMS (ESI): Calcd for $C_{33}H_{25}N_4S_2$ $[M + H]^+$ 541.1521, Found: 541.1506.

2-(4-bromophenyl)-6-chloro-3-((2-phenylimidazo[1,2-a]pyridine-3-yl)methyl)Imidazo[1,2-a]pyridine ***(3al).*** Orange solid (244 mg, 31%); mp 214-216 ºC; FT-IR (KBr, νmax/cm^{-1}) 3683, 3019, 1602, 1522, 1476, 1070, 830, 669, 626; δ_H (400 MHz; $CDCl_3$) = 7.72 (2H, d, *J* = 7.3 Hz), 7.65-7.60 (4H, m), 7.57-7.49 (3H, m), 7.45-7.40 (3H, m), 7.30 (1H, d, *J* = 6.8 Hz), 7.11-7.08 (1H, m), 7.03 (1H, dd, *J* = 9.5, 1.8 Hz), 6.53 (1H, t, *J* = 6.8 Hz), 4.90 (2H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 145.2 (C), 144.7 (C), 143.9 (C), 143.4 (C), 134.0 (C), 132.9 (C), 132.1 (2xCH), 130.3 (2xCH), 129.1 (2xCH), 129.0 (2xCH), 128.5 (CH), 126.1 (CH), 124.6 (CH), 123.5 (CH), 122.9 (C), 122.0 (CH), 120.8 (C), 117.8 (2xCH), 115.3 (C), 113.5 (C), 112.6

(CH), 19.7 (CH_2) ppm; HRMS (ESI): Calcd for $C_{27}H_{19}BrClN_4$ $[M + H]^+$ 513.0482, Found: 513.0476.

6,8-dichloro-3-((2-(4-methoxyphenyl)imidazo[1,2-a]pyridin-3-yl)methyl)-2-phenylimidazo[1,2-a]pyridine ***(3kh).*** White solid (192 mg, 29%); mp 174-176 ºC; FT-IR (KBr, νmax/cm^{-1}) 3683, 3019, 1602, 1522, 1420, 1022, 928, 668, 626; δ_H (400 MHz; $CDCl_3$) = 7.80 (2H, d, *J* = 7.1 Hz), 7.65 (2H, d, *J* = 8.6 Hz), 7.56-7.52 (3H, m), 7.47 (1H, br t, *J* = 7.2 Hz), 7.33 (1H, d, *J* = 1.6 Hz), 7.27 (1H, d, *J* = 6.9 Hz), 7.13 (1H, d, *J* = 1.6 Hz), 7.09-7.04 (3H, m), 6.49 (1H, t, *J* = 6.8 Hz), 4.90 (2H, s), 3.88 (3H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 160.0 (C), 145.6 (C), 145.1 (C), 144.5 (C), 141.0 (C), 133.6 (C), 130.3 (2xCH), 129.2 (2xCH), 129.1 (2xCH), 128.8 (CH), 126.4 (C), 124.6 (CH), 124.5 (CH), 123.6 (CH), 123.4 (C), 121.1 (CH), 119.6 (C), 117.6 (CH), 117.2 (C), 114.5 (2xCH), 113.1 (C), 112.4 (CH), 55.5, 19.7 (CH_2) ppm; HRMS (ESI): Calcd for $C_{28}H_{21}Cl_2N_4O$ $[M + H]^+$ 499.1092, Found: 499.1080.

6-bromo-3-((2-(4-methoxyphenyl)imidazo[1,2-a]pyridin-3-yl)methyl)-2-phenylimidazo[1,2-a]pyridine ***(3hi).*** White solid (182 mg, 27%); mp 194-196 ºC; FT-IR (KBr, νmax/cm^{-1}) 3683, 3389, 3019, 1634, 1522, 1403, 1069, 928, 831, 627; δ_H (400 MHz; $CDCl_3$) = 7.78 (2H, d, *J* = 7.2 Hz), 7.69 (2H, d, *J* = 8.7 Hz), 7.56-7.44 (5H, m), 7.38 (1H, d, *J* = 9.5 Hz), 7.28 (1H, d, *J* = 6.9 Hz), 7.11-7.03 (4H, m), 6.45 (1H, td, *J* = 6.8, 0.9 Hz), 4.92 (2H, s), 3.88 (3H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 159.9 (C), 145.0 (C), 144.9 (C), 144.4 (C), 143.4 (C), 134.1 (C), 130.4 (2xCH), 129.08 (2xCH), 129.0 (2xCH), 128.6 (CH), 127.8 (CH), 126.5 (C), 124.4 (CH), 124.3 (CH), 123.7 (CH), 118.0 (CH), 117.5 (CH), 115.3 (C), 114.6 (2xCH), 113.5 (C), 112.2 (CH), 107.0 (C), 55.5, 19.5 (CH_2) ppm; HRMS (ESI): Calcd for $C_{28}H_{22}BrN_4O$ $[M + H]^+$ 509.0977, Found: 509.0977.

6-(4-chlorophenyl)-5-((2-(4-methoxyphenyl)imidazo[1,2-a]pyridine-3-yl)methyl)imidazo[2,1-b]thiazole ***(3hu).*** Brown solid (219 mg, 35%); mp 234-236 ºC; FT-IR (KBr, vmax/cm^{-1}) 3387, 3019, 1636, 1403, 1215, 1069, 929, 831, 668; δ_H (400 MHz; $CDCl_3$) = 7.74 (2H, d, *J* = 8.7 Hz), 7.69 (2H, d, *J* = 8.4 Hz), 7.57 (1H, d, *J* = 9.0 Hz), 7.46 (2H, d, *J* = 8.4 Hz), 7.34 (1H, d, *J* = 6.9 Hz), 7.13-7.09 (1H, m), 7.04 (2H, d, *J* = 8.7 Hz), 6.56 (1H, td, *J* = 6.8, 0.7 Hz), 6.51 (1H, d, *J* = 4.6 Hz), 6.45 (1H, d, *J* = 4.6 Hz), 4.86 (2H, s), 3.88 (3H, s) ppm; δ_C (100 MHz; $CDCl_3$) = 159.8 (C), 149.5 (C), 145.0 (C), 143.9 (C), 143.7 (C), 133.7 (C), 133.0 (C), 129.9 (2xCH), 129.4 (2xCH), 129.1 (2xCH), 126.6 (C), 124.6 (CH), 123.3 (CH), 117.5 (CH), 117.4 (CH), 116.8 (C), 114.6 (2xCH), 114.0 (C), 112.9 (CH), 112.6 (CH), 55.5, 20.9 (CH_2) ppm; HRMS (ESI): Calcd for $C_{26}H_{20}ClN_4OS$ $[M + H]^+$ 471.1046, Found: 471.1076.

*2-phenylimidazo[1,2-a]pyridine-3-carbaldehyde (****4a****).*[6a] White solid (172 mg, 50%), mp 129-131 °C (lit.,[6a] 128-130 ºC), FT-IR (KBr, vmax/cm^{-1}) 3401, 3019, 1630, 1328, 1211, 831, 758, 669; δ_H (400 MHz; $CDCl_3$) 10.06 (1H, s), 9.66 (1H, dt, *J* = 6.8, 1.1 Hz), 7.84-7.79 (3H, m), 7.60-7.50 (4H, m), 7.12 (1H, td, *J* = 6.9, 1.2 Hz); δ_C (100 MHz; $CDCl_3$) 179.6, 158.4 (C), 147.8 (C), 132.4 (C), 130.5 (CH), 129.9 (3xCH), 128.98 (2xCH), 128.91 (CH), 120.8 (C), 117.5 (CH), 115.3 (CH); HRMS (ESI): Calcd for $C_{14}H_{11}N_2O$ $[M + H]^+$ 223.0871, Found: 223.0870.

ASSOCIATED CONTENT

Supporting Information

^{1}H and ^{13}C NMR and HRMS spectra of all compounds**.** 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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