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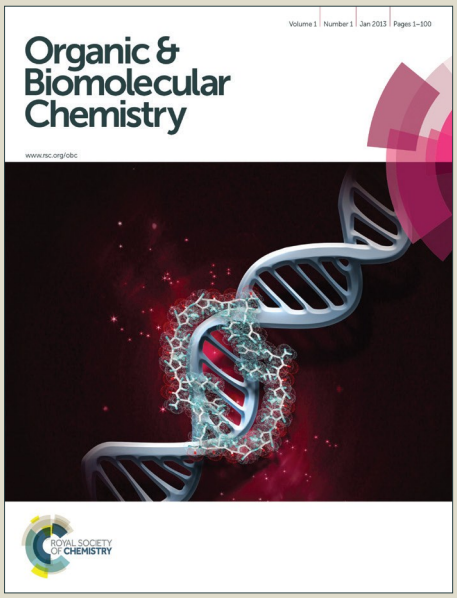

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ARTICLE

PIDA-I_2 Mediated Direct Vicinal Difunctionalization of Olefins: Iodoazidation, Iodoetherification and Iodoacyloxylation

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Tapas Kumar Achar,[a] Saikat Maiti[a] and Prasenjit Mal*[a]

I^+ (IOAc) was produced from the combination of phenyliodine diacetate (PIDA) and iodine. Following, I^+ facilitated the direct vicinal difunctionalization of olefins to α-azido, α-trideuteriomethoxy, α-2,2,2-trifluoroethoxy and α-acyloxy alkyl iodides *via* cation-π interaction at room temperature and under transition-metal free conditions.

Introduction

Difunctionalization of olefins is one of the most attractive research area in organic chemistry[1-3] and generally more difficult than that of alkynes due to low polarizability of olefins. Metal free or metal catalyzed olefin difunctionalization reactions are recently demonstrated as oxyarylation,[4] oxytrifluoromethylation,[5] iodotrifluoromethylation,[6] hydroxyarylation,[7] azido-oxygenation,[8] aminoazidation,[9] iodoazidation,[10] etc. Unactivated olefin difunctionalization reactions via cohalogenation is also considered for carbon heteroatom bond formation in regio-, chemo- and stereoselective manner.[11-13] Zbiral first demonstrated the reactions of alkenes for incorporation of azide using phenyliodine diacetate (PIDA)-trimethylsilylazide combination.[14] Moriarty and co-workers further extended this study with PhIO/NaN_3/AcOH for vicinal diazidation of alkenes via electrophilic activation with iodine.[15] Similar approach for azidation reactions are reported using IPy_2BF_4/Me_3SiN_3[16] and NBS/Me_3SiN_3-$Zn(OTf)_2$[17] combinations. Hassner showed that haloazidation of the alkenic double bond could easily be done by addition of iodine-azide[18] or bromine-azide.[19] This method provided a straightforward approach for incorporation of heteroatom functionality into organic compounds.[20, 21] Olefin difunctionlization reactions are mainly explored in activated olefins, however, little attention has been paid on relatively unactivated monosubstituted olefins.[21-26]

Results and discussion

As part of our ongoing studies[27-31] relating to hypervalent iodine chemistry,[32-34] we report here PIDA-I_2 combination led to an electrophilic species (I^+) which could activate various olefins via cation-π interaction for regioselective intermolecular vicinal difunctionalization using nucleophiles like sodium azide (NaN_3), trideuteriomethanol (CD_3OD), 2,2,2-trifluoroethanol (CF_3CH_2OH) and acetate anions (AcO-) (Figure 1).

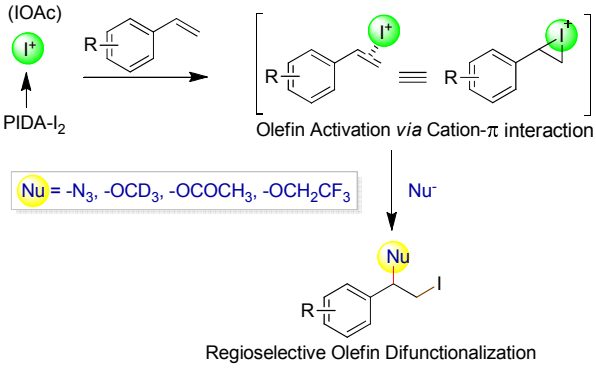

Figure 1 Strategy for olefin activation using PIDA-iodine

In synthesis, organic azides[35] have received copious attentions due to their use as precursor of *N*-containing heterocycles.[36-39] Owing to their stability under physiological conditions and their unique reactivity, azides are used in bioconjugation *via* Staudinger ligation,[40] in click chemistry etc.[41-43] Substitution reaction of primary or secondary alkyl halide with inorganic azide is the most common route to access alkyl azide.[44] Molecular iodine and inorganic azide combination was successfully applied to produce iodo-azide functionalization *via* bridged iodonium ion formation.[45] Furthermore, iodide anion (I^-) also used for iodo-functionalization in presence of oxidants

[a] *Dr. Prasenjit Mal, Mr. Tapas Kumar Achar, Mr. Saikat Maiti*
School of Chemical Sciences, National Institute of Science Education and Research (NISER) Bhubaneswar, PO Bhimpur-Padanpur, Via Jatni, District Khurda, Odisha 752050, India; Tel: +919439613856; E-mail: pmal@niser.ac.in
http://home.niser.ac.in/users/pmal

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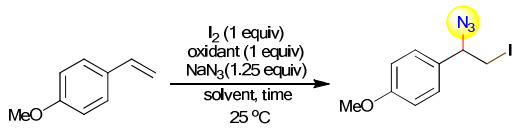
like oxone,[10] CAN,[46] phenyliodine diacetate,[47] etc. Initially, I^- was oxidized to iodonium cation (I^+) and that promoted olefin difunctionalization via bridged iodonium ion intermediate. Finally, nucleophilic addition to the bridged intermediate led to cohalogenated products.

Conditions for optimization of reaction are shown in Table 1. 4-Vinylanisole (**1a**) was considered as a model substrate for olefin difunctionalization under aerobic condition. Reactions of **1a**, iodine (I_2), NaN_3 (Caution!!) and $PhI(OAc)_2$ led to **2a** in 37% yield in dichloroethane (DCE) (entry 1). NaN_3 is sparingly soluble in DCE and therefore acetonitrile (MeCN), N,N-dimethylformamide (DMF), dimethylsulfoxide (DMSO) and acetonitrile-water (1:1) solvent systems were also used for the study. In acetonitrile, **2a** obtained in 68% and other solvents were not promising for this transformation (entries 3-5). Changing oxidant from PIDA to phenyliodine-bis(trifluoroacetate) (PIFA) or 2-iodoxybenzoic acid (IBX) did not lead to encouraging results (entries 6-7). We have further noticed that NaN_3 was a superior nucleophile than $TMSN_3$ (entry 11). In contrast, the desired product was not observed using I_2 without PIDA (entry 12). Finally, better results were obtained with 1.25 equiv of NaN_3 instead of 1.0 or 1.5 equiv (entries 9-10).

Table 1 Optimization of reaction conditions[a]



1a 2a

Entry	Oxidant	Solvent	Yield[b] (%)
1	PIDA	DCE	37
2	PIDA	MeCN	68
3	PIDA	DMF	<5
4	PIDA	DMSO	13
5	PIDA	MeCN:H_2O (1:1)	43
6	PIFA	MeCN	51
7	IBX	MeCN	14
8	PIDA	MeCN	59
9[c]	PIDA	MeCN	65
10[d]	PIDA	MeCN	--
11[e]	PIDA	DCE	37
12	---	MeCN	--
13[f]	PIDA	MeOH	--

[a]Conditions: **1a** (0.75 mmol), PIDA (0.75 mmol), I_2 (0.75 mmol), Solvent (2 mL), 25 °C, 1 h; [b]isolated yield [c]NaN_3 (1.0 equiv), [d]NaN_3 (1.5 equiv), [e]$TMSN_3$ (1.2 equiv) were used; [f]instead of N_3, -OMe was incorporated.

Under optimized condition (Table 1, entry 2), azido-iodination reactions of olefins were performed in MeCN in aerobic condition at room temperature (Figure 2). Styrene derivatives with both electron donating and withdrawing substituents provided vicinal iodoazides in good to excellent yields (61-92%). In addition, products obtained with styrenes containing –OMe (**2a**, **2c**-**d**), -CH_3 (**2g**, **2j**, **2m**), –Br (**2b**), -CN (**2h**) and –Cl (**2l**) substitutions and with heterocyclic moieties (**2i**, **2k**). Sterically hindered olefins (**2d**, **2g**, **2j**, **2n**, **2o**) also provided the desired azide derivatives in good yields. Exceptionally, in case of **2e**, two different regioisomers were isolated in the ratio of 1:0.55.

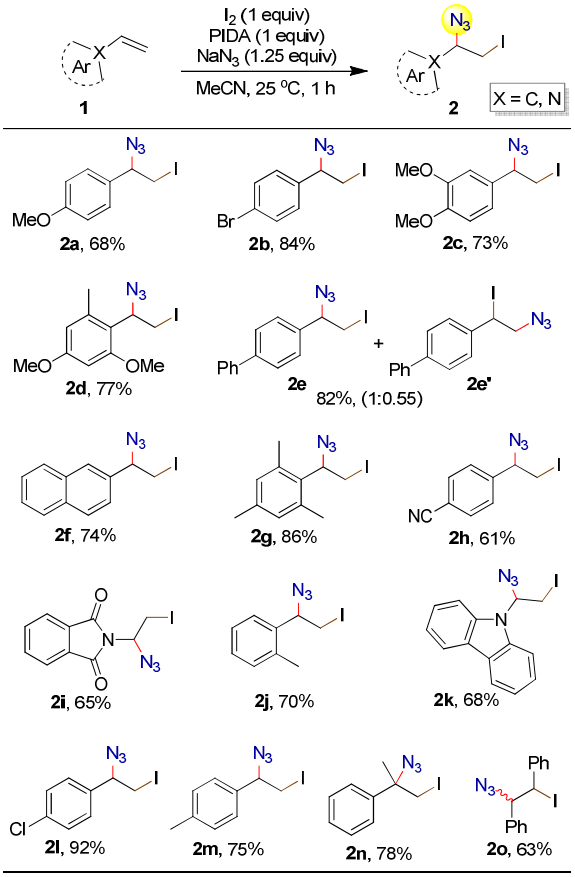


Figure 2 Iodoazidation of olefins

Transition metal free intermolecular addition of alkoxy (–OR) group to olefins is a popular subject of interest for synthesis of fine chemicals, agrochemicals, pharmaceuticals, materials, etc.[48-52] Physiochemical properties by the CF_3CH_2O- group like high electronegativity, lipophilicity, bioavailability and metabolic stability have added extra importance for CF_3CH_2O-containing compounds to be used as pharmaceutical agents.[53-55] However, deuterated compounds are also well recognized for metabolic studies due to their bioactivities.[56-58] Furthermore, metal free chemicals are popular in pharmaceutical or medicinal industries in order to minimize toxic metal contamination in drugs, to avoid the expensive metal leaching process and to introduce environmental friendly reagents.[59, 60] Therefore, developments of metal free and efficient methods for synthesis of fluorinated or deuterated functionalized ethereal compounds have significant potential in organic synthesis. Generally, ethers are

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synthesized *via* classical Williamson synthesis[61, 62] but have limited industrial applications due to requirements of high concentration of alkali metal carboxylates. In addition, silver triflate and iodine combination was also used for iodo-etherification of alkene.[63] Several other methods like transition metal catalyzed Ullman and Buclwald-Hartwig type of coupling reactions are also known for etherification *via* C-H activation.[64-69] We report here the iodoetherfication reactions using CF_3CH_2OH and CD_3OD as nucleophilic solvent. The results of iodoetherfication with olefins are shown in Figure 3. Interestingly, diastereoselectivity of **3h** was >95% and formation of **3p** turned out to be 100% diastereoselective.[70]

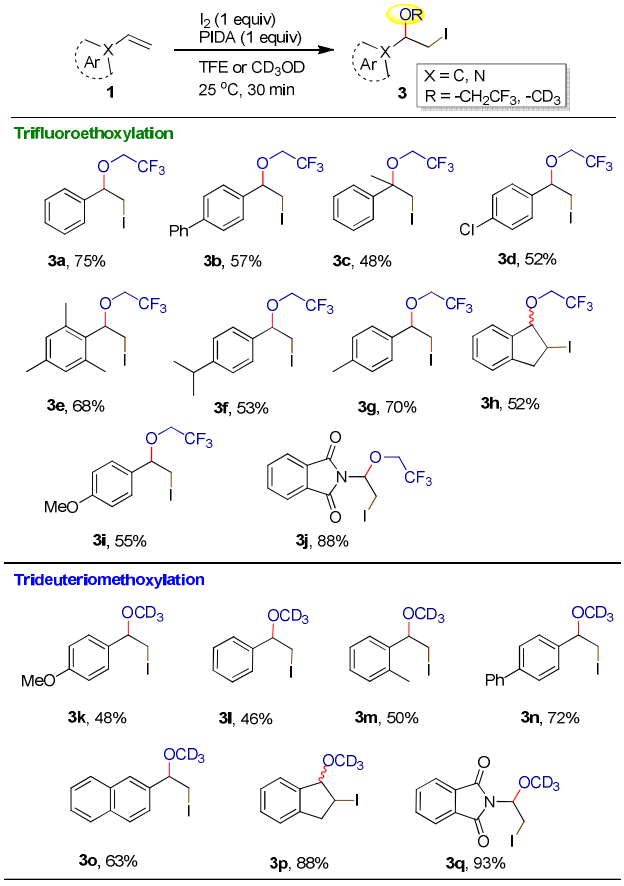

Figure 3 Iodoetherification of olefins

To understand the mechanism of reaction, we examined the role of PIDA and I_2. The iodobenzene obtained from the reactions of PIDA and I_2, led to identical ^{1}H NMR spectrum (Figure 4) with commercially available sample (CAS No. 591-50-4). Also, downfield shift of methyl group of -OAc could confirm the formation of IOAc.[71, 72] This *in situ* generated I^+ (from IOAc) was expected to form bridged iodonium ion with olefins for regioselective addition of nucleophiles. Thus the mechanism of the reaction is rationalized and shown in Figure 5. Regioselectivity was observed due to formation of stable benzylic carbocation intermediate **6** and the reaction followed path b (Figure 5c).

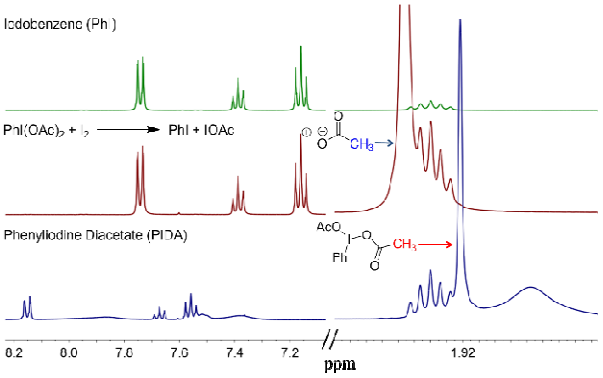

Figure 4 ^{1}H NMR spectra in MeCN-d_3. Formation of IOAc intermediate from the reaction of PIDA and I_2 is confirmed by comparative analysis with iodobenzene and PIDA

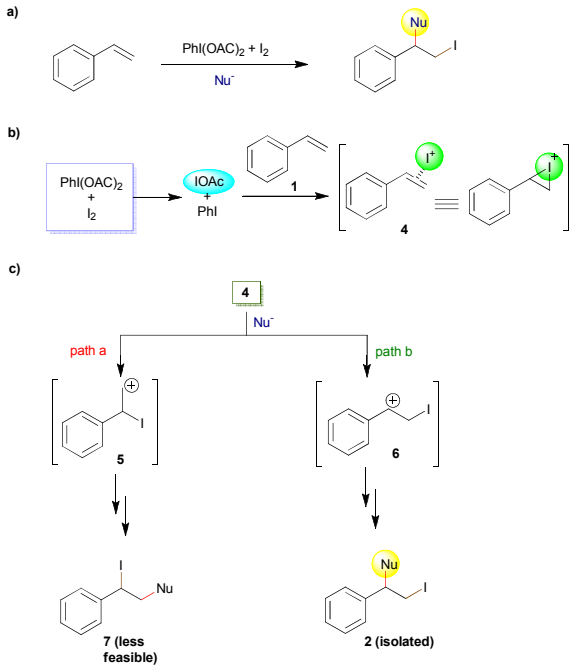

Figure 5 Mechanistic rationalization for co-iodination of olefins

Furthermore, we assumed for the formation of bridged-iodonium ion (**4**, Figure 5) and followed by addition of nucleophiles. Therefore in absence of any other externally added nucleophiles, acetate anion from IOAc could act as a nucleophile to result in iodo-acyloxylated derivatives. This reaction was found to be very fast (ca. 10 min at 25 °C) and afforded excellent yields of products (Table 2 and Figure 6). This fact further supported the mechanism of reaction as proposed in Figure 5.

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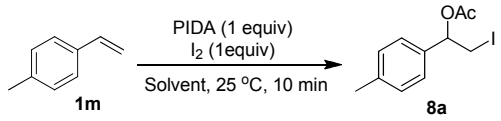
Table 2. Optimization of iodoacyloxylation reaction.



Entry	Iodine (equiv)	Oxidant (1.0 equiv)	Solvent	Yield (%)
1	1	PIDA	MeCN	82
2	1	PIDA	DCE	89
3	1	PIDA	DMF	---
4	1	PIDA	DMSO	---
5	1	PIDA	DCM	87
6	1	PIDA	THF	81
7	1	PIDA	EtOAc	78
8	0.75	PIDA	DCM	69
9	0.60	PIDA	DCM	64

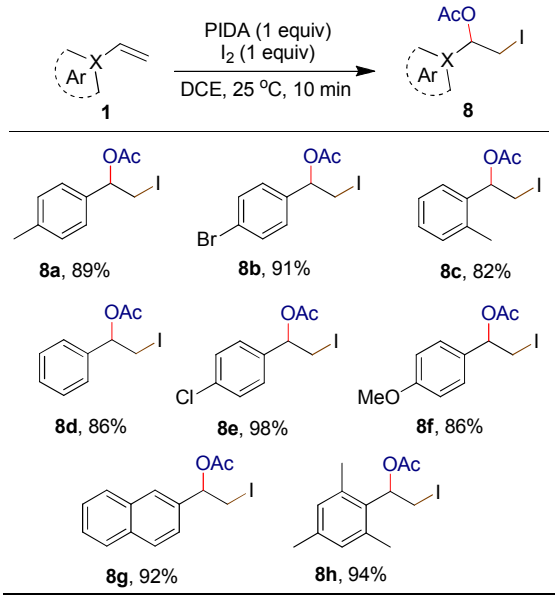
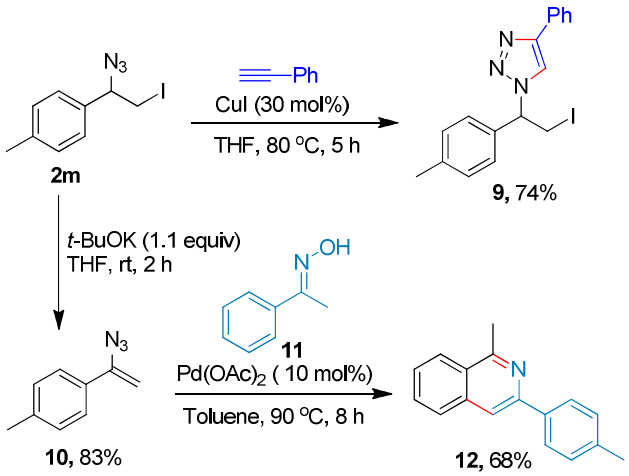


Figure 6 Iodoacyloxylation of olefins

To further exemplify the synthetic utility of iodoazidation products, we successfully used **2m** for the different synthetic transformations (Scheme 1). Upon treatment of **2m** with phenylacetylene using CuI as a catalyst, provided the click product **9** in 74% yield. Azidovinylbenzene (**10**) was prepared from **2m** by treating with *t*-BuOK in THF at room temperature. Azidovinylbenzene (**10)** was further used for the synthesis of 3-arylisoquinoline derivative (**12**) by using palladium as a catalyst with oxime (**11**) at 90 °C for 8h. Isoquinoline derivatives act as a potential constituent in biological active molecules[73], natural products[74] and also in material science[75]. Hence, our methodology provides a straight forward synthetic protocol for the preparation of synthetically useful compounds.



Scheme 1 Functionalization of **2m**

Conclusions

In summary, a vicinal difunctionalization of olefins is developed under transition metal free, room temperature and mild condition. A series of co-iodo functionalized derivatives are synthesized with functional groups like azide, alkoxy (fluorinated and deuterated) and acyloxy. Mechanistically we have shown that I(III) and I_2 led to I^+ which activated the relatively unactivated olefins *via* cation-π interaction for nucleophilic addition. Importantly, products obtained could be used as synthetic precursors for pharmaceuticals and materials applications. Therefore, we expect that our study may be helpful for better understanding of mechanistic organic chemistry by exploiting weak and non-covalent interactions.

Experimental section

General procedures

Dichloroethane (DCE) and acetonitrile were dried by following the standard procedures (dried over anhydrous CaH_2 and followed by distillation). All other reagents were used without further purification. Flash column chromatographic purification of compounds was performed using silica-gel (230-400 mesh) and diethyl ether-hexane/ ethyl acetate-hexane mixtures as solvent eluents. Spectra are reported as values in parts per million (ppm) relative to residual chloroform signal as internal standard (7.26 ppm for ^1H and 77.16 ppm for ^{13}C). Analytical thin-layer chromatography was performed with precoated silica gel 60 F254 plates (Merck) and the spots were visualized with UV light at 254 nm or by staining with phosphomolybdic acid (PMA) in methanol (10 gm PMA in 100 mL methanol).

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Caution

Azide derivatives are highly toxic (similar toxicity as cyanide ion; LD_{50} = 27 mg/kg for rats) and therefore during handling of any azide derivatives, personal protective equipment's should be exercised. General safety at laboratory should be carefully implemented and suggested that all reactions should be done in a well-ventilated fume hood behind a blast shield.

Representative procedure for iodoazidation of olefins

To a solution of PIDA (242 mg, 0.75 mmol) and I_2 (190 mg, 0.75 mmol) in acetonitrile (2 mL), NaN_3 (61 mg, 0.94 mmol) was added and stirred for 5 min. Then 4-vinylanisole **1a** (100 µL, 0.75 mmol) was added at room temperature (25 °C) and stirring continued until the complete consumption of starting material (TLC analysis), the reaction mixture was diluted with dichloromethane and washed with 10% (w/v) $Na_2S_2O_3$ in water and followed by water. Organic layer was dried over anhydrous Na_2SO_4 and evaporated under reduced pressure. Crude product was purified through column chromatography using 3% ethyl acetate in hexane as an eluent to obtain the analytically pure compound **2a** (68%, 155 mg) as a colorless oil.

Representative procedure for iodoetherification of olefins

A solution of PIDA (242 mg, 0.75 mmol) and I_2 (190 mg, 0.75 mmol) in 1.0 mL of 2,2,2-trifluoroethanol (methanol-d_4 in case of trideuteriomethoxylation) was kept stirring for 5 min. Then 4-methylstyrene **1m** (100 µL, 0.75 mmol) was added at ambient temperature and after being stirred at the same temperature until the consumption of starting material (by TLC analysis), the reaction mixture was diluted with dichloromethane and washed with 10% (w/v) $Na_2S_2O_3$ in water and followed by water. The organic layer was dried over anhydrous Na_2SO_4 and evaporated at reduced pressure. The crude product was purified through column chromatography using hexane as an eluent to obtain the analytically pure compound **3g** (70%, 120 mg) as colorless oil.

Representative procedure for iodoacyloxylation of olefins

To a suspension of PIDA (244 mg, 0.75 mmol) in acetonitrile (2 mL), I_2 (192 mg, 0.75 mmol) was added and stirred for 2 min. Then 4-methylstyrene **1m** (100 µL, 0.75 mmol) was added at room temperature and stirring was continued for 10 min (the reaction was monitored by TLC), the reaction mixture was diluted with dichloromethane and washed with 10% (w/v) $Na_2S_2O_3$ followed by distilled water. The organic layer was dried over anhydrous Na_2SO_4 and evaporated at reduced pressure. The crude product was purified through column chromatography using hexane as an eluent to obtain the analytically pure compound **8a** (89%, 215 mg) as a colorless oil.

1-(1-Azido-2-iodoethyl)-4-methoxybenzene (2a):[76] R_f = 0.32 (ethyl acetate/hexane = 1:19); colorless oil; yield 68% (155 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (d, *J* = 8.7 Hz, 2H), 6.93 (d, *J* = 8.7 Hz, 2H), 4.68 (t, *J* = 8 Hz, 1H), 3.82 (s, 3H), 3.37 (dd, *J* = 9.5, 3.3 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.2, 130.0, 128.1, 114.5, 66.9, 55.5, 8.6.

1-(1-Azido-2-iodoethyl)-4-bromobenzene (2b): R_f = 0.25 (in hexane); colorless oil; yield 84% (219 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 8.4 Hz, 2H), 7.20 (d, *J* = 8.4 Hz, 2H), 4.68 (t, *J* = 6.9 Hz, 1H), 3.36 (d, *J* = 6.7 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.0, 132.4, 128.5, 123.2, 66.5, 7.8.

4-(1-Azido-2-iodoethyl)-1,2-dimethoxybenzene (2c): R_f = 0.25 (ethyl acetate/hexane = 1:19); colorless oil; yield 73% (103 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.87 (s, 2H), 6.81 (s, 1H), 4.66 (t, *J* = 7.0 Hz, 1H), 3.90 (s, 3H), 3.88 (s, 3H), 3.37 (d, *J* = 7.1 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.6, 149.5, 130.4, 119.4, 111.3, 109.5, 67.2, 56.1, 56.0, 8.5.

2-(1-Azido-2-iodoethyl)-1,5-dimethoxy-3-methylbenzene (2d): R_f = 0.28 (ethyl acetate/hexane = 1:19); pale yellow oil; yield 77% (150 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.36 (s, 1H), 6.35 (s, 1H), 5.10 (t, *J* = 7.7 Hz, 1H), 3.83 (s, 3H), 3.80 (s, 3H), 3.67 (d, *J* = 7.8 Hz, 2H), 2.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.5, 159.4, 139.3, 115.9, 107.8, 97.0, 61.1, 55.7, 55.3, 20.9, 6.6.

4-(1-Azido-2-iodoethyl)-1,1'-biphenyl (2e): R_f = 0.60 (ethyl acetate/hexane = 1:19); white solid; yield 82% (159 mg); mp 64 – 67 °C; 1: 0.55 regioisomers; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 – 7.55 (m, 23H), 7.48 – 7.44 (m, 12H), 7.41 – 7.38 (m, 12H), 5.22 (t, *J* = 7.7 Hz, 2H), 4.77 (t, *J* = 7.0 Hz, 3H), 4.04 – 3.95 (m, 4H), 3.43 (d, *J* = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.1, 141.8, 140.4, 140.4, 139.4, 136.9, 129.0, 128.9, 128.1, 127.9, 127.9, 127.8, 127.2, 127.2, 67.1, 58.8, 27.8, 8.2.

2-(1-Azido-2-iodoethyl)naphthalene (2f):[76] R_f = 0.75 (ethyl acetate/hexane = 1:19); colorless oil; yield 74% (155 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (dd, *J* = 12.5, 6.8 Hz, 3H), 7.80 (s, 1H), 7.54 (dd, *J* = 6.3, 3.1 Hz, 2H), 7.42 (dd, *J* = 8.5, 1.7 Hz, 1H), 4.90 (t, *J* = 7.0 Hz, 1H), 3.48 (d, *J* = 6.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 135.4, 133.6, 133.3, 129.3, 128.3, 127.9, 126.9, 126.5, 123.8, 67.5, 8.2.

2-(1-Azido-2-iodoethyl)-1,3,5-trimethylbenzene (2g): R_f = 0.30 (in hexane); colorless oil; yield 86% (168 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.89 (s, 2H), 5.29 (dd, *J* = 10.0, 5.3 Hz, 1H), 3.55 (t, *J* = 10.3 Hz, 1H), 3.38 (dd, *J* = 10.5, 5.3 Hz, 1H), 2.42 (s, 6H), 2.28 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.3, 136.4, 130.9, 130.6, 64.1, 20.9, 20.8, 5.8.

4-(1-Azido-2-iodoethyl)benzonitrile (2h): R_f = 0.40 (ethyl acetate/hexane = 1:9); pale yellow oil; yield 61% (98 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (d, *J* = 6.8 Hz, 2H), 7.52 (d, *J* = 8.3 Hz, 2H), 5.12 (dd, *J* = 8.8, 6.5 Hz, 1H), 4.00 – 3.89 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.6, 132.9, 128.5, 118.3, 112.6, 58.2, 24.8.

2-(1-Azido-2-iodoethyl)isoindoline-1,3-dione (2i): R_f = 0.45 (ethyl acetate/hexane = 1:19); semisolid; yield 65% (128 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (dd, *J* = 5.5, 3.1 Hz, 2H), 7.81 (dd, *J* = 5.5, 3.1 Hz, 2H), 5.74 (dd, *J* = 9.3, 6.3 Hz, 1H), 4.10 (dd, *J* = 10.4, 9.4 Hz, 1H), 3.77 (dd, *J* = 10.5, 6.3 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.9, 134.9, 131.4, 124.2, 66.9, 0.98.

1-(1-Azido-2-iodoethyl)-2-methylbenzene (2j): R_f = 0.35 (in hexane); colorless oil; yield 70% (153 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.46 (m, 1H), 7.24 – 7.19 (m, 2H), 7.16 – 7.14 (m, 1H), 5.35 (t, *J* = 7.8 Hz, 1H), 4.04 (d, *J* = 7.7 Hz, 2H), 2.36 (s,

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3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.2, 135.5, 131.3, 128.8, 127.1, 126.9, 58.1, 24.7, 19.4.

9-(1-Azido-2-iodoethyl)-9H-carbazole (2k): R_f = 0.33 (in hexane); semisolid, yield 68% (127 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (d, *J* = 7.8 Hz, 2H), 7.61 (d, *J* = 8.3 Hz, 2H), 7.51 – 7.47 (m, 2H), 7.33 (t, *J* = 7.5 Hz, 2H), 6.44 (dd, *J* = 7.8, 6.7 Hz, 1H), 3.80 (dd, *J* = 10.7, 7.9 Hz, 1H), 3.68 (dd, *J* = 10.7, 6.7 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.8, 126.4, 124.2, 120.8, 120.8, 110.3, 73.0, 2.9.

1-(1-Azido-2-iodoethyl)-4-chlorobenzene (2l):[76] R_f = 0.25 (in hexane); colorless oil; yield 92% (235 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, *J* = 8.5 Hz, 2H), 7.28 (d, *J* = 8.5 Hz, 2H), 4.71 (t, *J* = 6.9 Hz, 1H), 3.41 – 3.34 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 136.5, 135.1, 129.4, 128.2, 66.4, 7.9.

1-(1-Azido-2-iodoethyl)-4-methylbenzene (2m):[45] R_f = 0.33 (in hexane); colorless oil; yield 75% (163 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23-7.21 (br, 4H), 4.70 (t, *J* = 7.0 Hz, 1H), 3.39 (d, *J* = 7.1 Hz, 2H), 2.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.0, 134.9, 129.8, 126.6, 67.0, 21.3, 8.4.

(2-Azido-1-iodopropan-2-yl)benzene (2n): R_f = 0.32 (in hexane); colorless oil; yield 78% (172 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.33 (m, 5H), 3.50 (dd, *J* = 14, 12 Hz, 2H), 1.90 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.8, 128.9, 128.4, 125.7, 65.2, 25.3, 17.9.

(1-Azido-2-iodoethane-1,2-diyl)dibenzene (2o):[16] R_f = 0.30 (in hexane); white solid; yield 63% (122 mg); mp 99 – 103 °C; E:Z = 1:1, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 6.7 Hz, 2H), 7.42 – 7.36 (m, 3H), 7.36 – 7.27 (m, 5H), 7.25 – 7.20 (m, 5H), 7.20 – 7.08 (m, 5H), 5.21 (dd, *J* = 15.4, 9.4 Hz, 2H), 5.11 (d, *J* = 9.2 Hz, 1H), 4.94 (d, *J* = 9.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.3, 140.2, 137.8, 136.4, 129.2, 128.8, 128.8, 128.7, 128.6, 128.6, 128.4, 128.4, 127.8, 127.4, 72.9, 72.0, 36.8, 34.5.

(2-Iodo-1-(2,2,2-trifluoroethoxy)ethyl)benzene (3a):[77] R_f = 0.6 (in hexane); colourless liquid; yield 75% (120 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -73.76; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43-7.36 (m, 3H), 7.35-7.32 (m, 2H), 4.59 (dd, $J_1 = J_2$ = 8 Hz, 1H), 3.82-3.67 (m, 2H), 3.45-3.40 (m, 2H), 3.36-3.32 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.3, 129.2, 129.1, 123.9 (q, $^1J_{C,F}$ = 278 Hz), 83.6, 66.6 (q, $^2J_{C,F}$ = 35 Hz), 8.7; HR-MS (ESI-TOF): m/z = 352.9646, calculated for ($M+Na^+$) 352.9621.

4-(2-Iodo-1-(2,2,2-trifluoroethoxy)ethyl)-1,1'-biphenyl (3b): R_f = 0.5 (in hexane); colourless liquid; yield 57% (77 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -73.69; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64-7.59 (m, 4H), 7.48-7.45 (m, 2H), 7.41-7.38 (m, 3H), 4.65 (dd, $J_1 = J_2$ = 8 Hz, 1H), 3.87-3.71 (m, 2H), 3.48-3.44 (m, 1H), 3.40-3.66 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.2, 140.4, 137.2, 129.0, 127.9, 127.8, 127.3, 127.2, 123.9 (q, $^1J_{C,F}$ = 277 Hz), 83.3, 66.6 (q, $^2J_{C,F}$ = 35 Hz), 8.6; HR-MS (ESI-TOF): m/z = 428.9962, calculated for ($M+Na^+$) 428.9934.

(1-Iodo-2-(2,2,2-trifluoroethoxy)propan-2-yl)benzene (3c): R_f = 0.6 (in hexane); colourless liquid; yield 48% (70 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -73.8; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42-7.34 (m, 5H), 3.67-3.60 (m, 1H), 3.59-3.53 (m, 2H), 3.47-3.44 (m, 1H), 1.79 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.1, 128.9, 128.6, 126.4, 124.0 (q, $^1J_{C,F}$ = 277 Hz), 78.5, 62.2 (q, $^2J_{C,F}$ = 34 Hz), 23.85, 18.0.

1-Chloro-4-(2-iodo-1-(2,2,2-trifluoroethoxy)ethyl)benzene (3d): R_f = 0.4 (in hexane); colourless liquid; yield 52% (138 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -73.7; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 (d, *J* = 8 Hz, 2H), 7.27 (d, *J* = 8 Hz, 2H), 4.57-4.54 (m, 1H), 3.77-3.70 (m, 2H), 3.41-3.37 (m, 1H), 3.32-3.28 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 136.9, 135.1, 129.3, 128.1, 123.7 (q, $^1J_{C,F}$ = 277 Hz), 82.8, 66.7 (q, $^2J_{C,F}$ = 35 Hz), 8.3; HR-MS (ESI-TOF): m/z = 386.9256, calculated for ($M+Na^+$) 386.9231.

2-(2-Iodo-1-(2,2,2-trifluoroethoxy)ethyl)-1,3,5-trimethylbenzene (3e): R_f = 0.7 (in hexane); colourless liquid; yield 68% (86 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -73.5; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.87 (s, 2H), 5.11-5.08 (m, 1H), 3.75-3.62 (m, 3H), 3.40-3.36 (m, 1H), 2.38 (s, 6H), 2.28 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.3, 136.9, 130.4, 124.0 (q, $^1J_{C,F}$ = 277 Hz), 80.8, 66.4 (q, $^2J_{C,F}$ = 34 Hz), 20.9, 20.4, 5.7; HR-MS (ESI-TOF): m/z = 395.0116, calculated for ($M+Na^+$) 395.0090.

1-(2-Iodo-1-(2,2,2-trifluoroethoxy)ethyl)-4-isopropylbenzene (3f): R_f = 0.6 (in hexane); colourless liquid; yield 53% (142 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -74.2; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22-7.16 (m, 4H), 4.97-4.94 (m, 1H), 3.97-3.90 (m, 4H), 2.98 (d, *J* = 4, 2H), 2.95-2.88 (m, 1H), 1.27 (d, *J* = 8, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.8, 132.3, 129.4, 126.8, 123.8 (q, $^1J_{C,F}$ = 276 Hz), 104.1, 62.8 (q, $^2J_{C,F}$ = 35 Hz), 39.2, 33.9, 24.1.

1-(2-Iodo-1-(2,2,2-trifluoroethoxy)ethyl)-4-methylbenzene (3g): R_f = 0.7 (in hexane); colourless liquid; yield 70% (120 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -74.2; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 4, 1H), 7.17 (d, *J* = 8, 2H), 7.12-7.09 (m, 1H), 4.89 (t, $J_1 = J_2$ = 4, 1H), 3.99-3.85 (M, 4H), 2.90 (d, *J* = 8, 2H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.3, 139.8, 134.2, 129.8, 129.4, 123.7 (q, $^1J_{C,F}$ = 276 Hz), 103.8, 101.2, 62.9 (q, $^2J_{C,F}$ = 35 Hz), 38.5, 27.8.

2-Iodo-1-(2,2,2-trifluoroethoxy)-2,3-dihydro-1H-indene (3h): R_f = 0.4 (in hexane); colourless liquid; yield 52% (154 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -74.3; d.r. > 19 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48-7.41 (m, 1H), 7.37-7.27 (m, 3H), 5.34 (d, *J* = 8, 1H), 4.46-4.42 (m, 1H), 4.22-4.09 (m, 2H), 3.75-3.69 (m, 1H), 3.34-3.28 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.5, 139.2, 129.7, 127.6, 125.1, 124.8, 124.0 (q, $^1J_{C,F}$ = 278 Hz), 93.5, 67.4 (q, $^2J_{C,F}$ = 34 Hz), 43.3, 24.9; HR-MS (ESI-TOF) m/z = 364.9644, calculated for ($M+Na^+$): 364.9621.

1-(2-Iodo-1-(2,2,2-trifluoroethoxy)ethyl)-4-methoxybenzene (3i): R_f = 0.3 (hexane : ethyl acetate 19 :1); colourless liquid; yield 55% (88 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -74.2; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 2.4, 1H), 7.18-7.16 (m, 1H), 6.76 (d, *J* = 8, 1H), 4.87 (t, $J_1 = J_2$ = 4, 1H), 3.96-3.87 (m, 4H), 3.86 (s, 3H), 2.88 (d, *J* = 4, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.4, 140.3, 130.6, 129.0, 123.7 (q, $^1J_{C,F}$ = 277 Hz), 110.9, 103.9, 86.0, 62.9 (q, $^2J_{C,F}$ = 35 Hz), 56.5, 38.2.

2-(2-Iodo-1-(2,2,2-trifluoroethoxy)ethyl)isoindoline-1,3-dione (3j): R_f = 0.3 (hexane : ethyl acetate 19 :1); colourless liquid; yield 88% (122 mg); ^{19}F NMR (376.3 MHz, $CDCl_3$) δ -74.2; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93-7.90 (m, 2H), 7.82-7.79 (m, 2H), 5.69-5.65 (m, 1H), 4.14-4.08 (m, 1H), 4.06-3.87 (m, 2H), 3.82-3.78 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.3, 134.9, 131.3, 124.2, 123.4 (q, $^1J_{C,F}$ = 277 Hz), 82.9, 67.1 (q, $^2J_{C,F}$ = 35 Hz), 1.2.

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1-(2-Iodo-1-trideuteriomethoxyethyl)-4-methoxybenzene (3k): R_f = 0.4 (hexane : ethyl acetate 19 :1); colourless liquid; yield 48% (63 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 (d, *J* = 4, 2H), 6.90 (d, *J* = 4, 2H), 4.27-4.23 (m, 1H), 3.81 (s, 3H), 3.37-3.27 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.8, 131.9, 127.8, 114.2, 83.2, 56.5-55.9 (m) 55.4, 10.9.

(2-Iodo-1-trideuteriomethoxyethyl)benzene (3l): R_f = 0.3 (in hexane); colourless liquid; yield 46% (58 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.31 (m, 5H), 4.31-4.28 (m, 1H), 3.39-3.31 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.9, 128.8, 128.5, 126.6, 83.5, 56.9-56.1 (m), 10.6.

1-(2-Iodo-1-trideuteriomethoxyethyl)-2-methylbenzene (3m): R_f = 0.3 (in hexane); colourless liquid; yield 50% (117 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45-7.42 (m, 1H), 7.32-7.27 (m, 2H), 7.25-7.21 (m, 1H), 4.63-4.59 (m, 1H), 3.37-3.30 (m, 2H), 2.40 (s, 3H); ^{13}C NMR (100 MHz, CDCl3) δ 137.9, 135.5, 130.7, 128.1, 126.5, 125.5, 80.3, 56.8-56.0 (m), 19.2, 9.3.

4-(2-Iodo-1-trideuteriomethoxyethyl)-1,1'-biphenyl (3n): R_f = 0.3 (in hexane); colourless liquid; yield 72% (68 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (d, J = 8 Hz, 4H), 7.47 (t, *J* = 8 Hz, 2H), 7.41-7.36 (m, 3H), 4.38-4.35 (m, 1H), 3.43 – 3.36 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.4, 140.6, 138.8, 128.9, 127.6,127.5, 127.1, 127.0, 83.3, 57.0-56.1 (m), 10.6.

2-(2-Iodo-1-trideuteriomethoxyethyl)naphthalene (3o): R_f = 0.2 (in hexane); colourless liquid; yield 63% (77 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90-7.86 (m, 3H), 7.81 (s, 1H), 7.55-7.51 (m, 2H), 7.47-7.44 (m, 1H), 4.51-4.47 (m, 1H), 3.51-3.41 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.2, 133.4, 133.2, 128.7, 127.9, 126.4, 126.3, 126.2, 123.8, 83.7,57.0-56.1 (m), 10.3.

2-Iodo-1-trideuteriomethoxy-2,3-dihydro-1H-indene (3p): R_f = 0.3 (hexane : ethyl acetate 19 :1); colourless liquid; yield 88% (105 mg); d.r. 100 : 0; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 8 Hz, 1H), 7.36-7.27 (m, 3H), 5.13 (d, *J* = 4 Hz, 1H), 4.53-4.49 (m, 1H), 3.79-3.73 (m, 1H), 3.34-3.29 (dd, $J_1 = J_2$ = 4, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.4, 140.2, 129.2, 127.23, 125.2, 124.8, 93.3, 57.2-56.4 (m), 43.6, 25.8.

2-(2-Iodo-1-trideuteriomethoxyethyl)isoindoline-1,3-dione (3q): R_f = 0.2 (hexane : ethyl acetate 19 :1); colourless liquid; yield 93% (108 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91-7.87 (m, 2H), 7.79-7.75 (m, 2H), 5.47 (dd, $J_1 = J_2$ = 4 Hz, 1H), 4.00-3.96 (m, 1H), 3.76-3.72 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.6, 134.6, 131.4, 123.9, 83.2, 57.1-56.2 (m), 2.5.

2-Iodo-1-(p-tolyl)ethyl acetate (8a):[78] R_f = 0.50 (ethyl acetate/hexane = 1:19); colorless oil; yield 89% (215 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 (d, *J* = 8.2 Hz, 2H), 7.18 (d, *J* = 8.0 Hz, 2H), 5.86 (dd, *J* = 7.9, 5.4 Hz, 1H), 3.46 (qd, *J* = 10.5, 6.7 Hz, 2H), 2.35 (s, 3H), 2.13 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 138.7, 135.5, 129.4, 126.5, 75.2, 21.3, 21.1, 7.9.

1-(4-Bromophenyl)-2-iodoethyl acetate (8b):[79] R_f = 0.45 (ethyl acetate/hexane = 1:19); colorless oil; yield 91% (257 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.3 Hz, 2H), 5.80 (t, *J* = 6.5 Hz, 1H), 3.47 – 3.39 (m, 2H), 2.12 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 137.6, 132.0, 128.3, 122.9, 74.6, 21.2, 7.5.

2-Iodo-1-(o-tolyl)ethyl acetate (8c): R_f = 0.52 (ethyl acetate/hexane = 1:19); colorless oil; yield 82% (189 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 (dd, *J* = 5.8, 3.3 Hz, 1H), 7.29 – 7.25 (m, 2H), 7.22 – 7.18 (m, 1H), 6.15 (dd, *J* = 8.3, 5.2 Hz, 1H), 3.51 – 3.42 (m, 2H), 2.47 (s, 3H), 2.17 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.7, 137.1, 135.3, 130.7, 128.6, 126.5, 125.5, 72.3, 21.0, 19.3, 6.7.

2-Iodo-1-phenylethyl acetate (8d):[80] R_f = 0.30 (in hexane); colorless oil; yield 86% (217 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.32 (m, 5H), 5.88 (dd, *J* = 7.6, 5.5 Hz, 1H), 3.51 – 3.43 (m, 2H), 2.14 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 138.5, 128.8, 128.8, 126.5, 75.3, 21.1, 7.9.

1-(4-Chlorophenyl)-2-iodoethyl acetate (8e):[81] R_f = 0.45 (ethyl acetate/hexane = 1:19); colorless oil; yield 98% (265 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 (d, *J* = 8.5 Hz, 2H), 7.28 (d, *J* = 8.6 Hz, 2H), 5.82 (dd, *J* = 7.3, 5.8 Hz, 1H), 3.48 – 3.40 (m, 2H), 2.13 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 137.0, 134.7, 129.1, 128.0, 74.6, 21.1, 7.4.

2-Iodo-1-(4-methoxyphenyl)ethyl acetate (8f): R_f = 0.30 (ethyl acetate/hexane = 1:19); colorless oil; yield 86% (145 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 (d, *J* = 8.7 Hz, 2H), 6.88 (d, *J* = 8.7 Hz, 2H), 5.83 (dd, *J* = 8.1, 5.4 Hz, 1H), 3.79 (s, 3H), 3.44 (ddd, *J* = 15.8, 10.5, 6.7 Hz, 2H), 2.10 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 159.9, 130.6, 127.9, 114.2, 75.1, 55.4, 21.2, 8.0.

2-Iodo-1-(naphthalen-2-yl)ethyl acetate (8g): R_f = 0.50 (ethyl acetate/hexane = 1:19); colorless oil; yield 92% (142 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 – 7. 83 (m, 4H), 7.52 – 7.44 (m, 3H), 6.06 (dd, *J* = 7.8, 5.4 Hz, 1H), 3.57 (qd, *J* = 10.6, 6.7 Hz, 2H), 2.17 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 135.8, 133.5, 133.2, 128.8, 128.2, 127.9, 126.6, 126.2, 123.7, 75.5, 21.2, 7.7.

2-Iodo-1-mesitylethyl acetate (8h): R_f = 0.25 (in hexane); colorless oil; yield 94% (193 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.84 (s, 2H), 6.34 (dd, *J* = 10.2, 5.1 Hz, 1H), 3.68 (t, *J* = 10.4 Hz, 1H), 3.43 (dd, *J* = 10.7, 5.1 Hz, 1H), 2.44 (s, 6H), 2.26 (s, 3H), 2.12 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 138.2, 136.6, 131.4, 130.3, 73.1, 20.9, 20.9, 20.6, 4.9.

Synthesis of 1-(2-iodo-1-(*p*-tolyl)ethyl)-4-phenyl-1*H*-1,2,3-triazole (9)[82]:

100 mg (0.34 mmol) of **2m** was taken in a 10 mL sealed tube and dissolved in THF (2 mL). Followed by phenyl acetylene (76 uL, 0.69 mmol) and CuI (19 mg, 0.1 mmol) were added and placed in a pre-heated oil bath at 80 °C. Reaction was monitored by TLC and after completion the reaction was allowed to cool down to room temperature. THF was evaporated under reduced pressure. Then compound was extracted with dichloromethane and washed with water. After drying under anhydrous Na_2SO_4, solvent was removed under reduced pressure and the crude mixture was subjected to column chromatography to obtain the desire product 1-(2-iodo-1-(*p*-tolyl)ethyl)-4-phenyl-1*H*-1,2,3-triazole (**9**). Yield 98 mg (74%); white solid; mp 112 – 115 °C; R_f = 0.22 (ethy acetate/hexane = 1:19); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 – 7.78 (m, 2H), 7.71 (s, 1H), 7.41 (dd, *J* = 10.3, 4.7 Hz, 2H), 7.36 – 7.26 (m, 3H), 7.21 (d, *J* = 8.0 Hz, 2H), 5.75 (dd, *J* = 8.8, 6.4 Hz, 1H), 4.23 (dd, *J* = 10.7, 8.9 Hz, 1H), 3.85 (dd, *J* = 10.7, 6.3 Hz,

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1H), 2.35 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.8, 139.6, 134.3, 130.5, 130.1, 128.9, 128.4, 126.9, 125.9, 119.6, 66.9, 21.3, 5.3; ESI-MS m/z = 389.8113, calculated for (M + H^+) 390.0467

Synthesis of 1-(1-azidovinyl)-4-methylbenzene (10)[83]:

2m (200 mg, 0.68 mmol) in THF was slowly added to a suspension of *t*-BuOK (116 mg, 1.04 mmol) in dry THF under N_2 atmosphere and allowed to stir for 2 h at room temperature. After completion of reaction THF was removed under reduced pressure. The crude product was dissolved in dichloromethane and washed with water. Finally the compound was purified by column chromatography. Yield 92 mg (83%); pale yellow liquid; R_f = 0.90 (in hexane); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 (d, *J* = 8.2 Hz, 2H), 7.18 (d, *J* = 8.3 Hz, 2H), 5.39 (d, *J* = 2.3 Hz, 1H), 4.92 (d, *J* = 2.3 Hz, 1H), 2.37 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.2, 139.3, 131.6, 129.3, 125.6, 97.3, 21.3; ESI-MS m/z = 160.0604, calculated for (M + H^+) 160.0875

Synthesis of 1-methyl-3-(p-tolyl)isoquinoline (12)[84]:

Acetophenone oxime **11** (60 mg, 0.44 mmol), azidovinylbenzene **10** (84 mg, 0.53 mmol) and $Pd(OAc)_2$ (9 mg, 0.04 mmol) were transferred to a 10 mL sealed tube and dissolved in dry toluene. The reaction vessel was closed with the teflon cap and placed in a pre-heated oil bath at 90 ^{o}C for 8 h. After completion of reaction (monitored by TLC), the crude product was cooled to room temperature and concentrated under vacuum. The residue was subjected to column chromatography to afford the desired isoquinoline derivative. Yield 70 mg (68%); colorless liquid, R_f = 0.60 (ethy acetate/hexane = 1:19); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (dd, *J* = 8.4, 0.6 Hz, 1H), 8.05 (d, *J* = 8.2 Hz, 2H), 7.89 (s, 1H), 7.84 (d, *J* = 8.2 Hz, 1H), 7.65 (m, 1H), 7.55 (m, 1H), 7.31 (d, *J* = 7.9 Hz, 2H), 3.04 (s, 3H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.6, 150.2, 138.3, 137.1, 136.9, 130.1, 129.6, 127.7, 126.9, 126.7, 126.6, 125.7, 114.8, 22.8, 21.4; ESI-MS m/z = 234.0419, calculated for (M + H^+) 234.1283.

For few compounds HRMS data could not be obtained even after several efforts due to instability of those compounds. These compounds are with azide (**2b-2e**, **2g**, **2h**, **2j**, **2k**), α-2,2,2-trifluoroethoxy (**3c, 3f, 3g, 3i, 3j**), α-trideuteriomethoxy (**3k-3q**) and α-acetoxy (**8c, 8f-8h**) functionalities.

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