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Chemoselective synthesis of isolated and fused fluorenones and their photophysical and antiviral properties

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Highly functionalized fluorenones was synthesized by intramolecular cyclization of 2''-halo-[1,1':3',1''-terphenyl]-4'-carbonitriles in presence of n-butyllithium or lithium aluminium hydride. The precursor was synthesized by ring transformation of 2-oxo-6-aryl/heteroaryl-4-(*sec.*amino)-2*H*-pyran-3-carbonitriles or 2-oxobenzo[h]chromenes with o-bromo/chloro/fluoro-acetophenone under basic conditions in moderate yield. We performed the control experiment to understand the proposed mechanism and found that presence of scondary amine in the starting material direct the reactivity. Photophysical properties of 3-methoxy-7-(piperidin-1-yl)-5*H*-indeno[2,1-*b*]phenanthren-8(6*H*)-one was explored and solvent dependent emission was observed . These compounds were also tested against HIV-1 and low to moderate activity was observed.

Introduction

Recently, fluorenones and its derivatives received wide attention due to their potential applications in molecular switches (figure 1),[1] photophysics,[2] crystal engineering[3] and biological and pharmaceutical science.[4] Interestingly, incorporation of electron donating and withdrawing groups in fluorenone can tune its photophysical properties and become more applicable for solar cell, OLEDs, organic laser and florescence probes.[2,5] The fluorenone based polyesters fibers exhibit outstanding fire resistance properties with high glass transition temperature and self-extinguishing behavior.[6] Recently, R-(+)-(5,6-dichloro-2,3,9,9a-tetrahydro-7-hydroxy-9*a*-hydrocarbyl-1*H*-fluoren-3-one was tested *in vivo* against animal spinal and brain ischemia and demonstrated 30 times better result than usual known drug (figure 1).[7] Some other important fluorenone based molecules are known for antiviral activity (figure 1)[8] and cardio-depressant behaviour (figure 1).[4c]

Various strategies for the synthesis of fluorenones was established, such as ionic and radical cyclization of biaryl carbonyls[9] and nitriles,[10] oxidation of fluorenes,[11] ring contraction of phenanthraquinones,[9f,12] dehydrogenative[13] and

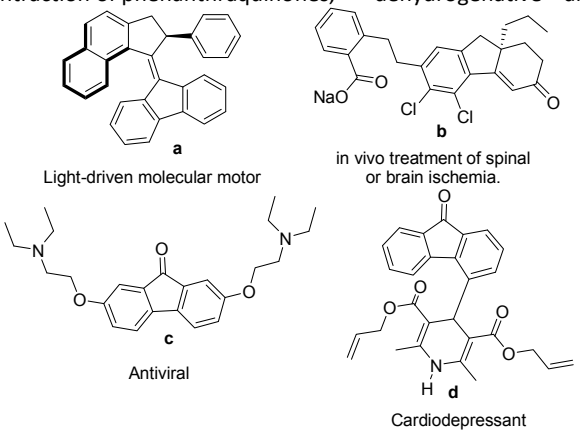

Figure 1. Some useful fluorene and fluorenone based compounds (a) (*S*)-9-(2-phenyl-2,3-dihydro-1H-cyclopenta[*a*]naphthalen-1-ylidene)-9*H*-fluorene; (b) GERI-E4; (c) Tilorone; (d) Fluodipine

dehydrohalogenative[14] annulation of various benzophenones. Among these methods, acid (specially acids of phosphorus) mediate intramolecular acylation of biarylcarboxlic acids[9b,15] and nitriles[10c,d,e] are most effective and widely used approach. Some metal catalyzed annulation[9d,10a,b] was also reported but base mediate anionic cyclization of biarylnitriles and carboxilc acids to fluorenone are very rare.[16] Anionic annulation of 2'-halo-[1,1'-biphenyl]-2-carbonitriles have been tried but the reagents selectively attacked on nitrile rather than halide and phenanthridines or phenanthridinones was obtained as sole

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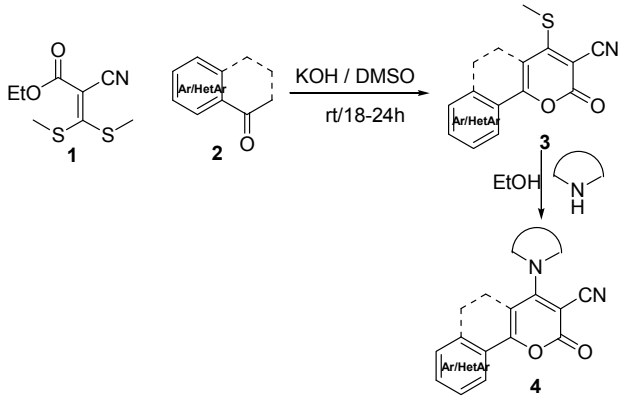
sproduct. Recently, Heish and co-workers developed ligand-free copper-catalyzed annulation of 2'-bromo-[1,1'-biaryl]-2-carbonitriles to phenanthridinones[17] and phenanthridines.[18] A Hydride-induced anionic cyclization of the 2'-bromo-[1,1'-biaryl]-2-carbonitriles also provide phenanthridines.[19] Begtrup *et al* reported that reaction of Grignard reagent and alkyl lithium (R-Li; R=aryl, alkyl and *sec.*amine) chemoselectively attack over the nitrile group of 2'-fluoro-[1,1'-biphenyl]-2-carbonitriles.[20] Cally *et al* reported a potassium hydroxide mediate Microwave assisted ring closure of 2'-fluoro-[1,1'-biphenyl]-2-carbonitriles[21] to afford phenanthridine. On the other hand, fluorenone was obtained by palladium catalyzed anionic annulation of 2'-iodo-[1,1'-biphenyl]-2-carbonitriles.[22] Due to wide range of application, we became interested in development of new protocol for the synthesis of fluorenone. Herein, we have reported substituent dependent transition metal free, anionic cyclization of 2'-halo-[1,1'-biphenyl]-2-carbonitriles to fluorenones through chemoselective lithiation of halide.

Results and discussion

To start our study, we have synthesized suitably functionalized 2'-halo-[1,1'-biphenyl]-2-carbonitriles. Various transition metal mediated approach for the synthesis of 2'-halo-[1,1'-biphenyl]-2-carbonitriles was reported, Herein, we have reported ring transformation strategy to afford the required precursor. Suitably functionalized 2'-halo-[1,1'-biphenyl]-2-carbonitriles were synthesized from 2-oxo-6-aryl-4-(*sec.*amino)-2*H*-pyran-3-carbonitriles. The precursor 2-oxo-6-aryl-4-(*sec.*amino)-2*H*-pyran-3-carbonitriles was synthesized in two steps. First step was preparation of 2-oxo-6-aryl-4-methylsulfanyl-2*H*-pyran-3-carbonitriles or 2-oxo-4-methylthio-benzo[*h*]chromenes by reaction of ketenedithioacetal (**1**) and various acetophenones or tetralones (**2**) under basic conditions. In the next step, obtained compound was refluxed with various secondary amine in ethanol to afford 2-oxo-6-aryl-4-(*sec.*amino)-2*H*-pyran-3-carbonitriles and 2-oxo-4-(*sec.*amino)-benzo[*h*]chromenes (Scheme 1).

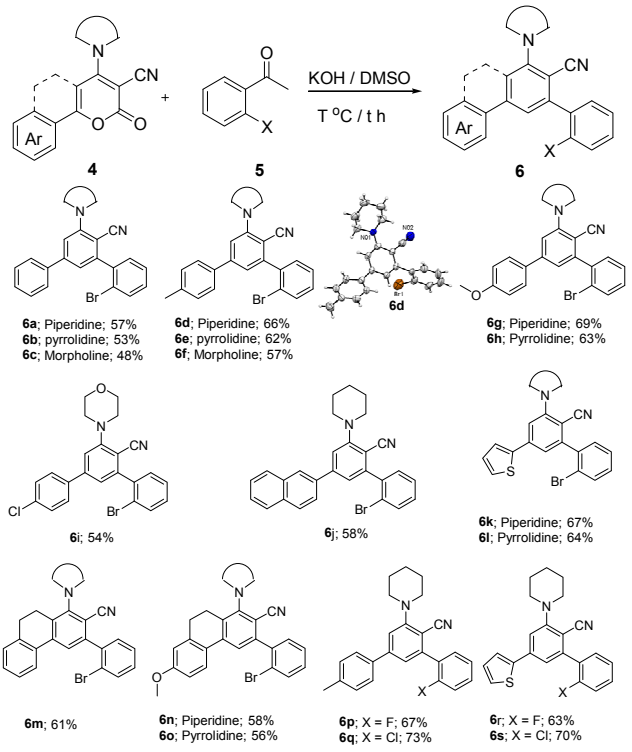
Scheme 1. Synthesis of 2-oxo-6-aryl-4-(*sec.*amino)-2*H*-pyran-3-carbonitriles and 2-oxo-4-(*sec.*amino)-benzo[*h*]chromenes (**4**)



It was reported that ring transformation reactions of functionalized 2*H*-pyran-2-ones with various ketones under basic conditions provides functionalized teraryls.[23] Herein, We have developed a base mediated regioselective approach for the synthesis of 2''-halo-5'-(*sec.*amino)-[1,1':3',1''-teraryl]-4'-carbonitriles. As a trial, we have performed the reaction of compound **4** and 2'-bromoacetophenone (**5a**) in DMSO using KOH as a base and moderate yield of 2''-bromo-4-methyl-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile (**6d**) was afforded.

To optimize the reaction condition, we have tried various base/solvent combinations (SI, Table 1). We have used polar and nonpolar solvents like THF, dioxane, DMF and DMSO in combinations of different bases such as sodium hydride, sodium hydroxide, potassium hydroxide, potassium carbonate and cesium carbonate. The KOH in DMSO at room temperature was found as best reaction condition and 66% of the desired product **6a** was afforded (SI, Table 1, entry 4). We proposed that moderate yield was obtained probably due to presence of bulky halo group at ortho position of acetophenone. Taking the best reaction conditions, we have synthesized a series of 2''-halo-5'-(*sec.*amino)-[1,1':3',1''-teraryl]-4'-carbonitriles in moderate to good yield. All the synthesized compounds were characterized by spectroscopic analysis and structure of the compound **6d** was confirmed by single crystal X-ray.

Scheme 2. Synthesis of various 2''-halo-5'-(*sec.*amino)-[1,1':3',1''-teraryl]-4'-carbonitriles (**6**)



Once desired precursor was prepared, we studied the intramolecular cyclization approach under various conditions.

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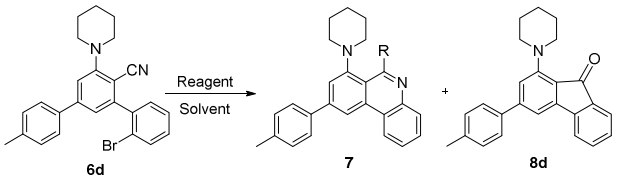
We used 2''-bromo-4-methyl-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile as a model substrate to study the intramolecular cyclization. As per earlier report, in the expectation of formation of phenanthridine, we treated the starting material with different amount of $Li(Et)_3BH$ in THF at 100 °C for 24 h, but surprisingly another product functionalized fluorenone (**8d**) was isolated in 15% and 36 % yield (Table 1, entry 1-3). Further, we used sodium borohydride but no reactions were observed (Table 1, Entry 4). Then, we have tried lithium aluminium hydride in THF at room temperature and no reaction was observed (Table 1, entry 5), but at higher temperature and ratio, moderate yield of fluorenone was

Table 1. Optimization of the reaction conditions[a]

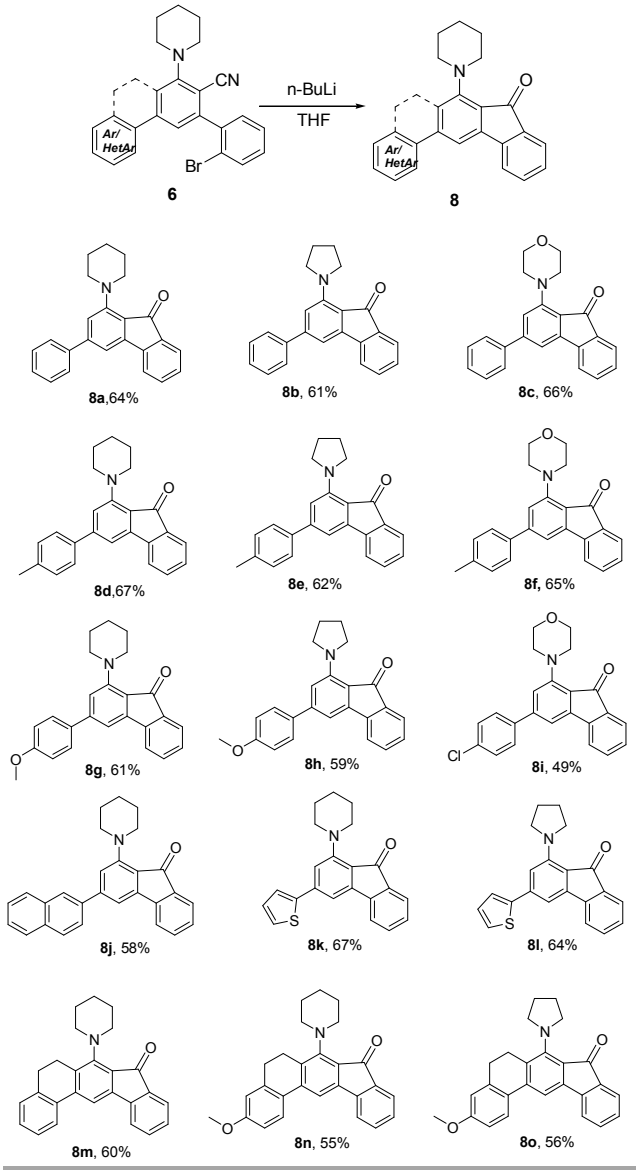


6d 7 8d

S.N.	Reagent	(eq.)	Solvent	Temp. (°C)	Time (h)	Yield[c] (%) 8d
1	$Li(Et)_3BH$	1.1	THF	100	24	trace
2	$Li(Et)_3BH$	2.0	THF	100	36	15
3	$Li(Et)_3BH$	3.0	THF	100	36	36
4	$NaBH_4$	3.0	THF	130-140	36	-
5	$LiAlH_4$	1.1	THF	rt[b]	12	-
6	$LiAlH_4$	1.1	THF	60	12	Trace
7	$LiAlH_4$	2.0	THF	60	12	34
8	**$LiAlH_4$**	**3.0**	**THF**	**60**	**12**	**55**
9	$LiAlH_4$	4.0	THF	60	12	47
10	$LiAlH_4$	3.0	THF	100	12	42
11	$LiAlH_4$	3.0	Dioxane	60	12	40
12	$LiAlH_4$	3.0	Hexane	60	12	32
13	$LiAlH_4$	3.0	Benzene	100	12	27
14	n-BuLi	1.5	THF	-75 to rt[b]	3	38
15	n-BuLi	2.0	THF	-75 to rt[b]	3	55
16	**n-BuLi**	**3.0**	**THF**	**-75to rt[b]**	**3**	**67**
17	n-BuLi	4.0	THF	-75 to rt[b]	3	57
18	n-BuLi	3.0	Hexane	-75 to rt[b]	3	25
19	n-BuLi	3.0	Dioxane	-75 to rt[b]	3	61

[a]The reaction was conducted with 2''-bromo-4-methyl-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile (0.3 mmol) in 1.5 mL solvent; [b]Room temperature varies from 30-35°C; [c]Yield of isolated product reported.

Scheme 3. Synthesis of various functionalized fluorenones



obtained (Table 1, entry 6-10). We also used other solvent like 1,4-dioxane, hexane and benzene in lieu of THF but no improvement was recorded (Table 1, entry 11-13). As we notice that first step is generation of phenyl anion/radical, we plan to use n-butyllithium as a base. A smooth reaction offered 38% of fluorenone in presence of 1.5 equivalent of n-BuLi at -75 °C to room temperature (Table 1, entry 14). The yield of fluorenone was improved to 67% by using 3 equivalent n-BuLi, but further increase in the amount of reagents lowers the yield (Table 1, entry 15-17). A comparable yield of **8d** was observed in 1,4-dioxane under similar reaction condition, but low yield was observed in hexane (Table 1, entry 18-19).

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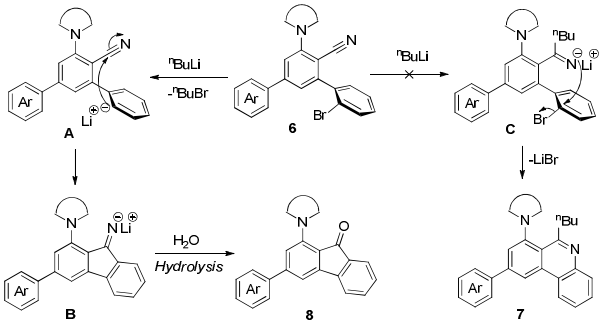
After optimization, the scope of the reaction was investigated with different functionalized 2'-bromo-5-aryl-3-*sec*.amino-biaryl-2-carbonitriles (scheme 3).

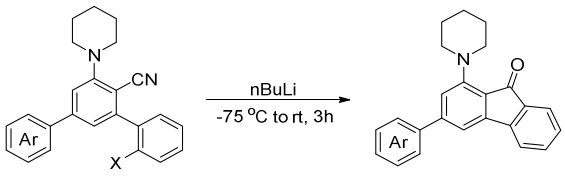
Various fused and isolated fluorenone (**8a-o**) was synthesized in moderate to good yield. It was observed that presence of various aryl/heteroaryl group and secondary amine group can be tolerated under the optimized reaction condition. These groups also do not affect the yield of desired product. The similar protocol was also applied for the synthesis of 6-*sec*.amino-12,13-dihydro-indeno[1,2-*a*]phenanthren-7-ones (**8m-o**) and good yield was obtained. It was reported that presence of electron donating amine group at ortho position of fluorenone furnished an important class of florescence compounds.[24] Along with the florescence property, the bulky ortho substitution also makes it applicable for the synthesis of molecular motors or photoswitches.

Scheme 4. Proposed mechanistic pathway for the synthesis of fluorenone with n-BuLi



We tried to understand the mechanistic pathways involved in cyclization by lithium aluminium hydride and n-BuLi. Earlier literatures[17-21] shows that n-alkyl lithium and hydride reagent chemoselectively react with nitrile group of 2'-halo-[1,1'-biphenyl]-2-carbonitriles followed by dehalogenative annulation to afford phenanthridine or phenanthridinone. Even n-BuLi was also found selective to nitrile of 2'-fluoro-[1,1'-biphenyl]-2-carbonitrile.[20a] Interestingly, in our case, n-

Scheme 5. Synthesis of fluorenone from **6p-6r**



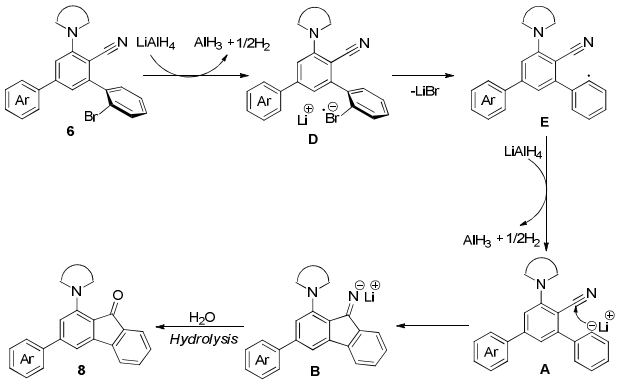
6p; Ar = C_6H_5; X = F
6q; Ar = C_6H_5; X = Cl
6r; Ar = Thienyl; X = F
6s; Ar = Thienyl; X = Cl

8a; 57%
8a; 61%
8k; 60%
8k; 63%

BuLi provides chemoselective lithiation of halide of compound **6**, instead of nitrile and gives intermediate **A** rather than the expected intermediate **C**. Then, we proposed that anionic annulation of intermediate **A** occurs by involvement of nitrile group in adjacent ring to furnish **B**. The imine thus formed undergoes hydrolysis to afford the desired product **8** (scheme 4). This change in the selectivity of n-BuLi from previous report[20a] is attributed probably due to presence of secondary amine at ortho position of nitrile, which make the nitrile group electron rich and anion attack was not possible. To examine the influence of halide, the fluoro derivative **6p** and **6r** were treated with n-BuLi under similar condition and corresponding fluorenone **8d** and **8k** were obtained in 57% and 60% respectively (scheme 5), whereas corresponding chloro derivatives **6q** and **6s** furnish 61% and 63% yield of **8d** and **8k** respectively (scheme 5). This result confirms that the chemoselectivity was achieved by presence of secondary amine at ortho of nitrile group and no role of halide occurs.

We wanted to understand the mechanistic pathway involved during use of lithium alminium hydride. As per literature report,[25] we proposed that radical mediated reaction is probably involved (scheme 6) and reaction is initiated by single electron transfer from Br group by interaction with LAH. In the next step bromide ion was lost with the formation of aryl radical, which can further interact with LAH to provide aryl anion, which attack on the nitrile group present in the adjacent ring to provide intermediate **B**. The intermediate **B** hydrolysed on wok-up to afford the fluorenone.

Scheme 6. Proposed mechanistic pathway for the synthesis of fluorenone with $LiAlH_4$



To support the mechanism, we performed some control reactions. Treatment of 4-methyl-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile **9** with n-BuLi provides no reaction and 95% starting material was recovered along with very small amount of unidentified side products. This reaction indicates that the anionic attack of n-BuLi on the nitrile group is not possible due to presence of secondary amine at ortho position [Scheme 7, (i)]. Further to trap the proposed anion, 2'-bromo-3-(piperidin-1-yl)-5-(thiophen-2-yl)-[1,1'-biphenyl]-2-carbonitrile **6k** was treated with n-BuLi at -78 °C and quenched the reaction with D_2O after 30 minute and a mixture of **8k** (35%) and **10** (23%) was obtained [Scheme 7,(ii)]. Formation of product **10** confirmed that the reaction proceed via intermediate **A** (Scheme 4). To confirm the reaction pathway of Scheme 6, three equivalent of $LiAlH_4$ was added to **6k** under standard protocol and 5 equivalent TEMPO was added after 30 minute. Almost 80% of the starting material was recovered with some decomposition after 15 hours of reaction (Scheme

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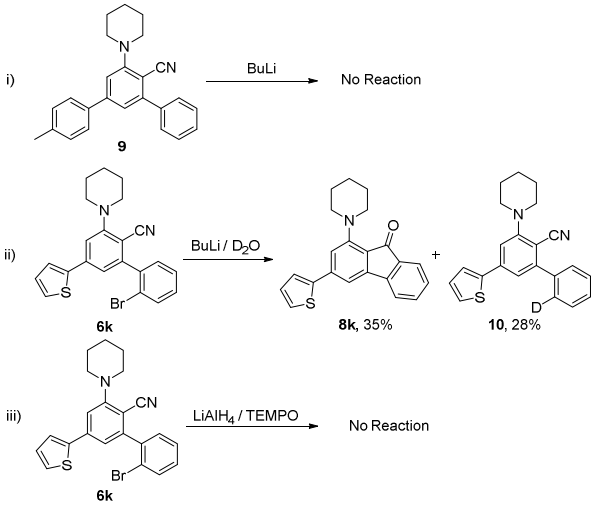
7,(iii)). We proposed that LAH is probably quenched by TEMPO and no reaction was observed, which support the radical mechanism.

Scheme 7. Control reactions in support of mechanism



This class of molecules are very florescent so we studied the property of one molecule. The UV-visible spectra and florescence spectra of 0.25 µM solution of 3-methoxy-7-(piperidin-1-yl)-5*H*-indeno[2,1-b]phenanthren-8(6*H*)-one **8n** was recorded in different solvent system at room temperature

Table 2. Photophysical property of **8n**

Solvent	λ_{max}^{abs} (nm)	λ_{max}^{fl} (nm)	Stokes shift(nm)
Hexane	435	444	9
DCM	439	467	28
DMF	447	502	55
DMSO	450	530	80

and summarized in table 2. The UV-visible absorption spectrum shows the different absorption band in the different solvents for same compound and peak at 435 nm, 439 nm, 447 nm and 450 nm was observed in hexane, DCM, DMF and DMSO respectively. From this result, it was revealed that the polar solvents pull the absorption band towards the higher wavelength of the absorption spectrum. As shown in the figure 2, the solvent did not produce any significant change in the absorption spectrum of the receptor **8n**. The polarity of the solvents does not show any significant change in the λ_{max} value of UV-visible absorption spectra of **8n** (figure 2). The λ_{max} for emission spectra of **8n** was recorded at 444 nm, 467 nm, 502 nm and 530 nm in hexane, DCM, DMF and DMSO, respectively and a noticeable red shift was observed in the florescence maxima (λ_{max}) with polarity of solvents.

Further we have studied the Anti-HIV-1 activity of our compounds on C8166 cell line. The cellular toxicity of compounds on C8166 was assessed by MTT colorimetric assay. The inhibition effect of samples on acute HIV-1 infection was measured by the syncytia formation assay. In the presence or absence of various concentrations of samples, five testing samples (**6b**, **6l**, **8e**, **8i** and **8m**) showed cytotoxicity on C8166 with CC_{50} values between 46µM to 80µM. The remaining samples had very low cytotoxicity on C8166 and the CC_{50} value

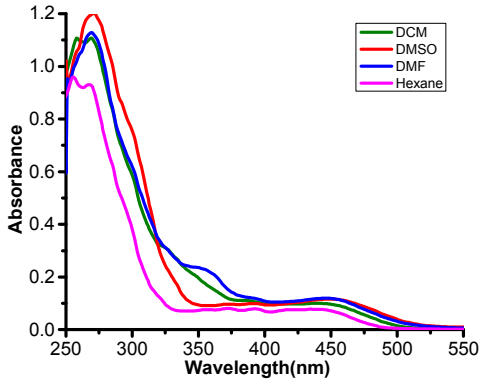


Figure 2. UV-Visible Spectra of **8n**

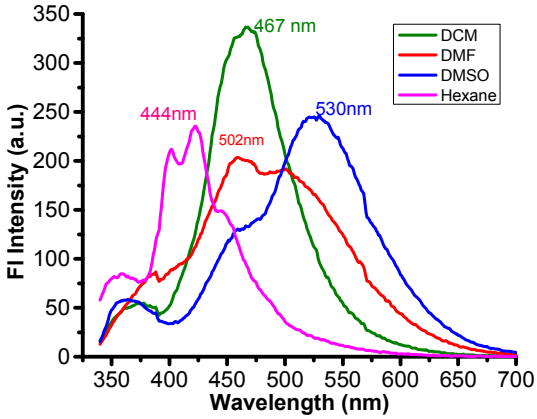


Figure 3. Florescence Spectra of **8n**

of them were higher than 200µM. Compound **6d**, **6g**, **6k**, **6m**, **8d** and **8n** showed weak to moderate anti-HIV-1 activity and their therapeutic index were >14.21, >46.19, >47.96, >21.51, >10.10, >13.74 respectively. As a control, AZT has the best anti-HIV activity (EC_{50} = 0.01008µM) in vitro and the CC_{50} of it is 3695.04µM, its therapeutic index is 366571.43.

Conclusions

In conclusion, we have developed a novel and transition metal free method for chemoselective synthesis of various isolated and fused fluorenones (**8a-o**) in moderate to good yield *via n*-BuLi mediated anionic ring closure. From this reaction, we have also concluded the presence of electron donation group at ortho and para position corresponding to nitrile group change their reactivity and make the nitile group non-reactive toward anionic attack, such as hydride and alkyl anion. We also

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performed the control experiment to support the mechanism and observed that reaction proceed through anionic annulations in presence of n-butyllithium. We have also explored the metal free, simple ring transformation method for synthesis of highly congested 2'-halo-[1,1'-biphenyl]-2-carbonitriles (**6a-s**). Along with development of new synthetic method, we also demonstrated the solvent dependent fluorescence properties of **8n** and found that polarity of solvent plays an important role. Antiviral properties of some of these compounds were also studied and moderate activity was obtained.

Acknowledgements

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Experimental

General: Commercially available reagents from Sigma Aldrich, Alfa Aesar and Spectrochem were used directly without any further purification. ^{1}H and ^{13}C NMR spectra were recorded on a 400 MHz NMR and 100 MHz NMR spectrometer and $CDCl_3$ was used as solvent. Chemical shifts for all the compounds are reported in parts per million shifts (δ-value) from considering $CDCl_3$ (δ 7.24 ppm for ^{1}H and 77.00 ppm for ^{13}C NMR) as an internal standard. In ^{1}H NMR signal patterns are reported as s, singlet; d, doublet; dd, double doublet; t, triplet; m, multiplet; bs, broad singlet and bm, broad multiplet. Coupling constant (J) for protons are reported in hertz (Hz). Infrared (IR) spectra of all the compounds was recorded on a Perkine Elmer AX-1 spectrophotometer and reported in wave number (cm^{-1}). HRMS reported are showing the peak for MH^+.

General protocol for the synthesis of 2''-bromo-4-substituted-5'-*sec*.amino-[1,1':3',1''-teraryl]-4'-carbonitriles (6a-o): A mixture of 6-aryl-4-*sec*.amino-2*H*-pyran-2-one-3-carbonitriles **4** (0.5 mmol) and 2'-bromoacetophenone **5a** (0.6 mmol) in dry DMSO (4.0 mL) in presence of powdered KOH (1.0 mmol) was stirred at room temperature for 8 h. After completion of reaction, mixture was poured onto crushed ice with constant stirring, and then neutralized with 10% HCl. Thus obtained precipitate was filtered and purified by silica gel column chromatography using ethyl acetate:hexane (1:19) as an eluent.

6a. 2''-Bromo-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 57%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 149-151°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.71 (d, *J* = 8.7 Hz, 1H, Ar-H), 7.65-7.57 (m, 2H, Ar-H), 7.46 (t, *J* = 7.3 Hz, 2H, Ar-H), 7.43-7.34 (m, 3H, Ar-H), 7.29 (ddd, *J* = 8.5, 6.2, 1.6 Hz, 1H, Ar-H), 7.21 (d, *J* = 1.8 Hz, 1H, Ar-H), 7.13 (d, *J* = 1.4 Hz, 1H, Ar-H), 3.38-3.16 (m, 4H, -CH_2), 1.82 (q, *J* = 4.3 Hz, 4H, -CH_2), 1.71-1.58 (m, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 157.8, 146.8, 145.6, 139.8, 133.0, 131.0, 130.0, 128.7, 127.3, 122.9, 121.7, 117.29, 116.5, 105.5, 53.5, 26.1, 24.0; IR: 2928, 2853, 2217, 1591, 1557 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{24}H_{22}BrN_2$: 417.0961; found: 417.0949

6b. 2''-bromo-5'-(pyrrolidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 53%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 141-143°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.69 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.60 (d, *J* = 8.4 Hz, 2H, Ar-H), 7.47-7.41 (2H, Ar-H), 7.38 (t, *J* = 6.5 Hz, 3H, Ar-H), 7.28 (q, *J* = 2.8 Hz, 1H, Ar-H), 6.88 (s, 1H, Ar-H), 6.83 (s, 1H, Ar-H), 3.71 (q, J = 5.8 Hz, 4H, -CH_2), 2.11-1.95 (m, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 151.2, 147.7, 145.3, 140.7, 140.1, 132.8, 131.8, 129.7, 128.5, 127.2, 123.1, 119.4, 117.1, 111.9, 94.4, 50.3, 25.8; IR: 2959, 2854, 2218 (CN), 1592, 1557, cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{23}H_{20}BrN_2$: 403.0804; found: 403.0784.

6c. 2''-bromo-5'-morpholino-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 48%; 0.35 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 164-166°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.72 (d, *J* = 7.6 Hz, 1H, Ar-H), 7.61 (d, *J* = 7.6 Hz, 2H, Ar-H), 7.54-7.35 (m, 5H, Ar-H), 7.35-7.28 (m, 1H, Ar-H), 7.23 (d, *J* = 1.5 Hz, 2H, Ar-H), 3.94 (q, *J* = 3.1 Hz, 4H, -CH_2), 3.44-3.21 (m, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 156.4, 147.1, 146.0, 139.5, 139.4, 133.1, 130.9, 130.2, 129.0, 128.7, 127.5, 127.3, 122.9, 122.8, 116.9, 116.4, 105.6, 67.0, 52.1; IR: 2960, 2853, 2217 (CN), 1591, 1556 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{23}H_{20}BrN_2O$: 419.0754; found: 419.0749.

6d. 2''-bromo-4-methyl-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 66%; 0.65 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 136-138°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.69 (d, *J* = 7.6 Hz, 1H, Ar-H), 7.49 (d, *J* = 7.6 Hz, 2H, Ar-H), 7.43-7.32 (m, 2H, Ar-H), 7.31-7.21 (m, 3H, Ar-H), 7.18 (s, 1H, Ar-H), 7.11 (s, 1H, Ar-H), 3.33-3.16 (m, 4H, -CH_2), 2.39 (s, 3H, -CH_3), 1.80 (d, *J* = 3.8 Hz, 4H, -CH_2), 1.61 (t, *J* = 5.7 Hz, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 157.8, 146.7, 145.5, 139.9, 138.5, 136.8, 133.0, 131.0, 130.0, 129.6, 127.4, 127.1, 123.0, 121.6, 117.3, 116.3, 105.1, 53.5, 26.1, 24.0, 21.17; IR: 2934, 2853, 2216 (CN), 1590, 1552, cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{25}H_{24}BrN_2$: 431.1117; found: 431.1121.

6e. 2''-bromo-4-methyl-5'-(pyrrolidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 62%; 0.65 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 130-132°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.69 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.50 (d, *J* = 6.9 Hz, 2H, Ar-H), 7.46-7.32 (m, 3H, Ar-H), 7.32-7.19 (m, 2H, Ar-H), 6.87 (dd, *J* = 20.2, 14.9 Hz, 2H, Ar-H), 3.70 (d, *J* = 6.1 Hz, 4H, -CH_2), 2.40 (s, 3H, -CH_3), 2.03 (s, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 151.4, 147.8, 145.4, 140.9, 138.5, 137.3, 132.9, 131.0, 129.8, 129.7, 127.4, 127.2, 123.3, 119.7, 117.2, 111.8, 94.3, 50.7, 26.0, 21.3; IR: 2925, 2866, 2206 (CN), 1592,

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1549cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{24}H_{22}BrN_2$: 417.0961; found: 417.0960.

6f. 2''-bromo-4-methyl-5'-morpholino-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 48%; 0.40 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 153-155^{o}C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.72 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.52 (d, *J* = 6.9 Hz, 1H, Ar-H), 7.46-7.34 (m, 4H, Ar-H), 7.34-7.25 (m, 1H, Ar-H), 7.25-7.20 (m, 2H, Ar-H), 7.12 (q, *J* = 3.1 Hz, 1H, Ar-H), 3.95 (t, *J* = 13.0 Hz, 4H, -CH_2), 3.40-3.25 (m, 4H, -CH_2), 2.41 (s, 3H, -CH_3); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 156.5, 147.1, 146.1, 139.7, 139.0, 136.6, 133.2, 131.0, 130.3, 129.9, 127.6, 127.3, 123.0, 122.7, 117.2, 116.2, 105.4, 67.4, 52.2, 21.5; IR: 2956, 2851, 2216 (CN), 1591, 1541 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{24}H_{22}BrN_2O$: 433.0910; found: 433.0927.

6g. 2''-bromo-4-methoxy-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 69%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 148-150^{o}C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.71 (d, *J* = 7.6 Hz, 1H, Ar-H), 7.59-7.50 (m, 2H, Ar-H), 7.44-7.34 (m, 2H, Ar-H), 7.30 (d, *J* = 9.2 Hz, 1H, Ar-H), 7.18 (d, *J* = 1.5 Hz, 1H, Ar-H), 7.10 (d, *J* = 1.5 Hz, 1H, Ar-H), 6.98 (d, *J* = 8.4 Hz, 2H, Ar-H), 3.86 (s, 3H, -OCH_3), 3.33-3.19 (m, 4H, -CH_2), 1.81 (s, 4H, -CH_2), 1.63 (t, *J* = 5.7 Hz, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 160.2, 158.0, 146.8, 145.3, 140.0, 133.1, 132.2, 131.1, 130.1, 129.0, 128.5, 127.5, 123.1, 121.4, 116.1, 114.5, 104.9, 55.5, 53.6, 26.3, 24.2; IR: 2926, 2853, 2216 (CN), 1590, 1557 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{25}H_{24}BrN_2O$: 447.1067; found: 447.1068.

6h. 2''-bromo-4-methoxy-5'-(pyrrolidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 63%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 137-139^{o}C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.69 (d, *J* = 7.6 Hz, 1H, Ar-H), 7.59-7.52 (m, 2H, Ar-H), 7.48 (s, 1H, Ar-H), 7.39 (d, *J* = 6.9 Hz, 2H, Ar-H), 7.32-7.23 (1H, Ar-H), 6.97 (d, *J* = 8.4 Hz, 1H, Ar-H), 6.81 (q, *J* = 8.6 Hz,2H, Ar-H), 3.85 (s, 3H, -OCH_3), 3.71 (d, *J* = 4.6 Hz, 4H, -CH_2), 2.04 (d, *J* = 5.3 Hz, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 157.9, 147.0, 144.3, 139.6, 138.6, 133.1, 132.0, 128.9, 128.8, 122.9, 121.5, 121.3, 117.1, 116.4, 116.1, 105.8, 57.9, 53.5, 26.1; IR: 2923, 2852, 2206 (CN), 1596, 1549, cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{24}H_{22}BrN_2O$: 433.0910; found: 433.0918.

6i. 2''-bromo-4-chloro-5'-morpholino-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 54%; 0.25 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 186-188^{o}C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.72 (d, *J* = 7.6 Hz, 1H, Ar-H), 7.55 (dd, *J* = 6.5, 1.9 Hz, 2H, Ar-H), 7.49-7.40 (m, 3H, Ar-H), 7.39-7.28 (m, 2H, Ar-H), 7.18 (s, 2H, Ar-H), 3.94 (t, *J* = 3.8 Hz, 4H, -CH_2), 3.41-3.24 (m, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 156.5, 147.2, 144.7, 139.3, 137.8, 134.9, 133.1, 130.9, 130.3, 129.2, 128.5, 127.5, 122.8, 122.6, 116.8, 116.1, 105.9, 66.9, 52.1; IR: 2961, 2854, 2218 (CN), 1593, 1553 cm^{-1}; HRMS (m/z): $[M+Na]^+$ calcd for $C_{23}H_{19}BrClN_2O$: 475.0183; found: 475.0249.

6j. 2'-bromo-5-(naphthalen-2-yl)-3-(piperidin-1-yl)-[1,1'-biphenyl]-2-carbonitrile: Yield: 58%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 158-160^{o}C;^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.07 (s, 1H, Ar-H), 7.99-7.81 (m, 3H, Ar-H), 7.78-7.69 (m, 2H, Ar-H), 7.53 (t, *J* = 4.2 Hz, 2H, Ar-H), 7.48-7.38 (m, 2H, Ar-H), 7.34 (s, 1H, Ar-H), 7.33-7.28 (m, 1H, Ar-H), 7.27 (s, 1H, Ar-H), 3.41-3.21 (m, 4H, -CH_2), 1.84 (d, *J* = 4.6 Hz, 4H, -CH_2), 1.65 (t, *J* = 5.7 Hz, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 157.9, 145.5, 133.0, 131.0, 130.0, 128.7, 128.3, 127.7, 127.4, 126.6, 126.6, 126.5, 125.1, 122.0, 116.7, 105.5, 53.5, 26.1, 24.0; IR: 2930, 2853, 2217 (CN), 1590, 1557 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{28}H_{24}BrN_2$: 467.1117; found: 467.1106.

6k. 2'-bromo-3-(piperidin-1-yl)-5-(thiophen-2-yl)-[1,1'-biphenyl]-2-carbonitrile: Yield: 67%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 163-165^{o}C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.71 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.48-7.33 (m, 4H, Ar-H), 7.30 (t, *J* = 6.5 Hz, 1H, Ar-H), 7.22 (s, 1H, Ar-H), 7.14 (s, 1H, Ar-H), 7.11 (t, *J* = 4.2 Hz, 1H, Ar-H), 3.26 (dt, *J* = 14.8, 5.5 Hz, 4H, -CH_2), 1.81 (d, *J* = 4.6 Hz, 4H, -CH_2), 1.63 (t, *J* = 5.7 Hz, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 158.0, 147.1, 142.8, 139.7, 138.6, 133.2, 131.0, 130.2, 128.4, 127.5, 126.8, 125.1, 123.0, 120.2, 117.2, 115.0, 105.4, 53.4, 26.2, 24.1; IR: 2927, 2853, 2218 (CN), 1581, 1555 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{22}H_{20}BrN_2S$: 423.0525; found: 423.0529.

6l. 2'-bromo-3-(pyrrolidin-1-yl)-5-(thiophen-2-yl)-[1,1'-biphenyl]-2-carbonitrile: Yield: 64%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 154-156^{o}C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.69 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.44-7.32 (m, 4H, Ar-H), 7.32-7.24 (m, 1H, Ar-H), 7.09 (q, *J* = 3.6 Hz, 1H, Ar-H), 6.91 (s, 1H, Ar-H), 6.85 (s, 1H, Ar-H), 3.70 (d, *J* = 6.1 Hz, 4H, -CH_2), 2.03 (s, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 151.2, 147.9, 143.1, 140.5, 138.1, 132.8, 130.8, 129.8, 128.1, 127.3, 126.3, 124.7, 123.1, 119.3, 115.6, 110.2, 94.4, 50.3, 25.8; IR: 2958, 2855, 2206 (CN), 1593, 1552 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{21}H_{18}BrN_2S$: 409.0369; found: 409.0390.

6m. 3-(2-bromophenyl)-1-(piperidin-1-yl)-9,10-dihydrophenanthrene-2-carbonitrile: Yield: 61%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 137-139 ^{o}C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.74-7.66 (m, 2H, Ar-H), 7.45 (s, 1H, Ar-H), 7.40 (t, *J* = 6.5 Hz, 2H, Ar-H), 7.30 (dd, *J* = 9.5, 2.7 Hz, 4H, Ar-H), 3.27 (s, 4H, -CH_2), 3.04-2.84 (m, 4H, -CH_2), 1.83-1.60 (m, 6H,-CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 154.1, 137.8, 134.8, 133.7, 133.0, 131.1, 129.9, 128.7, 127.9, 127.4, 127.1, 124.7, 121.2, 107.7, 52.1, 28.5, 26.8, 24.1, 23.3; IR: 2924, 2853, 2219 (CN), 1600, 1540 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{26}H_{24}BrN_2$: 443.1117; found: 443.1127.

6n. 3-(2-bromophenyl)-7-methoxy-1-(piperidin-1-yl)-9,10 dihydrophenanthrene-2-carbonitrile: Yield: 58%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 133-135^{o}C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.71 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.62 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.40 (dd, *J* = 8.0, 5.7 Hz, 3H, Ar-H), 7.31-7.27 (m, 1H, Ar-H), 6.82 (d, *J* = 9.2 Hz, 2H, Ar-H), 3.85 (s, 3H, -OCH_3), 3.26 (s, bs, 4H, -CH_2), 3.04-2.77 (4H, -CH_2), 1.73-1.55 (m, 6H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 160.0, 154.0, 144.4, 140.0, 139.7, 139.5, 133.9, 133.0, 131.2, 129.8, 127.4,

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126.6, 126.2, 123.3, 121.0, 118.2, 113.2, 112.5, 106.9, 55.3, 52.1, 28.9, 26.8, 24.1, 23.3; IR: 2926, 2850, 2219 (CN), 1602, 1543 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{27}H_{26}BrN_2O$: 473.1223; found: 473.1231.

6o. 3-(2-bromophenyl)-7-methoxy-1-(pyrrolidin-1-yl)-9,10-dihydrophenanthrene-2-carbonitrile: Yield: 56%; 0.60 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 130-132°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.67 (dd, *J* = 33.6, 8.4 Hz, 2H, Ar-H), 7.40 (q, *J* = 1.5 Hz, 3H, Ar-H), 7.31-7.23 (m, 1H, Ar-H), 6.83 (d, *J* = 9.9 Hz, 2H, Ar-H), 3.84 (s, 3H, -OCH_3), 3.44 (d, *J* = 6.9 Hz, 4H, -CH_2), 2.87 (d, *J* = 3.8 Hz, 4H, -CH_2), 2.04 (d, *J* = 6.1 Hz, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 150.6, 144.5, 139.8, 139.5, 137.9, 135.8, 133.7, 133.0, 131.2, 129.9, 128.7, 128.0, 127.4, 127.1, 124.7, 123.2, 121.9, 117.6, 109.0, 55.9, 51.4, 28.5, 26.3, 23.6; IR: 2929, 2842, 2217 (CN), 1582, 1539 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{26}H_{24}BrN_2O$: 459.1067; found: 459.1066.

Synthetic protocol for the synthesis of 2''-fluoro/chloro-4-substituted-5'-*sec.*amino-[1,1':3',1''-teraryl]-4'-carbonitriles (6p-s):

A mixture of 6-aryl-4-*sec.*amino-2*H*-pyran-2-one-3-carbonitriles 4 (0.5 mmol) and 2'-fluoro/chloro-acetophenone (0.6 mmol) in dry DMSO (4.0 mL) in presence of powdered KOH (1.0 mmol) was stirred at room temperature for 10 h. After completion of reaction, mixture was poured onto ice with constant stirring then neutralized with 10%HCl. The precipitate was filtered and purified by silica gel column chromatography with ethylacetate / hexane (1:19) as eluent.

6p. 2''-fluoro-4-methyl-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 67%; 0.65 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 157-159°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.50 (dd, *J* = 8.0, 1.9 Hz, 2H, Ar-H), 7.46-7.37 (m, 2H, Ar-H), 7.32-7.24 (m, 3H, Ar-H), 7.24-7.16 (m, 3H, Ar-H), 3.25 (t, *J* = 4.2 Hz, 4H, -CH_2), 2.41 (s, 3H, -CH_3), 1.82 (s, 4H, -CH_2), 1.63 (d, J = 4.6 Hz, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 158.2, 145.8, 141.6, 138.5, 136.8, 131.7, 130.8, 130.0, 129.2, 127.5, 126.6, 124.6, 122.3, 117.5, 116.9, 116.0, 105.2, 53.5, 26.1, 24.0; IR: 2930, 2854, 2217 (CN), 1592, 1554 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{25}H_{24}FN_2$: 371.1918; found: 371.1880.

6q. 2''-chloro-4-methyl-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile: Yield: 63%; 0.65 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 140-142°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.53-7.46 (m, 3H, Ar-H), 7.42-7.33 (m, 3H, Ar-H), 7.25 (d, *J* = 7.3 Hz, 2H, Ar-H), 7.19 (d, *J* = 1.8 Hz, 1H, Ar-H), 7.14-7.10 (1H, Ar-H), 3.33-3.17 (m, 4H, -CH_2), 2.42-2.36 (3H, -CH_3), 1.88-1.74 (m, 4H, -CH_2), 1.62 (q, *J* = 5.8 Hz, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 157.9, 145.6, 145.1, 138.5, 137.9, 136.8, 133.0, 131.1, 129.9, 129.8, 129.6, 127.0, 121.6, 117.3, 116.3, 105.3, 53.5, 26.1, 24.0, 21.2; IR: 2928, 2854, 2216 (CN), 1591, 1554 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{25}H_{24}ClN_2$: 387.1623; found: 387.1618.

6r. 2'-fluoro-3-(piperidin-1-yl)-5-(thiophen-2-yl)-[1,1'-biphenyl]-2-carbonitrile: Yield: 73%; 0.65 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 181-183°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.48-7.34 (m, 4H, Ar-H), 7.27 (d, *J* = 6.1 Hz, 1H, Ar-H), 7.24-7.17 (m, 3H, Ar-H), 7.11 (t, *J* = 3.8 Hz, 1H, Ar-H), 3.26 (t, *J* = 5.3 Hz, 4H, -CH_2), 1.81 (d, *J* = 4.6 Hz, 4H, -CH_2), 1.64 (d, *J* = 5.3 Hz, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 158.2, 142.7, 141.9, 138.7, 131.2, 130.7, 130.6, 128.3, 126.7, 125.0, 124.2, 120.5, 117.4, 116.2, 116.0, 115.0, 105.4, 53.4, 26.1, 24.0; IR: 2934, 2853, 2216 (CN), 1591, 1556, cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{22}H_{20}FN_2S$: 363.1226; found: 363.1234.

6s. 2'-chloro-3-(piperidin-1-yl)-5-(thiophen-2-yl)-[1,1'-biphenyl]-2-carbonitrile: Yield: 70%; 0.65 R_f (10% ethylacetate in hexane), white crystalline solid; mp: 166-168°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.59-7.46 (m, 1H, Ar-H), 7.43-7.35 (m, 5H, Ar-H), 7.22 (d, *J* = 0.9 Hz, 1H, Ar-H), 7.16 (d, *J* = 0.9 Hz, 1H, Ar-H), 7.11 (td, *J* = 4.4, 1.1 Hz, 1H, Ar-H), 3.26 (t, *J* = 6.0 Hz, 4H, -CH_2), 1.90-1.73 (m, 4H, -CH_2), 1.71-1.59 (m, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 158.0, 145.3, 142.7, 138.6, 137.6, 133.0, 131.0, 129.9, 129.9, 128.3, 126.8, 125.0, 120.2, 117.2, 114.9, 105.4, 53.4, 26.1, 24.0; IR: 2931, 2853, 2216 (CN), 1591, 1558 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{22}H_{20}FN_2S$: 379.1030; found: 379.1023.

General protocol for the synthesis of 1-*sec.*amino-3-aryl-9*H*-fluoren-9-ones (8a-o) with n-BuLi:

To the vacuum dried round bottom flask 2''-bromo-4-aryl-5'-*sec*- amino-[1,1':3',1''-teraryl]-4'-carbonitriles **6** (0.3 mmol) was taken under nitrogen atmosphere followed by addition of dry THF (1.0 mL). The solution of **6** was cooled to -78 °C and n-BuLi in THF (1.5 ml, 0.9 mmol) was added drop-wise to the solution. After complete addition of n-BuLi, dry ice bath was removed and the mixture was further stirred at room temperature for 3 hours. After completion, the reaction was quenched with saturated NH_4Cl (3.0 mL), extracted with ethyl acetate (3 times in 10 mL), and organic layer was dried over sodium sulphate. The solvent was evaporated to obtain the crude product, which was purified by silica gel column chromatography using DCM/hexane (3:7) as eluent.

Synthesis of 1-(piperidin-1-yl)-3-(p-tolyl)-9H-fluoren-9-one with $LiAlH_4$:

To a nitrogen flushed 10 ml pressure vial 2''-bromo-4-methyl-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile **6d** (0.3 mmol) was dissolved in THF (1.0 mL) and cooled to -20 °C. Then $LiAlH_4$ (0.9 mmol) was added to the solution at the same temperature and sealed the tube. Then, reaction was heated at 100 °C till completion of reaction. After completion, reaction mixture was diluted with ether (30 mL) and organic layer was washed with 10% NaOH solution (15 mLx2) and water (15 mLx2). The reaction mixture was dried over Na_2SO_4 and crude was purified by silica gel column chromatography using DCM/hexane (3:7) as eluent.

8a. 3-phenyl-1-(piperidin-1-yl)-9H-fluoren-9-one: Yield: 64%; 0.45 R_f (10% ethylacetate in hexane), yellow solid; mp: 114-

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116°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.62 (d, *J* = 8.2 Hz, 1H, Ar-H), 7.52 (d, *J* = 8.2 Hz, 2H, Ar-H), 7.42-7.29 (4H, Ar-H), 7.19 (q, *J* = 7.2 Hz, 2H, Ar-H), 7.13 (s, 1H, Ar-H), 7.05 (s, 1H, Ar-H), 3.21 (td, *J* = 12.7, 5.6 Hz, 4H, -CH_2), 1.81-1.64 (m, 4H, -CH_2), 1.61-1.46 (m, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 191.2, 157.8, 146.7, 145.6, 139.8, 133.0, 130.0, 128.9, 128.5, 127.4, 127.3, 122.9, 121.8, 117.2, 116.5, 105.4, 53.4, 26.1, 24.0; IR: 2927, 2854, 1691 (CO), 1595, 1557 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{24}H_{22}NO$: 340.1696; found: 340.1688.

8b. 3-phenyl-1-(pyrrolidin-1-yl)-9H-fluoren-9-one: Yield:61%; 0.43 R_f (10% ethylacetate in hexane), yellow solid; mp: 107-109°C; ^{1}H-NMR(400 MHz, $CDCl_3$): δ 7.70 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.64-7.57 (m, 2H, Ar-H), 7.45 (td, *J* = 7.2, 1.5 Hz, 2H, Ar-H), 7.42-7.36 (m, 3H, Ar-H), 7.32-7.27 (m, 1H, Ar-H), 6.88 (s, 1H, Ar-H), 6.83 (d, *J* = 1.5 Hz, 1H, Ar-H), 3.71 (q, *J* = 5.8 Hz, 4H, -CH_2), 2.12-1.95 (m, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 191.9, 157.9, 151.2, 147.8, 145.4, 140.2, 132.8, 130.9, 128.8, 128.3, 127.3, 123.1, 119.4, 117.2, 111.9, 105.3, 94.5, 53.3, 25.8; IR: 2925, 2854, 1684 (CO), 1593, 1553 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{23}H_{20}NO$: 326.1539; found: 326.1536.

8c. 1-morpholino-3-phenyl-9H-fluoren-9-one: Yield: 66%; 0.15 R_f (10% ethylacetate in hexane), yellow solid; mp: 134-136°C; ^{1}H-NMR(400 MHz, $CDCl_3$): δ 7.69-7.59 (m, 3H, Ar-H), 7.56 (d, *J* = 6.9 Hz, 1H, Ar-H), 7.53-7.42 (m, 4H, Ar-H), 7.31 (t, *J* = 6.9 Hz, 2H, Ar-H), 6.97 (s, 1H, Ar-H), 3.99 (t, *J* = 4.6 Hz, 4H, -CH_2), 3.38 (t, *J* = 4.6 Hz, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 191.5, 156.4, 151.8, 149.3, 143.3, 141.8, 135.3, 133.1, 130.9, 129.8, 127.0, 123.4, 121.0, 114.9, 112.2, 110.9, 105.4, 67.0, 52.0; IR: 2923, 2854, 1690 (CO), 1603, 1556 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{23}H_{20}NO_2$: 342.1489; found: 342.1499.

8d. 1-(piperidin-1-yl)-3-(p-tolyl)-9H-fluoren-9-one: Yield: 67%; 0.47 R_f (10% ethylacetate in hexane), yellow solid; mp: 102-104°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.62 (d, *J* = 6.9 Hz, 1H, Ar-H), 7.54 (dd, *J* = 7.1, 5.5 Hz, 3H, Ar-H), 7.43 (t, *J* = 8.0 Hz, 1H, Ar-H), 7.27 (dd, *J* = 8.0, 5.7 Hz, 3H, Ar-H), 7.23 (d, *J* = 1.5 Hz, 1H, Ar-H), 6.97 (d, *J* = 1.5 Hz, 1H, Ar-H), 3.33 (t, *J* = 5.3 Hz, 4H, -CH_2), 2.42 (s, 3H, -CH_3), 1.93-1.77 (m, 4H, -CH_2), 1.73-1.56 (m, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 191.2, 152.6, 149.1, 147.4, 143.0, 138.4, 137.7, 135.5, 133.2, 129.9, 128.2, 127.0, 126.3, 124.7, 123.2, 120.0, 117.5, 111.2, 109.9, 52.6, 26.1, 24.2, 21.2; IR: 2924, 2854, 1684 (CO), 1593, 1552 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{25}H_{24}NO$: 354.1852; found: 354.1863.

8e. 1-(pyrrolidin-1-yl)-3-(p-tolyl)-9H-fluoren-9-one: Yield: 62%; 0.45 R_f (10% ethylacetate in hexane), yellow solid; mp: 95-97°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.71 (d, *J* = 7.6 Hz, 1H, Ar-H), 7.53 (d, *J* = 7.6 Hz, 2H, Ar-H), 7.39 (dd, *J* = 16.8, 6.1 Hz, 3H, Ar-H), 7.35-7.27 (m, 2H, Ar-H), 6.89 (dd, *J* = 20.2, 14.9 Hz, 2H, Ar-H), 3.72 (d, *J* = 5.3 Hz, 4H, -CH_2), 2.42 (s, 3H, -CH_3), 2.05 (s, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.9, 152.7, 147.7, 143.7, 142.6, 141.4, 135.5, 133.3, 129.1, 128.3, 126.3, 124.8, 123.1, 119.9, 119.8, 115.6, 109.9, 52.6, 26.1, 24.3; IR: 2926, 2854, 1690 (CO), 1604, 1555 cm^{-1}; HRMS (m/z): $[M+Na]^+$ calcd for $C_{24}H_{22}NO$: 362.1521; found: 362.1539.

8f. 1-morpholino-3-(p-tolyl)-9H-fluoren-9-one: Yield: 65%; 0.20 R_f (10% ethylacetate in hexane), yellow solid; mp: 121-123°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.61 (d, *J* = 7.8 Hz, 2H, Ar-H), 7.55 (d, *J* = 10.5 Hz, 2H, Ar-H), 7.49-7.34 (m, 4H, Ar-H), 7.22 (s, 1H, Ar-H), 7.00 (s, 1H, Ar-H), 3.98 (t, *J* = 4.4 Hz, 4H, -CH_2), 3.39-3.35 (4H, -CH_2), 2.43 (s, 3H, -CH_3); ^{13}C-NMR (100 MHz, $CDCl_3$) : δ 191.1, 156.5, 151.8, 141.8, 133.6, 133.1, 129.7, 128.3, 127.0, 125.0, 123.4, 121.1, 119.9, 114.9, 112.2, 110.9, 105.5, 67.0, 52.2, 21.2; IR: 2955, 2854, 1690 (CO), 1604, 1556 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{24}H_{22}NO_2$: 356.1645; found: 356.1642.

8g. 3-(4-methoxyphenyl)-1-(piperidin-1-yl)-9H-fluoren-9-one: Yield: 61%; 0.40 R_f (10% ethylacetate in hexane), yellow solid; mp: 115-117°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.71 (d, *J* = 6.9 Hz, 1H, Ar-H), 7.62-7.53 (m, 2H, Ar-H), 7.47 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.44-7.34 (m, 2H, Ar-H), 7.29 (dd, *J* = 8.4, 6.9 Hz, 1H, Ar-H), 7.17 (d, *J* = 6.9 Hz, 1H, Ar-H), 7.09 (d, *J* = 3.8 Hz, 1H, Ar-H), 7.02-6.94 (1H, Ar-H), 3.86 (s, 3H, -OCH_3), 3.26 (t, *J* = 6.5 Hz, 4H,-CH_2), 1.81 (s, 4H, -CH_2), 1.67-1.60 (2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 191.0, 157.9, 152.8, 147.0, 142.7, 139.6, 138.6, 129.1, 127.5, 126.7, 126.3, 123.3, 119.8, 117.2, 115.6, 109.9, 105.3, 56.5, 53.4, 26.1, 24,3; IR: 2929, 2853, 1688 (CO), 1595, 1555 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{25}H_{24}NO_2$: 369.1961; found: 369.1964.

8h. 3-(4-methoxyphenyl)-1-(pyrrolidin-1-yl)-9H-fluoren-9-one: Yield: 59%; 0.38 R_f (10% ethylacetate in hexane), yellow solid; mp: 103-105°C; ^{1}H-NMR (400 MHz, $CDCl_3$) : δ 7.78-7.48 (m, 4H, Ar-H), 7.48-7.34 (m, 1H, Ar-H), 7.29 (t, *J* = 7.2 Hz, 1H, Ar-H), 7.10 (d, *J* = 1.5 Hz, 1H, Ar-H), 6.98 (dd, *J* = 13.4, 8.8 Hz, 2H, Ar-H), 6.82 (d, *J* = 15.3 Hz, 1H, Ar-H), 3.93-3.80 (s, 3H, -OCH_3), 3.76-3.58 (m, 4H, -CH_2), 2.10-1.94 (m, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 191.0, 157.6, 152.6, 147.7, 142.6, 138.6, 133.1, 130.9, 128.4, 127.5, 126.7, 123.0, 119.9, 119.7, 114.9, 109.8, 96.8, 57.5, 53.5, 26.1; IR: 2925, 2854, 1680 (CO), 1607, 1546 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{24}H_{22}NO_2$: 356.1645; found: 356.1640.

8i. 3-(4-chlorophenyl)-1-morpholino-9H-fluoren-9-one: Yield: 49%; 0.14 R_f (10% ethylacetate in hexane), yellow solid; mp: 148-150°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.62 (d, *J* = 6.9 Hz, 1H, Ar-H), 7.60-7.51 (m, 3H, Ar-H), 7.51-7.42 (m, 3H, Ar-H), 7.35-7.27 (m, 1H, Ar-H), 7.16 (d, *J* = 11.4 Hz, 1H, Ar-H), 6.92 (s, 1H, Ar-H), 3.97 (td, *J* = 9.5, 4.8 Hz, 4H, -CH_2), 3.35 (dt, *J* = 24.4, 4.6 Hz, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 191.4, 151.7, 147.9, 142.8, 138.8, 135.1, 134.7, 133.7, 129.3, 129.1, 128.5, 123.5, 120.4, 119.9, 116.7, 112.0, 67.0, 51.5; IR: 2924, 2855, 1690 (CO), 1604, 1554 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{23}H_{19}ClNO_2$: 376.1099; found: 376.1103.

8j. 3-(naphthalen-2-yl)-1-(piperidin-1-yl)-9H-fluoren-9-one: Yield: 58%; 0.42 R_f (10% ethylacetate in hexane), yellow solid; mp: 124-126°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 8.00 (s, 1H, Ar-H), 7.87-7.73 (m, 4H, Ar-H), 7.69-7.62 (m, 1H, Ar-H), 7.57-7.52 (1H, Ar-H), 7.49-7.39 (m, 3H, Ar-H), 7.37-7.30 (m, 1H, Ar-H), 7.19 (q, *J* = 7.1 Hz, 1H, Ar-H), 7.00 (s, 1H, Ar-H), 3.26 (t, *J* = 5.3 Hz, 4H, -

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CH_2), 1.84-1.71 (m, 4H, -CH_2), 1.63-1.49 (m, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 191.3, 152.6, 148.7, 147.5, 142.9, 137.9, 135.4, 133.4, 133.3, 133.1, 128.9, 128.7, 128.5, 128.3, 127.6, 127.4, 126.5, 126.4, 126.1, 125.1, 123.2, 119.8, 119.7, 117.7, 111.5, 53.4, 26.0, 24.2; IR: 2934, 2853, 1689 (CO), 1604, 1556 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{28}H_{24}NO$: 390.1852; found: ^{390}.1874.

8k. 1-(piperidin-1-yl)-3-(thiophen-2-yl)-9H-fluoren-9-one: Yield: 67%; 0.45 R_f (10% ethylacetate in hexane), yellow solid; mp: 128-130°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.62 (d, *J* = 6.9 Hz, 1H, Ar-H), 7.55 (d, *J* = 7.6 Hz, 1H, Ar-H), 7.49-7.41 (m, 2H, Ar-H), 7.40-7.33 (1H, Ar-H), 7.33-7.26 (m, 2H, Ar-H), 7.17-7.07 (m, 1H, Ar-H), 7.03 (s, 1H, Ar-H), 3.32 (t, *J* = 5.3 Hz, 4H, -CH_2), 1.94-1.77 (m, 4H, -CH_2), 1.65 (q, *J* = 5.8 Hz, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 191.3, 152.6, 147.5, 142.9, 137.9, 135.4, 133.3, 128.9, 128.5, 128.3, 127.7, 126.1, 125.1, 123.2, 119.7, 117.7, 111.5, 52.7, 26.0, 24.2; IR: 2926, 2853, 1689 (CO), 1603, 1555 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{22}H_{20}NOS$: 346.1260; found: 346.1263.

8l. 1-(pyrrolidin-1-yl)-3-(thiophen-2-yl)-9H-fluoren-9-one: Yield: 64%; 0.44 R_f (10% ethylacetate in hexane), yellow solid; mp: 120-122°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.76-7.63 (m, 1H, Ar-H), 7.44-7.32 (m, 4H, Ar-H), 7.28 (td, *J* = 7.8, 2.8 Hz, 1H, Ar-H), 7.09 (t, *J* = 4.2 Hz, 1H, Ar-H), 6.91 (d, *J* = 1.5 Hz, 1H, Ar-H), 6.86 (d, *J* = 1.5 Hz, 1H, Ar-H), 3.80-3.60 (m, 4H, -CH_2), 2.12-1.94 (m, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 190.6, 148.2, 147.2, 143.9, 142.2, 140.6, 135.9, 132.8, 128.9, 128.1, 126.0, 124.4, 122.9, 119.6, 115.5, 113.1, 107.4, 51.8, 25.8; IR: 2924, 2854, 1681 (CO), 1606, 1549 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{21}H_{18}NOS$: 332.1104; found: 332.1099.

8m. 7-(piperidin-1-yl)-5H-indeno[2,1-b]phenanthren-8(6H)-one: Yield: 60%; 0.52 R_f (10% ethylacetate in hexane), yellow solid; mp: 102-104°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.75-7.64 (m, 2H, Ar-H), 7.45 (s, 1H, Ar-H), 7.43-7.36 (m, 2H, Ar-H), 7.34-7.26 (m, 4H, Ar-H), 3.27 (s, 4H, -CH_2), 3.06-2.80 (m, 4H, -CH_2), 1.83-1.59 (6H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 192.2, 154.1, 144.5, 143.5, 139.5, 137.9, 135.8, 133.7, 133.0, 131.2, 129.8, 128.7, 127.4, 124.7, 123.2, 121.8, 119.3, 117.6, 108.9, 51.5, 28.5, 26.8, 26.3, 23.3; IR: 2929, 2851, 1696 (CO), 1599, 1541 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{26}H_{24}NO$: 366.1852; found: 366.1868.

8n. 3-methoxy-7-(piperidin-1-yl)-5H-indeno[2,1-b]phenanthren-8(6H)-one: Yield: 55%; 0.48 R_f (10% ethylacetate in hexane), yellow solid; mp: 100-102°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.69 (dd, *J* = 25.9, 8.4 Hz, 1H, Ar-H), 7.62-7.51 (m, 3H, Ar-H), 7.51-7.39 (m, 3H, Ar-H), 6.95-6.75 (m, 2H, Ar-H), 3.87 (s, 3H, -OCH_3), 3.20 (s, 4H, -CH_2), 3.02-2.75 (m, 4H, -CH_2), 1.73 (d, *J* = 15.3 Hz, 6H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 192.1, 159.9, 154.1, 151.2, 144.5, 143.6, 141.9, 133.0, 131.2, 129.9, 128.5, 127.4, 123.3, 121.1, 119.3, 113.3, 112.4, 111.5, 106.9, 55.3, 51.2, 26.9, 26.8, 24.4, 23.3; IR: 2927, 2850, 1699 (CO), 1605, 1539 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{27}H_{26}NO_2$: 396.1958; found: 396.1963.

8o. 3-methoxy-7-(pyrrolidin-1-yl)-5H-indeno[2,1-b]phenanthren-8(6H)-one: Yield: 56%; 0.47 R_f (10% ethylacetate in hexane), yellow solid; mp: 96-98°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.73 (d, *J* = 9.2 Hz, 1H, Ar-H), 7.57 (q, *J* = 8.4 Hz, 3H, Ar-H), 7.48-7.39 (m, 1H, Ar-H), 7.27 (d, *J* = 8.4 Hz, 2H, Ar-H), 6.95-6.77 (m, 2H, Ar-H), 3.87 (s, 3H, -OCH_3), 3.44-3.25 (m, 4H, -CH_2), 2.85 (dt, *J* = 27.5, 4.0 Hz, 4H, -CH_2), 2.20-1.97 (m, 4H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 192.2, 154.1, 150.6, 144.5, 139.5, 137.9, 133.0, 131.2, 129.9, 128.7, 128.0, 127.4, 124.7, 123.2, 121.8, 119.3, 117.7, 107.7, 56.2, 52.1, 28.5, 26.8, 26.3; IR: 2929, 2841, 1698 (CO), 1602, 1543 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{26}H_{24}NO_2$: 382.1802; found: 382.1818.

9. Synthesis of 4-methyl-5'-(piperidin-1-yl)-[1,1':3',1''-terphenyl]-4'-carbonitrile: A mixture of 4-(piperidin-1-yl)-6-tolyl-2*H*-pyran-2-one-3-carbonitriles (0.5 mmol) and acetophenone (0.6 mmol) in presence of powdered KOH (1.0 mmol) and dry DMSO (4.0 mL) was stirred at room temperature for 8 h. After completion, mixture was poured onto crushed ice with constant stirring, and then neutralized with 10% HCl. Thus obtained precipitate was filtered, washed with water, dried and purified by silica gel column chromatography using ethyl acetate:hexane (1:19) as an eluent.

yield: 75%; 0.7 R_f (10% ethyl acetate in hexane), white solid; mp: 102-104°C; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.56 (d, J = 8.2 Hz, 2H, Ar-H), 7.41-7.50 (m, 5H, Ar-H), 7.25 (d, J = 7.8 Hz, 2H, Ar-H), 7.20 (d, J = 1.4 Hz, 1H, Ar-H), 7.16 (d, J = 1.8 Hz, 1H, Ar-H), 3.24 (t, J = 5.0 Hz, 4H, -CH_2), 2.39 (s, 3H, CH_3), 1.78-1.84 (m, 4H, -CH_2), 1.58-1.64 (m, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ 155.8, 145.0, 143.0, 136.2, 135.7, 134.1, 126.8, 126.1, 125.6, 124.3, 118.5, 115.3, 113.1, 101.1, 50.8, 25.0, 23.3, 21.2; IR: 2927, 2855, 2215 (CN), 1594, 1553 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{25}H_{25}N_2$: 353.2012; found: 353.2031.

10. Synthesis of 3-(piperidin-1-yl)-5-(thiophen-2-yl)-[1,1'-biphenyl]-2-carbonitrile-2'-d:

A 10 ml dry round bottom flask 2''-bromo-3-(piperidin-1-yl)-5-(thiophen-2-yl)-[1,1'-biphenyl]-2-carbonitrile **6k** (0.3 mmol) was taken under nitrogen atmosphere and dissolved in dry THF (1.0 mL). The solution of **6k** was cooled to -78 °C and n-BuLi in THF (1.5 ml, 0.9 mmol) was added drop-wise. After complete addition of n-BuLi, dry ice bath was removed and mixture was stirred at room temperature for 30 minutes. Then reaction mixture was quenched with D_2O (0.5 mL) and stirring was continued for further half hour. Reaction mixture was extracted with ethyl acetate (10 mLX3) and organic layer was dried over sodium sulphate and crude product was purified by column chromatography with DCM/hexane (3:17) as eluent.

yield: 75%; 0.7 R_f (10% ethylacetate in hexane), white solid; ^{1}H-NMR (400 MHz, $CDCl_3$): δ 7.69 (dd, J = 8.0, 1.0 Hz, 1H, Ar-H), 7.38-7.40 (m, 2H, Ar-H), 7.26-7.31 (m, 1H, Ar-H), 7.21 (d, J = 1.5 Hz, 1H, Ar-H), 7.13 (d, J = 1.6 Hz, 1H, Ar-H), 7.09 (dd, J = 5.1, 3.7 Hz, 1H, Ar-H), 3.25 (t, J = 4.4 Hz, 4H, -CH_2), 1.80 (m, 4H, -CH_2), 1.61 (t, J = 5.8 Hz, 2H, -CH_2); ^{13}C-NMR (100 MHz, $CDCl_3$): δ

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158.0, 147.1, 142.8, 139.7, 138.6, 133.2, 131.0, 130.2, 128.4, 127.5, 126.8, 125.1, 123.0, 120.2, 117.2, 115.0, 105.4, 53.4, 29.8, 25.8; IR: 2957, 2855, 2214 (CN), 1623, 1575 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{22}H_{20}DN_2S$: 346.1483; found: 346.1446.

Conflicts of interest

There are no conflicts to declare.

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