Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

BF_3-Et_2O Promoted Bifunctionalization of Aldehydes for the Synthesis of Arylmethyl Substituted Organophosphorus Compounds

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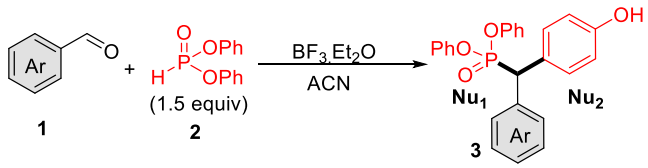
General Information. All chemicals were obtained from Sigma-Aldrich, Tokyo Chemical Industry and S. D. Fine, the progress of the reactions was monitored by thin-layer chromatography (TLC) on pre-coated silica-gel plates using Merck Silica Gel 60 F_{254}, Cat. No. 1.05554.0007 and visualized by short-wave ultraviolet light. Column chromatography was performed by hand using silica-gel (100–200 mesh, Silicycle).^{1}H, ^{13}C, NMR spectra were recorded on Bruker-Advance DPX FT-NMR 500 and 400 MHz instruments. Chemical data for protons are reported in parts per million (ppm) downfield from tetramethylsilane and are referenced to the residual proton in the NMR solvent (DMSO-d_6: 2.5 ppm and 3.4 ppm. Carbon nuclear magnetic resonance spectra ^{13}C NMR solvent DMSO-d_6: 39.90-40 ppm) were recorded at 125 MHz or 100 MHz: chemical data for carbons are reported in parts per million (ppm, δ scale) down field from tetramethylsilane and are referenced to the carbon resonance of the solvent. ESI-MS and HRMS spectra were recorded on Agilent 1100 LC-Q-TOF and HRMS-6540-UHD machines respectively.



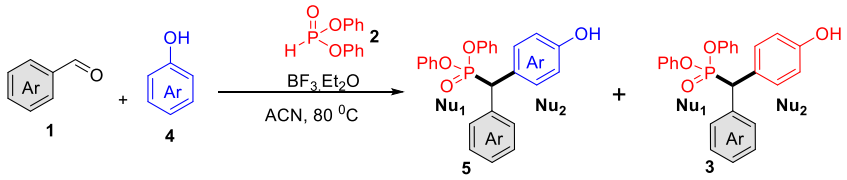
1 2 3

General procedure for synthesis of Compounds (3a-3l):

To a 30 ml glass vial were added benzaldehyde (1.0 mmol) and diphenyl phosphite (1.5 mmol) in acetonitrile ACN (10ml). Then boron trifluoride diethyl etherate (1.5 mmol) was added dropwise. The reaction mixture was heated to 80 ^{0} C in an oil bath for 8 hour. After the completion of the reaction as monitored by TLC, the reaction mixture was cooled down to room temperature, extracted with ethyl acetate (25 ml× 2) and washed with H_2O (50 ml × 2).

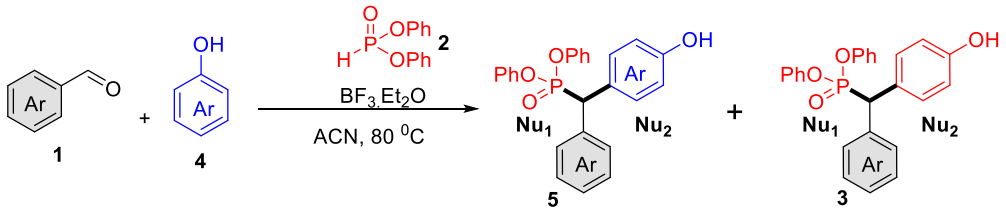
The organic layer was dried over anhydrous Na_2SO_4, concentrated via rotary evaporation, and purified by column chromatography on silica gel (petroleum ether: ethyl acetate) as a liquid.

General procedure for synthesis of Compounds (5a-5l):



To a 30 ml glass vial were added benzaldehyde (1.0 mmol), and diphenyl phosphite **2** (1.0 mmol), in acetonitrile ACN (10ml). Then boron trifluoride diethyl etherate (1.5 mmol), was added dropwise. After 20 minutes was added substituted phenol (1.0 mmol) and the reaction mixture was heated to 80 ^{0}C in an oil bath for 8 hour. After the completion of the reaction as monitored by TLC, the reaction mixture was cooled down to room temperature, extracted with ethyl acetate (25 ml× 2) and washed with H_2O (50 ml × 2). The organic layer was dried over anhydrous Na_2SO_4, concentrated via rotary evaporation, and purified by column chromatography on silica gel (petroleum ether: ethyl acetate) as a liquid.

Optimization Table 2.



entry	**2**	**4a**	**BF_3-OEt_2 (mmol)**	**5a (%yield)**	**3a(%yield)**
1	2.0	1.0	1.5	39	43
2	1.5	1.0	1.5	45	37
3	1.3	1.0	1.5	51	29

4	1.2	1.0	1.5	57	19
5	1.1	1.0	1.5	68	14
6	**1.0**	**1.0**	**1.5**	**81**	**11**
7	0.8	1.0	1.5	64	8
8	1.0	1.0	2.0	72	13
9	1.0	1.0	2.5	63	9
10	1.0	1.0	3.0	59	7
11	1.0	1.5	1.5	76	11
12	1.0	0.8	1.5	71	18
13	1.0	0.5	1.5	64	21
14	1.0	0.3	1.5	58	26

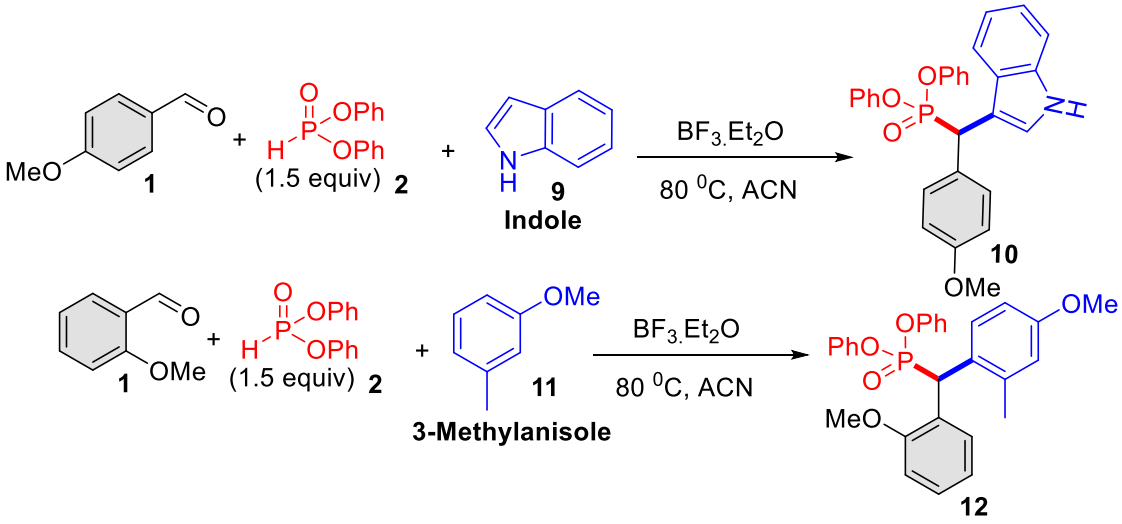
Conditions: Addition of benzaldehyde **1a** (1 mmol), diphenyl phosphite **2** (0.3 mmol) in 10 mL of ACN, followed by addition of BF_3-OEt_2 (1.5 mmol) and then add external phenol after 20 minutes (1.0 mmol) at 80 ^{o}C for 8 h.

General procedure for synthesis of Compounds (7a-7l):

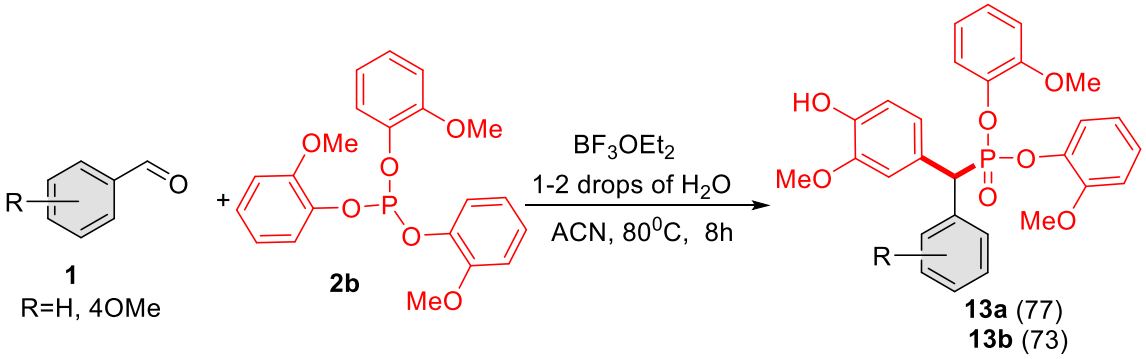
To a 30 ml glass vial were added benzaldehyde (1.0 mmol), and diphenyl phosphite **2** (1.0 mmol), in acetonitrile ACN (10ml). Then boron trifluoride diethyl etherate (1.5 mmol), was added dropwise. After that was added aliphatic thiol **6** (1.0 mmol) and the reaction mixture was heated to 80 ^{0}C in an oil bath for 8 hour. After the completion of the reaction as monitored by TLC, the reaction mixture was cooled down to room temperature, extracted with ethyl acetate (25 ml× 2) and washed with H_2O (50 ml × 2). The organic layer was dried

over anhydrous Na_2SO_4, concentrated via rotary evaporation, and purified by column chromatography on silica gel (petroleum ether: ethyl acetate) as a liquid.

General procedure for synthesis of Compounds 10 and **12:** To a 30 ml glass vial were added **1** (1.0 mmol), diphenyl phosphite **2** (1 mmol) and indole **9 or 11** (1 mmol) in acetonitrile (ACN). The boron trifluoride diethyl etherate (1.5 mmol) was added dropwise to the reaction mixture. The reaction mixture was heated to 80 ^{0} C in an oil bath for 8 hours. After the completion of the reaction as monitored by TLC, the reaction mixture was cooled down to room temperature, extracted with ethyl acetate (25 ml× 2) and washed with H_2O (50 ml × 2). The organic layer was dried over anhydrous Na_2SO_4, concentrated via rotary evaporation, and purified by column chromatography on silica gel (petroleum ether: ethyl acetate) to get the desired product **10 and 12** respectively**.**



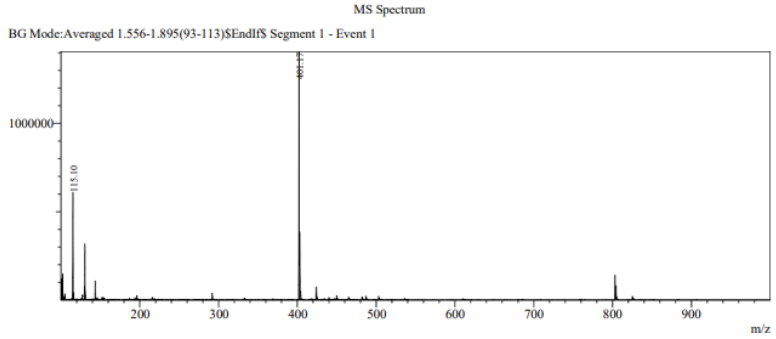
General procedure for synthesis of Compounds 13:



To a 50 ml oven dried round bottom flask were added PCl_3(0.4 mmol), and 2-methoxyphenol (3.2 mmol). The reaction mixture was stirred at ambedient temperature for 1 hour after which tris(2-methoxyphenyl) phosphite was formed (confirmed by LC-MS). After that 1-2 drops of water was added to the same reaction mixture. Then benzaldehyde **1** and boron trifluoride diethyl etherate (1.5 mmol) were slowly added to the reaction mixture. The reaction mixture was heated to 80 ^{0} C in an oil bath for 8 hours. After completion of the reaction as monitored by TLC, the reaction mixture was cooled down to room temperature, extracted with ethyl acetate (25 ml× 2) and washed with H_2O (50 ml × 2). The organic layer was dried over anhydrous Na_2SO_4, concentrated via rotary evaporation, and purified by column chromatography on silica gel (petroleum ether: ethyl acetate) as a liquid.

Sample Information

Sample Name	**: SAT-SP**	**Sample ID**	**:**
Tray#	**: 1**	**Vial#**	**: 41**
Injection Volume	**: 1**	**Data File**	**: 27042023Q_13.lcd**
Method File	**: MASS SCANNN 13APRIL2021.lcm**	**Processed by**	**: System Administrator**
Date Processed	**: 09/05/2023 1:39:04 PM**		



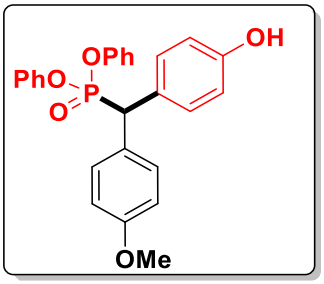
General procedure for synthesis of Compounds (8a-8i): Control Experiment (I)

To a 30 ml glass vial were added benzaldehyde (1.0 mmol), and diphenyl phosphite **2** (1.0 mmol), in acetonitrile ACN (10ml). Then boron trifluoride diethyl etherate (1.5 mmol), was added dropwise. The reaction mixture was heated to 80 ^{0}C in an oil bath for 8 hour. After the completion of the reaction as monitored by TLC, the reaction mixture was cooled down to room temperature, extracted with ethyl acetate (25 ml× 2) and washed with H_2O (50 ml × 2).

The organic layer was dried over anhydrous Na_2SO_4, concentrated via rotary evaporation, and purified by column chromatography on silica gel (petroleum ether: ethyl acetate) as a liquid.

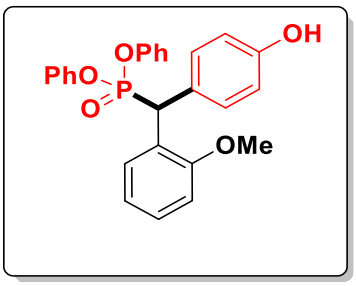
NMR Characterization data:

Diphenyl ((4-hydroxyphenyl 4-methoxyphenyl) methyl) phosphonate(3a):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 19:81); (185mg, 81%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.56 (s, 1H), 7.61 (d, *J* = 7.8 Hz, 2H), 7.50 (d, *J* = 7.8 Hz, 2H), 7.30 (t, *J* = 7.3 Hz, 4H), 7.15 (t, *J* = 7.3 Hz, 2H), 6.97 (d, *J* = 8.5 Hz, 2H), 6.86 (m, 6H), 5.13 (d, *J* = 25.9 Hz, 1H), 3.73 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 158.93 (s), 157.17 (s), 150.60 (s), 150.52 (s), 131.01 (s), 130.92 (s), 130.19 (d, *J* = 1.5 Hz), 129.01 (d, *J* = 4.6 Hz), 126.96 (d, *J* = 4.9 Hz), 125.55 (s), 120.90 (d, *J* = 3.7 Hz), 115.93 (s), 114.53 (s), 55.54 (s), 48.49 (d, *J* = 139.1 Hz).^{31}P NMR (162 MHz, DMSO) δ 19.98 (s). **HRMS** (ESI): m/z calcd. For $C_{26}H_{24}O5P^+$ $[M+1]^+$ 447.1361: found: 447.1364.

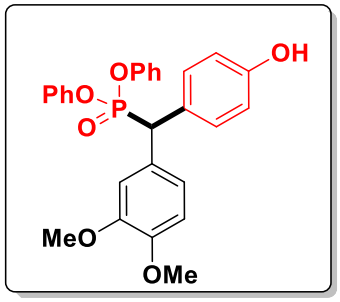
Diphenyl ((4-hydroxyphenyl) (2-methoxyphenyl) methyl) phosphonate(3b)



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 19:81); (180 mg, 78%) as a colourless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.98 (m, 1H), 7.33 – 7.25 (m, 4H), 7.17 (m, 4H), 7.00 (d, *J* = 1.0 Hz, 3H), 6.87 – 6.78 (m, 5H), 6.54 (d, *J* =

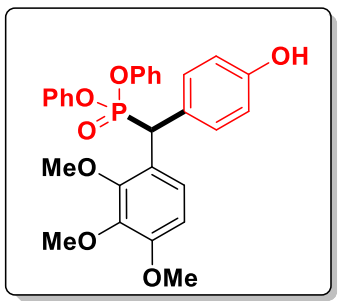
8.5 Hz, 2H), 5.43 (d, *J* = 25.8 Hz, 1H), 3.75 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 131.00 (s), 130.92 (s), 130.12 (s), 130.09 – 130.03 (d), 129.53 (s), 129.49 (s), 128.73 (s), 125.08 (s), 124.58 – 124.23 (d), 120.81 (d, *J* = 1.6 Hz), 120.75 (s), 120.71 (s), 115.96 (s), 110.86 (s), 55.65 (s), 41.23 (d, *J* = 142.5 Hz).**^{31}P NMR** (162 MHz, $CDCl_3$) δ 19.68 (s). **HRMS** (ESI): m/z calcd. For $C_{26}H_{24}O5P^+$ $[M+1]^+$ 447.1361: found: 447.1367.

Diphenyl ((3,4-dimethoxyphenyl) (4-hydroxyphenyl) methyl) phosphonate (3c):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 24:76); (190mg, 76%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.55 (s, 1H), 7.49 (m, 2H), 7.29 (m, 4H), 7.26 – 7.22 (m, 2H), 7.15 (t, *J* = 7.4 Hz, 2H), 6.97 (d, *J* = 8.6 Hz, 1H), 6.92 – 6.80 (m, 6H), 5.10 (d, *J* = 25.8 Hz, 1H), 3.74 (s, 3H), 3.71 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 157.15 (d, *J* = 1.7 Hz), 150.86 – 150.30 (m), 149.02 (s), 148.55 (d, *J* = 1.9 Hz), 130.96 (d, *J* = 8.3 Hz), 130.18 (s), 129.29 (d, *J* = 4.2 Hz), 126.87 (d, *J* = 5.1 Hz), 125.55 (s), 122.00 (d, *J* = 8.6 Hz), 120.86 (d, *J* = 3.8 Hz), 115.90 (s), 113.82 (d, *J* = 9.3 Hz), 112.42 (s), 55.95 (s), 55.92 (s), 48.80 (d, *J* = 138.9 Hz).**^{31}P NMR** (162 MHz, DMSO) δ 19.85 (s). **HRMS** (ESI): m/z calcd. For $C_{27}H_{26}O_6P$ $[M+1]^+$ 475.1310: found: 475.1305.

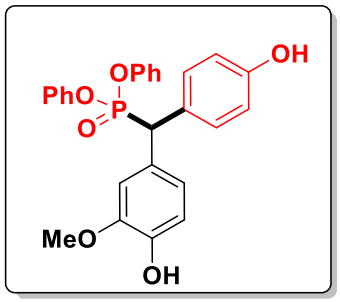
Diphenyl ((4-hydroxyphenyl) (3,4,5-trimethoxyphenyl) methyl) phosphonate(3d):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 32:68); (207mg, 79%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.53 (s, 1H), 7.49 (d, *J* = 7.2 Hz, 2H), 7.30 (m, 4H), 7.16 (m, 2H), 6.98 (s, 2H), 6.88 (d, *J* = 8.1 Hz, 4H), 6.81 (d, *J* = 8.4 Hz, 2H), 5.10 (d, *J* = 25.5 Hz, 1H), 3.72 (s, 6H), 3.65 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 157.25 (s), 153.29 (s), 150.69 (d, *J* = 9.7 Hz), 150.52 (d, *J* = 10.0 Hz),

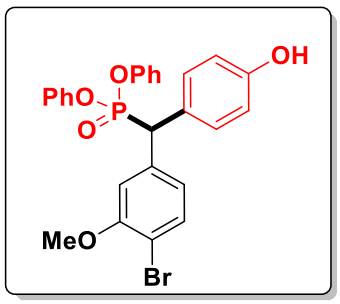
137.28 (s), 132.47 (d, *J* = 3.7 Hz), 130.95 (d, *J* = 8.0 Hz), 130.20 (s), 130.11 (s), 126.55 (s), 126.49 (s), 125.56 (d, *J* = 4.3 Hz), 120.81 (d, *J* = 3.9 Hz), 115.93 (s), 107.39 (d, *J* = 9.0 Hz), 60.49 (s), 56.30 (s), 49.36 (d, *J* = 138.5 Hz).^{31}P NMR (162 MHz, DMSO) δ 19.28 (s). **HRMS** (ESI): m/z calcd. For $C_{28}H_{28}O_7P$ $[M+1]^+$ 507.1573: found: 507.1569.

Diphenyl ((3-hydroxy-4-methoxyphenyl) (4-hydroxyphenyl) methyl) phosphonate (3e):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 25:75); (180mg, 78%) as a colourless oil. **^{1}H NMR (**400 MHz, DMSO) δ 9.51 (s, 1H), 9.13 (s, 1H), 7.46 (m, 2H), 7.28 (m, 4H), 7.18 – 7.12 (m, 3H), 7.07 – 7.01 (m, 1H), 6.93 – 6.77 (m, 7H), 4.99 (d, *J* = 25.8 Hz, 1H), 3.75 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 157.12 (s), 150.58 (d, *J* = 9.7 Hz), 147.45 (s), 146.92 (s), 130.97 (d, *J* = 8.6 Hz), 130.17 (d, *J* = 1.9 Hz), 129.46 (d, *J* = 4.5 Hz), 127.04 (d, *J* = 4.9 Hz), 125.53 (d, *J* = 3.1 Hz), 120.93 (t, *J* = 3.7 Hz), 120.72 (d, *J* = 9.2 Hz), 117.12 (d, *J* = 8.3 Hz), 115.85 (s), 112.75 (s), 56.08 (s), 48.70 (d, *J* = 139.2 Hz).**^{31}P NMR** (162 MHz, DMSO) δ 20.00 (s). **HRMS** (ESI): m/z calcd. For $C_{26}H_{24}O_6P$ $[M+1]^+$ 463.1310: found: 463.1313.

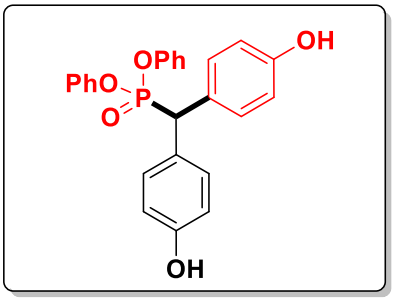
Diphenyl ((3-bromo-4-methoxyphenyl) (4-hydroxyphenyl) methyl) phosphonate(3f):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 18:82); (186 mg, 71%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.64 (s, 1H), 7.80 (t, *J* = 1.8 Hz, 1H), 7.64 (m, 1H), 7.44 (dd, *J* = 8.6, 1.6 Hz, 2H), 7.34 – 7.24 (m, 4H), 7.13 (m, 3H), 6.92 – 6.86 (m, 2H), 6.84 – 6.77 (m, 4H), 5.17 (d, *J* = 25.8 Hz, 1H), 3.81 (s,

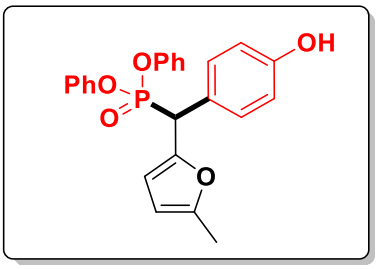
3H).). ^{13}C NMR (101 MHz, DMSO) δ 157.25 (s), 155.08 (s), 150.46 (d, *J* = 4.5 Hz), 150.36 (d, *J* = 4.5 Hz), 134.01 (d, *J* = 9.1 Hz), 130.95 (d, *J* = 8.4 Hz), 130.68 (d, *J* = 4.2 Hz), 130.24 (d, *J* = 6.3 Hz), 126.41 (d, *J* = 5.1 Hz), 125.68 (d, *J* = 4.1 Hz), 120.77 (d, *J* = 3.9 Hz), 116.05 (s), 113.23 (s), 110.93 (s), 56.68 (s), 47.76 (d, *J* = 139.5 Hz).**^{31}P NMR** (162 MHz, DMSO) δ 19.28 (s). **HRMS** (ESI): m/z calcd. For $C_{26}H_{23}BrO_5P$ $[M+1]^+$ 525.0466. found: 525.0469.

Diphenyl (bis(4-hydroxyphenyl) methyl) phosphonate(3g):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 20:80); (164mg, 76%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.49 (s, 2H), 7.47 – 7.41 (m, 4H), 7.29 (t, *J* = 7.9 Hz, 4H), 7.15 (t, *J* = 7.2 Hz, 2H), 6.87 – 6.74 (m, 8H), 5.00 (d, *J* = 26.0 Hz, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 157.04 (s), 150.61 (s), 150.51 (s), 130.97 (s), 130.88 (s), 130.16 (s), 127.17 (s), 127.12 (s), 125.51 (s), 120.89 (d, *J* = 4.0 Hz), 115.86 (s), 48.57 (d, *J* = 138.8 Hz).**^{31}P NMR** (162 MHz, DMSO) δ 20.11 (s). **HRMS** (ESI): m/z calcd. For $C_{25}H_{22}O_5P$ $[M+1]^+$ 433.1205. found: 433.1203.

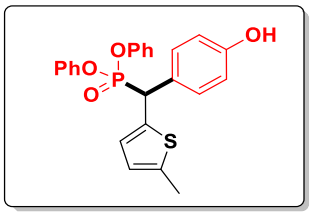
Diphenyl ((4-hydroxyphenyl(5-methylfuran-2-yl) methyl) phosphonate(3h):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 17:83); (174mg, 77%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.51 (s, 1H), 7.33 (m, 6H), 7.18 (m, 2H), 7.00 – 6.95 (m, 2H), 6.85 – 6.74 (m, 4H), 6.39 (s, 1H), 6.06 (d, *J* = 2.3 Hz, 1H), 5.21 (d, *J* = 26.9 Hz, 1H), 2.20 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 157.42 (s), 151.82 (s), 150.57 (d, *J* = 5.6 Hz), 147.70 (s), 131.18 (d, *J* = 6.9 Hz), 130.23 (d, *J* = 8.8 Hz), 125.61 (d, *J* = 6.1 Hz), 124.13 (d, *J* = 6.4 Hz), 120.83 (d, *J* = 4.2 Hz), 120.75 (d, *J* = 4.0 Hz),

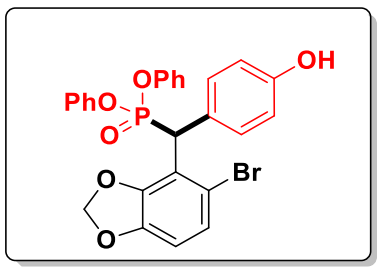
115.81 (s), 110.10 (d, *J* = 6.3 Hz), 107.34 (s), 43.83 (d, *J* = 141.9 Hz), 13.70 (s).**^{31}P NMR** (162 MHz, DMSO) δ 18.25 (s). **HRMS** (ESI): m/z calcd. For $C_{24}H_{22}O_5P$ $[M+1]^+$ 421.1205. found: 421.1199.

Diphenyl (S)-((4-hydroxyphenyl) (5-methylthiophen-2-yl) methyl) phosphonate(3i):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 18:82); (176mg, 76%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.54 (s, 1H), 7.43 (m, 2H), 7.32 (m, 4H), 7.22 – 7.12 (m, 2H), 7.07 (t, *J* = 3.2 Hz, 1H), 6.96 (m, 2H), 6.78 (d, *J* = 8.5 Hz, 4H), 6.70 (m, 1H), 5.40 (d, *J* = 26.5 Hz, 1H), 2.40 (s, 3H) **^{13}C NMR** (101 MHz, DMSO) δ 157.40 (d, *J* = 2.2 Hz), 150.51 (d, *J* = 10.0 Hz), 139.70 (d, *J* = 2.9 Hz), 136.35 (d, *J* = 5.1 Hz), 131.03 (s), 130.96 (s), 130.29 (s), 130.16 (s), 127.68 (d, *J* = 8.7 Hz), 126.18 (s), 125.62 (d, *J* = 9.2 Hz), 120.88 (d, *J* = 3.9 Hz), 120.77 (d, *J* = 4.0 Hz), 115.84 (s), 44.80 (d, *J* = 142.1 Hz), 15.33 (s).**^{31}P NMR** (162 MHz, DMSO) δ 17.72 (s). HRMS (ESI): m/z calcd. For $C_{24}H_{21}O_4PS$ $[M+1]^+$ 437.0976: found: 437.0976.

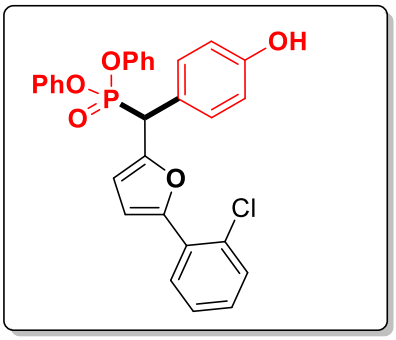
Diphenyl ((6-bromobenzo[d] [1,3] dioxol-5-yl) (4-hydroxyphenyl) methyl) phosphonate(3j):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 22:78); (193mg, 72%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.58 (s, 1H), 7.54 (d, *J* = 1.7 Hz, 1H), 7.44 – 7.26 (m, 7H), 7.24 – 7.12 (m, 2H), 6.91 (dd, *J* = 7.6, 1.0 Hz, 2H), 6.86 – 6.73 (m, 4H), 6.10 (m, 2H), 5.21 (d, *J* = 26.3 Hz, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 157.51 (s), 150.40 (s), 150.30 (s), 150.22 (s), 148.01 (d, *J* = 27.7 Hz), 131.07 (d, *J* = 7.9 Hz),

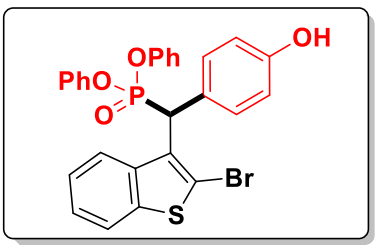
130.33 (d, *J* = 11.7 Hz), 128.67 (s), 125.80 (d, *J* = 9.0 Hz), 124.73 (s), 120.68 (d, *J* = 4.0 Hz), 116.14 (s), 115.83 (s), 115.69 (s), 113.25 (s), 110.03 (s), 102.83 (s), 48.00 (d, *J* = 141.6 Hz).^{31}P NMR (162 MHz, DMSO) δ 18.25 (s). HRMS (ESI): m/z calcd. For $C_{26}H_{21}BrO_6P$ $[M+1]^+$ 539.0259: found: 539.0264.

Diphenyl ((5-(2-chlorophenyl) furan-2-yl) (4-hydroxyphenyl) methyl) phosphonate(3k):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 23:77); (136mg, 71%) as a colourless oil. ^{1}H NMR (400 MHz, DMSO) δ 9.56 (s, 1H), 7.70 (m, 1H), 7.55 (m, 1H), 7.48 (m, 2H), 7.44 – 7.38 (m, 1H), 7.36 – 7.27 (m, 5H), 7.17 (d, *J* = 4.5 Hz, 2H), 7.12 (d, *J* = 3.4 Hz, 1H), 7.00 (d, *J* = 8.4 Hz, 2H), 6.86 (d, *J* = 8.4 Hz, 2H), 6.81 (d, *J* = 8.5 Hz, 2H), 6.70 (t, *J* = 3.2 Hz, 1H), 5.47 (d, *J* = 26.8 Hz, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 157.61 (s), 150.56 (s), 150.47 – 150.40 (d), 149.94 (s), 149.53 (s), 131.28 (d, *J* = 10.6 Hz), 130.28 (d, *J* = 7.5 Hz), 129.36 (s), 128.59 (s), 128.04 (s), 125.71 (s), 123.69 – 123.63 (d), 123.59 (s), 120.73 (t, *J* = 4.3 Hz), 115.96 (s), 112.61 (s), 111.66 (s), 43.88 (d, *J* = 141.6 Hz).**^{31}P NMR** (162 MHz, DMSO) δ 15.81 (s). HRMS (ESI): m/z calcd. For $C_{29}H_{23}ClO_5P$ $[M+1]^+$ 517.0972: found: 517.0966.

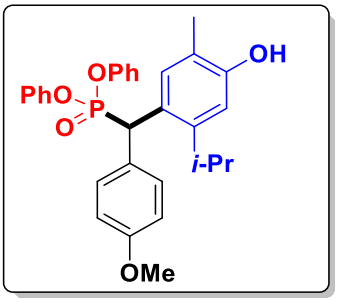
Diphenyl ((3-bromobenzo[b]thiophen-2-yl) (4-hydroxyphenyl) methyl) phosphonate(3l):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 21:79); (190mg, 69%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.68 (s, 1H), 8.07 (d, *J* = 7.6 Hz, 1H), 7.74 (d, *J* = 7.6 Hz, 1H), 7.58 – 7.42 (m, 4H), 7.30 (t, *J* = 7.7 Hz, 4H),

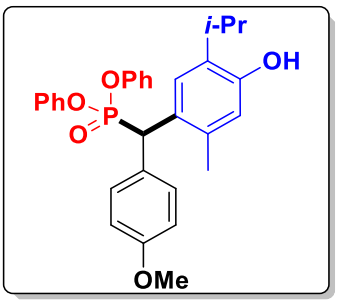
7.17 (m, 2H), 7.01 (d, *J* = 8.4 Hz, 2H), 6.83 (d, *J* = 8.3 Hz, 4H), 5.54 (d, *J* = 25.9 Hz, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 157.85 (s), 150.30 (d, *J* = 9.5 Hz), 150.09 (s), 137.89 (s), 137.03 (s), 134.83 (s), 131.25 (d, *J* = 7.4 Hz), 130.36 (d, *J* = 9.8 Hz), 126.56 (s), 126.23 (s), 125.93 (d, *J* = 6.7 Hz), 123.87 (s), 123.54 (s), 123.24 (s), 120.69 (d, *J* = 2.6 Hz), 116.26 (s), 109.07 (d, *J* = 15.1 Hz), 45.74 (d, *J* = 145.8 Hz).**^{31}P NMR** (162 MHz, DMSO) δ 15.68 (s). HRMS (ESI): m/z calcd. For $C_{27}H_{21}BrO_4PS$ $[M+1]^+$ 551.0082: found: 551.0083.

Diphenyl ((4-hydroxy-2-isopropyl-5-methylphenyl) (4-methoxyphenyl) methyl) phosphonate(5a):



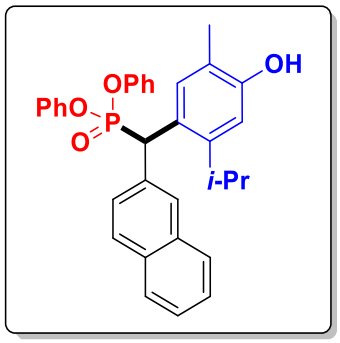
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 16:84); (198mg, 79%) as a colourless oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.72 (s, 1H), 7.44 (d, *J* = 8.5 Hz, 2H), 7.20 – 7.09 (m, 4H), 7.04 (m, 2H), 6.86 (d, *J* = 7.6 Hz, 2H), 6.80 (m, 4H), 6.68 (s, 1H), 6.48 (s, 1H), 5.04 (d, *J* = 27.6 Hz, 1H), 3.72 (s, 3H), 3.13 – 2.97 (m, 1H), 2.12 (s, 3H), 1.08 (d, *J* = 6.8 Hz, 3H), 0.89 (d, *J* = 6.8 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 158.77 (d, *J* = 2.4 Hz), 154.28 (s), 150.51 (dd, *J* = 10.1, 6.5 Hz), 145.94 (d, *J* = 12.3 Hz), 132.11 (d, *J* = 5.8 Hz), 130.95 (d, *J* = 7.6 Hz), 129.55 (d, *J* = 6.1 Hz), 127.99 (d, *J* = 5.6 Hz), 125.05 (s), 123.72 (s), 121.80 (s), 121.07 – 120.24 (d), 115.21 (s), 114.12 (s), 113.53 (s), 112.71 (s), 55.28 (s), 44.21 (d, *J* = 139.9 Hz), 28.73 (s), 23.84 (d, *J* = 17.8 Hz), 15.64 (s).**^{31}P NMR** (162 MHz, $CDCl_3$) δ 20.00 (s). **HRMS** (ESI): m/z calcd. For $C_{30}H_{32}O_5P$ $[M+1]^+$ 503.1987: found: 503.1992.

Diphenyl ((4-hydroxy-5-isopropyl-2-methylphenyl) (4-methoxyphenyl) methyl) phosphonate(5b):



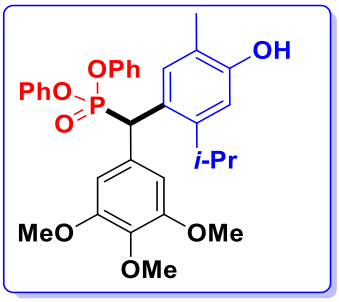
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 16:84); (196mg, 79%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.28 (s, 1H), 7.81 (d, *J* = 0.7 Hz, 1H), 7.49 (m, 2H), 7.33 – 7.24 (m, 4H), 7.14 (t, *J* = 7.4 Hz, 2H), 6.95 (d, *J* = 8.7 Hz, 2H), 6.85 (m, 4H), 6.65 (s, 1H), 5.03 (d, *J* = 27.0 Hz, 1H), 3.72 (s, 3H), 3.29 – 3.14 (m, 1H), 2.17 (s, 3H), 1.16 (m, 6H). **^{13}C NMR** (101 MHz, DMSO) δ 158.87 (d, *J* = 2.2 Hz), 153.87 (s), 150.61 (dd, *J* = 10.0, 2.5 Hz), 135.00 (d, *J* = 13.5 Hz), 132.22 (s), 131.32 (d, *J* = 7.6 Hz), 130.13 (d, *J* = 2.2 Hz), 128.01 (d, *J* = 5.4 Hz), 127.18 (d, *J* = 5.4 Hz), 120.81 (dd, *J* = 7.3, 4.0 Hz), 117.63 (s), 114.42 (s), 55.50 (s), 45.02 (d, *J* = 139.7 Hz), 26.68 (s), 23.03 (d, *J* = 5.0 Hz), 19.55 (s).**^{31}P NMR** (162 MHz, DMSO) δ 20.57 (s). **HRMS** (ESI): m/z calcd. For $C_{30}H_{32}O_5P$ $[M+1]^+$ 503.1987: found: 503.1993.

Diphenyl ((4-hydroxy-2-isopropyl-5-methylphenyl) (naphthalen-2-yl) methyl) phosphonate(5c):



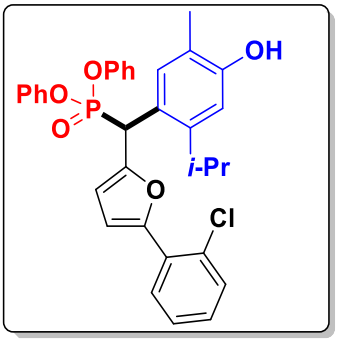
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 18:82); (190mg, 71%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.33 (s, 1H), 8.33 (d, *J* = 8.6 Hz, 1H), 7.96 (m, 2H), 7.89 (d, *J* = 8.2 Hz, 1H), 7.69 (s, 1H), 7.65 – 7.49 (m, 3H), 7.31 (t, *J* = 7.9 Hz, 2H), 7.17 (t, *J* = 7.8 Hz, 3H), 7.05 (t, *J* = 7.3 Hz, 1H), 6.87 (d, *J* = 8.4 Hz, 2H), 6.77 (s, 1H), 6.63 (d, *J* = 8.4 Hz, 2H), 6.05 (d, *J* = 27.7 Hz, 1H), 3.36 – 3.21 (m, 1H), 2.09 (s, 3H), 1.13 (d, *J* = 6.3 Hz, 3H), 0.78 (d, *J* = 6.7 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 155.52 (s), 150.84 – 150.18 (d), 146.27 (d, *J* = 11.9 Hz), 134.04 (s), 132.90 (d, *J* = 4.2 Hz), 132.40 (s), 131.48 (d, *J* = 9.8 Hz), 130.26 (s), 130.05 (s), 129.84 (s), 129.44 (s), 128.98 (d, *J* = 6.5 Hz), 128.48 (s), 127.01 (s), 126.26 (s), 125.82 (s), 125.70 (s), 125.40 (s), 123.62 (s), 123.05 (d, *J* = 3.5 Hz), 121.68 (s), 121.00 (d, *J* = 3.8 Hz), 120.48 (d, *J* = 4.1 Hz), 115.71 (s), 112.74 (s), 39.96 (d, J = 41.9, 21.0 Hz). 28.66 (s), 24.43 (d, *J* = 6.9 Hz), 16.33 (s).**^{31}P NMR** (162 MHz, DMSO) δ 20.53 (s). **HRMS** (ESI): m/z calcd. For $C_{33}H_{32}O_4P$ $[M+1]^+$ 523.2038: found: 523.2039.

Diphenyl ((4-hydroxy-2-isopropyl-5-methylphenyl) (3,4,5-trimethoxyphenyl) methyl) phosphonate(5d):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 28:72); (216mg, 81%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.37 (s, 1H), 7.74 (s, 1H), 7.35 – 7.25 (m, 4H), 7.14 (t, *J* = 7.4 Hz, 2H), 6.97 (d, *J* = 7.5 Hz, 4H), 6.93 – 6.85 (m, 3H), 5.27 (d, *J* = 27.2 Hz, 1H), 3.73 (s, 6H), 3.69 (s, 3H), 3.46 – 3.36 (m, 1H), 2.19 (s, 3H), 1.22 (d, *J* = 6.6 Hz, 3H), 1.08 (d, *J* = 6.7 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 155.56 (s), 153.26 (s), 150.92 (d, *J* = 9.7 Hz), 150.69 (d, *J* = 9.9 Hz), 146.10 (d, *J* = 11.8 Hz), 137.49 (s), 132.42 (d, *J* = 4.2 Hz), 131.88 (s), 130.10 (d, *J* = 7.6 Hz), 125.47 (d, *J* = 10.7 Hz), 123.00 (d, *J* = 3.5 Hz), 121.88 (s), 120.70 (t, *J* = 4.1 Hz), 112.52 (s), 107.90 (d, *J* = 8.5 Hz), 60.50 (s), 56.32 (s), 44.71 (d, *J* = 139.4 Hz), 28.52 (s), 24.45 (d, *J* = 41.2 Hz), 16.26 (s).**^{31}P NMR** (162 MHz, DMSO) δ 19.96 (s). **HRMS** (ESI): m/z calcd. For $C_{32}H_{36}O_7P$ $[M+1]^+$ 563.2199: found: 563.2202.

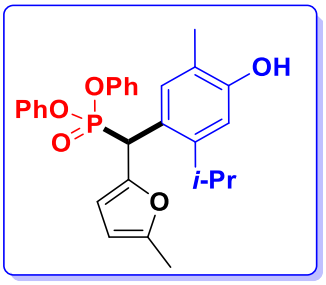
Diphenyl ((5-(2-chlorophenyl) furan-2-yl) (4-hydroxy-2-isopropyl-5-methylphenyl) methyl) phosphonate(5e):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 23:77); (217mg, 73%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.41 (s, 1H), 7.69 (d, *J* = 1.5 Hz, 1H), 7.56 (d, *J* = 1.3 Hz, 1H), 7.50 (dd, *J* = 8.0, 1.1 Hz, 1H), 7.40 – 7.25 (m, 6H), 7.20 – 7.06 (m, 5H), 6.85 (d, *J* = 5.9 Hz, 3H), 6.78 (t, *J* = 3.0 Hz, 1H), 5.48 (d, *J* = 27.6 Hz, 1H), 3.34 (m, 1H), 2.12 (s, 3H), 1.26 – 1.14 (m, 6H). **^{13}C NMR** (101 MHz, DMSO) δ 155.91 (s), 150.68 (s), 150.59 (s), 150.50 (s), 150.28 (d, *J* = 2.4 Hz), 149.52 (d, *J* = 2.4 Hz), 145.84 (d, *J* = 8.9 Hz), 132.46 (s), 131.21 (s), 130.24 (d, *J* = 8.3 Hz), 129.33 (d, *J* = 14.0 Hz), 128.59 (s), 127.94 (s), 125.68 (d, *J* = 7.6 Hz), 122.02 (s), 120.77 (d, *J* = 4.2 Hz), 120.57 (d, *J*

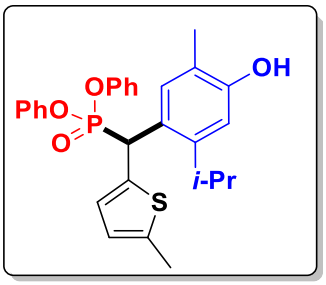
= 4.1 Hz), 120.26 (d, *J* = 5.4 Hz), 112.60 (s), 112.15 (s), 111.77 (d, *J* = 6.2 Hz), 28.82 (s), 24.88 (s), 23.45 (s), 16.23 (s).**^{31}P NMR** (162 MHz, DMSO) δ 16.08 (s). **HRMS** (ESI): m/z calcd. For $C_{33}H_{31}O_5PCl$ $[M+1]^+$ 573.1598: found: 573.1593.

Diphenyl ((4-hydroxy-2-isopropyl-5-methylphenyl) (5-methylfuran-2-yl) methyl) phosphonate(5f):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 16:84); (186mg, 78%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.33 (s, 1H), 7.40 – 7.33 (m, 3H), 7.32 – 7.25 (m, 2H), 7.18 (m, *J* = 21.3, 11.0, 3.8 Hz, 2H), 7.05 – 6.99 (m, 2H), 6.82 – 6.75 (m, 3H), 6.43 (t, *J* = 2.9 Hz, 1H), 6.05 (d, *J* = 2.2 Hz, 1H), 5.22 (d, *J* = 27.7 Hz, 1H), 3.31 – 3.18 (m, 1H), 2.19 (s, 3H), 2.07 (s, 3H), 1.14 (m, 6H). **^{13}C NMR** (101 MHz, DMSO) δ 155.67 (d, *J* = 2.5 Hz), 151.73 (d, *J* = 2.3 Hz), 150.60 (dd, *J* = 13.5, 9.9 Hz), 148.04 (d, *J* = 1.2 Hz), 145.67 (d, *J* = 9.0 Hz), 132.35 (d, *J* = 4.7 Hz), 130.22 (d, *J* = 6.9 Hz), 125.61 (d, *J* = 6.8 Hz), 121.83 (d, *J* = 2.5 Hz), 120.81 (d, *J* = 4.0 Hz), 120.59 (d, *J* = 4.1 Hz), 112.02 (s), 110.27 (d, *J* = 5.8 Hz), 107.36 (s), 40.82 – 39.14 (d), 28.67 (s), 24.84 (s), 23.41 (s), 16.19 (s), 13.70 (s).**^{31}P NMR** (162 MHz, DMSO) δ 16.75 (s). **HRMS** (ESI): m/z calcd. For $C_{28}H_{30}O_5P$ $[M+1]^+$ 477.1831: found: 477.1832.

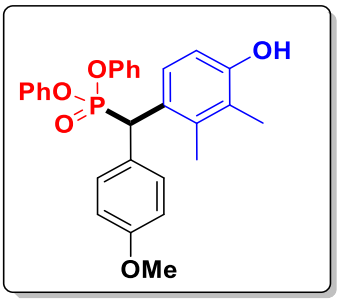
Diphenyl ((4-hydroxy-2-isopropyl-5-methylphenyl) (5-methylthiophen-2-yl) methyl) phosphonate(5g):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 17:83); (187mg, 76%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.36 (s, 1H), 7.52 (d, *J* = 8.8 Hz, 1H), 7.36 (dd, *J* = 11.1, 4.7 Hz, 2H), 7.28 (m, *J* = 10.9, 4.8 Hz, 2H), 7.23 – 7.09 (m, 3H), 7.02 (m, 2H), 6.78 (m, 3H), 6.70 (d, *J* = 2.3 Hz, 1H), 5.38 (d, *J* = 27.7 Hz, 1H),

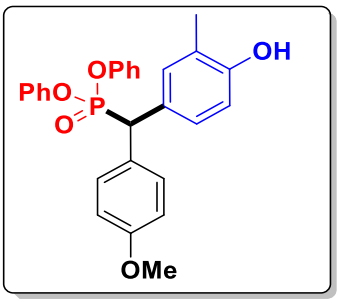
3.31 – 3.16 (m, 1H), 2.39 (s, 3H), 2.08 (s, 3H), 1.17 (d, *J* = 6.6 Hz, 3H), 1.10 (d, *J* = 6.7 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 155.69 (d, *J* = 1.9 Hz), 150.66 (d, *J* = 2.5 Hz), 150.57 (d, *J* = 2.3 Hz), 145.59 (d, *J* = 10.5 Hz), 139.74 (d, *J* = 3.0 Hz), 136.89 (d, *J* = 4.9 Hz), 131.93 (s), 130.28 (s), 130.15 (s), 127.75 (d, *J* = 8.4 Hz), 125.61 (d, *J* = 9.2 Hz), 122.82 (d, *J* = 3.9 Hz), 121.86 (d, *J* = 1.6 Hz), 120.84 (d, *J* = 4.1 Hz), 120.62 (d, *J* = 4.1 Hz), 112.14 (s), 40.94 – 39.18 (d), 28.65 (s), 24.57 (s), 23.85 (s), 16.28 (s), 15.32 (s).**^{31}P NMR** (162 MHz, DMSO) δ 17.94 (s). **HRMS** (ESI): m/z calcd. For $C_{28}H_{30}O_4PS$ $[M+1]^+$ 493.1602: found: 493.1601.

Diphenyl ((4-hydroxy-2,3-dimethylphenyl) (4-methoxyphenyl) methyl) phosphonate(5h):



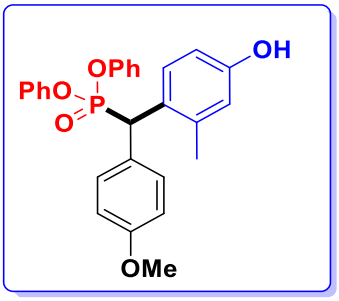
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 16:84); (184mg, 77%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.34 (s, 1H), 7.67 (d, *J* = 8.5 Hz, 1H), 7.46 (m, 2H), 7.33 – 7.24 (m, 4H), 7.14 (dt, *J* = 11.9, 7.3 Hz, 2H), 6.92 (d, *J* = 8.7 Hz, 2H), 6.86 (d, *J* = 8.4 Hz, 2H), 6.78 (m, 3H), 5.10 (d, *J* = 27.4 Hz, 1H), 3.72 (s, 3H), 2.13 (s, 3H), 2.06 (s, 3H) s). **^{13}C NMR** (101 MHz, DMSO) δ 158.83 (s), 154.73 (s), 150.65 (d, *J* = 10.0 Hz), 150.50 (d, *J* = 10.0 Hz), 136.84 (d, *J* = 13.2 Hz), 131.43 (d, *J* = 7.7 Hz), 130.17 (d, *J* = 6.0 Hz), 128.15 (d, *J* = 5.4 Hz), 127.09 (s), 125.60 (s), 125.43 (s, *J* = 17.6 Hz), 125.32 (s), 123.69 (s), 120.90 (d, *J* = 3.8 Hz), 120.76 (d, *J* = 4.0 Hz), 114.39 (s), 112.55 (s), 55.54 (s), 45.36 (d, *J* = 139.7 Hz), 15.92 (s), 12.76 (s).**^{31}P NMR** (162 MHz, DMSO) δ 20.70 (s). **HRMS** (ESI): m/z calcd. For $C_{28}H_{28}O_5P$ $[M+1]^+$ 475.1674: found: 475.1679.

Diphenyl ((4-hydroxy-3-methylphenyl) (4-methoxyphenyl) methyl) phosphonate(5i):



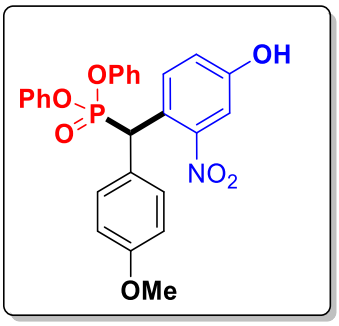
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 18:82); (174mg, 74%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.40 (s, 1H), 7.56 (m, 2H), 7.33 – 7.25 (m, 6H), 7.14 (t, *J* = 7.4 Hz, 2H), 6.94 (d, *J* = 8.7 Hz, 2H), 6.85 (d, *J* = 8.1 Hz, 4H), 6.79 (d, *J* = 8.9 Hz, 1H), 5.03 (d, *J* = 25.9 Hz, 1H), 3.73 (s, 3H), 2.11 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 158.87 (s), 155.18 (s), 150.63 (d, *J* = 2.9 Hz), 150.53 (d, *J* = 2.9 Hz), 132.13 (d, *J* = 9.0 Hz), 130.94 (d, *J* = 8.6 Hz), 130.16 (d, *J* = 1.8 Hz), 129.06 (d, *J* = 4.6 Hz), 128.05 (d, *J* = 8.3 Hz), 126.76 (d, *J* = 4.9 Hz), 125.51 (s), 124.48 (s), 120.90 – 120.84 (d), 115.14 (s), 114.49 (s), 55.53 (s), 48.57 (d, *J* = 138.9 Hz), 16.55 (s).**^{31}P NMR** (162 MHz, DMSO) δ 19.95 (s). **HRMS** (ESI): m/z calcd. For $C_{27}H_{26}O_5P$ $[M+1]^+$ 461.1518: found: 461.1514.

Diphenyl ((4-hydroxy-2-methylphenyl) (4-methoxyphenyl) methyl) phosphonate(5j):



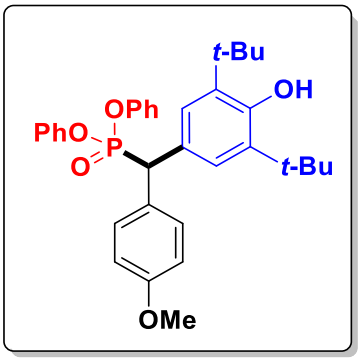
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 18:82); (174mg, 75%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.42 (s, 1H), 7.76 (dd, *J* = 8.5, 1.6 Hz, 1H), 7.55 – 7.44 (m, 2H), 7.29 (m, 4H), 7.15 (q, *J* = 7.2 Hz, 2H), 6.94 (d, *J* = 8.7 Hz, 2H), 6.84 (m, 4H), 6.76 – 6.69 (m, 1H), 6.65 (s, 1H), 5.03 (d, *J* = 26.9 Hz, 1H), 3.73 (s, 3H), 2.22 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 158.91 (s), 156.92 (s), 150.54 (t, *J* = 9.7 Hz), 138.39 (d, *J* = 12.9 Hz), 131.38 (d, *J* = 7.9 Hz), 130.42 (s), 130.21 (d, *J* = 4.6 Hz), 128.01 (d, *J* = 5.2 Hz), 125.58 (d, *J* = 12.5 Hz), 120.83 (dd, *J* = 6.5, 4.0 Hz), 117.99 (s), 114.47 (s), 113.50 (s), 55.54 (s), 44.61 (d, *J* = 140.0 Hz), 20.10 (s).**^{31}P NMR** (162 MHz, DMSO) δ 20.33 (s). **HRMS** (ESI): m/z calcd. For $C_{27}H_{26}O_5P$ $[M+1]^+$ 461.1518: found: 461.1513.

Diphenyl (R)-((3-chloro-4-hydroxyphenyl) (4-methoxyphenyl) methyl) phosphonate(5k):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 26:74); (170mg, 71%) as a colourless oil ^{1}H NMR (400 MHz, DMSO) δ 9.67 (s, 1H), 7.74 – 7.66 (m, 2H), 7.60 (d, *J* = 8.4 Hz, 2H), 7.30 (t, *J* = 7.7 Hz, 4H), 7.15 (t, *J* = 7.3 Hz, 2H), 7.06 – 6.88 (m, 8H), 5.19 (d, *J* = 25.9 Hz, 1H), 3.73 (s, 3H). ^{31}P NMR (162 MHz, DMSO) δ 19.57 (s). **^{13}C NMR** (101 MHz, DMSO) δ 159.00 (s), 157.31 (s), 150.70 (s), 150.60 (s), 131.08 (s), 131.00 (s), 130.18 (s), 130.17 (s), 129.03 (d, *J* = 4.5 Hz), 127.00 (s), 125.55 (s), 120.94 (s), 116.04 (s), 114.57 (s), 55.49 (s), 48.73 (d, *J* = 139.3 Hz). **^{31}P NMR** (162 MHz, DMSO) δ 19.57 (s). **HRMS** (ESI): m/z calcd. For $C_{26}H_{23}NO_7P$ $[M+1]^+$ 492.1212: found: 492.1219.

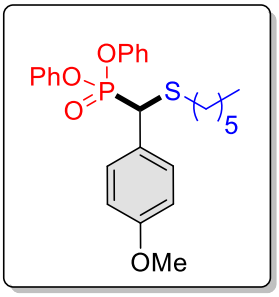
Diphenyl ((3,5-di-tert-butyl-4-hydroxyphenyl) (4-methoxyphenyl) methyl) phosphonate(5l):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 10:90); (220mg, 79%) as a colourless oil. ^{1}H NMR (400 MHz, DMSO) δ 7.58 (m, 2H), 7.40 (d, *J* = 1.7 Hz, 2H), 7.35 – 7.27 (m, 2H), 7.25 – 7.08 (m, 4H), 6.99 (s, 1H), 6.96 (d, *J* = 8.7 Hz, 2H), 6.92 – 6.87 (m, 2H), 6.67 (dd, *J* = 7.6, 0.9 Hz, 2H), 5.08 (d, *J* = 25.7 Hz, 1H), 3.74 (s, 3H), 1.34 (s, 18H). ^{13}C NMR (101 MHz, DMSO) δ 158.87 (s), 153.59 (s), 150.80 (s), 150.71 (s), 150.55 (s), 150.45 (s), 139.79 (s), 130.87 (d, *J* = 8.4 Hz), 130.19 (s), 129.92 (s), 129.04 (s), 127.34 (d, *J* = 4.8 Hz), 126.27 (d, *J* = 8.6 Hz), 125.53 (s), 125.33 (s), 120.87 (d, *J* = 4.0 Hz), 120.71 (d, *J* = 4.0 Hz), 114.50 (s), 55.54 (s), 49.18 (d, *J* = 137.5 Hz), 35.04 (s),

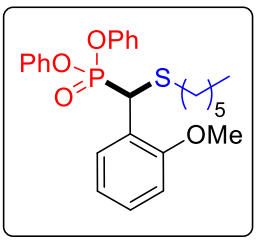
30.72 (s). ^{31}P NMR (162 MHz, DMSO) δ 20.10 (s). **HRMS** (ESI): m/z calcd. For $C_{34}H_{40}O_5P$ $[M+1]^+$ 559.2613: found: 559.2615.

Diphenyl -((hexylthio)(4-methoxyphenyl) methyl) phosphonate(7a):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 11:89); (390mg, 83%) as a colourless oil.**^{1}H NMR** (400 MHz, DMSO) δ 7.52 (m, 2H), 7.37 (d, J = 8.1 Hz, 2H), 7.29 (d, J = 8.1 Hz, 2H), 7.25 – 7.19 (m, 1H), 7.16 (d, J = 8.3 Hz, 3H), 6.96 (d, J = 8.6 Hz, 2H), 6.91 (d, J = 8.6 Hz, 2H), 4.88 (d, J = 20.9 Hz, 1H), 3.76 (s, 3H), 2.77 – 2.55 (m, 2H), 1.55 – 1.40 (m, 2H), 1.33 – 1.07 (m, 6H), 0.81 (t, J = 7.0 Hz, 3H).**^{13}CNMR**(101 MHz,) δ 159.42 (d, *J* = 2.4 Hz), 150.62 (dd, *J* = 9.8, 4.3 Hz), 131.12 (d, *J* = 7.0 Hz), 130.30 (s), 130.17 (s), 127.14 (d, *J* = 4.5 Hz), 125.64 (d, *J* = 12.4 Hz), 120.95 (d, *J* = 4.2 Hz), 120.76 (d, *J* = 4.2 Hz), 114.39 (s), 55.57 (s), 44.08 (d, *J* = 148.9 Hz), 32.43 (d, *J* = 6.6 Hz), 31.18 (s), 28.79 (s), 28.18 (s), 22.42 (s), 14.31 (s). **^{31}P NMR** (162 MHz, DMSO) δ 16.16 (s). **HRMS** (ESI): m/z calcd. For $C_{26}H_{31}O_4PS$ $[M+1]^+$ 471.1759: found: 471.1761.

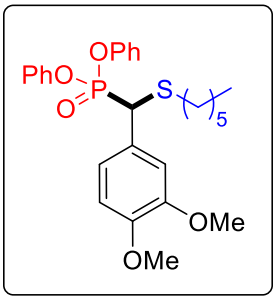
Diphenyl -((hexylthio) (2-methoxyphenyl) methyl) phosphonate(7b):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 11:89); (390mg, 84%) as a colourless oil.**^{1}H NMR** (400 MHz, DMSO) δ 7.69 (m, 1H), 7.38 (m, 2H), 7.35 – 7.25 (m, 6H), 7.14 (t, *J* = 7.3 Hz, 1H), 7.03 (d, *J* = 7.7 Hz, 2H), 6.91 (d, *J* = 8.5 Hz, 2H), 5.03 (d, *J* = 20.8 Hz, 1H), 3.76 (s, 3H), 2.67 (d, *J* = 6.0 Hz, 1H), 2.61 – 2.47 (m, 1H), 1.53 – 1.40 (m, 2H), 1.30 – 1.10 (m, 6H), 0.81 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 156.85 (d, *J* = 8.3 Hz), 150.66 (t, *J* = 9.9 Hz), 130.34 (s), 130.26 (s), 130.11 (s), 129.83 (s), 125.60 (d, *J* = 12.0 Hz), 123.29 (d, *J* = 2.7 Hz), 121.13 (s), 120.79 (d, *J* = 4.1 Hz), 120.55 (d, *J* = 4.0 Hz), 111.54 (s), 56.15 (s), 36.65 (d, *J* = 151.7 Hz), 32.70 (d, *J* = 5.9

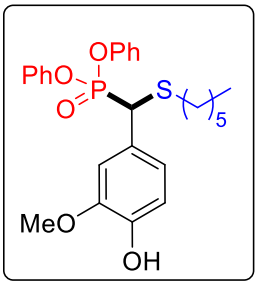
Hz), 31.19 (s), 28.81 (s), 28.04 (s), 22.40 (s), 14.26 (s). **^{31}P NMR** (162 MHz, DMSO) δ 15.90 (s). **HRMS** (ESI): m/z calcd. For $C_{26}H_{31}O_4PS$ $[M+1]^+$ 471.1759: found: 471.1763.

Diphenyl ((3,4-dimethoxyphenyl) (hexylthio) methyl) phosphonate(7c):



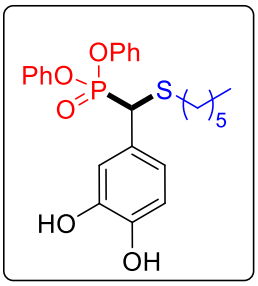
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 16:84); (430mg, 86%) as a colourless oil.^{1}H NMR (400 MHz, DMSO) δ 7.43 – 7.35 (m, 2H), 7.30 (t, *J* = 7.9 Hz, 2H), 7.19 (m, *J* = 19.0, 11.6, 6.5 Hz, 6H), 6.96 (m, 3H), 4.87 (d, *J* = 20.8 Hz, 1H), 3.76 (s, 3H), 3.71 (s, 3H), 2.70 – 2.54 (m, 2H), 1.51 (m, 2H), 1.32 – 1.10 (m, 6H), 0.81 (t, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, DMSO) δ 154.21 – 149.67 (m), 149.08 (dd, *J* = 8.7, 1.7 Hz), 130.19 (d, *J* = 15.2 Hz), 127.38 (d, *J* = 4.4 Hz), 125.59 (d, *J* = 13.4 Hz), 122.46 (d, *J* = 7.6 Hz), 120.91 (d, *J* = 4.0 Hz), 120.72 (d, *J* = 3.9 Hz), 113.50 (d, *J* = 6.8 Hz), 112.03 (s), 55.89 (d, *J* = 2.7 Hz), 44.54 (d, *J* = 148.5 Hz), 32.46 (d, *J* = 6.5 Hz), 31.22 (s), 28.82 (s), 28.23 (s), 22.46 (s), 14.27 (s). ^{31}P NMR (162 MHz, DMSO) δ 16.05 (s). **HRMS** (ESI): m/z calcd. For $C_{27}H_{34}O_5PS$ $[M+1]^+$ 501.1865: found: 501.1869.

Diphenyl -((hexylthio)(4-hydroxy-3-methoxyphenyl) methyl) phosphonate(7d):



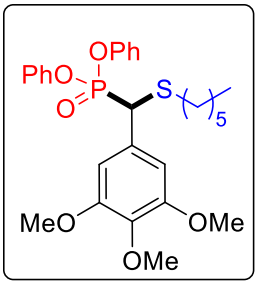
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 17:83); (399mg, 82%) as a colourless oil.**^{1}H NMR** (400 MHz, DMSO) δ 9.21 (s, 1H), 7.39 (m, 2H), 7.30 (m, 2H), 7.24 – 7.12 (m, 5H), 7.00 (m, 1H), 6.93 (t, *J* = 9.0 Hz, 3H), 4.76 (d, *J* = 20.7 Hz, 1H), 3.78 (s, 3H), 2.76 – 2.51 (m, 2H), 1.67 – 1.40 (m, 2H), 1.33 – 1.12 (m, 6H), 0.82 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 150.72 (s), 150.64 (s), 148.06 (d, *J* = 2.6 Hz), 147.06 (s), 130.26 (s), 130.11 (s), 127.46 (d, *J* = 4.4 Hz), 125.61 (d, *J* = 11.2 Hz), 120.99 (d, *J* = 4.0 Hz), 120.82 (d, *J* = 3.9 Hz), 116.99 (d, *J* = 6.1 Hz), 112.33 (s), 56.03 (s), 44.51 (d, *J* = 149.0 Hz), 32.46 (d, *J* = 6.4 Hz), 31.22 (s), 28.83 (s), 28.24 (s), 22.46 (s), 14.31 (s). **^{31}P NMR** (162 MHz, DMSO) δ 16.27 (s). **HRMS** (ESI): m/z calcd. For $C_{26}H_{32}O_5PS$ $[M+1]^+$ 487.1708: found: 487.1710.

Diphenyl -((3,4-dihydroxyphenyl) (hexylthio)methyl) phosphonate(7e):



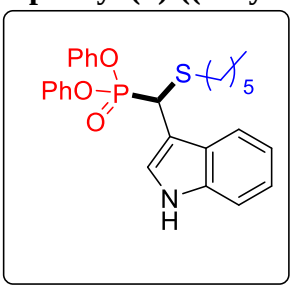
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 19:81); (392mg, 83%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.12 (s, 1H), 9.03 (s, 1H), 7.38 (t, *J* = 7.3 Hz, 2H), 7.29 (t, *J* = 7.3 Hz, 2H), 7.24 – 7.12 (m, 4H), 7.08 (s, 1H), 6.91 (d, *J* = 7.9 Hz, 2H), 6.85 (d, *J* = 8.0 Hz, 1H), 6.78 – 6.73 (m, 1H), 4.67 (d, *J* = 20.5 Hz, 1H), 2.61 (m, 2H), 1.55 – 1.37 (m, 2H), 1.32 – 1.13 (m, 6H), 0.88 – 0.71 (t, 3H). ^{13}C NMR (101 MHz, DMSO) δ 150.69 (d, *J* = 9.8 Hz), 145.83 (d, *J* = 2.4 Hz), 145.77 (s), 130.26 (s), 130.11 (s), 125.60 (d, *J* = 12.3 Hz), 121.28 (d, *J* = 8.1 Hz), 121.00 (d, *J* = 4.1 Hz), 120.83 (d, *J* = 4.0 Hz), 117.12 (d, *J* = 6.3 Hz), 115.80 (s), 44.55 (d, *J* = 149.4 Hz), 32.40 (d, *J* = 6.4 Hz), 31.20 (s), 28.83 (s), 28.23 (s), 22.44 (s), 14.32 (s).**^{31}P NMR** (162 MHz, DMSO) δ 16.49 (s). **HRMS** (ESI): m/z calcd. For $C_{25}H_{30}O_5PS$ $[M+1]^+$ 473.1552: found: 473.152.

Diphenyl-((hexylthio)(3,4,5-trimethoxyphenyl) methyl) phosphonate(7f):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 21:79); (456mg, 86%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 7.40 (t, *J* = 7.9 Hz, 2H), 7.34 – 7.26 (m, 2H), 7.21 (m, 3H), 7.15 (d, *J* = 7.4 Hz, 1H), 6.92 (m, 4H), 4.86 (d, *J* = 20.9 Hz, 1H), 3.71 (s, 6H), 3.67 (s, 3H), 2.75 – 2.58 (m, 2H), 1.64 – 1.44 (m, 2H), 1.32 – 1.06 (m, 6H), 0.80 (t, *J* = 6.9 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 153.19 (d, *J* = 1.4 Hz), 150.81 (s), 150.70 (d, *J* = 2.8 Hz), 150.59 (s), 137.69 (s), 130.87 (d, *J* = 3.9 Hz), 130.33 (s), 130.08 (s), 125.63 (d, *J* = 19.9 Hz), 120.85 (d, *J* = 4.2 Hz), 120.57 (d, *J* = 4.1 Hz), 107.42 (d, *J* = 7.3 Hz), 60.46 (s), 56.27 (s), 45.05 (d, *J* = 147.6 Hz), 32.63 (d, *J* = 6.7 Hz), 31.19 (s), 28.81 (s), 28.15 (s), 22.42 (s), 14.27 (s). **^{31}P NMR** (162 MHz, DMSO) δ 15.65 (s). **HRMS** (ESI): m/z calcd. For $C_{28}H_{36}O_6PS$ $[M+1]^+$ 531.1970: found: 531.1970.

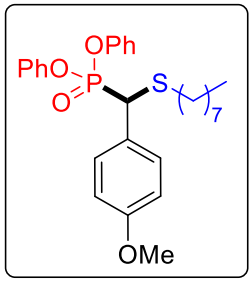
Diphenyl (S)-((hexylthio)(1H-indol-3-yl) methyl) phosphonate(7g):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 24:76); (374mg, 86%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 11.21 (d, *J* = 2.0 Hz, 1H), 7.85 (d, *J* = 8.0 Hz, 1H), 7.51 (t, *J* = 2.5 Hz, 1H), 7.39 (m, *J* = 10.5, 6.5, 5.2 Hz, 3H), 7.29 – 7.10 (m, 7H), 7.07 – 7.00 (m, 1H), 6.93 – 6.85 (m, 2H), 5.14 (d, *J* = 19.8 Hz,

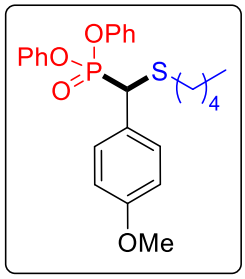
1H), 2.80 – 2.68 (m, 1H), 2.58 (dt, *J* = 12.5, 7.2 Hz, 1H), 1.47 (m, *J* = 14.3, 7.2, 3.1 Hz, 2H), 1.27 – 1.10 (m, 6H), 0.79 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 150.81 (d, *J* = 9.9 Hz), 150.66 (s), 136.56 (s), 130.20 (d, *J* = 15.5 Hz), 126.69 (d, *J* = 8.1 Hz), 126.09 (d, *J* = 7.3 Hz), 125.55 (d, *J* = 11.1 Hz), 122.01 (s), 120.97 (d, *J* = 4.1 Hz), 120.80 (d, *J* = 4.1 Hz), 119.90 (s), 119.32 (s), 112.16 (s), 106.95 (d, *J* = 3.6 Hz), 36.77 (d, *J* = 155.4 Hz), 32.18 (d, *J* = 4.1 Hz), 31.16 (s), 28.87 (s), 28.24 (s), 22.39 (s), 14.32 (s). **^{31}P NMR** (162 MHz, DMSO) δ 16.68 (s). **HRMS** (ESI): m/z calcd. For $C_{27}H_{31}NO_3PS$ $[M+1]^+$ 480.1762: found: 480.1769.

Diphenyl (S)-((4-methoxyphenyl) (octylthio) methyl) phosphonate(7h):



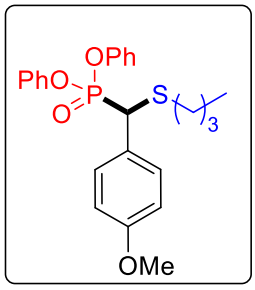
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 09:91); (414mg, 83%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 7.59 (m, 2H), 7.41 – 7.34 (m, 2H), 7.32 – 7.25 (m, 2H), 7.25 – 7.18 (m, 3H), 7.13 (dd, *J* = 13.8, 6.5 Hz, 1H), 6.97 (d, *J* = 8.6 Hz, 4H), 4.89 (d, *J* = 20.9 Hz, 1H), 3.75 (s, 3H), 2.74 – 2.56 (m, 2H), 1.60 – 1.44 (m, 2H), 1.31 – 1.16 (m, 10H), 0.86 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 159.49 (d, *J* = 2.2 Hz), 150.71 (dd, *J* = 9.8, 4.2 Hz), 131.13 (d, *J* = 7.1 Hz), 130.16 (s), 130.04 (s), 127.07 (d, *J* = 4.4 Hz), 125.54 (d, *J* = 12.0 Hz), 120.95 (d, *J* = 4.0 Hz), 120.77 (d, *J* = 3.9 Hz), 114.31 (s), 55.45 (s), 44.35 (d, *J* = 148.9 Hz), 32.49 (d, *J* = 6.5 Hz), 31.77 (s), 29.11 (s), 29.02 (s), 28.89 (s), 28.59 (s), 22.62 (s), 14.33 (s). **^{31}P NMR** (162 MHz, DMSO) δ 16.06 (s). **HRMS** (ESI): m/z calcd. For $C_{28}H_{36}O_4PS$ $[M+1]^+$ 499.2072: found: 499.2077.

Diphenyl (S)-((4-methoxyphenyl) (pentylthio)methyl) phosphonate(7i):



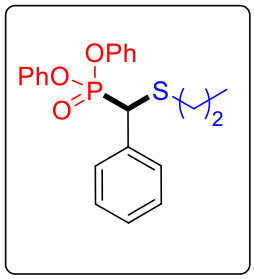
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 11:89); (370mg, 81%) as a colourless oil. ^{1}H NMR (400 MHz, DMSO) δ 7.54 (dd, *J* = 8.8, 2.0 Hz, 2H), 7.42 – 7.36 (m, 2H), 7.29 (t, *J* = 7.9 Hz, 2H), 7.24 – 7.11 (m, 4H), 6.99 – 6.90 (m, 4H), 4.89 (d, *J* = 20.8 Hz, 1H), 3.75 (s, 3H), 2.73 – 2.55 (m, 2H), 1.50 (p, *J* = 7.2 Hz, 2H), 1.32 – 1.12 (m, 4H), 0.80 (t, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, DMSO) δ 159.44 (d, *J* = 2.6 Hz), 150.70 (d, *J* = 4.3 Hz), 150.60 (d, *J* = 4.0 Hz), 131.12 (d, *J* = 7.0 Hz), 130.28 (s), 130.14 (s), 127.13 (d, *J* = 4.5 Hz), 125.62 (d, *J* = 12.5 Hz), 120.94 (d, *J* = 4.0 Hz), 120.76 (d, *J* = 4.1 Hz), 114.39 (s), 55.55 (s), 44.17 (d, *J* = 148.9 Hz), 32.42 (d, *J* = 6.5 Hz), 30.74 (s), 28.54 (s), 22.09 (s), 14.21 (s). ^{31}P NMR (162 MHz, DMSO) δ 16.16 (s). **HRMS** (ESI): m/z calcd. For $C_{25}H_{30}O_4PS$ $[M+1]^+$ 457.1602: found: 457.1603.

Diphenyl (S)-((butylthio)(4-methoxyphenyl) methyl) phosphonate(7j):



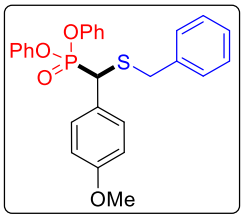
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 08:92); (354mg, 80%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 7.50 (m, 2H), 7.43 – 7.36 (m, 2H), 7.30 (t, *J* = 7.9 Hz, 2H), 7.22 (s, 1H), 7.19 – 7.11 (m, 3H), 6.96 (d, *J* = 8.6 Hz, 2H), 6.89 (d, *J* = 8.5 Hz, 2H), 4.87 (d, *J* = 20.8 Hz, 1H), 3.76 (s, 3H), 2.78 – 2.52 (m, 2H), 1.47 (m, 2H), 1.28 (m, *J* = 13.0, 8.1, 5.0 Hz, 3H), 0.80 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 159.40 (d, *J* = 2.5 Hz), 150.61 (s), 150.55 (s), 131.10 (d, *J* = 7.1 Hz), 130.28 (d, *J* = 14.2 Hz), 127.11 (d, *J* = 4.6 Hz), 125.67 (d, *J* = 12.8 Hz), 120.94 (d, *J* = 4.0 Hz), 120.75 (d, *J* = 4.0 Hz), 114.41 (s), 55.60 (s), 44.00 (d, *J* = 148.8 Hz), 32.06 (d, *J* = 6.4 Hz), 30.88 (s), 21.66 (s), 13.86 (s). **^{31}P NMR** (162 MHz, DMSO) δ 16.20 (s). **HRMS** (ESI): m/z calcd. For $C_{24}H_{28}O_4PS$ $[M+1]^+$ 443.1446: found: 443.1455.

Diphenyl (S)-((4-methoxyphenyl) (propylthio) methyl) phosphonate(7k):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 12:88); (335mg, 84%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 7.96 – 6.43 (m, 15H), 4.95 (d, *J* = 19.5 Hz, 1H), 2.56 (d, *J* = 40.2 Hz, 2H), 1.38 (d, *J* = 116.9 Hz, 2H), 0.85 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 150.59 (d, *J* = 9.8, 4.0 Hz), 135.71 (d, *J* = 4.4 Hz), 130.34 (s), 130.18 (s), 129.96 (d, *J* = 6.9 Hz), 128.99 (d, *J* = 1.1 Hz), 128.41 (d, *J* = 2.3 Hz), 125.70 (d, *J* = 14.1 Hz), 120.97 (d, *J* = 4.0 Hz), 120.74 (d, *J* = 4.1 Hz), 44.77 (d, *J* = 147.7 Hz), 34.66 (d, *J* = 6.6 Hz), 22.32 (s), 13.55 (s). **^{31}P NMR** (162 MHz, DMSO) δ 16.00 (s). **HRMS** (ESI): m/z calcd. For $C_{22}H_{24}O_3PS$ $[M+1]^+$ 399.1184: found: 399.1188.

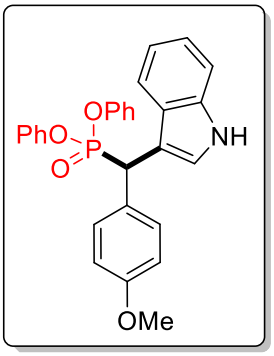
Diphenyl (S)-((benzylthio)(4-methoxyphenyl) methyl) phosphonate(7l):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 10:90); (352mg, 74%) as a colourless oil. ^{1}H NMR (400 MHz, DMSO) δ 7.45 – 7.36 (m, 3H), 7.35 – 7.21 (m, 8H), 7.16 (t, *J* = 7.0 Hz, 1H), 7.10 (d, *J* = 8.6 Hz, 2H), 6.97 (t, *J* = 5.9 Hz, 2H), 6.86 (d, *J* = 8.6 Hz, 2H), 4.62 (d, *J* = 20.5 Hz, 1H), 3.93 (m, 1H), 3.77 (s, 3H), 3.75 – 3.69 (m, 1H). ^{13}C NMR (101 MHz, DMSO) δ 159.51 (s), 150.54 (s), 137.33 (s), 131.11 (d,

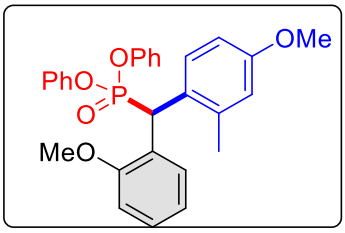
J = 6.8 Hz), 130.41 (s), 130.25 (s), 129.53 (s), 129.04 (s), 127.77 (s), 126.40 (s), 125.76 (d, *J* = 13.4 Hz), 120.87 (d, *J* = 4.0 Hz), 120.69 (d, *J* = 4.1 Hz), 114.59 (s), 55.64 (s), 44.06 (d, *J* = 148.7 Hz), 36.41 (s). ^{31}P NMR (162 MHz, DMSO) δ 15.60 (s). **HRMS** (ESI): m/z calcd. For $C_{27}H_{26}O_4PS$ $[M+1]^+$ 477.1289: found: 477.1293.

Diphenyl ((1H-indol-3-yl 4-methoxyphenyl) methyl) phosphonate (10):



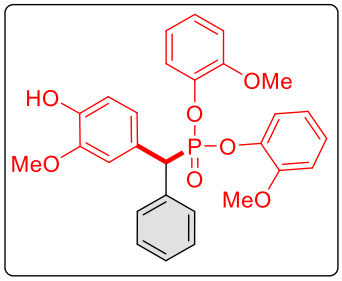
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 13:87); (136mg, 83%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 11.21 (d, J = 2.1 Hz, 1H), 7.75 – 7.67 (m, 2H), 7.62 (dd, J = 8.8, 2.2 Hz, 2H), 7.42 (d, J = 8.1 Hz, 1H), 7.28 (t, J = 7.9 Hz, 4H), 7.13 (m, 3H), 7.05 – 6.97 (m, 1H), 6.91 (dd, J = 11.6, 4.7 Hz, 4H), 6.82 (d, J = 8.6 Hz, 2H), 5.43 (d, J = 26.3 Hz, 1H), 3.71 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 158.88 (d, *J* = 2.8 Hz), 150.75 (d, *J* = 5.9 Hz), 150.65 (d, *J* = 5.8 Hz), 136.24 (s), 131.15 (d, *J* = 7.1 Hz), 130.16 (d, *J* = 1.8 Hz), 128.75 (d, *J* = 5.8 Hz), 127.19 (d, *J* = 12.6 Hz), 125.49 (d, *J* = 9.5 Hz), 124.70 (s), 121.97 (s), 120.95 (d, *J* = 3.8 Hz), 120.82 (d, *J* = 4.1 Hz), 119.19 (d, *J* = 14.1 Hz), 114.28 (s), 112.06 (s), 109.46 (d, *J* = 5.1 Hz), 55.53 (s), δ 40.98 (d, *J* = 79.0 Hz).**^{31}P NMR** (162 MHz, DMSO) δ 20.20 (s). **HRMS** (ESI): m/z calcd. For $C_{28}H_{25}NO_4P$ $[M+1]^+$ 470.1521: found: 470.1526.

Diphenyl (S)-((4-methoxy-2-methylphenyl) (2-methoxyphenyl) methyl) phosphonate (12):



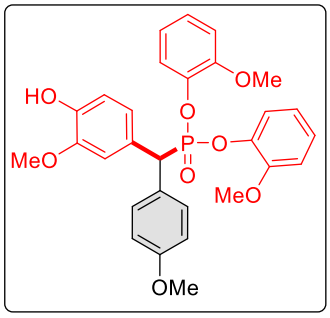
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 09:91); (350 mg, 74%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 7.94 – 7.79 (m, 1H), 7.48 (d, *J* = 6.8 Hz, 2H), 7.28 (m, 4H), 7.16 (d, *J* = 7.4 Hz, 2H), 6.93 (d, *J* = 8.6 Hz, 2H), 6.88 – 6.77 (m, 6H), 5.07 (d, *J* = 26.8 Hz, 1H), 3.73 (s, 6H), 2.28 (d, *J* = 14.1 Hz, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 158.95 (s), 158.73 (s), 150.60 (s), 150.44 (d, *J* = 10.2 Hz), 138.60 (d, *J* = 13.0 Hz), 131.82 (s), 131.37 (d, *J* = 7.9 Hz), 130.26 (s), 130.19 (s), 127.75 (d, *J* = 5.5 Hz), 127.07 (d, *J* = 2.9 Hz), 125.60 (d, *J* = 13.0 Hz), 120.80 (d, *J* = 4.2 Hz), 120.74 (d, *J* = 4.0 Hz), 116.73 (s), 114.50 (s), 114.23 (s), 111.90 (s), 55.58 (s), 55.47 (s), 44.63 (d, *J* = 140.0 Hz), 20.13 (s). **^{31}P NMR** (162 MHz, DMSO) δ 20.04 (s). **HRMS** (ESI): m/z calcd. For $C_{28}H_{28}O_5P$ $[M+1]^+$ 475.1674: found: 475.1681.

bis(2-methoxyphenyl) (S)-((4-hydroxy-3-methoxyphenyl) (phenyl) methyl) phosphonate (13a):



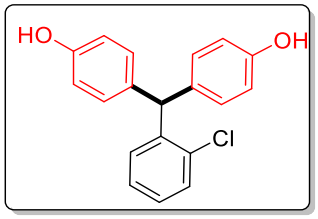
^{1}H NMR (400 MHz, DMSO) δ 9.16 (s, 1H), 7.50 (d, *J* = 7.1 Hz, 1H), 7.32 – 7.22 (m, 6H), 7.19 – 7.12 (m, 3H), 6.97 (d, *J* = 8.3 Hz, 1H), 6.94 – 6.80 (m, 5H), 5.09 (d, *J* = 25.7 Hz, 1H), 3.74 (s, 6H), 3.72 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 157.17 (s), 150.63 (d, *J* = 10.0 Hz), 149.05 (s), 148.62 (s), 147.95 (s), 147.53 (s), 146.97 (s), 146.48 (s), 130.98 (d, *J* = 8.4 Hz), 130.17 (s), 129.22 (s), 127.13 (d, *J* = 41.9 Hz), 125.53 (s), 122.09 (s), 120.86 (d, *J* = 3.4 Hz), 117.13 (d, *J* = 7.7 Hz), 115.91 (s), 114.32 (d, *J* = 8.9 Hz), 113.96 (d, *J* = 8.9 Hz), 112.78 (s), 112.47 (s), 56.09 (s), 55.97 (s), 48.99 (d, *J* = 138.8 Hz). **^{31}P NMR** (162 MHz, DMSO) δ 19.65 (s). **HRMS** (ESI): m/z calcd. For $C_{28}H_{28}O_7P$ $[M+1]^+$: 507.1573found: 507.1579.

bis(2-methoxyphenyl) (S)-((4-hydroxy-3-methoxyphenyl) (4-methoxyphenyl) methyl) phosphonate (13b):



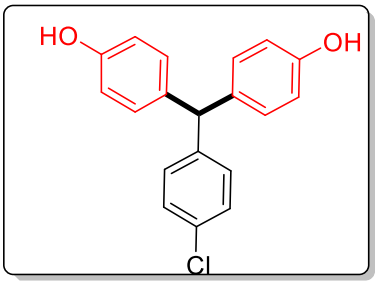
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 40:60); (396 mg, 73%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.21 (s, 1H), 7.37 – 7.22 (m, 6H), 7.14 (m, 2H), 7.07 (m, 2H), 7.00 – 6.92 (m, 5H), 5.22 – 5.12 (d, 1H), 3.78 (s, 3H), 3.75 (s, 6H), 3.70 (s, 3H).**^{13}C NMR** (101 MHz, DMSO) δ 153.28 (s), 150.77 (s), 150.67 (s), 150.55 (s), 147.94 (s), 146.56 (d, J = 2.0 Hz), 137.34 (s), 132.40 (d, J = 3.9 Hz), 130.15 (d, J = 7.8 Hz), 127.00 (d, J = 5.3 Hz), 125.54 (d, J = 4.0 Hz), 122.37 (d, *J* = 8.5 Hz), 120.79 (d, *J* = 1.6 Hz), 116.14 (s), 115.94 (s), 114.26 (d, *J* = 8.7 Hz), 107.42 (d, *J* = 8.9 Hz), 60.50 (s), 56.32 (s), 49.63 (d, *J* = 138.3 Hz). **^{31}P NMR** (162 MHz, DMSO) δ 19.22 (s). **HRMS** (ESI): m/z calcd. For $C_{29}H_{30}O_8P$ $[M+1]^+$: 537.1678 found: 537.1682.

4,4'-((2-chlorophenyl) methylene) diphenol(8a):



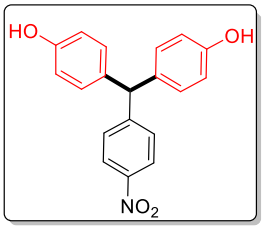
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 17:83); (254mg, 82%) as a colourless oil. **^{1}H NMR** (400 MHz, Acetone) δ 8.34 (s, 2H), 7.42 (m 1H), 7.30 – 7.23 (m, 2H), 7.01 (m, 1H), 6.90 (t, *J* = 5.6 Hz, 4H), 6.80 (t, *J* = 5.6 Hz, 4H), 5.80 (s, 1H). **^{13}C NMR** (101 MHz, Acetone) δ 155.92 (s), 142.64 (s), 133.97 (s), 133.80 (s), 131.02 (s), 130.28 (s), 129.47 (s), 127.73 (s), 126.70 (s), 115.05 (s), 51.77 (s). **HRMS** (ESI): m/z calcd. For $C_{19}H_{16}ClO_2$ $[M+1]^+$: 311.0839. found: 311.0841.

4,4'-((4-chlorophenyl) methylene) diphenol(8b):



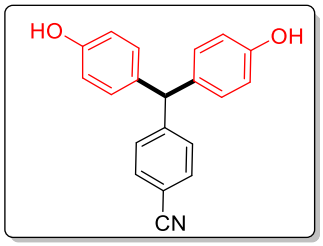
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 16:84); (251mg, 81%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.31 (s, 2H), 7.32 (d, *J* = 8.5 Hz, 2H), 7.08 (t, *J* = 6.9 Hz, 2H), 6.87 (d, *J* = 8.5 Hz, 4H), 6.70 (d, *J* = 8.6 Hz, 4H), 5.37 (s, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 156.14 (s), 144.58 (s), 134.61 (s), 131.14 (s), 131.01 (s), 130.28 (s), 128.56 (s), 115.56 (s), 54.07 (s). **HRMS** (ESI): m/z calcd. For $C_{19}H_{16}ClO_2$ $[M+1]^+$: 311.0839. found: 311.0841.

4,4'-((4-nitrophenyl) methylene) diphenol(8c):



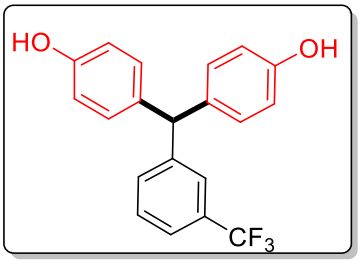
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 20:80); (253mg, 79%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.34 (s, 2H), 8.25 – 8.06 (m, 2H), 7.33 (t, *J* = 10.0 Hz, 2H), 6.89 (d, *J* = 8.5 Hz, 4H), 6.78 – 6.67 (m, 4H), 5.55 (s, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 156.35 (s), 153.65 (s), 146.22 (s), 133.78 (s), 130.54 (s), 130.37 (s), 123.90 (s), 115.70 (s), 54.40 (s). **HRMS** (ESI): m/z calcd. For $C_{19}H_{16}NO_4$ $[M+1]^+$: 322.1079found: 322.1084.

4-(bis(4-hydroxyphenyl) methyl) benzonitrile(8d):



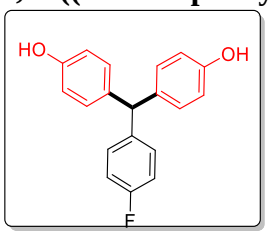
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 16:84); (234mg, 78%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.35 (s, 2H), 7.75 (d, *J* = 8.3 Hz, 2H), 7.26 (d, *J* = 8.2 Hz, 2H), 6.87 (d, *J* = 8.5 Hz, 4H), 6.70 (d, *J* = 8.5 Hz, 4H), 5.48 (s, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 156.29 (s), 151.41 (s), 133.88 (s), 132.63 (s), 130.35 (s), 119.40 (s), 115.65 (s), 109.22 (s), 54.62 (s). **HRMS** (ESI): m/z calcd. For $C_{20}H_{16}NO_2$ $[M+1]^+$: 302.1181. found: 302.1188.

4,4'-((3-(trifluoromethyl) phenyl) methylene) diphenol(8e):



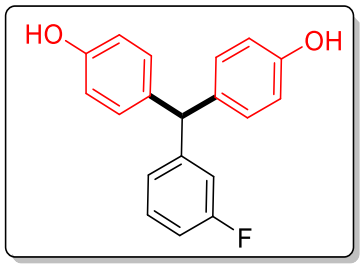
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 19:81); (251mg, 73%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.35 (s, 2H), 7.53 (dt, *J* = 15.6, 7.8 Hz, 2H), 7.43 – 7.31 (m, 2H), 6.90 (d, *J* = 8.5 Hz, 4H), 6.72 (d, *J* = 8.5 Hz, 4H), 5.52 (s, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 156.25 (s), 147.04 (s), 134.23 (s), 133.47 (s), 130.32 (s), 129.72 (s), 125.50 (d, *J* = 3.8 Hz), 123.24 (d, *J* = 3.7 Hz), 120.79 (s), 115.67 (s), 54.31 (s). **^{19}F NMR** (377 MHz, DMSO) δ -61.15 (s). **HRMS** (ESI): m/z calcd. For $C_{20}H_{16}F_3O_2$ $[M+1]^+$: 345.1102. found: 345.1110.

4,4'-((4-fluorophenyl) methylene) diphenol(8f):



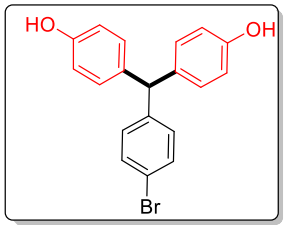
The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 18:82); (238mg, 81%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.29 (s, 2H), 7.13 – 7.05 (m, 4H), 6.86 (d, *J* = 8.5 Hz, 4H), 6.73 – 6.64 (m, 4H), 5.37 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 166.91 (s), 164.51 (s), 160.80 (s), 146.43 (s), 139.69 (s), 135.78 (d, *J* = 8.0 Hz), 134.99 (s), 120.19 (d, *J* = 8.6 Hz), 119.94 (s), 58.65 (s). **^{19}F NMR** (377 MHz, DMSO) δ -103.61 (dt, *J* = 8.3, 5.5 Hz). **HRMS** (ESI): m/z calcd. For $C_{19}H_{16}FO_2$ $[M+1]^+$: 295.1134. found: 295.1139.

4,4'-((3-fluorophenyl) methylene) diphenol(8g):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 18:82); (235mg, 80%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.37 (s, 2H), 7.32 (td, *J* = 8.0, 6.4 Hz, 1H), 7.01 (td, *J* = 8.3, 2.3 Hz, 1H), 6.92 (d, *J* = 7.7 Hz, 1H), 6.88 (d, *J* = 8.5 Hz, 4H), 6.82 (m, 1H), 6.72 – 6.66 (m, 4H), 5.39 (s, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 163.79 (s), 161.37 (s), 156.18 (s), 148.59 (d, *J* = 6.8 Hz), 134.41 (s), 130.49 (d, *J* = 8.3 Hz), 130.27 (s), 125.48 (s), 115.90 (d, *J* = 21.3 Hz), 115.55 (s), 113.16 (d, *J* = 20.9 Hz), 54.35 (s). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -110.46 (td, *J* = 5.3, 3.0 Hz). **HRMS** (ESI): m/z calcd. For $C_{19}H_{16}FO_2$ $[M+1]^+$: 295.1134. found: 295.1139.

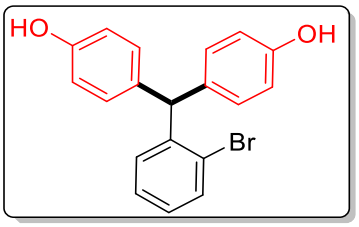
4,4'-((4-bromophenyl) methylene) diphenol(8h):



The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 16:84); (277mg, 77%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.30 (s, 2H), 7.51 – 7.41 (m, 2H), 7.02 (d, *J* = 8.4 Hz, 2H), 6.86 (t, *J* = 5.6 Hz, 4H), 6.73 – 6.65 (m, 4H), 5.36 (s, 1H). **^{13}C NMR** (101 MHz, DMSO) δ 156.13 (s), 145.03 (s), 134.52 (s), 131.52 (d, *J* = 7.0

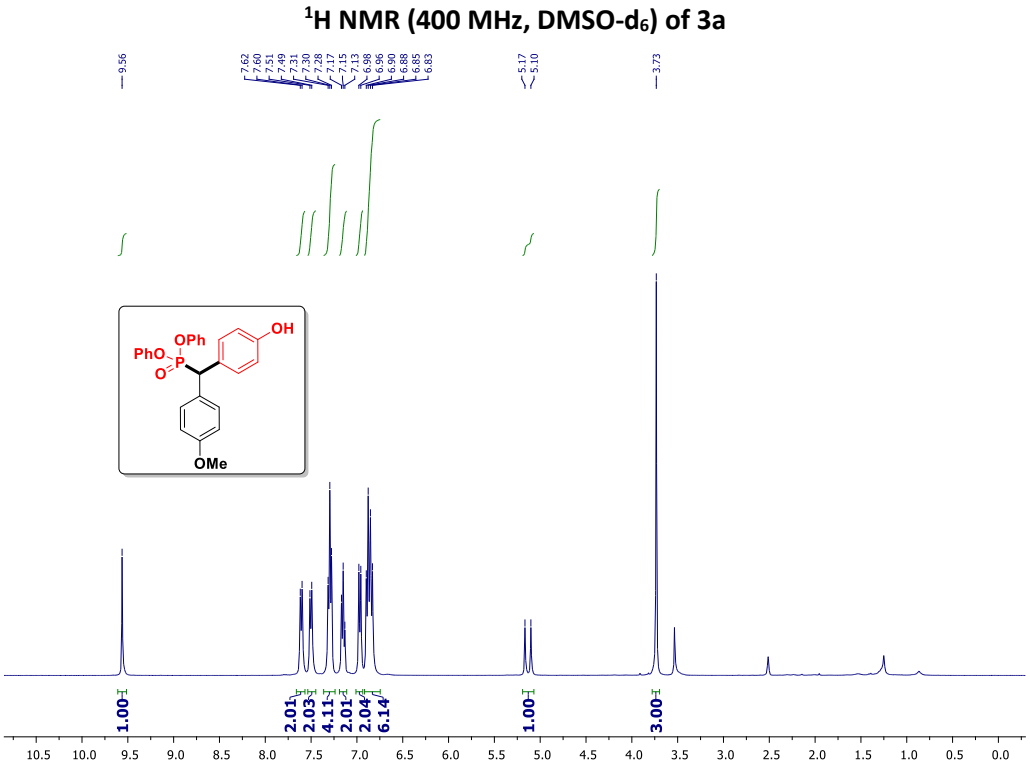
Hz), 130.28 (s), 119.49 (s), 115.54 (s), 54.09 (s). **HRMS** (ESI): m/z calcd. For $C_{19}H_{16}BrO_2$ $[M+1]^+$: 355.0334. found: 355.0341.

4,4'-((2-bromophenyl) methylene) diphenol(8i):

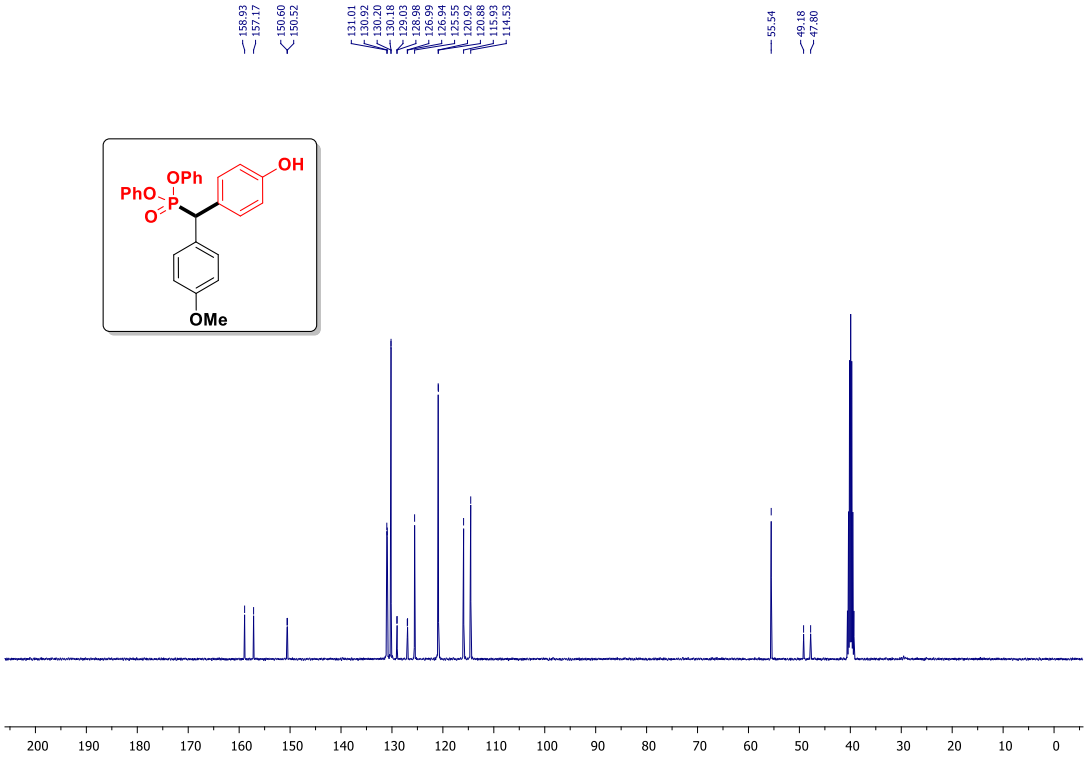


The title compound was purified by column chromatography with the eluent (EtOAc/hexane = 17:83); (258mg, 75%) as a colourless oil. **^{1}H NMR** (400 MHz, DMSO) δ 9.33 (s, 2H), 7.60 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.30 (dd, *J* = 7.5, 1.2 Hz, 1H), 7.16 (d, *J* = 1.7 Hz, 1H), 6.93 (m, 1H), 6.81 (m, 4H), 6.71 – 6.67 (m, 4H), 5.64 (s, 1H). ^{13}C NMR (101 MHz, DMSO) δ 156.19 (s), 144.19 (s), 133.40 (s), 133.28 (s), 131.41 (s), 130.50 (s), 128.67 (s), 127.98 (s), 125.04 (s), 115.58 (s), 54.32 (s). **HRMS** (ESI): m/z calcd. For $C_{19}H_{16}BrO_2$ $[M+1]^+$: 355.0334. found: 355.0341.

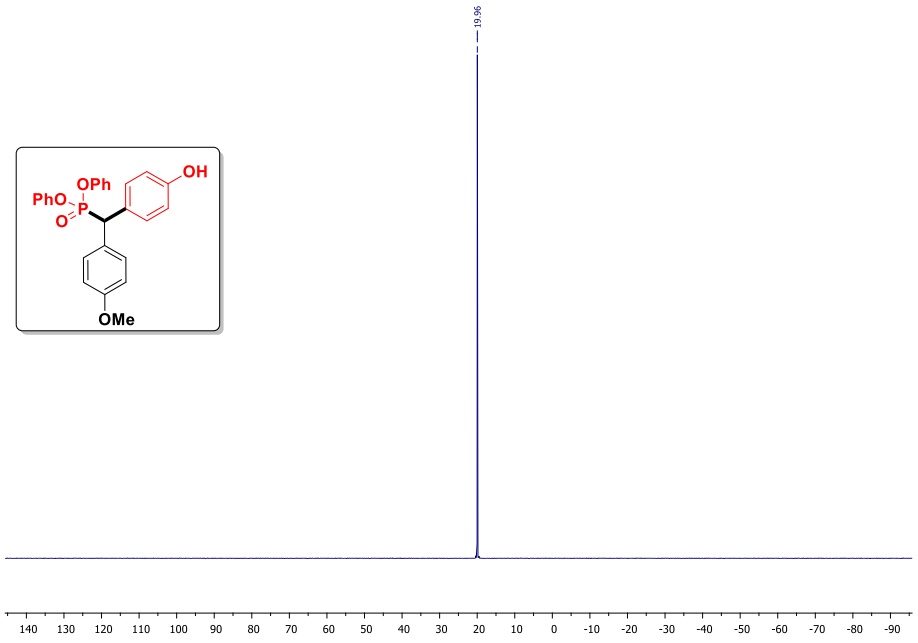
^{1}H NMR, ^{13}C{^{1}H} NMR, and ^{31}PNMR spectra:



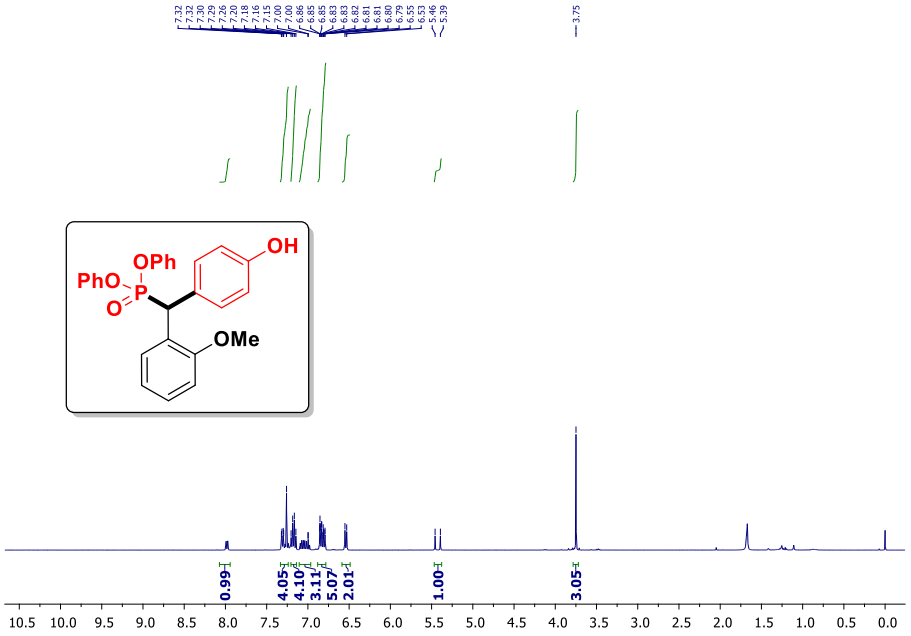
^{13}C NMR (101 MHz, DMSO- d_6) of 3a



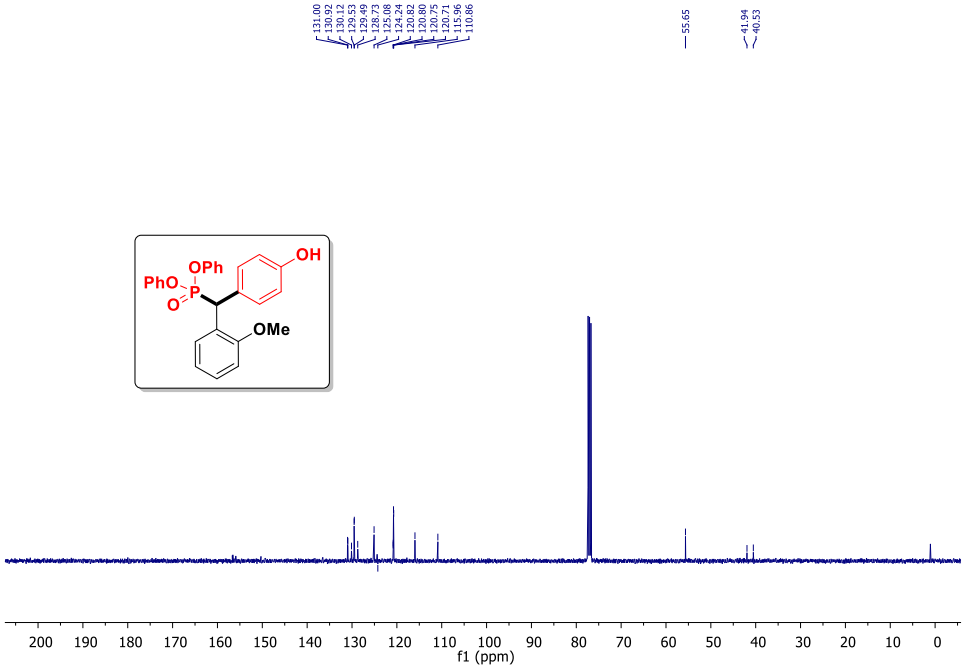
^{31}P NMR (400 MHz, DMSO-d_6) of 3a



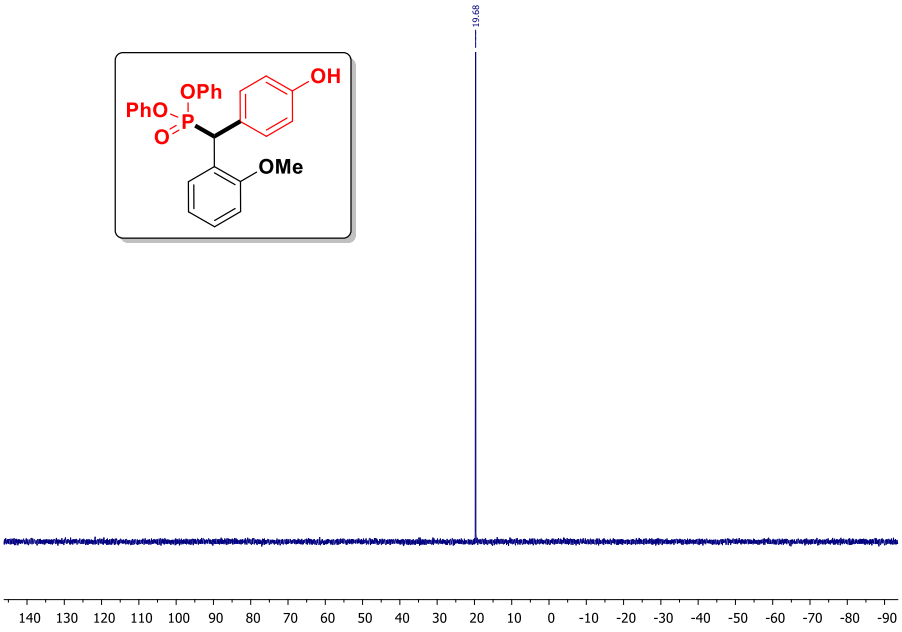
^{1}H NMR (400 MHz, DMSO-d_6) of 3b



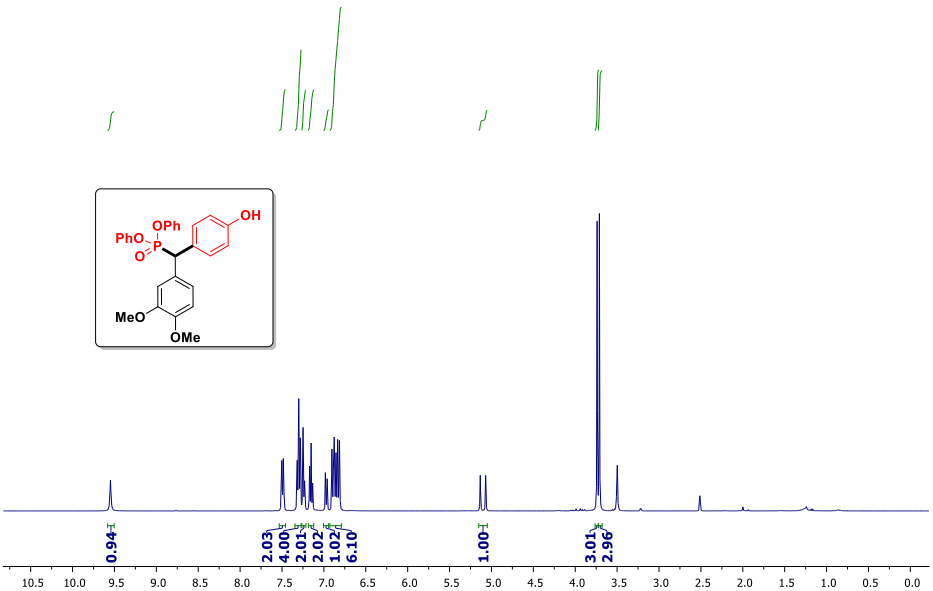
^{13}C NMR (101 MHz, DMSO- d_6) of 3b



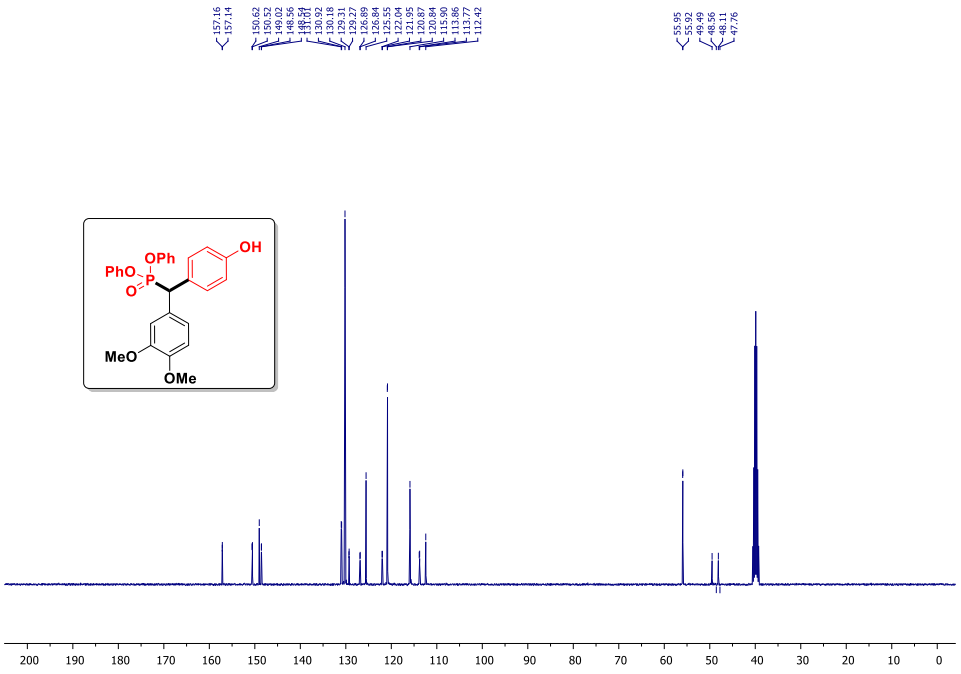
^{31}P NMR (400 MHz, $CDCl_3$) of 3b



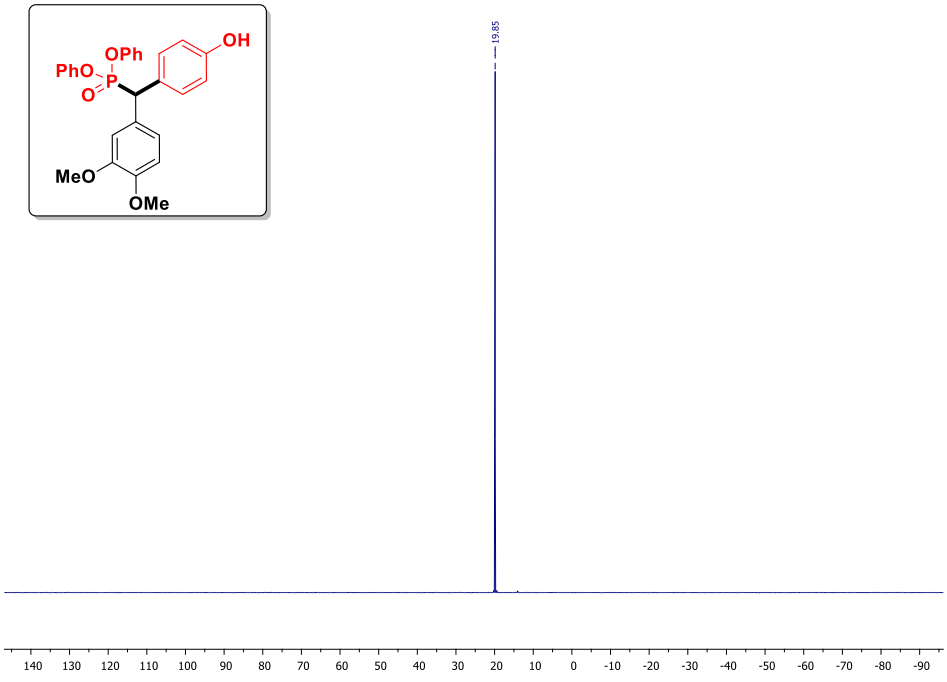
^{1}H NMR (400 MHz, DMSO-d_6) of 3c



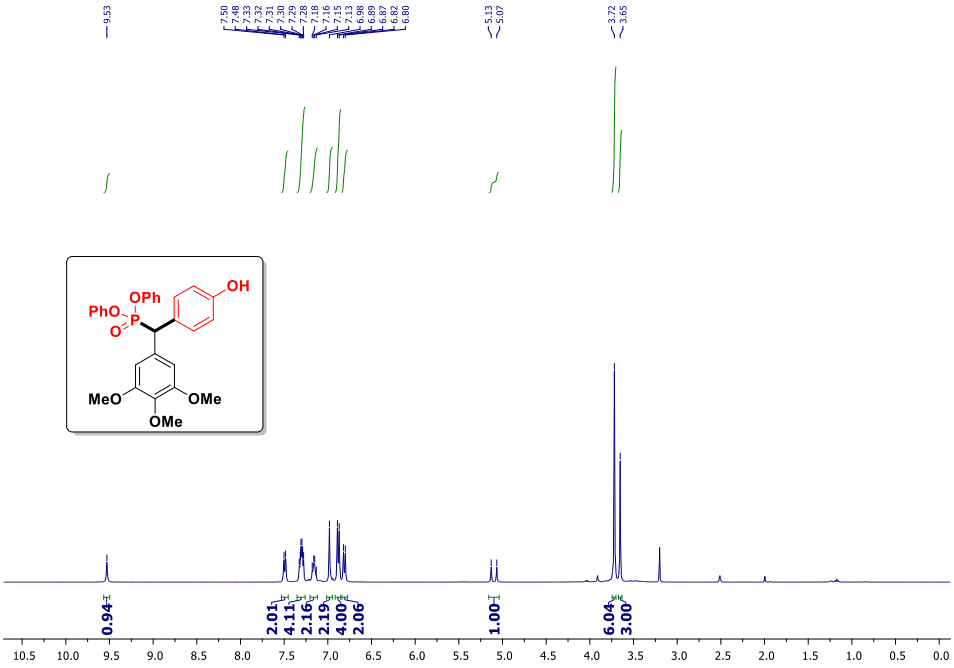
^{13}C NMR (101 MHz, DMSO- d_6) of 3c



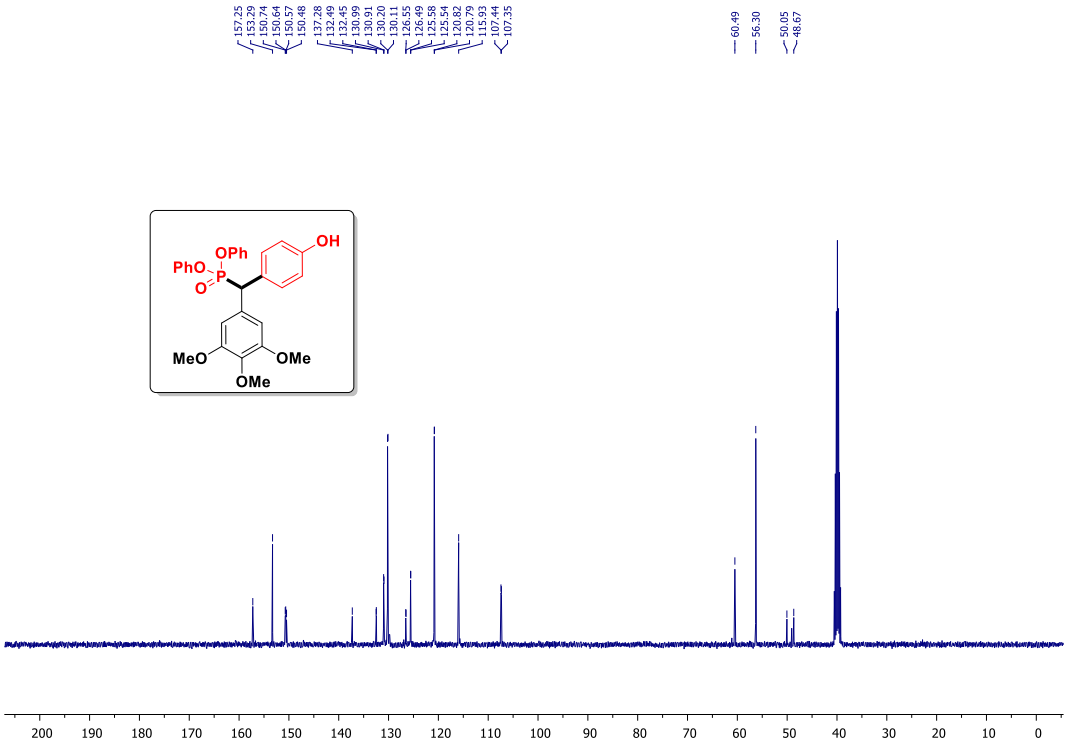
^{31}P NMR (400 MHz, DMSO-d_6) of 3c



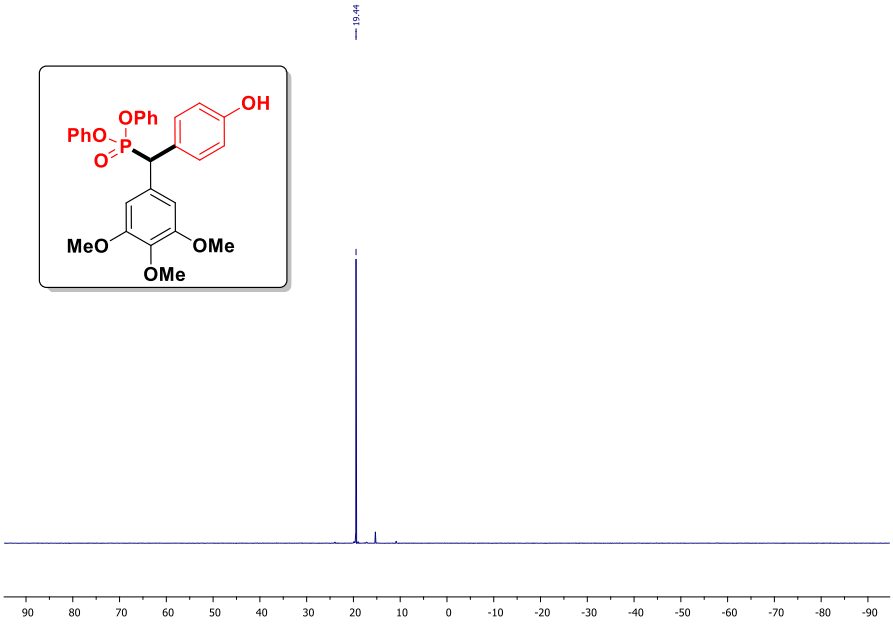
^{1}H NMR (400 MHz, DMSO-d_6) of 3d



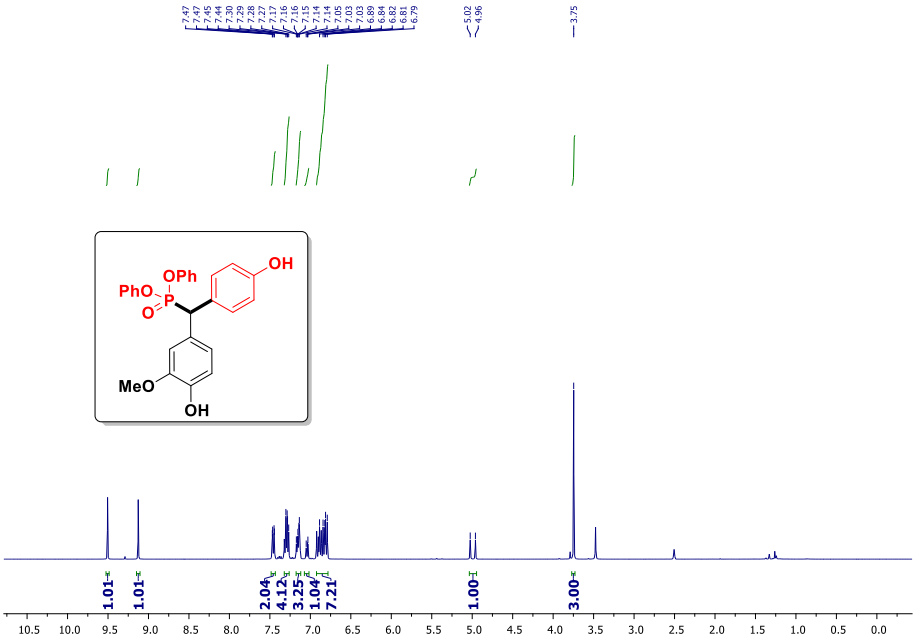
^{13}C NMR (101 MHz, DMSO- d_6) of 3d



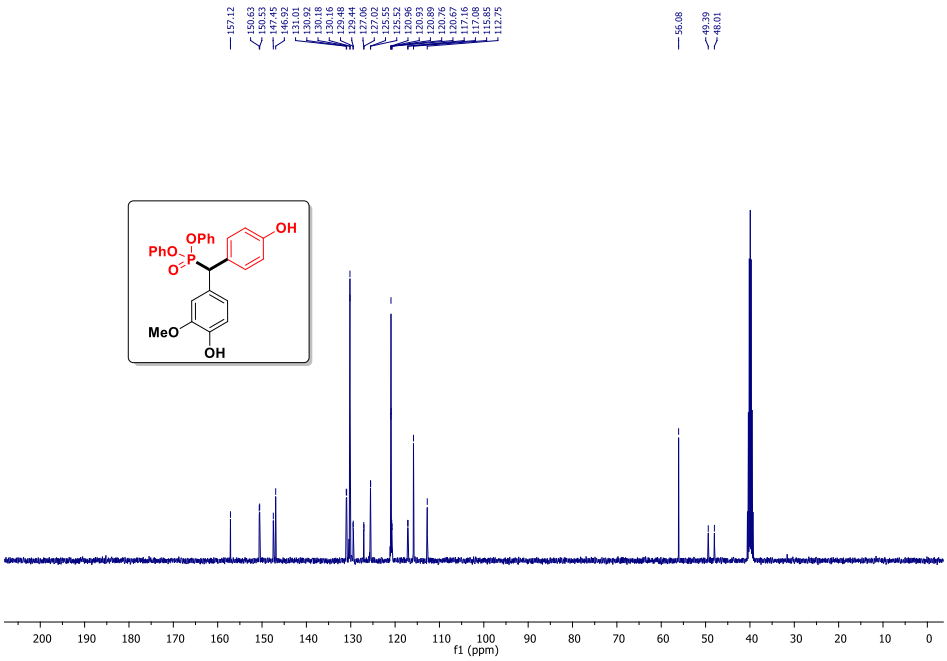
^{31}P NMR (400 MHz, DMSO-d_6) of 3d



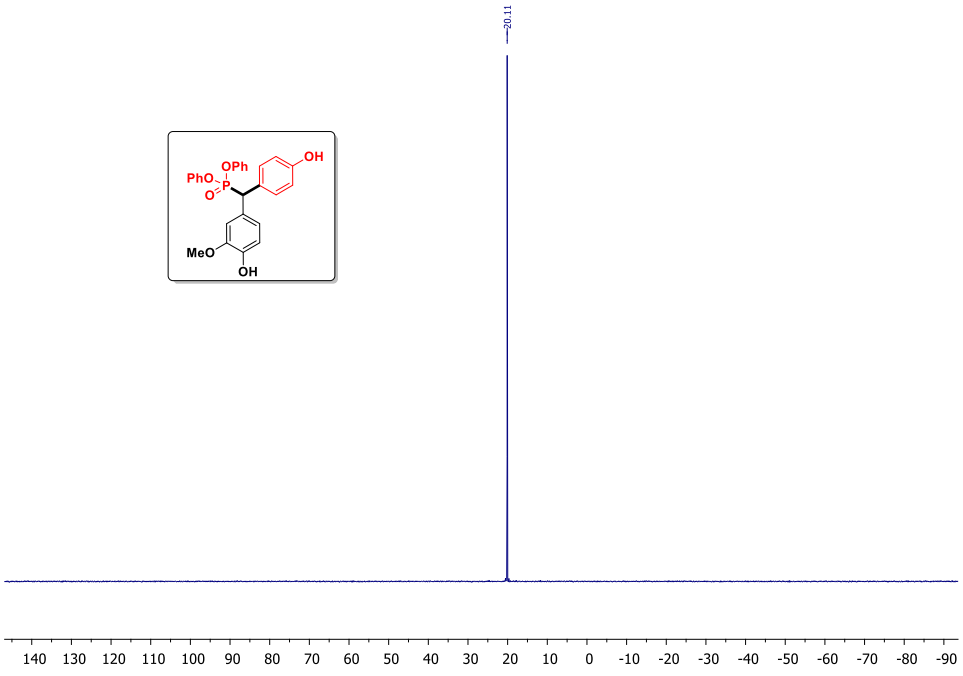
^{1}H NMR (400 MHz, DMSO-d_6) of 3e



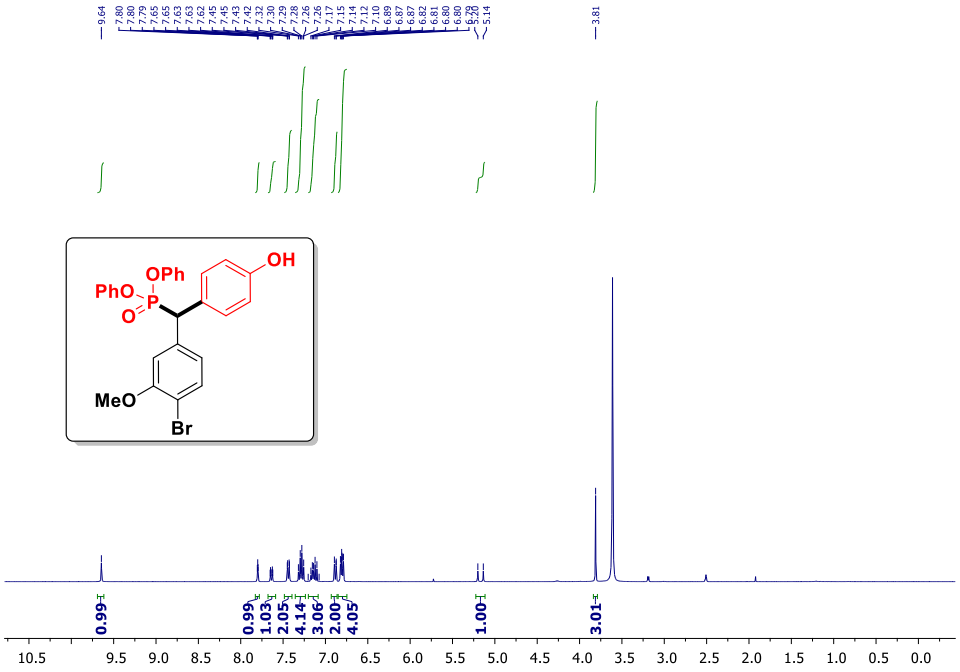
^{13}C NMR (101 MHz, DMSO- d_6) of 3e



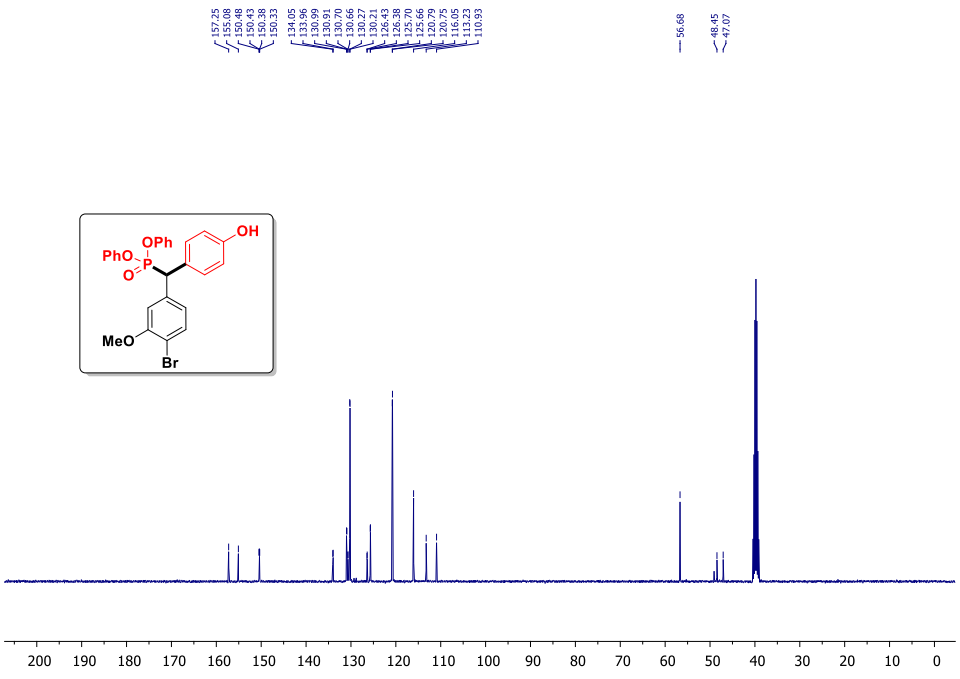
^{31}P NMR (400 MHz, DMSO-d_6) of 3e



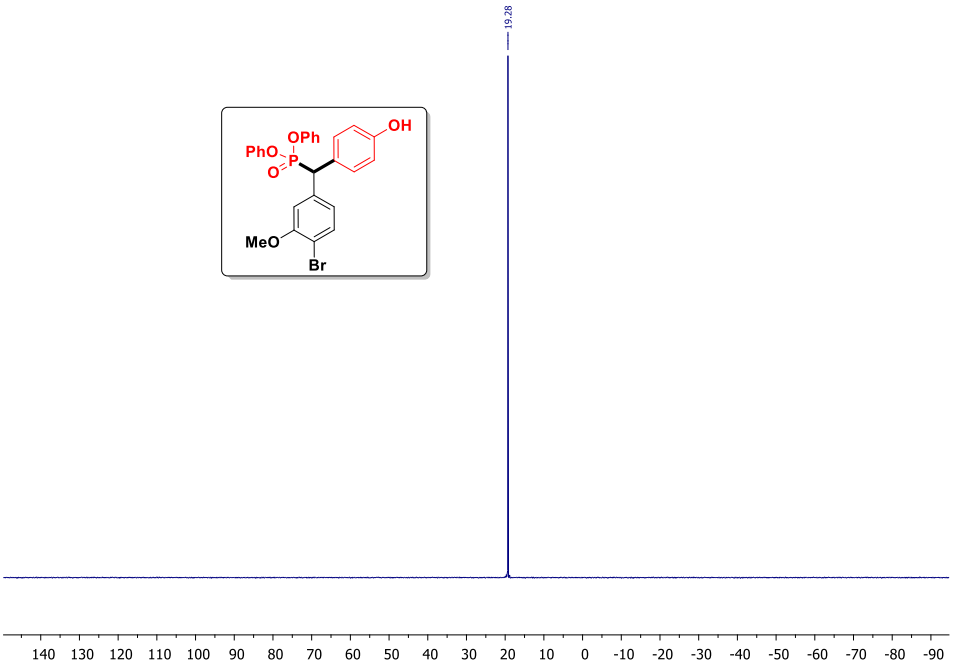
^{1}H NMR (400 MHz, DMSO-d_6) of 3f



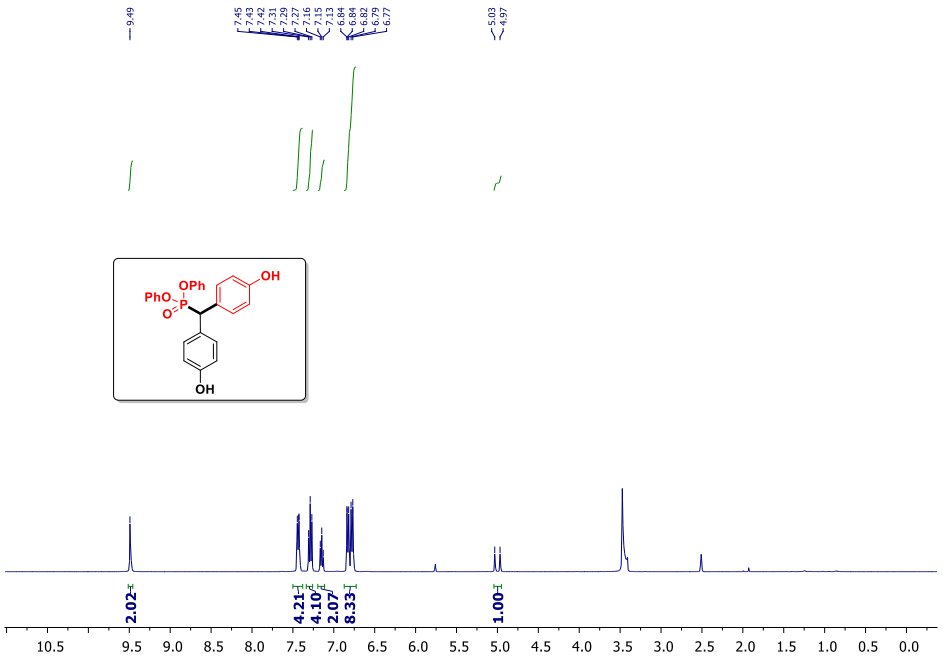
^{13}C NMR (101 MHz, DMSO- d_6) of 3f



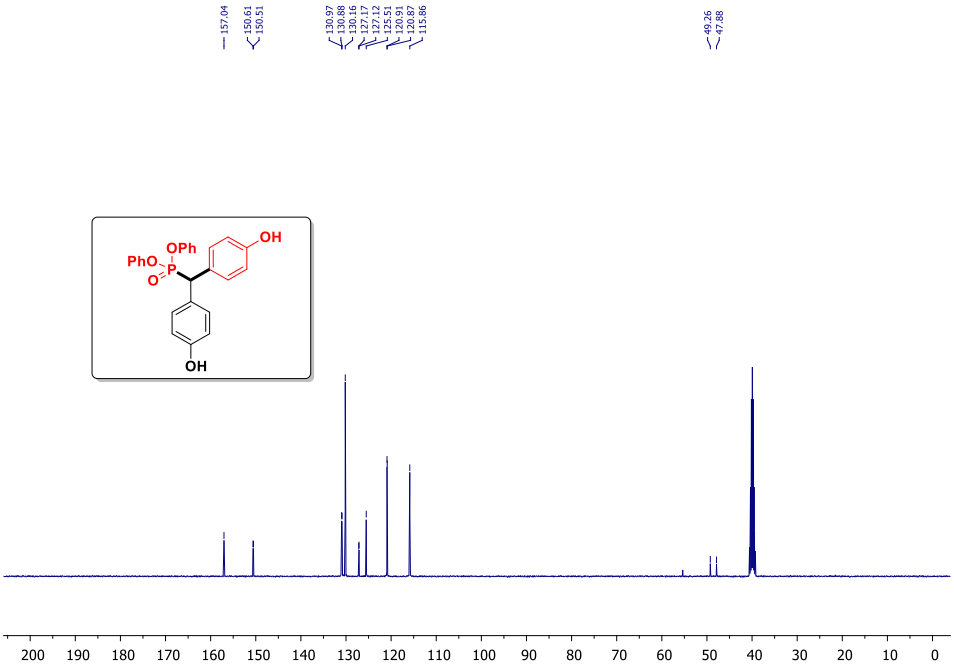
^{31}P NMR (400 MHz, DMSO-d_6) of 3f



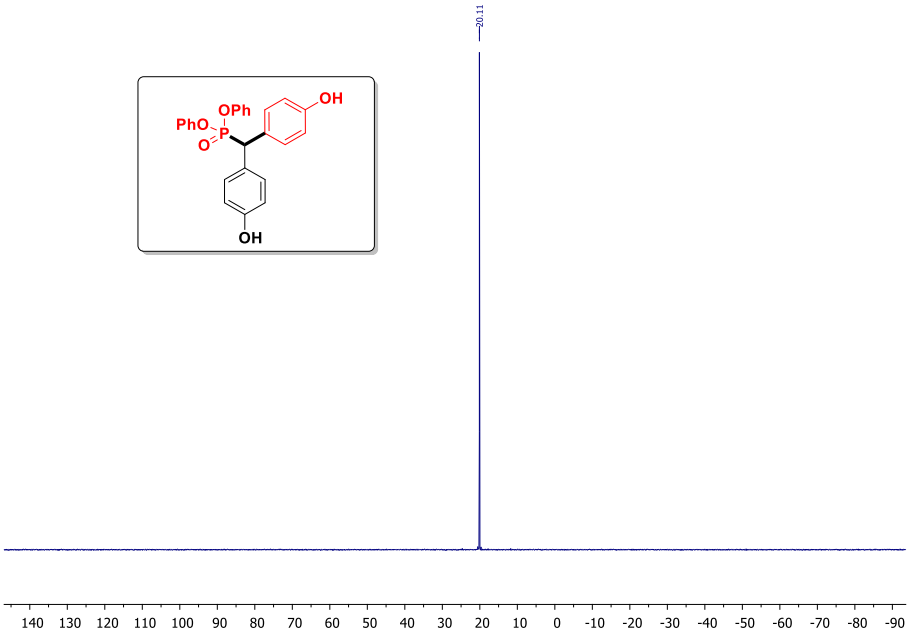
^{1}H NMR (400 MHz, DMSO-d_6) of 3g



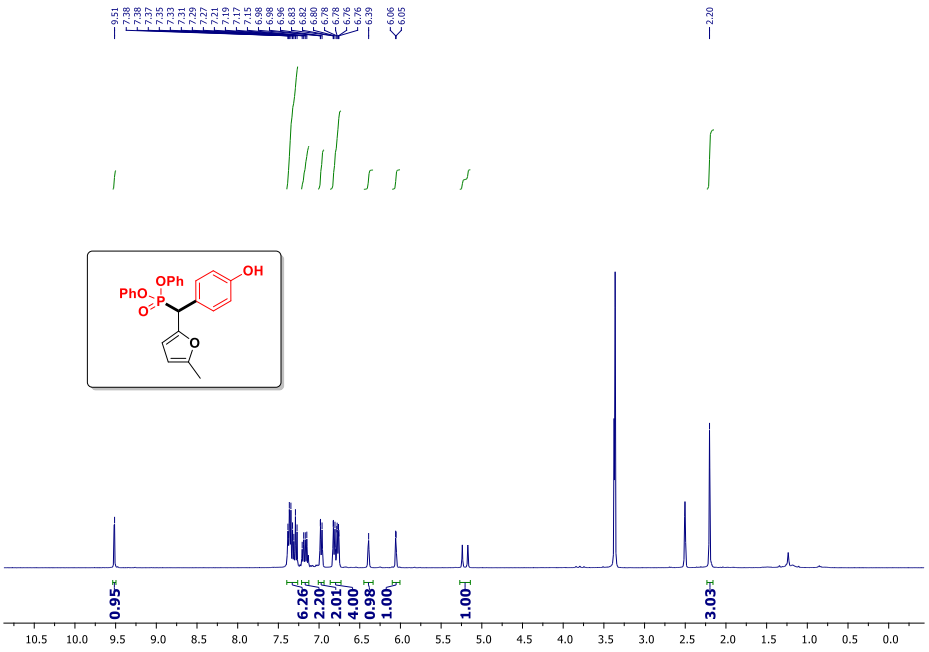
^{13}C NMR (101 MHz, DMSO- d_6) of 3g



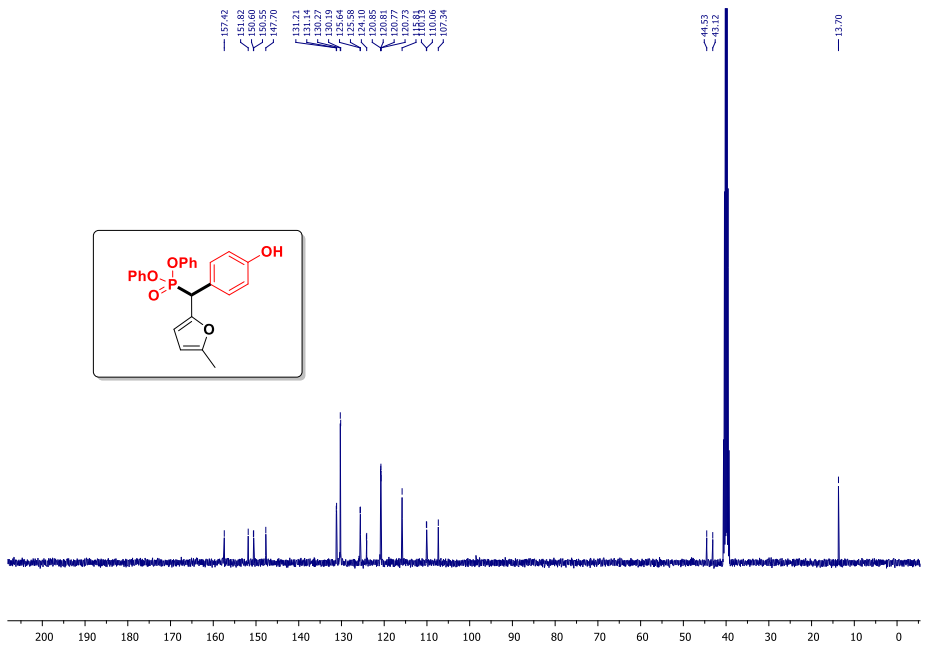
^{31}P NMR (400 MHz, DMSO-d_6) of 3g



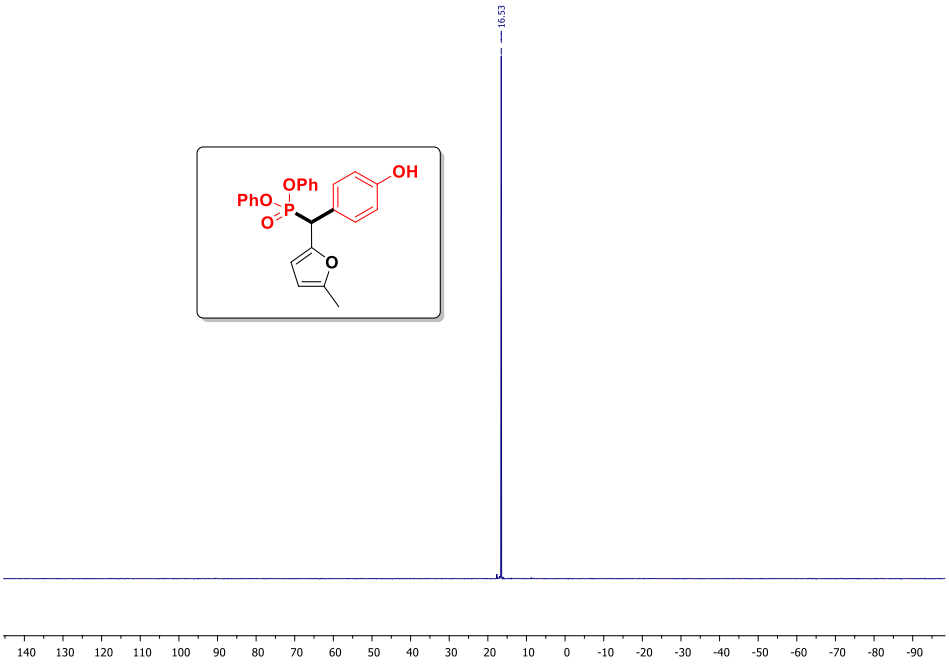
^{1}H NMR (400 MHz, DMSO-d_6) of 3h



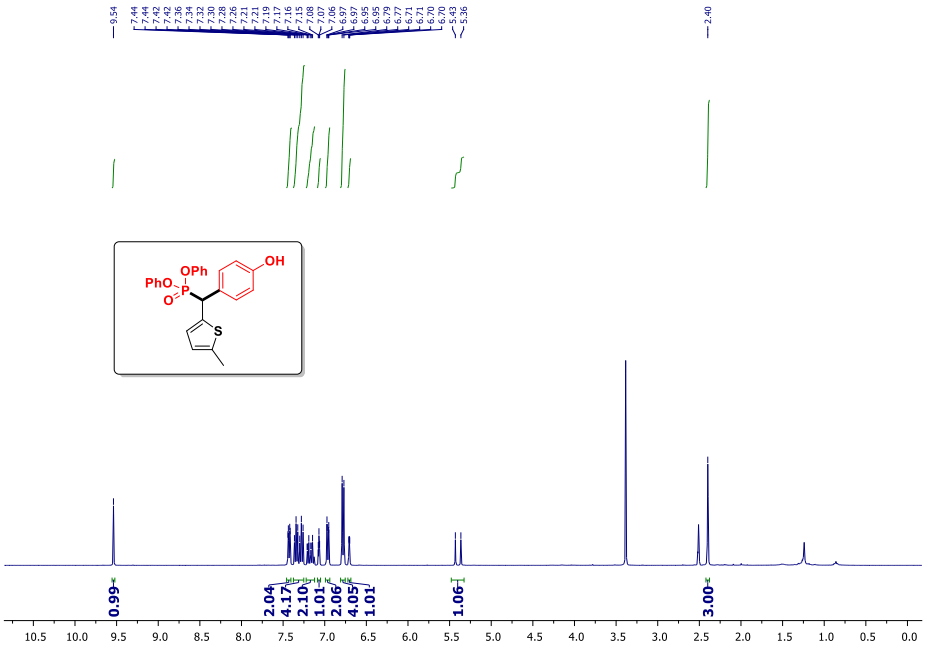
^{13}C NMR (101 MHz, DMSO- d_6) of 3h



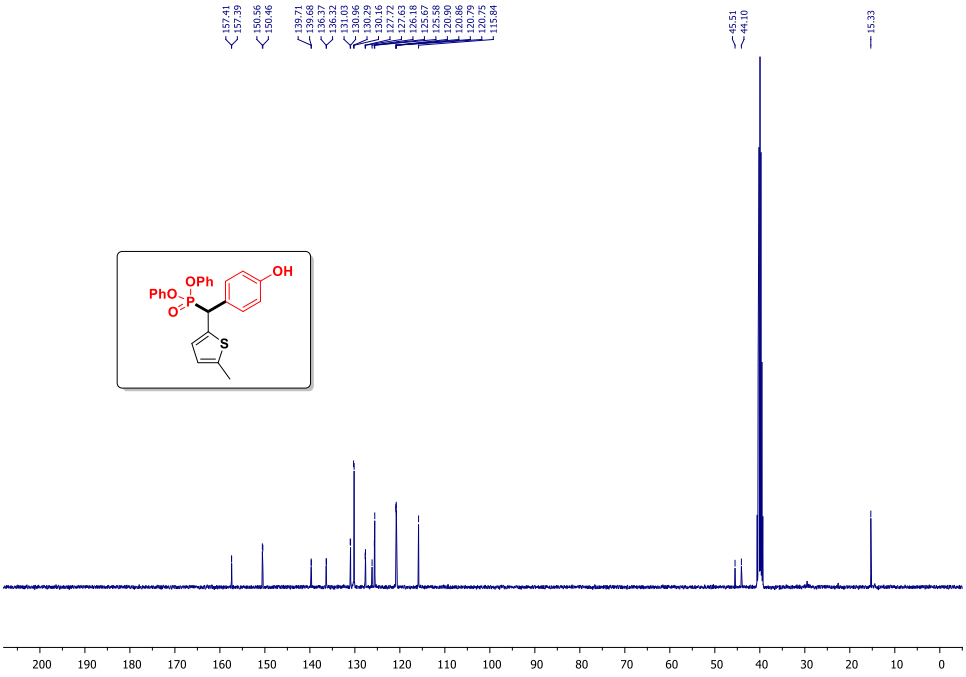
^{31}P NMR (400 MHz, DMSO-d_6) of 3h



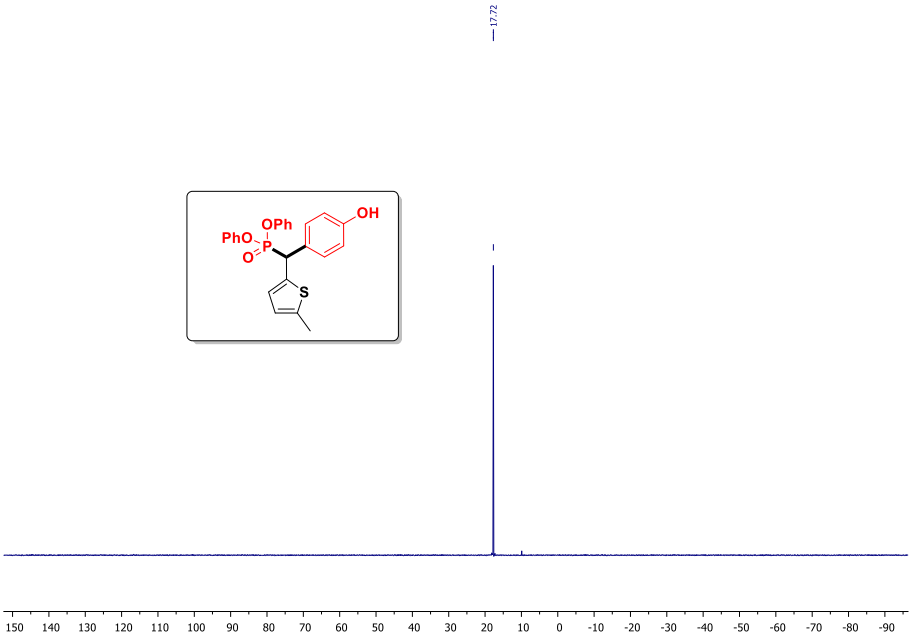
^{1}H NMR (400 MHz, DMSO-d_6) of 3i



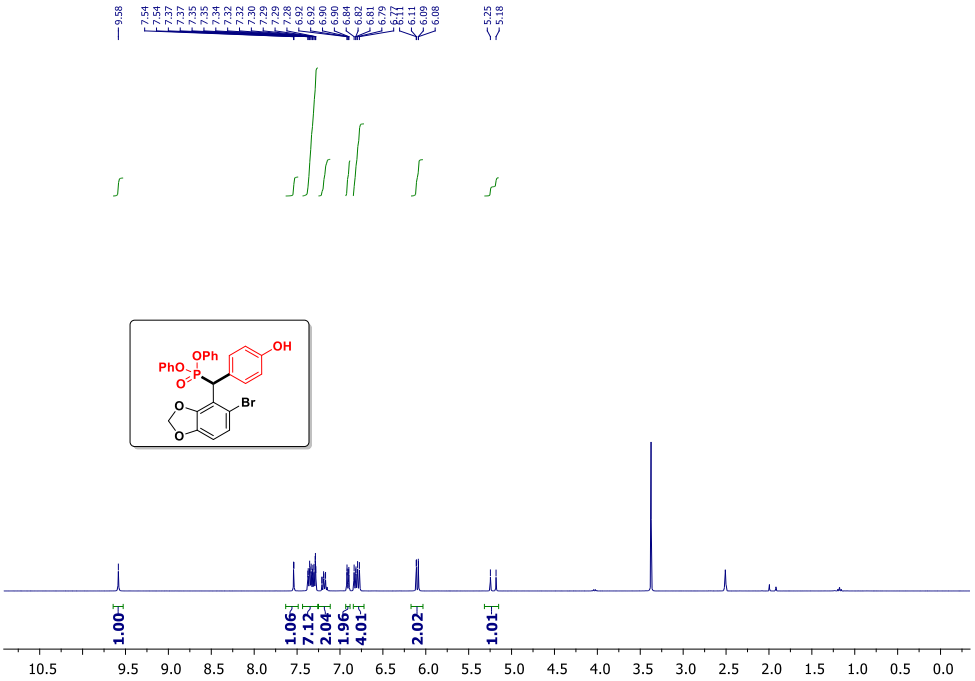
^{13}C NMR (101 MHz, DMSO- d_6) of 3i



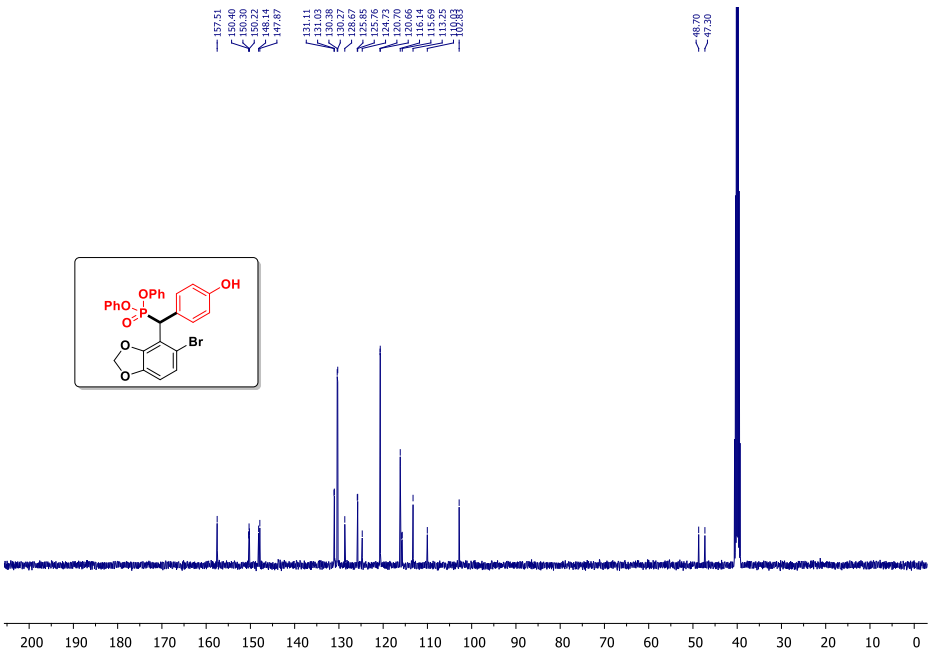
^{31}P NMR (400 MHz, DMSO-d_6) of 3i



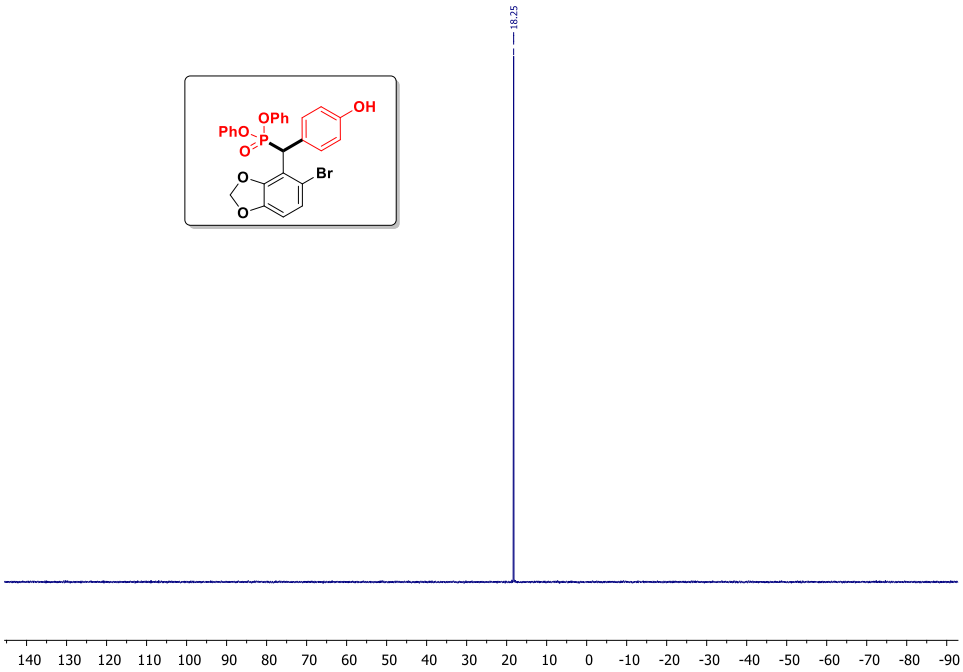
^{1}H NMR (400 MHz, DMSO-d_6) of 3j



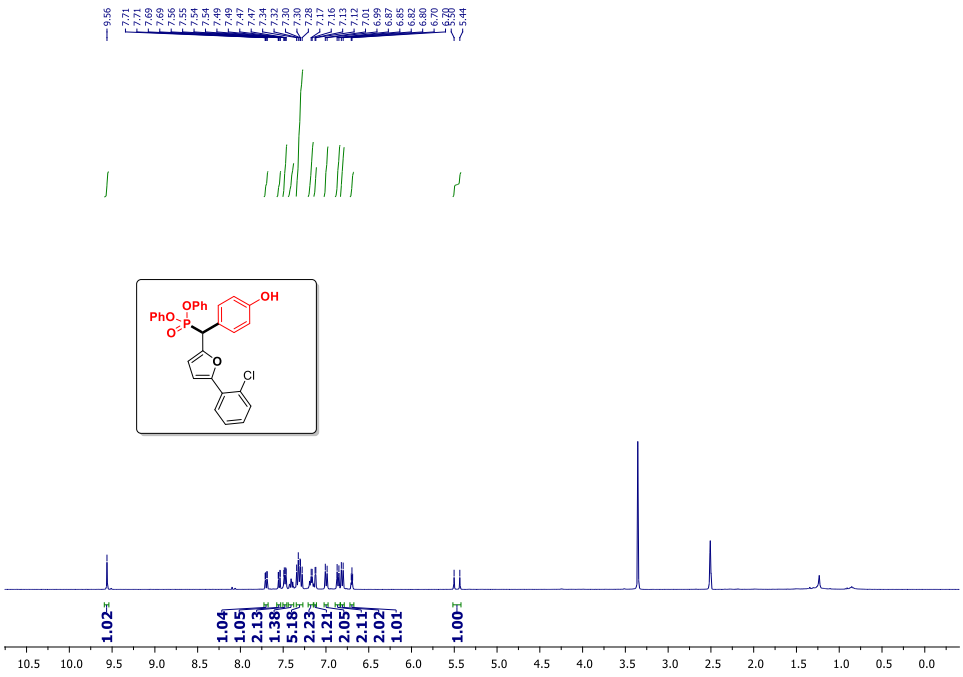
^{13}C NMR (101 MHz, DMSO- d_6) of 3j



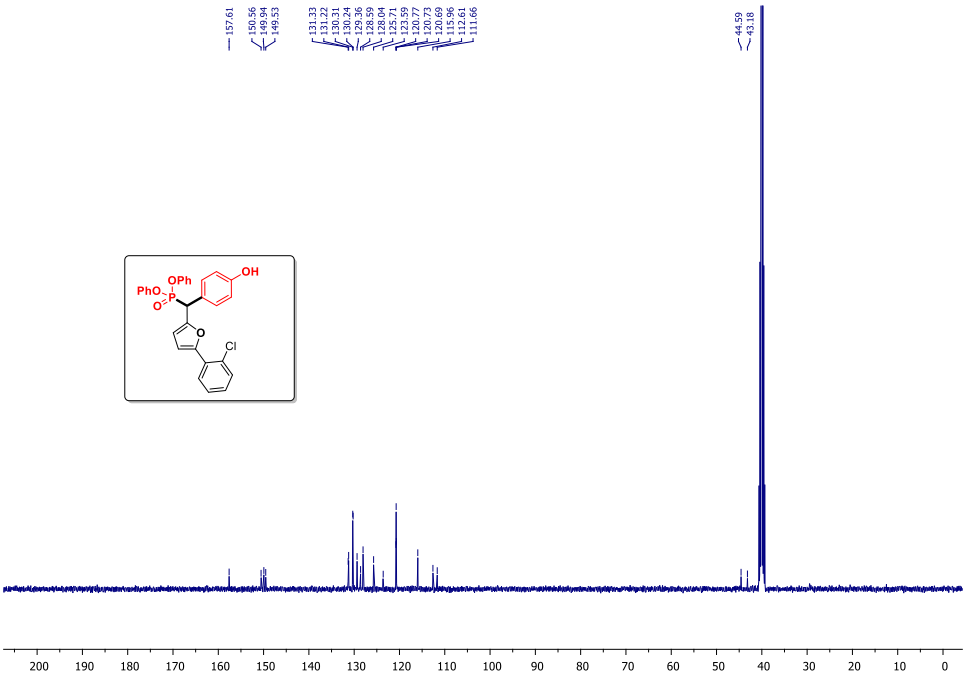
^{31}P NMR (400 MHz, DMSO-d_6) of 3j



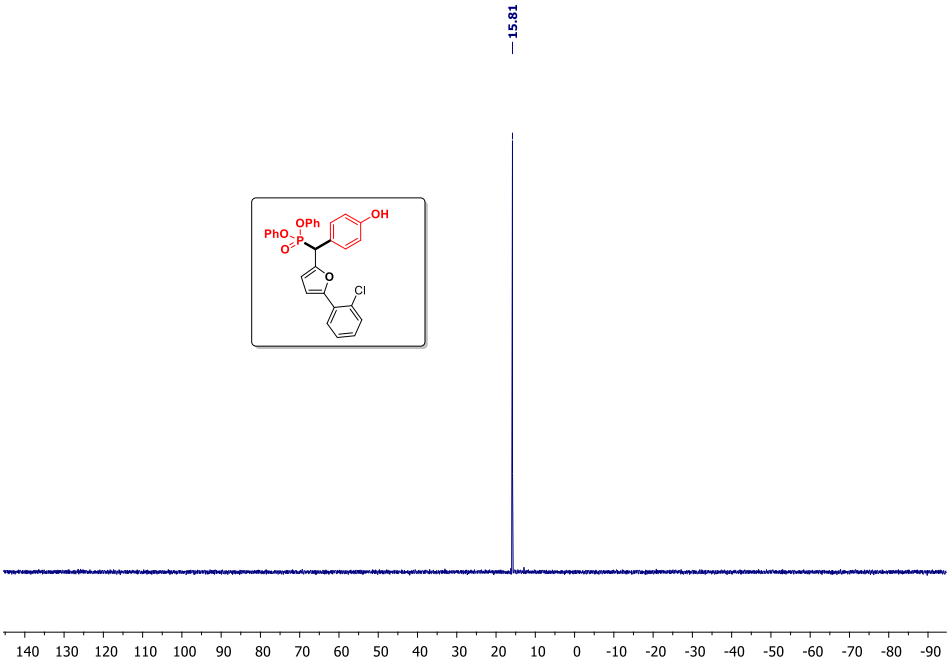
^{1}H NMR (400 MHz, DMSO-d_6) of 3k



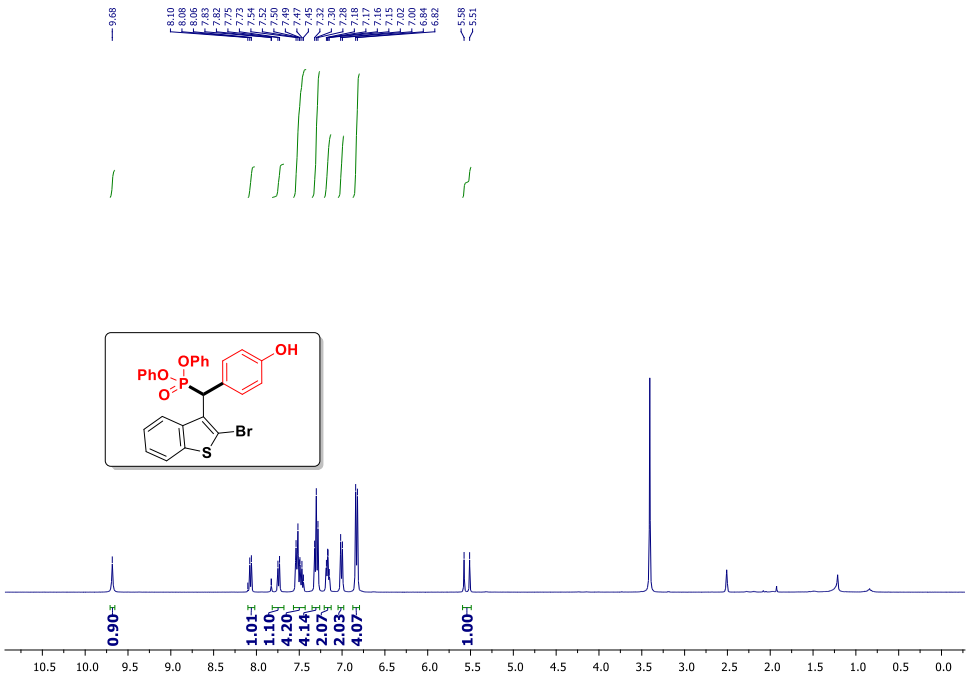
^{13}C NMR (101 MHz, DMSO- d_6) of 3k



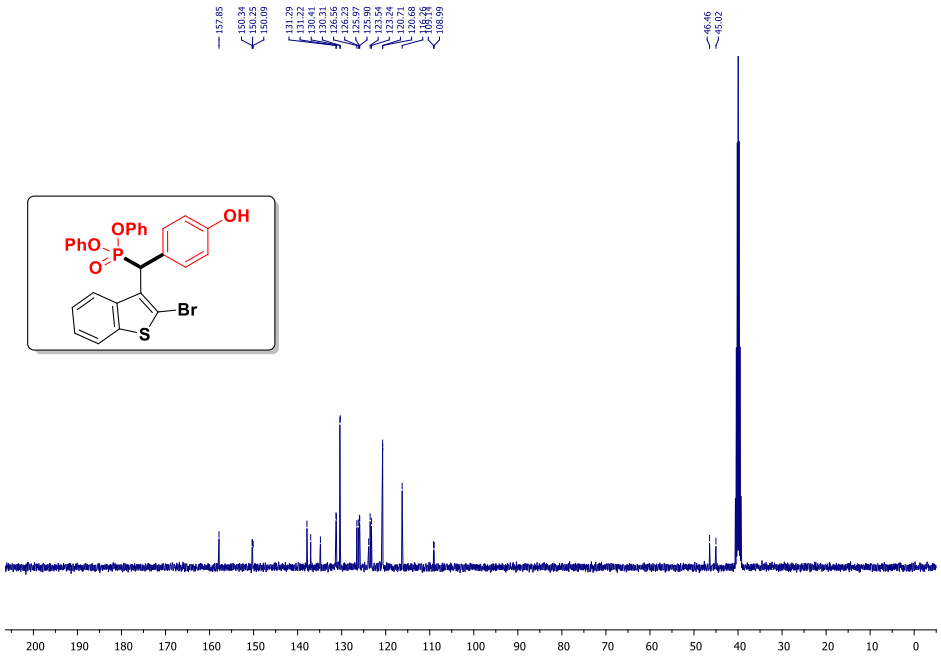
^{31}P NMR (400 MHz, DMSO-d_6) of 3k



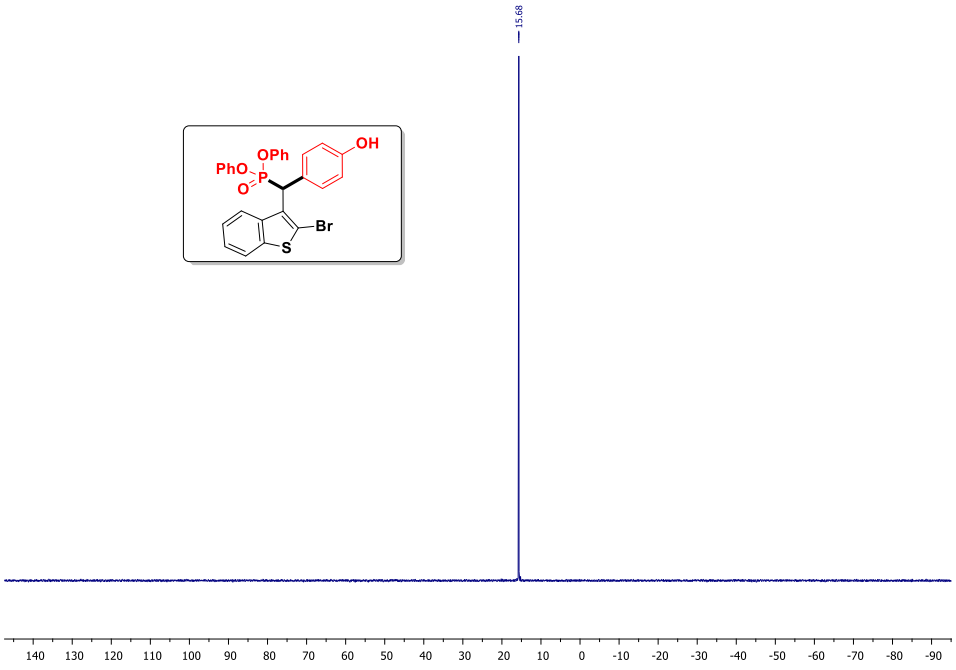
^{1}H NMR (400 MHz, DMSO-d_6) of 3l



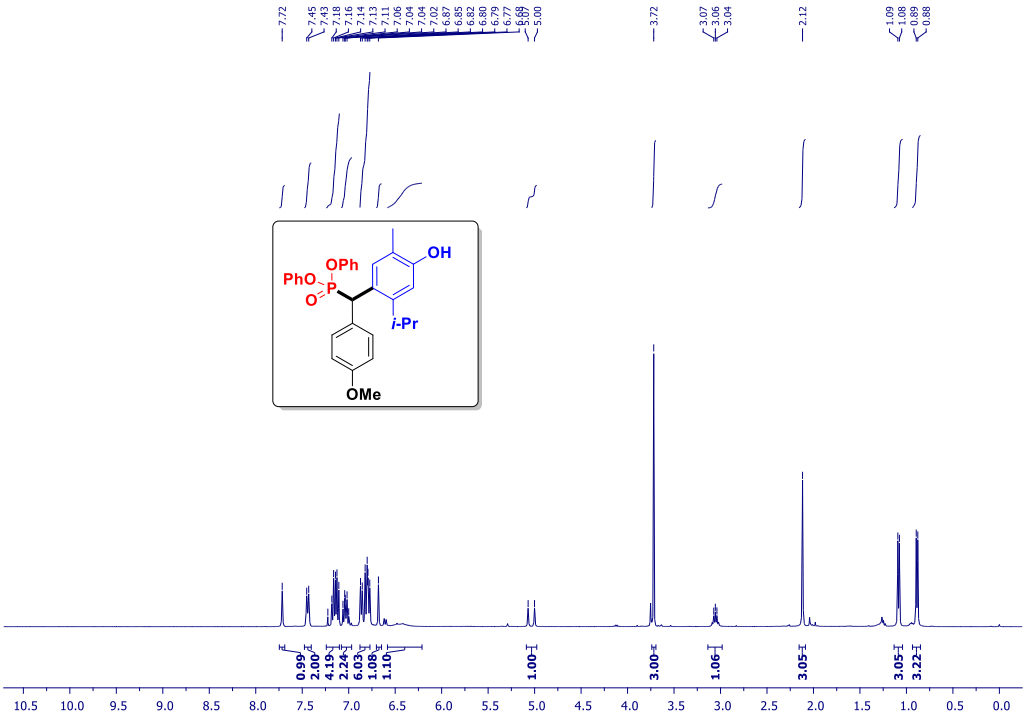
^{13}C NMR (101 MHz, DMSO- d_6) of 3l



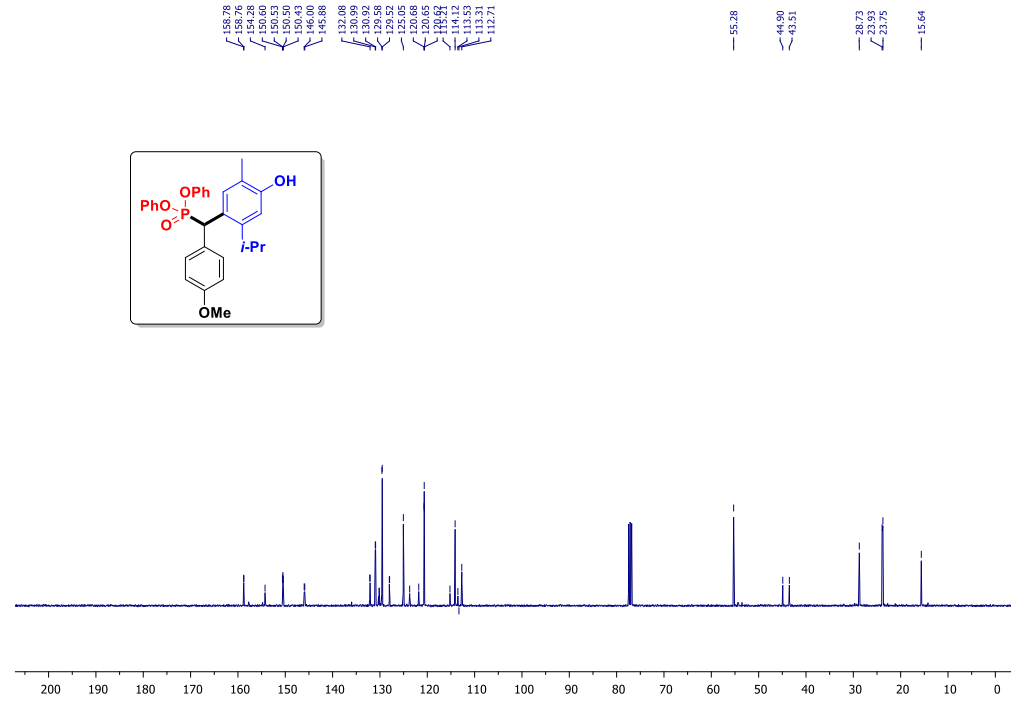
^{31}P NMR (400 MHz, DMSO-d_6) of 3l



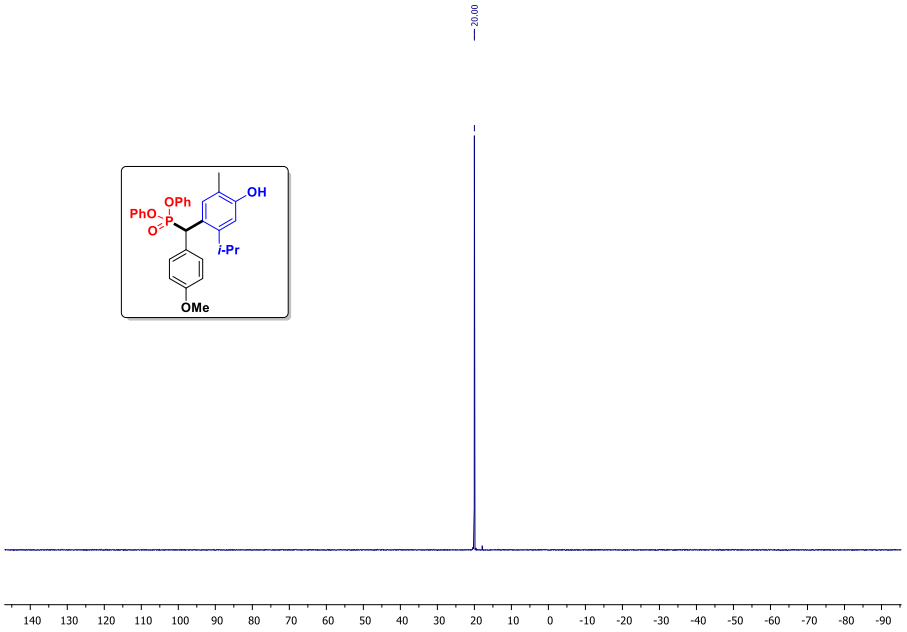
^{1}H NMR (400 MHz, $CDCl_3$-d_6) of 5a



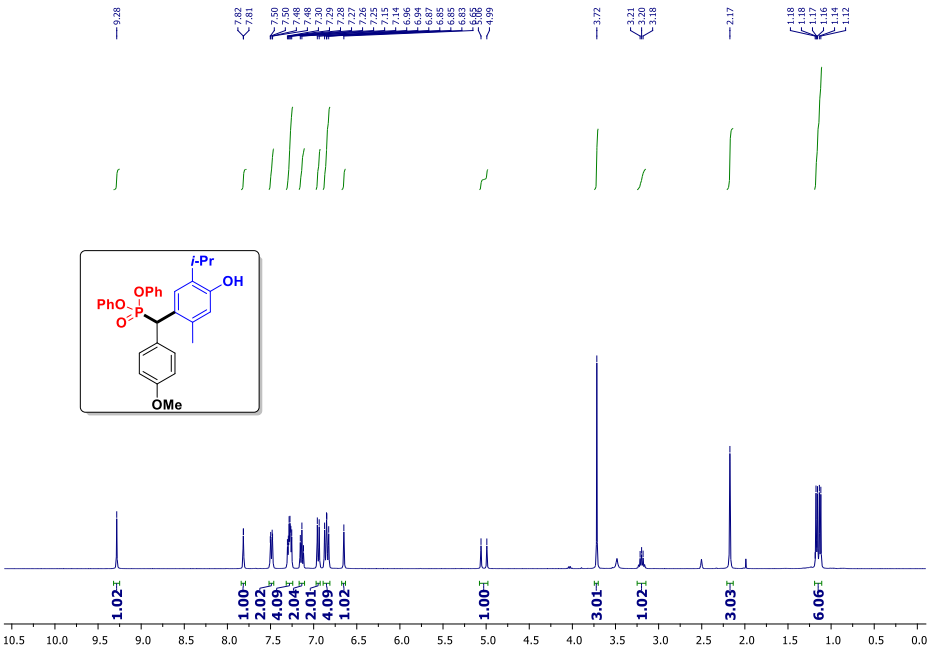
^{13}C NMR (101 MHz, $CDCl_3$- d_6) of 5a



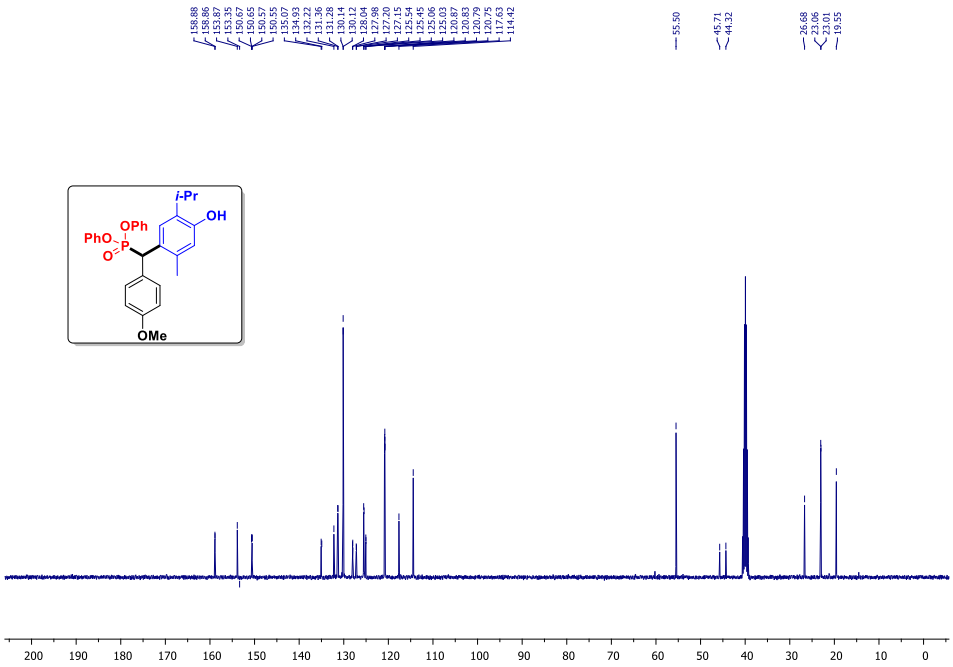
^{31}P NMR (400 MHz, $CDCl_3$-d_6) of 5a



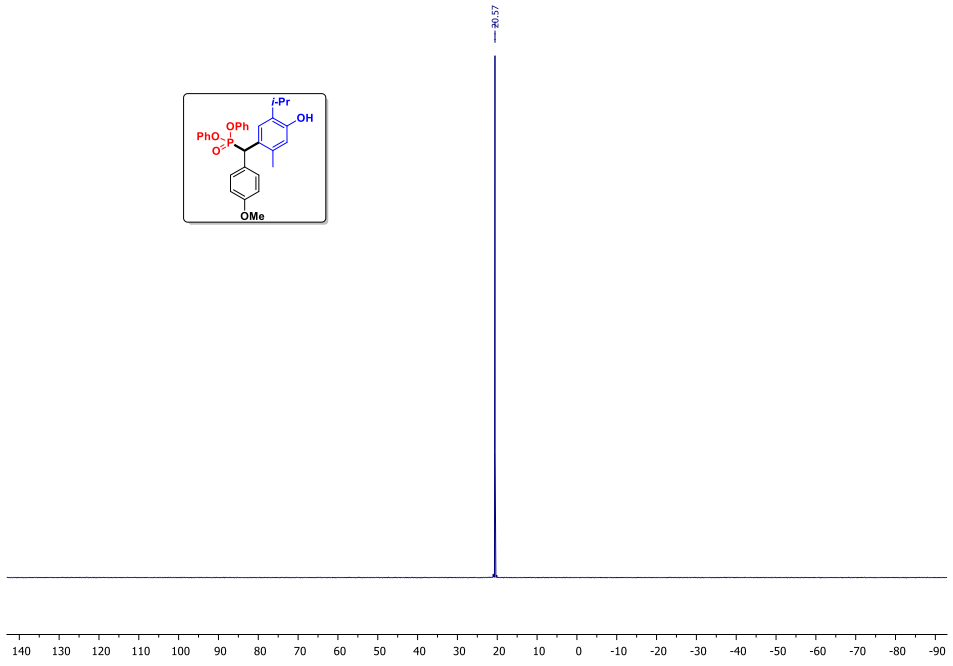
^{1}H NMR (400 MHz, DMSO-d_6) of 5b



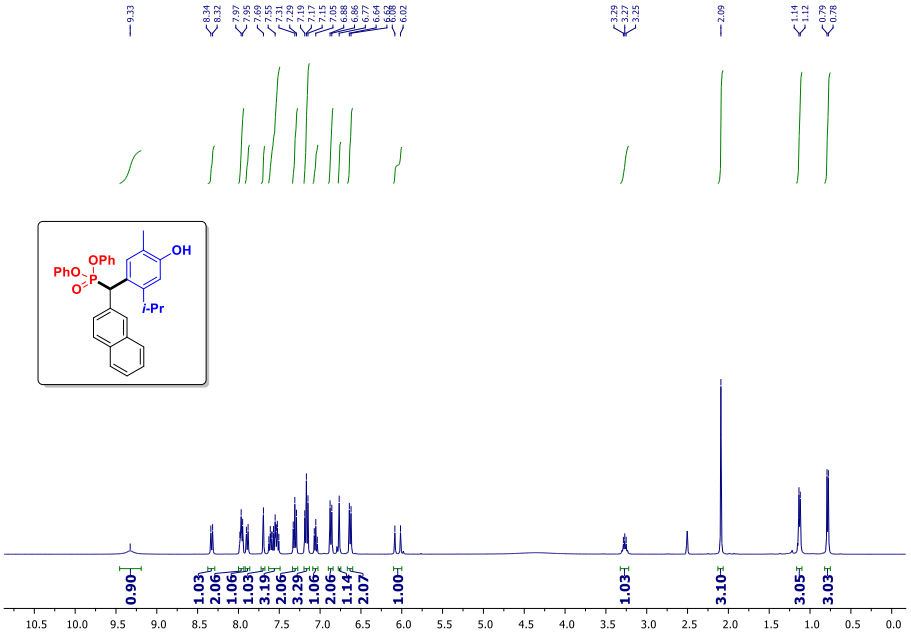
^{13}C NMR (101 MHz, DMSO- d_6) of 5b



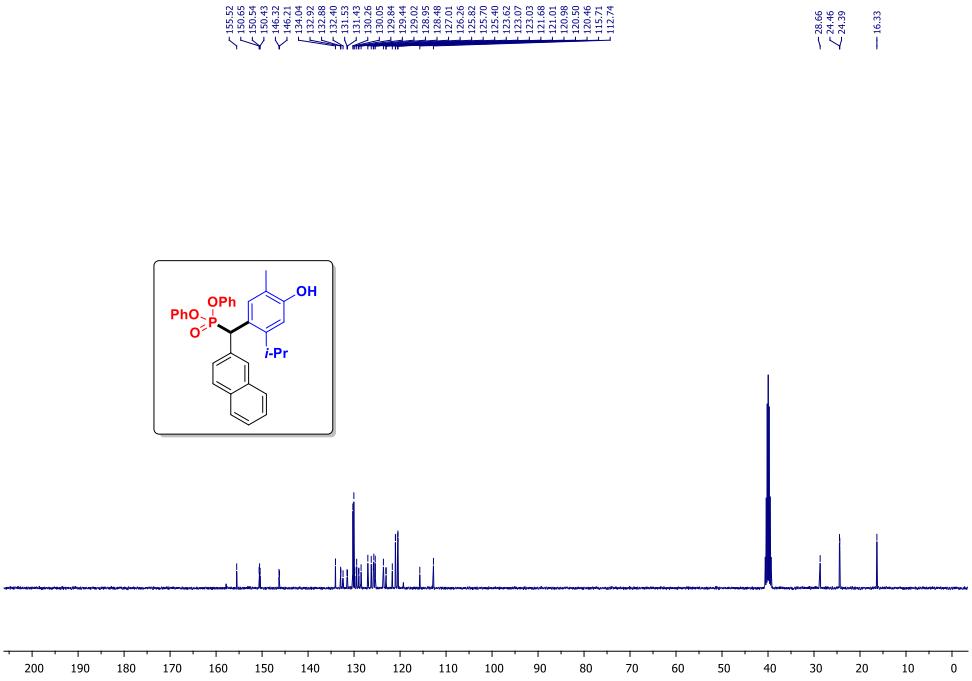
^{31}P NMR (400 MHz, DMSO-d_6) of 5b



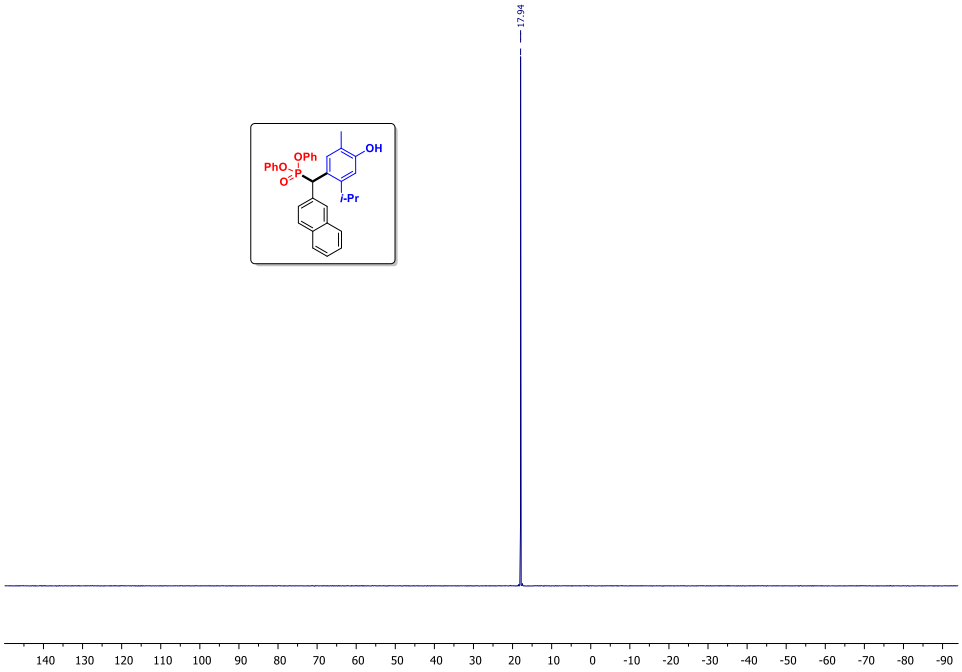
^{1}H NMR (400 MHz, DMSO-d_6) of 5c



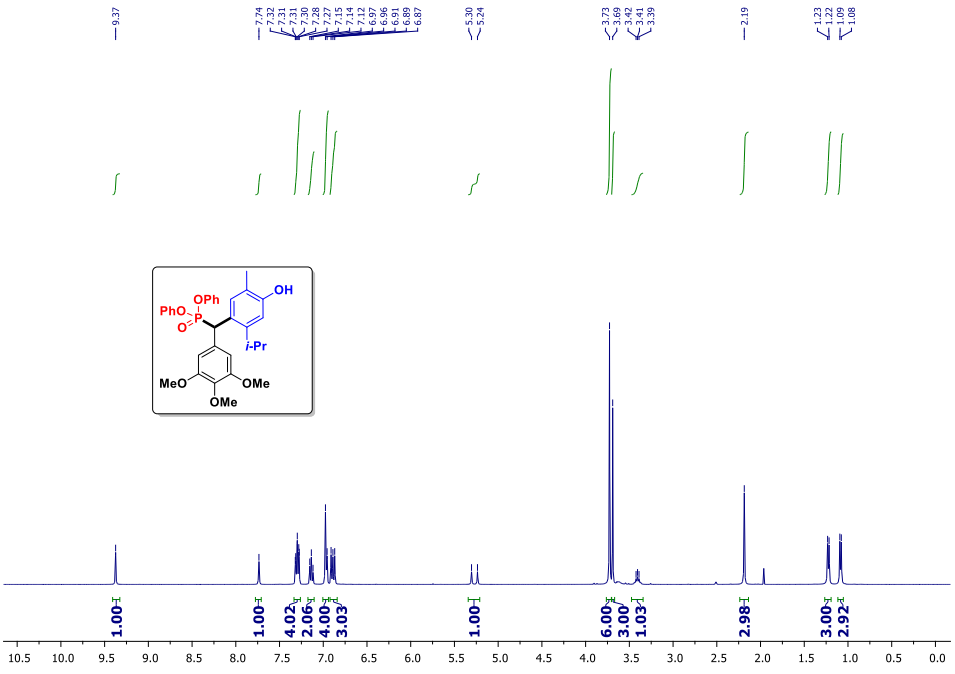
^{13}C NMR (101 MHz, DMSO- d_6) of 5c



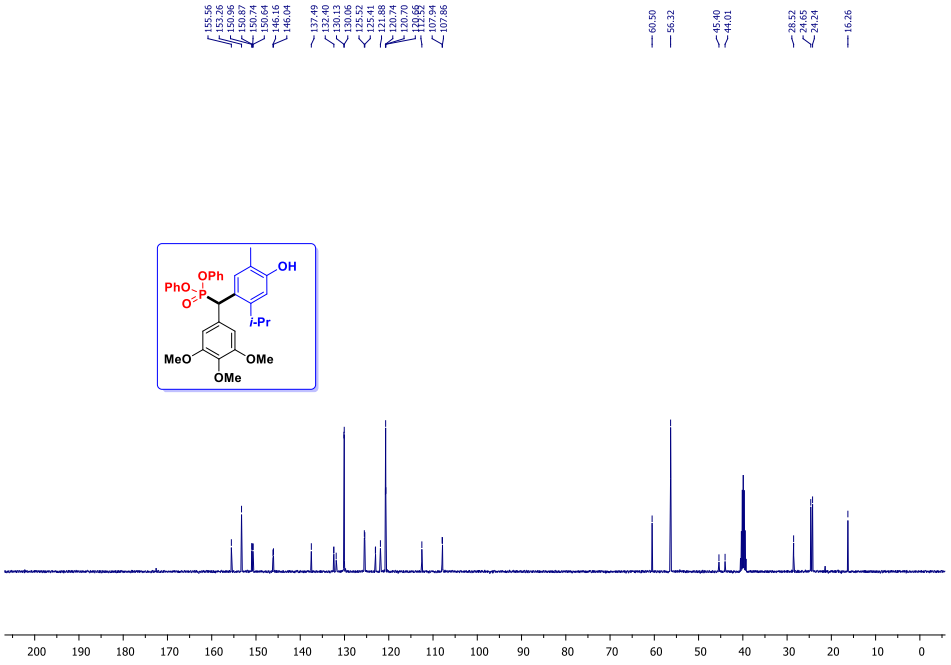
^{31}P NMR (400 MHz, DMSO-d_6) of 5c



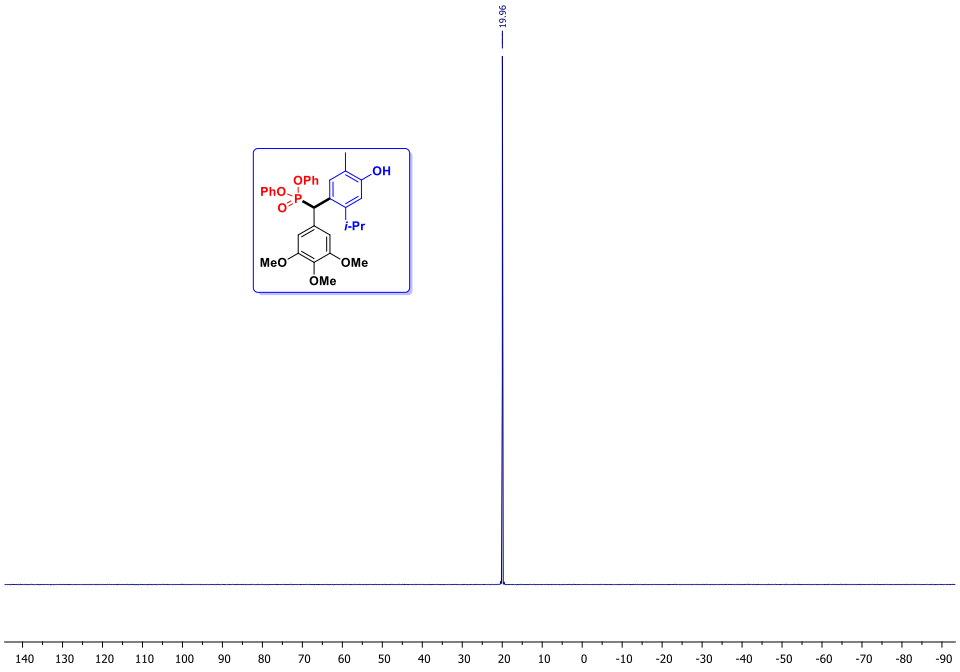
^{1}H NMR (400 MHz, DMSO-d_6) of 5d



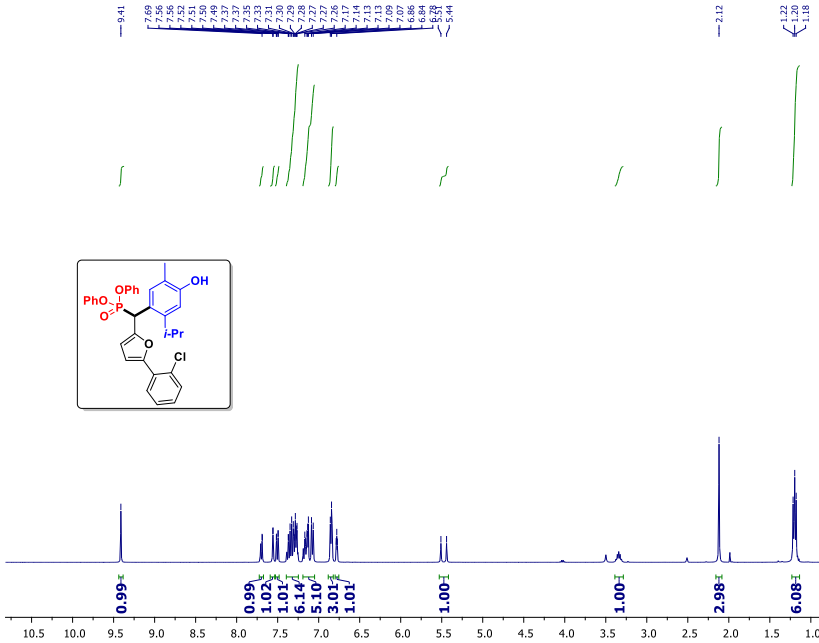
^{13}C NMR (101 MHz, DMSO- d_6) of 5d



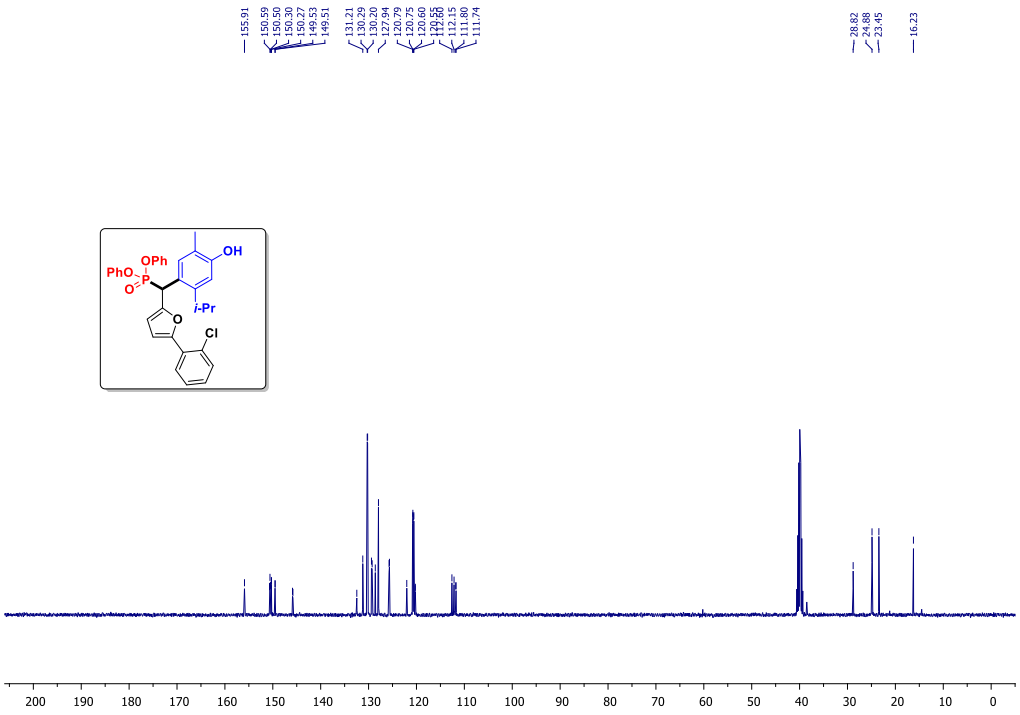
^{31}P NMR (400 MHz, DMSO-d_6) of 5d



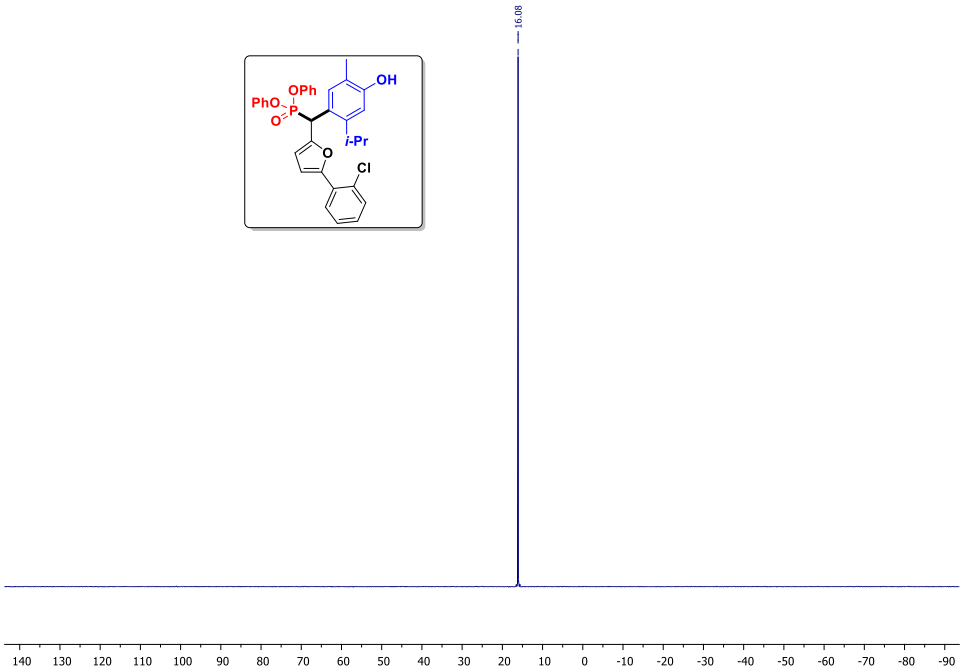
^{1}H NMR (400 MHz, DMSO-d_6) of 5e



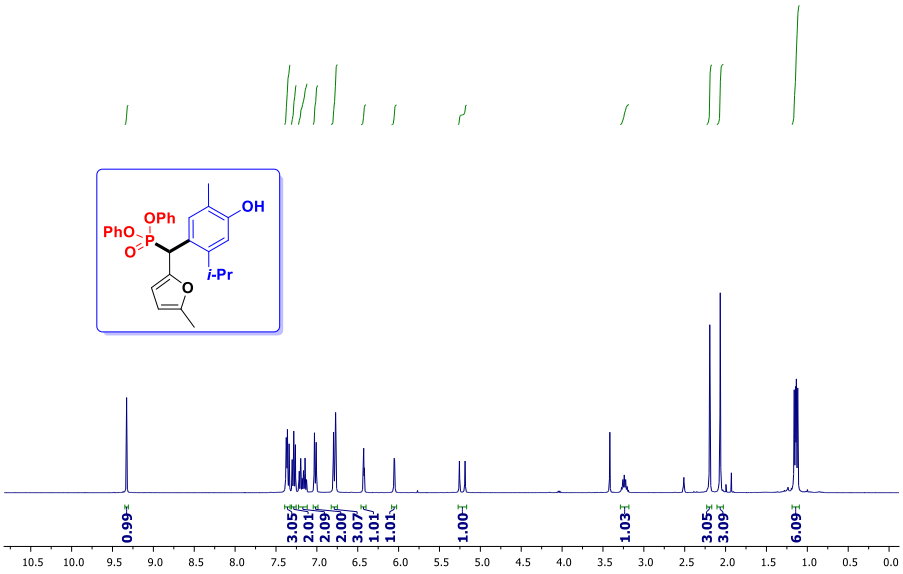
^{13}C NMR (101 MHz, DMSO- d_6) of 5e



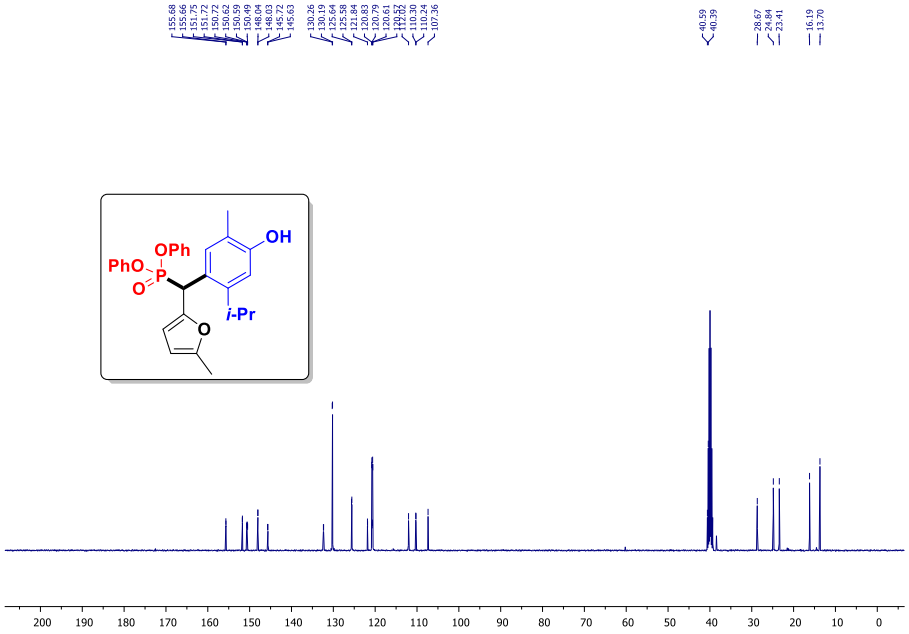
^{31}P NMR (400 MHz, DMSO-d_6) of 5e



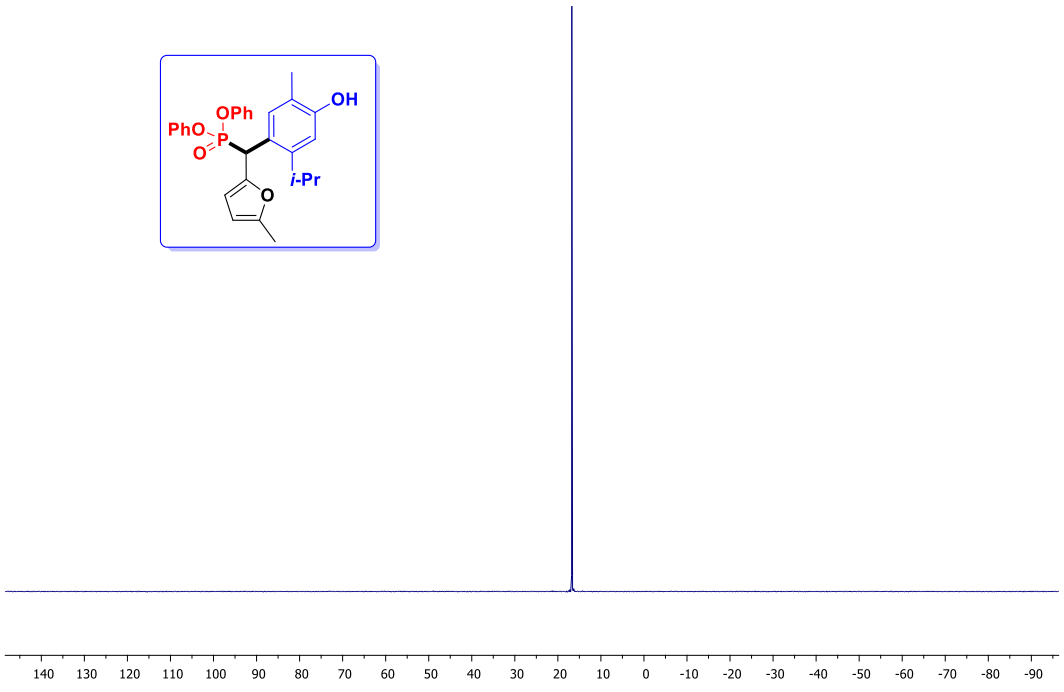
^{1}H NMR (400 MHz, DMSO-d_6) of 5f



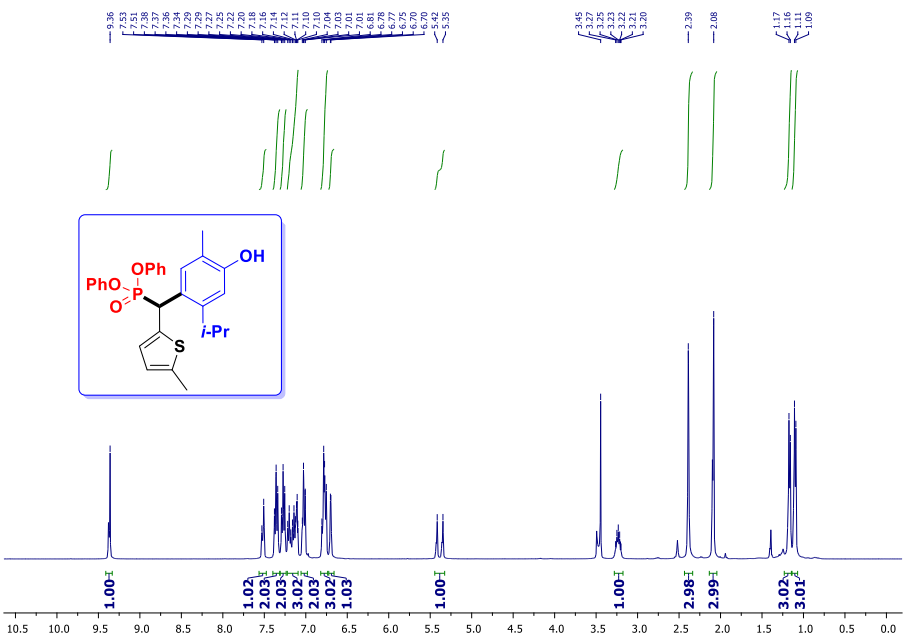
^{13}C NMR (101 MHz, DMSO- d_6) of 5f



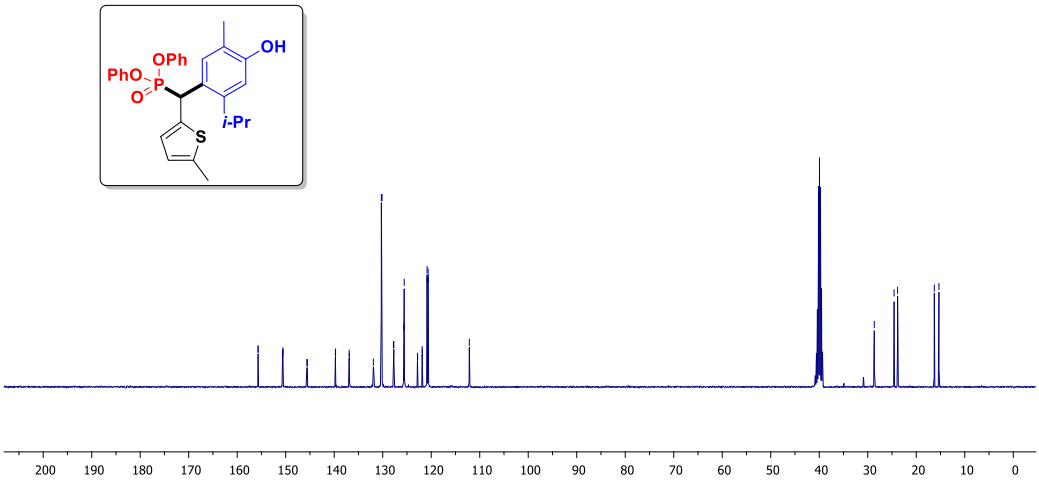
^{31}P NMR (400 MHz, DMSO-d_6) of 5f



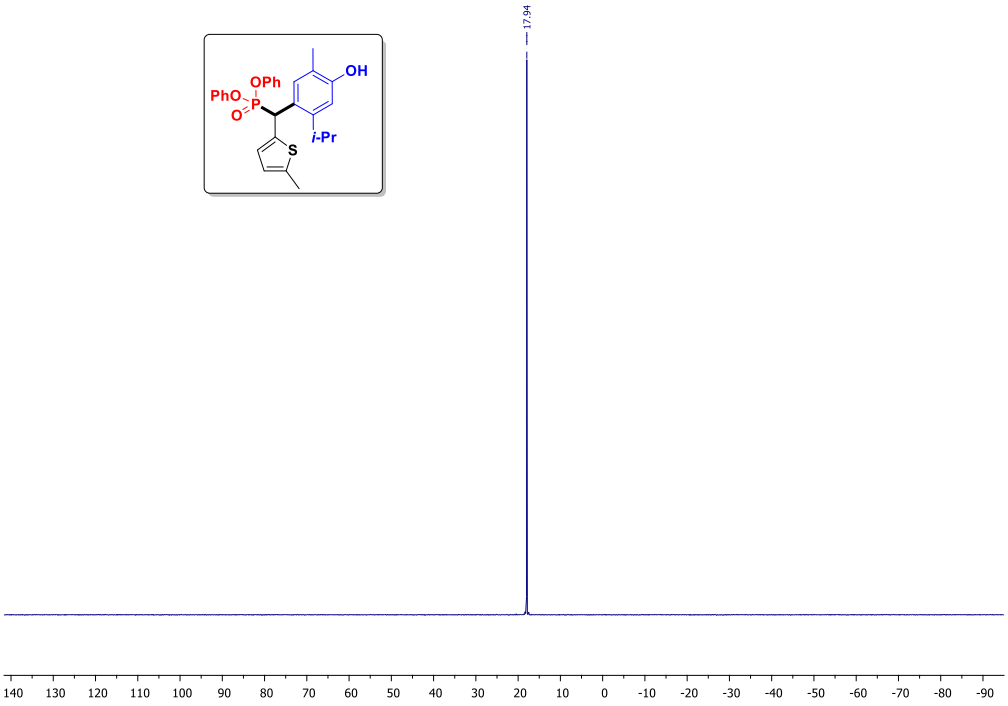
^{1}H NMR (400 MHz, DMSO-d_6) of 5g



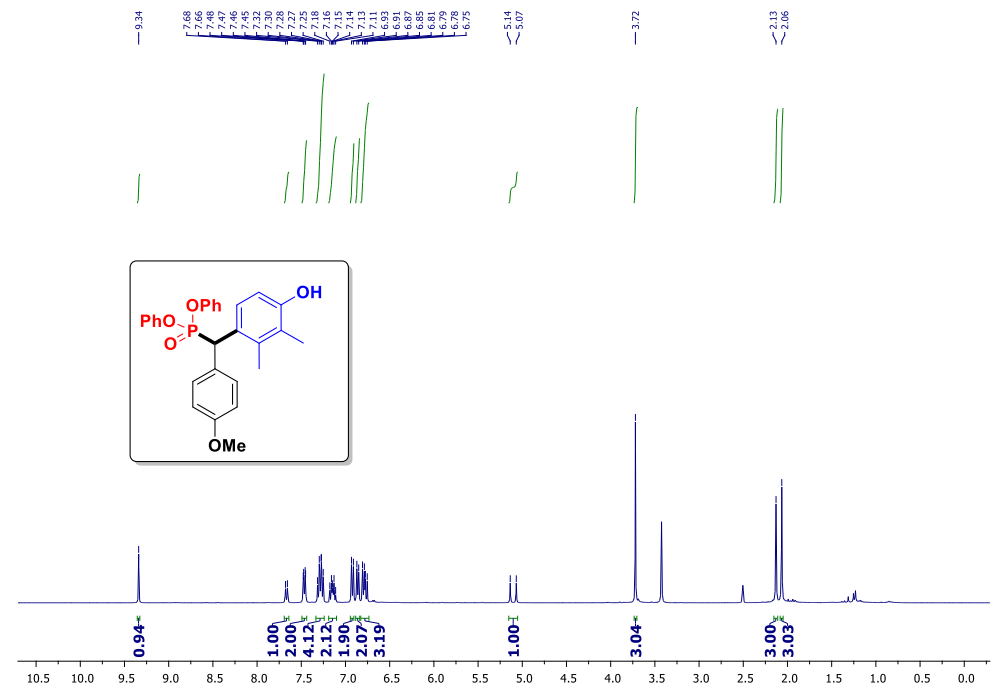
^{13}C NMR (101 MHz, DMSO- d_6) of 5g



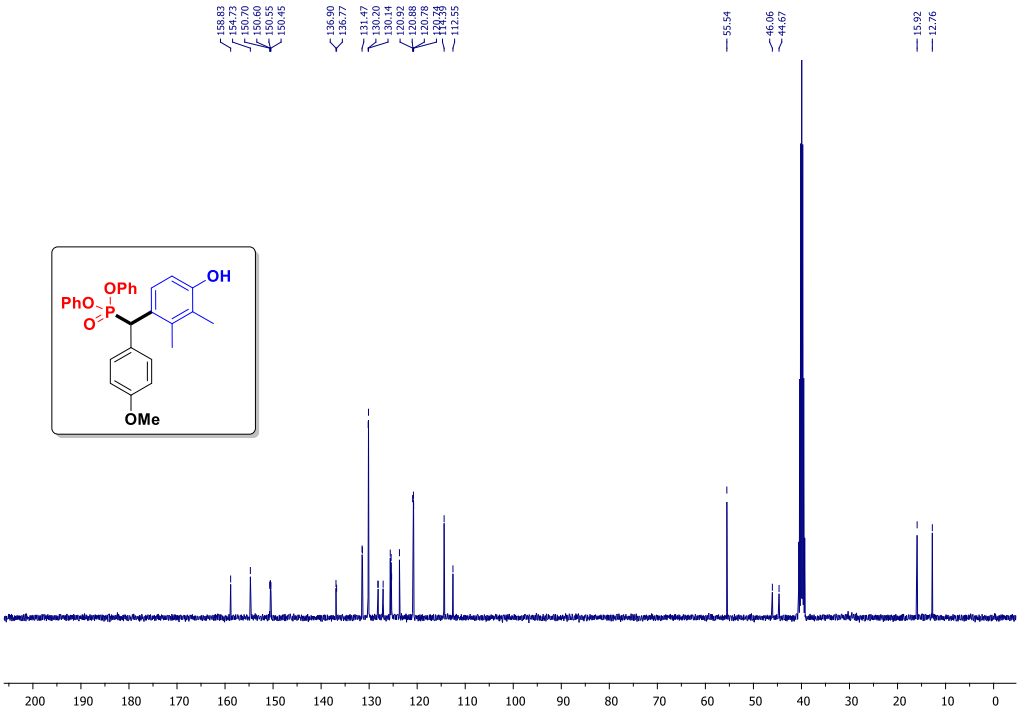
^{31}P NMR (400 MHz, DMSO-d_6) of 5g



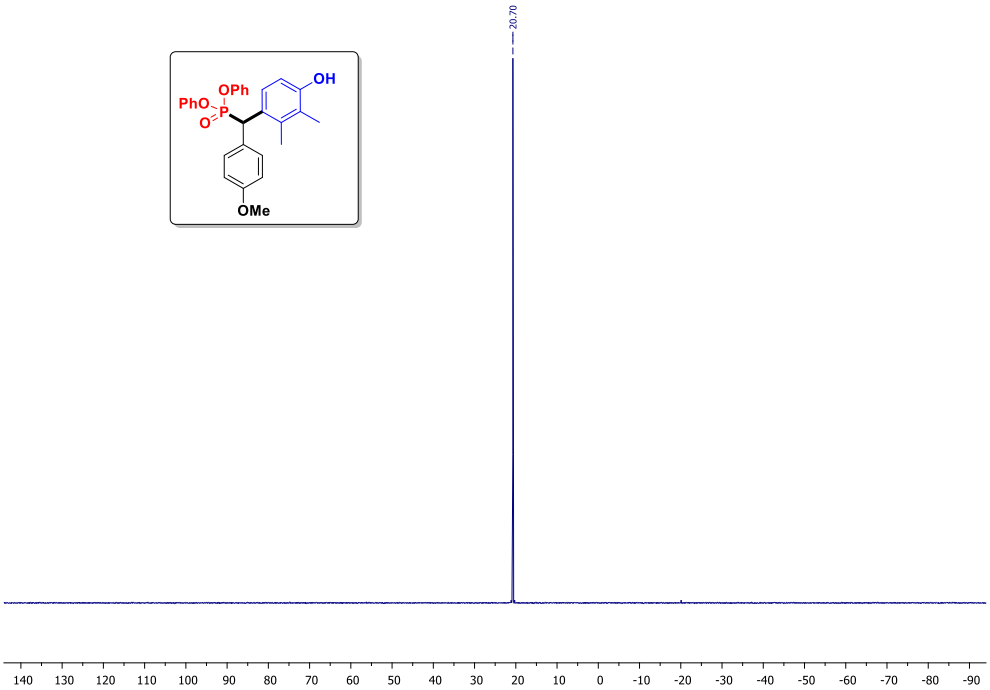
^{1}H NMR (400 MHz, DMSO-d_6) of 5h



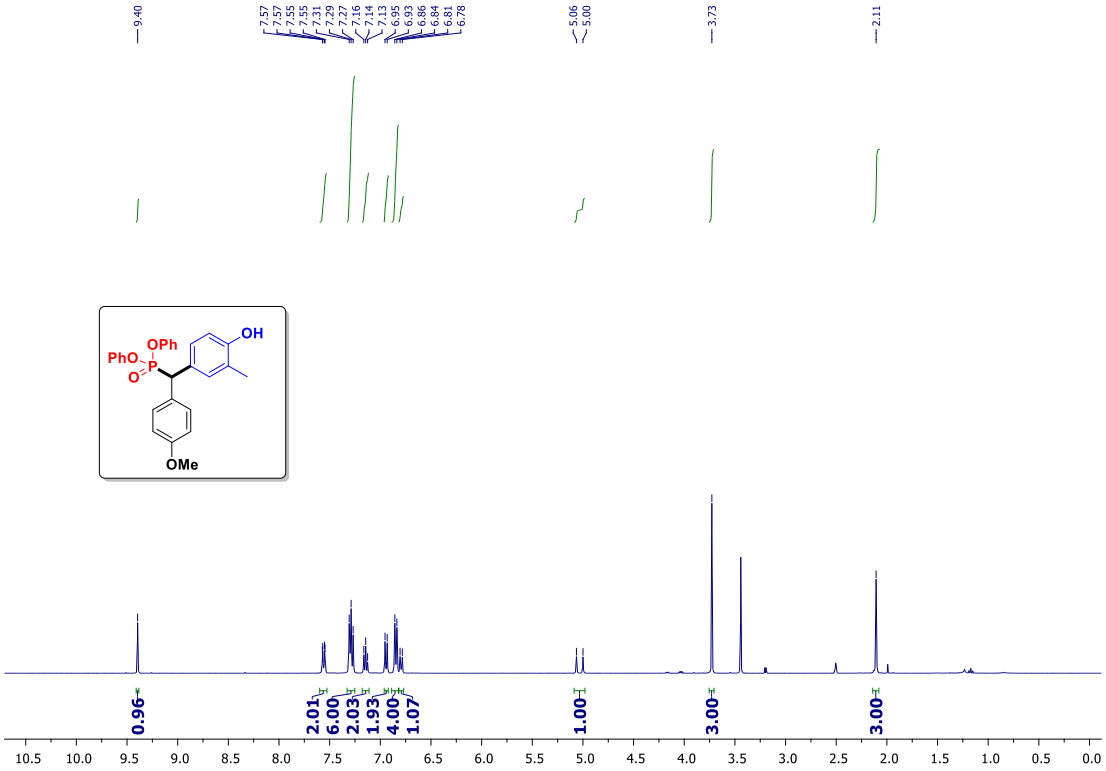
^{13}C NMR (101 MHz, DMSO- d_6) of 5h



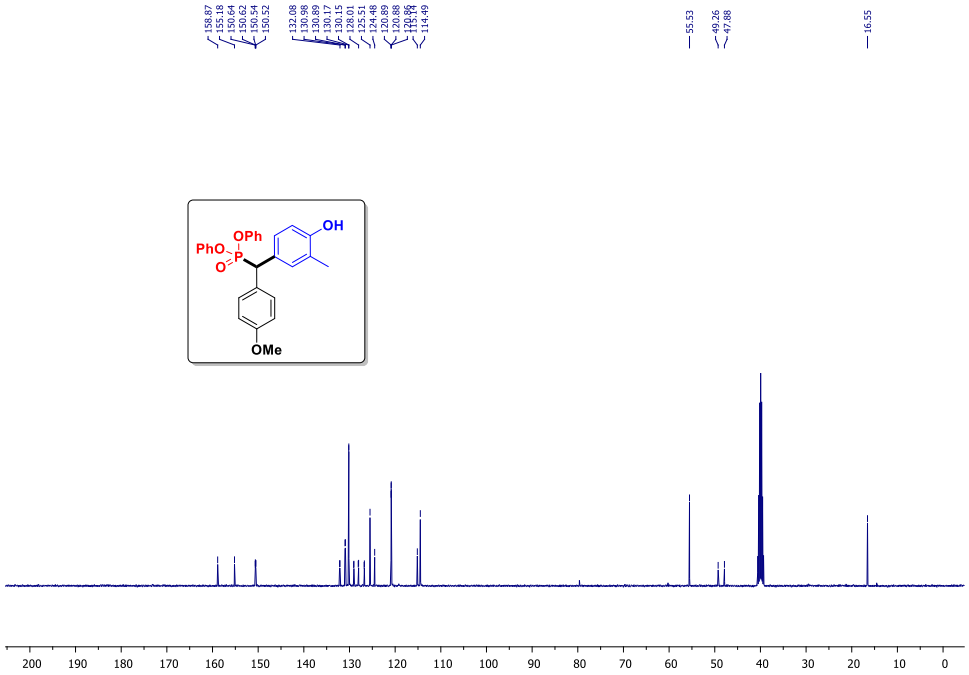
^{31}P NMR (400 MHz, DMSO-d_6) of 5h



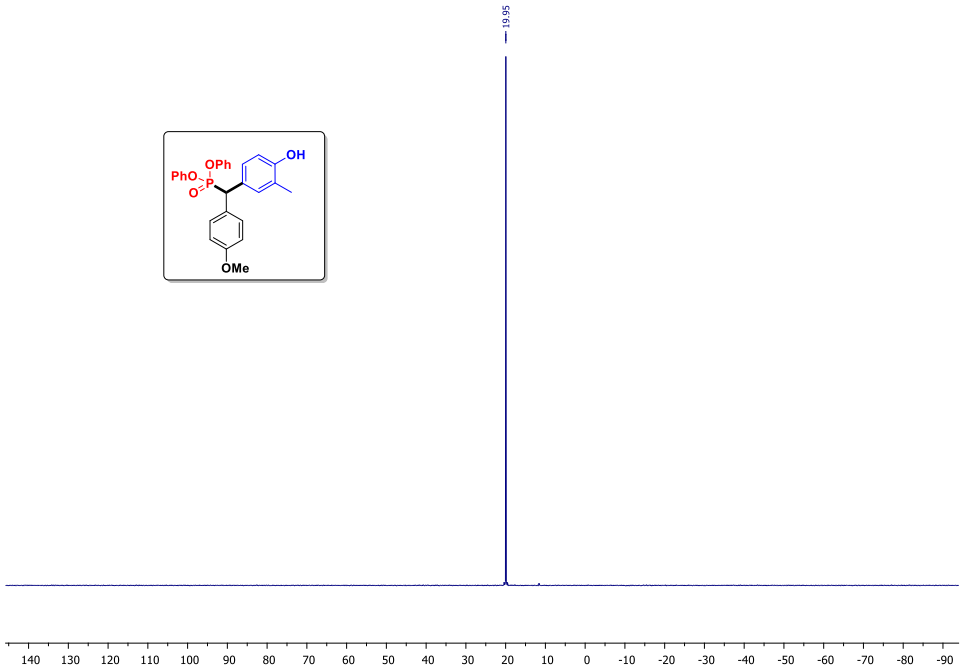
^{1}H NMR (400 MHz, DMSO-d_6) of 5i



^{13}C NMR (101 MHz, DMSO- d_6) of 5i



^{31}P NMR (400 MHz, DMSO-d_6) of 5i



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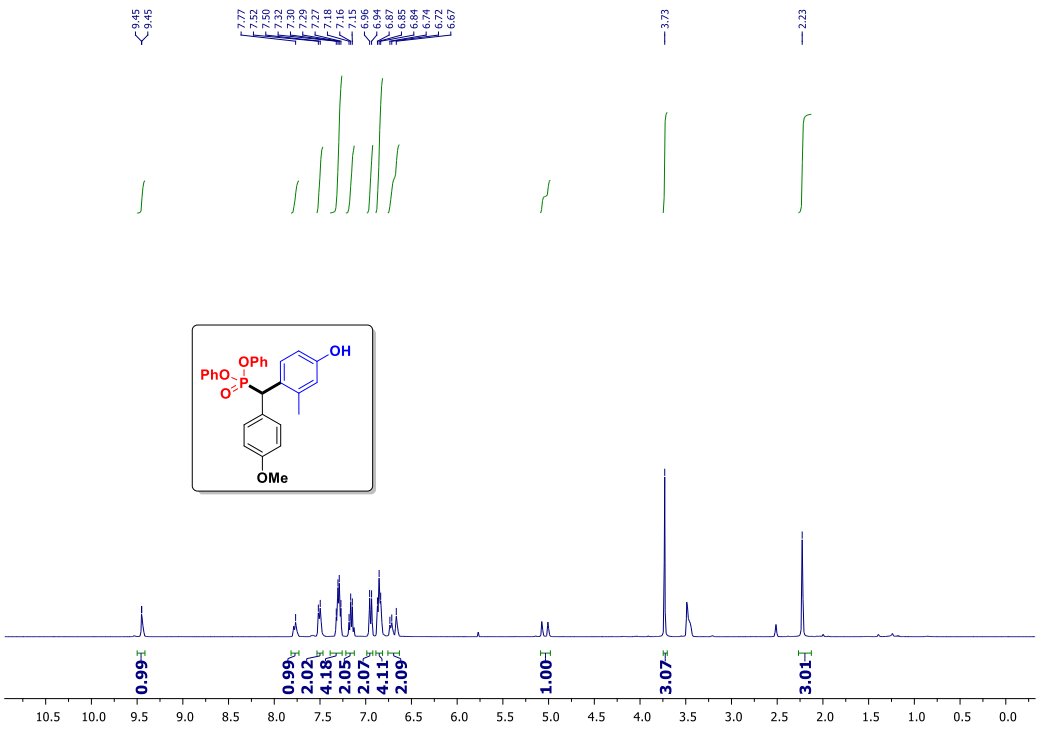
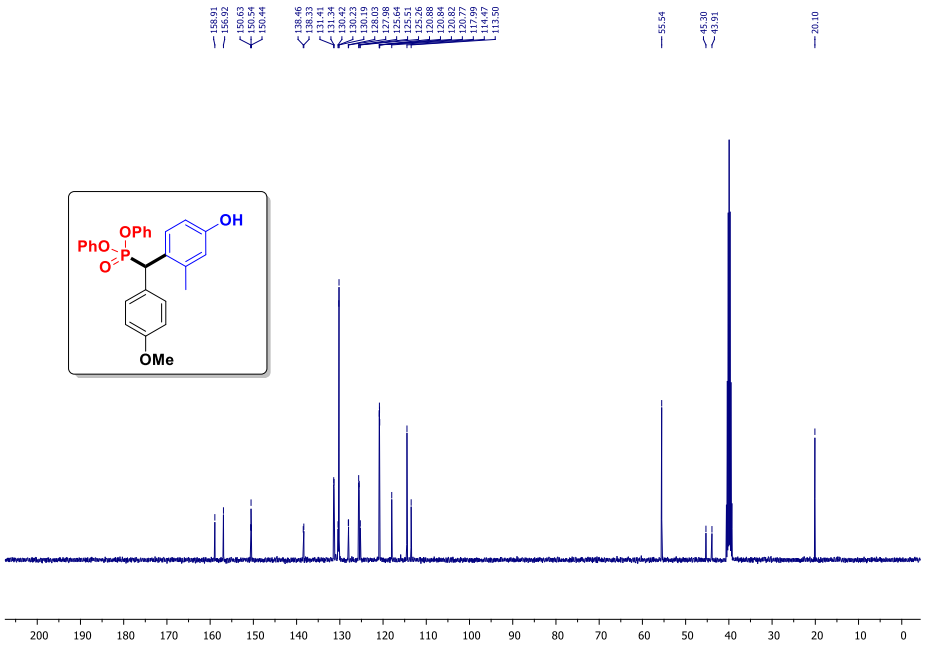
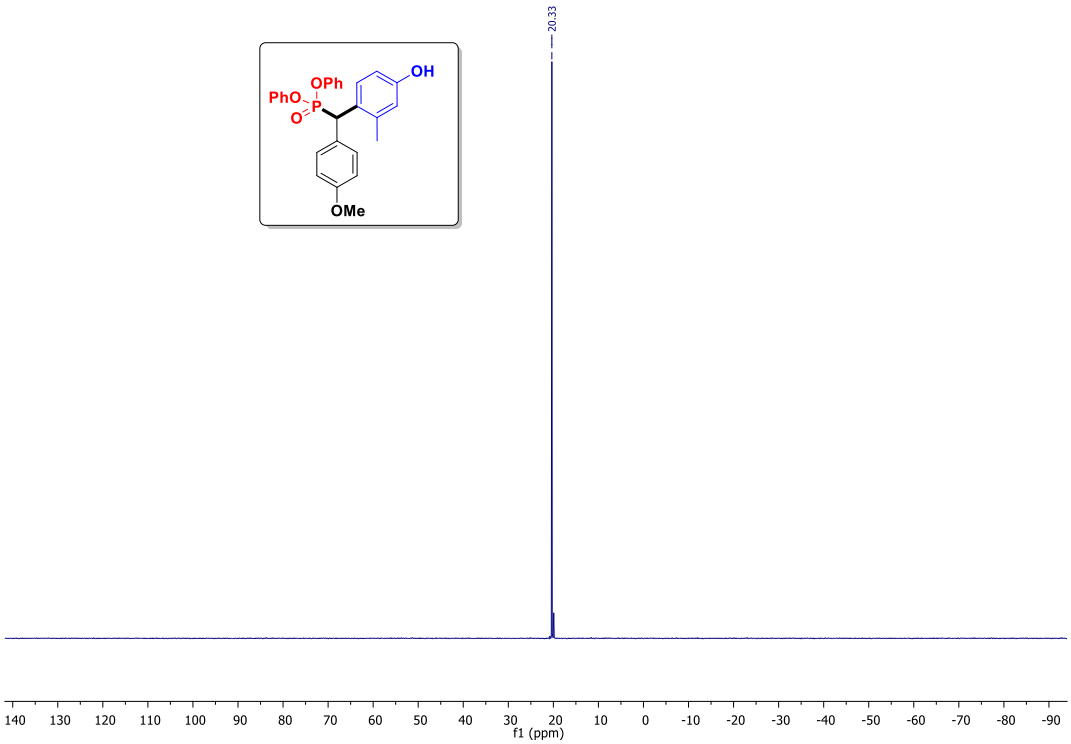


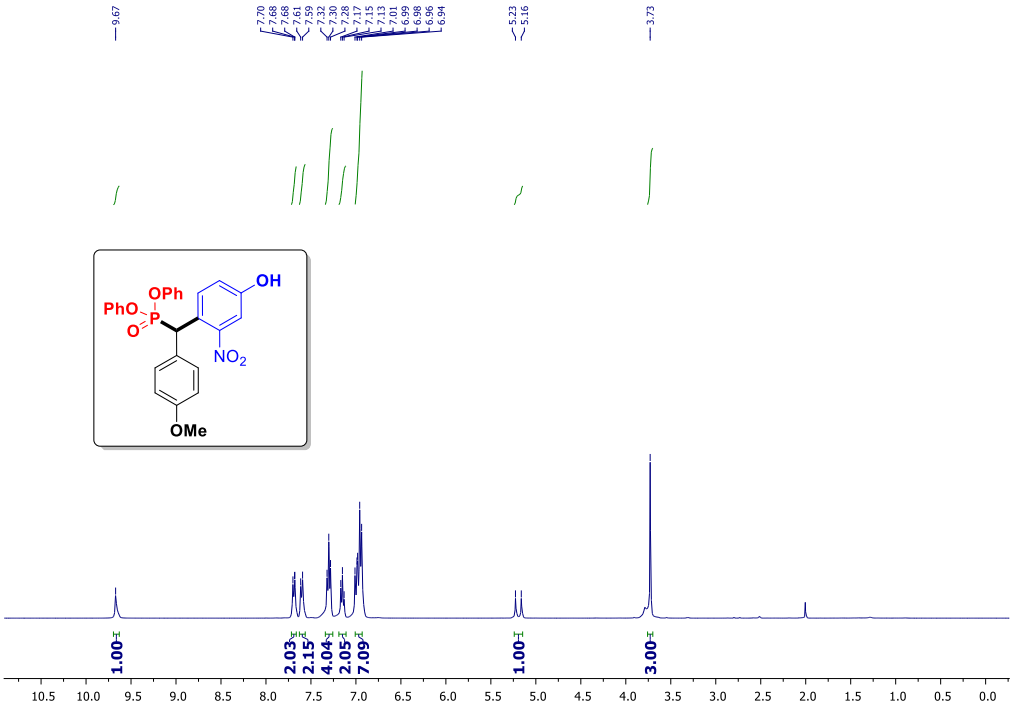
^{13}C NMR (101 MHz, DMSO- d_6) of 5j



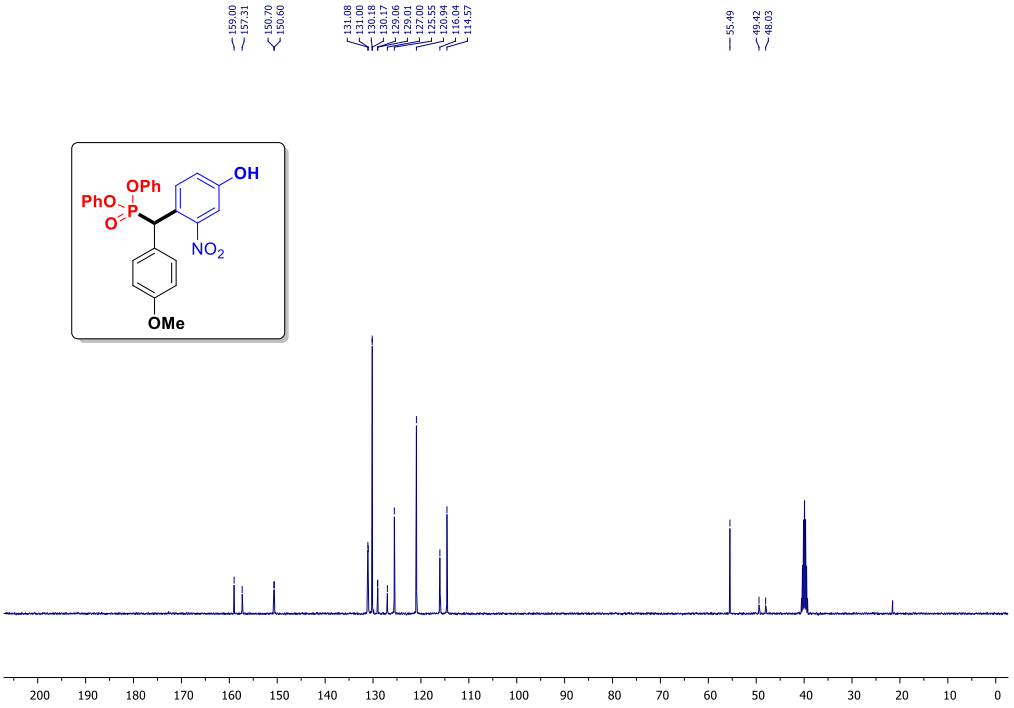
^{31}P NMR (400 MHz, DMSO-d_6) of 5j



^{1}H NMR (400 MHz, DMSO-d_6) of 5k



^{13}C NMR (101 MHz, DMSO- d_6) of 5k



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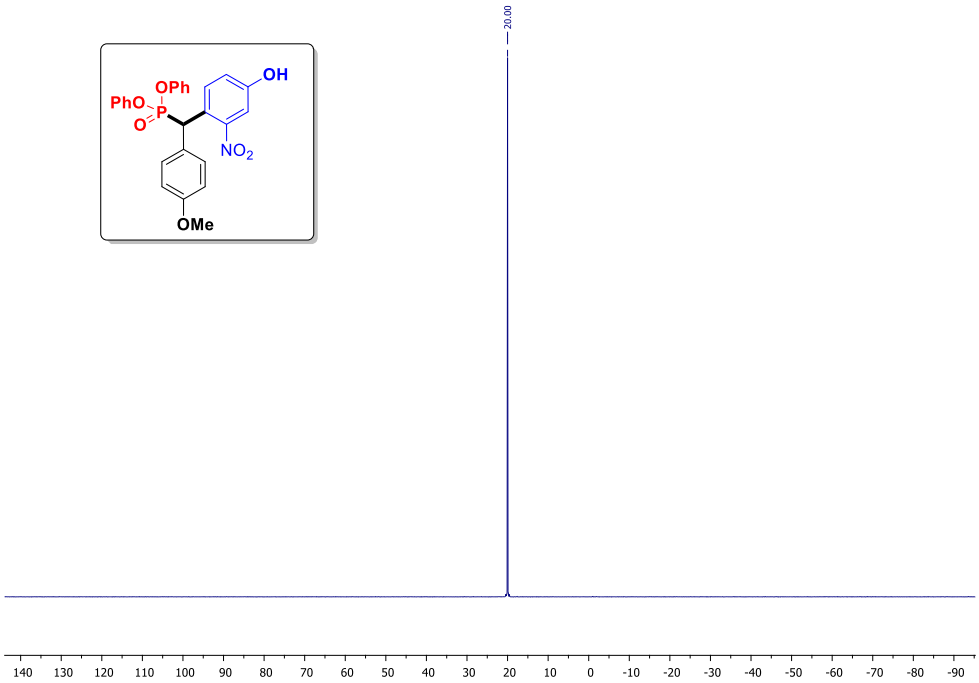
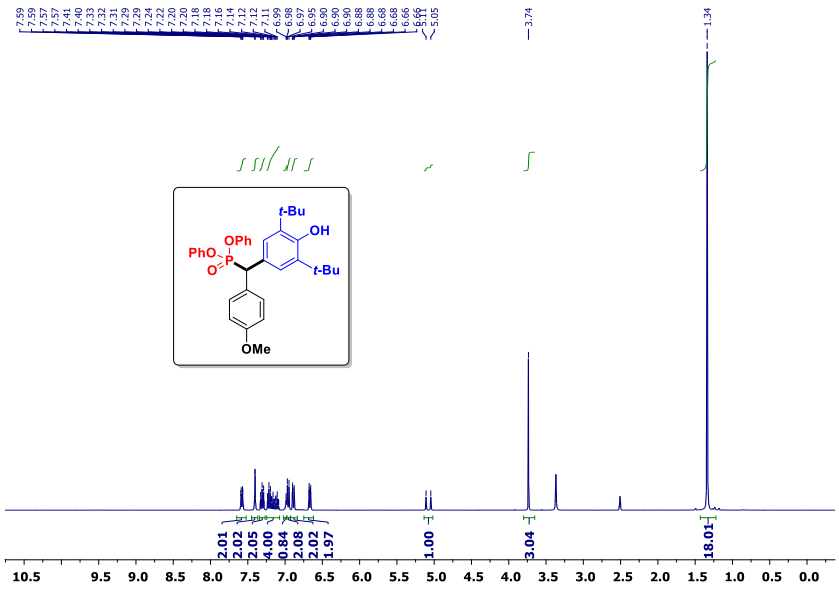
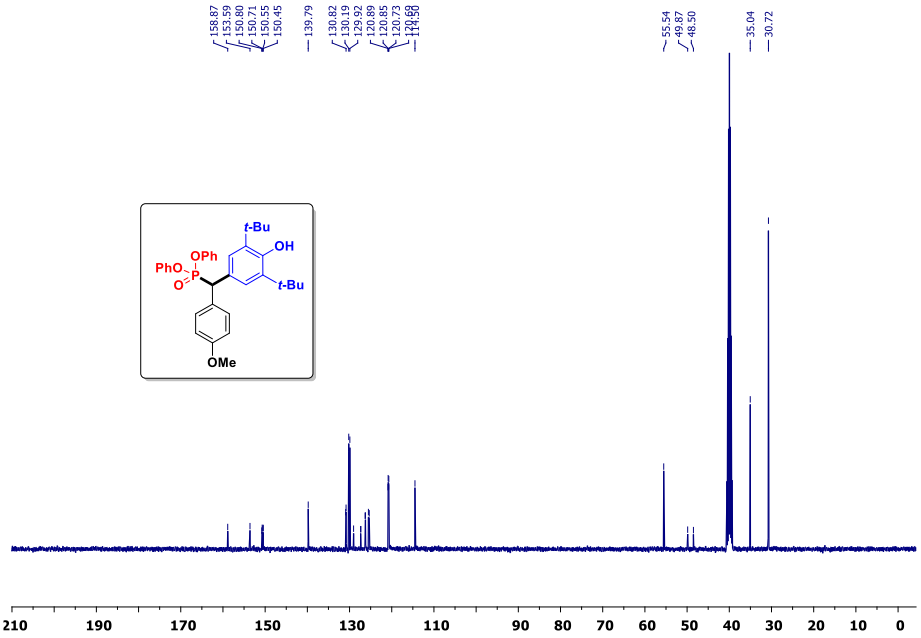


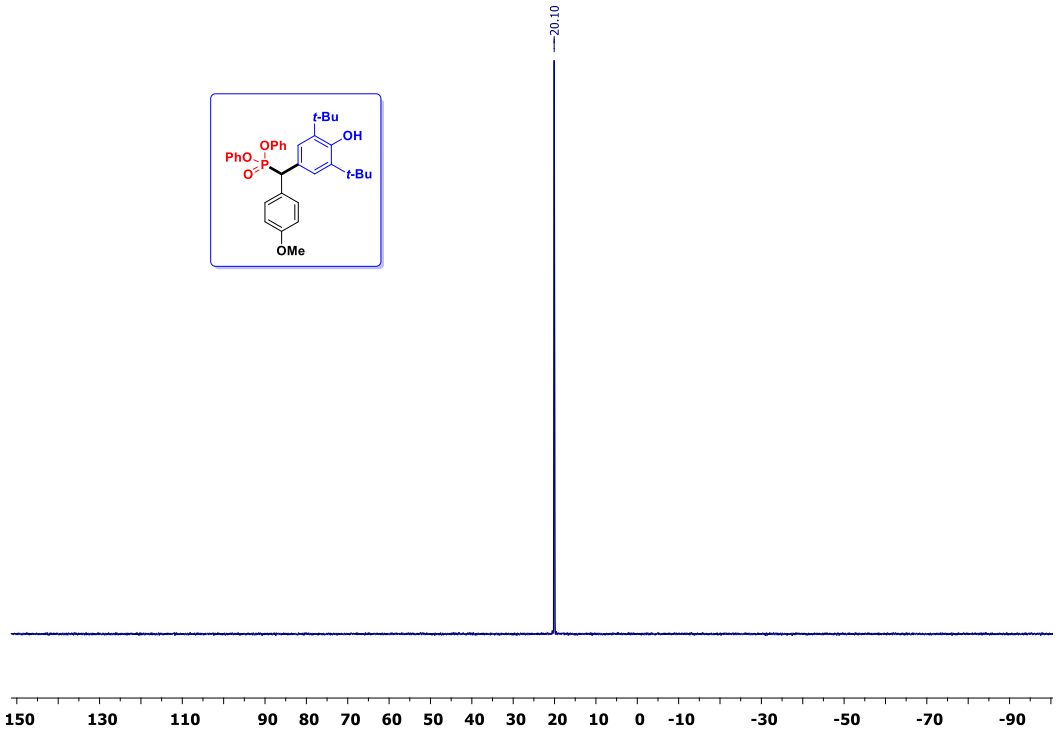
^{1}H NMR (400 MHz, DMSO-d_6) of 5l



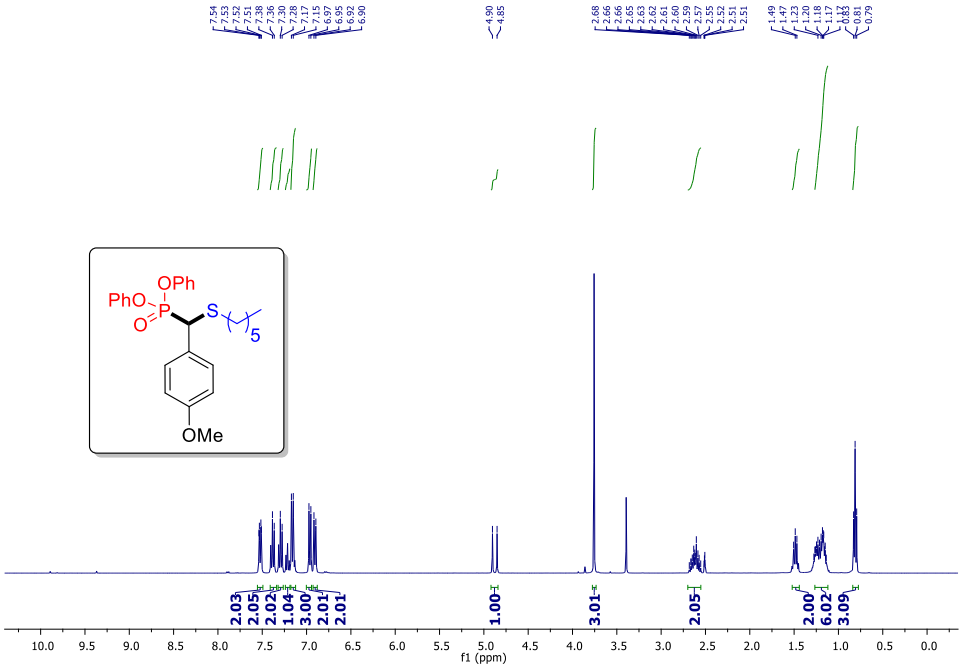
^{13}C NMR (101 MHz, DMSO- d_6) of 5l



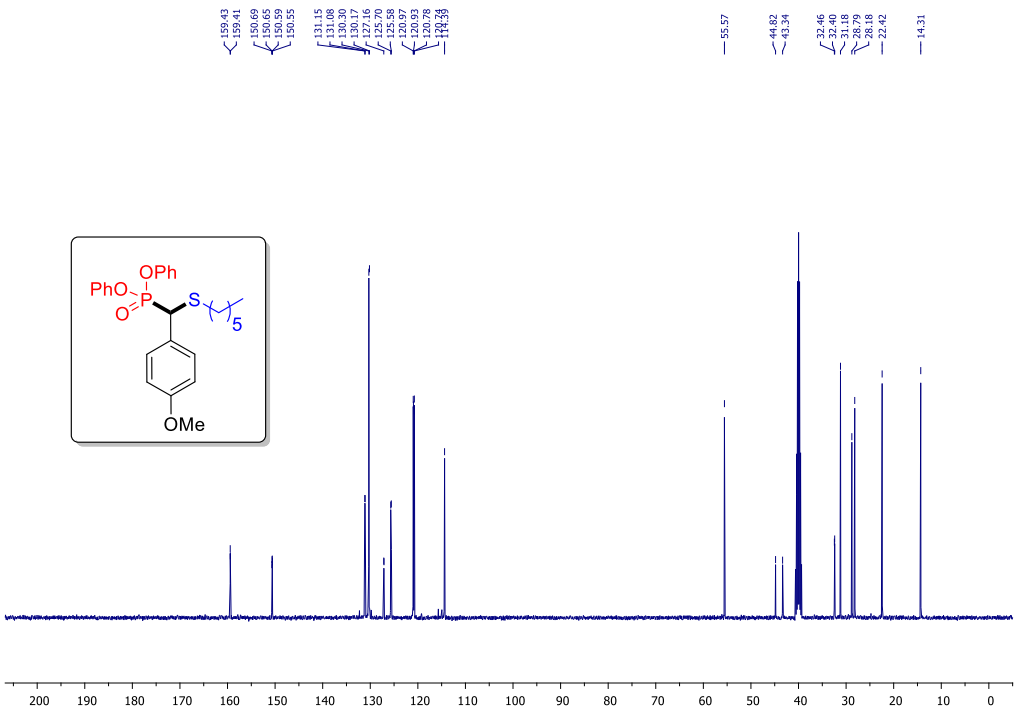
^{31}P NMR (400 MHz, DMSO-d_6) of 5l



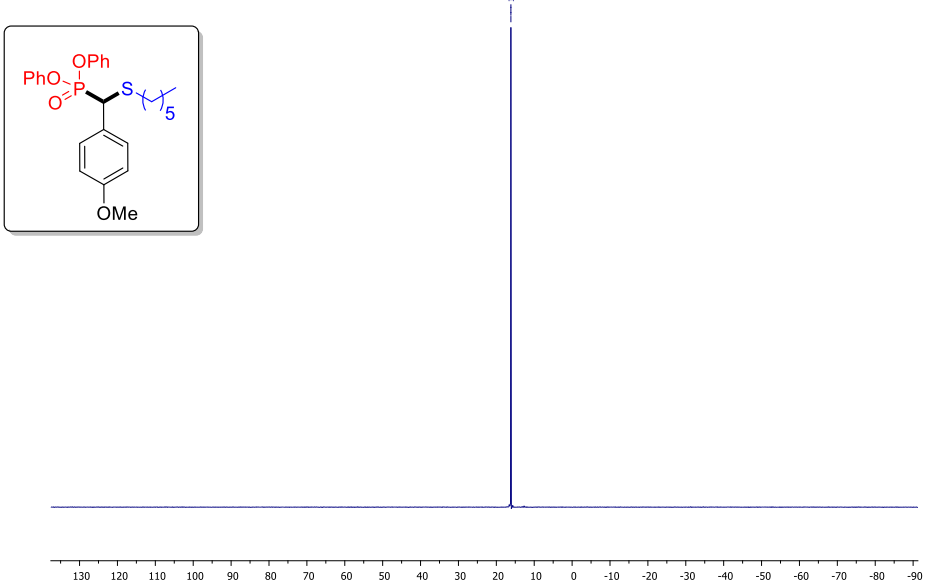
^{1}H NMR (400 MHz, DMSO-d_6) of 7a



^{13}C NMR (101 MHz, DMSO- d_6) of 7a



^{31}P NMR (400 MHz, DMSO-d_6) of 7a



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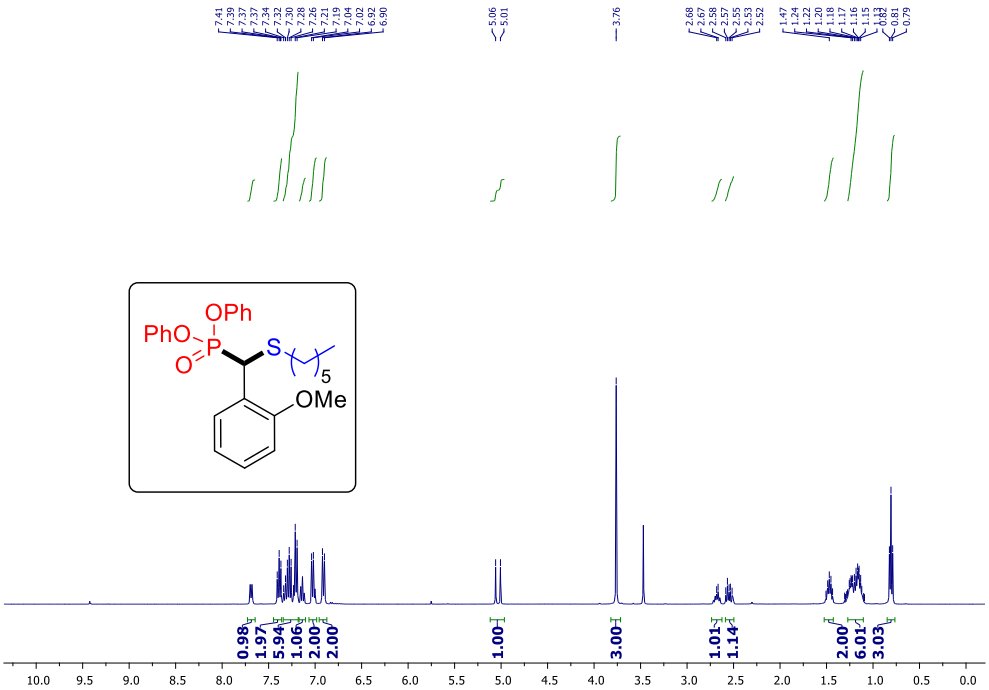
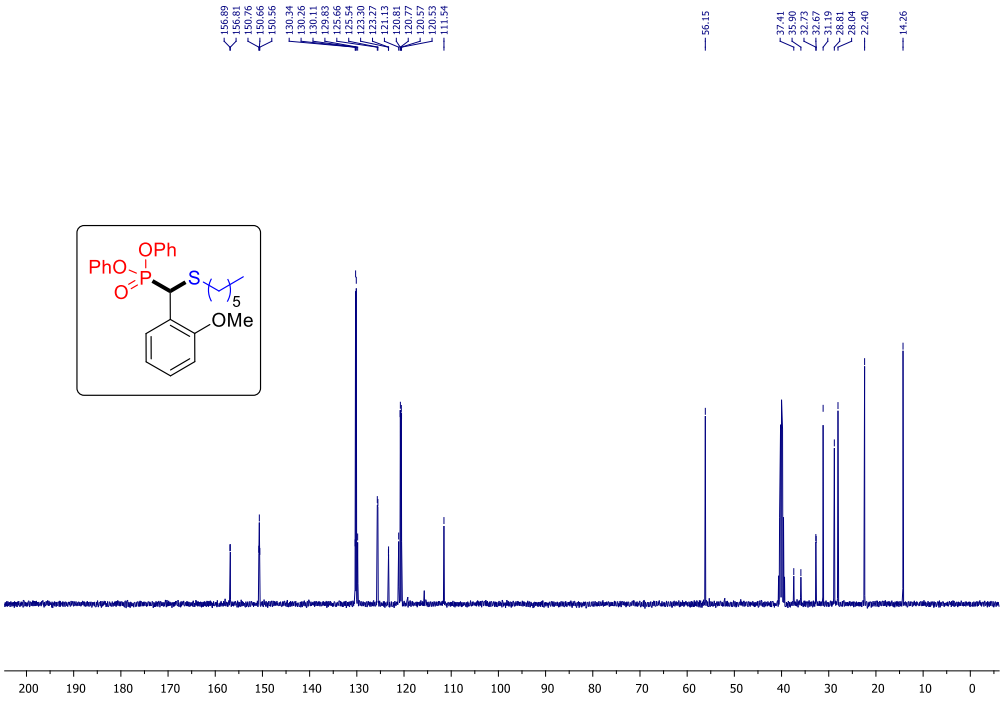
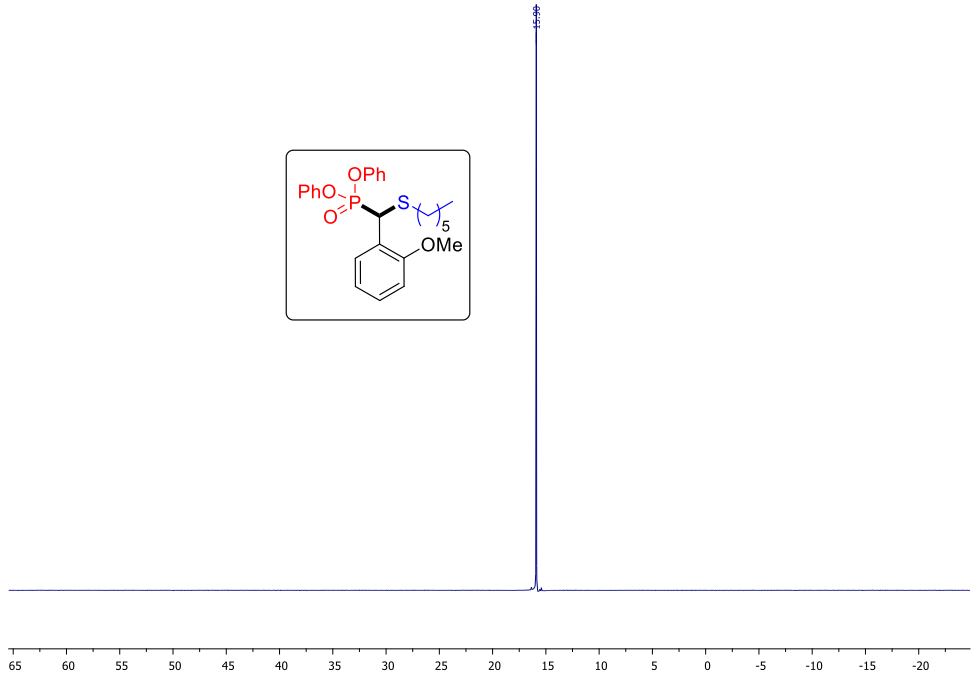


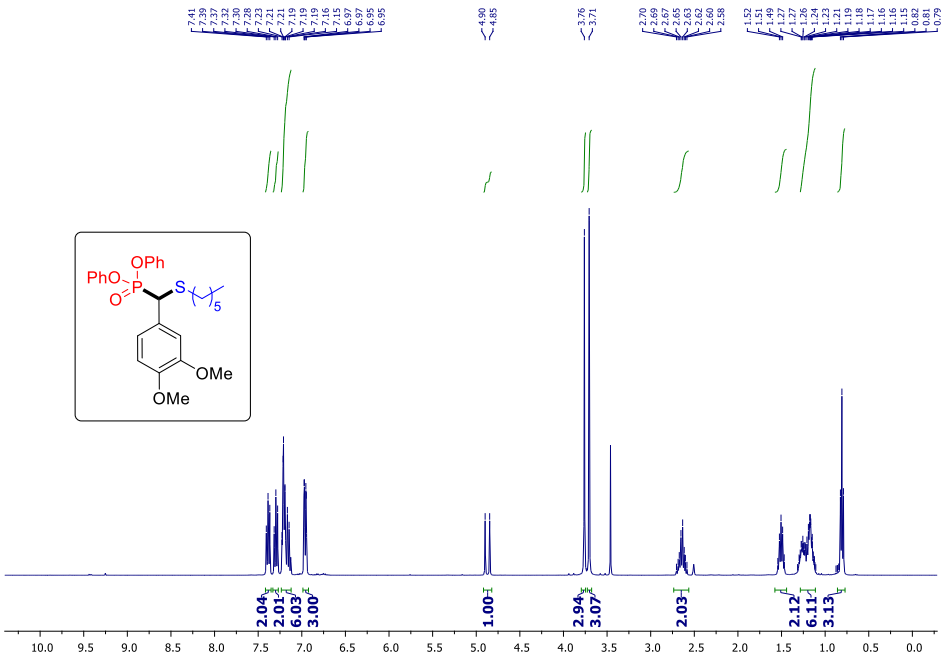
^{13}C NMR (101 MHz, DMSO- d_6) of 7b



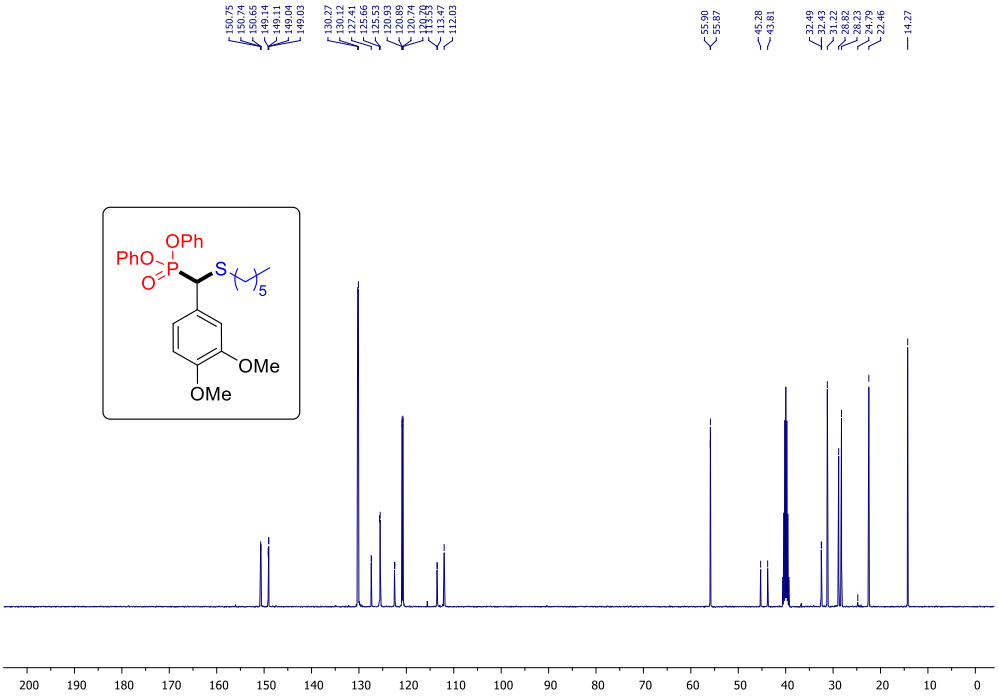
^{31}P NMR (400 MHz, DMSO-d_6) of 7b



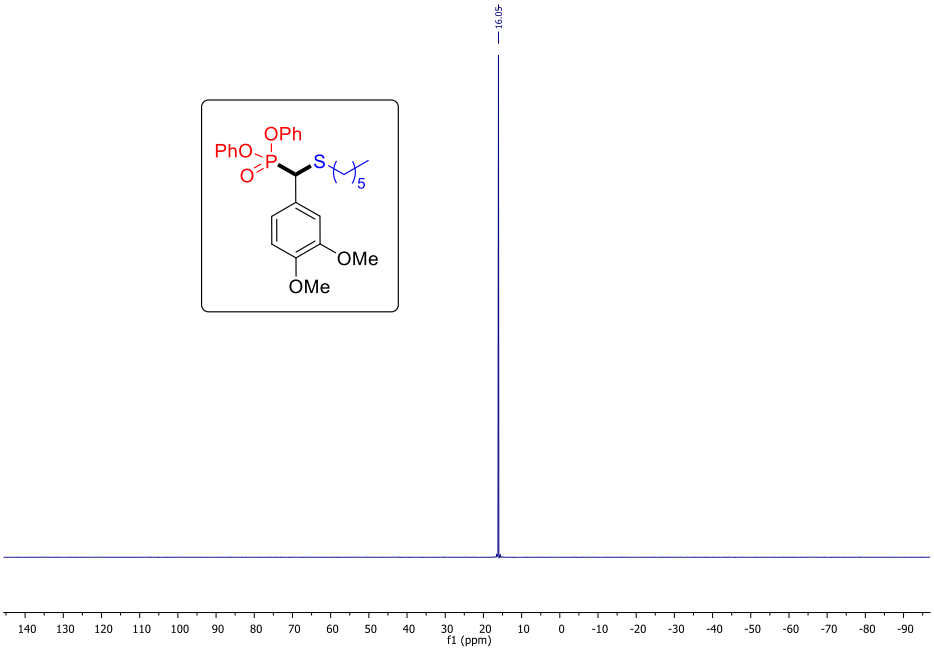
^{1}H NMR (400 MHz, DMSO-d_6) of 7c



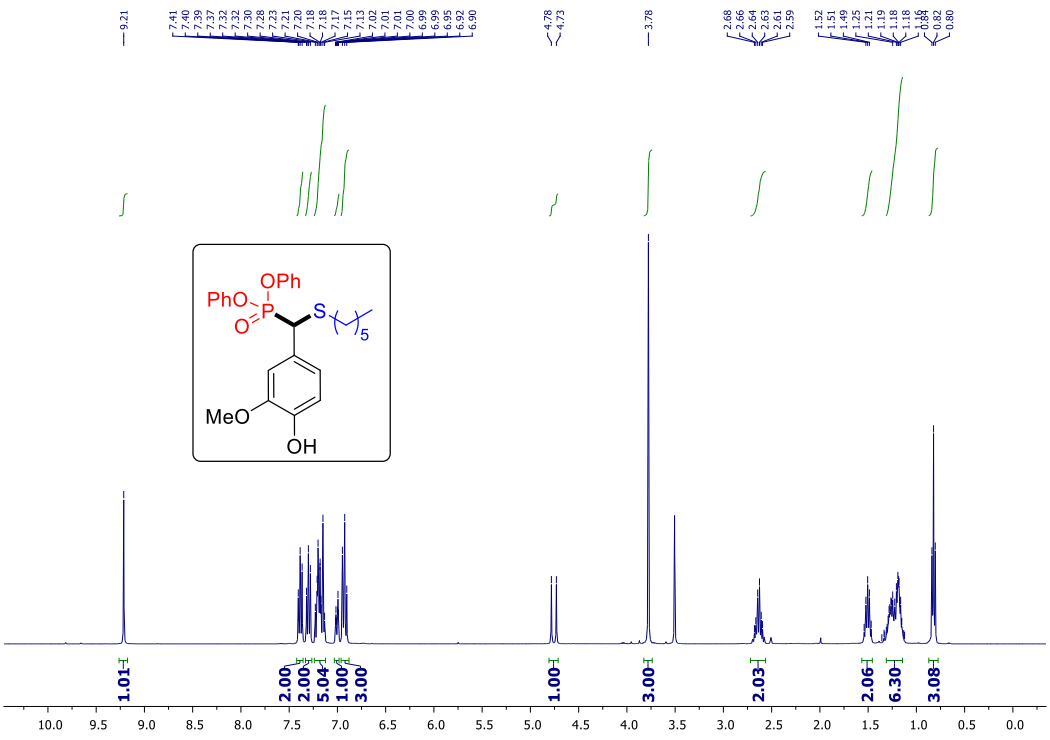
^{13}C NMR (101 MHz, DMSO- d_6) of 7c



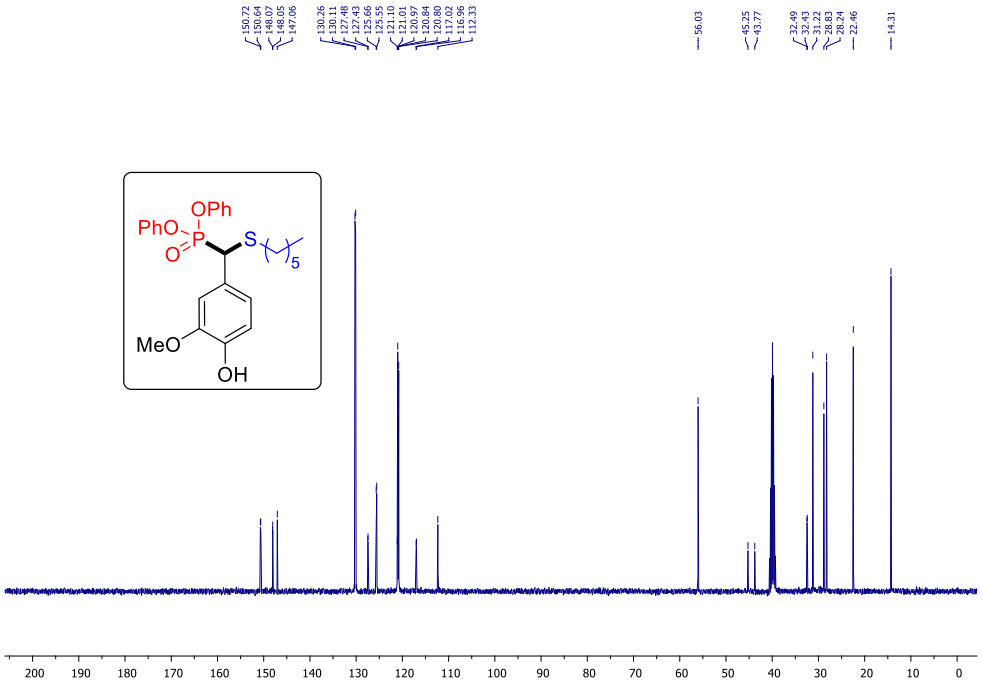
^{31}P NMR (400 MHz, DMSO-d_6) of 7c



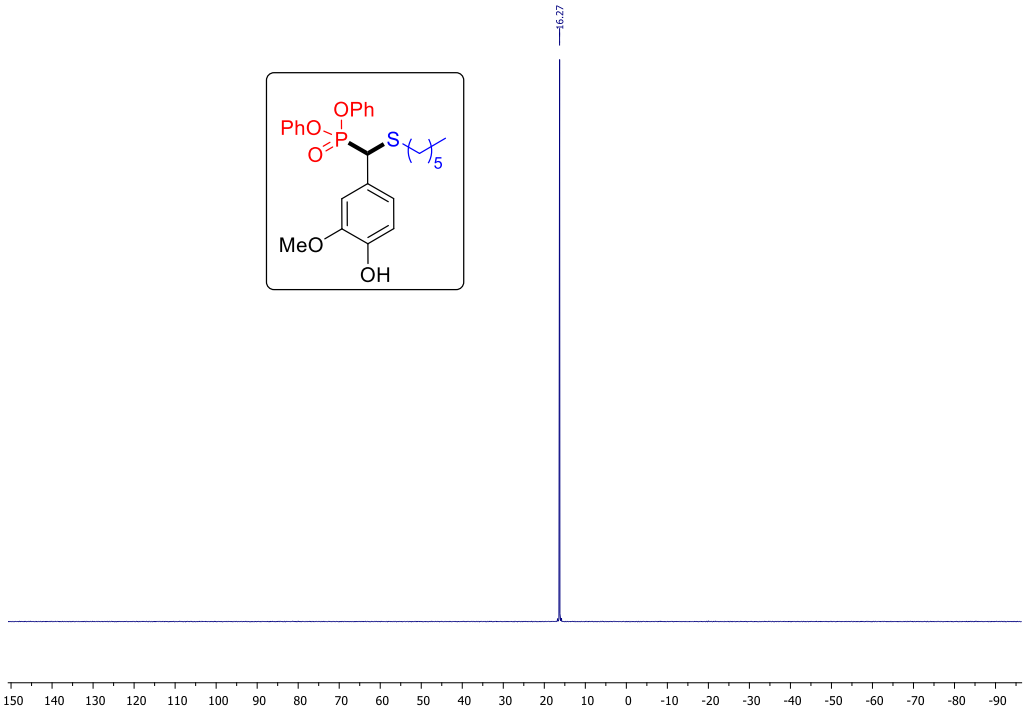
^{1}H NMR (400 MHz, DMSO-d_6) of 7d



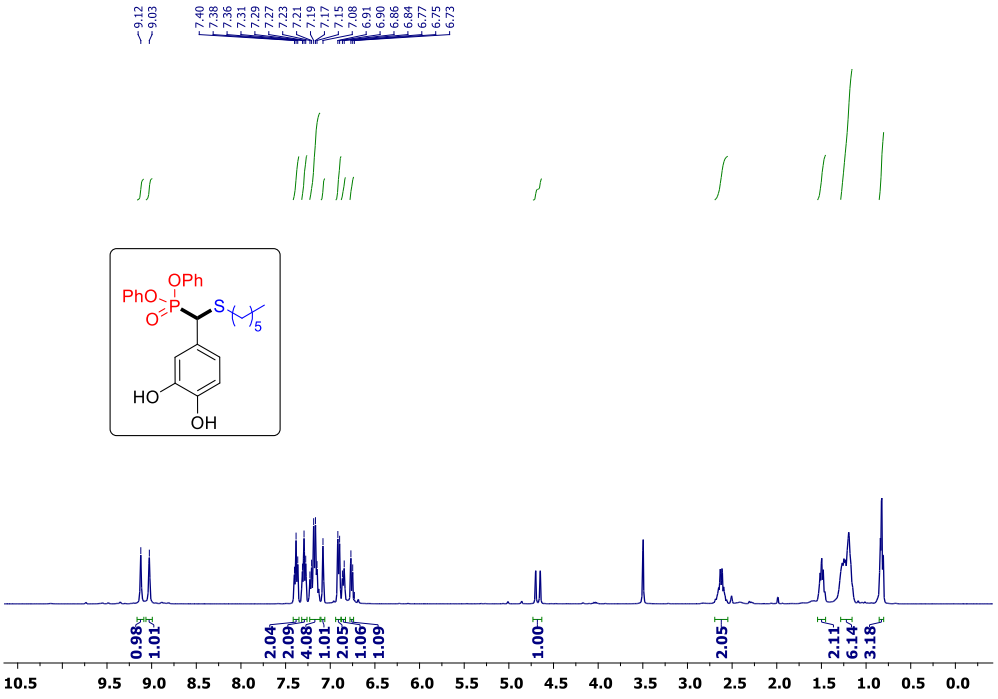
^{13}C NMR (101 MHz, DMSO- d_6) of 7d



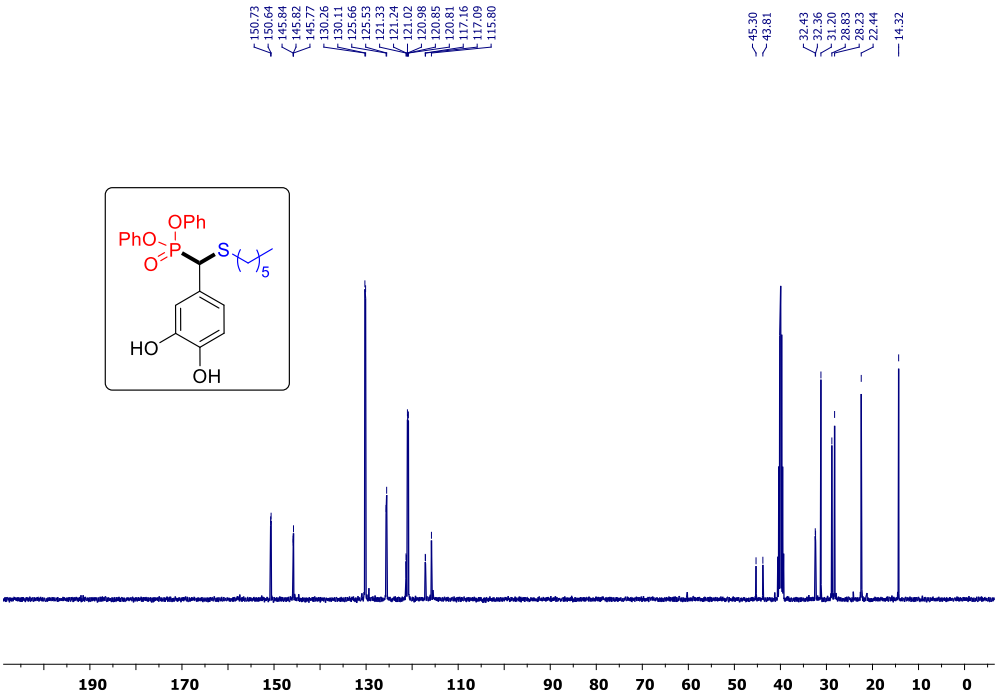
^{31}P NMR (400 MHz, DMSO-d_6) of 7d



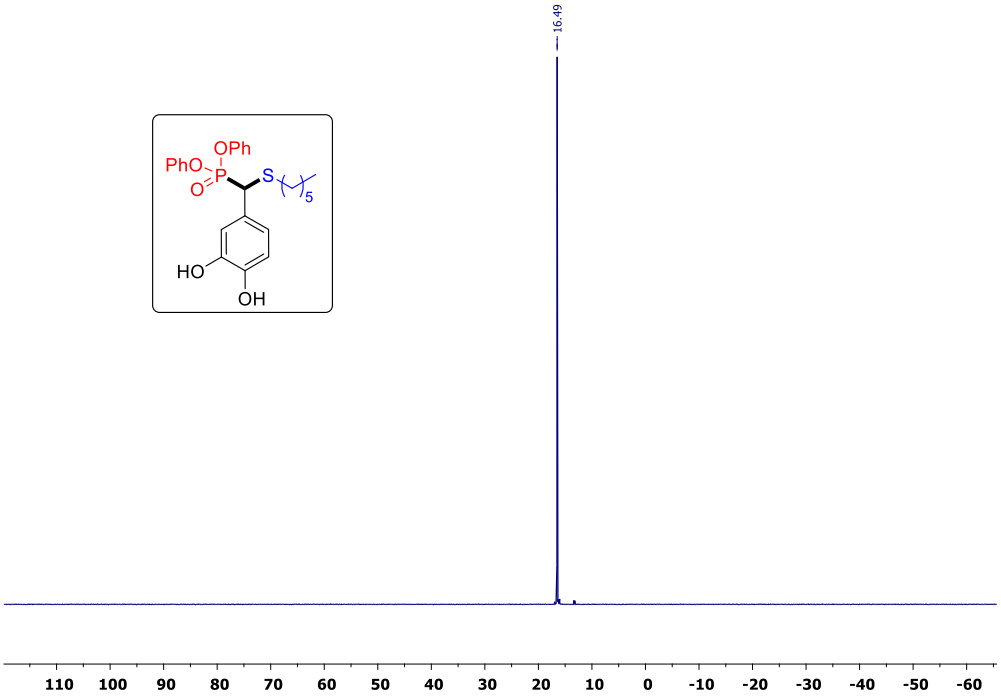
^{1}H NMR (400 MHz, DMSO-d_6) of 7e



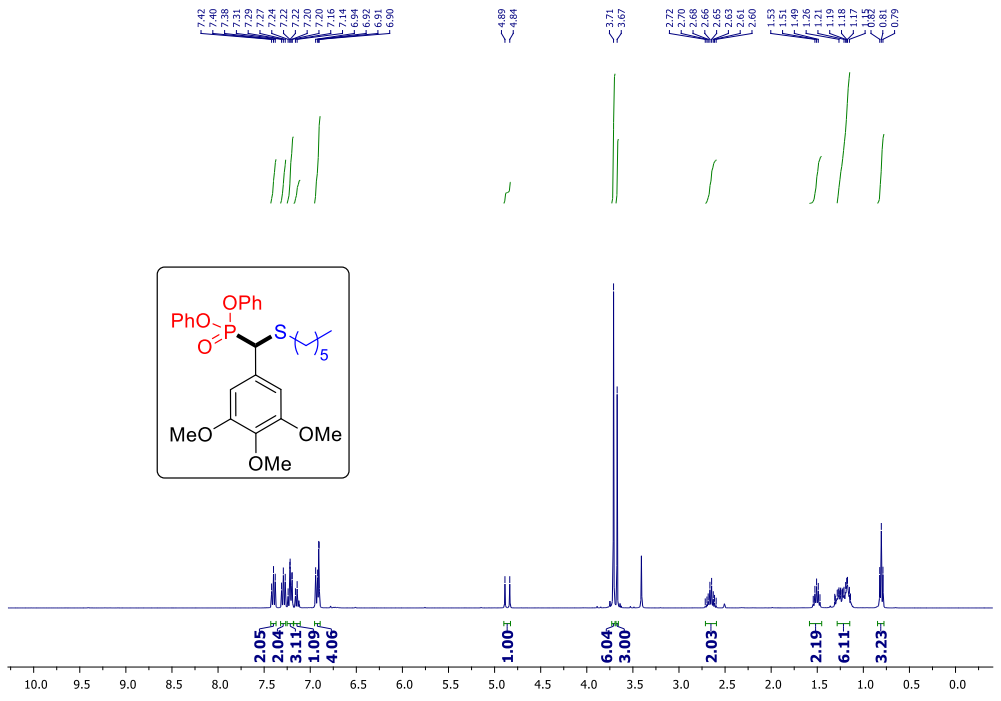
^{13}C NMR (101 MHz, DMSO- d_6) of 7e



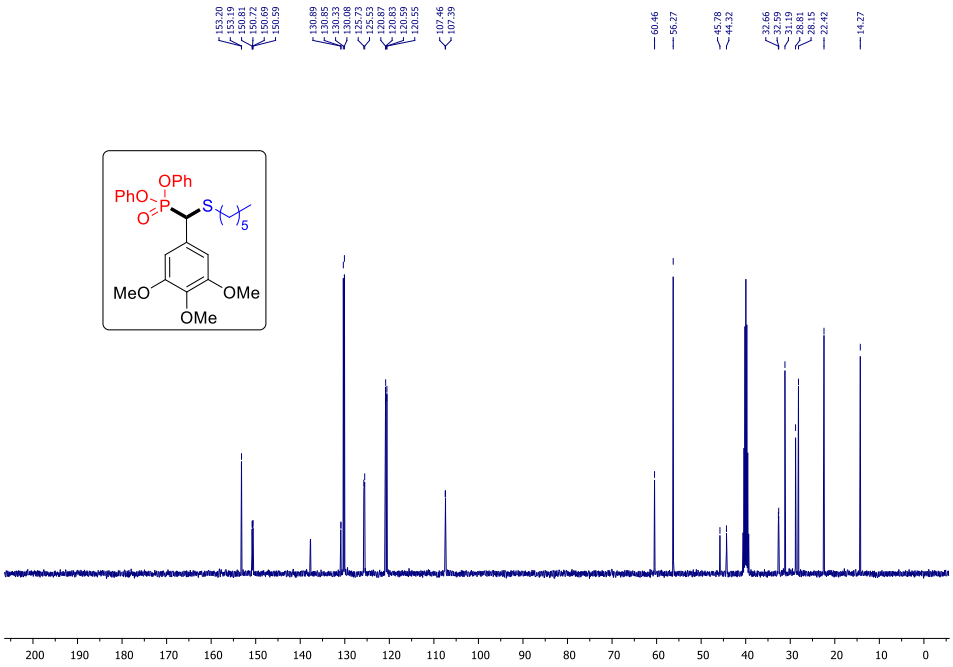
^{31}P NMR (400 MHz, DMSO-d_6) of 7e



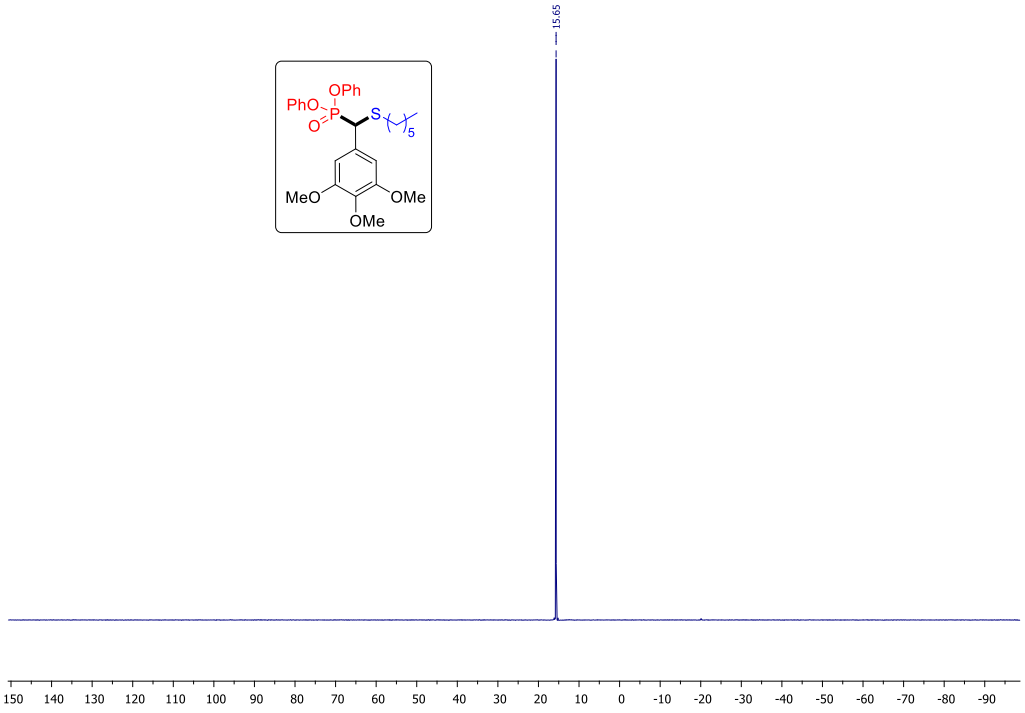
^{1}H NMR (400 MHz, DMSO-d_6) of 7f



^{13}C NMR (101 MHz, DMSO- d_6) of 7f



^{31}P NMR (400 MHz, DMSO-d_6) of 7f



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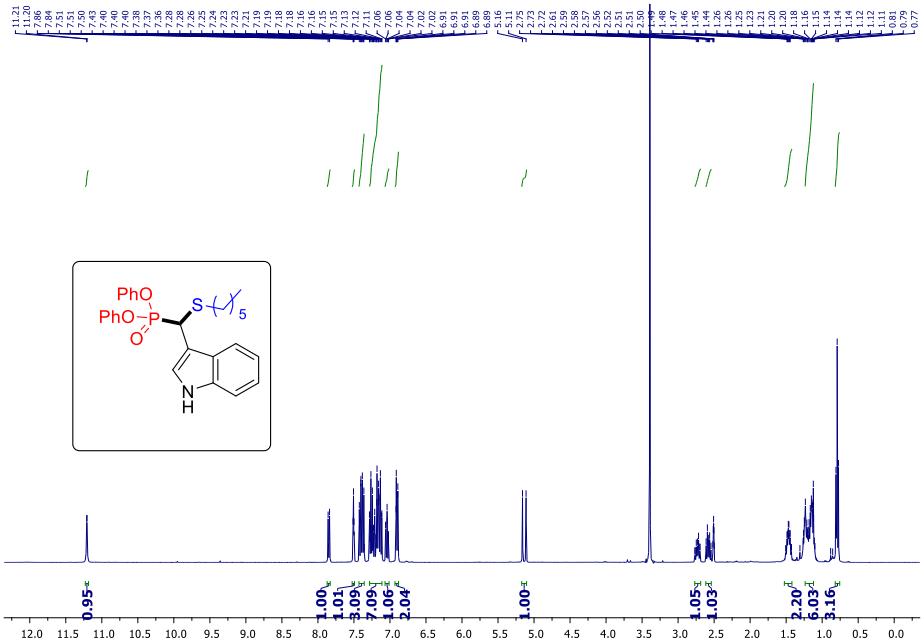
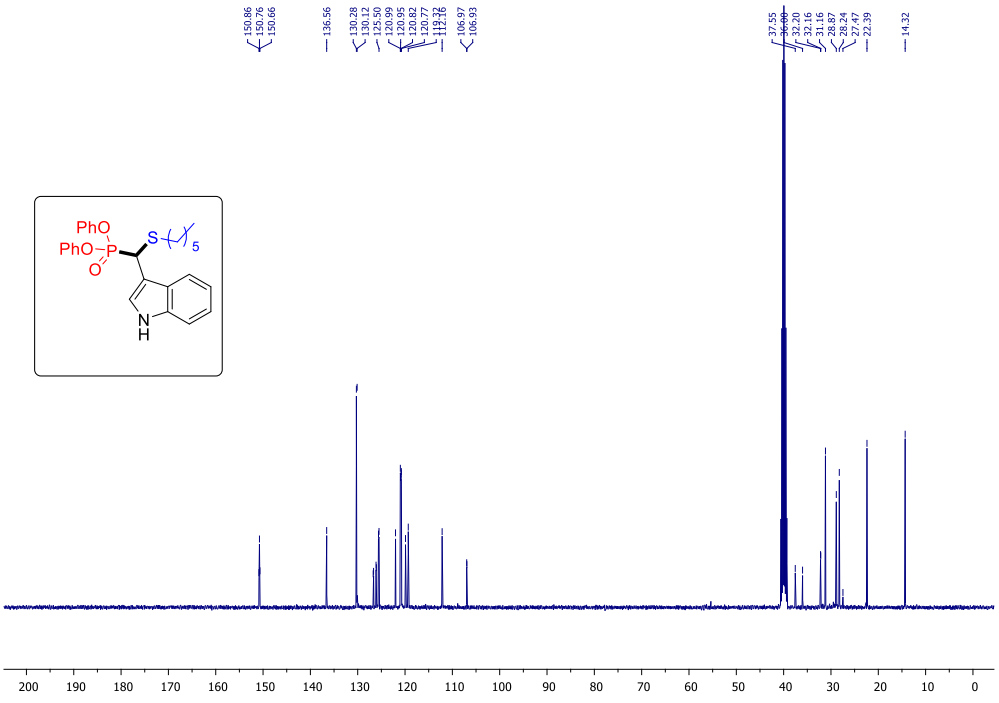


^{13}C NMR (101 MHz, DMSO- d_6) of 7g



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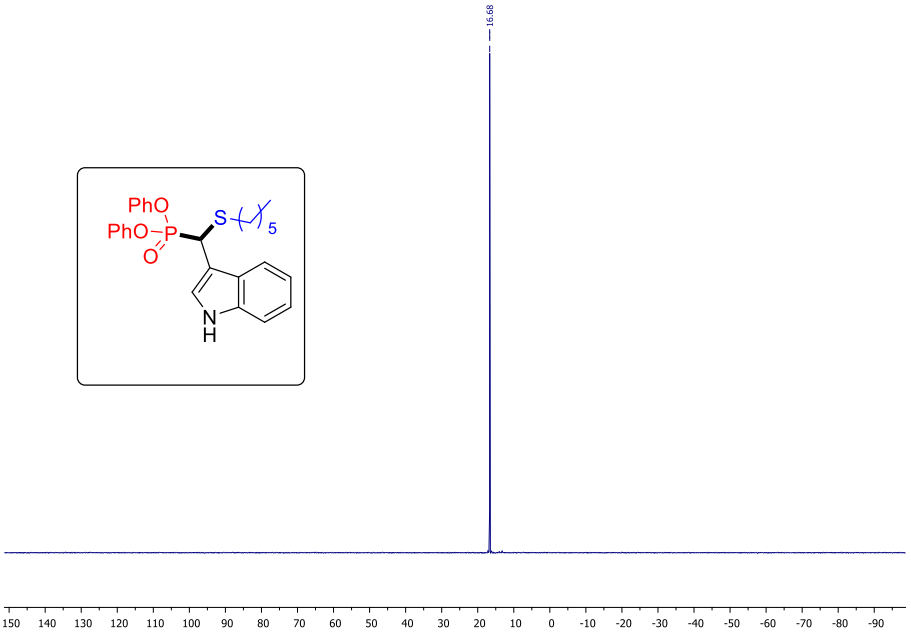

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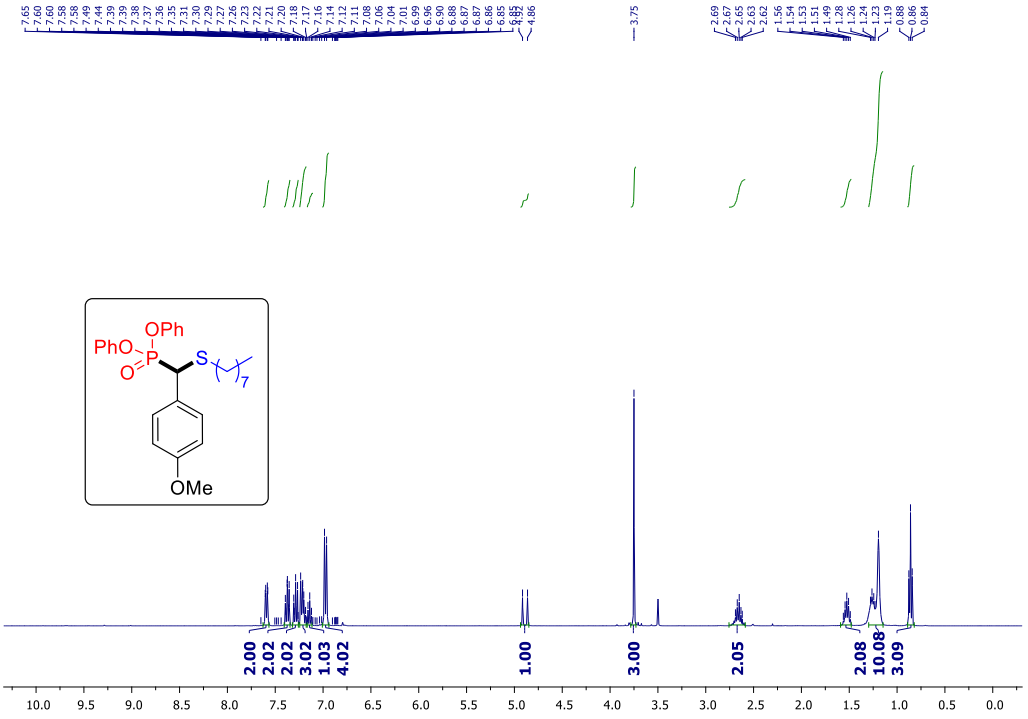
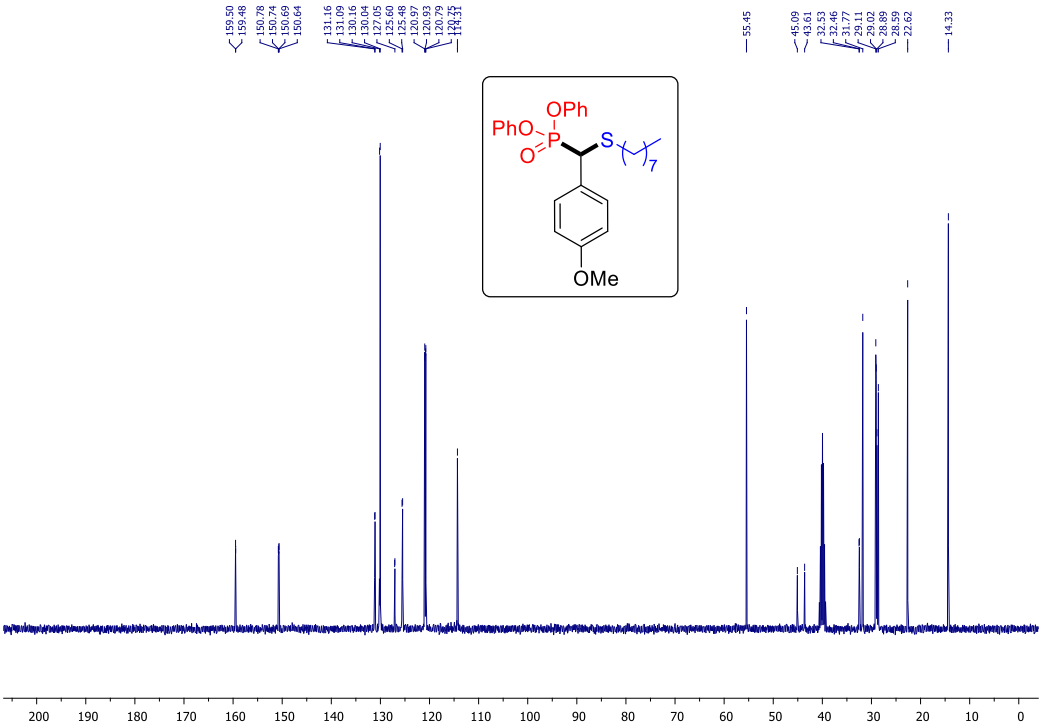
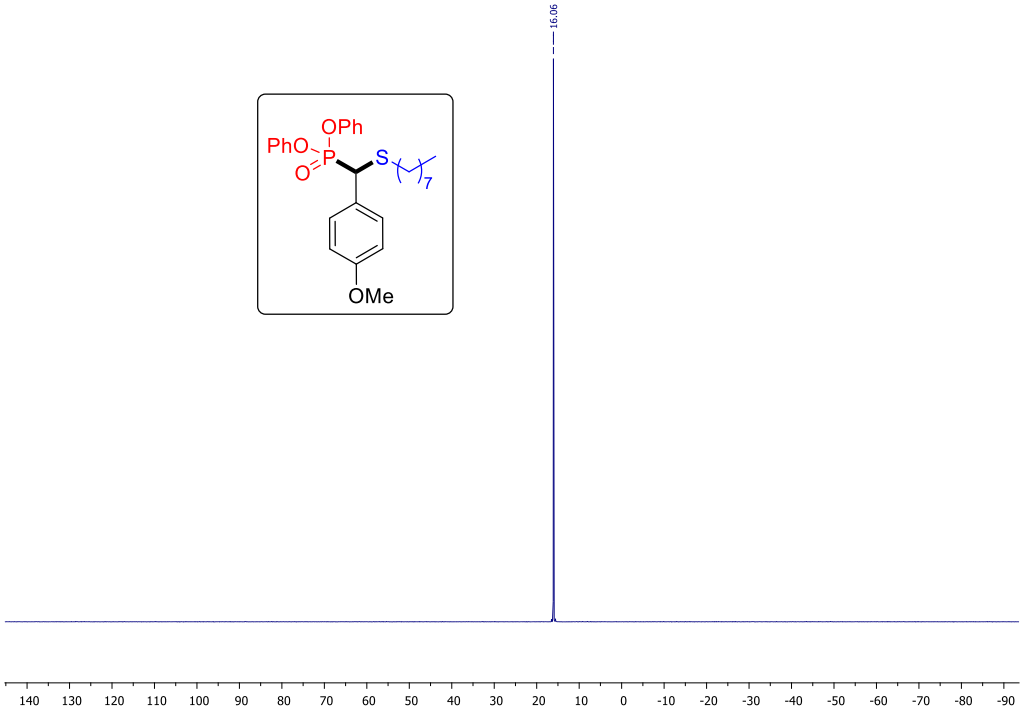


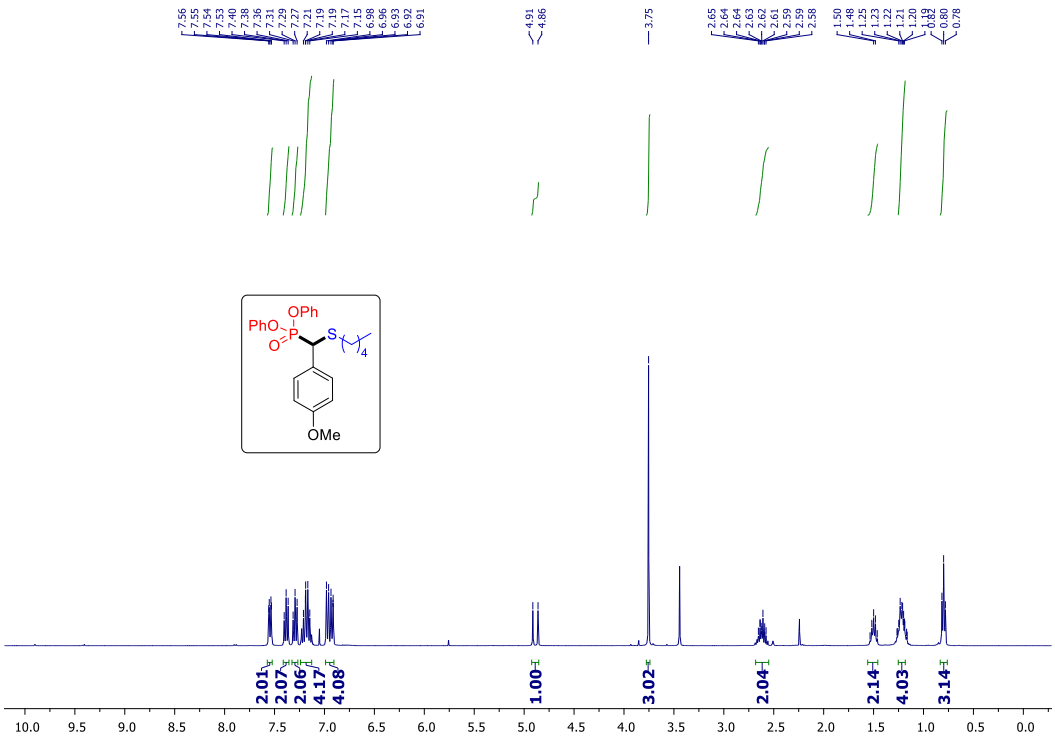
^{13}C NMR (101 MHz, DMSO- d_6) of 7h



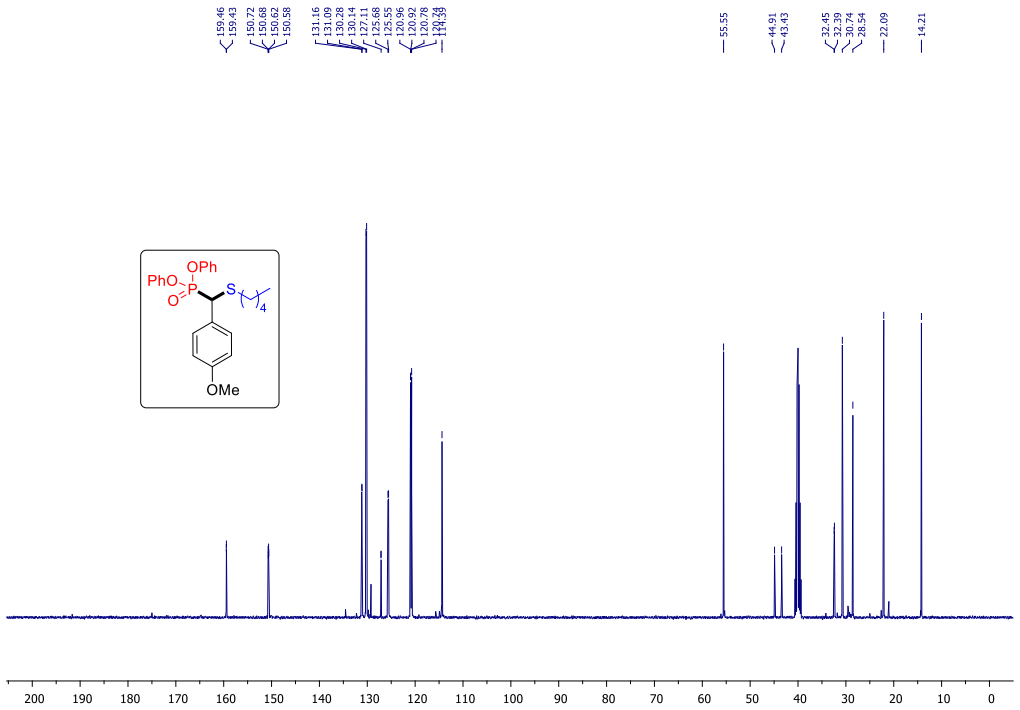
^{31}P NMR (400 MHz, DMSO-d_6) of 7h



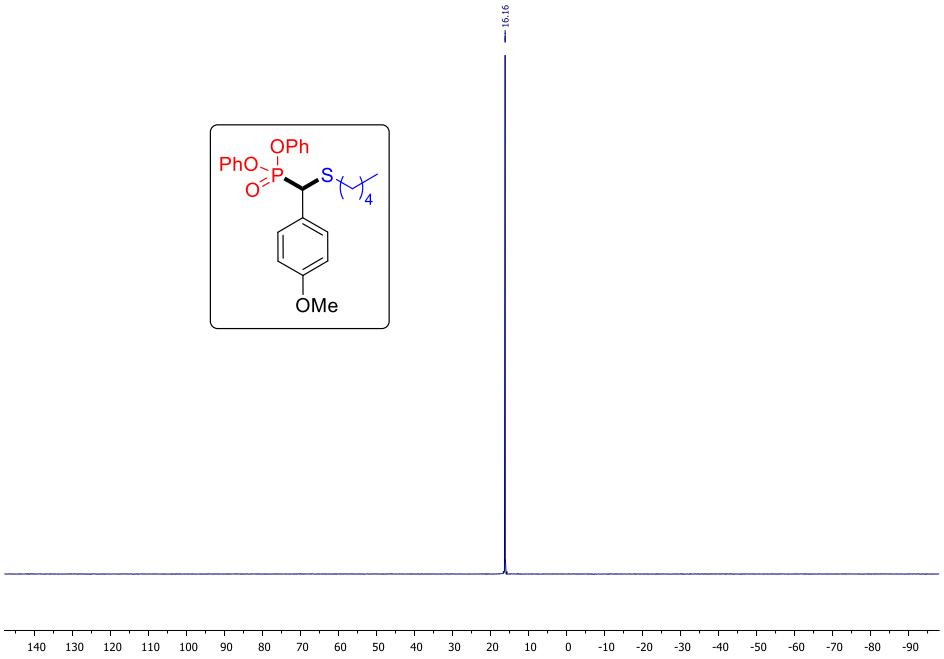
^{1}H NMR (400 MHz, DMSO-d_6) of 7i



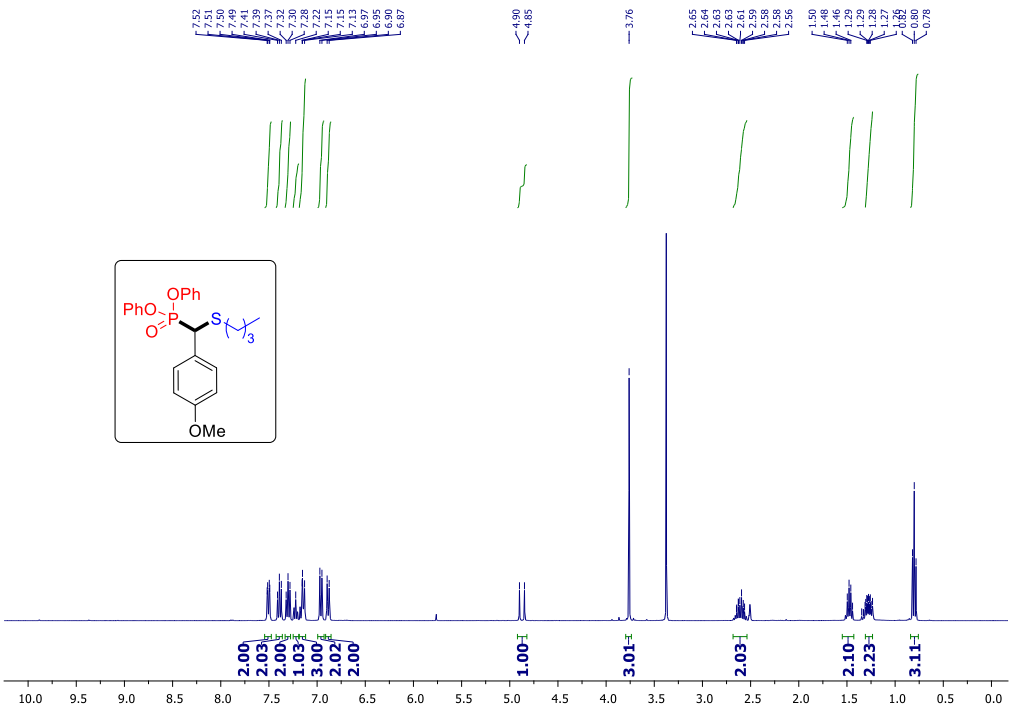
^{13}C NMR (101 MHz, DMSO- d_6) of 7i



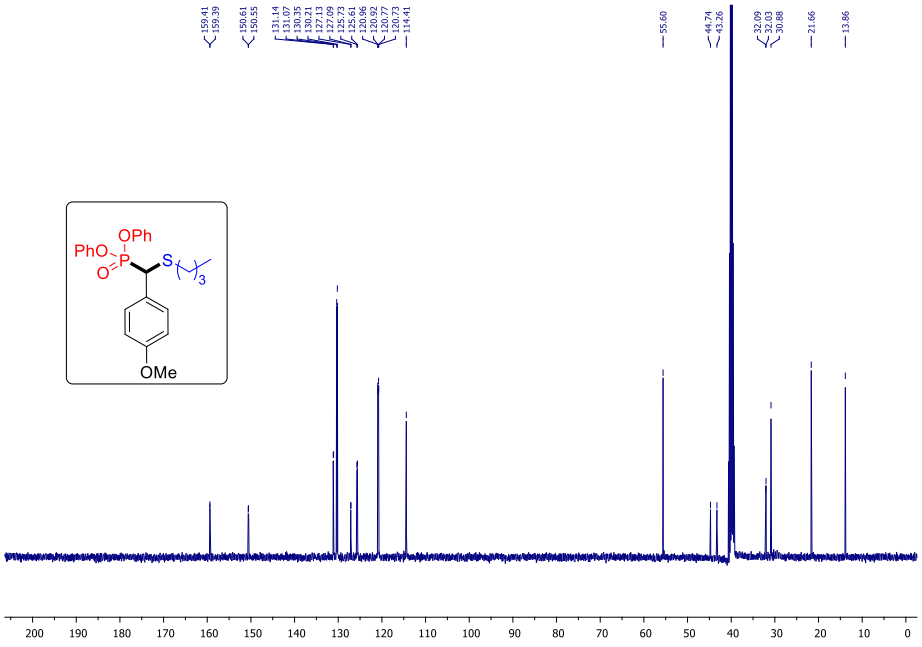
^{31}P NMR (400 MHz, DMSO-d_6) of 7i



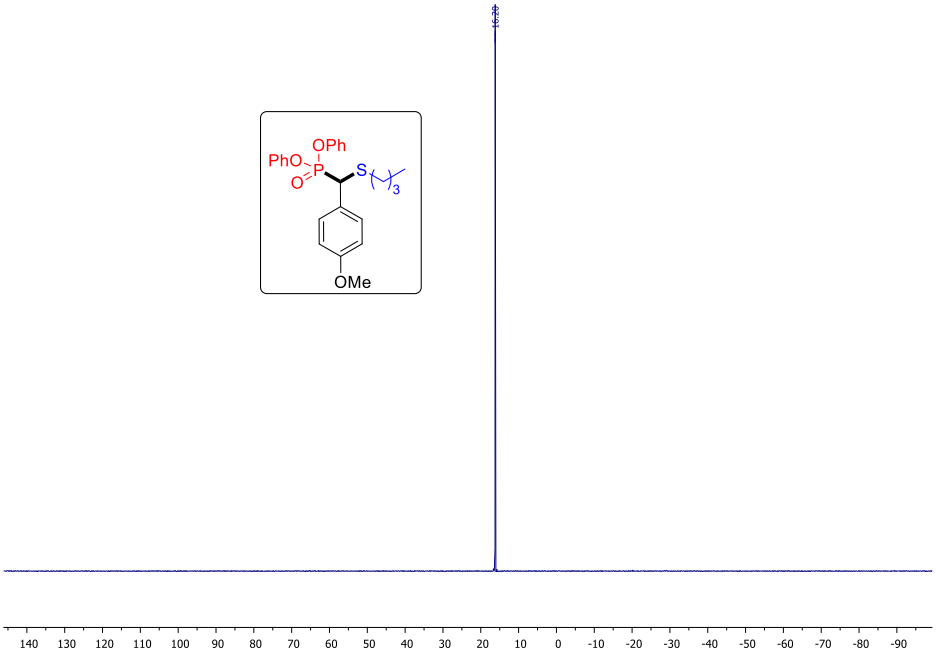
^{1}H NMR (400 MHz, DMSO-d_6) of 7j



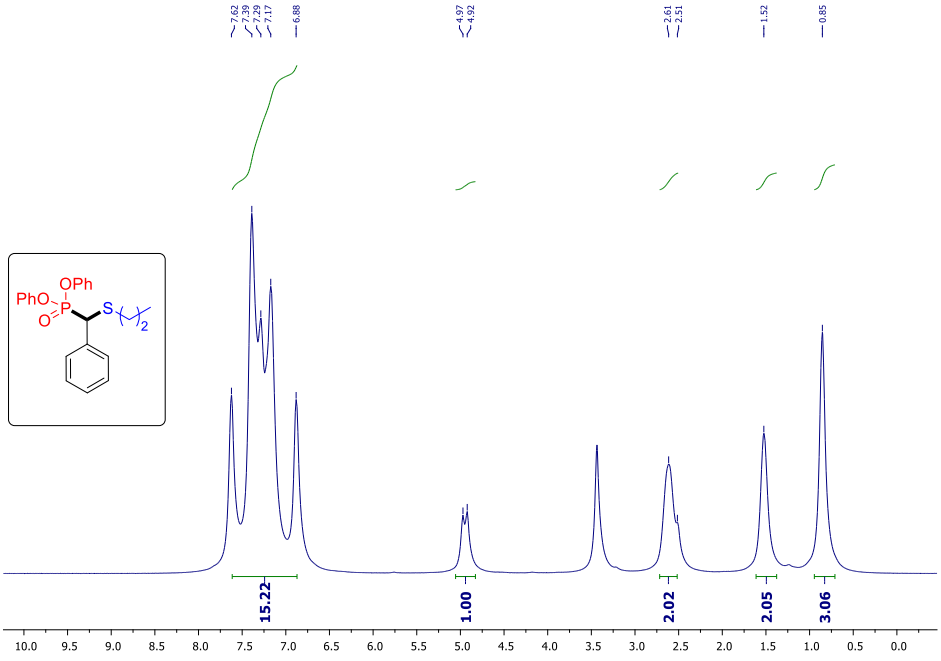
^{13}C NMR (101 MHz, DMSO- d_6) of 7j



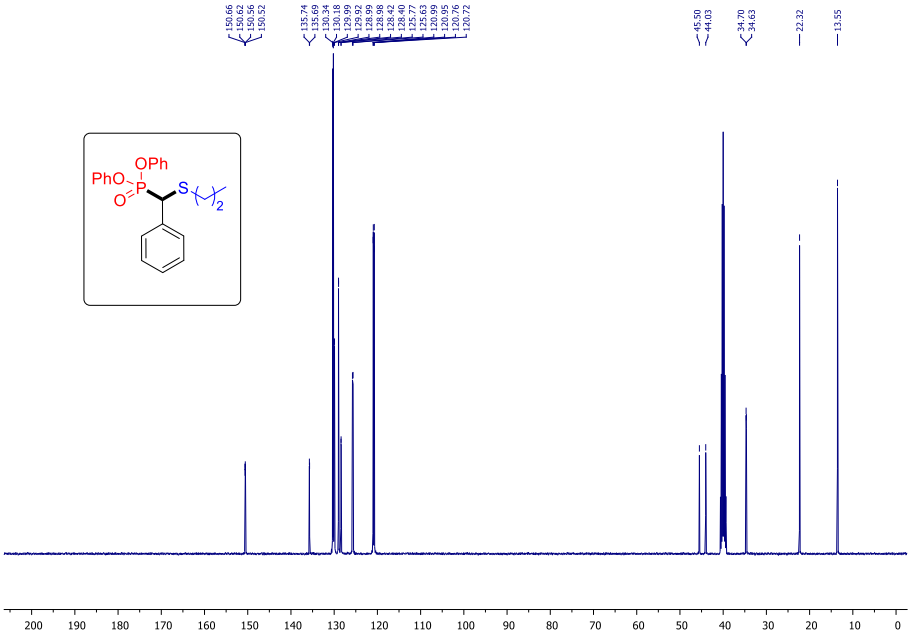
^{31}P NMR (400 MHz, DMSO-d_6) of 7j



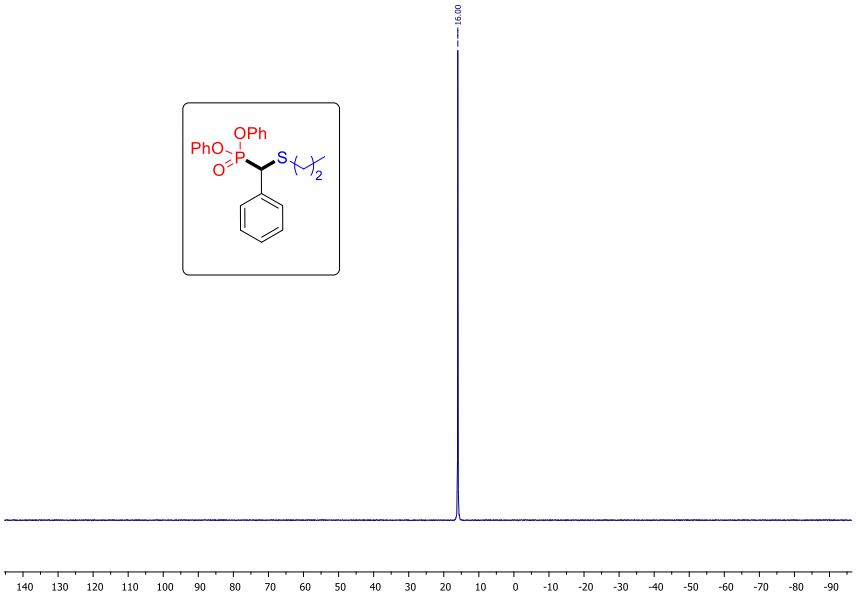
^{1}H NMR (400 MHz, DMSO-d_6) of 7k



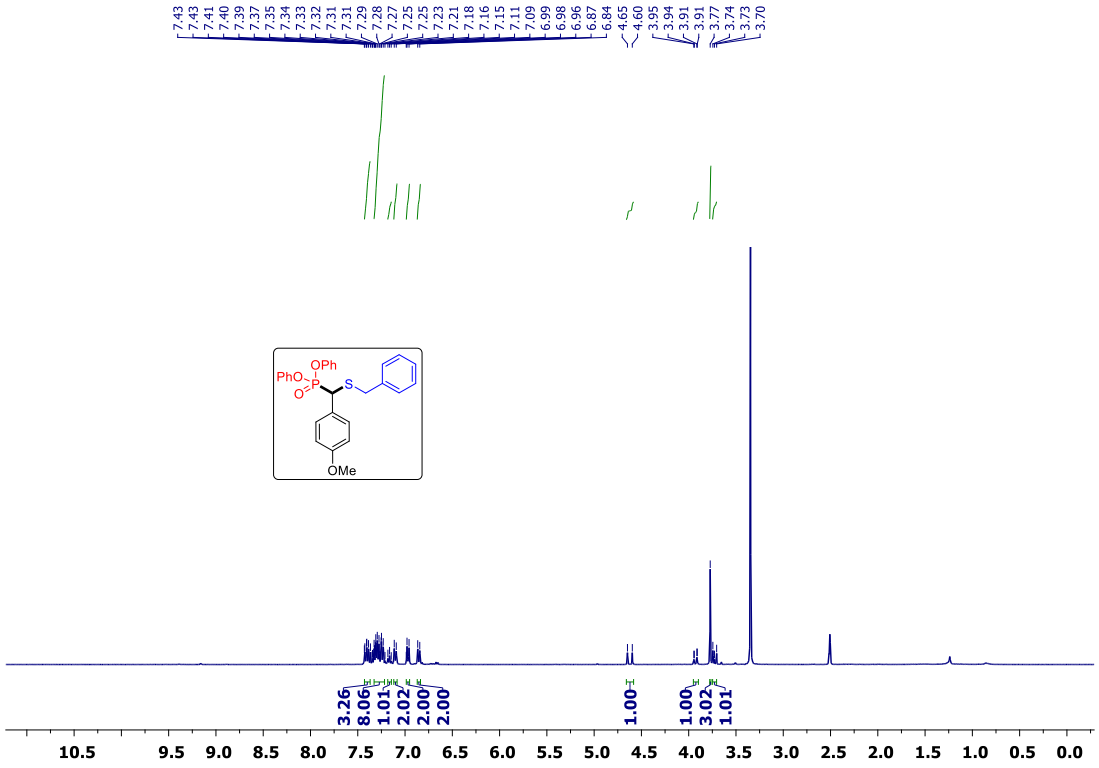
^{13}C NMR (101 MHz, DMSO- d_6) of 7k



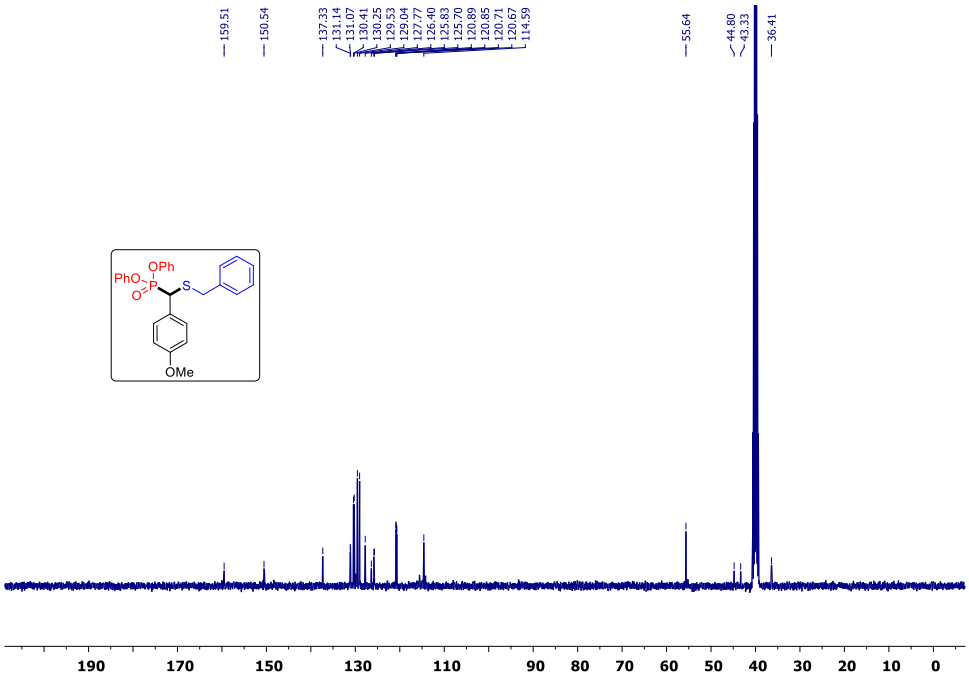
^{31}P NMR (400 MHz, DMSO-d_6) of 7k



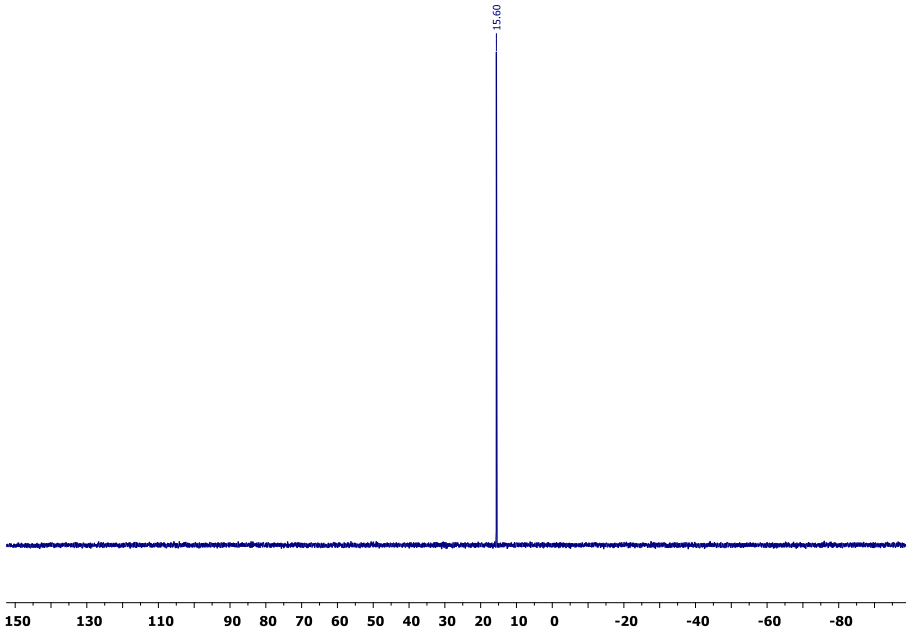
^{1}H NMR (400 MHz, DMSO-d_6) of 7l



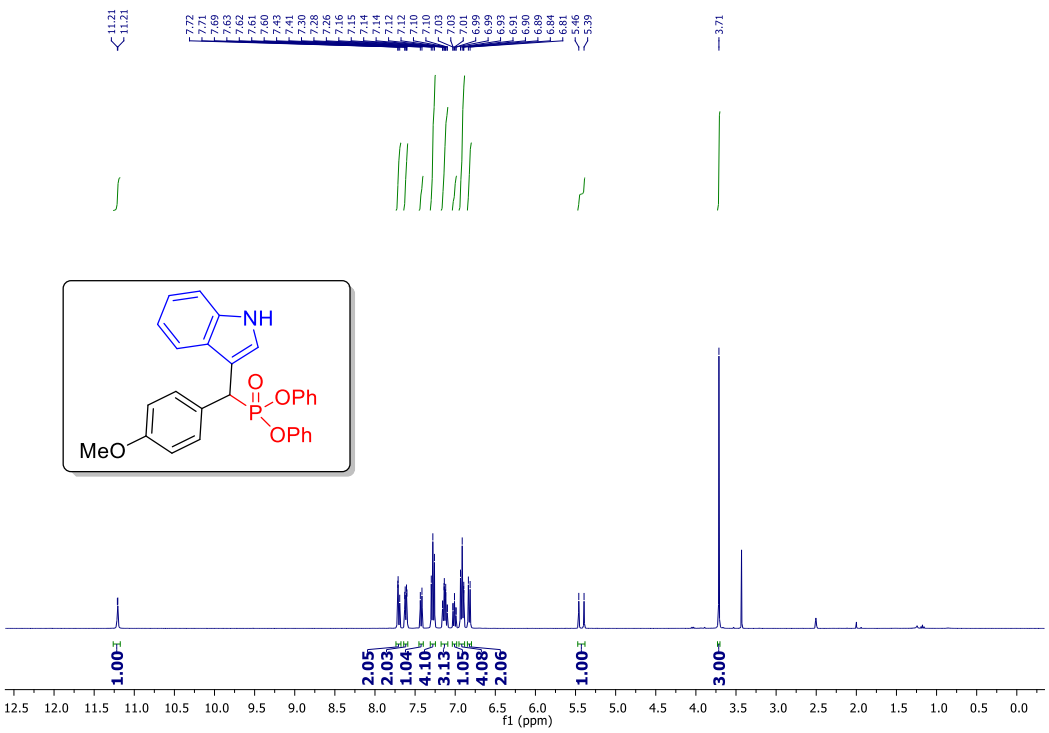
^{13}C NMR (101 MHz, DMSO- d_6) of 7l



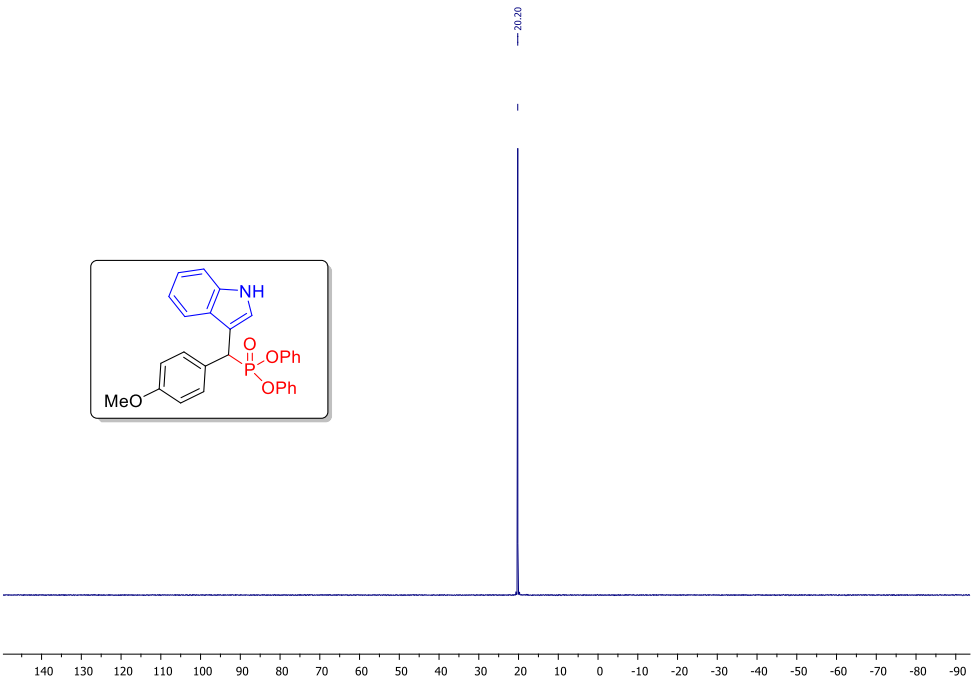
^{31}P NMR (400 MHz, DMSO-d_6) of 7l



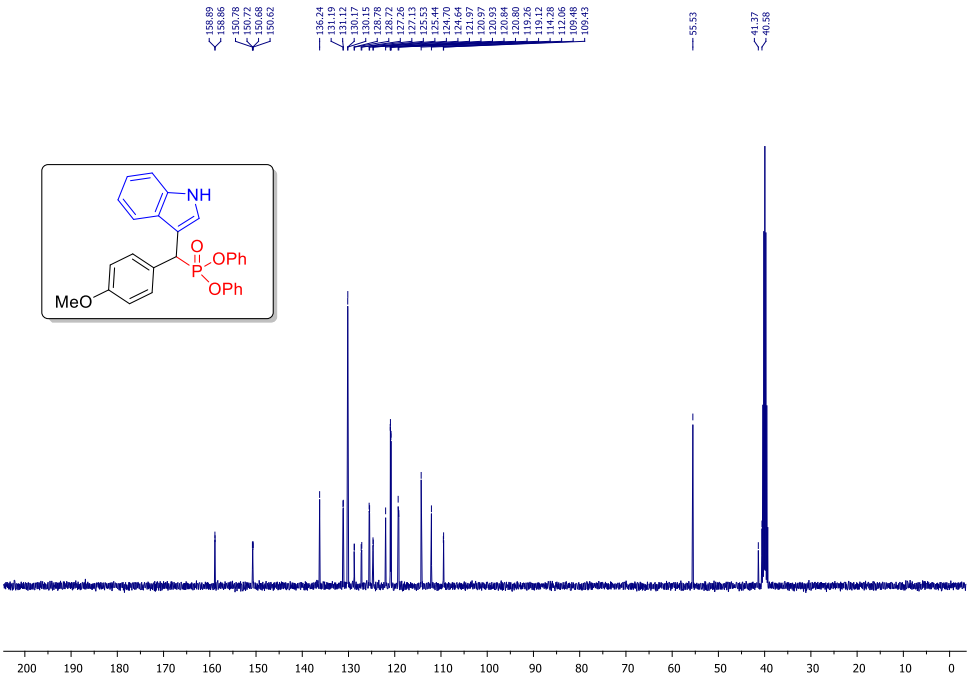
^{1}H NMR (400 MHz, DMSO-d_6) of 10



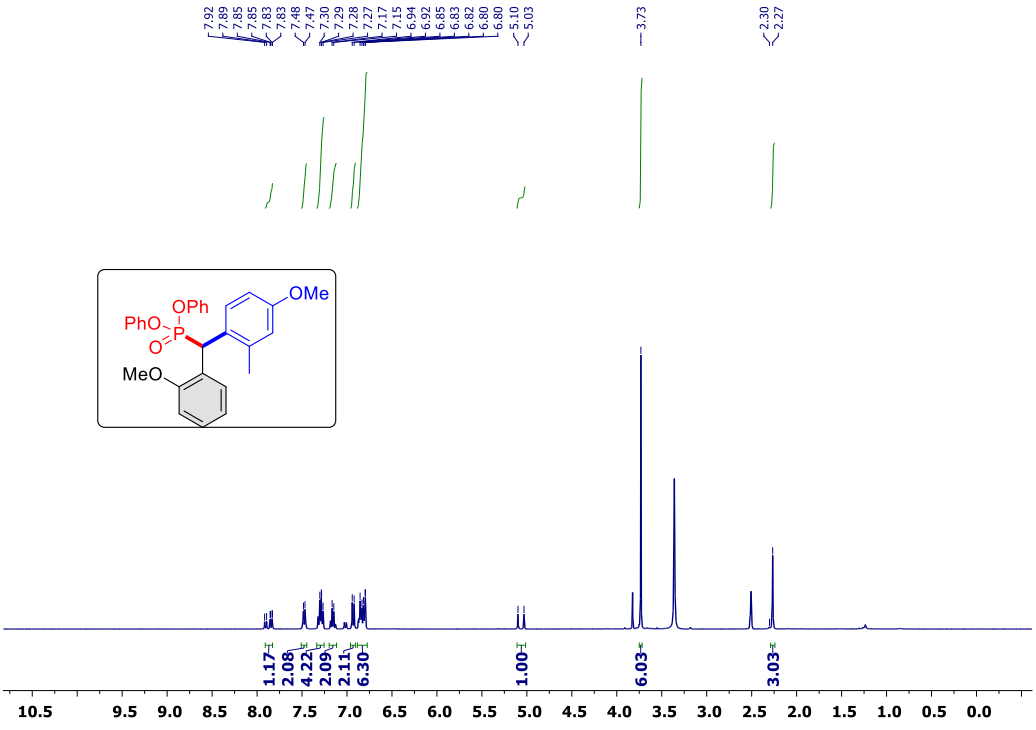
^{31}P NMR (400 MHz, DMSO-d_6) of 10



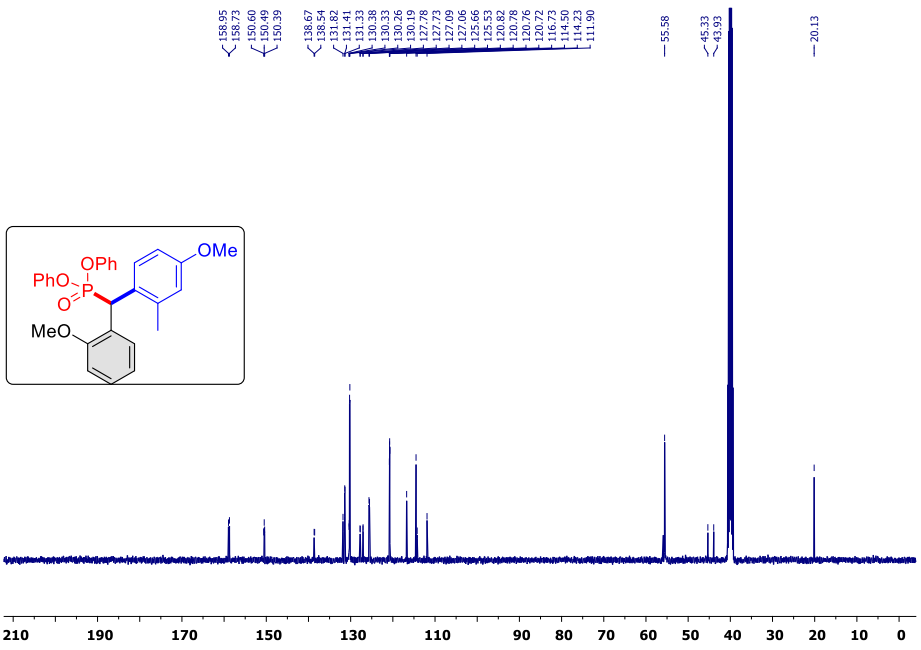
^{13}C NMR (101 MHz, DMSO- d_6) of 10



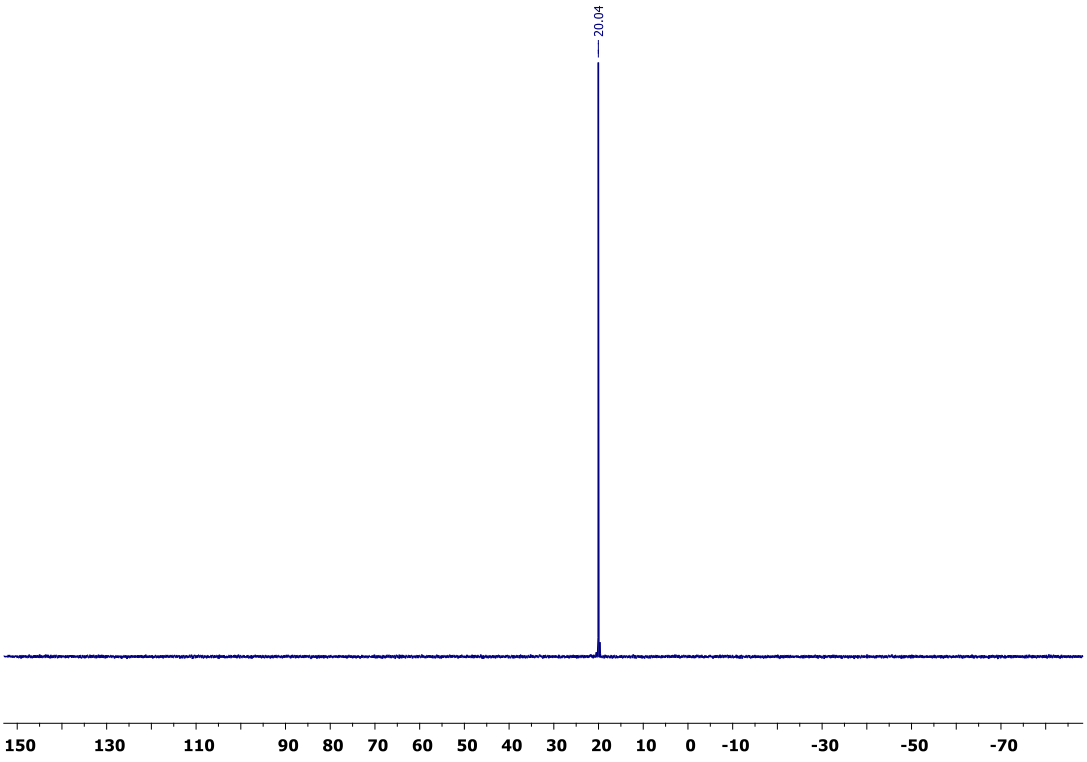
^{1}H NMR (400 MHz, DMSO-d_6) of 12



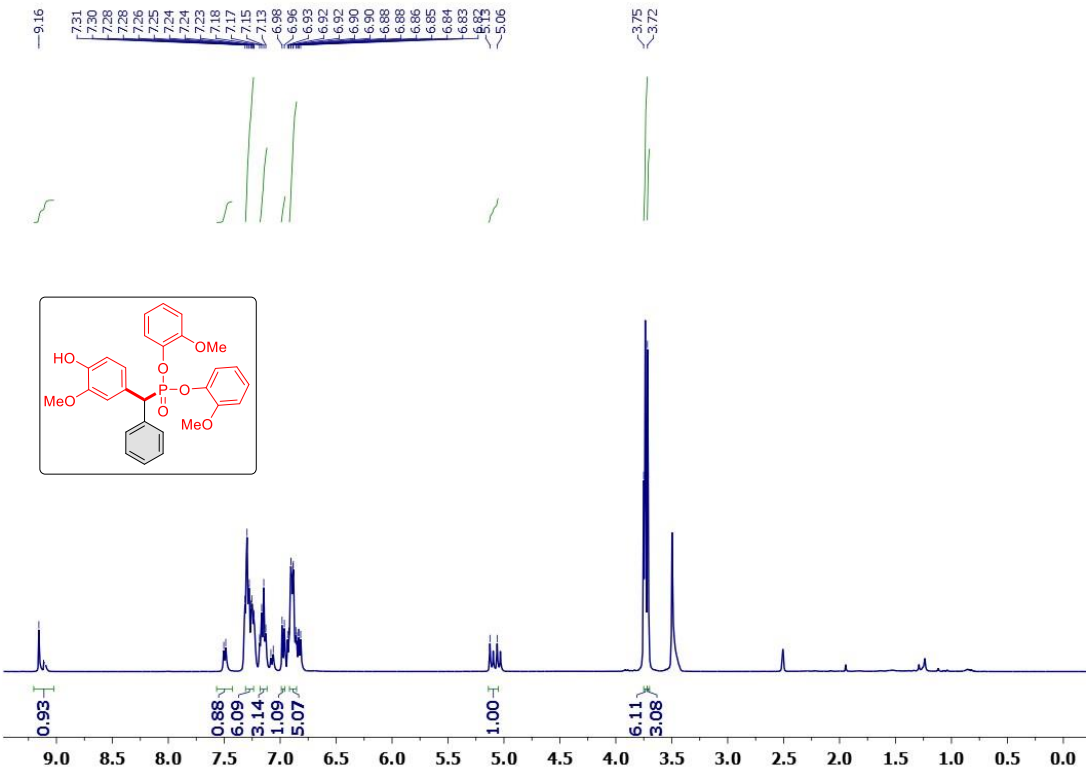
^{13}C NMR (101 MHz, DMSO- d_6) of 12



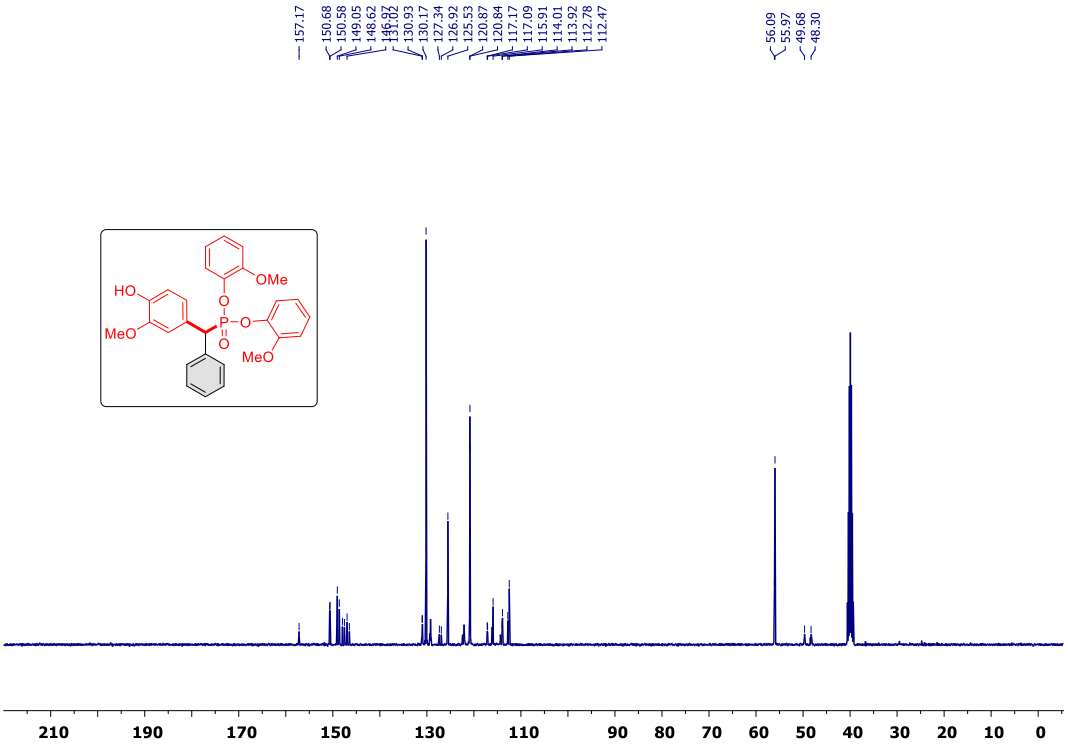
^{31}P NMR (400 MHz, DMSO-d_6) of 12



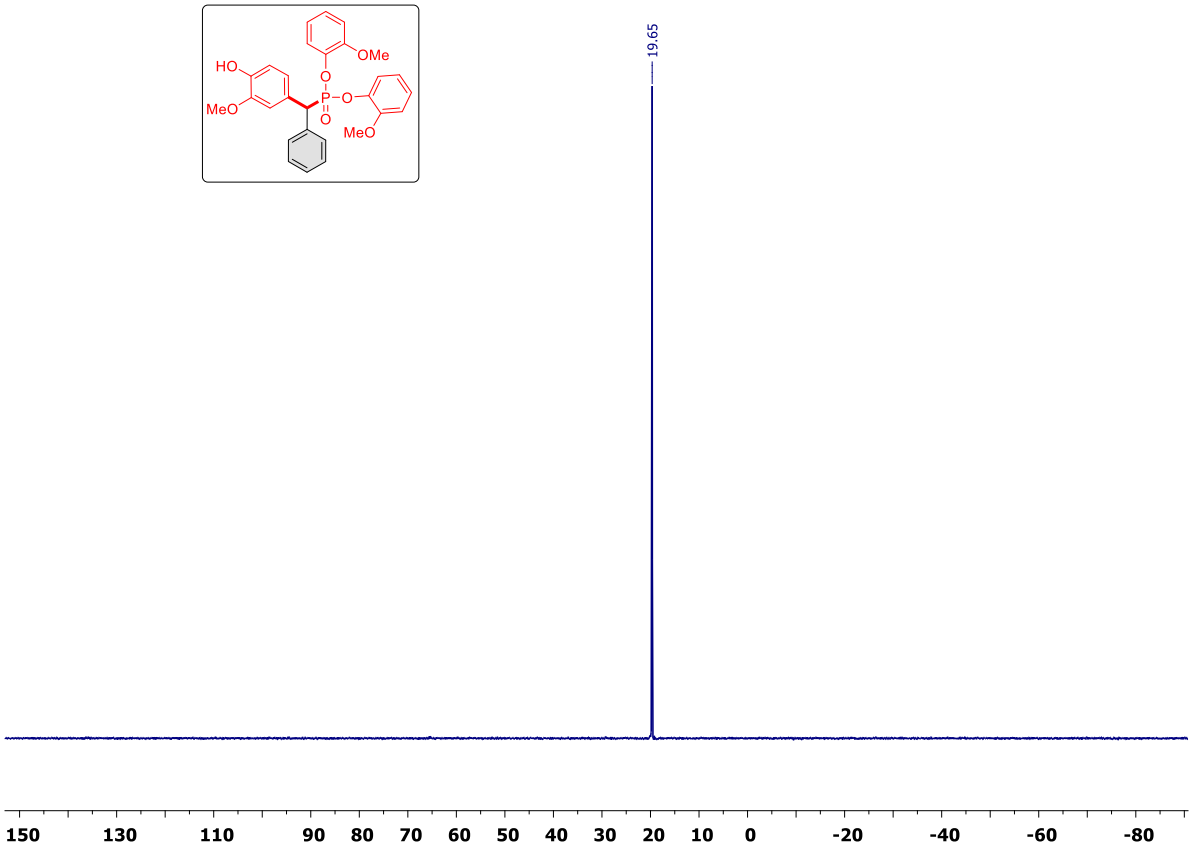
^{1}H NMR (400 MHz, DMSO-d_6) of 13a



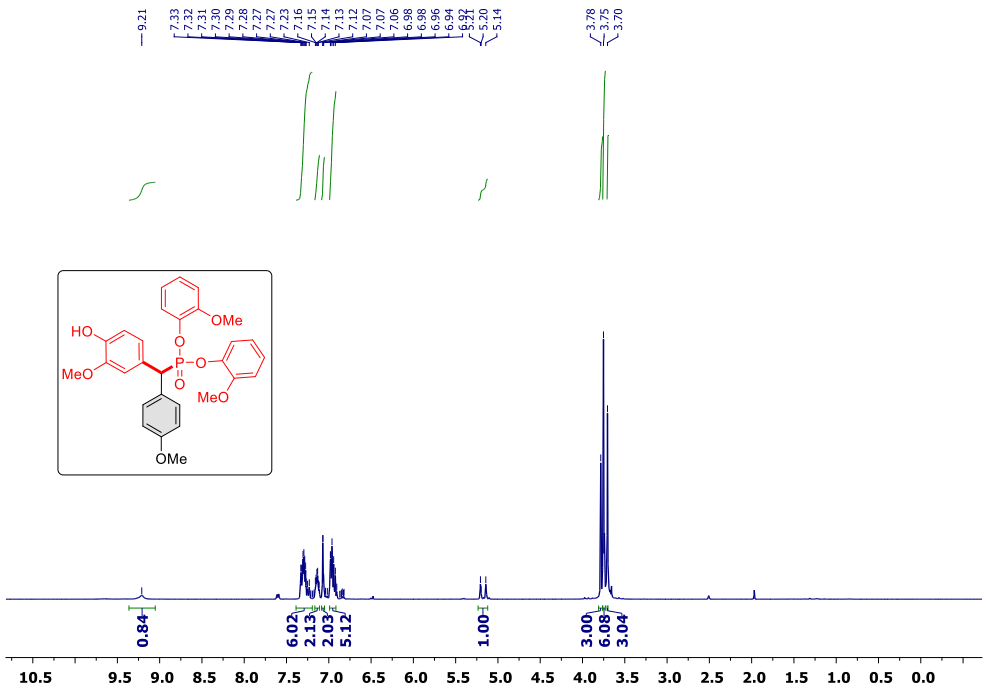
^{13}C NMR (101 MHz, DMSO- d_6) of 13a



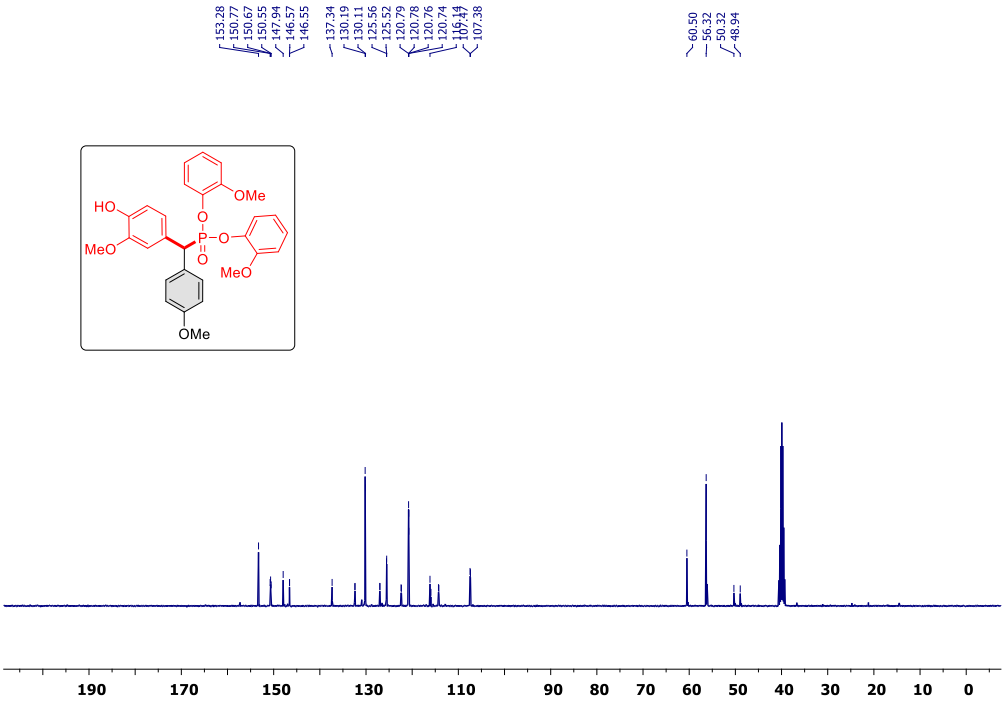
^{31}P NMR (400 MHz, DMSO-d$_6$) of 13a



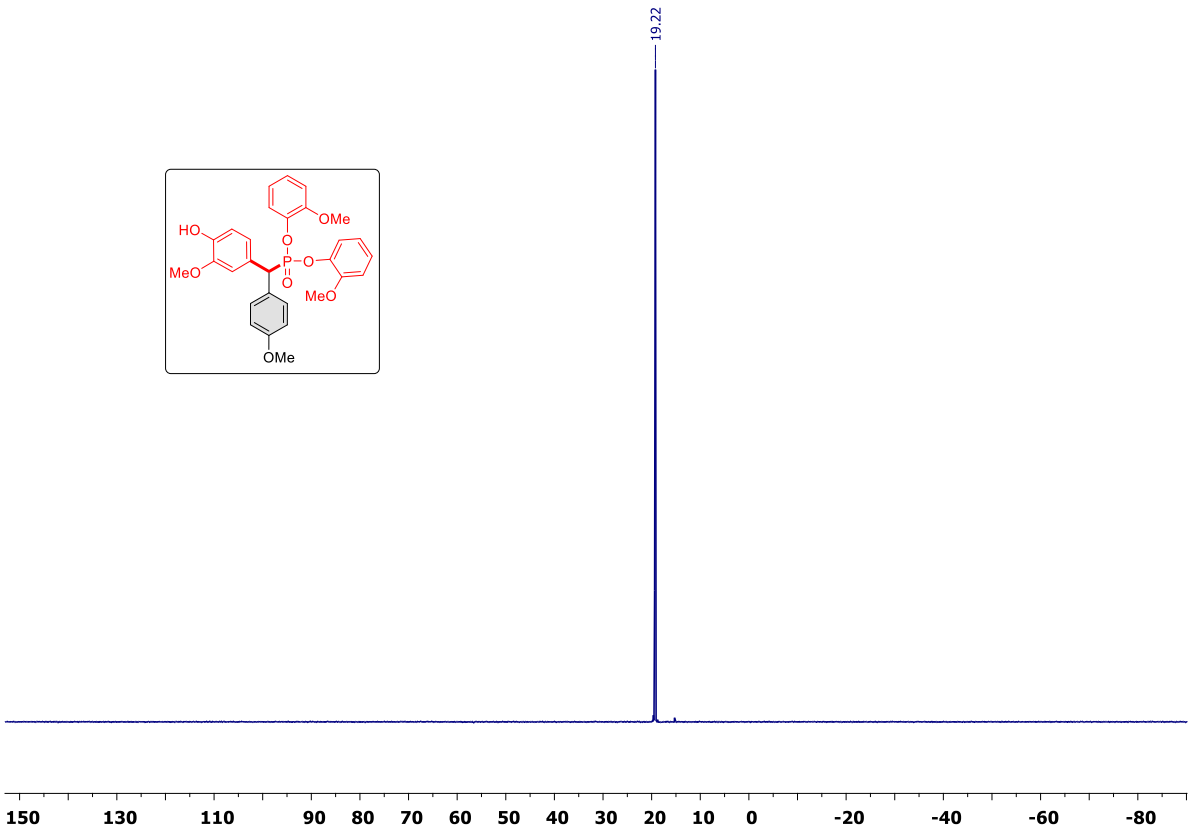
^{1}H NMR (400 MHz, DMSO-d$_6$) of 13b



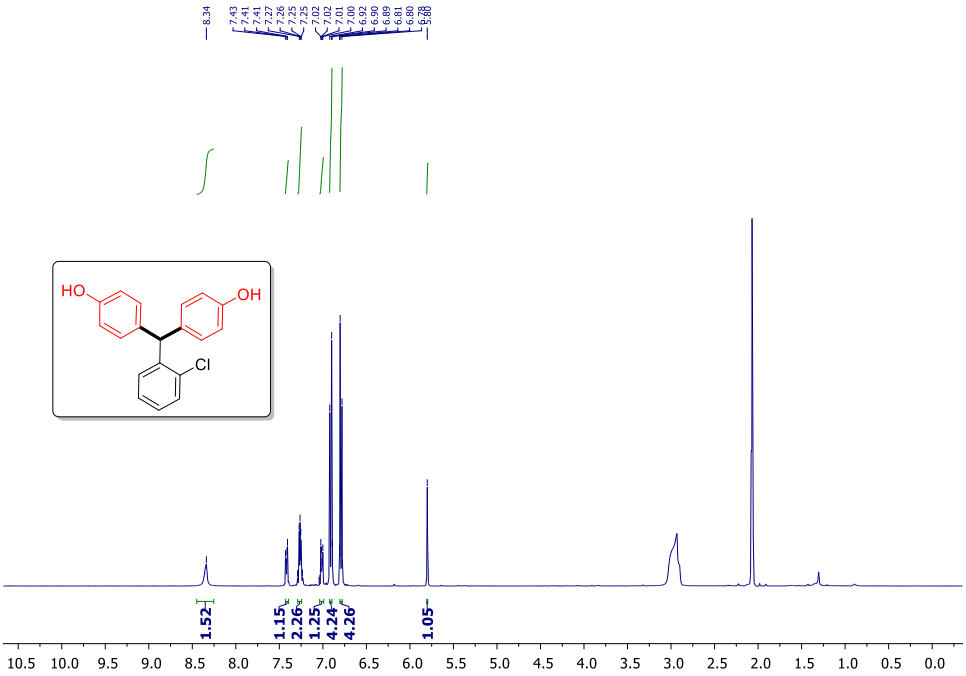
^{13}C NMR (101 MHz, DMSO- d_6) of 13b



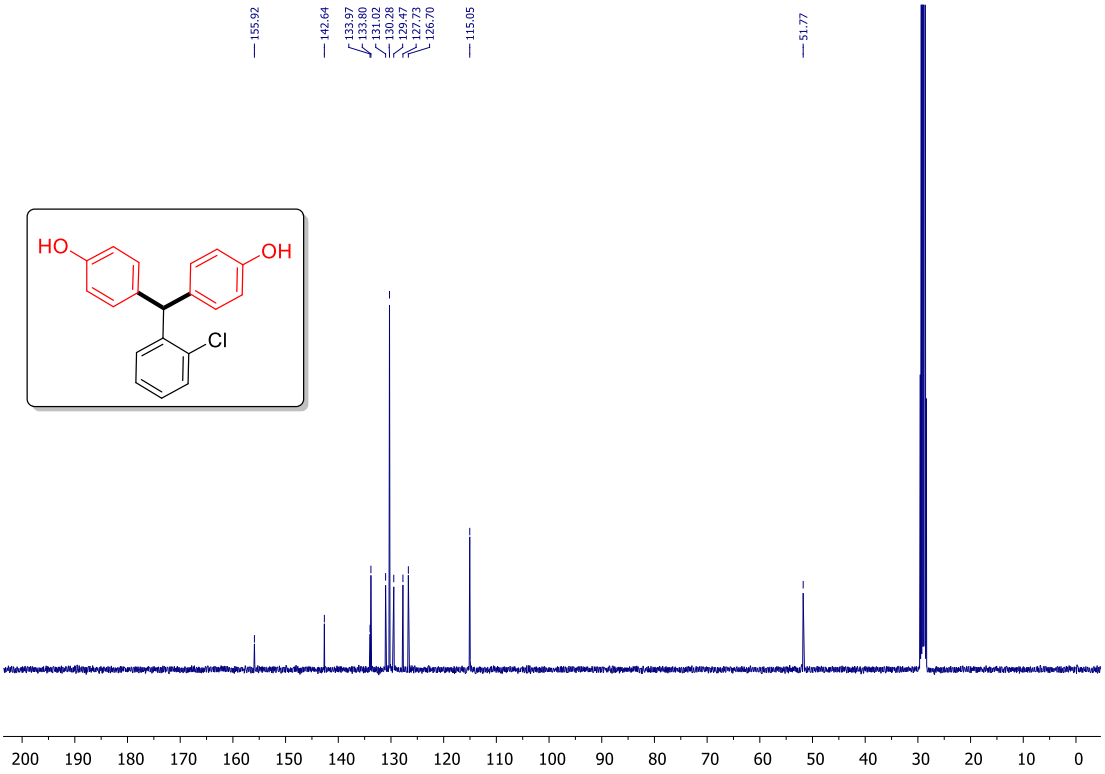
^{31}P NMR (400 MHz, DMSO-d_6) of 13b



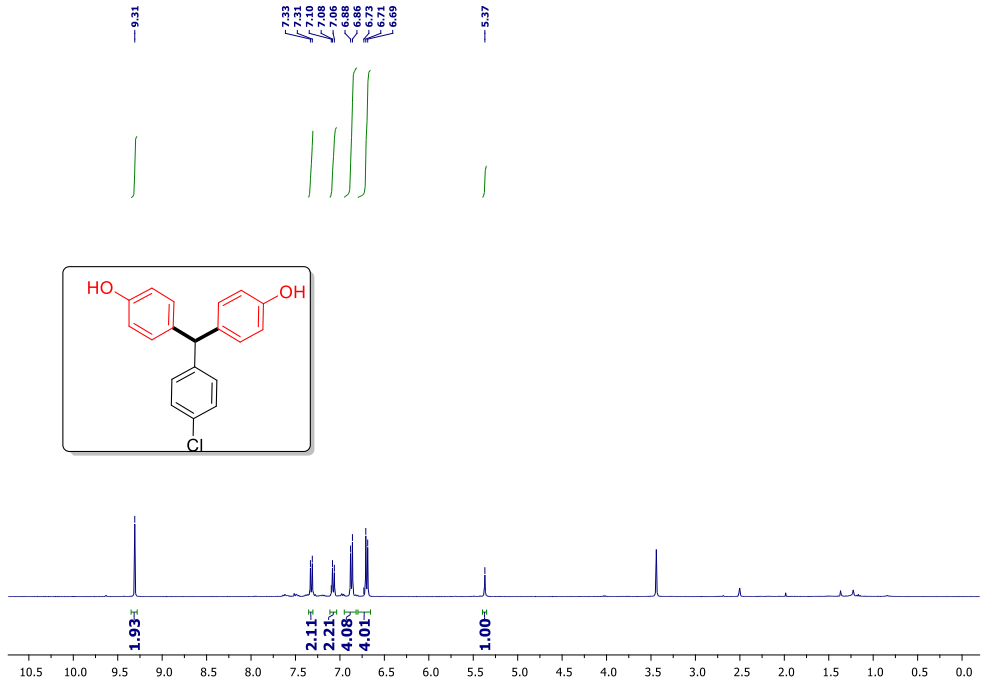
^{1}H NMR (400 MHz, Acetone-d_6) of 8a



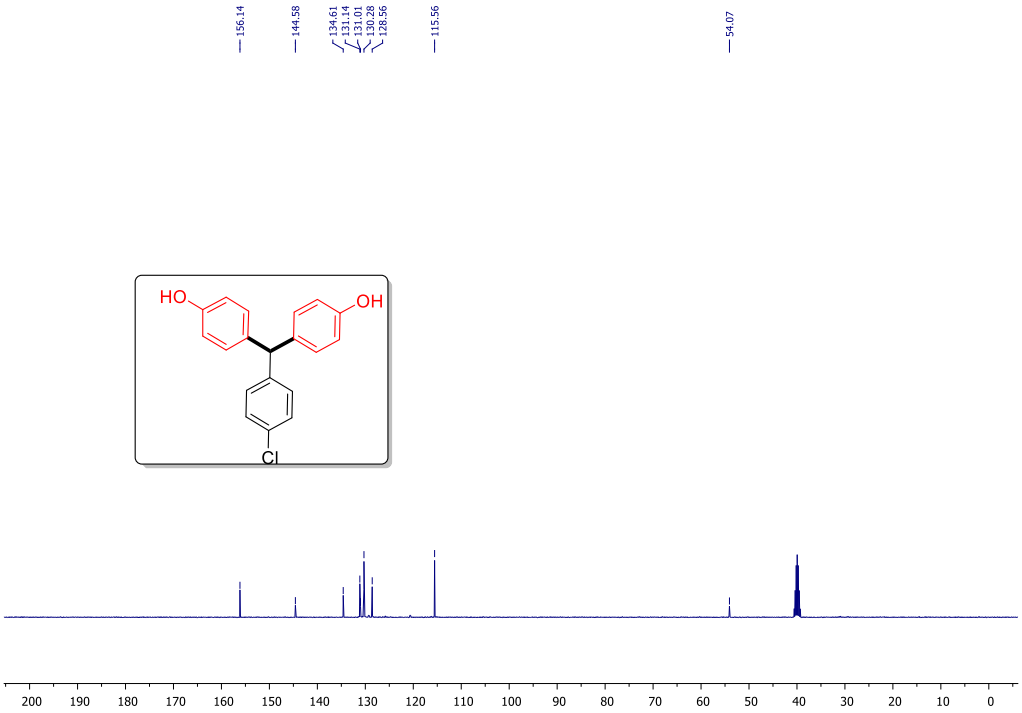
^{13}C NMR (101 MHz, Acetone- d_6) of 8a



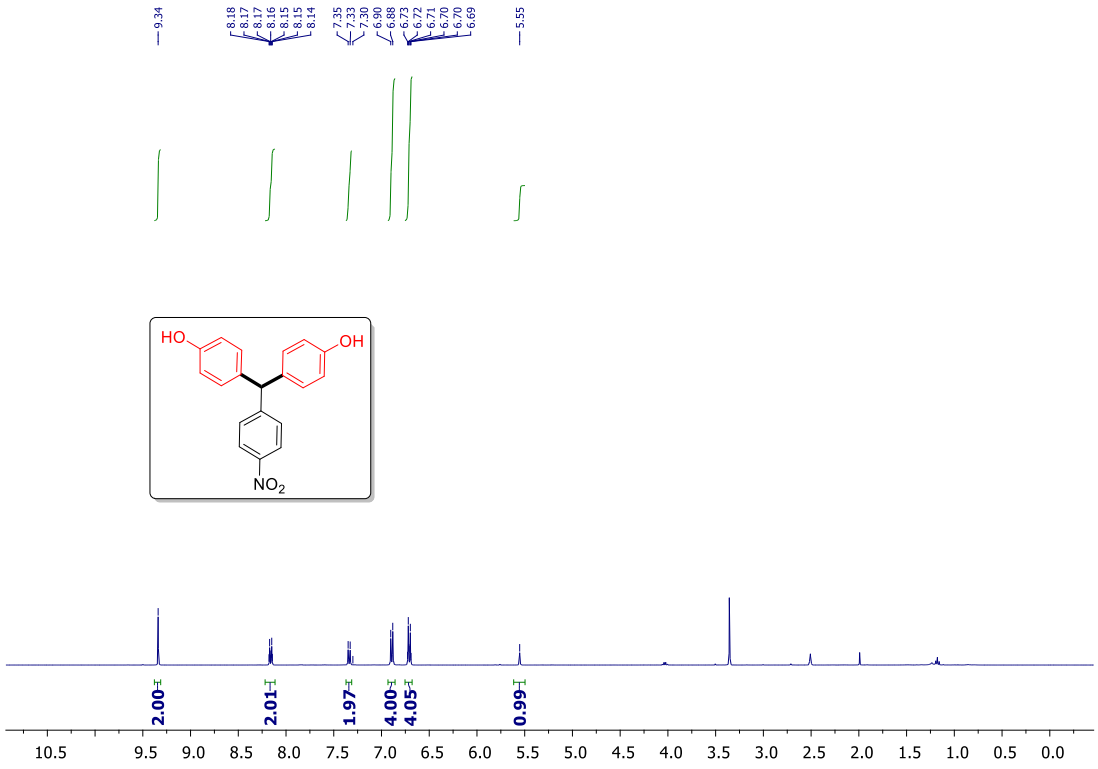
^{1}H NMR (400 MHz, DMSO-d_6) of 8b



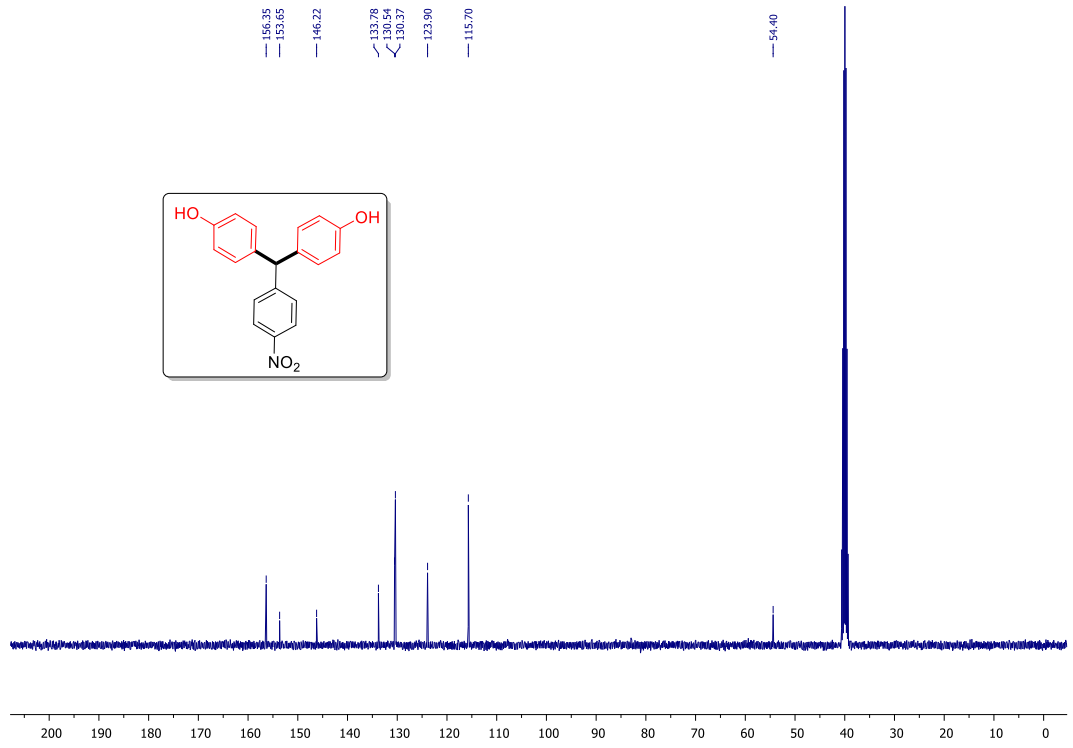
^{13}C NMR (101 MHz, DMSO- d_6) of 8b



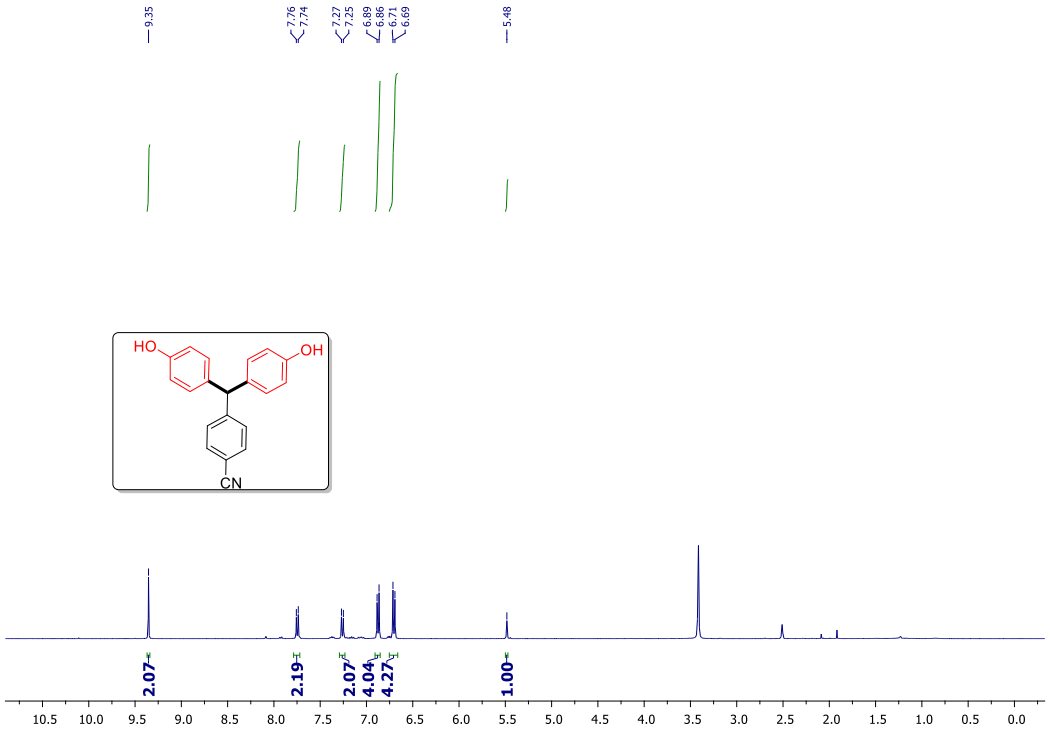
^{1}H NMR (400 MHz, DMSO-d_6) of 8c



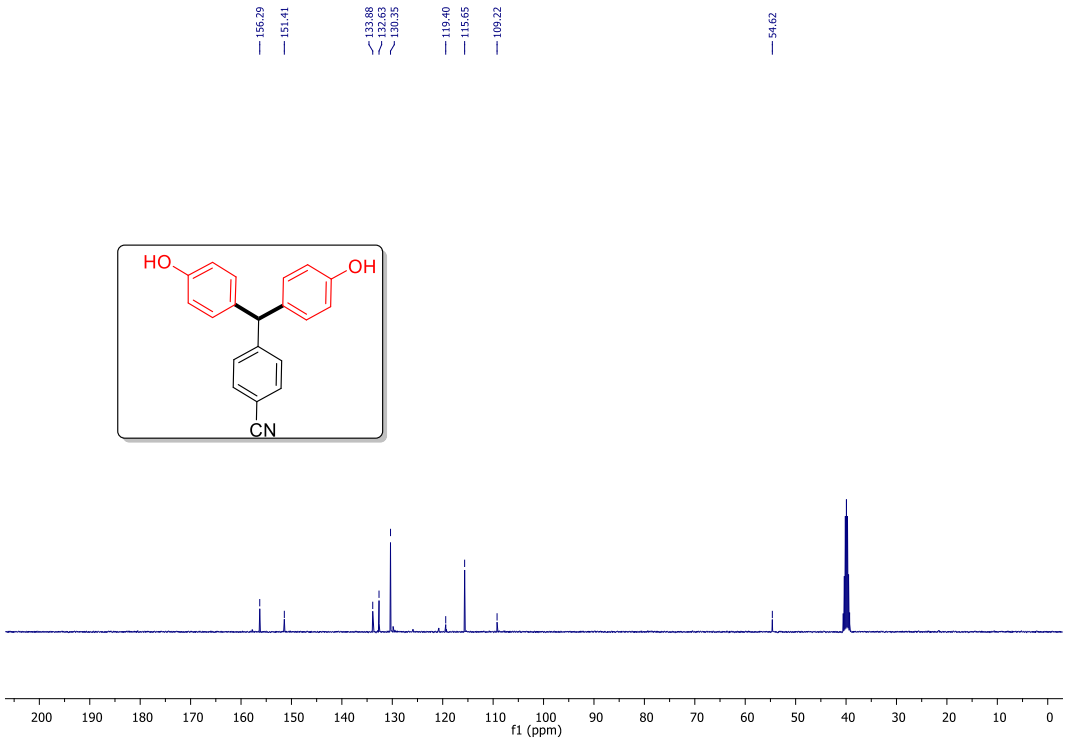
^{13}C NMR (101 MHz, DMSO- d_6) of 8c



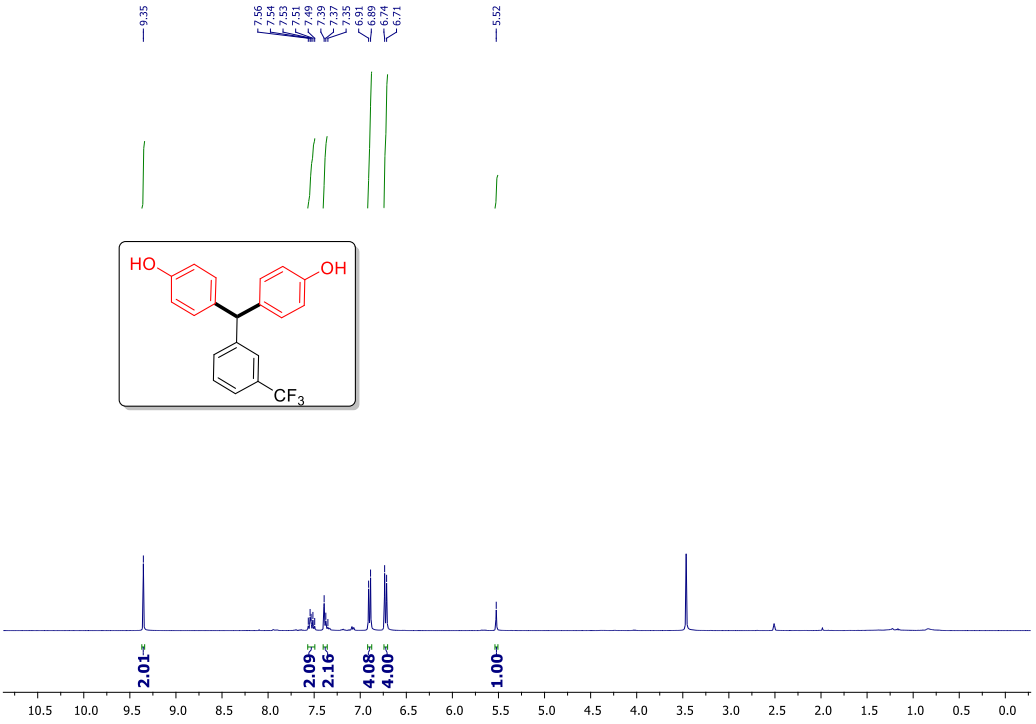
^{1}H NMR (400 MHz, DMSO-d_6) of 8d



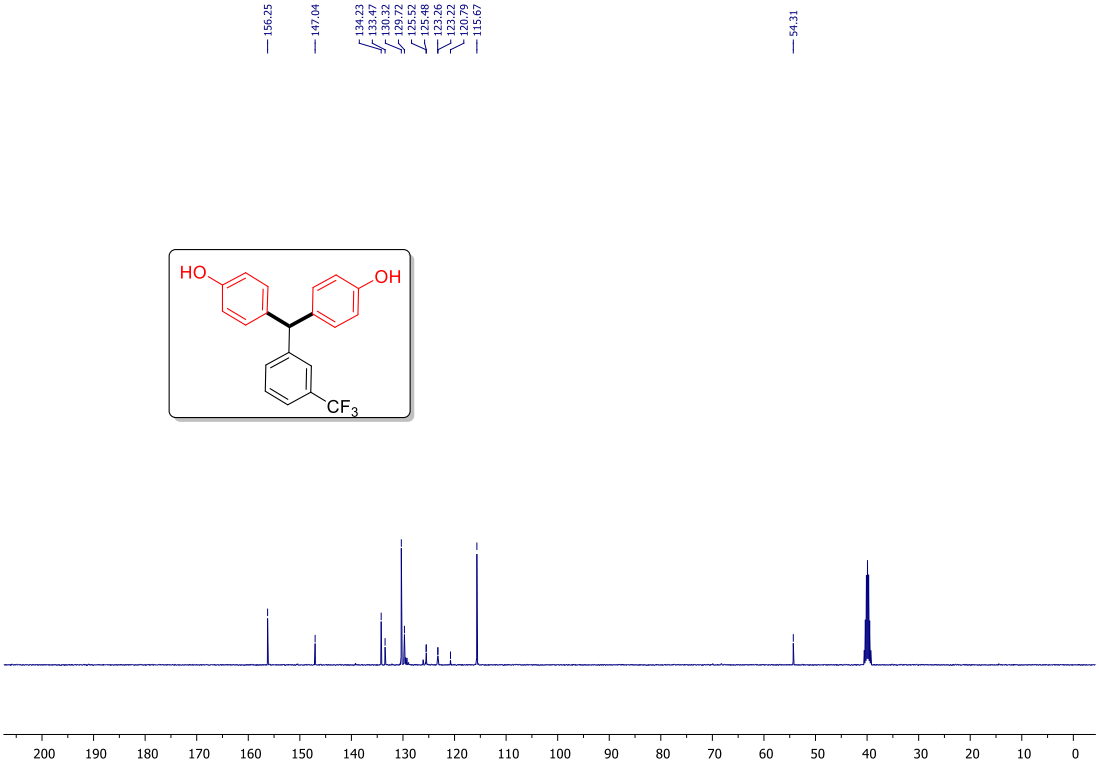
^{13}C NMR (101 MHz, DMSO- d_6) of 8d



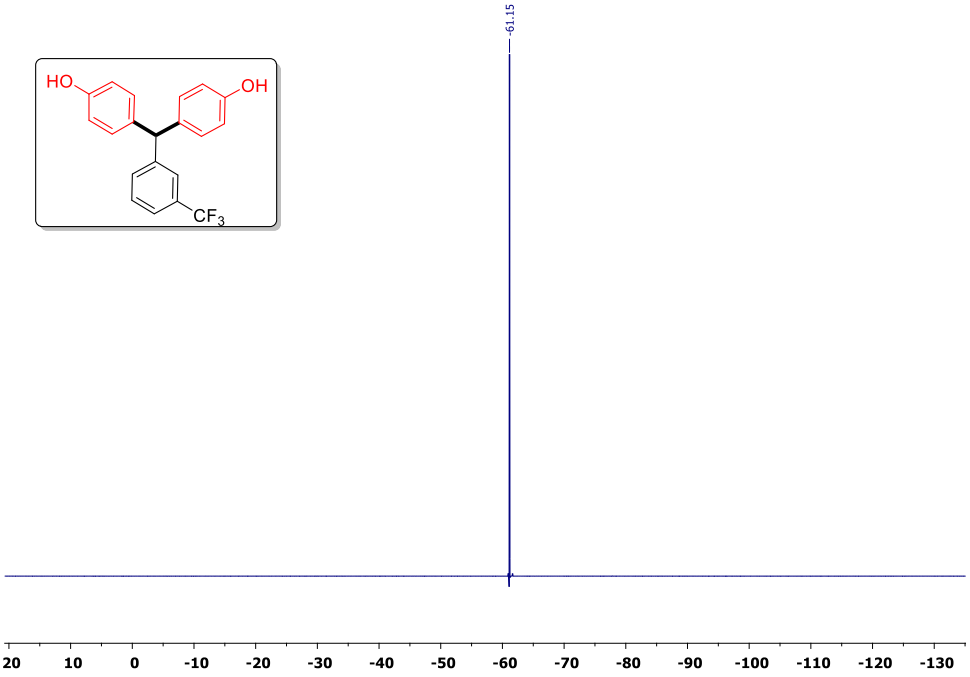
^{1}H NMR (400 MHz, DMSO-d_6) of 8e



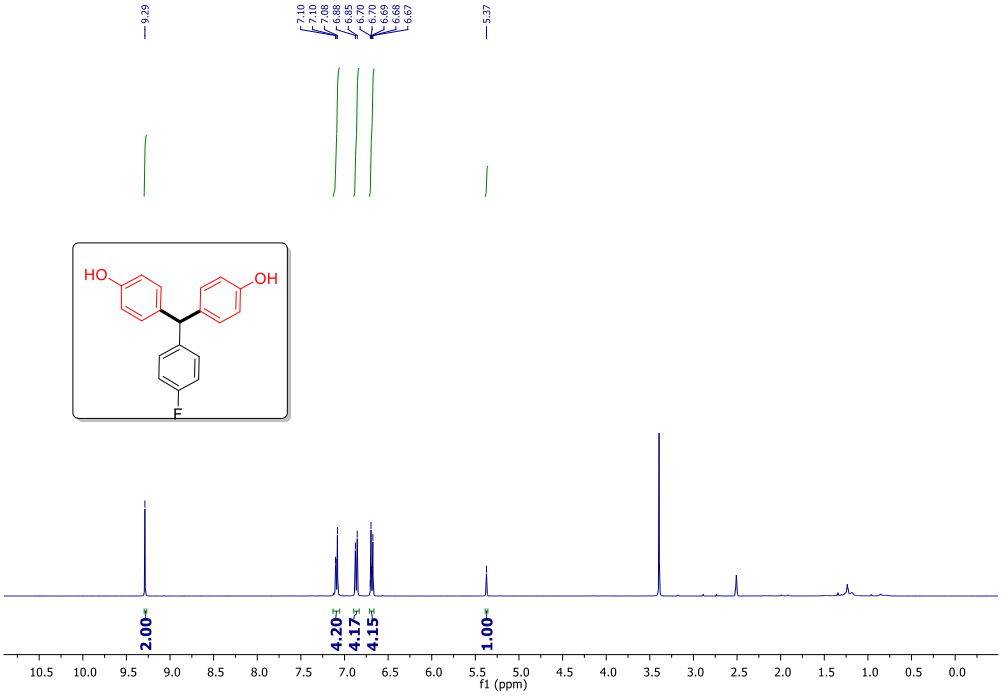
^{13}C NMR (101 MHz, DMSO- d_6) of 8e



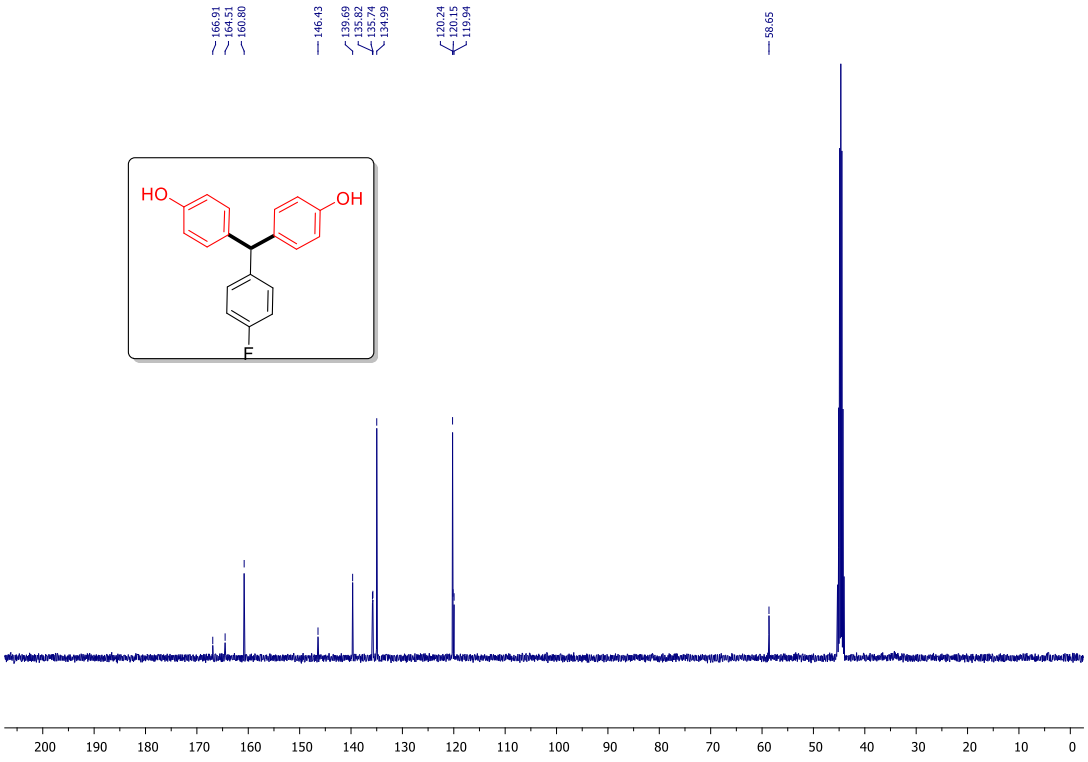
^{19}F NMR (377 MHz, DMSO-d_6) of 8e



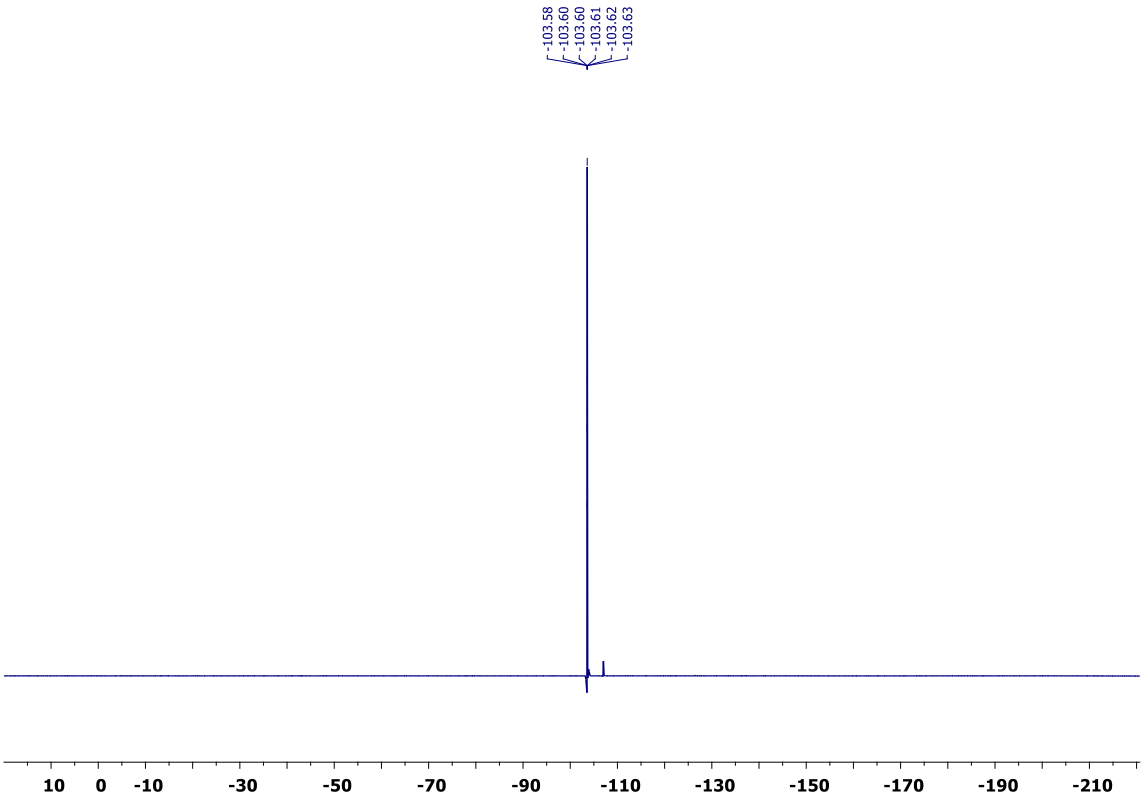
^{1}H NMR (400 MHz, DMSO-d_6) of 8f



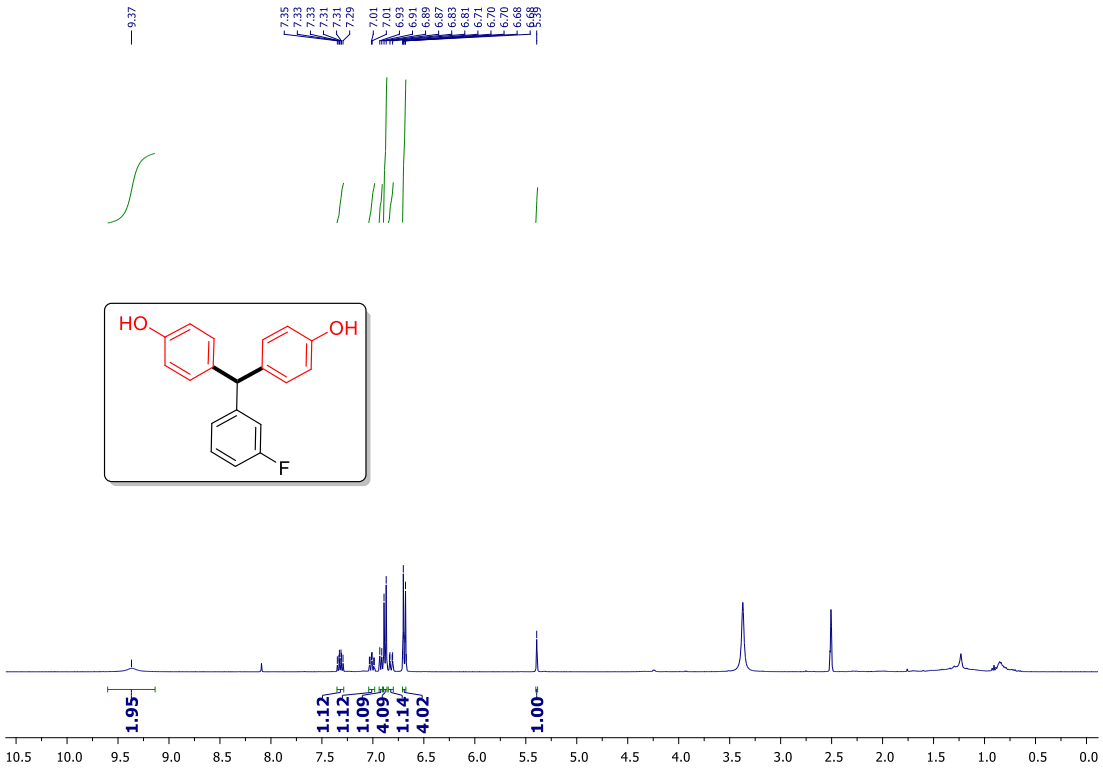
^{13}C NMR (101 MHz, DMSO- d_6) of 8f



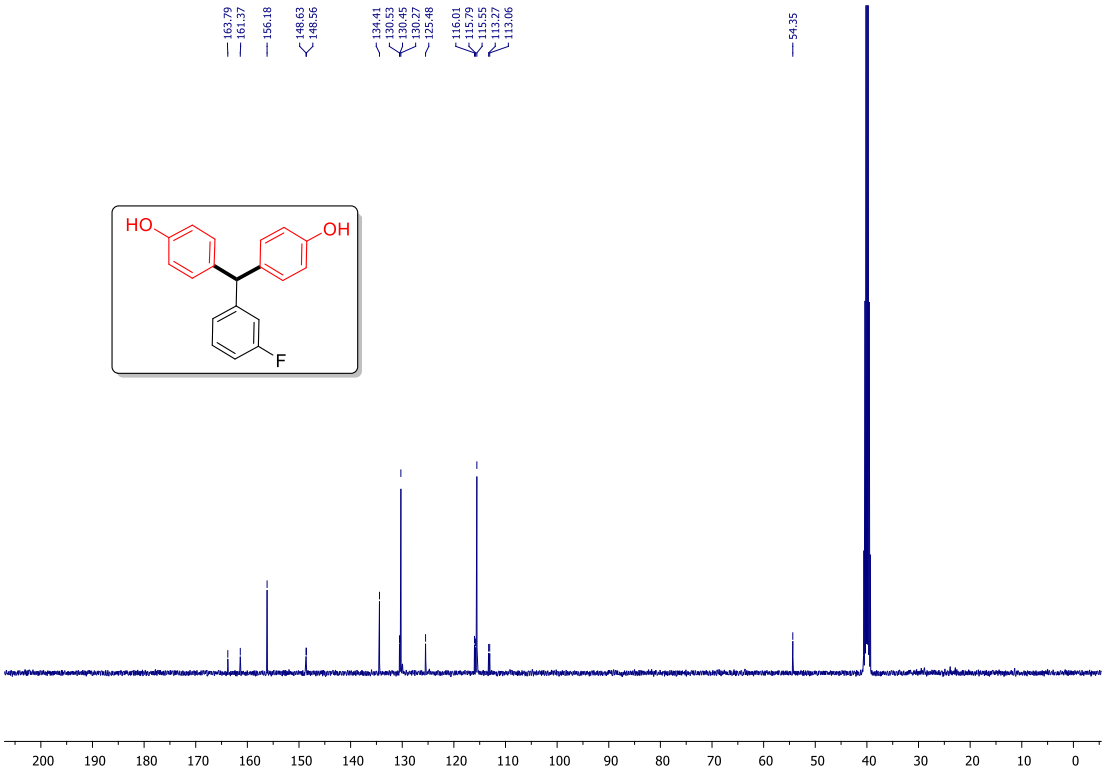
^{19}F NMR (377 MHz, DMSO-d_6) of 8f



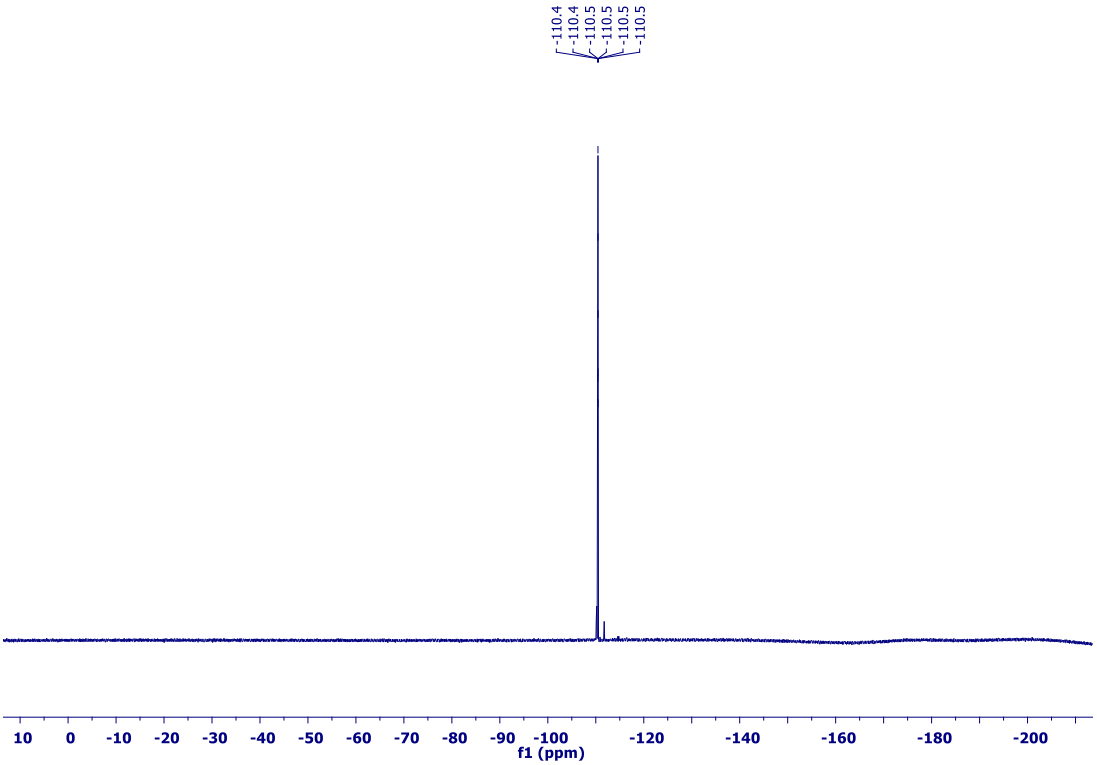
^{1}H NMR (400 MHz, DMSO-d_6) of 8g



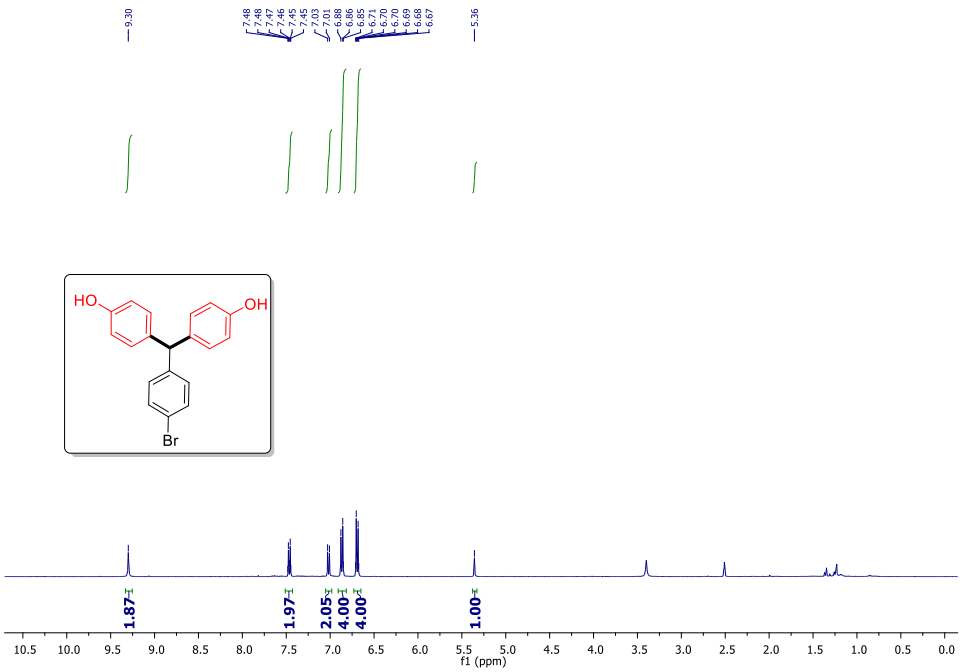
^{13}C NMR (101 MHz, DMSO- d_6) of 8g



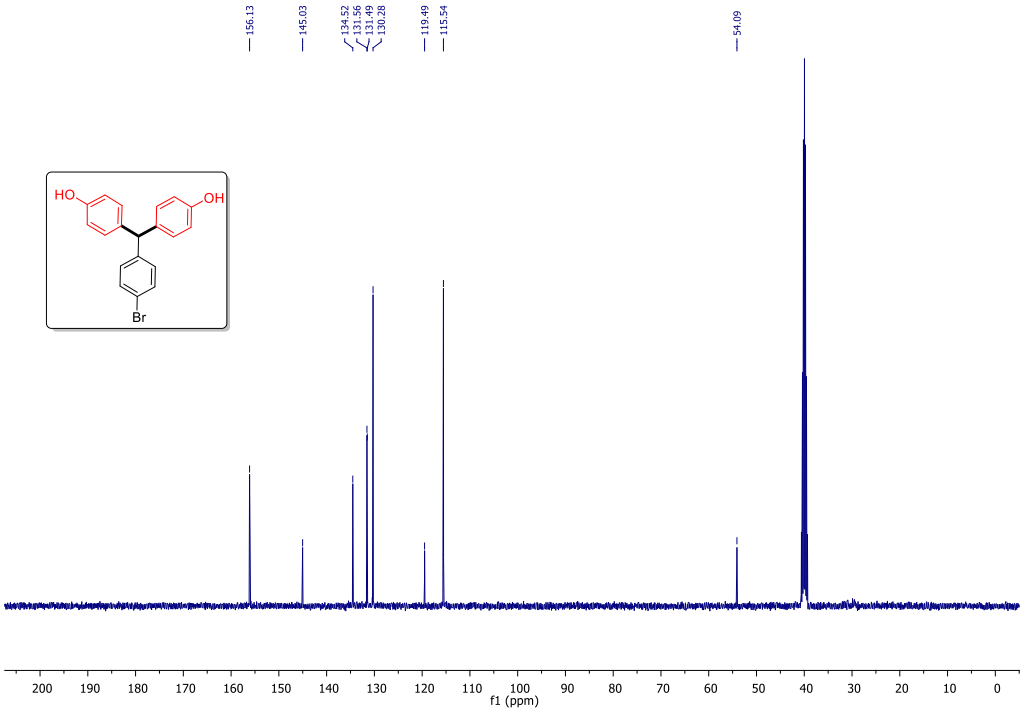
^{19}F NMR (377 MHz, $CDCl_3$) of 8g



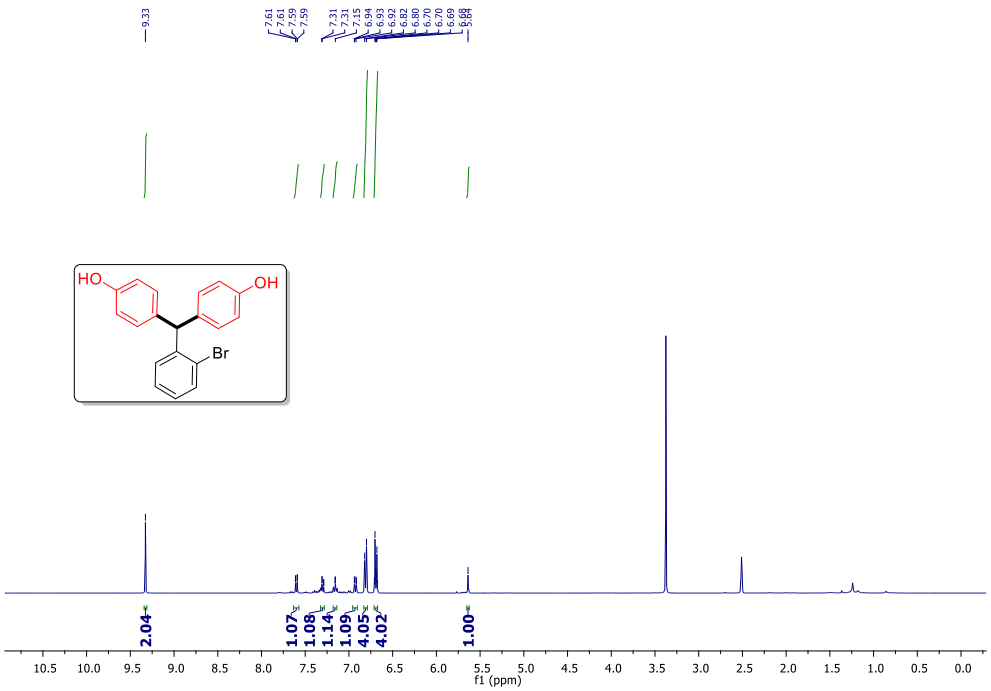
^{1}H NMR (400 MHz, DMSO-d_6) of 8h



^{13}C NMR (101 MHz, DMSO- d_6) of 8h



^{1}H NMR (400 MHz, DMSO-d_6) of 8i



^{13}C NMR (101 MHz, DMSO- d_6) of 8i