Electronic Supporting Information

Visible-Light-Induced Mn(0)-Catalyzed Direct C–3 Mono-, Di- and Perfluoroalkylations of 2H-Indazoles

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1. General information:

All reagents were purchased from commercial sources and used without further purification. 

\(^1\)H NMR spectra were determined on 400 MHz spectrometer as solutions in CDCl\(_3\). Chemical shifts are expressed in parts per million (\(\delta\)) and the signals were reported as s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), and coupling constants (\(J\)) were given in Hz. 

\(^{13}\)C\{\(^1\)H\} NMR spectra were recorded at 100 MHz in CDCl\(_3\) solution. Moreover, \(^{19}\)F \{\(^1\)H decoupled\} and \(^{31}\)P NMR spectra were recorded at 376.5 MHz, and 162 MHz in CDCl\(_3\) solution. Chemical shifts are referenced to CDCl\(_3\) (\(\delta = 7.26\) for \(^1\)H and \(\delta = 77.16\) for \(^{13}\)C\{\(^1\)H\} NMR) as internal standard. High-resolution mass spectra (HRMS) were collected using electrospray ionization (ESI) on a time-of-flight (TOF) mass spectrometer. TLC was done on silica gel coated glass slide. All solvents were dried and distilled before use. All reactions involving moisture sensitive reactants were executed using oven dried glassware. All the 2\(H\)-indazoles\(^1\) and bromodifluoroacetamide derivatives\(^2\) were prepared by reported method. Melting points (mp.) were determined after recrystallization of solid compounds from a solution of dichloromethane/petroleum ether (1:3).

2. Light information:

Kessil 34 W blue LED (Model No. H150-BLUE) was used as a light source for light promoted reactions.

**Rating of LED:** 24VDC 1.5A 34W

**Model:** H150-BLUE

**Range of wavelength:** 450-530 nm. Manufacturer: Kessil, 1689 Regatta blvd, Richmond, CA94804 ([www.kessil.com](http://www.kessil.com)).
3. Pictorial presentation of the reaction set-up:

The Borosilicate glass reaction tube was used to carry out light-promoted reaction. The reaction tube was kept 5-7 cm apart from the exposed of Kessil 34 W blue LED. Regular fan was used to keep up the temperature 28 to 30 °C during the reaction. We did not use any filter.

Fig: S1.1: LED reaction set-up

Fig: S1.2: LED reaction set-up
4. Experimental procedures:

4.1. Typical experimental procedure for the synthesized compounds 3aa-3pa:

A mixture of 2-Arylindazoles (0.2 mmol) (1), BrCF₂PO(OEt)₂ (0.4 mmol, 106.8 mg) (2a), Mn₂(CO)₁₀ (5 mol %, 3.9 mg), NaHCO₃ (2.0 equiv, 33.6 mg), and 1,4-Dioxane (2 mL) was added to an oven-dried reaction vessel (tube) equipped with a magnetic stirrer, and the reaction vessel was irradiated with Kessil 34 W blue LED at room temperature under nitrogen atmosphere for 36 h. After completion of the reaction (TLC), the reaction mixture was extracted with ethyl acetate. The organic phase was dried over anhydrous Na₂SO₄. The crude residue was obtained after evaporating the solvent in vacuum and was purified by column chromatography on silica gel using a mixture of petroleum ether and ethyl acetate as an eluting solvent to afford the pure products 3aa-3pa.

4.2. Experimental procedure for the synthesized compounds 3ab-3ge:
A mixture of 2-Arylindazoles (0.2 mmol) (1), XCF_R^4 (X=Br, I, R^4= –COOEt, amides, –C_3F_7) (0.4 mmol) (2), Mn_2(CO)_10 (5 mol %, 3.9 mg), NaHCO_3 (2.0 equiv, 33.6 mg), and 1,4-Dioxane (2 mL) was added to an oven-dried reaction tube equipped with a magnetic stirrer, and the reaction vessel was irradiated with Kessil 34 W blue LED at room temperature under nitrogen atmosphere for 36 h. After completion of the reaction (TLC), the reaction mixture was extracted with ethyl acetate. The organic phase was dried over anhydrous Na_2SO_4. The crude residue was obtained after evaporating the solvent in vacuum and was purified by column chromatography on silica gel using a mixture of petroleum ether and ethyl acetate as an eluting solvent to afford the pure products 3ab-3ge.

4.3. Experimental procedure for the synthesized compounds 5af-5nf:

A mixture of 2-Arylindazoles (0.2 mmol) (1), BrCFHCO(OEt)_2 (0.4 mmol, 74 mg) (4f), Mn_2(CO)_10 (5 mol %, 3.9 mg), NaHCO_3 (2.0 equiv, 33.6 mg), and 1,4-Dioxane (2 mL) was added to an oven-dried reaction vessel (tube) equipped with a magnetic stirrer, and the reaction vessel was irradiated with Kessil 34 W blue LED at room temperature under nitrogen atmosphere for 36 h. After completion of the reaction (TLC), the reaction mixture was extracted with ethyl acetate. The organic phase was dried over anhydrous Na_2SO_4. The crude residue was obtained after evaporating the solvent in vacuum and was purified by column chromatography on silica gel using a mixture of petroleum ether and ethyl acetate as an eluting solvent to afford the pure products 5af-5nf.
5. Gram-scale preparation of 3ba:

![Diagram of the reaction](image)

A mixture of 2-(p-tolyl)-2H-indazole (4.0 mmol, 832.0 mg) (1b), BrCF₂PO(OEt)₂ (8.0 mmol, 2.14 g) (2a), Mn₂(CO)₁₀ (5 mol%, 78 mg), NaHCO₃ (2.0 equiv, 672 mg), and 1,4-Dioxane (30 mL) was added to an oven-dried reaction vessel (tube) equipped with a magnetic stirrer, and the reaction vessel was irradiated with Kessil 34 W blue LED at room temperature under nitrogen atmosphere for 36 h. After completion of the reaction (TLC), the reaction mixture was extracted with ethyl acetate. The organic phase was dried over anhydrous Na₂SO₄. The crude residue was obtained after evaporating the solvent in vacuum and was purified by column chromatography on silica gel using a mixture of petroleum ether and ethyl acetate as an eluting solvent to afford the pure product 3ba (1.16 g, 74%) as a yellow solid.


![Diagram of the reaction](image)

A mixture of ethyl 2,2-difluoro-2-(2-(p-tolyl)-2H-indazol-3-yl)acetate (0.3 mmol, 99 mg) (3bb), K₂CO₃ (2.0 equiv, 82.9 mg) and 2 mL of MeOH: H₂O (1:1) as solvent in an oven-dried reaction tube equipped with magnetic bar was stirred for 2 h at room temperature. Thereafter, evaporation of the solvent mixture was done and then workup with crude ethyl
acetate and water. Finally, the crude mixture was taken in an oven-dried reaction tube and added 1.0 equiv of CsF in 2 mL of DMF and stirred at 150 °C temperature for 12 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was dried over anhydrous Na₂SO₄ and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with petroleum ether and ethyl acetate (9:1) to afford the product 6bc (85%, 65 mg) as white solid.

7. Structure determination (X-ray crystallographic data for 3fa):

The colourless crystal of 3fa was obtained by crystallization from a solution in dichloromethane/petroleum ether after purification by column chromatography. Chemical formula: C₁₉H₁₈F₅N₂O₃P.

For single crystal structure determination, a suitable single crystal was carefully selected under a polarizing microscope and glued carefully to a thin glass fiber. The single crystal data were collected on a Bruker D8 Quest diffractometer at 293 (2) K (Fig. S2). The X-ray generator was operated at 50 kV and 1 mA using Mo Kα radiation (λ = 0.71073 Å), controlled by the APEX3 software package³. Data were collected with ω scan width of 0.3º. A total of 408 frames were collected in three different setting of φ (0, 90, 180º) keeping sample-to-detector distance fixed at 6.03 cm and the detector position (2θ) fixed at -25º. The data were reduced using SAINTPLUS, and an empirical absorption correction was applied using the SADABS program. The structure was solved and refined using SHELXL97⁴ present in the OLEX 2⁵ suit of programs.
<table>
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<th><strong>Wavelength</strong></th>
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<td><strong>Formula</strong></td>
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<tr>
<td><strong>Space group</strong></td>
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<td>b = 9.764(2) Å, β = 98.77(3) °</td>
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<td>c = 26.580(5) Å, γ = 90 °</td>
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<td><strong>R-factor (%)</strong></td>
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The crystallographic data have been deposited with the Cambridge Crystallographic Data Centre as a supplementary publication with a CCDC reference number CCDC 2191201.
View of ORTEP diagram for the crystal structure of the compound **Diethyl (difluoro(2-(4-(trifluoromethyl)phenyl)-2H-indazol-3-yl)methyl)phosphonate (3fa)** (Thermal ellipsoid contour at 50% probability level).
8. Mechanistic studies of the reaction:

Different radical inhibitors such as 2,6-di-tert-butyl-4-methyl phenol (BHT), benzoquinone (BQ), and 2,2,6,6-tetramethyl-1-oxylpiperidine (TEMPO) in the reaction which completely suppressed the desired product of the reaction (Fig S3, eq A). Furthermore, the radical adduct diethyl (1,1-difluoro-3,3-diphenylallyl)phosphonate (7a) was produced in 80% yield by the addition of 2.0 equiv of 1,1-diphenylethylene to the present reactions (Fig S3, eq B). The above experimental outputs suggest that a radical pathway might be involved in the reaction.
9. Physical data of the compounds:

*Diethyl (difluoro(2-phenyl-2H-indazol-3-yl)methyl)phosphonate (3aa):*

![Structural formula of 3aa]

Yellow liquid (60 mg, 80%); R_f 0.4 (PET:EtOAc = 7:3); ^1H NMR (CDCl₃, 400 MHz): δ 7.85 (d, J = 8.8 Hz, 1H), 7.77 (d, J = 8.4 Hz, 1H), 7.68–7.66 (m, 2H), 7.52–7.48 (m, 3H), 7.39–7.35 (m, 1H), 7.25–7.21 (m, 1H), 4.19–4.01 (m, 4H), 1.25 (t, J = 7.2 Hz, 6H); ^13C{^1H} NMR (CDCl₃, 100 MHz): δ 148.5, 140.7, 129.6, 128.5, 127.2 (d, J_{C-F} = 5.0 Hz) 125.9, 124.1, 122.3, 120.7, 118.2, 117.0, 114.8, 65.2 (d, J_{C-F} = 7.0 Hz), 16.4 (d, J_{C-F} = 6.0 Hz); ^19F NMR (376.5 MHz, CDCl₃): δ -101.6 (d, J_{F-P} = 116.71 Hz); ^31P NMR (CDCl₃, 162 MHz): δ 4.94 (t, J_{P-F} = 118.2 Hz); HRMS (ESI–TOF) m/z: [M + H]^+ Calcd for [C₁₈H₂₀F₂N₂O₃P]: 381.1174; Found 381.1159.

*Diethyl (difluoro(2-(p-tolyl)-2H-indazol-3-yl)methyl)phosphonate (3ba):*

![Structural formula of 3ba]

Yellow solid (64 mg, 82%); mp. 64–65 °C; R_f 0.4 (PET:EtOAc = 7:3); ^1H NMR (CDCl₃, 400 MHz): δ 7.85 (d, J = 8.8 Hz, 1H), 7.76 (d, J = 8.8 Hz, 1H), 7.54 (d, J = 8.0 Hz, 2H), 7.38–7.34 (m, 1H), 7.29–7.25 (m, 2H), 7.23–7.20 (m, 1H), 4.20–3.99 (m, 4H), 2.44 (s, 3H), 1.25 (t, J = 7.2 Hz, 6H); ^13C{^1H} NMR (CDCl₃, 100 MHz): δ 148.5, 139.6, 138.3, 129.0,
127.0 (d, $J_{C,F} = 8.0$ Hz), 123.9 (d, $J_{C,F} = 9.0$ Hz), 122.3, 120.7, 119.7, 118.1, 117.4, 114.5, 65.1 (d, $J_{C,F} = 7.0$ Hz), 21.4, 16.4 (d, $J_{C,F} = 5.0$ Hz); $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -101.5 (d, $J_{F,P} = 116.7$ Hz); $^{31}$P NMR (CDCl$_3$, 162 MHz): $\delta$ 4.97 (t, $J_{P,F} = 116.6$ Hz); HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{19}$H$_{22}$F$_2$N$_2$O$_3$P]$^+$: 395.1331; Found 395.1314

Diethyl (difluoro(2-(4-methoxyphenyl)-2H-indazol-3-yl)methyl)phosphonate (3ca):

![Image of 3ca](image)

Yellow solid (66 mg, 81%); mp. 84–85 °C; R$_f$ 0.4 (PET:EtOAc = 3:2); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.84 (d, $J = 8.4$ Hz, 1H), 7.76 (d, $J = 8.8$ Hz, 1H), 7.58 (d, $J = 8.8$ Hz, 2H), 7.36 (t, $J = 8.0$ Hz, 1H), 7.23–7.20 (m, 1H), 7.00–6.96 (m, 2H), 4.19–4.02 (m, 4H), 3.87 (s, 3H), 1.25 (t, $J = 7.2$ Hz, 6H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 160.3, 148.4, 133.6, 128.4, 127.0, 126.0 (d, $J_{C,F} = 45.0$ Hz), 123.9, 122.3, 120.7, 118.1, 114.8, 113.5, 65.1 (d, $J_{C,F} = 6.0$ Hz), 55.6, 16.4 (d, $J_{C,F} = 5.0$ Hz); $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -101.8 (d, $J_{F,P} = 112.9$ Hz); $^{31}$P NMR (CDCl$_3$, 162 MHz): $\delta$ 4.97 (t, $J_{P,F} = 116.6$ Hz); Anal. Calcd for HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{19}$H$_{22}$F$_2$N$_2$O$_3$P]$^+$: 411.1280; Found 411.1285.

Diethyl ((2-(4-chlorophenyl)-2H-indazol-3-yl)difluoromethyl)phosphonate (3da):

![Image of 3da](image)
Yellow solid (70 mg, 85%); mp. 80–81 °C; R_f 0.5 (PET:EtOAc = 4:1); ^1H NMR (CDCl₃, 400 MHz): δ 7.83 (d, J = 8.4 Hz, 1H), 7.76 (d, J = 8.8 Hz, 1H), 7.66 (d, J = 8.4 Hz, 2H), 7.47 (d, J = 8.4 Hz, 2H), 7.38 (t, J = 8.4 Hz, 1H), 7.26–7.21 (m, 1H), 4.23–4.03 (m, 4H), 1.27 (t, J = 7.2 Hz, 6H); ^13C{^1H} NMR (CDCl₃, 100 MHz): δ 148.7, 139.2, 135.6 128.6 (d, J_C-F = 22.0 Hz), 127.4, 124.3, 122.4, 120.6, 119.4 (d, J_C-F = 44.0 Hz), 118.2, 117.1 (d, J_C-F = 38.0 Hz), 114.7, 65.3 (d, J_C-F = 6.0 Hz), 16.4 (d, J_C-F = 6.0 Hz); ^19F NMR (376.5 MHz, CDCl₃): δ -101.9 (d, J_F-P = 116.7 Hz); ^31P NMR (CDCl₃, 162 MHz): δ 4.82 (t, J_P-F = 115.0 Hz); HRMS (ESI–TOF) m/z: [M + H]^+ Calcd for [C₁₈H₁₀ClF₂N₂O₃P]: 415.0784; Found 415.0790.

Diethyl (2-(3-bromophenyl)-2H-indazol-3-yl)difluoromethyl)phosphonate (3ea):

Yellow liquid (76 mg, 83%); R_f 0.5 (PET:EtOAc = 4:1); ^1H NMR (CDCl₃, 400 MHz): δ 7.89 (s, 1H), 7.84 (d, J = 8.8 Hz, 1H), 7.76 (d, J = 8.8 Hz, 1H), 7.69–7.63 (m, 2H), 7.40–7.35 (m, 2H), 7.25–7.21 (m, 1H), 4.25–4.05 (m, 4H), 1.28 (t, J = 7.2 Hz, 6H); ^13C{^1H} NMR (CDCl₃, 100 MHz): δ 148.7, 141.7, 132.7, 130.4, 129.7, 127.4, 126.0, 124.3, 122.4 (d, J_C-F = 3.0 Hz), 121.8, 120.7, 118.2, 117.1 (d, J_C-F = 37.0 Hz), 114.5 (d, J_C-F = 35.0 Hz), 65.3 (d, J_C-F = 7.0 Hz), 16.4 (d, J_C-F = 5.0 Hz); ^19F NMR (376.5 MHz, CDCl₃): δ -101.7 (d, J_F-P = 112.9 Hz); ^31P NMR (CDCl₃, 162 MHz): δ 4.91 (t, J_P-F = 113.4 Hz); HRMS (ESI–TOF) m/z: [M + H]^+ Calcd for [C₁₈H₁₀BrF₂N₂O₃P]: 459.0279; Found 459.0266.
**Diethyl (difluoro(2-(4-(trifluoromethyl)phenyl)-2H-indazol-3-yl)methyl)phosphonate (3fa):**

![Chemical structure of 3fa]

White solid (71 mg, 80%); mp. 79–80 °C; \( R_f 0.5 \) (PET:EtOAc = 7:3); \(^1\text{H} \text{NMR} \) (CDCl\(_3\), 400 MHz): \( \delta \) 7.89–7.83 (m, 3H), 7.77 (d, \( J = 8.8 \) Hz, 3H), 7.39 (t, \( J = 8.4 \) Hz, 1H), 7.27–7.23 (m, 1H), 4.24–4.04 (m, 4H), 1.27 (t, \( J = 7.2 \) Hz, 6H); \(^{13}\text{C}\{^1\text{H}\} \text{NMR} \) (CDCl\(_3\), 100 MHz): \( \delta \) 148.9, 143.5, 131.3 (q, \( J_{\text{C-F}} = 63.0 \) Hz), 127.6 (d, \( J_{\text{C-F}} = 15.0 \) Hz), 125.7 (q, \( J_{\text{C-F}} = 4.0 \) Hz), 125.1, 124.5, 122.5 (t, \( J_{\text{C-F}} = 7.0 \) Hz), 120.7, 118.2, 116.9, 114.7 (d, \( J_{\text{C-F}} = 3.0 \) Hz), 65.3 (d, \( J_{\text{C-F}} = 7.0 \) Hz), 16.4 (d, \( J_{\text{C-F}} = 5.0 \) Hz); \(^{19}\text{F} \text{NMR} \) (376.5 MHz, CDCl\(_3\)): \( \delta \) -62.6, -101.6 (d, \( J_{\text{F-P}} = 116.7 \) Hz); \(^{31}\text{P} \text{NMR} \) (CDCl\(_3\), 162 MHz): \( \delta \) 4.79 (t, \( J_{\text{p-F}} = 113.4 \) Hz); \text{HRMS} \ (ESI–TOF) m/z: [M + H]\(^+\) Calcd for \([\text{C}_{19}\text{H}_{19}\text{F}_5\text{N}_2\text{O}_3\text{P}]^+\): 449.1048; Found 449.1053.

**Diethyl ((5-chloro-2-(p-tolyl)-2H-indazol-3-yl)difluoromethyl)phosphonate (3ga):**

![Chemical structure of 3ga]

Reddish yellow liquid (72 mg, 84%); \( R_f 0.4 \) (PET:EtOAc = 4:1); \(^1\text{H} \text{NMR} \) (CDCl\(_3\), 400 MHz): \( \delta \) 7.82 (s, 1H), 7.71 (d, \( J = 8.8 \) Hz, 1H), 7.53 (d, \( J = 8.0 \) Hz, 2H), 7.31–7.25 (m, 3H), 4.21–4.05 (m, 4H), 2.43 (s, 3H), 1.28 (t, \( J = 7.2 \) Hz, 6H); \(^{13}\text{C}\{^1\text{H}\} \text{NMR} \) (CDCl\(_3\), 100 MHz): \( \delta \) 146.7, 142.0, 139.9, 137.9, 129.7, 129.1, 128.5, 126.7, 122.6, 119.6 (d, \( J_{\text{C-F}} = 18.0 \) Hz), 116.8, 114.3 (d, \( J_{\text{C-F}} = 37.0 \) Hz), 65.2 (d, \( J = 7.0 \) Hz), 21.4, 16.4 (d, \( J = 6.0 \) Hz); \(^{19}\text{F} \text{NMR} \)
(376.5 MHz, CDCl$_3$): $\delta$ -102.1 (d, $J_{F,P} = 112.9$ Hz); $^{31}$P NMR (CDCl$_3$, 162 MHz): $\delta$ 4.65 (t, $J_{P,F} = 116.6$ Hz); HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{19}$H$_{21}$ClF$_2$N$_2$O$_3$P]$^+$: 429.0941; Found 429.0925.

**Diethyl (difluoro(5-fluoro-2-phenyl-2H-indazol-3-yl)methyl)phosphonate (3ha):**

![Diagram of 3ha]

Yellow solid (65 mg, 82%); mp. 81−82 °C; R$_f$ 0.4 (PET:EtOAc = 4:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.77−7.74 (m, 1H), 7.67−7.65 (m, 2H), 7.53−7.48 (m, 3H), 7.43 (d, $J = 9.6$ Hz, 1H), 7.20−7.15 (m, 1H), 4.22−4.03 (m, 4H), 1.27 (t, $J = 7.2$ Hz, 6H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 159.5 (d, $J_{C,F} = 241.0$ Hz), 145.9, 140.6, 129.7, 128.5, 127.1, 122.0 (d, $J_{C,F} = 11.0$ Hz), 120.4 (d, $J_{C,F} = 10.0$ Hz), 119.0 (d, $J_{C,F} = 29.0$ Hz), 116.8, 114.6, 103.5 (d, $J_{C,F} = 26.0$ Hz), 65.2 (d, $J_{C,F} = 7.0$ Hz), 16.4 (d, $J_{C,F} = 5.0$ Hz); $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -101.9 (d, $J_{P,F} = 112.9$ Hz), -116.2; $^{31}$P NMR (CDCl$_3$, 162 MHz): $\delta$ 4.81 (t, $J_{P,F} = 116.6$ Hz); HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{18}$H$_{19}$F$_3$N$_2$O$_3$P]$^+$: 399.1080; Found 399.1085.

**Diethyl ((2-(3-chlorophenyl)-5-fluoro-2H-indazol-3-yl)difluoromethyl)phosphonate (3ia):**

![Diagram of 3ia]

Yellow solid (67 mg, 78%); mp. 78−79 °C; R$_f$ 0.4 (PET:EtOAc = 4:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.77−7.72 (m, 2H), 7.62 (d, $J = 7.6$ Hz, 1H), 7.51−7.49 (m, 1H), 7.46−7.42 (m, 2H), 7.20−7.15 (m, 1H), 4.22−4.03 (m, 4H), 1.27 (t, $J = 7.2$ Hz, 6H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 159.5 (d, $J_{C,F} = 241.0$ Hz), 145.9, 140.6, 129.7, 128.5, 127.1, 122.0 (d, $J_{C,F} = 11.0$ Hz), 120.4 (d, $J_{C,F} = 10.0$ Hz), 119.0 (d, $J_{C,F} = 29.0$ Hz), 116.8, 114.6, 103.5 (d, $J_{C,F} = 26.0$ Hz), 65.2 (d, $J_{C,F} = 7.0$ Hz), 16.4 (d, $J_{C,F} = 5.0$ Hz); $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -101.9 (d, $J_{P,F} = 112.9$ Hz), -116.2; $^{31}$P NMR (CDCl$_3$, 162 MHz): $\delta$ 4.81 (t, $J_{P,F} = 116.6$ Hz); HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{18}$H$_{19}$F$_3$N$_2$O$_3$P]$^+$: 399.1080; Found 399.1085.
7.22–7.16 (m, 1H), 4.27–4.08 (m, 4H), 1.30 (t, $J = 7.2$ Hz, 6H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 161.9, 159.6 (d, $J_{C-F} = 244.0$ Hz), 146.1, 141.4, 134.2, 129.7 (d, $J_{C-F} = 36.0$ Hz), 127.5, 125.4, 123.3, 122.0 (t, $J_{C-F} = 5.0$ Hz), 120.5 (d, $J_{C-F} = 9.0$ Hz), 119.4 (d, $J_{C-F} = 29.0$ Hz), 114.5, 103.5 (d, $J_{C-F} = 26.0$ Hz) 65.3 (d, $J_{C-F} = 7.0$ Hz), 16.4 (d, $J_{C-F} = 5.0$ Hz); $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -102.1 (d, $J_{F-P} = 112.9$ Hz), -115.6; $^{31}$P NMR (CDCl$_3$, 162 MHz): $\delta$ 4.78 (t, $J_{P-F} = 115.0$ Hz); HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{18}$H$_{18}$ClF$_3$N$_2$O$_3$P]: 433.0690; Found 433.0696.

**Diethyl (difluoro(3-methyl-1H-indol-2-yl)methyl)phosphonate (3oa):**

![Diagram of 3oa](image)

Brown gummy (47 mg, 75%); $R_f$ 0.45 (PET:EtOAc = 7:3); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 8.91 (s, br, 1H), 7.62 (d, $J = 8.0$ Hz, 1H), 7.37 (d, $J = 8.0$ Hz, 1H), 7.28–7.25 (m, 1H), 7.17–7.13 (m, 1H), 4.28–4.13 (m, 4H), 2.47 (q, $J = 2.8$ Hz, 2.4 Hz, 3H), 1.32 (t, $J = 7.2$ Hz, 6H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 136.0, 128.4, 124.1, 123.2 (d, $J_{C-F} = 13.0$ Hz), 119.8 (d, $J_{C-F} = 15.0$ Hz), 117.6, 115.4, 114.1 (t, $J_{C-F} = 3.0$ Hz), 111.7, 65.3 (d, $J_{C-F} = 6.0$ Hz), 16.4 (d, $J_{C-F} = 5.0$ Hz), 8.8; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -105.1 (d, $J_{F-P} = 112.9$ Hz); $^{31}$P NMR (CDCl$_3$, 162 MHz): $\delta$ 5.75 (t, $J_{P-F} = 115.0$ Hz).

**Diethyl (difluoro(1-methyl-1H-indol-2-yl)methyl)phosphonate (3pa):**

![Diagram of 3pa](image)
Brown gummy (38 mg, 61%); Rf 0.50 (PET:EtOAc = 3:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.65 (d, $J = 8.0$ Hz, 1H), 7.38 (d, $J = 8.0$ Hz, 1H), 7.34–7.30 (m, 1H), 7.17–7.13 (m, 1H), 6.93 (d, $J = 0.8$ Hz, 1H), 4.30–4.16 (m, 4H), 3.92 (s, 3H), 1.34 (t, $J = 7.2$ Hz, 6H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 139.1, 127.7, 126.3, 123.9, 121.9, 120.3, 117.2, 109.9, 105.4 (t, $J_{C\text{-}F} = 10.0$ Hz), 65.2 (d, $J_{C\text{-}F} = 7.0$ Hz), 31.7, 16.4 (d, $J_{C\text{-}F} = 6.0$ Hz); $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -102.5 (d, $J_{F\text{-}P} = 112.9$ Hz); $^{31}$P NMR (CDCl$_3$, 162 MHz): $\delta$ 5.10 (t, $J_{P\text{-}F} = 115.0$ Hz).

Ethyl 2,2-difluoro-2-(2-phenyl-2H-indazol-3-yl)acetate (3ab):

Light yellow solid (53 mg, 84%); mp. 140–141 °C; Rf 0.6 (PET:EtOAc = 9:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.88 (d, $J = 8.4$ Hz, 1H), 7.81 (d, $J = 8.8$ Hz, 1H), 7.56–7.51 (m, 4H), 7.42–7.38 (m, 1H), 7.28–7.24 (m, 1H), 4.04 (q, $J = 8.8$ Hz, 2H), 1.13 (t, $J = 7.2$ Hz, 3H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 162.1 (t, $J_{C\text{-}F} = 35.0$ Hz), 148.5, 139.6, 130.0, 129.0, 127.2, 126.7, 126.1 (d, $J_{C\text{-}F} = 33.0$ Hz), 124.5, 122.1, 120.2 (t, $J_{C\text{-}F} = 3.0$ Hz), 118.3, 110.9 (d, $J_{C\text{-}F} = 249.0$ Hz), 63.7, 13.7; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -94.5; HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{17}$H$_{15}$F$_2$N$_2$O$_2$]$^+$: 317.1096; Found 317.1104.
Ethyl 2,2-difluoro-2-(2-(p-tolyl)-2H-indazol-3-yl)acetate (3bb):

Yellow solid (53 mg, 81%); mp. 132–133 °C; $R_f$ 0.65 (PET:EtOAc = 9:1); $^1H$ NMR (CDCl$_3$, 400 MHz): $\delta$ 7.87 (d, $J = 8.8$ Hz, 1H), 7.80 (d, $J = 8.8$ Hz, 1H), 7.42–7.37 (m, 3H), 7.30 (d, $J = 8.0$ Hz, 2H), 7.27–7.23 (m, 1H), 4.05 (q, $J = 7.2$ Hz, 2H), 2.45 (s, 3H), 1.14 (t, $J = 7.2$ Hz, 3H); $^{13}C\{^1H\}$ NMR (CDCl$_3$, 100 MHz): $\delta$ 162.2 (t, $J_{C-F} = 50.0$ Hz), 148.5, 140.2, 137.1, 130.2 (d, $J_{C-F} = 4.0$ Hz), 129.6, 127.1, 126.5, 124.3, 122.1, 120.2 (t, $J_{C-F} = 5.0$ Hz), 118.2, 111.0 (t, $J_{C-F} = 248.0$ Hz), 63.7, 21.4, 13.7; $^{19}F$ NMR (376.5 MHz, CDCl$_3$): $\delta$ -94.74; HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{18}$H$_{17}$F$_2$N$_2$O$_2$]: 331.1253; Found 331.1258.

Ethyl 2-(2-(4-chlorophenyl)-2H-indazol-3-yl)-2,2-difluoroacetate (3db):

Yellow liquid (55 mg, 79%); $R_f$ 0.65 (PET:EtOAc = 9:1); $^1H$ NMR (CDCl$_3$, 400 MHz): $\delta$ 7.85 (d, $J = 8.8$ Hz, 1H), 7.79 (d, $J = 8.8$ Hz, 1H), 7.506–7.500 (m, 4H), 7.42–7.38 (m, 1H), 7.28–7.23 (m, 1H), 4.13 (q, $J = 7.2$ Hz, 2H), 1.18 (t, $J = 7.2$ Hz, 3H); $^{13}C\{^1H\}$ NMR (CDCl$_3$, 100 MHz): $\delta$ 162.2 (t, $J_{C-F} = 34.0$ Hz), 148.7, 138.2, 136.1, 129.9, 129.2, 128.0, 127.5, 124.7, 122.3 (d, $J_{C-F} = 13.0$ Hz), 120.1 (t, $J_{C-F} = 4.0$ Hz), 118.3, 110.8 (t, $J_{C-F} = 250.0$ Hz), 63.9, 13.8;
**19F NMR** (376.5 MHz, CDCl3): δ -95.0; **HRMS** (ESI–TOF) m/z: [M + H]+ Calcd for [C17H14ClF2N2O2]+: 351.0706; Found 351.0711.

*Ethyl 2-(5-chloro-2-(p-tolyl)-2H-indazol-3-yl)-2,2-difluoroacetate (3gb):*

![Chemical structure of 3gb](image)

Yellow liquid (54 mg, 75%); Rf 0.6 (PET:EtOAc = 9:1); **1H NMR** (CDCl3, 400 MHz): δ 7.87 (s, 1H), 7.73 (d, J = 9.2 Hz, 1H), 7.39 (d, J = 8.4 Hz, 2H), 7.34–7.29 (m, 3H), 4.05 (q, J = 7.2 Hz, 2H), 2.45 (s, 3H), 1.14 (t, J = 7.6 Hz, 3H); **13C{1H} NMR** (CDCl3, 100 MHz): δ 161.9 (t, J_{C-F} = 34.0 Hz), 146.8, 140.5, 136.7, 130.3 (d, J_{C-F} = 12.0 Hz), 129.7, 128.7, 126.3, 122.4, 120.9 (d, J_{C-F} = 39.0 Hz), 119.8, 119.0 (t, J_{C-F} = 3.0 Hz), 110.7 (t, J_{C-F} = 249.0 Hz), 63.8, 21.4, 13.7; **19F NMR** (376.5 MHz, CDCl3): δ -94.9. **HRMS** (ESI-TOF) m/z: [M + H]+ Calcd for [C18H16ClF2N2O2]+: 365.0863; Found 365.0887.

*Ethyl 2-(5-chloro-2-phenyl-2H-indazol-3-yl)-2,2-difluoroacetate (3jb):*

![Chemical structure of 3jb](image)

White solid (58 mg, 83%); mp. 165–166 °C; Rf 0.65 (PET:EtOAc = 9:1); **1H NMR** (CDCl3, 400 MHz): δ 7.88 (s, 1H), 7.76–7.73 (m, 1H), 7.55–7.51 (m, 5H), 7.35–7.32 (m, 1H), 4.04 (q, J = 7.2 Hz, 2H), 1.14 (t, J = 7.2 Hz, 3H); **13C{1H} NMR** (CDCl3, 100 MHz): δ 161.9 (t, J_{C-F} = 35.0 Hz), 146.9, 139.3, 130.3 (d, J_{C-F} = 8.0 Hz), 129.7, 129.2, 128.8, 126.6, 122.5 (d,
$J_{\text{C-F}} = 7.0$ Hz), 120.9, 119.8, 119.1 (t, $J_{\text{C-F}} = 3.0$ Hz), 110.7 (t, $J_{\text{C-F}} = 248.0$ Hz), 63.9, 13.7; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -94.8; HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{17}$H$_{14}$ClF$_2$N$_2$O$_2$]$^+$: 351.0706; Found 351.0712.

2,2-Difluoro-1-morpholino-2-(2-(p-tolyl)-2H-indazol-3-yl)ethan-1-one (3bc):

Light yellow liquid (63 mg, 85%); R$_f$ 0.4 (PET:EtOAc = 7:3); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.79 (t, $J = 10.0$ Hz, 2H), 7.45 (d, $J = 8.0$ Hz, 2H), 7.41–7.37 (m, 1H), 7.30 (d, $J = 8.4$ Hz, 2H), 7.27–7.23 (m, 1H), 3.60–3.58 (m, 2H), 3.44–3.42 (m, 2H), 3.37–3.35 (m, 2H), 3.20–3.18 (m, 2H), 2.44 (s, 3H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 160.0 (t, $J_{\text{C-F}} = 31.0$ Hz), 148.5, 140.2, 137.2, 129.6, 127.2, 126.7 (d, $J_{\text{C-F}} = 32.0$ Hz), 126.2, 124.6, 121.4, 119.7, 118.5, 112.3 (t, $J_{\text{C-F}} = 247.0$ Hz), 66.4, 66.1, 46.3, 43.3, 21.4; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -88.4; HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{20}$H$_{20}$F$_2$N$_3$O$_2$]$^+$: 372.1518; Found 372.1524.

2,2-difluoro-N-(p-tolyl)-2-(2-(p-tolyl)-2H-indazol-3-yl)acetamide (3bd):
Colourless liquid (65 mg, 84%); Rf 0.5 (PET:EtOAc = 4:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.89 (d, $J = 8.8$ Hz, 1H), 7.81–7.73 (m, 2H), 7.41–7.32 (m, 3H), 7.26–7.23 (m, 1H), 7.18 (d, $J = 8.8$ Hz, 3H), 7.13–7.08 (m, 2H), 2.31, 2.30 (2s, 6H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 159.7 (t, $J_{C-F} = 30.0$ Hz), 148.4, 140.4, 136.9, 135.6, 133.0, 130.2 (d, $J_{C-F} = 11.0$ Hz), 129.6 (t, $J_{C-F} = 14.0$ Hz), 127.0 (d, $J_{C-F} = 17.0$ Hz), 126.4 (d, $J_{C-F} = 33.0$ Hz), 125.5, 124.5, 122.4, 121.1 (d, $J_{C-F} = 16.0$ Hz), 120.2 (d, $J_{C-F} = 19.0$ Hz), 118.2, 112.5 (t, $J_{C-F} = 252.0$ Hz), 21.3, 21.0; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -94.7; HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{23}$H$_{20}$F$_2$N$_3$O]$^+$: 392.1569; Found 392.1597.

3-(Perfluorobutyl)-2-(p-tolyl)-2H-indazole (3be):

White solid (64 mg, 76%); mp. 62–63 °C; Rf 0.85 (PET:EtOAc = 9:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.83–7.76 (m, 2H), 7.43–7.40 (m, 1H), 7.36–7.34 (m, 2H), 7.32–7.28 (m, 3H), 2.46 (s, 3H); $^{13}$C{$^1$H} NMR (CDCl$_3$, 100 MHz): $\delta$ 148.3, 140.3, 137.6, 130.3, 129.3, 127.3, 126.8 (t, $J_{C-F} = 8.0$ Hz), 125.4, 125.2, 123.2 (d, $J_{C-F} = 13.0$ Hz), 122.4, 122.1 (d, $J_{C-F} = 8.0$ Hz), 121.1 (d, $J_{C-F} = 7.0$ Hz), 119.8, 118.5, 21.4; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -80.8--80.9 (m, 3F), -103.7--103.8 (m, 2F), -121.4--121.5 (m, 2F), -125.9--126.0 (m, 2F); HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{18}$H$_{12}$F$_9$N$_2$]$^+$: 427.0851; Found 427.0857.
2-(4-Chlorophenyl)-3-(perfluorobutyl)-2H-indazole (3de):

White solid (65 mg, 73%); mp. 59–60 °C; Rf 0.85 (PET:EtOAc = 9:1); \(^1^H\) NMR (CDCl\(_3\), 400 MHz): \(\delta\) 7.81 (d, \(J = 9.2\) Hz, 1H), 7.77 (d, \(J = 8.8\) Hz, 1H), 7.54–7.48 (m, 2H), 7.45–7.42 (m, 3H), 7.33–7.30 (m, 1H); \(^1^H\) NMR (CDCl\(_3\), 100 MHz): \(\delta\) 148.6, 138.6 (d, \(J_{C-F} = 12.0\) Hz), 136.4, 130.0, 129.9, 129.0, 128.5, 127.7, 125.7 (d, \(J_{C-F} = 27.0\) Hz), 123.3, 122.6, 122.4 (q, \(J_{C-F} = 8.0\) Hz), 122.0 (t, \(J_{C-F} = 8.0\) Hz), 119.7, 118.5; \(^{19}\)F NMR (376.5 MHz, CDCl\(_3\)): \(\delta\) -80.8--80.9 (m, 3F), -103.6--103.7 (m, 2F), -121.4--121.5 (m, 2F), -125.9--126.0 (m, 2F); 

HRMS (ESI–TOF) m/z: [M + H]\(^+\) Calcd for \([C_{17}H_{9}ClF_{9}N_{2}]^+\): 447.0305; Found 447.0311.

5-Chloro-3-(perfluorobutyl)-2-(p-tolyl)-2H-indazole (3ge):

White liquid (66 mg, 72%); Rf 0.85 (PET:EtOAc = 9:1); \(^1^H\) NMR (CDCl\(_3\), 400 MHz): \(\delta\) 7.78–7.75 (m, 2H), 7.37–7.33 (m, 3H), 7.31–7.29 (m, 2H), 2.46 (s, 3H); \(^1^H\) NMR (CDCl\(_3\), 100 MHz): \(\delta\) 146.7, 140.6, 138.1, 137.4, 136.8, 131.3, 130.3 (d, \(J_{C-F} = 6.0\) Hz), 129.4, 128.9, 126.6 (q, \(J_{C-F} = 15.0\) Hz), 123.5 (d, \(J_{C-F} = 12.0\) Hz), 123.2 (d, \(J_{C-F} = 6.0\) Hz), 121.2 (t, \(J_{C-F} = 17.0\) Hz), 120.1, 118.4 (d, \(J_{C-F} = 12.0\) Hz), 21.4; \(^{19}\)F NMR (376.5 MHz, CDCl\(_3\)): \(\delta\) -80.8--80.9 (m, 3F), -103.8--103.9 (m, 2F), -121.3--121.4 (m, 2F), -125.8--125.9
(m, 2F); **HRMS (ESI–TOF) m/z: [M + H]^+ Calcd for [C\textsubscript{18}H\textsubscript{11}ClF\textsubscript{9}N\textsubscript{2}]^+: 461.0462; Found 461.0467.**

**Ethyl 2-fluoro-2-(2-phenyl-2H-indazol-3-yl)acetate (5af):**

![Chemical structure](image)

Yellow liquid (45 mg, 77%); R\textsubscript{f} 0.65 (PET:EtOAc = 9:1); **\textsuperscript{1}H NMR** (CDCl\textsubscript{3}, 400 MHz): \(\delta\) 7.82 (d, \(J = 8.8\) Hz, 1H), 7.74 (d, \(J = 8.4\) Hz, 1H), 7.70–7.67 (m, 2H), 7.61–7.53 (m, 3H), 7.40–7.37 (m, 1H), 7.22 (t, \(J = 8.0\) Hz, 1H), 6.12 (d, \(J = 47.6\) Hz, 1H), 4.30–4.15 (m, 2H), 1.20 (t, \(J = 7.2\) Hz, 3H); **\textsuperscript{13}C{\textsuperscript{1}H} NMR** (CDCl\textsubscript{3}, 100 MHz): \(\delta\) 166.7 (d, \(J_{C-F} = 30.0\) Hz), 148.8, 139.0, 129.8, 129.6, 127.3 (d, \(J_{C-F} = 25.0\) Hz), 126.4, 124.0, 121.8, 121.2 (d, \(J_{C-F} = 6.0\) Hz), 119.3, 118.3, 80.4 (d, \(J_{C-F} = 184.0\) Hz), 62.7, 14.1; **\textsuperscript{19}F NMR** (376.5 MHz, CDCl\textsubscript{3}): \(\delta\) -168.7 (d, \(J = 48.9\) Hz); **HRMS** (ESI–TOF) m/z: [M + H]^+ Calcd for [C\textsubscript{17}H\textsubscript{16}FN\textsubscript{2}O\textsubscript{2}]^+: 299.1190; Found 299.1196.

**Ethyl 2-fluoro-2-(2-(p-tolyl)-2H-indazol-3-yl)acetate (5bf):**

![Chemical structure](image)

Light yellow solid (51 mg, 82%); mp. 109–110 °C; R\textsubscript{f} 0.65 (PET:EtOAc = 9:1); **\textsuperscript{1}H NMR** (CDCl\textsubscript{3}, 400 MHz): \(\delta\) 7.81 (d, \(J = 8.8\) Hz, 1H), 7.73 (d, \(J = 8.4\) Hz, 1H), 7.55 (d, \(J = 8.4\) Hz, 2H), 7.39–7.36 (m, 3H), 7.23–7.19 (m, 1H), 6.11 (d, \(J = 47.6\) Hz, 1H), 4.30–4.15 (m, 2H),
2.47 (s, 3H), 1.19 (t, J = 7.2 Hz, 3H); $^{13}$C$^1$H NMR (CDCl$_3$, 100 MHz): $\delta$ 166.7 (d, $J_{C,F}$ = 30.0 Hz), 148.7, 140.1, 136.4, 130.1, 127.4, 127.1 (d, $J_{C,F}$ = 7.0 Hz), 126.1, 123.8, 121.3 (d, $J_{C,F}$ = 60.0 Hz), 119.3, 118.3, 80.4 (d, $J_{C,F}$ = 184.0 Hz), 62.6, 21.4, 14.1; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -168.7 (d, $J = 48.9$ Hz); HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{18}$H$_{18}$FN$_2$O$_2$]$^+$: 313.1347; Found 313.1352.

**Ethyl 2-fluoro-2-(2-(4-methoxyphenyl)-2H-indazol-3-yl)acetate (5cf):**

![Diagram](image)

Yellow liquid (49 mg, 75%); R$_f$ 0.5 (PET:EtOAc = 9:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.80 (d, $J =$ 8.8 Hz, 1H), 7.72 (d, $J =$ 8.4 Hz, 1H), 7.61–7.57 (m, 2H), 7.38 (t, $J =$ 8.0 Hz, 1H), 7.21 (t, $J =$ 8.0 Hz, 1H), 7.08–7.04 (m, 2H), 6.09 (d, $J =$ 47.6 Hz, 1H), 4.29–4.17 (m, 2H), 3.89 (s, 3H), 1.20 (t, $J =$ 7.2 Hz, 3H); $^{13}$C$^1$H NMR (CDCl$_3$, 100 MHz): $\delta$ 166.7 (d, $J_{C,F}$ = 30.0 Hz), 160.6, 148.6, 134.3, 131.8, 127.6 (d, $J_{C,F}$ = 16.0 Hz), 127.1 (d, $J_{C,F}$ = 21.0 Hz), 126.2, 123.8, 121.6, 119.2 (d, $J_{C,F}$ = 100.0 Hz), 114.6, 80.4 (d, $J_{C,F}$ = 184.0 Hz), 62.6, 55.8, 14.1; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -168.7 (d, $J = 52.7$ Hz); HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{18}$H$_{18}$FN$_2$O$_3$]$^+$: 329.1296; Found 329.1301.

**Ethyl 2-(2-(4-bromophenyl)-2H-indazol-3-yl)-2-fluoroacetate (5kf):**

![Diagram](image)
Yellow solid (58 mg, 78%); mp. 110−111 °C; Rf 0.7 (PET:EtOAc = 9:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.80 (d, $J$ = 8.8 Hz, 1H), 7.73−7.70 (m, 3H), 7.60−7.56 (m, 2H), 7.39 (t, $J$ = 8.0 Hz, 1H), 7.25−7.21 (m, 1H), 6.10 (d, $J$ = 47.6 Hz, 1H), 4.29−4.18 (m, 2H), 1.20 (t, $J$ = 7.2 Hz, 3H); $^{13}$C$\{^1$H$\}$ NMR (CDCl$_3$, 100 MHz): $\delta$ 166.4 (d, $J_{C-F}$ = 29.0 Hz), 148.9 (d, $J_{C-F}$ = 5.0 Hz), 141.4, 137.9, 132.8, 127.8, 127.4 (d, $J_{C-F}$ = 5.0 Hz), 127.2, 124.1 (d, $J_{C-F}$ = 21.0 Hz), 122.0, 119.3, 118.3, 80.2 (d, $J_{C-F}$ = 185.0 Hz), 62.8, 14.1; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -168.2 (d, $J$ = 48.9 Hz); HRMS (ESI−TOF) m/z: [M + H]$^+$ Calcd for [C$_{17}$H$_{15}$BrF$_2$N$_2$O$_2$]$^+$: 377.0295; Found 377.0295.

Ethyl 4-(3-(2-ethoxy-1-fluoro-2-oxoethyl)-2H-indazol-2-yl)benzoate (5lf):

![Diagram of 5lf](attachment:image.png)

Yellow liquid (51 mg, 70%); Rf 0.65 (PET:EtOAc = 9:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 8.27 (d, $J$ = 8.4 Hz, 2H), 7.81 (t, $J$ = 8.4 Hz, 3H), 7.74 (d, $J$ = 8.8 Hz, 1H), 7.40 (t, $J$ = 8.4 Hz, 1H), 7.26−7.22 (m, 1H), 6.13 (d, $J$ = 47.6 Hz, 1H), 4.43 (q, $J$ = 7.2 Hz, 2H), 4.28−4.17 (m, 2H), 1.43 (t, $J$ = 7.2 Hz, 3H), 1.19 (t, $J$ = 7.2 Hz, 3H); $^{13}$C$\{^1$H$\}$ NMR (CDCl$_3$, 100 MHz): $\delta$ 166.4 (d, $J_{C-F}$ = 29.0 Hz), 165.5, 149.0 (d, $J_{C-F}$ = 4.0 Hz), 142.3, 131.6, 130.9, 127.6, 127.3 (d, $J_{C-F}$ = 24.0 Hz), 126.1, 124.3, 122.1, 119.3, 118.4, 80.1 (d, $J_{C-F}$ = 185.0 Hz), 62.8, 61.7, 14.4, 14.1; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -168.2 (d, $J$ = 45.1 Hz); HRMS (ESI−TOF) m/z: [M + H]$^+$ Calcd for [C$_{20}$H$_{20}$FN$_2$O$_4$]$^+$: 371.1402; Found 371.1407.
**Ethyl 2-fluoro-2-(2-(m-tolyl)-2H-indazol-3-yl)acetate (5mf):**

Yellow liquid (46 mg, 74%); R$_f$ 0.65 (PET:EtOAc = 9:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.81 (d, $J = 8.8$ Hz, 1H), 7.74 (d, $J = 8.4$ Hz, 1H), 7.51 (s, 1H), 7.48–7.43 (m, 2H), 7.40–7.35 (m, 2H), 7.21 (t, $J = 7.6$ Hz, 1H), 6.13 (d, $J = 47.2$ Hz, 1H), 4.31–4.16 (m, 2H), 2.47 (s, 3H), 1.20 (t, $J = 7.2$ Hz, 3H); $^{13}$C$^1$H NMR (CDCl$_3$, 100 MHz): $\delta$ 166.7 (d, $J_{C-F}$ = 29.0 Hz), 148.7 (d, $J_{C-F}$ = 3.0 Hz), 139.9, 138.8, 130.6, 129.3, 127.3, 127.1 (d, $J_{C-F}$ = 4.0 Hz), 126.9, 123.9, 123.3, 121.7, 119.3, 118.3, 80.4 (d, $J_{C-F}$ = 184.0 Hz), 62.6, 21.4, 14.1; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -168.7 (d, $J$ = 45.1 Hz).

**Ethyl 2-(2-(tert-butyl)-2H-indazol-3-yl)-2-fluoroacetate (5nf):**

Colourless liquid (26 mg, 47%); R$_f$ 0.65 (PET:EtOAc = 9:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.73 (d, $J = 8.8$ Hz, 1H), 7.66 (d, $J = 8.4$ Hz, 1H), 7.29-7.26 (m, 1H), 7.11 (t, $J = 7.6$ Hz, 1H), 6.64 (d, $J = 47.2$ Hz, 1H), 4.35-4.22 (m, 2H), 1.88 (s, 9H), 1.21 (t, $J = 7.2$ Hz, 3H); $^{13}$C$^1$H NMR (CDCl$_3$, 100 MHz): $\delta$ 167.0 (d, $J_{C-F}$ = 30.0 Hz), 146.2 (d, $J_{C-F}$ = 5.0 Hz), 125.9 (d, $J_{C-F}$ = 8.0 Hz), 125.6, 123.0 (d, $J_{C-F}$ = 35.0 Hz), 120.3, 119.5 (d, $J_{C-F}$ = 27.0 Hz), 118.1, 81.0 (d, $J_{C-F}$ = 184.0 Hz), 63.0, 62.5, 31.5, 14.1; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -169.5 (d, $J$ = 48.9 Hz).
Hz); Anal. Calcd for C₁₁₂₄F₂N₂O₂: C, 64.73; H, 6.88; N, 10.07%; Found C, 64.54; H, 6.93; N, 10.18%.

**Ethyl 2-((5-chloro-2-phenyl-2H-indazol-3-yl)-2-fluoroacetate (5jf):**

![Chemical Structure of 5jf](image)

Yellow solid (55 mg, 83%); mp. 83–84 °C; Rᵥ 0.6 (PET:EtOAc = 9:1); **¹H NMR** (CDCl₃, 400 MHz): δ 7.76–7.74 (m, 2H), 7.68–7.65 (m, 2H), 7.61–7.56 (m, 3H), 7.33–7.30 (m, 1H), 6.08 (d, J = 47.2 Hz, 1H), 4.32–4.18 (m, 2H), 1.23 (t, J = 7.2 Hz, 3H); **¹³C{¹H} NMR** (CDCl₃, 100 MHz): δ 166.3 (d, Jₑₑ = 29.0 Hz), 147.1 (d, Jₑₑ = 3.0 Hz), 138.7, 130.1, 129.8 (d, Jₑₑ = 3.0 Hz), 129.7, 128.7, 127.1 (d, Jₑₑ = 26.0 Hz), 126.3, 122.1, 119.9, 118.2, 80.3 (d, Jₑₑ = 186.0 Hz), 62.8, 14.1; **¹⁹F NMR** (376.5 MHz, CDCl₃): δ -169.4 (d, J = 41.4 Hz); **HRMS** (ESI–TOF) m/z: [M + H]⁺ Calcd for [C₁₁₂₄ClF₂N₂O₂]⁺: 333.0801; Found 333.0806.

**Ethyl 2-((5-chloro-2-(p-tolyl)-2H-indazol-3-yl)-2-fluoroacetate (5gf):**

![Chemical Structure of 5gf](image)

Yellow solid (55 mg, 80%); mp. 109–110 °C; Rᵥ 0.65 (PET:EtOAc = 9:1); **¹H NMR** (CDCl₃, 400 MHz): δ 7.74 (d, J = 9.2 Hz, 2H), 7.53 (d, J = 8.4 Hz, 2H), 7.37 (d, J = 8.0 Hz, 2H), 7.32–7.29 (m, 1H), 6.06 (d, J = 47.2 Hz, 1H), 4.31–4.19 (m, 2H), 2.47 (s, 3H), 1.23 (t, J = 7.2 Hz, 3H); **¹³C{¹H} NMR** (CDCl₃, 100 MHz): δ 166.4 (d, Jₑₑ = 29.0 Hz), 147.0, 140.4,
136.1, 130.2, 129.6, 128.6, 127.1 (d, $J_{\text{C-F}} = 25.0$ Hz), 126.0, 122.0, 119.8, 118.2, 80.3 (d, $J_{\text{C-F}} = 185.0$ Hz), 62.8, 21.4, 14.1; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -169.4 (d, $J = 48.9$ Hz);

HRMS (ESI–TOF) m/z: [M + H]$^+$ Calcd for [C$_{18}$H$_{17}$ClF$_2$O$_2$]$^+$: 347.0957; Found 347.0957.

Ethyl 2-(2-(3-chlorophenyl)-5-fluoro-2H-indazol-3-yl)-2-fluoroacetate (5if):

![Chemical structure of ethyl 2-(2-(3-chlorophenyl)-5-fluoro-2H-indazol-3-yl)-2-fluoroacetate (5if)]

Yellow solid (51 mg, 73%); mp. 81−82 °C; R$_f$ 0.7 (PET:EtOAc = 9:1); $^1$H NMR (CDCl$_3$, 400 MHz): $\delta$ 7.80−7.77 (m, 1H), 7.73−7.72 (m, 1H), 7.60−7.52 (m, 3H), 7.33−7.31 (m, 1H), 7.22−7.18 (m, 1H), 6.08 (d, $J = 47.2$ Hz, 1H), 4.32−4.21 (m, 2H), 1.24 (t, $J = 7.2$ Hz, 3H);

$^{13}$C{H} NMR (CDCl$_3$, 100 MHz): $\delta$ 166.2 (d, $J_{\text{C-F}} = 29.0$ Hz), 160.8, 158.4, 146.3 (d, $J_{\text{C-F}} = 3.0$ Hz), 139.7, 135.5, 130.6, 130.2, 127.7 (d, $J_{\text{C-F}} = 9.0$ Hz), 125.4 (d, $J_{\text{C-F}} = 228.0$ Hz), 120.7 (d, $J_{\text{C-F}} = 10.0$ Hz), 119.4 (d, $J_{\text{C-F}} = 19.0$ Hz), 114.4, 102.1 (d, $J_{\text{C-F}} = 25.0$ Hz), 80.1 (d, $J_{\text{C-F}} = 186.0$ Hz), 62.9, 14.1; $^{19}$F NMR (376.5 MHz, CDCl$_3$): $\delta$ -115.5, -168.9 (d, $J = 45.1$ Hz);

HRMS (ESI–TOF) m/z: [M + Na]$^+$ Calcd for [C$_{17}$H$_{13}$ClF$_2$N$_2$O$_2$Na]$^+$: 373.0526; Found 373.0526.

3-(Difluoromethyl)-2-(p-tolyl)-2H-indazole (6bc):

![Chemical structure of 3-(Difluoromethyl)-2-(p-tolyl)-2H-indazole (6bc)]
White solid (43 mg, 85%); mp. 89–90 °C; Rf 0.75 (PET:EtOAc = 9:1); \(^1\)H NMR (CDCl\(_3\), 400 MHz): \(\delta\) 7.92–7.90 (m, 1H), 7.82–7.79 (m, 1H), 7.49 (d, \(J = 8.4\) Hz, 2H), 7.41–7.35 (m, 3H), 7.26–7.23 (m, 1H), 6.89 (t, \(J = 50.0\) Hz, 1H), 2.47 (s, 3H); \(^{13}\)C\(^{\{1\}H}\) NMR (CDCl\(_3\), 100 MHz): \(\delta\) 148.6 (d, \(J_{C-F} = 2.0\) Hz), 140.2, 136.6, 130.2, 127.8, 127.3 (d, \(J_{C-F} = 31.0\) Hz), 125.6, 124.1, 121.1, 119.9, 118.2, 110.0 (t, \(J_{C-F} = 233.0\) Hz), 21.3; \(^{19}\)F NMR (376.5 MHz, CDCl\(_3\)): \(\delta\) -109.1 (d, \(J = 52.7\) Hz); HRMS (ESI–TOF) m/z: [M + H]\(^+\) Calcd for [C\(_{15}\)H\(_{13}\)F\(_2\)N\(_2\)]\(^+\): 259.1041; Found 259.1047.

**Diethyl (1,1-difluoro-3,3-diphenylallyl)phosphonate (7a):**

![Diagram of compound 7a]

Light yellow liquid (58 mg, 80%); Rf 0.4 (PET:EtOAc = 7:3); \(^1\)H NMR (CDCl\(_3\), 400 MHz): \(\delta\) 7.35–7.33 (m, 3H), 7.32–7.27 (m, 5H), 7.26–7.23 (m, 2H), 6.19–6.10 (m, 1H), 4.27–4.17 (m, 4H), 1.34 (t, \(J = 7.2\) Hz, 6H); \(^{13}\)C\(^{\{1\}H}\) NMR (CDCl\(_3\), 100 MHz): \(\delta\) 151.1 (q, \(J_{C-F} = 8.0\) Hz), 141.5, 138.2, 129.6, 129.0, 128.4, 128.0 (d, \(J_{C-F} = 7.0\) Hz), 127.6, 118.6, 117.1 (q, \(J_{C-F} = 20.0\) Hz), 116.4, 64.7 (d, \(J_{C-F} = 7.0\) Hz), 16.5 (d, \(J_{C-F} = 6.0\) Hz); \(^{19}\)F NMR (376.5 MHz, CDCl\(_3\)): \(\delta\) -102.0 (d, \(J_{F-P} = 15.0\) Hz), -102.3 (d, \(J_{F-P} = 15.0\) Hz); \(^{31}\)P NMR (CDCl\(_3\), 162 MHz): \(\delta\) 6.70 (t, \(J_{P-F} = 113.4\) Hz); HRMS (ESI–TOF) m/z: [M + Na]\(^+\) Calcd for [C\(_{19}\)H\(_{21}\)F\(_2\)NaO\(_3\)P]\(^+\): 389.1089; Found 389.1094.
10. References:


11. NMR spectra $[^1\text{H}, ^{13}\text{C}[^1\text{H}], ^{19}\text{F}, \text{ and } ^{31}\text{P}]$ of synthesized products
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

![Chemical Structure](image)

3aa
$^{13}$C\{$^1$H} NMR : 100 MHz
Solvent : CDCl$_3$

EtO $\overset{\text{O=P}}{\text{OEt}}$

3aa
$^{19}\text{F NMR: 376.5 MHz}$

Solvent: CDCl$_3$

EtO$_2$ $^\text{F}$

3aa
$^{31}\text{P NMR}: 162\text{ MHz}$

Solvent: CDCl$_3$

![Chemical Structure](image)
1H NMR: 400 MHz
Solvent: CDCl₃

3ba
$^{13}$C$^1$H NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR : 376.5 MHz
Solvent : CDCl$_3$

3ba
$^{31}\text{P NMR : 162 MHz}$

Solvent : CDCl$_3$

![Chemical Structure](image)

3ba
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

![NMR Spectrum Diagram](image)
$^{13}$C{\textsuperscript{1}H} NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^{31}$P NMR : 162 MHz
Solvent : CDCl$_3$
$^{13}$C$\{^1\text{H}\}$ NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$

3da
$^{31}$P NMR : 162 MHz
Solvent : CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$
$^{13}\text{C}^{1\text{H}}\text{NMR: 100 MHz}$

Solvent: CDCl$_3$
$^{19}$F NMR : 376.5 MHz
Solvent : CDCl$_3$
$^{31}$P NMR: 162 MHz
Solvent: CDCl$_3$

3ea
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

![NMR spectrum of compound 3fa](image)
$^{13}\text{C}\{^1\text{H}\}$ NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^{31}$P NMR: 162 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz  
Solvent: CDCl$_3$
$^{13}$C-{\textsuperscript{1}H} NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^{31}$P NMR : 162 MHz
Solvent : CDCl$_3$
$^1$H NMR : 400 MHz
Solvent : CDCl$_3$
$^{13}$C{$^{1}$H} NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^{31}\text{P NMR : 162 MHz}$

Solvent : CDCl$_3$

EtO\text{O}_\text{Et}

O=\text{P}

F

F

3ha
$^1$H NMR: 400 MHz  
Solvent: CDCl$_3$  

![Chemical Structure](image)

EtO, OEt

F

F

Cl

3ia
$^{13}$C{$^1$H} NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$

[Chemical structure image]
$^{31}\text{P NMR} : 162 \text{ MHz}$

Solvent : CDCl$_3$
$^{13}$C$^1$H NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^{31}$P NMR: 162 MHz
Solvent: CDCl$_3$

![Chemical Structure](image)

30a
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

![Chemical Structure Image]

3pa
$^{13}{\text{C}}\{^1\text{H}\} \text{ NMR : 100 MHz}$

Solvent : CDCl$_3$

![Chemical Structure Image]

$3\text{pa}$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^{31}$P NMR: 162 MHz
Solvent: CDCl$_3$

![Chemical Structure Image]
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz  
Solvent: CDCl$_3$
$^{13}C\{^1H\}$ NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

![Chemical Structure]

3db
$^{13}\text{C}^{\text{H}}$ NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR : 376.5 MHz
Solvent : CDCl$_3$
$^1$H NMR: 400 MHz  
Solvent: CDCl$_3$
$^{13}$C-$^1$H NMR: 100 MHz
Solvent: CDCl$_3$

![Chemical Structure Image]
$^{19}$F NMR : 376.5 MHz
Solvent : CDCl$_3$

![Chemical Structure Diagram](Image)
$^1$H NMR : 400 MHz
Solvent : CDCl$_3$
$^{13}\text{C}^{1\text{H}} \text{ NMR} : 100 \text{ MHz}$

Solvent: CDCl$_3$
$^{19}$F NMR : 376.5 MHz
Solvent : CDCl$_3$
$\text{\textsuperscript{13}C}\{\text{\textsuperscript{1}H}\} \text{ NMR : 100 MHz}$

Solvent : CDCl$_3$

![Chemical Structure](image)
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

![Chemical Structure](image)

3bd
$^{13}\text{C}^{\text{1H}}$ NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}\text{F NMR : 376.5 MHz}$

Solvent : CDCl$_3$

-38.71 ppm
$^{1}H$ NMR: 400 MHz
Solvent: CDCl$_3$
$^{13}$C$^1$H NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR: 376.5 MHz

Solvent: CDCl$_3$

![Chemical Structure Diagram]
$\text{H NMR : 400 MHz}$

Solvent : CDCl$_3$

\[ \begin{array}{c}
\text{F}_3\text{C} \quad \text{CF}_2 \\
\text{F}_2\text{C} \quad \text{F} \\
\text{N} \quad \text{Cl} \\
\end{array} \]

3de
$^{13}$C{H} NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$
$^{13}\text{C}^{1\text{H}}$ NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR : 400 MHz
Solvent : CDCl$_3$
$^{13}\text{C}\{^1\text{H}\}$ NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR : 376.5 MHz
Solvent : CDCl$_3$

![Chemical Structure](image)

5af
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

![Chemical Structure]
$^{13}C^{1H}$ NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$
$^{13}\text{C}\{^1\text{H}\}$ NMR: 100 MHz
Solvent: CDCl$_3$

![Chemical Structure]
$^{19}\text{F NMR : 376.5 MHz}$

Solvent : CDCl$_3$
$^{1}$H NMR: 400 MHz
Solvent: CDCl$_3$
$^{13}\text{C}\{{}^1\text{H}\}}$ NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1\text{H NMR : 400 MHz}$

Solvent : CDCl$_3$

\[\text{O=CO}_{\text{Et}} \quad \text{H} \quad \text{F} \quad \text{N} \quad \text{CO}_2\text{Et}\]
$^{13}$C($^1$H) NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

![Chemical Structure Image]
$^{13}\text{C}^{1\text{H}} \text{ NMR : 100 MHz}$

Solvent : CDCl$_3$
19F NMR: 376.5 MHz
Solvent: CDCl₃
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

[Chemical structure image]

5nf
$^{13}$C$^1$H NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$
$^{13}$C$^1$H NMR : 100 MHz
Solvent : CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$
$^{13}$C\textsuperscript{1H} NMR : 100 MHz

Solvent : CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$
$^{13}$C/$^1$H NMR: 100 MHz
Solvent: CDCl$_3$
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$

![NMR Spectrum]

6bc
$^{13}\text{C}^{1\text{H}} \text{ NMR: 100 MHz}
\text{Solvent: CDCl}_3

6bc
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$

6bc
$^1$H NMR: 400 MHz
Solvent: CDCl$_3$
$^{13}\text{C}^{1\text{H}}$ NMR : 100 MHz

Solvent : CDCl$_3$

![Chemical Structure](image)

190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

S141
$^{19}$F NMR: 376.5 MHz
Solvent: CDCl$_3$
$^{31}$P NMR: 162 MHz
Solvent: CDCl$_3$

Chemical structure of compound 7a is shown with NMR spectrum. The spectrum displays peaks at various ppm values, indicating the presence of different chemical environments.