SUPPLEMENTARY CONTENT

SYNTHESIS OF NOVEL DISPIRO 1,4-BENZOTHIAZINE HYBRID HETEROCYCLES THROUGH 1,3-DIPOLAR CYCLOADDITION

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EXPERIMENTAL

General. The melting points were measured in open capillary tubes and are uncorrected. The $^1$H, $^{13}$C and the 2D NMR spectra were recorded on a Bruker (Avance) 300 MHz NMR instrument using TMS as internal standard and CDCl$_3$ or DMSO-d$_6$ as solvent. Standard Bruker software was used throughout. Chemical shifts are given in parts per million ($\delta$-scale) and the coupling constants are given in Hertz. Elemental analyses were performed on a Perkin Elmer 2400 Series II Elemental CHNS analyzer. Silica gel-G plates (Merck) were used for tlc analysis with a mixture of petroleum ether (60–80°C) and ethyl acetate as eluent. All the chemicals were purchased from Sigma-Aldrich and used without any further purification.

General procedure for the synthesis of dispiro 1,4-benzothiazine hybrid heterocycles: A mixture of (3, 1 mmol), acenaphthylene-1,2-dione or isatins (4 or 13, 1.2 mmol) and the respective $\alpha$-amino acid (5–8, 1.5 mmol) in ethanol (10 mL) was heated to reflux on a water bath for 3 h. After completion of the reaction as evident from TLC, the mixture was poured into crushed ice and the resulting solid was filtered off and purified by column chromatography on silica gel employing ethyl acetate/petroleum ether (10:90 v/v) as eluent to obtain pure products 9–12 and 14–16.

*Methyl 1'-methyl-[spiro[2',2'']-acenaphthene-1''-one]-3-oxo-3,4-dihydrospiro[benzo[b][1,4]thiazine-2,3'-pyrrolidine]-4'-carboxylate (9a):* Obtained as colourless solid; Yield 75%; m.p. 219-221°C; Anal. Calcd. for C$_{25}$H$_{20}$N$_2$O$_4$S: C, 67.55; H, 4.54; N, 6.30; S, 7.21. Found: C, 67.62; H, 4.46; N, 6.23; S, 7.28. $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ H: 2.08 (s, 3H), 3.49 (t, $J=8.4$Hz, 1H), 3.73–3.82 (m, 3H), 4.19 (t, $J=9.3$Hz, 1H), 4.94 (t, $J=9.0$ Hz, 1H), 5.92 (d, $J=7.8$Hz, 1H), 6.34 (t, $J=7.5$ Hz, 1H), 6.44 (t, $J=7.8$ Hz, 1H), 6.66 (d, $J=7.5$ Hz, 1H), 7.41 (d, $J=4.5$Hz, 1H), 7.44–7.50 (m, 2H), 7.52–7.56 (m, 2H), 7.63 (d, $J=7.8$ Hz, 1H), 7.78 (d, $J=8.1$ Hz, 1H), 9.57 (s, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$) $\delta$C: 34.8, 39.3, 39.6, 39.8, 46.6, 51.6,
Ethyl 1'-methyl-[spiro[2',2'"]-acenapthene-1"-one]-3-oxo-3,4-dihydrospiro[benzo[b][1,4]thiazine-2,3'-pyrrolidine]-4'-carboxylate (9b): Obtained as colourless solid; Yield 72%; m.p. 176–178°C; Anal. Calcd. for C_{26}H_{22}N_{2}O_{4}S: C, 68.10; H, 4.84; N, 6.11; S, 6.99. Found: C, 68.18; H, 4.77; N, 6.03; S, 7.07. \(^1^H\) NMR (300 MHz, CDCl\(_3\)) \(\delta_H\): 1.33 (t, \(J=7.2\)Hz, 3H), 2.08 (s, 3H), 3.51 (t, \(J=8.4\)Hz, 1H), 4.19 (t, \(J=9.3\)Hz, 1H), 4.29 (dd, \(J=13.8, 6.6\)Hz, 2H), 4.88 (t, \(J=9.0\)Hz, 1H), 5.87 (d, \(J=7.5\)Hz, 1H), 6.39 (t, \(J=7.5\)Hz, 1H), 6.50 (t, \(J=6.6\)Hz, 1H), 6.71 (d, \(J=7.5\)Hz, 1H), 7.42–7.52 (m, 3H), 7.56–7.62 (m, 2H), 7.77 (d, \(J=7.6\)Hz, 1H). \(^1^C\) NMR (75 MHz, CDCl\(_3\)) \(\delta_C\): 14.2, 35.2, 47.1, 54.6, 58.6, 61.2, 81.6, 115.1, 117.5, 119.9, 121.4, 123.1, 125.4, 127.0, 127.1, 127.5, 128.1, 129.5, 130.6, 131.7, 133.5, 136.0, 142.1, 166.7, 169.9, 203.1.

Methyl [spiro[3',2'"]-acenapthene-1"-one]-3-oxo-5'-phenyl-3,4-dihydrospiro[benzo[b][1,4]thiazine-2,3'-pyrrolidine]-4'-carboxylate (10a): Obtained as pale white solid; Yield 68%; m.p. 204–206°C; Anal. Calcd. for C\(_{31}\)H\(_{24}\)N\(_2\)O\(_4\)S: C, 71.13; H, 4.38; N, 5.53; S, 6.33. Found: C, 71.21; H, 4.32; N, 5.46; S, 6.41 \(^1^H\) NMR (300 MHz, DMSO-D\(_6\)/CDCl\(_3\)) \(\delta_H\): 1.20 (t, \(J=6.6\)Hz, 3H), 4.13 (d, \(J=6.9\)Hz, 2H), 4.79 (d, \(J=10.5\)Hz, 1H), 5.60 (d, \(J=6.3\)Hz, 1H), 5.83 (d, \(J=7.8\)Hz, 1H), 6.54 (d, \(J=7.8\)Hz, 1H), 6.58–6.63 (m, 1H), 6.93 (d, \(J=7.5\)Hz,1H), 7.30–7.46 (m, 5H), 7.56–7.60 (m, 2H), 7.62–7.75 (m, 4H), 7.86 (d, \(J=7.8\)Hz, 1H). \(^1^C\) NMR (75 MHz, CDCl\(_3\)) \(\delta_C\): 13.1, 56.3, 59.1, 59.9, 61.7, 76.6, 114.5, 115.7, 119.0, 120.5, 121.7, 124.2, 126.3, 126.5, 126.6, 126.8, 127.0, 127.3, 128.3, 129.7, 130.2, 135.9, 137.3, 139.1, 139.9, 163.9, 168.2, 202.4.

Ethyl [spiro[3',2'"]-acenapthene-1"-one]-3-oxo-5'-phenyl-3,4-dihydrospiro[benzo[b][1,4]thiazine-2,3'-pyrrolidine]-4'-carboxylate (10b): Obtained as pale white solid; Yield 86%; m.p. 201–203°C; Anal. Calcd. for C\(_{31}\)H\(_{24}\)N\(_2\)O\(_4\)S: C, 71.52; H, 4.65; N, 5.38; O, 12.29; S, 6.16.
C, 71.44; H, 4.71; N, 5.45; S, 6.10. $^1$H NMR (300 MHz, DMSO-$d_6$/CDCl$_3$) $\delta_H$: 1.20 (t, $J$=6.9Hz, 3H), 4.17 (dd, $J$=14.1, 6.9Hz, 1H), 4.76 (d, $J$=10.2Hz, 1H), 5.64–5.69 (m, 2H), 6.57 (t, $J$=7.8Hz, 1H), 6.67 (t, $J$=7.5Hz, 1H), 7.02 (d, $J$=7.8Hz, 1H), 7.30–7.41 (m, 5H), 7.57 (d, $J$=7.8Hz, 1H), 7.65 (d, $J$=6.9Hz, 1H), 7.65–7.71 (m, 3H), 7.93 (dd, $J$=6.3, 2.4Hz, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$) $\delta_C$: 14.1, 22.6, 29.6, 57.2, 60.2, 61.2, 62.8, 77.9, 115.3, 117.5, 120.3, 121.5, 123.5, 127.5, 127.6, 127.8, 128.0, 128.2, 128.4, 128.6, 129.4, 130.8, 131.1, 136.1, 136.1, 137.9, 140.3, 140.8, 165.8, 169.1, 203.6.

Methyl [spiro[3',2'']-acenaphthene-1''-one]-3-oxo-1',3,3',4,5',6',7',7a'-octahydrospiro[benzo[b][1,4]thiazine-2,2'-pyrrolizine]-1'-carboxylate (11a): Obtained as pale white solid; Yield 75%; m.p. 199–201°C; Anal. Calcd. for C$_{27}$H$_{22}$N$_2$O$_3$S: C, 68.92; H, 4.71; N, 5.95; S, 6.81 Found: C, 68.99; H, 4.64; N, 6.03; S, 6.87. $^1$H NMR (300 MHz, DMSO-$d_6$/CDCl$_3$) $\delta_H$: 1.11 (t, $J$=7.2Hz, 3H), 2.17 (d, $J$=5.7Hz, 3H), 2.42–2.45 (m, 1H), 2.65 (t, $J$=4.8Hz, 1H), 3.72–3.78 (m, 1H), 3.94–4.03 (m, 1H), 4.45 (dd, $J$=16.8Hz, 7.8Hz, 1H), 4.83 (d, $J$=9.6Hz, 1H), 5.30 (s, 1H), 6.03 (d, $J$=7.5Hz, 1H), 6.80 (t, $J$=7.5Hz, 1H), 6.88 (t, $J$=7.5Hz, 1H), 7.19 (d, $J$=6.0Hz, 1H), 7.64 (d, $J$=8.7Hz, 2H), 7.79 (d, $J$=6.9Hz, 1H), 7.82 (d, $J$=6.9Hz, 1H), 7.95 (d, $J$=8.4Hz, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$) $\delta_C$: 29.2, 30.7, 39.2, 39.4, 40.0, 40.2, 46.1, 51.4, 52.7, 64.3, 66.2, 81.8, 115.7, 117.8, 119.4, 122.9, 124.6, 124.6, 124.8, 125.8, 127.2, 129.6, 130.6, 132.1, 134.4, 162.1, 169.5, 205.3.

Ethyl [spiro[3',2'']-acenaphthene-1''-one]-3-oxo-1',3,3',4,5',6',7',7a'-octahydrospiro[benzo[b][1,4]thiazine-2,2'-pyrrolizine]-1'-carboxylate (11b): Obtained as pale white solid; Yield 84%; m.p. 197–199°C; Anal. Calcd. for C$_{28}$H$_{24}$N$_2$O$_4$S: C, 69.40; H, 4.99; N, 5.78; S, 6.62. Found: C, 69.33; H, 5.86; N, 5.72; S, 6.69. $^1$H NMR (300 MHz, DMSO-$d_6$/CDCl$_3$) $\delta_H$: 1.11 (t, $J$=7.2Hz, 3H), 2.17 (d, $J$=5.7Hz, 3H), 2.42–2.45 (m, 1H), 2.65 (t, $J$=4.8Hz, 1H), 3.72–3.78 (m, 1H), 3.94–4.03 (m, 1H), 4.45 (dd, $J$=16.8Hz, 7.8Hz, 1H), 4.83 (d, $J$=9.6Hz, 1H), 5.30 (s, 1H), 6.03 (d, $J$=7.5Hz, 1H), 6.80 (t, $J$=7.5Hz, 1H), 6.88 (t, $J$=7.5Hz, 1H), 7.19 (d, $J$=6.0Hz,
Methyl [spiro[3′,2′]-acenaphthene-1′-one]-3-oxo-3,3′,4,5′,7′,7a′-hexahydro-1′H-spiro[benzo [b][1,4]thiazine-2,6′-pyrrolo[1,2-c]thiazole]-7′-carboxylate (12a): Obtained as pale white solid; Yield 74%; m.p. 220–222°C; Anal. Calcd. for C26H20N2O3S: C, 63.92; H, 4.13; N, 5.73; S, 13.13. Found: C, 63.84; H, 4.18; N, 5.78; S, 13.06. ¹H NMR (300 MHz, DMSO-D₆/CDCl₃) δH: 3.12 (d, J=7.5Hz, 1H), 3.32–3.38 (m, 1H), 3.42 (d, J=8.7Hz, 1H), 4.62 (d, J=10.2Hz, 1H), 4.89 (d, J=4.2Hz, 1H), 5.89 (d, J=7.8Hz, 1H), 6.70 (t, J=7.5Hz, 1H), 6.81 (t, J=7.2Hz, 1H), 7.11 (d, J=7.5Hz, 1H), 7.27 (d, J=6.6Hz, 1H), 7.43–7.48 (m, 1H), 7.57–7.62 (m, 1H), 7.82 (d, J=8.4Hz, 1H), 7.95 (t, J=8.7Hz, 2H), 9.51 (s, 1H). ¹³C NMR (75 MHz, CDCl₃) δC: 34.6, 50.0, 51.2, 62.7, 66.6, 79.1, 114.9, 116.0, 119.1, 122.0, 123.2, 124.8, 126.1, 126.5, 126.7, 127.2, 128.5, 129.7, 130.2, 132.2, 135.5, 139.3, 161.3, 168.1, 199.6.

Ethyl [spiro[3′,2′]-acenaphthene-1′-one]-3-oxo-3,3′,4,5′,7′,7a′-hexahydro-1′H-spiro[benzo[b] [1,4]thiazine-2,6′-pyrrolo[1,2-c]thiazole]-7′-carboxylate (12b): Obtained as pale white solid; Yield 71%; m.p. 222–224°C; Anal. Calcd. for C₂₇H₂₂N₂O₄S₂: C, 64.52; H, 4.41; N, 5.57; S, 12.76. Found: C, 64.59; H, 4.34; N, 5.63; S, 12.68. ¹H NMR (300 MHz, DMSO-D₆/CDCl₃) δH: 1.28 (t, J=7.2Hz, 3H), 3.30–3.36 (m, 1H), 3.42 (d, J=8.7Hz, 1H), 3.77 (d, J=8.7Hz, 1H), 4.23 (dd, J=14.1, 7.2Hz, 2H), 4.59 (d, J=10.2Hz, 1H), 4.83–4.9 (m, 1H), 5.84 (d, J=7.8Hz, 1H), 6.68 (t, J=7.8Hz, 1H), 6.79 (t, J=7.5Hz, 1H), 7.08 (d, J=7.5Hz, 1H), 7.26 (d, J=6.9Hz 1H), 7.46 (t, J=7.5Hz, 1H), 7.59–7.64 (m, 1H), 7.83 (d, J=8.4Hz, 1H), 7.91 (d, J=7.2Hz, 1H), 7.98 (d, J=8.1Hz, 1H), 9.74 (s, 1H). ¹³C NMR (75 MHz, CDCl₃) δC: 13.3, 35.0, 38.1, 50.5,
Methyl 1'-methyl-[spiro[2',3'\]-oxindole]-3-oxo-3,4-dihydropyrpyrrolidone[benzo[b][1,4]thiazine-2,3'-pyrrolidone]-4'-carboxylate (14a): Obtained as colourless solid; Yield 71%; m.p. 266-268°C; Anal. Calcd. for C21H19N3O4S: C, 61.60; H, 4.68; N, 10.26; S, 7.83. Found: C, 61.67; H, 4.61; N, 10.29; S, 7.75. 1H NMR (300 MHz, DMSO-D6/CDCl3) δH: 3.11 (s, 3H), 3.31 (t, J = 11.2Hz, 1H), 3.74 (s, 3H), 4.07 (t, J = 9.3Hz, 1H), 4.82–4.89 (m, 1H), 6.33 (d, J = 7.5Hz, 1H), 6.29 (d, J = 6.9Hz, 1H), 6.71–6.78 (m, 2H), 6.80–6.91 (m, 2H), 7.05 (d, J = 6.9Hz, 1H), 7.13–7.15 (m, 1H), 9.56 (s, 1H), 10.30 (s, 1H). C13 NMR (75 MHz, CDCl3) δC: 33.8, 44.8, 50.4, 52.1, 55.4, 76.6, 107.4, 114.1, 115.2, 119.8, 121.4, 124.4, 125.8, 128.1, 135.1, 141.8, 164.5, 169.0, 173.5.

Ethyl 1'-methyl-[spiro[2',3'\]-oxindole]-3-oxo-3,4-dihydropyrpyrrolidone[benzo[b][1,4]thiazine-2,3'-pyrrolidone]-4'-carboxylate (14b): Obtained as pale white solid; Yield 70%; m.p. 279–281°C; Anal. Calcd. for C22H21N3O4S: C, 62.40; H, 5.00; N, 9.92, S, 7.57. Found: C, 62.32; H, 4.93; N, 9.98; S, 7.49. 1H NMR (300 MHz, DMSO-D6/CDCl3) δH: 1.29 (t, J = 7.2Hz, 1H), 2.05 (s, 3H), 3.32 (t, J = 8.7Hz, 1H), 4.06 (t, J = 9.0Hz, 1H), 4.21 (dd, J = 14.4, 7.2Hz, 2H), 4.81 (t, J = 8.7Hz, 1H), 6.22 (d, J = 7.5Hz, 1H), 6.28 (d, J = 7.8Hz, 1H), 6.75 (t, J = 6.3Hz, 2H), 6.79–6.88 (m, 2H), 7.06 (d, J = 7.2Hz, 1H), 7.14 (d, J = 6.9Hz, 1H), 9.52 (s, 1H), 10.26 (s, 1H). 13C NMR (75 MHz, CDCl3) δC: 12.8, 33.7, 44.6, 52.0, 55.2, 59.2, 76.6, 107.2, 113.9, 115.2, 119.6, 121.1, 123.2, 124.3, 125.6, 128.0, 135.0, 141.7, 164.4, 168.3, 173.3.

Methyl 1'-methyl-[spiro[2',3'\]-5-chlorooxindole]-3-oxo-3,4-dihydropyrpyrrolidone[benzo[b][1,4]thiazine-2,3'-pyrrolidone]-4'-carboxylate (14c): Obtained as colourless solid; Yield 81%; m.p. 272-274°C; Anal. Calcd. for C21H18ClN3O4S: C, 56.82; H, 4.09; N, 4.97; S, 7.22. Found: C, 56.76; H, 4.03; N, 4.90; S, 7.18. 1H NMR (300 MHz, DMSO-D6/CDCl3) δH: 2.23 (s, 3H), 3.50 (t, J = 8.7 Hz, 1H), 3.70 (s, 1H), 3.91–3.95 (m, 3H), 4.20 (t, J = 9.3Hz, 1H), 4.95–5.01 (m,
1H), 6.34–6.38 (m, 1H), 6.55–6.57 (m, 1H), 6.95–6.98 (m, 1H), 7.11 (d, J=8.1Hz, 2H), 7.22 (d, J=2.1Hz, 1H), 7.30–7.32 (m, 1H), 9.93 (s, 1H), 10.81 (s, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$) $\delta$C: 34.4, 45.2, 50.9, 52.7, 56.0, 76.6, 109.0, 114.7, 115.7, 121.9, 123.9, 125.4, 126.4, 126.6, 126.8, 128.4, 135.6, 140.9, 169.4, 173.8.

**Ethyl 1'-methyl-[spiro[2',3'']-5-chlorooxindole]-3-oxo-3,4-dihydrospiro[benzo[b][1,4]thiazine-2,3'-pyrrolidine]-4'-carboxylate (14d):** Obtained as colourless solid; Yield 82%; m.p. 289-291°C; Anal. Calcd. for C$_{22}$H$_{20}$ClN$_3$O$_4$S: C, 57.70; H, 4.40; Cl, 7.74; N, 9.18; S, 7.00. Found: C, 57.77; H, 4.32; Cl, 7.81; N, 9.23; S, 7.06. $^1$H NMR (300 MHz, DMSO-D$_6$/CDCl$_3$) $\delta$H: 2.08 (s, 3H), 3.34–3.40 (m, 1H), 4.04 (t, $J=9.0$Hz, 1H), 4.22 (dd, $J=13.1$, 7.2Hz, 2H), 4.78 (t, $J=9.0$Hz, 1H), 6.19 (d, $J=7.1$Hz, 1H), 6.38–6.41 (m, 1H), 6.76–6.79 (m, 2H), 6.84–6.87 (m, 1H), 7.13–7.16 (m, 1H), 9.47 (s, 1H), 10.40 (s, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$) $\delta$C: 13.7, 29.0, 34.7, 45.6, 53.2, 56.3, 60.4, 78.4, 109.2, 115.0, 116.3, 122.2, 124.3, 125.9, 126.7, 126.9, 127.2, 128.8, 136.0, 141.2, 165.5, 169.3, 171.3.

**Methyl [spiro[2',3'']-oxindole]-3-oxo-5'-phenyl-3,4-dihydrospiro[benzo[b][1,4]thiazine-2,3'-pyrrolidine]-4'-carboxylate (15a):** Obtained as pale white solid; Yield 99%; m.p. 228–230°C; Anal. Calcd. for C$_{26}$H$_{21}$N$_3$O$_4$S: C, 66.23; H, 4.49; N, 8.91; S, 6.80. Found: C, 66.31; H, 4.41; N, 8.97; S, 6.73. $^1$H NMR (300 MHz, DMSO-D$_6$/CDCl$_3$) $\delta$H: 2.81 (d, $J=6.9$Hz, 1H), 3.67 (s, 3H), 4.75 (d, $J=9.9$Hz, 1H), 5.58–5.64 (m, 1H), 6.31 (d, $J=7.5$Hz, 1H), 6.34–6.37 (m, 1H), 6.84–6.88 (m, 3H), 7.17–7.24 (m, 3H), 7.28–7.34 (m, 3H), 7.61 (d, $J=7.5$Hz, 2H), 9.64 (s, 1H). $^{13}$C NMR: 50.1, 55.3, 56.0, 59.7, 73.0, 107.0, 113.9, 114.9, 115.7, 119.3, 121.1, 121.8, 123.0, 125.4, 125.6, 125.8, 126.1, 126.4, 126.7, 127.7, 134.9, 139.5, 140.8, 164.2, 168.2, 175.9.

**Ethyl [spiro[2',3'']-oxindole]-3-oxo-5'-phenyl-3,4-dihydrospiro[benzo[b][1,4]thiazine-2,3'-pyrrolidine]-4'-carboxylate (15b):** Obtained as colourless solid; Yield 73%; m.p. 218–220°C; Anal. Calcd. for C$_{27}$H$_{23}$N$_3$O$_4$S: C, 66.79; H, 4.77; N, 8.65; S, 6.60. Found: C, C, 66.71; H,
4.82; N, 8.57; S, 6.67. \textsuperscript{1}H NMR (300 MHz, DMSO-D\textsubscript{6}/CDCl\textsubscript{3}) \(\delta\)H: 1.21 (t, J=7.2Hz, 3H), 2.73 (d, J=7.5Hz, 1H), 4.10–4.18 (m, 2H), 4.71 (d, J=9.9Hz,1H), 6.00 (m, 1H), 6.31 (d, J=7.5Hz, 1H), 6.35–6.38 (m, 1H), 6.82–6.88 (m, 3H), 6.95 (t, J=7.8Hz, 1H), 7.18–7.24 (m, 1H), 7.29–7.37 (m, 3H), 7.62 (d, J=7.2Hz, 2H), 7.67 (s, 1H), 9.58 (s, 1H), 10.27 (s, 1H). NMR (75 MHz, CDCl\textsubscript{3}) \(\delta\)C: 13.1, 56.0, 57.5,60.0, 61.1, 73.7, 108.0, 114.7, 120.3, 121.9, 123.7, 126.3, 126.5, 126.7, 127.0, 127.4, 128.5, 135.5, 139.8, 141.0, 164.8, 168.4, 176.6.

*Methyl [spiro[2',3'']-oxindole]-3-oxo-5'-phenyl-3,4-dihydrospiro[benzo[b][1,4]thiazine-2,3'-pyrrolidine]-4'-carboxylate (15c):* Obtained as pale white solid; Yield 99%; m.p. 212–214°C; Anal. Calcd. for C\textsubscript{26}H\textsubscript{20}ClN\textsubscript{3}O\textsubscript{4}S: C, 61.72; H, 3.98; Cl, 7.01; N, 8.30; S, 6.34. Found: C, 61.80; H, 3.91; Cl, 7.08; N, 8.37; S, 6.34. \textsuperscript{1}H NMR (300 MHz, DMSO-D\textsubscript{6}/CDCl\textsubscript{3}) \(\delta\)H: 1.20 (t, J=7.2Hz, 3H), 2.81 (d, J=6.9Hz,1H), 3.66 (s, 3H), 3.80 (s, 1H), 4.75 (d, J=9.9Hz, 1H), 5.58–5.63 (m, 1H), 6.29 (d, J=7.5Hz, 1H), 6.35–6.37 (m, 1H), 6.83–6.88 (m, 3H), 6.93 (d, J=7.3Hz, 1H), 7.17–7.23 (m, 3H), 7.28–7.34 (m, 3H), 7.61 (d, J=7.5Hz, 2H), 9.63 (s, 1H), 10.35 (s, 1H). NMR (75 MHz, CDCl\textsubscript{3}) \(\delta\)C:50.1, 55.3, 56.0,59.7, 73.0, 107.0, 113.9, 114.9, 115.7, 119.3, 121.1, 121.8, 123.0, 125.4, 125.6, 125.8, 126.1, 126.4, 126.7, 127.7, 134.9, 139.5, 139.5, 140.8, 164.2, 168.2, 175.8.

*Ethyl [spiro[2',3'']-5-chlorooxindole]-3-oxo-5'-phenyl-3,4-dihydrospiro[benzo[b][1,4]thiazine-2,3'-pyrrolidine]-4'-carboxylate (15d):* Obtained as pale white solid; Yield 98%; m.p. 240–242°C; Anal. Calcd. for C\textsubscript{27}H\textsubscript{23}ClN\textsubscript{3}O\textsubscript{4}S: C, 62.36; H, 4.26; N, 8.08; S, 6.17. Found: C, 62.44; H, 4.19; N, 8.02; S, 6.24. \textsuperscript{1}H NMR (300 MHz, DMSO-D\textsubscript{6}/CDCl\textsubscript{3}) \(\delta\)H: 1.20 (t, J=7.2Hz, 3H), 4.08–4.14 (m, 2H), 4.60 (d, J=9.3Hz, 1H), 5.55 (dd, J=9.6, 6.3Hz, 1H), 6.21 (d, J=5.1Hz, 1H), 6.39–6.41 (m, 1H), 6.84–6.92(m, 3H), 7.15–7.20 (m, 2H), 7.27–7.37 (m, 3H), 7.58 (d, J=7.5Hz, 2H), 9.87 (s, 1H), 10.7 (s, 1H). NMR (75 MHz, CDCl\textsubscript{3}) \(\delta\)C:
12.6, 27.8, 55.1, 56.0, 59.1, 59.8, 72.9, 108.2, 114.1, 115.1, 121.2, 123.4, 124.1, 125.9, 126.0, 126.2, 126.7, 127.4, 128.6, 135.1, 139.5, 139.7, 164.1, 167.6, 175.9.

*Methyl [spiro[5',3'']-oxindole]-3-oxo-3',4,5',7',7a'-hexahydro-1'H-spiro[benzo[b][1,4]thiazine-2,6'-pyrrolo[1,2-c]thiazole]-7'-carboxylate (16a):* Obtained as pale white solid; Yield 73%; m.p. 252–254°C; Anal. Calcd. for C_{22}H_{19}N_{3}O_{4}S_{2}: C, 58.26; H, 4.22; N, 9.27; S, 14.14. Found: C, 58.19; H, 4.27; N, 9.31; S, 14.07. \(^1H\) NMR (300 MHz, DMSO-D\(_6\)/CDCl\(_3\)) \(\delta\)H: 2.59 (t, \(J=1.8\)Hz, 1H), 2.96 (dd, \(J=10.5, 5.4\)Hz, 1H), 3.34 (d, \(J=7.8\)Hz, 1H), 3.64 (d, \(J=7.8\)Hz, 1H), 3.74 (s, 3H), 4.54 (d, \(J=10.2\)Hz, 1H). 4.77–4.85 (m, 1H), 6.50 (dd, \(J=11.1, 7.2\)Hz, 2H), 6.86–6.92 (m, 3H), 7.05 (d, \(J=7.8\)Hz, 1H), 7.18 (d, \(J=7.5\)Hz, 1H), 7.41 (d, \(J=7.5\)Hz, 1H), 9.77 (s, 1H), 10.37 (s, 1H). \(^13C\) NMR (75 MHz, CDCl\(_3\)) \(\delta\)C: 32.5, 47.5, 49.7, 50.6, 61.0, 65.3, 73.4, 107.7, 114.4, 115.2, 119.4, 121.3, 122.6, 125.3, 125.7, 126.2, 128.3, 135.0, 141.1, 161.6, 167.7, 173.1.

*Ethyl [spiro[5',3'']-oxindole]-3-oxo-3',4,5',7',7a'-hexahydro-1'H-spiro[benzo[b][1,4]thiazine-2,6'-pyrrolo[1,2-c]thiazole]-7'-carboxylate (16b):* Obtained as pale white solid; Yield 88%; m.p. 271–273°C; Anal. Calcd. for C_{23}H_{21}N_{3}O_{4}S_{2}: C, 59.08; H, 4.53; N, 8.99; S, 13.72. Found: C, 59.16; H, 4.46; N, 9.05; S, 13.65. \(^1H\) NMR (300 MHz, DMSO-D\(_6\)/CDCl\(_3\)) \(\delta\)H: 1.21–1.30 (m, 3H), 3.00 (dd, \(J=10.8, 6.3\)Hz, 2H), 3.24 (dd, \(J=10.8, 6.3\)Hz, 1H), 3.41 (d, \(J=8.1\)Hz, 1H), 3.72 (d, \(J=8.1\)Hz, 1H), 4.19–4.28 (m, 2H), 4.52 (d, \(J=10.2\)Hz, 1H), 4.80–4.8 (m, 1H), 6.54 (d, \(J=7.8\)Hz, 2H), 6.82–6.96 (m, 3H), 7.06–7.11 (m, 1H), 7.35 (d, \(J=7.5\)Hz, 1H), 9.40 (s, 1H), 10.0 (s, 1H). \(^13C\) NMR (75 MHz, CDCl\(_3\)) \(\delta\)C: 13.6, 34.7, 50.1, 51.4, 60.8, 62.2, 66.6, 75.1, 108.9, 115.5, 116.8, 120.4, 122.4, 123.2, 126.6, 127.2, 127.4, 129.4, 135.8, 141.7, 161.9, 168.2, 173.9.

*Methyl [spiro[5',3'']-5-chlorooxindole]-3-oxo-3',4,5',7',7a'-hexahydro-1'H-spiro[benzo[b][1,4]thiazine-2,6'-pyrrolo[1,2-c]thiazole]-7'-carboxylate (16c):* Obtained as pale white solid; Yield 76%; m.p. 266–268°C; Anal. Calcd. for C_{22}H_{18}ClN_{3}O_{4}S_{2}: C, 54.15; H, 3.72; N,
8.61; S, 13.14. Found: C, 54.07 H, 3.80 N, 8.68; S, 13.05. $^1$H NMR (300 MHz, DMSO- D$_6$/CDCl$_3$) $\delta_{H}$: 3.20 (dd, $J$=10.5, 6.0Hz, 1H), 3.37 (d, $J$=8.1Hz, 1H), 3.66 (t, $J$=7.8Hz, 2H), 3.76 (s, 3H), 4.51 (d, $J$=9.9Hz, 1H), 4.77–4.82 (m, 1H), 6.46 (d, $J$=8.4Hz, 1H), 6.56 (d, $J$=7.8Hz, 1H), 6.84–6.89 (m, 1H), 6.92–6.97 (m, 1H), 7.06 (dd, $J$=8.1, 1.8Hz, 1H), 7.20 (d, $J$=7.2Hz, 1H), 7.45 (d, $J$=1.8Hz, 1H), 9.74 (s, 1H), 10.42 (s, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$) $\delta_{C}$: 33.5, 48.6, 50.5, 51.3, 56.2, 61.9, 66.0, 74.1, 109.4, 115.1, 115.8, 122.0, 125.0, 126.4, 127.0, 128.8, 135.5, 140.3, 161.7, 168.2, 173.6.

Ethyl [spiro[5',3' ]-5-chlorooxindole]-3-oxo-3',4,5',7',7a'-hexahydro-1'H-spiro[benzo[b] [1,4]thiazine-2,6'-pyrrolo[1,2-c]thiazole]-7'-carboxylate (I$^6$d): Obtained as pale white solid; Yield 94%; m.p. 266–268°C; Anal. Calcd. for C$_{23}$H$_{20}$ClN$_3$O$_4$S$_2$: C, 55.03; H, 4.02; N, 8.37; S, 12.77. Found: C, 55.09; H, 3.95; N, 8.29; S, 12.83. $^1$H NMR (300 MHz, DMSO-D$_6$/CDCl$_3$) $\delta_{H}$: 1.23–1.33 (m, 3H), 2.95 (dd, $J$=7.2, 6.0Hz, 1H), 3.15–3.20 (m, 2H), 3.36 (d, $J$=10.5Hz, 1H), 3.63 (d, $J$=7.8Hz, 1H), 4.17–4.26 (m, 2H), 4.58 (d, $J$=9.9Hz, 1H), 4.74–4.79 (m, 1H), 6.43 (d, $J$=7.1Hz, 1H), 6.54 (d, $J$=7.8Hz, 1H), 6.84–6.96 (m, 2H), 7.03–7.06 (m, 1H), 7.19 (d, $J$=7.5Hz, 1H), 9.86 (s, 1H), 10.52 (s, 1H). $^{13}$C NMR (75 MHz, CDCl$_3$) $\delta_{C}$: 13.2, 28.5, 33.6, 48.7, 50.5, 60.4, 61.9, 66.0, 74.2, 109.4, 115.1, 115.9, 122.0, 124.9, 125.0, 126.4, 127.0, 128.8, 135.6, 140.3, 161.8, 167.6, 173.7.
Figure 1. $^1$H NMR spectrum of 9a

Figure 2. $^{13}$C NMR spectrum of 9a
Figure 3. $^1$H NMR spectrum of 9b

Figure 4. $^{13}$C NMR spectrum of 9b
Figure 5. $^1$H NMR spectrum of 10a

Figure 6. $^{13}$C NMR spectrum of 10a
Figure 7. $^1\text{H}$ NMR spectrum of 10b

Figure 8. $^{13}\text{C}$ NMR spectrum of 10b
Figure 9. $^1$H NMR spectrum of 11a

Figure 10. $^{13}$C NMR spectrum of 11a
Figure 11. $^1$H NMR spectrum of 11b

Figure 12. $^{13}$C NMR spectrum of 11b
Figure 13. $^1$H NMR spectrum of 12a

Figure 14. $^{13}$C NMR spectrum of 12a
Figure 15. $^1$H NMR spectrum of 12b

Figure 16. $^{13}$C NMR spectrum of 12b
Figure 17. DEPT-135 spectrum of 12b

Figure 18. H,H-COSY spectrum of 12b
Figure 19. C,H-COSY spectrum of 12b

Figure 20. HMBC spectrum of 12b
Figure 21. $^1$H NMR spectrum of 14a

Figure 22. $^{13}$C NMR spectrum of 14a
Figure 23. $^1$H NMR spectrum of 14b

Figure 24. $^{13}$C NMR spectrum of 14b
Figure 25. $^1$H NMR spectrum of 14c

Figure 26. $^{13}$C NMR spectrum of 14c
Figure 27. $^1$H NMR spectrum of 14d

Figure 28. $^{13}$C NMR spectrum of 14d
Figure 29. $^1$H NMR spectrum of 15a

Figure 30. $^{13}$C NMR spectrum of 15a
Figure 31. $^1$H NMR spectrum of 15b

Figure 32. $^{13}$C NMR spectrum of 15b
Figure 33. $^1$H NMR spectrum of 15c

Figure 34. $^{13}$C NMR spectrum of 15c
Figure 35. $^1$H NMR spectrum of 15d

Figure 36. $^{13}$C NMR spectrum of 15d
Figure 37. $^1$H NMR spectrum of 16a
Figure 38. $^{13}$C NMR spectrum of 16a
Figure 39. $^1$H NMR spectrum of 16b

Figure 40. $^{13}$C NMR spectrum of 16b
Figure 41. $^1$H NMR spectrum of 16c

Figure 42. $^{13}$C NMR spectrum of 16c
Figure 43. $^1$H NMR spectrum of 16d

Figure 44. $^{13}$C NMR spectrum of 16d