Electronic Supplementary Information (ESI)

Cyclopentadienyl iron dicarbonyl ($CpFe(CO)_2$) derivatives as apoptosis-inducing agents

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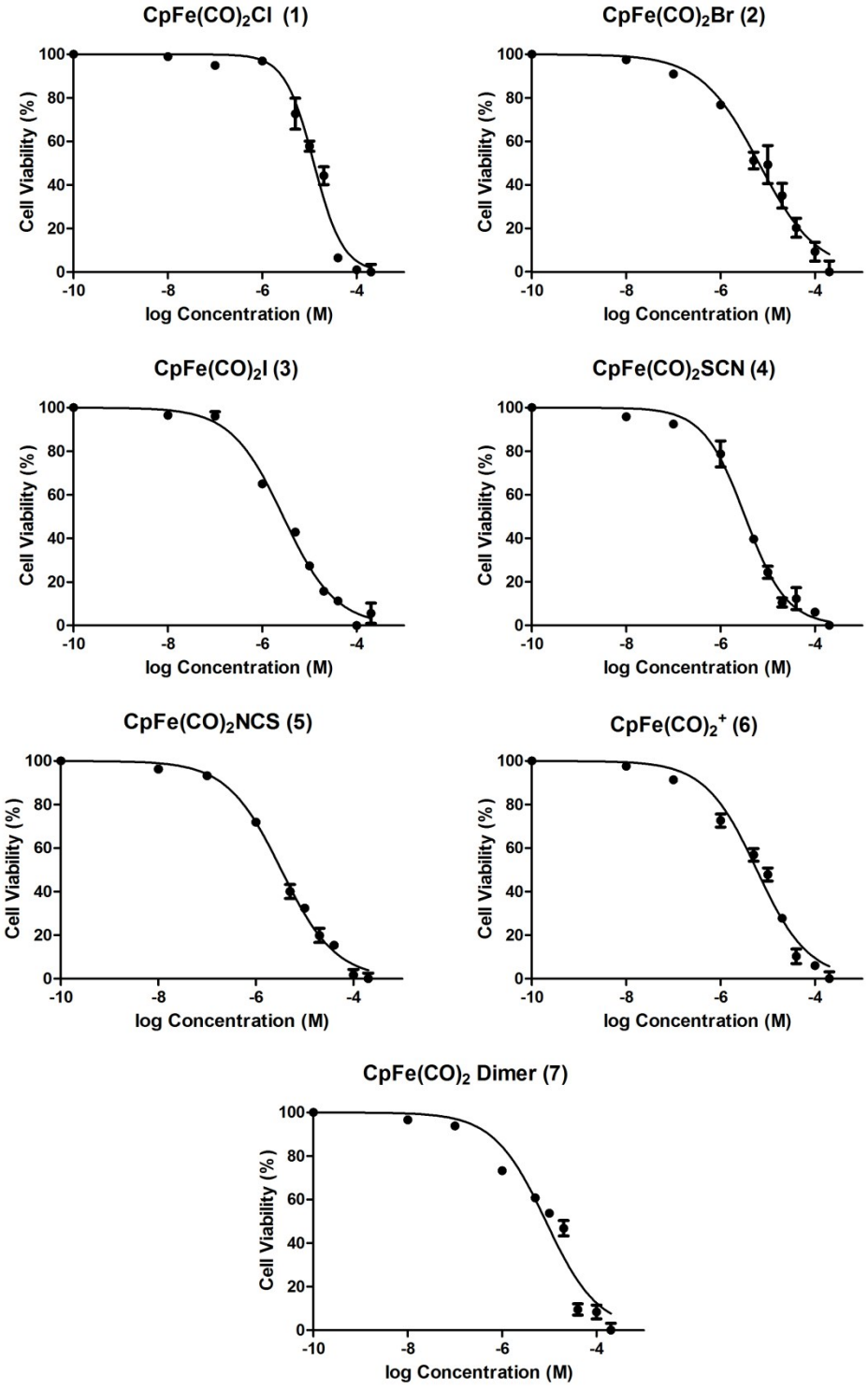
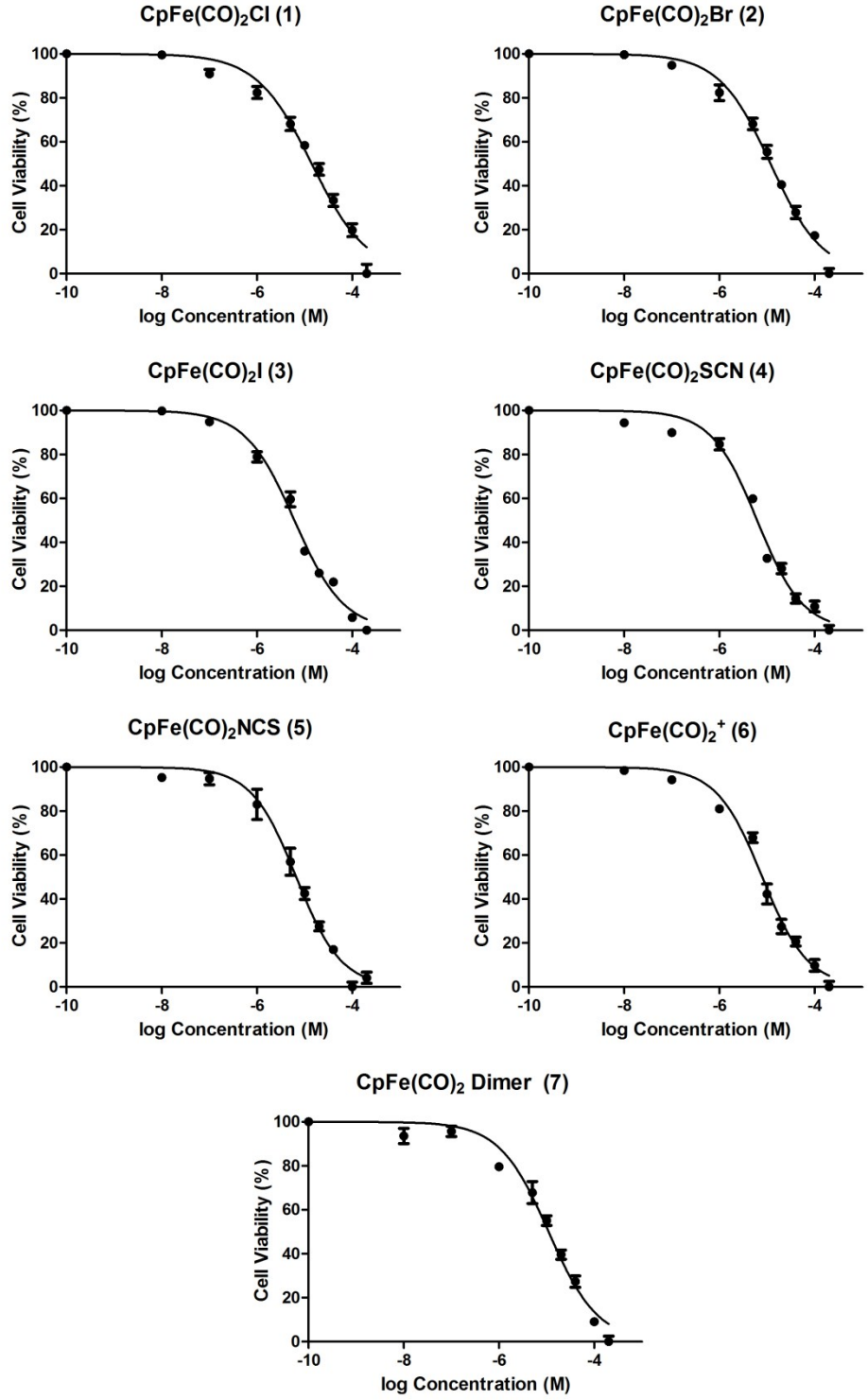


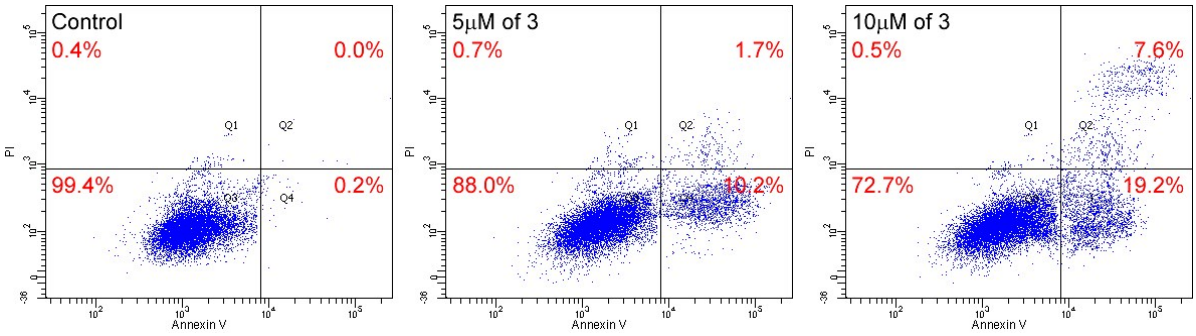
IC_{50} curves for $CpFe(CO)_2$ complexes **1** to **7**. MTS measurements were made on the MDA-MB-231 cell line after 24 hour treatment with the respective complexes at 37°C.

2. IC_{50} Curve for HeLa Cell Line

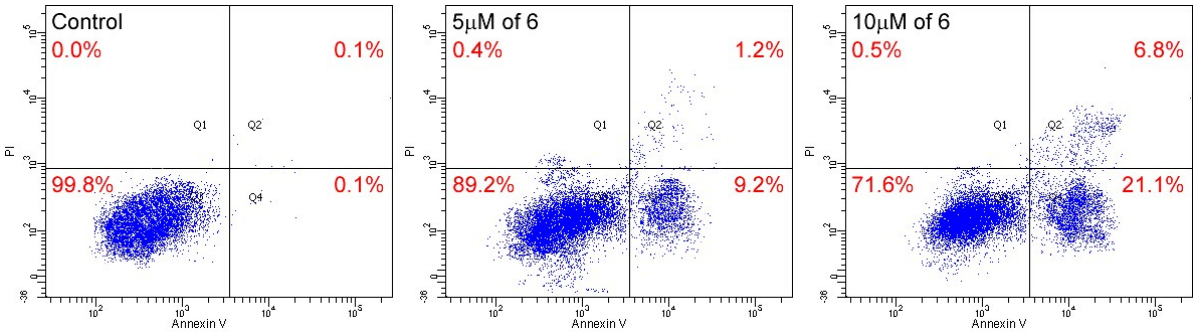


IC_{50} curves for $CpFe(CO)_2$ complexes **1** to **7**. MTS measurements were made on the HeLa cell line after 24 hour treatment with the respective complexes at 37°C.

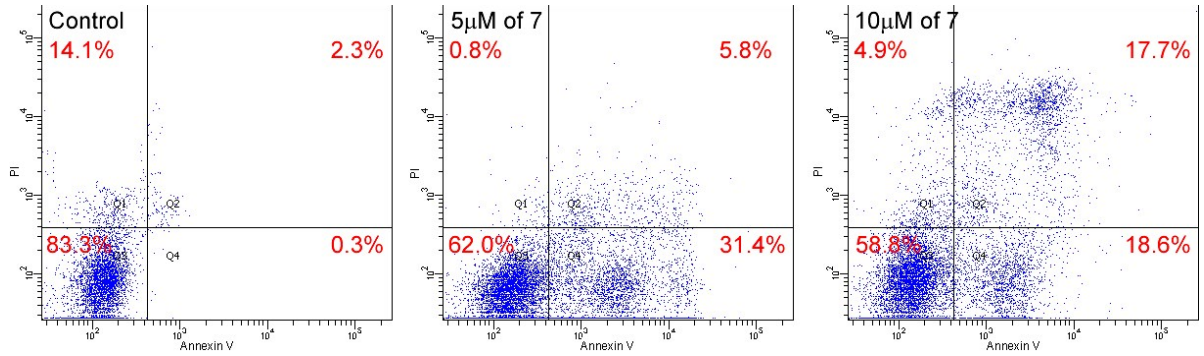
3. Flow Cytometry Dot Plots (MDA-MB-231)



Detection of early and late apoptotic MDA-MB-231 cells after staining with Annexin V-Alexa Fluor 488 and PI. Cells were incubated for 24 h with 0 μM (control), 5 μM and 10 μM solutions of complex **3** before staining.

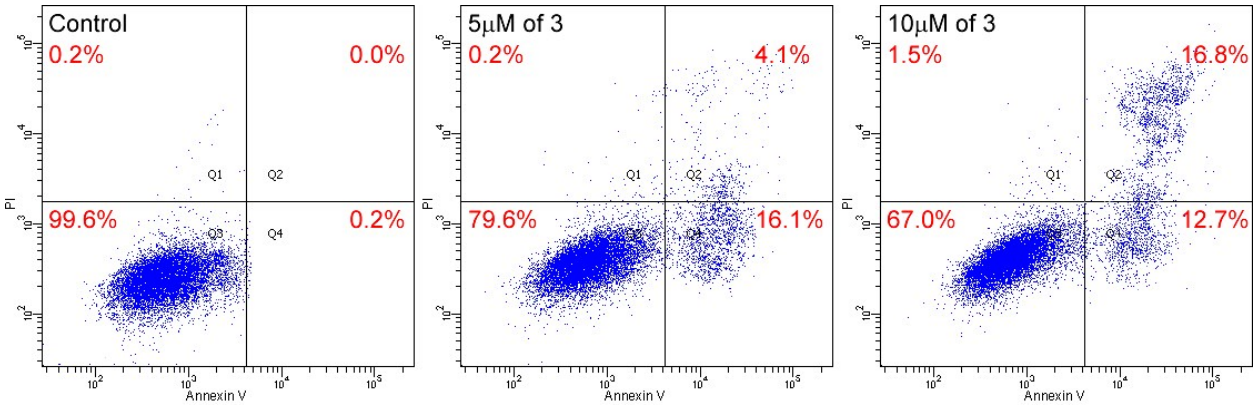


Detection of early and late apoptotic MDA-MB-231 cells after staining with Annexin V-Alexa Fluor 488 and PI. Cells were incubated for 24 h with 0 μM (control), 5 μM and 10 μM solutions of complex **6** before staining.

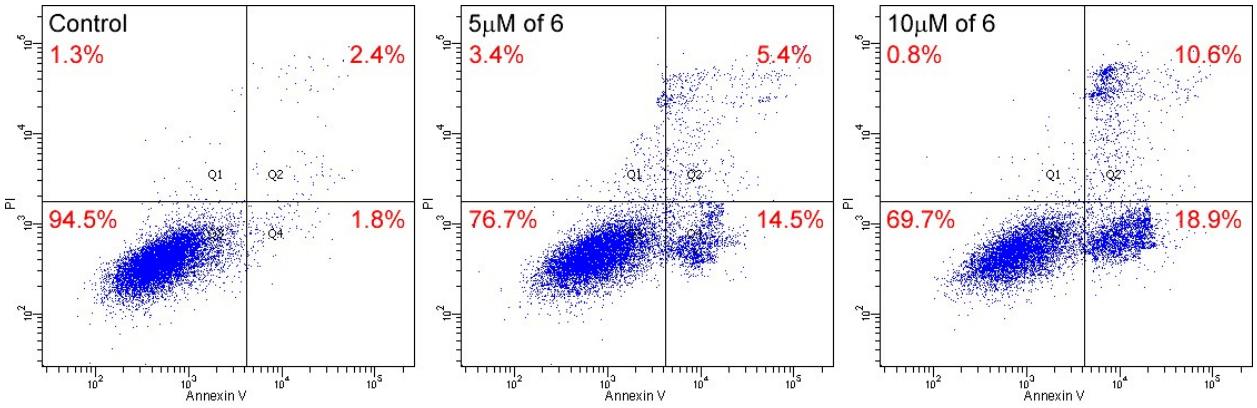


Detection of early and late apoptotic MDA-MB-231 cells after staining with Annexin V-Alexa Fluor 488 and PI. Cells were incubated for 24 h with 0 μM (control), 5 μM and 10 μM solutions of complex **7** before staining.

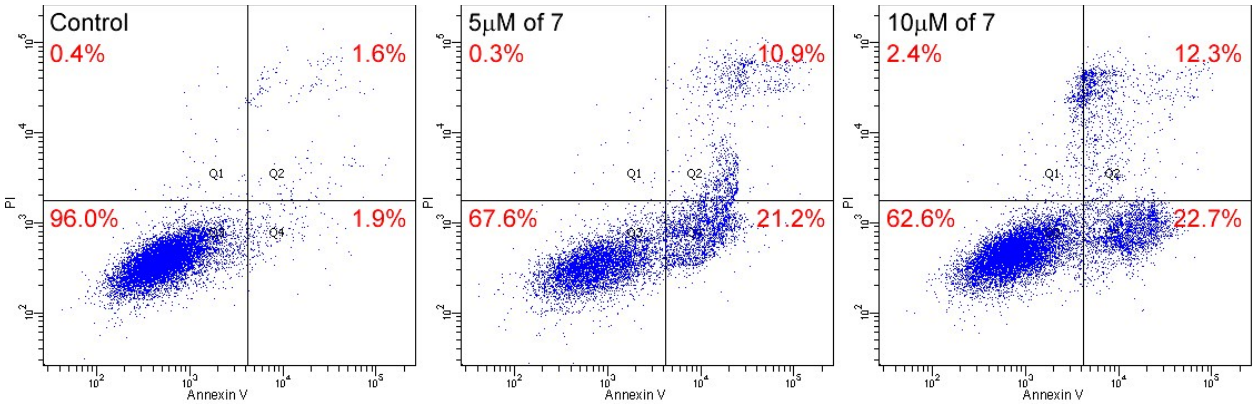
4. Flow Cytometry Dot Plots (HeLa)



Detection of early and late apoptotic HeLa cells after staining with Annexin V-Alexa Fluor 488 and PI. Cells were incubated for 24 h with 0 μM (control), 5 μM and 10 μM solutions of complex **3** before staining.

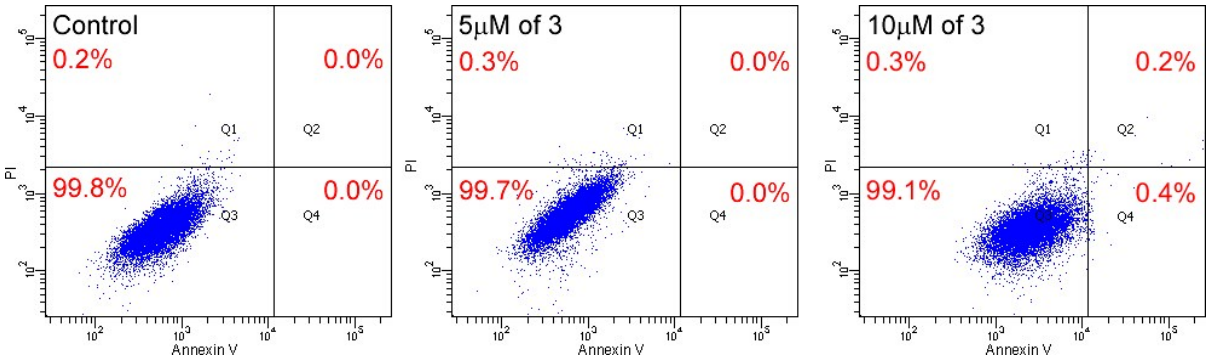


Detection of early and late apoptotic HeLa cells after staining with Annexin V-Alexa Fluor 488 and PI. Cells were incubated for 24 h with 0 μM (control), 5 μM and 10 μM solutions of complex **6** before staining.

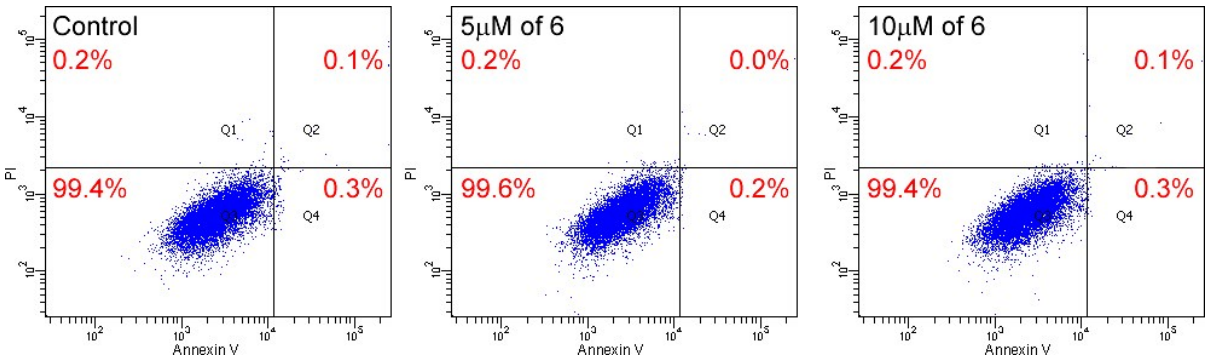


Detection of early and late apoptotic HeLa cells after staining with Annexin V-Alexa Fluor 488 and PI. Cells were incubated for 24 h with 0 μM (control), 5 μM and 10 μM solutions of complex **7** before staining.

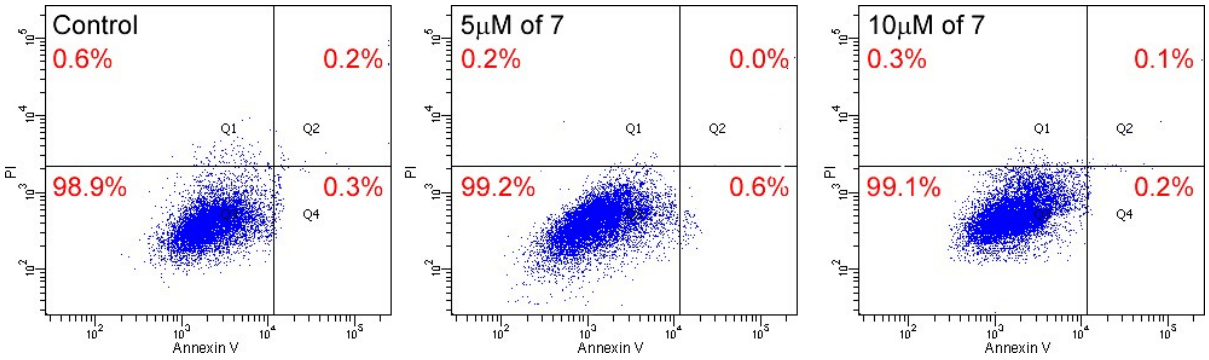
5. Flow Cytometry Dot Plots (MCF-10A)



Detection of early and late apoptotic MCF-10A normal mammary cells after staining with Annexin V-Alexa Fluor 488 and PI. Cells were incubated for 24 h with 0 μM (control), 5 μM and 10 μM solutions of complex **3** before staining.

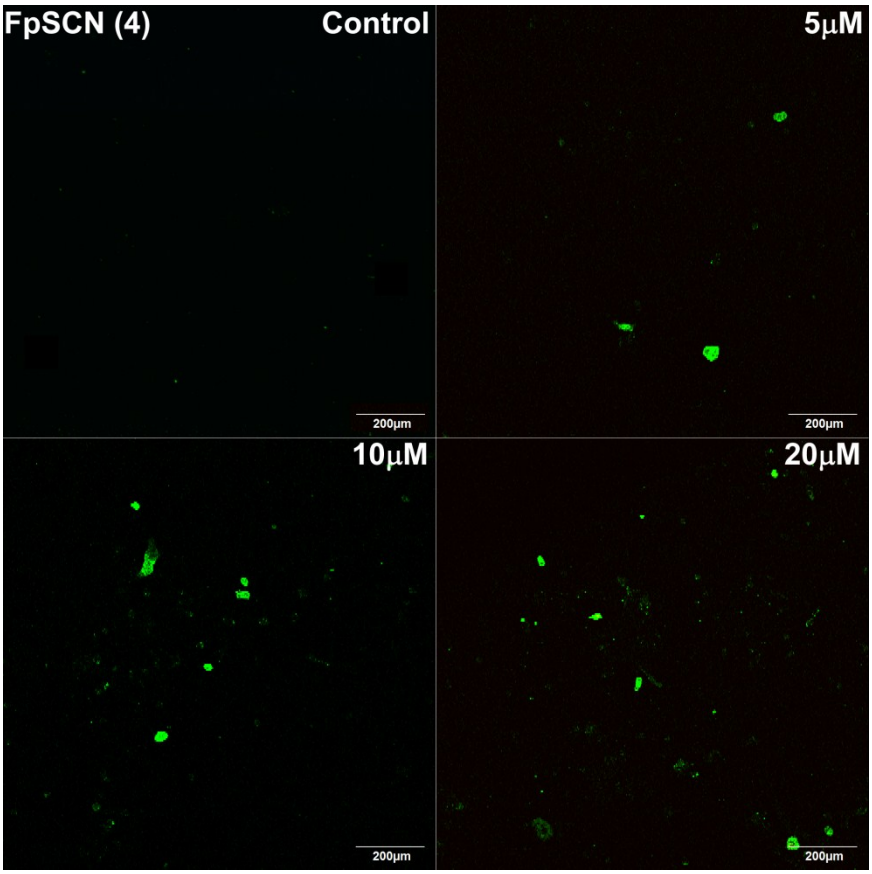


Detection of early and late apoptotic MCF-10A normal mammary cells after staining with Annexin V-Alexa Fluor 488 and PI. Cells were incubated for 24 h with 0 μM (control), 5 μM and 10 μM solutions of complex **6** before staining.

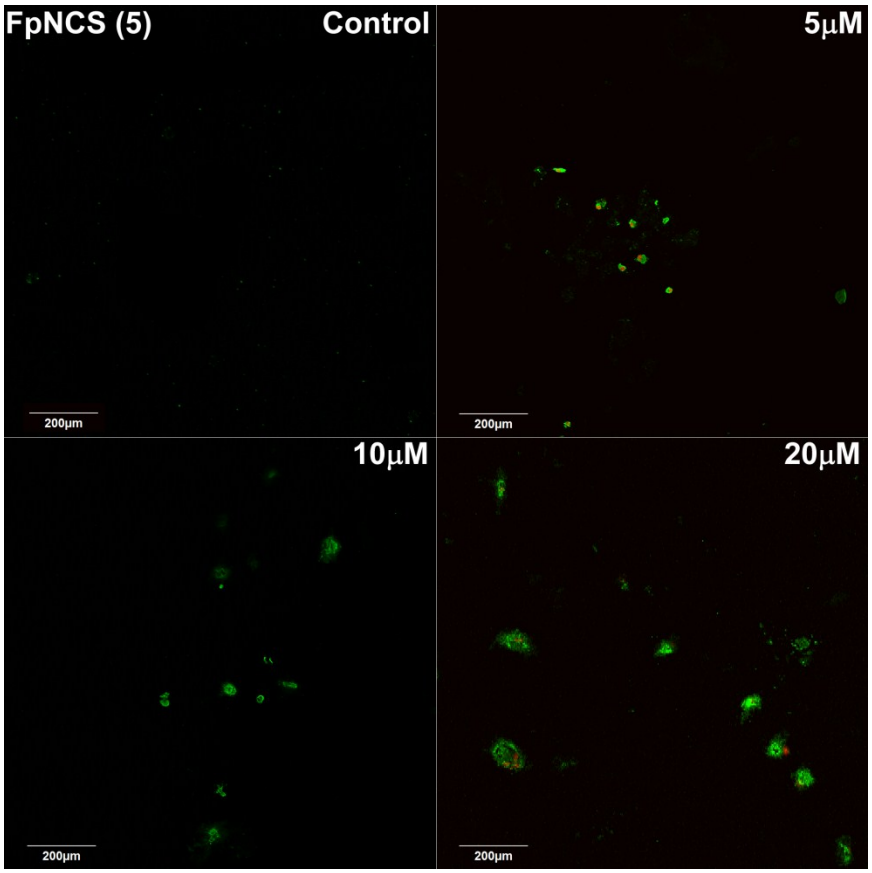


Detection of early and late apoptotic MCF-10A normal mammary cells after staining with Annexin V-Alexa Fluor 488 and PI. Cells were incubated for 24 h with 0 μM (control), 5 μM and 10 μM solutions of complex **7** before staining.

6. Confocal Images for MDA-MB-231 Cell Line



Annexin V (green) and PI (red) stained MDA-MB-231 cells after treatment with 0 μM (control), 5 μM, 10 μM and 20 μM of complex **4** at 37 °C for 24 hours.



Annexin V (green) and PI (red) stained MDA-MB-231 cells after treatment with 0 μM (control), 5 μM, 10 μM and 20 μM of complex **5** at 37 °C for 24 hours.

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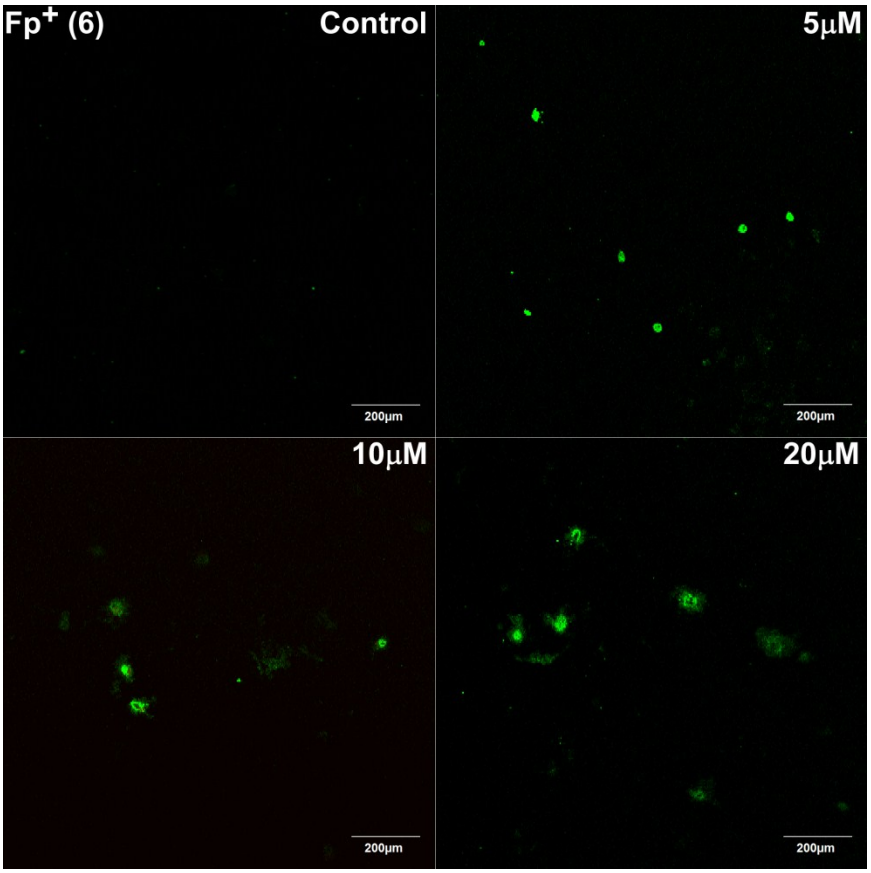
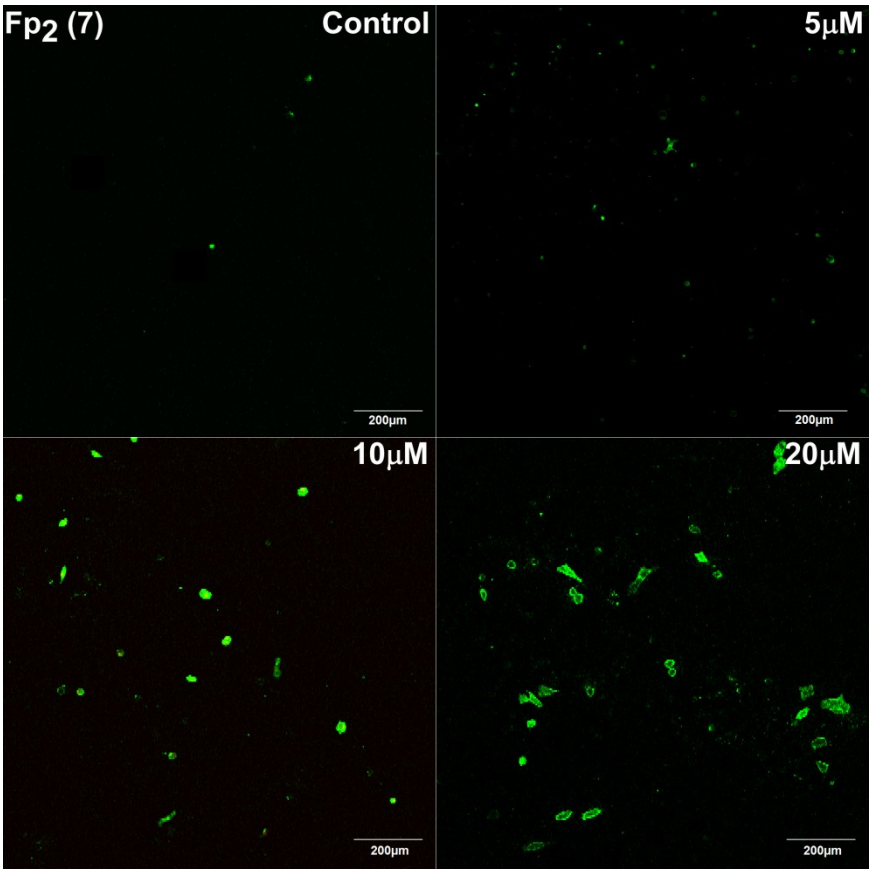
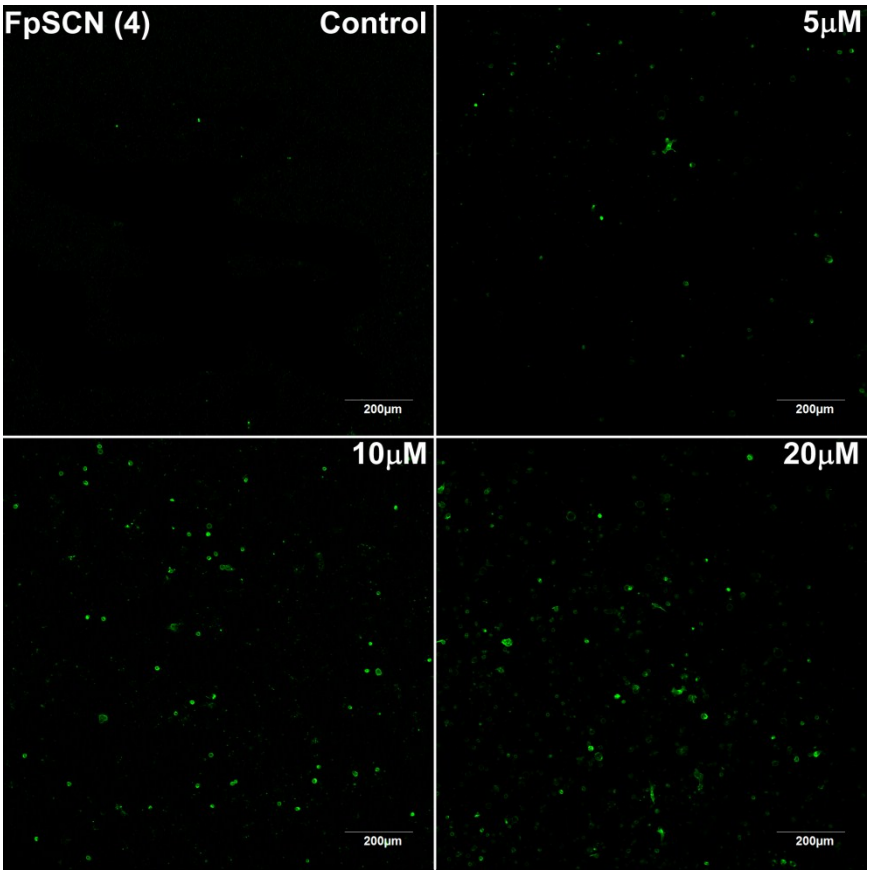


Annexin V (green) and PI (red) stained MDA-MB-231 cells after treatment with 0 μM (control), 5 μM, 10 μM and 20 μM of complex **6** at 37 °C for 24 hours.

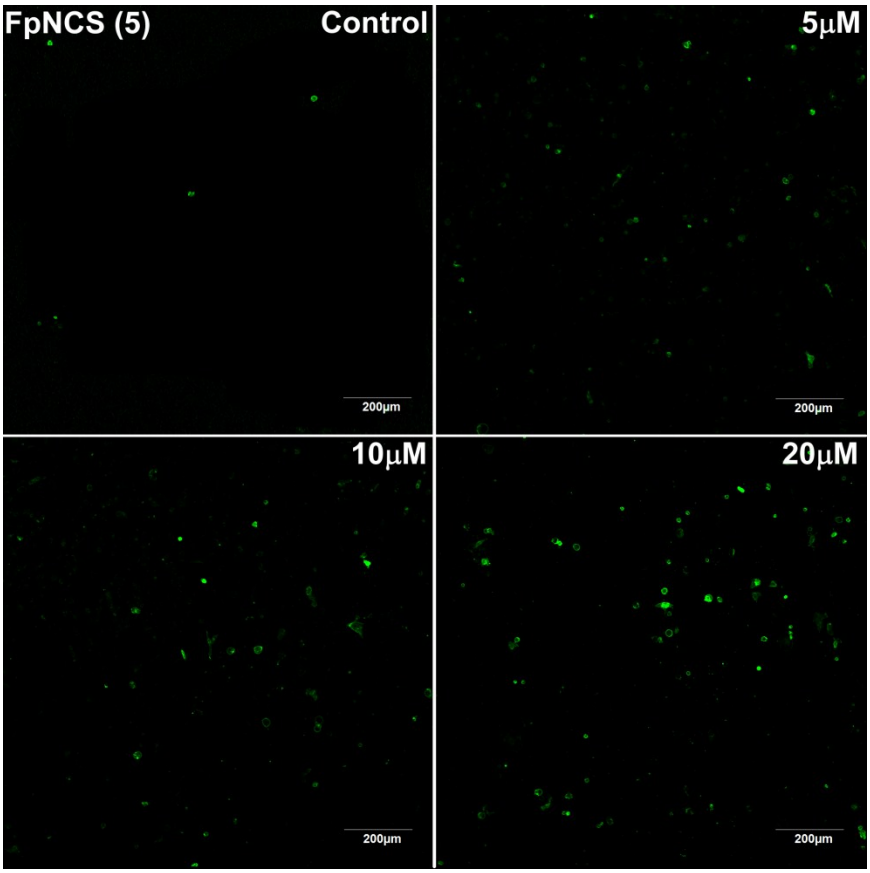


Annexin V (green) and PI (red) stained MDA-MB-231 cells after treatment with 0 μM (control), 5 μM, 10 μM and 20 μM of complex **7** at 37 °C for 24 hours.

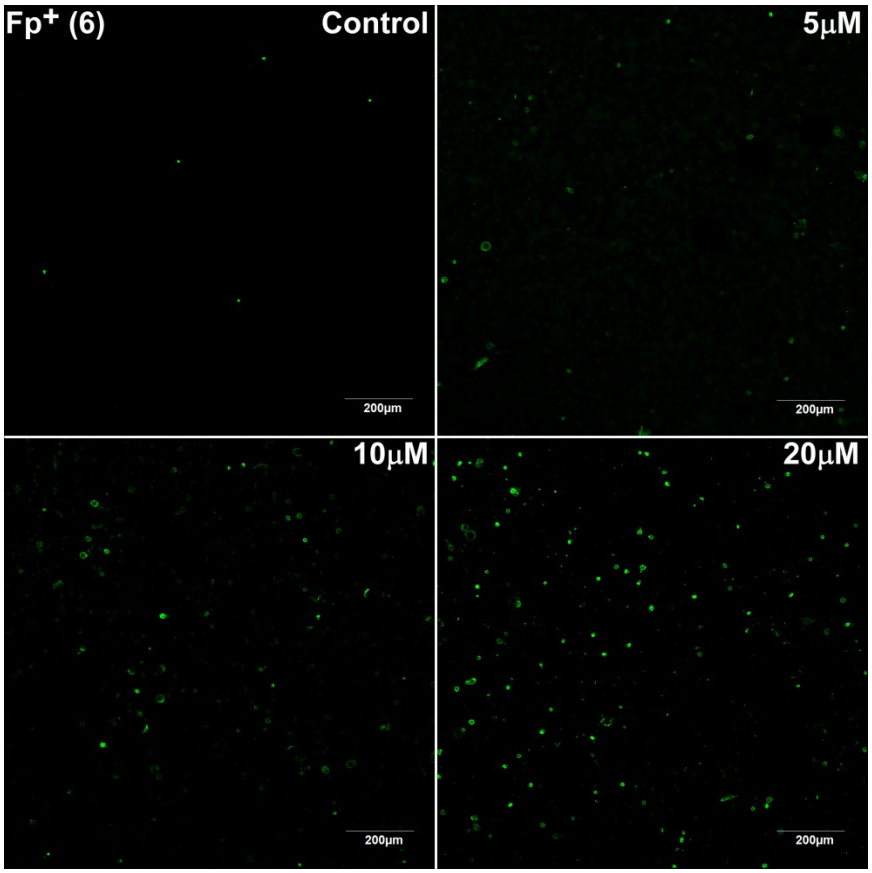
7. Confocal Images for HeLa Cell Line



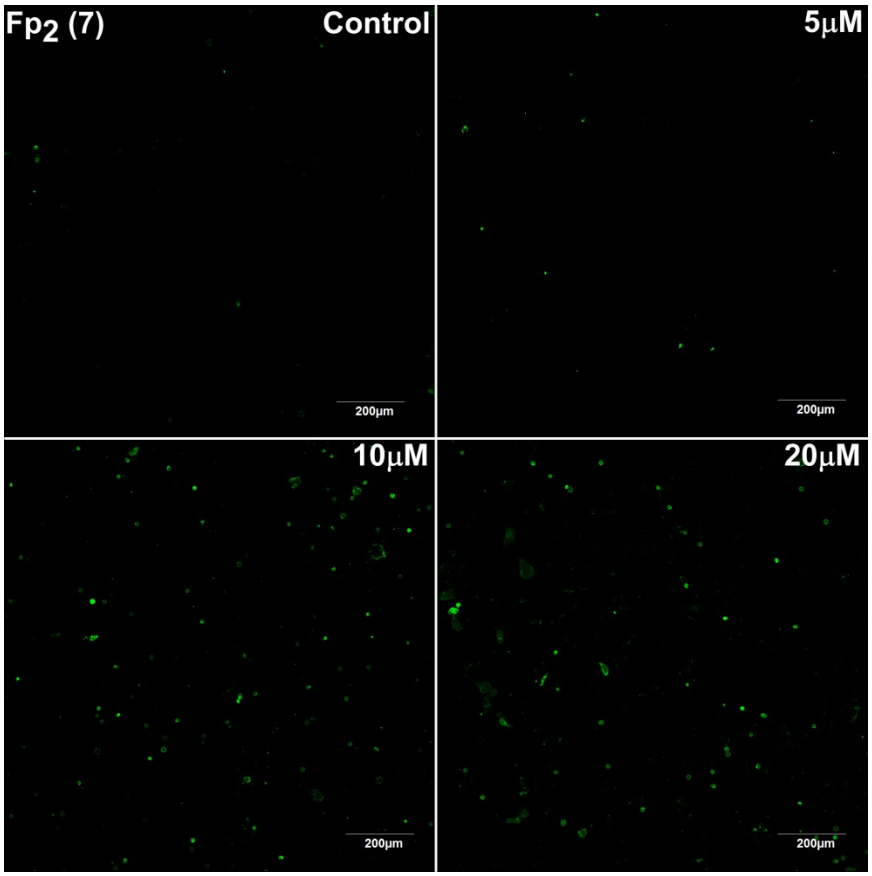
Annexin V (green) and PI (red) stained HeLa cells after treatment with 0 μM (control), 5 μM, 10 μM and 20 μM of complex **4** at 37 °C for 24 hours.



Annexin V (green) and PI (red) stained HeLa cells after treatment with 0 μM (control), 5 μM, 10 μM and 20 μM of complex **5** at 37 °C for 24 hours.



Annexin V (green) and PI (red) stained HeLa cells after treatment with 0 μM (control), 5 μM, 10 μM and 20 μM of complex **6** at 37 °C for 24 hours.



Annexin V (green) and PI (red) stained HeLa cells after treatment with 0 μM (control), 5 μM, 10 μM and 20 μM of complex **7** at 37 °C for 24 hours.

8. X-ray structural reports for $CpFe(CO)_2(SCN)$, 4 and $CpFe(CO)_2(NCS)$, 5

$CpFe(CO)_2(SCN)$, 4

Table 1. Crystal data and structure refinement for C790.

Identification code	c790	
Empirical formula	C8 H5 Fe N O2 S	
Formula weight	235.04	
Temperature	100(2) K	
Wavelength	0.71073 Å	
Crystal system	Triclinic	
Space group	P-1	
Unit cell dimensions	a = 6.798(4) Å	a= 93.169(7)°.
	b = 7.024(4) Å	b= 95.036(7)°.
	c = 10.813(6) Å	g = 118.514(7)°.
Volume	449.1(4) $Å^3$	
Z	2	
Density (calculated)	1.738 Mg/m^3	
Absorption coefficient	1.871 mm^{-1}	
F(000)	236	
Crystal size	0.40 x 0.26 x 0.10 mm^3	
Theta range for data collection	1.90 to 27.50°.	
Index ranges	-8<=h<=8, -9<=k<=9, -14<=l<=14	
Reflections collected	4151	
Independent reflections	2052 [R(int) = 0.0515]	
Completeness to theta = 27.50°	99.3 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.7457 and 0.5570	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	2052 / 0 / 118	
Goodness-of-fit on F^2	1.065	
Final R indices [I>2sigma(I)]	R1 = 0.0533, wR2 = 0.1200	
R indices (all data)	R1 = 0.0738, wR2 = 0.1469	
Largest diff. peak and hole	0.932 and -0.803 $e.Å^{-3}$	

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3) for C790. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
Fe(1)	5305(1)	2275(1)	2345(1)	10(1)
S(1)	3906(2)	-1262(2)	1484(1)	17(1)
O(1)	1895(6)	898(6)	4058(3)	23(1)
O(2)	2515(7)	3033(7)	435(4)	28(1)
N(1)	3899(8)	-3427(8)	3640(4)	23(1)
C(1)	7645(8)	4815(8)	3658(5)	16(1)
C(2)	7870(9)	5491(9)	2433(5)	21(1)
C(3)	8446(8)	4115(9)	1697(5)	17(1)
C(4)	8586(9)	2631(9)	2479(5)	20(1)
C(5)	8068(8)	3019(8)	3681(5)	17(1)
C(6)	3916(8)	-2506(8)	2776(5)	15(1)
C(7)	3219(8)	1435(8)	3394(4)	13(1)
C(8)	3615(9)	2715(8)	1168(5)	17(1)

Table 3. Bond lengths [Å] and angles [°] for C790.

Fe(1)-C(8)	1.778(5)
Fe(1)-C(7)	1.789(5)
Fe(1)-C(2)	2.083(5)
Fe(1)-C(1)	2.084(5)
Fe(1)-C(5)	2.096(5)
Fe(1)-C(3)	2.109(5)
Fe(1)-C(4)	2.114(5)
Fe(1)-S(1)	2.2970(18)
S(1)-C(6)	1.690(5)
O(1)-C(7)	1.135(6)
O(2)-C(8)	1.146(6)
N(1)-C(6)	1.163(7)
C(1)-C(5)	1.422(7)
C(1)-C(2)	1.428(7)
C(1)-H(1)	1.0000
C(2)-C(3)	1.432(8)
C(2)-H(2)	1.0000
C(3)-C(4)	1.410(7)
C(3)-H(3)	1.0000
C(4)-C(5)	1.422(7)
C(4)-H(4)	1.0000
C(5)-H(5)	1.0000
C(8)-Fe(1)-C(7)	93.9(2)
C(8)-Fe(1)-C(2)	91.3(2)
C(7)-Fe(1)-C(2)	122.0(2)
C(8)-Fe(1)-C(1)	121.2(2)
C(7)-Fe(1)-C(1)	91.4(2)
C(2)-Fe(1)-C(1)	40.1(2)
C(8)-Fe(1)-C(5)	158.1(2)
C(7)-Fe(1)-C(5)	96.8(2)
C(2)-Fe(1)-C(5)	66.9(2)
C(1)-Fe(1)-C(5)	39.8(2)
C(8)-Fe(1)-C(3)	97.6(2)

C(7)-Fe(1)-C(3)	158.5(2)
C(2)-Fe(1)-C(3)	40.0(2)
C(1)-Fe(1)-C(3)	67.1(2)
C(5)-Fe(1)-C(3)	66.8(2)
C(8)-Fe(1)-C(4)	133.4(2)
C(7)-Fe(1)-C(4)	132.7(2)
C(2)-Fe(1)-C(4)	65.9(2)
C(1)-Fe(1)-C(4)	66.2(2)
C(5)-Fe(1)-C(4)	39.5(2)
C(3)-Fe(1)-C(4)	39.0(2)
C(8)-Fe(1)-S(1)	90.99(17)
C(7)-Fe(1)-S(1)	91.22(16)
C(2)-Fe(1)-S(1)	146.40(17)
C(1)-Fe(1)-S(1)	147.46(15)
C(5)-Fe(1)-S(1)	107.74(15)
C(3)-Fe(1)-S(1)	106.59(15)
C(4)-Fe(1)-S(1)	88.71(15)
C(6)-S(1)-Fe(1)	100.96(17)
C(5)-C(1)-C(2)	107.8(4)
C(5)-C(1)-Fe(1)	70.5(3)
C(2)-C(1)-Fe(1)	69.9(3)
C(5)-C(1)-H(1)	126.1
C(2)-C(1)-H(1)	126.1
Fe(1)-C(1)-H(1)	126.1
C(1)-C(2)-C(3)	108.3(5)
C(1)-C(2)-Fe(1)	70.0(3)
C(3)-C(2)-Fe(1)	71.0(3)
C(1)-C(2)-H(2)	125.8
C(3)-C(2)-H(2)	125.8
Fe(1)-C(2)-H(2)	125.8
C(4)-C(3)-C(2)	106.9(5)
C(4)-C(3)-Fe(1)	70.7(3)
C(2)-C(3)-Fe(1)	69.0(3)
C(4)-C(3)-H(3)	126.5
C(2)-C(3)-H(3)	126.5
Fe(1)-C(3)-H(3)	126.5

C(3)-C(4)-C(5)	109.5(5)
C(3)-C(4)-Fe(1)	70.3(3)
C(5)-C(4)-Fe(1)	69.6(3)
C(3)-C(4)-H(4)	125.2
C(5)-C(4)-H(4)	125.2
Fe(1)-C(4)-H(4)	125.2
C(4)-C(5)-C(1)	107.4(4)
C(4)-C(5)-Fe(1)	70.9(3)
C(1)-C(5)-Fe(1)	69.7(3)
C(4)-C(5)-H(5)	126.3
C(1)-C(5)-H(5)	126.3
Fe(1)-C(5)-H(5)	126.3
N(1)-C(6)-S(1)	177.7(5)
O(1)-C(7)-Fe(1)	179.9(5)
O(2)-C(8)-Fe(1)	178.1(5)

Symmetry transformations used to generate equivalent atoms:

Table 4. Anisotropic displacement parameters ($Å^2 x\ 10^3$) for C790. The anisotropic displacement factor exponent takes the form: $-2p^2[\ h^2\ a^{*2}U^{11} + ...\ + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Fe(1)	10(1)	11(1)	4(1)	1(1)	-1(1)	2(1)
S(1)	23(1)	13(1)	8(1)	-1(1)	-1(1)	3(1)
O(1)	21(2)	33(2)	12(2)	5(2)	8(2)	9(2)
O(2)	27(2)	47(3)	15(2)	13(2)	0(2)	20(2)
N(1)	26(3)	24(2)	18(2)	5(2)	2(2)	12(2)
C(1)	16(3)	11(2)	11(2)	-3(2)	0(2)	0(2)
C(2)	13(2)	15(3)	24(3)	7(2)	-3(2)	-1(2)
C(3)	9(2)	23(3)	9(2)	3(2)	1(2)	-1(2)
C(4)	15(3)	26(3)	14(2)	-1(2)	0(2)	6(2)
C(5)	10(2)	17(3)	17(3)	4(2)	-6(2)	2(2)
C(6)	16(2)	9(2)	16(3)	-2(2)	0(2)	5(2)
C(7)	16(3)	14(2)	4(2)	-1(2)	-3(2)	4(2)
C(8)	19(3)	14(2)	21(3)	7(2)	6(2)	9(2)

Table 5. Hydrogen coordinates ($x\ 10^4$) and isotropic displacement parameters ($Å^2 x\ 10^3$) for C790.

	x	y	z	U(eq)
H(1)	7290	5504	4377	19
H(2)	7692	6735	2145	25
H(3)	8733	4214	805	20
H(4)	8953	1459	2221	24
H(5)	8057	2213	4416	20

$CpFe(CO)_2(NCS)$, 5

Table 1. Crystal data and structure refinement for C532.

Identification code	c532	
Empirical formula	C8 H5 Fe N O2 S	
Formula weight	235.04	
Temperature	100(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P2(1)/m	
Unit cell dimensions	a = 6.3240(10) Å	a= 90°.
	b = 8.9082(14) Å	b= 91.684(4)°.
	c = 7.8468(12) Å	g = 90°.
Volume	441.86(12) $Å^3$	
Z	2	
Density (calculated)	1.767 Mg/m^3	
Absorption coefficient	1.902 mm^{-1}	
F(000)	236	
Crystal size	0.20 x 0.11 x 0.05 mm^3	
Theta range for data collection	2.60 to 27.50°.	
Index ranges	-7<=h<=8, -11<=k<=11, -9<=l<=10	
Reflections collected	3137	
Independent reflections	1075 [R(int) = 0.0322]	
Completeness to theta = 27.50°	99.1 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.9109 and 0.7022	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	1075 / 0 / 67	
Goodness-of-fit on F^2	1.236	
Final R indices [I>2sigma(I)]	R1 = 0.0310, wR2 = 0.0783	
R indices (all data)	R1 = 0.0405, wR2 = 0.1073	
Largest diff. peak and hole	0.647 and -0.688 $e.Å^{-3}$	

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3) for C532. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
Fe(1)	674(1)	2500	1677(1)	11(1)
S(1)	-3062(2)	2500	-3619(1)	19(1)
O(1)	-1864(3)	26(2)	3000(3)	22(1)
N(1)	-857(5)	2500	-481(4)	16(1)
C(1)	3507(6)	2500	301(5)	17(1)
C(2)	3410(4)	1206(3)	1345(4)	17(1)
C(3)	3288(4)	1702(3)	3076(4)	19(1)
C(4)	-916(4)	996(3)	2500(3)	16(1)
C(5)	-1746(6)	2500	-1793(5)	14(1)

Table 3. Bond lengths [Å] and angles [°] for C532.

Fe(1)-C(4)	1.806(3)
Fe(1)-C(4)#1	1.806(3)
Fe(1)-N(1)	1.925(4)
Fe(1)-C(3)#1	2.083(3)
Fe(1)-C(3)	2.083(3)
Fe(1)-C(2)#1	2.102(3)
Fe(1)-C(2)	2.102(3)
Fe(1)-C(1)	2.118(4)
S(1)-C(5)	1.636(4)
O(1)-C(4)	1.128(4)
N(1)-C(5)	1.159(5)
C(1)-C(2)#1	1.416(4)
C(1)-C(2)	1.416(4)
C(2)-C(3)	1.433(4)
C(3)-C(3)#1	1.422(6)
C(4)-Fe(1)-C(4)#1	95.80(17)
C(4)-Fe(1)-N(1)	92.50(11)
C(4)#1-Fe(1)-N(1)	92.50(11)
C(4)-Fe(1)-C(3)#1	120.42(12)
C(4)#1-Fe(1)-C(3)#1	89.99(12)
N(1)-Fe(1)-C(3)#1	146.56(11)
C(4)-Fe(1)-C(3)	89.99(12)
C(4)#1-Fe(1)-C(3)	120.42(12)
N(1)-Fe(1)-C(3)	146.56(11)
C(3)#1-Fe(1)-C(3)	39.91(16)
C(4)-Fe(1)-C(2)#1	156.97(12)
C(4)#1-Fe(1)-C(2)#1	96.10(12)
N(1)-Fe(1)-C(2)#1	106.59(11)
C(3)#1-Fe(1)-C(2)#1	40.05(11)
C(3)-Fe(1)-C(2)#1	66.98(11)
C(4)-Fe(1)-C(2)	96.10(12)
C(4)#1-Fe(1)-C(2)	156.97(12)
N(1)-Fe(1)-C(2)	106.59(11)

C(3)#1-Fe(1)-C(2)	66.98(11)
C(3)-Fe(1)-C(2)	40.05(11)
C(2)#1-Fe(1)-C(2)	66.53(15)
C(4)-Fe(1)-C(1)	132.08(9)
C(4)#1-Fe(1)-C(1)	132.08(9)
N(1)-Fe(1)-C(1)	87.88(15)
C(3)#1-Fe(1)-C(1)	66.33(13)
C(3)-Fe(1)-C(1)	66.33(13)
C(2)#1-Fe(1)-C(1)	39.22(9)
C(2)-Fe(1)-C(1)	39.22(9)
C(5)-N(1)-Fe(1)	178.9(3)
C(2)#1-C(1)-C(2)	109.0(4)
C(2)#1-C(1)-Fe(1)	69.75(18)
C(2)-C(1)-Fe(1)	69.75(18)
C(1)-C(2)-C(3)	107.5(3)
C(1)-C(2)-Fe(1)	71.03(19)
C(3)-C(2)-Fe(1)	69.27(15)
C(3)#1-C(3)-C(2)	107.97(17)
C(3)#1-C(3)-Fe(1)	70.05(8)
C(2)-C(3)-Fe(1)	70.68(16)
O(1)-C(4)-Fe(1)	177.9(2)
N(1)-C(5)-S(1)	178.5(4)

Symmetry transformations used to generate equivalent atoms:

#1 x,-y+1/2,z

Table 4. Anisotropic displacement parameters ($Å^2 x\ 10^3$) for C532. The anisotropic displacement factor exponent takes the form: $-2p^2[\ h^2\ a^{*2}U^{11} + ...\ + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Fe(1)	12(1)	11(1)	11(1)	0	0(1)	0
S(1)	26(1)	19(1)	13(1)	0	-5(1)	0
O(1)	23(1)	17(1)	26(1)	1(1)	5(1)	-5(1)
N(1)	16(2)	16(2)	16(2)	0	0(1)	0
C(1)	12(2)	19(2)	20(2)	0	4(2)	0
C(2)	10(1)	17(1)	24(1)	-2(1)	1(1)	2(1)
C(3)	12(1)	24(2)	19(1)	4(1)	-3(1)	1(1)
C(4)	16(1)	18(1)	14(1)	-2(1)	0(1)	4(1)
C(5)	14(2)	10(2)	17(2)	0	3(2)	0

Table 5. Hydrogen coordinates ($x\ 10^4$) and isotropic displacement parameters ($Å^2 x\ 10^3$) for C532.

	x	y	z	U(eq)
H(1)	3596	2500	-969	21
H(2)	3455	140	948	20
H(3)	3248	1042	4106	22