COPPER(II) COMPLEXES BASED ON 5-METHYL-1H-TETRAZOLE AND 2,2'-BIPYRIDINE, 1,10-PHENATHROLINE DERIVATIVES: SYNTHESIS, CRYSTAL STRUCTURES AND EXTENDED CYTOTOXICITY STUDY

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Electronic Supplementary Information

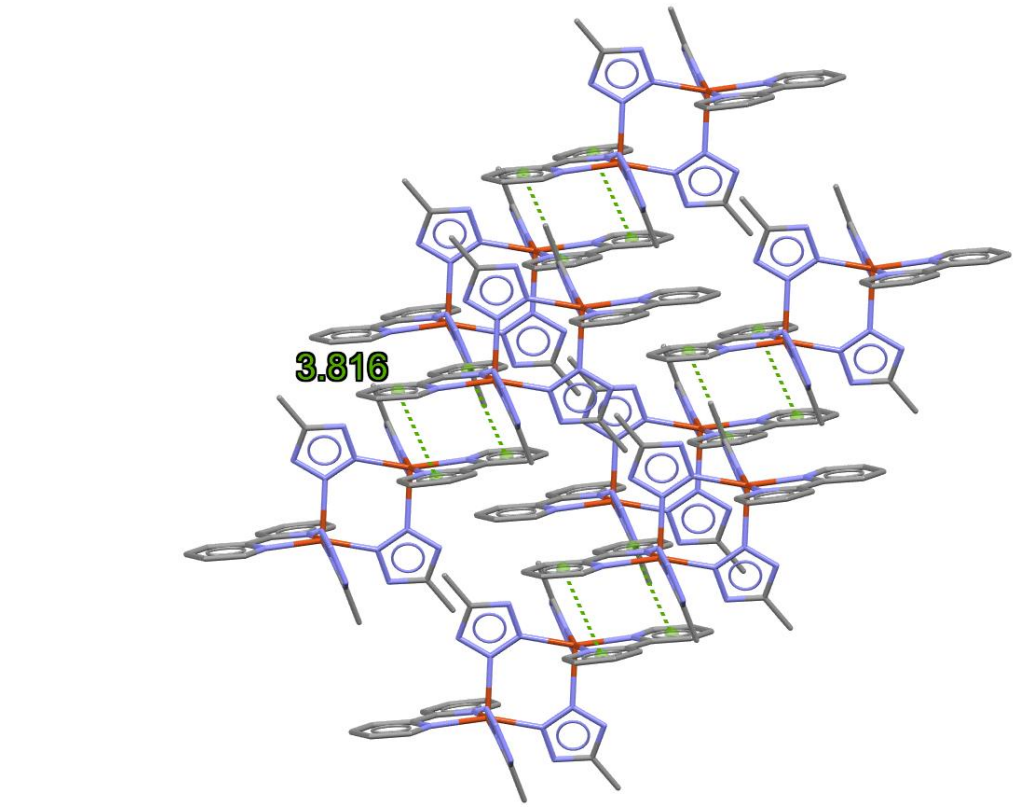
Table S1. The bond lengths and angles in the obtained complexes

Bond	**1**	**2**	**Bond**	**3**	**Bond**	**3a**
Cu–N1	2.0246(18)	2.0295(13)	Cu–N1	2.030(3)	Cu–N1	2.023(4)
Cu–N2	2.0352(18)	2.0445(13)	Cu–N2	2.027(3)	Cu–N2	2.040(5)
Cu–N3	1.9856(18)	1.9824(13)	Cu–N3	1.988(4)	Cu–N4	1.989(5)
Cu–N8	2.0039(18)	1.9974(13)	Cu–N7	2.001(3)	Cu–N7	2.005(5)
Cu–N9	2.2085(18)	2.2028(14)	Cu–N8	2.217(3)	Cu–N8	2.179(5)
Angle	**1**	**2**	**Angle**	**3**	**Angle**	**3a**
N1–Cu–N2	79.88(7)	80.90(5)	N1–Cu–N8	101.56(12)	N1–Cu–N8	102.48(18)
N1–Cu–N9	95.36(7)	93.67(5)	N2–Cu–N1	79.94(13)	N1–Cu–N2	80.28(17)
N2–Cu–N9	99.68(7)	96.61(5)	N2–Cu–N8	96.79(13)	N2–Cu–N8	97.57(17)
N3–Cu–N1	168.99(7)	168.91(6)	N7–Cu–N1	92.88(13)	N4–Cu–N8	97.1(2)
N3–Cu–N2	93.70(7)	93.50(5)	N7–Cu–N2	163.26(13)	N4–Cu–N1	159.7(2)
N3–Cu–N9	94.53(7)	96.50(5)	N7–Cu–N8	99.47(12)	N4–Cu–N2	91.86(19)
N3–Cu–N8	90.89(7)	91.61(5)	N3–Cu–N1	159.95(14)	N4–Cu–N7	88.93(19)
N8–Cu–N1	92.28(7)	91.14(5)	N3–Cu–N2	92.06(14)	N7–Cu–N8	101.68(17)
N8–Cu–N2	160.07(7)	162.72(6)	N3–Cu–N7	89.72(14)	N7–Cu–N1	92.39(18)
N8–Cu–N9	99.27(7)	99.21(5)	N3–Cu–N8	97.60(14)	N7–Cu–N2	160.49(19)

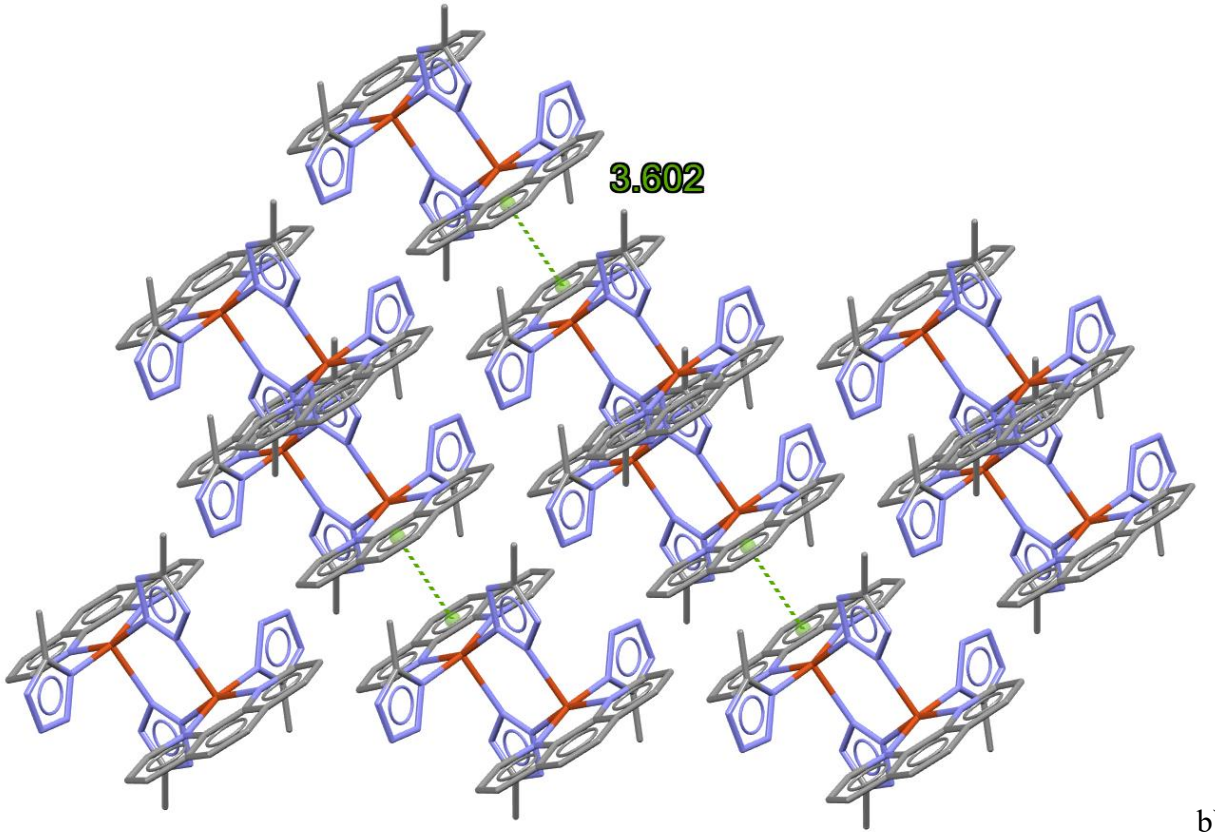
Bond	**3b**	**Angle**	**3b**
Cu1–N1	2.029(4)	N1–Cu1–N2	79.91(17)
Cu1–N8	2.014(4)	N1–Cu1–N20	90.33(17)
Cu1–N2	2.070(5)	N8–Cu1–N1	92.06(17)
Cu1–N20	2.195(5)	N8–Cu1–N2	158.52(18)
Cu1–N3	1.990(4)	N8–Cu1–N20	104.77(18)
Cu2–N10	2.021(4)	N2–Cu1–N20	95.23(17)
Cu2–N11	2.064(4)	N3-Cu1-N1	164.13(19)
Cu2–N17	2.168(4)	N3–Cu1–N8	90.62(19)
Cu2–N13	1.986(4)	N3–Cu1–N2	92.03(18)
Cu2–N12	2.038(5)	N3–Cu1–N20	104.10(19)
		N10–Cu2–N11	93.95(17)
		N10–Cu2–N17	105.05(18)
		N10–Cu2–N12	160.8(2)
		N11–Cu2–N17	96.53(17)
		N13–Cu2–N10	88.44(19)
		N13–Cu2–N11	157.5(2)
		N13–Cu2–N17	104.48(19)
		N13–Cu2–N12	91.10(19)
		N12–Cu2–N11	79.38(18)
		N12–Cu2–N17	93.69(19)

Table S2. Crystallographic data and structure refinement details for compounds **1-3b**

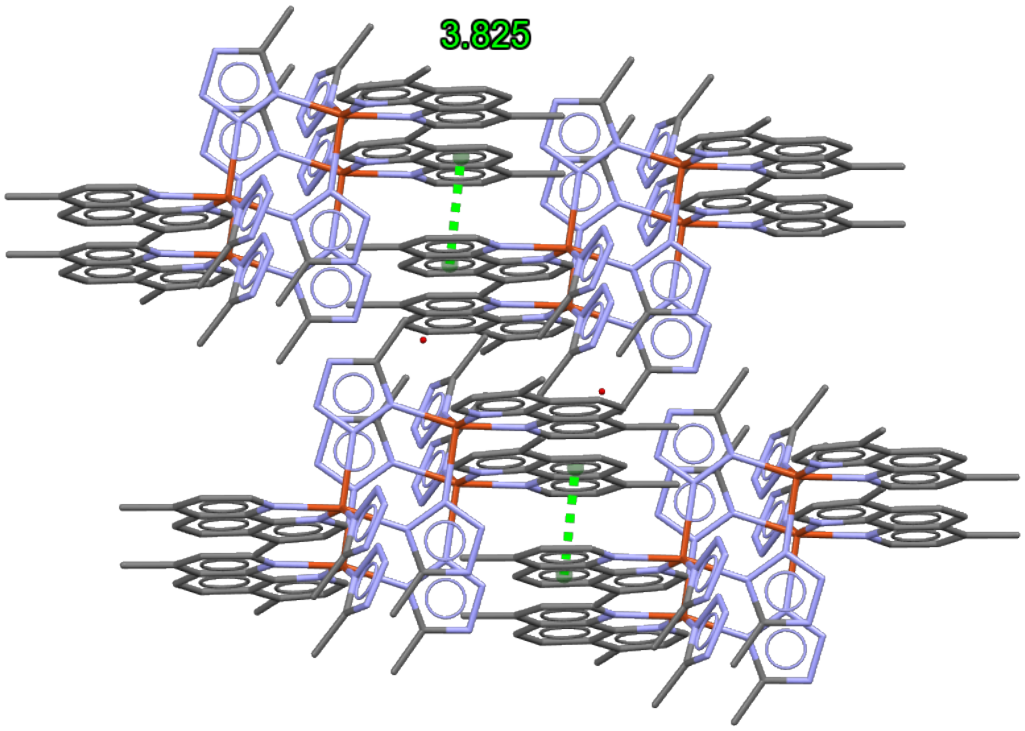
Compound	**1**	**2**	**3**	**3a**	**3b**
Empirical formula	$C_{28}H_{28}Cu_2N_{20}$	$C_{32}H_{28}Cu_2N_{20}$	$C_{36}H_{40}Cu_2N_{20}O_2$	$C_{40}H_{48}Cu_2N_{20}O_2$	$C_{72}H_{76}Cu_4N_{40}O_2$
Formula weight	771.78	819.79	911.96	968.08	1787.88
Temperature/K	150	150	300	150	293
Crystal system	triclinic	triclinic	triclinic	triclinic	triclinic
Space group	P-1	P-1	P-1	P-1	P-1
a/Å	8.6567(7)	8.7700(5)	11.0916(13)	10.987(3)	11.224(2)
b/Å	9.9109(8)	10.7512(7)	11.1446(12)	11.354(3)	14.614(3)
c/Å	10.7222(8)	10.7578(6)	11.1875(10)	11.406(3)	14.652(3)
α/°	109.317(3)	107.668(2)	113.708(3)	100.136(7)	105.79(3),
β/°	110.058(3)	104.604(2)	97.123(3)	109.237(6)	101.79(3),
γ/°	96.050(3)	110.418(2)	118.018(3)	118.587(6)	112.04(3)
Volume/Å^3	790.23(11)	829.78(9)	1030.66(19)	1079.9(5)	2013.1(9)
Z	1	1	1	1	1
ρ_{calc}g/cm^3	1.622	1.641	1.469	1.489	1.475
μ/mm^{-1}	1.404	1.342	1.09	1.047	1.12
Crystal size/mm^3	0.066 × 0.048 × 0.028	0.094 × 0.058 × 0.036	0.12 × 0.05 × 0.02	0.175 × 0.039 × 0.017	0.22 × 0.05 × 0.02
2Θ range for data collection/°	4.398 to 63.066	4.338 to 63.086	4.496 to 55.76	4.274 to 52.882	3.076 to 56.614
Index ranges	-12 ≤ h ≤ 12, -14 ≤ k ≤ 14, -15 ≤ l ≤ 15	-12 ≤ h ≤ 12, -15 ≤ k ≤ 15, -15 ≤ l ≤ 15	-14 ≤ h ≤ 14, -14 ≤ k ≤ 14, -14 ≤ l ≤ 13	-13 ≤ h ≤ 13, -14 ≤ k ≤ 14, -14 ≤ l ≤ 14	-14 ≤ h ≤ 14, -19 ≤ k ≤ 19, -19 ≤ l ≤ 19
Reflections collected	22224	16623	14397	14190	19862
Independent reflections	5273 [R_{int} = 0.0700, R_{sigma} = 0.0704]	5534 [R_{int} = 0.0330, R_{sigma} = 0.0409]	4895 [R_{int} = 0.0592, R_{sigma} = 0.0790]	4345 [R_{int} = 0.0940, R_{sigma} = 0.1226]	9966 [R_{int} = 0.1274, R_{sigma} = 0.1847]
Restraints / parameters	0/228	0/246	0/278	0/303	0/543
Goodness-of-fit on F^2	1.026	1.040	1.030	1.049	1.025
Final R indexes [I>=2σ (I)]	R_1 = 0.0425, wR_2 = 0.0782	R_1 = 0.0330, wR_2 = 0.0732	R_1 = 0.0601, wR_2 = 0.1499	R_1 = 0.0725, wR_2 = 0.1701	R_1 = 0.0791, wR_2 = 0.2001
Final R indexes [all data]	R_1 = 0.0720, wR_2 = 0.0887	R_1 = 0.0421, wR_2 = 0.0773	R_1 = 0.0897, wR_2 = 0.1639	R_1 = 0.1323, wR_2 = 0.1967	R_1 = 0.1375, wR_2 = 0.2443
Largest diff. peak/hole / e Å^{-3}	0.54/-0.56	0.49/-0.43	0.65/-0.50	1.63/-0.76	0.78/-0.72
CCDC number	2424836	2424833	2424835	2424834	2424837



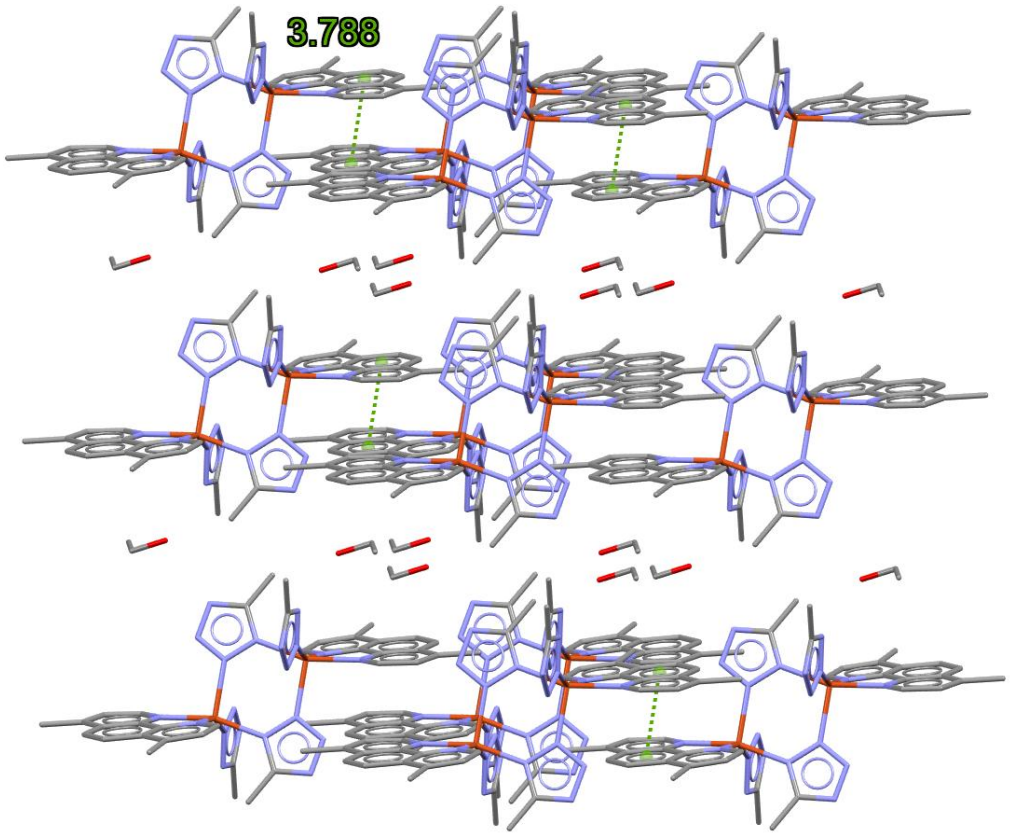
a)



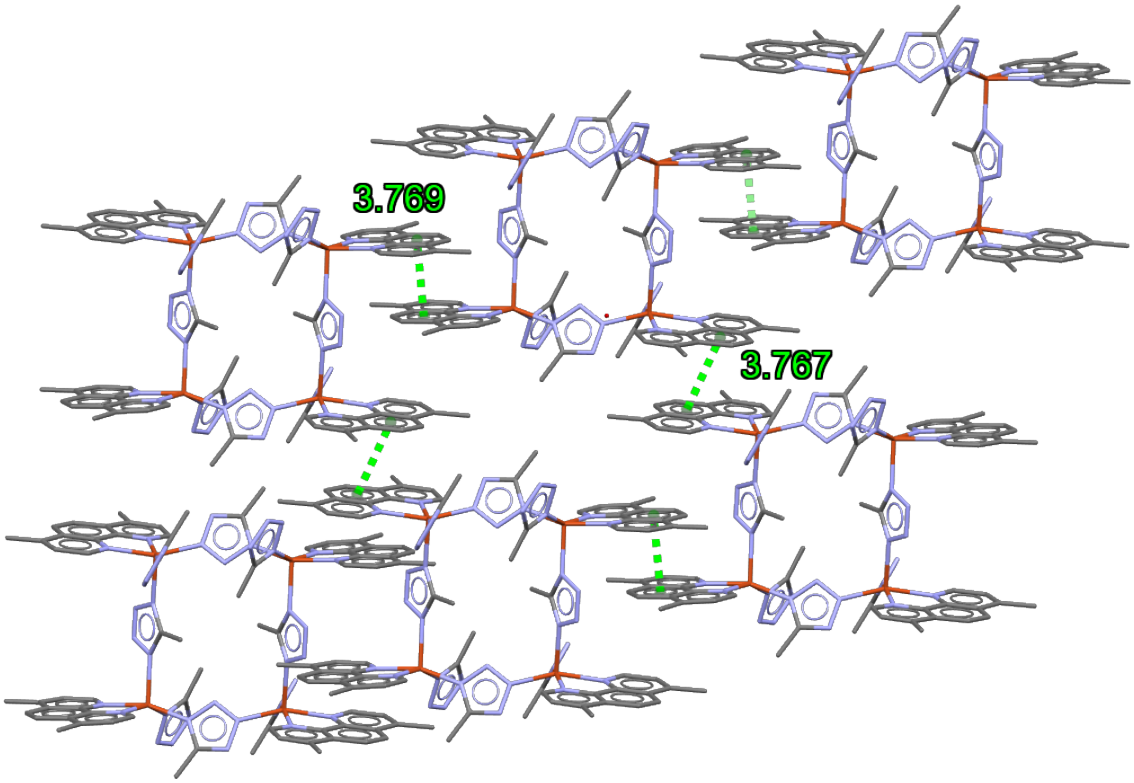
b)



c)



d)



e)

Figure S1. The molecules packing as a result of the π-stacking for **1** (a), **2** (b), **3** (c), **3a** (d) and **3b** (e). Hydrogen atoms are not shown.

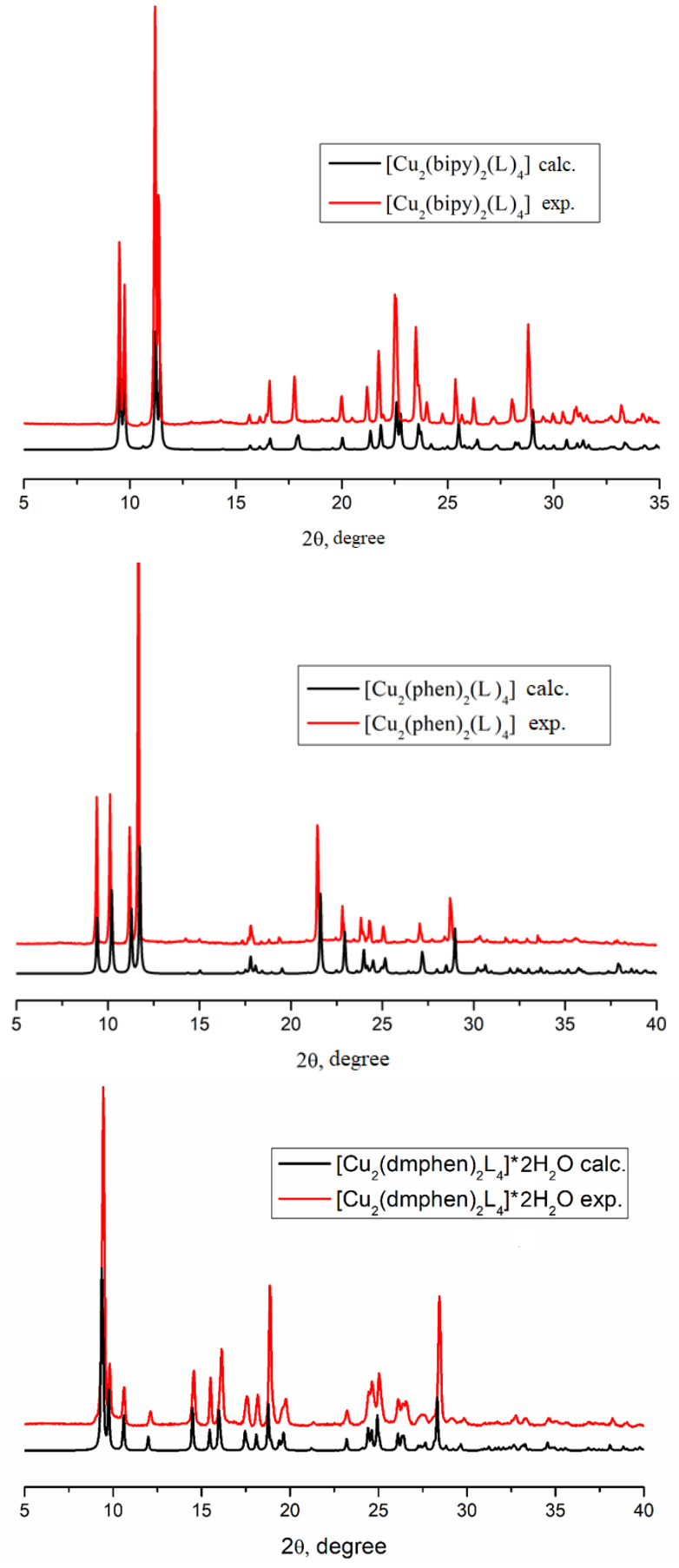
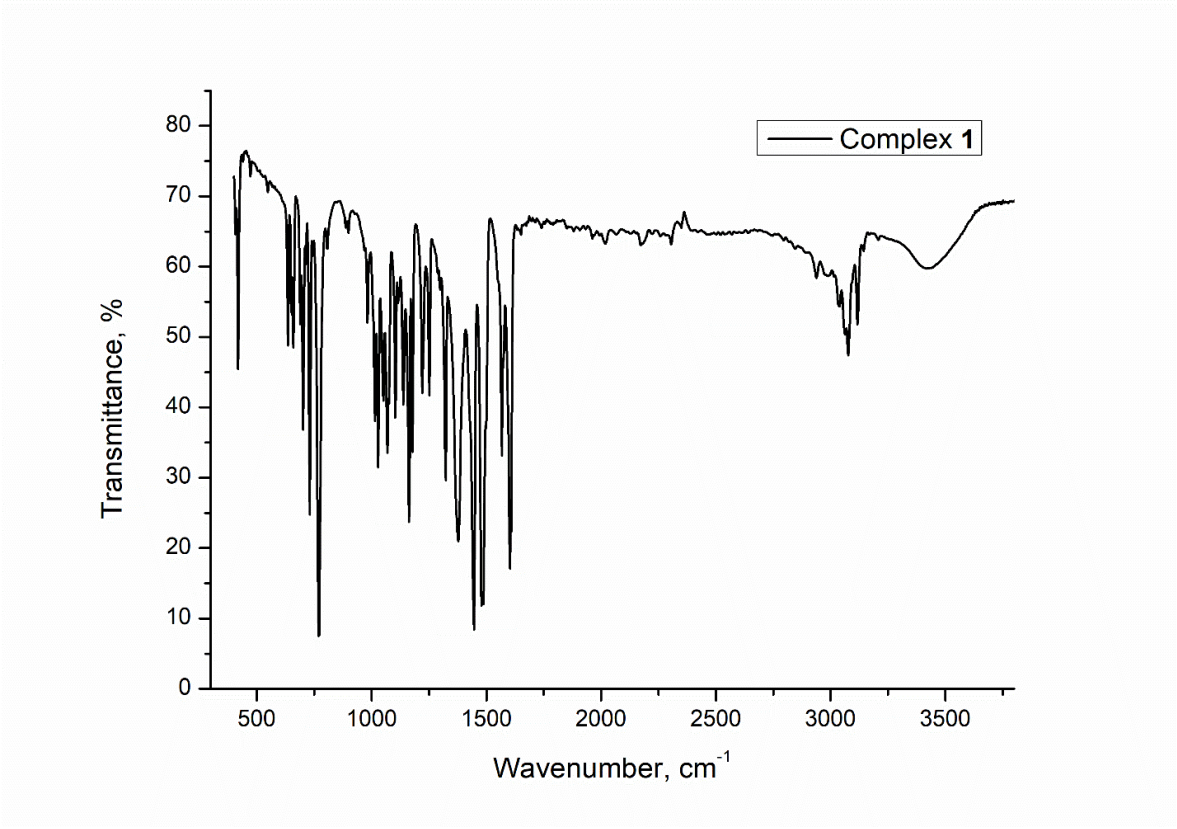


Figure S2. X-ray powder patterns for complexes **1-3**.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Transmittance, %
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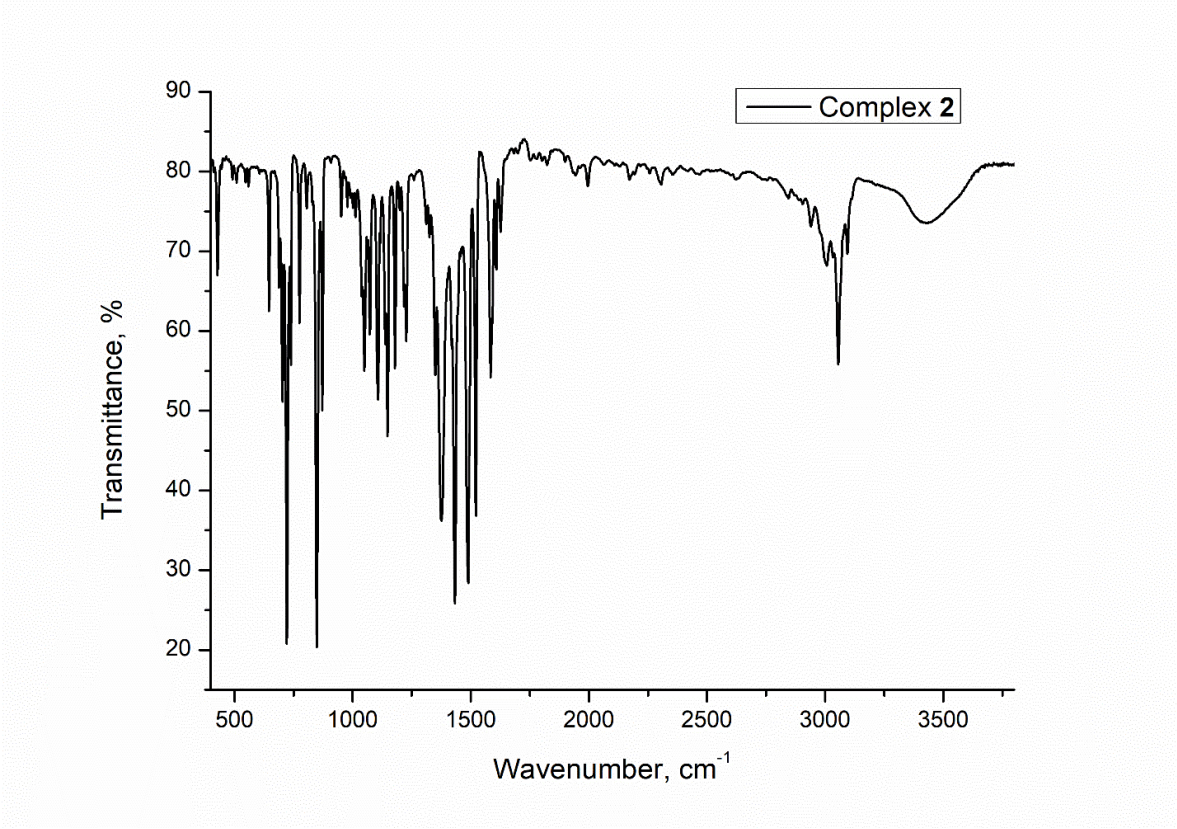
30
40
50
60
70
80
500
1000
1500
2000
2500
3000
3500


Complex 2
Transmittance, %
Wavenumber, cm-1
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90
500
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1500
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3000
3500

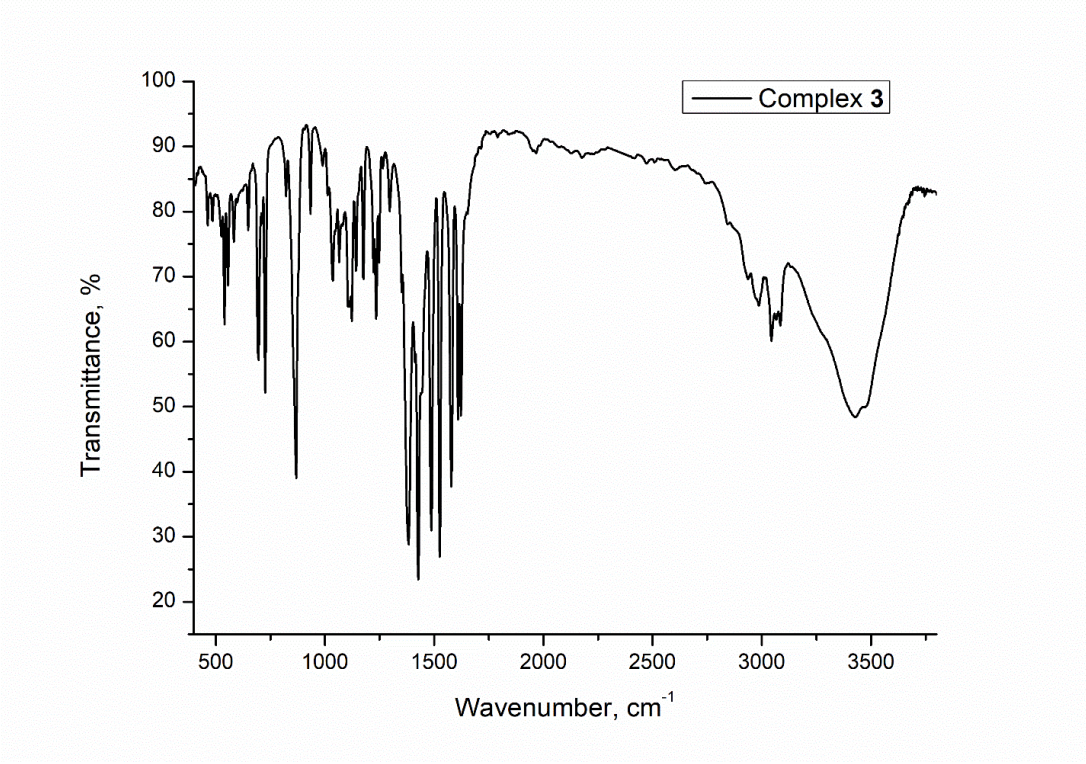

Figure S3. IR spectra of complexes **1-3** registered in KBr pellets

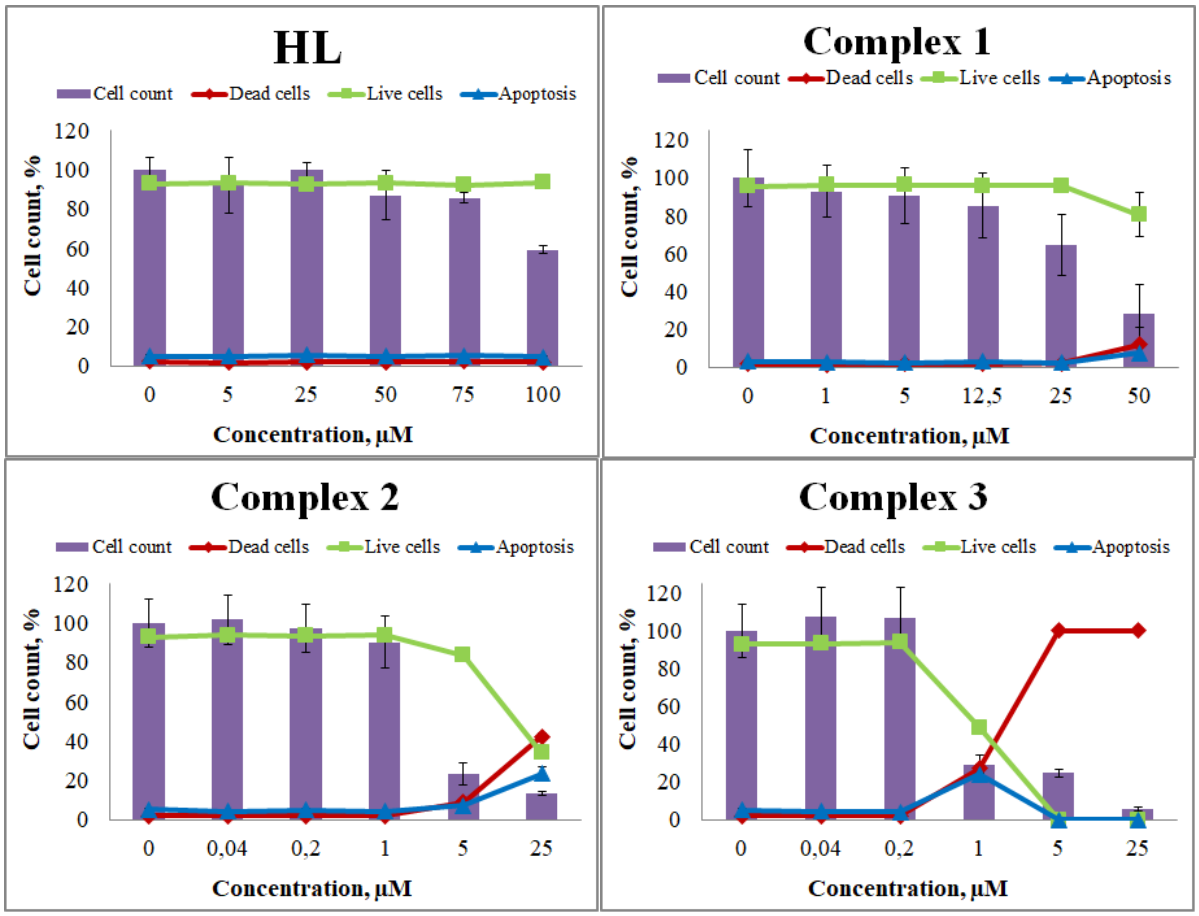

Figure S4. Effect of HL and complexes **1-3** on the viability of A549 cells determined by dual staining with Hoechst 33342/propidium iodide after 48 hours of incubation.

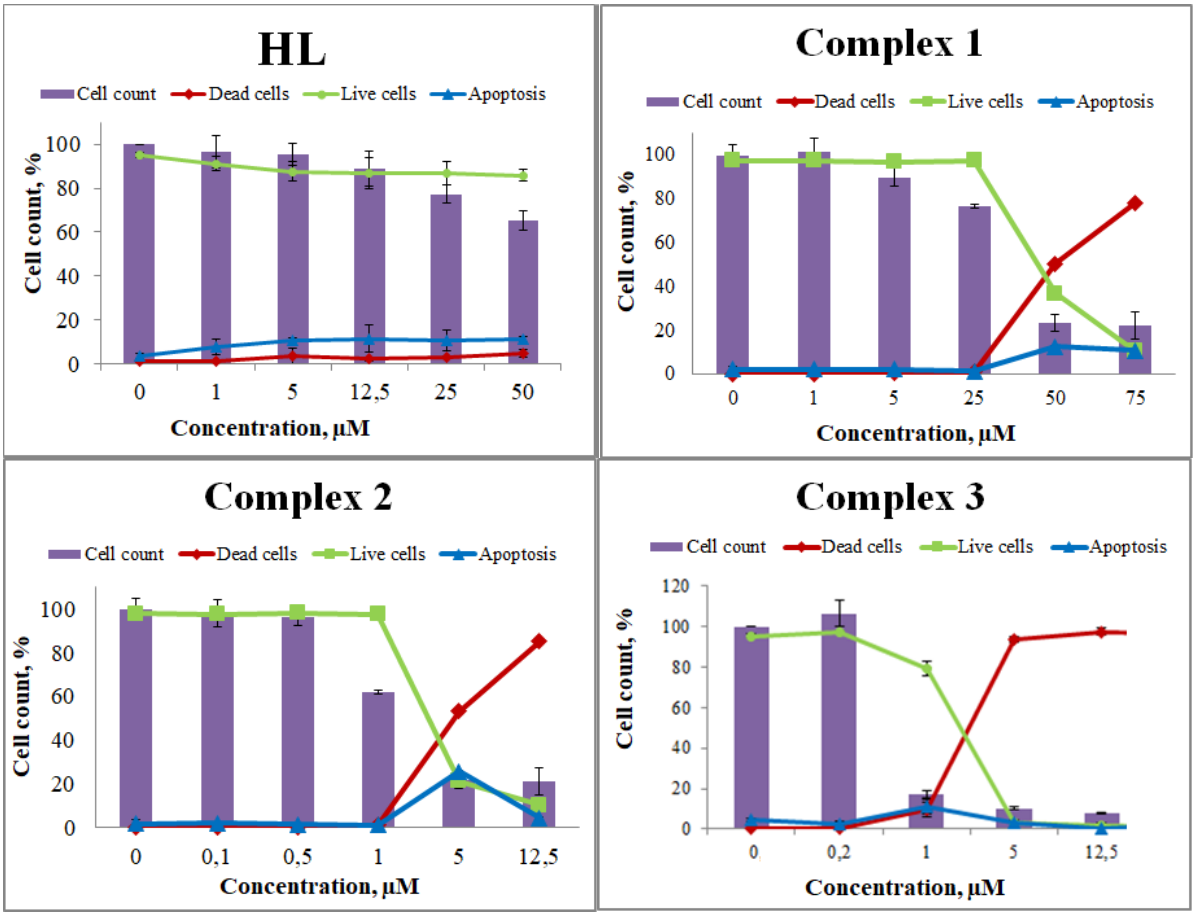

Figure S5. Effect of HL and complexes **1-3** on the viability of Hep2 cells determined by dual staining with Hoechst 33342/propidium iodide after 48 hours of incubation.

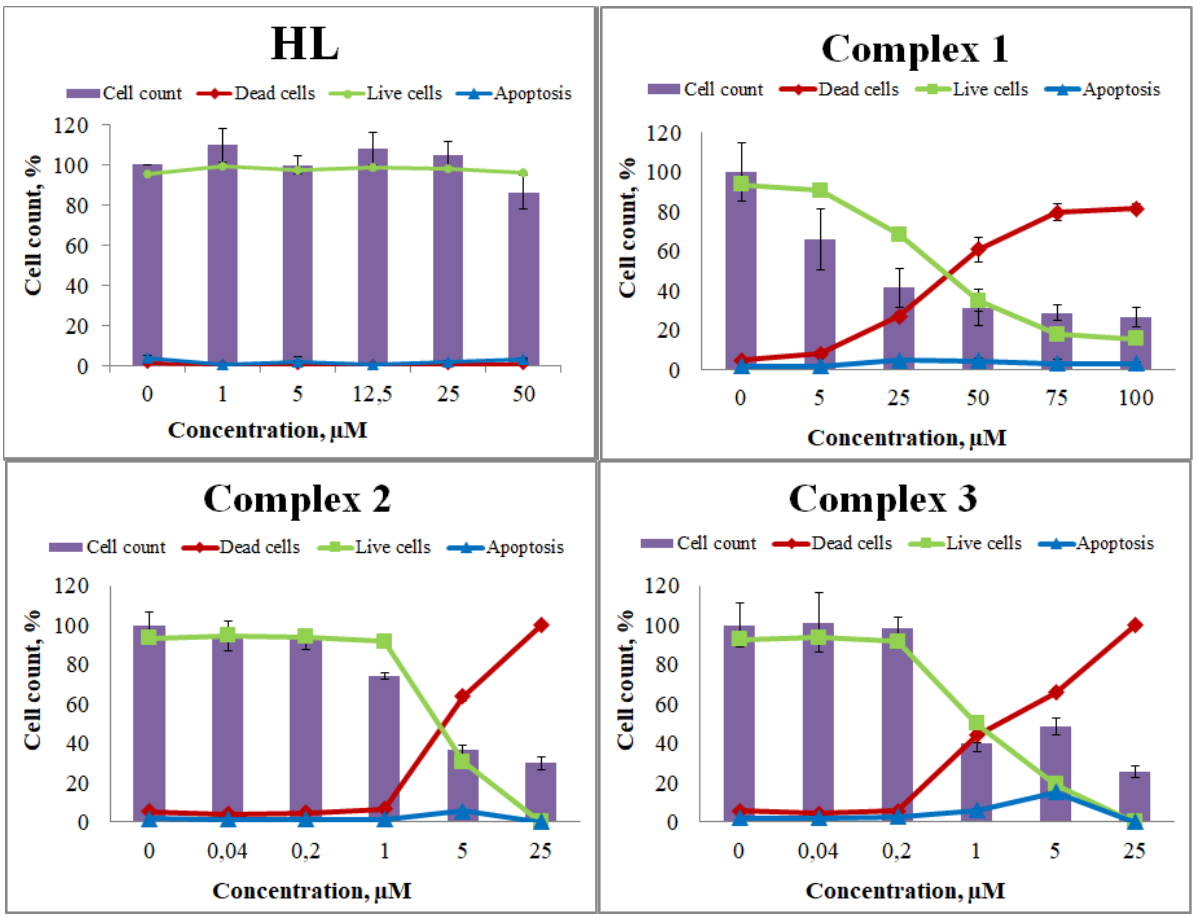

Figure S6. Effect of HL and complexes **1-3** on the viability of MCF7 cells determined by dual staining with Hoechst 33342/propidium iodide after 48 hours of incubation.

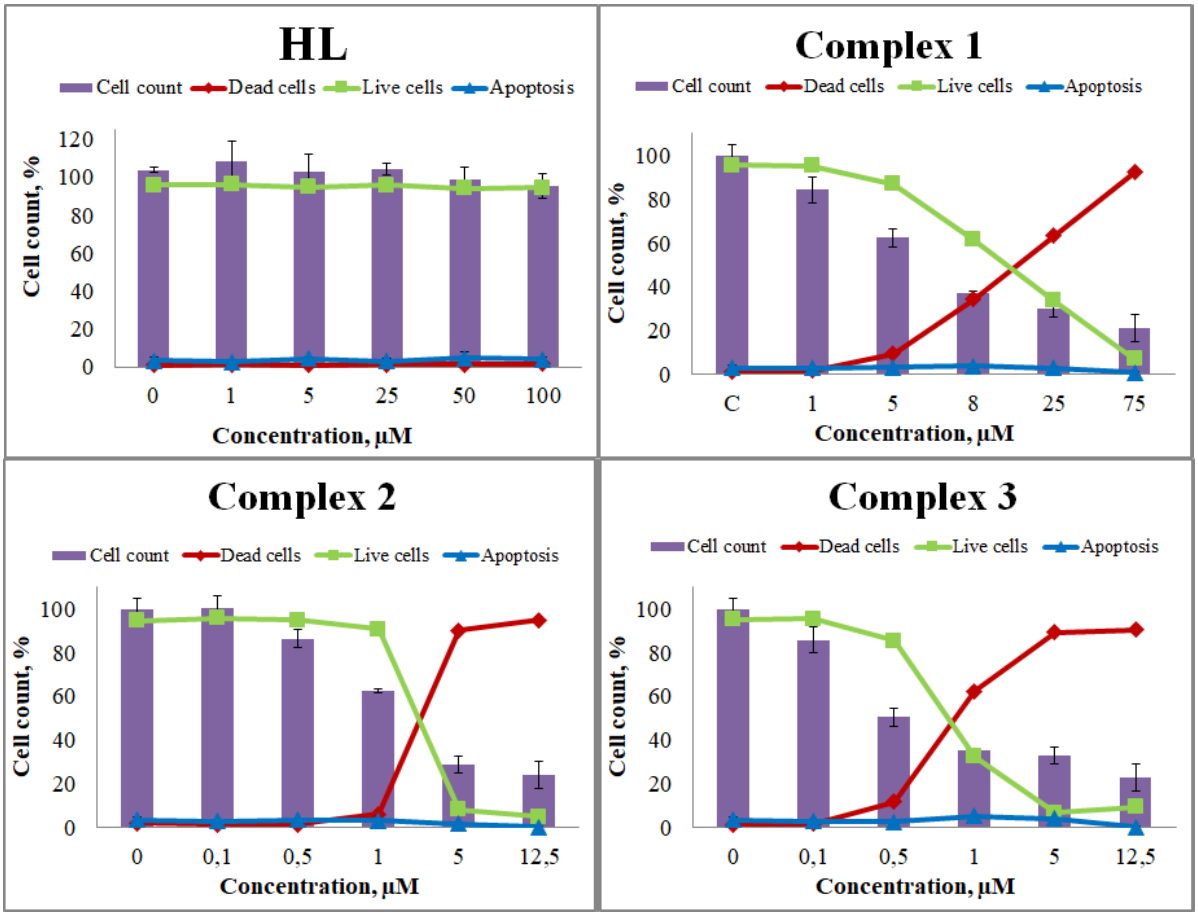

Figure S7. Effect of complexes **1-3** on the viability of HepG2 cells determined by dual staining with Hoechst 33342/propidium iodide after 48 hours of incubation.

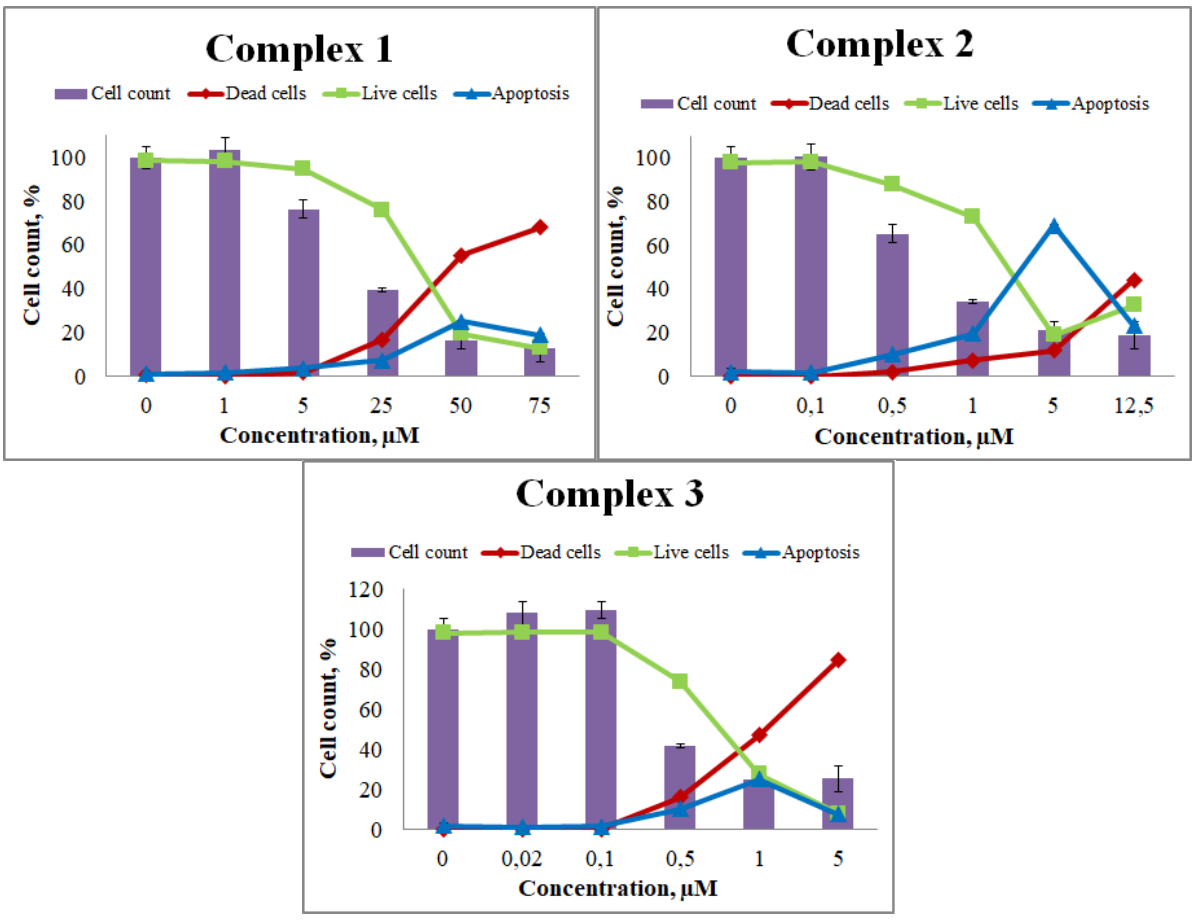

Figure S8. Effect of complexes **1-3** on the viability of HEK293A cells determined by dual staining with Hoechst 33342/propidium iodide after 48 hours of incubation.

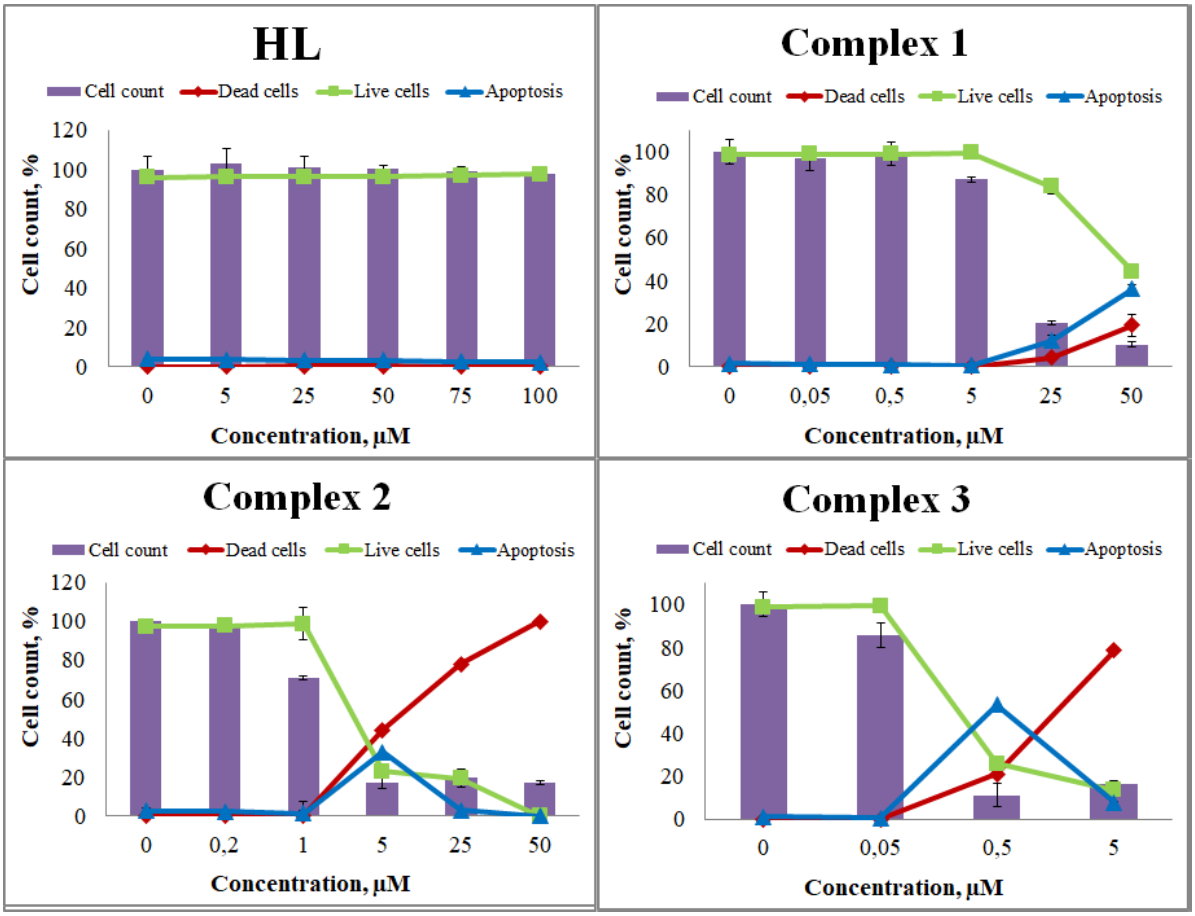

Figure S9. Effect of HL and complexes **1-3** on the viability of MRC5 cells determined by dual staining with Hoechst 33342/propidium iodide after 48 hours of incubation.

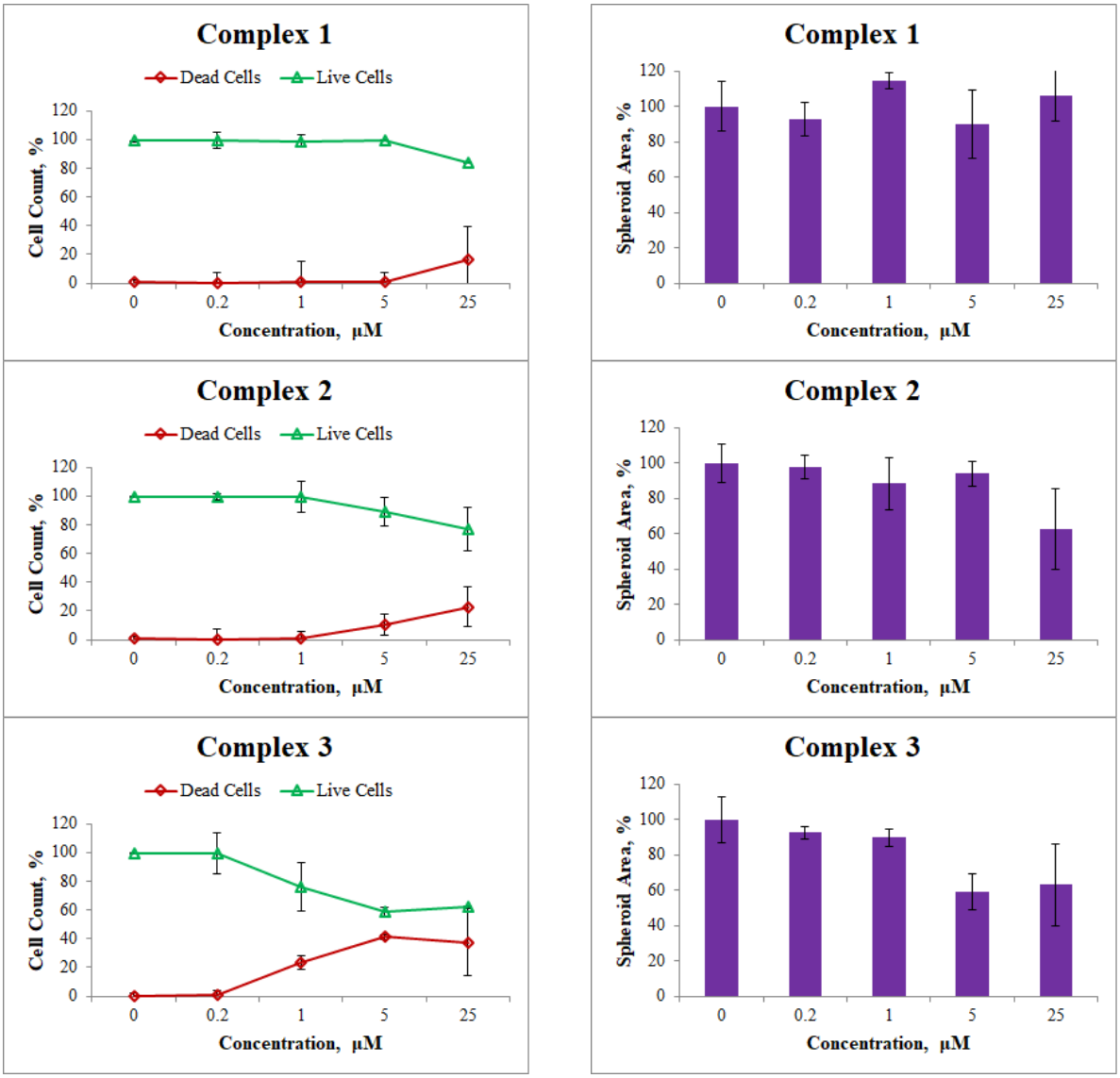

Figure S10. Effect of complexes **1-3** on the viability of HepG2 spheroids (cell count and spheroid area) determined by dual staining with Hoechst 33342/propidium iodide after 48 hours of incubation.

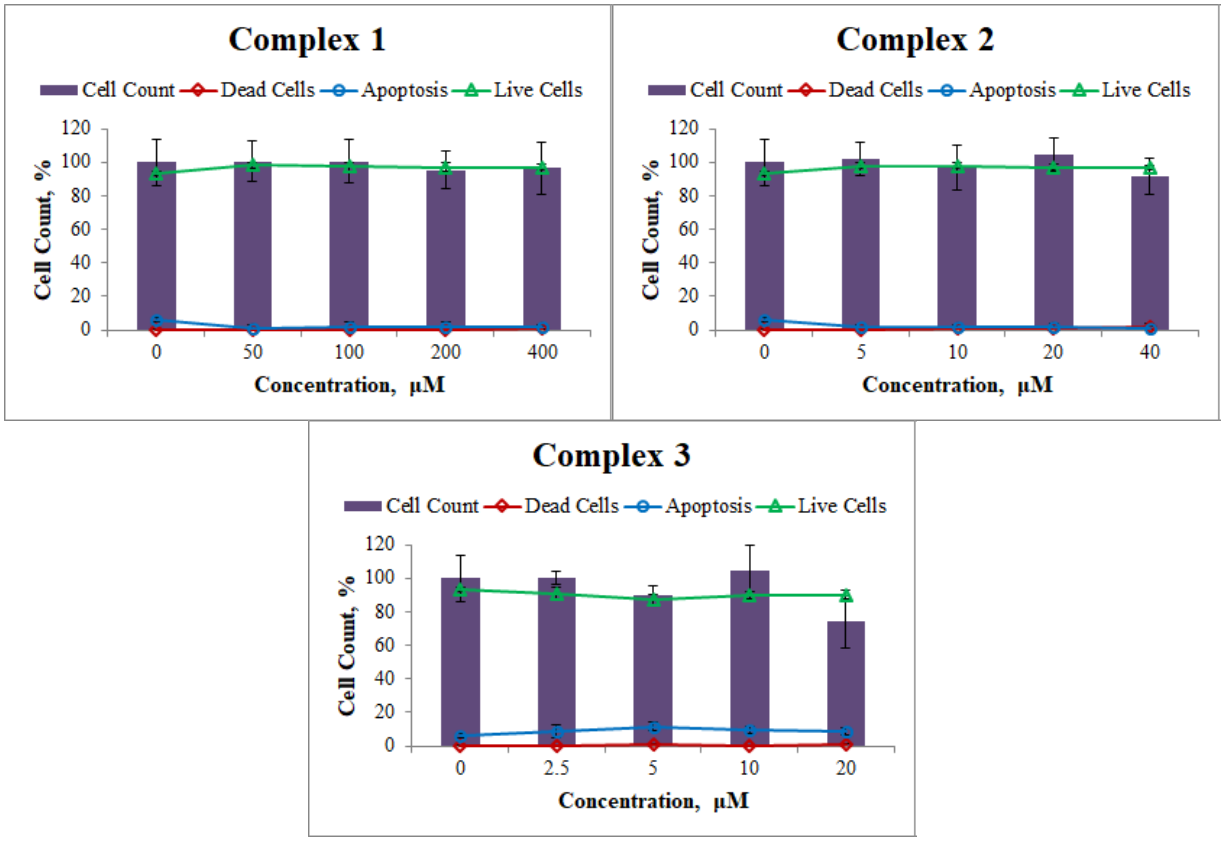

Figure S11. Effect of complexes **1-3** on the viability of Hep2 cells determined by dual staining with Hoechst 33342/propidium iodide after 1 hour of incubation.

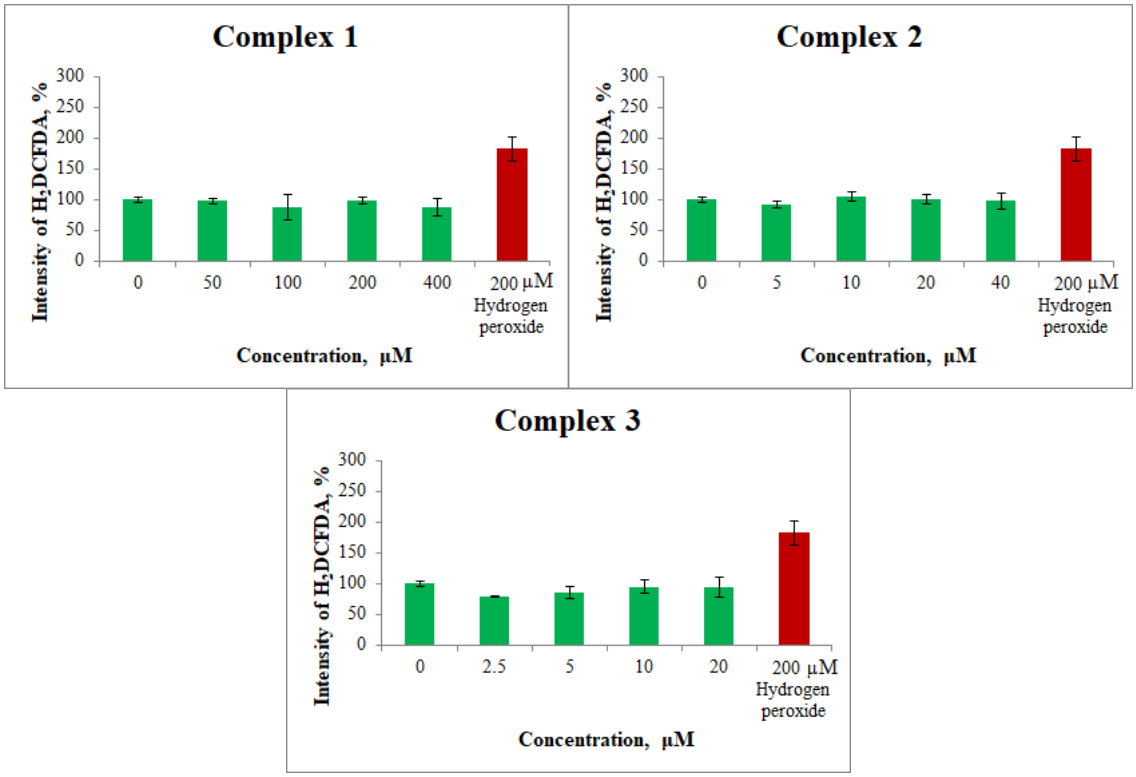

Figure S12. Total intracellular reactive oxygen species in HepG2 cells determined by fluorescent H_2DCFDA signal intensity. Green bars indicate intensity in cells incubated with complexes **1–3**, red bars indicate H_2DCFDA intensity in positive control (cells incubated with 200 µM H_2O_2).

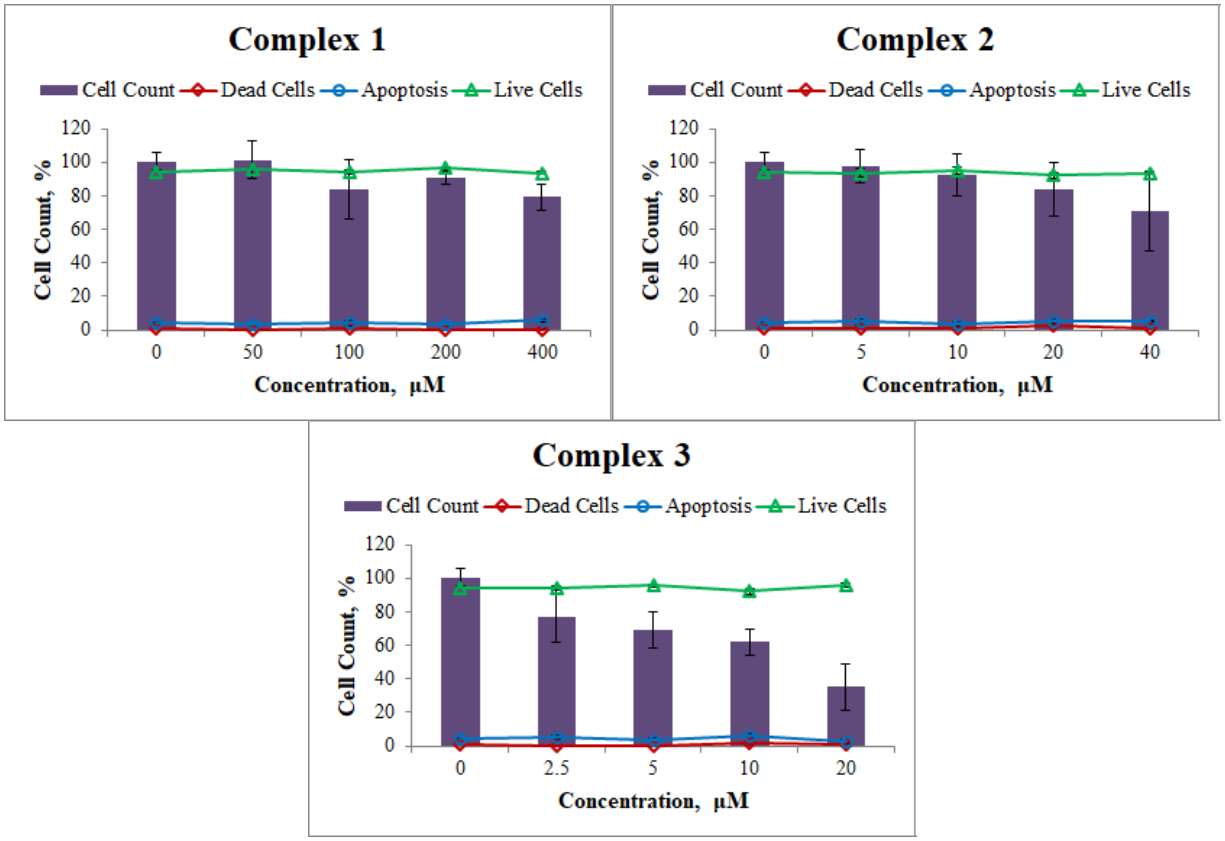

Figure S13. Effect of complexes **1-3** on the viability of HepG2 cells determined by dual staining with Hoechst 33342/propidium iodide after 1 hour of incubation.