**Electronic supplementary information**

# CRYSTAL STRUCTURE AND CYTOTOXIC ACTIVITY OF Cu(II) COMPLEXES WITH *BIS*—BENZOXAZOLYLHYDRAZONE OF 2,6-DIACETYLPYRIDINE

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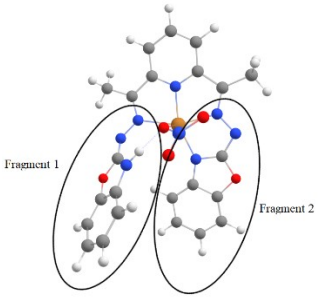
**Table S1**. Experimental and calculated (for isomer 1a) IR spectral data of *bis*-benzoxazolylhydrazone **1**

| Assignment | Calculated | | Experimental |
|---|---|---|---|
| | Frequency, $cm^{-1}$ | Intensity, kM $mol^{-1}$ | Frequency, $cm^{-1}$ (intensity*) |
| ν(NH) | 3431 | 26 | 3453(m) |
| | | 20 | |
| $\nu_s$(CH, benzox) | 3094 | 33 | 3097(w) |
| $\nu_{as}$(CH, benzox) | 3090 | 34 | 3058(w) |
| | 3077 | 36 | |
| $\nu_{as}(CH_3)$ | 2952 | 41 | 2963(w) |
| $\nu_s(CH_3)$ | 2911 | 32 | |
| ν(C=N, benzox) | 1636 | 1582 | 1632(s) |
| ν(C=N, azom) | 1607 | 230 | 1619(m) |
| ν(C=C, aromatic) | 1568 | 562 | 1580(s) |
| | | | 1565(m) |
| ν(C=C, pyridine) | 1556 | 543 | 1541(m) |
| $\delta(CH_3)$ | 1444 | 252 | 1453(m) |
| δ(CH, pyridine) | 1426 | 205 | 1406(w) |
| ν(C–O) + δ(NH) | 1233 | 377 | 1277(w) |
| ν(benzox ring) | 1220 | 558 | 1239(w) |
| δ(CH, pyridine) | 1159 | 569 | 1168(w) |

*Intensities are denoted as follows: vs-very strong, s-strong, m-medium, w-weak.

**Table S2**. Experimental and calculated IR spectral data of complex **2**

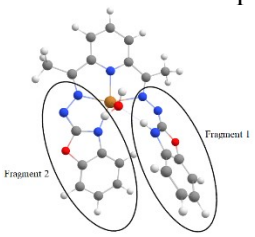



Optimized cation structure of complex **2**

| Assignment | Calculated | | Experimental |
|---|---|---|---|
| | Frequency, $cm^{-1}$ | Intensity, kM $mol^{-1}$ | Frequency, $cm^{-1}$ (intensity*) |
| ν(CH, benzox) | 3097 | 16 | 3097(w) |
| | 3083 | 23 | |
| ν(CH, pyridine) | 3076 | 18 | 3061(w) |
| | 2988 | 13 | |
| $\nu(CH_3)$ | 2973 | 15 | 2924(w) |
| | 2927 | 22 | |
| ν(NH) | 2780 | 963 | 3189(w) |
| ν(N=C, hydraz1) + ν(C–N, benzox1) + δ(NH) | 1646 | 1316 | 1649(s) |
| | | | 1624(m) |
| | | | 1592(w) |
| ν(N=C, hydraz2) + ν(C=N, azom1) + δ(NH) + $\nu(NO_3)$ | 1531 | 327 | 1524(m) |
| | 1511 | 286 | 1506(w) |
| | 1487 | 564 | 1477(w) |
| ν(CN, pyridine) + $\delta(CH_3)$ | 1393 | 529 | 1391(m) |
| ν(C–C, azom) + $\nu(NO_3)$ + δ(N=C, benzox1) | 1311 | 346 | 1312(s) |
| | 1286 | 366 | 1290(s) |
| ν(N–N) | 1220 | 219 | 1215(m) |
| | 1177 | 217 | 1158(s) |

*Intensities are denoted as follows: vs-very strong, s-strong, m-medium, w-weak.

**Table S3**. Experimental and calculated IR spectral data of complex **3**

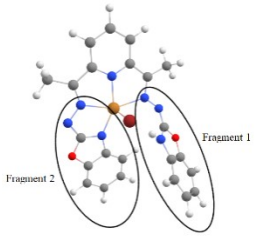



Optimized cation structure of complex 3

| Assignment | Calculated | | Experimental |
|---|---|---|---|
| | Frequency, $cm^{-1}$ | Intensity, kM $mol^{-1}$ | Frequency, $cm^{-1}$ (intensity*) |
| $\nu_s(H_2O)$ | 3741 | 51 | 3350(w) |
| $\nu_{as}(H_2O)$ | 3642 | 17 | |
| ν(NH) | 3318 | 259 | 3287(w) |
| ν(N=C, hydraz1) + δ(NH) | 1635 | 1327 | 1650(s)<br>1630(m) |
| ν(C=C, pyridine) + ν(C=N, azom2) | 1564 | 220 | 1594(m)<br>1573(w)<br>1543(m) |
| ν(N=C, hydraz2) + ν(C=N, azom1) | 1504 | 564 | 1516(m) |
| ν(N=C, hydraz2) | 1475 | 254 | 1474(m) |
| ν(CN, pyridine) + $\delta(CH_3)$ | 1391 | 429 | 1416(m) |
| δ(N=C, hydraz1) + ν(C–C, azom) | 1310 | 332 | 1330(m) |
| ν(N–N) | 1220 | 166 | 1218(w) |
| | 1181 | 200 | 1162(m) |

*Intensities are denoted as follows: vs-very strong, s-strong, m-medium, w-weak.

**Table S4**. Experimental and calculated IR spectral data of complex **4**

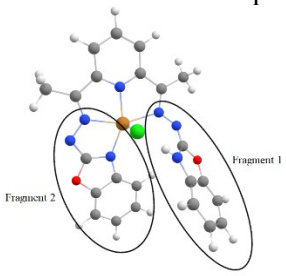



Optimized cation structure of complex **4**

| Assignment | Calculated | | Experimental |
|---|---|---|---|
| | Frequency, $cm^{-1}$ | Intensity, kM $mol^{-1}$ | Frequency, $cm^{-1}$ (intensity*) |
| | 3096 | 18 | |
| ν(CH, benzox) | 3083 | 21 | 3062(w) |
| | 3081 | 19 | |
| ν(CH, pyridine) | 3076 | 18 | |
| ν(NH) | 2936 | 928 | 3242(w) |
| ν(N=C, hydraz1) | 1638 | 1319 | 1667(m) |
| ν(C=C, pyridine) + ν(C=N, azom2) | 1565 | 158 | 1616(m)<br>1589(m) |
| ν(N=C, hydraz2) + ν(C=N, azom1) | 1515 | 529 | 1514(s) |
| | 1479 | 363 | |
| ν(CN, pyridine) + $\delta(CH_3)$ | 1391 | 479 | 1407(w)<br>1375(w) |
| ν(C=C, benzox) | 1343 | 159 | 1345(w) |
| δ(N=C, hydraz2) | 1335 | 192 | 1303(w) |
| ν(C–C, azom) | 1315 | 325 | |
| ν(N–N) | 1219 | 219 | 1244(w) |
| | 1173 | 199 | 1198(w) |

*Intensities are denoted as follows: vs-very strong, s-strong, m-medium, w-weak.

**Table S5**. Experimental and calculated IR spectral data of complex **5**




Optimized cation structure of complex **5**

| Assignment | Calculated | | Experimental |
|---|---|---|---|
| | Frequency, $cm^{-1}$ | Intensity, kM $mol^{-1}$ | Frequency, $cm^{-1}$ (intensity*) |
| | 3096 | 17 | |
| ν(CH, benzox) | 3083 | 21 | 3094(w) |
| | 3081 | 19 | |
| ν(CH, pyridine) | 3075 | 18 | 3044(w) |
| ν($CH_3$) | 2925 | 27 | 2954(w) |
| ν(NH) | 2865 | 957 | 3248(w) |
| ν(N=C, hydraz1) | 1636 | 1335 | 1640(s)<br>1618(s) |
| ν(C=C, pyridine) + ν(C=N, azom2) | 1566 | 174 | 1590(m) |
| ν(C=C, pyridine) + ν(N=C, hydraz2) + ν(C=N, azom1) | 1517<br>1479 | 543<br>384 | 1511(s)<br>1476(m)<br>1460(m) |
| ν(CN, pyridine) + δ($CH_3$) | 1392 | 508 | 1415(m) |
| δ(N=C, hydraz2) + ν(C=C, benzox2) | 1343<br>1335 | 176<br>180 | 1352(m) |
| ν(C=C, pyridine) + ν(C–C, azom) | 1315 | 287 | 1329(m) |
| ν(N–N) | 1220<br>1175 | 221<br>206 | 1207(w)<br>1160(m) |

*Intensities are denoted as follows: vs-very strong, s-strong, m-medium, w-weak.

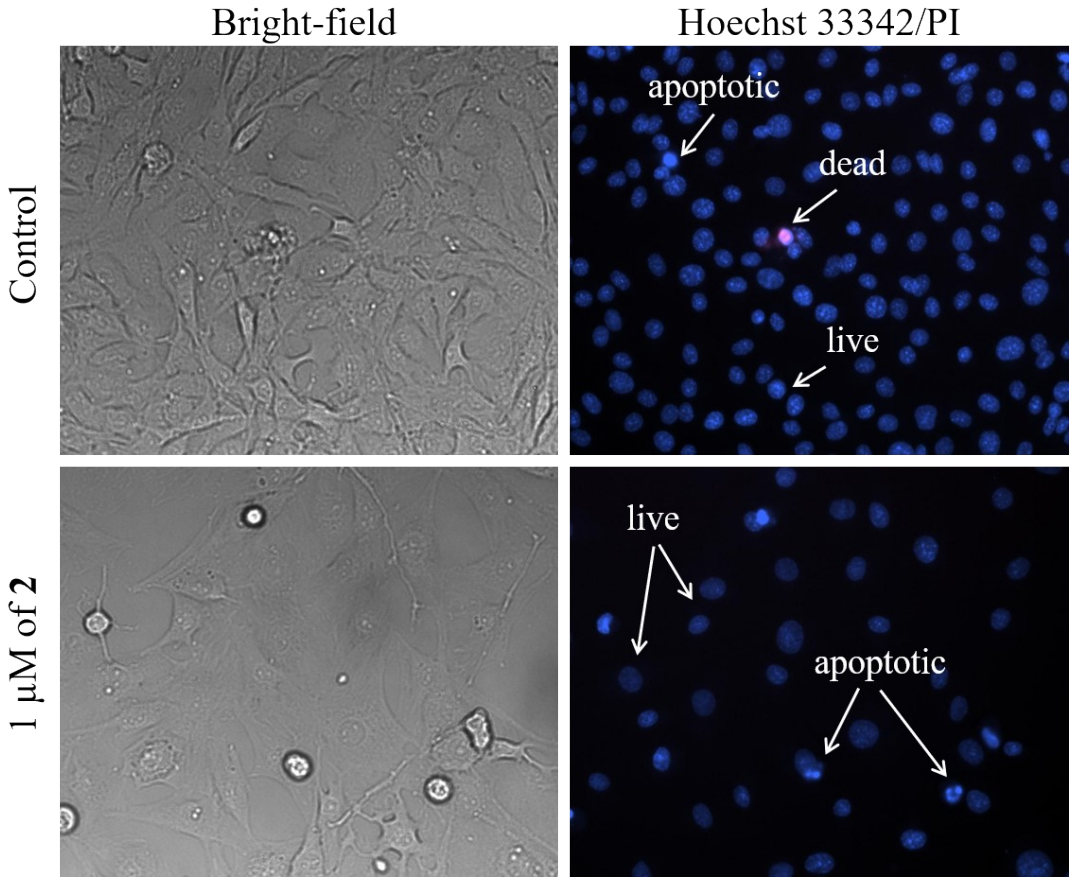



**Fig. S1.** Morphological changes of MRC-5 cells after 48 hours incubation with **2**, according to analysis of dual staining with Hoechst 33342/ propidium iodide (PI) and bright-field microscopy. Cells were treated with: above – no treatment (control); below – **2**, 1 μM. The cells were classified as live cells (normal nuclei: blue noncondensed chromatin uniformly dispersed over the entire nucleus), apoptotic cells (round cells, bright blue chromatin that is highly condensed or fragmented) and dead cells (red, enlarged nuclei with smooth normal structure or bright red, slightly condensed nuclei).

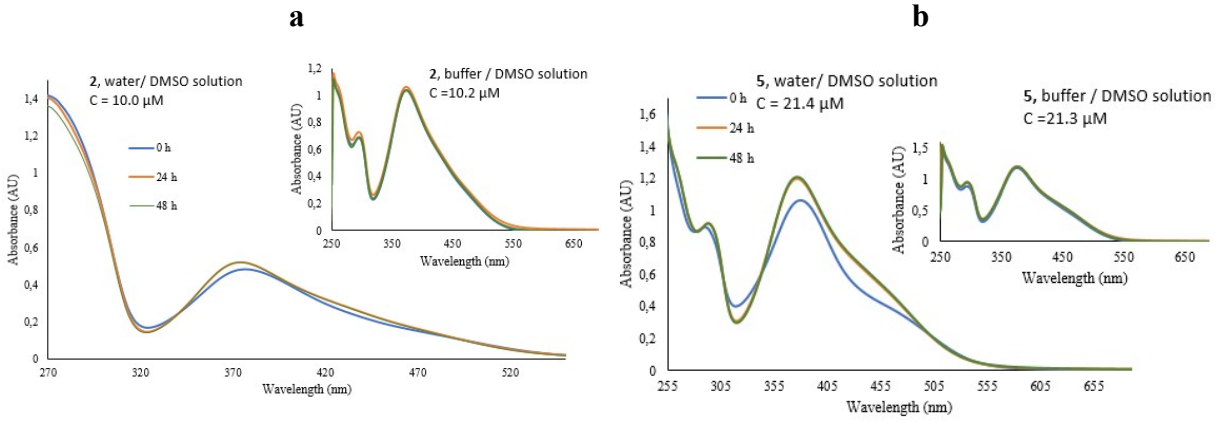
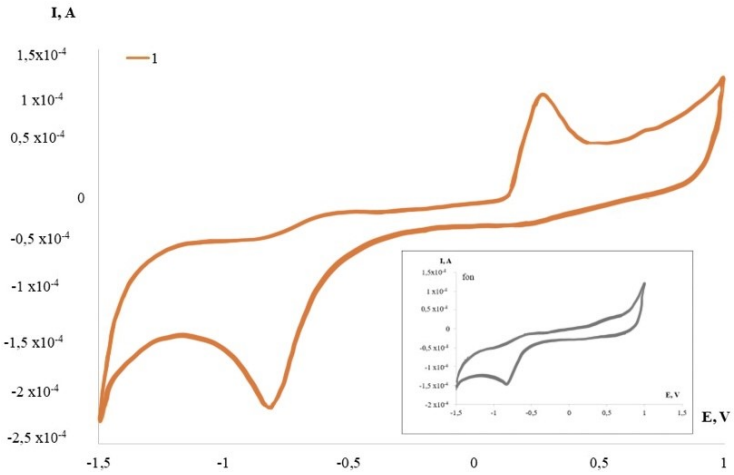


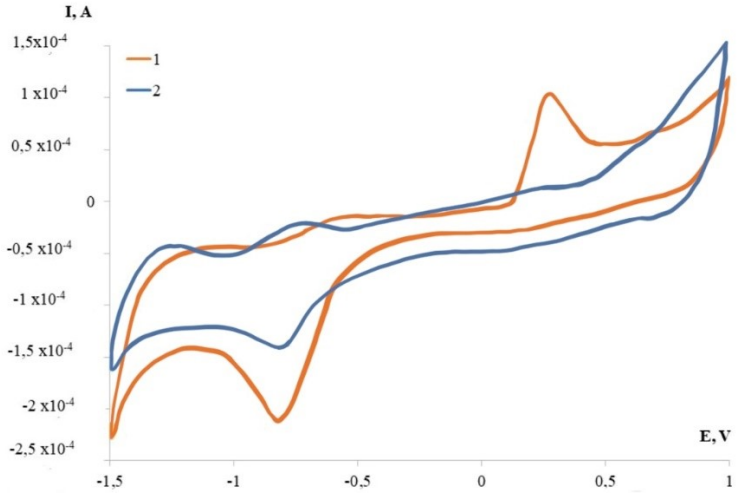

**Fig. S2.** Time-dependent UV–vis absorption spectra of the complex **2** (a) and **5** (b) in water–DMSO solution (1:40 by volume) and in phosphate buffer saline (in the insert) at t = 0, 24, 48 h.

**A**


I, A
1,5x10-4
1 x10-4
0,5 x10-4
0
-0,5 x10-4
-1 x10-4
-1,5 x10-4
-2 x10-4
-2,5 x10-4
1
E, V
-1,5
-1
-0,5
0
0,5
1

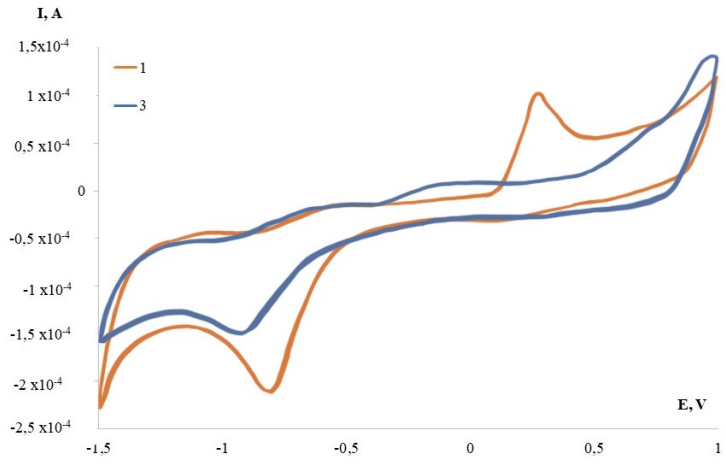
**1**

**B**


I, A
1,5x10-4
1 x10-4
0,5 x10-4
0
-0,5 x10-4
-1 x10-4
-1,5 x10-4
-2 x10-4
-2,5 x10-4
1
2
E, V
-1,5
-1
-0,5
0
0,5
1

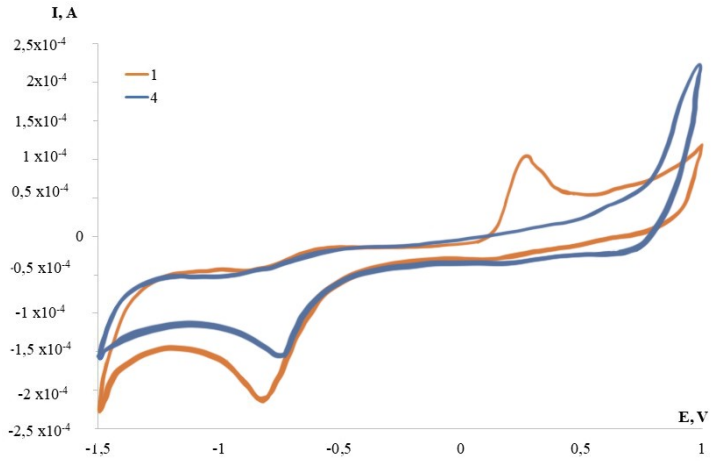
**2**

**C**


I, A
1,5x10-4
1 x10-4
0,5 x10-4
0
-0,5 x10-4
-1 x10-4
-1,5 x10-4
-2 x10-4
-2,5 x10-4
1
3
E, V
-1,5
-1
-0,5
0
0,5
1

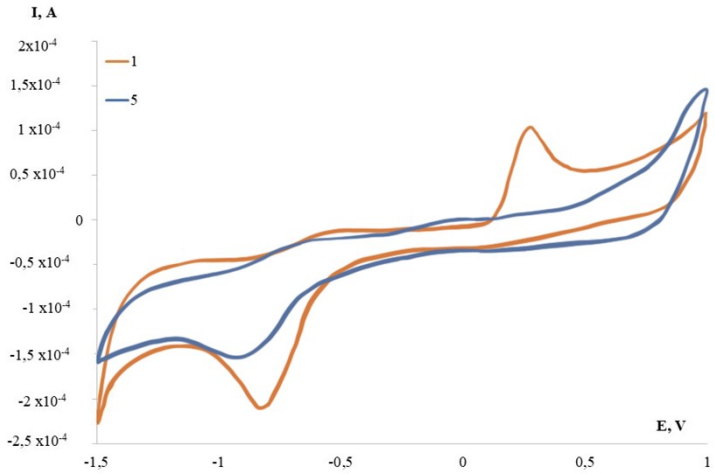
**3**

**D**



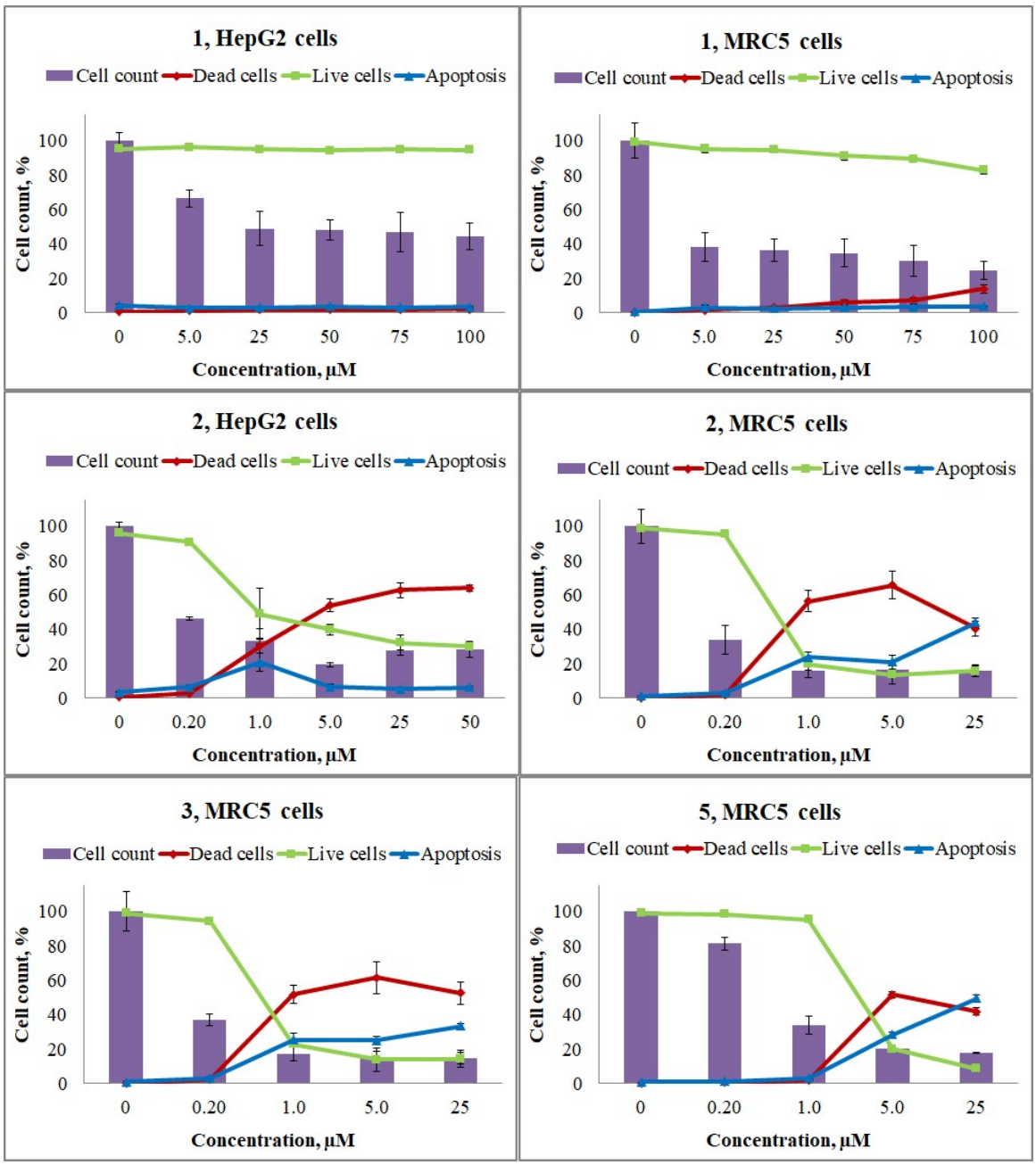

**4**

**E**




**5**

**Fig. S3.** Cyclic voltammograms in DMSO solution containing 0.1M $LiClO_4$ and $H_2L$ (panel A,in the insert – CVA $LiClO_4$ in DMSO), **2** (panel B), **3** (panel C), **4** (panel D) and **5** (panel E).


1, HepG2 cells
Cell count
Dead cells
Live cells
Apoptosis
Cell count, %
Concentration, μM
1, MRC5 cells
2, HepG2 cells
2, MRC5 cells
3, MRC5 cells
5, MRC5 cells

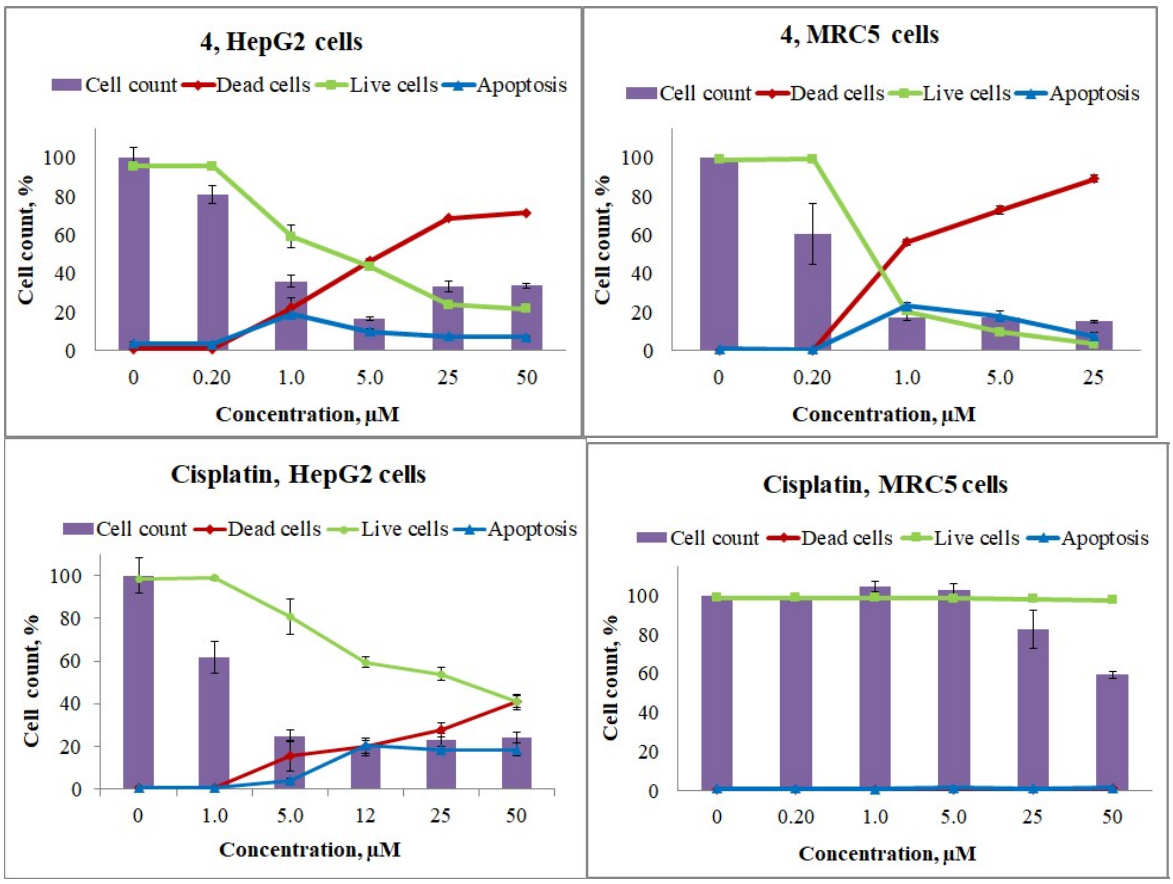



**Fig. S4.** Effect of **1-5** and cisplatin on the viability of HepG2 and MRC-5 cells determined by dual staining with Hoechst 33342/propidium iodide.