Supplementary Information

Smartphone Readable Colorimetric Sensing Platform for Rapid Multiple Proteins Detection

Feiyang Wang,[a] Yuexiang Lu,[b] Jiacheng Yang, [a] Ying Chen,[a] Wenjie Jing,[a] Liuying He,[a] Yueying Liu*[a]

[a] Department of Chemistry, Capital Normal University, Beijing, 100048, P. R. China

[b] Institute of Nuclear and New Energy Technology, Collaborative Innovation Center of Advanced Nuclear Energy Technology, Beijing Key Lab of Radioactive Waste Treatment, Tsinghua University, Beijing, 100084, P. R. China

*Corresponding author.

E-mail address: yueyingliu@cnu.edu.cn

Supplementary Figure and Table

Table S1. Basic properties and manufacturers of proteins.

Protein	**MW(kDa)**	**pI**
Concanavalin A (Con-A)	102	7.1
Cytochrome C(Cyt-C）	12.3	10.7
Egg white albumin(EA)	44.3	4.6
Hemoglobin (Hem)	64.5	6.8
Horseradish peroxidase (HRP)	～40	3.9
Human serum albumin (HSA)	69.4	5.2
Immunglobulin G (IgG)	150	7.5
Lysozyme (Lys)	14.4	11
Bovine serum albumin (BSA)	66.3	4.8
Pepsin (Pep)	35	1～2.5
Transferrin (TRF)	80	9.6
Trypsin (Try)	24	10.5

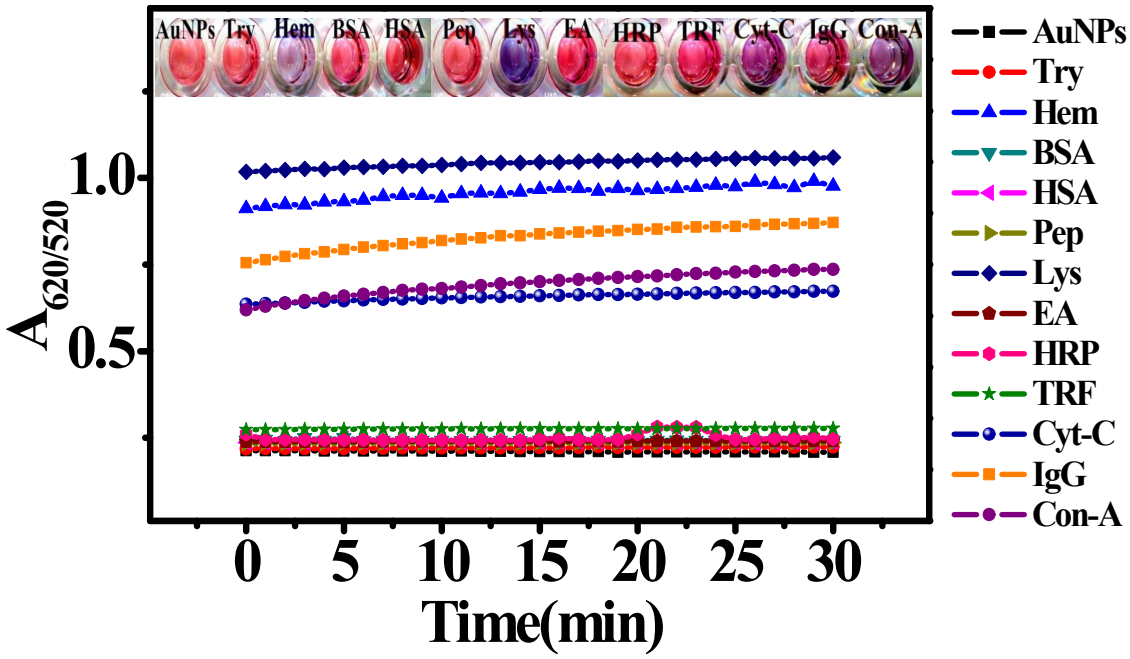


Figure S1. The absorbance spectra of AuNPs with different proteins at 50 nM.

Table S2. Training matrix of colorimetric response patterns of sensor array against various native proteins (50 nM).

	0 mM NaCl	5 mM NaCl	10 mM NaCl	15 mM NaCl	20 mM NaCl
Try	1.099	1.077	1.059	1.068	1.123
Try	1.079	1.066	1.018	0.959	1.045
Try	1.079	1.067	1.029	0.969	1.048
Try	1.107	1.097	1.063	1.070	1.123
Try	1.121	1.109	1.080	1.089	1.129
Try	1.167	1.114	1.111	1.099	1.138
Hem	4.521	3.960	3.218	1.457	1.164
Hem	4.526	3.972	3.229	1.464	1.165
Hem	4.649	4.006	3.278	1.479	1.179
Hem	4.501	3.908	3.162	1.440	1.151
Hem	4.511	3.913	3.166	1.448	1.159
Hem	4.551	3.990	3.239	1.474	1.172
BSA	1.328	1.111	0.928	0.476	0.399
BSA	1.335	1.111	0.929	0.486	0.401
BSA	1.365	1.126	0.950	0.509	0.427
BSA	1.351	1.116	0.944	0.498	0.416
BSA	1.356	1.119	0.945	0.505	0.418
BSA	1.394	1.137	0.959	0.517	0.428
HSA	1.187	1.081	0.923	0.459	0.385
HSA	1.215	1.110	0.936	0.464	0.387
HSA	1.301	1.148	0.959	0.469	0.394
HSA	1.160	1.038	0.880	0.450	0.384
HSA	1.177	1.073	0.908	0.456	0.385
HSA	1.299	1.136	0.949	0.469	0.392
Pep	1.023	0.858	0.712	0.367	0.326
Pep	1.027	0.858	0.715	0.368	0.329
Pep	1.032	0.861	0.721	0.374	0.334
Pep	1.075	0.870	0.736	0.380	0.337
Pep	1.061	0.867	0.735	0.379	0.337
Pep	0.969	0.855	0.709	0.364	0.315
Lys	5.065	4.732	3.861	1.739	1.358
Lys	5.072	4.748	3.872	1.742	1.359
Lys	5.085	4.749	3.872	1.749	1.361
Lys	5.021	4.694	3.825	1.730	1.340
Lys	5.041	4.715	3.844	1.733	1.346
Lys	5.055	4.724	3.853	1.734	1.349
EA	1.156	1.098	0.849	0.414	0.421
EA	1.161	1.101	0.863	0.421	0.425
EA	1.169	1.104	0.868	0.423	0.428

EA	1.135	1.083	0.841	0.407	0.391
EA	1.156	1.094	0.848	0.414	0.421
EA	1.163	1.102	0.864	0.422	0.428
HRP	1.076	1.043	0.870	0.395	0.301
HRP	1.081	1.052	0.890	0.397	0.305
HRP	1.061	1.021	0.853	0.386	0.299
HRP	1.067	1.035	0.855	0.389	0.300
HRP	1.089	1.052	0.903	0.397	0.306
HRP	1.095	1.058	0.914	0.398	0.308
TRF	1.504	1.622	1.223	0.623	0.547
TRF	1.527	1.625	1.230	0.627	0.548
TRF	1.612	1.712	1.334	0.634	0.572
TRF	1.621	1.723	1.358	0.676	0.582
TRF	1.627	1.731	1.426	0.677	0.585
TRF	1.649	1.746	1.462	0.720	0.589
Cyt-C	3.690	3.616	3.279	1.732	1.332
Cyt-C	3.696	3.620	3.332	1.732	1.332
Cyt-C	3.586	3.585	3.152	1.729	1.325
Cyt-C	3.586	3.589	3.215	1.730	1.328
Cyt-C	3.630	3.594	3.270	1.731	1.330
Cyt-C	3.706	3.683	3.383	1.735	1.336
IgG	1.351	1.233	1.350	1.200	1.145
IgG	1.417	1.356	1.367	1.234	1.146
IgG	1.226	1.177	1.183	1.151	1.113
IgG	1.226	1.179	1.184	1.155	1.115
IgG	1.320	1.204	1.304	1.188	1.118
IgG	1.461	1.472	1.463	1.248	1.157
Con-A	4.490	4.295	3.697	1.670	1.312
Con-A	4.507	4.534	3.699	1.680	1.317
Con-A	4.564	4.637	3.710	1.683	1.319
Con-A	4.393	4.224	3.685	1.658	1.297
Con-A	4.425	4.226	3.687	1.659	1.298
Con-A	4.466	4.240	3.695	1.666	1.307

Table S3. Identification of unknown protein samples (50 nM) using the colorimetric sensor array in aqueous solution.

Samples	0 mM NaCl	5 mM NaCl	10 mM NaCl	15 mM NaCl	20 mM NaCl	Identification	Verification
1	4.550	3.975	3.232	1.472	1.169	Hem	Hem
2	1.038	0.865	0.733	0.378	0.336	Pep	Pep
3	5.024	4.714	3.839	1.732	1.343	Lys	Lys
4	1.074	1.039	0.856	0.394	0.300	HRP	HRP
5	1.080	1.047	0.872	0.395	0.303	HRP	HRP
6	1.116	1.102	1.067	1.071	1.127	Try	Try
7	4.648	3.995	3.256	1.479	1.175	Hem	Hem
8	1.342	1.114	0.931	0.487	0.408	BSA	BSA
9	1.356	1.120	0.947	0.505	0.426	BSA	BSA
10	5.066	4.736	3.866	1.741	1.358	Lys	Lys
11	1.139	1.088	0.843	0.408	0.398	EA	EA
12	1.152	1.090	0.847	0.412	0.406	EA	EA
13	1.616	1.717	1.346	0.671	0.578	TRF	TRF
14	1.647	1.737	1.448	0.685	0.589	TRF	TRF
15	3.589	3.591	3.252	1.731	1.329	Cyt-C	Cyt-C
16	3.652	3.613	3.275	1.732	1.330	Cyt-C	Cyt-C
17	1.442	1.452	1.422	1.246	1.151	IgG	IgG
18	4.444	4.233	3.689	1.665	1.306	Con-A	Con-A
19	1.264	1.129	0.948	0.468	0.390	HSA	HSA
20	0.971	0.857	0.712	0.366	0.320	Pep	Pep
21	1.090	1.075	1.053	1.067	1.122	Try	Try
22	1.389	1.132	0.952	0.514	0.427	BSA	BSA
23	1.175	1.054	0.903	0.455	0.384	HSA	HSA
24	3.697	3.673	3.377	1.735	1.333	Cyt-C	Cyt-C
25	1.249	1.191	1.273	1.182	1.117	IgG	IgG
26	1.330	1.209	1.328	1.198	1.142	IgG	IgG
27	1.093	1.057	0.911	0.398	0.306	HRP	HRP
28	1.531	1.635	1.328	0.630	0.556	TRF	TRF
29	4.520	4.550	3.707	1.681	1.318	Con-A	Con-A
30	1.205	1.092	0.936	0.459	0.386	HSA	HSA
31	1.151	1.113	1.089	1.099	1.133	Try	Try
32	4.512	3.959	3.204	1.454	1.160	Hem	Hem
33	1.160	1.099	0.862	0.415	0.421	EA	EA
34	1.028	0.861	0.717	0.370	0.330	Pep	Pep
35	4.480	4.288	3.696	1.667	1.308	Con-A	Con-A
36	5.055	4.730	3.860	1.739	1.354	Lys	Lys

Table S4. Training matrix of response patterns against proteins at 200 nM spiked in 50% human urine.

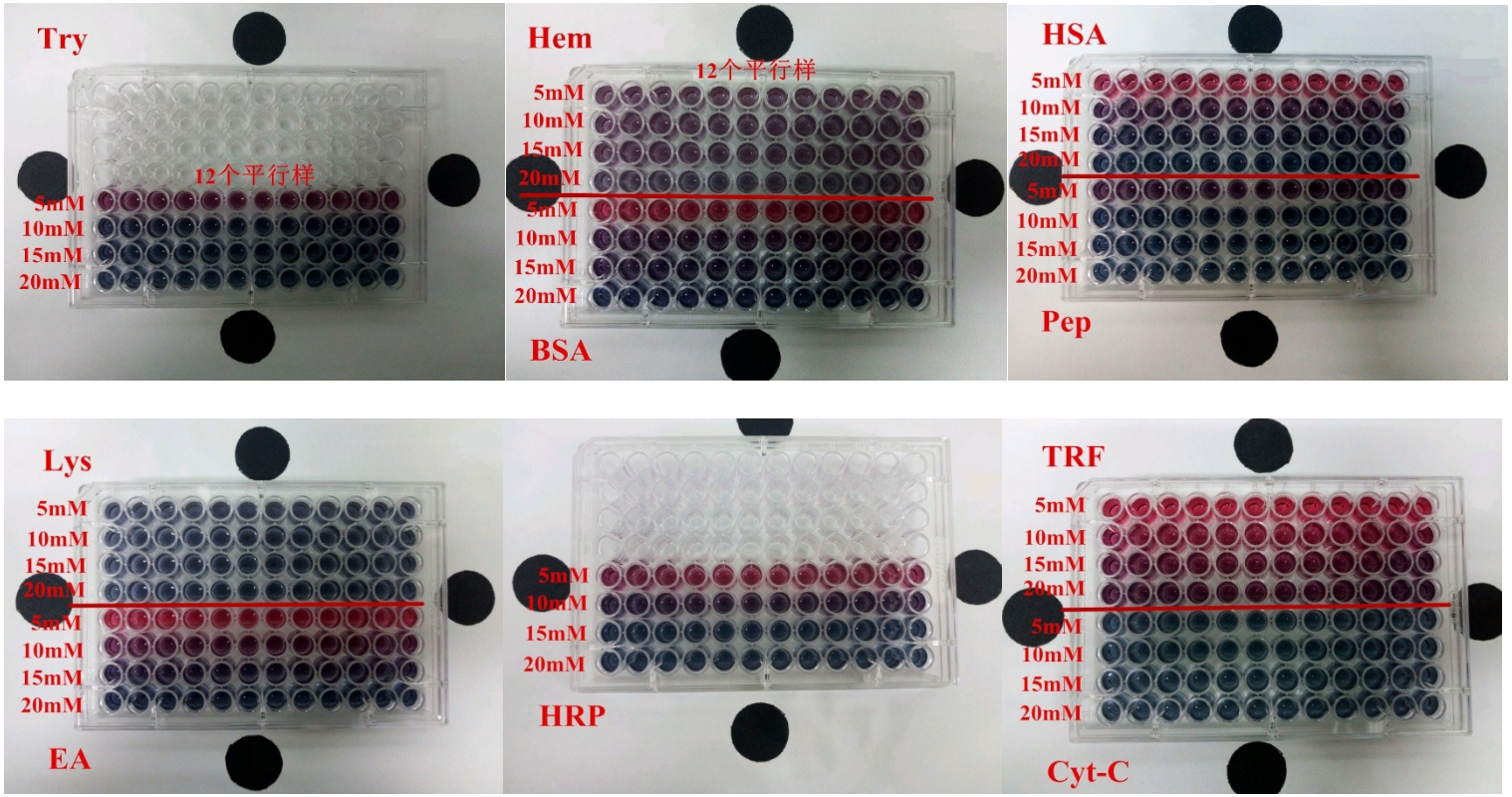
	5 mM NaCl	10 mM NaCl	15 mM NaCl	20 mM NaCl
Try	1.736	1.289	1.042	1.018
Try	1.744	1.290	1.042	1.018
Try	1.777	1.326	1.052	1.021
Try	1.748	1.304	1.044	1.020
Try	1.749	1.312	1.047	1.021
Try	1.781	1.329	1.053	1.024
Hem	3.234	1.265	0.887	0.885
Hem	3.239	1.280	0.893	0.886
Hem	3.272	1.287	0.903	0.894
Hem	3.277	1.306	0.911	0.899
Hem	3.222	1.251	0.879	0.880
Hem	3.226	1.251	0.883	0.881
BSA	0.992	0.934	0.846	0.732
BSA	0.994	0.946	0.849	0.737
BSA	1.004	0.955	0.867	0.739
BSA	0.976	0.927	0.844	0.721
BSA	0.987	0.929	0.845	0.722
BSA	0.998	0.954	0.865	0.739
HSA	1.011	0.946	0.937	0.837
HSA	1.016	0.955	0.938	0.842
HSA	1.022	0.957	0.939	0.845
HSA	1.027	0.958	0.942	0.846
HSA	0.997	0.946	0.930	0.822
HSA	1.004	0.946	0.933	0.824
Pep	2.290	1.518	1.134	1.046
Pep	2.321	1.521	1.137	1.048
Pep	2.336	1.523	1.139	1.048
Pep	2.288	1.507	1.116	1.039
Pep	2.288	1.511	1.123	1.041
Pep	2.323	1.522	1.137	1.048
Lys	3.860	1.542	1.072	0.972
Lys	3.869	1.545	1.073	0.975
Lys	3.889	1.550	1.083	0.988
Lys	3.911	1.561	1.087	0.993
Lys	3.944	1.562	1.089	0.999
Lys	3.929	1.562	1.089	0.996
EA	0.847	0.884	0.784	0.725
EA	0.963	0.886	0.785	0.746
EA	0.980	0.890	0.790	0.751
EA	0.843	0.884	0.784	0.724

EA	0.989	0.890	0.791	0.753
EA	1.002	0.891	0.791	0.755
HRP	1.498	1.168	1.119	1.004
HRP	1.513	1.176	1.127	1.007
HRP	1.483	1.152	1.118	0.999
HRP	1.488	1.156	1.119	1.001
HRP	1.529	1.181	1.130	1.010
HRP	1.505	1.169	1.123	1.006
TRF	0.746	0.467	0.446	0.465
TRF	0.747	0.476	0.450	0.465
TRF	0.750	0.478	0.453	0.474
TRF	0.751	0.479	0.455	0.476
TRF	0.757	0.502	0.460	0.485
TRF	0.759	0.507	0.471	0.490
Cyt-C	4.219	1.684	1.170	1.038
Cyt-C	4.221	1.688	1.171	1.044
Cyt-C	4.212	1.681	1.168	1.033
Cyt-C	4.218	1.683	1.169	1.038
Cyt-C	4.236	1.688	1.171	1.048
Cyt-C	4.210	1.677	1.168	1.031
IgG	2.360	0.975	0.718	0.645
IgG	2.381	0.990	0.724	0.655
IgG	2.347	0.966	0.711	0.640
IgG	2.349	0.971	0.711	0.642
IgG	2.359	0.974	0.717	0.642
IgG	2.383	0.990	0.725	0.657
Con-A	2.709	1.154	0.860	0.841
Con-A	2.711	1.161	0.871	0.845
Con-A	2.677	1.120	0.852	0.835
Con-A	2.677	1.123	0.852	0.835
Con-A	2.693	1.132	0.856	0.839
Con-A	2.694	1.136	0.858	0.839

Table S5. Identification of unknown protein samples (200 nM) in the presence of human urine using the colorimetric sensor array.

Samples	5 mM NaCl	10 mM NaCl	15 mM NaCl	20 mM NaCl	Identification	Verification
1	0.995	0.949	0.854	0.739	BSA	BSA
2	1.011	0.946	0.937	0.835	HSA	HSA
3	4.220	1.685	1.170	1.040	Cyt-C	Cyt-C
4	2.356	0.974	0.713	0.642	IgG	IgG
5	0.919	0.885	0.785	0.739	EA	EA
6	0.971	0.886	0.785	0.747	EA	EA
7	1.778	1.329	1.052	1.022	Try	Try
8	3.232	1.261	0.885	0.881	Hem	Hem
9	2.288	1.512	1.131	1.043	Pep	Pep
10	2.313	1.518	1.134	1.046	Pep	Pep
11	1.510	1.175	1.125	1.007	HRP	HRP
12	0.748	0.476	0.452	0.470	TRF	TRF
13	2.681	1.129	0.855	0.835	Con-A	Con-A
14	2.696	1.142	0.858	0.839	Con-A	Con-A
15	1.489	1.165	1.119	1.002	HRP	HRP
16	0.756	0.482	0.457	0.485	TRF	TRF
17	4.212	1.683	1.169	1.037	Cyt-C	Cyt-C
18	3.243	1.285	0.902	0.887	Hem	Hem
19	0.990	0.930	0.845	0.731	BSA	BSA
20	0.993	0.936	0.847	0.736	BSA	BSA
21	3.874	1.545	1.079	0.978	Lys	Lys
22	0.976	0.887	0.785	0.749	EA	EA
23	1.498	1.168	1.121	1.006	HRP	HRP
24	2.699	1.145	0.860	0.840	Con-A	Con-A
25	1.747	1.300	1.044	1.020	Try	Try
26	1.765	1.312	1.051	1.021	Try	Try
27	2.319	1.520	1.135	1.046	Pep	Pep
28	3.900	1.556	1.084	0.989	Lys	Lys
29	3.905	1.560	1.087	0.990	Lys	Lys
30	3.237	1.271	0.887	0.885	Hem	Hem
31	2.367	0.981	0.718	0.648	IgG	IgG
32	2.369	0.984	0.724	0.650	IgG	IgG
33	4.219	1.684	1.170	1.039	Cyt-C	Cyt-C
34	1.012	0.955	0.938	0.841	HSA	HSA
35	1.022	0.957	0.939	0.843	HSA	HSA
36	0.752	0.480	0.457	0.477	TRF	TRF

Figure S2. Images for proteins at 200 nM spiked in 50% human urine using receptors with NaCl accounting for 5 mM, 10 mM, 15 mM and 20 mM taken under different light conditions.



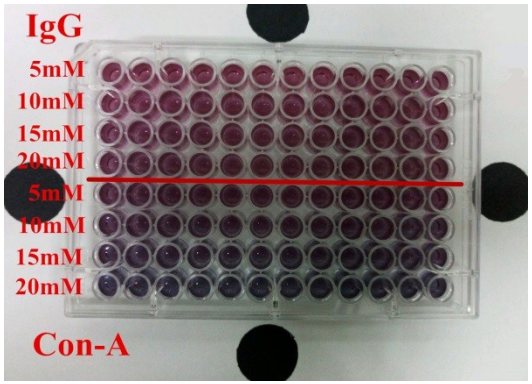

IgG
5mM
10mM
15mM
20mM
5mM
10mM
15mM
20mM
Con-A

Table S6. Color difference database for proteins at 200 nM spiked in 50% human urine using receptors with NaCl accounting for 5 mM, 10 mM, 15 mM and 20 mM taken under different light conditions.

	5 mM			10 mM			15 mM			20 mM		
	R	**G**	**B**	**R**	**G**	**B**	**R**	**G**	**B**	**R**	**G**	**B**
Blank	91	29	41	42	34	49	25	32	51	42	58	83
Blank	93	22	37	34	20	35	28	36	49	22	40	54
Blank	91	17	34	27	16	30	11	18	34	13	30	43
Blank	86	18	31	23	25	26	8	14	30	16	28	40
Blank	81	13	26	18	10	21	8	10	23	3	17	28
Blank	77	5	18	14	4	13	3	7	16	18	32	43
Try	51	21	33	10	13	28	8	14	28	15	28	37
Try	50	16	30	13	11	22	5	12	22	6	18	30
Try	46	14	29	8	10	22	7	14	22	6	19	28
Try	39	11	23	2	4	16	10	14	23	6	15	24
Try	42	11	26	5	8	15	3	6	15	3	12	19
Try	40	9	24	6	9	16	0	7	13	5	12	18
Hem	87	101	103	63	43	54	63	46	56	56	49	57
Hem	80	88	107	64	37	56	54	40	53	44	41	50
Hem	85	71	86	52	42	50	47	37	46	34	33	39
Hem	79	62	78	55	41	54	64	41	57	38	37	42
Hem	86	68	84	72	56	69	42	32	41	35	30	46
Hem	71	60	74	49	39	48	38	26	36	34	35	40
BSA	84	12	24	26	9	25	28	21	39	28	34	58
BSA	83	15	30	25	8	24	20	13	31	26	33	52
BSA	69	9	21	15	7	20	13	13	25	19	26	44

BSA	66	6	16	12	4	15	11	13	125	16	25	42
BSA	58	7	16	13	3	14	9	7	21	6	15	30
BSA	58	7	16	14	4	13	6	4	17	6	14	27
HSA	134	48	73	56	37	56	24	27	46	8	22	35
HSA	146	46	80	38	19	38	22	24	39	7	19	31
HSA	126	36	61	40	22	38	15	17	32	10	18	31
HSA	128	38	63	39	16	36	20	21	41	4	20	31
HSA	126	44	66	38	19	38	13	11	32	13	26	43
HSA	124	40	63	34	17	33	14	16	31	1	10	25
Pep	23	7	20	11	18	37	19	28	45	27	38	56
Pep	27	5	18	6	12	26	9	16	35	33	42	57
Pep	23	7	18	1	5	16	3	15	27	18	31	47
Pep	29	13	26	1	5	14	0	7	15	7	17	27
Pep	12	19	17	0	3	12	0	4	13	13	24	30
Pep	14	5	8	0	2	7	2	6	15	6	15	22
Lys	73	79	101	48	55	74	41	46	65	39	46	65
Lys	79	84	103	38	45	64	34	40	54	31	38	57
Lys	69	77	96	28	36	49	31	36	55	25	34	49
Lys	59	70	88	25	34	41	18	30	42	20	24	38
Lys	55	68	85	27	37	47	19	25	37	13	23	33
Lys	59	71	87	21	29	40	28	32	43	16	25	34
EA	86	14	27	68	25	45	25	17	40	31	36	56
EA	86	19	36	42	9	28	18	11	27	13	25	39
EA	82	11	28	36	3	20	15	8	24	10	13	30
EA	83	7	20	32	4	16	11	5	19	9	18	33
EA	82	10	21	24	1	9	5	3	17	8	11	26

EA	74	21	3	25	2	12	15	9	19	11	14	31
HRP	81	54	74	31	22	39	21	28	44	24	36	52
HRP	82	23	41	29	21	34	14	26	40	22	38	51
HRP	92	28	45	24	16	29	19	29	41	20	33	42
HRP	89	22	39	28	17	33	14	28	41	29	45	58
HRP	90	23	40	25	14	28	19	29	41	16	28	42
HRP	98	31	48	34	23	37	13	25	37	23	33	45
TRF	196	50	87	96	23	43	74	20	43	33	6	21
TRF	173	57	78	99	14	37	67	13	29	29	6	16
TRF	159	41	67	95	12	32	56	9	29	39	9	21
TRF	174	49	79	108	23	46	63	10	30	41	5	17
TRF	169	46	75	100	17	35	66	13	31	41	7	21
TRF	167	45	70	103	20	40	66	11	30	39	5	22
Cyt-C	17	27	36	16	33	43	33	45	61	60	79	96
Cyt-C	8	22	31	6	25	32	18	34	47	37	55	69
Cyt-C	8	18	27	8	22	31	14	33	40	32	48	61
Cyt-C	5	18	24	2	21	28	10	29	35	40	60	67
Cyt-C	14	25	31	10	25	32	15	33	45	23	43	52
Cyt-C	16	34	35	5	22	29	24	37	45	23	42	48
IgG	139	75	101	129	75	101	105	58	78	68	35	46
IgG	142	78	105	101	39	60	80	30	55	62	30	41
IgG	116	54	79	85	37	53	70	27	44	56	26	36
IgG	116	62	85	77	30	56	65	29	41	56	24	35
IgG	117	63	87	78	32	45	64	28	38	52	23	28
IgG	108	52	77	80	36	49	62	29	38	44	17	26
Con-A	56	25	40	48	24	38	43	31	45	44	36	47

Con-A	47	21	32	36	19	29	39	27	39	43	43	55
Con-A	40	14	23	37	17	29	34	24	35	35	34	39
Con-A	36	13	21	34	14	26	33	21	33	32	32	40
Con-A	39	16	24	44	27	37	34	24	32	30	29	34
Con-A	46	20	33	34	17	25	30	20	31	24	27	34

Table S7. Color difference database for proteins at 200nM spiked in 50% human urine using receptors with NaCl accounting for 5 mM, 10 mM, 15 mM and 20 mM taken under different light conditions after "four spots" calibration.

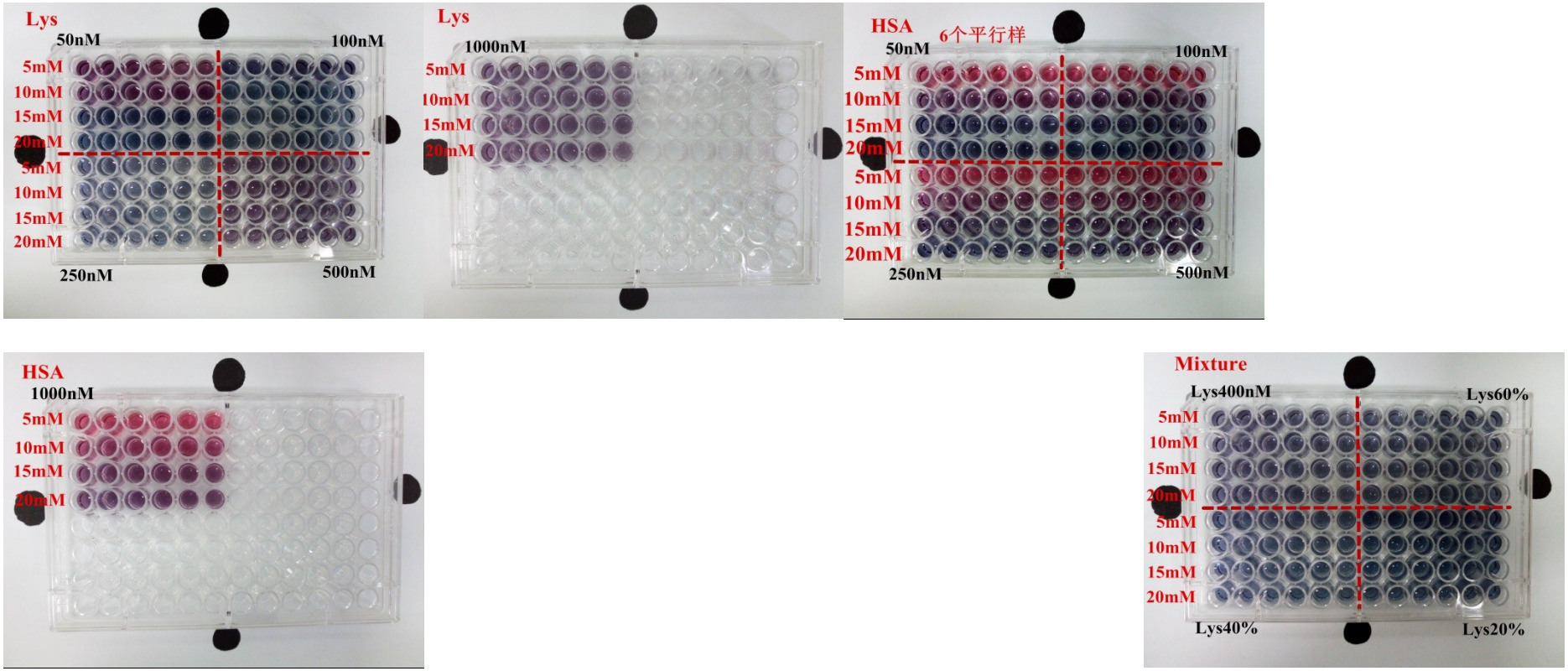
	5 mM			10 mM			15 mM			20 mM		
	R	**G**	**B**	**R**	**G**	**B**	**R**	**G**	**B**	**R**	**G**	**B**
Blank	91	29	41	42	34	49	25	32	51	42	58	83
Blank	93	22	37	34	20	35	28	36	49	22	40	54
Blank	91	17	34	27	16	30	11	18	34	13	30	43
Blank	86	18	31	23	25	26	8	14	30	16	28	40
Blank	81	13	26	18	10	21	8	10	23	3	17	28
Blank	77	5	18	14	4	13	3	7	16	18	32	43
Try	45	19	30	4	11	25	2	12	25	9	26	34
Try	44	14	27	7	9	19	-1	10	19	0	16	27
Try	40	12	26	2	8	19	1	12	19	0	17	25
Try	33	9	20	-4	2	13	4	12	20	0	13	21
Try	36	9	23	-1	6	12	-3	4	12	-3	10	16
Try	34	7	21	0	7	13	-6	5	10	-1	10	15
Hem	86	100	98	62	42	49	62	45	51	55	48	52
Hem	79	87	102	63	36	51	53	39	48	43	40	45
Hem	84	70	81	51	41	45	46	36	41	33	32	34
Hem	78	61	73	54	40	49	63	40	52	37	36	37
Hem	85	67	79	71	55	64	41	31	36	34	29	41
Hem	70	59	69	48	38	43	37	25	31	33	34	35
BSA	83	11	19	25	8	20	27	20	34	27	33	53

BSA	82	14	25	24	7	19	19	12	26	25	32	47
BSA	68	8	16	14	6	15	12	12	20	18	25	39
BSA	65	5	11	11	3	10	10	12	120	15	24	37
BSA	57	6	11	12	2	9	8	6	16	5	14	25
BSA	57	6	11	13	3	8	5	3	12	5	13	22
HSA	127	43	68	49	32	51	17	22	41	1	17	30
HSA	139	41	75	31	14	33	15	19	34	0	14	26
HSA	119	31	56	33	17	33	8	12	27	3	13	26
HSA	121	33	58	32	11	31	13	16	36	-3	15	26
HSA	119	39	61	31	14	33	6	6	27	6	21	38
HSA	117	35	58	27	12	28	7	11	26	-6	5	20
Pep	23	7	18	11	18	35	19	28	43	27	38	54
Pep	27	5	16	6	12	24	9	16	33	33	42	55
Pep	23	7	16	1	5	14	3	15	25	18	31	45
Pep	29	13	24	1	5	12	0	7	13	7	17	25
Pep	12	19	15	0	3	10	0	4	11	13	24	28
Pep	14	5	6	0	2	5	2	6	13	6	15	20
Lys	73	79	99	48	55	72	41	46	63	39	46	63
Lys	79	84	101	38	45	62	34	40	52	31	38	55
Lys	69	77	94	28	36	47	31	36	53	25	34	47
Lys	59	70	86	25	34	39	18	30	40	20	24	36
Lys	55	68	83	27	37	45	19	25	35	13	23	31
Lys	59	71	85	21	29	38	28	32	41	16	25	32
EA	84	12	24	66	23	42	23	15	37	29	34	53
EA	84	17	33	40	7	25	16	9	24	11	23	36

EA	80	9	25	34	1	17	13	6	21	8	11	27
EA	81	5	17	30	2	13	9	3	16	7	16	30
EA	80	8	18	22	-1	6	3	1	14	6	9	23
EA	72	19	0	23	0	9	13	7	16	9	12	28
HRP	79	52	71	29	20	36	19	26	41	22	34	49
HRP	80	21	38	27	19	31	12	24	37	20	36	48
HRP	90	26	42	22	14	26	17	27	38	18	31	39
HRP	87	20	36	26	15	30	12	26	38	27	43	55
HRP	88	21	37	23	12	25	17	27	38	14	26	39
HRP	96	29	45	32	21	34	11	23	34	21	31	42
TRF	199	51	87	99	24	43	77	21	43	36	7	21
TRF	176	58	78	102	15	37	70	14	29	32	7	16
TRF	162	42	67	98	13	32	59	10	29	42	10	21
TRF	177	50	79	111	24	46	66	11	30	44	6	17
TRF	172	47	75	103	18	35	69	14	31	44	8	21
TRF	170	46	70	106	21	40	69	12	30	42	6	22
Cyt-C	19	29	38	18	35	45	35	47	63	62	81	98
Cyt-C	10	24	33	8	27	34	20	36	49	39	57	71
Cyt-C	10	20	29	10	24	33	16	35	42	34	50	63
Cyt-C	7	20	26	4	23	30	12	31	37	42	62	69
Cyt-C	16	27	33	12	27	34	17	35	47	25	45	54
Cyt-C	18	36	37	7	24	31	26	39	47	25	44	50
IgG	141	77	103	131	77	103	107	60	80	70	37	48
IgG	144	80	107	103	41	62	82	32	57	64	32	43
IgG	118	56	81	87	39	55	72	29	46	58	28	38

IgG	118	64	87	79	32	58	67	31	43	58	26	37
IgG	119	65	89	80	34	47	66	30	40	54	25	30
IgG	110	54	79	82	38	51	64	31	40	46	19	28
Con-A	55	25	38	47	24	36	42	31	43	43	36	45
Con-A	46	21	30	35	19	27	38	27	37	42	43	53
Con-A	39	14	21	36	17	27	33	24	33	34	34	37
Con-A	35	13	19	33	14	24	32	21	31	31	32	38
Con-A	38	16	22	43	27	35	33	24	30	29	29	32
Con-A	45	20	31	33	17	23	29	20	29	23	27	32

Figure S3. Images for HSA, Lys (at different concentration) and the mixtures of Lys and HSA at different molar ratios (total protein concentration: 400 nM) spiked in 50% human urine using receptors with NaCl accounting for 5 mM, 10 mM, 15 mM and 20 mM taken under different light conditions.



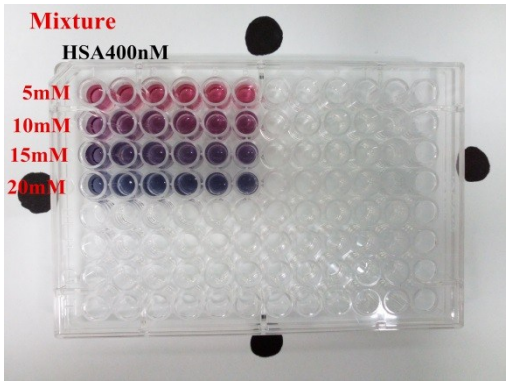

Mixture
HSA400nM
5mM
10mM
15mM
20mM

Table S8. Color difference database for HSA, Lys (at different concentration) and the mixtures of Lys and HSA at different molar ratios (total protein concentration: 400 nM) spiked in 50% human urine using receptors with NaCl accounting for 5 mM, 10 mM, 15 mM and 20 mM taken under different light conditions.

	5 mM			10 mM			15 mM			20 mM	
	R	**G**	**B**	**R**	**G**	**B**	**R**	**G**	**B**	**R**	**G**	**B**
Lys 50 nM	92	47	76	45	15	35	20	20	36	26	33	51
Lys 50 nM	68	29	56	52	24	46	27	29	54	26	33	59
Lys 50 nM	68	28	52	48	16	40	19	26	45	17	34	54
Lys 50 nM	81	39	63	42	10	33	18	16	38	20	27	46
Lys 50 nM	95	51	76	44	11	32	17	15	36	19	26	44
Lys 50 nM	89	45	72	40	6	30	12	13	31	20	27	43
Lys 100 nM	44	45	73	27	39	55	29	33	44	39	46	56
Lys 100 nM	39	40	61	27	35	48	30	37	47	31	39	50
Lys 100 nM	37	39	64	26	39	56	32	39	47	29	38	47
Lys 100 nM	39	34	56	26	42	58	24	30	42	23	29	41
Lys 100 nM	37	33	58	28	39	57	34	42	61	35	44	59
Lys 100 nM	36	33	60	25	27	52	23	27	45	36	45	48
Lys 250 nM	77	78	109	61	59	83	67	82	89	86	93	112
Lys 250 nM	68	73	93	76	77	97	73	80	99	90	92	105
Lys 250 nM	83	89	111	63	69	88	66	72	88	94	100	116
Lys 250 nM	68	70	82	68	72	83	78	86	97	96	109	125
Lys 250 nM	77	77	87	64	70	86	63	69	81	97	107	117

Lys 250 nM	75	75	85	68	72	83	75	88	96	96	100	111
Lys 500 nM	54	40	53	65	51	68	75	54	71	98	77	96
Lys 500 nM	52	38	51	62	45	63	63	46	65	86	72	89
Lys 500 nM	47	36	50	58	42	55	74	64	75	90	77	94
Lys 500 nM	43	32	46	51	39	53	67	65	86	82	76	88
Lys 500 nM	53	41	61	62	45	61	58	46	66	80	69	83
Lys 500 nM	56	38	54	61	46	69	79	70	89	82	68	91
Lys 1000 nM	114	96	122	117	97	124	87	59	82	87	57	81
Lys 1000 nM	108	90	114	103	80	106	90	68	89	91	66	95
Lys 1000 nM	96	74	95	93	75	99	82	58	80	102	79	105
Lys 1000 nM	93	75	97	93	79	102	84	72	90	89	72	91
Lys 1000 nM	92	78	101	86	68	92	77	64	82	87	68	87
Lys 1000 nM	97	84	101	96	81	100	81	64	83	93	79	96
HSA 50 nM	167	77	103	75	42	73	31	31	55	24	29	51
HSA 50 nM	150	54	81	79	47	71	27	27	55	15	21	43
HSA 50 nM	150	47	76	67	41	66	27	32	54	20	27	45
HSA 50 nM	164	55	84	66	19	51	21	23	46	23	21	42
HSA 50 nM	160	41	73	74	28	56	31	32	52	21	22	40
HSA 50 nM	153	50	77	73	35	58	35	37	62	22	21	39
HSA 100 nM	121	33	57	64	35	63	39	36	65	24	25	43
HSA 100 nM	133	41	66	60	30	58	42	41	57	16	22	38
HSA 100 nM	124	39	60	55	31	55	37	39	51	17	27	39
HSA 100 nM	118	35	53	55	23	44	40	42	54	18	17	31
HSA 100 nM	115	33	37	59	34	56	40	40	52	19	17	38
HSA 100 nM	129	51	73	65	38	57	45	43	67	16	14	35
HSA 250 nM	114	27	44	61	4	45	36	24	48	43	48	68

HAS 250 nM	120	25	47	73	30	57	40	28	50	43	46	81
HAS 250 nM	120	28	49	68	30	53	38	33	55	40	46	48
HSA 250 nM	111	22	40	69	25	50	40	39	55	49	50	70
HSA 250 nM	118	26	47	60	27	46	38	30	45	39	37	58
HSA 250 nM	118	27	45	66	33	50	36	32	46	42	49	57
HSA 500 nM	90	9	24	69	25	42	53	41	61	46	45	61
HSA 500 nM	89	18	32	71	33	48	48	37	54	47	45	67
HSA 500 nM	92	15	53	67	33	50	49	42	58	45	43	65
HSA 500 nM	82	11	27	72	38	54	43	31	45	52	44	67
HSA 500 nM	87	15	35	74	32	44	50	43	61	48	35	52
HSA 500 nM	86	3	21	68	31	49	57	44	61	49	39	50
HSA 1000 nM	186	93	120	132	63	91	93	50	80	99	66	95
HSA 1000 nM	172	68	93	119	50	78	87	47	73	91	60	92
HSA 1000 nM	156	58	83	121	46	76	83	43	67	88	59	87
HSA 1000 nM	173	73	101	129	46	76	83	40	67	82	46	74
HSA 1000 nM	176	68	94	123	43	72	78	38	62	83	45	70
HSA 1000 nM	172	61	93	123	44	73	82	42	66	96	52	82
Lys 100 %	77	60	92	54	53	71	43	35	56	48	42	68
Lys 100 %	79	78	96	56	55	73	51	46	68	45	42	63
Lys 100 %	70	69	83	59	53	77	50	47	66	46	44	57
Lys 100 %	73	71	93	55	54	70	43	42	58	41	45	57
Lys 100 %	76	78	99	54	59	79	42	42	54	41	45	56
Lys 100 %	76	73	90	50	52	64	46	49	58	43	43	55
Lys 60 %	74	79	101	51	50	69	45	45	57	37	37	45
Lys 60 %	70	77	96	51	51	63	41	43	55	36	40	49
Lys 60 %	70	79	96	47	47	59	40	44	53	35	36	41

Lys 60 %	73	77	78	49	51	63	40	50	53	36	39	46
Lys 60 %	76	80	89	45	47	59	47	51	60	42	47	50
Lys 60 %	74	74	84	45	45	55	43	44	48	40	43	50
Lys 40 %	39	49	85	49	62	57	72	79	105	65	71	105
Lys 40 %	42	48	64	46	61	80	72	82	107	68	79	101
Lys 40 %	47	53	75	50	56	78	77	85	104	69	76	95
Lys 40 %	40	45	65	46	59	75	69	73	74	67	84	100
Lys 40 %	44	48	59	46	59	76	72	83	87	63	83	104
Lys 40 %	43	47	56	41	49	60	73	81	89	73	80	96
Lys 20 %	10	19	34	27	42	61	21	38	54	47	56	71
Lys 20 %	10	17	33	20	29	44	23	32	47	42	51	66
Lys 20 %	7	10	25	20	28	39	19	32	48	54	62	75
Lys 20 %	14	14	26	26	33	41	16	25	40	45	55	67
Lys 20 %	13	15	28	22	31	47	16	24	37	56	60	69
Lys 20 %	7	8	29	30	40	52	16	25	43	48	57	68
HSA 100 %	146	60	87	91	46	79	70	60	87	47	47	75
HSA 100 %	150	64	84	88	48	74	70	56	82	42	42	70
HSA 100 %	143	58	81	85	42	69	64	46	72	42	47	69
HSA 100 %	147	46	78	79	34	55	73	60	78	46	47	67
HSA 100 %	143	51	76	86	33	59	76	60	86	43	42	60
HSA 100 %	149	59	85	88	45	64	75	56	86	44	42	64

Table S9. Color difference database for HSA, Lys (at different concentration) and the mixtures of Lys and HSA at different molar ratios (total protein concentration: 400 nM) spiked in 50% human urine using receptors with NaCl accounting for 5 mM, 10 mM, 15 mM and 20 mM taken under different light conditions after "four spots" calibration.

	5 mM			**10 mM**			**15 mM**			**20 mM**		
	R	**G**	**B**	**R**	**G**	**B**	**R**	**G**	**B**	**R**	**G**	**B**
Lys 50 nM	92	47	76	45	15	35	20	20	36	26	33	51
Lys 50 nM	68	29	56	52	24	46	27	29	54	26	33	59
Lys 50 nM	68	28	52	48	16	40	19	26	45	17	34	54
Lys 50 nM	81	39	63	42	10	33	18	16	38	20	27	46
Lys 50 nM	95	51	76	44	11	32	17	15	36	19	26	44
Lys 50 nM	89	45	72	40	6	30	12	13	31	20	27	43
Lys 100 nM	44	45	73	27	39	55	29	33	44	39	46	56
Lys 100 nM	39	40	61	27	35	48	30	37	47	31	39	50
Lys 100 nM	37	39	64	26	39	56	32	39	47	29	38	47
Lys 100 nM	39	34	56	26	42	58	24	30	42	23	29	41
Lys 100 nM	37	33	58	28	39	57	34	42	61	35	44	59
Lys 100 nM	36	33	60	25	27	52	23	27	45	36	45	48
Lys 250 nM	54	40	53	65	51	68	75	54	71	98	77	96
Lys 250 nM	52	38	51	62	45	63	63	46	65	86	72	89
Lys 250 nM	47	36	50	58	42	55	74	64	75	90	77	94
Lys 250 nM	43	32	46	51	39	53	67	65	86	82	76	88
Lys 250 nM	53	41	61	62	45	61	58	46	66	80	69	83
Lys 250 nM	56	38	54	61	46	69	79	70	89	82	68	91
Lys 500 nM	77	78	109	61	59	83	67	82	89	86	93	112

Lys 500 nM	68	73	93	76	77	97	73	80	99	90	92	105
Lys 500 nM	83	89	111	63	69	88	66	72	88	94	100	116
Lys 500 nM	68	70	82	68	72	83	78	86	97	96	109	125
Lys 500 nM	77	77	87	64	70	86	63	69	81	97	107	117
Lys 500 nM	75	75	85	68	72	83	75	88	96	96	100	111
Lys 1000 nM	102	96	122	95	97	124	85	59	82	85	57	81
Lys 1000 nM	106	90	114	101	80	106	88	68	89	89	66	95
Lys 1000 nM	94	74	95	91	75	99	80	58	80	100	79	105
Lys 1000 nM	91	75	97	91	79	102	82	72	90	87	72	91
Lys 1000 nM	90	78	101	84	68	92	75	64	82	85	68	87
Lys 1000 nM	95	84	101	94	81	100	79	64	83	91	79	96
HSA 50 nM	168	57	81	76	43	76	32	32	58	25	30	54
HSA 50 nM	151	55	84	80	48	74	28	28	58	16	22	46
HSA 50 nM	151	48	79	68	42	69	28	33	57	21	28	48
HSA 50 nM	165	56	87	67	20	54	22	24	49	24	22	45
HSA 50 nM	161	42	76	75	29	59	32	33	55	22	23	43
HSA 50 nM	154	51	80	74	36	61	36	38	65	23	22	42
HSA 100 nM	122	34	60	65	36	66	40	37	68	25	26	46
HSA 100 nM	134	42	69	61	31	61	43	42	60	17	23	41
HSA 100 nM	125	40	63	56	32	58	38	40	54	18	28	42
HSA 100 nM	119	36	56	56	24	47	41	43	57	19	18	34
HSA 100 nM	116	34	40	60	35	59	41	41	55	20	18	41
HSA 100 nM	130	52	76	66	39	60	46	44	70	17	15	38
HSA 250 nM	115	28	47	62	5	48	37	25	51	44	49	71
HSA 250 nM	121	26	50	74	31	60	41	29	53	44	47	84
HSA 250 nM	121	29	52	69	31	56	39	34	58	41	47	51

HSA 250 nM	112	23	43	70	26	53	41	40	58	50	51	73
HSA 250 nM	119	27	50	61	28	49	39	31	48	40	38	61
HSA 250 nM	119	28	48	67	34	53	37	33	49	43	50	60
HSA 500 nM	91	10	27	70	26	45	54	42	64	47	46	64
HSA 500 nM	90	19	35	72	34	51	49	38	57	48	46	70
HSA 500 nM	93	16	56	68	34	53	50	43	61	46	44	68
HSA 500 nM	83	12	30	73	39	57	44	32	48	53	45	70
HSA 500 nM	88	16	38	75	33	47	51	44	64	49	36	55
HSA 500 nM	87	4	24	69	32	52	58	45	64	50	40	53
HSA 1000 nM	76	8	20	73	31	56	48	50	61	70	53	45
HSA 1000 nM	72	7	21	76	34	57	49	47	60	61	42	61
HSA 1000 nM	73	8	23	80	40	55	43	45	67	67	48	61
HSA 1000 nM	73	10	22	74	28	49	50	45	61	67	50	64
HSA 1000 nM	76	12	22	68	32	50	57	43	67	69	54	57
HSA 1000 nM	72	9	23	70	34	53	54	44	65	71	44	61
Lys 100 %	78	61	93	55	54	72	44	36	57	49	43	69
Lys 100 %	80	79	97	57	56	74	52	47	69	46	43	64
Lys 100 %	71	70	84	60	54	78	51	48	67	47	45	58
Lys 100 %	74	72	94	56	55	71	44	43	59	42	46	58
Lys 100 %	77	79	100	55	60	80	43	43	55	42	46	57
Lys 100 %	77	74	91	51	53	65	47	50	59	44	44	56
Lys 60 %	75	80	102	52	51	70	46	46	58	38	38	46
Lys 60 %	71	78	97	52	52	64	42	44	56	37	41	50
Lys 60 %	71	80	97	48	48	60	41	45	54	36	37	42
Lys 60 %	74	78	79	50	52	64	41	51	54	37	40	47
Lys 60 %	77	81	90	46	48	60	48	52	61	43	48	51

Lys 60 %	75	75	85	46	46	56	44	45	49	41	44	51
Lys 40 %	40	50	86	50	63	58	73	80	106	66	72	106
Lys 40 %	43	49	65	47	62	81	73	83	108	69	80	102
Lys 40 %	48	54	76	51	57	79	78	86	105	70	77	96
Lys 40 %	41	46	66	47	60	76	70	74	75	68	85	101
Lys 40 %	45	49	60	47	60	77	73	84	88	64	84	105
Lys 40 %	44	48	57	42	50	61	74	82	90	74	81	97
Lys 20 %	11	20	35	28	43	62	22	39	55	48	57	72
Lys 20 %	11	18	34	21	30	45	24	33	48	43	52	67
Lys 20 %	8	11	26	21	29	40	20	33	49	55	63	76
Lys 20 %	15	15	27	27	34	42	17	26	41	46	56	68
Lys 20 %	14	16	29	23	32	48	17	25	38	57	61	70
Lys 20 %	8	9	30	31	41	53	17	26	44	49	58	69
HSA 100 %	149	62	89	94	48	81	73	62	89	50	49	77
HSA 100 %	153	66	86	91	50	76	73	58	84	45	44	72
HSA 100 %	146	60	83	88	44	71	67	48	74	45	49	71
HSA 100 %	150	48	80	82	36	57	76	62	80	49	49	69
HSA 100 %	146	53	78	89	35	61	79	62	88	46	44	62
HSA 100 %	152	61	87	91	47	66	78	58	88	47	44	66