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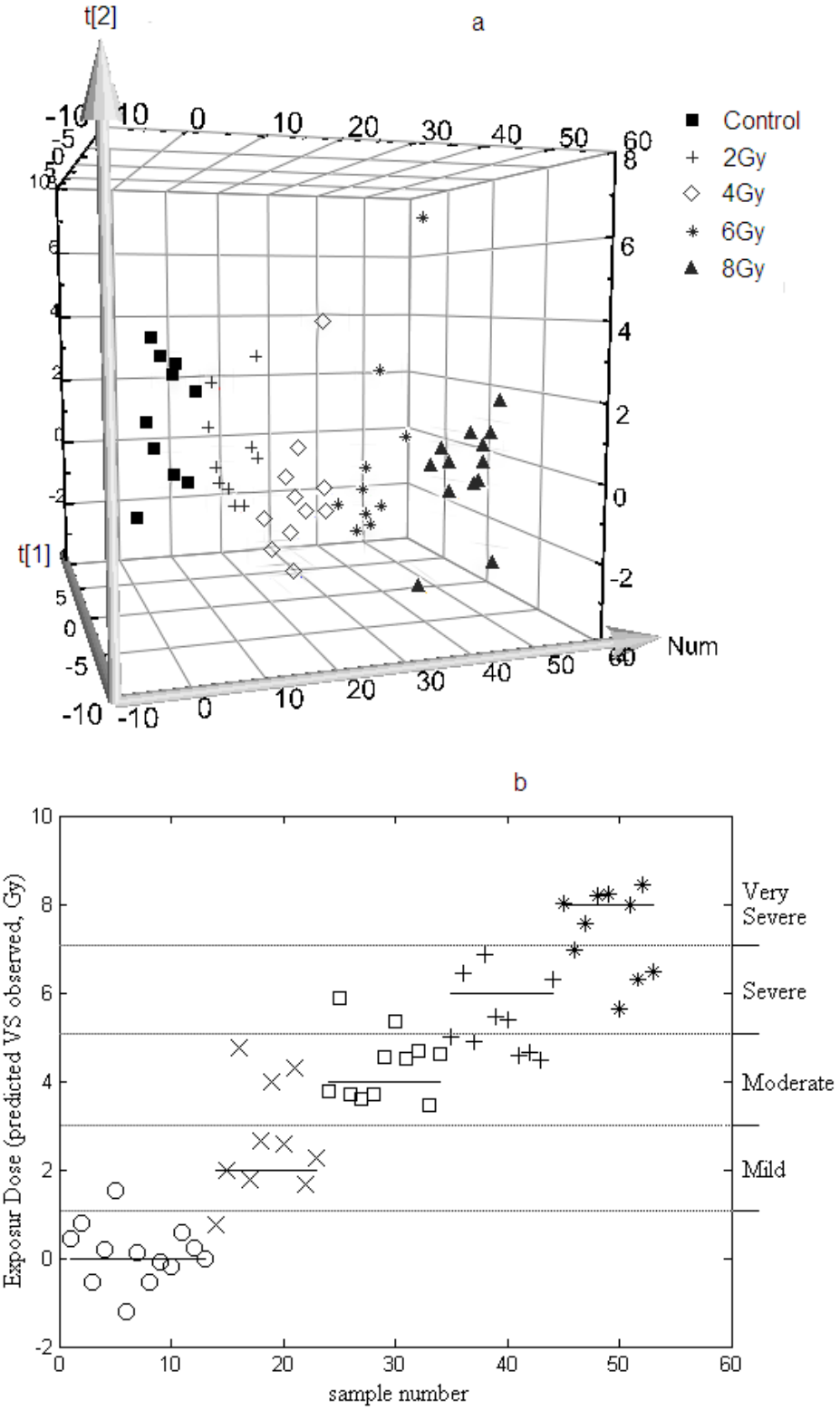


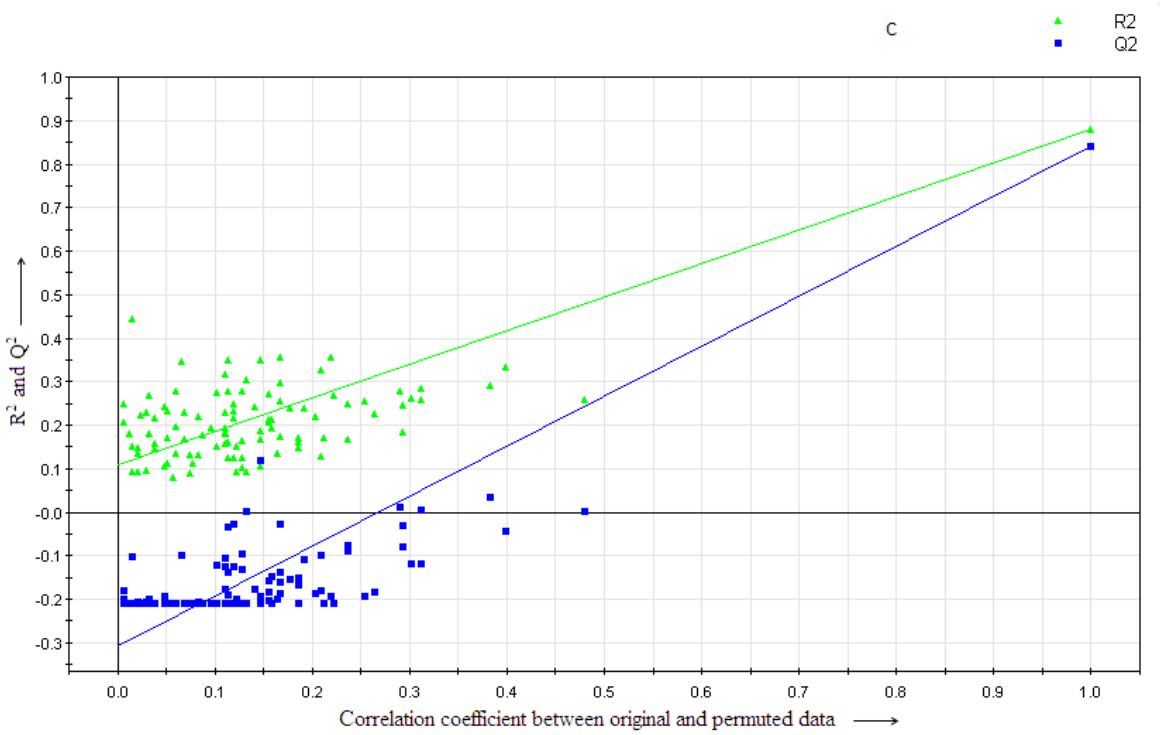
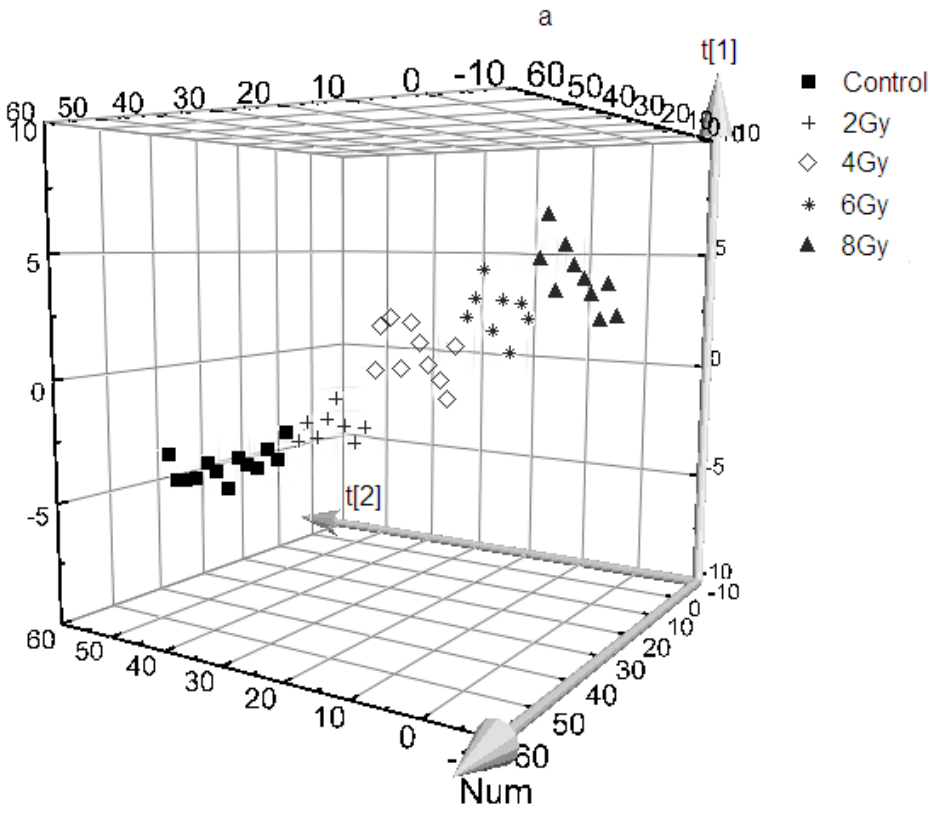


Fig.S1 (a) Non-linear KPLS 3D representation score plot. (b) Comparison between the predicted radiation doses and observed values and (c) validation plot obtained from 100 permutation tests based on 5 h urinary amino acids after radiation exposure.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t[2]
Num
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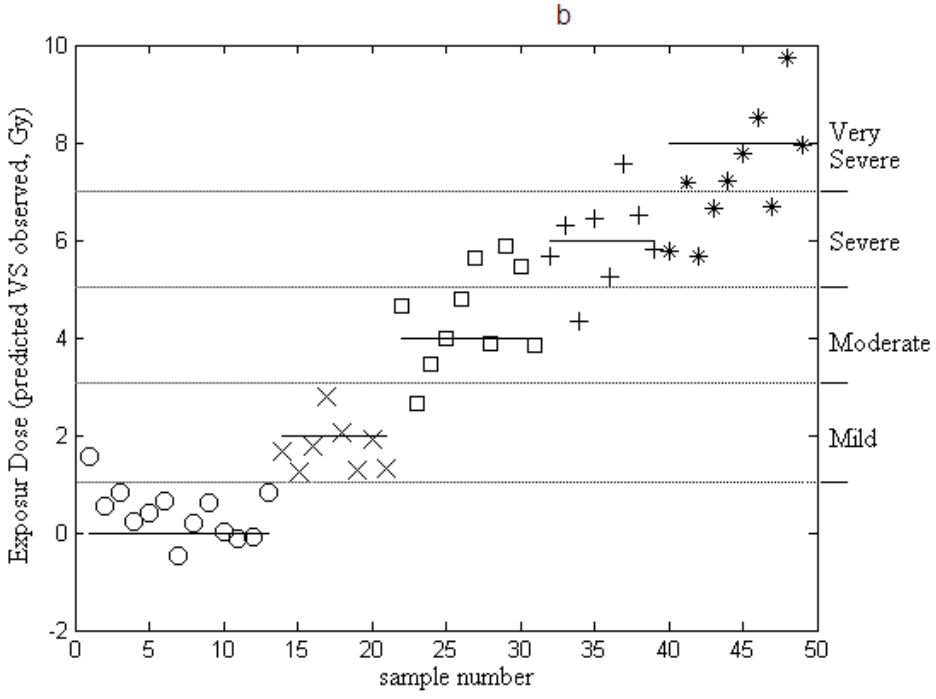
4Gy
6Gy
8Gy


b
Exposur Dose (predicted VS observed, Gy)
sample number
Very Severe
Severe
Moderate
Mild

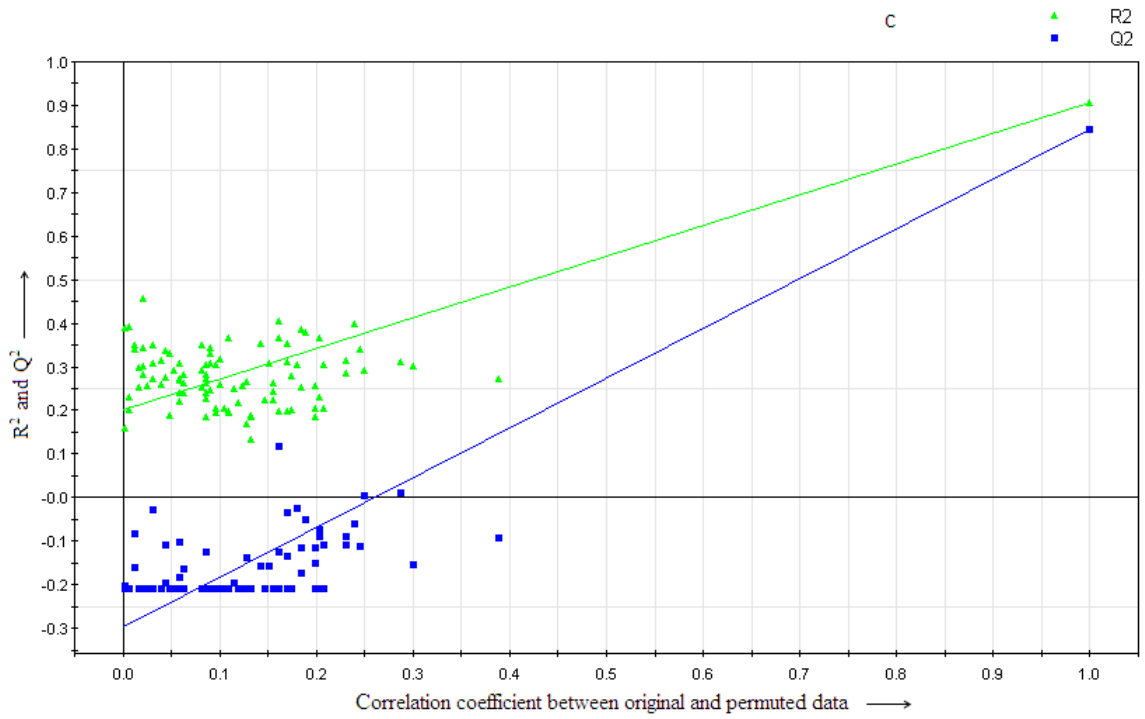
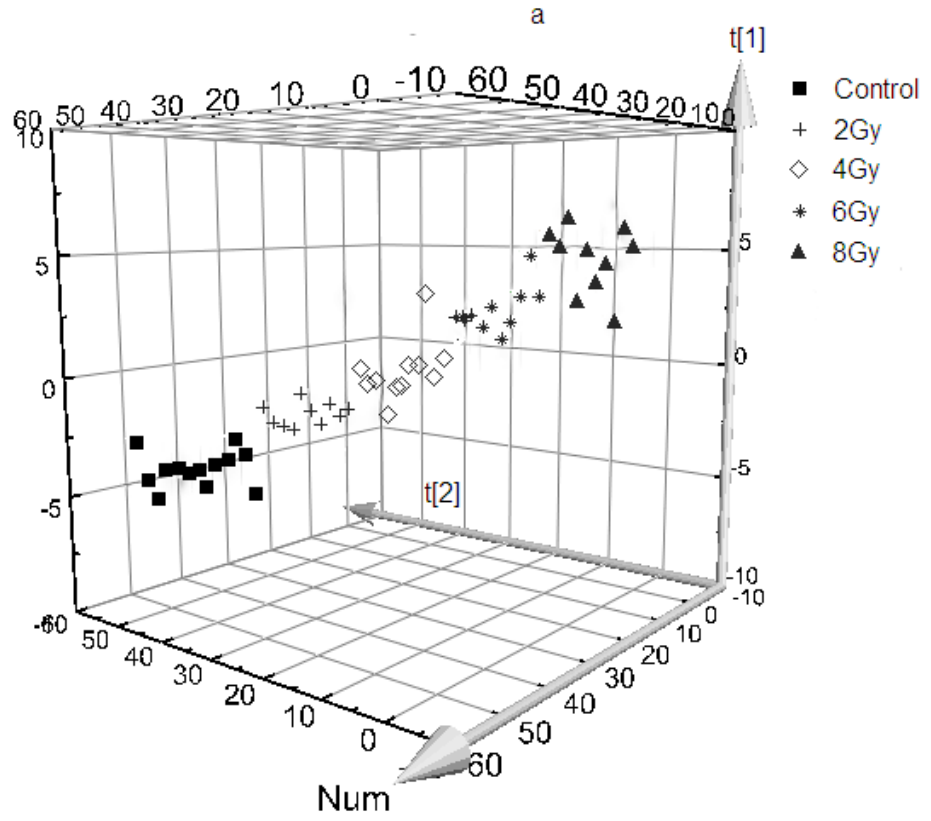
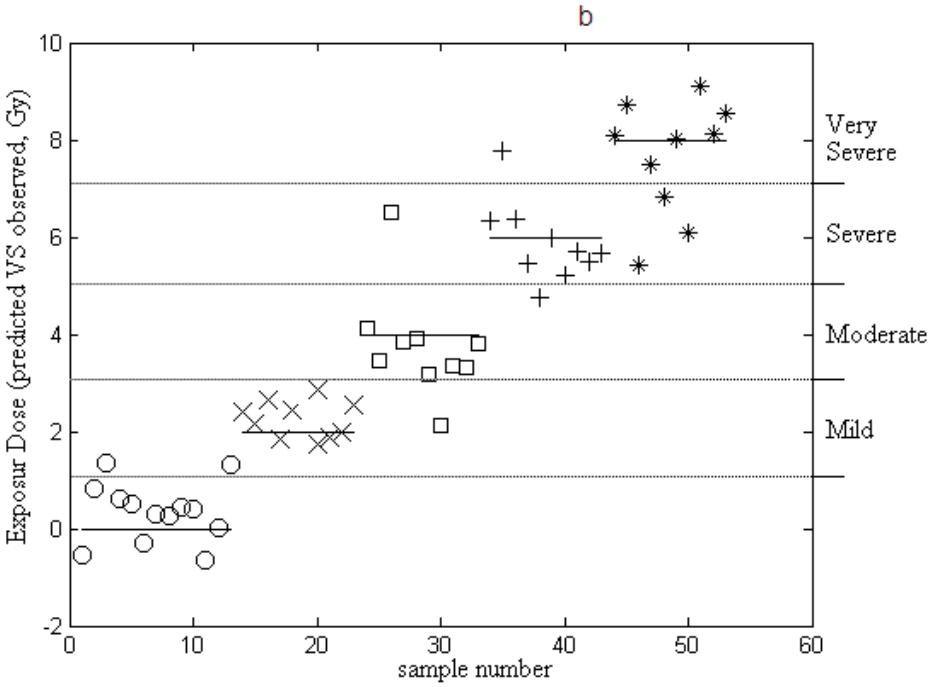


Fig.S2 (a) Non-linear KPLS 3D representation score plot. (b) Comparison between the predicted radiation doses and observed values and (c) validation plot obtained from 100 permutation tests based on 24 h urinary amino acids after radiation exposure.


a
t[1]
t[2]
Num
Control
2Gy
4Gy
6Gy
8Gy


b
Exposur Dose (predicted VS observed, Gy)
sample number
Very Severe
Severe
Moderate
Mild

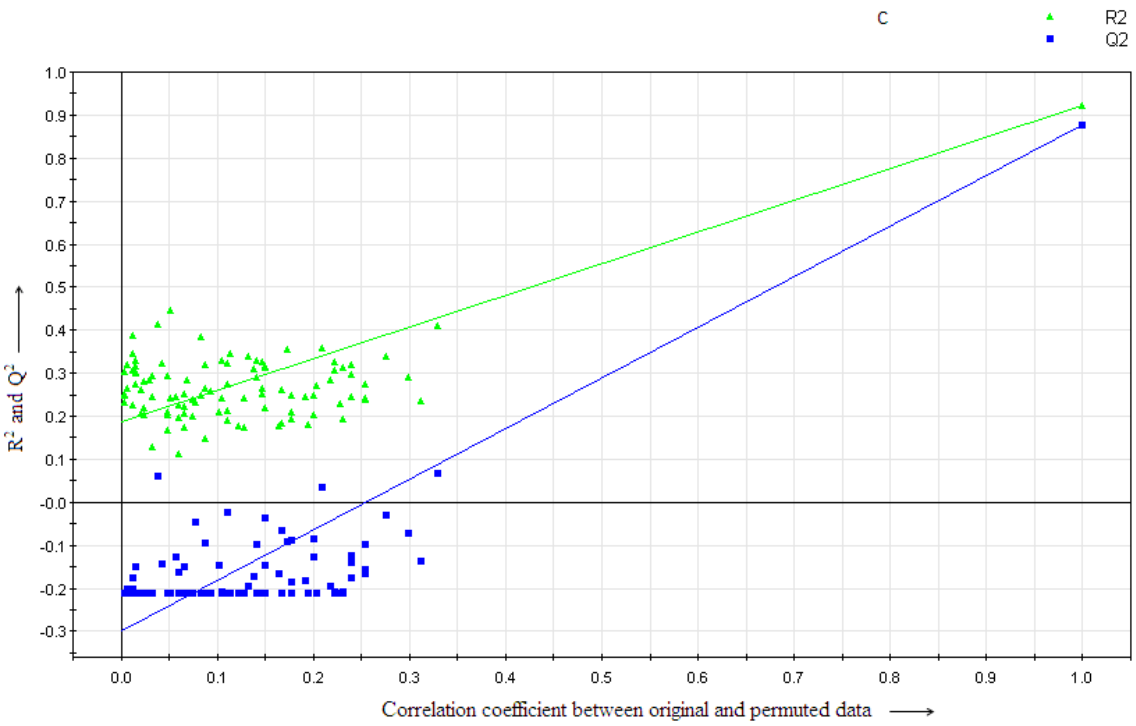


Fig.S3 (a) Non-linear KPLS 3D representation score plot. (b) Comparison between the predicted radiation doses and observed values and (c) validation plot obtained from 100 permutation tests based on 48 h urinary amino acids after radiation exposure.

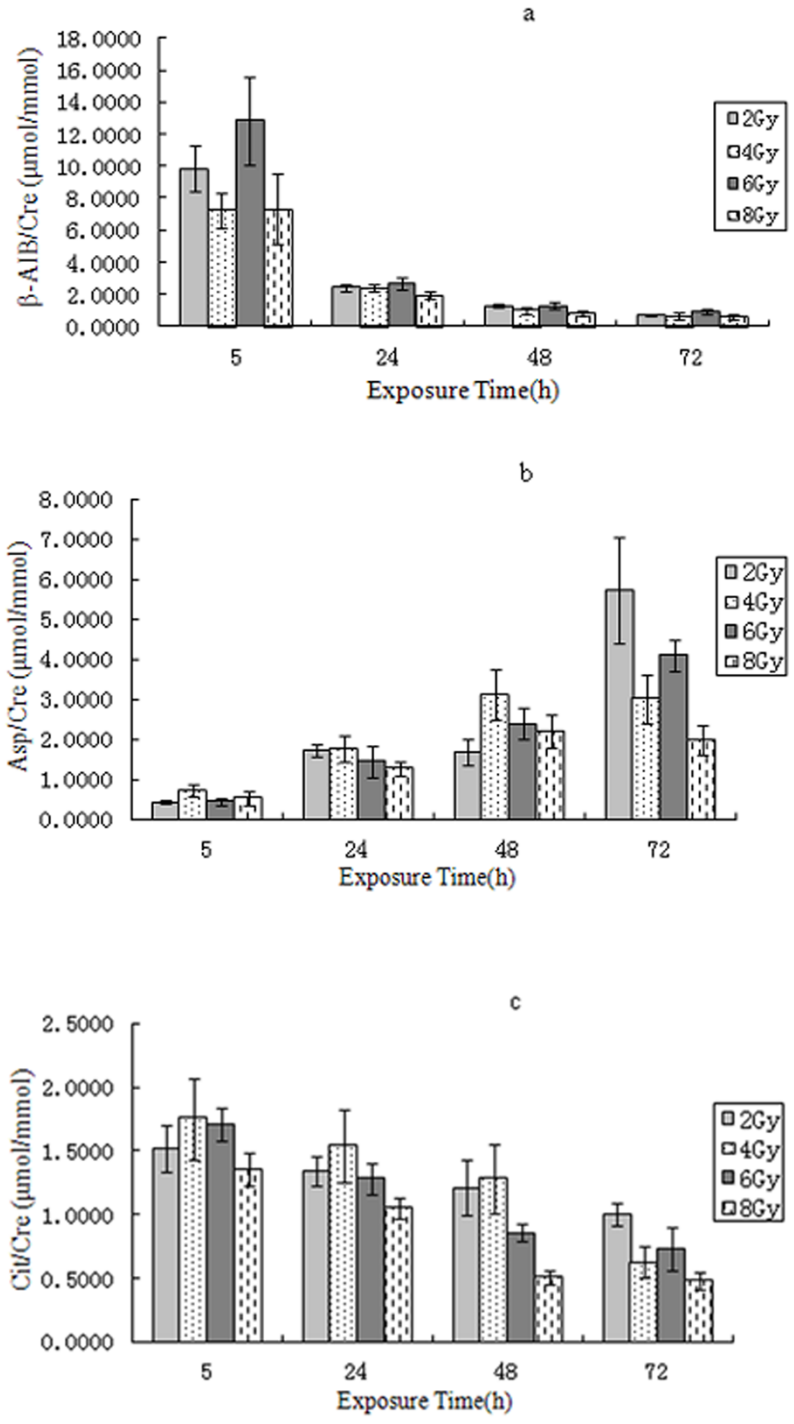


Fig.S4 The time-response relationship of β-AIB (a), Asp (b) and (c) Cit in urine samples after radiation exposure.

Table S1 Effects of ionizing radiation on amino acid concentrations (μmol/mmol Cre, mean±SD) in rat urine at 5 h after exposure

Amino acids	Control (n=13) μmol·L^{-1}	2Gy (n=10) μmol·L^{-1}	4Gy (n=11) μmol·L^{-1}	6Gy (n=10) μmol·L^{-1}	8Gy (n=10) μmol·L^{-1}
Trp	0.38±0.17	0.55±0.22	0.25±0.14$^{\#\#}$	0.41±0.15	0.25±0.13$^{\#\#}$
His	14.62±5.29	14.49±1.85	11.87±2.5	14.87±3.3	11.2±3.24
Arg	20.79±8.34	30.12±22.03	12.27±3.54*	22±12.47	13.75±6.37
Tyr	32.62±15.69	16.16±15.64*	18.85±8.31	17.84±7.68*	15.1±4.92**
Cy2	1.05±0.28	1.21±0.51	1.98±1.29*	1.64±0.71	1.92±0.58
Phe	2.5±0.88	3.49±1.71	2.49±0.47	3.21±1.49	2.5±1.1
Ala	15.27±3.92	21.19±12.36	13.95±4.16	15.09±4.12	13.89±6.1
Gln	121.22±51.78	103.7±69.92	178.98±99.2	155.74±93.22	145.28±70.78
AIB	1.82±0.81	9.84±4.58**	7.27±3.62**	12.82±8.64*	7.3±6.95
Hyp	3.04±1.33	3.21±2.17	4.12±1.57	3.59±2.27	3.61±2.31
Asn	5.09±2.17	16.27±25.53	6.29±2.25	8.56±4.48	6.81±2.16
Glu	15.09±15.77	20.32±16.43	8.69±8.17	17.14±15.55	10.13±6.33
Thr	50.06±12.95	75.63±18.66	60.27±16.97	88.28±36.98**	72.31±25.13
Leu	3.06±0.76	4.36±2.63	3.32±0.87	3.46±1.04	3.1±1.09
Val	26.82±10.57	60.85±59.78	21.21±8.59	27.64±11.4	19.89±6.42
Pro	5.88±2.16	5.87±2.72	6.49±2.11	4.87±1.93	5.83±3.18

Ile	2.24±0.51	3.23±1.08*	2.32±0.63	2.65±0.93	2.11±0.69#
Asp	1.67±0.97	0.44±0.14**	0.73±0.5*	0.45±0.26**	0.52±0.52*
Gly	30.42±7.5	38.48±5.91	29.87±7.51	34.93±8.97	33.37±15.7
Ser	6.3±1.83	6±3.08	8.26±3.08	7.71±3.48	7.97±4.09
Lys	95.64±58.94	12.28±3.21**	6.86±2.47**, ##	10.53±4.35**	7.75±3.54**
Cit	1.9±0.63	1.52±0.58	1.75±1.05	1.71±0.42	1.35±0.42
Nov	14.7±6.54	10.01±4.01	19.04±5.56##	12.14±4.72	14.76±6.65
Orn	6.91±1.7	13±4.74*	6.56±2.52#	8.13±2.86	5.69±1.31 ##
Cys	6.3±1.8	5.95±2.71	9.19±3.62	8.22±2.24	8.75±2.19

Note. Compared with control, $^{*}p < 0.05$, $^{**}p < 0.01$; Compared with 2 Gy, $^{\#}p < 0.05$, $^{\#\#}p < 0.01$; Compared with 4 Gy, $^{\&}p < 0.05$, $^{\&\&}p < 0.01$; Compared with 6 Gy, $^{\$}p < 0.05$, $^{\$\$}p < 0.01$

Table S2 Effects of ionizing radiation on amino acid concentrations (μmol/mmol Cre, mean±SD) in rat urine at 24 h after exposure

Amino acids	Control (n=13) μmol·L^{-1}	2 Gy (n=8) μmol·L^{-1}	4 Gy (n=10) μmol·L^{-1}	6 Gy (n=8) μmol·L^{-1}	8 Gy (n=10) μmol·L^{-1}
Trp	0.38±0.17	0.34±0.09	0.26±0.14	0.36±0.1	0.2±0.09*
His	14.62±5.29	11.74±1.47	10.27±2.5	13.85±3.89	8.73±3.22**
Arg	20.79±8.34	14.33±4.22	13.74±6.68	19.25±5.68	12.04±5.87*
Tyr	32.62±15.69	22.61±4.82	22.91±8.64	25.88±12.83	17.87±5.26*
Cy2	1.05±0.28	1.01±0.34	1.1±0.41	1.53±0.42*	1.07±0.34
Phe	2.5±0.88	2.01±0.38	2.13±0.88	2.37±0.74	1.77±0.33
Ala	15.27±3.92	11.97±1.8	14.3±4.63	14.51±1.87	12.09±3.74
Gln	121.22±51.78	133.75±15.45	152.5±45.63	175.56±61.88	146.43±32.41
AIB	1.82±0.81	2.45±0.62	2.42±0.66	2.71±1.03	1.93±0.73
Hyp	3.04±1.33	3±1.02	2.78±0.78	3.56±1.63	2.44±0.77
Asn	5.09±2.17	4.31±1.43	3.58±2.4	4.88±1.23	3.85±2.29
Glu	15.09±15.77	9.73±2.09	7.18±2.02	10.28±5.6	7.47±2.1
Thr	50.06±12.95	51.66±9.76	47.77±18.31	61.35±12.06	46.47±11.35
Leu	3.06±0.76	2.36±0.38	2.88±1.99	2.46±0.7	2.05±0.37
Val	26.82±10.57	17.59±5.15	19.09±10.89	19.66±5.38	14.15±6.9*
Pro	5.88±2.16	3.94±0.69	4.73±1.34	4.17±0.99	4.07±1.31

Ile	2.24±0.51	1.65±0.22*	2.02±1.26	1.69±0.54	1.45±0.27**
Asp	1.67±0.97	1.72±0.43	1.77±1	1.45±1.1	1.27±0.6
Gly	30.42±7.5	25.53±2.66	25.55±8.16	27.35±6.1	23.64±4.37
Ser	6.3±1.83	6.46±0.92	6.34±2.13	7.16±2.43	6.13±1.47
Lys	95.64±58.94	9.08±2.3**	7.4±1.97**	10.44±2.5**	6.54±2.19$^{**,\$}$
Cit	1.9±0.63	1.34±0.33	1.54±0.91	1.28±0.35	1.05±0.25**
Nov	14.7±6.54	23.29±5.92*	23.28±6.13*	21.59±4.32	21.17±6.72
Orn	6.91±1.7	5.45±2.1	4.58±1.33**	5.93±1.25	4.29±1.21**
Cys	6.3±1.8	7.66±1.95	6.62±1.93	9.34±1.99$^{**,\&}$	8.59±1.89

Note. Compared with control, $^{*}p < 0.05$, $^{**}p < 0.01$; Compared with 2 Gy, $^{\#}p < 0.05$, $^{\#\#}p < 0.01$; Compared with 4 Gy, $^{\&}p < 0.05$, $^{\&\&}p < 0.01$; Compared with 6 Gy, $^{\$}p < 0.05$, $^{\$\$}p < 0.01$

Table S3 Effects of ionizing radiation on amino acid concentrations (μmol/mmol Cre, mean±SD) in rat urine at 48 h after exposure

Amino acids	Control (n=13) μmol·L^{-1}	2 Gy (n=10) μmol·L^{-1}	4 Gy (n=10) μmol·L^{-1}	6 Gy (n=10) μmol·L^{-1}	8 Gy (n=10) μmol·L^{-1}
Trp	0.38±0.17	0.34±0.07	0.18±0.11$^{*, \#}$	0.33±0.07$^{\&}$	0.2±0.08$^{*, \#\#, \$}$
His	14.62±5.29	12.52±2.34	9.75±2.08*	13.18±2.36	9.55±4.35*
Arg	20.79±8.34	14.2±4.32*	10.52±3.44**	14.73±3.4	9.14±2.78**
Tyr	32.62±15.69	18.99±7.74*	19.02±6.71*	22.4±8.42	13.96±8.13**
Cy2	1.05±0.28	1.05±1.04	0.77±0.48	0.89±0.28	0.58±0.28
Phe	2.5±0.88	2.16±0.46	2.35±0.71	2.82±0.62	1.97±1.01
Ala	15.27±3.92	13.03±4.02	13.75±5.23	14.98±3.56	10.23±3.54
Gln	121.22±51.78	95±55.18	115.92±47.69	160.27±57.66	107.38±56.24
AIB	1.82±0.81	1.27±0.36	1.02±0.69	1.3±0.56	0.81±0.35**
Hyp	3.04±1.33	2.2±0.82	2.88±1.11	3.34±0.62	2.34±1.66
Asn	5.09±2.17	4.14±1.1	2.18±1.76*	3.93±2.7	3.54±1.86
Glu	15.09±15.77	10.53±7.03	11.52±4.82	18.14±7.3	11.73±6.12
Thr	50.06±12.95	49.48±13.5	47.54±15.57	66.03±13.24	51.04±20.19
Leu	3.06±0.76	2.51±0.53	2.67±0.9	2.93±0.67	2.34±0.85

Val	26.82±10.57	17.92±5.09	13.77±4.52**	17.94±7.94	10.14±4.95**
Pro	5.88±2.16	3.47±0.99*	3.95±1.3	4.44±1.1	4.18±1.74
Ile	2.24±0.51	1.84±1.09	2.2±1.34	2.12±0.49	1.61±0.53
Asp	1.67±0.97	1.68±0.99	3.11±1.99	2.39±1.25	2.21±1.28
Gly	30.42±7.5	30.46±8.29	35.87±14.52	44.66±8.47*	34.31±14.13
Ser	6.3±1.83	5.34±1.52	6.77±3.16	8.99±2.76#	6.64±2.26
Lys	95.64±58.94	10.54±3.12**	8.23±4.63**	9.86±2.78**	6.59±4.23**
Cit	1.9±0.63	1.21±0.7	1.28±0.87	0.85±0.21**	0.51±0.17**, $$
Nov	14.7±6.54	20.08±9.13	23.54±7.07*	20.68±4.19	14.86±4.9&
Orn	6.91±1.7	7.99±3.26	5.03±1.92	5.39±1	3.86±1.61**, #
Cys	6.3±1.8	7±1.92	6.59±3.34	8.88±3.05	6.53±2.19

Note. Compared with control, * $p < 0.05$, ** $p < 0.01$; Compared with 2 Gy, # $p < 0.05$, ## $p < 0.01$; Compared with 4 Gy, & $p < 0.05$, && $p < 0.01$; Compared with 6 Gy, $ $p < 0.05$, $$ $p < 0.01$

Table S4 Effects of ionizing radiation on amino acid concentrations (μmol/mmol Cre, mean±SD) in rat urine at 72 h after exposure

Amino acids	Control (n=13) μmol·L^{-1}	2 Gy (n=10) μmol·L^{-1}	4 Gy (n=10) μmol·L^{-1}	6 Gy (n=10) μmol·L^{-1}	8 Gy (n=10) μmol·L^{-1}
Trp	0.38±0.17	0.33±0.07	0.27±0.1	0.38±0.1	0.42±0.65
His	14.62±5.29	14.07±2.23	11.94±2.19	20.43±6.12$^{\&}$	9.69±5.36$^{\$\$}$
Arg	20.79±8.34	9.79±5.91	14.38±9.79	13.07±8.83	14.79±13.29
Tyr	32.62±15.69	26.61±6.33	18.94±5.98	40.98±20.83	17.39±12.29
Cy2	1.05±0.28	1.04±0.39	0.72±0.29	1.41±0.66	1.65±0.75$^{\&}$
Phe	2.5±0.88	2.12±0.44	1.68±0.33	3.2±1.37	2.38±2.19
Ala	15.27±3.92	13.16±3.39	11.4±3.2	15.93±3.11	9±4.64$^{**,\$\$}$
Gln	121.22±51.78	152.7±17.96	111.61±17.08$^{\#\#}$	259.7±119.46$^{*,\ \&}$	183.1±74.91
AIB	1.82±0.81	0.71±0.33**	0.65±0.55**	0.93±0.59*	0.6±0.52**
Hyp	3.04±1.33	2.19±1.64	1.32±0.5	3.88±3.11$^{\&}$	1.68±1.56
Asn	5.09±2.17	4.53±2.39	5.02±1.94	6.75±2.79	5.91±2.98
Glu	15.09±15.77	3.79±5.04	6.95±6.03	12.38±6.39$^{\#}$	11.09±12.78
Thr	50.06±12.95	46.83±14.52	41.64±13.56	74.14±21.82$^{*,\#,\&\&}$	61±27.01
Leu	3.06±0.76	2.65±0.56	2.14±0.7	2.94±0.8	3.2±2.97
Val	26.82±10.57	23.4±6.21	20.71±5.95	26.94±7.25	6.44±3.14$^{** ,\#\# ,\&\&, \$\$}$

Pro	5.88±2.16	4.43±0.97	4.26±1.15	6.02±1.5	7.39±11.66
Ile	2.24±0.51	1.43±0.37**	1.24±0.51**	2.48±2.04	2.02±1.89
Asp	1.67±0.97	5.73±4.15	3.01±1.92	4.11±1.22**	1.99±1.18$^{\$\$}$
Gly	30.42±7.5	26.38±4.69	22.28±5.37	44.2±8.56$^{*,\#\#,\&\&}$	32.22±17.53
Ser	6.3±1.83	6.46±1.67	4.33±0.82$^{*,\#}$	9.94±2.38$^{**,\#\#,\&\&}$	6.44±2.55$^{\$}$
Lys	95.64±58.94	118.97±26.79	90.16±19.94	150.73±40.87$^{\&}$	83.51±61.55$^{\$}$
Cit	1.9±0.63	1±0.28**	0.62±0.39**	0.73±0.55**	0.48±0.21**
Nov	14.7±6.54	23.76±8.17	21.22±7.39	40.24±16.89$^{**,\ \&}$	17.23±10.56$^{\$}$
Orn	6.91±1.7	7.36±1.83	6.83±2.07	9.15±3.57	5.5±4.65
Cys	6.3±1.8	5.87±2.23	5.54±1.95	9.34±4.08$^{\&}$	8.07±3.46

Note. Compared with control, $^{*}p < 0.05$, $^{**}p < 0.01$; Compared with 2 Gy, $^{\#}p < 0.05$, $^{\#\#}p < 0.01$; Compared with 4 Gy, $^{\&}p < 0.05$, $^{\&\&}p < 0.01$; Compared with 6 Gy, $^{\$}p < 0.05$, $^{\$\$}p < 0.01$

Table S5 Main features based on GA analysis for distinguishing different irradiated groups.

Time point	Features selected by GA
At 5 h after radiation exposure	Trp, Thr, Asp, Lys, Cit, Orn
At 24 h after radiation exposure	His, Phe, Gln, Hyp, Leu, Asp, Cit, Cys
At 48 h after radiation exposure	His, Ala, Hyp, Thr, Ile, Gly, Cit, Orn
At 72 h after radiation exposure	His, Ala, Thr, Gly, Cit, Nov

Table S6 Influence of radiation doses and time after exposure on the urinary amino aids levels of rats.

Amino acids	Interaction *P*-value	*P*-value for radiation doses	*P*-value for time after exposure
Trp	0.2025	0.002	0.0723
His	0.269	<.0001	<.0001
Arg	0.0238	0.0039	0.0005
Tyr	0.9583	<.0001	<0.0001
Cy2	0.0028	0.1904	<0.0001
Phe	0.2861	0.0078	0.0079
Ala	0.0488	0.0027	0.0084
Gln	0.0232	0.0002	0.002
β-AIB	0.2099	0.0238	<.0001
Hyp	0.1956	0.0373	0.0047
Asn	0.203	0.2757	0.0009
Glu	0.2521	0.0222	0.0095
Thr	0.8478	<0.0001	<0.0001
Leu	0.2366	0.7132	0.0017
Val	0.0011	<0.0001	<0.0001
Pro	0.6964	0.6374	0.049
Ile	0.055	0.2855	0.0012
Asp	0.0002	0.0607	<.0001
Gly	0.0077	0.0002	<.0001
Ser	0.012	0.0003	0.3813
Lys	1	<.0001	<.0001
Cit	1	<0.0001	<0.0001
Nov	<.0001	0.0001	<0.0001
Orn	0.0014	<.0001	<.0001
Cys	0.1156	0.0004	0.1526