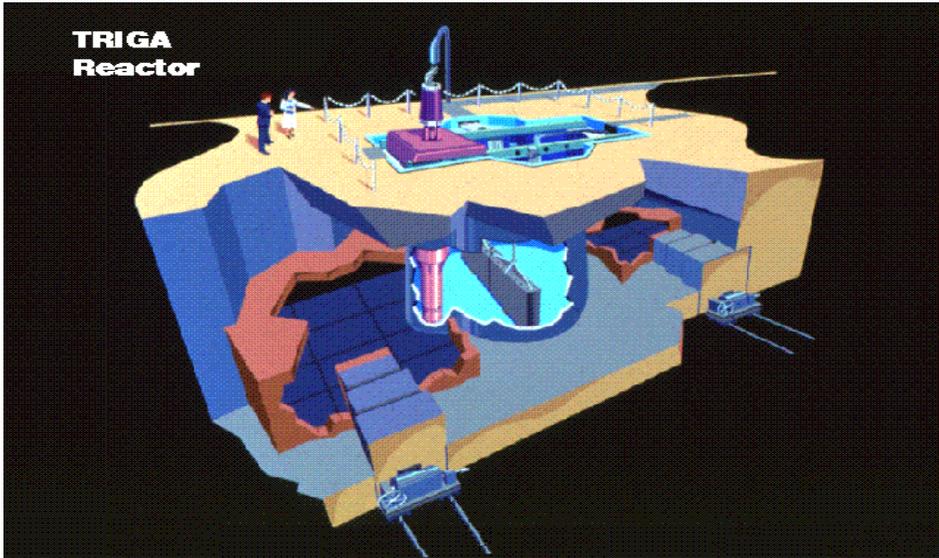

The Use of Uranium Isotopes To Evaluate Depleted Uranium Health Effects

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Armed Forces Radiobiology Research Institute

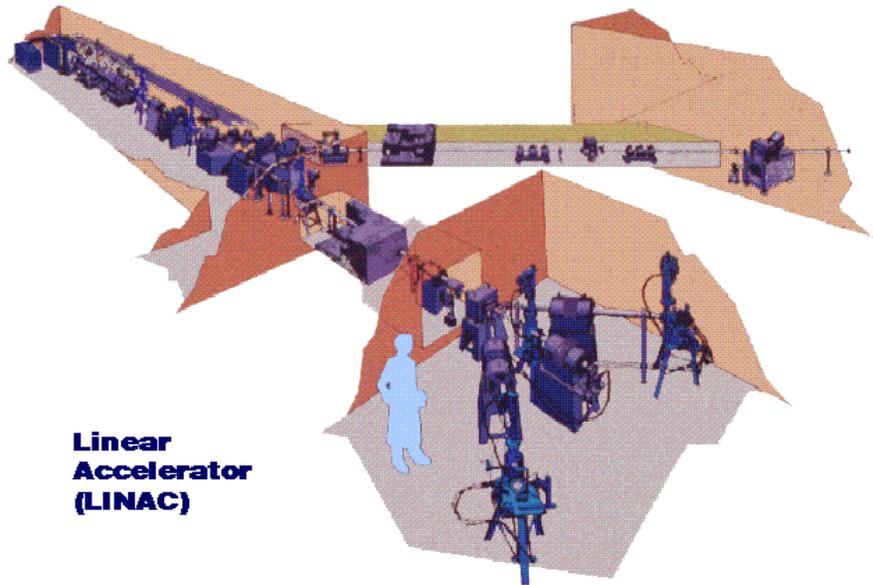
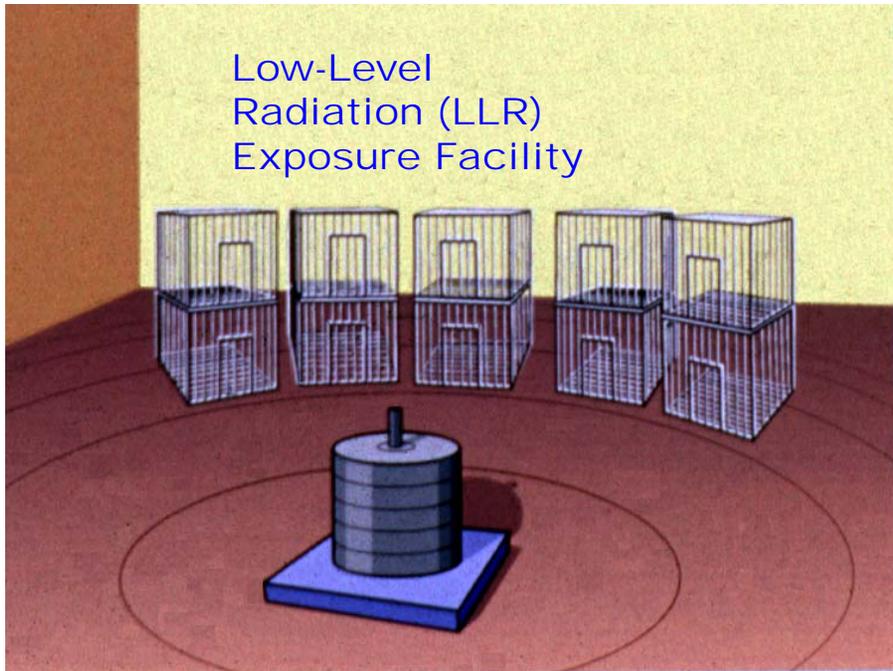
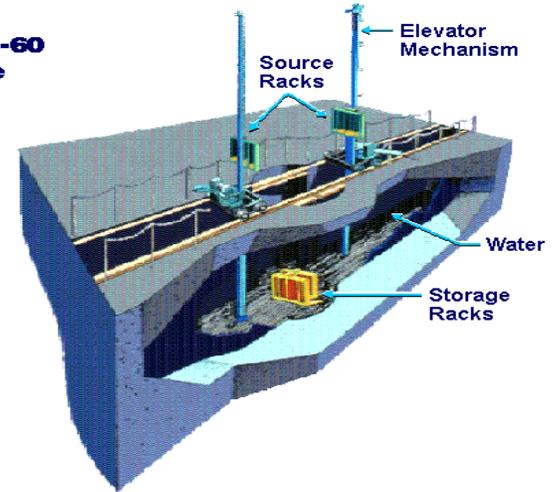
The work presented represents the opinion of the author and is not the opinion of the U.S. Department of Defense or the U. S. Government.

The AFRRI Mission

- **To conduct research in the field of radiobiology and related matters essential to the operational and medical support of the U.S. Department of Defense and the Military Services.**
- **To provide training to medical personnel.**
- **Advisory**



Cobalt-60 Source



Depleted Uranium

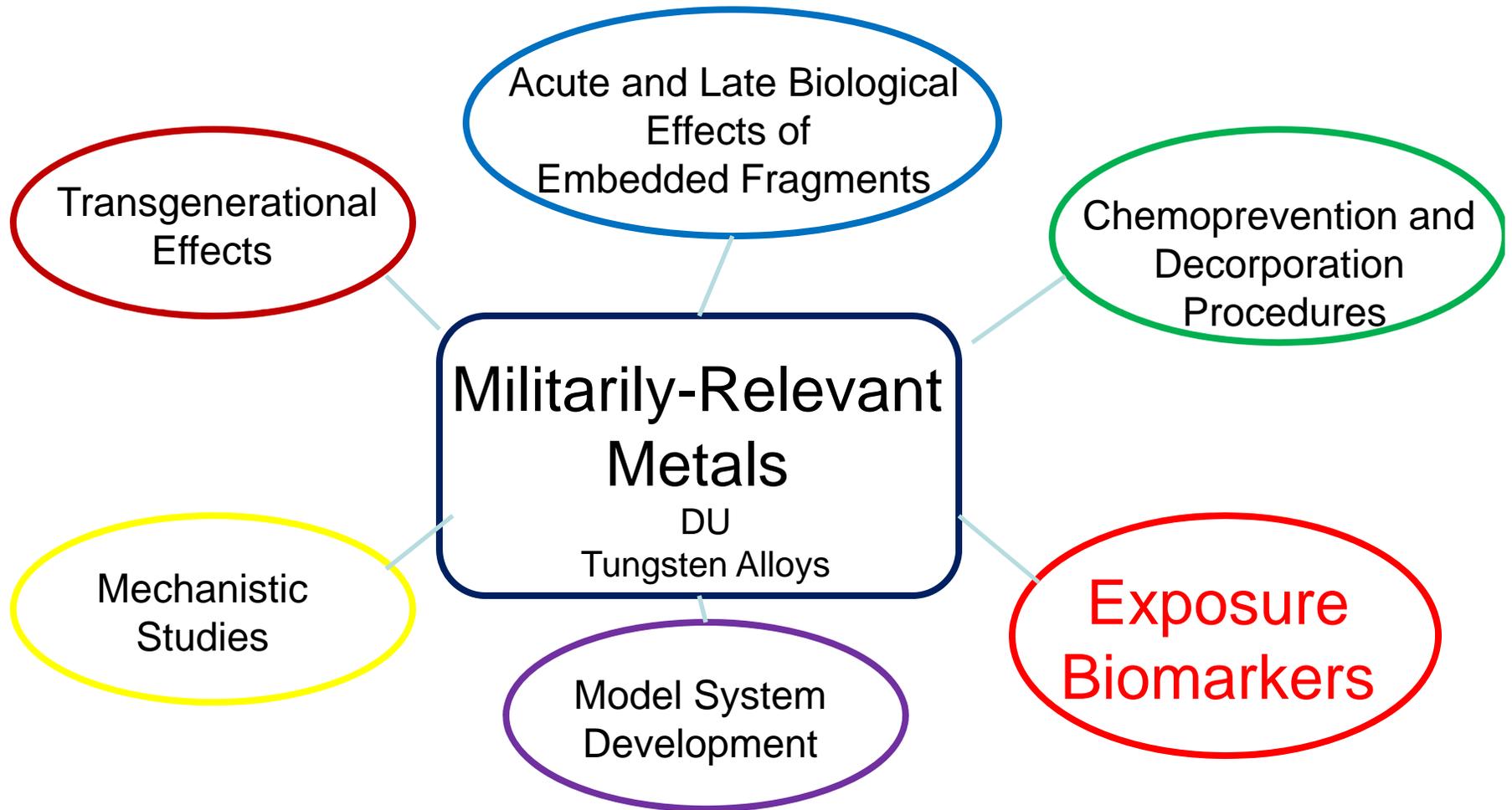
- ⚛ Used in military munitions/tanks
- ⚛ Uranium with less than 0.2% by weight of U^{235} (natural uranium has 0.72%)
- ⚛ Reduced U^{234} , no daughter products, e.g Radium, radon
- ⚛ Chronic internal exposure: US Soldiers Injured with DU Shrapnel 1991 Gulf War, British soldiers Iraq 2003
- ⚛ Potential for inhalation exposure

Comparison of the Relative Contribution of
Uranium Isotopes*
(natural and depleted)

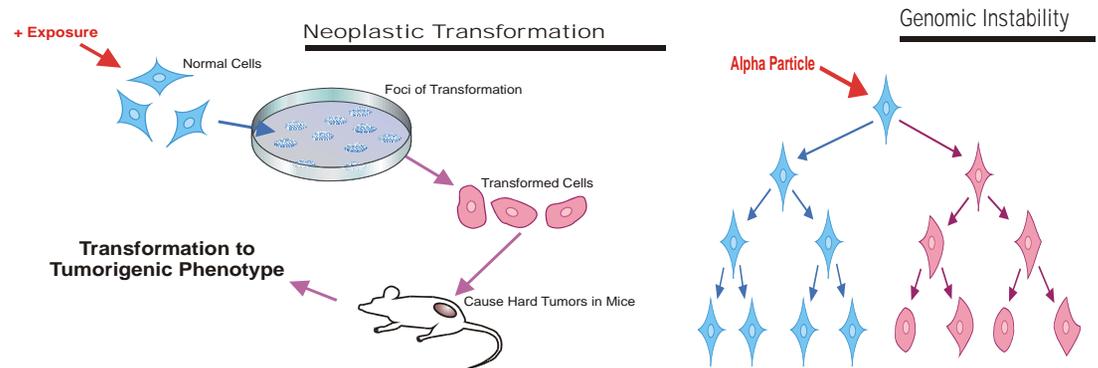
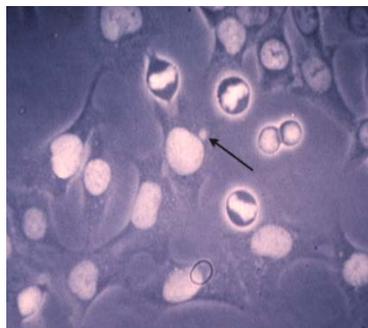
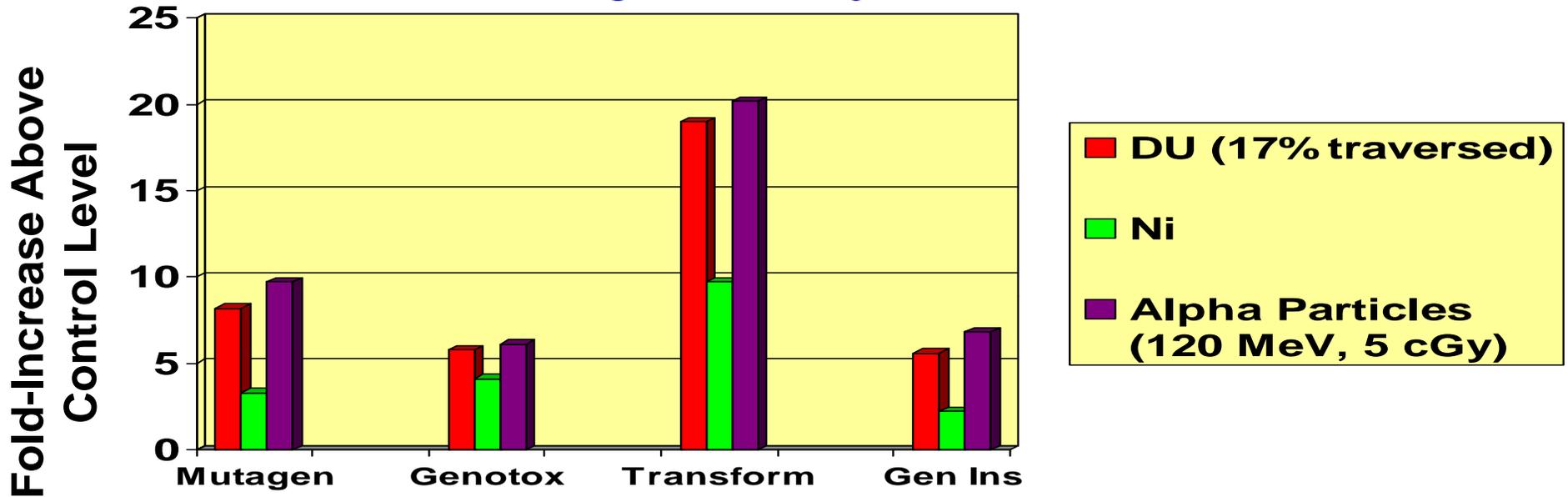
Isotope	Specific Activity ($\mu\text{Ci/g}$)	DU SA by WT% ($\mu\text{Ci/g}$)	Natural Uranium SA by WT% ($\mu\text{Ci/g}$)
^{238}U	0.333	0.332	0.331
^{236}U (not naturally occurring)	63.6	0.0001	0
^{235}U	2.2	0.0044	0.051
^{234}U	6200	0.093	0.310
Total		0.4295	0.692

*Contribution of the daughter products is not included.

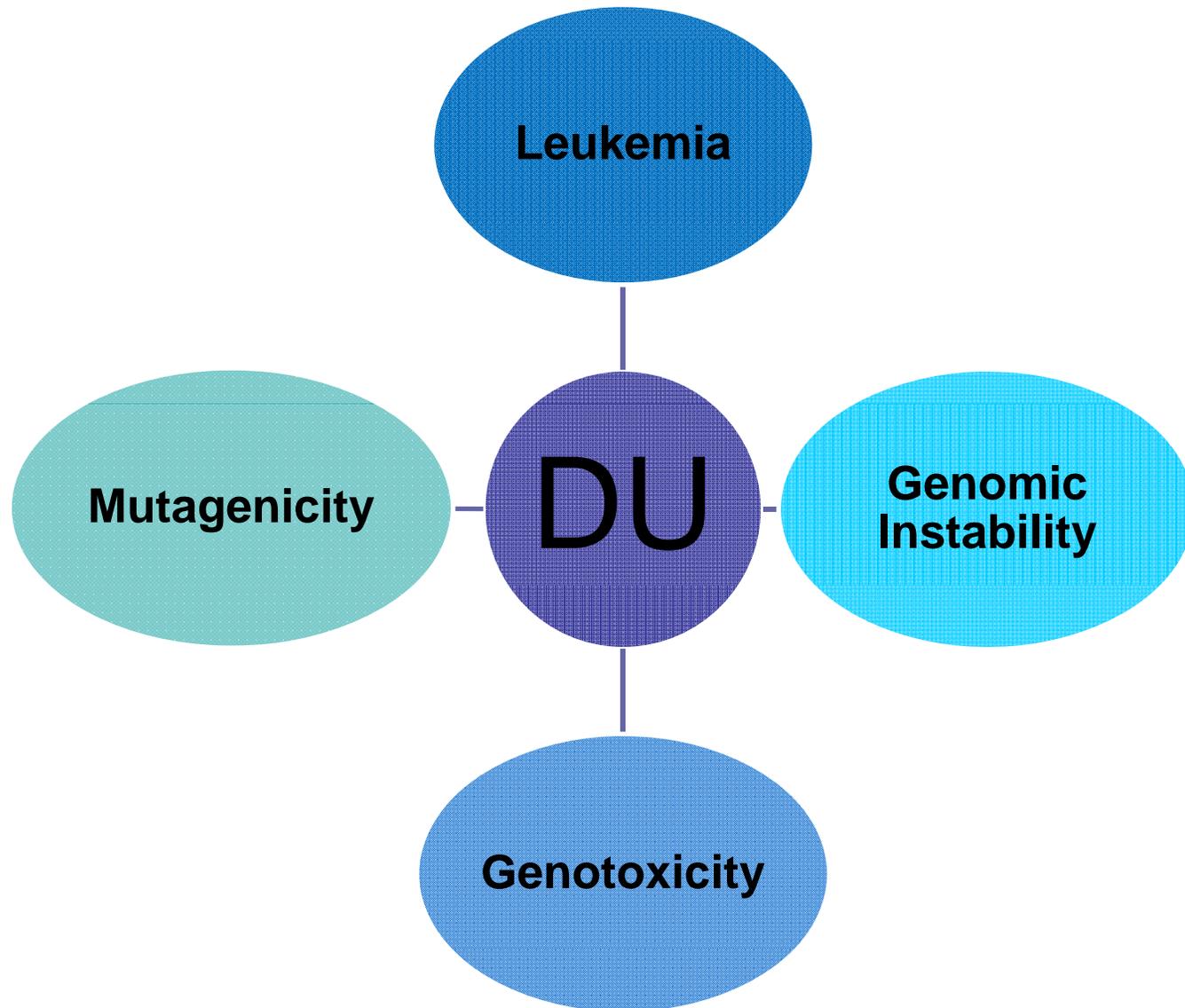
DU Program Overview at AFRRRI



Short-Term Carcinogenicity Tests: Relative Comparison of DU, Nickel, and Alpha Particles Using DU-Uranyl Nitrate



Published *In vivo* Results



How to Answer Question Regarding DU Radiation Specific Effects??

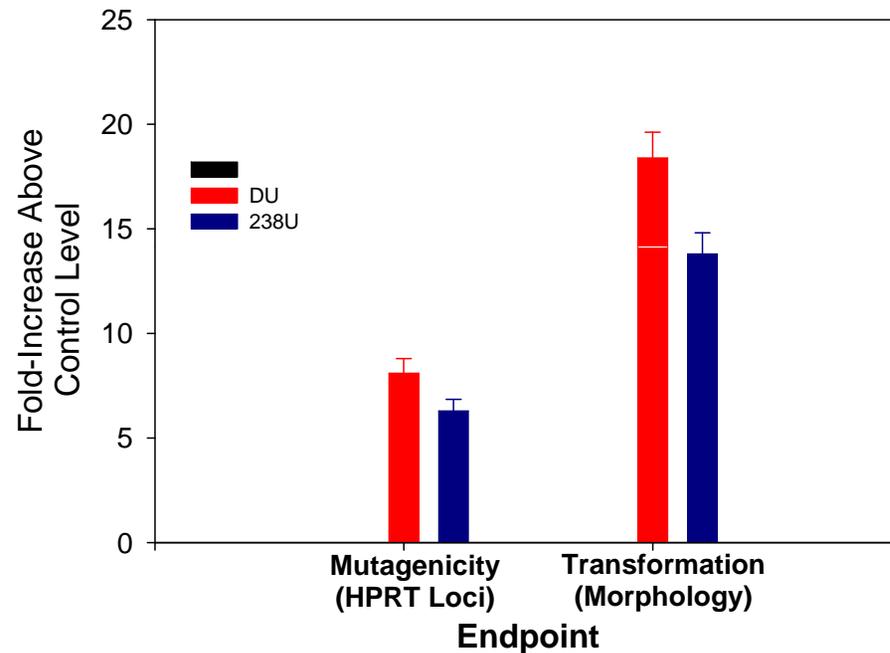
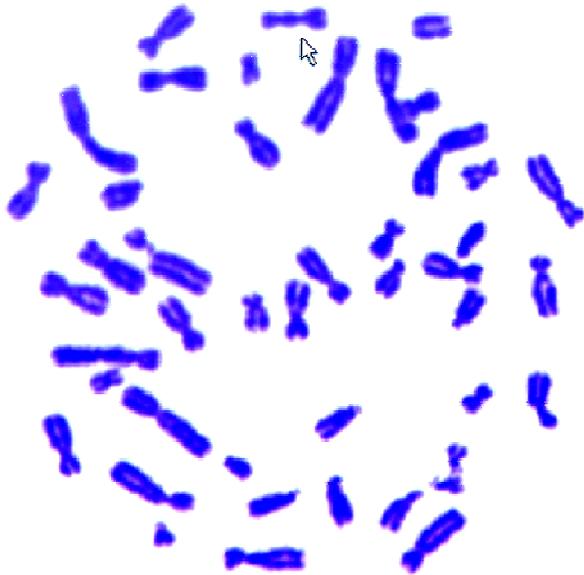
Uranium Isotope Comparison Model System

<u>Uranium Isotopes:</u>	<u>Specific Activity</u>
^{235}U	2.2
DU	0.43
^{238}U	0.33

Does DU Cause Radiation Specific Damage?

Radiation Effects of DU: *In vitro* studies

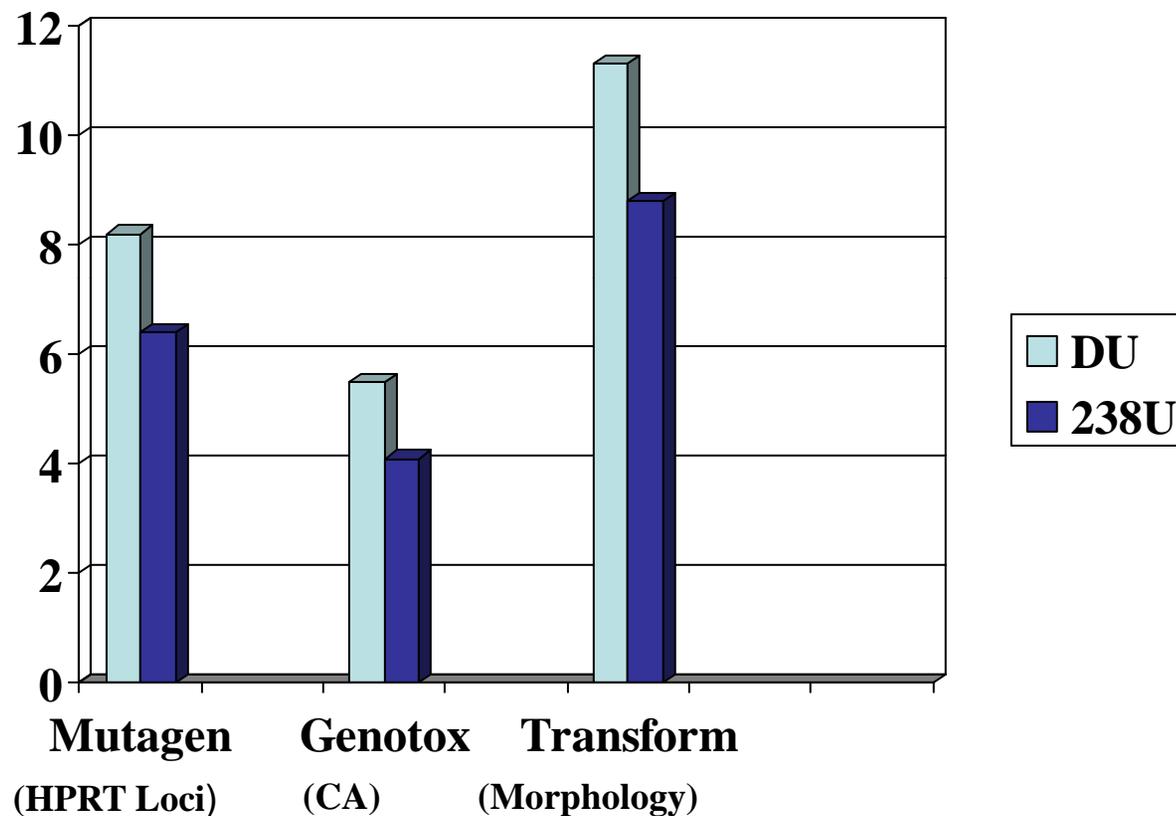
Dicentric Chromosomes



<u>Uranium Isotopes:</u>	<u>Rad Activity</u>	<u>Chem Tox</u>
DU	0.43	1.0
²³⁸U	0.33	1.0

Miller, *et al.*, *Radiat Prot Dosimetry*, 99(1-4):275-8, 2002
Miller *et al.*, *Radiation Measurements*, 42:6-7:1090, 2007.

Radiation Specific Effects *in Vitro*: Heavy Metal Mutagenicity, Genotoxicity Neoplastic Transformation: Comparison of DU and ²³⁸U at Equal Concentrations



Miller, *et al*, *Environmental Health Persp*, Vol. 106, 1998

Miller, *et al*, *Carcinogenesis*, Vol. 22, 2001.

Unpublished data.

Miller, *et al.*, *Radiat Prot Dosimetry*, 99(1-4):275-8, 2002

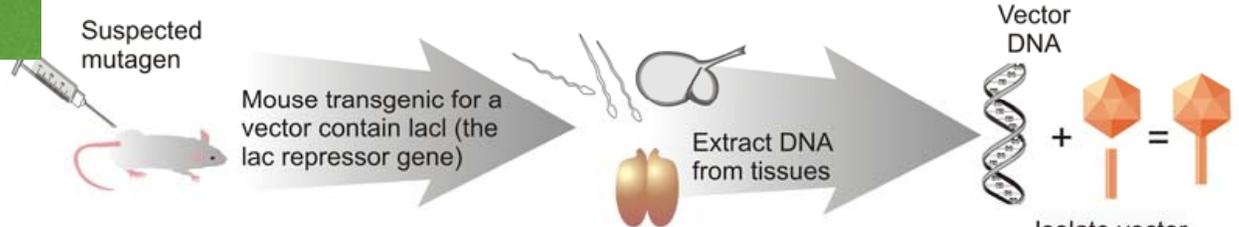
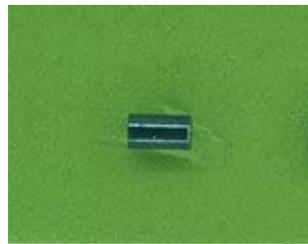
Miller *et al.*, *Radiation Measurements*, 42:6-7:1090, 2007.

<u>Uranium Isotopes:</u>	<u>Specific Activity</u>
²³⁵ U	2.2
DU	0.43
²³⁸ U	0.33

Use of Uranium Isotopes to Evaluate *In vivo* Effects

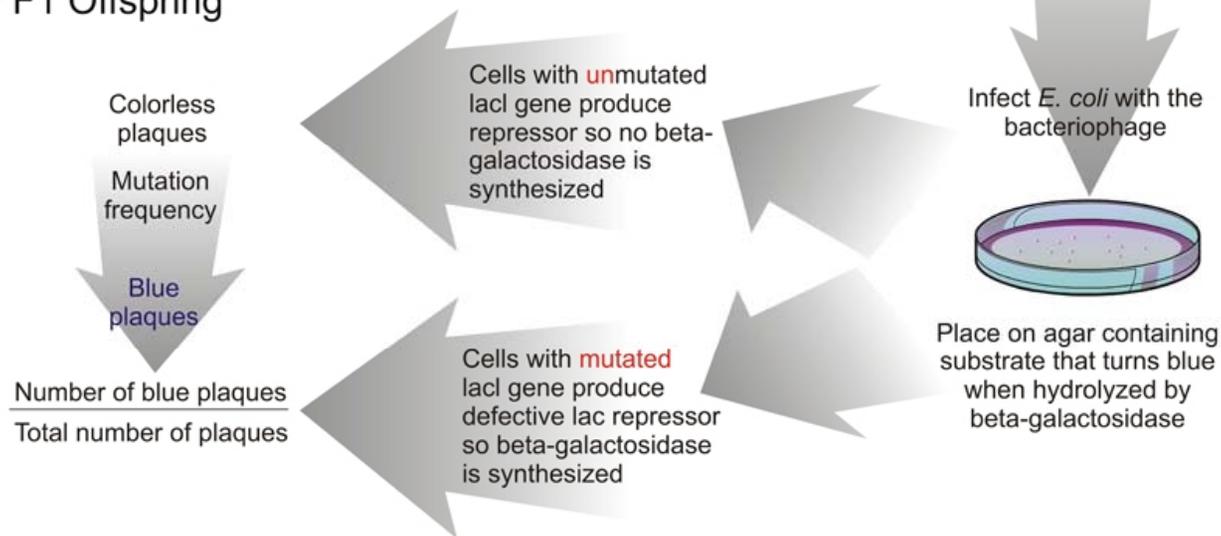
Model to Assess Transgenerational Effects of Radiation or Heavy Metals

“Big Blue” Mutation and Offspring Assessment Assay

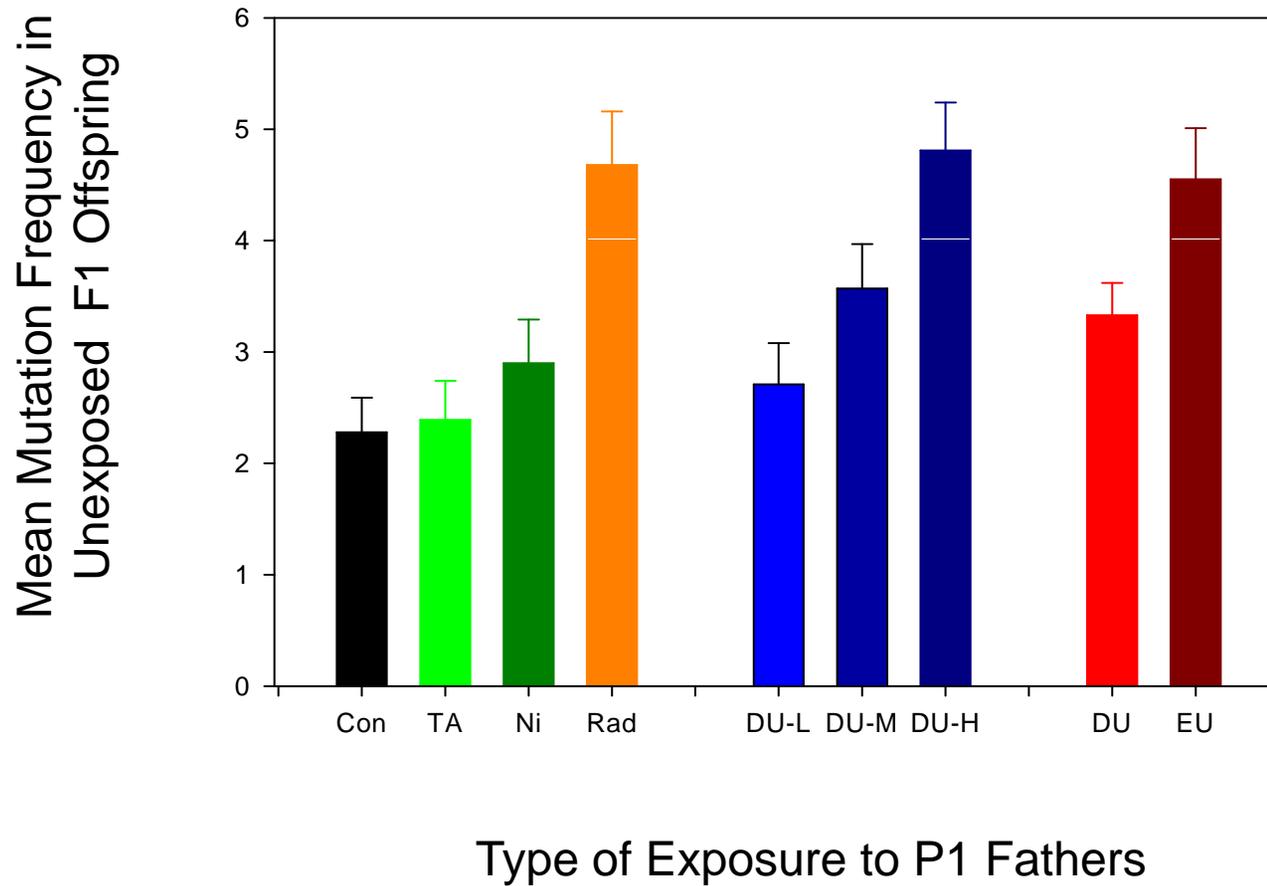


Assay:

- Exposed Parent
- F1 Offspring



Transgenerational Effects of Depleted Uranium: Involvement of Radiation



Miller et al., 2010 *Health Physics*, epub Aug 30, 2010

Conclusions

In vitro

- 1. DU induces neoplastic transformation, mutagenicity, and genotoxicity *in vitro*.**
- 2. Radiation effects are associated with DU-induced neoplastic transformation, mutagenicity, and chromosomal damage.**

In vivo

- 1. Radiation Effects are associated with transgenerational genomic instability**

Acknowledgements

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