



Lawrence Berkeley National Laboratory



U.S. DEPARTMENT OF  
**ENERGY**

## A Murine Melanoma Growth Suppression Case Study for Pb-212

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LBNL - Chemical Sciences Division

2021 Isotope User Group Meeting – Pb-212  
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# Elements with Isotopes of Interest for Targeted Alpha-Therapy

## Considerations:

- Half life
- Radiation type
- Activity & daughters
- Chemical properties
- Availability

**Periodic Table of the Elements**

1 <b>H</b> Hydrogen 1.008	2 <b>He</b> Helium 4.003																
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012											5 <b>B</b> Boron 10.811	6 <b>C</b> Carbon 12.011	7 <b>N</b> Nitrogen 14.007	8 <b>O</b> Oxygen 15.999	9 <b>F</b> Fluorine 18.998	10 <b>Ne</b> Neon 20.180
11 <b>Na</b> Sodium 22.990	12 <b>Mg</b> Magnesium 24.305	3 <b>III B</b> 3B	4 <b>IV B</b> 4B	5 <b>V B</b> 5B	6 <b>VI B</b> 6B	7 <b>VII B</b> 7B	8 <b>VIII</b> 8	9 <b>VIII</b> 8	10 <b>VIII</b> 8	11 <b>IB</b> 1B	12 <b>IIB</b> 2B	13 <b>Al</b> Aluminum 26.982	14 <b>Si</b> Silicon 28.086	15 <b>P</b> Phosphorus 30.974	16 <b>S</b> Sulfur 32.066	17 <b>Cl</b> Chlorine 35.453	18 <b>Ar</b> Argon 39.948
19 <b>K</b> Potassium 39.098	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.956	22 <b>Ti</b> Titanium 47.867	23 <b>V</b> Vanadium 50.942	24 <b>Cr</b> Chromium 51.996	25 <b>Mn</b> Manganese 54.938	26 <b>Fe</b> Iron 55.845	27 <b>Co</b> Cobalt 58.933	28 <b>Ni</b> Nickel 58.693	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.38	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.631	33 <b>As</b> Arsenic 74.922	34 <b>Se</b> Selenium 78.971	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 83.798
37 <b>Rb</b> Rubidium 85.468	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.906	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.906	42 <b>Mo</b> Molybdenum 95.95	43 <b>Tc</b> Technetium 98.907	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.906	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.868	48 <b>Cd</b> Cadmium 112.414	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.711	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.6	53 <b>I</b> Iodine 126.904	54 <b>Xe</b> Xenon 131.294
55 <b>Cs</b> Cesium 132.905	56 <b>Ba</b> Barium 137.328	57-71	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.948	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.217	78 <b>Pt</b> Platinum 195.085	79 <b>Au</b> Gold 196.967	80 <b>Hg</b> Mercury 200.592	81 <b>Tl</b> Thallium 204.383	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.980	84 <b>Po</b> Polonium [208.982]	85 <b>At</b> Astatine 209.987	86 <b>Rn</b> Radon 222.018
87 <b>Fr</b> Francium 223.020	88 <b>Ra</b> Radium 226.025	89-103	104 <b>Rf</b> Rutherfordium [261]	105 <b>Db</b> Dubnium [262]	106 <b>Sg</b> Seaborgium [266]	107 <b>Bh</b> Bohrium [264]	108 <b>Hs</b> Hassium [269]	109 <b>Mt</b> Meitnerium [278]	110 <b>Ds</b> Darmstadtium [281]	111 <b>Rg</b> Roentgenium [280]	112 <b>Cn</b> Copernicium [285]	113 <b>Nh</b> Nihonium [286]	114 <b>Fl</b> Flerovium [289]	115 <b>Mc</b> Moscovium [289]	116 <b>Lv</b> Livermorium [293]	117 <b>Ts</b> Tennessine [294]	118 <b>Og</b> Oganesson [294]

- U-230 (20 d)
- Th-227 (18 d)
- Ac-225 (10 d)
- Ra-223 (11 d)
- Pb-212 (10.6 h)
- At-211 (7.2 h)
- Bi-213 (46 min)

Lanthanide Series	57 <b>La</b> Lanthanum 138.905	58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.908	60 <b>Nd</b> Neodymium 144.243	61 <b>Pm</b> Promethium 144.913	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.925	66 <b>Dy</b> Dysprosium 162.500	67 <b>Ho</b> Holmium 164.930	68 <b>Er</b> Erbium 167.259	69 <b>Tm</b> Thulium 168.934	70 <b>Yb</b> Ytterbium 173.055	71 <b>Lu</b> Lutetium 174.967
Actinide Series	89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]

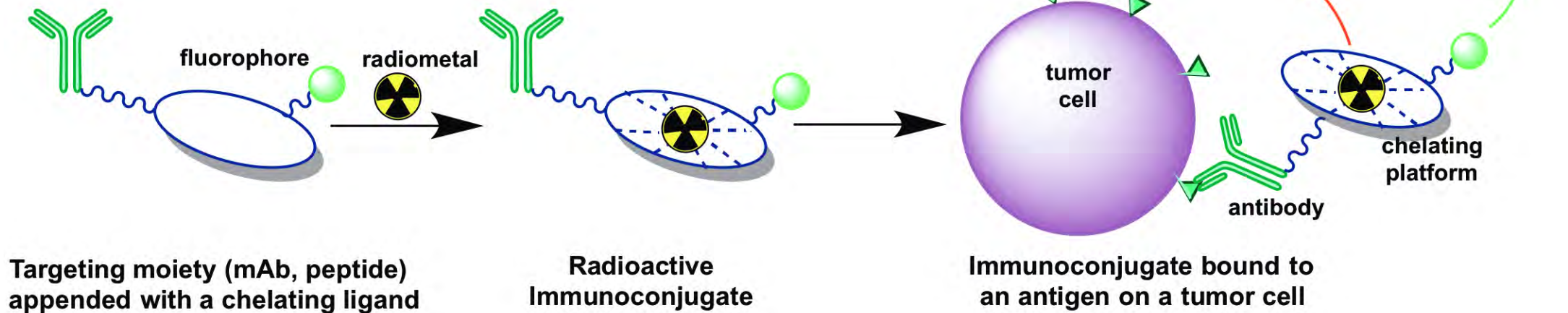
# Radiolabeling Biological Molecules with Radiometals

Periodic Table of the Elements

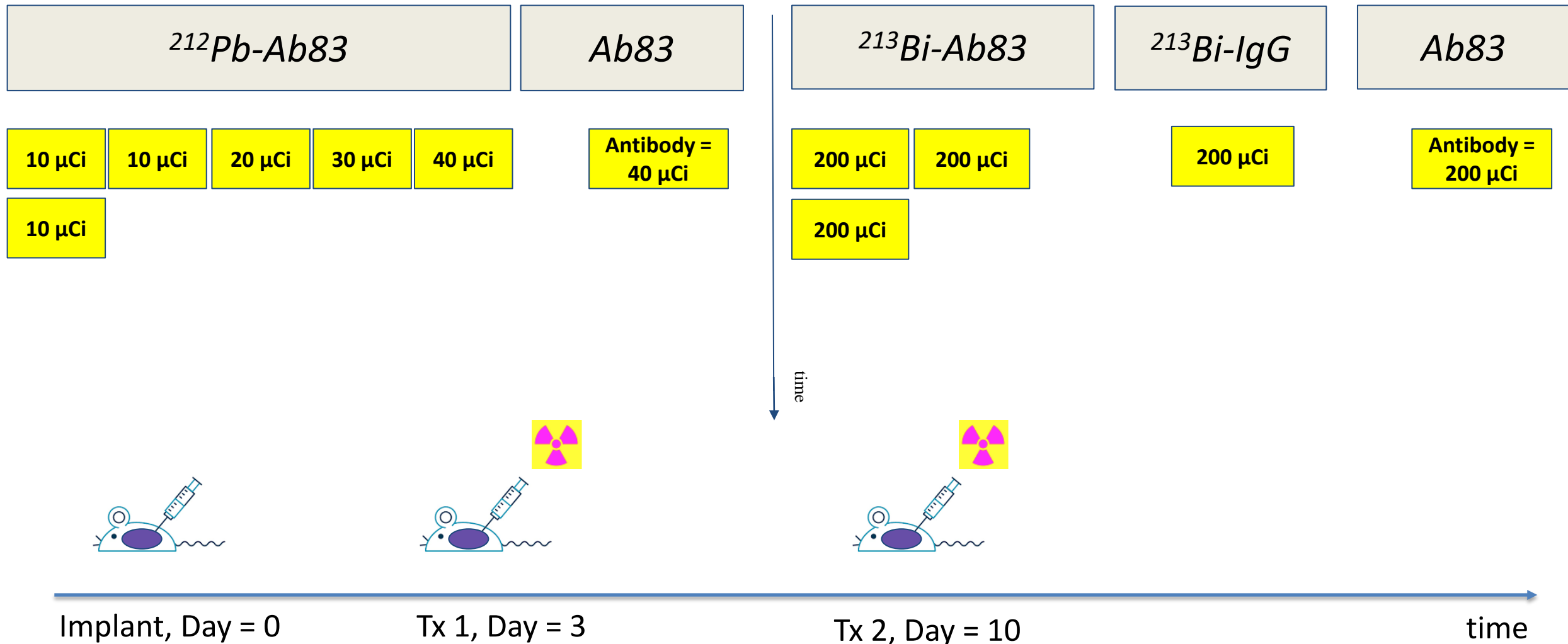
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## Considerations:

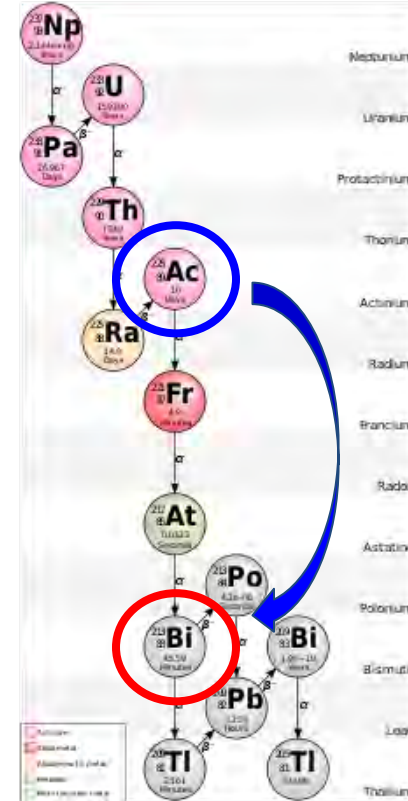
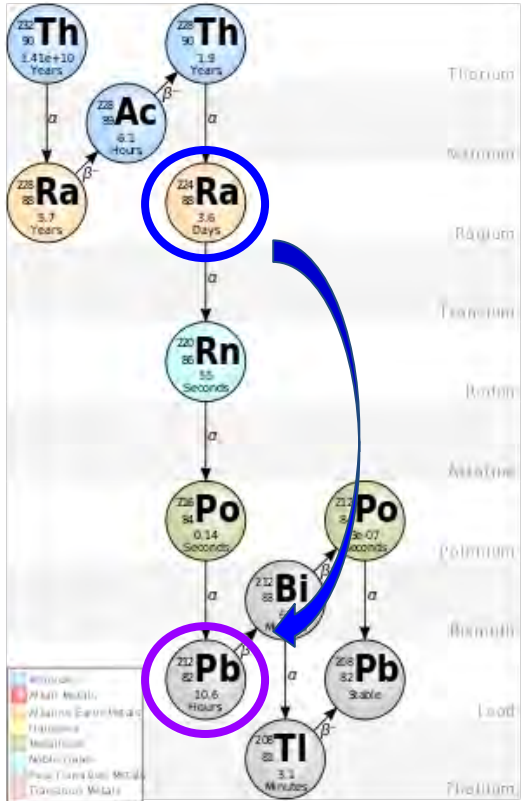
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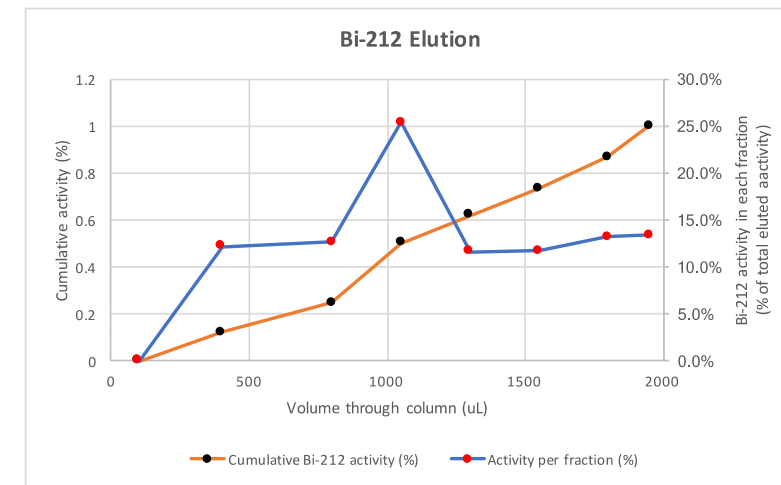
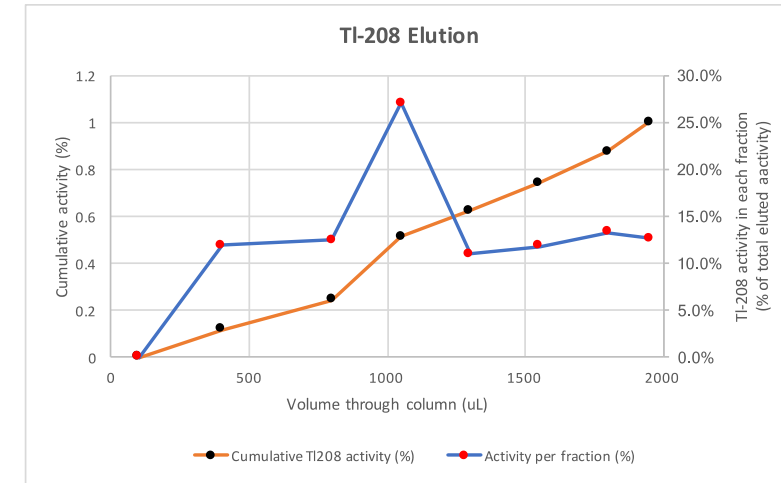
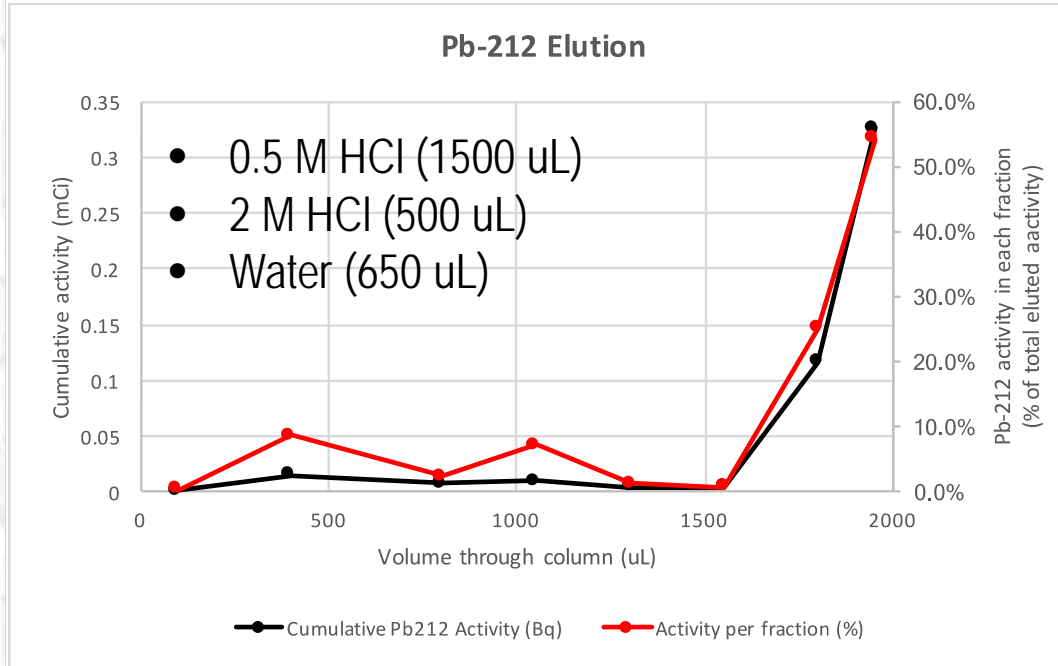
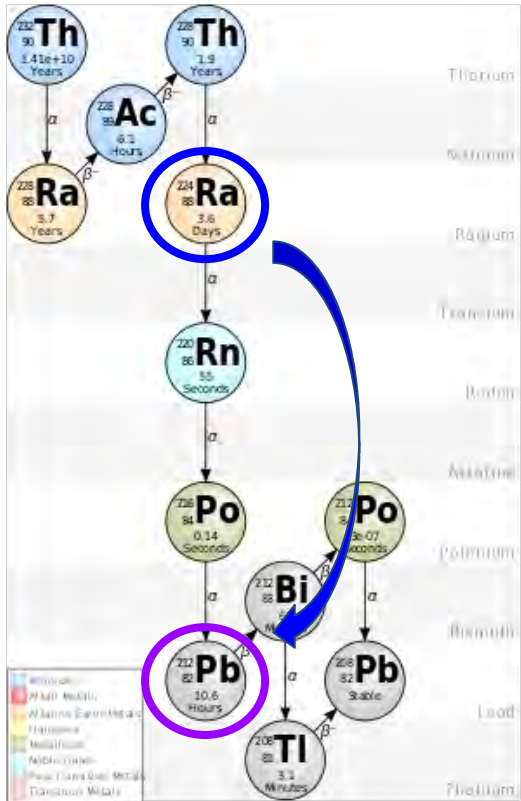
# Murine Melanoma Growth Suppression Study Design – Bi-213 vs Pb-212



# Different Radiometals $\leftrightarrow$ Different Generators

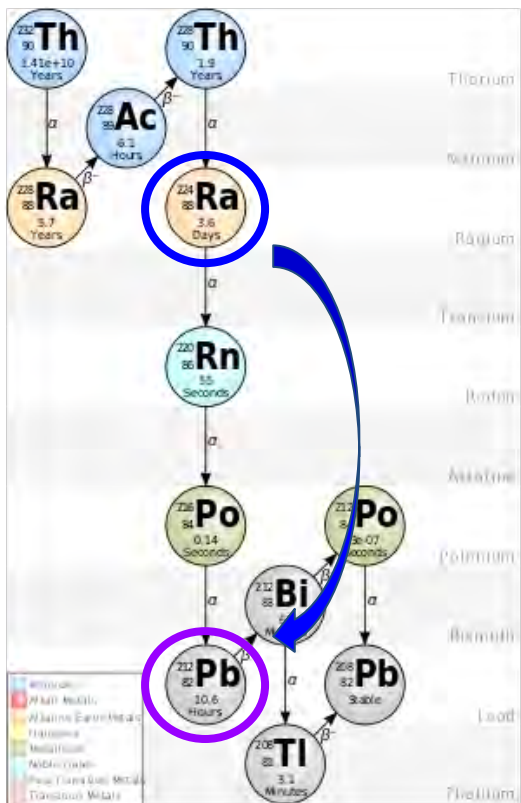


# Different Radiometals $\leftrightarrow$ Different Generators

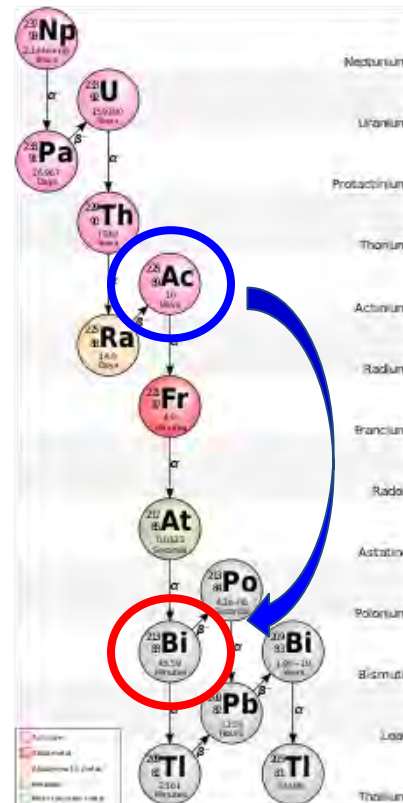
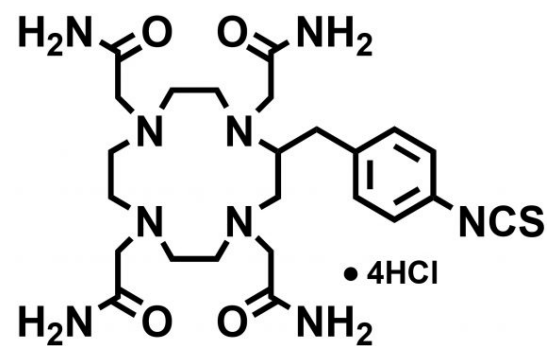


- Is matrix exchange necessary?

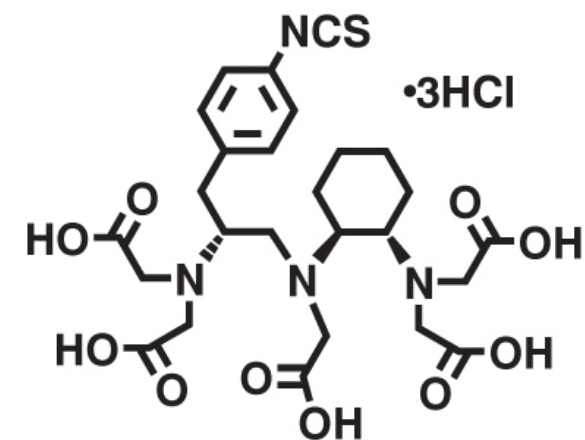
# Different Radiometals $\leftrightarrow$ Different Chelators



p-SCN-Bn-TCMC



p-SCN-Bn-CHX-A''-DTPA



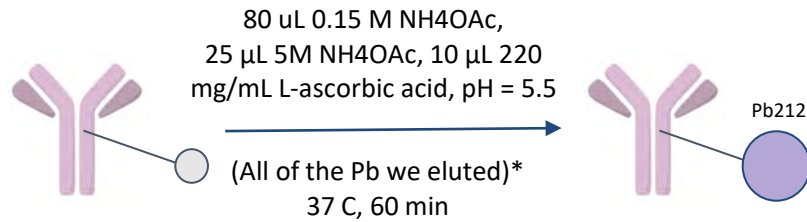
# Antibody Labeling

## CAR +/- sd

<b>Ab83-CHX-A'</b>	<b>1.86 +/- 0.38</b>
<b>Ab83-TCMC</b>	<b>3.039 +/- 0.45</b>
<b>IgG-CHX-A'</b>	<b>2.058 +/- 0.15</b>

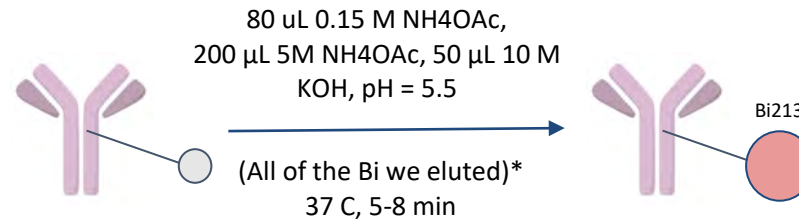
## Pb-212 Radiolabeling

Date	RadioPurity (%)
5/7	92.93
5/8	87.94
5/14	61.06
5/15	81.76
5/20	30.26
5/20	28.11

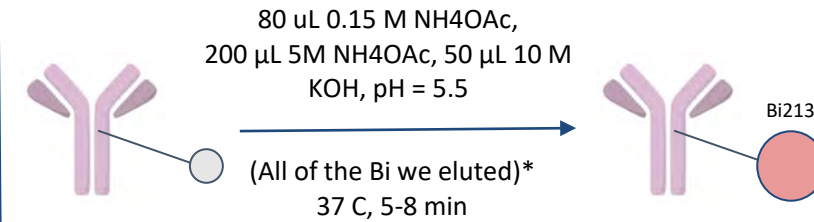


\*H8C3-TCMC concentration was 4 mg/mL for radiolabeling.

**<sup>212</sup>Pb-Ab83**



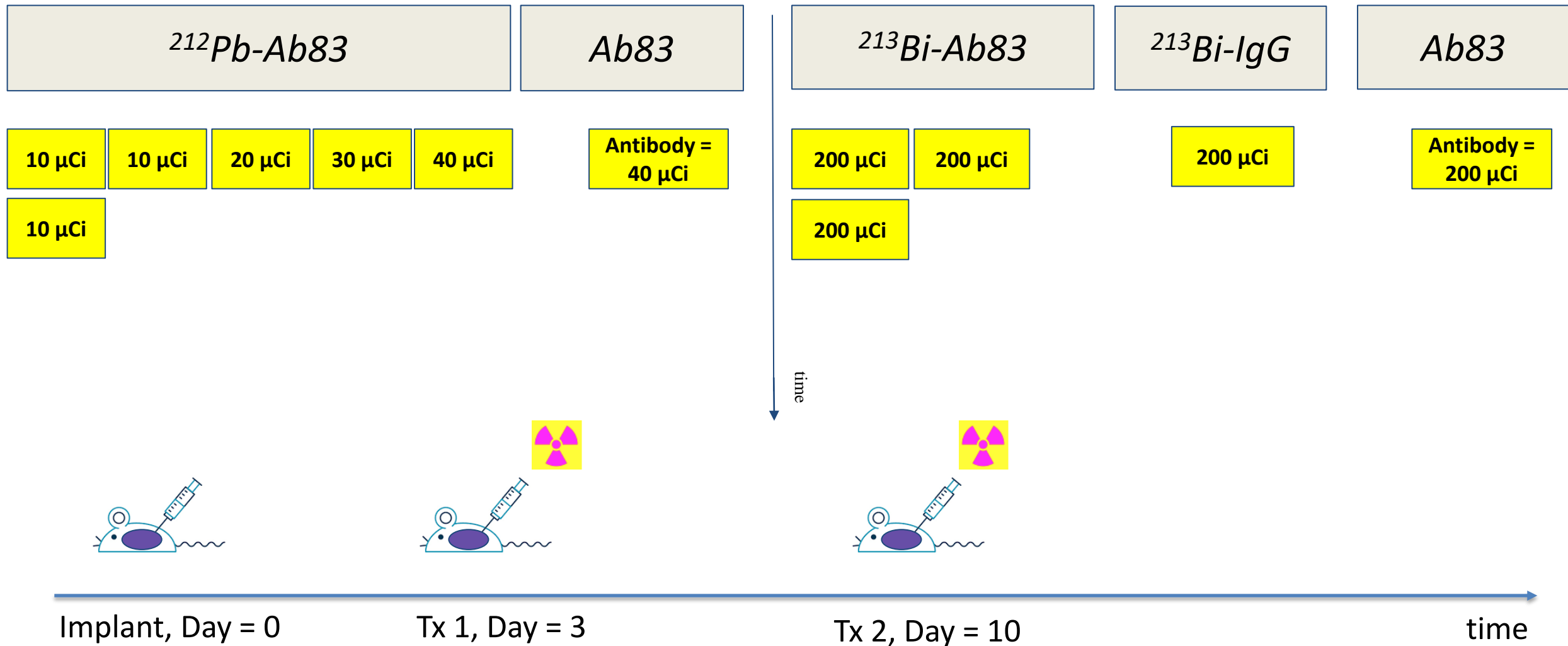
**<sup>213</sup>Bi-Ab83**



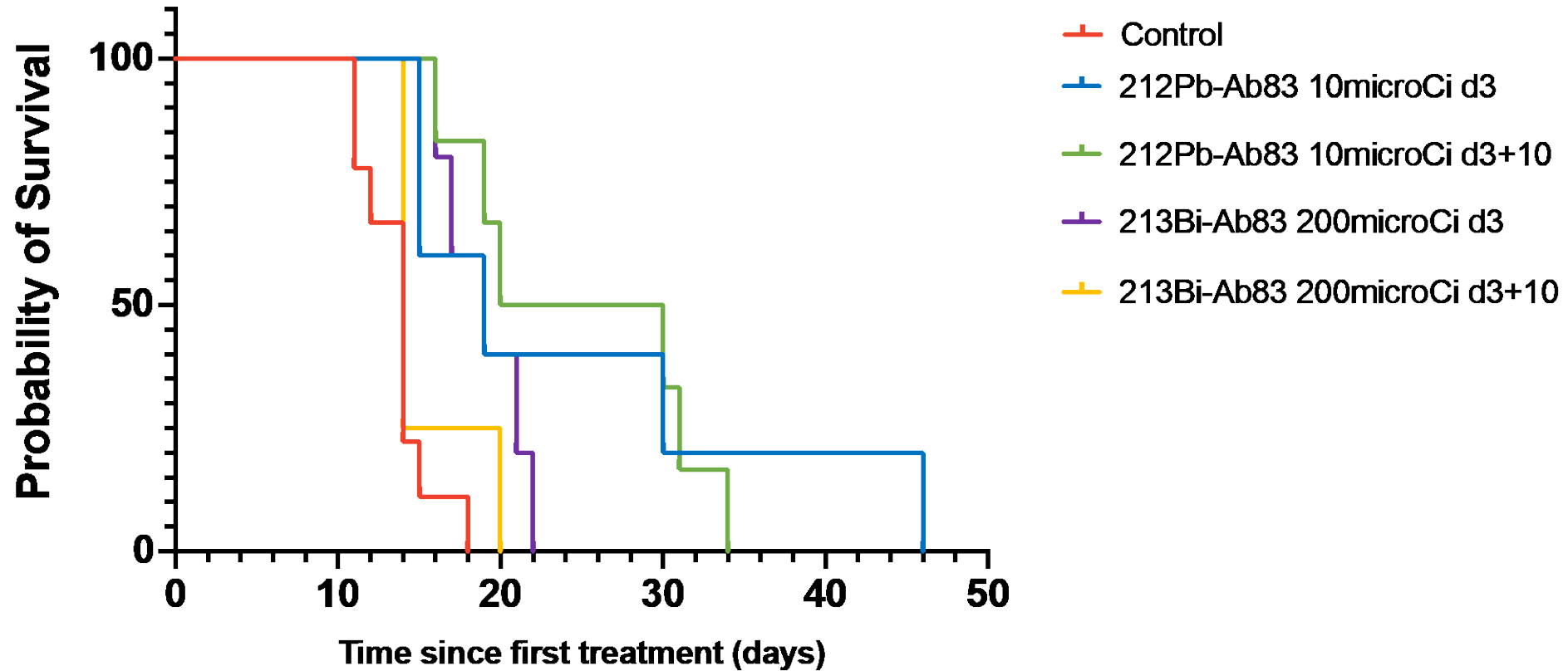
**<sup>213</sup>Bi-IgG**



# Murine Melanoma Growth Suppression Study Design



# Murine Melanoma Growth Suppression Study – $^{213}\text{Bi}$ vs $^{212}\text{Pb}$



Median survivals: 14d, 19d, 25d, 19d, 14d (Log-rank test  $P = 0.0001$ )

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Dr. Jen Wacker (PD)

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Matt Flick (PostBac)

Josh Chen (PostBac)

Carly Hui (Ugrad)

Jesus Rios (Ugrad)

Hailie O'Bryan (Ugrad)

Elizabeth Wang (Ugrad)

Emily Greer (Ugrad)

Fion Chang (Ugrad)

Vicky Kang (Ugrad)

## LBNL Radiation Protection

