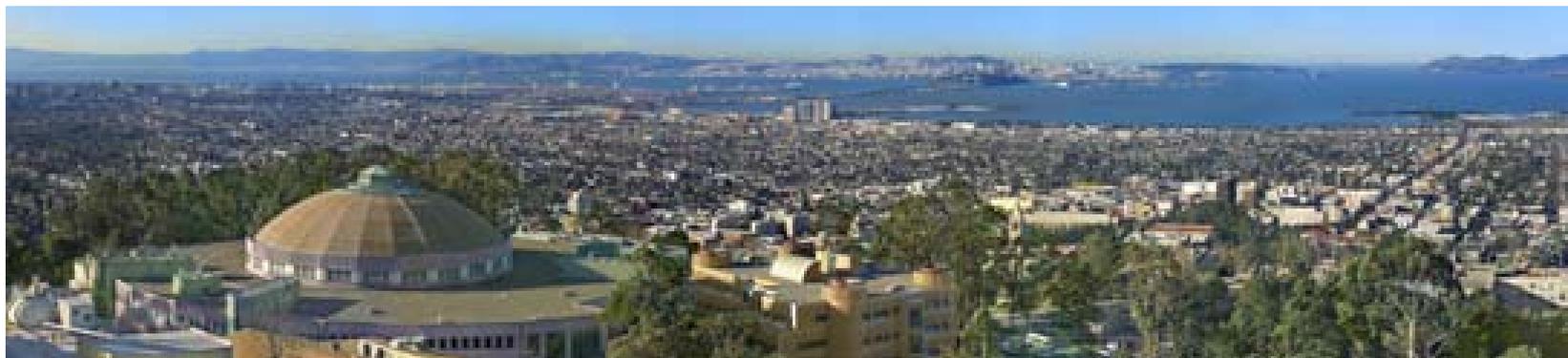


# Introductory Comments for the Inaugural Pat Durbin Memorial Lecture



***Kenneth N. Raymond***

*Glenn T. Seaborg Center, Chemical Sciences Division*

*Lawrence Berkeley National Laboratory, Berkeley, CA 94720 USA*

**April 13, 2010**

**April 7, 1927 – March 5, 2009**

- **NCRP's 31st Lauriston S. Taylor Lecturer, 2007**

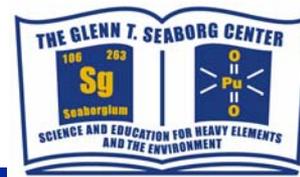
**Selected for the Taylor lectureship, the NCRP's highest award, for her scientific contributions to the field of actinide chemistry and biology, her commitment to radiation protection, and her 50 years of service to the NCRP.**

- **Fellow of the Health Physics Society, 1985**
- **Health Physics Society Scientific Achievement Award, 1984**





# Pat's Oral History



*Medical Physics Oral History Series*

## Radionuclide Research at Crocker Laboratory and the Lawrence Berkeley Laboratory

Patricia C. Wallace Durbin-Heavey

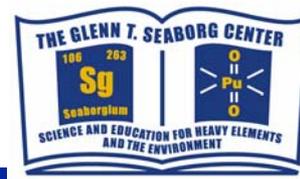
*Interviews Conducted by  
Sally Smith Hughes, Ph.D.  
in 1979 and 1980*

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[http://content.cdlib.org/view?docId=kt3s2004wc&brand=calisphere&doc.view=entire\\_text](http://content.cdlib.org/view?docId=kt3s2004wc&brand=calisphere&doc.view=entire_text)



# Pat's Background



## Hughes

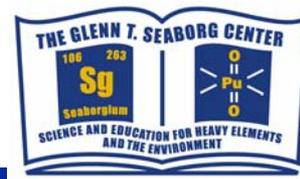
Dr. Durbin, I would like to start with your grandparents. Could you tell me, on both sides, where they came from, what their education was, and what they did?

## Durbin

I know a lot more about my maternal grandparents than I do about my father's family. My maternal grandparents were both native Californians. They lived in Plumas County; both were born in Plumas County or close by. My grandmother, Edna Elim, went to the state normal school at Chico about the turn of the century and probably, apart from her grandfather, Dr. Pratt, who was a physician who settled in Chico, was the best educated member of her family. Another one of her sisters became a nurse, but I'm not sure that the length of education and so on for nursing at the turn of the century was as exacting as it was for people who were preparing to be school teachers.



# Pat starts at Berkeley



## Hughes

What about your undergraduate education?

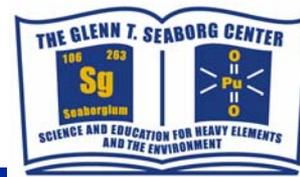
## Durbin

I looked at the catalogue again, not wanting to do anything more than I absolutely had to. The catalogue said that if you took a bachelor's degree in chemistry in the College of Letters and Science that in the lower division you had to have all these requirements in things like English, philosophy, and music appreciation, and so on. But if you matriculated in the College of Chemistry you didn't have to have any of those things. You did, however, have to take some heavier science courses. So that sounded to me like a much better deal.

I think that again the advising system at Berkeley in 1944 was something beyond belief. The entering freshmen gathered at the women's gym and we sat in kind of an auditorium seating arrangement. As your turn came, you got to go up and sit at this table with one of these half a dozen advisers. I have no notion who it was that I talked to but he had never heard of the College of Chemistry and had to look in the catalogue to make sure there was such a place before he would sign my slip that said I could go into this program.



# Pat and Crocker Lab



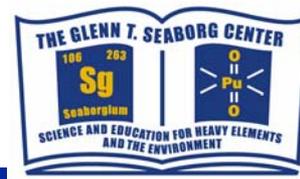
## Durbin

This shows you how it's possible to go around--even somebody who happens to be curious and reasonably alert--without ever noticing something which is absolutely next door. Geographically, the freshman chemistry laboratory was where the upper end of Latimer Hall is now. Right next to the freshmen chemistry laboratory, out the windows of the room where I had taken freshman chemistry, was this other funny building which had two stories on one end and one on the other end.

The back end of this funny building housed the 60-inch cyclotron and this was the Crocker Laboratory. There was barbed wire around it and lights on it at night and a guard and I never even noticed it. Never even noticed it! It was embarrassing, although perhaps subliminally I had noticed it. But I had no recollection of even knowing that the thing existed before the day I walked in there to interview for a job.



# Pat and Family Life



By this time, I had a boyfriend. Now, my name is Patricia Wallace. In 1953 I married the sportswriter Frank Durbin. We had been going together and engaged since 1949 and he lived out in Pittsburg, California, which is not too far away. He had absolutely delightful parents--wonderful, lovely people. His mother went to junior college at the Sacred Heart Academy down in Belmont (I guess it's Belmont) and his father almost finished a degree in agricultural science at Oregon State at Corvallis. They thought it was neat that I was going to graduate school.

When Frank Durbin and I finally separated, I had already published some things under that name and some colleagues, from Oak Ridge particularly, said, "Oh, you can't do this to us. You can't go back to Wallace. Suppose you married again. Everybody will be so confused." So I decided that I owed Dad Durbin something and so I just have kept Durbin as a professional name.

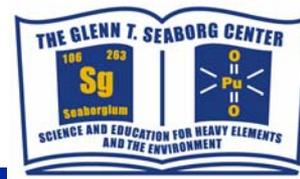
[Pat later married James Heavey, who brought to the marriage four children from a previous marriage (Loanne Slapar, James Heavey, Kevin Heavey and Kerry Sundberg), and with Jim bore her daughter Lenore Heavey. And when asked "What about being a scientist and a mother and a wife?"

## Durbin

That's right. And it's all worth it in the end when you get a copy of the beautiful high school graduation picture [of your child], with what other people would think was a corny sentiment, but it's practically a tear jerker, and it's all worthwhile.



# Pat and Radiation Biophysics



## Employment

1995–†	Senior Scientist, Actinide Chemistry Group, Chemical Sciences Division, LBNL
1991–1995	Senior Scientist (retired), Research Medicine and Radiation Biophysics Div., LBNL
1978–1991	Staff Senior Physiologist, Biology & Medicine, LBNL
1953–1978	Physiologist, Biology Medicine Division, LBNL

## Other Experience and Professional Memberships

1956–present	National Council on Radiation Protection
1993–present	Honorary Council Member
1998–present	Comm. 57-17 on Radionuclide Dosimetry Models for Wounds
1977–1993	Council Member
1985–1991	Comm. 57-12 on Metabolism and Effects of $^{90}\text{Sr}$
1977–1985	Comm. 57 on Internal Dose
1956–present	National Council on Radiation Protection
1969–1976	Comm. 30 on Physical and Biological Properties of Radionuclides
1956–1969	Comm. II on Internal Dose
1976–1985	National Academy of Sciences, National Research Council
1977–1989	U.S. Transuranium and Uranium Registries Advisory Committee
1977–1989	Committee on Dosimetry
1982–1985	Panel on Oak Ridge National Laboratory Wastes
1979–1981	Committee on Federal Research on The Effects of Ionizing Radiation

# Pat and Actinide-Specific Sequestering Agents

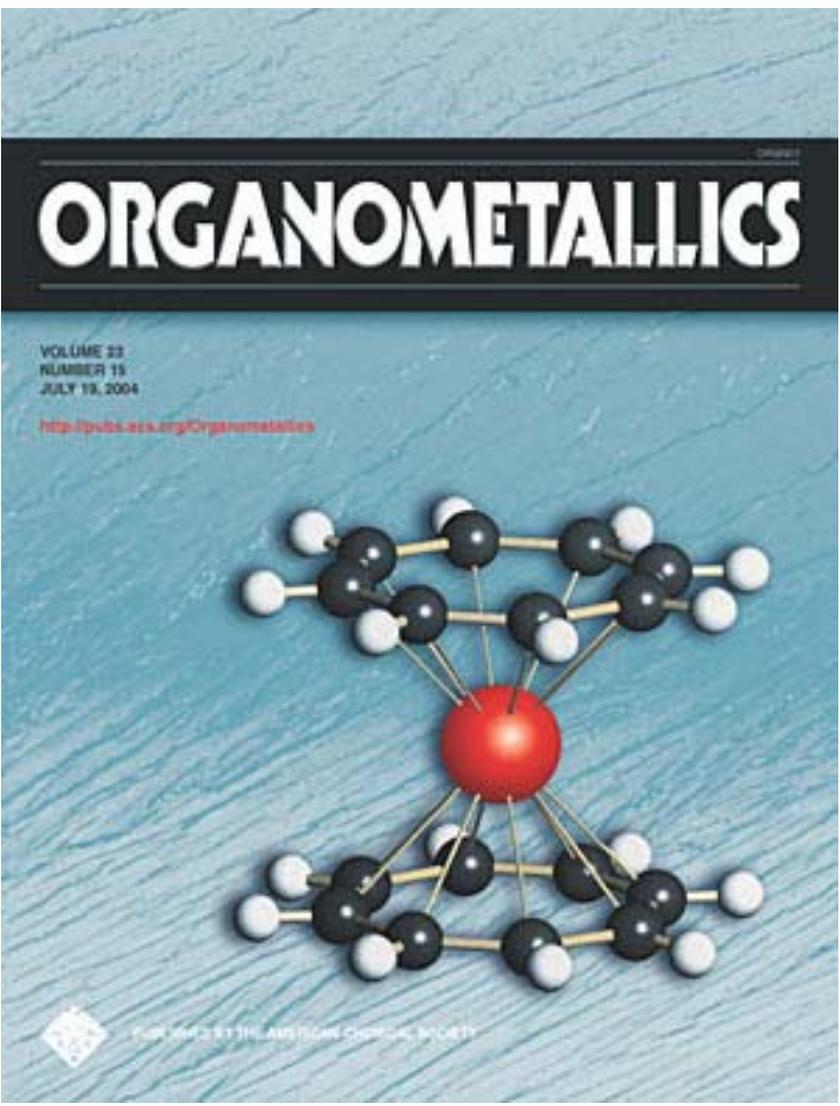
Pat in 1976, about the time she began her collaboration with my research group on the development of actinide-specific sequestering agents.

In 1975 the Actinide Group at LBNL began under the leadership of Norman Edelstein. It brought together Norman and Jerry Bucher (previously of the Seaborg program), and Andy Streitwieser and me from campus. Work on our catechol ligands was reported on by Steve Sofen at the noontime Actinide group meetings that were held every two weeks. Seaborg was a frequent attendee. We wrote an LDRD with Pat with the goal of making plutonium specific sequestering agents, including synthesis, thermodynamic evaluation and mouse tests.



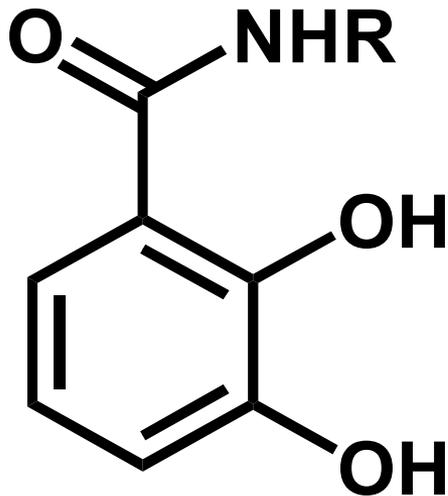
Patricia Durbin-Heavey, 1976.

(photo courtesy of Lawrence Berkeley Lab Photographic Services)

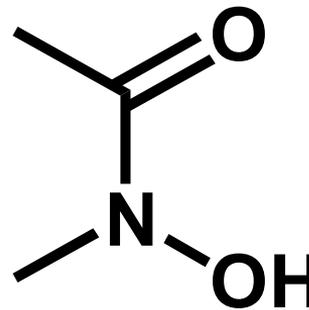


**Kenneth Raymond and Andrew Streitwieser in 1978, at the celebration of the 10th anniversary of the discovery of uranocene**

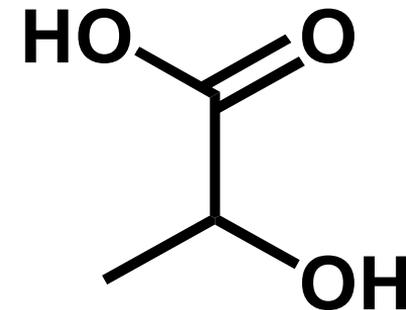
- Ferric ion chelators of the microbial world
- High formation constants
- Three common binding groups



catecholamide



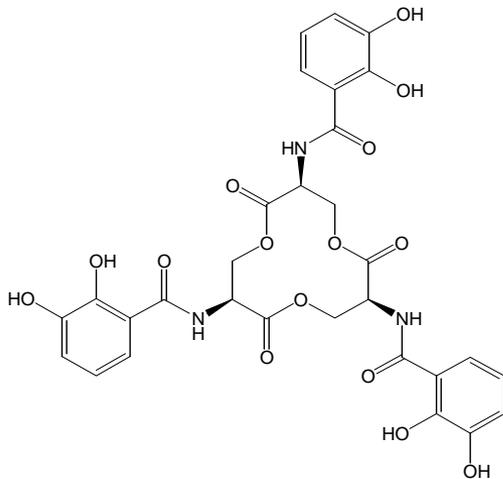
hydroxamic acid



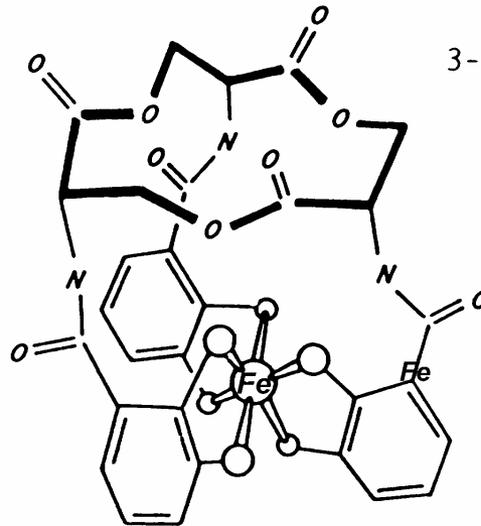
$\alpha$  - hydroxycarboxylic  
acid

# The Siderophore Hypothesis

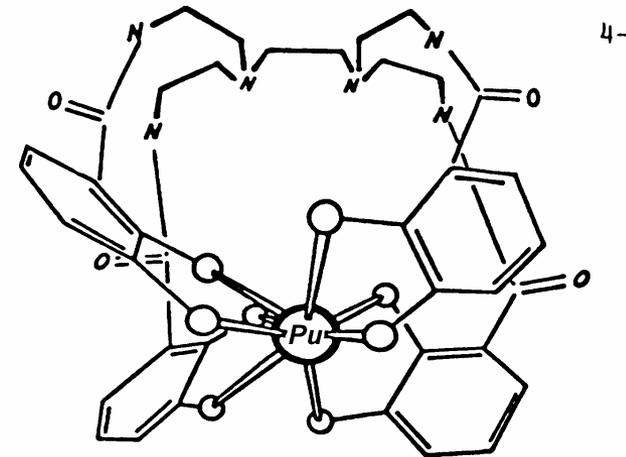
- Modeled after enterobactin, actinide sequestering agents are composed of catecholate and HOPO chelating subunits attached to various molecular backbones via amide linkages, to match the coordination environment of specific actinide ions.



Enterobactin



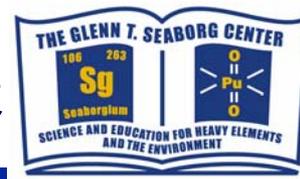
Fe Enterobactin Complex



Modeled Pu(IV) Complex



# Plutonium– Important & Toxic Element

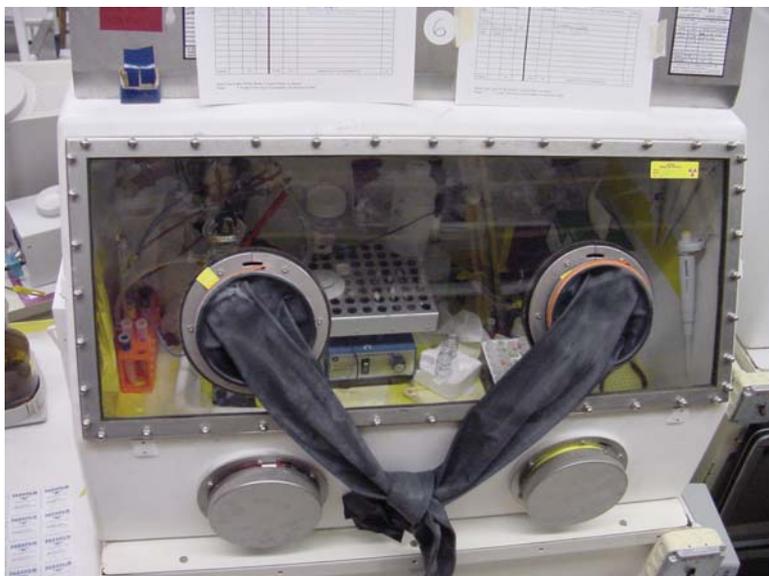
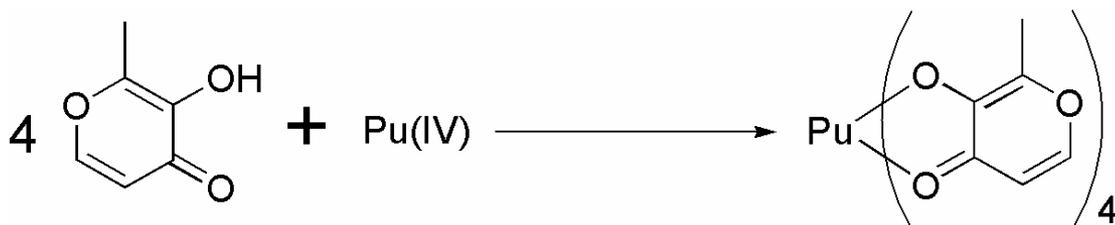


- Strong  $\alpha$ -emitting radionuclide, half-life of 24,360 years.
- Radioactivity is  $2 \times 10^5$  times that of  $^{238}\text{U}$ .
- The biological effects of inhaled Pu include bone neoplasia, which has occurred in animals at dose levels of about 0.01 mCi/g lung.
- A  $\text{PuO}_2$  particle of 1  $\mu\text{m}$  in diameter, weight  $6.0 \times 10^{-12}$  g, is a strong radiation source (0.012 Bq). If inhaled it could give a dose of tens of thousands of Gray (100 rad/Gray) to local neighboring tissue (a dose of 10 Gray to the whole body causes death).
- Annual worldwide production has been estimated to 8,000 kg for the period of 1990-2000.
- More than 6000 kg of plutonium have been released to the environment due to human activities.

Gorden, A. E. V. et al, *Chem. Rev.* **2003**, 4207-82

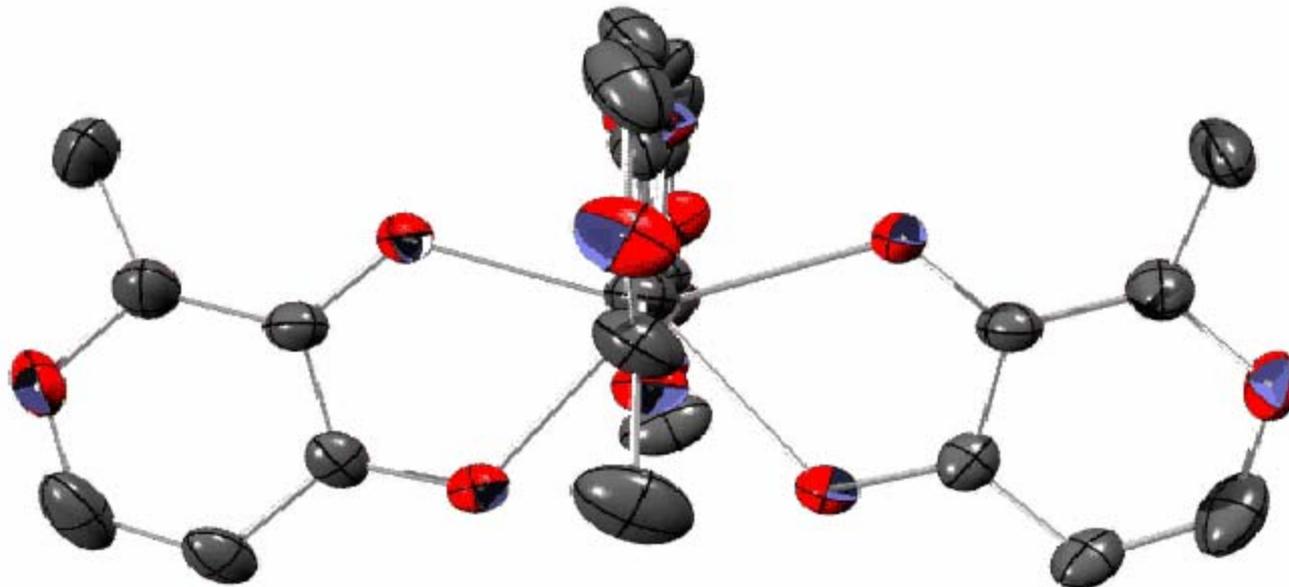
# Pu(maltol)<sub>4</sub>

- Crystallized using evaporation of MeOH/H<sub>2</sub>O solution; → red clusters
- Almost identical to Ce(maltol)<sub>4</sub> structure



0.05 x 0.03 x 0.03 mm<sup>3</sup>

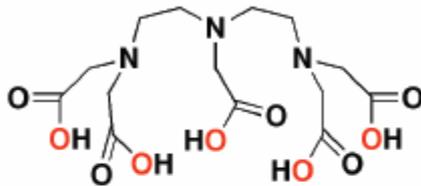
# Crystal Structure of Pu(maltol)<sub>4</sub>



**Pu-O<sub>carbonyl</sub>: 2.406 Å**

**Bite Angle: 67.77°**

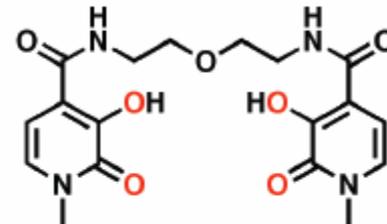
**DTPA: the only approved treatment  
for actinide chelation**



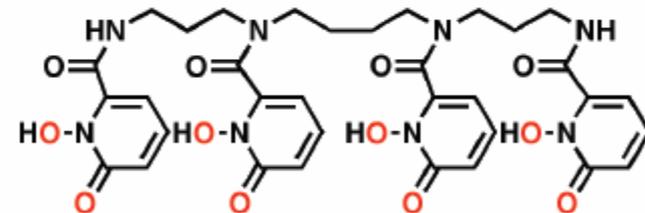
**Diethylenetriamine pentaacetic acid**

- Ameliorates or prevents acute radiation damage and chemical toxicity
- Reduces late radiation effects
- Used as  $\text{CaNa}_3$ - or  $\text{ZnNa}_3$ - salt
- Octadentate ligand
- Poor oral availability
- Efficacy limited to trivalent An

**Selected ligands from a 30-  
year research record at LBNL**



**5-LIO(Me-3,2-HOPO)**

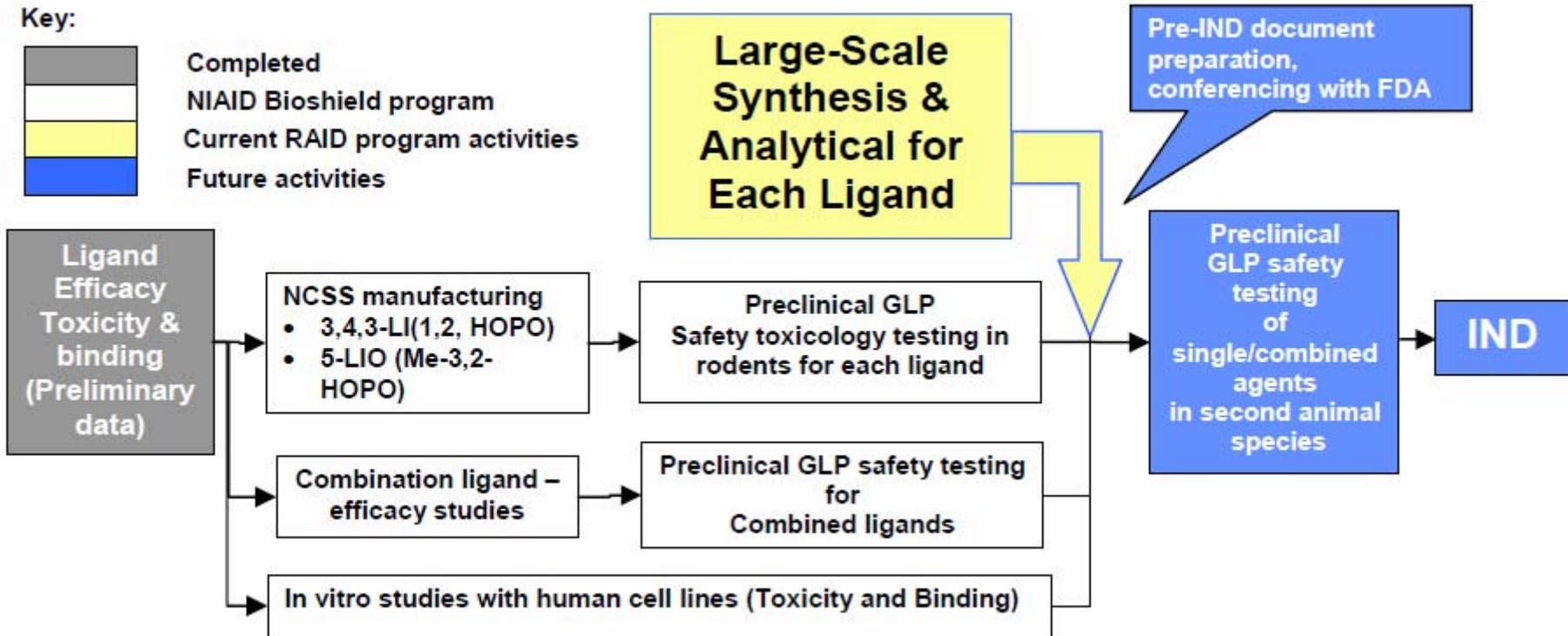


**3,4,3-LI(1,2-HOPO)**

Gorden A.E.V. *et al.*, *Chem. Rev.* **2003**, 103, 4207  
Durbin P. W. *Health Phys.* **2008**, 95, 465

# Bioshield and RAID Plan Objectives

The objective of this research is to bring forth two new decorporation agents in tandem and successfully accelerate their development to pre-IND and IND.

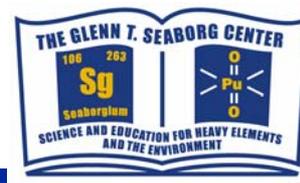


Pat in April 2008 dancing with Dr. Tom Garrett, previously a graduate student with whom she worked in the 1980's, on the occasion of an American Chemical Society award celebration. She had recently written a major review article and another shorter review based on her award of the Lauriston S. Taylor Lecture which she presented in 2007, an honor bestowed by the National Council on Radiation Protection and Measurements. Her lecture entitled "The Quest for Therapeutic Actinide Chelators" was a summary of much of the research of the latter half of her career. She was the doyenne of the health physics community and, more specifically, of the Lawrence Berkeley National Laboratory.





# Inaugural Pat Durbin Memorial Lecture



**Raymond A. Guilmette**, Ph.D., Senior Scientist and Director, Center for Countermeasures Against Radiation (CCAR), Lovelace Respiratory Research Institute, Albuquerque NM

## "It's All About the Dose: A History of Internal Dosimetry Research"

B.S. (Nuclear Engineering) 1968, RPI  
M.S. (Environmental Health Science) 1971, NYU, New York  
Ph.D. (Radiological Health) 1975, NYU, New York  
Postdoctoral Fellow, 1974-1977, ANL (Biological & Medical Research)



Dr. Guilmette is an internationally recognized expert in the biokinetics, dosimetry and health effects from internally deposited radionuclides in animals and humans. He was one of the principal architects of a wound biokinetic model for NCRP (report 156), which has become the international consensus standard for wound dosimetry from incorporated radionuclides. He is a past president of the Health Physics Society, recipient of the HPS Distinguished Scientific Achievement award (2002), and was the G. William Morgan Lecturer at the 2009 HPS annual meeting.

