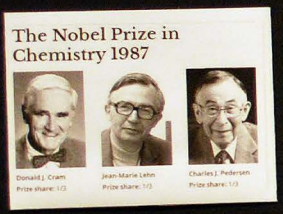
2018

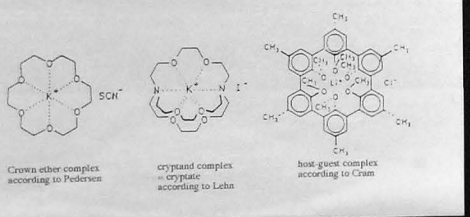
The Scientific Contributions of Donald J. Cram

Leiah Carney
Parkland College

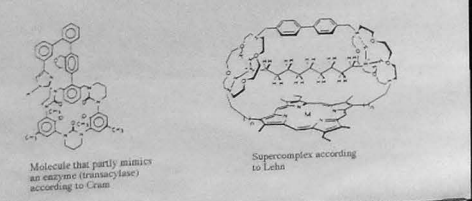
Winning a Nobel Prize

- 1985 Nobel Prize winner with Professor Jean-Marie Lehn and research chemist Charles J Pedersen for their combined work with "development and use of molecules with structure-specific interactions of high selectivity".[1]
- Credited with being the founders of supramolecular chemistry
  - Also referred to as lock and key or host-guest



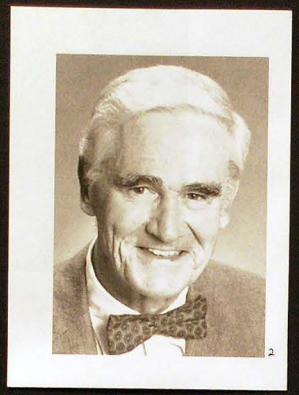


- Cram designed immobile host molecules[1]
  - Strong complexes
  - Extremely selective



The Scientific Contributions of Donald J. Cram

Leiah Carney
CHE 203-001



April 22, 1919 – June 17, 2001

Career

- 1947-1995 (retirement) – University of California, Los Angeles

Awards

- 1965 – American Chemical Society Newby McCoy Award
- 1974 – American Chemical Society Arthur C. Cope Award
- 1974 – California Scientist of the year
- 1975 – American Chemical Society Newby McCoy Award
- 1987 – Nobel Prize for Chemistry

Representative Publications[4]

1. "Container Molecules and Their Guests," by D.J. Cram and J.M. Cram, Monographs in Supramolecular Chemistry, J. Fraser Stoddart, Ed., The Royal Society of Chemistry, Cambridge. 1994.

2. "Spherands: Hosts Preorganized for Binding Cations," by E. Maverick and D.J. Cram, in "Comprehensive Supramolecular Chemistry," Vol. 1, J.-M. Lehn, Ed., Elsevier Science Ltd., 1996.

3. "Carcerands and Hemicarcerands: Hosts that Imprison Molecular Guests," by E. Maverick and D.J. Cram, in "Comprehensive Supramolecular Chemistry," Vol. 2, J.-M. Lehn, Ed., Elsevier Science Ltd., 1996.

4. Hemicarcerands with Interiors Potentially Capable of Binding Large Guests, *J. Chem. Soc., Chem. Commun.*, **1995**, 1085-1087, by Cx-d. Bueche-Hunnefeld, D. Buhring, C.B. Knobler and D.J. Cram.

5. Comparisons of Activation Energies for Dimethyl Sulfoxide Rotations in the Inner Phase of Seven Carcerands, *J. Chem. Soc., Chem. Commun.* **1995**, 1259-1260, by S.K. Kurdistani, T.A. Robbins and D.J. Cram.

6. Comparisons of Activation Energies for Guest Escapes from the Inner Phases of Hemicarcerands with Varying Numbers of Bowl-linking Groups, *J. Chem. Soc., Chem. Commun.* **1995**, 1515-1516, by T.A. Robbins and D.J. Cram.

7. Binding Properties and Crystal Structure of a Hemicarcerand Containing Four Diethylene Glycol Units Connecting Two Bowls, *J. Chem. Soc., Chem. Commun.*, **1995**, 1825-1827, by Y.-S. Byun, D. Vadlau, M.T. Blanda, C.B. Knobler and D.J. Cram.

8. Stepwise Shell Closures Provide Hosts That Expose or Protect Guests from Outer-Phase Reactants, *J. Am. Chem. Soc.*, **1995**, *117*, 1659-1660, by S.K. Kurdistani, R.C. Helgeson and D.J. Cram.

9. Synthesis, Binding Properties and Crystal Structure of a Hemicarcerand Containing Four Pentamethylenedioxy Groups Spanning Two Bowls, *J. Chem. Soc., Chem. Commun.*, **1995**, 1947-1948, by Y.-S. Byun, T.A. Robbins, C.B. Knobler and D.J. Cram.

10. Guest-Assisted and Guest-Inhibited Shell Closures Provide Differently Shaped Carceplexes and Hemicarceplexes, *J. Am. Chem. Soc.*, **1996**, *118*, 5590-5604, by R.C. Helgeson, K. Paek, C.B. Knobler, E.F. Maverick and D.J. Cram.

11. Synthesis, Binding Properties, and Structures of Seven New Hemicarcerands Each Composed of Two Bowls Bridged by Three Tetramethylenedioxy Groups and a Fourth Unique Linkage, *J. Org. Chem.*, **1996**, *61*, 9323-9339, by J. Yoon, C. Shea, K.N. Houk, C.B. Knobler and D.J. Cram.

12. The First Water-Soluble Hemicarceplexes, *J. Chem. Soc., Chem. Commun.*, **1997**, 497-498, by J. Yoon and D.J. Cram.

13. Correlations of Structure with Binding Ability Involving Nine Hemicarcerand Hosts and Twenty-Four Guests, *J. Am. Chem. Soc.*, **1997**, *119*, 3229-3244, by R.C. Helgeson, C.B. Knobler and D.J. Cram.

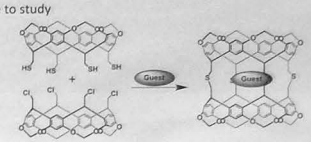
Conclusion

Donald J Cram was a brilliant chemist who made a huge impact in the field of organic chemistry. His work with hemicarcerands and carcerands changed our ability to study unstable molecules. He was able to wrap those previously volatile molecule inside of host molecules, allowing them to be stable and allowing scientists to study them. However, one of his biggest contributions was his role as a professor at the University of California, Los Angeles. He was a professor at University of California, Los Angles from 1947 until his retirement in 1987. During his time as a professor, he directly taught over 12,000 undergraduate organic chemistry students. While winning many awards, including a Nobel Prize for Chemistry, and making a huge impact in the field of chemistry, he would still state that the careers of his co-workers are his finest monument.

A continuation of Donald Crams work

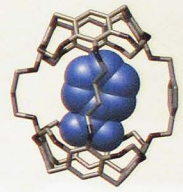
Carcerands

- In the 80's, Donald Cram was the first to develop carcerands
  - A molecular container that can trap guest species
  - Guest is unable to leave
  - The union is called a carceplex
- Carcerands are very selective when choosing a guest
- Carcerands allow the study of volatile substances that were previously impossible to study

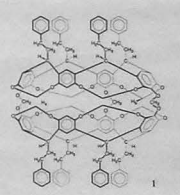


Hemicarcerand

- With the creation of hemicarcerand, the guest was able to leave
- When the guest is present, they car called hemicarceplexes



- By synthesizing cyclobutadine inside of this hemicarcerand they were able to study it[6]
- To synthesize it inside of the hemicarcerand they had to go through multiple reactions[6]
  - One biomolecular
  - Three photochemical
  - Two thermal



References

1. The Official Web Site of the Nobel Prize. Press Release. https://www.nobelprize.org/nobel_prizes/chemistry/laureates/1987/press.html (accessed April 11, 2018)
2. The Official Web Site of the Nobel Prize. Donald J. Cram – Facts. https://www.nobelprize.org/nobel_prizes/chemistry/laureates/1987/cram-facts.html (accessed April 11, 2018)
3. NNDB Tracking the Entire World. Donald J. Cram. http://www.nndb.com/people/671/000103171/ (accessed April 11, 2018)
4. UCLA. Donald J. Cram. http://www.chem.ucla.edu/dept/Faculty/cram.html (accessed April 11, 2018)
5. Cram, D. J.; Tanner, M. E.; Thomas, R. The Taming of Cyclobutadiene https://onlinelibrary.wiley.com/doi/abs/10.1002/anie.199110241 (accessed Apr 17, 2018).
6. Main Page https://www.wikipedia.org/ (accessed Apr 17, 2018).
7. Cram, D. J.; Tanner, M. E.; Thomas, R. The Taming of Cyclobutadiene https://onlinelibrary.wiley.com/doi/abs/10.1002/anie.199110241 (accessed Apr 17, 2018).