Stanford



James Collman

George A. and Hilda M. Daubert Professor of Chemistry, Emeritus

CONTACT INFORMATION

- **Administrative Contact**

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Bio

BIO

Professor Emeritus James Collman has made landmark contributions to inorganic chemistry, metal ion biochemistry, homogeneous catalysis, and transition metal organometallic chemistry. He pioneered numerous now-popular research tools to reveal key structural and functional details of metalloenzymes essential to respiration and energy, and hemoglobin and myoglobin, essential to oxygen transport in the blood.

Born 1932 in Beatrice, Nebraska, James P. Collman studied chemistry at U. Nebraska–Lincoln (B.S. 1954, M.S. 1956). His doctoral work at U. Illinois at Urbana-Champaign (Ph.D., 1958) focused on Grignard reagents. As a faculty member at U. North Carolina, he demonstrated aromatic reactivity in metal acetylacetonates, and he developed metal complexes that hydrolyze peptide bonds under physiological conditions. He came to Stanford University as Professor of Chemistry in 1967. Among many honors, Prof. Collman's was elected to the National academy of Sciences in 1975, and named California Scientist of the Year in 1983.

At Stanford, Prof. Collman invented a new paradigm for studying biological systems using functional synthetic analogs of metal-containing enzyme systems, free from the protein coatings that can affect metalloprotein chemical properties. This strategy allowed him to elucidate the intrinsic reactivity of the metal center as well as the effects of protein-metal interactions on biological function.

One focal point of this research has involved heme-proteins such as the oxygen (O2) carrier hemoglobin (Hb), and the O2-storing protein myoglobin (Mb). Prof. Collman was the first to prepare and characterize stable, functional analogues of the Hb and Mb active sites, which contain an iron derivative of the large flat "porphyrin" ligand. In his "picket fence" porphyrin, groups installed on the periphery block side reactions, which would otherwise degrade the structure. This protected iron complex manifests the unique magnetic, spectroscopic and structural characteristics of the O2-binding Hb and Mb sites, and exhibits very similar O2-binding affinities.

The Collman Group also prepared functional mimics of the O2-binding/reducing site in a key respiration enzyme, cytochrome c oxidase, CcO, which converts O2 to H2O during biosynthesis of the energy storage molecule ATP. This enzyme must be very selective: partial O2 reduction products are

toxic. Prof. Collman invented a powerful synthetic strategy to create analogs of the CcO active site and applied novel electrochemical techniques to demonstrate that these models catalyze the reduction of O2 to water without producing toxic partially-reduced species. He was able to mimic slow, rate-limiting electron delivery by attaching his CcO model to a liquid-crystalline membrane using “click chemistry.” He demonstrated that hydrogen sulfide molecules and heterocycles reversibly bind to the metal centers at CcO’s active site, connecting a synthetic enzyme model to simple molecules that reversibly inhibit respiration. These respiration inhibitors exhibit physiological properties, affecting blood clotting and controlling the effects of the hormone, nitric oxide, NO.

In addition, Prof. Collman performed fundamental studies of organometallic reactions. He also prepared and characterized homodinuclear and heterodinuclear complexes having metal-metal multiple bonds, and made the first measurements of the rotational barriers found in multiple metal-metal bonds.

Prof. Collman’s impactful textbook “Principles and Applications of Organotransition Metal Chemistry” has seen multiple editions. His book “Naturally Dangerous: Surprising Facts About Food, Health, and the Environment” explains the science behind everyday life, and received favorable reviews in Nature and The Washington Post.

ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Chemistry

ADMINISTRATIVE APPOINTMENTS

- Professor of Chemistry, Stanford University, (1967- present)
- Professor of Organic and Inorganic Chemistry, University of North Carolina, (1966-1967)
- Associate Professor, University of North Carolina, (1962-1962)
- Assistant Professor, University of North Carolina, (1959-1962)
- Instructor, University of North Carolina, (1958-1959)

HONORS AND AWARDS

- Ronald Breslow Award for Achievement in Biomimetic Chemistry, American Chemical Society (2009)
- Alfred Bader Award in Bioinorganic or Bioorganic Chemistry, American Chemical Society (1997)
- Pauling Award, American Chemical Society, Puget Sound and Oregon Section (1990)
- Honorary Doctorate, University of Nebraska (1988)
- Docteur Honoris Causa, Universite de Bourgogne, France (1988)
- California Scientist of the Year Award, California Science Center (1983)
- Member, American Academy of Arts and Sciences (1975)
- Member, National Academy of Sciences (1975)
- Award in Inorganic Chemistry, American Chemical Society (1975)
- ACS California Section Award (13 Western States), American Chemical Society (1972)
- International Award in Coordination Chemistry, Japanese Society of Coordination Chemistry (2008)
- The Oesper Award, Cincinnati Section of the American Chemical Society (2007)
- Fellow, American Association for the Advancement of Science (2004)
- Hans Fischer Award in Porphyrin Chemistry, International Conference of Porphyrins and Phthalocyanines, Japan (2002)
- Basolo Medal, American Chemical Society (2000)

- Joseph Chatt Lectureship, Royal Society of Chemistry (1998)
- John C. Bailar Jr. Medal, University of Illinois, Urbana-Champaign (1995)
- Award for Distinguished Service in the Advancement of Inorganic Chemistry, American Chemical Society (1991)
- Arthur C. Cope Scholar Award, American Chemical Society (1986)
- Guggenheim Fellow, John Simon Guggenheim Foundation (1985-86)
- Guggenheim Fellow, John Simon Guggenheim Foundation (1977-78)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Member, Stanford Department of Chemistry Industrial Affiliates Committee
- Member, Stanford Department of Chemistry Executive Committee
- Member, Stanford Department of Chemistry Graduate Admissions Committee

PROFESSIONAL EDUCATION

- PhD, University of Illinois at Urbana-Champaign , Organic Chemistry (1958)
- MS, University of Nebraska , Inorganic Chemistry (1956)
- BS, University of Nebraska , Chemistry (1954)

LINKS

- The Collman Group: http://web.stanford.edu/group/collman/

Publications

PUBLICATIONS

- **Inhibiting platelet-stimulated blood coagulation by inhibition of mitochondrial respiration** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Barile, C. J., Herrmann, P. C., Tyvoll, D. A., Collman, J. P., Decreau, R. A., Bull, B. S.
  2012; 109 (7): 2539-2543
- **Using a functional enzyme model to understand the chemistry behind hydrogen sulfide induced hibernation** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Collman, J. P., Ghosh, S., Dey, A., Decreau, R. A.
  2009; 106 (52): 22090-22095
- **Functional biomimetic models for the active site in the respiratory enzyme cytochrome c oxidase** *CHEMICAL COMMUNICATIONS*
  Collman, J. P., Decreau, R. A.
  2008: 5065-5076
- **A cytochrome c oxidase model catalyzes oxygen to water reduction under rate-limiting electron flux** *SCIENCE*
  Collman, J. P., Devaraj, N. K., Decreau, R. A., Yang, Y., Yan, Y., Ebina, W., Eberspacher, T. A., Chidsey, C. E.
  2007; 315 (5818): 1565-1568
- **The first quadruple bond between elements of different groups** *ANGEWANDTE CHEMIE-INTERNATIONAL EDITION*
  Collman, J. P., Boulatov, R., Jameson, G. B.
  2001; 40 (7): 1271-?
- **O-2 AND CO BINDING TO IRON(II) PORPHYRINS - A COMPARISON OF THE PICKET FENCE AND POCKET PORPHYRINS** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*
  Collman, J. P., Brauman, J. I., Iverson, B. L., Sessler, J. L., Morris, R. M., Gibson, Q. H.
  1983; 105 (10): 3052-3064
- **COOPERATIVITY IN O-2 BINDING TO IRON PORPHYRINS** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Collman, J. P., Brauman, J. I., Rose, E., Suslick, K. S.

1978; 75 (3): 1052-1055

- **MODEL COMPOUNDS FOR T-STATE OF HEMOGLOBIN** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Collman, J. P., Brauman, J. I., Doxsee, K. M., HALBERT, T. R., Suslick, K. S.
  1978; 75 (2): 564-568

- **PICKET-FENCE PORPHYRINS - SYNTHETIC MODELS FOR OXYGEN BINDING HEMOPROTEINS** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*
  Collman, J. P., GAGNE, R. R., Reed, C. A., HALBERT, T. R., Lang, G., Robinson, W. T.
  1975; 97 (6): 1427-1439

- **REVERSIBLE OXYGEN ADDUCT FORMATION IN FERROUS COMPLEXES DERIVED FROM A PICKET FENCE PORPHYRIN - MODEL FOR OXYMYOGLOBIN** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*
  Collman, J. P., GAGNE, R. R., HALBERT, T. R., Marchon, J. C., Reed, C. A.
  1973; 95 (23): 7868-7870