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# UCLA appoints three of world's leading chemistry scholars to endowed chairs

**By Stuart Wolpert** | July 31, 2009

Three internationally renowned chemists have been appointed to prestigious endowed chairs in UCLA's Department of Chemistry and Biochemistry.

UCLA Chancellor Gene Block has named Kendall N. Houk to the Saul Winstein Chair in Organic Chemistry, Omar M. Yaghi to the Irving and Jean Stone Chair in Physical Sciences, and Shimon Weiss to the Dean M. Willard Chair in Chemistry.

"These are three outstanding scientists who add to the distinction and prestige of UCLA, and we are honored to count them among our colleagues," said Albert Courey, professor and chair of the chemistry and biochemistry department.

**Kendall N. Houk: Saul Winstein Chair in Organic Chemistry**
Kendall N. Houk is one of the most prolific chemists in the world, with more than 750 publications to his name. He has pioneered the use of computer calculations and simulations to study organic chemistry and to predict chemical reactivity, proving that computation is one of the central tools for exploring mechanisms in this field. His research group has made predictions of new phenomena that have been verified experimentally.

"Ken Houk is one of the world's leading physical organic chemists," Courey said. "He has made many groundbreaking contributions to our understanding of chemical reactivity, explaining why some chemical reactions occur and others do not and allowing us to predict chemical reactivity by applying the most fundamental principals.

"He is studying how enzymes can be such powerful and selective catalysts. Every cell in your body is the site of thousands of reactions, and each one of these reactions is catalyzed by a different, exquisitely designed enzyme. Ken has made critical contributions to our understanding of how enzymes are able to selectively catalyze reactions," he said.

Houk's research group recently used computer methods to create "designer enzymes" and to predict structures of proteins that can catalyze reactions which do not occur naturally. He and his colleagues are now working on computational methods to predict catalysts for reactions that will have important applications in industry and in therapies for fighting disease. Houk's research has been honored by both organic and computational chemists.

Houk is currently collaborating with Jorge Barrio, professor of molecular and medical pharmacology at the David Geffen School of Medicine at UCLA, who designs new molecules for positron emission tomography (PET) imaging of amyloid fibrils, the harmful, rope-like structures that build up in the brains of Alzheimer's disease patients. Their joint research may enable the diagnosis of the disease at an earlier stage than is now possible, before symptoms even appear.

"Our work is theoretical and computational but is always tied to real phenomena," said Houk, who is a member of the California NanoSystems Institute at UCLA. "We first try to understand what is happening and then try to make predictions that experimentalists can test."

"Ken is an outstanding and very dedicated teacher," Courey said. "Ken mentors many graduate students and has served as director of a major program that is federally funded by the National Institutes of Health to train graduate students at the intersection of chemistry and biology."

A member of UCLA's faculty since 1986, Houk earned all of his degrees at Harvard University. He teaches both undergraduate and graduate students.

Saul Winstein, a professor at UCLA from 1941 until his death in 1969, was one of the leading physical organic chemists of the 1950s and '60s, employing the tools of physical chemistry to explore reactions in solution. In 1971, he was posthumously awarded the prestigious National Medal of Science. Winstein, his wife, Sylvia, who passed away this year, and their children all were undergraduates at UCLA.

"Saul Winstein was the most prominent physical organic chemist in the period when I began my career," Houk said. "He is one of my heroes in chemistry. His specialty was understanding how reactions occur in solution. He developed many of the concepts that we use today. We now do computationally things that Saul Winstein used to do experimentally."

The Winstein Chair at UCLA was formerly held by 1987 Nobel laureate in chemistry Donald J. Cram and by Fraser Stoddart.

"Don Cram was a legend in chemistry, as was Saul Winstein," said Houk, who was instrumental in recruiting Stoddart to join UCLA's faculty and who published scientific papers with Cram and Stoddart. "I am thrilled and honored to be the third Winstein Chair."

Houk, along with UCLA professor emeritus of chemistry and biochemistry Herbert Kaesz, was recently elected to the inaugural class of Fellows of the American Chemical Society, in recognition of his outstanding achievements in science. Both will be honored at a ceremony during the society's national meeting in Washington, D.C., on Aug. 17.



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Kendall N. Houk

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For more on Houk, visit his website at www.chem.ucla.edu/dept/Faculty/houk.html.

**Omar M. Yaghi: Irving and Jean Stone Chair in Physical Sciences**
Omar M. Yaghi is the director of UCLA's Center for Reticular Chemistry and is a member of the California NanoSystems Institute at UCLA. His research overlaps chemistry, materials science and engineering.

"Omar has revolutionized inorganic chemistry and revitalized the materials side of inorganic chemistry," Courey said. "He has developed a whole new branch of synthetic chemistry that he named reticular chemistry. He uses what we know about organic and inorganic reactivity to build up large compounds — macromolecules — but not ones that nature ever thought of; they are macromolecules conceived in the mind of Omar Yaghi. [Nature's macromolecules are large biological molecules such as proteins, DNA and RNA.] These compounds have potentially very important properties because they are very porous and because he is able to control their synthesis in such detail."

In 2008, Yaghi and colleagues reported a major advance toward reducing heat-trapping emissions, demonstrating that they could successfully isolate and capture carbon dioxide using a new class of materials Yaghi and his group designed called zeolitic imidazolate frameworks, or ZIFs. The findings could lead to power plants efficiently capturing carbon dioxide — which contributes to global warming, rising sea levels and increased ocean acidity — without using toxic materials.

"The technical challenge of selectively removing carbon dioxide has been overcome," Yaghi said at the time. "Now we have structures that can be tailored precisely to capture carbon dioxide and store it like a reservoir, as we have demonstrated. No carbon dioxide escapes. Nothing escapes unless you want it to do so. We believe this to be a turning point in capturing carbon dioxide before it reaches the atmosphere."

ZIFs are porous and chemically robust structures, with large surface areas, that can be heated to high temperatures without decomposition and boiled in water or organic solvents for a week and still remain stable.

"The selectivity of ZIFs to carbon dioxide is unparalleled by any other material," Yaghi said. "The capture of carbon dioxide creates cleaner energy. ZIFs in a smokestack would trap carbon dioxide in the pores prior to its delivery to its geologic storage space."

In the early 1990s, Yaghi invented a class of materials called metal-organic frameworks (MOFs), which are like scaffolds made of linked rods and have been described as crystal sponges. One gram of a MOF has roughly the surface area of a football field. MOFs, like ZIFs, have pores — openings on the nanoscale in which Yaghi and his colleagues can store gases that are usually difficult to store and transport. Yaghi's laboratory has made many MOFs, with a variety of properties and structures.

In 2006, Yaghi and colleagues at UCLA and the University of Michigan reported an advance toward the goal of cars that run on hydrogen rather than gasoline. While the U.S. Department of Energy estimates that practical hydrogen fuel will require concentrations of at least 6.5 percent, the chemists, using MOFs, achieved concentrations of 7.5 percent — nearly three times as much as had been reported previously — at a very low temperature of 77 degrees Kelvin. The research could lead to a hydrogen fuel that powers not only cars but laptop computers, cellular phones, digital cameras and other electronic devices.

"We have a class of materials in which we can change the components nearly at will. There is no other class of materials where one can do that," Yaghi said. "We have achieved 7.5 percent hydrogen; we want to achieve this percent at ambient temperatures."

MOFs can be made from low-cost ingredients, such as zinc oxide — a common element in sunscreen — and terephthalate, which is found in plastic soda bottles.

"MOFs will have many applications," Yaghi said. "Molecules can go in and out of them unobstructed. We can make polymers inside the pores with well-defined and predictable properties. There is no limit to what structures we can get, and thus no limit to the applications."

In 2006, Popular Science ranked Yaghi among its "Brilliant 10" for expanding the limits of science, calling him a "hydrogen nano-architect" whose "research papers rank among the most influential in his field."

"Many chemists believe that Yaghi's creations, if suitably tailored to store hydrogen, could lead to the first workable fuel tank for a hydrogen car," Popular Science said. "If you zoomed in a billion times, his substances would look like enormous scaffolds. Materials scientists had seen similar frameworks before, but they couldn't custom-build them for specific purposes."

The magazine quoted University of South Florida professor Mike Zaworotko as saying, "it was a dream" to engineer these frameworks to chemists' specifications and that "Yaghi was the person who turned it into reality."

Yaghi teaches inorganic chemistry to undergraduates and graduate students.

Literary figures Jean and Irving Stone, who were married for more than 50 years, collaborated on best-selling biographical novels such as "The Agony and the Ecstasy," "The Passions of the Mind" and "Lust for Life." Jean Stone was also among the most sought-after editors of her day. Although they often traveled to Europe to research the historical figures on whom their books were based, when at home in Beverly Hills, Calif., the Stones relied on the research facilities of the UCLA Library. They came to love the UCLA campus and became generous supporters of the university. They established four endowed faculty chairs at UCLA.

For more on Yaghi, visit his website at http://yaghi.chem.ucla.edu.

**Shimon Weiss: Dean M. Willard Chair in Chemistry**
Biophysical chemist Shimon Weiss is a professor of chemistry and biochemistry, physical chemistry, and physiology and a member of the California NanoSystems Institute at UCLA.

"Shimon is one of the world's leading chemists in the use of single-molecule techniques, especially to study biological molecules," Courey said. "Classically, in chemistry, you don't measure the properties of single molecules — that was thought to be impossible. Previously, we could measure only the average properties of an ensemble of molecules, typically trillions and trillions of molecules. In the last 10 years or so, chemists have realized that perhaps we can measure the properties of molecules one at a time and see the variation at the single-molecule level."

Weiss and his research group are enhancing our understanding of life's most important class of molecules — proteins — using state-of-the-science techniques known as fluorescence spectroscopy, fluorescence microscopy and biological imaging.

Proteins, Weiss said, "have a hand in doing just about anything significant that happens in living organisms." They are responsible for the replication of DNA and the replication of cells, and they are the engines of metabolic pathways providing organisms with energy. Enzymes, a class of proteins, are vital for catalyzing other biochemical reactions necessary for life. Weiss studies enzymes in their natural environment.

"Shimon has made important contributions to our understanding of an enzyme called RNA polymerase, which does the first step in decoding the genetic code," Courey said. "He has been able to learn in unprecedented detail how RNA polymerase is able to bring about this decoding process."

Weiss earned his doctorate in electrical engineering from the Technion in Israel in 1989 and joined UCLA's faculty in 2001.

"Shimon was trained as an engineer and brings the perspective of an engineer to biological problems," Courey said. "He has developed instrumentation that has the sensitivity and resolution to study a single molecule."

When scientists shine electromagnetic radiation on a chemical compound, its electrons get excited into a higher energy level. When those electrons return to their original, lower-energy state, they emit light; that is called fluorescence. By measuring how compounds absorb light and emit the energy as fluorescence, chemists can learn about the structure of the compounds.

Weiss has developed highly sensitive fluorescing probes called quantum dots that can enter cells and label their proteins and nucleic acids, and he can detect and measure the properties and locations of large molecules inside cells.

"Identifying and cataloging all gene sequences and their corresponding protein high-resolution static three-dimensional structures is only a prelude to the real challenges of future biological inquiries," Weiss said. "We need to understand the dynamic structural changes of isolated macromolecules undergoing biochemical reactions. We need to identify transient interactions between macromolecules. We need to decipher the cell circuitry and its detailed, time-dependent responses to various stimuli. We need to decode intracellular and extracellular communication signals and the corresponding molecular-level responses of live cells, tissues and whole organs.

"High-sensitivity fluorescence methods will play a vital role in this endeavor because they offer many advantages for probing isolated molecules and molecules in live cells, tissues and organs," he said. "Fluorescence is noninvasive. It provides imaging and sectioning capabilities in three dimensions; it has high sensitivity, down to the single-molecule level; and it allows the observation of molecular and organelle-specific signals. Our group develops and applies ultrahigh-resolution, ultrahigh-sensitivity fluorescence imaging and spectroscopy tools to solving outstanding problems in biology."

Determining the intricate network of protein interactions that take place within the cell of an organism allows the understanding of the mechanisms that control its growth, maintenance and disease, Weiss said.

Weiss' group is made up of scientists from many disciplines, including chemists, biologists, physicists, mathematicians, biochemists and computer scientists.

A business executive and longtime UCLA supporter, Dean M. Willard served from 1972 to 1989 as president and CEO of Products Research and Chemical Corp. He has served as a top executive for numerous corporations, including Courtaulds Aerospace (Products Research and Chemical Corp.'s successor company), Permatex, HAAS TCM, Reinhold Industries, and Advanced Chemistry and Technology.

For more on Weiss, visit his website at www.chem.ucla.edu/dept/Faculty/sweiss.

The tradition of endowing chairs to attract and retain internationally renowned scholars and to recognize academic excellence dates back to 16th-century England.

**UCLA** is California's largest university, with an enrollment of nearly 38,000 undergraduate and graduate students. The UCLA College of Letters and Science and the university's 11 professional schools feature renowned faculty and offer more than 323 degree programs and majors. UCLA is a national and international leader in the breadth and quality of its academic, research, health care, cultural, continuing education and athletic programs. Four alumni and five faculty have been awarded the Nobel Prize.

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