2006 Election Results

2006 Norris Award to Brian P. Coppola

Student Affiliates at Atlanta ACS Meeting

Summer Scholar Report
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For additional information contact: Jean Harris
Department of Chemistry & Chemical Biology
Northeastern University
Boston, MA 02115
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Cover: ACS and GDCh-JungChemikerForum Organizing Committees planning the 2007 exchange: (l-r) seated: Kurt Begitt (GDCh), Ivan Korendovych (Tufts University), Stefan Picker (University of Münster), Claudia Halter (University Hospital Freiburg); standing: Mike Strem (Strem Chemicals), mortar Hoffman (Boston University), Ruth Tanner (University of Massachusetts Lowell) (Photo: Courtesy of Morton Z. Hoffman)

Deadlines: October 2006 Issue: August 18, 2006
November 2006 Issue: September 15, 2006

THE NUCLEUS

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The Nucleus Summer 2006
On Tuesday, April 4th, the inaugural meeting of the Analytical Laboratory Manager’s Association (ALMA) local “beanpot” chapter was held and hosted by Cabot Corporation in Billerica, MA. This was the first opportunity for many lab managers to meet their local colleagues and discuss common issues.

The main part of the program was a talk by Dr. Lawrence Murphy, Cabot Corporation, Analytical Director, on the topic of “Outsourcing” reflecting Larry’s approach and strategy. Along with an overview of the international ALMA organization, the attendees discussed topics for future meetings and meeting logistics. The meeting concluded with lunch and a tour of the Cabot Analytical Laboratories. This was not your typical conference where everyone sits and listens to the speaker. The concept here is that there is active sharing among the participants and that’s exactly what happened. The energy in the room was exhilarating. Everyone present was interested in repeating their experience and the next meeting has already been set up for Tuesday, June 15th at 9:30 at Thermo Electron, Waltham, MA. Wayne Collins, an active member of ALMA and frequent author and current editor for “Managing the Modern Laboratory”, a quarterly journal published by ALMA will be speaking on, “‘Using Benchmarking Metrics to Improve Laboratory Productivity.”

For additional information, please contact: Lynne Garone at lgarone(at)eink.com.

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ALMA Meeting Report

1st Meeting—April 4, 2006
by Lynne Garone

On Tuesday, April 4th, the inaugural meeting of the Analytical Laboratory Manager’s Association (ALMA) local “beanpot” chapter was held and hosted by Cabot Corporation in Billerica, MA. This was the first opportunity for many lab managers to meet their local colleagues and discuss common issues. The main part of the program was a talk by Dr. Lawrence Murphy, Cabot Corporation, Analytical Director, on the topic of “Outsourcing” reflecting Larry’s approach and strategy. Along with an overview of the international ALMA organization, the attendees discussed topics for future meetings and meeting logistics. The meeting concluded with lunch and a tour of the Cabot Analytical Laboratories. This was not your typical conference where everyone sits and listens to the speaker. The concept here is that there is active sharing among the participants and

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2006 Election Results

Chair-Elect
Marietta Schwartz 419

Treasurer
James U. Piper 422

Auditor
Anthony L. Rosner 416

Trustee
Joseph A. Lima 413

Councillor/Alternate
Catherine E. Costello 331(##)
Patricia A. Mabrouk 295(##)
Amy E. Tapper 295(##)
Michaeline F. Chen 265(##)
Dorothy J. Phillips 265(##)
Julia H. Miwa 253(#)  
Alfred Viola 252(#)
Eva Binun 218(#)  
Robert G. Grubbs 210(#)  
Wallace J. Gleekman 205(#)  
Jerry P. Jasinski 203  
Marietta Schwartz 202  

Councilor/Alternate continued
Edward J. Brush 197
Michael Hurrey 182
Denye K. Wicht 158
Mukund S. Chorghade 153
Angeles Dios 144

Director-at-Large
Gary R. Weisman 249
Cassandra Celatka 239
W. Harry Mandeville 207
Ivan V. Korendovych 140

Nominating Committee
Thomas R. Gilbert 277
Patrick M. Gordon 220
Arthur Greenberg 181
Mark Froimowitz 135

Norris Award Committee
Mary Jane Shultz 312
Morton Z. Hoffman 220
Dean Wilcox 189
Todd Wimpfheimer 118

## Elected Councilor    # Elected Alternate Councilor
Underlined Candidates were elected to their respective positions.

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4 The Nucleus Summer 2006
Hoffman Receives ACS Service Award

Morton Z. Hoffman, emeritus professor of chemistry at Boston University, was selected to receive the 2007 ACS Award for Volunteer Service to ACS. Hoffman was selected for his outstanding contributions to education on a regional, national and international level. Along with Professor Hoffman, S. Allen Heininger, was selected to receive the 2007 Charles Lathrop Parsons Award.

Chemical Abstracts Service will become a National Historic Chemical Landmark in 2007.

The James Flack Norris And Theodore William Richards Undergraduate Summer Research Scholarships

The Northeastern Section of the American Chemical Society (NESACS) established the James Flack Norris and Theodore William Richards Undergraduate Summer Scholarships to honor the memories of Professors Norris and Richards by promoting research interactions between undergraduate students and faculty. Research awards of $3250 have been given for the summer of 2006. The student stipend is $2750 for a minimum commitment of ten weeks of full-time research work. The remaining $500 of the award goes to the research advisor to use on supplies, travel, and other items relevant to the student project. The 2006 scholarships have been awarded to:

Kerry Heinzelmann, Boston College; The Synthesis of New Inhibitors of Dihydrooratase; Prof. Evan Kantrowitz, Advisor

Jessica Lynch, MIT; Engineering a Monovalent Avidin with Femtomolar Affinity; Prof. Alice Ting, Advisor

Chayasith Uttamapinat, Harvard University; The Synthesis of 4'-Fluorinated Oligonucleotides; Prof. Gregory Verdine, Advisor

Todd Andrade, University of Massachusetts Dartmouth; DNA Adduct Formation in Plants by Interaction with Phenoxo and Carbamate Pesticides; Donald Boerth, Advisor

Award winners are required to submit a report of their summer projects by November 2006 for publication in THE NUCLEUS. They are also required to participate in the Northeast Student Chemistry Research Conference (NSCRC) in April 2007.

Northeastern Section-American Chemical Society Vendor Fair

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Cost: $400 per 6-foot table (address checks to NESACS)

Looking for seminars in the Boston area?
Check out the NESACS Calendar
www.nesacs.org/seminars
News from the ACS Meeting

NESACS Student Affiliates Chapters Score Big in Chemvention Competition

The Student Affiliates (SA) Chapters from Bridgewater State College and Northeastern University were among the five finalists in the ACS 2005 Chemvention competition to create a toy that teaches concepts of chemistry. The top award, presented on Sunday, March 26, 2006, at the National SA Awards Ceremony at the ACS National Meeting in Atlanta in the presence of more than 1,500 students affiliates and faculty advisors, went to the Bridgewater State College SA chapter for its “Green Machine.” The grand prize of $2,000 from Air Products & Chemicals will be used for the purchase of computer equipment that will benefit students in the chemical sciences. The Northeastern University SA chapter will receive four Texas Instruments TI-89 Platinum Graphing Calculators as its finalist award.

Chemvention is a team competition sponsored by the ACS as part of National Chemistry Week activities. SA chapters compete against each other to solve a common problem, using their chemical intuition to invent a device or method that works better and is more clever than its competitors. The finalists presented posters that described their Chemvention at Sci-Mix on Monday evening.

Bridgewater State College
Bridgewater’s “Green Machine” is a toy designed to teach chemical principles from a green chemistry perspective, and was created for children between the ages of 10 and 14 years. The “Green Machine” is similar to a Rube Goldberg device in that one action directly leads to another. Each module in the “Green Machine” demonstrates separate chemical concepts, such as acid-base reactions and pH indicators, solubility rules, gas laws, Archimedes principle, and electrolyte conductivity. Furthermore, the toy utilizes common, inexpensive reagents typically found in the home, presents minimal hazards, and follows green chemistry principles. The “Green Machine” was displayed at “Green Chemistry Day” at the Boston Museum of Science on December 15, 2005. The BSC “Green Team” members were Lindsay McDonald, Bethany Collins, and Sarah Lane, and co-advisors Drs. Ed Brush, Cielito De Ramos-King, and Frank Gorga.

In addition to the Chemvention award, the Bridgewater group also received “Honorable Mention” recognition and was awarded “Green Chemistry Affiliate” status for its activities in 2005. These two additional awards were accepted by the club’s past president, Bethany Masten.

Northeastern University
This was the second year in which the Northeastern University SA chapter participated in the national Chemvention competition. The board game for high school and general chemistry students that was created, called “ELEMENTS,” involved the following skills: balancing chemical equations, connecting the names and symbols of the elements, and understanding periodic trends. The game also includes true/false questions that test a general knowledge of chemistry. Players can move their pieces around the game board by rolling an element die and by accumulating “electron” points by answering questions correctly. The Northeastern University SA chapter is made up of 60 members from all five years of the cooperative education undergraduate program; its faculty advisor is Dr. Tom Gilbert. It also received “Honorable Mention” recognition for its 2005 activities.
A Chemistry Yankee Goes South

An Undergraduate’s Reflections on Her First ACS National Meeting

by Amy Kallmerten

My name is Amy Kallmerten. I am a senior chemistry major at Northeastern University. I am also president of our Student Affiliates chapter. In the past four years I have seen our chapter go from myself and my friends (about 12 people total) to its present membership of seventy-five. Part of the fun of having a club so new is that nothing is set up for you. I have yet to receive a how-to guide for any new event, program, or issue that comes our way and that is one of the things I am most grateful for. I have been an executive officer of the club for almost two and a half years. With every new event or program we participate in or put on, I find myself wishing even more to continue to expand both my own and the club’s horizons in every way I can. This year, my department was generous enough to sponsor not only myself, but four other members of our group to attend the National Meeting in Atlanta. I have to say, this has been one of the best experiences ACS has offered me thus far.

It is amazing how a world so big can grow smaller every day. I didn’t realize until I attended the National Meeting in March how universal the characteristics of chemistry majors are and, more importantly, I had no idea how much of a reality-check this experience would be.

In the South, there is no such thing as a Southern accent. If I had a dollar for every time someone chuckled back at me; “you’re from Bah-stan” I’d be on a beach somewhere instead of preparing for my summer finals. This could be indicative of the differences in cultures and speech no matter where you go, but it is a better indication of the many friends, acquainances and contacts I made at the meeting. We got up early Sunday morning to go to the presentation of the undergraduate demo’s and began to interact with other student affiliates immediately. Standing out among the people we met, of course, were our beloved friends from Arkansas. This interaction eventually ended up in email exchanges and words about next year.

Although part of me saw this as a four day break from the semester, I have to admit, I learned a lot at the meeting. Being president of my university’s Student Affiliates chapter, it would be a huge understatement to say I am only slightly excited for this year’s National Chemistry Week. I am only now beginning to grasp how broad the term chemistry is and how many different career choices we have upon graduation. I also would be lying if I said I wasn’t inspired by how charismatic people involved with ACS can be. After interacting with the President of the ACS, I thought to myself, who knows—maybe that will be me someday.

This is what I feel is the most important lesson I took away from this meeting. At events like the annual conferences of national organizations—It is not always about the technical skills you gain. Sometimes it is about the people you meet and the experiences you take away with you. As a result of the emphasis on networking and group activities incorporated in the undergraduate program I now have an inkling I am not the only one who has caught onto this detail. However, I am a firm believer that this is something every person must learn and apply for him or herself. Not everyone is going to value networking, connections, and meeting people outside your everyday group, but I think that as a product of the ACS National Meeting, this is not something I will put on the back burner in this lifetime.

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**Lyman C. Newell Grants**

The Northeastern Section of the American Chemical Society has awarded four Lyman C. Newell Grants for the 68th Annual Summer Conference of the New England Association of Chemistry on *Green Chemistry* at Bridgewater State College, in Bridgewater, MA, August 7-10, 2006. Grants of $225.00 each to partially cover the cost of the conference have been awarded to the following high school teachers:

- **Esther Hines** of Lexington High School in Lexington, MA
- **Nancy Jean Ward** of East Bridgewater High School in East Bridgewater, MA
- **Kimberly Rebello** of Bristol Plymouth Technical High School in Taunton, MA
- **Marcia Boccuzzi** of Fairfield Ludlowe High School in Trumbull, CT

The Lyman C. Newell Grants commemorate a former chair of the Northeastern Section who was a distinguished chemist, teacher, and historian of chemistry. For many years he was chair of the Chemistry Department at Boston University. Lyman Newell served as the first president of NEACT from 1889 to 1900 and expressed a continuing interest in training chemistry students throughout his long career. His efforts are continued by grants that bear his name.

**ACS Designates Historical Chemical Landmark**

*Development of baking powder receives historical recognition*

By Morton Z. Hoffman

The discovery of baking powder — which made baking easier, quicker and more reliable — was designated a National Historic Chemical Landmark in a special ceremony in East Providence, R.I., on June 12. The ACS sponsors the Landmarks program, which is open for nominations from local sections. Much of the credit for this recognition of a Rhode Island landmark can be given to Professor Martin Saltzman of Providence College.

In the mid-19th century, Eben Horsford, a chemist at Harvard University, devised a unique mixture of bicarbonate of soda (baking soda) and calcium acid phosphate, which he named “yeast powder” and later called baking powder. In the presence of water, the mixture releases carbon dioxide, which leavens biscuits, cookies and quick breads. To prevent a premature chemical reaction, Horsford introduced starch to keep the mixture dry.

Horsford and his business partner, George Wilson, established the Rumford Chemical Works in East Providence in the 1850s to market baking powder. Rumford Baking Powder was marketed for decades using the formula first devised by Horsford in the 1850s and refined in the 1860s.

Ann Nalley, ACS President, presented a commemorative bronze plaque to Nancy Moore, president of the East Providence Historical Society, sponsor of the designation ceremony.

**Save the Date!**

*The 5th Annual New England Environmental Research Symposium*

Saturday, November 11, 2006
9:00 AM – 3:00 PM
Bridgewater State College

Undergraduate and graduate student research posters in all environmental disciplines are welcome.

Please email Ed Brush (EBrush@bridgew.edu) to add your name to our email distribution list. A formal “Call for Abstracts” will be sent electronically in mid-September.

and Colin Kane of Peregrine LLC, a real estate development firm that is restoring the old Rumford Chemical Works on the corner of Newman and Greenwood Avenues in the Rumford section of East Providence.

Eben Norton Horsford was born in upstate New York in 1818, attended Rensselaer Polytechnic Institute and received his formal education in chemistry in Germany, where he studied for two years with the noted chemist, Justus von Liebig. In 1847 he returned to the United States to assume the Rumford Professorship at Harvard, a chair endowed by Benjamin Thompson, the physicist who fled the American Revolution and who eventually became Count Rumford of the Holy Roman Empire. When Horsford and Wilson began their chemical plant, Horsford chose the name Rumford, after his Harvard chair.
EMERGING TECHNOLOGIES AND THE CHEMICAL SCIENCES
34th Northeast Regional Meeting of the American Chemical Society

October 5–7, 2006
www.nerm2006.org

Hosted by the Binghamton Local Section, Binghamton, NY

Join us for a unique regional meeting that brings together the American Chemical Society with the IEEE CPMT Society, the Watson School of Engineering and Applied Science and the Integrated Electronics Engineering Center (IEEC) at Binghamton University, and other participating organizations to create an exciting program highlighting emerging technologies and the chemical sciences.

Along with traditional chemistry sessions on analytical, inorganic, organic, and physical chemistry, biochemistry, chemical education, traditional and undergraduate poster sessions, and an open public session on environmental issues important to our local region, additional symposia will cover topics such as:

- Organic and flexible electronics
- Sensors and small scale systems integration
- Lithography
- Environmentally benign materials and processes
- Nanomaterials
- Electronics packaging

We hope to see you at NERM 2006
October 5–7, 2006
Binghamton, NY
www.nerm2006.org

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Binghamton University
Endicott Interconnect Technologies, Inc.
Chemistry of Understanding
Bal Ram Singh, Department of Chemistry and Biochemistry, University of Massachusetts Dartmouth

Although there are amazing things going on all the time, we rarely stop to think and notice them. Recently, a young lady, while taking information for a subscription over the phone, casually asked me what I teach. On hearing that I teach chemistry, I heard the so often repeated phrase, “Oh, I was never good at chemistry.” I had heard such amazements at chemistry among the general public before, but I had really never given any serious thought to what it exactly meant. Most of the time, I took it as a conversation point, or a compliment at the most.

During this latest conversation on this topic, suddenly, it came to my realization that everybody was good at chemistry, for without being good at chemistry, no one could survive. After all, proper and adequate chemistry is at the heart of the life of all kinds, not just humans. And not just the life but sheer existence of everything, be it rock or the rocket, is good and dependent on chemistry. I know, I know - those who say they are not good at chemistry, they mean they do not understand it well, not that they really are not good at chemistry. That is the point. Even humans do not realize that every one of them is a really good chemist, albeit subconsciously.

So, it basically boils down to the understanding of the chemistry, which is difficult, and consequently distinct for different people. But the idea that “everything is good at chemistry” remains, and only the understanding differs. Thus if we understand the chemistry of anything well we will have the same good understanding of chemistry. This should remove all the notions of a superiority complex among various types of chemists, analytical (most major departments are trying to eliminate it!), bio (NIH is its is biggest supporter!), organic (bad name, with too many environmentally unfriendly synthetic chemicals; in danger of being replaced with green chemistry), inorganic (most students cannot get excited by it, for too long now), and physical (too dependent on physicists, who seem to have lost clues to matter).

The major advantage we as chemists have is the understanding. This idea has become ingrained in people so much so that it has become a journalistic and political jargon – good chemistry between two leaders, etc. What do we as chemists make of these references? It probably refers to a good understanding between two individuals. It is the understanding, stupid!

We understand this world by observing all the matters (remember, chemistry is defined as the study of matter), primarily using five sensory faculties. Of course, there is much known information on the chemistry of sensory perception, though we still are substantially far from complete understanding of these reactions. So, we need instruments of all kinds to get to the bottom of some of these processes. To make an instrument, we use our primitive understanding of tools to design and build parts, assemble them, and make measurements to analyze and understand.

Since nothing is perfect in this world, efficiency at every level is less than one, and ultimate efficiency is a product of efficiencies of all the steps. Assuming 0.9 for efficiency (being quite generous) of every step (part, process, design, analysis, understanding, etc.), and 24 steps in examining an item (no, I am not talking about Mars though Hubble), the ultimate understanding remains only 0.08. This is terrible way to develop an understanding, and the results are everywhere to see – from Osama bin Laden to George Bush.

Where does this lead us then? My answer: commonsense. That is nonsense, you say: How could chemistry, being such a sophisticated source of understanding, have anything serious to do with commonsense?

Let us try. In order to understand anything, it seems the best way is to...
New England Association of Chemistry Teachers

The 68th Annual NEACT Summer Conference

August 7-10, 2006

Bridgewater State College
Bridgewater, Massachusetts

Topic: Green Chemistry

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Informal discussion time with participants and speakers
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Continuing Education Credits available for Mass, Conn and RI teachers

—— Keynote Speakers ——
UMass Lowell’s John Warner
Pfizer’s “Buzz” Cue
ACS’s GCI (Green Chemistry Institute): Kathryn Parent

NEACT and NEACS Scholarships available

Program details will be posted at: www.neact.org

Registration information will be available soon
Approximate cost for entire conference is about $300 per participant

contact Kathy Siok, Registrar-Treasurer at neactks@cox.net
National Chemistry Week Events

Celebrating
Your Home – It’s All Built on Chemistry!!

October 22, 2006 – Wellesley College Science Center

Phyllis A. Brauner Memorial Lecture by Dr. Bassam Shakhashiri

Dr. Bassam Shakhashiri is a Professor of Chemistry at the University of Wisconsin-Madison and is the William T. Evjue Distinguished Chair for the Wisconsin Idea. Professor Shakhashiri has captivated audiences with his scientific demonstrations at a variety of locations including Boston’s Museum of Science, the National Academy of Sciences and the Smithsonian’s National Air and Space Museum in Washington.

Room 277, 11 am – 12 pm and 2 pm – 3 pm

The Sunday presentations are free and open to the public. Tickets are available on a first come, first serve basis though reservations are recommended. To reserve tickets, please contact Marilou Cashman either via email mcash0953@aol.com (preferred) or by phone 1-800-872-2054 before October 19, 2006. Tickets will be available for pick-up outside of the Science Center on the 22nd. Parking is free. For directions to Wellesley College, please visit http://www.wellesley.edu/Admin/travel.html. While at Wellesley, a visit to the arboretum and greenhouses (which are open to the public) is a must.

For more information, visit http://www.wellesley.edu/FOH/greenhouse.html.

Kicking off National Chemistry Week 2006 festivities

Join us in a variety of hands-on activities related to the yearly theme. Taking place from 10 am – 3:30 pm on October 22, 2006 inside of the Wellesley Science Center for more information, please visit www.nesacs.org.

October 28, 2006

Boston Children’s Museum

NCW volunteers will be on-hand to perform demonstrations and assist in hands-on activities related to the yearly theme.

Museum of Science, Boston

NCW volunteers will be on-hand to perform demonstrations and assist in hands-on activities related to the yearly theme.

October 22 – 28, 2006

K-12 students participate in the NCW poster competition. Grades 9-12 may participate in the puzzle contest as well. See www.nesacs.org for detailed information.
Brian P. Coppola has been very active with the American Chemical Society as well as other professional organizations. He participated in an ACS Task Force on Minority Faculty in the Chemical Academic Community. He currently serves on the ACS Society Committee on Science, and has been a member of the ACS Committee on Professional Relations, the ACS Council, as well as having served a 10-year term as Councilor for the Huron Valley local section of the ACS. He has served on a number of editorial advisory boards, including those of the Journal of Science Education and Technology, the International Journal of Science Education, The Chemical Educator, and the Journal of College Science Teaching. Brian has received numerous awards, fellowships, and grants as well, all of which speak to his expertise in and love of teaching.

 Argentine Chemists Receive Journal Donations

By Dan Eustace

We all have our approaches to staying abreast in our fields. One of the significant benefits of our society membership is receiving journals containing cutting edge research in chemistry and related fields. For years I have subscribed to JACS and perused the growing literature and knowledge base. But what do we do with journals that publish more than 10,000 pages of text each year?

One practice I used in the past was Project Bookshare; a project run by the International division of the ACS to donate personal subscription journals to libraries in needy countries throughout the world. We all, for the most part, have access to libraries of journals so archiving is not necessary for most of us. However, Project Bookshare ended in early 2006.

With the end of Project Bookshare, I had to research other approaches to donate my journals. I was not going to just toss them out! We are planning a trip to Argentina this year and thought this might be an interesting way to make a good contact with someone there who we might know and visit.

By “googling” <chemistry and Argentina>, a search returned 27 million hits. The leading hit was a review on the history of chemistry in Argentina by Professor Maximo Baron. Professor Baron is at Facultad de Ciencias Exactas y Naturales, Universidad de Belgrano in Buenos Aires, Argentina. Not only is he Titular Member of IUPAC’s Macromolecular Division Committee and Secretary of the Commission on Macromolecular Nomenclature but he also chairs the group that acquires journals for the Argentine nation’s universities. I emailed Maximo to learn if he would be interested in a donation of my back issues.

Dr. Baron indicated that he was very happy to help me donate my journals, “for apart from my work in research and teaching at the University of Belgrano, for a number of years I am Director of the Library of the Argentine Chemical Society AQA (www.aqa.org.ar). With great effort we have managed to keep up with some journals. In the golden days we did this by exchange but, Alas! No longer. Now hard cash is required and this is something we have little access to. So we have to resort to donations and gifts.” “For some time the ACS Book Share Program was of great help… Therefore, if you would like to consider donating JACS and the Journal of the Electrochemical Society we would be more than happy to accept them.”

“Also if you know of any colleague that has the same “problem” please feel free to let us know. Do not fear the possibility of duplications because for some time we have been acting as a clearing house for other Libraries in the country that are willing to accept donations and do not have access to donors. The transportation costs can be handled at this end.”

On June 3, 2006 I shipped six million bags of journals containing about sixty pounds each to Argentina. It will take about six weeks for the highly prized journals to arrive in Buenos Aires.

At this point, I also ask Northeastern Section members: Do you have an interest in sharing your personal or corporate journals with Argentina? This will be good for you (doing the right thing for the right reason, and getting a tax deduction), good for the Argentine Chemists.

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Introduction

Crystal growth in organisms such as sea urchins and brittle stars is highly regulated yielding structures of astonishing complexity. Such control over crystallization has yet to be routinely reproduced in the laboratory. Organisms control mineral growth using special assemblies of biological macromolecules.\(^1\),\(^2\) Over the past 20 years, extensive research involved the control over growth and orientation of calcite crystals.\(^3\) Calcite is attractive because it has a relatively simple structure, its precipitation has been extensively studied, and it is frequently found with specifically controlled orientations in nature.\(^2\) In the laboratory, micropatterned,\(^4\) self-assembled monolayers (SAM) of alkanethiolates on gold\(^5\) have been used as substrates to control calcite nucleation.\(^2\),\(^6\)\(^-\)\(^8\) Microcontact printed (µCP) SAMs have provided the most effective templating agents resulting in previously unmatched control over the crystallization of calcite.\(^1\) Calcite showed a tendency to nucleate on carboxy- and sulfate-terminated regions of monolayers, while methyl- and hydroxy-terminated regions of the monolayers prohibited nucleation.\(^2\)

Micropatterned SAMs of alkanethiolates on gold may prove useful for understanding the operative crystal growth mechanism involved in other biologically relevant crystal systems, for example, calcium oxalate monohydrate (COM), Figure 1, the main inorganic component in 70-80% of all kidney stones.\(^9\),\(^10\) Kidney stone formation is one of the most common examples of pathological crystallization in the body. Of the three calcium oxalate forms; mono-, di-, and tri-hydrate, COM is the most thermodynamically stable, and the nucleation, growth, and kinetics of COM crystallization has been studied at length.\(^11\),\(^12\) Although COM has been studied in the context of its pathogenic nature, the mechanism of kidney stone formation remains elusive.

The direct role of urinary constituents such as large macromolecules or metabolic byproducts in the inhibition or promotion of COM and consequently kidney stone formation is currently a topic of interest.\(^9\),\(^13\) Real-time, atomic force microscopy studies of COM growth mechanisms in the presence of citrate ions and the protein osteopontin in vitro support the importance of anionic molecules in the inhibition and promotion of COM growth, respectively.\(^14\)\(^-\)\(^16\) Polyaspartate has been also found to inhibit COM growth.\(^17\),\(^18\) µCP SAMs simulate macromolecules whose surfaces are rich with anionic functional groups.

SAMs can be prepared easily by submerging an appropriate substrate in a solution containing a ligand with the form \((Y(CH_2)_nX)\). The anchoring group, \(Y\), is reactive to the substrate’s surface and is the major limiting factor for the self-assembly of monolayers, as some groups bind selectively to certain substrates. The surface properties can be manipulated by modifying the head group, \(X\). SAMs of alkanethiolates \((CH_3(CH_2)_nS-)\) form most readily on gold and silver\(^4\) and is believed to occur with a loss of dihydrogen.\(^5\) The sulfur atoms at the end of the alkanethiolate form a uniform ordered layer on the (111) plane of gold. The chains extend from the surface tilted at approximately 30º from the normal, and adopt a trans-configuration to maximize the van der Waals interactions between the methylene groups, Figure 2.\(^4\)

Further control over the nucleation site on a surface of a SAM can be controlled via µCP. A patterned elastomeric polydimethylsiloxane (PDMS) stamp is “inked” with an alkanethiol in ethanol solution of a primary functionality. All of the ethanol must be evaporated so as to prevent spreading of the alkanethiol molecules across the substrate’s entire surface. The stamp is turned over and pressed gently against the surface of a gold substrate so that the alkanethiol ink transfers onto the regions of the gold that make contact with the stamp. Subsequent interaction with an alkanethiol of secondary functionality permits the patterning of SAMs

![Figure 1](image1.png)

**Figure 1.** (a) COM crystals with a characteristic coffin shape. (b) Twinning along the (-101) plane is also commonly observed.

![Figure 2](image2.png)

**Figure 2.** Idealized representation of SAM of alkanethioates on gold. Mercaptohexadecanoic acid (left) mercaptohexadecane (right) on gold.
having two different functionalities. A contact time of around 0.3 seconds forms a highly ordered monolayer of an alkanethiol on a gold substrate. The process of µCP is quick, reasonably simple, and generates a minimal amount of waste.

Here, we present methods of controlling COM nucleation, density and growth using SAMs. Ability to specifically control location of nucleating crystals has applications in further studying growth promotion and inhibition of these pathogenic crystals. Micropatterning techniques were employed using SAMs of alkanethiolates on gold to template COM growth. Careful control over calcium oxalate crystal growth could lead to improved research over this pathogenic crystal’s growth and consequently, its growth inhibition.

Materials

Gold-coated glass slides (1.0” x 3” x 0.04” with 5 nm of titanium and 100 nm of gold) were purchased from EMF Corporation (Ithaca, NY). Organic impurities were removed from the surface of the gold coated and glass slides using an UVO-Cleaner® Model No. 42, Jelight Company, Inc. (Irvine, CA). Microposit S1813 positive photoresist from Shipley was deposited using a spin coater Model P6700, Specialty Coating Systems, Inc. (Indianapolis, IN). Microposit MF-319 developer was purchased from Rohm and Haas. Sylgard 184 silicon elastomer kit was purchased from Robert McEwon Company (DOW Corning). Nanogauge reference calibration grating (10 μm, z 20 nm) from Ted Pella, Inc. Square 400 mesh Cu TEM grids from Electron Microscopy Sciences.

Differential interference contrast images were collected with a Leica DMLM reflected light microscope and captured with a Diagnostic Instruments Spot digital camera. Scanning Electron Microscopy (SEM) measurements were performed on a JEOL JSM5510-LV Scanning Electron Microscope operating at 2 kV. Ultrapure water was obtained from a Barnstead NANOpure Diamond Life Science (UV/UF) filtration and ion-exchange system (resistivity of 18.2 MW·cm.)

Calcium chloride (anhydrous), sodium chloride, hexanes used as received from Fisher Scientific. HEPES buffer (N-2-hydroxyethylpiperazine-N’-2-ethanesulfonic acid), potassium oxalate monohydrate (99%), ethyl alcohol (200 proof), 1-hexadecanethiol (92%), 16-mercaptophexadecanoic acid (90%), and 11-mercapto-1-undecanol (97%) were used as received from Aldrich Chemical Company. Acrylic desiccator cabinet (with 4 shelves), Fisherbrand plain glass microslides (3” x 1”) from Fisher Scientific. Fixed point diamond tipped scriber was used to cut glass slides (McMaster & Carr).

Methods

1. Preparation of A Master

A plain glass slide was cut into 1” squares using a diamond tipped scriber. The slide was placed in an UVO-Cleaner® for five minutes, rinsed with ethanol, washed with Ultrapure water before drying with compressed nitrogen. The slide was spin coated with 0.150 mL of Microposit S1813 positive photoresist at 500 rpm for 20 seconds. Using forceps, the slide was removed from the spin-coater and warmed on a 100°C hot-plate (2 min.). Scheme 1a. A square 400 mesh Cu TEM grid was gently placed on the surface of the photoresist-coated slide, covered with a second 1” glass slide, and placed in the UVO-Cleaner® for one minute to polymerize the areas of the slide not protected by the TEM grid. The slide was then placed upside down on two PDMS stands affixed to a Petri dish. The COM growth solution is poured into the Petri dish until contact is made between the solution and the gold slide. The slide is allowed to sit for 24 hours while COM crystals nucleate and grow.

Ultrapure water before drying with compressed nitrogen. The slide was spin coated with 0.150 mL of Microposit S1813 positive photoresist at 500 rpm for 20 seconds. Using forceps, the slide was removed from the spin-coater and warmed on a 100°C hot-plate (2 min.), Scheme 1a. A square 400 mesh Cu TEM grid was gently placed on the surface of the photoresist-coated slide, covered with a second 1” glass slide, and placed in the UVO-Cleaner® for one minute to polymerize the areas of the slide not protected by the TEM grid. The slide was gently swirled in 10 mL of Microposit MF-319 developer in a small beaker for 5 minutes. Upon careful removal from the developer solution, the slide was rinsed with Ultrapure water and dried with compressed nitrogen, Scheme 1b. The Master was affixed in a glass Petri dish with Epoxy resin.

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2. Preparation of a PDMS Stamp

Sylgard 184 elastomeric polymer was measured into a vial on a balance using a scupula. Curing agent was then added to the polymer to produce a 10:1 ratio of polymer to curing agent. Using the wooden end of a cotton swab, the polymer and curing agent were mixed together until it had a white, frothy appearance. The mixture was then poured into the Petri dish containing the previously prepared Master. The entire assembly was allowed to sit at room temperature until the bubbles rose, and then placed in a 70° oven for 45 minutes, or until the polymer firm. The assembly was then allowed to cool. Using an exacto knife, the polymer around the master was cut and gently pulled out of the Petri dish, Scheme 1c. Any excess polymer was trimmed off using a razor blade.

3. Microcontact Printing (µCP)

Gold-coated glass slides were cut into 1 x 2.5 cm rectangular tangles using a diamond-tipped scriber. Each slide was placed in an UVO-Cleaner® for five minutes, rinsed with ethanol, washed with Ultrapure water before drying with compressed nitrogen. One drop of a 1mM solution of 16-mercaptophexadecanoic acid in ethanol was placed onto the patterned side of a PDMS stamp so that the small patterned area was covered, and the ethanol was allowed to evaporate completely, thereby coating the pattern with 16-mercaptophexadecanoic acid, Scheme 1d. The stamp was turned over and placed into contact with a gold-coated slide. Gentle pressure was initially applied and the assembly was left untouched for one minute. The stamp was removed using forceps, the gold slide was rinsed with ethanol (200 proof) and dried with compressed nitrogen, Scheme 1e. The entire slide was submerged in a 1mM solution of 16-mercaptophexadecane in ethanol for one minute to backfill the carboxyl pattern. After a minute, the slide was rinsed with ethanol, dried with compressed nitrogen, Scheme 1f, and immediately used for crystal growth studies, Scheme 1g.

4. Growing Calcium Oxalate Crystals on a Patterned Surface

To prepare a crystal growth chamber, cured PDMS was cut into two thin strips (~4 cm long x 8mm wide) and glued about 1 inch apart in a Petri dish using epoxy. A patterned stamp was turned gold-side-down and placed between the PDMS supports. A typical calcium oxalate growth solution was prepared according to the following procedure: X mL of a 10 mM calcium chloride solution was added to a 250 mL volumetric flask containing a Y mL of buffer solution (0.15 M NaCl and 0.01 M HEPES buffer in Ultrapure water titrated with NaOH to produce the desired pH (6.8 – 8.2)) with vigorous shaking before introducing Z mL of a 10 mM sodium oxalate solution to the flask. [Crystal growth solutions for initial ion concentration studies: \( [\text{Ca}^{2+}] = [\text{C}_2\text{O}_4^{2-}] = 4 \times 10^{-4} \text{mM} \) (X=Z=2, Y=46); 6 x 10^{-4} mM, (X=Z=3, Y=44); 8 x 10^{-4} mM (X=Z=4, Y=42); 1 x 10^{-3} mM (X=Z=5, Y=40). The effect of increasing ion concentrations of \([\text{Ca}^{2+}]\) and \([\text{C}_2\text{O}_4^{2-}]\) on COM nucleation density at pH 7.5: \([\text{Ca}^{2+}] = [\text{C}_2\text{O}_4^{2-}] = 7 \times 10^{-4} \text{mM} \) (X=Z=3.5, Y=43); 7.5 x 10^{-4} mM, (X=Z=3.75, Y=42.5); 8 x 10^{-4} mM, (X=Z=4, Y=42); 8.50 x 10^{-4} mM, (X=Z=4.25, Y=41.5); 9 x 10^{-4} mM, (X=Z=4.5, Y=41).] The solution was poured into the Petri dish that contained the gold slide (up-side-down), and placed in a closed acrylic desiccator cabinet at ambient temperature and pressure for 24 hours, Scheme 1g.

5. Harvesting and Visualizing Slides

After 24 hours, the Petri dishes were removed from the desiccator, and submerged in a beaker containing an Ultrapure water layer below a layer of hexanes. The slide was rinsed in the water layer, slowly pulled through the hexanes layer, and placed face up on a KimWipe. Once completely dry, the slide was viewed using the Leica DMLM microscope operating in the differential interference contrast reflectance (DIC) mode. Patterned areas could be easily located by breathing on the slide, causing air to condense on the hydrophilic carboxyl-terminated regions.

Results/Discussion

Others have suggested that the most cost-effective way to create a master is through photolithography. A photore sist-coated, glass-slide (Scheme 1a) is masked with a micron-scaled pattern printed onto transparent celluloid film. A copper TEM grid with 30 µm square features will also suffice. The square patterns etched into photoresist upon development (Scheme 1b) and the stamp created from the master using an elastomeric polymer were visualized via DIC microscopy (Scheme 1c, Figure 3). 1 drop of a 1 mM ethanolic (absolute) solution of mercaptophexadecane was placed on the stamp and the ethanol was allowed to evaporate (Scheme 1d) before the stamp was placed in contact with the gold slide (Scheme 1e). The image of the TEM grid with mercaptophexadecane (30µm waffle) was visualized by SEM, Figure 4. Gold substrates with 30 mm square islands of mercaptophexadecanoic acid monolayers in a waf
fle grid (TEM) pattern surrounded by mercaptohexadecane monolayer were prepared via the micropatterning technique (Scheme 1e,f). The micropatterned slides were placed upside down on PDMS stands affixed in clean Petri dishes. Calcium oxalate growth solution was poured into a Petri dish, Scheme 1g.

Figure 4. Patterned SAM of hexadecanethiol on gold imaged using SEM. Imaging electrons penetrate the areas with the SEM at a slower rate than the solely gold terminated surface and appear lighter in contrast.

Initial ion concentration studies (\([\text{Ca}^{2+}]=[\text{C}_2\text{O}_4^{2-}]=4 \times 10^{-4}\text{ mM}, 6 \times 10^{-4}\text{ mM}, 8 \times 10^{-4}\text{ mM}, 1 \times 10^{-3}\text{ mM}\) ), first demonstrated the templating abilities of the micropatterned SAMs on COM., Figure 5. Lower concentrations (\([\text{Ca}^{2+}]=[\text{C}_2\text{O}_4^{2-}]=4 \times 10^{-4}\text{ mM}, 6 \times 10^{-4}\text{ mM}\) ) were not saturated enough in calcium and oxalate ions to nucleate COM crystals within a 24 hour incubation period. Water vapor selectively condensing onto -CO\(_2\text{H}\) terminated regions ensured successful μCP technique, Figure 5a,b. \([\text{Ca}^{2+}]=[\text{C}_2\text{O}_4^{2-}]=8 \times 10^{-4}\text{ mM}\) resulted in over-nucleation such that the 30μm square was completely covered with COM crystals, producing a 30 by 30μm COM aggregate, Figure 5d.

The aforementioned ion concentration studies led to more specific testing within the range of \([\text{Ca}^{2+}]=[\text{C}_2\text{O}_4^{2-}]=7 \times 10^{-4}\text{ mM} \text{ to } 9 \times 10^{-4}\text{ mM}\). As ion concentration increased, nucleation density also increased, Figure 6. Qualitative evidence shows that increasing the ion concentration also decreases the size of COM crystals. At the lowest concentration necessary to produce COM nucleations, density of COM crystals was still too high to be useful in crystal growth studies. Changing the ion concentration alone was not enough to produce single COM cof fins in the desired patterned regions. Varying the pH of HEPES buffer also had no noticeable effect on COM nucleation or COM density, Figure 7. Working within the effective range of HEPES buffer (6.8 - 8.2 pH) resulted in little to no change over COM nucleation and growth.

In an attempt to decrease nucleation density of COM crystals, and thereby potentially increase crystal size, concentration of mercaptohexadecanoic acid per 30μm square was decreased by forming mixed monolayers with varying

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**Figure 7.** The effect of increasing pH on COM nucleation density with fixed ion concentrations $[Ca^{2+}]=[C_2O_4^{2-}]=7.5 \times 10^{-4}$ mM on a SAM: 30 x 30 µm squares of HS(CH$_2$)$_3$CO$_2$H surrounded by HS(CH$_2$)$_3$CH$_3$ supported on a gold surface. DIC micrographs of templated COM crystal growth at (a) pH = 6.8, (b) pH = 7.3, (c) pH 7.8, (d) pH 8.2.

**Figure 8.** DIC micrographs of COM crystals ($[Ca^{2+}]=[C_2O_4^{2-}]=7.5 \times 10^{-4}$ mM, pH = 7.7) nucleating on templates of mixed SAMs: (a) 30 x 30 µm squares of 100% HS(CH$_2$)$_3$CO$_2$H surrounded by HS(CH$_2$)$_3$CH$_3$; (b) 30 x 30 µm squares of 50% HS(CH$_2$)$_3$CO$_2$H : 50% HS(CH$_2$)$_3$CH$_3$ surrounded by HS(CH$_2$)$_3$CH$_3$; (c) 30 x 30 µm squares of 25% HS(CH$_2$)$_3$CO$_2$H : 75% HS(CH$_2$)$_3$CH$_3$ surrounded by HS(CH$_2$)$_3$CH$_3$ supported on a gold surface.

**Figure 9:** DIC micrographs of COM crystals ($[Ca^{2+}]=[C_2O_4^{2-}]=7.5 \times 10^{-4}$ mM, pH = 7.7) nucleating on templates of mixed SAMs: 30 x 30 µm squares of 25% HS(CH$_2$)$_3$CO$_2$H : 75% HS(CH$_2$)$_3$CH$_3$ surrounded by HS(CH$_2$)$_3$CH$_3$ supported on a gold surface grown over (a) 24 hours, (b) 48 hours. Increasing the time in growth solution increased nucleation density without affecting the average size of the COM crystals.

**Figure 10.** Representative DIC micrographs of COM crystals nucleating on templates of SAMs: 30 x 30 µm squares of HS(CH$_2$)$_3$OH surrounded by HS(CH$_2$)$_3$CH$_3$ supported on a gold surface grown over 24 hours. Varying the ion concentration ($[Ca^{2+}]=[C_2O_4^{2-}]=7 \times 10^{-4}$ mM, $[Ca^{2+}]=[C_2O_4^{2-}]=7.5 \times 10^{-4}$ mM, $[Ca^{2+}]=[C_2O_4^{2-}]=8 \times 10^{-4}$ mM) and pH = 6.8 to 8.2 had little effect on nucleation density.
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ratios of mercaptohexadecanoic acid to mercaptohexadecane. The mixed monolayer study may also more closely approximate the surface of a biological macromolecule, which is not often a two-dimensional crystalline interface of single functionality as is prepared via a SAM of mercaptohexadecanoic acid. As the ratio of mercaptohexadecanoic acid to mercaptohexadecane was decreased, nucleation density dramatically decreased. Not only did the average number of crystals per growth region decrease, but the average crystal size also decreased, contrary to our original hypothesis, Figure 8. Further attempts to increase crystal size by permitting growth to continue for 48 hours did not lead to increased crystal size, but simply increased nucleation density, Figure 9.

Terminal SAM functional groups have been shown to have a profound effect on the nucleation, size, and orientation of calcite. 2,6 SAMs of hydroxy-terminated alkanethiols had a similar effect as methyl-terminated SAMs on calcite growth. In an attempt to lower COM nucleation density, mercaptoundecanecan was patterned onto the gold surface and the pattern was backfilled with mercaptohexadecane. The mercaptoundecanecan templated COM growth such that nucleation density was lowered, and crystal size was increased, Figure 10.

Conclusion
µCP SAMs of w-functionalized alkanethiols on gold are effective templating agents for the growth of COM. COM crystals nucleate on carboxyl terminated µCP SAM patterns regardless of ion concentrations, once a critical concentration is reached, and regardless of pH, within the effective range of the HEPES buffer. The µCP carboxyl terminated patterned SAMs appeared to be ineffective in controlling the orientation of the COM crystals and relative ratios of twinned COM crystals formed. Evidence of the di- and tri-hydrate forms of calcium oxalate was also not observed.

While the surface of biological macromolecules important in kidney stone formation and inhibition are rich in anionic functionality, a SAM, which can be approximated by a two-dimensional crystalline slice of a long-chain carboxylic acid crystal may not serve as an appropriate mimic. Mixed µCP SAMs of mercaptohexadecane and mercaptohexadecanoic acid with varying ratios may better model the surface of biological macromolecules by both decreasing the anionic functionality and by forming more disordered interfaces with the growth solution. These mixed µCP SAMs appear to nucleate lower densities of COM, while at the same time decreasing average crystal size. Longer growth periods did not increase crystal size, but served to decrease the effectiveness of the templating surface as COM nuclei formed on the surface without regard for the functionality of the micropattern. Complete alteration of the terminal alkanethiolate functional group to a hydroxyl terminated thiol, had a significant effect on both the nucleation density and size of the COM crystals within the normal 24-hour incubation period.

These studies provide the impetus to synthesize other non-commercially available w-functionalized alkanethiols to further study COM nucleation and growth by µCP SAMs.

References
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**Historical Notes**

**Grace L. Priest (1914-2005)**

Grace L. Priest, retired chief physical chemist of the Materials Research Laboratory, U.S. Army Materials Research Agency, Watertown Arsenal, in Massachusetts, died on October 20, 2005, at the age of 91.

She was born June 30, 1914 in Manchester by the Sea, Massachusetts, as Grace L. Ernst.

Priest received her bachelor’s degree in chemistry from the University of New Hampshire in 1935 and her master’s degree from the same institution in 1936. She married Homer F. Priest and followed him to Columbia University where he was pursuing his doctorate with Nobel Laureate Harold Urey. She worked in the chemistry department studying the chemistry of uranium hexafluoride. Both she and her husband were enlisted to work on the Manhattan Project. From 1941 to 1944 she worked in the chemistry division at the K25 gaseous diffusion plant performing materials research to develop barriers for the separation of uranium isotopes in the gaseous diffusion process. As a result of her work she was recognized as an international authority on the chemistry of uranium hexafluoride.

In 1957 she was a chemist at the U.S. Army Materials and Mechanics Research Laboratory where she performed materials research and analysis of energetic materials using neutron activation analysis. She retired as a senior chemist in 1980.

She was an avid birder and spent many of her winter vacations in Florida observing and photographing in the everglades. She was a lifelong member of the Massachusetts Audubon Society, the National Audubon Society, the Wilderness Society, and the National Wildlife Federation. An emeritus member, she joined ACS in 1941.

By Dr. John Hobbs

**Carl W. Christensen (1903 –2006)**

Carl W. Christensen, at age 102 peacefully passed away on Tuesday evening, February 7, 2006 in Peterborough, NH, surrounded by family and friends.

He was born in Highland Park, IL, the eldest son of Danish parents who, having second thoughts about leaving Denmark, returned there for two years. He and his parents then immigrated to the United States where he was raised in Spring Creek, PA. He also lived in Hinsdale, IL and Beverly, MA.

He graduated as valedictorian from Corry High School in Corry, PA in 1921, and earned a degree in Chemical Engineering from Penn State in 1927. During his long career with several divisions of Armour and Co. (later Dial) and the Shipley Co. (later Rohm and Haas) he worked in chemical research and development in areas as diverse as food chemistry, fats and oils, leather, and the breakthrough chemistry which allowed for the production of microchips in computers. He was a member of the American Chemical Society for 74 years and held over 40 patents for his work.

He looked forward to the arrival of each issue of The Nucleus.

He was able to travel to Denmark again at the age of 90 with his daughter. However, the best part of his golden years were spent in residence at Summerhill in Peterborough, chatting with old friends by email, leading a daily aerobics class for fellow residents. He thoroughly enjoyed life and had a passion for learning something new. Every day he considered to be a grand adventure. At the age of 101 “The Old Viking” discovered a talent for painting and eventually had a one-man show of his watercolors at Summerhill.

He was predeceased by his wife and beloved soulmate of 62 years, Ruth Michell Christensen. His memory is cherished by family and friends.

—— Karen Wells, daughter

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**Argentine Chemists**

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Dr. Robert L. Carter, Chair
Department of Chemistry
University of Massachusetts Boston
100 Morrissey Blvd.
Boston, MA 02125
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Location: Boston, MA
Type: Temporary, full-time instructor (12 contact hours per week for academic year 2005-6, beginning Sept. 5, 2006

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Possible graduate course teaching assignment in spring semester.

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apply the least steps to maintain fidelity of the information by reducing the loss in efficiency. The one object that we can understand with the least number of instruments, processes, design, etc. is ourselves. The most anyone, instrument, theory, analysis, etc. can understand us is ourselves. So, it is the self-study of self (SOS) which could lead to the most understanding. And, chemistry is by far the best modern way to SOS, making the circle of learning through something we all are very good at, i.e., chemistry of self. I know, I know. You say, isn’t that biotechnology?

As a biophysical chemist, I say it is more than that. It will always be more than anything anyone else ever tells you about you. Chemistry of self is not just interdisciplinary or central science; it is life to learn individually and infinitely.

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Chemistry of Understanding
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Calendar

Notices for the Nucleus Calendar should be sent to:
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