

# THE NUCLEUS

January 2000

Vol. LXXVIII, No. 5

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## Book Review

*At Home in the Universe*  
by S. Kauffman

## Rare Earth Separation

*Reported at the National Historic Chemical Landmark Designation at the University Of New Hampshire*

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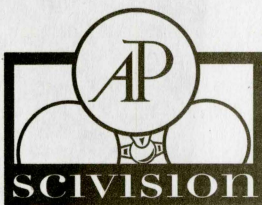
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**Cover:** *Dr. Doris I. Lewis, 2000 Chair (photo by Bachrach)*

**Deadlines:** *April 2000: February 24, 2000*

*May 2000: March 20, 2000*

## THE NUCLEUS

The Nucleus is distributed to the members of the Northeastern Section of the American Chemical Society, to the secretaries of the Local Sections, and to editors of all local A.C.S. Section publications. Forms close for advertising on the 1st of the month of the preceding issue. Text must be received by the editor six weeks before the date of issue.

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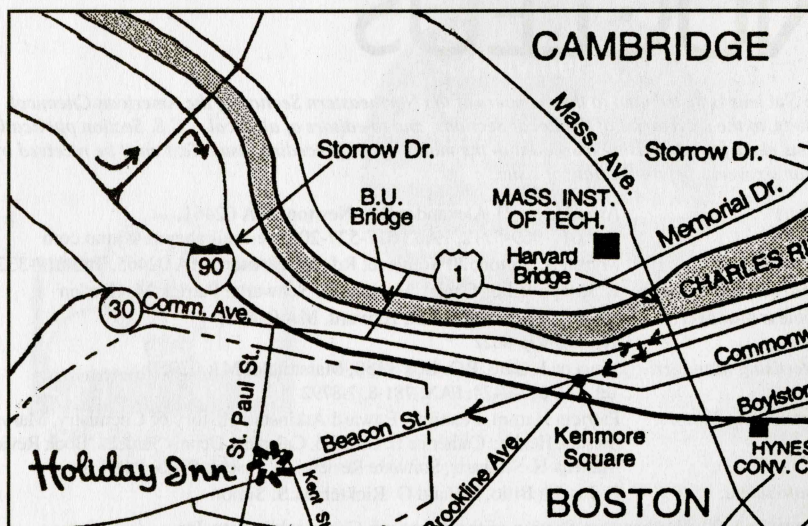
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# From the New Chair

Greetings to my fellow chemists in the Northeastern Section, and a special welcome to the members of the Central Massachusetts Local Section, joining us for the first time this month as readers of *The NUCLEUS*. As I begin my year as chair, I would like first to share some of the experiences of my past year as chair-elect and program chair. Contacting speakers for our monthly meetings has been a pleasure and a privilege. How fortunate we are in the Northeastern Section to have so many eminent and generous colleagues willing to share their knowledge at our monthly meetings. This morning's newspaper featured excited accounts of the possibility of growing new tissue and even new human organs on synthetic scaffolds, but this is old news to our members: Last February and April, enthralled NESACS audiences were treated to lectures by our Esselen award winner Robert Langer on biodegradable polymers as implantable scaffolds for mammalian cells to create new organ transplants, as well as drug delivery systems. At the Education Night meeting in May, we heard audible gasps from the audience of educators, students and scientists as Eric Martz used molecular visualization tools from free internet software to

show bond stretching and a simultaneous infrared frequency pattern. Charles Kolb, recipient of the 1997 ACS Award for Creative Advances in Science and Technology, explored the analytical challenges of atmospheric chemistry for us in March, while Karl Selavka, Director of the State Crime Lab, in January showed that the crime scene presents analytical chemistry challenges as well; both were eye-opening demonstrations of the wide applications of this field. At an historic first joint meeting with the New England Section of the Electrochemical Society in September, Pam Mabrouk presented interesting new findings in metalloprotein structure and function, then revealed that the work had been performed by an undergraduate using Project Seed money from the Northeastern Section. Madeleine Jacobs, editor of the *Chemical and Engineering News*, attracted a large and appreciative audience in October as she gave a no-holds-barred analysis of employment prospects for chemists in the new millennium. November featured eminent educator John Lagowsky's address as recipient of the Norris Award for Excellence in Teaching Chemistry, and the December meeting address on chiral ion pairs by Thomas Pochapsky was part of a symposium on the timely topic of chiral synthesis and separation organized by our active Medicinal Chemistry Group.

*continued on page 6*



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**From the South or North:** Take Rte. I-93 to Boston. Exit unto Storrow Drive at Exit 26. Continue on Storrow Drive to the Kenmore Exit. Follow \* below.

**\*From the Kenmore Exit off Storrow Drive:** At the first set of lights turn right onto Beacon Street. In Kenmore Square stay in the center lane and take the center road, which is Beacon St. The Holiday Inn is about 0.6 Mi. on the right at St. Paul St. Enter the driveway into the garage at the in-town end of the building. Parking at meters on Beacon Street may also be available, should the garage be full (no meter charge after 6:00 pm).

**By Public Transportation:** Take (or change at Park St. to) the Green Line, "C" train. Exit at the St. Paul St. stop (3<sup>rd</sup> stop after Kenmore) across from the Holiday Inn. ♦

# Monthly Meeting

*The 812th Meeting of the Northeastern Section of the American Chemical Society*

**Thursday, January 13, 2000**

**Holiday Inn, 1200 Beacon St., Brookline, Mass.**

**5:30 pm** Social Hour; a table of Career Services Literature and Aids will be available

**6:30 pm** Dinner

**8:00 pm** Evening meeting, Dr. Doris Lewis, Chair, presiding  
Dr. Mark Nelson, Paratek Pharmaceuticals, Inc., *Reversing Antibiotic Resistance*

Dinner reservations should be made no later than January 6, noon. Please call or fax Marilou Cashman at 800-872-2054. Reservations not canceled at least 24 hours in advance must be paid. Members, \$25.00; Non-members, \$28.00; Retirees, \$15.00; Students, \$8.00. **THE PUBLIC IS INVITED.**

*Anyone who needs special services or transportation, please call Marilou Cashman a few days in advance so that suitable arrangements can be made.*

**Free Parking:** Basement level, enter from Beacon St. westbound. Space is limited, if full, park at meters on street.

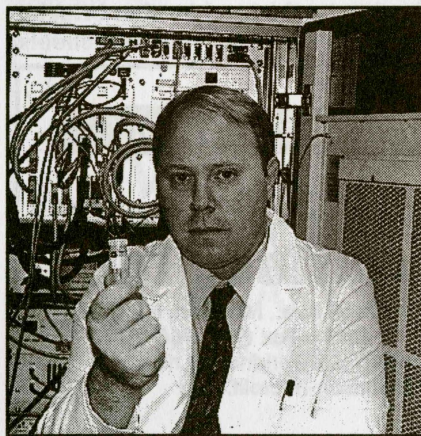
**Next Meeting:** February 10, 2000, Holiday Inn, 1200 Beacon St., Brookline, MA. Social hour and dinner: 5:30 pm. Speaker and topic to be announced.

## Biography

Mark L. Nelson, Ph.D., is currently Senior Director of Chemistry at Paratek Pharmaceuticals, Inc., a biotechnology company in Boston concerned with the synthesis and biological evaluation of antibiotics effective against antibiotic-resistant bacteria and drug resistance mechanisms.

As an undergraduate at Gannon University in Erie, PA, he studied the bacteriocidal effects of ozone against pathogenic microorganisms, receiving a B. S. in Chemistry and Microbiology. He then attended Temple University, Schools of Pharmacy and Medicine, receiving a Ph.D. in Medicinal Chemistry and Molecular Pharmacology in 1987, where his thesis centered on the structure-activity relationships of derivatives of traditional Chinese medicines as inhibitors of platelet function and cardiovascular processes.

Since 1988, he has been active in antibiotic chemistry in association with



Dr. Stuart B. Levy at Tufts University School of Medicine, The Center for Adaptation Genetics and Drug Resistance, studying the SAR of antibiotics effective against antibiotic efflux and ribosomal protection mechanisms. Dr. Nelson has publications and patents concerning the organic chemistry and molecular pharmacology of antibiotics and is considered a leading authority in the area of tetracycline chemistry and antibiotic resistance.

## Abstract

### *Reversing Antibiotic Resistance in Bacteria*

Since the dawning of the antibiotic era, "magic bullets" such as penicillin and tetracycline have been used to fight a broad spectrum of bacteria and have saved the lives and increased the life expectancy of people everywhere. But this is no longer the case. Many bacteria are now resistant to not only single but multiple antibiotics by devising efflux pumps, antibiotic modification, or target modification processes enabling them to survive in therapeutic levels of once toxic antibiotics. Now that these "superbugs" are more threatening, the Center for Disease Control reports that new and resistant organisms accounts for a 58% increase in mortality from infectious diseases between 1980 and 1992, making infection the third leading cause of death in the U. S. alone.

Our laboratory has been studying the structure-activity relationships of tetracyclines and the effect of chemi-

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He is a frequent lecturer and invited speaker, including the ACS National Medicinal Chemistry Symposium, Gordon Research Conference on "Non-antibiotic Properties of Tetracyclines and Other Antibiotics" and was elected Chairman of the next GRC on "New Properties of Antibiotics". In 1995 he was awarded a Fulbright Distinguished Lecturer Award to travel to Egypt to promote international collaboration in organic chemistry and microbiology.

His main research interests are in the modulation of drug resistance processes in microorganisms, the chemical modification of antibiotics, and the use of small molecules and genetic switches in antibiotic-repressor systems for transgenics.

He lives in Wellesley, MA with his wife Janice, daughter Catherine, and four dogs. ◇

## Abstract

continued from page 5

cally-modified antibiotics to modulate drug resistance efflux processes in both Gram-negative and Gram-positive bacteria. From studying these transport-antiprot proteins, the Tet family of efflux pumps, we have produced compounds that can essentially "reverse" antibiotic resistance. We have explored new chemistry and substitutions that can effectively block efflux and target-modified resistance and restore potent antibacterial activity to the tetracycline family of antibiotics. Concurrently, these new antibiotic derivatives have also been found to be active against MRSA (methicillin resistant *S. aureus*) and VRE (vancomycin resistant *Enterococcus*) affording new hope that these pathogens can continue to be treated therapeutically as resistant bacterial strains emerge and thrive. ◇

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## From the New Chair

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If the lengthy list above has triggered a pang of regret on the part of the reader that one of these meetings was missed, it has fulfilled its purpose. These regular meetings of our society are rare opportunities to hear the very latest and most important discoveries of our time in a gathering that is intimate, yet includes chemists from a wide variety of interests and career paths. Please consider this message my personal invitation for you to join us on at least some occasions in the coming year.

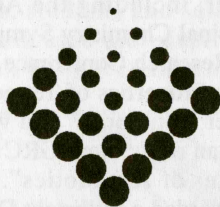
The Northeastern Section offers you myriad other opportunities for the advancement of the chemical profession and of your own career. It's by now a frustrating truism that "chemical" no longer has positive associations for the vast majority of the American public, and that science literacy in general is at an abysmal level. Skilled professionals at the national offices of the ACS have developed programs and materials for volunteers who want to make a difference in improving public relations at the local level or bringing hands-on chemistry into the schools,

but it's up to us to provide the volunteers. This year the ACS succeeded in getting National Chemistry Week into Parade Magazine; can we bring it to Boston in a visible way next year? This past October we helped dedicate the first National Chemical Historic Landmark in New England at the University of New Hampshire; should there not be many more in this historic area? We have active groups working to help find appropriate jobs for our unemployed members and to mentor new members; can you help? In my experience, involvement in worthwhile projects such as these starts in small ways: a phone call, an afternoon's involvement, a conversation. Most people become involved for one reason: they were asked. Accordingly, I invite you to explore whether the Northeastern Section can provide the right opportunity for you to make a contribution to advancing the chemical profession. You can always reach me and the other Section officers through the information on the Nucleus masthead, or through the toll-free number at the Section office.

Finally, allow me to share with you one of my concerns regarding our Society: the relationship between the individual member and this large organization, the largest such scientific organization in the world. Some find it frustrating and feel voiceless in such a large entity. Others don't consider very much whether the ACS is taking the direction they would prefer. Being a large section, we have a number of councilors whose function it is to represent you; be sure to let one or more councilors know if you have concerns or suggestions to convey to the national organization. And, if you want a more personal, local connection to your professional society, attend a Section meeting or become involved in the Section activity of your choice. You'll find yourself joining an increasing number of chemists of all ages and interests who are participating in our Section activities. I look forward to serving as your Chair of the Northeastern Section in the coming millenium year; let's make it an eventful one!

Doris Lewis ◇

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## From the Editor

### Welcome to the Central Massachusetts Section

As your Chair, Glenn Jones, and our Chair, Doris Lewis have already greeted you, I would simply like to add that we welcome articles from any of you: technical articles of general interest to chemical scientists, newsworthy events or information, historical articles, book reviews, and even puzzles. Just send them to me – my address is listed on page 3 of every issue. I welcome them as hard copy, fax (if not too long), e-mail (preferably in WORD for PC), or ASCII, or on diskette. Because of space restrictions, I may have to edit them for length and consistency with our editorial format.

Our deadlines are typically 6 weeks before the first of the month of issue. The deadlines for upcoming issues are listed on page 3. If pictures are included, they should be sharp and with good contrast – either B&W or color, preferably 4"x 6" or larger. Pictures via internet do not reproduce well: Contrast is usually poor and sharpness is only suitable for small print size. Issues are mailed from Worcester usually about the 20<sup>th</sup> of the month preceding the month of issue, so you should receive them quite promptly.

Our Business Manager, Karen Piper, handles all matters concerning address changes.

Arno Heyn, Editor ◇

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The 1999 NESACS Directory is available at no charge to members for their personal use.

Send request to:

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## Central Massachusetts Section

Dear members of the CMS,

We have arranged to include you on the mailing list for *The Nucleus*. We hope that in addition to enjoying the articles in this monthly newsletter that you will look to this column for information concerning future CMS activities. Of course, you are encouraged to participate in the myriad of events sponsored by our neighbors in the New England section, as well. Never hesitate to contact me with comments or suggestions... especially if you want to know how to become more active in your local ACS section!

Stay tuned,  
Glenn Jones  
CMS Chair  
gjones@holycross.edu  
(508) 793-2793 ◇

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Deadline for meetings July 1 to  
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# ACS Scholarship Programs

ACS has announced that its scholarship programs are ready to receive applications for the 2000-2001 academic year. These programs are designed to encourage African American, Hispanic/Latino, and American Indian students to pursue undergraduate college degrees in the chemical sciences and chemical technology. The goal of the scholarship program is to aid in building an awareness of the values and rewards associated with careers in the chemical sciences and chemical technology by assisting students in acquiring the skills and credentials needed for success in these areas.

To qualify, candidates must be:

African American, Hispanic/Latino, or American Indian; a US, citizen or permanent resident of the US.; a full time student at an accredited college, university, or community college; high academic achievers in chemistry or science; able to demonstrate evidence of financial need according to the FAFSA (Free Application for Federal Student Aid) form; a high school senior, college freshman, sophomore, or junior intending to or already majoring in chemistry, biochemistry, chemical engineering, or a chemically related science, i.e., environmental science, materials science, or toxicology, and planning a career in the chemical sciences or chemical technology.

NOTE: Students planning careers in medicine or pharmacy are not eligible for these programs.

The Society will award approximately 100 scholarships nationwide valued at up to \$2500 each for the academic year.

For application forms and more information, contact ACS toll-free at (800)227-5558 (ext. 6250), via e-mail at <scholars@acs.org>, or on the Internet at <<http://www.acs.org/>

# Career Services

## *Careers 2000 Workshops: Career Management Strategies for the Next Century*

Chemists and other technical professionals are facing some interesting career challenges as Y2K approaches. Job security rests in employability and portability of skills or, more succinctly, in the ability to get another job. What career management strategies can chemists use to maintain marketability? What options exist for obtaining the technical retooling and soft skills training necessary to stay abreast of the marketplace? What assistance can ACS offer its members to help them in their current careers or assist them in career transitions?

To assist members in answering these and related questions, the Career Services Committee of the Northeastern Section of ACS, in conjunction with ACS National, is planning to offer a series of career meetings and workshops in the year 2000. The purpose of these sessions is to assist NESACS members develop and improve proactive career management skills.

Watch for registration information about these upcoming programs in *The NUCLEUS* and on the NESACS Web Site: <http://people.ne.mediaone.net/obermayer/nesacs>

For additional information, contact Pat Hamm at [drhamm@mediaone.net](mailto:drhamm@mediaone.net), Mukund Chorghade at [mukund\\_chorghade@leukosite.com](mailto:mukund_chorghade@leukosite.com) or Dan Eustace at [eustacd@polaroid.com](mailto:eustacd@polaroid.com) ◇

*minorityaffairs/*>. All materials (forms, transcripts, letters of recommendation, SAT or ACT scores) must be received **no later than February 15, 2000**, and should be mailed to the following address:

American Chemical Society Scholars  
Program  
Department of Minority Affairs  
1155 Sixteenth Street, NW  
Washington, DC 20036 ◇

# Book Review

*At Home in the Universe. The Search For Laws of Self-Organization and Complexity*, by Stuart Kauffman (Oxford University Press, 1995) 320 pp., ISBN 0-19-509599-5; \$16.95

Reviewed by Dennis J. Sardella  
Department of Chemistry  
Boston College  
Chestnut Hill, MA 02467

This review has proven to be a difficult one for me to write, not because Stuart Kauffman's *At Home In The Universe* is not a good book, but because it seems almost *too* good. In fact, as I read it, I couldn't help recalling a slogan from the Massachusetts Attorney General's campaign against fraud from several years ago: "If it seems too good to be true, chances are it isn't."

Subtitled "The Search for Laws of Self-Organization and Complexity", *At Home In The Universe* deals with the area of complexity theory, focusing on the question of how order arises in a chaotic universe. Complexity theory is, in a sense, the counterpart of chaos theory, popularized by James Gleick's book *Chaos. Making a New Science* (Penguin Books, 1987). Kauffman, a member of the Santa Fe Institute, a major center of complexity theory research, is a fluid and compelling writer whose prose can sweep you along so that you can find yourself wondering if you're responding to the substance or the wrapping.

Perhaps the most striking idea in the book, and in a sense its intellectual core, is presented in Chapter 3 ("We The Expected"), where Kauffman argues that the emergence of life, rather than being the highly unlikely occurrence that both everyday experience and the Second Law of Thermodynamics lead us to expect, is actually inevitable.

He begins with a startlingly simple

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# Nominations

## *Aula Laudis*

The Northeastern Section annually honors teachers of chemistry at the secondary level in our region by choosing several for selection to the honor society, *Aula Laudis*. Election to membership in *Aula Laudis* is a recognition of excellence in the teaching of chemistry at the secondary school level. This recognition is based on both qualitative and quantitative criteria that involve the totality of an individual's participation in and contribution to the teaching profession. Inasmuch as teaching is a skillful art with a wide range of marks of excellence, no one criterion for election to *Aula Laudis* is sufficient and no one criterion is necessary. The following criteria, in their broadest sense, shall be considered by the Selection Committee:

- Having taught chemistry to students who have won state-wide, regional, or national chemistry competitions, such as the Ashdown Examination Award;
- Having received awards for excellence in teaching from state-wide, regional or national organizations;
- Having advanced the scholarship of chemical education, including curriculum design, laboratory development, and the introduction of pedagogical methods and techniques through publication in recognized chemical education journals and/or through presentations at scientific meetings and continuing education symposia;
- Having served as the adviser of extra-curricular activities, such as clubs, science programs and science talent searches, in which the interest of chemistry students in the subject is advanced and developed;
- Having performed special service to the chemical education community, such as through the organization of continuing education symposia in chemistry;
- Having demonstrated excellence in classroom teaching as evidenced from written in-class evaluations by

## *Philip L Levins Memorial Prize*

Nominations for the Philip L. Levins Memorial Prize for outstanding performance by a graduate student on the way to a career in chemical science should be sent to the Executive Secretary, NESACS, 23 Cottage St., Natick, MA 01760 by **March 1, 2000**. The graduate student's research should be in the area of organic analytical chemistry and may include other areas of organic analytical chemistry such as environmental analysis, biochemical analysis, or polymer analysis.

Nominations may be made by a faculty member, or the student may submit an application. A biographical sketch, transcripts of graduate and undergraduate grades, a description of present research activity and three references must be included. The nomination should be specific concerning the contribution the student has made to the research and publications (if any) with multiple authors.

The award will be presented at the May 2000 Section Meeting. ◇

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supervisors;

- Having had a significant personal impact on students as evidenced by letters from alumni/ae on behalf of the nominee.

The Selection Committee will accept nominations on behalf of active and retired secondary school chemistry teachers; the length of teaching service is not a criterion. The criteria for each final recommendation shall be recorded in the minutes of the Selection Committee.

Nominations, including a one-page summary of the nominee's relevant accomplishments, are to be sent to: David Olney

P.O. Box 559

Mattapoisett, MA 02739

e-mail: [djolney@ma.ultranet.com](mailto:djolney@ma.ultranet.com)

Nominations are due **February 15, 2000**. ◇

## Book Review

*continued from page 8*

illustration that can easily be reproduced on a desktop computer. Imagine a two-dimensional grid of 10,000 points ("buttons"). Randomly choose two sets of coordinates and connect the corresponding points with a line ("thread"), then continue this process, monitoring the size of the largest cluster. Initially, the likelihood that two threads will share a button is negligible and the maximum cluster size will be two. Eventually, however, three-point, four-point, and larger clusters will begin to appear, until eventually the entire set of points is linked, forming a single massive cluster. Intuitively, one probably expects to see a slow, steady, relatively featureless increase in the cluster size. Surprisingly, however, the results show that if the maximum cluster size is graphed as a function of the threads/buttons ratio, the result is something startlingly similar to a strong acid-strong base titration curve, with the maximum cluster size remaining relatively small until the ratio of threads to buttons approaches 1:1, when the system abruptly switches over to a nearly completely-connected cluster. Kauffman likens this behavior to a phase transition and argues by analogy that, if the buttons are taken to represent molecules and the threads to represent catalyzed reactions which interconvert them, then the results suggest that the emergence of self-sustaining, collectively autocatalytic systems ("life"), rather than being a highly unlikely and fortuitous event, is instead inevitable. In Kauffman's words,

"The analogue in the origin-of-life theory will be that when a large enough number of reactions are catalyzed in a chemical reaction system, a vast web of catalyzed reactions will suddenly crystallize. Such a web, it turns out, is almost certainly autocatalytic — almost certainly self-sustaining, alive."

A living system must be homeostatic (i.e., relatively resistant to moderate external perturbations).

*continued on page 10*

## Book Review

continued from page 9

Kauffman next (Chapter 4, "Order for Free") describes his *in silico* studies of homeostasis, using as analogs Boolean networks of  $N$  lightbulbs, in which the state of each bulb (on or off) is governed by the state of one or more ( $K$ ) of its neighbors (through the existence of logic rules). He shows that, while the behavior of most systems is chaotic, endlessly flipping among the enormous numbers of various lighting patterns with cycle times longer than the life of the universe, when  $K=2$ , systems quickly settle into one of a minuscule subset of states (the familiar "attractors" of chaos theory) with cycle times of the order of microseconds. By analogy, Kauffman suggests that molecular systems in which each molecule is controlled by two other molecules (the situation most commonly found in biochemical systems) should likewise exhibit homeostasis.

Moving up the scale of complex-

ity, Kauffman next examines in successive chapters "The Mystery of Ontogeny" (Chapter 5) and the evolution of the biosphere (Chapter 6, "Noah's Vessel"), again by extending his studies of the behavior of systems of interconnected objects controlled by Boolean logic.

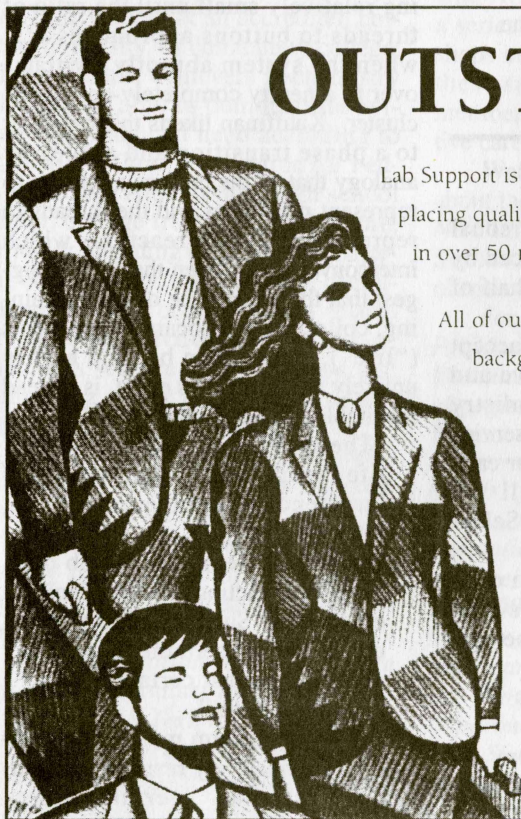
Chapter 7 ("The Promised Land") brings us to some real chemistry when Kauffman describes "applied molecular evolution," the generation of combinatorial libraries of randomly-generated polynucleotides which can then be screened for activity by what he calls the key-lock-key approach: develop an antibody (the "lock") to, e.g., insulin (the "key"), then use the antibody to fish out appropriate members (new "keys") of the combinatorial set. Here once again, the ideas fly fast and furious, segueing into one another with lightning speed that leaves you wondering what substance underlies the smooth assurance.

In Chapter 8 ("High Country Adventures") Kauffman addresses evo-

lution via natural selection, visualizing evolving organisms as migrating in a series of random steps (an accumulation of small mutations) across a "fitness landscape" toward peaks representing optimal fitness. Failure to reach such a peak means extinction. He argues against Darwinian gradualism on the grounds that once a system reaches a local maximum it will be trapped forever in its vicinity, whereas if an organism's mutation rate is sufficiently high, it can execute jumps to other remote maxima on the fitness landscape, increasing its chances of achieving dramatic increases in fitness.

Chapter 9 ("Organisms and Artifacts") begins by extending the ideas derived in the previous chapter to the proliferation of lifeforms seen in the Cambrian explosion, then eventually applies the principles to the process of technological innovation as well. Kauffman argues that as a system evolves across the fitness landscape, long leaps are most effective, and

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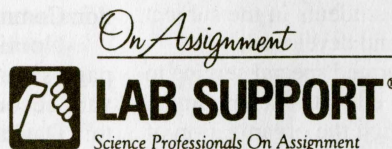


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prevalent, in early generations, where a wide range of highly divergent possibilities is sampled, but that short jumps are best for later ones. He poses the question of whether biological and human evolution follow the same laws.

With "An Hour Upon the Stage" (chapter 10) Kauffman reaches the top rung of the landscape of life by addressing the topic of co-evolution (the way in which species develop in the presence of other evolving species), seeking — and finding — evidence for the existence of approximate power laws in cases of real and simulated extinction events, much like those found in other cases of self-organized criticality (such as collapsing sandpiles and earthquakes).

In Chapter 11 ("In Search of Excellence") Kauffman crosses the boundary from biology into the realm of political and management science, extending the model of fitness landscapes to optimization in organizations, processes and societies. Interestingly, his results suggest that the social models that most efficiently promote optimization in political systems and business look a lot like democracy and capitalism.

The basic problem for me was that while all the "experiments" described in the book are computer-based (*in silico*), nothing is actually physically modeled, raising the question of in what sense one can make a connection between them and the real world. A physicist acquaintance helped by pointing out that it is now generally accepted that laws governing vastly different classes of phenomena can belong in the same "universality class," and that Kauffman's work rests on the hope that the behavior of his simple *in silico* systems will be described by laws belonging to the same universality class as the laws governing the behavior of complex chemical, biological, economic and political systems. Kauffman puts it this way:

"Discovering the existence of key biological properties of complex living systems that do not depend on all the details lies at the center of a hope to build a deep theory of biological order.

If all properties of living systems depend on every detail of their structure and logic, if organisms are arbitrary widgets inside arbitrary contraptions all the way down, then the epistemological problems that confront us in attempting to understand the wonder of the biosphere will be vast. If, instead, core phenomena of the deepest importance do not depend on all the details, then we can hope to find beautiful and deep theories."

Still, the connection was not immediately obvious to me, and there were moments when I found myself wondering whether I was responding to the substance of Kauffman's arguments or to his enthusiastic and compelling prose — rather as people have sometimes criticized resonance theory as having influenced the thinking and vocabulary of several generations of chemists more as a result of Pauling's superior salesmanship than of the inherent merits of valence bond theory relative to molecular orbital theory. Since *At Home In The Universe* has been written for a nonspecialist audience, its arguments are difficult to evaluate on a technical basis. For that, one would clearly need to turn to Kauffman's earlier, books: *Molecular Evolution on Rugged Landscapes: Proteins, RNA and the Immune System* (Perseus Press, 1990; co-edited with Alan S. Perelson) and *The Origins of Order: Self-organization and Selection in Evolution* (Oxford University Press, 1993).

*At Home In The Universe* is an intriguing book that propounds an exhilarating thesis with potentially profound implications for the way in which we view the natural world, with a range of potential applications that is dizzying. It is also remarkably well-written, approaching the poetic at times, which may perversely be a liability as well as one of its strengths. Scientists are simultaneously dreamers who live in the hope and expectation of sweeping advances in knowledge, and professional skeptics who view sweeping claims with great skepticism. In the face of the remarkable claims

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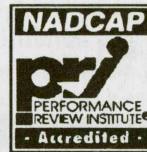
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## Book Review

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Kauffman makes, the skeptic in me keeps thinking "If it seems too good to be true, chances are it isn't," but the dreamer keeps saying (to paraphrase a comment I once heard at the conclusion of a seminar) "It's such a great story, if it isn't true, it ought to be." I thoroughly enjoyed reading it and incline hopefully to the latter view. Read *At Home In The Universe* for yourself and see what you think. ◇

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## Meeting Report

### Separation of Rare Earth Elements

*On the Occasion of the National Historic Chemical Landmark Designation of Conant Hall, University of New Hampshire on October 29, 1999.*

Reprinted by permission from the text of a booklet of the same title, prepared by the Office of Communications and the Division of the History of Chemistry of the American Chemical Society with the help of Dr. Clarence J. Murphy (East Stroudsburg University of Pennsylvania), Mylinda S. Woodward, (University of New Hampshire) and Paul R. Jones, (University of Michigan).

On October 29, 1999 a plaque marking this event was presented to the University of New Hampshire. The inscription reads:

"Beginning in 1906, in a laboratory in Conant Hall, Charles James (1880-

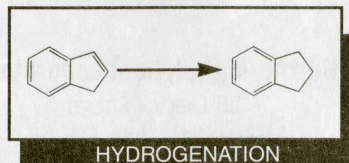
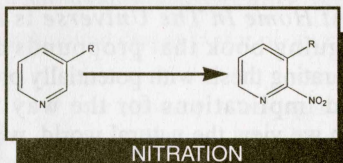
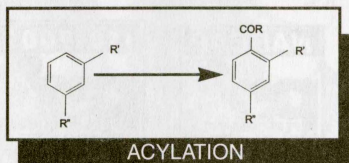
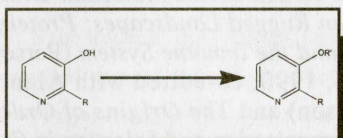
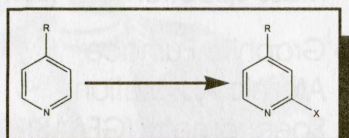
1928) developed novel fractional crystallization techniques for separating rare earth elements, which were widely adopted by other chemists. James used this method to separate large amounts of ytterbium, hitherto considered to be a single element, into two elements, now known as ytterbium and lutetium. When the simultaneous isolation of lutetium was published in 1907 by Georges Urbain, James made no public claim for his own pioneering work. Despite his retiring nature, James was internationally recognized as an expert in rare earth chemistry. His highly purified rare earth specimens were in demand by research laboratories throughout the world."

### Discovery and Separation of The Rare Earths

The 17 rare earth elements, or lanthanides, consist of elements 21 (scandium), 39 (yttrium), and 57 (lanthanum) to 71 (lutetium). The rare earths were so named because of their low concentration in minerals which were scarce. However, some of the elements are not as rare as once thought. Today, the rare earths are used in color television picture tubes, glass polishes, ceramic glazes, protective goggles, lasers, and superconductors. Most recently, some have been used in diagnostic imaging in the field of nuclear medicine.

The story of their discovery is probably the most confusing and complex of any of the elements. The search for and identification of the rare earth elements constituted an integral part of the development of science and technology in the late 19th and early 20th centuries. Several factors made their identification difficult: the chemical and physical properties of the different elements are quite similar; the elements were isolated as "earths" or oxides of the elements; and the methods of separation and purification depended on laborious fractional precipitation and crystallization techniques. Compounding the difficulties of separation were a lack of good methods for identification

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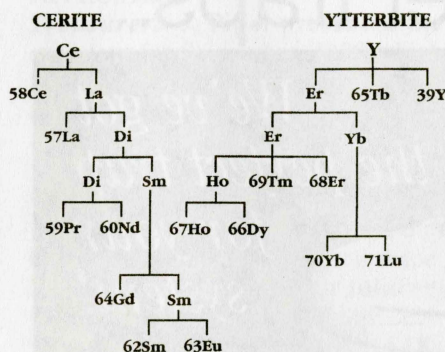
and assessment of purity and a lack of knowledge of the number of rare earth elements that existed.

A University of New Hampshire (UNH) professor, Charles James (1880-1928), all but forgotten today, was well known and highly respected by his contemporaries for his contribution to rare earth chemistry. The very first paper published by James in the *Journal of the American Chemical Society*, "A New Method for the Separation of the Yttrium Earths," indicates the direction of his research. Keenly motivated to improve the methods of separation and endowed with imagination and determination, James experimented with the preparation of many different salts of the rare earths derived from simple inorganic to complex organic acids. Letters in the UNH archives show that he supplied numerous workers worldwide with samples of the compounds that he had prepared, including the sample of terbium that Henry Moseley, an English scientist, used to determine its atomic number. James's use of bromates and double magnesium nitrates for fractional crystallization became known as the "James Method." Developed in the early 1900s, his method was used widely by others and remained the best for separating rare earth elements until the advent of ion exchange in the 1940s.

James's work with the rare earths is part of a long history that illuminates more areas of chemical progress than does any other group of elements. It stretches from the discovery of the first rare earth mineral in 1787 by Carl Axel Arrhenius to the unequivocal identification of the last in 1947 by Jacob Marinsky, Lawrence Glendenin, and Charles Coryell. The story involves the discovery of emission spectroscopy by Gustav Robert Kirchhoff and Robert Wilhelm Bunsen, the development of the periodic table by Dmitri Ivanovich Mendeleev and Lothar Meyer, and the discovery of X-rays by Wilhelm Conrad Roentgen. It includes the formulation of atomic numbers by Moseley, atomic structure by Niels Bohr and Ernest Rutherford, and work on the atomic bomb during

World War II. Over the course of a century, two minerals — ytterbite and cerite — were separated into eight and seven stable elements, respectively, as shown in the diagram below.

Separation of the Lanthanides (1794-1907)



### Discovery, 1794-1947

The first rare earth element, yttrium, was isolated in 1794 by the Swedish chemist Johan Gadolin from a heavy black mineral, ytterbite, named for the village of Ytterby where it was found. In 1803, Jons Jacob Berzelius and Wilhelm Hisinger in Sweden and Martin Klaproth in Germany announced almost simultaneously that they had isolated a new element, cerium, from the mineral cerite. This provoked the first of several priority disputes in the pathway to the discovery of rare earth elements.

The invention of the spectroscope by Kirchhoff and Bunsen in 1859 and the development of spectral analysis, along with the development of the periodic table by Mendeleev and Meyer in 1869, provided valuable tools for the study of rare earths. The impact of these advances is clear. In the 60 or so years before their introduction, only six rare earths had been identified, one of them erroneously. In the following 50 years, the number jumped to 15. However, problems remained. The rare earths severely challenged Mendeleev's periodic system, because he did not know where to place them in the table. He made many modifications simply to accommodate them. Meanwhile, spectroscopic analysis was causing difficulties.

Because of the complexity of the spectra of the rare earths and the questionable purity of the samples, many claims were being made for new elements that proved false. Despite these difficulties, by 1901 only two rare earths were still undiscovered.

In 1907, almost simultaneously, Georges Urbain in France, Carl Auer von Welsbach in Austria, and Charles James in the United States separated ytterbium into two fractions. Urbain's designation of the new element as lutetium, after the Roman name for his native city — Paris, was accepted by most, although von Welsbach's name cassiopium was used in German-speaking countries for many years. Von Welsbach contested Urbain's priority for the discovery of lutetium. James, although he had accumulated a substantial amount of highly purified lutetium oxide, withdrew a paper he had submitted for publication and made no public claim for his own work.

Lutetium was the 16th of the rare earths to be identified. Using X-ray spectroscopy, Moseley demonstrated that only one rare earth element remained to be discovered: element 61. He determined the atomic numbers of the elements and showed that they were arranged in the periodic table in order of atomic number, not atomic weight, as Mendeleev had thought. In the 1920s, James, B. Smith Hopkins, and Luigi Rolla each thought he had isolated element 61. Hopkins's publication preceded that of James, and so Hopkins's designation of the element as illinium was accepted temporarily. The last of the priority disputes over discovery of a rare earth element ended inconclusively, however, when none of the claims could be substantiated. The authentic discovery of element 61 had to await the development of a new separation technique, ion exchange chromatography, and work on the atomic bomb during World War II. Finally, in 1947, Marinsky, Glendenin, and Coryell announced the discovery of the unstable element 61, which they named promethium after the Titan who stole fire from the gods.

*continued on page 14*

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## Meeting Report

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### *Chemistry at the University Of New Hampshire, 1866—1928*

Few contributions to the understanding of the rare earths could overshadow the achievements accomplished in the chemistry laboratories at UNH. Chemistry has been a part of the university from its beginning. UNH traces its origins to the acceptance of the Morrill Act by the New Hampshire Legislature in June 1866, which led to the establishment of the New Hampshire College of Agriculture and Mechanic Arts in Hanover, in association with Dartmouth College. The first faculty member of the college in 1868 was Ezekiel W. Dimond, who was appointed professor of general and applied chemistry. An 1865 graduate of Middlebury College, Dimond was synonymous with the institution in its early days. Not only was he professor of chemistry, he was also the president, business manager, architect, supervisor of construction, and lobbyist in the state legislature. His efforts led to the construction of Culver Hall, which contained a chemistry laboratory, described in 1874 as the only one in the state. Thus the Department of Chemistry is the only department that has existed for the entire history of the university. Dimond served as professor of chemistry until his untimely death, at the age of 40, in 1876.

Succeeding Dimond as head of chemistry were Benjamin T. Blanpied (1877-1889), Fred W. Morse (1889-1909), and Charles L. Parsons (1909-1911). When Parsons resigned in 1911 to become chief chemist of the U.S. Bureau of Mines, James succeeded him and served as professor and head of the Department of Chemistry from 1912 until his death in 1928. For the most part, the department focused on the inorganic and analytical disciplines under his leadership.

### *Conant Hall*

While the New Hampshire College of Agriculture and Mechanic Arts was still located on the campus of

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# Board of Directors

## Notes of the Meeting of October 14, 1999

*NOTE: Board Meetings are held on the Monthly Meeting day at 4:30 p.m. Section members are invited to attend.*

### Officers' Reports:

**Chair:** D. Rickter introduced and welcomed Claudia Vanderborgh who has agreed to serve as chair of the NESACS National Chemistry Week Committee. With the Board's assent he designated Michael Singer, Secretary-elect for 2000, as acting secretary for NESACS for the remainder of 1999. D. Rickter thanked all past acting secretaries over the last year, including M. Singer, P. Hamm, A. Wick Light, and T. Light. Reminded Board members that the National Historic Chemical Landmark activities will take place October 29, 1999, starting at 3:00 p.m. at UNH in Durham, NH. D. Rickter will represent NESACS and will be one of the meeting speakers. All members are invited to attend. The University of New Hampshire has offered to host NERM 2001 and the Board agreed to support the UNH bid. D. Rickter announced that one of the students of Carol Murphree (Acton-Boxborough H.S.) was one of the finalists for the Chemistry Olympiad 1999.

**Chair-Elect:** D. Lewis announced that the joint meeting with the Medicinal Chemistry Group is scheduled for Monday, December 13, to be held at the MIT Faculty Club. She asked the Board to assist her in maintaining staffing of NESACS committees for 2000.

**Secretary:** The minutes of the September 9, 1999 meeting were modified as follows (additions underlined): In the Trustees Report, "...selected from a list of candidates provided by the National ACS Scholars Program. The NESACS Education Committee is to make the final selection." Under Chemical Education Committee: Item 5 should say: "...selection committee

for the Norris Award." MCG report: the issue of "hanging" was replaced with "formal representation to the NESACS Board of Directors is an open issue." Under Old Business: Information from the Trustees was requested and not provided.

The revised minutes were APPROVED.

**Treasurer:** J. Piper presented the summary for September, 1999 which was APPROVED after some discussion. J. Piper requested all committee chairs to present budget proposals for 2000 prior to or at the November Board meeting.

**Trustees:** E.A. Hopkins reported that the NESACS trusts are in good shape. The current valuation is as follows: CONSOLIDATED: 1.3 M; ESSELEN: 333K; HILL: 4.3 K; LEVINS: 14K; NORRIS: 18.6K; PERMANENT: 50.7K; PUBLICATION: 16.5 K; RICHARDS: 56.5K; **Total Funds:** 1.83M

**Archivist:** M. Simon reported that progress is being made in working up the backlog of materials in the archives. He reminded the Board that the October meeting in the past has been designated as the Professional Relations Meeting. He recommended that future October meetings be set up in conjunction with the Professional Relations Committee.

### Standing Committees:

**Bd. Of Publications:** The NESACS 1999 Directory has been produced and was distributed to Board members at the October Board meeting. It is available on request to any NESACS member free of charge. The budget for 2000 has been drafted. Because of increased advertising income, the net cost to the Section is decreasing, rapidly approaching zero. Currently the NUCLEUS print run is 6,000 copies. Starting January, members of the Central Massachusetts Section will receive copies of The NUCLEUS, resulting in a \$200 increase in production costs, which is considered small, compared to the additional benefits derived from a broader circulation. J. Neumeyer suggested that new member's names be listed in The NUCLEUS. This will be taken under

consideration.

**Editor:** A. Heyn stated that the October issue has been mailed. The November 1999 issue will be 20 pages. Since arrangement for speakers, date and location of the December meeting, to be made by the Medicinal Chemistry Group have not been completed, as yet, no pre-announcement of this meeting will be in the November issue. The Lehigh Valley Section has asked permission to reprint three articles from the October 1999 issue of The NUCLEUS, which was granted by the Board of Publications after obtaining assent from the authors. He stated that Local Section newsletter editors exchange copies of their respective section publications.

**Chemistry Education:** R. Tanner announced that the Student Affiliate Chapter at Suffolk University has received an Honorable Mention from the ACS Education Committee for its 1998 activities, the faculty co-advisor being Doris Lewis. The Undergraduate Research Conference will be held Saturday, April 29, 2000 at MIT. The Grant-in-Aid deadline of October 22, 1999 is a very tight one, necessary because of the ACS deadline.

**Professional Relations:** T. Light, reporting for P. Hamm: The NESACS Local Section Career Program (LSCP) is setting up joint programming for an evening program on job search skills. Brown University has offered to provide facilities and some refreshments for this 2-hour program, tentatively scheduled for mid-February 2000. The Peer Mentoring Program needs more exposure to develop a core group of mentors and "mentees". The committee plans more aggressive publicity for this program via e-mail and the NESACS Website. Programming for Mid-Career chemists: LSCP is investigating workshops and seminars offered by the National ACS Career Services on maintaining top performer status and general career management, possible to be offered in late winter/early spring 2000.

### Other Committees:

**Continuing Education:** A. Viola stated that the next Short Course will

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# CALL FOR PAPERS

# 2000

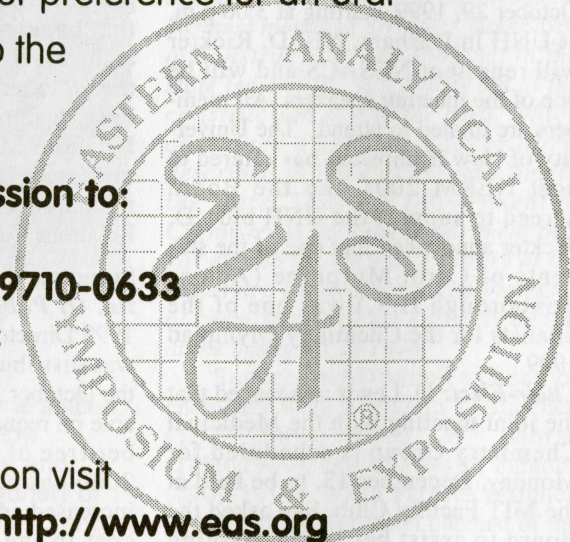
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## Meeting Report

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Dartmouth College at Hanover, the State of New Hampshire was bequeathed the entire fortune of a Durham farmer, Benjamin Thompson. He specified that an agricultural college be founded on his property in Durham. In 1891, preparations began for the college to move to Durham. Charles Parsons designed the new chemistry laboratories in Conant Hall, which was constructed during

1892-1893 at a cost of \$40,000 to house the Department of Chemistry and other science departments. From 1906 to 1928, Conant Hall also housed the offices and laboratories of James. By the late 1920s, Conant Hall was no longer adequate to accommodate chemistry; James designed a new building for chemistry and agricultural chemistry. Completed after James's death, the Charles James Hall was dedicated at the 1929 fall meeting of the Northeastern Section of the American Chemical Society (ACS). Conant Hall is now one of the three surviving original buildings of UNH at Durham. The interior has been completely altered since its use by the Department of Chemistry, and today it serves as a classroom and office building. The exterior, however, is remarkably unchanged from its appearance in 1893, when the Department of Chemistry first occupied Conant Hall and when, in subsequent years, James and his students conducted the thousands of manipulations needed to complete rare earth separations. Conant Hall and Durham became known worldwide among chemists as a center of rare earth research. ◇

## Board of Directors

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be given October 28/29 and will be a repeat of the course on Molecular Biology and Recombinant DNA Technology. So far only 9 people have pre-registered; ten are needed to offer the course. J. Kaufman MOVED and it was VOTED that the Section provide

funds (about \$300) to provide the 10<sup>th</sup> registration so the course can be given. A. Viola stated that nationally, Short Course attendance has decreased.

**Natl. Chemistry Week:** C. Vanderborght stated that NCW is scheduled for November 7-13, 1999. NESACS activities will include: Undergraduate Day at Boston University on November 13, 1999. Jerry Bell will be speaking on the Synergies in College/Pre-College Chemical Education at Simmons College. D. Phillips will be leading a high school field trip to the National Plastics Museum in Leominster.

**Health and Safety:** J. Kaufman reported that the committee is looking for host sites for their one-day Laboratory Health and Safety presentations. This is a NESACS sponsored presentation, at no cost to the host institution.

**Old Business:** R. Tanner asked that the Younger Chemists Committee (YCC) be set up as an Other Committee of the Section. A. Heyn pointed out that the chair has the power to appoint such committees. J. Piper expressed concern for the continuity of leadership of such a committee. It was MOVED

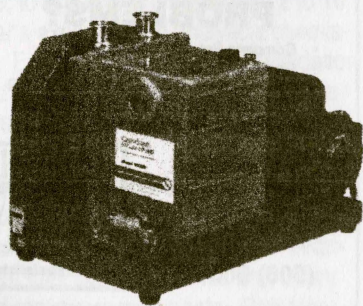
and VOTED to appoint the YCC as an Other Committee of NESACS.

E.A. Hopkins MOVED that NESACS sponsor a student under the National ACS Scholars Program, to be chosen from among nominees provided by the National ACS Scholars Program. The motion was PASSED.

E.A. Hopkins further MOVED that the Section increase the amount of the ACS James Flack Norris Award for Physical Organic Chemistry, sponsored by this Section to \$ 5,000, as required by the ACS. Discussion centered on the nature of the award as a national ACS award vs. a Local Section award. The motion was PASSED.

**New Business:** E.A. Hopkins announced that nominations are being solicited for the 2000 National Medal of Technology, with a deadline in December 1999. Similarly, nominations are sought for the Presidential Green Chemistry Awards. It was urged that this information be provided to A. Obermayer, webmaster of the NESACS website for inclusion on the website.

From the minutes by Michael Singer, Acting Secretary. ◇

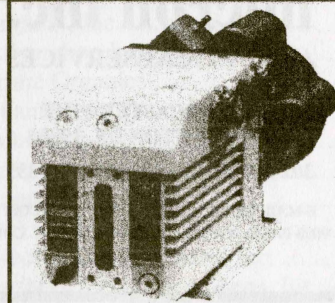


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Check NESACS Homepage for late additions:  
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### Jan. 5

Prof. Bruce Foxman (Brandeis Univ.)  
 "Reactions in Single Crystals: Design, Discovery  
 and Understanding"  
 Mass. Inst. of Tech.  
 Rm. 6-120, 4 PM

### Jan. 13

Prof. Keith Woerpl (Univ. CA, Irvine)  
 Title TBA  
 Mass. Inst. of Tech.  
 Rm. 6-120, 4 PM

### Jan. 14

Prof. Keith Woerpel (Univ. CA, Irvine)  
 "New Methods for Stereoselective Synthesis  
 Based Upon the Reactions of Silacyclopropane"  
 Boston University  
 Metcalf Sci. Ctr., Rm. 294, 3 PM

### Jan. 20

Prof. Kent Gates (Univ. MO, Columbia)  
 "Mechanism of Action of the DNA Damaging  
 Drug, Leinomycin"  
 Mass. Inst. of Tech.  
 Rm. 6-120, 4 PM  
 Dr. David Ofer  
 "Lithium Ion Batteries"  
 Northeastern Univ.  
 Hurtig Hall, Rm. 129, 4 PM

### Jan. 24

Prof. Xiaoliang (Sunney) Xie (Harvard Univ.)  
 "Single Molecule Enzymology"  
 Boston University  
 Metcalf Sci. Ctr., Auditorium, 4 PM

### Jan. 24 and 26

Prof. David Tirrell (Cal. Inst. Technol.)  
 Karl Pfister Visiting Lecturer  
 Mass. Inst. of Tech.  
 Rm. 6-120, 4 PM

### Jan. 26

Prof. Jeff Davis (Univ. MD)  
 "Self-Assembled Ionophores from Nucleosides:  
 Their Structures and Functions"  
 Boston University  
 Metcalf Sci. Ctr., Rm. 294, 4 PM

### Jan. 27

Prof. Charles Kolb (Aerodyne Research, Inc.)  
 "Chemistry of the Sodium Nightglow: Chemical  
 Kinetics at 90 km"  
 Boston College  
 Merkert Chemistry Ctr., Rm.130, 4 PM

### Jan. 31

Prof. Scott C. Mohr (Boston Univ.)  
 "Building Biology's Periodic Table"  
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 Metcalf Sci. Ctr. Auditorium, 4 PM

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## Grants-in-Aid Awarded to Undergraduates

Grants-in-Aid of \$250 each have been awarded by the Education Committee to five undergraduates at universities within the Northeastern Section to enable them to attend the ACS National Meeting in San Francisco, and to present a paper at the Undergraduate Research Poster Session in the Division of Chemical Education on Monday, March 27, 2000. In addition, the Committee awarded the Grants-in-Aid to the undergraduates who received the Norris Richards Summer Research Grants for the summer of 1999; they will also present a paper at the Undergraduate Research Poster Session. Matching funds have been committed by the institutions to support travel of the students. The awardees, their research supervisors, and the titles of the papers are as follows:

Janelle Comita, Stonehill College (Prof. Maria Curtin), *Synthesis and Study of Polyhydroxylated Pyrrolidines*

Samson Jolly, University of New Hampshire (Prof. Gary Weisman), *Synthesis of Bis-(Crossbridged-Tetraazamacrocycles)*

Takuo Hama, University of Massachusetts Dartmouth (Prof. Gerald Hammond), *Thermal and Photochemical Cycloaddition of  $\alpha$ -Fluoroallylphosphonate*

Theodor Agapie, Massachusetts Institute of Technology (Prof. Christopher Cummins), *Applications of Titanium tris-(*t*-Butyl-3, 5-Dimethyl) Anilide Reactivity in Organic Chemistry*

Erin Navin, University of Massachusetts Dartmouth (Prof. Gerald Hammond), *Desilylation Chemistry: An Exploration of the Fluorinated Synthon 3-Bromo-3, 3-Difluoro-1-Triisopropylsilylpropyne*

### Norris Richards Summer Research Grant Recipients

Suzanne Muggeo, Regis College (Prof. Lathleen J. LaChance-Galang), *trans-{Ru<sup>III</sup>(NH<sub>3</sub>)<sub>4</sub>Py} as a Possible DNA Cleaving Agent*

Patricia Ong, Boston University (Prof. Pericles Stavropoulos), *Catalytic Asymmetric Carbenoid Insertions into the Si-H Bonds Catalyzed by Chiral Copper (I) Schiff Base Complexes*

Kimberly Dougherty, Boston College (Prof. Martha Teeter), *The Cloning and Purification of the Dopamine D1 Receptor* ◊