THE NUCLEUS

March 1995 *Of the Northeastern Section of the American Chemical Society* *Vol. LXXIII, No. 7*

Monthly Meeting

Peter Setlow on long-term survival of dormant bacterial spores

Meeting Reports

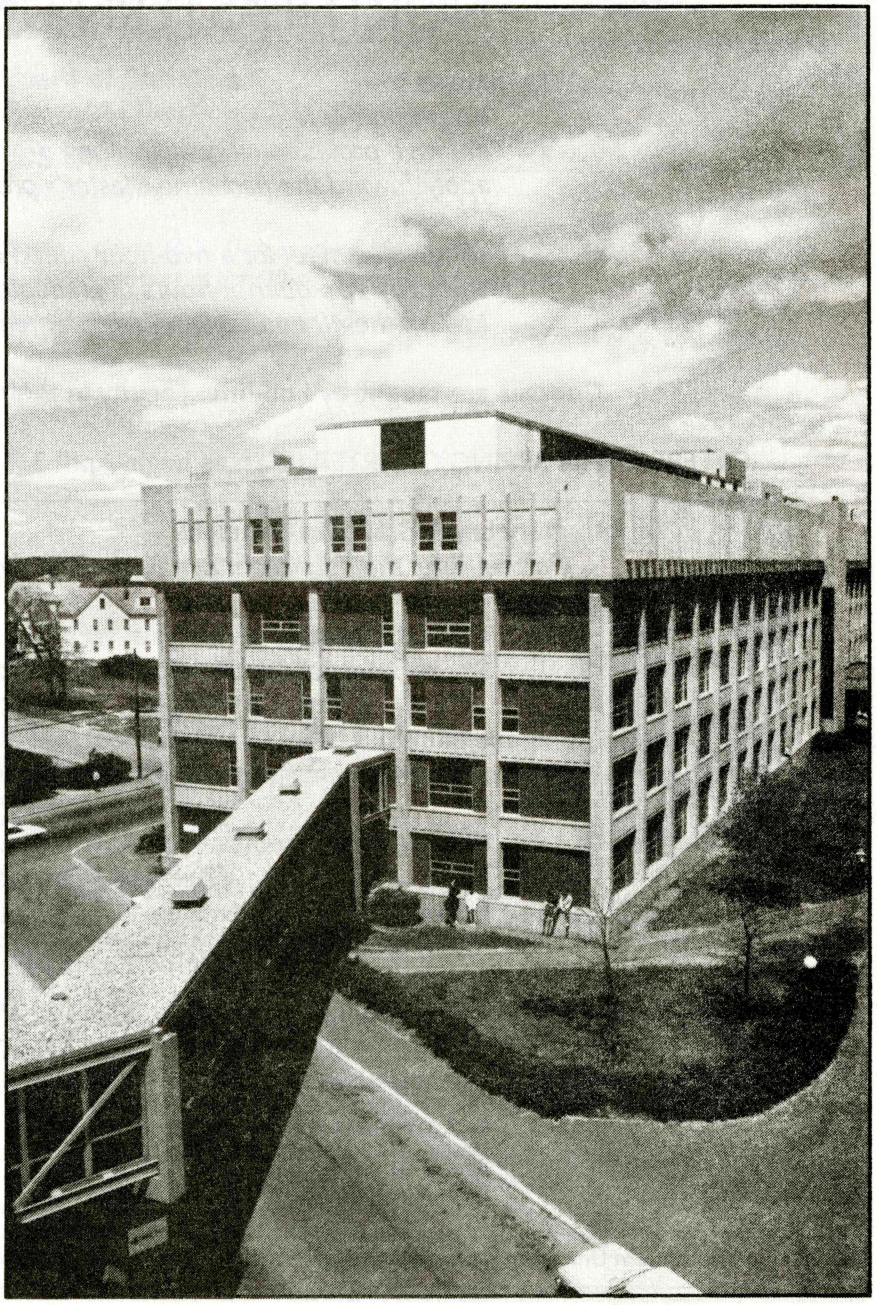
On the two afternoon symposium talks at the December 15, 1994 joint-meeting with MCG

Board of Directors

Meeting of December 15, 1994

ACS Workforce Report

Fringe benefits



The Northeastern Section of the American Chemical Society, Inc.

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Any Section business may be conducted via the business office above.
Washington, D.C. ACS Hotline: 1-800-227-5558

Contents

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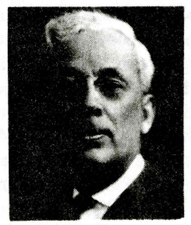
Deadlines: *May 1995 issue: March 20, 1995*

THE NUCLEUS

Dedicated to the Memory of James Flack Norris
Published monthly from September to May by the Northeastern Section of the American Chemical Society, Inc.



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 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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Proofreaders: Ernest I. Becker, M.S. Simon

Undergraduates

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

The Northeastern Section 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 $3,000 will be given for the summer of 1995. The student stipend is $2,500 (for a minimum commitment of ten weeks of full-time research work). The remaining $500 of the award can be spent on supplies, travel, faculty support, and other items related to the student project.

Institutions whose student/faculty team receive a Norris/Richards Undergraduate Summer Research Scholarship are expected to contribute toward the support of the faculty members and to waive any student fees for summer research. Academic credit may be granted to the students at the discretion of the institutions.

Award winners are required to submit a report (~5-7 double-spaced pages, including figures, tables and bibliography) of their summer projects to the Education Committee by November 1, 1995, for publication in *The NUCLEUS*. They are also expected to participate in the NESACS College Research Symposium in April, 1996.

Call for Papers

Undergraduate Research Poster Session at the 210th National Meeting of the American Chemical Society Chicago, Illinois August 20-24, 1995

The ACS invites undergraduate students to submit abstracts of their research papers for presentation at the Undergraduate Research Poster Session, which will be part of the extensive programming for undergraduates at this national meeting. Send abstracts on standard ACS forms to:

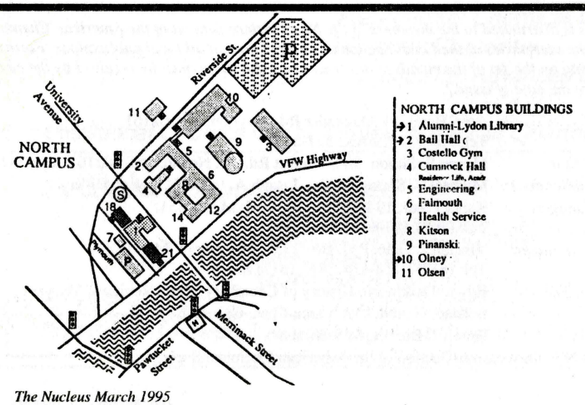
John W. Higuchi, Student Affiliates Program, American Chemical Society, 1155 Sixteenth Street, NW, Washington, DC 20036.

Deadline for receipt of abstracts: April 7, 1995.

Eligibility: Applications will be accepted from student/faculty teams from colleges and universities within the Northeastern Section. The undergraduate student must be a chemistry, biochemistry, chemical engineering, or molecular biology major in good standing, and have completed at least two full years of college-level chemistry by Summer, 1995.

Application: Application forms are available from departmental chairs and the NESACS office. Completed applications with two photocopies should be submitted no later than **March 24, 1995** to the Chairman of the Selection Committee: Prof. Edwin Jahngen, Department of Chemistry, University of Massachusetts Lowell, Lowell, MA 01854.

Notification: Winners will be notified by April 21, 1995. ◇



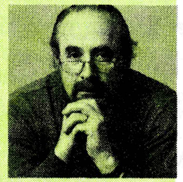
Directions

U. Mass-Lowell

From Route 95/128: Follow Rte. 95/128 (north or south) to Rte. 3 North. From Rte. 3 take exit 30 North onto the Lowell Connector. Take Exit 5N, Thorndike Street, bear right off the exit ramp, heading north on Thorndike. After the train station on the left, go under the bridge and bear right at the lights. Take the third left onto Merrimack Street to its end. Turn right, then immediately left. Go across the Textile Bridge and through the traffic lights. This is the North Campus and the road becomes University Ave. The Library where the Social Hour and Dinner is held is on your left. For the evening meeting, continue on University Ave. to the next traffic light. Turn right onto Riverside St. Ball Hall is immediately on your right. Parking is beyond Olney Hall, the second building on your right.

From Route 93: Take Rte. 93 north or south to Rte. 495 South, towards Lowell, and follow 495 to the Lowell Connector. Continue as above from the Lowell Connector. ◇

Monthly Meeting



The 769th Meeting of the Northeastern Section of the American Chemical Society

Thursday, March 9, 1995
University of Massachusetts-Lowell
North Campus

5:30 Social Hour, Faculty Lounge, Lydon Alumni Library, University Ave.

6:30 Dinner

8:00 Evening Meeting, Valerie Wilcox, presiding
Room 210, Ball Hall, Riverside Street
Prof. Peter Setlow, University of Connecticut, *Survival of Dormant Spores of* Bacillus *species for Years and Years, and ...: How do they do it?*

Refreshments will be served after the program.

Dinner reservations should be made no later than noon, March 2. Please call or fax Marilou Cashman at (800) 872-2054. Reservations not cancelled at least 24 hours in advance must be paid. Members, $21.00; Non-members, $23.00; Retirees, $12.50; 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 beyond Olney Hall, see directions on page 4.

Next meeting: ***Wednesday, April 12****. (Note change in the meeting day due to the holidays.)* ***Esselen Award Meeting****, Dr. Edward J. Schaeffer of Burroughs Wellcome Co. will speak on developing the herpes antiviral agent Acyclovir (title to be announced). 5:30 Reception and dinner, Harvard Faculty Club, 8:00 Evening meeting at a Harvard location to be announced.*

Biography

Peter Setlow, a native of New Haven, Conn., received a B.A. from Swarthmore College and a Ph.D. in Biochemistry from Brandeis University in 1969. Dr. Nathan O. Kaplan was his thesis adviser. He spent 1968-1971 on a postdoctoral stay at the Department of Biochemistry at the Stanford University School of Medicine working for Dr. Arthur Kornberg. In 1971 he joined the University of Connecticut Health Center at Farmington, Conn. as Assistant Professor and is currently Professor of Biochemistry.

His research interests are the biochemistry and regulation of bacterial sporulation and germination, specifically: (1) regulation of gene expression during sporulation; (2) biochemical mechanisms of spore dormancy; (3) mechanisms of spore germination; and (4) biochemical mechanisms underlying spore resistance and long term survival. ◇

Abstract

When one or more nutrients are depleted from the medium of bacteria of *Bacillus* or *Clostridium* species, these organisms initiate the process of sporulation, whereby the growing cell is converted into a spore. These spores are metabolically dormant, as they lack ATP and have no detectable metabolism of endogenous or exogenous compounds. Dormant spores are also extremely resistant to a variety of environmental stresses, including radiation, heat, desiccation, and various types of chemical, including oxidative damage. Thus, these spores are survival packages, and there is evidence that spores can survive for hundreds, and possibly for millions of years. In order for spores to survive for such long periods of time, it is essential that their genome be protected against damage, because while DNA is a rather stable molecule, it does undergo quite significant rates of chemical damage such as oxidative attack and depurination under normal physiological conditions. Spores of *Bacillus,* and undoubtedly *Clostridium* species, as well, have a number of mechanisms to greatly reduce the rate of DNA damage during their potentially long period of dormancy. These include: (1) permeability barriers which restrict access of damaging chemicals to the spore's DNA; (2) a large reduction in the water content in the spore compartment containing the DNA – from ~4g water/g dry weight in growing cells to ~0.4 g water/g dry weight in spores; and (3) a unique family of small, DNA binding proteins which saturate the spore chromosome and dramatically change the DNA's reactivity resulting in: (1) greatly reduced rates of oxidative damage; (2) a complete alteration in the DNA's photochemistry with ultraviolet light; and (3) a large reduction in DNA depurination. With the spore DNA thus protected against DNA damage during long periods of dormancy, the spore then "waits" for the proper signal, usually the presence of one or more key metabolites, whereupon the spore's dormancy is broken and it "returns to life" via the process of spore germination. ◇

Support Our Advertisers

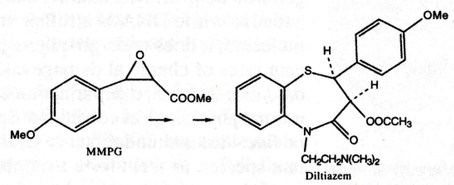
Meeting Report

From a talk given at the December Meeting MCG Symposium

Resolution of Methylmethoxyphenyl Glycidate (MMPG)

Jorge Lopez, Sepracor, Inc.; reported by M. Simon

MMPG is an intermediate in the synthesis of the drug Diltiazem.

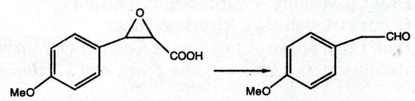


To obtain the required stereoisomer of MMPG the plan was to enzymatically hydrolyze the undesired isomer. This the Sepracor group proposed to do in a multiphase membrane bioreactor. The ester in a 22% by weight toluene solution would be passed through a hydrophilic polyacrylonitrile membrane containing the enzyme and the resulting acid from the hydrolysis of the undesired isomer would be removed in the aqueous phase.

A bioreactor unit is made up of an inner tube, a membrane of porosity too small for the enzyme to pass through, and an outer concentric membrane tube through which the enzyme can pass. The enzyme can be loaded into the annulus between inner and outer tubes by application in an aqueous solution from the outside of the outer tube and immobilized by the pressure of the organic solution of the ester, also introduced from outside the outer tube. The aqueous phase within the inner tube carries away the acid product, leaving the desired stereoisomer of the ester in the organic phase.

Two hundred enzymes were screened before *candida cylindracea* lipase was selected. Two kg of the selected enzyme ($150/kg) yielded 100 kg of product in a throughput time suitable for manufacturing.

A problem arose because the acid product decarboxylated



to aldehyde which deactivated the enzyme. The introduction of bisulfite converted the aldehyde into its water soluble addition product.

Ester of 84% enantiomeric excess (e.e.) was obtained in 50% yield. This could be recrystallized to 100% e.e. By monitoring e.e. as a function of time an e.e. of 80% could be maintained by lengthening the throughput time. When the time became too long to be desirable the enzyme was discarded. Replacement of the enzyme could be done efficiently by backwashing through the outer membrane.

This process was scaled up on a manufacturing scale to 50 tons per annum. ◇

1995 NESACS Candidates for Election

Chairman-Elect *(one to be elected)*
Martin Idelson *(retired)*, Leon Rubin *(retired)*

Secretary *(one to be elected)*
Michael Hearn *(Wellesley College)*

Trustee *(one to be elected)*
William Foye *(retired)*, Esther Hopkins *(Mass. Dept. Envir. Protect.)*, Martin Idelson *(retired)*

Councilor/Alternate Councilor *(4 Councilors and 4 Alternate Councilors to be elected)*
Charles Beardsley *(retired)*, E. Joseph Billo *(Boston College)*, Charles Blank *(retired)*, Mary Burgess *(Army Labs, Watertown)*, Michael Dube *(Wellesley College)*, Thomas Gilbert *(Northeastern U.)*, Morton Hoffman *(Boston U.)*, Steven Lantos *(Brookline H.S.)*, Truman Light *(retired)*, Margaret Merritt *(Wellesley College)*, Patricia Samuel *(Boston U.)*, Michael Singer *(Arqule)*, Frank Wagner *(Strem Chemicals)*, Valerie Wilcox *(Natl. Plastics Ctr/Museum)*

Nominating Committee *(two to be elected)*
Edward Jahngen *(U. Mass.-Lowell)*, Cynthia McGowan *(Merrimack College)*, Jane Roman *(Regis College)*, Debra Saez *(Consultant)*

Esselen Award Committee *(two to be elected)*
Henry Brown *(retired)*, Linda Charpentier *(Avco)*, Myron Simon *(retired)*, Sophia Su *(Polaroid)*

Richards Award Committee *(two to be elected)*
Ernest Grunwald *(Brandeis U.)*, Guilford Jones *(Boston U.)*, Ross Kelley *(Boston College)*, David Lamal *(Dartmouth College)*

Petition Candidates: In accordance with the Northeastern Section Constitution, Article VIII, Sec. 3,

"Any group comprising 2 percent or more of the membership of the Northeastern Section may nominate candidates for any elective office provided that such nomination (accompanied by the signatures of the nominating group) shall be presented in writing to the Chairman of the Nominating Committee not more than ten days following the March meeting of the Northeastern Section." Accordingly, such petitions are due March 19, 1995 and should be sent to Dr. James Kaufman, 101 Oak St., Wellesley, MA 02181. At least 100 valid signatures are required. Preferably, the petition should be sent by certified mail.

Nominating Committee: James Kaufman (chairman), Michaeline Chen, Wallace Gleekman, Joseph A. Lima, J. Donald Smith. ◇

Calendar

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March 22
Dr. Augustine Silveira, Jr. (State Univ. of NY, Oswego)
"Project-Oriented Laboratories – A Trend for the Nineties"
UMass Dartmouth, Rm. 305 Sci. & Eng. Bldg. (Gr. II) at 4:00 pm

March 23
Prof. Brian E. Bent (Columbia University)
"A Question of Radicals: Surface Science and the Ullmann Coupling Reaction"
Boston College
Rm. 127 Merkert Chem. Ctr. at 4:00 pm

March 24
Richard H. Mueller, David M. Floyd (Bristol-Myers Squibb Pharmaceuticals)
"Discovery and Development of BMS-180291, a Thromboxane Receptor Antagonist"
Boston University, Rm. 107, Metcalf Ctr. for Sci. & Eng. at 2:30 pm

March 27
Dr. Paul Reider (Merck)
"Practical Asymmetric Synthesis"
Harvard University
12 Oxford St., Mb-23 at 4:15 pm

Prof. David J. Jebaratnam (NortheasternU)
"Non-Enediyne Approaches for Mimicking Enediyne Chemistry"
Boston University, 590 Commonwealth Ave., SCI 107 at 4:00 pm

Mr. Jeff R. Dieffenbach (IBIS Associates, Inc.)
"The Economics of Automobile Recycling: Implications of a Changing Materials Mix"
Tufts University, Rm. 136, STC Bldg. 4 Colby St. at 2:30 pm

March 28
Prof. Fred Luzzio (Univ. of Louisville)
"Recent Synthetic Studies in the Nucleoside Area"
Tufts University
Pearson Chem. Bldg., Rm. 104 at 4:30 pm

March 29
Dr. John W. Larsen (Lehigh University)
"The Macromolecular Structure of Coal"
UMass Dartmouth, Rm. 305 Sci. & Eng. Bldg. (Gr. II) at 4:00 pm

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ACS Short Course

Chemical Engineering for Chemists

A Two-Day Short Course Sponsored by the Northeastern Section, ACS, Committee on Continuing Education

National ACS is making top-rated ACS Short Courses available to local sections at tuition fees greatly reduced from the normal $785. The NESACS Committee on Continuing Education is pleased to present this course, which has been offered successfully at each National ACS Meeting since 1976.

Dates and Time: Thursday, **May 18,1995, 8:30 a.m. – 5:00 p.m.**
and Friday, **May 19,1995, 8:30 a.m. – 5:00 p.m.**

Place: Snell Library, Room 90, Northeastern University, 360 Huntington Ave., Boston, MA

Program Agenda:

Relations of Chemical Processes and Phenomena to Chemical Engineering Principles: industrial examples.

Chemical Engineering Principles: concept of driving force; similarities and dissimilarities of fluid flow, heat transfer and mass transfer; concept of dimensionless groups; scale up.

Fluid Flow and Statics: laminar and turbulent flow; the Reynold's number; pressure drops.

Fluid Flow: momentum balance; the Bernoulli equation; friction factors; flow rates; pressure drops; circular and noncircular ducts; equipment design and flow; measurement; industrial examples; agitation and mixing; non-Newtonian fluids.

Heat Transfer: heat transfer modes; steady and unsteady state conduction; convection heat transfer; laminar and turbulent flow; radiation design procedures; industrial examples.

Mass Transfer: rate process and equilibrium approaches; diffusion and Fick's law.

Applied Thermodynamics: phase equilibria; thermodynamic behavior of multicomponent systems.

Mass Transfer: equilibrium stage operation; application to industrial separations.

Chemical Process Economics: time value of money; economic alternatives; process equipment costs; overall process economic evaluation; marketing.

Instructor: Prof. Richard G. Griskey, Ph.D., P.E., has over 35 years of experience in industry, academia, government and consulting and has authored over 200 technical publications. He is one of the highest-rated instructors in the ACS continuing education program.

Pre-registration Required — Registration Fees:
ACS Members if mailed before May 1 ..... $225.00; after May 1 ..... $275.00
Non-ACS Members if mailed before May 1 ..... $325.00; after May 1 ..... $375.00

There will be a limited number of scholarships for unemployed ACS Members on a space-available basis.

Parking Fee $3.00/day University cafeterias will be available for lunches.

For further information contact: Prof. Alfred Viola — (617) 373 2809

Registration form for Short Course: Chemical Engineering for Chemists

Name: _____ Affiliation: _____

Mailing Address _____ Telephone: _____

_____

Mail with remittance to :
(Please make checks payable to NESACS)

Prof. Alfred Viola, Chair
NESACS Committee on Cont. Ed.
Department of Chemistry
Northeastern University
Boston, MA 02115

Cross-Linked Enzyme Crystals in Organic Synthesis

A report of the talk delivered at the December Meeting MCG Symposium

by Jim Lalonde, Altus Biologics Inc.

While the exquisite selectivity of enzymes in enantioselective transformations has been known for many years, very few large scale commercial applications of biocatalysts have been developed. It has been proposed that the reasons for this are threefold; the poor stability, unpredictability, and the high cost of protein catalysts.

The development of Cross-Linked Enzyme Crystals (CLECs™) as an answer to the limitations of enzymes was discussed. The basis of the CLEC methodology lies in the cross-linking of highly pure enzyme micro-crystals with bi-functional reagents such as glutaraldehyde. Such cross-linked enzyme crystals remain active and insoluble in environments that are otherwise incompatible with enzyme function, including multiple reaction cycles, prolonged exposure to high temperatures, near-anhydrous organic solvents and aqueous-organic solvent mixtures. By putting the catalyst in the form of a crystal, one concentrates the activity in the densest possible form. Since enzyme molecules within the crystal are chemically cross-linked, the crystal is insoluble and recoverable.

CLEC's have been described in the literature since the late sixties, but it was thought that such crystals would be impermeable to organic molecules and would be unsuitable as biocatalysts. This assumption turned out to be false. Experimentally, it has been found that with protein micro-crystals (around 50 microns in size), small organic molecules rapidly diffuse in and of the crystal. Only molecules of molecular weight above about 3000 daltons were found to have slow diffusion rates. The accessibility of the entire crystal is a result of the high porosity of protein crystals. Analysis of crystal structure data for 119 protein crystal structures shows that the average protein crystal has about 50% of its volume filled with solvent. Analysis of the thermolysin crystal structure shows large pore channels with a radius of 26Å. As a point of reference, the typical zeolite channel is between 11 and 15Å.

The thermal stability of *Candida rugosa* lipase CLEC and Thermolysin protease CLEC was shown to be increased two to three orders of magnitude over that of the monomeric protein. It was proposed that the protein molecule in a crystal is surrounded by identical catalyst molecules in an extended array, so that the enzyme catalyst is kept in the active conformation through intermolecular ion-pair and hydrogen bonding interactions. The chemical cross-linking adds an additional barrier to denaturation of the catalyst and serves to maintain insolubility of the crystal. The stability of the lipase and the protease CLEC in water miscible organic solvents was also shown to be improved dramatically (three orders of magnitude) over the soluble protein.

Thermolysin CLEC, as a result of its resistance to denaturation can be used in the presence of high concentrations of water miscible organic solvents like dimethyl formamide to couple amino acids and peptides. Proteases like thermolysin were designed by nature to hydrolyze proteins and peptides, but chemists can use these catalysts to stereospecifically and regiospecifically couple amino acids and peptides. Limiting the water activity with organic solvents and precipitating out the coupled product shifts the equilibrium away from hydrolysis and towards the synthesis of the amide bond. Thermolysin, for example, is used commercially to synthesize the dipeptide sweetener Aspartame. The protease catalyzes the coupling of aspartic acid and phenyl alanine methyl ester stereospecifically and regiospecifically. Since the peptide coupling can been done in high concentrations of organic solvents, e.g., ethyl acetate, virtually quantitative yields of the peptide can be achieved with the protease CLEC. After the coupling is complete, the CLEC can be recovered and reused for 18 coupling cycles with negligible loss of activity.

Candida rugosa lipase (CRL) CLEC, in addition to the organic solvent and thermal stability, benefits from the high purity of the crystalline catalyst. CRL has been applied by organic chemists to the resolution of hundreds of chiral alcohols and carboxylic acids through enantioselective hydrolysis of their esters. Despite this wide utility, commercial CRL is impure and contains four hydrolases which act on organic esters with different enantioselectivities and rates. Most commercial enzyme preparations typically contain from a maximum of about 10% to less than 1% of the active catalyst. The rest of preparation contains from 90 to 99% of other enzymes and proteins, cell debris, stabilizers and salts. In contrast, the CRL CLEC contains only one enzyme, a crystalline lipase. CRL CLEC has been used to prepare 2-aryl propionic acid anti-inflammatory drugs such as Ketoprofen and Ibuprofen in enantiomeric purity of >95% e.e. through hydrolysis of their racemic esters. The high purity of the CRL CLEC results in a 5 to 10 fold improvement in enantioselectivity over the soluble commercial CRL preparation. The CLEC catalyst is stable and reusable and was used for 20 resolution cycles with only 30% loss of activity.

Cross-linked enzyme crystals of *Pseudomonas* lipase, *Penicillin* acylase, *Subtilisin* and their application to the synthesis of enantiomerically pure organic esters and peptides were also discussed. ◇

Board of Directors

NOTE: Board meetings are held on the meeting day at 4:30 p.m. Section members are invited to attend.

Notes of Meeting of December 15, 1994

Officer's Reports:

Chairman: Dr. Kaufman conveyed the thanks of Prof. J. Cannon (U. of Iowa) to the Section for the excellence of arrangements for the short course "Pharmacology for Chemists" Nov. 17-18, 1994.

Treasurer: The board VOTED to accept the financial report and VOTED to transfer some budget items for administrative clarity.

Archivist: Dr. Simon invited members to send memorabilia of Section activities or members for inclusion in the Section's archives.

Committee Reports:

Publications: Dr. Billo stated that the *NUCLEUS* will finish the year on budget. Advertising results for 1995 are promising in that 85% of the anticipated advertising revenue has already been contracted for 1995.

Continuing Education: Dr. Viola reported that the proceeds from the November short course will be more than $2,000. There were 38 registrants.

Project SEED: Dr. Phillips reported that information for the summer 1995 SEED program will be sent shortly. Preceptors are needed. ◇

Nominations

National Technology Medal

All ACS members are invited by the Committee on Patents and Related Matters (CP&RM) to suggest possible candidates for nomination for the National Technology Medal. Recently funded by the United States Department of Commerce and established by the Stevenson-Wyndler Innovation Act

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ACS News

Workforce Report on Fringe Benefits

Condensed and in part quoted verbatim from a report by Corinne A. Marasco, Dept. of Career Services, ACS

Fringe benefits add significantly to the value received by employees, and thus represents about 30% of total compensation paid by an employer. Although benefits vary widely by occupation, the most common benefits received were paid leaves (vacations, holidays), life insurance, health insurance and retirement. A much smaller fraction of workers received other benefits, such as child care.

A *fringe benefit* can be defined as any benefit a worker receives in addition to pay. Federal and state laws do not mandate any fringe benefits, except for payments made on behalf of the worker for Social Security, unemployment insurance (both federal and state) and workers' compensation.

Health insurance is not required, but for those employers who do provide it, it must fulfill minimum benefits set by each state–usually coverage for newborn children and for pregnancy.

The report viewed the following aspects of fringe benefits: the array of benefits available, data on benefits being provided currently (based in part on information from the 1994 ACS Salary Survey), and the future of compensation packages as a function of changes in the workforce and the needs of employees and employers.

Basic Benefits

World War II brought competition among employers because of a tight labor market. The demand for limited domestic goods created inflationary pressures. To control these pressures, the War Labor Board controlled wage increases and encouraged employers to offer noninflationary forms of compensation, starting the practice of offering benefits such as paid vacations, insurance and pensions as an inducement. In the postwar years employee benefits became more common and were incorporated in union contracts. Court interpretations of the Wagner Act (National Labor Relations Act of 1935) expanded its scope to benefits beyond the traditional wage, hours and working conditions package. Typical benefit packages might include the items in the following chapter headings:

Health Insurance

This is the most common benefit, but may not be provided for part-time employees or by small companies. A large number of different plans have been developed which may share common features: Some plans offer a free choice of physicians and hospitals, giving full or partial reimbursement, called "fee for service"; others use Health Maintenance Organizations (HMOs) which provide health care services for a set rate; Preferred Provider Organizations (PPOs) offer a choice of designated providers at lower medical cost.

Some plans include the cost of prescriptions, some with a co-payment of $5-10. Some plans encourage use of generic brands by charging a fee for brand medications. Dental care benefits are included in some plans, or may be available in place of health insurance.

Disability Insurance

Under disability insurance, a worker who becomes ill, injured, or is on maternity leave receives a portion of the salary. Such coverage may be short-term for temporary illness or disability, or long-term for those permanently disabled to replace a portion of the lost wages.

Life Insurance

Life insurance may pay a flat sum to the estate which may be as high as twice the annual salary. Some plans allow the employee to purchase additional insurance at the same rate.

Pensions

Although employers are not required to provide pensions to workers, if such a benefit is provided it must meet minimum standards under the Employee Retirement Income Security Act of 1974 (ERISA). Some plans are defined benefit plans, others are defined contribution plans. The former establish an employees retirement benefits on basis of a fixed formula, usually based on earnings and length of service. Regular employer contributions provide the funds for these benefits. Defined contribution plans usually establish employer and employee contributions. There is an account for each employee and the retirement benefits are based on the sum in this account. Under the Tax Reform Act of 1986, non-forfeitable vested rights must be given to employees with five to seven years of employment with an employer. (Previously, 10 years was the minimum standard).

Vacations

This benefit is usually offered to full-time employees with the length of the vacation determined by the years of service.

Other Benefits

These may include relocation benefits for employees who are transferred to other locations, discounts on products or services produced by the employer, use of a credit union — either a company credit union or some other local credit union with the possibility of direct deposit of pay by the employer, and/or direct deposit of pay to a bank of the employees choosing. Credit unions often give higher interest on deposit accounts or lower interest on, or easier access to loans. They also frequently offer buying services at discounts for major items.

Companies may provide tuition assistance for courses which are relevant to the employee's position.

Some companies provide programs to promote the health of its employees such as smoking cessation classes, stress reduction seminars, health club memberships and other Employee Assistance Programs, such as counselling and referral for mental

health or drug abuse problems.

With an increase in the number of single-parent and dual-career couples in the workplace, there has been an increase in the need for child care services. Some companies have on-site child care facilities, others have contracts for such services. Some smaller companies have joined together to provide day-care facilities.

Employee Benefit Diversity and Cost

According to the Bureau of Labor Statistics, about 80% of employees received paid holidays and vacations during 1990-91, more than 50% were covered by paid sick leave and most employees received leaves for jury duty or bereavement. Military and personal leave was offered less commonly. In 1990-91, 28% of employers made unpaid maternity leave available and 17% offered unpaid paternity leave. Paid parental leave was even less common. However, as an unanticipated consequence of the Family and Medical Leave Act of 1993 (FMLA) there has been a significant increase in the family leave plans. Yet, a survey of 300 employers showed that 40% of them failed to provide the 12 weeks leave, the job guarantee on returning, or continued access to benefits during leave as required by the FMLA. There appears to be a widespread lack of knowledge of the law. The Labor Department, which has the responsibility of implementing the law, found violations in 61% of the 965 family-leave complaints received up to June 30, 1994.

Company-paid life insurance was provided to 70% of employees, either as a flat-sum or on basis of the employees' earnings. Some plans allowed employees to buy additional insurance at the same rates.

In the 1990-91 period, about 70% of employees were covered by a medical care plan. More than 2/3 of the covered employees were in plans which were fully paid by the employer for the employee, about 20% included the family, as well. Participation in fee-for-service plans is declining but is rising rapidly in PPOs and HMOs as a consequence of the rapid increase in health care costs. PPOs and HMOs are popular because they are managed care programs.

About 40% of employees had dental coverage — 27% of the covered employees were fully employer-paid coverage, 19% had wholly employer-paid family coverage.

Short-term disability coverage to provide income protection during illness or disability was offered to about 30% of employees in some form. Long-term coverage or retirement for extended or permanent disability was provided to about 25% of employees.

About 60% of employees were covered by some form of retirement plan. A little over 40% by a defined benefit plan, 30% by a defined contribution plan. The latter have increased as a consequence of tax laws allowing employees to defer taxes on pay used for contributions until retirement. Other defined contribution plans included savings and thrift plans, profit sharing plans, employee stock ownership plans and money purchase pension plans (where employers make fixed contributions to an individual's employee account).

Benefits received were greater for employees in companies of 100 or more employees as compared to employees in smaller companies:

Benefit	Benefit offered to % of employees in	
	Med.+Large	Small firms
Health	76	56
Life insurance	86	52
Retirement plans	80	45
Dental	55	~27
Maternity leave (unpaid)	35	~17
L.term disability	36	~18
Paid vacations, holidays	90	80
Paid milit. leave	54	21
Paid personal lv.	21	12
Paid bereavemt. lv	80	~50
Unpd. matern. lv.	37	18
Unpd. Patern. lv.	26	8
Pd. sick leave	66	~50
Medical care	80	70
Fully paid (employee)	50	53
(employee+family)	33	27
Sickness+disabil. insur.	~50	~25
Wellness programs	33	<10
Educ. assistance	75	36

1994 ACS Salary Survey

For the first time questions on fringe benefits were included, but will not be included every year. Almost all respondents received holidays and annual leaves. The median annual number of days of holiday leave was 10, vacation leave 15-20 days. Other average annual leaves were: Sick leave 10-13 days, bereavement leave 3 days, Jury duty leave 5-7 days. Leave to care for sick family members was available to 45% of industrial chemists, 35% of academic chemists and 31% of government chemists. Paid parental leave was available to only 18% of industrial, 12% of academic and 8% of government chemists.

Fully paid life insurance was available to about half of all respondents, the other half shared costs.

Long term disability was more available to industrial chemists than to others. Median percentage of salary paid under long-term disability was 60% for all employer types. For short-term disability the median benefit percentage of salary was 100% for industrial, 80% for academic and 67% for government chemists.

Medical coverage for the chemist employee and family was almost universal. For industrial and government chemists, 2/3 of employers pay between 50-99% of the premiums, for academic chemists about 47% of employers pay >50%, but less than the full premium. Dental coverage was far more common among industrial chemists. Prescription drug programs cover 75% of industrial, ~66% of academic and government chemists.

At least 2/3 of chemists participate in a defined benefit retirement program, 89% in a savings plan, with an average 4% of salary contributed by the employer. Employee stock ownership programs were used by 40% of industrial chemists, again with an average 4% of salary contribution by the employer. About 47% of academic chemists participate in retirement savings plans, such as TIAA-CREF with a median employer contribution of 8% of salary. About 60% of government chemists participate in savings plans, with a median contribution of 5%.

Professional Development Activities

More than 70% of industrial chemists reported that their employers provided financial support to attend, on average, two professional association meetings per year. Academic chemists reported that their employer paid, on average, for one or two association memberships, while industrial employers paid, on average, for one such membership. However, about 2/3 of industrial chemists' dues are thus paid vs. 17% for academic and 15% of government chemists.

On-site child care varies greatly: Available to 32% of academic chemists, 20% of government chemists, but only 5% of industrial chemists. Less than 10% of all chemists have access to off-site child care paid for by their employer.

The Future of Benefits

(Editor's note: the Workforce report was published two months prior to the recent election, therefore the projections may have become obsolete in part).

"Employee compensation, especially fringe benefits have been influenced by three significant changes that have occurred in the second half of the 20th century: the increasing participation of women in the workforce, especially women with children; the growth of multi-earner families; and the ability of more men to retire at earlier ages. In addition, the structural changes in the economy and in employer-employee relationships have also affected compensation packages." The shift from a goods-producing economy toward a service economy has affected the industry and occupational mix. The service sector now accounts for 60% of all jobs, goods producing for less than one-fourth. This shift has been accompanied by an increase in the proportion of contingent workers, including those who work for temporary help firms, on-call workers, leasing arrangements and contractors. The age distribution also has changed. From 1960 to 1979 the proportion of workers of 17 - 24 years of age in the workforce rose from 17% to more than 24% (baby boom generation), but by 1988 dropped to 19% and is projected to decline to 16% by the year 2000. In the next 25 years two trends are likely to converge: a diverse labor force with varying family concerns, and a labor market demanding highly educated and skilled workers. This suggests that flexible compensation packages may be needed which are designed to attract and hold scarce labor resources.

Since paid leave accounts for about 7% of compensation costs, it has been predicted that traditional types of paid leave, such as holiday, vacation and personal leave plans will be replaced with comprehensive leave plans which cover all forms of leave. Thus, an employee could exchange vacation time for a leave for a family event, such as childbirth or parental care.

Life, health and disability insurance currently accounts for about 6% of compensation, but is likely to grow because of rapidly increasing health costs. Uncertainty prevailed because of the uncertain fate of health-care reform *(ed: well, uncertainty no longer prevails: health care reform is dead for the foreseeable future).*

Over the last decade defined benefit plans have given way increasingly to defined contribution plans. Retirement plans will have to allow for current workforce trends: a greater mobility of the work force. Thus, defined contribution plans would be expected to become more popular because of their innate portability.

Legally required benefits account currently for about 9% of total compensation costs. The largest items are Social Security, workers' compensation and State unemployment insurance. "Although future compensation trends cannot be predicted with any type of certainty, there is likely to be greater variety and fewer distinctions between pay and benefits overall."

Copies of the complete 8-page report can be obtained from Corinne A. Marasco, Editor, Workforce Studies, American Chemical Society, 1155 Sixteenth St., NW, Washington, DC 20036. ◇

Nominations

continued from page 10

of 1980, the medal is awarded annually by the President. It may be awarded to individuals, groups, companies, or institutions within the United States for outstanding contributions to technology or for the promotion of the technological workforce.

Nomination documents may be obtained by calling (202) 872-8725, or writing to the staff liaison to CP&RM, Ms. Debora Fillinich, American Chemical Society, 1155 Sixteenth St., NW, Washington, DC 20036. The deadline for submitting nominations for the 1996 Award is May 30, 1995. Nominators should be aware that six recommendation letters are required supporting the nomination.

Background Information:

CP&RM will select an ACS nominee from the nominations received by the ACS office.

The documentation provided nominators includes a list of past recipients of the medal 1985-1993. Scanning this list, we note the following names familiar to members of this Section: 1988: Edwin H. Land (Polaroid), Harold Edgerton (EG&G, MIT). 1991: Carl Djerassi (Stanford Univ.) ◇

Calendar

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March 30

Prof. T. Ross Kelly (Boston College)
"Molecular Synthesis and Design"
Boston College
Rm. 127 Merkert Chem. Ctr. at 4:00 pm

March 31

Milan R. Uskokovic (Hoffman La Roche, Inc.)
"Drugs Based on the Vitamin D Endocrine System"
Boston University, Rm. 107, Metcalf Ctr. for Sci. & Eng. at 2:30 pm

Notices for the Nucleus Calendar should be sent to:

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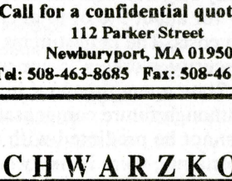

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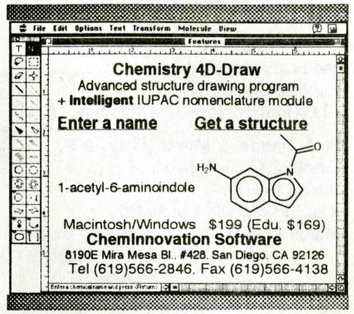

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UMass Dartmouth – (508) 999-8232
UMass Lowell – (508) 934-3650
University of New Hampshire – (603) 862-1550

March 1

Dr. Marc Snapper (Boston College)
"Small Molecules as Probes of Biological Receptors: Chemical Studies of Didemnin B, Brefeldin A, and Ilimaquinone"
UMass Dartmouth, Rm. 305 Sci. & Eng. Bldg. (Gr. II) at 4:00 pm

Dr. Vitalli Goldanskii (Semenov Institute of Chemical Physics, Moscow)
"Applications of Chemical Physics to the Problems of Prebiotic Evolution"
Harvard University
12 Oxford St., Mb-23 at 4:00 pm

March 2

Prof. Y. Shimoyama (Univ. of Hokkaido)
"Fabrication of Giant Monodomain Polydiacetylene Monolayers and EPR Study of the Langmuir-Blodgett Films"
Northeastern University
129 Hurtig Building at 4:00 pm

Prof. David J. Hart (Ohio State University)
"Studies in Alkaloid Total Synthesis"
Boston College
Rm. 127 Merkert Chem. Ctr. at 4:00 pm

March 3

Jean Nichols, John O'Loughlin, Cory Waters (Seragen, Inc.)
"Fusion Toxins: A New Class of Biological Therapeutic Compounds: Developing Strategies for the Production and Characterization of Non-Evolved Proteins"
Boston University, Rm. 107, Metcalf Ctr. for Sci. & Eng. at 2:30 pm

March 6

Prof. Robert Grubbs (CalTech)
"Polymer and Organic Synthesis Using Metal Carbene Complexes"
Harvard University
12 Oxford St., Mb-23 at 4:15 pm

Mr. Frank A. Marino (Raytheon Company)
"Industrial Environmental Risk Management in Industry Today: Raytheon's Perspective"
Tufts University, Rm. 136, STC Bldg., 4 Colby Street at 2:30 pm

March 8

Dr. Joseph Epstein (Lederle Laboratories)
"Novel Agonists for the Opiate Receptor Studied by X-Ray Crystallography and Computer Graphics"
UMass Dartmouth, Rm. 305 Sci. & Eng. Bldg. (Gr. II) at 4:00 pm

Prof. Kate Kirby (Harvard College Observatory)
"The Lithium Chemistry of the Early Universe"
Harvard University
12 Oxford St., Mb-23 at 4:00 pm

March 13

Prof. Digby D. MacDonald (PennState)
"The Electrochemistry of Nuclear Reactors"
The Cottage Crest Restaurant, 610 Trapelo Rd., Waltham, MA; Social Hour 5:30 PM; Dinner 6:30 PM
For Dinner Reservations call Prof. John Reardon at (617) 287-6155

Prof. Steven M. Cramer (Rensselaer Polytechnic Institute)
"Novel Low Molecular Weight Displacers for Protein Purification"
Tufts University, Rm. 136, STC Bldg., 4 Colby Street at 2:30 pm

Symposium in Honor of Prof. Jack Roberts
2:00pm Prof. Andrew G. Myers (CalTech)
3:00pm Prof. George Whitesides (Harvard)
"Molecular Self-Assembly"
4:00pm Break
4:30pm Prof. Jack Roberts (CalTech)
Harvard University
12 Oxford St., Mb-23

Prof. Daniel Kahne (Princeton University)
"Chromomycin as a Blueprint for Designed Metal Complexes"
Boston University, 590 Commonwealth Ave., SCI 107 at 4:00 pm

March 15

Prof. Martin Head-Gordon (UCal, Berkeley)
"Excited States Nonadiabatic Coupling and Femtochemistry"
Harvard University
12 Oxford St., Mb-23 at 4:00 pm

Prof. Thomas J. Meyer (Univ. of N. Carolina, Chapel Hill)
Boston College
Rm. 127 Merkert Chem. Ctr.
March 15 4:00 pm "Controlling Excited States. Photoinduced Electron and Energy Transfer"
March 16 8:00 pm "Multiple Electron Transfer. From Water Oxidation to Dinitrogen Reduction"
March 17 4:00 pm "Creating Images and Microstructures in Thin Polymeric Films"

March 20

Prof. John Caradonna (Yale University)
"Insights into Non-Heme Iron Metalloenzymes: Characterization of Phenylalanine Hydroxylase"
Boston University, 590 Commonwealth Ave., SCI 107 at 4:00 pm

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