PSNA News

Phytochemical Society of North America
Sociedad Fitoquímica de América del Norte
Société Phytochimique de L'Amerique du Nord

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The Upcoming 53rd Annual Meeting of the Phytochemical Society of North America

Dear PSNA Members

Registration for the 53rd Annual Meeting in Raleigh, North Carolina, is now open! Also this year we will have a several awards for early career scientists. Take the opportunity to apply yourself or nominate fellow members! See below for more detail regarding process and deadlines. In this brief communication, I would also like to draw your attention to "PSNA Members in the News" featuring Norman Lewis' research on GMO poplars that should smell like roses!

Sincerely,

Fred Stevens
PSNA President

The 53rd Annual Meeting of the PSNA will be held on the campus of North Carolina State University in Raleigh on August 9-13. Check go.ncsu.edu/psna for updates on the program and how to participate. The scientific program will reflect the society's mission, with symposia focused on natural product biosynthesis and plant metabolism, plant metabolomics, bioproducts and biofuels, botanicals and medicinals, and on the role that phytochemicals play in the interaction between plants and their environment. The Annual Meetings provide ample opportunities for students, postdoctoral fellows, and established researchers to learn from each other and from top experts in the field of phytochemistry in its broadest sense.

Have you been in the news or do you know of a colleague who has been in the news and you think the news might be of interest to your fellow PSNA members?

Send us a note!

Welcome to the upcoming 53rd annual meeting of the Phytochemical Society of North America

This meeting will be held on August 9th to 13th, 2014, at the McKimmon Center on the campus of North Carolina State University, Raleigh, USA.

As you know, there is nothing without "Phytochemicals."

This meeting will gather scientists from all phytochemicals-related disciplines to share their research successes. The PSNA annual meeting is a perfect gathering for you and other scientists - from young students to seniors - in the areas of medicinal chemistry, biosynthesis, metabolic engineering, agriculture, pathogens, metabolomics, genomics, metabolomics, systems biology, synthetic biology, medicinal plants and so on. Your attendance is essential to strengthen the PSNA and research in understanding phytochemicals-the gifts of Mother Nature.

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The web PDF version can be downloaded from the website: www.psna-online.org.

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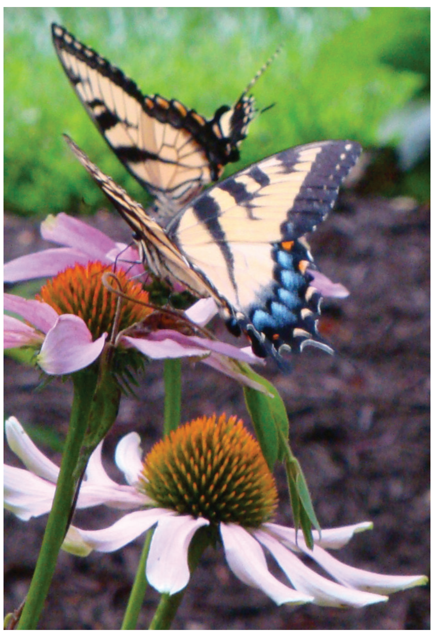

ADVISORY COUNCIL

Daniel Owens (2 year term)
daniel.owens@ars.usda.gov

Mark Bernards (3 year term)
bernards@uwo.ca

Norman Lewis (3 Year Term)
lewisn@wsu.edu

The Phytochemical Society of North America

The Phytochemical Society of North America (PSNA) is a nonprofit scientific organization whose membership is open to anyone with an interest in phytochemistry and the role of plant substances in related fields. Annual membership dues are U.S. $60 for regular members and $30 for student members. Annual meetings featuring symposium topics of current interest and contributed papers by conference participants are held throughout the United States, Canada, and Mexico. PSNA meetings provide participants with exposure to the cutting-edge research of prominent international scientists, but are still small enough to offer informality and intimacy that are conducive to the exchange of ideas. This newsletter is circulated to members to keep them informed of upcoming meetings and developments within the society, and to provide a forum for the exchange of information and ideas. If you would like additional information about the PSNA, or if you have material that you would like included in the newsletter, please contact the PSNA Secretary or visit our website at www.psna-online.org. Annual dues and changes of address should be sent to the PSNA Treasurer. Also check the PSNA website for regular updates.

The PSNA is an all volunteer organization which depends on its membership to run the organization. We appreciate the time and effort these volunteers are putting in to keep the organization up and running. As a member, please consider volunteering to serve on one of these committees. The PSNA can always use more help!

PSNA EXECUTIVES

President
Fred Stevens, Ph.D.
Linus Pauling Institute and the Department of Pharmaceutical Sciences,
Oregon State University,
307 Linus Pauling Science Center,
Corvallis OR, 97330 USA
fred.stevens@oregonstate.edu

President Elect
Franck Dayan, Ph.D.
USDA, ARS, NPUR
University of Mississippi
University, MS 38677-8048
Phone: 622-915-1035
fdayan@olemiss.edu

Past President
Toni Kutchan, Ph.D.
Oliver M. Langenberg Distinguished Investigator,
VP for Research,
Danforth Center
975 N. Warson Rd.
St. Louis, MO 63132
314-587-1473
tmkutchan@danforthcenter.org

Secretary
Eric Johnson, Ph.D.
Crop Bioprotection Research
USDA-ARS-NCAUR
1815 N. Univeristy St.
Peoria, IL 61604 USA
309-681-6177 (phone)
eric.johnson20@yahoo.com

Treasurer
Daniel Owens, Ph.D.
Natural Products Utilization Research
USDA-ARS
P.O. Box 8048
University, MS 38677
662-915-1039 (phone)
dkowens@olemiss.edu

Editor-in-Chief, RAP
Reinhard Jetter, Ph.D.
Departments of Botany and Chemistry,
University of British Columbia,
6270 University Blvd, Vancouver BC,
V6T 1Z4 Canada
reinhard.jetter@botany.ubc.ca

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Please mark your calendar to come home to meet your old friends and make new friends.

For those who've never before had the opportunity to visit the Raleigh area, North Carolina has much to offer - from beautiful beaches to snow-capped mountains, historic attractions to the Research Triangle. North Carolina's special "barbecue" served with southern hospitality will make this region one of your favorites. Research Triangle Park (RTP), where "Taxol" and "Camptothecin" were discovered, is a dream location for scientists in different disciplines.

Register now for the 53rd annual meeting of the PSNA now! We look forward to seeing you at North Carolina State University!

DeYu Xie, Ph.D.
Chair of the 53rd annual meeting of the PSNA
Associate Professor
Department of Plant and Microbial Biology
4213 Gardner Hall
North Carolina State University
P.O. Box 7612
100 Derieux Place
Raleigh, NC, 27695
Tel: 919.515.2129 (o), 3792 (lab)
Fax: 919.515.3436
Email: dxie@ncsu.edu
www.cals.ncsu.edu/plantbiology/Faculty/dxie/dxie.html

Symposia and Keynote Speakers

Plenary Speakers
Topics
Metabolic Biology of Plant Natural Products
Botanical Medicines
Synthetic Biology of Biofuel

Symposium I: Biosynthesis of Plant Natural Products
Chairs: Dr. Sangeeta Dhaubhadel, Dr. Li Tian, Dr. Monica Borghi and Dr. Xu Li
Featured speakers:
Dr. Vincenzo de Luca, Brock University, Canada
Dr. Asaph Aharoni, Weizmann Institute of Science, Israel
Dr. Natalia Dudareva, Purdue University, USA
Dr. Jose Alonso, North Carolina State University, USA

Symposium II: Plant Metabolomics
Chairs: Dr. Lining Guo and Dr. Reinhard Jetter
Featured speakers:
Dr. John Ryals, Metabolon, Inc. USA
Dr. Lloyd Sumner, Plant Biology Division, Noble Foundation, USA

Symposium III: Plant Systems Biology
Chairs: Dr. Rosangela Sozzani and Dr. David Gang
Featured speakers:
Dr. Joerg Schwender, Brookhaven National Laboratory, USA
Dr. Adrienne Roeder, Department of Plant Biology, Cornell University, USA

Symposium IV: Renewable Petro Biofuel from Plants
Chairs: Dr. Danny J. Schnell and Dr. Deyu Xie
Featured speakers:
Dr. Danny J. Schnell, University of Massachusetts, USA
Dr. Edgar B. Cahoon, University of Nebraska, USA
Dr. Amy Grunden, North Carolina State University, USA

Symposium V: Botanical Medicines
Chairs: Dr. Nicholas Oberlies and Dr. Jeremy Johnson
Featured speakers:
Dr. Douglas Kinghorn, Ohio State University
Dr. Luc Pieters, Department of Pharmaceutical Sciences, University of Antwerp, Belgium

Symposium VI: Arthur Neish Young Investigator Award Symposium and Elsevier/Phytochemistry Award Lecture
Chairs: Dr. Fred Stevens, Dr. Argelia Lorence and Dr. Toni Kutchan
Award winners will be announced in May.

Symposium VII: Phytochemicals, pathogens and insects
Chairs: Dr. Mark Bernards and Dr. Eric Johnson
Featured speakers:
Dr. Reuben Peters, Iowa State, University, USA
Dr. Soren Bak, Department of Plant and Environmental Sciences, University of Copenhagen, Denmark

Symposium VIII: Phytochemicals, Crops and Agriculture
Chairs: Dr. Dan Sung, Dr. Baochun Li, Dr. Xi-Qing Wang, Dr. Nic Bate, Dr. Mark Berhow
Featured speakers:
Dr. Elvira DeMeija, the University of Illinois, USA
Dr. John Littleton, University of Kentucky, USA
Dr. Sean Cutler, University of California, River side, CA USA
Dr. Marie Petracek, Monsanto, St. Luis, MI USA
Dr. Jill Stevenson, BASF Plant Science, L.P., Research Triangle Park, NC, USA

Elsevier/Phytochemistry Young Investigator Award: Call for applications

The PSNA's most prestigious award for early-career phytochemists and plant molecular biochemists is the Elsevier/Phytochemistry Young Investigator Award, sponsored by Elsevier. It will be awarded again in 2014 to an individual who has exhibited exceptional creativity in and dedication to the field of phytochemistry, plant biochemistry, or plant molecular biology. The recipient will receive $10,000 for proposed research and up to $2,000 for travel and lodging to present a lecture at the 2015 PSNA meeting. The recipient will receive half of the prize money at the 2014 PSNA meeting and half upon submission of a substantive and original review paper to Phytochemistry. PSNA members are encouraged to nominate candidates and eligible candidates may submit applications to the Chair of the PSNA Awards Committee, Dr. David Gang, at gangd@wsu.edu. Eligibility criteria and instructions to apply are available on the society's website at www.psna-online.org. The deadline for receipt of nominations and applications is May 1, 2014.

Arthur C. Neish Young Investigator Award: Call for nominations

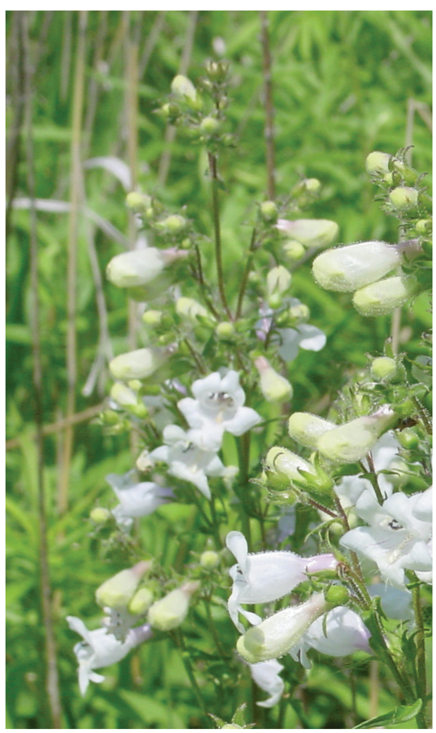
This PSNA award is named after Dr. Arthur C. Neish who pioneered in elucidating biosynthetic pathways using radiolabeled precursors and who inspired many generations of phytochemists. PSNA members are encouraged to nominate deserving candidates for this award. More information on eligibility criteria and instructions for submitting nomination packages can be found on the society's website at www.psna-online.org. The deadline for receipt of nominations is May 1, 2014. Recipients of the 2014 Award will be invited to speak at the upcoming annual meeting of the PSNA (August 9-13, 2014) in Raleigh, North Carolina. In addition to a waiver of the conference fee, recipients will receive $500 to defray travel and lodging expenses.

PSNA Members in the News

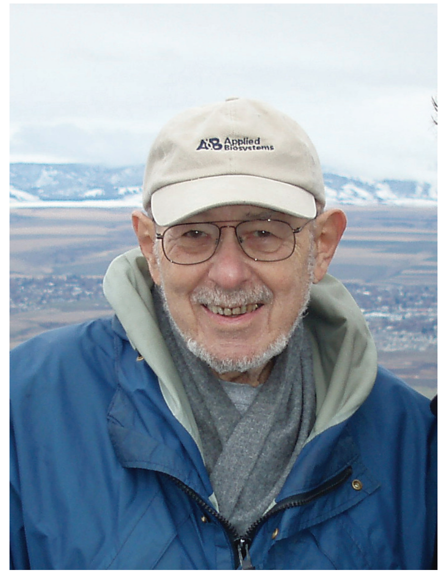
Professor Norman Lewis at Washington State University was on the front page of the Seattle Times on Monday, February 10: http://seattletimes.com/html/localnews/2022874911_poplartreesxml.html. His genetically engineered poplar trees produce 2-phenylethanol, a common flavor ingredient used by the cosmetics and perfume industry. Check out this amazing story on page 9.

2014 PSNA Member Dues

Forgot to renew your PSNA membership? No problem. You can conveniently renew online with a credit card payment on the PSNA online dues page. http://www.psna-online.org/join.html



Frank A. Loewus (October 22, 1919 – January 21, 2014): A Life Well Spent and Well Remembered



Professor Emeritus **Frank A. Loewus,** largely renowned worldwide for his and fellow scientist wife Mary's discoveries in the ***myo*-inositol** signaling and ascorbic acid (**vitamin C**) biosynthetic pathways, passed away peacefully in late January in Pullman, Washington. Some 94 years young, Frank had had a good life and a genuine thirst for scientific knowledge. Frank was blessed - not only with a very productive scientific career, caring family, and lifelong scientific friendships - but also with good health and a keenness and sharpness in mental agility that belied his years.

I thus enthusiastically and graciously invite the reader to join in celebrating Frank's life, with all of its richness and variety of experience. I must also underscore that my own modest contribution to this celebration of his life is made resplendent with a few short vignettes and recollections from previous co-workers, contemporaries, friends and admirers alike. In this regard, both he and his beloved spouse/fellow researcher and partner, Mary, made highly significant scientific contributions spanning from the early 1950s to the late 1990s. As the late Nobel Prize-winner Sir Derek H.R. Barton reflected years back, scientists must be judged not only from their contributions, but also from the technologies and dogmas in place at the time they were made. Frank (and Mary) are wonderful examples of the wisdom of such a philosophical outlook, and the scientific contributions they made began at a time when equipment and technologies, and indeed our understanding of many biological processes, were all in their infancy. Let me try and do justice to these contributions, and in reviving happy memories.

Scientific Contributions:

These were initially prominently made on the then unknown stereochemistry of hydride transfer reactions in enzymatic reactions using the cofactors NAD/NADH (then called DPN/DPNH) in the early 1950s, and involving a star-studded research team that he was part of. Then followed an independent career at various institutions, where his scientific interests led him to vitamin C (ascorbic acid) and *myo*-inositol, respectively. Indeed, his work at various institutions serves to remind that the important part of a life's scientific contribution is that of the discoveries and progress made, as it is those which are mostly remembered - rather than the home institution(s) where the work was done. Let's look again at each main area and celebrate the successes.

The discovery and functions of NAD/NADH (DPN/DPNH) and the University of Chicago Years:

Following his doctoral work at the University of Minnesota (see below), Frank joined the brilliant team at the University of Chicago from 1952-1955 that was led by **Birgit Vennesland** and **Frank Westheimer** (who later went on to further prominence at Harvard University). Other outstanding team members at the time included **Eric Conn, Harvey Fisher** and **Paul Talalay,** with the latter a highly gifted young MD/biochemist. The late plant scientist **Helen Stafford** was another contemporary. Thus began heady days in enzymology; this experience helped sculpt Frank Loewus' future scientific direction, outlook, and rigor, that would be the signature hallmark of his scientific pursuits and career.

As part of the joint Vennesland/Westheimer team, he was intrigued by their discovery of an enzymatic hydrogen transfer from NAD (then called DPN), and he was tasked with investigating the stereospecificity of hydrogen transfer from beef heart lactic dehydrogenase (LDH) (J. Biol. Chem. **202,** 687 and 699, 1953), thus building on the earlier seminal work on alcohol dehydrogenase (ADH) by the other team members. Next up was whether the stereospecificity of hydrogen (hydride) transfer also applied to the substrates, and this was established to be the case (J. Am. Chem. Soc, **75,** 5018, 1953). Paul Talalay, a contemporary at the time, today fondly recalls a seminal moment in these studies:

"When a steroid dehydrogenase that I discovered appeared not to transfer the alcohol dehydrogenase "hydrogen" directly, we showed that it used the diastereomeric hydrogen. This was the first demonstration that NADH could use both diastereomers, and was published in J. Biol. Chem. **212,** 801-809, 1955. (Talalay P, Loewus FA, and Vennesland B. The enzymatic transfer of hydrogen. IV. The reaction catalyzed by a beta-hydroxysteroid dehydrogenase."

Thus emerged what we now take for granted, namely discovery of this beautiful stereochemical control over oxidative/reductive processes (actually hydride addition and abstraction with NAD/NADH and their substrates) in Nature's resplendent armoury. Brilliant discoveries indeed and which stood the test of time! (For additional context, **Paul Talalay** went on to worldwide renown at Johns Hopkins University, and continues to this day with a vibrant program in developing our understanding of dietary plant substances conferring cancer protection). Importantly, these three years at Chicago thus began to develop

Frank's skills at working independently, and in identifying the new and productive new opportunities that beckoned.

Vitamin C (Ascorbic Acid) and *myo*-Inositol:

These studies spanned mainly the timeframe from 1955 onwards with lengthy sojourns at the USDA Western Regional Research Lab, Albany, CA (1955-1964), the Department of Biology at SUNY Buffalo (1965-1975), summer stints at Woods Hole (Mass.) Marine Biological Labs (1970-1974), and the Institute of Biological Chemistry (IBC), Washington State University (from 1975-1990, and thereafter as Professor Emeritus).

Vitamin C, myo-Inositol and Frank A. Loewus,

as contributed by Fred Stevens, Oregon State University:

"Frank first developed an abiding interest in ascorbic acid (vitamin C) biosynthesis when he was investigating oxidative processes in stored fruit at the USDA Western Regional Research Laboratory. While a pathway for the biosynthesis of ascorbic acid in animals had been proposed and supported with experimental data by the early 1960s, the situation in plants appeared to be much more complicated. His first surprise finding was that ripening strawberries, when fed D-[^{14}C]-glucose via cut stems, produced ascorbic acid without inversion of the carbon chain positions, thus differing from what had been demonstrated and reported in rats. This finding suggested that the pathways for ascorbic acid biosynthesis proceeded differently in strawberries and rats, a finding that those in the mammalian field dismissed at the time as Frank often reminded Norman Lewis in private conversation. Nevertheless, undeterred, he next hypothesized that *myo*-inositol served the role of its biosynthetic precursor in plants, as *myo*-inositol is readily oxidized in plants to produce D-glucuronic acid, a now known intermediate in both plant and animal pathways. He then demonstrated that *myo*-inositol is produced in two steps from glucose-6-phosphate via 5-ketoglucose-6-phosphate and D-*myo*-inose-1-phosphate. The biosynthetic formation of *myo*-inositol-1-phosphate involves an oxidation at position 5 of glucose-6-phosphate, followed by aldol condensation between carbon 6 and the aldehyde carbon 1, and reduction of the keto functionality. His research group isolated the responsible enzyme, *myo*-inositol-1-phosphate synthase, from pollen of *Lilium longiflorum*, and characterized its properties. Phosphatase-mediated removal of the phosphate group and subsequent oxidative ring cleavage between carbon atoms 5 and 6 yielded D-glucuronic acid. This pathway thus satisfactorily explains the metabolic labeling pattern in ascorbic acid formed from D-glucose in his earlier strawberry feeding experiments. Now, 50 years or so later, four distinct plant pathways for the biosynthesis of vitamin C are known: the 'Loewus' *myo*-inositol pathway, the mannose/galactose route (Smirnoff-Wheeler pathway), the gulose shunt, and the galacturonate pathway.

In his pursuit to elucidate the biosynthetic formation of ascorbic acid, Dr. Loewus made a number of other seminal discoveries. When he fed radiolabeled myo-inositol to leaf or fruit, he found the bulk of the label in hemicellulose and pectin of the cell wall, demonstrating the importance of myo-inositol as a versatile biosynthetic intermediate. At SUNY/Buffalo, his research group, which by then included his wife Mary, discovered that the enzymatic cleavage of ascorbic acid between carbons 4 and 5 or between carbons 2 and 3 to form L-(+)-tartaric acid depends not only on the plant species, but also on the stage of development. Since Dr. Loewus' early observations, it has now been well established that ascorbic acid is a major biosynthetic source of tartaric acid (and oxalic acid) in plants.

Frank Loewus' long chain of discoveries in the vitamin C field thus started with research on oxidative processes in stored fruit. While vitamin C plays many important roles not only as a cofactor for several hydroxylating enzymes but also in maintaining proper cellular redox balance, Dr. Loewus' example of tartaric acid suggests that ascorbic acid may play a prominent but poorly recognized role as a biosynthetic precursor or building block for a host of phytochemicals. A 2009 survey of the literature published in Phytochemistry describes 33 phytochemicals derived from ascorbic acid, which may only represent the metaphorical tip of the iceberg."

Scientific Service to the Community:

Frank also worked tirelessly in support of the scientific community. Among other responsibilities, he was President of the Phytochemical Society of North America (PSNA) in 1975, and later successfully took on the organization of the first joint annual meeting of the then American Society of Plant Physiology (now ASPB) and PSNA in August 4-7, 1980. While the meeting was a rewarding endeavor overall, it was not without some headache. Frank often remembered it from the perspective of some nearby colleagues not providing the level of help he felt had been needed! A further complication was that on May 18 of that year, Mt. St. Helens had erupted and, at the actual meeting itself, a further small eruption led to a small sprinkling of ash in Pullman, enough he recalled for everyone to take home a small sample. Frank though took all of these things in his stride, and the meeting was a great success.

Recognition: During his professional career, Frank received accolades from his peers, including the Charles Reid Barnes Life Membership from the American Society of Plant Biology (ASPB) in 1993, and the 2007 Phytochemical Society of North America (PSNA) Phytochemistry Pioneer Award. Frank later provided a most informative summary of his scientific career and personal development in the February 2008 PSNA News, an article well worth reading. Frank and Mary's legacy is also kept very much alive with the Frank and Mary Loewus travel awards given annually for deserving PSNA students.

A Very Private Man:

Frank was a very private man, but solid and reliable in all he did. His word was his bond. He came into this world in Duluth, Minnesota, on October 22, 1919, with his mother passing away when he was only 2, and then his father when he was 17. Growing up as a youngster in the abundant woodland and shorelines surrounding Lake Superior, he was drawn initially to pre-forestry which ultimately culminated in a BSc in Forestry in 1942 from the University of Minnesota. This experience and training whetted his appetite for a graduate program in biochemistry, which was thwarted at the time due to World War 2.

The World War 2 Years: Following receipt of his BSc degree, Frank then enlisted in the Army Air Corps, serving as a first lieutenant in the Pacific Theater, which took him across the South Pacific, through the Philippines, and ultimately to Japan. In his tour duty in Japan which lasted until 1946, he served as an intelligence officer, and by this time had seen firsthand the destruction and human loss that accompanied this terrible conflict. Indeed, Frank would occasionally reflect on the horrors he had witnessed and the level of destruction he encountered on landing in Japan. Nevertheless, he left Japan with enormous respect and admiration for the Japanese nation, and later made lifelong friendships with Japanese scientific colleagues that continued to his passing. For individuals like me, that never directly experienced the horrors of warfare, we salute those whose sacrifices have enabled us to pursue our own scientific passions today.

Post-War Education, the GI Bill, and a Happy Marriage: After military duty overseas, and initially leaning towards an industrial career, a chance visit to his old alma mater resulted in him immediately beginning graduate school in the Department of Biochemistry at the University of Minnesota under the tutelage of Professor David Briggs. Frank then became a recipient of funding through the GI bill, and completed his MSc in 1950, and his PhD in 1952 on the chemistry of amylose retrogradation. While in graduate school, he met his beloved wife Mary; they were married on December 26, 1947 and this happy union continued until his passing. She had also hailed from Duluth! Their marriage also marked the beginnings of their own life-long personal and professional interactions as a research team.

Frank and Mary have 3 children, Rivkah, David, and Daniel, and six grandchildren of whom they were also very proud. Interestingly, one of Frank's sons, David, went on to complete his PhD degree at Harvard with Frank Westheimer, who had previously been the co-leader of the University of Chicago team with Birgit Vennesland, that father Frank had been part of earlier.

A Keen Sense of Humor: Frank had a very well-developed sense of humor, and regrettably some of his best jokes probably should not be repeated here! To whet the appetite of what I mean to those that may not have known Frank, the first professional interaction I remember was during an interview for the position I have held since 1990 (namely Director, Institute of Biological Chemistry). Many faculty told me that Frank had some difficulties with the Dean. When I enquired about this, the only quietly given and straight-faced clarification I received from Frank was:

"Difficulty with the Dean? Which Dean do you have in mind? I have been here since 1975, and I have had problems with all of them!"

Frank Loewus at Home: Many of my own recollections of Frank also stem from him being our next door neighbor from the early 1990s until he and Mary decided to move to Bishop Place Senior Living apartments many years later. My main sightings and recollections of Frank at home as a neighbor were as an avid gardener. He spent seemingly endless hours in his backyard growing amongst many other things, wonderful tomatoes and geraniums, which he would often generously provide us with. As he became somewhat physically frailer in his still youthful 80's, his exercise regime in his front yard then seemed to be mainly restricted to using – with what appeared to require increasing amounts of physical over-exertion – what may have been the only hand-pushed lawn mower in this college town. There were quite a few instances when either his mower and/

or roto-tiller would get the upper hand. Any suggestion though of offering help was quickly – but politely and unmistakably - rebuffed.

In Memoriam:

In the days following the sad news of Frank's passing, we were heartened to hear from previous collaborators and colleagues of Frank and Mary, to express their condolences, including: Bruce Baldi (previous graduate student), Wendy Boss (North Carolina State University), Daneel Ferreira (University of Mississippi), Heinz G. Floss, Professor Emeritus, Univ.Washington), Jack Preiss (Michigan State University), Ralph Quatrano (Washington University), Kazumi Saito (Professor Emeritus, Kyoto University), Nick Smirnoff (University of Exeter), Fred Stevens (Oregon State University), Paul Talalay (Johns Hopkins University), and Mechthild Tegeder (WSU, and widow of the late Vince Franceschi, another collaborator that Frank enjoyed immensely working with), as well as George Wagner (University of Kentucky), who began his successful professorial career as a dishwasher in Frank's lab. George still remembers Frank coming into the lab at 3 am to check how his work was progressing, and I assume to establish whether he was actually really there! In our own laboratory, we also have a strong connection with the Loewus lab, as when Frank retired, his previous technician, Diana Bedgar, began working with us and this has continued to this very day. Diana still misses the Woods Hole days, and visiting Frank there during the summer. It's hard to know though if her nostalgia also derives from missing fresh lobster and crab! Nonetheless, Diana was very well trained, I am pleased to report! All of these folks remember Frank and his spouse Mary with sincere fondness and as as rigorous scientists and great people. Furthermore, the WSU community share greatly in our loss, and he was highly regarded and respected by all of the IBC faculty, staff, students and visiting scientists.

As I close this celebration, it is worthwhile reflecting on this wonderful scientist and person. He had quietly endured much through life, but remained captivated with the science that he had been eager to pursue until the very end. One of his very last literature contributions was with Pushpa Murthy (Michigan Technological University) on an overview on inositol metabolism, of which he was very proud.

We also remember Frank's 90th birthday celebration in our conference room; the 90 candles that I had insisted we put on and light on his birthday cake quickly resembled the output of a flame thrower, but all turned out fine. Frank leaned over the burning mass, and quickly blew out this blazing monument in honor of our proud nonagenarian, without need for the fire department.

Frank is survived by wife Mary, who is in good care, as well as his 3 children and 6 grandchildren.

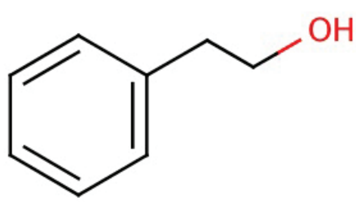
Respectfully submitted on behalf of all contributors,

Norman G. Lewis,
Institute of Biological Chemistry,
Corresponding Fellow, Royal Society of Edinburgh,
Washington State University.
23 February 2014.

Rose scent in poplar trees? WSU turns to genetic engineering

A WSU team aims to turn poplars and other fast-growing trees into living factories that churn out valuable chemicals.

By Sandi Doughton



2-phenylethanol: An aromatic alcohol. It occurs widely in nature and is found in a variety of essential oils, including rose, carnation, hyacinth, Aleppo pine, orange blossom, ylang-ylang, geranium, neroli and champaca.

Sniff the air around Norman Lewis' experimental poplars, and you won't pick up the scent of roses.

But inside the saplings' leaves and stems, cells are hard at work producing the chemical called 2-phenylethanol — which by any other name would smell as sweet.

Sweeter still is the fact that perfume and cosmetics companies will pay as much as $30 an ounce for the compound that gives roses their characteristic aroma. Because what Lewis and his colleagues at Washington State University are really chasing is the smell of money.

Born out of the frustrating quest to wring biofuels from woody plants, the WSU project takes a different tack. Instead of grinding up trees to produce commercial quantities of so-called cellulosic ethanol, their goal is to turn poplars into living factories that churn out modest levels of chemicals with premium price tags.

The potential market for specialty chemicals — many of which are now synthesized from petroleum — is big, said Lewis, director of WSU's Institute of Biological Chemistry. He's already patented some of the technology, which relies on genetic engineering, and created a spinoff company called Elasid.

In the longer term, the profits from high-end products could boost the struggling biofuel industry by helping companies survive what's called the "valley of death" — the point where firms need to scale up production, but money is hard to come by.

The ideal operation would combine the two product lines, extracting valuable chemicals and using the waste for biofuel. But that's a long way off, Lewis said.

"Biofuels don't provide a compelling economic case at this point in time," he said. "We've been trying for many decades to understand how plants make these special chemicals that can be used in flavorings, fuels and medicinals, and that seemed like the obvious first place to target."

But failures outnumber successes in the world of green technology, and it remains to be seen whether Lewis and his group will buck the trend.

Costs and controversy

Extracting chemicals from plants can be very costly, cautioned Oregon State University bioengineer Ganti Murthy. He and his colleagues engineered poplars to produce a component of biodegradable plastics. But they haven't been able to get the concentrations high enough to make it profitable.

"Economics play a huge part in all of this," he said.

The use of genetic engineering also adds an element of controversy and layers of regulation that many companies and investors would rather avoid, Murthy pointed out.

No genetically engineered forest trees have been approved for commercial use in the U.S., though the Department of Agriculture is considering an application from a company called ArborGen that has developed a cold-tolerant eucalyptus. (Papaya trees genetically engineered to resist the ring spot virus are grown in Hawaii.)

Activists who firebombed the University of Washington's Center for Urban Horticulture in 2001 mistakenly thought they were targeting genetically engineered poplars. Several environmental groups continue to wage battle against transgenic trees, which they fear will contaminate native forests and raise the risk of fire.

"Trees are not like crop plants," said Anne Petermann, executive director of the Global Justice Ecology Project, a New York-based group that has called for a ban on GE trees. "We have no idea what the long-term impacts will be and very little idea of the short-term impacts, like interactions with soil microorganisms and wildlife."

Lewis believes the concerns will abate once genetic engineering begins to yield useful products. But in the meantime, he and his team prefer not to disclose the exact location of their test plots.

Safeguards

With 12,000 trees on about 11 acres in Western Washington, Lewis believes his poplars represent the biggest ongoing field test of genetically engineered trees in the country — and perhaps the world.

Under USDA regulations, every tree is tagged and its GPS coordinates noted, explained WSU staff scientist Barri Herman, who oversees the field trials. Each plot is bordered by a wide buffer, which Herman and his crew spray with Roundup and patrol for wayward shoots. If any sapling disappears, the rules require them to track it down — which sometimes means digging up vole burrows, Herman said.

To prevent crossbreeding with other trees, the genetically engineered poplars are cut by the age of 5, before they are able to flower and produce pollen.
Some of the trees in the experimental plots were genetically altered to produce lower amounts of lignin. The matrix that makes wood strong and rot-resistant, lignin is the bane of those who want to break wood down into its component chemicals.

A second batch of poplars contains genes inserted from other plants that coax the trees to produce clove- and basil-scented chemicals.
But it's the trees with the added rose gene that seem the most economically promising, Lewis said. In a recently published study, he and his colleagues reported that young plants contained up to 4 percent of the chemical in their leaves. The team hopes it may eventually be able to increase those concentrations tenfold.

Not only is 2-phenylethanol used in products ranging from talcum powder to soft drinks, it can also be processed to produce components of jet fuel, Lewis said.

People have been extracting medicines, oils and other useful chemicals from plants for centuries. But the push to find alternate sources of energy has increased the funding and focus on biofuels and other plant-derived substances that could be substituted for petrochemicals.
Ethanol made from corn is a common ingredient in gasoline but has raised concerns over the use of crops and farmland for fuel.

Plants become products

WSU and the University of Washington are sharing in an $80 million U.S. Department of Agriculture grant to find ways to convert trees and waste wood to jet fuel. The federal government has invested $2 billion in research and loan guarantees to help companies produce fuel from nonfood plants.

But it's harder and more expensive to make ethanol from wood and grass than from corn. So far, no one has been able to produce significant amounts of cellulosic ethanol at a competitive price — though several facilities are scheduled to go into operation this year.

"I say this with sadness," said Murthy. "But it doesn't really matter how much we talk about green, if it costs more at the pump it's not going to fly."

So like Lewis, many scientists and entrepreneurs are searching for better ways to turn plants into products. A company called NatureWorks is already producing biodegradable plastics from chemicals extracted from corn. British scientists hope to gain approval for field trials of flax-like plants engineered to produce the omega-3 fatty acids found in fish oil. The researchers say plant-derived fish oil would be more sustainable and less environmentally damaging than harvesting vast quantities of small fish to extract the oil.

Poplars are an appealing species to work with, because they grow up to 10 feet a year, Lewis said. Young trees can be mowed down like grass, and will resprout, with fields yielding two crops a year.

They can also be grown on marginal land, so the tree farms won't compete with food production for prime locations.

Lewis hopes the rose-scented chemical will be the first of many he and his team can coax their trees to produce. Under the Elasid banner, they're already scouting out a location for a commercial-scale operation. But first — in addition to finding money, getting federal approval and juggling all the other challenges of a startup — they have to make sure results from the lab will translate to the field.

"That's where the proof of the pudding is," Lewis said.

Contact Sandi Doughton at: 206-464-2491 or sdoughton@seattletimes.com

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