inChemistry

THE MAGAZINE FOR ACS STUDENT MEMBERS
April/May 2016

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Published for student members by the American Chemical Society Education Division at 1155 Sixteenth Street, NW, Washington, DC 20036

ACS Chemistry for Life®

Canadian GST Reg. No. 127571347

inChemistry

THE MAGAZINE FOR ACS STUDENT MEMBERS

Volume 24 • Number 4
April/May 2016

PHOTO: SUNY CORTLAND ACS STUDENT CHAPTER

Cover: Members of the SUNY Cortland ACS student chapter don bunny suits to tour a clean room at Kionix, Inc. 22

CONTENTS

ACS Chemistry for Life™ SCI America AIChE

Call for Applications

SCI SCHOLARS

Summer Industrial Internship Program for Undergraduates

Summer 2017

The Society of Chemical Industry (SCI) is pleased to offer the **SCI Scholars Program**, which provides exceptional chemistry and chemical engineering students with 10-week internships during the summer of 2017. If you plan to pursue a career in chemical industry, apply for this opportunity to build your skills and gain valuable experience!

Benefits:

- Industrial workplace experience
- $6,000–10,000 work stipend (varies by employer)
- Certificate and $1,000 travel award to participate in a scientific meeting
- Opportunity to nominate a high school chemistry teacher for recognition and a $1,000 award

Requirements:

- Current sophomore or junior
- Chemistry or chemical engineering major
- Minimum GPA of 3.5
- U.S. citizen or permanent resident

SCI Scholars will be selected based upon the strength of their application, statement of interest, and letters of recommendation.

To see information and apply, visit www.acs.org/sci

Deadline to apply is November 30, 2016

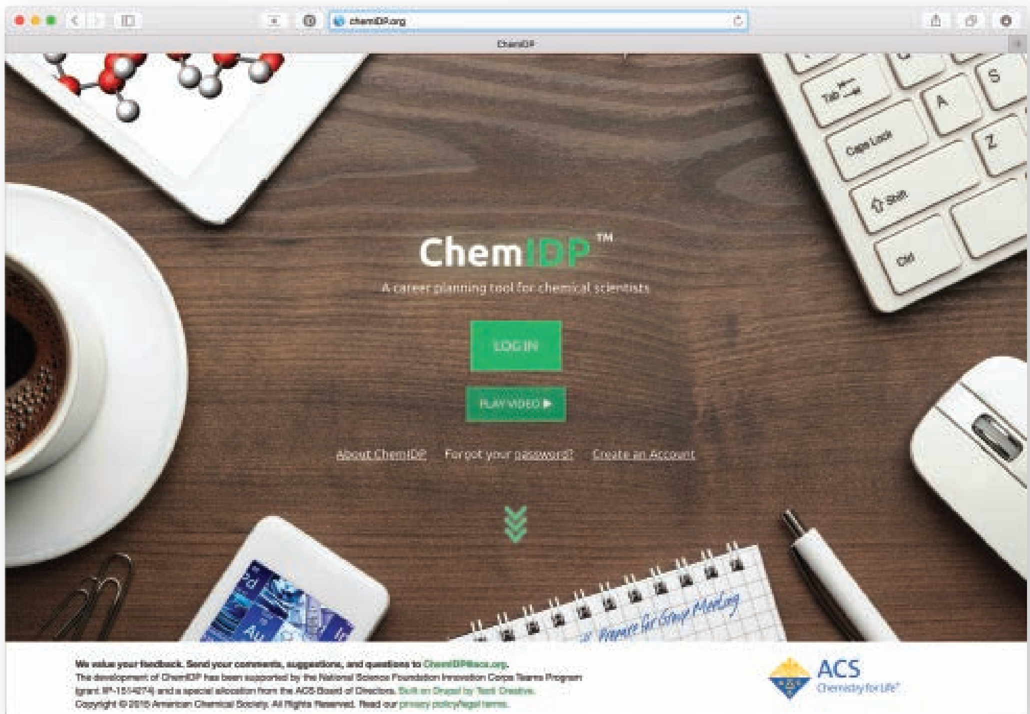
EDITORIAL:
It's Your Career — Plan It, Own It!

BY MARY KIRCHHOFF

Planning for your career can be difficult and daunting, making it a prime target for procrastination. It may seem as if no one expects you to spend time on it or has time to help you with it.

As a result, it's easy to get caught up in short-term issues that arise each week, and continually put off career planning. You complete a task or fix an issue and move on to the next, but have you taken time to consider the overall picture of your college education and your progress toward achieving career goals? It is well worth your time investment.

ACS has introduced an Individual Development Plan resource to help you. ChemIDP, a tool ACS designed specifically for students in the chemical sciences, is based on steps employers use for career development. Supported by the National Science Foundation Innovation Corps Teams Program, ChemIDP is a highly comprehensive and up-to-date career planning resource.



Regardless of whether you just started your degree program or will be in the job market soon, you can benefit from using ChemIDP. Dive into the thought-provoking questions; take advantage of the insights and advice in crafting your plan and putting it into action. Working through your career path now will make the next few years more efficient, effective, and successful.

- **Explore more than 50 career descriptions in a variety of sectors to better understand work environments and roles and responsibilities of different positions in the field.**
- **Identify and set your own career goals and tactics to achieve them.**
- **Perform a self-assessment to take an introspective look into what you value and to identify your proficiencies in technical, knowledge, and professional skills.**
- **Explore ideas to strengthen the skills you will need to achieve your career goals.**

ChemIDP brings these pieces together so you can review all of this information in one report, set milestones, and create reminders to ensure you are on track.

Preparing and updating an IDP is a process that reflects your background, experiences, and career dreams. ChemIDP is a private space for you to consider your options, capture your thoughts, and map out plans. Share your plan with those who can assist you, such as your research advisor, your college career center, and your mentors.

Completing an IDP is just the beginning. Your IDP should be fluid and flexible, because your answers to the thought-provoking questions will change over time as you build your portfolio of experiences. It's your career; don't wait for it to happen to you. ChemIDP can help you identify the skills you need to prepare for the career you want. Start today at **ChemIDP.org**. iC

Mary Kirchhoff *is Director of the Education Division at the American Chemical Society and former Assistant Director of the Green Chemistry Institute. She received her Ph.D. in Organic Chemistry from the University of New Hampshire.*

ATOMIC NEWS

COMPILED BY JESSICA ROBERTS

Source: ACS Office of Public Affairs Weekly PressPac, www.acs.org/news

Recyclable, sugar-derived foam — **a renewable alternative to traditional polyurethanes?**

Polyurethanes in products from cushy sofas to stretchy spandex have made sitting, sleeping, and walking more comfortable. But once they have served their purpose, most of the non-degradable materials pile up in landfills. Now researchers report in the journal *ACS Macro Letters* a potential way to reduce future waste: a chemically recyclable foam made using a new sugar-derived material.

Polyurethanes are highly versatile materials. In addition to furniture and clothing, manufactures use them in electronics, cars, floors, and medical devices. But the materials come from petroleum, and efforts to recycle them are limited. To tackle the huge amount of waste this creates, researchers are pursuing more sustainable options. Marc A. Hillmyer and colleagues developed an efficient method to make a sugar-derived rubbery polyester compound called poly(β-methyl-δ-valerolactone), or PMVL, that can be used in new chemically-recyclable polyurethanes.

Using this new polymer, the researchers made flexible polyurethane foams that were comparable in performance to commercial analogs. To test whether the foams could be recycled, the team first added a catalyst, then heated the materials to a high temperature. Through this process, the researchers recovered up to 97 percent of the starting β-methyl-δ-valerolactone (MVL) monomer in high purity. The researchers then used what they recovered to re-make PMVL with essentially identical properties.

Read more about the research: "Chemically Recyclable Biobased Polyurethanes," *ACS Macro Letters*, 2016, 5, pp 515–518.

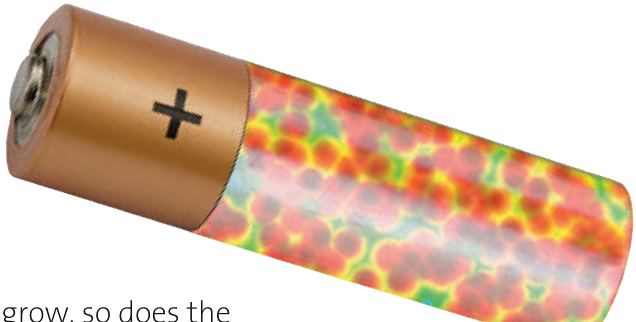
How ocean acidification and warming could affect the **culturing of pearls**

Pearls have adorned the necklines of women throughout history, but some evidence suggests that the gems' future could be uncertain. Increasingly acidic seawater causes oyster shells to weaken, which doesn't bode well for the pearls forming within. But, as researchers report in ACS' journal *Environmental Science & Technology*, the mollusks might be more resilient to changing conditions than previously thought.

Pearl aquaculture is big business, particularly in Asia and Australia. But much of it takes place in oceans, which are susceptible to the increasing amounts of carbon dioxide in the atmosphere, which released by human activity. CO_2 from the air gets absorbed by the oceans and become more acidic as a result. Research has found that pearl oysters produce weaker shells under these conditions, and this could hurt their chances of survival. But in addition to acidity, rising water temperature could also play a role in oyster health. Rongqing Zhang, Liping Xi, and colleagues wanted to see how combining acidity and water temperature would affect pearl oysters.

Researchers tested oysters for two months under varying water temperature and pH conditions, including those predicted for oceans in 2100. Their results confirmed previous work that had found boosting acidity led to weaker shells, but that effect didn't occur when the water temperature was also higher. The researchers concluded that warmer oceans could buffer these valuable marine animals from increasingly acidic seawater.

Read more about the research: "Interactive Effects of Seawater Acidification and Elevated Temperature on the Transcriptome and Biomineralization in the Pearl Oyster Pinctada fucata," *Environmental Science & Technology*, 2016, 50 (3), pp 1157–1165.



So long lithium, **hello bacteria batteries?**

As renewable energy sources grow, so does the demand for new ways to store the resulting energy at low-cost and in environmentally friendly ways. Now researchers report in ACS' journal *Environmental Science & Technology Letters* a first-of-its-kind development toward that goal: a rechargeable battery driven by bacteria.

Solar, wind, and other renewable energy sources are gaining ground as nations work to lower greenhouse gas emissions and reliance on petroleum. But sunlight and wind are not constant, so consumers can't count on them 24-7. Storing energy can make renewables more reliable, but current technologies such as lithium-ion batteries are limited by safety issues, high costs, and other factors. Sam D. Molenaar and his colleagues from Wageningen University and Wetsus (The Netherlands) wanted to come up with a less expensive, sustainable solution.

Researchers combined, for the first time, two separate microbial energy systems: one that uses bacteria to form acetate from electricity and one to convert the produced acetate back into electricity. Molenaar and his team successfully charged the battery over a 16-hour period and discharged it over the next 8 hours, mimicking the day-night pattern typical for solar energy production. They repeated this cycle 15 times in as many days. With further optimization, they say the energy density of the microbial battery could be competitive with conventional technologies. Someday it could help us store energy from local renewable sources safely and at a lower cost than current options.

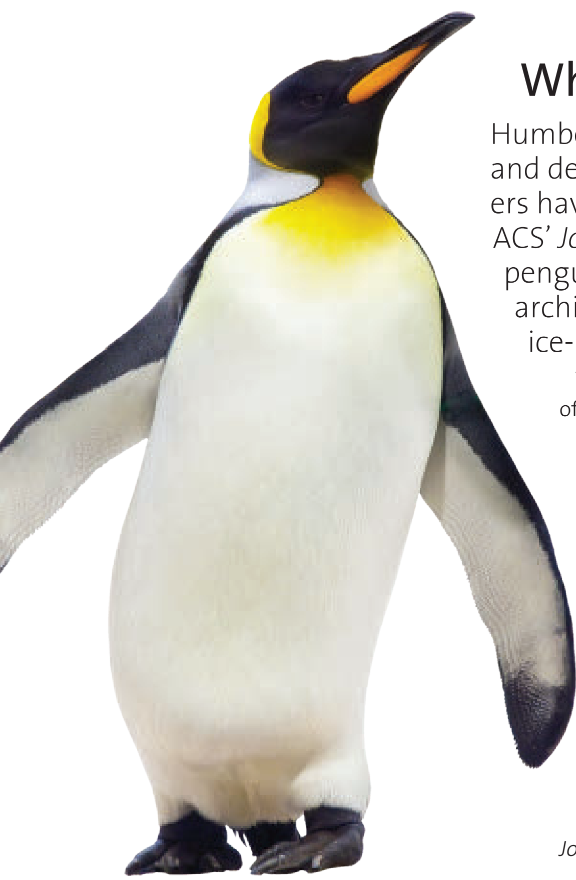
Read more about the research: "Microbial Rechargeable Battery: Energy Storage and Recovery through Acetate," *Environmental Science & Technology*, 2016, 3 (4), pp 144–149.

85 The percent of light let through transparent wood created when researchers removed lignin and replaced it with acrylic.

6,000 ***The number of carbon atoms in the longest linear carbon chain, which was synthesized by researchers in Austria.***

5 *The average strength in gigapascals (GPa) of the strongest natural material known to date, teeth from a limpet (an aquatic snail).*

32 **The percent of greenhouse gas emissions resulting from the burning of gasoline and diesel fuel in the U.S., according to the E.P.A.**



What makes **penguin feathers** ice-proof?

Humboldt penguins live in places that dip below freezing in the winter, and despite getting wet, their feathers stay sleek and free of ice. Researchers have now figured out what could make that possible. They report in ACS' *Journal of Physical Chemistry C* that the key is in the microstructure of penguins' feathers. Based on their findings, the researchers replicated the architecture in a nanofiber membrane that could be developed into an ice-proof material.

The range of Humboldt penguins extends from coastal Peru to the tip of southern Chile. Some of these areas can get frigid, and the water the birds swim in is part of a cold ocean current that sweeps up the coast from the Antarctic. Their feathers keep them both warm and ice-free.

Researchers had suspected that penguin feathers' ability to easily repel water explained why ice doesn't accumulate on them: Water would slide off before freezing. But research has found that under high humidity or ultra-low temperatures, ice can stick to even superhydrophobic surfaces. So, Jingming Wang and colleagues sought another explanation.

The researchers closely examined Humboldt penguin feathers using a scanning electron microscope. They found that the feathers were comprised of a network of barbs, wrinkled barbules, and tiny interlocking hooks. In addition to being hydrophobic, this hierarchical architecture with grooved structures is anti-adhesive. Testing showed that ice wouldn't stick to it. Mimicking the feathers' microstructure, the researchers developed an icephobic polyimide fiber membrane. They say it could potentially be used in applications such as electrical insulation.

Read more about the research: "Icephobicity of Penguins Spheniscus Humboldti and an Artificial Replica of Penguin Feather with Air-Infused Hierarchical Rough Structures," *The Journal of Physical Chemistry C,* 2016, Article ASAP.

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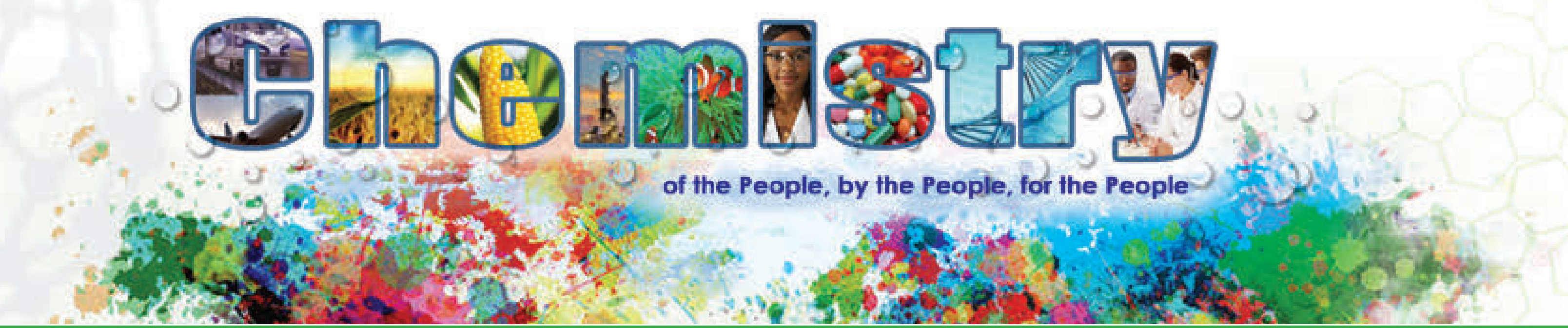


UNDERGRADUATE PROGRAM

Sunday, August 21

Hospitality Center
8:30 am – 5:00 pm

Undergraduate Research Oral Sessions
8:30 am – 5:00 pm

Networking Basics for Students
Cosponsored by PROF & YCC
9:00 – 10:15 am

Graduate School Reality Check, Pt 1 – Getting In
10:30 am – 12:00 pm

Graduate School Reality Check, Pt 2 – You're In, Now What?
12:00 – 1:30 pm

Networking Social with Graduate School Recruiters
2:00 – 5:00 pm

The Science Behind Pixar
Cosponsored by YCC
6:00 – 8:00 pm

ATTENTION: Graduate School Recruiters

Meet great chemistry undergraduate students and tell them about your graduate programs. Register to participate in Networking Social with Graduate School Recruiters. For more information, contact Blake Aronson at b_aronson@acs.org.

www.acs/Philadelphia2016
#acsPhiladelphia

National Meeting & Exposition

August 21–25, 2016
Philadelphia, PA

UNDERGRADUATE PROGRAM

Monday, August 22

Hospitality Center
8:30 am – 5:00 pm

Undergraduate Research Oral Sessions
8:30 am – 5:00 pm

Chemists Are Everywhere! – The Spectrum of Careers in Chemistry
9:00 – 10:00 am

What It Means To Be "We the Chemists" Today
10:15 – 11:15 am

Eminent Scientist Luncheon and Lecture
Cosponsored by INOR
Dr. Tobin J. Marks, Northwestern University
11:30 am – 1:30 pm

Undergraduate Research Poster Session
2:00 – 4:00 pm

Student Speed Networking with Chemistry Professionals
4:15 – 5:45 pm

Sci-Mix/Successful Student Chapter Posters
8:00 – 10:00 pm

ATTENTION: Chemical Professionals

Meet your future colleagues and share your experiences with undergraduate and graduate students. Register to participate in Student Speed Networking with Chemical Professionals. For more information, contact Blake Aronson at b_aronson@acs.org.

All events are sponsored or cosponsored by the Society Committee on Education Undergraduate Programs Advisory Board

CHAIR: Michael R. Adams, Xavier University of Louisiana

PROGRAM CHAIR: Michelle Boucher, Utica College, NY

Times and events subject to change. To view the latest updates to the Undergraduate Program, go to **www.acs.org/UndergradMeetingInfo**.

Meet the 2016 SCI Scholars!

BY BLAKE ARONSON

In March 2016, ACS announced the 2016 SCI Scholars, a group of 27 undergraduates who were selected from over 240 applications for paid industrial summer internships.

What made these candidates so special? And what's the big deal with SCI Scholars, anyway? Read on to find out.

What is the SCI Scholars program?

SCI Scholars is a summer internship program for high-performing chemistry and chemical engineering students. It was developed by the Society of Chemical Industry (SCI) to encourage excellent students to consider careers in industry through internship experiences.

SCI member companies provide 10–12 week summer internshipss. In addition to a salary and benefits, SCI Scholars receive a certificate and a $1,000 grant to use toward professional development or participation in a scientific meeting. And, of course, they gain valuable workplace experiences and skills that benefit them throughout their careers.

SCI Scholars also have the opportunity to recognize a high school science teacher who helped them on their path. The teacher receives a certificate and a $1,000 grant to support his or her classroom.

The SCI Scholars program is administered by ACS and co-sponsored by the American Institute of Chemical Engineers (AIChE).

Who can apply to become an SCI Scholar?

SCI Scholars must meet the following minimum requirements:

- **At least 3.5 GPA**
- **Chemistry or chemical engineer major**
- **Current sophomore or junior**
- **US citizen or permanent resident**

Applicants submit their transcripts, résumés, two letters of recommendation, and general contact information. The applicants also submit statements of interest, both general and regarding specific internship positions.

Unlike most internship programs, SCI Scholars applications are reviewed by an independent panel of industry professionals and faculty. The panel identifies the top candidates from all the exceptional applicants, and those superstar candidates receive the internship offers.

What does an SCI Scholar do?

SCI Scholars internships are full-time jobs that take place for 10-12 weeks over the summer. Duties vary by company and location, and can range from writing procedures and developing process recommendations to testing equipment, protocols, and procedures.

In addition to the prestige of the SCI Scholars program, participants gain valuable insight into industry. They learn how projects get funded, how to collaborate at a professional level, how to manage their resources and time, and how to communicate with a broad range of people.

Visit **www.facebook.com/SCIAmerica** to see how the 2015 SCI Scholars spent their summers.

How do I apply for the SCI Scholars program?

Visit **www.acs.org/sci** to view a list of the available 2017 ACS Scholars internships, which will be posted in September 2016. The program will accept applications from October 1 to November 30, 2016, and internship offers will be made in Spring 2017.

What if I can't be an SCI Scholar?

SCI Scholars is a highly competitive program, so you may want to explore other possible internships or experiential opportunities for a back-up plan. Here are some places to look:

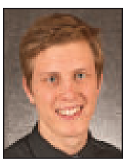
- **www.acs.org/GetExperience**
  database of internships, research opportunities, and more
- **www.acs.org/DGRweb**
  click on "REU Search" to search for undergraduate research opportunities
- **www.internships.com/chemistry**
  an internship database
- **www.indeed.com/q-Chemistry-Internships-jobs.html**
  an internship database

Blake Aronson *is a Lead Education Associate in the ACS Undergraduate Programs Office. In addition to SCI Scholars, she supports an variety of programs for two-year colleges and undergraduate students.*

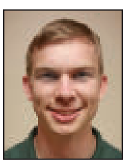
Who are the 2016 SCI Scholars?

The following 27 students were selected from 243 applications to participate in 10-12 week paid summer internships, and also received $1,000 grants for professional development. The winners' names, institutions, and internship locations are listed below.

Congratulations to the 2016 SCI Scholars, and thanks to everyone who applied.



Christopher Balzer
Arizona State University
CHEMTURA,
EL DORADO, AZ



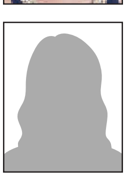
Patrick Brennan
Missouri University of Science & Technology
CHEMTURA,
EL DORADO, AZ

Emma Brown
Indiana University-Purdue University Indianapolis
HEXION,
STAFFORD, TX

Abigail Cawoski
Westminster College
LYONDELLBASELL,
CINCINNATI, OH

Jenalyn Clegg
Brigham Young University
CHEMTURA,
FORDS, NJ

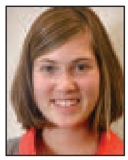
Kathleen Cooley
University of Maryland
W.R. GRACE,
COLUMBIA, MD



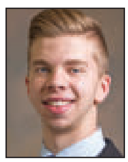
Alicia Curti
University of Nebraska, Lincoln
HONEYWELL,
GEISMAR, LA

Claire Dang
University of Tulsa
CARUS CORP.,
LASALLE, IL

Kyle Diuro
Villanova University
CHEMTURA,
PERTH AMBOY, NJ

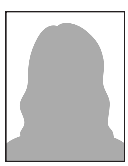


Emma Donahoe
Hope College
EXXONMOBIL,
BAYTOWN, TX

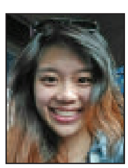


Joshua Greenlee
Ohio University, Athens
EASTMAN CHEMICAL,
KINGSPORT, TN

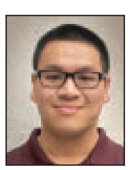
Stephanie Guerin
University of South Carolina, Columbia
EXXONMOBIL,
BATON ROUGE, LA



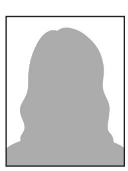
Crystal Gunther
Meredith College
CHEMTURA,
NAUGATUCK, CT



Xin Ru Han
University of Minnesota, Twin Cities
DOW CHEMICAL,
MIDLAND, MI



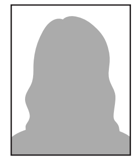
Janson Ho
University of Rochester
ALBEMARLE,
BATON ROUGE, LA



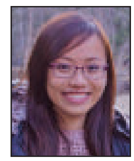
Isabella Hung
New York University
AIR LIQUIDE,
DALLAS, TX

Melissa Huynh
University of Alabama, Tuscaloosa
CHEVRON PHILLIPS,
PASADENA, TX

Sandhiya Kannan
Stony Brook University, SUNY
CHEMTURA,
NAUGATUCK, CT



Kimberlee Keithley
Rochester Institute of Technology
DOW CORNING,
MIDLAND, MI

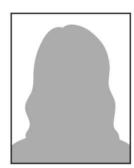


Thao Le
University of California, Berkeley
TRINSEO,
MIDLAND, MI

Michael Malmberg
Brigham Young University
TRINSEO,
MIDLAND, MI

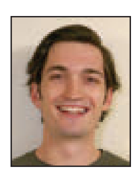
Michael Pfaff
University of California, Riverside
WESTLAKE CHEMICAL,
SULPHUR, LA

Joy Rutherford
Michigan State University
MILLIKEN & CO.,
SPARTANBURG, SC

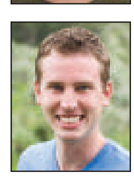


Shadi Torabi
University of California, Los Angeles
LYONDELLBASELL,
HOUSTON, TX

Luan Tran
Louisiana State University, Baton Rouge
CHEVRON PHILLIPS,
SWEENY, TX



Zachary Weintraut
Camden County College
CARUS CORP.,
LASALLE, IL



Jonathon Wheelwright
Brigham Young University
CHEVRON PHILLIPS,
BAYTOWN, TX

FEATURE

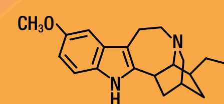
Psychedelic Compounds Like Ecstasy May Be Good for More Than Just a High

BY JYLLIAN KEMSLEY

Psychedelic drugs were studied for medical uses in the 1950s and 1960s before being banned in the 1970s. Now researchers are looking again to the compounds as possible treatments for patients that do not respond to conventional therapies for mental health conditions. Read on for some of the research underway with five common psychedelics.

Ibogaine

12-Methoxyibogamine



STREET NAMES:
Ibo, iboga root

NATURAL PRODUCT SOURCE:
roots of plants in the Apocynaceae family (for example, *Tabernanthe iboga*)

CURRENT MEDICAL USE:
none

POTENTIAL MEDICAL USE:
addiction

In the early 1990s, University of Miami neurology professor Deborah C. Mash traveled to Amsterdam to see ibogaine treatments firsthand. "A single dose of ibogaine could completely block the signs and symptoms of opiate withdrawal," says Mash, who has spent her career studying the effects of drugs and alcohol on the brain. She and others are now studying ibogaine as a treatment for opiate, cocaine, alcohol, and nicotine addiction.

Ibogaine was first isolated in 1901. It interacts with glutamate receptors in the brain that are involved in learning, memory, and creation of new neural pathways. The receptor interactions are likely the source of ibogaine's consciousness-altering effects.

But ibogaine is metabolized within 24 hours: A hydroxyl replaces ibogaine's methoxy group, producing noribogaine. Noribogaine binds to serotonin transporter, opioid, and nicotinic receptors and is cleared from the body slowly. Consequently, noribogaine is likely the compound that's responsible for reducing patients' withdrawal symptoms and cravings over the long term, as well as the accompanying anxiety and depression (Neuropharmacology 2015, DOI: 10.1016/j.neuropharm.2015.08.032).

Mash has patented noribogaine and related compounds, as well as their formulations. She founded a company, DemeRx, to bring them into clinical treatment. DemeRx is currently running a Phase II clinical trial to evaluate noribogaine's use as an alternative to methadone or Suboxone to help opioid addicts transition to sobriety in combination with support for behavioral changes. iC

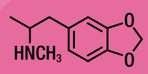
This article was adapted from "Psychedelic medicines." *C&EN*. 94 (13) March 28, 2016, pp. 28-32.
cen.acs.org/articles/94/i13/Psychedelic-compounds-like-ecstasy-just.html

To read more from or subscribe to C&EN, visit cen.acs.org

Artwork in article: Yang H. Ku/C&EN/Shutterstock

MDMA

±3,4-(Methylenedioxy)methamphetamine



STREET NAMES:
disco biscuit, E, ecstasy, hug drug, X

CURRENT MEDICAL USE:
none

POTENTIAL MEDICAL USE:
posttraumatic stress disorder, anxiety related to life-threatening illnesses, social anxiety in autistic adults, addiction

"After 100 years of modern psychiatry, our current best treatment for trauma-related disorders is only effective for 50% of people," says U.K. psychiatrist Ben Sessa.

The cure for posttraumatic stress disorder (PTSD) is psychotherapy — talking through and processing the trauma with a mental health specialist. "About half of people will talk and, over weeks or months, will overcome their high level of distress and get better," Sessa says. For others, talking about their experience is overwhelming. "They drop out of treatment and use dangerous drugs such as alcohol to mask their symptoms. They have high levels of self-harm and high levels of completed suicide," Sessa says.

MDMA interacts with a transporter in the brain that causes the release of serotonin, which in turn causes the release of other neurotransmitters and hormones. For people who might otherwise flee psychotherapy, MDMA reduces fear and increases trust and empathy. MDMA is also mildly stimulating rather than sedating. The overall effect is to calm patients and help them engage with a therapist about difficult experiences. Sessa likens MDMA to a life jacket.

U.S. psychiatrist Michael Mithoefer leads clinical trials studying MDMA for PTSD. In an initial trial, Mithoefer and colleagues worked with patients who had PTSD for an average of 20 years, mostly from sexual trauma. The patients had undergone previous psychotherapy for an average of almost five years and were not helped by conventional antidepressants. They received MDMA or a placebo two to three times, with doses one month apart, as part of eight-hour sessions with two therapists followed by an overnight stay at the clinic for continued monitoring (J. Psychopharmacol. 2010, DOI: 10.1177/0269881110378371).

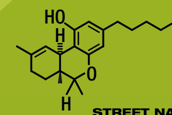
Going through the psychedelic experience, patients could focus inward and stay quiet as they wished or talk with the therapists. They also had extensive preparatory and follow-up psychotherapy sessions. Of 12 patients who received MDMA, 10 of them (83%) showed significant relief of their PTSD symptoms. In the placebo group, only two out of eight patients (25%) showed improvement with the same psychotherapy support.

Other studies show similar positive results, although "it is hard to have an effective 'blind' with this type of substance," Mithoefer concedes, because patients can usually tell whether they've been given a placebo or the real thing.

Nevertheless, the Multidisciplinary Association for Psychedelic Studies aims to start Phase III trials for PTSD next year, with MDMA synthesized by an unnamed U.K. contract manufacturing company following current Good Manufacturing Practices. iC

Marijuana

Psychoactive component:
tetrahydrocannabinol (THC)



STREET NAMES:
dope, ganja, grass, Mary Jane, pot, weed

NATURAL PRODUCT SOURCE:
Cannabis sativa, Cannabis indica

CURRENT MEDICAL USES:
nausea from cancer chemotherapy, weight loss from AIDS

POTENTIAL MEDICAL USE:
neuropathic pain, epilepsy, schizophrenia, anxiety, inflammatory conditions, posttraumatic stress disorder, muscle spasticity from multiple sclerosis, inflammatory conditions

"There is a very, very broad range of medical conditions for which cannabis or its constituent chemicals could find applications," says Daniele Piomelli, a professor of neuroscience and pharmacology at the University of California, Irvine. However, few good clinical studies have been completed.

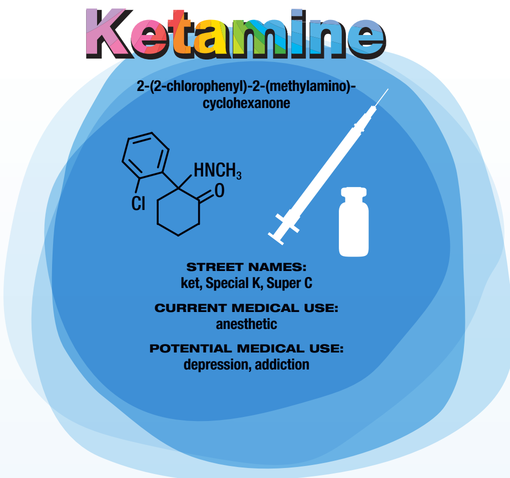
Mammals naturally make some cannabinoids, including anandamide, which likely plays a role in stress response and social behavior, and 2-arachidonoylglycerol, which is involved in modulating activity at the brain's nerve cell junctions.

Other cannabinoids, such as those produced in marijuana, can target the same neurological receptors as endogenous cannabinoids. Tetrahydrocannabinol is the one that generates a psychoactive response. It is already approved as dronabinol to treat nausea in patients undergoing cancer chemotherapy and appetite loss in people with AIDS. However, Piomelli notes it has poor bioavailability and has a complex metabolism.

Researchers are studying another cannabis compound, cannabidiol, to treat seizure disorders, schizophrenia, and other conditions. Cannabidiol is not psychoactive, but unraveling its pharmacology is difficult because it interacts with a variety of receptors beyond the endocannabinoid system.

California's Center for Medicinal Cannabis Research has studied smoked or vaporized cannabis to treat neuropathic pain, which originates in damaged nerve fibers (J. Pain 2015, DOI: 10.1016/j.jpain.2015.03.008). Short-term pain studies indicate that cannabis relieves the pain, "but what we haven't answered is whether it works forever," says Igor Grant, director of the center and a professor of psychiatry at the University of California, San Diego. "Does the efficacy remain, or do people get used to it and it no longer works as well? Is it possible that after a year you see side effects that you don't see after a few weeks?"

With broadening legalization of medical and recreational marijuana in the U.S., Piomelli says, "We typically hear about positive favorable effects because those tend to surface, but we don't have studies that are done appropriately for all these different uses." iC



Compared with conventional antidepressants, ketamine is "remarkable," says David Feifel, a professor of psychiatry and director of a center specializing in advanced treatments for depression at the University of California, San Diego.

Starting in 2004, Carlos A. Zarate Jr., chief of the Experimental Therapeutics & Pathophysiology Branch of the National Institute of Mental Health, led a study in which his team used ketamine to treat 17 patients who had already been through an average of six antidepressants. They observed 12 patients (71%) improve within 24 hours.

That speedy response time contrasts with conventional antidepressants such as sertraline and fluoxetine, which target serotonin pathways in the brain and typically take weeks to work.

Ketamine binds to the same glutamate receptors as ibogaine. Its half-life in the body is two to three hours. But ketamine's relief of depression lasts an average of around seven to 18 days, with some patients improving for as long as five months, Feifel says.

Zarate is conducting a range of studies — including neurological imaging, proteomics, and metabolomics — to unravel ketamine's effects in the brain. He points to dehydronorketamine as a particularly interesting metabolite. Zarate and colleagues have found that it may play a role in alleviating depression by interacting with a nicotinic receptor involved in long-term memory (Eur. J. Pharmacol. 2013, DOI: 10.1016/j.ejphar.2012.11.023).

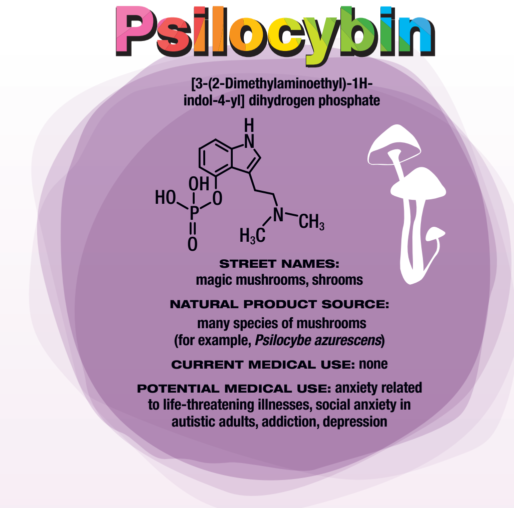
A racemic mixture of ketamine enantiomers is currently approved and manufactured for use as an anesthetic. Doctors administer it for depression off-label as an injection or intravenous infusion, at a dose low enough to avoid unconsciousness. Johnson & Johnson's Janssen R&D unit has an intranasal formulation of the S-(+)-ketamine enantiomer, known as esketamine, in clinical trials. In both cases, patients are dosed in clinics and monitored until the altered consciousness effects dissipate. Allergan is developing a related compound, rapastinel, that targets the same glutamate receptors but does not induce altered consciousness.

None of the compounds provides a single-dose cure for depression—they all require continuing treatment. Nevertheless, they could be a much-needed help when other treatments do not work.

"It was unlike anything I've seen in psychopharmacology before," says Roland R. Griffiths, a professor of psychiatry and behavioral sciences at Johns Hopkins University, of his first trial examining the safety of psilocybin in healthy volunteers.

Those volunteers had positive effects that could last for years. "People had increased satisfaction and quality of life," Griffiths says. "They felt more generous, centered, optimistic, and caring toward other people in their lives." Patients' friends, family members, and work colleagues confirmed the differences.

Griffiths has since conducted trials of psilocybin for tobacco addiction, anxiety, and depression in patients with life-threatening cancer. iC



Like MDMA, psilocybin targets serotonin receptors. Also like MDMA, the effects of psilocybin seem to stem from patients' experiences when their consciousness is altered. But instead of undergoing psychotherapy during the acute psilocybin experience, researchers encourage patients receiving psilocybin to focus inwardly and process their experience with a therapist afterward.

"The best treatment outcomes are with those subjects who, during the course of the psilocybin session, had what they described as a profound psychospiritual epiphany," says Charles Grob, a professor of psychiatry and pediatrics at the University of California, Los Angeles, School of Medicine and chief of child and adolescent psychiatry at Harbor-UCLA Medical Center (Arch. Gen. Psychiatry. 2011, DOI: 10.1001/archgenpsychiatry.2010.116).

Cigarette smokers given psilocybin report that the drug helps them understand their nicotine craving. That makes them able to quit more successfully when they're also undergoing a cognitive behavioral therapy program for tobacco addiction, Griffiths says (J. Psychopharmacol. 2014, DOI: 10.1177/0269881114548296).

For people diagnosed with cancer and struggling with the existential fears associated with dying, "it's harder to say what the nature of the attitude shifts are," Griffiths says. "But it seems to be an increased sense of wonder and openness to the mystery of life and death. In spite of the tragedy that they're dying, they might see that there's something beautiful and organic about the process." iC

Jyllian N. Kemsley *is a Senior Editor for C&EN. She specializes in reporting chemical research, particularly inorganic, physical, and theoretical chemistry.*

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Applications will be accepted November 1, 2016 through March 1, 2017.

Approximately 120 scholarships will be awarded.

10 Tips to Jumpstart Your Job Search — *Plus One*

BY LISA M. BALBES, PH.D.

Whether you're looking for your first professional position or a temporary job to build your bank account over the summer, searching for a job can be overwhelming. While it's tempting to do nothing and hope a job falls in your lap, that is probably not your best course of action. There are many things you can do right now to increase the chances of finding that perfect position.

If you're just getting moving (or wondering where to begin), the suggestions below will help you jumpstart your job search, and put you on the path to professional success.

One. Take One Bite at a Time

The only way to eat an elephant is one bite at a time. Make it a priority to spend one hour every day working on your job search. Go someplace your friends can't find you, turn your phone off (not just silent), and make real progress on your search. You don't have to do everything today, but you do have to do something.

Two. Refresh Your Résumé

Your résumé is your single most important professional document. It is your marketing tool, where you present yourself to potential employers in the best possible light. In many cases, it is the first impression a potential employer has of you — but hopefully not the last one. You've probably been using the same résumé for a long time, updating it in bits and pieces as your situation changed. Now is the time to take a fresh, critical look at the overall picture.

- **Verify that everything is up-to-date and absolutely current. Are all of your most recent and most relevant skills included?**
- **Look at the overall impression your résumé gives. Now is the time to remove some of your extracurricular activities from high school, especially ones that aren't relevant to your career path.**
- **Make sure your strongest selling points are up front, and quantify accomplishments where possible. You may need to reorganize the sections and update the headers to more accurately reflect your recent accomplishments. For example, instead of "Experience with HPLC" say, "Analyzed 25 samples per week using HPLC, including performing routine maintenance and upgrades to equipment".**
- **Create the best possible basic résumé, then customize it for each position. Your résumé will be one, or at most two, pages, so make every line count.**

Three. Update Your LinkedIn Profile

Take a critical look at your professional profile on LinkedIn. This is the first place most industrial employers go to look for candidates, so if you're not there, you are invisible to most potential employers. If you don't have an account yet, sign up (it's free).

- **Copy and paste content from your now-awesome résumé in to the appropriate sections of your LinkedIn profile.**

- Include a photo — a nice headshot with a plain background, taken by a friend (no selfies).
- Include all the professional skills (and keywords) that are relevant to your current job search, and make sure they are consistent with what's on your résumé. Don't advertise only your analytical chemistry skills on LinkedIn, then send a résumé selling your organic chemistry knowledge — employers like a coherent story.
- Use your LinkedIn profile to go beyond what's on your resume. By participating in discussion groups and including links to your own blog and publications, you can expand the reach of your profile.

Four. Perfect Your Intro Speech

When you are interviewing for a position, it's imperative to be prepared. Practice — out loud — your 2 or 3 sentence response to the questions, "Who are you?" and "What kind of a job are you looking for?" Describe not only what you are doing now, but where you want to go. For example, "My name is Alex James, and I am about to graduate from Big State University with a B.S. in chemistry. I especially enjoyed my undergraduate research project conducting HPLC analysis of over 50 steroid analogs, and I'm currently seeking an industrial position that will let me expand my skills in this area." If you give people enough information so they know what you're looking for, you can turn your entire network into job search agents. Just remember to return the favor (see next tip).

Five. Organize Your Contacts List

Start a database, spreadsheet, text document, Google Doc, or whatever format works for you to track all your networking contacts and job leads. Meticulously record:

- Names of people you contact
- Dates the contacts were made
- Conversation topics
- Information gleaned from the conversation
- New job leads
- Anything you might have promised to them, and the due date.

Once you have recorded this information, use these documents follow up with all available leads. This can be especially helpful when your contact Victoria suggests you call her contact James. If you documented the conversation, you can contact Victoria afterwards and let her know how conversation went, and how much you appreciate the lead.

Create another document to track jobs you have applied for, or might want to apply for. Again, keep track of how you heard about the position, who you know at that company, when you applied, which version of your résumé you sent them, and so on. When you meet someone new, you can quickly tell if you've applied to their company, and, if so, for what position.

Six. Update Your References

Keep a reference list of the names and contact information for three people who know you well and will speak well of you to potential employers. Make sure to touch base with them regularly. Updating them on your job search progress will force you to make progress, so you'll have something to tell them. You should also decide if these are still the three best people to talk about your professional skills, or if some of them should be updated.

Seven. Expand Your Contacts List

Possible sources of new contacts include:

- Current and former employers, teachers, co-workers
- Current and former classmates
- Speakers who came on campus, and other audience members at their presentations
- Fellow volunteers at science outreach activities
- Friends from social clubs, other campus activities
- Scientific recruiters

Think back through your professional history, and identify people with whom you've lost touch. Use LinkedIn and other tools to reconnect — to rebuild your relationship, not just ask for a job! Ideally, you will have an in-person conversation, and even a short phone call is better than an email exchange, but whatever they have time for is better than nothing. You can ask for ideas for possible career paths, information about organizations, and especially for introductions to other people.

Recruiters and staffing agencies can be a good way for new graduates to get a first position, because they use their professional network on your behalf. However, their primary focus is to fill the position, not to find you a job — an important distinction.

Eight. Do Your Research on Job Listing Sites

Using “chem” or “scient” will find many openings, often for jobs you’ve never heard of. Ignore the job titles, and focus on the descriptions. Learn what skills employers are looking for, and identify keywords to use in your résumé and to use in future searches. Sites to start searching include:

- *C&EN* Jobs — **chemistryjobs.acs.org**
- LinkUp — **www.linkup.com**
- Indeed — **www.indeed.com**
- LinkedIn — **www.linkedin.com**

Nine. Browse Company Web Sites

Study the web sites of companies in your local area that hire chemists. Read press releases about new areas of expansion and marketing literature about new products, and sign up for alerts about new information. Will they need people to support their new efforts? Do they sponsor lectures or outreach events where you might meet some of their employees?

Ten. Be Where the Chemists Are

Put yourself anywhere that your fellow professional chemists will be. Seminars, student chapter meetings, ACS local section meetings... even science nights at local pubs, science museums, science cafés, and so on can be great places to meet fellow scientists and learn about the job market.

Ask about career fairs — when employers come on campus to interview students. The fair may be school-wide, or focus on a specific department. If there are none at your school, check nearby schools and ask if you can attend their career fair.

Since you’re going to volunteer, why not do it strategically? Find the student chapter or local section near you (**webapps.acs.org/lslookup**), and ask to help with any of their activities, such as science fairs, tutoring, or outreach events. Volunteering with your fellow professionals showcases your passion for science and your outstanding work ethic.

Bonus: Learn a New Skill

It’s never too late to learn something new. Look at the skills required for the jobs you’re interested in, determine what you’re missing, and figure out how to get it. Suppose your dream job requires “experience collaborating on dynamic teams.” You could create a team of students to help each other study for final exams. Assign topics to individual members, arrange meeting times and locations, and find problem sets or sample tests for everyone to work on together. Not only will you be helping yourself, but you will be able to add “Organized study team of 10 students “ to your résumé.

In summary, don’t panic just because you don’t have a position lined up. There are many things you can do to make yourself more visible and attractive to employers. The key is to start now, make a plan, and continue working every day until you reach your goal. iC.

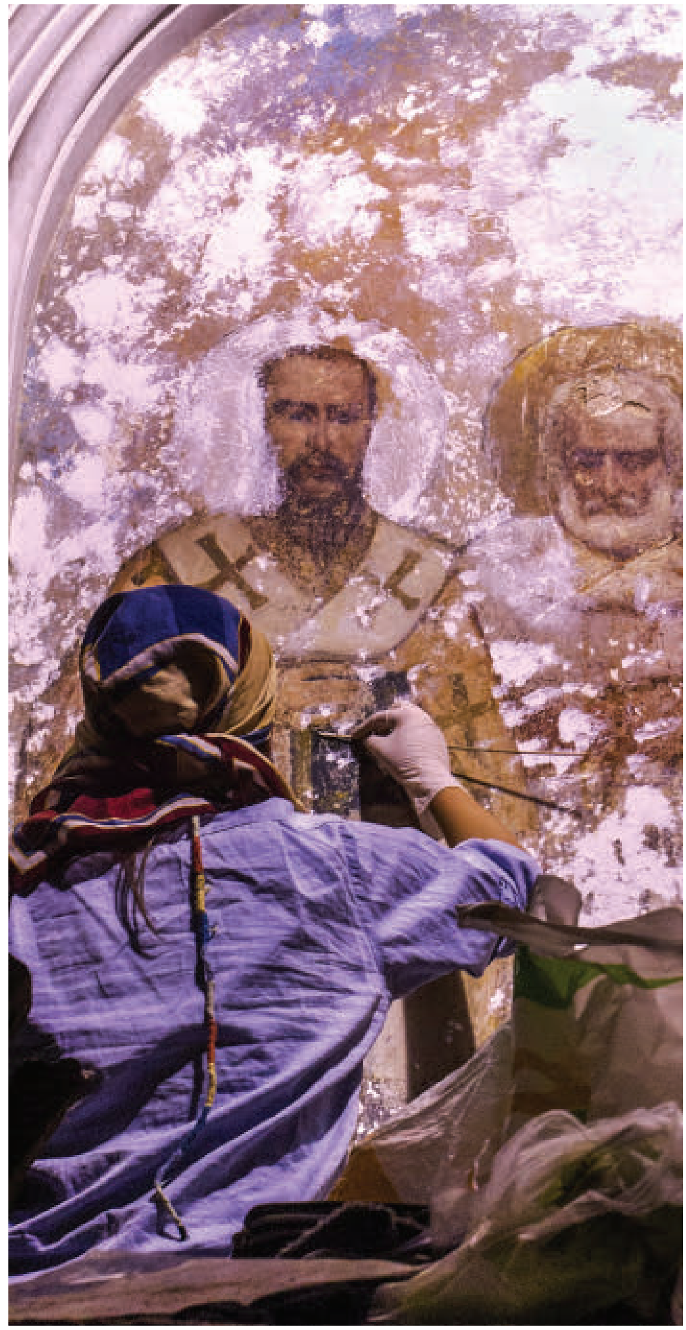
Lisa M. Balbes, *PhD, has been a freelance technical writer and editor at Balbes Consultants LLC for over 20 years. She is the author of Nontraditional Careers for Chemists: New Formulas for Chemistry Careers (Oxford University Press).*

Resources:

College to Career — www.acs.org/collegetocareer
Working in Industry — www.acs.org/content/acs/en/careers/career-services/career-pathways/industry.html
Chemists and Materials Scientists — www.bls.gov/ooh/life-physical-and-social-science/chemists-and-materials-scientists.htm
A Future in Chemistry — www.rsc.org/careers/future
Nontraditional Careers for Chemists: New Formulas in Chemistry by Lisa M. Balbes

Art Conservation

BY ACS STAFF



Art and chemistry have been linked since the day the first cave dweller smeared mineral pigments on a rock wall. Today's art conservation chemists (or, conservators) work in a variety of functions to understand, preserve, and repair all types of works of art. As part of their duties, they may document, clean, preserve, and repair works of art. Often, an analysis of the materials used in the artwork and in previous restoration efforts is necessary in order to select or custom-design a restoration method.

Conservators work with irreplaceable objects, many of them very old and fragile. They are often asked to strike a balance between restoring or repairing an object and leaving it "as is" to convey its authenticity and antiquity. Laboratory test samples are often very small, to avoid excessive damage to the object, and nondestructive testing is preferred. Laboratory instruments are sometimes adapted to accommodate very large works of art to avoid having to extract samples.

Other conservators may be responsible for authenticating works of art and other artifacts using laboratory analysis and a knowledge of the materials and methods in use during the relevant period in history.

Career path

In the past, conservators entered their field through a series of apprenticeships. Today, however, it is more common to obtain an academic degree, often at the graduate level. Internships and apprenticeships remain an important part of this education, however. Post-graduate fellowships are also valued for professional development and broadening the conservator's base of knowledge.

Conservators may start their careers at smaller local and regional establishments, and then move to larger facilities as they gain experience and build their reputations.

Future employment trends

Public interest in science, art, history, and technology will continue to spur demand for curators, museum technicians, and conservators. Because museum attendance is expected to rise over the coming decade, many museums should remain financially healthy and are expected to schedule additional building and renovation projects.

However, competition is intense for the limited number of openings in conservation graduate programs. Conservators should be willing to relocate to fill available openings. The number of museum curators who move to other occupations is relatively low, and they tend to work beyond the typical retirement age of workers in other occupations.

During recessions, museums may experience government funding cuts that limit opportunities. Demand from the private sector may offset some of these cutbacks.

U.S. employment for museum technicians and conservators is expected to rise from 11,900 to 12,700 between 2010 and 2020, an increase of 7%. That increase is about half the predicted growth of 14% for all occupations, but more than the 4% predicted for chemists in general (from 82,200 to 85,400).

Is this career a good fit for you?

Art authenticators and conservators must have good analytical and critical thinking skills, as the objects they deal with present a wide variety of unconventional challenges. They must be meticulous and patient because of the rarity and great value of the objects they deal with. They must have an avid interest in the materials and techniques typical of various periods in history, and they must keep current on advances in technology and methods. iC

Technical Skills Required

- Laboratory analysis methods and instrumentation (sometimes customization)
- Computer imaging skills
- Documentation and databases
- Knowledge of historical materials, the time periods during which they were typically used, and their compatibility with contemporary materials
- Mastery of fabrication and conservation techniques
- Materials testing methods
- Knowledge of materials aging, corrosion, weathering, and microbial degradation processes
- Knowledge of health and safety factors and government regulations
- Writing and other communications skills

Quick Facts

OPPORTUNITIES

- Competition is intense for the top museum positions. Individual research and publications are important for advancement in larger institutions.

REQUIRED EDUCATION

- A career in art conservation requires a master's degree in conservation or a closely related field and substantial work experience. Entry to the limited number of graduate programs in the U.S. is very competitive, and requires prior work experience (or an internship or apprenticeship) and an academic background in chemistry, archaeology, studio art, art history, and possibly one or more foreign languages. Graduate programs last 2 to 4 years, which includes internship training.

SALARIES

- Most conservators work full-time. The median annual wage of museum technicians and conservators was $37,310 in May 2010. The lowest 10 percent earned less than $24,440, and the top 10 percent earned more than $68,250. The median annual wage of museum technicians and conservators in the federal government was $38,790. (Median wage for all occupations was $33,840.)

PROFESSIONAL ORGANIZATIONS & INSTITUTIONS

- Smithsonian Museum Conservation Institute, Museum Support Center
- Yale University Library, Technical Art History and Conservation Research

RESOURCES

- Become a Conservator: A Guide to Conservation Education and Training

Chemists in the Real World: Eric Breitung

RESEARCH SCIENTIST
METROPOLITAN MUSEUM OF ART
PH.D., PHYSICAL ORGANIC CHEMISTRY,
UNIVERSITY OF WISCONSIN-MADISON

Eric Breitung helps art conservators preserve the priceless works of art at New York's Metropolitan Museum of Art. He studies the ways that various art materials age and degrade, and he consults with the museum's building engineers to produce an environment that helps prevent damage to everything from modern artwork made from polymers to ancient pieces made from metal.

Q: How did you find your first chemistry-related job after you graduated?

Breitung: I got my first chemistry job at General Electric's R&D center through an on-campus recruiter, and I worked there for nine years after graduate school. I did research and development of thin films and coatings, which is indirectly related to what I do now. I hadn't considered going into art, but I saw a job posting in 2007, when I was looking to relocate to New York City. I didn't have the background to get into the art museum field right away, so I took a fellowship to get that experience. Afterward, I worked full-time at the Smithsonian and the Library of Congress in Washington, DC, for about five years before receiving my current job at the Met. Doing fellowships is very common, since there are few job openings in this field.

Q: What personal talent or trait makes you a great fit for your job?

Breitung: My industrial experience at GE prepared me well on how to organize and lead projects while working collaboratively with others. I have a "jack of all trades" background, which is an asset in a field with a wide range of unresolved technical issues. I know how to run many instruments on a general level, rather than being an expert in a narrowly focused area. I use techniques as I need them.

Q: What's the best career advice you've received?

Breitung: When my physics professor said, "Go into chemistry, not physics" it got me into an area that was a much better fit to my interests.

Q: What are your primary responsibilities in your current position?

Breitung: I work on the science that helps to preserve art. I determine how artists' materials degrade, with a focus on effects due to atmospheric and physical environment. The materials I work on include nearly all modern and historic materials, from polymers to ancient metals. I consult with conservators and forensics experts, but my work is more about the analysis methods than the conservation work itself. I help conservators understand what they have, in terms of layer structures, for example, and how the layers are made. Most of my work involves organic analysis.

Q: What do you like most about your job?

Breitung: I like the ability to work with creative, thoughtful people, where my hallways are filled with beautiful objects. I also like the freedom to explore solutions to technical problems applied to art through collaborations with both academia and industry.

Q: What advice would you give students who are interested in following in your footsteps?

Breitung: Find a lab in a museum early on in your academic career and volunteer there. If the museum in your area does not have a science lab (most don't), find a scientist or other professional expert (in chemistry, physics, statistics, math, computer science, etc.) on campus who might be interested in collaborating with your local museum's conservation department or collections care manager. Essentially, get involved. Apply for internships at cultural heritage institutions (libraries, museums, archives). Archives and libraries also employ conservation scientists and some of the major institutions have paid summer internships.

You'll likely need a master's degree or Ph.D. to get a job in a museum, and you'll certainly need experience in a museum (internship, fellowship, volunteer) before you'll get that job. Chemistry professors can incorporate art conservation and related topics into their coursework, so you may be able to get involved at your local university. Spending time in a museum, archive, or library handling and working with objects is equally important. iC

Safer Demos Through Safety Data Sheets

BY BRIAN ROHRIG

THIS ARTICLE WAS ADAPTED WITH PERMISSION FROM "SAFETY DATA SHEETS: INFORMATION THAT COULD SAVE YOUR LIFE." *CHEMMATTERS*. DECEMBER 2015/JANUARY 2016, P. 5–7.

On September 15, 2014, a high school chemistry teacher in Colorado intended to demonstrate the characteristic emission spectra of metal ions with a flame test large enough for the entire classroom to watch. The different colored flames produce the so-called rainbow effect, which would certainly impress the students. Unfortunately, in this instance, four students were injured. All four suffered burns, one seriously.

Traditionally, the "Rainbow Demonstration" is performed by placing 5–7 grams of a metal chloride in a glass Petri dish and then adding 7–10 milliliters (mL) of methanol. The lights are dimmed, the mixture is ignited, and the audience observes the flame test color. But demonstrators are cautioned not to add more methanol to the Petri dish after starting the demonstration — the mistake this teacher made.

The flame quickly traveled back up into the bottle and ignited the rest of the alcohol. Pressure built up within the bottle, as the temperature of the gases produced in this chemical reaction quickly increased, and the bottle spewed a fiery stream of alcohol at a distance of 12 feet (3.6 meters), hitting a student in the chest.

In September and October 2014, a total of 22 students and two adults were injured throughout the United States in four separate incidents involving methanol used in rainbow demonstrations.

These accidents could have been prevented by using methanol's Safety Data Sheet (SDS). Formerly known as Material Safety Data Sheets (MSDS), SDSs contain a wealth of information in a simple, easy-to-read format. Each chemical has its own SDS, and learning to read them can help you handle the chemical appropriately and address any potential health hazards.

Understanding the hazards of chemicals

If you ever read the labels of chemical products, you may have noticed a lot of symbols. The use of these symbols is a direct result of recent efforts to modernize and standardize the way chemicals' potential hazards are labeled. One update is the adoption of a uniform set of pictograms developed by the United Nations, which is used throughout the world. (Take the quiz on page 23 to see if you can match these symbols with their warnings.)

An SDS meets the requirements of the Occupational Safety and Health Administration (OSHA), a U.S. federal agency created to ensure a safe work environment for all employees. OSHA mandates that all workers exposed to chemicals have the right to know about the potential hazards of these chemicals. Although OSHA regulations were developed to protect employees, state laws typically extend similar protections to students. So when you or your professor order chemicals, each chemical will come shipped with an SDS, either in written or electronic form. Having an SDS on hand for each chemical you use is not just a good idea — it's the law.

The SDS for any particular chemical is written by the supplier or manufacturer of that chemical. There is a great deal of motivation for these companies to be thorough and accurate, as any incomplete or false information could lead to serious harm by the user, not to mention a lawsuit. *(Note that an SDS does not address the possible hazards that could occur as a chemical reaction moves takes place, so it's a good idea to look up SDSs for the products and by-products of your reactions, too.)*.

Using an SDS

An SDS can seem like a flurry of cautions and warnings. Learning how to sift through the information is the key to dealing with dangers and using chemicals safely. Consider an example of an SDS for methanol.

Section 2 of the SDS is labeled "Hazards Identification." A typical listing for methanol under this section may read as shown below.

Highlights from "Section 2: Hazards Identification"

DANGER

- **Highly flammable liquid and vapor**
- **Keep away from heat, sparks, open flames, hot surfaces — No smoking**
- **Toxic if swallowed, in contact with skin or if inhaled**
- **Causes damage to organs**
- **Use only non-sparking tools**
- **Take precautionary measures against static discharge**

This section documents the highly flammable nature of methanol, It is so flammable that there is a direct warning to avoid open flames and even sparks.

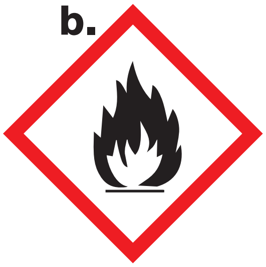
Although the label says that both the liquid and vapor are flammable, liquids themselves do not actually burn. When a liquid is ignited, it is the vapors on top of the liquid that actually burn. For a liquid to be considered flammable, it needs to evaporate so quickly that the vapors above the surface of the liquid concentrated enough to combust. If enough heat is applied, these vapors will ignite.

Even though most people know better than to pour a flammable liquid, such as methanol, onto an open flame,

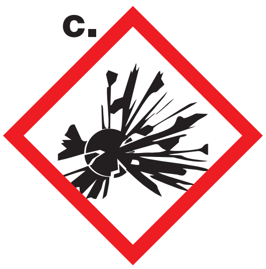
Test your knowledge

a.

b.



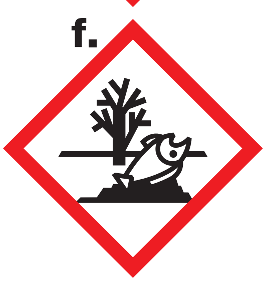
c.



d.

e.

f.



___ 1) Gases under pressure

___ 2) Explosive

___ 3) Irritant

___ 4) Acute toxicity (severe)

___ 5) Corrosive

___ 6) Oxidizer

___ 7) Environmental toxicity

___ 8) Flammable

___ 9) Carcinogen, reproductive or organ toxicity, or respiratory sensitizer

Answers can be found at the end of this article

g.

h.

i.

sometimes even trained professionals make this mistake, with disastrous consequences. Read through section 5 of the SDS below to see if you can figure out why this mistake may occur.

Highlights from “Section 5: Fire-Fighting Measures”

- **Highly flammable liquid and vapor**
- **Sealed containers exposed to excessive heat may explode**
- **Vapors may travel back to ignition source**
- **Flame may be invisible during the day**
- **Use dry chemical, CO_2, or foam to extinguish**
- **Avoid using water to extinguish — water may not cool the fire to a temperature below methanol’s flash point. Water will cause fire to spread if not contained**
- **Water and methanol mixtures still flammable at concentrations above 20% methanol**

Because methanol burns with a clear, clean flame, it is often difficult to see this flame in the daytime. As stated in the SDS, the flame may appear invisible during the day. If you are performing a demonstration where a methanol flame is produced and then the flame dies down, you might be tempted to add more, thinking that the fire has gone out. This could be a tragic mistake.

Flash point and autoignition temperature

Methanol does not have to be poured directly onto a flame to produce unintended results. On September 3, 2014, a demonstrator at a science museum in Reno, Nev., attempted to conduct a flame tornado demonstration on a rotating platform that makes a vortex composed of flames. He poured some additional methanol onto cotton balls in a dish after the flames had apparently gone out, but the cotton balls were still smoldering and instantly re-ignited when the methanol was added. The flame traveled up into the bottle (as described in the SDS), spraying the flaming liquid into the audience. Thirteen people were injured, mostly children.

How is it possible to ignite methanol without an actual flame? To answer that question, we need to look at Section 9 of the SDS for methanol (see below).

Highlights from “Section 9: Physical Data”

- **Melting point : -97.8 °C**
- **Freezing point : -97.6 °C**
- **Boiling point : 64.7 °C**
- **Flash point : 11 °C**
- **Auto-ignition temperature : 464 °C**

If you examine the data above (which is only a small portion of what is contained in the SDS for this section), you will notice the terms “flash point” and “autoignition temperature.” The flash point is the temperature at which the vapors above a liquid ignite if an outside ignition source, such as a spark or flame, comes near.

For example, if a beaker of methanol is at a temperature below its flash point, you cannot set it afire, even if you put an open flame to it. So, at 10 °C and below, methanol will not catch on fire. But once it reaches 11 °C—its flash point—you can set it on fire if you light it.

As a liquid warms, the average kinetic energy of its molecules increases. Because more molecules have enough kinetic energy to escape the attractive forces holding them together in the liquid phase, its evaporation rate increases, producing more vapor. The flash point occurs when a sufficient concentration of vapor has accumulated above the liquid, which, in combination with oxygen, will burn if ignited. Remember: only vapors burn, not liquids.

When the flash point is reached, the vapors will ignite, but the fire will not be sustained, because there is not enough vapor present to sustain combustion. This ignition is still very dangerous, as a quick burst of flame can produce severe burns, and if other combustible substances are nearby, they can also catch on fire.

A more useful value is the fire point, which is the point at which a flammable liquid will not only catch on fire if lit but will also keep burning for five seconds. The fire point is typically only a few degrees higher than the flash point.

Under most ambient conditions, methanol will be above its fire point, so when lit, it will continue to burn. Although the fire point is not included on the SDS, it is important to know how it differs from the flash point.

The autoignition temperature is the temperature at which a substance will burst into flames without an outside ignition source, such as a spark or a flame. At the auto-ignition temperature, spontaneous combustion occurs. According to the SDS for methanol, the auto ignition temperature is 464 °C. So, when the methanol was poured onto the smoldering cotton balls, if they were at a temperature above 464 °C, the methanol would instantly burst into flames on contact. Substances do not need flames to catch on fire—they only need a sufficient amount of heat along with air.

Considering the number of students who take chemistry or see chemistry demonstrations, the number of students who are involved in such accidents is relatively small, and of the accidents that occur, most are relatively minor.

The number of students injured in science labs is smaller than those injured in sports. This good safety record is due to vigilance about enforcing safety. So, the next time you do a chemistry demonstration, make sure you follow all safety protocols—use well-established procedures, make sure you and your audience are wearing googles and any other appropriate protection, and read up on all the hazards associated with your chemicals and equipment. You can find recommendations and other information for demos at **www.acs.org/safety**.

The recent incidents with methanol likely could have been avoided, had the experimenters used the information in the SDSs appropriately. Anytime chemicals are used, there are risks involved, but these risks can be minimized by understanding the chemicals involved. By keeping your demos safe, you and your audience can focus on the excitement and fun of chemistry, not the fear of injuries! iC.

In Case of a Lab Fire

If a fire occurs in a lab, it is important to know that different types of fire extinguishers are used for different types of fires. In the United States, fires are classified depending on the materials that catch fire. Methanol combustion is an example of a Class B fire. Most classroom fire extinguishers should be able to extinguish this kind of fire, but to make sure, read the label on the fire extinguisher.

- **CLASS A:** Wood, paper, cloth, trash, and other ordinary liquids
- **CLASS B:** Gasoline, oil, paint, and other flammable liquids
- **CLASS C:** Wiring, live electrical equipment, computers, and other electrical sources
- **CLASS D:** Combustible metals and combustible metal alloys

Brian Rohrig, *is a science writer who lives in Columbus, Ohio. His most recent ChemMatters article, "Eating with Your Eyes: The Chemistry of Food Colorings," appeared in the October/November 2015 issue.*

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Answers to quiz: 1.e; 2.c;, 3.g; 4.i; 5.d; 6.a; 7.f; 8.b; 9.h

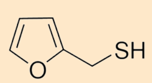
WHAT MAKES COFFEE TASTE AND SMELL DELICIOUS?

The major difference between coffee roasts comes from the chemical reactions that occur in the coffee beans at certain temperatures. These chemical reactions create, balance, and alter the beans' aromatics, acids, and other flavor components to build the characteristic flavor, acidity, aftertaste, and body of coffee.

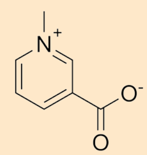
1 MAILLARD REACTION

A key reaction for the development of roasted coffee flavor and color is the Maillard reaction. In the temperature range of 150-200°C, carbonyl groups (from sugars) and amino groups in proteins react to form aroma and flavor compounds. Hundreds of coffee flavor compounds are formed from Maillard chemistry, including the potent coffee aroma flavor compound, 2-furfurylthiol.

FLAVOR COMPOUND



The roasted flavor in coffee comes from 2-furfurylthiol

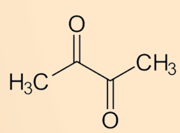


Trigonelline gives coffee that bitter taste

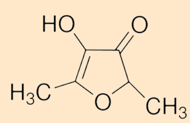
2 CARAMELIZATION

From 170–200°C the sugars in coffee start caramelizing, which browns the sugar and realeases aromatic and acidic compounds. During roasting, most of the sucrose is converted to caramelized coumpounds, but if you roast the coffee too lightly, the bitter tasting coumpounds won't degrade.

CARAMELIZED COMPOUNDS



Diacetyl gives coffee a buttery or butterscotch flavor



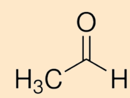
Furanones have a burnt sugar flavor.

3 FIRST CRACK

Around 205°C water inside the bean vaporizes, causing the bean to expand and crack (both physically and audibly). This first crack makes the bean double in size. Prior to the first crack, the bean changes from a green/yellow color to a light brown color. At this point, the bean loses about 5% of its weight from water loss. Light roasts are done after this step.

4 PYROLYSIS

At approximately 220°C, the heat causes a chemical change inside the bean, leading to the release of carbon dioxide. This process is called pyrolysis. The color changes to a medium brown and the bean loses 13% of its weight.

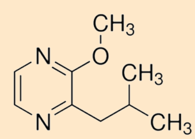


Acetaldehyde is produced during pyrolysis and has a green apple aroma

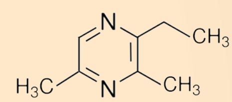
5 SECOND CRACK

Pyrolysis continues as temperatures reach 225–230°C, causing the second crack in the bean. That second crack is the cellulose in the cell wall of the bean breaking apart. The bean is now medium-dark brown in color and has an oily sheen. It's during this step where the aromatic compounds are released, contributing to coffee's classic flavor.

AROMATIC COMPOUNDS



2-isobutyl-3-methoxypyrazine gives coffee an earthy scent



2-ethyl-3,5-dimethylpyrazine adds earthy, roasted notes

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www.coffeeresearch.org/coffee//roasting.htm
www.sweetmarias.com/roast.carlstaub.html

facebook.com/acsreactions @acsreactions youtube.com/acsreactions

SPOTLIGHT

Chapter Event Highlights

PORTLAND STATE UNIVERSITY STUDENT CHAPTER

The Science of E-Cigarettes

The student chapter teamed up with the Neuroscience Club and Science Outreach Society at Portland State to host a presentation on electronic cigarettes. A behavioral neuroscientist, a biochemist, and an environmental engineer spoke about the chemistry of electronic cigarettes and the addictive properties of nicotine. Two of the speakers recently published somewhat controversial research on the vapor of e-cigarettes. iC

VALDOSTA STATE UNIVERSITY STUDENT CHAPTER

Dr. Seuss Day

With support from the ACS Community Interactions Grant, the student chapter held a Seussical Day at the South Georgia Regional Library. Demonstrations and experiments related to Dr. Seuss books were performed. Slime and non-Newtonian fluids were used to represent the Oobleck. To show how important the small thing are, kids built molecules with jelly beans representing Horton and the Who. Thing One and Thing Two were competing in Mentos racing cars. But the coolest activities were also the coldest, as dry ice and other materials were used to explain the properties and uses of cryogenics. iC

CARLOW UNIVERSITY STUDENT CHAPTER

Murder Mystery Dinner

Carlow University's ACS student chapter collaborated with the Biological Honor Society to host a murder mystery dinner. They purchased a scientific kit online, which included tests on tire marks, "blood" samples, and even the aging of maggots. iC

WAYNE STATE UNIVERSITY STUDENT CHAPTER

"For the Love of Chemistry" Symposium

Wayne State's biggest and most successful event this year, the "For the Love of Chemistry" symposium, invited students from the Detroit area and surrounding colleges to hear chemistry-career professionals to discuss why they love chemistry. The full day event included a keynote on "The Chemistry of Love" from Dr. Ariel Fenster, lunch, a chem demo competition, tours of the chemistry building, and a social event to end the day. iC

ALVERNIA UNIVERSITY STUDENT CHAPTER

Hershey Chocolate World Speaker

The chapter hosted a speaker from the chemistry lab at Hershey's Chocolate World to give a lecture on the chemistry behind making chocolate. The speaker talked about the different processes that go into making chocolate, as well as the chemical reactions that take place not only when making it, but also when eating it. iC

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