Volume 110, No. 6 June 2023

THE CHEMICAL BULLETIN

Chicago Section of the American Chemical Society Newsletter

112th Willard Gibbs Award Celebration

Wednesday, June 7, 2023 6:00–10:00 PM CDT

The Chemistry of CRISPR: From Bacterial Immunity to Genome Editing

Dr. Jennifer A. Doudna

Nobel Laureate
Professor of Chemistry
Professor of Biochemistry & Molecular Biology
Li Ka Shing Chancellor's Prof of Biomedical Science
University of California, Berkeley

ABSTRACT

Fundamental research to understand how bacteria fight viral infections uncovered the function of CRISPR-Cas programmable proteins that detect and cut specific DNA or RNA sequences. Current research to understand the mechanisms and origins of these fascinating systems will be discussed, as well as their use in clinical and microbiome applications.

IN-PERSON DINNER MEETING ONLY

Dinner and Award Address

Meridian Banquets
1701 Algonquin Rd.
Rolling Meadows, IL 60008
http://www.meridianbanquets.com
847-952-8181

$50 for in-person dinner and lecture
FREE for in-person lecture only

Registration

Contact us by phone (847-391-9091), email (chicagoacs@ameritech.net) or online:

REGISTER HERE

Deadline to register is:
Noon on Friday, June 2

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GIBBS MEETING DINNER PROGRAM

6:00–7:00 PM	Reception
7:00–8:30 PM	Dinner
8:30–8:45 PM	Gibbs Award Ceremony
8:45–9:45 PM	Gibbs Award Address

Soup: Cream of tomato basil bisque with bleu cheese

Meridian Salad

Choice of entree:

- BEEF–Roast top sirloin with rosemary merlot sauce
- SALMON–Fresh broiled Norwegian salmon with dill sauce
- VEGETARIAN–Portobello mushroom with zucchini

Dessert: Hot fudge brownie à la mode

$50 for in-person dinner and lecture

FREE for in-person lecture only

For history about the Willard Gibbs Award and a list of previous award winners, please visit https://chicagoacs.org/Willard_Gibbs_Award.

CITATION

- For expertise in the structure and function of RNA leading to the discovery of CRISPR-Cas9 and its underlying mechanism.
- For initiating a watershed moment in scientific research making possible the accurate enzymatic splicing of DNA and the targeted genomic editing of cells, tissues and whole organisms.
- For creating an accessible technology with potential impacts in agriculture, biotechnology, and medicine, including the "green" manufacture of biofuels and biomaterials.

BIOGRAPHY

Jennifer A. Doudna holds the Li Ka Shing Chancellor's Chair and is a Professor in the Departments of Chemistry and of Molecular and Cell Biology at the University of California, Berkeley. Her groundbreaking development of CRISPR-Cas9 as a genome-engineering technology, with collaborator Emmanuelle Charpentier, earned the two the 2020 Nobel Prize in Chemistry and forever changed the course of human and agricultural genomics research.

This powerful technology enables scientists to change DNA—the code of life—with a precision only dreamed of just a few years ago. Labs worldwide have redirected the course of their research programs to incorporate this new tool, creating a CRISPR revolution with huge implications across biology and medicine.

In addition to her scientific achievements, Doudna is a leader in public discussion of the ethical implications of genome editing for human biology and societies, and advocates for thoughtful approaches to the development of policies around the safe use of CRISPR technology.

Doudna is an investigator with the Howard Hughes Medical Institute, senior investigator at Gladstone Institutes, and the founder of the Innovative Genomics Institute. She cofounded and serves on the advisory panel of several companies that use CRISPR technology in unique ways.

She is a member of the National Academy of Sciences, the National Academy of Medicine, the National Academy of Inventors, and the American Academy of Arts and Sciences. Doudna is also a Foreign Member of the Royal Society, a member of the Pontifical Academy of Sciences, and has received numerous other honors including the Breakthrough Prize in Life Sciences (2015), the Japan Prize (2016), Kavli Prize (2018), the LUI Che Woo Welfare Betterment Prize (2019), and the Wolf Prize in Medicine (2020). Doudna's work led TIME to recognize her as one of the "100 Most Influential People" in 2015 and a runner-up for "Person of the Year" in 2016. She is the coauthor of *A Crack in Creation*, a personal account of her research and the societal and ethical implications of gene editing.

LETTER FROM THE CHAIR

Chicago Section Demographics

The Chicago Section is continually renewing its membership, as is true (and essential) for many organizations. This is especially important for a geographical sector like the greater Chicagoland area that includes many colleges and universities. A quick look at our current demographic data, which is sent monthly by the National ACS office, reveals that 50% of Chicago Section members have five or fewer years of service in the American Chemical Society. Some of these individuals have completed the volunteer interest checklist on our website, while others contacted committee chairpersons directly or volunteered at the Fall 2022 National Meeting or other outreach events. I am grateful that our newer and younger members are choosing to get involved—we need your energy, ideas, creativity, and drive!

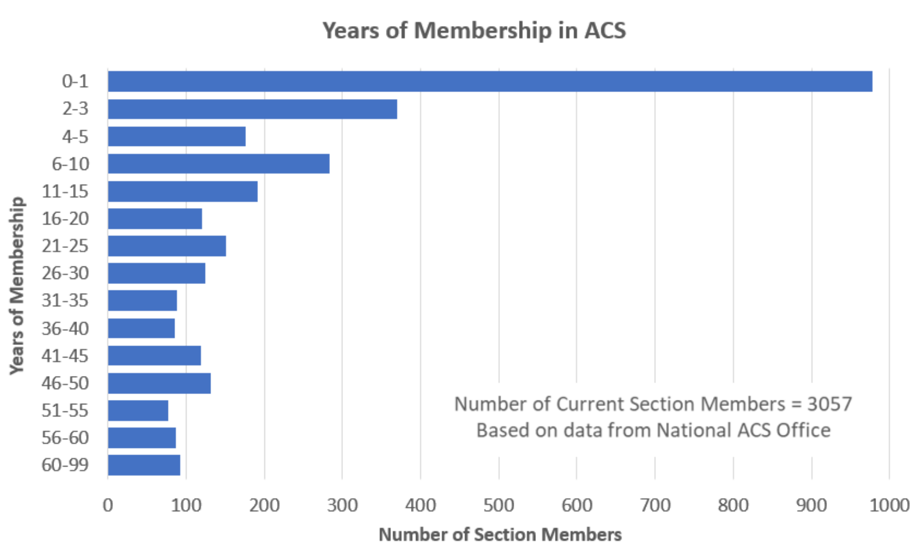
Another cohort of our local section includes individuals celebrating significant membership anniversaries, as listed in the May issue of *The Chemical Bulletin*. It was a pleasure to receive responses from some of our 50-, 60- and 70-year members after individual email invitations were sent to them to celebrate their anniversaries in May. We are proud of your accomplishments and service to the chemical enterprise over a half-century or more! Here are a few of the insights they shared.

Mike Avram, a 50-year member, reminisced: "When I was a graduate student in pharmacology in the '70s I wanted something more than I was getting in the pharmacology program, so I took courses in the hot new analytical chemistry tools of high-performance liquid chromatography and quantitative mass spectrometry offered by the Chicago section. I remember clearly that Milt Levenberg, long active in the Chicago ACS and then at Abbott, taught the MS course. Much of the research I have conducted has depended on the application of these analytical tools, which are now at the heart of the services offered by the Clinical Pharmacology Core at Northwestern. I shall be forever grateful."

Alan Carlson wrote, "I joined ACS 70 years ago while at my first job as a chemist in the former Standard Oil Company Research Lab in Whiting, Indiana. For most of my career, until retirement, I enjoyed my position as faculty member in the Chemistry Department at Purdue University Calumet (Hammond, Indiana). It is an honor to be recognized for my 70 years as a member of ACS."

Another 70-year member wrote, "Thanks for the invitation, but I am not leaving the house much these days. If there is a video of the event, I'd love to watch from home. I've enjoyed my career and appreciate the ACS for your support."

Certificates for "longevity" were presented at the May 19th monthly dinner program meeting. It was an honor to spend some time with these valued section members.—MARGARET SCHOTT



FROM THE EDITORS' DESK

Celebrating a Tradition of Service

Communicating the value of ACS membership to Chicago Section members and the public is vital to the section's success. Our monthly newsletter publication, *The Chemical Bulletin,* has been the principal communication tool for 110 years, and it has undergone many changes and adaptations in that time.

A selection of *Bulletin* mastheads

The commitment to serve has never changed, however, and the importance of the *Bulletin* has only increased as the section has grown and become more diverse and dispersed.

As editors for the past two years, we have endeavored to publish a variety of news articles, announcements, promotional flyers, and special features to ensure timely promulgation of section activities and encourage member participation. Our overarching goal has been to provide a vibrant and welcoming community for members to share their commitment to the core values of the American Chemical Society.


Chicago ACS celebrating the 2022 Willard Gibbs medalist, Joseph S. Francisco.

The Chemical Bulletin has a rich history, and we encourage all Chicago Section members to add to this legacy in the future by contributing news and information, as well as personal insights based on their passion for the chemistry profession. We are stronger together, and together we can effect positive change for the Society and society!

Chicago ACS volunteers making a difference together at an outreach activity at Navy Pier in 2021.

This issue marks the last issue of the *Bulletin* before our annual summer hiatus in July and August. Beginning in September the Chicago Section will transition to a new editorial team. We pledge our assistance to make the transition as smooth as possible and wish the new team great success and personal fulfillment as they shape a new legacy. Editing the *Bulletin* has been an honor and a privilege, and we have greatly enjoyed the journey together with so many of you!

In recognition of the ways the past, present, and future combine to define who we are, as both individuals and a local ACS section, we dedicate this issue of *The Chemical Bulletin* to the thousands of Chicago Section members who have contributed to the practice of chemistry in the area for more than 110 years. Thank you, and enjoy the summer!

We thank our contributors who made this newsletter special during our tenure: Amy Balija, Aistė Baumhardt, Paul Brandt, Mark Cesa, David Crumrine, Helen Dickinson, Ken Fivizzani, Herb Golinkin, Russ Johnson, Michael Koehler, Russ Kohnken, Fran Kravitz, Josh Kurutz, Margy Levenberg, Milt Levenberg, Tim Marin, Raelynn Miller, Michael Morello, Jason Romero, Sherri Rukes, Margaret Schott, James Seale, Susan Shih, and Andrea Twiss-Brooks.
—AMBER ARZADON AND IRENE CESA

EDUCATION

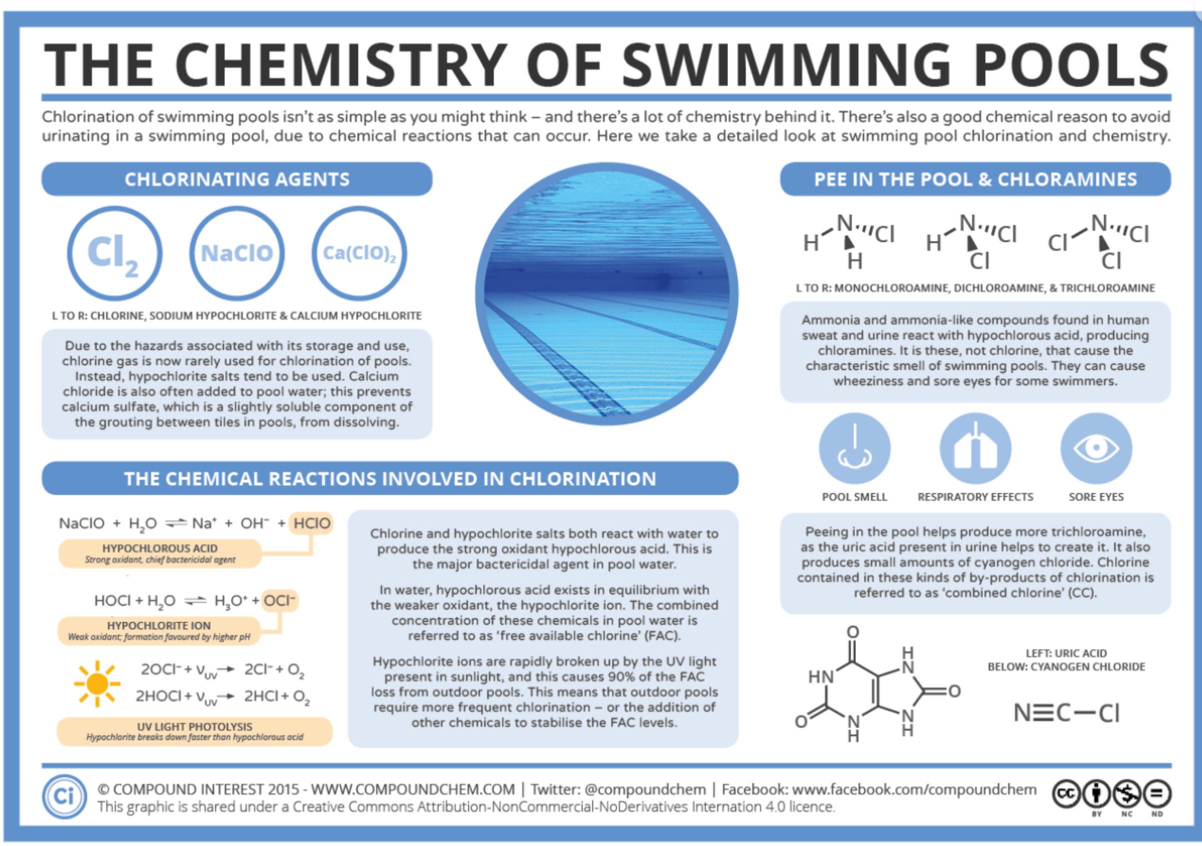
Artificial Intelligence in the Chemistry Classroom

Open artificial intelligence (AI) platforms such as ChatGPT are raising many questions and generating a great deal of discussion today, particularly in my profession of teaching. These discussions got me thinking about the potential impact of AI on education. Many educators are concerned that students will just use AI to write their five-page essays with little effort. Other teachers note, however, that students already use study help sites like Chegg to do this.

AI is far more sophisticated than Chegg (and it's free), and the current controversy reminded me of when teachers first began incorporating calculators into teaching and assessment. Teachers used this "new technology" to help students think about more sophisticated aspects of math beyond simple arithmetic. Graphing calculators allowed students to visually convert equations into lines and curves. Calculators, of course, are a mainstay in math education today, and overall this has not been a bad thing for education.

It is clear to me that how we do things will forever evolve and change, and I'm not just speaking about how the education field works. How will industry use new artificial intelligence tools? Will AI be an idea generator for them? Can it be used for data analysis? Do you envision AI designing new molecules or aiding in their syntheses? Or will the professional world spurn AI out of fear of the loss of intellectual property? If industry begins to use AI, then surely academia will follow that lead. But how can we get students to use it the way that industry will find beneficial, and how can we make sure that students will use AI responsibly in a way that will carry over into students' professional careers? If you have thoughts on this subject, please send them to editor@chicagoacs.org.

—PAUL BRANDT



Get ready for summer by learning about "The chemistry of swimming pools" by Andy Brunning/Compound Interest. https://www.compoundchem.com/2015/08/12/swimming-pools/

PFAS Regulations

The prevalence of PFAS (per- and polyfluoroalkyl substances) in the environment seems to be matched only by their recent prevalence in the news. It's hard to go a week without reading about these toxic contaminants, and **Safety First!** is no exception. Last month we discussed two prominent local PFAS stories: the high concentration of these contaminants detected in Great Lakes fish, and an innovative method to break down certain PFAS discovered recently in a lab at Northwestern University.

But the battle against PFAS does not, of course, belong only to the scientists. Regulatory agencies across the states have long had these contaminants in their crosshairs. In March, the EPA proposed new federal limits on the levels of six specific PFAS in drinking water. These regulations would require all public water systems to monitor for the targeted PFAS and notify the public when their concentrations exceed specified limits (https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas).

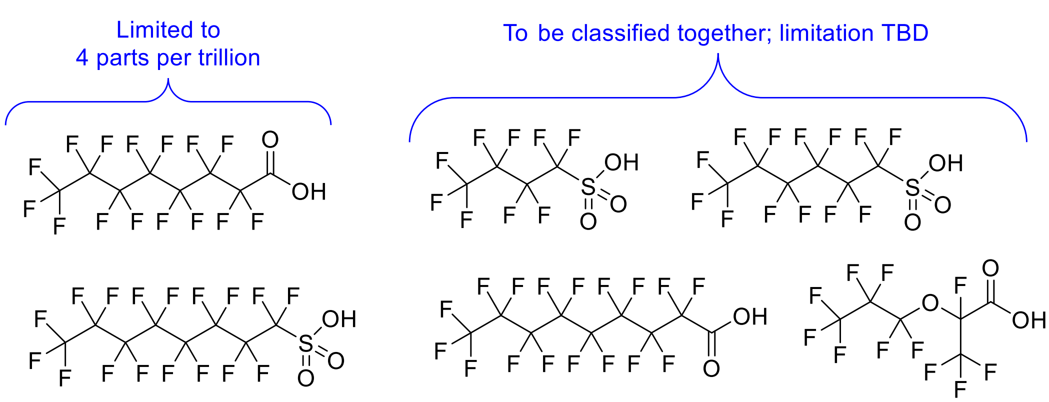
Two notorious PFAS are targeted in the proposed EPA regulations: perfluorooctanoic acid and perfluorooctanesulfonic acid. Their concentrations would be limited to a maximum of 4 parts per trillion each. Note that these concentration limits do not mean these amounts are necessarily safe. Rather, the limits represent the lowest concentrations at which these compounds can currently be detected with accuracy (https://www.washingtonpost.com/climate-environment/2023/03/14/epa-drinking-water-regulations-pfas/). In the EPA's proposal, four other PFAS will be regulated together, based on an estimation of the hazard posed by those species in a mixture.

A final ruling on the proposed EPA regulation for PFAS is anticipated at the end of 2023. This is not the first regulation of PFAS in the US: multiple states have enacted legislation limiting or banning the addition of PFAS to various consumer products, from carpets to cosmetics (https://www.morganlewis.com/pubs/2023/04/exploring-the-universe-of-pfas-regulation-and-litigation). These represent preventive measures, as compared to the EPA's broad curative approach.

The regulation race is also not limited to the US. The European Union (EU) is considering an outright ban on thousands of PFAS (https://cen.acs.org/environment/persistent-pollutants/EU-proposal-ban-10000-PFAS/101/i6). Such a categorical ban comes with many complications and caveats, however. PFAS used in essential applications such as in medical devices, which currently have no feasible substitute, may be granted multiyear ban exemptions. The complexity of PFAS regulations will thus reflect our far-reaching reliance on these toxic substances.

The European proposal is being championed by five countries—Germany, Denmark, the Netherlands, Sweden, and Norway—and, if enacted, would apply to the entire EU. A decision is expected in 2025, for implementation in 2026. At a press briefing, a spokesperson for the Norwegian environmental protection agency highlighted the global reach of the PFAS problem: "You can find PFAS in penguins in the Antarctic, in polar bears in the arctic, and in the rainwater of Tibet." (https://www.reuters.com/markets/commodities/eu-considers-ban-forever-chemicals-urges-search-alternatives-2023-02-07/)

—JAMES SEALE



Perfluorooctanoic acid and perfluorooctanesulfonic acid (shown left) would be limited to 4 ppt in drinking water by the new regulations. The proposed concentration limit for mixtures of the four other targeted PFAS (perfluorobutanesulfonic acid, perfluorononanoic acid, perfluorohexanesulfonic acid, and hexafluoropropylene oxide dimer acid) have not yet been set.

More Fun with Baking Soda and Vinegar

In my own little experiment, I explored what Open AI (artificial intelligence) might generate in response to the prompt for a "safe chemical demonstration that can be done at home." Many of the initial ChatGPT responses were for activities that have previously appeared in ChemShorts for Kids!

The activity described below using baking soda and vinegar is based on the third or fourth idea generated. Although similar experiments are quite well known, this activity is suitable for a more quantitative approach, if desired (see the Extensions). **Please note however, that the original AI "procedure" has been modified in two very important ways.** First, and crucially from a safety standpoint, the AI response featured an absurd ratio of baking soda and vinegar. Secondly, the AI version had the chemicals added in the reverse order. Like all ChemShorts for Kids activities, **the procedure shown below has been tested to ensure that it is safe and effective.**

Materials

Baking soda, 1 tbsp.
Balloon
Measuring cup
Plastic water bottle, empty
Tablespoon (measuring spoon)
Vinegar, 1 cup
Optional: Funnel

Be Safe

If you get vinegar on a cut or sore, it will sting. Be careful not to get vinegar in your eyes. Do not inhale the gas produced. Adult supervision is recommended.

Experiment

Pour 1 cup of vinegar into the empty bottle. Using a funnel if available, add a tablespoon of baking soda into the balloon. Without tipping the balloon, stretch the opening of the balloon to fit over the opening of the bottle. When you are ready to observe, tip the balloon upside down so its contents will pour into the bottle containing the vinegar. Observe.

What's happening?

You should have seen bubbles come from the reaction immediately. The bubbles are a gas called carbon dioxide and the reaction that takes place is an acid (vinegar, $HC_2H_3O_2$) reacting with a base (baking soda, $NaHCO_3$) to form sodium acetate ($NaC_2H_3O_2$) and carbonic acid (H_2CO_3).

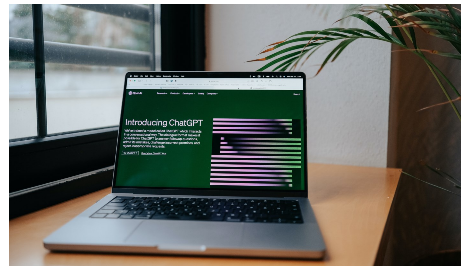


Photo credit: https://www.pexels.com/photo/open-laptop-on-desk-16037283/

Carbonic acid immediately breaks down into carbon dioxide (CO_2) and water (H_2O).

$$HC_2H_3O_2 + NaHCO_3 \rightarrow H_2O + CO_2 + NaC_2H_3O_2$$

CO_2 is a gas that causes the balloon to inflate. The quantities of reactants (baking soda and vinegar) used are about equal in terms of **how many molecules of each** are present. (Molecules are very tiny: there's actually about 1.2×10^{23} molecules of each reactant.) That also means we generated about 1.2×10^{23} molecules of CO_2 gas. Because gas molecules take up so much more space (volume) than liquids and solids, the balloon expands and inflates to contain all of those molecules of CO_2 gas.

Extensions

Try doubling or halving the amount of baking soda to see what effect that has on the size of the inflated balloon. Another semi-quantitative modification would be to run the reaction at different temperatures. Other possible variations include adding an acid/base indicator (red cabbage juice), to make it more colorful, and exploring other household acids and bases, such as lemon juice, baking powder, washing soda, etc.

Using ChatGPT

The ChatGPT responses were **generally** suitable for children to perform at home. The quantities suggested for this particular activity were NOT realistic however! If you want to use AI for idea-generating purposes, ALWAYS search online for a documented, tested procedure, and independently VERIFY all safety considerations before doing any activity.

References

https://teachbesideme.com/amazing-self-inflating-balloon/

To view all past "ChemShorts for Kids" articles, go to: https://chicagoacs.org/ChemShorts

—PAUL BRANDT

AMERICAN CHEMICAL SOCIETY
Chicago Local Section

NEEDS YOU

WE COULD USE NEW MEMBERS ON THE FOLLOWING COMMITTEES:

Communications
Office
Audio/Visual
Program
Outreach
Women Chemists Committee

The Chicago ACS is seeking volunteers.
Meet new people and build networks!
Learn new skills!
Have fun working with others!

Visit us at https://chicagoacs.org
for more information or to volunteer

UPCOMING EVENTS

June 7	112th Willard Gibbs Award Celebration (In-person meeting)
June 8	Chicago Board of Directors Meeting
June 20	Central Regional Meeting (CERM) Dearbon, MI
June 23	WCC Seminar, "What to Expect When Expecting in the Lab"
June 27	27th Annual Green Chemistry & Engineering Conference
August 3	Chicago Board of Directors Meeting
August 10	Articles due for the September 2023 *Bulletin* issue

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