Volume 110, No. 4 April 2023

THE CHEMICAL BULLETIN

Chicago Section of the American Chemical Society Newsletter

April Virtual Monthly Meeting

Friday, April 21, 2023 7:00–8:15 PM CDT

Stimuli-Responsive and Biohybrid Materials

Dr. Alshakim Nelson

Professor of Chemistry
University of Washington

ABSTRACT

The Nelson Laboratory develops stimuli-responsive materials and biohybrid materials that are compatible with additive manufacturing (AM, or 3D printing) processes. We utilize synthetic polymer chemistry and supramolecular chemistry to control macromolecular architecture and composition, which govern the viscoelastic properties of polymeric materials. We particularly focus on developing materials for AM that can impact applications in the life sciences. As an interdisciplinary team of researchers, we have a broad set of skills that include polymer synthesis, microbial culture, and 3D printing. The team has developed a bioreactor that not only keeps bugs alive and active for months at a time, but can also be made in minutes, using low-cost chemicals and a 3D printer. Another example is a hydrogel platform that enables on-demand production of medicines and chemicals, thus alleviating the need for refrigeration. The group has also embedded yeast inside 3D-printed hydrogel cubes for use in beer fermentation.

MEETING PROGRAM

7:00–7:10 PM	Announcements Peggy Schott, Chair
7:10–8:00 PM	Presentation Dr. Alshakim Nelson
8:00–8:15 PM	Q&A

REGISTRATION

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

REGISTER HERE

Deadline to register is
Friday, April 21 at 8 PM

IN THIS ISSUE

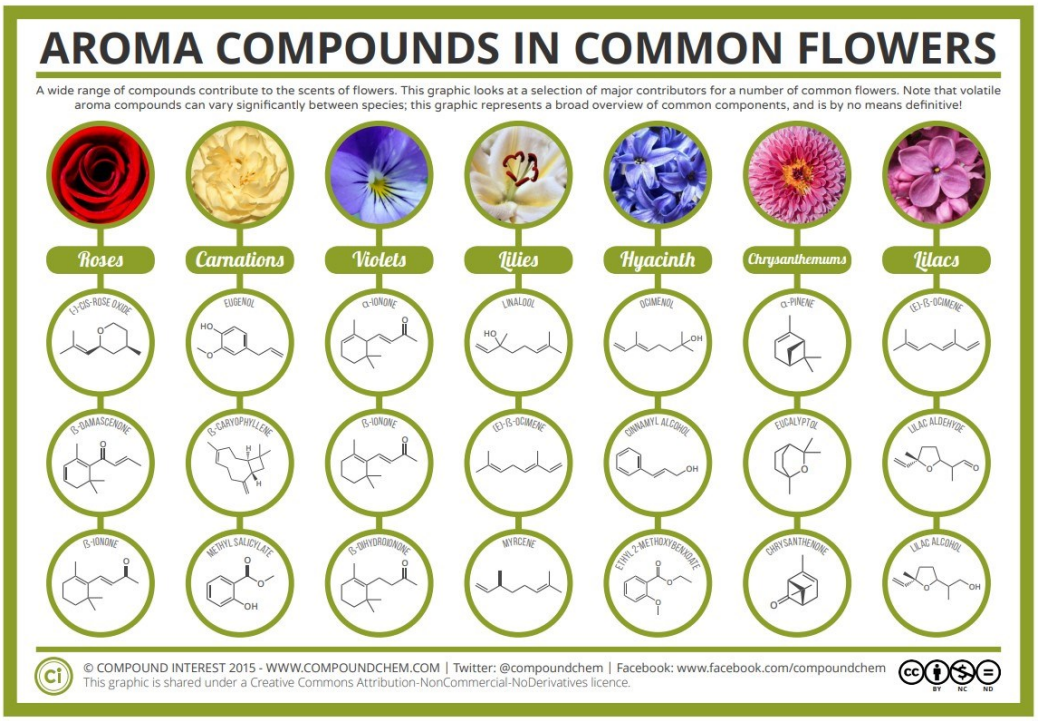
MEET THE SPEAKER

Alshakim Nelson received his Ph.D. in organic chemistry from the University of California, Los Angeles in 2004, where he worked with Sir J. Fraser Stoddart on carbohydrate-containing polymers and macrocycles. Dr. Nelson was next an NIH postdoctoral fellow at the California Institute of Technology working for Professor Robert Grubbs on olefin metathesis catalysts for the formation of supramolecular ensembles. In 2005, Dr. Nelson joined IBM Almaden Research Center as a Research Staff Member, where he focused on the synthesis of nanomaterial building blocks that enabled large-area nanomanufacturing via self-assembly. He joined the faculty at the University of Washington in 2015, leading an interdisciplinary research group focused on the synthesis, characterization, and processing of stimuli-responsive materials for 3D printing. These materials are centered around applications in medicine, soft robotics, sensors, and sustainability. Prof. Nelson's honors and awards include recognition as an IBM Master Inventor, ACS PMSE Young Investigator, Kavli Foundation Fellow, NSF CAREER award, and 3M Non-Tenured Faculty Award.

FROM THE EDITORS' DESK

Spring Is in the Air

Spring has arrived and gardens will soon be brimming with color. Have you ever wondered how flowers get their wonderful fragrance? Andy Brunning at Compound Interest created a graphic elucidating the aroma chemistry behind some common flowers. As we begin to stop and smell the roses, also take a moment to appreciate our amazing contributors: Paul Brandt, Helen Dickinson, Ken Fivizzani, Josh Kurutz, Sherri Rukes, Margaret Schott, and James Seale.—AMBER ARZADON AND IRENE CESA



"Aroma Compounds in Common Flowers" by Andy Brunning/Compound Interest.
https://www.compoundchem.com/2015/02/12/flowers/

LETTER FROM THE CHAIR

The Power of Ten

Do you recall watching *The Powers of Ten* film by Ray and Charles Eames? The 1977 film, based on the book *Cosmic View: The Universe in 40 Jumps*, was screened in science classrooms across America, taking students on a voyage that spanned 40 orders of magnitude, from the astronomical to the infinitesimal.

Beginning with a picnic scene on the Chicago lakefront, the Eames' audiovisual tour engages our imagination as we suddenly find ourselves zooming upward on a journey deep into space. We experience the camera moving ten times farther away every ten seconds until it reaches the edge of the known universe. Then the journey reverses, as the camera focuses on smaller and smaller length scales until we are inside a single atom.

By considering the vast powers-of-ten realities in our universe we are drawn to ponder the interrelatedness of all things. The film's subtitle is apt: "A Film Dealing with the Relative Size of Things in the Universe and the Effect of Adding Another Zero."

Why dust off this memory? Because the powers of ten have just been officially expanded! In December 2022, the Bureau International des Poids et Mesures (BIPM; International Committee for Weights and Measures) introduced four new prefixes for SI units.*

Multiplying Factor	Name	Symbol
10^{27}	ronna	R
10^{-27}	ronto	r
10^{30}	quetta	Q
10^{-30}	quecto	q

The new prefixes are ronna (R) and ronto (r), followed by quetta (Q) and quecto (q). The abbreviations use letters not previously assigned for SI prefixes, in reverse alphabetical order. The R/r and Q/q prefixes expand the previous set, which "only" went from 10^{24} down to 10^{-24}. As with all SI prefixes, the new ones pertain to measurements of length, mass, time, electric current, thermodynamic temperature, amount of a substance, and luminous intensity.

* SI stands for Système International d'Unités (International System of Units)

According to BIPM, the naming of these multiplying factors is necessary as the amount of digital information grows. (It is estimated that all the world's data will total about 175 zettabytes by 2025.) SI prefixes facilitate the sharing of technical information around the globe and across disciplines. They are also convenient for expressing values of quantities on a "human scale" between, say, 1 and 100, while avoiding the need to use factors of 10. Take, for example, the Andromeda Galaxy, which is 2.4×10^{22} meters distant from Earth. Using an SI prefix, the same distance can be expressed as 24 zettameters. It feels closer already!

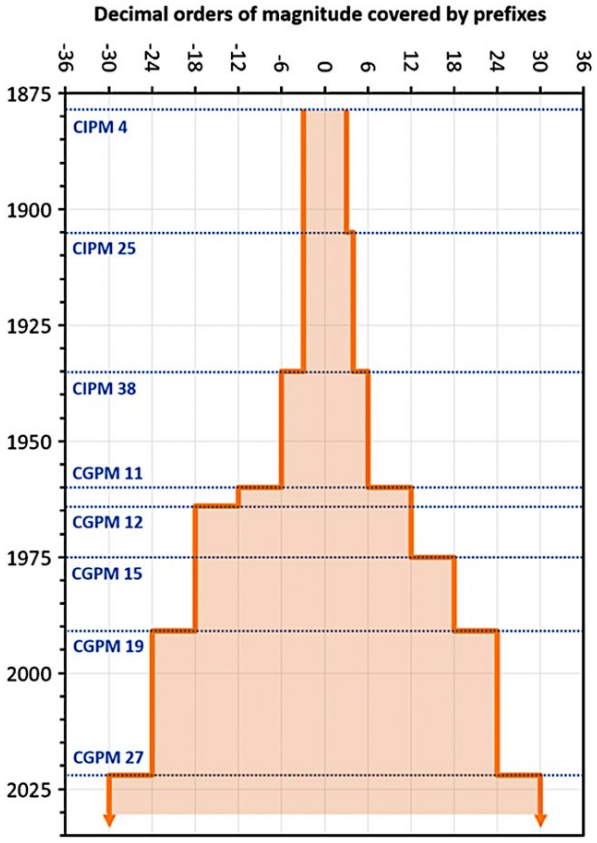
Further Reading

https://www.eamesoffice.com/works/films/

Richard J C Brown, A further short history of the SI prefixes. *Metrologia*, 2023, 60, 013001 (online) SI-prefix-history

The Films of Charles and Ray Eames: A Universal Sense of Expectation. Eric Schuldenfrei, Routledge (2014). Accessed via Google books.

—MARGARET SCHOTT



The set of SI prefixes has been evolving since 1875. CIPM and CGPM refer to committees and conferences.

PAST MEETING

Promoting Good Science on TV or in the Movies

Our March Program Meeting took place on Thursday, March 16, at the Volunteer Resource Center located at Caldwell Woods (part of the Forest Preserves of Cook County). The venue was selected to entice a diverse audience to our meeting. It succeeded in this regard, as a very large number of students attended, including international students who hailed from countries as far away as Thailand, Algeria, and Australia.

The speaker that evening was Prof. Donna Nelson from the University of Oklahoma, who served as ACS President in 2016. Unfortunately, inclement weather resulted in the cancellation of the speaker's flight arrangements, and the in-person presentation was switched to a Zoom event. Special thanks to the audiovisual team, led by Milt Levenberg and Nicolas Gerst, who quickly pivoted that night to be able to welcome Donna virtually.

Donna Nelson spoke about her experiences working as a science advisor to the award-winning television series *Breaking Bad*. In this role, she was motivated by one overarching consideration—to present and promote sound science to the public. The director of the show wanted to ensure that everything the actors said or did on set, from chemical structures shown on the blackboard to the yields obtained in chemical synthesis, were accurate to the best of their ability.

Despite technical difficulties due to the pivot from a live presentation to the Zoom format, the presentation was engaging. The attendees especially enjoyed the video clips that accompanied the anecdotes and stories that the speaker used to illustrate not only her role on the show but also her motivation. It was clear that Donna Nelson saw everything she did as a continuation of her service as a chemistry educator. Like our guests that evening, her students really were from all over the world, as *Breaking Bad* was hugely popular in many countries.

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FOR MORE INFORMATION
https://chicagoacs.org/meetinginfo.php?id=192&ts=1677477484

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The Curious Chemistry of

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April 16-22, 2023

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Stories	Activities
Algae are Elemental	Transforming Gels
Edible Algae	Know by the Glow
A Bright Glow from Tiny Creatures	Algae Across the Ages

CHEMICAL EDUCATION

Bringing Educators Together at ChemEd

ChemEd, a biennial chemical education conference, is the largest North American conference for high school chemistry educators. The gathering, which celebrates its 50th anniversary this year, is held at colleges and universities across Canada and the United States in alternate cycles. ChemEd 2023 will take place July 23–27 at the University of Guelph in Ontario, Canada.

Two special aspects of ChemEd have made it a must-have destination for chemistry educators for half a century. The first is that at ChemEd, chemistry is a verb! Teachers don't just sit around and talk about chemistry. They do chemistry! Lots of it! Demonstrations, experiments, and make-and-take workshops are a defining feature of ChemEd. The second defining characteristic of ChemEd is the people and the camaraderie it inspires. The conference provides abundant formal and informal opportunities for teachers to share stories, experiences, and inspiration. Teachers form friendships that last a lifetime!

The most recent in-person, pre-pandemic ChemEd gathering was held at North Central College (NCC) in Naperville in the summer of 2019. ChemEd 2019 was chaired by Sue Bober of Schaumburg High School and Paul Brandt of North Central College. Sue and Paul are shown here on the NCC track next to the world's largest periodic table cake, which was shared by the 750 conference attendees.

Grant for ChemWest members! North Central College/ChemEd2019 is looking to "pay it forward" by supporting ChemWest members to attend this wonderful opportunity! Fill out this form if you'd like to apply for a $250 grant ($500 if 2023 will be your first ChemEd attendance)! Contact Paul Brandt (pfbrandt@noctrl.edu) for more information.

Scan the QR code to obtain more information, register, and sign up for ChemEd 2023 email updates.

CALL FOR ACTION

Scientists Helping Ukraine

The Section recently received the following communication from Zafra Lerman that we would like to pass on to our members.

Dear Chicago ACS Section Members,

I'm a member of the Board of International Counselors of the National Research Foundation of Ukraine (NRFU), their young NSF. One of my board's prime duties is to help NRFU expand its pool of international reviewers for their proposals, which are in all areas of fundamental research (including humanities). Currently, they have only 1,000 foreign reviewers and at least need to double them.

We envision an initiative in which professional societies, both US and other, can publish simple notices in their journals calling on scientists to register with NRFU as reviewers. It's very easy: see Evaluation of Applications. It's also a very easy way for scientists who want to do something for Ukraine to help out in a very meaningful way.

Zafra M. Lerman, Ph.D., FRSC
Distinguished Professor of Science and Public Policy (Emerita)
Columbia College Chicago
President, Malta Conferences Foundation

Safety Data Sheets Are Insufficient

When planning to use an unfamiliar chemical, many chemists look to a Safety Data Sheet (SDS) as the first port of call. During my lab training in the UK, referring to the SDS was protocol, with a list of SDS-derived hazards to be compiled and signed-off by a senior colleague before any chemical reaction was attempted. Ideally, such an exalted safety document would prepare a person for all hazards associated with a chemical.

The reality, though, is that while SDSs were created for the purpose of hazard communication, they also serve as legal protection for the chemical manufacturer. Derek Lowe has written a couple of great blog posts illustrating this point (here: https://www.science.org/content/blog-post/un-safety-data-sheets, and here: https://www.science.org/content/blog-post/uselessness-msds), highlighting the often redundant, overly cautious, and sometimes insufficiently informative nature of these supposed safety aids. He points out that the SDS for sand lists it as a carcinogen that must be handled in the fume hood. In the spirit of Derek's posts, here are some safety statements taken from the SDS for a common organic substance that may well be coursing through your veins right now:

Signal word: Warning. Harmful if swallowed.
Acute toxicity, Oral (Category 4), H302.
Short-term (acute) aquatic hazard (Category 3), H402.

Seems bad, right? It's caffeine (https://www.sigmaaldrich.com/US/en/sds/sial/c0750).

One of the obvious issues here is the lack of quantification or context in the hazard statement. Caffeine is described as "harmful if swallowed" which, for large amounts, is certainly true. But the same might be said for an apple, given that it may be swallowed whole by an uninformed eater. To understand the toxicity in context, you have to know the criteria for assigning it, which are based on its LD_{50} values. Those are found (buried?) further down in Section 11 of the SDS, under Toxicological Information.

Another issue is the use of nonintuitive categories. Any person, seeing statements such as "Category 4" oral toxicity and "Category 3" aquatic hazard, may assume these warnings to be at the more severe end of the scale. In fact, these categories run in a counterintuitive DEFCON-like reverse order, where Category 1 is most severe, and Category 5, the least. (See https://www.epa.gov/sites/default/files/2015-09/documents/ghscriteria-summary.pdf.) For another hazard type, "serious eye damage/eye irritation", the categories are, for some reason, changed to 1/2A/2B. In this and other ways, SDSs may defeat clarity and common sense. This leads to the risk that researchers become desensitized to the actual, very specific hazards and risks of chemicals. As a first step in combating this risk, it's vital that chemists learn about the hazard classifications and language used on SDSs.

What's the solution?

In last month's **Safety First!** report, we highlighted the dangers associated with the reagent sodium azide. Alarmingly, some of its hazards, such as the danger of combining it with the common solvent dichloromethane, are not covered in the SDS. Other key hazards, such as toxicity when combined with acid, are easily missed in the sea of technical information provided (10 pages in this SDS, reminiscent of the long Terms of Service we ritually skip in everyday life).

The best practice is to consult standard operating procedures (SOPs) in tandem with the SDS. A good SOP is a condensed version of an SDS combined with common-sense practical guidance. Many SOPs are available from research safety offices and are also readily available from reputable online sources, such as universities or national laboratories. SOPs tend to be shorter and clearer than SDSs (Yale's for sodium azide is three pages https://ehs.yale.edu/sites/default/files/files/sodium-azide-sop.pdf) and, critically, designed for the purpose of practical safety first and foremost.

—JAMES SEALE

If an SOP isn't available, the best reference for the reactivity of chemicals is Bretherick's Handbook of Reactive Chemical Hazards. Also, explore PubChem, a public chemical database maintained by the National Institutes of Health with chemical information collected from hundreds of data sources. The ACS has a great video tutorial on the subject.

*DEFCON is an acronym for Defense Ready Condition, which the US armed forces use to describe levels of alert.

Using Social Media to Promote Inquiry and CER*

As a teacher I sometimes feel that I am competing with social media, even in my own classroom. Have you ever set up an activity, only to have students say that they have already seen it on Instagram or TikTok? What to do? One approach is to have students explain the activity—how and why it works—and then relate their understanding of the video, for example, to the concepts being discussed in class that day.

My students generally love doing experiments and cancelling a lab activity because some students may have seen it on social media isn't really an option. At the same time, as teachers we really do need to use all the tools at our disposal to engage our students. Social media is one of those tools! How can we use social media platforms to better advantage in order to promote a more positive experience in our classrooms?

The Chemical Education Xchange (ChemEd X) recently featured a blog post on their website from a teacher who uses videos found on social media for students to practice CER ("Claim, Evidence, Reasoning"). The teacher calls the activity "Cap/No Cap Wednesday." (The title is styled after similar terminology currently popular among students. In another day it might have been called "Truth or Dare.") Basically, the teacher shows a video and challenges students to make a **claim.** Is the phenomenon being depicted true or false? Students then have to provide **evidence** to back up the claim and explain their **reasoning.** The teacher was impressed with the CER skills developed by students in this activity:

> *"They watched the video intently and made observations, discussed how those observations backed up their claim and determined possible solutions for how the video was created."*

In the May 2021 issue of *The Chemical Bulletin*, I wrote an article about a classroom activity based on the ACS *Reactions* video series. The *Reactions* videos explore the chemistry of everyday things, and they always start with a question. (See, for example, the most recent video, "Why are electric vehicle fires so hard to put out?") **Before watching the video,** students have to answer three questions related to the video title. What do you already know about this topic, what do you need to know to answer the title question, and how and why did you answer the title question in the first place?

Photo credit: https://www.pexels.com/photo/facebook-application-icon-147413/

Based on the success of this activity, I have modified it to include other social media videos. Here are two more ideas for using social media in the classroom:

- Have students analyze a short video related to your current classroom topic to determine if the video is fake or real. For example, this video by Tom Kuntzleman, which is popular on both Twitter and YouTube, explores whether diamonds burn. When students started analyzing the video, it was amazing the chemistry concepts they brought up: thermodynamics, bonding, etc. WOW! Even after I explained the chemistry, students still questioned the video because they couldn't see the top of the test tube. Let's hope students will use these same critical thinking skills to question more of the information they get from social media!
- Use social media demos as prompts for further inquiry in the classroom or lab. I have used the "Glowing Mountain Dew" demo by Chemical Kim, for example, to explore the topics of chemical reactions, reaction rates, and chemiluminescence. The students were very engaged, and the demo really made them think.

Would you like to contribute to a growing list of teacher resources for using social media in the chemistry classroom? Please let me know and I will share my list with you and we can continue to grow it.
—SHERRI RUKES

* For more information about CER, visit https://www.modelteaching.com/education-articles/writing-instruction/claim-evidence-reasoning-cer.

CHEMSHORTS FOR KIDS

Why do we sweat?

Photo credit: https://www.pexels.com/photo/woman-with-white-sunvisor-running-40751/

We all do it—sweat, that is! But why do we sweat? The answer lies in the chemistry and physics of the human body.

Materials

Cotton balls or other absorbent material (tissues), 2
Dropper
Isopropyl or rubbing alcohol
Plate
Water

***Be Safe*—**If you get rubbing alcohol on a cut or open sore, it will sting. Adult supervision is recommended.

Experiment

On your left wrist, swipe a water-wet cotton ball across it and note how it feels on your skin. Once you have taken note of this, dry the water from the skin and then do the same thing on the right wrist using an alcohol-wet cotton ball. Is there a difference in how the two solutions feel on the wrist? Now take a drop of water and put it on a plate and do the same with a drop of alcohol. Check on these drops over the course of a couple of hours and notice what happens to them.

What's happening?

In all cases above the liquid is evaporating. This means that the substance starts out as a liquid and turns into a gas. Which liquid droplet disappeared first? The reason that a liquid disappears* into the gas phase is because heat from the room causes the liquid to warm. This, in turn, causes the molecules in the liquid state to vibrate more and more.

As molecules vibrate more and more, some of them will break away from other molecules at the surface of the liquid and enter the surrounding air. This is evaporation. The hotter, on average, the liquid molecules get, the faster they will "disappear" into the gas phase. What's more, when the molecules turn to gas, the remaining liquid gets cooler! That's why your skin feels cool when water or alcohol evaporates from it. (Alcohol evaporates faster than water, making you feel even cooler!) Think of what happens when you are physically working hard. When you start to get hot, your body tells you to sweat. The sweat takes the heat that you are producing and puts that heat into the liquid molecules. Liquid sweat molecules turn into a gas, thereby cooling you off as they take away the heat.

Extension: Dogs cool differently than we do. Their sweat glands are on the paws of their feet so you may see them leave wet prints on the ground on a hot day. Dogs also cool themselves when they pant and their warm blood can circulate close to the surface of their skin to help cool them as well. How do other animals cool themselves?

Photo credit: https://www.pexels.com/photo/brown-dog-running-on-field-2197906/

References

https://www.ducksters.com/science/experiment_skin_temperature.php
https://www.akc.org/expert-advice/health/do-dogs-sweat/

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

—PAUL BRANDT

* Molecules don't really "disappear." They enter the gas phase, however, so we no longer see them. But they are still present!

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2023 Chemists Celebrate Earth Week (CCEW) Illustrated Poem Contest

"The Curious Chemistry of Amazing Algae"

The Chicago Local Section of the American Chemical Society (ACS) is sponsoring an illustrated poem contest for students in kindergarten through 12th grade.

Contest Deadline: April 30, 2023 @ 11:59 PM
Prizes: Theme-related prize or gift card
Local Contact: Sherri Rukes (community@chicagoacs.org)
Entry Form: https://chicagoacs.org/CommunityActivities
Submission: Sherri Rukes (community@chicagoacs.org)

Winners of the Chicago Local Section's Illustrated Poem Contest will advance to the National Illustrated Poem Contest for a chance to be featured on the ACS website and to win prizes!

Write and illustrate a poem using the CCEW theme, "**The Curious Chemistry of Amazing Algae.**" Your poem must be **no more** than 40 words and in one of the following styles to be considered:

HAIKU - LIMERICK - ODE - ABC POEM - FREE VERSE - END RHYME - BLANK VERSE

Possible topics related to the theme include:

- Seaweed
- Micro- or macro- algae
- Photosynthesis
- Bioluminescent algae
- Algae as food & habitat for animals
- Consumer products from algae
- Oxygen from algae
- Biofuels from algae

Entries will be judged based upon:

- Artistic Merit - use of color, quality of drawing, design, and layout
- Poem Message - fun, motivational, inspiring about yearly theme
- Originality and Creativity - unique, clever and/or creative design
- Neatness - free of spelling and grammatical errors

Contest rules:

- All poems must be no more than 40 words and in one of the following styles to be considered: Haiku, Limerick, Ode, ABC poem, Free verse, End rhyme, and Blank verse.
- Entries are judged based upon relevance to and incorporation of the CCEW theme, word choice and imagery, colorful artwork, adherence to poem style, originality and creativity, and overall presentation.
- All entries must be original works without aid from others. Poems may be submitted by hand on an unlined sheet of paper not larger than 11" by 14" or scanned and sent via email. Illustrations may be created using crayons, watercolors, other types of paint, colored pencils, or markers. The illustration may also be electronically created by using a digital painting and drawing app on a computer, tablet, or mobile device.
- The text of the poem should be easy-to-read and may be typed before the hand-drawn or digital illustration is added, or the poem may be written on lined paper, which is cut out and pasted onto the unlined paper with the illustration.
- No clipart or unoriginal images can be used.
- Only one entry per student will be accepted; all entries must include an entry form.

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For more information, contact
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UPCOMING EVENTS

April 10	Articles due for the May 2023 *Bulletin* issue
April 13	Chicago Board of Directors Meeting
April 21	Chicago ACS Monthly Program Meeting (Virtual)
May 10	Articles due for the June 2023 *Bulletin* issue
May 11	Chicago Board of Directors Meeting
May 19	Chicago ACS Monthly Program Meeting
May 20	Argonne National Laboratory Open House
June 7	112th Willard Gibbs Award Celebration (In-person meeting only)

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