The American Chemical Society
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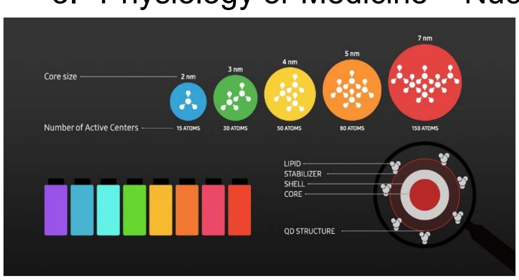
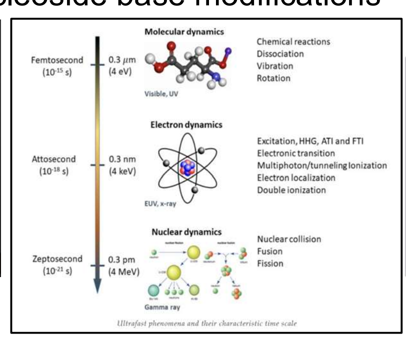
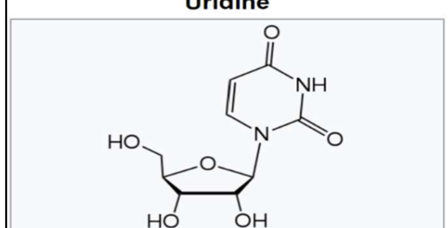




Uridine



Review

The Vortex is published monthly except July and August by the California Section, American Chemical Society. Opinions expressed by the editors or contributors to *THE VORTEX* do not necessarily reflect the official position of the Section. The publisher reserves the right to reject copy submitted. Subscription included in the annual dues payment.

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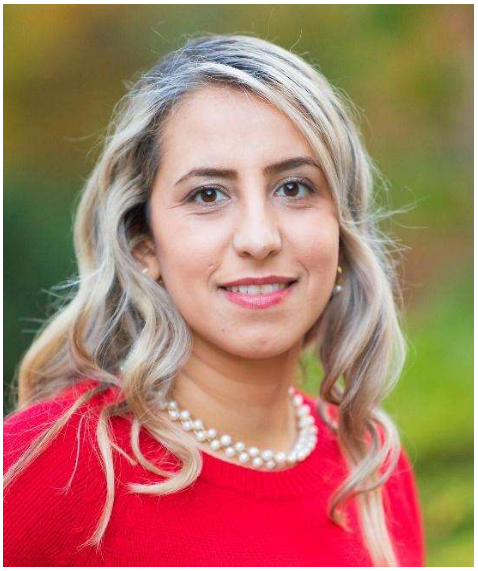
Top: November speaker, Rachel Woods-Robinson.
Bottom: Images representing the 3 Nobel Prizes Influence. Left: Samsung Schematic for quantum dot and size: https://www.samsungdisplay.com/eng/tech/quantum-dot.jsp
; Middle: Standard Model for Particle Physics, Center for Relativistic Laser Center (Korea): https://corels.ibs.re.kr/html/corels_en/research/research_0305.html
; Right: uridine structure Wikipedia.

If you have material you think is worthy, submit it to donald.maclean.acs@gmail.com.

Chair Message

Atefeh Taheri



Warm greetings as we unveil the November edition of The Vortex! It is hard to believe we are nearing the end of another year, and as I pen this message, I am reminded of the journey we have undertaken together over the past months.

Firstly, I would like to apologize for not writing the Chair's message in the recent editions. While my direct communication may have been sparse, please know that behind the scenes, our section has been a hive of activity, dedication, and achievements.

One of the standout moments for our section was our remarkable presence at the ACS National Meeting in SF this past August. It was a monumental event, and our section's determination shone brightly as we secured several ChemLuminary Awards. This is not just a recognition for a few but a testament to the collective spirit and drive of our entire community. While we bask in the glory of this year's accomplishments, our ambitions are set even higher for the next.

October, too, was filled with memorable moments. Our annual awards luncheon was not just an event but a celebration of unity, achievements, and the enduring spirit of our long-standing members. Their commitment and contributions over the years have been the pillars that have upheld our section's esteemed legacy.

As the golden hues of fall envelop us this November, it is a month rich in significance and celebrations. We wholeheartedly embrace the National Native American Heritage Month. The traditions, languages, stories, and enduring spirit of the Native American, Alaska Native, Native Hawaiian, and Island communities deserve our deepest respect and recognition. Their unparalleled contributions have enriched our nation, and we must continue to amplify and celebrate their narratives for future generations.

Additionally, November heralds the festive season, ushering in the warmth of Thanksgiving. This is more than just a holiday; it is a reminder to pause, reflect, and express our gratitude for our blessings and cherish moments with our loved ones.

Before I conclude, I must emphasize the importance of the upcoming section elections this month. The direction and vision for our section lie in your hands. The roles of Chair-Elect, Director-at-Large, Member-at-Large, and Councilors are pivotal, and we urge each member to participate actively and cast their votes. Your voice and choice will shape our path in the coming years.

In wrapping up, I wish to convey my appreciation for the trust, support, and relentless energy each of you brings to our community. Together, we are not just a section; we are a force, a family. Here is to many more milestones … and memories!

Section Elections

By Michael Cheng

Look out for local section election email notice from the Cal ACS Section Office.

1. **Chair-elect (1 position)** - The Chair-Elect shall be Chair of the Program Committee and shall assist the Chair with the direction and management of the Section.

2. **Treasurer (1 position)** - The Treasurer shall have charge of the funds of the Section, including receiving all monies coming to the Section.

3. **Councilors (3 positions)** - Representing CalACS members in the meeting of the Councils during ACS National meetings.

4. **Director At Large (1 position)** - It is a member of the Board of Directors, and has full power to conduct, manage, and direct the business affairs of the Section.

5. **Members At Large (3 positions)** - Assist the officers; bringing before the Executive Committee items of concern from members of the Section.

Ballots will be sent in early November, voting will close near 11/20/2023. Elections will be held using Survey Monkey.

Upcoming Events

By Donald MacLean

1. BACS 2023, UCSF Mission Bay - @ Robertson Auditorium, November 3, 2023. See flyer.
2. "Shining Light on Solar Cells and Their Material Impacts", Rachel Woods-Robinson, PhD, @ Zoom, Saturday, November 4th, 2023, starting at 10:30 am (PST). See flyer.
3. Outreach:
    1. Fairmont Elementary School Festival Thurs. Nov. 16th El Cerrito, 9am -12 pm.
    2. Richmond Elementary, Nov. 16th STEAM (Science, Technology, Engineering, Art, Math). Contact Alex Madonik for more information. [Note date is a correction].
4. Berkeley Science Bowl Invitational, Sunday December 3, 2023. See calacs.org website for details.

BACS

BAY AREA CHEMISTRY SYMPOSIUM
connecting industry + academia

an ACS sponsored event

Please join us for

The 4th annual **Bay Area Chemistry Symposium**, an ACS sponsored symposium for Synthesis and Design in Medicinal & Process Chemistry

WHEN	**Friday, November 3rd, 2023**
WHERE	**Robertson Auditorium, UCSF**
SUBMIT	**Abstracts for talks & posters today!**

This symposium, unique in the Bay, will provide an ideal forum for students, postdocs, and industrial chemists to meet and exchange ideas covering themes in chemical biology, synthesis, and computational chemistry. The 2023 symposium will feature keynote seminars from leading local academics & industrial chemists, as well as short talks from students, post-docs, and industry researchers. A lively poster session promises a much-anticipated return to networking with local chemists through this opportunity to learn about cutting-edge chemistry across the Bay Area's outstanding institutions. Visit our website for more details!

OUR 2023 KEYNOTE ACADEMIC SPEAKERS

Prof. Kevan Shokat
UC San Francisco

Prof. Carrie Partch
UC Santa Cruz

Prof. John Hartwig
UC Berkeley

Last year's BACS was generously supported by our

INDUSTRY SPONSORS

Novartis, AbbVie, Gilead, Ascendis Pharma, Maze, Merck, Arcus Biosciences, ACS, Nurix, Schrödinger, Cytokinetics, Genentech, Eikon Therapeutics, Bristol Myers Squibb

For more information on sponsorship & registration, visit: bayareachemistrysymposium.com

California Section American Chemical Society

Women CHEMISTS Committee

All are welcome

Saturday, November 4, 2023

Title

Shining light on solar cells and their material impacts

Time

10:30 – 11:00 am Chatting

11:00 am Talk and Discussion

Reservation

Please visit the CalACS website www.calacs.org to register for this meeting or use Brown Paper Tickets.

RSVP here!

Please register before Thursday, November 2, 2023, 12 noon. Your email address is needed to send the ZOOM link, which will be shared with attendees on or before the day of the event via Brown Paper Tickets.

Cost

Free!

About the Speaker

Rachel Woods-Robinson, PhD

Rachel Woods-Robinson (she/her) received a B.S. in Physics from UCLA, and a Ph.D. at U.C. Berkeley and Berkeley Lab designing new crystals for solar energy by combining computational chemistry, thin film growth, and device fabrication. Rachel recently started as a Postdoctoral Fellow at University of Washington's Clean Energy Institute to study environmental and human impacts of such new solar materials. In addition to research goals to curtail climate change, Rachel aims to support scientists in sharing our work accessibly and engaging collaboratively with our communities, and loves outdoor adventuring. She co-founded "Cycle for Science," in which scientists go on bicycle tours and visit K-12 classes to teach hands-on lessons about sustainability, and she instructs "Cycle the Rockies" (Wild Rockies Field Institute), an immersive month-long course in which undergrads ride bicycles across Montana to learn about local energy and climate impacts.

Abstract

Addressing climate change requires transitioning to renewables such as photovoltaic solar panels, but one key barrier to this transition is that we need better materials. In this talk, we'll start at the sun and then zoom into a solar panel all the way down to the nanoscale, highlighting materials challenges that scientists face at each length scale to make solar more efficient, reliable, and sustainable. We'll meet the different material components, such as absorbers and transparent conductors (TCs), and I'll share some of my research into designing new TCs for solar. Next, we'll zoom back out to discuss challenges we face beyond the lab in bringing solar to society, including critical raw materials, environmental impacts, and "green sacrifice zones." Lastly, I'll share some insights from my outreach project Cycle for Science and college course Cycle the Rockies.

Questions?

Please contact Elaine Yamaguchi at eyamaguchi08@gmail.com

Atefeh Taheri wins Meridian Award from Association for Women in Science (AWIS)

By Donald MacLean

The Association for Women in Science (AWIS) announced that one of the 2023 recipients of this year's Meridian awards is Atefeh Taheri. The MERIDIAN AWARD recognizes mid-career professionals whose diversity and inclusion efforts represent true leadership in the pursuit of workplace equity. AWIS has 3 award levels based on where recipients are in their careers. These awards are given to AWIS members who demonstrate strong leadership skills, innovative thinking, and a commitment to inclusivity, diversity, equity, and accessibility in STEM.

"AWIS received dozens of nominations highlighting members who launched initiatives to identify gaps and opportunities, designed and established programs to fill these needs, and fostered welcoming and supportive STEM environments. Their efforts included outreach to historically excluded communities, mentoring programs for first-generation low-income students, creating virtual learning to support rural or disadvantaged students, managing grants focused on gender and minority support, developing DEI action plans to ensure inclusion environments, chairing committees, training leaders, and encouraging, recognizing and supporting women in science.

'These women epitomize the values of AWIS," said Meredith Gibson, AWIS CEO. "We recognize that diverse perspectives, experiences, and backgrounds are critical to driving innovation and progress in scientific fields, and we are committed to promoting diversity, equity, and inclusion in STEM. AWIS is thrilled to recognize these members and appreciate the contributions of all our nominees.'"

A list of awardees is shown at https://awis.org/awis-announces-2023-award-winners/

2023 CalACS Section Award Pictures

By Donald MacLean

See the link for pictures taken by Norman Wu at the 2023 CalACS section awards.

https://onedrive.live.com/?authkey=%21AMEpv66lI78OAz8&id=5134E7C5EE33F81E%2117211&cid=5134E7C5EE33F81E

The 2023 Llyod Ryland outstanding High School Chemistry Teacher Award recipient is Brad Vereen from Dublin High.   has been a frequent participant in the Chemistry Olympiad and his students are consistently high performers. He is also active in a number of extracurricular activities and is highly regarded by his students.

The 2023 Walter B. Petersen Award for volunteerism is Toni Miao. Much of her activity has been with Project SEED and WCC (Women's Chemist Committee).

Top Left: Left to right are Eileen Nottoli, Brad Vereen, and Atefeh Taheri.

Left: Toni Miao
Right Top: Jim Postma, Margaret Leong, Koon Leong
Right: Jeanette Sutor, Paul Sutor, and Paul Vartanian

Bottom Right: Jeannette Von Emon's husband, Jeannette Von Emon, Marinda Wu.

Above Left: Marinda Wu, 60 year member George L. Kenyon, and section chair Atefeh Taheri

Above Right: 50 year member Kent Campbell

Right: Marinda Wu, 50 year Member Koon Wah Leong, Atefeh Taheri

Below Right: 50 year member Karim Nafisi Movaghar

Below left: Marinda Wu, Stephen Miller, Markella Konstantinidou, Vanessa Marx, and Atefeh Taheri

2023 Nobel Prizes

By Donald MacLean

Chemistry

The 2023 Nobel Prize in Chemistry went to Moungi Bawendi of Mass. Institute of Technology (USA), Louis Brus of Columbia University (USA), and Alexey Ekimov of Nanocystals Technology (Russia) for “the discovery and synthesis of quantum dots”. An announcement for 2023 chemistry awardees can be seen in the October 9, 2023 issue of C&EN, 101 (33): 4.[1]

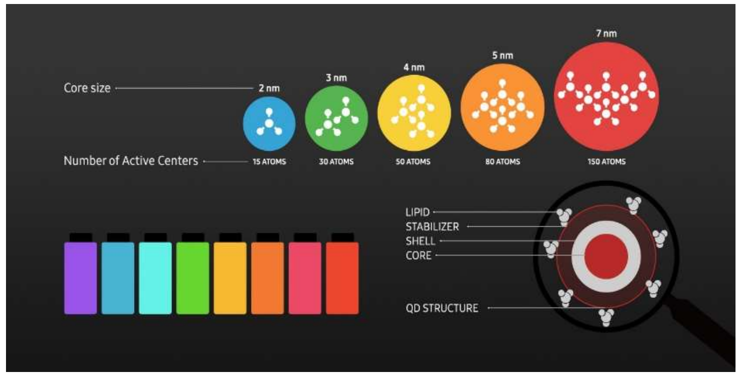


Figure 1. Colorfully colors from quantum dots.[2] Laser light is the excitation source. The fluorescence emission is size dependent, the larger the particle, the more redshifted.

Quantum dots (QDs) are semi-conductor nanometer sized particles, having optical electronic properties that differ from those of larger particles as a result of quantum mechanical effects (they omit different color light based on their size). Keeping chemical composition constant, size determines the absorption and fluorescence emission wavelength and lifetimes. In general, the larger the dot, the redder its absorption onset and fluorescence spectrum (lower-energy) (Red Shift or Bathochromic Effect) with a longer fluorescence lifetime. Conversely, smaller dots absorb and emit bluer light (higher-energy) (Blue Shift or Hypsochromic Effect) (see Figure 1) with shorter fluorescence lifetime.

Applications with quantum dots are television screens, photovoltaic cells, diodes, lasers, and other light emitting devices (see Figure 2).

An interesting application is the use of quantum dots as a medical record substitution in areas that do not have sufficient infrastructure. For therapy, quantum dots can be used to differentiate healthy cells from cancer cells (see Figure 3).

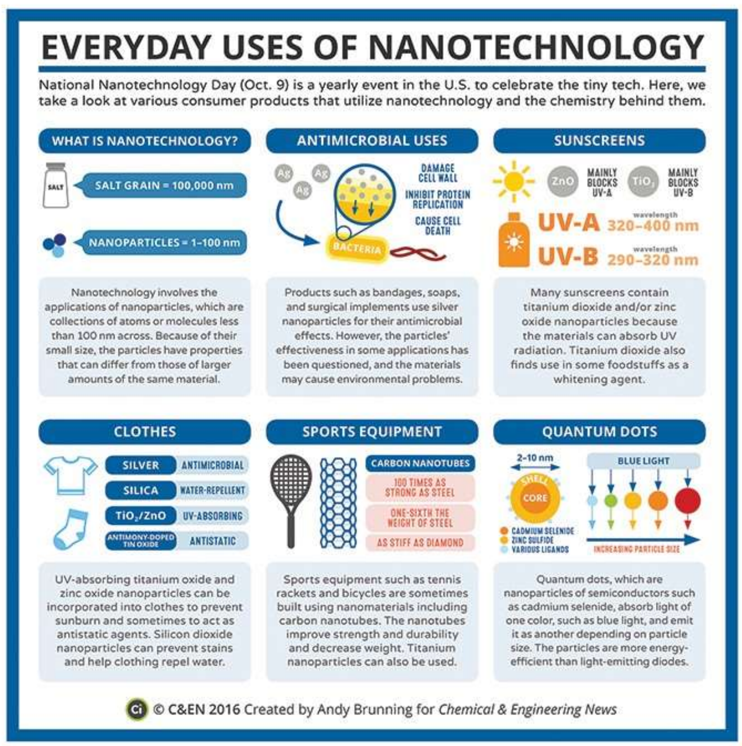


Figure 2. Quantum Dot Use, Periodic Graphics.[3]

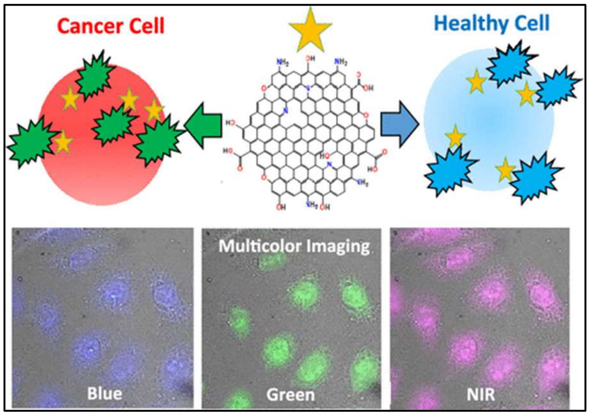


Figure 3. Quantum Dots for Cell Status. Nitrogen, boron/nitrogen, and sulfur-doped graphene quantum dots (GQDs) used to differentiate healthy cells from cancer cells.[4]

References for Chemistry Section:

1. 3 Quantum Dot Researchers Awarded Nobel Prize in Chemistry, C&EN 101 (33)(October 9, 2023): 4.
2. Schematic for quantum dot and size: https://www.samsungdisplay.com/eng/tech/quantum-dot.jsp
3. Periodic Graphics: Andy Brunning, Everyday Uses of Nanotechnology, C&EN 94 (40)(October 7, 2016).
4. Doped Graphene Quantum Dots for Intracellular Multicolor Imaging and Cancer Detection, Campbell E., et al., ACS Biomater. Sci. Eng. 2019, 5 (9), 4671–4682 https://pubs.acs.org/doi/abs/10.1021/acsbiomaterials.9b00603
5. Quantum Dots and Their Applications: What Lies Ahead?, *Mônica A. Cotta, ACS Applied Nano Materials* ***2020*** *3 (6), 4920-4924, DOI: 10.1021/acsanm.0c01386*

Physics

The 2023 Nobel Prize in Physics went to Pierre Agostini of The Ohio State University (France), Ferenc Krausz of Max Plank Institute (Germany), and Anne L'Huillier of Lund University (Sweden) "for experimental methods that generate attosecond pulses of light for the study of electron dynamics in matter". An announcement for 2023 physics awardees can be seen in the October 9, 2023 issue of C&EN, 101 (33): 6.[6]

Here is a quote from PBS that exemplifies what attosecond pulses can do. "As an analogy, imagine a camera that could only take longer exposures, around 1 second long. Things in motion, like a person running toward the camera or a bird flying across the sky, would appear blurry in the photos taken, and it would be difficult to see exactly what was going on. Then, imagine you use a camera with a 1 millisecond exposure. Now, motions that were previously smeared out would be nicely resolved into clear and precise snapshots. That's how using the attosecond scale, rather than the femtosecond scale, can illuminate electron behavior."[7]

However, attosecond is not the shortest signal ever detected as shown in Table 1. Figure 4 shows the dynamic classes that are monitored using femtosecond (UV-vis), attosecond (extreme ultraviolet, X-ray), and zeptosecond sources/ emission. Table 1 shows the type of elementary particles that could be investigated with attosecond and a future zeptosecond pulse.

The main interests of attosecond physics (and chemistry) are [see Figure 4]:

1. Atomic: investigation of electron correlation effects, photo-emission delay and ionization tunneling.

2. Molecular: role of electronic motion in molecular excited states (e.g. charge-transfer processes), light-induced photo-fragmentation, and light-induced electron transfer processes.
3. Solid-state: investigation of exciton dynamics in advanced 2D materials, petahertz charge carrier motion in solids, spin dynamics in ferromagnetic materials.

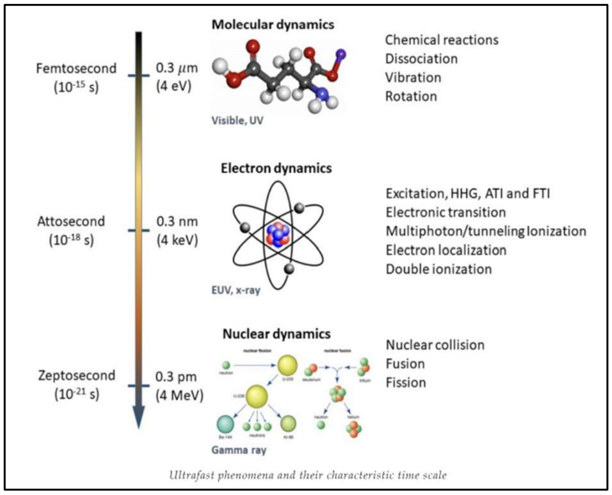


Figure 4. The Dynamic Applications to Pulsed Light. Note that the shorter the time (greater frequency), the greater the energy. Attosecond X-ray pulses are used to see atomic electrons move. A still to be developed zeptosecond pulse would be used for nuclear dynamics.[8]

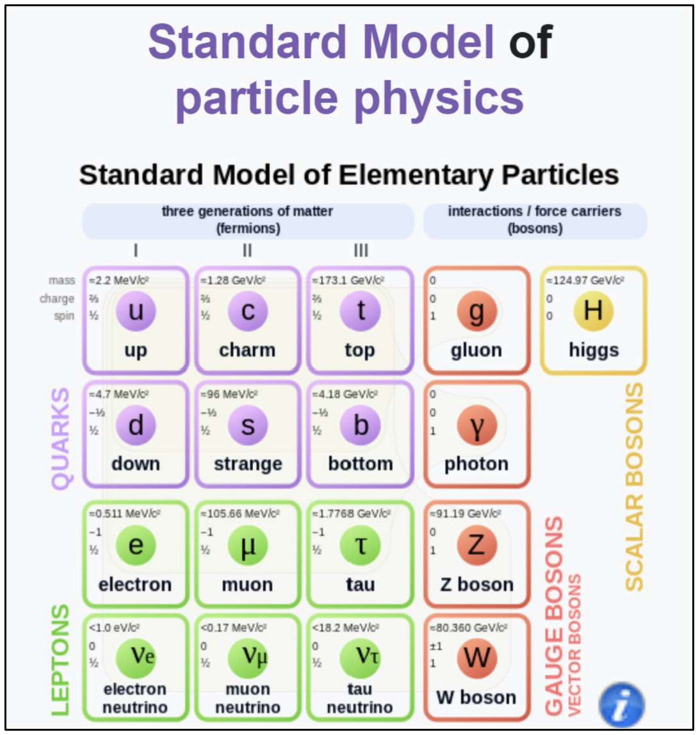


Figure 5. Elementary Particles. The mass of an electron is 0.511 MeV which is the half the energy from a positron-electron inhilation interaction (1.024 MeV is total, the photons are 180 degrees apart with 0.511 MeV each, the basis for PET imaging). The mass of a protein is 938.272 MeV with ½ ħ spin (h bar = Planck's constant divided by 2π).[9]

Table 1. Time Scale and Events or Phenomenon.[10] See the reference for reference within table. Calculation used E=hv, c= λ/v, time = 1/ v

Second Multiple Unit Symbol	**Comparative examples & common units, comment**
10^{-44} Planck Time t_P	5.39×$\mathbf{10^{-14}}$ **qs**: The length of one Planck time (is the briefest physically meaningful span of time. It is the unit of time in the natural units system known as Planck units.
10^{-30} quectosecond qs	
10^{-27} rontosecond rs	**300 rs**: The mean lifetime of W and Z bosons
10^{-24} yoctosecond ys	**23 ys**: The lower estimated bound on the half-life of isotope 7 of hydrogen (Hydrogen-7) Wikipedia states 652 ys[11] **143 ys**: The half-life of the Nitrogen-10 isotope of Nitrogen **156 ys**: The mean lifetime of a Higgs Boson
10^{-21} zeptosecond zs	**1.3 zs**: Smallest experimentally controlled time delay in a photon field. **2 zs**: The frequency of a 2 MeV gamma ray (6.20x10E-4 nm). **247 zs**: The experimentally-measured travel time of a photon across a hydrogen molecule, "for the average bond length of molecular hydrogen" (247 zs = 0.074 nm, hydrogen covalent diameter is 0.031 ± 0.005 nm)[12]
10^{-18} attosecond as	**12 as**: The best timing control of laser pulses **43 as**: The shortest X-ray laser pulse (13 nm) **53 as**: The shortest electron laser pulse
10^{-15} femtosecond fs	**1 fs**: 300 nm light wavelength **290 fs**: The lifetime of a tauon

Information on details:
(W and Z bosons are heavy elemental particles about 80 times heavier than a proton). Z bosons decay into a fermion and its antiparticle. W bosons decay into lepton and antilepton or to a quark and its opposite charge quark.
H-7 isotope has 6 neutrons and 1 proton, decay by double neutron emission to H-5 or quadruple neutron emission to H-3.
N-10 isotope has 3 neutrons and 7 protons, decay by proton emission to C-9.
Higgs Boson is zero spin zero charge elementary particle that has many possible decay daughters.
Tauon is an elementary negative charge particle with ½ h bar spin, whose mass is about 2 times the mass of protons, which degrades into Hadrons.

References for Physics Section:

6. Nobel Prize in Physics Awarded to 3 for Achievements in Attosecond Science, C&EN 101 (33) (October 9, 2023): 6.
7. What extraordinarily brief light flashes can tell us about electrons and the nature of matter, PBS, October 4, 2023: https://www.pbs.org/newshour/science/what-extraordinarily-brief-light-flashes-can-tell-us-about-electrons-and-the-nature-of-matter

8. Standard Model for Particle Physics, Center for Relativistic Laser Center (Korea): https://corels.ibs.re.kr/html/corels_en/research/research_0305.html
9. Standard Model of Particle Physics: https://en.wikipedia.org/wiki/Standard_Model
10. Orders of magnitude (time): https://en.wikipedia.org/wiki/Orders_of_magnitude_(time)
11. Isotopes of Hydrogen: https://en.wikipedia.org/wiki/Isotopes_of_hydrogen
12. Hydrogen, Wikipedia: https://en.wikipedia.org/wiki/Hydrogen

Physiology or Medicine

The 2023 Nobel Prize in Physiology or Medicine has been awarded to Katalin Karikó of Szeged University (Hungary) and Drew Weissman of the University of Pennsylvania (USA) for their discoveries concerning nucleoside base modifications that enabled the development of effective mRNA vaccines against COVID-19. An announcement for 2023 Physiology or Medicine awardees can be seen in the October 9, 2023 issue of C&EN, 101 (33): 5.[13]

Nucleotides are composed of phosphate, ribose sugar, and a nitrogenous base, either adenine, uracil, cytosine, and /or guanine. This is very similar to DNA, except the 5 carbon sugar is deoxyribose, and the nitrogenous bases are either adenine, thymine, cytosine, and /or guanine. Uracil is the unmethylated form of thymine. For RNA, the base is connected to a ribose which is connected to phosphate. That phosphate is then connected to another base in a chain fashion to create RNA strands. Bases connected only to the sugar are called nucleoside as it is missing the phosphate group. Uracil connected to a ribose is called uridine.

There are different biologically active RNAs, including mRNA (messenger, carries information from DNA to the ribosome), tRNA (transfer, transfers a specific amino acid to a growing polypeptide chain), rRNA (ribosomal, catalytic component of translation process), snRNAs (small nuclear, role in RNA biogenesis and guide chemical modifications of rRNAs and other tRNA and snRNAs), and other non-coding RNAs.

Synthetic RNA is immunogenic. By converting the uridine to pseudouridine in mRNA produced in vitro reduced the inflammatory response. This later proved to be more stable and produced more protein. Moderna and BioNTech used this method for their vaccine. Pseudouridine (known as psi (Ψ)), is the C5-glycoside isomer of uridine that contains a C-C bond between C1 of the ribose sugar and C5 of uracil, rather than usual C1-N1 bond found in uridine. [Figure 6]

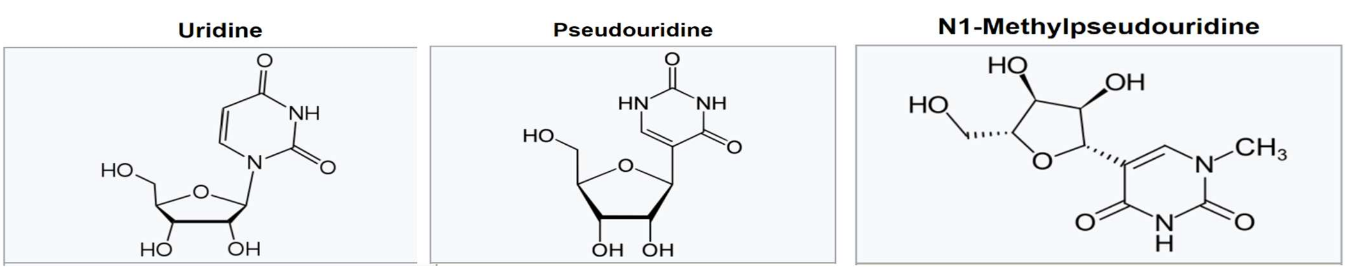


Figure 6. Chemical structure for uridine, pseudouridine, and N1-methylpseudouridine.[14 - 16]

In the SARS-CoV2 vaccine from BioNTech/Pfizer, also known as BNT162b2 [internal name], tozinameran [nonproprietary name] or Comirnaty [Brand name], and elasomeran from Moderna,

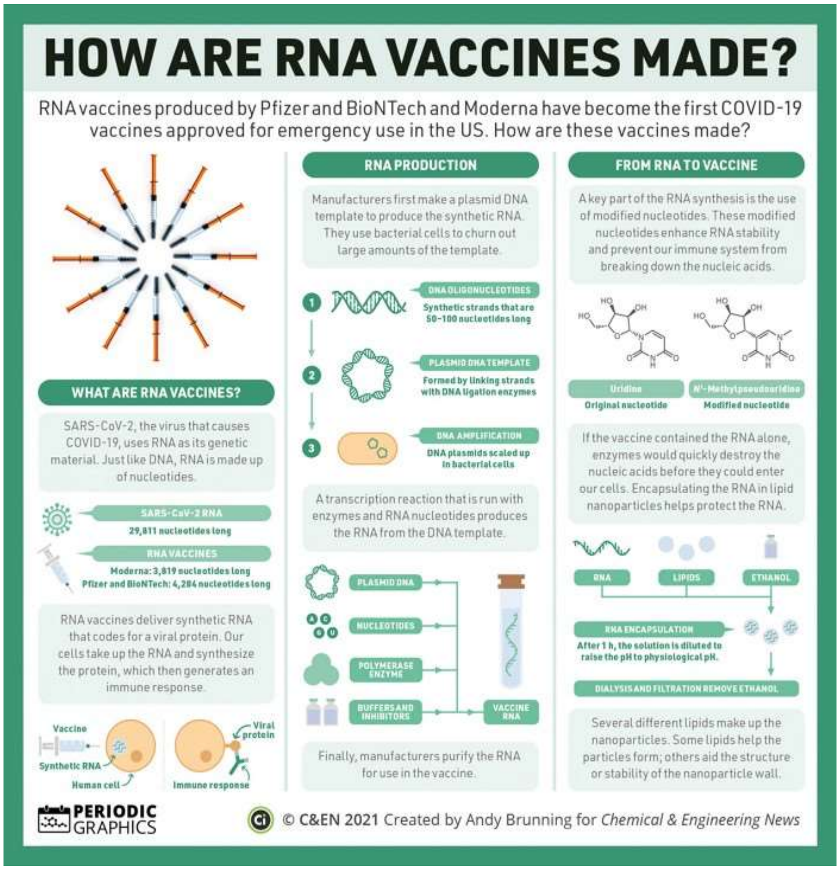


Figure 7. Periodic Graphics for RNA vaccines.

all uridines have been substituted with N1-methylpseudouridine, a nucleoside (base plus sugar, no phosphate) related to Ψ that contains a methyl group added to N1 atom. One RNA vaccine that was considered a failure is the Curavac mRNA vaccine [INN zorecimeran] that had approximately 50% efficacy, compared to the 90% efficacy from Pfizer and Moderna mRNA vaccines.[19] A possible reasoning that CureVac's vaccine was not as effective was its use of an unmodified mRNA or that its trial dose was much lower. A synopsis can be looked up in the provided reference.

As a note, C&EN had a Periodic Graphics in the January 3, 2021 vol 99 (1) issue that shows the application of modifying RNA to make Covid 19 RNA vaccine (Figure 7).[17] In this pictograph more than just the conversion of uridine nucleoside to pseudouridine or N1-methyl-pseudouridine nucleosides are necessary to create the RNA vaccines approved in the USA. The structures of uridine, pseudouridine, and methylpseudouridine are shown in Figure 6.

The Covid 19 vaccines approved in the USA are (company – type - status):

1. Pfizer–BioNTech – RNA – Fully approved
2. Moderna – RNA – Fully approved
3. Janssen - Adenovirus vector (this has information encoded into the adenovirus) – Emergency Use only – no longer available in USA as of May 2023.
4. Novavax - Protein based with adjuvant – Emergency use only

The Covid 19 vaccines approved elsewhere (company – type):

1. Oxford–AstraZeneca COVID-19 vaccine - Adenovirus vector
2. Sputnik V COVID-19 vaccine - Adenovirus vector
3. Convidecia - Adenovirus vector
4. Sanofi–GSK – Subunit

Etc.

Notable mRNA Covid 19 vaccines that failed clinical assessment (company -type)

1. Curavac (Bayer was codeveloper) – RNA[18, 19]

References for Physiology or Medicine Section:

13. Nobel for Medicine Recognizes mRNA Vaccine Research, CEN 101 (33) (October 9, 2023): 5
14. Structure: https://en.wikipedia.org/wiki/Pseudouridine
15. Structure: https://en.wikipedia.org/wiki/Uridine
16. Structure: https://en.wikipedia.org/wiki/N1-Methylpseudouridine
17. Periodic Graphics: Andy Brunning, How are RNA Vaccines Made?, C&EN 99 (1) (January 3, 2021)
18. Bayer to manufacture mRNA vaccine in Germany : https://www.bayer.com/media/en-us/bayer-to-manufacture-mrna-vaccine-in-germany/
19. What went wrong with CureVac's highly anticipated new mRNA vaccine for COVID-19, Jon Cohen, Science, 18 (JUN 2021): https://www.science.org/content/article/what-went-wrong-curevac-s-highly-anticipated-new-mrna-vaccine-covid-19

General References:

20. Nobel Prize Announcement: https://www.nobelprize.org/all-nobel-prizes-2023/

Chemistry In Action

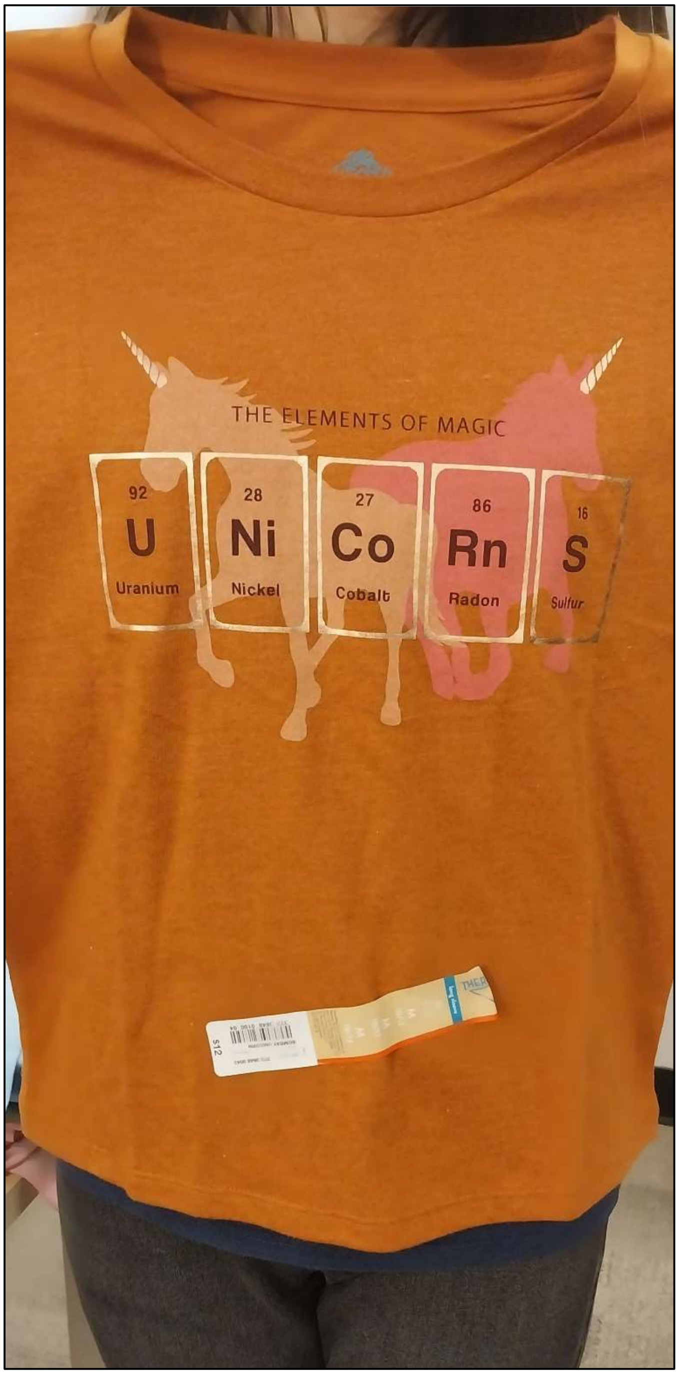


Figure. Unicorn is made from uranium, nickel, cobalt, and radon. Add sulfur pixie dust to get more unicorns. This was found on a girl's Tee shirt.

Photo by Donald MacLean