CHEM MAJOR NEWS

In Conjunction with the American Chemical Society
Student Affiliates at the University of Pittsburgh

Volume 32, Issue 4 January 8, 2024

Welcome Back!

Welcome Back Everyone!!

Welcome back my fellow chemists, biologists, and general science lovers! Whether you've spent the break catching up on sleep, working a part time job, and/or catching up with old high school and family friends, I hope you all found it restful, refreshing, and relaxing! We'll all certainly need a clear and fresh mindset going into the new year and new semester full of STEM classes!

I always find that going into the spring semester I feel more motivated to do well in class and take hold of new opportunities that I may have missed out on in the Fall term. The Spring semester offers us a second chance to improve upon everything we wished we would have done differently in the previous semester. Spring is a fresh start, a clean state to start achieving the goals we've set for ourselves in college and in the new year!

However, I wouldn't get bogged down by the "what ifs" and "should haves" from the previous semester. At the end of the day, college is meant to be challenging, and feeling the stress and strain of that challenge only means that you're growing and maturing into a better version of yourself! Whether you're endeavoring into the second part of a year-long course, like general, organic, or physical chemistry, or are beginning a new chemistry-related course that you feel intimidated by, I want you all to keep in mind that ***you are all brilliant and capable students***, and that doing your best is always going to be enough! As a graduating senior, I can say with full certainty that life in STEM becomes a lot easier when you start to enjoy the process of **learning** the cool science presented in class instead of stressing about whether you've studied enough, are smart enough, or have done as much as your peers. With this being said, I also want to remind everyone that regardless of where you're at, don't forget to take a little break every once in a while—go outside and have a snowball fight, get some hot chocolate with friends to warm up, or watch a cozy winter movie to relax! That chemistry assignment, exam, or project will still be there after you take a little break—so don't forget to put yourself first this semester!

Lastly, as you navigate the periodic challenges of the semester, remember that even the noblest gases can't resist a good reaction! So, approach your classes this semester with the enthusiasm of an electron transitioning into a new, higher energy orbital! May your academic journey this semester be as exhilarating as a catalyst facilitating a chemical reaction—full of energy and positive outcomes!

Good luck and have the best time!
Becca Hotton

2 Billion Years in the Making:
Natural Fission Reactors

By: Victoria Zerbach, *Newsletter Editor*

In spontaneous fission a radioactive nuclide splits into two smaller, more stable daughter nuclei, releasing copious energy and fast neutrons. Nuclear power plants harness the heat produced from chain fission reactions to run turbines and produce energy. Fission reactors produce 10% of all energy consumed worldwide, according to the IEA. And in the US, approximately 20% of our energy is nuclear. Fission keeps the lights on; and, I think about that every time I wake up and turn on my poo bear bedside lamp. In all seriousness, fission is valued, even beyond its use in energy or weapons. Fission reactors are also used in radioisotope production, making fission reactors extremely important to cancer therapy and diagnostics. Fission was first discovered in 1938 by Otto Hahn, Lise Meitner, and Fritz Strassman when they observed something unexpected while bombarding uranium with neutrons in their Berlin laboratory. The last thing they expected was to discover barium isotopes in the decay products, because most believed it would be impossible for a tiny neutron to crack a nucleus in two. But, this is what happened. This discovery prompted the construction of the liquid drop model by Meitner and Frisch. Chemists and physicists have spent a lot of time studying nuclei, and, for unfortunate reasons, focused research gave the scientific world a wealth of scientific knowledge on fission and fusion in the following years.

Uranium-235 is the only naturally abundant fissile isotope. Meaning, uranium-235 can undergo chain fission reactions. For all nuclides that fission, neutrons boil off the surface of the excited daughter nuclei produced by the fission of the parent. The neutrons produced in the fission of a U-235 nuclei can cause secondary U-235 fission events. This is because Uranium-238 is very fissionable upon bombardment with low energy neutrons.

Uranium-235 has a natural abundance of 0.720%. Uranium deposits are largely Uranium-238 (99.2742%), which can undergo spontaneous fission events and is fissionable, but is not fissile. Essentially, Uranium-238 will not undergo fission when bombarded with a low energy neutron, but Uranium-235 will. Fission reactors use fuel that has been enriched with 3% Uranium-235. In 1941, Yakov Borisovich Zeldovich was the first to speculate that chain fission reactions may have occurred within naturally occurring uranium deposits in the distant past when the natural abundance of uranium-235 was closer to 3%. Uranium-235 has a shorter half-life than uranium-238, so about 2 billion years ago the natural abundance of uranium-235 was around 3%.

1.950 billion years ago in a uranium deposit, located in what is modern day Africa, a fission reactor existed. The Franceville basin, in Gabon, had 15 reactors in total, 14 of which were in one deposit, the Oklo deposit. In 1972, during a standard mass-spec analysis in a French ore-enriching factory a uranium-hexafluoride sample was found to be significantly depleted in Uranium-235, leading to an investigation that traced the sample back to Oklo. Additionally, there was an uncommon distribution of rare earth elements, which are uranium fission products. This was evidence enough to say that fission reactions were happening at that site 2 billion years ago. The reactor cycled between 30 minute “ON” periods and 2-hour “OFF” periods. Scientists were able to define the “ON” and “OFF” periods thanks to the entrapment of fission products in aluminum phosphate crystals, which require cooler environments to form. Groundwater acted as both a coolant and a moderator. After 30 minutes of running the reactor core would get so hot that all the water would evaporate off. When the water would evaporate off the reaction would stop until the water condensed. At least two hours off were needed for the water to condense and for the aluminum phosphate crystals to form. The Oklo reactor ran for several 100,000’s of years and the study of fission product migration from this site can tell us about how spent nuclear fuel will impact the environment over many years. Studying these natural reactors has given us a better idea of how fission products migrate over long periods of time in this type of ecological environment.

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January Drug of the Month: *Sunlenca*

By: Jimmy Rekowski, *Pharm Writer*

According to the Center for Disease Control (CDC) an estimated 1.2 million people in the United States had Human Immunodeficiency Virus (HIV) at the end of 2021. Additionally, in 2021, 36,136 people in the United States and dependent areas received a new HIV diagnosis. HIV is a viral infection that directly affects our immune system. Without treatment for HIV, this can lead to acquired immunodeficiency syndrome (AIDS). HIV presents in three stages: Stage 1) acute HIV infection, Stage 2) chronic HIV infection, and Stage 3) AIDS. HIV attacks the CD4 T Lymphocytes in the body's immune system. According to the National Health Institute, HIV uses "the machinery of the CD4 cells to multiply and spread throughout the body." The seven stages of the HIV life cycle include "binding, fusion, reverse transcription, integration, replication, assembly, and budding." The most common way to transmit HIV is through anal or vaginal sex, however, anything that could cause bodily fluids including sharing needles, syringes, or other drug injection equipment. Hence, with the prevalence and incidence of the disease, a need exists to develop effective treatments. However, with the long history of HIV, infections have continued to become stronger, and resistant to some of the most current treatment plans for the disease. Other, newer treatments provide strong alternatives and boosts to current treatment plans for the disease.

Sunlenca or Lenacapavir is a human immunodeficiency virus type 1 (HIV-1) capsid inhibitor that is prescribed for the treatment of HIV-1 infection in adults. Importantly, the adults using this new drug will be heavily treatment-experienced adults with multidrug resistant HIV-1 infection. This infection is failing the regimen that was currently prescribed to the individual due to resistance, intolerance or even safety concerns. *Sunlenca* is a subcutaneous injectable treatment for HIV with a dosing schedule of twice a year. *Sunlenca* works as a selective inhibitor of HIV-1 capsid function that binds between capsid proteins in the overall structure of the virus. The capsid core, specifically in HIV-1 is responsible for reproduction of the viral genome and reverse-transcription machinery, essentially growing the HIV-1 infection. Sunlenca specifically acts as an inhibitor to this HIV-1 replication by interfering with important steps of the viral life cycle including necessary steps such as virus assembly and release as well as that capsid core formation.

The molecular structure of *Sunlenca* (**Figure 1**) will bind to important structures on the viral system leading to the question of which functional groups allow for this to occur. Some of the cyclic groups could bind in different ways providing opportunity to inhibit nuclear transport, capsid assembly, and/or virus assembly.

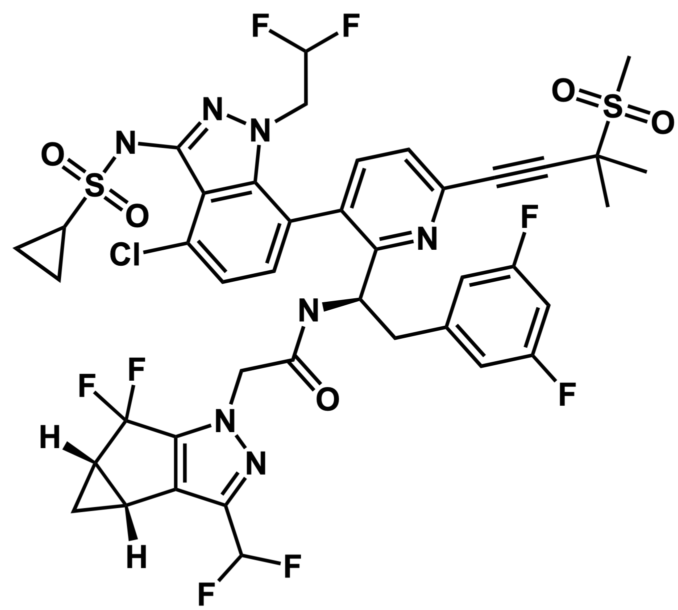

Figure 1. Chemical structure of *Sunlenca* (GS-6207).

In summary, *Sunlenca* provides an effective alternative for individuals in need of treatment for HIV. With the incidence rates of HIV continuing to decrease in recent years the need for novel treatment options for HIV is not as prevalent. However, similar viruses still exist that are still just as noteworthy and increasing in incidence. Hopefully, *Sunlenca* and the capsid core inhibitor technique will continue to broaden treatment options for other human viruses in the world.

In *This* Economy?

By: Piper Read, *Green Chemistry Writer*

As we start a new semester and a new year, I want to introduce a new quantitative approach to determining the sustainability of a synthetic route: Atom Economy!

What is Atom Economy?

In the realm of chemical synthesis, percent yield is taught as the method used for evaluating the efficacy of a reaction, though I hope after reading this article you can see the value in considering Atom Economy as a measure of synthetic efficiency. While both metrics offer insights into the success of a synthesis, they address different aspects of the process. Atom Economy quantifies the efficiency of a chemical reaction by considering the ratio of the molecular weight of the desired product to the total molecular weight of all reactants. This measure emphasizes the importance of maximizing the incorporation of reactant atoms into the final product while minimizing the generation of waste. Atom Economy is a qualitative indicator that reflects the environmental sustainability of a synthesis, focusing on the efficient utilization of atoms in the reaction. Percent Yield, on the other hand, is a quantitative measure that assesses the efficacy of a reaction by comparing the actual yield of the desired product to the theoretical yield (i.e. The synthesis yields the desired amount of the desired product).

Example of a High Atom Economy Reaction

One classic example of a reaction with excellent atom economy is the hydrogenation of an alkene to form an alkane. In this reaction, hydrogen gas (H_2) is used to reduce the carbon-carbon double bond in the alkene, resulting in the formation of a saturated alkane. The only byproduct of this reaction is the catalyst that is frequently used to lower the activation energy of such a reaction. Aside from this catalyst, all the atoms from the starting materials are incorporated into the final product. This exemplifies a high atom economy reaction, as most of the reactant mass contributes directly to the desired outcome.

Example of a Low Atom Economy Reaction

Conversely, consider the traditional method of synthesizing the common pain reliever aspirin (acetylsalicylic acid). The conventional synthesis involves the acetylation of salicylic acid using acetic anhydride. The reaction produces acetylsalicylic acid as the desired product, but acetic acid is generated as a byproduct. This byproduct contributes to the overall mass of the reaction but is not part of the final pharmaceutical product. Therefore, the atom economy of this reaction is lower than that of the hydrogenation example, as not all atoms from the starting materials are incorporated into the final product.

Relevance to Undergraduate Teaching Labs

Integrating the concept of Atom Economy into undergraduate teaching labs is essential for instilling green chemistry principles in the next generation of chemists. By incorporating experiments that highlight high atom economy reactions, students gain an understanding of the importance of designing efficient and sustainable synthetic routes. This approach not only reinforces the theoretical concepts of green chemistry but also provides students with practical experience in choosing environmentally friendly methods for chemical synthesis. Moreover, emphasizing Atom Economy in teaching labs encourages students to critically evaluate and compare different synthetic routes. By considering the atom economy of reactions, students learn to appreciate the environmental impact of their chosen methodologies, fostering a sense of responsibility in their future roles as scientists and researchers. This awareness extends beyond the classroom, influencing their contributions to the broader scientific community.

The University of Pittsburgh
Department of Chemistry

is proud to announce

The McKeever, Pratt, Siska, and *Wass*

Summer Undergraduate Research Fellowships

These Undergraduate Research Fellowships will be awarded for 2024 Summer.

These Fellowships will provide a stipend of $4,500.00 to the recipient for the work carried out in the research lab of one of our faculty members.

To apply please email a letter of recommendation from a faculty mentor which includes your qualifications and details of the planned research project (1–2 pages) and a one page personal statement of your future goals to **sharone@pitt.edu by February 9, 2024.**

All nominations will be reviewed by our Undergraduate Curriculum Committee and the recipients will be recognized at our Undergraduate Awards Ceremony within the University of Pittsburgh, Department of Chemistry.

The deadline to receive all materials for these Fellowships is February 9, 2024.

ACS 2024 Spring Schedule

January

12th Welcome to the New Year – Pizza

19th Industry Day – Sherwin Williams with Carolyn Skillman

26th Talks by Undergraduate Students

February

2nd Medical and Dental School Round Table

9th Meet our new Faculty – Professor Jessica Anna

16th Graduate School Round Table

23rd Pasta Lunch from the Pleasure Bar and Restaurant – ***Reservations Required***

March

1st Family Feud

8th Registration

15th Spring Break Recess

22nd Physical Chemistry Talk – Professor Geoffery Hutchinson

29th Scientific Education Talk – Professor Chandra Singh

April

5th Officer Nomination for 2024–2025

12th Officer Election

17th SENIOR FAREWELL

2023–2024 ACS-SA Officers and Staff

Ahssan Sekandari – *Co-President*
Dhruthi Gunduaro – *Co-President*
Rebecca Babendreier – *Co-Vice President*
Shane Osborne – *Co-Vice President*
Christina Raad – *Secretary*
Dennis Skiba – *Co-Treasurer*
Donny Truong – *Co-Treasurer*
Holly Krug – *Technology Wizard*
Anna Welser – *Outreach Coordinator*
Joe Storey – *Outreach Coordinator*
Rebecca Hotton – *Feature Writer/Editor*
Victoria Zerbach – *Newsletter Editor*
Piper Read – *Green Chem Contributor*
Jimmy Rekowski – *Pharm Contributor*