CHEM MAJOR NEWS

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

Volume 25, Issue 5 **February 5, 2016**

IMPORTANT DATES FOR REGISTRATION

February 15	Summer Term Registration (2167) begins for all degree students.
March 6-13	Spring Break!
March 20	Deadline for August 2016 (2167) graduation applications in 140 Thackeray Hall.
March 28	Fall Term (2171) registration begins and your on-line registration appointment will be sent to you based on credits earned.

Advisees who already have a permanent advisor should make their Summer registration appointments with their advisor on or after February 10th for Summer Term (2167).

Advisees who will be asked to select their permanent advisors (via an email to be sent February 8th) should do that after February 10th. See Dr. George C. Bandik or Regina Mahouski in 107 Chevron Science Center.

New advisees who have declared chemistry as their major within A&S should make an appointment with Dr. George C. Bandik, Dr. Ericka Huston for Dr. Michelle Ward after February 12th for Summer Term (2167) and March 07 for Fall Term (2171) in 107 Chevron Science Center.

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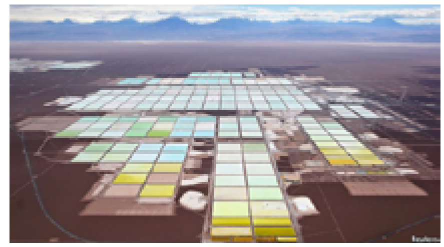
Is Lithium the New Gasoline?

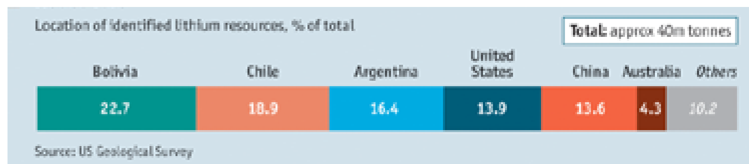
By: Jordan Leventhal

Over the last century, oil has transformed the earth as we know it. From cars to industrial processes, almost every product on the planet today in some way owes its existence to oil. Our dependence on oil is so great that wars have even been waged over the goopy black liquid. So when Goldman Sachs, an investment bank, recently called lithium "the new gasoline," they were making quite a statement. Let's examine why Goldman might think this is the case.

Lithium has recently seen a spike in demand due to a major increase in the use of lithium-ion batteries. As countries across the world scramble to phase out fossil fuel based energy production and move to clean energy sources, the need for long-term energy storage has sky rocketed. Lithium-ion batteries have a high energy density, can provide very high current, and require little maintenance, making them an ideal choice for many storage applications. They are being used to power cell phones, laptops, electric cars, and even grid energy storage units. Looking to the future, lithium-ion batteries have the potential to become a cornerstone of global energy production.



Lithium is generally produced by pumping brine from underground pools into surface ponds. As the water evaporates, these ponds change to colors of blue and green as seen in the picture of a Chilean lithium mine below. This process precipitates lithium chloride which is then processed into powdered lithium carbonate and lithium hydroxide. These lithium salts are used with an organic solvent as the electrolyte for lithium-ion batteries.



The problem is that, although lithium is found in many rocks and brines, it is a comparatively rare element. According to the Handbook of Lithium and Natural Calcium, "There are a fairly large number of both lithium mineral and brine deposits but only comparatively few of them are of actual or potential commercial value. Many are very small, others are too low in grade." These commercially viable lithium deposits are fairly concentrated and a majority of them are found in South America. Chile has led the charge in beginning to develop industrial scale lithium mining operations, but Bolivia, worried about negative foreign influence, has left their lithium reserves largely untouched. This has resulted in a lithium supply that cannot meet global demand and lithium carbonate prices have quadrupled in the last year.

So, is lithium the new gasoline? Let's see… nonrenewable resource? Check. Critical to meet future generations' energy needs? Yup. Lack of global supply? Mhmm. Majority of resources located in undeveloped nations? Yessiree.

The upshot is that lithium is a vitally important material for future energy production and the world is not yet prepared for its big debut. However, with advances in battery technology and lithium mining innovations on the horizon we may be able to harness the power of lithium to power our world in a whole new way.

Sources:

1) Handbook of Lithium and Natural Calcium Chloride, 1st Ed., Garrett, Donald (2004)
2) The Economist, An increasingly precious metal (2016)

ACS-SA Spring Term Schedule
FEBRUARY

February

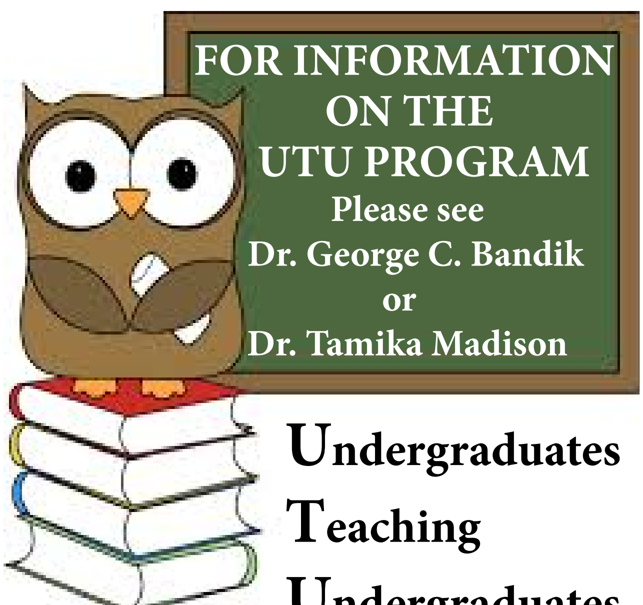
05 — ***Air Pollution Control***
with Mr. Tim Tallon
Process Combustion Corporation

12 — ***Chemical Trivia with Pizza***

19 — **Meet Our Faculty**

26 — ***The Role of Laboratory Informatics in Today's Scientific Workplace***
with Brandon Mills, Past ACS-SA President

Ever wonder what it is like on the other side of the podium? Becoming a UTU is great way to find out. As a UTU, you get the chance to teach General, Organic or Analytical Chemistry. It is a great experience, no matter what your career path is!



Undergraduates
Teaching
Undergraduates

The Kenneth P. Dietrich School of Arts & Sciences
Summer Undergraduate Research Awards

The Summer Undergraduate Research Awards provide a $3,500 stipend to conduct independent research over the course of the summer. Titles of recent SURA topics range from Internet Memes and Popular Culture to The Mirror and the Mind: Medieval Literary Mirrors and the Neuroscience of the Mirror Response. SURA recipients also enroll in a 12-week summer SURA course to learn how to communicate their research findings to a general audience.

As part of the summer awards program, all SURA recipients participate in an ethics workshop where ethics case studies are discussed with Dietrich School faculty and staff members from the Academic Resource Center and OUR. Because ethical concerns are inherent in every kind of research, the ethics workshop provides students, faculty, and staff with a meaningful opportunity to reflect on the kinds of ethical concerns that will guide young scholars far into the future.

Speak with your departmental advisor to learn how to apply for a SURA or call the OUR at 412-624-6828.

Application: https://asundergrad.secure.pitt.edu/our/summer-undergraduate-research-award

Deadline: February 29, 2016

Green Chemistry

by: Viktor Polites, Green Chemistry Contributor

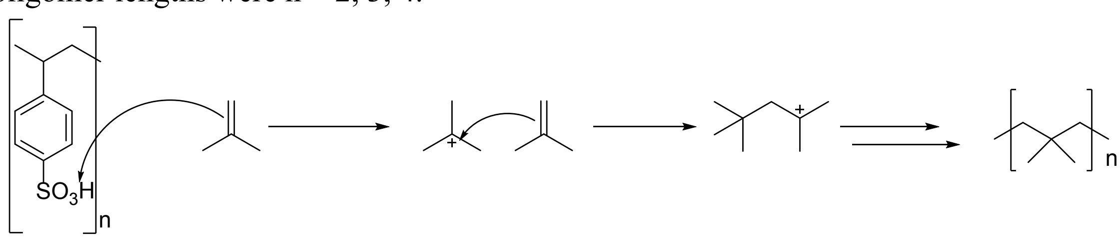
Using biomass for energy and raw materials

It is an ongoing effort to transition from using petroleum-derived fuel and raw chemicals to using those derived from renewable resources. To this end, biomass is an attractive resource since it can be converted to fuels and chemical feedstocks similar in composition to petroleum distillates, allowing existing energy and chemical infrastructure to remain intact.

Methods for producing synthetic fuels have existed for nearly a century. Being poor in petroleum resources, Nazi-Germany relied on the Fischer-Tropsch process to produce a sizeable fraction of its liquid fuel from coal during the Second World War. The feedstock (coal or biomass) is first charred to produce water and carbon monoxide. Then, the water and some sacrificial carbon monoxide is reacted to produce hydrogen and waste carbon dioxide. The hydrogen/carbon monoxide intermediate is called synthesis gas (syngas), and can be converted to liquid alkanes (Fischer-Tropsch), methanol, or exclusively hydrogen.[1]

Syngas is an attractive intermediate for synthetic fuel production because it can be produced from lignocellulose biomass such as that derived from wood, switchgrass, or agricultural wastes. Lignocellulose biomass is cheap, abundant, and inedible.[2] The drawback to syngas is that to date, no method exists which is efficient enough to produce liquid fuels that can compete with cost of petroleum distillates. Recently, Dagle and co-workers published a highly-efficient four reactor system to convert syngas into alkanes through solid-supported acid-catalyzed polymerization of isobutene followed by olefin reduction (Fig. 1).[3]

Figure 1. Abbreviated mechanism of acid-catalyzed (Amberlyst-36 resin) isobutene oligomerization. Typical oligomer lengths were n = 2, 3, 4.



To produce isobutene, syngas is converted to ethanol with a RhIrMn-catalyst. Next, using a ZnZrO catalyst, ethanol is dehydrogenated and ketonized to yield acetone. Then, the same catalyst facilitates the aldol condensation of acetone to mesityl oxide, which subsequently undergoes C-C cleaveage to isobutene and acetaldehyde.[3]

Dagle and co-workers reported that their system was overall 41% efficient in carbon; that is, 41% of carbon by weight from syngas was incorporated into the final alkanes. The isobutene oligomerization exhibited a relatively high yield (81%). The overall yield takes a hit from the ketonization step where 25% of the carbon mass is lost to the non-desired product. The authors speculate that alternative C-C bond coupling reactions could be explored which are non-sacrificial in carbon.[3]

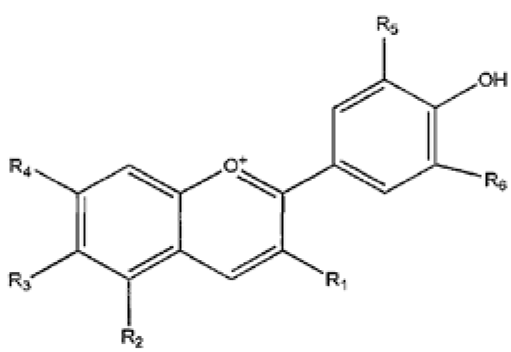
1. Leckel, D., Energy & Fuels 2009, (23), 2342-2358.
2. Huber, G. W.; Iborra, S.; Corma, A., Chem. Rev. 2006, (106), 4044-4098.
3. Dagle, V. L.; Smith, C.; Flake, M.; Albrecht, K. O.; Gray, M. J.; Ramasamy, K. K.; Dagle, R. A., Integrated process for the catalytic conversion of biomass-derived syngas into transportation fuels. Green Chem. 2016, (Advance Article).

Just What is the Color of Health?

By: Dan Willis, *Chem Major Newsletter Editor*

You might not know just from looking at it, but you're supporting European imperialist monarchies whenever you buy carrots. Specifically, orange carrots. Okay, let me explain.

Carrots have been cultivated for many centuries, originally for their leaves, which were used as fresh herbs. Modern carrots still have salvageable leaves, by the way; you can use them to finish pan sauces or even as a substitute for basil in pesto. Anyways, around the 10th century, the first carrots with edible roots were bred in modern-day Afghanistan, and these early carrots were not orange, but red, yellow and most often *purple*. That's right! The roots of early carrot plants were purple. It wasn't until the 17th century that the modern orange carrot was first developed in--where else--the Netherlands.



Dutch breeders have been so skilled throughout history, that the Dutch Embassy estimates 70% of the modern produce contains at least one trait selectively bred in the Netherlands. Orange carrots were originally bred so that dishes could be made in honor of the 17th century Dutch flag, whose orange stripe was meant to honor the Principality and Royal House of Orange.

But purple carrots are making a comeback; they've been reintroduced at trendy grocery stores because of the purported health effects of the very chemicals that give it its violet hue: anthocyanins. Anthocyanins (from the Greek for "blue flower") are a class of phytochemicals. And as you can see on the above diagram, there are six sites on the anthocyanin group which may substituted by hydrogen, hydroxy-, hydroxymethyl- groups to produce any of nine major anthocyanins, and they typically have a slightly tart flavor, a deep blue or purple color, and powerful antioxidizing properties.

Most red, blue or purple produce, including concord grapes, eggplants, blackcurrants and the very fashionable acai berry contain high concentrations of anthocyanins. But anthocyanin content can also be bred or genetically engineered into plants, resulting in produce that's allegedly healthier, but certainly more strikingly colored. You may be familiar with some of these breeds already--black cherries, blood oranges--but there are some weirder ones that are a little harder to find. Ever had the purple varieties of potato, asparagus, corn or cauliflower? How about a blue tomato? Or some ancient Chinese black rice, which was so rare, it was reserved only for royalty, and referred to by commoners as 'forbidden rice'?

Plus they're healthy too! A diet rich in antioxidizing anthocyanins has been proven to regulate blood pressure, boost immune health, improve liver function and inhibit the formation and growth of tumors. And while the betacarotene in orange carrots has been shown to improve visual acuity, so have anthocyanins. So, besides maybe availability or price, there's really no reason to choose orange over purple anymore. Besides, the current King of the Netherlands isn't even a member of the Orange family by blood anymore.

References:

1. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1082894/
2. http://www.the-netherlands.org/you-and-the-netherlands/you-and-the-netherlands%5B2%5D/about-the-netherlands/agriculture/plant-breeding--production-in-the-netherlands.html

The Science Behind Being Attractive

by: Nuria Marquez, *Co-Editor*

In my seventh grade science class I learned about pheromones. Mr. Petrossian, (tall guy, rumored to grow marijuana in the schools greenhouse), gave every single one of us fourteen-year-olds a small, plastic tube. In the tube was a clear liquid. Pheromones, he said as he instructed us to dab some of the liquid behind our ears, on our wrists, the napes of our necks. He told us to pay attention during the next 24 hours and jot down any time a stranger smiled at us or gave us any type of seemingly flirtatious attention.

It was a weird assignment for a group of recent teens in the throes of puberty. C'mon, who was going to flirt with us?

But I remember thinking about how these pheromones were something like a love potion. They could make anyone who smelled them fall in love with you and you'd be sure they were your soul mate because they were the only ones who would be able to smell it.

I was, and still am, a romantic.

There hasn't been much confirmation on whether or not pheromones are really what affect human attraction, but in the last twenty years, research has shown that there's a molecule in the immune system that may be controlling how we…choose our mates, right? That's the science way to say that?

The major histocompatibility complex (MHC), is a group of genes in the immune system of all evolved vertebrates. These proteins help the immune system recognize foreign substances in the body. Class I molecules are present in almost every cell tissue in the body, while Class II molecules are only present in macrophages and lymphocytes. In the 50s, a skin graft experiment on mice confirmed that MHC molecules were responsible for transplant rejection. The MHC molecule has been tested numerous times in both animals in the wild, like rodents, fish and birds, and humans.

In a 2008 study published by The Royal Society, the team tested the impact of MHC molecules on the mating preferences of what science calls a 'promiscuous primate,' the grey mouse lemur. What they found was that MHC constitution in lemur dads and lemur moms differed greatly. So when they were looking for a mate, they were most attracted to lemurs of the opposite sex with dissimilar immune systems. Which makes sense because at the end of the day, animals want to make the healthiest and fittest offspring, one that has the strongest and most diverse immune system.

This isn't the only animal that has been studied for MHC compatibility. Scientists tested wild Atlantic salmon against artificially bred salmon. They found that the wild salmon offspring were more MHC-dissimilar than the artificially bred salmon which actually had four times more parasites than wild salmon. In another study, it was shown that female Savannah sparrows who are paired with mates who have similar MHC molecules will seek out 'extra-pair relationships' with other sparrows who have different MHC make-up. There's been studies with lizards, mice, charr, rosefinches…you guys get it.

And they found the same thing in humans. The original study was conducted in 1995 with a group of 121 women and men. They were asked to smell sweaty t-shirts and rank them based on pleasantness. Males and females who were reminded of their current or ex-mate based on the smell ranked those t-shirts higher than others. The wearers of those t-shirts had very few, if any, MHC alleles in common with the subjects. Which confirmed that although it's not the only factor in attraction, MHC-composition certainly plays a role in who we choose to spend the day with.

So with that information, I wish you all a wonderful Smelling Day…I mean, Valentine's Day! Duh!