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GOSSIP

CURIOSITIES

TECHNICAL NOTES

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ASIA PACIFIC

Variation of Inventory listing following revocation of CBI approval - 7 August 2023

2023-08-07

The Executive Director varied the terms of the Inventory listings for the following chemicals because approval had been revoked for the proper names of the industrial chemicals to be treated as confidential business information (CBI). The terms of the listings as varied are:

CAS number	390359-18-9
Chemical name	Benzoic acid, 4-methoxy-, 1,1' -(1,6-hexanediyl) ester
Molecular formula	C22H26O6
Specific information requirements	Obligations to provide information apply. You must tell us within 28 days if the circumstances of your importation or manufacture (introduction) are different to those in our assessment.
Listing date	14 July 2023

CAS number	1225046-56-9
Chemical name	2-Propenoic acid, 2-methyl-, hexadecyl ester, polymer with ethene, ethenyl acetate, 2-hydroxyethyl 2-methyl-2-propenoate, isodecyl 2-methyl-2-propenoate and octadecyl 2-methyl-2-propenoate
Molecular formula	(C22H42O2.C20H38O2.C14H26O2.C6H10O3.C4H6O2.C2H4)x
Specific information requirements	Obligations to provide information apply. You must tell us within 28 days if the circumstances of your importation or manufacture (introduction) are different to those in our assessment.
Listing date	4 August 2023

Read More

AICIS, 07-08-23

https://www.industrialchemicals.gov.au/news-and-notices/variation-inventory-listing-following-revocation-cbi-approval-7-august-2023

China investigates domestic production and usage of medium-chain chlorinated paraffin and long-chain PFCAs

2023-08-04

On July 20, 2023, the Ministry of Ecology and Environment of China issues a notice to start collecting information on the production, uses, import/export, alternative substances and alternative technologies of "long-chain perfluorocarboxylic acids and their salts and related compounds" (long-chain PFCAs) and "medium-chain chlorinated paraffin" (MCCPs), which will be reviewed at the nineteenth meeting of the POPs Review Committee (POPRC19) of the Stockholm Convention. The information collection will last until August 27, 2023.

Chemicals seeking information:

- Long-chain perfluorocarboxylic acids and their salts and related compounds

According to the draft risk management evaluation released by the POPRC19 of the Stockholm Convention on July 4, 2023, the long-chain PFCAs are recommended for consideration by the Conference of the Parties for listing in Annexes A-Elimination with specific exemptions.

- Medium-chain chlorinated paraffin (Chlorinated paraffins with carbon chain lengths in the range C14-17 and chlorination levels at or exceeding 45 per cent chlorine by weight)

According to the draft risk management evaluation released by the POPRC19 of the Stockholm Convention on July 4, 2023, MCCPs are recommended for consideration by the Conference of the Parties for listing in Annexes A-Elimination to the Convention with specific exemptions, and a specified concentration limit for the level of these components in other chlorinated paraffin commercial products.

Information to be collected:

- Production and uses (production volume, usage volume and purpose of use, etc.)

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- Alternative substances and alternative technologies (introduction of alternative products and alternative technologies, substitution costs and substitution effects).

Read More

Envillance, 04-08-23

https://enviliance.com/regions/east-asia/cn/report_10629

China releases draft of 2023 guidelines on development of standards for carbon peaking, carbon neutrality in industry

2023-07-24

On May 22, 2023, China's Ministry of Industry and Information Technology released a draft of 2023 guidelines on the development of standards for carbon peaking and carbon neutrality in the industry sector. The ministry is accepting comments on the draft through June 22, 2023. The draft guidelines provide frameworks for standards for carbon peaking and carbon neutrality in industry and include a list of standards under development and revision.

Development targets:

- By 2025, develop most of the standards for carbon peaking and carbon neutrality in industry.
- Develop over 200 standards immediately needed to achieve carbon peaking.
- Develop standards with focuses on basic and general standards, calculation and verification standards, low-carbon technology and equipment standards, etc. as key areas; and provide technical support for carbon dioxide emissions assessment, emissions reduction, etc. in industry.
- Expedite the consideration and development of standards for carbon dioxide emissions management and assessment, promote further emissions reduction in industry, and lead the low-carbon and high-quality development of relevant industries.

Main points of the draft guidelines:

Standards for carbon peaking and carbon neutrality in industry are classified into five categories: basic and general standards, calculation and verification standards, technology and equipment standards, monitoring

standards, and management and evaluation standards. Here is an outline of the standards categories:

Basic and general standards include standards for:

- terminology,
- data quality,
- labeling of greenhouse gas emissions and emissions reduction,
- carbon labeling of products, and
- low-carbon evaluation labeling.

Read More

Enviliance, 24-07-23

https://enviliance.com/regions/east-asia/cn/report_10532

AMERICA

US FDA wants to strengthen post-market review of food contact substances

2023-08-04

The US Food and Drug Administration (FDA) announced it is revamping its process to reassess food contact substances after release on the market. According to the press release, "the FDA is embarking on a more modernized, systematic reassessment of chemicals with a focus on post-market review." Currently, agency-initiated reviews of post-market substances have low priority since most of the other processes come with strict response deadlines. So, "we [the FDA] are working to develop new approaches to mine existing data more efficiently and prioritize substances for in-depth review based on risk."

A food contact substance at the US FDA includes food additives as well as chemicals from food packaging and processing equipment. Currently, most reviews take place either before a chemical goes on the market or in response to stakeholder petitions (FPF reported).

The FDA has been under fire in the last year for seemingly prioritizing the work of the drugs part of the agency over that of the food branch (FPF reported). Civil society organizations particularly highlighted in recent years the slow pace of change and the reliance on industry self-reporting to be classified "generally recognized as safe" (GRAS, FPF reported, also here and here). Both the US Congress' General Accountability Office and

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an independent panel commissioned by the FDA suggested structural changes in late 2022 (FPF reported here and here, respectively) and this recent re-focusing effort is part of implementing the proposed changes.
Read More

FPF, 04-08-23

https://www.foodpackagingforum.org/news/us-fda-wants-to-strengthen-post-market-review-of-food-contact-substances

FDA Issues Draft Guidance on Registration and Listing of Cosmetic Product Facilities and Products

2023-08-07

The U.S. Food and Drug Administration, today, issued draft guidance on cosmetic product facility registrations and product listings, as mandated by the Modernization of Cosmetics Regulation Act of 2022 (MoCRA).

When finalized, the draft guidance will assist stakeholders with cosmetic product facility registration and product listing submissions to FDA, by describing who is responsible for making the registration and listing submissions, what information to include, how to submit, and when to submit, as well as certain exemptions to the registration and listing requirements.

MoCRA provided new authorities to FDA including:

- Facility Registration: Cosmetic product manufacturers and processors must register their facilities with FDA, update content within 60 days of any changes, and renew their registration every two years.
- Product Listing: A responsible person must list each marketed cosmetic product with FDA, including product ingredients, and provide any updates annually.

Responsible person means the manufacturer, packer, or distributor of a cosmetic product whose name appears on the label of such cosmetic product in accordance with section 609(a) of the FD&C Act or section 4(a) of the Fair Packaging and Labeling Act.

Exemptions:

MoCRA exempts certain small businesses from facility registration and product listing requirements.

However, such exemptions do not apply to facilities that manufacture or process, or responsible persons for, the following cosmetic products:

- Products that regularly come into contact with mucus membrane of the eye under customary or usual conditions of use.
- Products that are injected.
- Products that are intended for internal use.
- Products that are intended to alter appearance for more than 24 hours under customary or usual conditions of use and removal by the consumer is not part of such conditions of use.

Read More

FDA, 07-08-23

https://www.fda.gov/cosmetics/cosmetics-news-events/fda-issues-draft-guidance-registration-and-listing-cosmetic-product-facilities-and-products

How Will EPA's Proposed Power Plant Carbon Rule Impact Public Health?

2023-08-10

We are at the height of Danger Season, the time of year when extreme weather events driven by climate change are most prevalent across North America. The power sector is the second highest source of climate pollution in the U.S. thus, it is crucial that we address carbon emissions from power plants.

The Environmental Protection Agency (EPA) recently published a proposed rule which would limit carbon pollution from fossil fuel burning power plants, a move which is critically important, statutorily required, and long overdue.

Dr. Marc Futernick, an emergency physician in Los Angeles and steering committee chairman at the Medical Society Consortium on Climate and Health, spoke with me about how the rule would impact public health and how as a medical professional he participates in the public process to help influence these standards.

Read More

The Equation, 10-08-23

https://blog.ucsusa.org/brady-watson/how-will-epas-proposed-power-plant-carbon-rule-impact-public-health/

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Recent EPA Actions Show Why Companies Must Understand Products' Individual Chemical Constituents

2023-08-09

Historically, the US Environmental Protection Agency (EPA) has generally declined to regulate manufactured goods or finished products' known as "articles" ' under the Toxic Substances Control Act (TSCA). This long-standing practice seems to now be falling by the wayside, however, as EPA has begun affirmatively including articles in many new regulatory measures under TSCA. For companies that import, manufacture, process, or distribute finished goods for commercial sale, it is more critical than ever to know what chemicals are contained in those products.

TSCA regulations define "articles" to include manufactured goods or finished products. In 2021, Michal Freedhoff, whose legislative work includes the 2016 reauthorization of TSCA and who now heads EPA's chemicals program office, made clear that the individual chemical constituents of articles can be subject to regulation under TSCA.

Additionally, in recent regulatory actions EPA has proposed (in the case of still-pending regulations) or required that companies know whether per- and polyfluoroalkyl substances (PFAS); persistent, bioaccumulative, and toxic (PBT) substances; methylene chloride; perchloroethylene (PCE); or carbon tetrachloride are in any product that the company manufactures, imports, processes, or distributes, including in the products' internal components.

Freedhoff's 2021 comments confirm that these are not isolated regulatory actions, but the result of a significant policy shift in EPA's use of its authority to regulate "articles." Similar regulatory actions for additional substances are anticipated to follow. As Freedhoff forewarned, it is becoming increasingly important for companies to communicate with their supply chains about the composition of their parts and products to ensure they can comply with future TSCA regulations.

Read More

JDSupra, 09-08-23

https://www.jdsupra.com/legalnews/recent-epa-actions-show-why-companies-9273700/

EUROPE

Europe - CLP is being updated: 19th and 20th ATPs

2023-07-25

The 19th and 20th ATPs of CLP

On July 11th 2023 **Regulations 2023/1434** and **2023/1435**, corresponding to the **19th and 20th ATPs** respectively, have been published on the official EU journal. These

Regulations amend Regulation 1272/2008 (CLP).

19th ATP: what's new?

The **19th ATP** updates Annex VI to Regulation 1272/2008 (CLP) by adding three new notes:

Note X:

The classification for the hazard class(es) in this entry is based only on the hazardous properties of the part of the substance which is common to all substances in the entry. The hazardous properties of any substances in the entry also depend on the properties of the part of the substance which is not common to all substances in the group. The latter must be evaluated to assess whether more severe classification(s) (i.e., a higher category) or a broader scope of the same classification (additional differentiation, target organs and/or hazard statements) might apply for the hazard class(es) in the entry.

Note 11:

The classification of mixtures as reproductive toxicant is necessary if the sum of the concentrations of individual boron compounds that are classified as reproductive toxicant in the mixture as placed on the market is ≥ 0,3 %

Note 12:

The classification of mixtures as reproductive toxicant is necessary if the sum of the concentrations of individual substances covered by this entry in the mixture as placed on the market is equal to, or above, the applicable generic concentration limit for the assigned category, or a specific concentration limit given in this entry Of particular relevance are Note 11 and Note 12, which modify the classification criteria as Reprotoxicant of

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mixtures containing substances with Note 11 or Note 12 as part of their harmonized classification.

20th ATP: what's new?

The **20th ATP** updates Annex VI to CLP by modifying four entries with the addition of Note 11 to boric acid (Index: 005-007-00-2), diboron trioxide (Index: 005-008-00-8) and various disodium salts (Index: 005-011-00-4) and, among other changes, by adding Note X and 12 to 2-ethylhexanoic acid and its salts (Index: 607-230-00-6).

19th and 20th APTs: when?

Both ATPs will come into force on 31st of July 2023. The new notes, introduced by the **19th ATP**, will be applied in the amended Annex VI entries of **20th ATP** for the first time.

Read More

Selerant, 25-07-23

https://selerant.com/resources/ehs-blog-en/europe-clp-is-beign-updated-19th-and-20th-atps

REGULATION (EU) 2023/988

2023-08-04

New regulation for consumer products

On 12th June 2023, the **General Product Safety Regulation (EU) 2023/988 (GPSR)** entered into force. Until 13th December 2024, this new regulation will exist alongside the Directive 2001/95/EC on general product safety (GPSD).

This new regulation revises and updates the GPSD in light of new technologies and online selling, which has created new business models, challenges for product safety, and new economic operators on the market. Ensuring better product safety is vital to protecting consumers and providing safe products.

Economic operators and consumers should be aware of the below changes under GPSR:

- The legislation for product safety in European Union(EU) is now classified as a regulation, meaning that it is directly applicable in all Member States and can be immediately enforced (unlike as a directive,

in which case each Member State must transpose it into national law within a specific timeframe).

- Economic operators and providers of online marketplaces should be obliged to place only safe products on the market.
- New definition of economic operators and providers of online marketplaces have been defined, as well as their obligations.
- Manufacturers should draw up technical documentation regarding the products they place on the market, which should contain the necessary information to prove that those products are safe. The technical documentation should be based on an internal risk analysis carried out by the manufacturer and this information must be kept for 10 years.
- Information about the identification of a product and the economic operators, as well as instructions and safety information, may additionally be provided by the economic operators in a digital form by means of electronic solutions, such as a QR or data matrix code.

Read More

Eurofins, 04-08-23

https://www.eurofins.com/consumer-product-testing/media-centre/news/regulation-eu-2023988/

INTERNATIONAL

Canada and Germany propose plans to reduce plastic, support reusable packaging

2023-08-03

The Canadian government published a pollution prevention planning notice for plastic food packaging as part of ongoing efforts to address plastic waste and pollution (FPF reported). The proposed notice would require large Canadian grocery retailers (defined in the document as retailers that generate grocery retail sales in Canada over $4 billion annually) to formulate and apply a pollution prevention plan to meet reuse and recycle targets by eliminating unnecessary packaging, displacing single-use packaging with reuse-refill systems, and providing food-safe plastics designed to be reused, recycled, and composted in Canadian facilities.

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The Government of Canada's proposed objectives for the pollution prevention plan:

- "Reduce the environmental impact of primary food plastic packaging along the value chain to the greatest extent practicable through the elimination of unnecessary or problematic packaging and design for circularity" by 2035.
- 75% of "[f]resh fruits and vegetables are distributed and sold in bulk and/or plastic-free packaging" by 2026, and 95% by 2028.
- "All primary food plastic packaging is reusable, recyclable, or compostable" by 2028.
- "Develop strategies, outside of fresh produce, to increase, by a certain percentage, the sale of products within a reuse-refill system, products free of plastic packaging, and/or concentrated products", 20% by 2026, 50% by 2030, and 60% by 2035.
- "Non-reusable plastic food packaging contains post-consumer recycled content", 10% by 2028, 20% by 2030, and 30% by 2035.

Read More

FPF, 03-08-23

https://www.foodpackagingforum.org/news/canada-and-germany-propose-plans-to-reduce-plastic-support-reusable-packaging

REACH Update

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Current calls for comments and evidence

2023-08-10

Calls for comments and evidence allow interested parties to signal their interest and express their views and concerns in the preparatory phase of the restriction proposal. They also let interested parties comment on the different documents under preparation in ECHA in relation to restrictions, such as reports on substances in articles and guidelines on restriction entries.

Additional information to justify or support comments made is also welcomed. The information gathered will provide an input into developing Annex XV restriction dossiers or other documents. When we open a call for comments and evidence, we intend to give parties who otherwise might not have been identified and consulted a chance to submit information.

The calls for comments and evidence do not take the place of the public consultation on restriction proposals developed by Member States or ECHA, which forms a standard part of the restriction process.

Consultations close at 23:59 Helsinki time.

Current calls for comments and evidence

Name	EC Number	CAS Number	Start of	Deadline for	Subject of the call	
UV-328	247-384-8 223-383-8 253-037-1 223-346-6	25973-55-1 3864-99-1 36437-37-3 3846-71-7			Call for	Details

Read More

ECHA, 10-08-23

https://echa.europa.eu/calls-for-comments-and-evidence

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Janet's Corner

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Culture

2023-08-18

https://twitter.com/ErrantScience/status/1639235246314094593

1,1,2-Trichloroethane

2023-08-18

USES [2,3]

1,1,2-Trichloroethane is used as a chemical intermediate and a solvent. 1,1,2-Trichloroethane is primarily used as a chemical intermediate in the production of 1,1-dichloroethene. It is also used as a solvent for chlorinated rubbers, fats, oils, waxes, and resins.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

Industry sources: The primary sources of 1,1,2-Trichloroethane emissions are the industries that manufacture it or use it in production. Some of the industries that use it in production are the chemical industry, rubber manufacturers, heavy equipment manufacturing, the timber products industry, the plastics and synthetics industries and laundries. These are emissions to the air unless there is a spill.

Diffuse sources: Other possible emitters of 1,1,2-Trichloroethane are the electronics industry (solvent use) and manufacturers of fabricated metal parts.

Natural sources: 1,1,2-Trichloroethane does not occur naturally in the environment.

Transport sources: No mobile sources.

Consumer products: Aerosol paint concentrates.

Routes of Exposure

1,1,2-Trichloroethane can enter the body when a person breathes air contaminated with it, or when a person drinks water containing this compound. It can also enter the body through the skin. After it enters the body, it is carried by the blood to organs and tissues such as the liver, kidney, brain, heart, spleen, and fat.

Experiments in which animals were given 1,1,2- trichloroethane by mouth have shown that most 1,1,2-trichloroethane leaves the body unchanged in the breath and as other substances that it was changed into in the urine in about 1 day. Very little stays in the body more than 2 days.

1,1,2-Trichloroethane, or 1,1,2-TCE, is an organochloride solvent with the molecular formula C2H3Cl3. It is a colourless, sweet-smelling liquid that does not dissolve in water, but is soluble in most organic solvents. [1] 1,1,2-Trichloroethane does not burn easily and boils at a higher temperature than water.[1,2]

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HEALTH EFFECTS [4]

Acute Health Effects

In high concentrations, in air, with closed or poorly ventilated areas, single exposures to 1,1,2-Trichloroethane may cause central nervous system effects leading to dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking or walking, and possibly unconsciousness, coma and death. It is a narcotic at high levels. Exposures to vapour concentrations near 2,000 parts per million for five minutes cause central nervous system depression and the effect of being anaesthetised. Adverse liver and kidney effects have are possible from high exposures or from long-term exposure to 1,1,2-Trichloroethane. It will also defat the skin causing irritation and dryness. Other effects may include headache, tremor, dizziness, and irritation of the eyes, nose and throat.

Carcinogenicity

- No studies are available regarding cancer in humans from inhalation or oral exposure.
- A study by the National Toxicology Program reported liver tumours and adrenal tumours in mice, but no tumours in rats from exposure to 1,1,2-trichloroethane by gavage.
- EPA has classified 1,1,2-trichloroethane as a Group C, possible human carcinogen.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.
- **Skin Contact:** After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.
- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

- **Inhalation:** Allow the victim to rest in a well-ventilated area. Seek immediate medical attention.
- **Serious Inhalation:** Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.
- **Ingestion:** Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Workplace Controls & Practices [4]

Control measures include:

- Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value.
- Ensure that eyewash stations and safety showers are proximal to the workstation location.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling 1,1,2-trichloroethane:

- Splash goggles;
- Lab coat;
- Gloves

Personal Protection in Case of a Large Spill:

- Splash goggles;
- Full suit;
- Boots;
- Gloves;
- Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

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REGULATION

United States

OSHA: Occupational Safety & Health Administration has established the following Permissible Exposure Limits (PEL):

- **General Industry:** 29 CFR 1910.1000 Z-1 Table -- 10 ppm, 45 mg/m3 TWA; Skin
- **Construction Industry:** 29 CFR 1926.55 Appendix A -- 10 ppm, 45 mg/m3 TWA; Skin
- **Maritime:** 29 CFR 1915.1000 Table Z-Shipyards -- 10 ppm, 45 mg/m3 TWA; Skin

ACGIH: American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for 1,1,2-trichloroethane of 10 ppm, 55 mg/m3 TWA for an 8-hour workday in a 40-hour workweek.

NIOSH: National Institute for Occupational Safety and Health has established a Recommended Exposure Limit (REL) for 1,1,2-trichloroethane of 10 ppm, 45 mg/m3 TWA;

EPA: The Environmental Protection Agency has set a limit of 0.005 milligrams of 1,1,2-trichloroethane per litre of drinking water (0.005 mg/L). Discharges, spills, or accidental releases of 100 pounds or more of 1,1,2-trichloroethane must be reported to the EPA.

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3. http://www.epa.gov/ttn/atw/hlthef/tri-etha.html
4. http://www.npi.gov.au/resource/112-trichloroethane
5. http://www.sciencelab.com/msds.php?msdsId=9927632
6. https://www.osha.gov/dts/chemicalsampling/data/CH_272900.html

The same metal found on hot rods and Harleys could revolutionize solar panels

2023-08-16

Whenever a company's fridge, tool, or other item is advertised as "stainless steel," they have chromium to thank. Manufacturers have long valued the hard, shiny metal's anticorrosive properties, and adding it into steel allows it to resist degradation and tarnishing. Meanwhile, electroplating a thin layer of chromium atop another metal produces what is commonly known as chrome plating—think Harley-Davidson motorcycles, or hot-rod cars. Chrome can reflect as much as 70 percent of visible spectrum light, as well as 90 percent of infrared radiation.

According to findings recently published in Nature Chemistry from a team at Switzerland's University of Basel, carefully substituting chromium into catalysts and luminescent materials also works nearly as well as their traditional noble metal components, osmium and ruthenium, but for a fraction of the cost. What's more, chromium is 20,000 times more common within the Earth's crust than either noble meta—both of which are nearly as rare as gold or platinum.

As The Independent explained on August 14, the team first inserted chromium atoms next to hydrogen, carbon, and nitrogen within a stiff molecular framework. In this array, chromium was much more reactive than its noble metal counterpoints, while simultaneously keeping energy loss at a minimum during molecular vibrations.

When irradiated by a red lamp, the chromium compound also stored energy within its molecules for potential later use, much like a plant's photosynthesis. "Because of this, there's also the potential to use our new materials in artificial photosynthesis to produce solar fuels," Oliver Wenger, research lead and a professor within the University of Basel's department of chemistry, said in a recent statement.

Although previous research into noble metal alternatives investigated the potential of using iron and copper to some success, chromium initially appears to perform much better than either option. That said, Wenger concedes that "it seems unclear which metal will ultimately win the race when it comes to future applications in luminescent materials and artificial photosynthesis."

Going forward, Wenger's team hopes to scale their research to be tested in other applications, which could allow molecules to glow across the color spectrum to include red, green, and blue hues. Additionally, optimizing its catalytic attributes could further push it towards a viable alternative material to use in solar power arrays.

Some of the most expensive and difficult-to-source materials found in smartphone screens and solar cells may soon be phased out for a cheaper, exponentially more common substitute. This substitute isn't a new find—it is actually most often associated with kitchen appliances and motorcycles.

Popular Science, 16 August 2023

https://popsci.com

Microplastic pollution: New device uses wood dust to trap up to 99.9% of microplastics in water

2023-08-16

While the experiment remains a lab set-up at this stage, the team is convinced that the solution can be scaled up easily and inexpensively once they find the right industry partner.

Microplastics are tiny pieces of plastic debris resulting from the breakdown of consumer products and industrial waste. Keeping them out of water supplies is a huge challenge, says Dr. Orlando Rojas, the institute's scientific director and the Canada Excellence Research Chair in Forest Bioproducts.

He noted one study which found that virtually all tap water is contaminated by microplastics, and other research which states that more than 10 billion tons of mismanaged plastic waste will be dispersed in the environment by 2025.

"Most solutions proposed so far are costly or difficult to scale up. We're proposing a solution that could potentially be scaled down for home use or scaled up for municipal treatment systems. Our filter, unlike plastic filters, does not contribute to further pollution as it uses renewable and biodegradable materials: tannic acids from plants, bark, wood and leaves, and wood sawdust—a forestry byproduct that is both widely available and renewable."

Captures a wide variety of plastics

For their study, the team analyzed microparticles released from popular tea bags made of polypropylene. They found that their method (they're calling it "bioCap") trapped from 95.2 percent to as much as 99.9 percent of plastic particles in a column of water, depending on plastic type. When tested in mouse models, the process was proved to prevent the accumulation of microplastics in the organs.

Dr. Rojas, a professor in the departments of wood science, chemical and biological engineering, and chemistry at UBC, adds that it's difficult to

Could plants be the answer to the looming threat of microplastic pollution? Scientists at UBC's BioProducts Institute found that if you add tannins—natural plant compounds that make your mouth pucker if you bite into an unripe fruit—to a layer of wood dust, you can create a filter that traps virtually all microplastic particles present in water.

capture all the different kinds of microplastics in a solution, as they come in different sizes, shapes and electrical charges.

"There are microfibers from clothing, microbeads from cleansers and soaps, and foams and pellets from utensils, containers and packaging. By taking advantage of the different molecular interactions around tannic acids, our bioCap solution was able to remove virtually all of these different microplastic types."

Collaborating on sustainable solutions

The UBC method was developed in collaboration with Dr. Junling Guo, a professor at the Center of Biomass Materials and Nanointerfaces at Sichuan University in China. Marina Mehling, a Ph.D. student at UBC's department of chemical and biological engineering, and Dr. Tianyu Guo, a postdoctoral researcher at the BioProducts Institute, also contributed to the work.

"Microplastics pose a growing threat to aquatic ecosystems and human health, demanding innovative solutions. We're thrilled that the BioProducts Institute's multidisciplinary collaboration has brought us closer to a sustainable approach to combat the challenges posed by these plastic particles," said Dr. Rojas.

Phys Org, 16 August 2023

https://phys.org

Pyrolysed plastic waste converted into valuable chemical feedstocks

2023-08-16

Despite huge pressure to address the growing plastic waste problem, recycling rates remain low, with less than 10% of global plastic waste effectively recycled. One of the biggest stumbling blocks is the challenge of developing an economically efficient treatment process. While researchers have developed many different ways to chemically degrade plastics, the cost of operating these processes on scale typically exceeds the value of the repurposed products, making these strategies unfeasible without extensive government subsidies.

With these economic considerations in mind, two teams in the US have now developed alternative chemical upcycling processes that take advantage of existing industrial infrastructures to produce high-value products at low cost.

New methods of upcycling plastic waste into high-value chemical feedstocks could provide a crucial economic incentive to improve future rates of plastic recycling. By exploiting reactive chemical groups present in degraded plastics, two research teams have developed new ways of preparing valuable products using robust and established chemistry.

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Exploiting the olefins

Pyrolysis is currently the most common way to recover hydrocarbons from plastic and involves heating the waste to high temperatures. The long polymer chains thermally decompose through a radical mechanism, forming an olefin-rich mixture known as pyrolysis oil which can then be used as a fuel for other industrial processes. However, George Huber from the University of Wisconsin–Madison believes we could extract greater value from this hydrocarbon mixture by exploiting the high proportion of alkenes present in the oil. 'The whole chemical industry is based on first making an olefin from crude oil and then using that to access all these different chemistries,' he explains. 'So why not take advantage of the olefin functionality in pyrolysis oil and use it to make higher-value chemicals rather than just making fuels from it, or feeding it back to a steam cracker?'

The team pyrolysed a mixture of polyethylene and polypropylene post-consumer waste and distilled batches of the pyrolysis oil obtained into cuts of similar-sized alkenes. They subjected these separated fractions to industrial hydroformylation conditions, converting the olefins into aldehydes using carbon monoxide and hydrogen in the presence of a cobalt catalyst. The resulting aldehyde mixtures could then undergo further reactions such as hydrogenation, amination, or oxidation to create higher-value chemical products including diols, amines, and fatty acids. 'We're making products that are worth five to 20 times more than the current products of pyrolysis oil,' says Huber 'Our most valuable products are the diols – they're worth $3000–5000 [£2400–4000] per ton and we can make them to 99.99% purity with this technology.'

Controlling pyrolysis

At Virginia Tech, Guoliang Liu was likewise keen to exploit the alkenes produced when plastics thermally decompose. His team was particularly interested in larger hydrocarbon fragments and developed a specialised reaction vessel that applied a temperature gradient over the pyrolysis step to control the size of the breakdown products. 'The temperature is just high enough to partially break some of the bonds in the polymer chains so we produce short-chain waxes rather than small molecules,' explains Liu. 'The products are evaporated and then condensed in a colder region of the vessel, so the thermal gradient controls the extent of chain scission.'

Oxidation over a manganese catalyst in a second vessel then converts these waxy alkenes into long-chain fatty acids – widely used in surfactant products such as soaps and detergents and worth around four times as much as the virgin plastic. 'Practically, the economic value of recycled

products must be higher than the plastic waste to provide sufficient financial incentive for industrial deployment of the recycling processes,' says Liu. 'If we can design these processes with an economic mindset, we have a higher likelihood of pushing the technology from the lab to a commercial reality.'

A positive forecast

Susannah Scott, a sustainable catalysis researcher at the University of California Santa Barbara, US was impressed by both teams' work and is optimistic about the future of chemical recycling solutions. 'Processes like these are the key to molecular recycling of polymers,' she says. 'A strength of both is that the processes are simple, the catalysts are inexpensive and robust, and the products are suitable for a variety of fairly large-scale uses, with the potential to displace fossil fuel-based chemicals. Waste plastics are a hydrocarbon source not much different from crude oil and can eventually be a substitute for oil in a circular carbon economy.'

Both teams have already performed preliminary economic analyses of their methods and forecast that sale of their chemical products would be profitable at the 10,000-ton scale, with larger production plants potentially recouping the initial investment cost within as little as three years. In the immediate future, they will each be working with industrial partners to develop their products and methods at a larger scale, with the ultimate aim of translating these processes into commercial treatments for plastic waste.

Chemistry World, 16 August 2023

https://chemisrtryworld.com

Climate change is messing with photosynthesis in unexpected ways

2023-08-14

New science has showed the rate of photosynthesis around the globe has been increasing, but now there is evidence the rate has slowed and might soon plateau.

During photosynthesis plants take water and CO2 and convert it into oxygen and carbohydrates – storing carbon inside the plant and soil. A higher availability of CO2 increases the rate of this process, acting as a sort of brake on global warming by sequestering more CO2.

Increases in CO2 in the atmosphere brought about by anthropogenic activity was expected to increase the rate of photosynthesis in plants and perhaps increase plant yield and growth.

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However, a new modelling study, published in the journal Science, has found that the increase in photosynthesis has slowed since 2001 due to an adverse effect of climate change.

The study looked at satellite images of various environments covered by foliage – such as savannas, croplands, and forests – and used machine-learning to find changes, such as leaf colour, to reveal rates of photosynthesis. They also studied data on CO2 and water vapour levels in the air between 1982-2016.

Combining these datasets, they modelled changes in global photosynthesis rates from 1982 to 2016 and found that, as CO2 levels rose from 1982 to 2000, global rates of photosynthesis also increased significantly. But from the year 2000 onwards, this increase in the rate of photosynthesis began to slow.

The researchers think this is probably due to an increased vapour pressure deficit, or VPD. VPD is the difference between the amount of moisture in the air and how much moisture the air can hold when it is saturated – basically it's a measure of how dry air is.

Increased VPD (drier air) imposes water stress on photosynthesis because it causes more water to evaporate from plants' tissues through transpiration.

Transpiration predominantly occurs through a small opening in the leaves of plants, called stomata. But, if too much water is lost too quickly, plants close the stomata to slow transpiration. This effects photosynthesis because CO2 also enters the plant through these pores when they're open.

"As a result of temperature rise-induced increases in VPD, global ecosystem photosynthesis has become suppressed and, thus, so has the ability of global ecosystems to assimilate carbon," the authors write in their study.

The authors suggest that existing climate data and projections indicate that this trend will likely continue into the future. Increasing VPD is "projected to persist at least into 2050, and possibly beyond in response to rising air temperature" and the resulting impact on photosynthesis is expected to be long-lasting.

They conclude that "this study emphasises that human reliance on nature-based climate sinks to achieve [carbon] neutrality may be undermined by the adverse effects of climate change."

website, date

https://cosmosmagazine.com

Phytoplankton Used To Fight Waterway Mercury Contamination

2023-08-10

Phytoplankton, or microalgae, are known as accumulators of methylmercury. The plankton introduce methylmercury into the food chain, where it makes its way to fish and eventually to humans. But researchers found that some forms of phytoplankton are also good at detoxifying methylmercury, even where there is no sunlight.

"We already knew that bacteria and photochemical processes can demethylate methylmercury, but we proved that phytoplankton alone could do the job," said ORNL's Baohua Gu.

"The global mercury cycle is very complex, with lots of reactions taking place," said ORNL's Alex Johs. "Here we've discovered a new mechanism that can be used to improve the prediction and accuracy of mercury-cycling models to better assess risks to human health and the environment."

Reference: Liang X, Zhong H, Johs A, et al. Light-independent phytoplankton degradation and detoxification of methylmercury in water. Nat Water. Published online August 7, 2023:1-11. doi:10.1038/s44221-023-00117-1

Technology Networks, 10 August 2023

https://technologynetworks.com

Metal–organic framework encourages iron centre in ferrocene to oxidise

2023-08-11

Ferrocene contains an iron atom sandwiched between two cyclopentadiene rings. Ever since it was first made over 70 years ago, chemists have unpicked the organometallic molecule's distinct reactivity, thermal and chemical stability, steric properties and redox activity.

In the search for ways to fight methylmercury in global waterways, scientists at Oak Ridge National Laboratory discovered that some forms of phytoplankton are good at degrading the potent neurotoxin.

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However, scientists have never managed to oxidise ferrocene's iron centre – until now.

Timo Thonhauser, from Wake Forest University in the US, and colleagues devised a cobalt-based MOF to overcome ferrocene's unreactive iron centre. The cobalt atoms form chains that can either be ferromagnetic or anti-ferromagnetic in nature. Adsorbing ferrocene into an anti-ferromagnetic chain sees the sandwich compound's structure bend, which weakens the ligand field energy of the cyclopentadiene rings and allows iron to take on a high-spin state.

Oxygen in the air oxidises this high-spin iron, pushing the cyclopentadiene ligands apart to give ferrocene a more angular shape. This structure is distinct to the commonly known sandwich complex motif.

The work extends scientists' understanding surrounding the electronic and magnetic structure of ferrocene so could feed into research developing oxygen storage systems and artificial blood.

Chemistry World, 11 August 2023

https://chemistryworld.com

Protein Explains How Part of the Nucleolus Evolved

2023-08-16

Inside all living cells, loosely formed assemblies known as biomolecular condensates perform many critical functions. However, it is not well understood how proteins and other biomolecules come together to form these assemblies within cells.

MIT biologists have now discovered that a single scaffolding protein is responsible for the formation of one of these condensates, which forms within a cell organelle called the nucleolus. Without this protein, known as TCOF1, this condensate cannot form.

The findings could help to explain a major evolutionary shift, which took place around 300 million years ago, in how the nucleolus is organized. Until that point, the nucleolus, whose role is to help build ribosomes, was divided into two compartments. However, in amniotes (which include reptiles, birds, and mammals), the nucleolus developed a condensate that acts as a third compartment. Biologists do not yet fully understand why this shift happened.

A single protein is critical for the formation of part of the nucleolus, giving clues to how the nucleolus evolved.

"If you look across the tree of life, the basic structure and function of the ribosome has remained quite static; however, the process of making it keeps evolving. Our hypothesis for why this process keeps evolving is that it might make it easier to assemble ribosomes by compartmentalizing the different biochemical reactions," says Eliezer Calo, an associate professor of biology at MIT and the senior author of the study.

Now that the researchers know how this condensate, known as the fibrillar center, forms, they may be able to more easily study its function in cells. The findings also offer insight into how other condensates may have originally evolved in cells, the researchers say.

Former MIT graduate students Nima Jaberi-Lashkari PhD '23 and Byron Lee PhD '23 are the lead authors of the paper, which appears today in Cell Reports. Former MIT research associate Fardin Aryan is also an author of the paper.

Condensate formation

Many cell functions are carried out by membrane-bound organelles, such as lysosomes and mitochondria, but membraneless condensates also perform critical tasks such as gene regulation and stress response. In some cases, these condensates form when needed and then dissolve when they are finished with their task.

"Almost every cellular process that is essential for the functioning of the cell has been associated somehow with condensate formation and activity," Calo says. "However, it's not very well sorted out how these condensates form."

In a 2022 study, Calo and his colleagues identified a protein region that seemed to be involved in forming condensates. In that study, the researchers used computational methods to identify and compare stretches of proteins known as low-complexity regions (LCRs), from many different species. LCRs are sequences of a single amino acid repeated many times, with a few other amino acids sprinkled in.

That work also revealed that a nucleolar protein known as TCOF1 contains many glutamate-rich LCRs that can help scaffold biomolecular assemblies.

In the new study, the researchers found that whenever TCOF1 is expressed in cells, condensates form. These condensates always include proteins usually found within a particular condensate known as the fibrillar center (FC) of the nucleolus. The FC is known to be involved in the production

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of ribosomal RNA, a key component of ribosomes, the cell complex responsible for building all cellular proteins.

However, despite its importance in assembling ribosomes, the fibrillar center appeared only around 300 million years ago; single-celled organisms, invertebrates, and the earliest vertebrates (fish) do not have it.

The new study suggests that TCOF1 was essential for this transition from a "bipartite" to "tripartite" nucleolus. The researchers found without TCOF1, cells form only two nucleolar compartments. Furthermore, when the researchers added TCOF1 to zebrafish embryos, which normally have bipartite nucleoli, they could induce the formation of a third compartment.

"More than just creating that condensate, TCOF1 reorganized the nucleolus to acquire tripartite properties, which indicates that whatever chemistry that condensate was bringing to the nucleolus was enough to change the composition of the organelle," Calo says.

Scaffold evolution

The researchers also found that the essential region of TCOF1 that helps it form scaffolds is the glutamate-rich low-complexity regions. These LCRs appear to interact with other glutamate-rich regions of neighboring TCOF1 molecules, helping the proteins assemble into a scaffold that can then attract other proteins and biomolecules that help form the fibrillar center.

"What's really exciting about this work is that it gives us a molecular handle to control a condensate, introduce it into a species that doesn't have it, and also get rid of it in a species that does have it. That could really help us unlock the structure-to-function relationship and figure out what is the role of the third compartment," Jaberi-Lashkari says.

Based on the findings of this study, the researchers hypothesize that cellular condensates that emerged earlier in evolutionary history may have originally been scaffolded by a single protein, as TCOF1 scaffolds the fibrillar center, but gradually evolved to become more complex.

"Our hypothesis, which is supported by the data in the paper, is that these condensates might originate from one scaffold protein that behaves as a single component, and over time, they become multicomponent," Calo says.

The formation of certain types of biomolecular condensates has also been linked to disorders such as ALS, Huntington's disease, and cancer.

"In all of these situations, what our work poses is this question of why are these assemblies forming, and what is the scaffold in these assemblies? And if we can better understand that, then I think we have a better handle on how we could treat these diseases," Lee says.

Technology Networks, 16 August 2023

https://technologynetworks.com

Researchers design efficient iridium catalyst for hydrogen generation

2023-08-15

However, their widescale deployment for hydrogen production remains limited due to slow rates of oxygen evolution reaction (OER)—an important component of electrolysis—and high loading levels of expensive metal oxide catalysts, such as iridium (Ir) and ruthenium oxides, in electrodes. Therefore, developing cost-effective and high-performance OER catalysts is necessary for the widespread application of PEMWEs.

Recently, a team of researchers from Korea and U.S., led by Professor Chanho Pak from Gwangju Institute of Science and Technology in Korea, has developed a novel mesoporous tantalum oxide (Ta2O5)-supported iridium nanostructure catalyst via a modified formic acid reduction method that achieves efficient PEM water electrolysis.

Their study was published in the Journal of Power Sources. The study was co-authored by Dr. Chaekyung Baik, a post-doctoral researcher at Korea Institute of Science and Technology (KIST).

"The electron-rich Ir nanostructure was uniformly dispersed on the stable mesoporous Ta2O5 support prepared via a soft-template method combined with an ethylenediamine encircling process, which effectively decreased the amount of Ir in a single PEMWE cell to 0.3 mg cm–2," explains Prof. Pak. Importantly, the innovative Ir/Ta2O5 catalyst design not only improved the utilization of Ir but also facilitated higher electrical conductivity and a large electrochemically active surface area.

Additionally, X-ray photoelectron and X-ray absorption spectroscopies revealed strong metal–support interaction between Ir and Ta, while density functional theory calculations indicated a charge transfer from Ta to Ir, which induced the strong binding of adsorbates, such as O and OH,

The energy demands of the world are ever increasing. In our quest for clean and eco-friendly energy solutions, transportable hydrogen energy offers considerable promise. In this regard, proton exchange membrane water electrolyzers (PEMWEs) that convert excess electric energy into transportable hydrogen energy through water electrolysis have garnered remarkable interest.

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and maintained Ir (III) ratio in the oxidative OER process. This, in turn, led to the enhanced activity of Ir/Ta2O5, with a lower overpotential of 0.385 V compared to a 0.48 V for IrO2.

The team also demonstrated high OER activity of the catalyst experimentally, observing an overpotential of 288 ± 3.9 mV at 10 mA cm−2 and a mass activity of 876.1 ± 125.1 A g−1 of Ir at 1.55 V, significantly higher than the corresponding values for Ir Black. In effect, Ir/Ta2O5 exhibited excellent OER activity and stability, as further confirmed through membrane electrode assembly single cell operation of over 120 hours.

The proposed technology offers the dual benefit of reduced Ir loading levels and an enhanced OER efficiency. "The improved OER efficiency complements the cost-effectiveness of the PEMWE process, enhancing its overall performance. This advancement has the potential to revolutionize the commercialization of PEMWEs, accelerating its adoption as a primary method for hydrogen production," speculates an optimistic Prof. Pak.

Phys Org, 15 August 2023

https://phys.org

Sugars affect brain 'plasticity,' helping with learning, memory, recovery

2023-08-16

The researchers will present their results today at the fall meeting of the American Chemical Society (ACS).

The sugars that sweeten fruits, candies or cakes are actually just a few simple varieties of the many types of sugars that exist. When strung together, they can make a wide array of complex sugars. GAGs are formed by then attaching other chemical structures, including sulfate groups.

"If we study the chemistry of GAGs in the brain, we can learn about brain plasticity and hopefully, in the future, use this information to restore or enhance neural connections involved in memory," says Linda Hsieh-Wilson, Ph.D., the project's principal investigator presenting the research at the meeting.

"These sugars regulate numerous proteins, and their structures change during development and with disease," she explains. Hsieh-Wilson is at the California Institute of Technology.

Can you recognize someone you haven't seen in years, but forget what you had for breakfast yesterday? Our brains constantly rearrange their circuitry to remember familiar faces or learn new skills, but the molecular basis of this process isn't well understood. Today, scientists report that sulfate groups on complex sugar molecules called glycosaminoglycans (GAGs) affect "plasticity" in the brains of mice. Determining how GAGs function could help us understand how memory and learning work in humans, and provide ways to repair neural connectivity after injuries.

In the brain, the most common GAG form is chondroitin sulfate, which is found throughout the extracellular matrix surrounding the brain's many cells. Chondroitin sulfate can also form structures known as "perineuronal nets," which wrap around individual neurons and stabilize the synaptic connections between them.

One way a GAG's function can be changed is through sulfation motifs, or patterns of sulfate groups tacked onto the sugar chains. Hsieh-Wilson's team is interested in how those sulfation patterns become altered, and how they might regulate biological processes such as neuroplasticity and social memory. This could also one day allow researchers to modulate these functions as a potential treatment for central nervous system injuries, neurodegenerative diseases or psychiatric disorders.

When the team deleted the Chst11 gene responsible for forming two major sulfation patterns on chondroitin sulfate in mice, defects formed in their perineuronal nets. However, the number of nets actually increased in the absence of the sulfation motifs, changing the types of synaptic connections between neurons. In addition, the mice were unable to recognize mice to whom they had previously been introduced, which suggests that these patterns affect social memory.

Interestingly, these nets might be more dynamic than once thought—they could be playing a role in both childhood and adulthood. When the researchers targeted Chst11 specifically in the brains of adult mice, they found the same effects on perineuronal nets and social memory. "That result suggests that it may be possible to manipulate these nets during adolescence or adulthood to potentially rewire or strengthen certain synaptic connections," says Hsieh-Wilson.

In other recent experiments, the team wanted to understand how GAGs and their sulfation patterns could affect axon regeneration, or the ability of neurons to rebuild themselves after injury. The researchers are now working to identify protein receptors that bind particular sulfation motifs. So far, they have found that specific motifs cause these receptors to cluster together at the cell's surface and inhibit regeneration. This process could be blocked to create tools or treatments to promote axon regeneration. Having more insight about this process could someday help repair damage caused by certain neurodegenerative diseases or strokes, Hsieh-Wilson says.

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Scientists develop a sustainable way to convert kale waste into products for health and personal care

2023-08-16

Millions of tons of food and vegetables are discarded globally every year. In the case of leafy vegetables like kale and lettuce, farmers cut off outer leaves as they are harvested, in order to sell perfectly sized and aesthetically pleasing vegetables with no signs of damage or yellowing. This commercial practice results in a significant amount of perfectly good, edible leaves being thrown away.

In Singapore, some 817,000 tons of food waste were generated in 2021, almost half of which was fruit and vegetables.

Phytochemicals found in plants are known to prevent damage to cells in the body and are widely used in consumer products. They include health-promoting supplements, like antioxidants and lutein, as well as face scrubs and hair shampoo with kale extracts.

Current processes for extracting phytochemicals from kale are energy-intensive, requiring high pressure and temperatures, which contribute additional CO2 emissions to the environment. Moreover, the industrial extraction processes only target a single type of phytochemical each time.

Seeking a more sustainable and efficient method to turn vegetable waste into "treasure," the NTU researchers looked to naturally-derived natural deep eutectic solvents (NADES)—non-toxic liquids made up of plant-based compounds such as amino acid, sugar, and vegetable oil by-product—for answers.

While NADES have long been studied in separation technology for food and pharmaceutical industries, not much is known about their ability to extract different classes of bioactive compounds from vegetable waste.

Focusing on bioactive compounds in kale, the NTU research team explored a range of NADES, mixing them with processed kale waste to observe how molecules reacted to each other.

After repeated testing, the researchers established the best NADES solvent for optimal extraction of bioactive compounds. The NTU team found that when the kale waste and NADES mixture is stirred and set aside, it naturally separated into layers, facilitating the easy extraction of the phytochemicals from kale (polyphenols, carotenoids, and chlorophylls) without the need for heating.

Scientists from Nanyang Technological University, Singapore have developed a new technique to convert kale waste for use in health and personal care products, reducing food waste and emissions.

Since there is no need to heat or pre-treat the kale waste, for example by freeze drying, the costs of the simpler extraction process are kept down. The NTU research team is confident their newly developed method would be scalable and attractive cost wise to the industry.

Lead author of the study, Professor Hu Xiao from the NTU School of Materials Science and Engineering (MSE) and Program Director, Sustainable Chemistry & Materials, Nanyang Environment & Water Research Institute (NEWRI), said, "The use of non-toxic and naturally derived solvents in our method makes it a food-safe technique. At the same time, our method preserves the potency of the extracted active ingredients, making it highly attractive for industry adoption. The extracted nutrients can potentially be used for applications in personal care products, cosmetics, food supplements, and herbal extracts."

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Protein Explains How Part of the Nucleolus Evolved

2023-08-16

Inside all living cells, loosely formed assemblies known as biomolecular condensates perform many critical functions. However, it is not well understood how proteins and other biomolecules come together to form these assemblies within cells.

MIT biologists have now discovered that a single scaffolding protein is responsible for the formation of one of these condensates, which forms within a cell organelle called the nucleolus. Without this protein, known as TCOF1, this condensate cannot form.

The findings could help to explain a major evolutionary shift, which took place around 300 million years ago, in how the nucleolus is organized. Until that point, the nucleolus, whose role is to help build ribosomes, was divided into two compartments. However, in amniotes (which include reptiles, birds, and mammals), the nucleolus developed a condensate that acts as a third compartment. Biologists do not yet fully understand why this shift happened.

"If you look across the tree of life, the basic structure and function of the ribosome has remained quite static; however, the process of making it keeps evolving. Our hypothesis for why this process keeps evolving is that it might make it easier to assemble ribosomes by compartmentalizing the different biochemical reactions," says Eliezer Calo, an associate professor of biology at MIT and the senior author of the study.

Now that the researchers know how this condensate, known as the fibrillar center, forms, they may be able to more easily study its function in cells. The findings also offer insight into how other condensates may have originally evolved in cells, the researchers say.

Former MIT graduate students Nima Jaberi-Lashkari PhD '23 and Byron Lee PhD '23 are the lead authors of the paper, which appears today in Cell Reports. Former MIT research associate Fardin Aryan is also an author of the paper.

Condensate formation

Many cell functions are carried out by membrane-bound organelles, such as lysosomes and mitochondria, but membraneless condensates also perform critical tasks such as gene regulation and stress response. In some cases, these condensates form when needed and then dissolve when they are finished with their task.

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In the new study, the researchers found that whenever TCOF1 is expressed in cells, condensates form. These condensates always include proteins usually found within a particular condensate known as the fibrillar center (FC) of the nucleolus. The FC is known to be involved in the production of ribosomal RNA, a key component of ribosomes, the cell complex responsible for building all cellular proteins.

However, despite its importance in assembling ribosomes, the fibrillar center appeared only around 300 million years ago; single-celled organisms, invertebrates, and the earliest vertebrates (fish) do not have it.

The new study suggests that TCOF1 was essential for this transition from a "bipartite" to "tripartite" nucleolus. The researchers found without TCOF1, cells form only two nucleolar compartments. Furthermore, when the researchers added TCOF1 to zebrafish embryos, which normally have bipartite nucleoli, they could induce the formation of a third compartment.

"More than just creating that condensate, TCOF1 reorganized the nucleolus to acquire tripartite properties, which indicates that whatever chemistry that condensate was bringing to the nucleolus was enough to change the composition of the organelle," Calo says.

Scaffold evolution

The researchers also found that the essential region of TCOF1 that helps it form scaffolds is the glutamate-rich low-complexity regions. These LCRs appear to interact with other glutamate-rich regions of neighboring TCOF1 molecules, helping the proteins assemble into a scaffold that can

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then attract other proteins and biomolecules that help form the fibrillar center.

"What's really exciting about this work is that it gives us a molecular handle to control a condensate, introduce it into a species that doesn't have it, and also get rid of it in a species that does have it. That could really help us unlock the structure-to-function relationship and figure out what is the role of the third compartment," Jaberi-Lashkari says.

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Technology Networks, 16 August 2023

https://technologynetworks.com

Vacuum-field catalysis could change chemistry – but reproducibility concerns linger

2023-08-14

Behind these astonishing results is a seemingly simple setup: a small box, only a few micrometres wide, with mirrored walls. In this optical cavity molecules behave strangely: reactions can be sped up or slowed down, product distributions can be altered, polarity or electrical conductivity changed. The cavity allows scientists to tap into the power of the vacuum field, the transient quantum fluctuations that are baked into the makeup of the universe.

But there's still no consensus on the mechanism behind the phenomenon and no way to predict which reactions are susceptible to the vacuum

Earlier this year, a team of chemists created extraordinary electrical conductance in polystyrene, a usually non-conducting polymer, without altering its chemical makeup. Another group lowered the melting temperature of DNA so that it could fold into 'origami' structures at lower temperatures – again, without changing the molecules' structure. And yet another research team managed to decrease the polarity of long-chained alcohol solvents without chemical modification.

field's influence. This, combined with failures to reproduce a number of results, has made some researchers sceptical that the cavity's effect on chemical reactivity is real at all. Researchers are now trying to bridge the gap between theory and experiment to understand what is really going on in a cavity.

Space, the final frontier?

Empty, dark space is not truly empty, nor dark. It's teeming with 'virtual' particles that emerge from random quantum fluctuations. Photons and other particles pop into existence, seemingly out of nothing, and disappear again. This vacuum field sounds a little like a return to the long-discarded aether theory, but it becomes apparent in other quantum phenomena such as the Casimir effect and zero-point energy.

The way to access the vacuum field's power for chemistry is by capturing it inside a cavity. As physical chemist Marissa Weichman from Princeton University, US puts it: 'The cavity field confines light.' Only photons whose wavelengths fit an integral multiple of the gap between the mirrors can exist inside the cavity.

The trapped field of light, or cavity mode, can be tuned to resonate in energy with one of the vibrations of molecules placed into the cavity. In the same way atomic orbitals interact and mix to form molecular orbitals with entirely new properties, the cavity's light field couples with the molecules' vibrations to form new hybrid light–matter states. These vibrational polaritons inherit the wavelike nature of light while maintaining the molecule's structure. And they often have dramatically different properties to their parent molecules – so dramatic that they could be likened to a new state of matter.

Oriol Vendrell, a theoretical chemist at Heidelberg University, Germany, explains that a molecule can be thought of as a complicated mechanical system made of vibrating bonds and angles – some with softer and some with stiffer springs. 'When you put the molecule in a cavity, it's like adding new springs to the molecule.'

The basic idea of polaritonic chemistry revives a proposal from the mid-20th century. Bond- or mode-selective chemistry was meant to excite certain vibrations within a molecule using laser light of a specific wavelength until it breaks at a specific point and initiates a reaction. 'These are really beautiful ideas, but they never really took off,' Weichman says.

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As a 1982 paper entitled 'Is bond selective chemistry possible?' puts it: 'Although there have been many attempts using conventional CO2 lasers to carry out bond-selective reactions by infrared multiphoton excitation, none has been successful.' The problem is that energy pushed into a vibrational mode doesn't stay neatly confined to it. It quickly redistributed across the entire molecule. 'You end up just kind of heating up the system instead of doing something specific,' Weichman explains.

In 2012, a team around Thomas Ebbesen at the University of Strasbourg, France, showed for the first time that the vacuum field can change the rate of a chemical reaction: the photoisomerisation of a spiropyran derivative slows down inside a cavity. Many other experiments since have shown changes in rate and product distribution, including in named reactions, biochemical transformations and enzymatic reactions.

Cavity catalysis could steer reactions down different paths without changing temperature or pressure, without adding any reagents or altering the reactants' chemical structure. 'This is totally different from what we usually think about catalysis,' says Wei Xiong from the University of California San Diego, US.

So far, experiments could only show altered reaction rates or product distributions. Angel Rubio from Germany's Max Planck Institute for the Structure and Dynamics of Matter, says that the first demonstration of vacuum-field catalysis producing an entirely different product would be a real breakthrough. Cavity-controlled chiral chemistry in particular, he adds, would have 'tremendous implications'.

Most experiments have demonstrated reactions slowing down, which is arguably not as useful as speeding them up. But it might help to shut off unwanted side reactions or increase selectivity towards one of several possible products. 'It has the potential to influence energy generation and storage,' says Blake Simpkins from the US Naval Research Laboratory. Slowing down the degradation of organic photovoltaic materials, he points out, would be very useful.

Several theoretical studies have given tantalising glimpses of what might be possible. Rubio's team, for example, showed that a click reaction run in a cavity doesn't need a catalyst. And if the reactants could be aligned in a particular way, the reaction could be selective for only one of the two possible click products. 'I think the dream is that you'd be able to integrate these sorts of cavity devices into microfluidic flow reactors and actually use them in real industrial thermal reactions,' says Weichman.

Theory remains elusive

Having a new knob with which to tune chemical properties could revolutionise synthesis. But how to operate this knob remains unclear. There's no single accepted theory that can fully explain experimental observations.

A team led by Simpkins and Felipe Herrera from the University of Santiago, Chile, recently showed that the vacuum field can slow down the alcoholysis of phenyl isocyanate with cyclohexanol by 80%. 'It's one of the most compelling data points that you can alter chemical reaction rates in cavities,' says Weichman. The team suggests that the cavity is affecting the population of vibrational levels. 'It's almost as if things are cooling down a little bit,' say Simpkins. 'It's almost like we're siphoning off a little bit of vibrational excitation, and that redistributed system now has less excitation to drive it toward the reaction.'

As with some other proposals, 'what is missing, I think, is a direct connection between these hypotheses and an actual rate', says Vendrell. What researchers agree on is that vacuum-field catalysis is not about reaction energetics. 'I think what most people in the field would say at this point is that … the way that vibrational energy flows in the system is somehow altered in cavities,' Weichman says.

Most reactions or compounds that are susceptible to the vacuum field have been discovered by coincidence. None of the theories currently have predictive power. There do seem to be some general trends: Rubio says that reactions that interact strongly with the cavity usually have a large dipole moment.

Herrera points out that it's still early days. 'You have to compare the state of the field today with [transition state] theory in the 1950s,' says Herrera. 'People could not calculate the reaction rate constant. They can do it trivially now.'

And there's a fundamental paradox that needs to be addressed: logically, the cavity effect should be too small for each molecule to make a difference. In calculations, when a single molecule is placed inside a cavity and the effect of the light–matter coupling is put into that one molecule, 'then things happen', says Vendrell. But a real cavity contains an enormous number of molecules. The cavity effect becomes so thinly stretched out over all of them that it is essentially non-existent for each individual molecule. 'We don't understand how these very tiny couplings per

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molecule may end up having an effect on the total reaction rate,' Vendrell says.

Simpkins suggests that disorder might be key to solving the mystery. Even chemically identical molecules have different local environments. 'The disorder, these little sub-populations, they're able to harness the cavity-induced effects more effectively than if all the molecules were identical,' he explains. 'The impact remains localised on a fewer number of molecules and therefore it's larger.'

Replication complication

The lack of theoretical consensus, combined with lingering concerns about reproducibility, makes some researchers sceptical that the effect is real. Xiong says that at this point he is 'not confident' to claim that dark cavities really alter chemical reactivity. 'I would be confident if one day I can reproduce someone's result.'

In 2021, he and a colleague attempted to reproduce an ester hydrolysis that was reported to be an order of magnitude faster inside a cavity. Even after getting in touch with the team that originally reported the experiment and tweaking their setup accordingly, they failed. 'There must be some really subtle condition that was overlooked between our attempt and their result,' Xiong says. Another team, led by Noel Giebink from Pennsylvania State University, US, was unable to reproduce an experiment that reported a 100-fold enhanced rate of a cyanate ion hydrolysis.

'The big issue is that there really aren't established best practices for how to build the cavities, how to interrogate them, how to how to ensure that there are no artefacts contaminating your data, ' says Simpkins. The tiny, nanolitre volume of the cavity means that even small inconsistencies can have large consequences. 'I think what's really hard is the analysis,' adds Weichman. 'Unless you're very, very careful, I think you could also trick yourself into thinking you're seeing reactivity that you're not.'

When Weichman and her team examined a simple, highly exothermic reaction between cyanide radicals and chloroform, they found a conspicuous absence of cavity effects. This doesn't mean the cavity never has an effect on any reaction, but they argue that reporting null results is crucial for understanding the mechanism.

Part of the problem is that theory and experiment haven't quite met yet, Weichman suggests. Many theoretical approaches simplify too much and many experiments use systems too complicated to be treated

theoretically. 'But I think there's mutual goodwill to try to bridge that gap,' she says. Her team is part of that effort, working on simple, clean systems such as gas-phase polaritons that are easier to simulate computationally.

Simpkins thinks that some researchers might be hesitant to get into the field because of the reproducibility issues. But for others, it might be a call to action. 'It's actually really a rare time in a field for there to be results that are so exciting and really not fully understood yet,' says Weichman. 'That's, I think, why a lot of people are flocking to this field, because there's a lot of work to do, and a lot of questions that are ripe for study.'

Chemistry World, 14 August 2023

https://chemistryworld.com

Decoding How Molecules "Talk" to Each Other To Develop New Nanotechnologies

2023-08-16

Two molecular languages at the origin of life have been successfully recreated and mathematically validated, thanks to pioneering work by Canadian scientists at Université de Montréal.

Published this week in the Journal of American Chemical Society, the breakthrough opens new doors for the development of nanotechnologies with applications ranging from biosensing, drug delivery and molecular imaging.

Living organisms are made up of billions of nanomachines and nanostructures that communicate to create higher-order entities able to do many essential things, such as moving, thinking, surviving and reproducing.

"The key to life's emergence relies on the development of molecular languages – also called signalling mechanisms – which ensure that all molecules in living organisms are working together to achieve specific tasks," said the study's principal investigator, UdeM bioengineering professor Alexis Vallée-Bélisle.

In yeasts, for example, upon detecting and binding a mating pheromone, billions of molecules will communicate and coordinate their activities to initiate union, said Vallée-Bélisle, holder of a Canada Research Chair in Bioengineering and Bionanotechnology.

Scientists recreate and compare molecular languages at the origin of life.

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"As we enter the era of nanotechnology, many scientists believe that the key to designing and programming more complex and useful artificial nanosystems relies on our ability to understand and better employ molecular languages developed by living organisms," he said.

Simple mathematical equations to detect antibodies

The researchers found that simple mathematical equations could well describe both languages, which unravelled the parameters and design rules to program the communication between molecules within a nanosystem.

For example, while multivalent language enabled control of both the sensitivity and cooperativity of the activation or deactivation of the molecules, the corresponding allosteric translation only enabled control of the sensitivity of the response.

With this new understanding at hand, the researchers used the language of multivalency to design and engineer a programmable antibody sensor that allows the detection of antibodies over different ranges of concentration.

"As shown with the recent pandemic, our ability to precisely monitor the concentration of antibodies in the general population is a powerful tool to determine the people's individual and collective immunity," said Vallée-Bélisle.

In addition to expanding the synthetic toolbox to create the next generation of nanotechnology, the scientist's discovery also shines a light on why some natural nanosystems may have selected one language over another to communicate chemical information.

Technology Networks, 16 August 2023

https://technologynetworks.com

Novel enzyme could boost sustainable production of aviation fuel

2023-08-16

"After three and a half years of research, we identified an enzyme that can replace the traditional catalysts used in thermochemical routes for the production of aviation biokerosene," said Letícia Zanphorlin, principal investigator for the project and head of the Brazilian Biorenewables

In recent decades, scientists have sought solutions to improve the sustainable production of biofuels from renewable sources. The latest advance in this field was announced at the end of May by Brazilian researchers and could boost the production of sustainable biofuels for aviation and maritime shipping.

National Laboratory (LNBR) at the Brazilian National Center for Research in Energy and Materials (CNPEM).

The enzyme discovered by the CNPEM group is OleTPRN, a polyunsaturated alkene-producing decarboxylase belonging to the cytochrome P450 superfamily.

This metalloenzyme derived from the bacterium Rothia nasimurium promises to be the key to development of novel biotechnological routes in the production of renewable hydrocarbons for aviation from different feedstocks, such as oleaginous biomass from soy, macaw palm (Acrocomia aculeata) or corn, among others, and lignocellulosic biomass from sugarcane bagasse or straw and in the paper industry.

"Compared with conventional or chemical catalysts, the novel enzyme decarboxylates fatty acids [breaking the carbon-carbon bond and removing the carboxyl group] with high yields and is selective for different sizes and types of carbon chain. It promotes deoxygenation, which is one of the trickiest processes to master in producing SAF [sustainable aviation fuel]," Zanphorlin explained.

Oxygen can damage aircraft parts and engines, she added, which helps understand why biofuels already mass-produced in Brazil, such as ethanol and biodiesel, are not used in aviation and explains the demand for novel biocatalysts. In general, conventional catalysts used in aviation fuel production involve metals such as cobalt, platinum, nickel or palladium.

"To produce the deoxygenation reaction, these metallic catalysts must be applied under severe conditions, particularly high temperature and pressure, and can be environmentally harmful, producing technological waste and leading to financial losses," she said.

According to the researchers, enzymes act as biological catalysts, accelerating chemical reactions in the living organisms present in nature. In the study in question, the enzyme converted fatty acids in a single step into alkenes (olefins), a type of hydrocarbon and an important chemical intermediary.

Fatty acids are essential components of lipids, a class of organic compound that includes all kinds of fat and oil. Lipids are found in plants, animals and microorganisms.

The discovery and elucidation of the molecular mechanisms involved in the enzyme's action were the fruit of a multidisciplinary approach. The scientists searched public databases for enzymes with specific

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properties and functions, using bioinformatics tools and genomic data for microorganisms.

Candidate enzymes were analyzed at the atomic level using synchrotron light, a type of high-flux high-brightness electromagnetic radiation encompassing a large proportion of the spectrum, from infrared through ultraviolet to X-rays. Synchrotron light is produced when a beam of charged particles accelerated almost to the speed of light is deflected by a magnetic field. When applied to protein crystals, it causes electron diffraction and permits elucidation of their three-dimensional structure.

"We evaluated the position of every amino acid in the enzyme's atomic structure, and mapped its intermolecular interactions with fatty acids," Zanphorlin said, noting that this showed them all the possible applications of the discovery.

In parallel with this laboratory investigation, other teams at CNPEM worked on patent filings and on technical, economic and environmental analysis of the biological routes, the results of which will be published soon.

"A patent on the enzyme was applied for in 2021. One of CNPEM's key advantages is that we can develop a technological solution, implement a pilot project, ramp it up to an industrial scale, and perform the technical, economic and environmental assessments needed to detect any potential improvements in the innovation as it's being developed," Zanphorlin said.

There are exciting possibilities for the production of aviation biofuels using the enzyme. "Brazil currently produces some 150 million metric tons of lignocellulosic waste from sugarcane in dry mass terms. This could be increased without adverse environmental impacts," she said.

To implement the technology, biofuel production facilities would need to be adapted, but the distribution infrastructure used by fossil fuels could be shared by renewables acting as "drop-in" fuels—substitutes for petroleum-derived hydrocarbons that would not require adaptation of engines, fuel systems or distribution networks.

The researchers are optimistic about applications in several industrial sectors. "The versatility of this enzyme makes it adaptable for use in different sectors. Alkenes are produced by enzyme reaction and are the basis for some two-thirds of the products made by the chemical industry

today, especially polymers and plastics. They're also essential to the food, cosmetics, pharmaceutical and transportation sectors," Zanphorlin said.

Phys Org, 16 August 2023

https://phys.org

Body of article

website, date

https://website

Canopy Soil Gives Up Its Chemical Secrets

2023-08-07

This organic matter, composed of decaying leaves and branches, airborne particulates and moisture, is called canopy soil or arboreal soil. Its study is relatively new, says Utah State University ecologist Jessica Murray. She's among researchers unraveling mysteries of the dense, mossy humus that provides rich habitat for insects, birds, fungi, worms and plants, as well as a generous reservoir for carbon storage.

Murray and colleagues from Texas A&M University, the University of Toronto Scarborough and Imperial College London published new information about the enigmatic resource in the July 27, 2023, online edition of Geoderma. The team's research was supported by USU, the U.S. Department of Agriculture National Institute of Food and Agriculture, and the Natural Sciences and Engineering Research Council of Canada.

"In this study, we sought to understand where canopy soils are found, where they are most abundant, and if their properties — and thus, soil development processes — differ as a function of climate or other small-scale factors," says Murray, a doctoral student in USU's Department of Biology and Ecology Center. "This is the first study to look at the distribution patterns of canopy soils across forests and one of very few studies that have sought to examine canopy soil properties."

Murray collected much of the data for the study some 80 feet above the ground at six primary forest sites across Costa Rica's Cordillera de Tilarán and Cordillera Volcánica Central, encompassing both Caribbean and

When we think of soil, most of us think of dirt on the ground. But a surprising amount of the planet's soil thrives in the treetops of old-growth forests, high above terra firma.

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Pacific slope mountain ranges. Her field equipment includes climbing gear, ropes, a safety harness and helmet.

"I climbed about 30 trees to collect data," she says. "And getting to one of those sites was the hardest hike of my life."

Murray is referring to a site designated "Puesto 1070," located along a contiguous tract of primary forest, which required a steep trek from about 1,970 feet in elevation to 3,608 — in thick mud.

"It took eight hours to complete the hike just to the study site," she says. "We were carrying all of our climbing gear, food for eight days, sleeping bags and sampling equipment. Thank heavens we finished that site early, because with our hard-earned appetites, we also nearly finished our food supply ahead of schedule."

Murray says tree canopies in the tropical montane forest systems are especially dense, with thick moss, soil and an abundance of epiphytes — plants that grow on other plants, often referred to as "air plants" — that are not parasitic and have little or no attachment to other obvious nutrient sources.

"It's like another world in the air: canopies teeming with plant, insect and animal life," she says. "I initially conducted surveys to assess canopy soil abundance from the ground with binoculars. But it was really necessary to climb up into the trees to get an accurate picture of what was going on."

Murray asserts forest canopies store much more carbon that generally assumed.

"It's kind of a back-of-the-envelope calculation on my part, but one I'm ready to defend and eager to investigate further," she says. "I think canopy soil stores 0.4 to 4 percent of total soil carbon in the forests where it is found, which is not being counted in ecosystem carbon budgets."

Mentored by USU Biology Professor John Stark and former USU faculty member Bonnie Waring, the latter now with Imperial College London and an author on the paper, Murray says the team's results indicate both climate and tree size play an important role in canopy soil abundance, carbon stocks and chemistry.

"Climate, particularly fog and temperature changes, appear to drive canopy soil abundance across forests, while tree size determines canopy soil abundance within a forest," she says. "Our findings reveal canopy soil's

vulnerability to climate change, and its decline, could cause a significant decrease in carbon storage resources."

Further, she says, those resources could take longer than expected to restore.

"When we talk about reforestation, we don't stop to consider the time needed for forest regrowth plus canopy mat regrowth," Murray says. "It may take decades longer for recovered forests destroyed by wildfire or development to regenerate robust canopy soil mats."

A 2022 recipient of the Ecological Society of America's Katherine S. McCarter Graduate Student Policy Award, Murray is among a number of Aggies presenting at the ESA's 2023 Annual Meeting Aug. 6-11 in Portland, Oregon. She presents the talk "The Persistence of Metabolically Protected vs. Mineral-Associated Soil Organic Carbon in the Presence of Organic Inputs" at 4:45 p.m. Thursday, Aug. 10, in Room B115 of the Oregon Convention Center.

"For that meeting, I'll be presenting on research different from, but related to, the study published in Geoderma, including work about the basic mechanisms of soil carbon sequestration that uses canopy soils from my sites in Costa Rica," she says.

technology networks, 7 August 2023

https://technologynetworks.com

DNA evidence on dogs can help track down offenders

2023-08-15

The new Australian study, by researchers in Victorian and South Australia, expands the opportunities for DNA to assist investigations of criminal activities by expanding knowledge about the presence and transfer of human DNA on pets such as cats and dogs.

Flinders University researcher Heidi Monkman in collaboration with Roland van Ooorschot from the Victoria Police Forensic Services Department and Bianca Szkuta from Deakin University collected human DNA from 20 pet dogs of various breeds from multiple households.

This preliminary study conducted at Deakin showed that human DNA can be retrieved from all areas of the dogs that were sampled, although some areas consistently provided more DNA than others, such as the head and back.

Canines are often used in tracking down criminals but forensic science researchers say they could also help provide crucial evidence in police investigations—by being a witness or resident at the crime scene.

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"This study demonstrated that human DNA can be transferred to dogs upon contact by a person's hand and that it can be transferred from dogs to a contacting surface, such as during patting and walking," says first author Heidi Monkman, from Flinders University's College of Science and Engineering.

"This information may assist those investigating criminal acts in which dogs are involved to consider situations in which it may be useful to sample for human DNA from a dog."

"It also showed that investigators may need to consider dogs as a vector for indirect transfer of human DNA within particular scenarios."

In addition to the dog owner(s), and people living in the same household, the study also found DNA from unknown sources, which required further investigation.

Animals in domestic environments could be a victim, offender, or innocent party associated with a crime however we have very limited knowledge of human DNA transfer, persistence, prevalence and recovery (DNA TPPR) associated with domestic animals, the researchers say.

Further work on the transfer of human DNA to and from companion animals is being conducted at Flinders University to build more understanding and provide data that will assist forensic investigators and legal arbiters.

The article, "Presence of Human DNA on Household Dogs and Its Bi-Directional Transfer," has been published in Genes.

Phys Org, 15 August 2023

https://phys.org

"Demon particle" accidentally discovered, solving 67-year mystery

2023-08-13

Electrons are strange particles. When they travel through solids, their interactions with each other can form collective excitations that function like entirely new particles with different characteristics. These are known as quasiparticles.

A particular form of quasiparticle, called a plasmon, occurs due to plasma oscillations, and these have a new charge and mass separate from the

While studying a material that could help unlock the secrets of superconductors, scientists have accidentally discovered a "demon" particle that was first theorized almost 70 years ago, but had never been experimentally confirmed.

electrons that make them up. However, plasmons were thought to be impossible at room temperature because energy levels are inadequate for the masses required to form them.

But in 1956, theoretical physicist David Pines predicted an exception to the rule – electrons in multiple energy bands could group together in an out-of-phase pattern, forming a plasmon that has no mass or charge. Without any mass they can form at any energy level, and therefore any temperature. This theoretical particle became known as "Pines' demon," and has eluded detection ever since – at least, until now.

Scientists at the University of Illinois Urbana-Champaign and Kyoto University have now made the first direct detections of the demon in a metal called strontium ruthenate. The key, it turns out, was to not even be looking specifically for it.

"The vast majority of experiments are done with light and measure optical properties, but being electrically neutral means that demons don't interact with light," said Peter Abbamonte, lead author of the study. "A completely different kind of experiment was needed."

Strontium ruthenate is an intriguing metal that exhibits some properties of high-temperature superconductors, although it itself isn't one. The team hoped that they might find some clues to that valuable phenomenon by studying the material's electronic properties with a method called momentum-resolved electron energy-loss spectroscopy. This involves blasting the metal with electrons to observe its properties, including any quasiparticles that might form. In doing so, the researchers discovered a puzzling plasmon with no mass.

"At first, we had no idea what it was," said Ali Husain, co-author of the study. "Demons are not in the mainstream. The possibility came up early on, and we basically laughed it off. But, as we started ruling things out, we started to suspect that we had really found the demon."

To identify the culprit, the scientists followed up by exploring the electronic structure of strontium ruthenate. And sure enough, the demon that had stayed hidden for 67 years finally came into focus.

"Pines' prediction of demons necessitates rather specific conditions, and it was not clear to anyone whether strontium ruthenate should have a demon at all," said Edwin Huang, co-author of the study. "We had to perform a microscopic calculation to clarify what was going on. When we

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did this, we found a particle consisting of two electron bands oscillating out-of-phase with nearly equal magnitude, just like Pines described."

The team believes that demons may play a key role in the electronic behaviors of a wide range of metals.

New Atlas, 13 August 2023

https://newatlas.com

Researchers identify biomarkers that may detect risk of advance prostate cancer in Black men

2023-08-15

The research will be highlighted in the press program for the American Chemical Society (ACS) Fall 2023, a hybrid meeting that will be held virtually and in person in San Francisco from Aug. 13 to 17.

Black men are more than twice as likely than other men to die from prostate cancer. In a continued search to develop inclusive diagnostic and predictive tests and personalized treatments, City of Hope researchers conducted a small clinical trial that identified four metabolism-related biomarkers linked to an increased risk of metastatic prostate cancer, or prostate cancer that has spread to other parts of the body, in men of West African heritage. City of Hope leads the nation in having the first research department focused on the intersection between cancer and diabetes.

"We have identified genetic and molecular changes that can be developed into a tool to predict which Black men are at the highest risk of developing metastatic prostate cancer," said Sarah Shuck, Ph.D., principal investigator of the trial who will present the data at ACS. Shuck is an assistant professor in the Arthur Riggs Diabetes & Metabolism Institute and Department of Diabetes & Cancer Metabolism at City of Hope.

"This test would give doctors the ability to more accurately predict patients' prognoses and equip scientists with more data as they work to design therapies that prevent prostate cancer from developing in the first place," Shuck added.

The problem appears to be production of a highly reactive compound known as methylglyoxal (MG), a byproduct of metabolism that is elevated in people with diabetes. MG binds to DNA, RNA and protein, creating a complex that may promote cancer emergence due to its instability and disrupted function.

Scientists at City of Hope, one of the largest cancer research and treatment organizations in the United States and a leading research center for diabetes and other life-threatening illnesses, have identified a cell metabolism process found in men with diabetes and metastatic prostate cancer that could one day lead to improved testing and treatments for Black men with these diseases.

Prostate cancer is the second most common cancer in men. Black men are 70% more likely than white men to be diagnosed with prostate cancer and two to four times more likely than other racial and ethnic groups to die from the disease, according to 2023 data from the American Cancer Society.

Diabetes is a chronic metabolic disease characterized by elevated levels of blood glucose or sugar, which over time leads to serious damage to the heart, blood vessels, eyes, kidneys and nerves. Black adults are 60% more likely than white adults to be diagnosed with diabetes and twice as likely to die from diabetes, according to the most recent data available from the U.S. Department of Health and Human Services Office of Minority Health.

Shuck's lab focuses on the study of how metabolic dysregulation causes diabetes and cancer. She and her colleagues investigate the biochemistry involved when excess sugar damages important molecules.

To see if the identified dysregulated complexes were linked to race and genetics, the team conducted a small clinical study where they gathered blood samples from 371 men with and without prostate cancer from across the nation. To determine race, they assessed samples for genetic evidence of West African heritage using methods developed by collaborators Rick Kittles, Ph.D., M.S., and Leanne Woods-Burnham, Ph.D., who were at City of Hope when the research was conducted.

Next the researchers, including John Termini, Ph.D, professor in the Department of Cance Biology and Molecular Medicine at City of Hope, looked at four biomarkers associated with MG and the complexes it forms with DNA, RNA and protein. The biomarkers also included variation in a gene, GLO1, that encodes a protein which detoxifies these complexes.

Surprisingly, the men of West African descent had fewer of these malignancy-promoting complexes in their blood. Contrary to expectations, a lower level of these complexes was linked to greater risk of metastatic disease.

The researchers hypothesize that, in men of West African descent, tumor cells sequester these complexes and spur metastatic processes from within. These findings did not apply to men of European descent. (In technical terms, they hypothesize that MG-AGEs, sRAGE, GLO1 and AGER SNPs may be used as biomarkers for prostate cancer in Black men and that the gene variation GLO1 may play a role in the accumulation of mutations that lead to prostate cancer cell growth.)

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City of Hope researchers intend to gain a better understanding of prostate cancer disparities in the hopes of developing a diagnostic test.

Phys Org, 15 August 2023

https://phys.org

Protein May Predict Mild Cognitive Impairment Years Before Symptoms

2023-08-02

The findings, which may potentially offer new targets for treating or preventing Alzheimer's and other dementias, showed that a relatively low level of the protein known as NPTX2 is not only a likely standalone risk factor for MCI and Alzheimer's dementia, but also improves prediction of cognitive impairment after accounting for levels of traditional biomarkers and well-established genetic risk factors for Alzheimer's.

The study, conducted by Johns Hopkins Medicine scientists on more than 250 primarily middle-aged adults, the vast majority of whom were white, concluded that the findings were consistent with and expand prior studies by establishing that measurements of NPTX2 in cerebrospinal fluid were predictive of MCI onset within or even beyond seven years before symptoms occurred.

A report on the study was published July 25 in the Annals of Neurology.

According to the Alzheimer's Association, MCI, marked by mild memory loss or challenges with other cognitive processes, such as language or executive function, affects up to 18% of people age 60 and older. People with MCI maintain most normal daily activities, but are known to be at higher risk of Alzheimer's disease or other forms of dementia. It is estimated that 6.7 million Americans age 65 and older are living with Alzheimer's dementia, with that number expected to double by 2050. The growing prevalence of dementias has given urgency to the search for better and earlier predictors, and targets for treatments that prevent or slow progression. At present, there is only one FDA-approved drug on the market known to even modestly slow symptoms of Alzheimer's in its early stages, and there are no cures or preventives.

"Our research shows declining levels of NPTX2 occur many years prior to the emergence of MCI or Alzheimer's symptoms, which raises the possibility of developing new therapeutics that target NPTX2," says Anja Soldan, Ph.D., associate professor of neurology at the Johns Hopkins

Results of a long-term, federally funded study of cognitively healthy adults — most with a family history of Alzheimer's disease — have added to evidence that low spinal fluid levels of a protein linked to learning and memory in mice may serve as an early predictor of mild cognitive impairment (MCI) years before symptoms appear.

University School of Medicine and corresponding author of the study. "Additionally, it appears that this protein is not a specific marker to just Alzheimer's, and these findings may be relevant to a variety of other neurodegenerative diseases. So if we can find ways of increasing levels of NPTX2, then it could be applied to identify early and possibly treat other types of memory loss or cognitive impairment as well."

For the study, which involved adults recruited by the National Institutes of Health and Johns Hopkins Medicine, researchers conducted baseline medical and cognitive exams on 269 cognitively normal individuals, and collected spinal fluid samples biannually. The average age of participants at baseline was 57.7 years. Nearly all were white, 59% were female, most were college educated and 75% had a close relative with Alzheimer's. NPTX2 levels were measured, as well as the main abnormal proteins found in patients with Alzheimer's, namely beta-amyloid, total tau and phosphor-tau. Subjects underwent clinical and cognitive assessments for an average of 16 years.

Results showed:

- Over time, 77 subjects progressed to MCI or dementia within or after seven years of baseline measurements. Of those participants, 88% were diagnosed with Alzheimer's as a primary or secondary cause of dementia.
- Those who progressed to MCI had on average of about 15% lower levels of NPTX2 at baseline compared with those who remained unimpaired, a difference that remained significant after accounting for baseline Alzheimer's biomarker levels and genetic factors.
- Higher levels of baseline tau and phosphor-tau levels were associated with greater decreases in NPTX2 over time, suggesting that NPTX2 may decline in response to tau pathology.

"Currently, we only have drugs that modify mild symptoms of Alzheimer's disease and nothing right now to give people who are cognitively normal but at higher risk," Soldan emphasized. But when and if that changes, Soldan adds, having an accurate way to predict such risk will play a large role in targeting treatments.

Soldan also cautioned that "we're a long way out" from a simple way to routinely test spinal fluid samples for NPTX2 levels, and further research is

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needed to determine what factors alter the protein's levels. Potential root causes could be genetics, lifestyle factors or a combination of them.

Technology Networks, 2 August 2023

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Bulletin Board

Technical Notes

AUG. 18, 2023

(NOTE: OPEN YOUR WEB BROWSER AND CLICK ON HEADING TO LINK TO SECTION)

CHEMICAL EFFECTS

Spatial and seasonal controls on dissolved organic matter composition in shallow aquifers under the rapidly developing City of Patna, India

Determining the toxicity of organic compounds to the nematode Caenorhabditis elegans based on aqueous concentrations

Role of Chemical Reduction and Formulation of Graphene Oxide on Its Cytotoxicity towards Human Epithelial Bronchial Cells

ENVIRONMENTAL RESEARCH

Conversion of solid wastes and natural biomass for deciphering the valorization of biochar in pollution abatement: A review on the thermo-chemical processes

Anthropogenic pollutants induce enhancement of aerosol acidity at a mountainous background atmosphere in southern China

Functional MOF-Based Materials for Environmental and Biomedical Applications: A Critical Review

PHARMACEUTICAL/TOXICOLOGY

Presence of Perfluoroalkyl Substances in Landfill Adjacent Surface Waters in North Carolina

Prevalence and predictors of skin cancer screening among a sample of US volunteer firefighters

OCCUPATIONAL

Expanding Behavioral and Occupational Health Research in Military Police

Does Decreased Diffusing Capacity of the Lungs for Carbon Monoxide Constitute a Risk of Decompression Sickness in Occupational Divers?

Effects of postnatal exposure to phthalate, bisphenol a, triclosan, parabens, and per- and poly-fluoroalkyl substances on maternal postpartum depression and infant neurodevelopment: a korean mother-infant pair cohort study